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Perspectives

Avoiding maladaptation to climate change: towards guiding principles

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Abstract

The recent publication of the Physical Science Basis volume of IPCC's Fifth Assessment Report reaffirms an already known conclusion: even drastic reductions of global greenhouse gas emissions will be insufficient to avoid some of the impacts of climate change, and is becoming increasingly clear that the temperature increase by the end of the century is likely to exceed the official target of +2°C. Urgent efforts are thus more than ever needed to support socio-ecological systems threatened by climate change, but how to make adaptation happen on the ground remains vague. Consequently, there is a real risk that climate funding may support initiatives that are actually harmful for the socio-ecological systems, i.e. that foster adaptation in the short-term but insidiously affect systems' long-term vulnerability and/or adaptive capacity to climate change. This generally defines "maladaptation", and this paper affirms that avoiding maladaptation is a first key concrete step towards adaptation in a broader sense.

Focusing on coastal areas at a local scale and with the aim of providing insights to help avoiding maladaptation to climate change on the ground, this paper develops eleven practice-oriented guidelines that address the environmental, sociocultural and economic dimensions of adaptation initiatives (policies, plans, projects). Based upon this, it affirms that the more guidelines an initiative addresses, the lower will be the risk of maladaptation. Together, these guidelines and this assumption constitute the "Assessment framework" for approaching maladaptation to climate change at a local level.

KEYWORDS: Adaptation, Maladaptation, Climate Change

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1. INTRODUCTION

Many initiatives labelled as "climate change adaptation" are now emerging in both developing and developed countries. They cover a wide array of territorial levels, ranging from projects developed at the micro-local level to national policies and regional initiatives (Pacific, Europe, South-West Indian Ocean, *etc.*). At the international level, also, negotiators are debating the amounts and architecture of global funding for adaptation. This indicates a growing awareness over the last two decades of how important the adaptation component has become. Albeit encouraging, it is not enough since the methods and specific components required to implement adaptation remain relatively obscure (Hinkel, 2011; Dupuis & Biesbroek, 2013; Ford *et al.*, 2013). What constitutes a "good" project or a "good" adaptation policy?

To adapt implies maintaining or strengthening resilience against current disruptions, on the one hand, and being capable of planning for the long term, on the other (Cardona *et al.*, 2012; Magnan, 2013). The latter point, in particular, involves wagering on the future benefits of initiatives that are committed to today. However, it is extremely difficult to know in advance whether an initiative undertaken now will meet the challenges of tomorrow. Added to this, of course, is the uncertainty related to the intensity and frequency of future impacts of climate change at the local and regional levels (Meehl *et al.*, 2007; Stocker *et al.*, 2013). Beyond the aims set down "on paper", the recurring question therefore is how to adapt to changes that cannot yet be precisely defined. When developing initiatives, there is thus a strong temptation to wait for science (of climate impacts and vulnerability) to provide more precise information. While this wait-and-see stance is in some ways understandable, it is untenable. It is indeed far from sure that uncertainty will diminish with time, for three main reasons: 1—advances in climate science may lead to increased uncertainty, especially when new processes are identified[1]; 2—the magnitude of future climate change will greatly depend on future greenhouse gas emissions, and consequently on decisions not yet taken; and 3—future impacts will affect future societies whose precise characteristics we cannot identify decades in advance.

Uncertainty thus cannot be an excuse to do nothing at the present, and this paper argues that a promising way to encounter uncertainty and start engaging robust adaptation on the ground is to focus the attention on avoiding maladaptation to climate change. This is a first concrete step towards adaptation in the broader sense, and this paper puts forward some guidelines to this end. In order to be as concrete as possible, these guidelines apply to small-scale coastal territories facing climate-related hazards and environmental changes.

Section 2 addresses the concept of maladaptation to climate change and presents some existing frameworks used to capture maladaptation. It draws conclusions regarding the limitations of these approaches to addressing maladaptation in coastal areas – the scope of this paper – and the need for a more comprehensive analytical grid. Section 3 presents such a new analytical grid, based upon eleven guiding principles. Section 4 draws general conclusions regarding the overarching benefit of this work and suggests directions for future research.

2. DEFINING MALADAPTATION TO CLIMATE CHANGE

2.1 THE CONCEPT OF MALADAPTATION

The use of maladaptation as a concept in the sphere of climate change dates back to the late 1990s. Scheraga and Grambsch (1998) refer to it indirectly through nine principles that characterise effective adaptation, including the importance of accounting for "potential adverse side effects of adaptive strategies... to avoid solutions that are worse than the problem" (p.85). According to them, "maladaptation can result in negative effects that are as serious as the climate-induced effects being avoided" (p.87). The term also appears in the IPCC's Third Assessment Report, which defines maladaptation as "an adaptation that does not succeed in reducing vulnerability but increases it instead" (McCarthy *et al.*, 2001: 990). Smithers and Smit (1997) and Schipper (2009) also mention the term maladaptation in their work. More recently, Barnett and O'Neill (2010 – see also Barnett & O'Neill, 2013, Barnett *et al.*, 2013), while focusing on responses to water stress engineering in the city of Melbourne (Australia), refer to "an 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). Very recently, the IPCC Working Group II contribution to the Fifth Assessment Report (AR5-WGII) (Field *et al.*, 2014) contains numerous references

1 New research usually leads to the better understanding – sometimes the discovery – of feedbacks between various parameters (e.g. within the atmosphere or between the atmophere and the ocean). When positives, these feedbacks effects could lead to the acceleration of key processes (e.g., sea ice melting) and related detrimental phenomena (see Alley et al., 2003). This inevitably leads to an increase in uncertainty, especially regarding the impacts to expect on ecosystems and societies.

to the concept, including a one-page section dedicated to 'Addressing Maladaptation' (Noble *et al.*, 2014).

This suggests both that there is a scholarship of maladaptation, and that the concept is making its way into the mainstream, but it does not imply that there is clarity on what it means. The glossary of the AR5-WGII report proposed to define maladaptation as: "Actions that may lead to increased risk of adverse climate related outcomes, increased vulnerability to climate change, or diminished welfare, now or in the future" (Field *et al.*, 2014). This definition is partly derived from that developed in November 2012 by sixteen experts during a three-day workshop[2] on the maladaptation issue:

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. (1)

This last definition (1) has been used as a basis for the work presented here, as it is the one that best reflects, from our point of view, the various timescales of maladaptation and, more precisely, the importance of systematically linking present challenges with future threats. Indeed, according to the widely shared view that, at least on coastal areas, climate change will essentially exacerbate already known problems (Parry *et al.*, 2007; Cardona *et al.*, 2012; Wong *et al.*, 2014), an initiative may not be considered as adaptation if it does not significantly reduce the system's both current and future vulnerability to natural hazards. This means *a minima* restricting societies' exposure to existing hazards (*e.g.* avoiding urbanisation too close to shorelines), limiting the sensitivity of the ecosystems to current climate stress (*e.g.* rehabilitating coastal sand dunes) and strengthening current societies' adaptive capacities (*e.g.* improving risk management systems). This reflects the three pillars of IPCC's definition of vulnerability to climate change, with the difference that here, the entry point is the reduction of current driving factors of risk, with the underlying hypothesis that these driving factors are major vectors of maladaptation to climate change. Definition (1) thus puts to one side the uncertainty about future climate and environmental conditions, focussing instead on the potentially adverse effects of an initiative that may be taken now in the name of adaptation.

Essentially, definition (1) considers maladaptation as a pathway, limits it to the detrimental effects of an adaptation initiative on the system's vulnerability to climate variability and change, links it to the necessity for flexibility in order to face current and future climate-related extreme events and gradual environmental changes, and emphasizes its multi-temporal nature. In doing so, it indirectly highlights a key message of this paper: a prerequisite for any adaptation process is "first, do no harm". At first glance, such a message may not seem to bring anything new into the debate on sustainability and adaptation. This paper however affirms the opposite, arguing that adaptation does not rely only on innovative initiatives, but also on "doing well what we currently do badly", *i.e.* on improving the implementation of already well-known solutions to well-known problems (*e.g.* coastal erosion). A key rationale for such a position is that future risks are deeply rooted in current ones (Cardona *et al.*, 2012; Wong *et al.*, 2014) – such as the ones induced by over-urbanisation in low-lying coastal areas or the loss in risk memory, for example – so that addressing current drivers of risk/vulnerability also contributes to reducing future risks/vulnerability. This brings us back to the "first, do no harm" principle and thus to avoiding maladaptation to climate change.

2.2 EXISTING FRAMEWORKS FOR UNDERSTANDING MAL-ADAPTATION

Although the issue of maladaptation is of growing concern, surprisingly few frameworks exist that help better understand and identify the risks and forms of maladaptation. Two such, that we have called the *Pathways framework* and the *Precautionary framework*, are presented here. A brief description is given of both their benefits and limitations, these latter justifying the development of a complementary framework (see section 3).

The *Pathways framework* is based on the work of Barnett and O'Neill (2010) on two engineering responses[3] to water stress in Melbourne, Australia. Their work identified five main characteristics of maladaptation, presented in Table 1, that they propose could form the basis of five principles for the evaluation of decisions about adaptation, and then for the tracking of maladaptation. In Table 1, we both present the characteristics of maladaptation and also reframe them as principles for avoiding maladaptation. We named this approach the *Pathways framework* according to words used by the authors themselves[4].

The *Precautionary framework* refers to Hallegatte's paper on 'Strategies to adapt to an uncertain climate change' (2009) which, although not using the term "maladaptation", deals with maladaptation. The author indeed argues: "since climate models and observation cannot provide what current decision-making frameworks need, the only solution is to amend these frameworks to make them able to take this uncertainty into account" (p.242). Now, dealing with both climate change uncertainty and the potential negative impacts of an initiative – currently implemented or soon to be – is the central aim of

2 November 6-9, 2012 at the Rockefeller Foundation centre in Bellagio, Italy. Attendees (in alphabetical order): S. Anderson (IIED, UK), S. Bharwani (SEI, Sweden), F. Briones (CIESAS, Mexico), M. Burkett (University of Hawaii, USA), I. Burton (University of Toronto, Canada), S. Eriksen (University of Oslo, Norway), F. Gemenne (Iddri, France), A. Magnan (Iddri, France), M. Mortimore (Ahmadu Bello University and Bayero University, Niger), R. Peou (Consultant, Cambodia), S. Raihan (ActionAid, Bangladesh), J. Schaar (currently: Swedish International Development Cooperation Agency, Sweden – at the time of the workshop: World resources Institute, USA), L. Schipper (SEI, USA), H. Singh (ActionAid, India), A. Tauqeer-Sheikh (CDKN, Pakistan), G. Ziervogel (University of Cape Town, South Africa). A collective paper is in preparation that is focused on this definition.

3 The Wonthaggi desalination plant and the Sugarloaf Pipeline Project (for water transfers).

4 Barnett and O'Neill (2010) talk about "five different pathways through which maladaptation arises" (p. 210) and about "pathways of maladaptation" (p. 212).

Table 1. The five principles of the *Pathways framework* (adapted from Barnett & O'Neill, 2010). The first column lists the characteristics of maladaptation identified by Barnett & O'Neill, and the second column reformulates this as principles for avoiding maladaptation.

Characteristic of maladaptation	Principle for avoiding maladaptation	Justification
Increasing emissions of greenhouse gases	1. Ensure that the initiative does not increase emissions of greenhouse gases	"The problem with energy-intensive adaptation actions is that while they may address current needs, they create a positive feedback by increasing emissions of greenhouse gases, thereby increasing the likelihood that further adaptation to climate change will be required in the future" (p.212). Adaptation must not contribute to increasing greenhouse gases emissions, as mitigation and adaptation are complementary means and goals of the fight against climate change.
Disproportionately burdening the most vulnerable	2. Ensure economically and socially equitable initiatives	"Adaptation actions are maladaptive if, in meeting the needs of one sector or group, they increase the vulnerability of those most at risk, such as minority groups or low-income households" (p.212). Strengthening part of the society by weakening the most vulnerable cannot be a sustainable option, as it will very likely result in an increase in pressures on other natural and human systems (vulnerability increase).
High opportunity cost	3. Avoid high-cost initiatives	"Approaches may be maladaptive if their economic, social or environmental costs are high relative to alternatives" (p.212). Cost-benefit analyses (on economic, social, environmental... dimensions) should be conducted before choosing the right option to implement. Neglecting such an approach can lead to adopting options that are too costly in the long run.
Reduce incentive to adapt	4. Increase incentive to adapt	Actions are maladaptive if "they reduce incentive to adapt, for example by encouraging unnecessary dependence on others, stimulating rent-seeking behaviour, or penalising early actors" (p.212). The involvement of community, economic and policy bodies into an adaptation process is of major importance to allow its achievement. This multilateral involvement however relies on various elements such as equity, risk perception, power relations, etc. that must not be eroded.
Path dependency	5. Build flexibility into the initiative	"A major issue with large infrastructural development [the one considered in the authors' case study] is the way they commit capital and institutions to trajectories that are difficult to change in the future" (p. 212). This deals with the extent to which present choices (here, infrastructural) can restrict the range of future options, and thus reduce the room for manoeuvre of the system in the future. This criterion refers to the generation of irreversibility and the induced decrease in the system's flexibility.

the reflection on maladaptation. And in his paper, Hallegatte insists on the importance of reducing the risk of increasing systems' vulnerability by taking into account a wide range of climate change impacts. This view notably fits with that of Barnett and O'Neill.

Referring to 'ill-adaptation', Hallegatte suggests that instead of looking for the best choice under one specific scenario, it is better to try to identify the most robust option, namely "the one that is the most insensitive to future climate conditions" (2009: 242). Such positioning explains why we named this approach the *Precautionary framework*: it strongly relies on the aim of avoiding irreversibility and strengthening socio-ecological systems' flexibility. Its underlying assumption is indeed that "many strategies that would reduce risks posed by climate change or exploit opportunities make sense whether or not the effects of climate change are realized" (Scheraga & Grambsch, 1998: 93).

Hallegatte's approach is based upon previous works done notably by Scheraga and Grambsch (1998), Lempert and Schlesinger (2000), Lempert *et al.* (2006), and Lempert and Collins (2007) on the concepts of robust and no-regret options. Although Hallegatte focuses his study on infrastructures and engineering adaptation options, the six-pillar framework he proposes (Table 2) could be applied to a wide range of adaptation initiatives.

These two frameworks are definitely helpful in moving from the concept of maladaptation to more practice-oriented guidelines. However, their usefulness for studies dealing with coastal areas in the face of climate-related hazards is limited, because they focus mostly on infrastructure[5], ignoring other driving forces of vulnerability and adaptation in coastal areas, *e.g.* the role of ecosystems, risk perception by local communities, *etc*. The following section addresses this gap by proposing a third framework, which we have called the *Assessment framework* and which is based upon eleven practical guidelines.

3. PRACTICAL GUIDELINES FOR AVOIDING MALADAPTATION IN COASTAL AREAS

The elaboration of these guidelines relies on the assumption that adaptation requires the climate change dimension (both extreme events and gradual changes) to be central to a broader approach to sustainable development (preserving the environment, reducing people's exposure to natural hazards, *etc.*). Considering this, and for practical reasons, we artificially distinguish between environmental, sociocultural and economic maladaptations, in order to allow the identification of specific guidelines. We also consider a broad range of adaptation implementation forms (policies, plans,

5 Except the fourth principle of the Precautionary framework.

Table 2. The six principles of the Precautionary framework (adapted from Hallegatte, 2009).

Criteria	Justification
1. No-regret strategies	"These strategies yield benefits even in the absence of climate change" (p.244). Hallegatte gives the example of limiting leakage in a water distribution network. He adopts an economic view, and in doing so does not address the potential costs and benefits of an action from social and environmental perspectives.
2. Reversible strategies	"It is wise to favour strategies that are reversible and flexible over irreversible choices. The aim is to keep as low as possible the cost of being wrong about future climate change" (p.244). *e.g.* urban planning on low-lying coastal areas. Here again, the author refers to economic costs, but the notion of "cost" could also be of another nature.
3. Safety margin strategies	"Strategies that reduce vulnerability at null or low costs (...). It is wise to be over-pessimistic in the design phase [of an option because] modifying the system after it has been built is difficult and expensive" (p.244). Hallegatte argues that the marginal higher cost to building bigger infrastructures (drainage infrastructures, dams, dikes...) is usually small compared to the initial total cost. Using safety margins could allow avoiding maladaptation; naturally on the condition that they represent an acceptable extra cost (economic, environmental, social...) at the time the option is designed and implemented.
4. Soft strategies	"Technical solutions are not the only way of adapting to changing climates. Sometimes, institutional or financial tools can also be efficient" (p.245). *e.g.* "institutionalization" of long-term planning, insurance schemes, early warning systems, *etc.*. Hallegatte refers here to non-technical and non-engineering options, which actually represent an extremely wide range of potential maladaptations. Cultural, social and political dimensions are thus also concerned.
5. Strategies that reduce decision-making time horizons	"The uncertainty regarding future climate conditions increases rapidly with time. Reducing the lifetime of investments, therefore, is an option to reduce uncertainty and corresponding costs" (p.245). *e.g.* species with a shorter rotation time in forestry. This criterion is quite disputable as on the other hand, one can consider the reduction in decision-making timescales as a major source of maladaptation. It could indeed encourage actors to not take into account long-term potential adverse effects of the action, inducing a potential increase in their own vulnerability or in neighbouring systems' vulnerability.
6. Taking into account conflicts and synergies between strategies	"Adaptation strategies often have side effects that can be either negative or positive. (...) There are also conflicts between adaptation options, [and] adaptation also interact with mitigation policies" (pp.245-6). Assessing maladaptation involves focussing on negative effects of an adaptation initiative. But one should be aware that this should be done by putting these negative effects into a double context: the overall effects of the initiative itself (the balance of the positive and negative) and of the implementation of other initiatives (dealing both with adaptation and mitigation). Thus, maladaptation is always relative.

projects), using the generic term "adaptation initiatives"[6]. Finally, we propose eleven guidelines (Table 3), arguing that because they necessarily interact with each other, initiatives that address many or all of the guidelines will have a lower risk of maladaptation compared to initiatives that address few or none of them.

Table 3. The *Assessment framework*: eleven guidelines for avoiding maladaptation to climate change in coastal areas.

Avoiding environmental maladaptation

1. Avoid degradation that causes negative effects *in situ*.
2. Avoid displacing pressures onto other environments (neighbouring areas or areas that are connected ecologically or socio-economically).
3. Support the protective role of ecosystems against current and future climate-related hazards.
4. Integrate uncertainties concerning climate change impacts and the reaction of ecosystems.
5. Set the primary purpose as being to promote adaptation to climate-related changes rather than to reduce greenhouse gas emissions.

Avoiding sociocultural maladaptation

6. Start from local social characteristics and cultural values that could have an influence on risks and environmental dynamics.
7. Consider and develop local skills and knowledge related to climate-related hazards and the environment.
8. Call on new skills that the community is capable of acquiring.

Avoiding economic maladaptation

9. Promote the reduction of socio-economic inequalities.
10. Support the relative diversification of economic and/or subsistence activities.
11. Integrate any potential changes in economic and subsistence activities resulting from climate change.

We called this framework the *Assessment framework* because it lays the foundations for the elaboration of an assessment grid[7] that could help practitioners to better design their initiatives ("are we reducing the risk of maladaptation?") and funding bodies to decide whether or not to support a given initiative (based upon its potential to reduce the risk of maladaptation). This *Assessment framework* is thus destined

6 As the Pathways and the Precautionary approaches do with the terms "actions" and "strategies", respectively.

7 This work is on progress in the context of the *CapAdapt* project (see the following footnote).

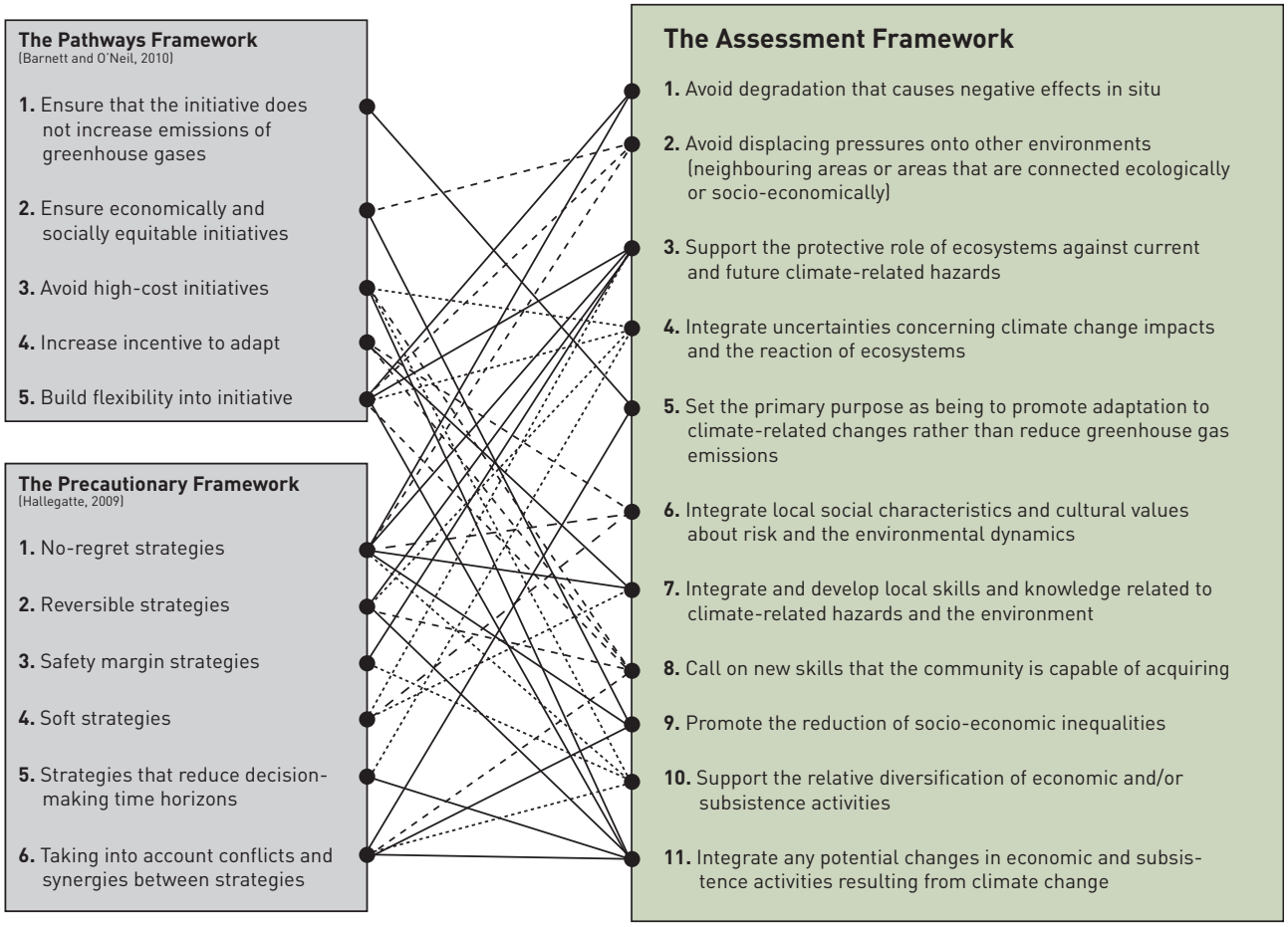

Figure 1. The main linkages between the *Pathways* and the *Precautionary frameworks*, and the *Assessment framework*. N.B.: The various line styles have no significance other than legibility.

to inform the formulation of adaptation initiatives prior to their implementation (*ex ante* approach), rather than to enable an *ex post* evaluation of the benefits and shortcomings of initiatives undertaken in the name of adaptation.

From a methodological point of view, the identification of the guidelines has been based upon a two-fold approach. First, we identified the principles from the *Pathways* and the *Precautionary frameworks* that could be applied in the context of a small-scale coastal community facing climate-related hazards. We complemented this with a review of the literature dealing with the implementation of adaptation (*e.g.* Ebi *et al.*, 2004; de França Doria *et al.*, 2009; Berrang-Ford, 2011; Ford *et al.*, 2013) and with the identification of concrete adaptation options (*e.g.* on "robust" and "no regret" options – Lempert & Schlesinger, 2000; Lempert & Collins, 2007; Hallegatte, 2009; Heltberg *et al.*, 2009). Second, we capitalize on our own ten-year experience of research in low-lying coastal areas in Kiribati and Bangladesh (*CapAdapt* project[8]), in Reunion Island (*VulneraRe* project[9]) and in the Maldives and Mauritius islands (Magnan, 2005; Gemenne & Magnan, 2010; Magnan, 2012). Finally, we arrived at the eleven guidelines reported in Table 3 and detailed in the following sub-sections. Figure 1 also illustrates some linkages with the principles proposed in the *Pathways* and the *Precautionary frameworks*.

8 http://www.iddri.org/Projets/Capacites-d-adaptation-au-changement-climatique-%28Bangladesh,-Kiribati%29-%5BCapAdapt%5D

9 http://www.iddri.org/Projets/VulneraRe

3.1 AVOIDING ENVIRONMENTAL MALADAPTATION

The extent of flexibility available to socio-ecological systems when responding to natural or anthropogenic disruptions that destabilise economic and subsistence activities depends on existing environmental balances (Ostrom, 2009). Thus, a core objective is to avoid damaging the environment not only of the socio-ecological system on which the initiative is implemented but also of neighbouring or distant socio-ecological systems. An adaptation initiative that simply shifts environmental pressures elsewhere is considered here as maladaptation in that the components of vulnerability are relocated rather than reduced. To constitute an adaptation, an initiative must be consistent with the nature and dynamics of existing environmental components, and must take into account the potential threats of climate change on evolving environmental conditions (*e.g.* direct and indirect impacts on resources). Five guidelines support this objective:

1—Avoid degradation that causes negative effects in situ, *i.e.* in the socio-ecological system in which the initiative is implemented (direct environment). An example of such degradation is the destruction of sand dunes that results

from building a resort close to the water, which subsequently increases the new building's exposure to storm surges. This guideline is consistent with principle 5 of the *Pathways framework* and principle 1 of the *Precautionary framework* (see Figure 1). An ideal initiative would of course have an attenuating effect or, at the very least, no collateral effect on assets' exposure to climate-related hazards, overexploitation of resources, habitat degradation or pollution of ecosystems. This is however not always possible on the ground, as it is often necessary to make trade-offs between development and environmental challenges[10] (*e.g.* when a large coastal city has to be protected, dikes can be the best solution, although they prevent sand returning and increase erosion). In this case, the initiative may only be considered as "adaptation" if it takes its own *in situ* negative effects into account and if, in parallel, it puts in place compensation mechanisms (*e.g.* protection of marine ecosystems from pollution, to allow them to maintain their natural resilience and adaptive capacities, and then ensuring their buffer function against waves, for example).

2—Avoid displacing pressures onto other socio-ecological system (neighbouring systems or systems that are connected ecologically and/or socio-economically). The aim of any adaptation process is to reduce pressures on the environment and not to displace them, *i.e.* not to lead to increased pressures on the environment elsewhere. A classical counterexample is the development of a coastal groyne that helps limit erosion *in situ* by capturing sand, but that disturbs natural movements of sand along the coast (*e.g.* from west to east) and thus generates erosion downstream. Again, however, it is not always possible to avoid such displacement of pressures, which means that it is crucial to take this constraint into account and engage in parallel compensation mechanisms (*e.g.* a legal obligation for stakeholders to feed the downstream coast with additional sand, or to use groynes equipped with a by-pass system). This guideline is consistent with principle 5 of the *Pathways framework* and principle 1 of the *Precautionary frameworks*.

3—Support the protective role of ecosystems against current and future climate-related hazards, so as to maintain natural buffer zones in face of the impacts of both sudden events (*e.g.* storms, floods) and gradual changes (*e.g.* sea level rise). Coastal dunes are one example, as they act as a buffer against storm surges when in good condition (continuity of the dune belt and presence of dune-binding vegetation). Mangroves are another good example. This principle is consistent with principle 5 of the *Pathways framework* and principle 3 of the *Precautionary framework*, respectively.

4—Integrate uncertainties concerning climate change impacts and the reaction of ecosystems, so as to maintain enough flexibility to adjust activities in the event of unpredicted environmental changes and new scientific knowledge. The concept of flexibility is considered here as a mainstay of adaptive capacity (Adger *et al.*, 2005; Cardona *et al.*, 2012). The same rationale is expressed in principle 3 of the *Pathways framework* and principle 2 of the *Precautionary framework*.

5—Set the primary purpose as being to promote adaptation to climate-related changes rather than to reduce greenhouse gas emissions. This guideline is consistent with principle 1 of the *Pathways framework* and, more indirectly, with principle 6 of the *Precautionary framework*. If the initiative can help to reduce greenhouse gas emissions, it must above all focus on resilience and the alleviation of vulnerability to natural hazards and gradual environmental changes. This principle aims to avoid the confusion – still very common on the ground – between adaptation and mitigation (*e.g.* both local stakeholders and population often identify the treatment of wreckages or the installation of solar panels as adaptation options – see for example in Magnan, 2012).

3.2 AVOIDING SOCIOCULTURAL MALADAPTATION

The options available to socio-ecological systems facing natural or anthropogenic disturbances will of course also depend on human characteristics, specifically those related to the environment (beliefs, risk perceptions, traditional uses of natural resources, *etc.*). Adaptation initiatives must therefore be consistent with the social characteristics and cultural values of the community concerned, and based on local capacities and knowledge in the field of environment and natural hazards (Adger *et al.*, 2005; Adger *et al.*, 2009). This means avoiding upsetting the sociocultural equilibrium by developing skills at the community level and, at the same time, generating or maintaining collective responses. Three main guidelines apply here:

6—Start from local social characteristics and cultural values that could have an influence on risks and environmental dynamics. Initiatives must take into account the expectations of the community in terms of material and immaterial living conditions, both in the present and the future, as these expectations are key drivers of changes in risk exposure over time, and more generally of vulnerability to climate variability and change. The consideration of land tenure systems in urban settlement planning in Pacific Islands is an example (Yamano *et al.*, 2007; Duvat *et al.*, 2013), as is the desire of many people from Europe, for example, to spend summer holidays at the coast.

7—Consider and develop local skills and knowledge related to climate-related hazards and the environment, in order to support the involvement of members of the community in and/or around the initiative taken in the name of adaptation to climate change. One example is the integration of historical data on marine flooding into urban development plans. Another example deals with raising awareness of hazards and risk areas in contexts where new inhabitants coming from other and sometimes distant areas have massively and rapidly replaced indigenous people. Newcomers generally know nothing about risk in the destination area, which leads them to develop bad practices such as the building of no-storey houses in low-elevated areas (*e.g.* Vinet *et al.*, 2012). Improving the awareness of risk is key to making people

10 This refers to the winners-losers dilemma.

accept new building norms, for example. More generally, this guideline is decisive for the success of any initiative, as the long-term benefits often partly depend on the self-confidence of the community members in their ability to drive the change.

8—Call on new skills the community is capable of acquiring. The previous guidelines do not necessarily imply that the community should be limited to the skills and knowledge it already has: first, because these skills are not always favourable to the environmental balance – and thus have to evolve – and, secondly, because new needs may emerge as environmental conditions change. Here, acquiring new knowledge and expertise is part of adaptation. Like the previous guideline, this one also raises the importance of enhancing people's self-confidence in their ability to drive the change, which is consistent with principle 4 of the *Pathways framework*.

3.3 AVOIDING ECONOMIC MALADAPTATION

This is the dimension that is most readily recognised by analytical works on adaptation initiatives (see for example Barr *et al.*, 2010), and it is very influential in the *Pathways* and the *Precautionary framework*. In short, the overall idea is to prevent the initiative from creating poverty, on the one hand, or investment irreversibility, on the other (investments put to use at a given time but which can no longer be used at a later date). Three guiding principles are:

9—Promote the reduction of socio-economic inequalities, as they indirectly affect the exploitation of natural resources (Billé *et al.*, 2012) and stimulate settlements in marginalized and hazard-prone areas (*e.g.* in atoll countries: Spennemann, 1996; Yamano *et al.*, 2007; Duvat *et al.* 2013), and consequently exacerbate vulnerability. As suggested in the *Pathways framework*, socio-economic inequalities also have a major influence on 'disproportionally burdening the most vulnerable' (principle 2). In an ideal scenario, an initiative must ensure that the present income that various groups derive from economic and/or subsistence activities does not decrease, and should provide a new source of income. Thus, reducing socio-economic inequalities constitutes a 'no-regret strategy' as well as an opportunity to 'consider existing conflicts between different strategies' (principles 1 and 6 of the *Precautionary framework*). However, in the vast majority of situations, there will almost inevitably be "winners and losers" (because environmental degradation affect existing economic activities, or because an extreme event occurs, or because new activities are developed). In other words, the redeployment or development of activities is not equally beneficial to all of the groups concerned. Recognising this reality is a prerequisite for an initiative's sustainability and thus for its relevance in terms of adaptation to climate change. Reducing this winner/loser gap or, at the very least, not widening it, is thus a critical issue.

10—Support the relative diversification of economic and/or subsistence activities. By avoiding a situation where all activities are threatened by the same climate-related hazards (*e.g.* coastal tourism and agriculture in the face of marine flooding in small islands' coastal plains), diversification enables the community to acquire or maintain a certain leeway in the event of both sudden and gradual environmental disturbances that, together with climate change, will affect various natural resources and means of production. This guideline is consistent with principle 3 of the *Pathways framework* and the principles 3 and 6 of the *Precautionary framework*.

11—Integrate any potential changes in economic and subsistence activities resulting from climate change, notably to avoid developing activities that require heavy investment (money, time and energy) but which will quickly become obsolete due to climate change. Hallegatte also insists on this point when he writes that a good way to by-pass the problem of climate uncertainty is to target "options that [are] the most insensitive to future climate conditions" (2009: 242). This is especially reflected in principles 1, 3 and 5 of the *Precautionary framework*, as well as principle 3 of the *Pathways framework*. The development of new infrastructures or the improvement of existing ones illustrate this guideline – Barnett and O'Neill (2010) use the example of a desalination plant and of a pipeline project, while Hallegatte (2009) refers to water distribution systems, dams and dikes.

Finally, the above eleven guidelines strongly interact and as a consequence, the more guidelines an initiative addresses, the lower will be the risk of maladaptation.

4. CONCLUSIONS

Based on the assumption that avoiding maladaptation to climate change is a first key concrete step towards adaptation in the broader sense, this paper proposes a framework for avoiding maladaptation (called the *Assessment Framework*). This framework consists of eleven practice-oriented guidelines (see Table 3), and it applies to coastal areas at a local scale and to the design phase of an initiative (*i.e.* before its implementation). The paper thus argues that *ex ante* analysis of adaptation initiatives is just as important as *ex post* evaluation. While the latter provides monitoring of the effectiveness of implementing adaptation and using dedicated funds, *ex ante* analysis also plays a part in improving adaptation efforts, mainly because it helps to avoid maladaptation (or at least, to limit the risk of maladaptation).

This approach carries very positive news for decision-makers and practitioners in charge of implementing adaptation on the ground. In fact, avoiding maladaptation is largely based on not repeating past and present mistakes (*e.g.* in spatial planning), which is in line with the "First, do no harm" principle developed in the late 19th century in the medical field (Smith, 2005). In practical terms, this means that various stakeholders already have empirical experience of coastal hazards, on the basis of which they can begin to adapt, and thus that they already have the means to partially circumvent the problem of uncertainty of climate change impacts.

However, a key challenge for future research is to transform these eleven guidelines into quantified indicators, *i.e.* to move from the *Assessment Framework* to an assessment grid of the risk of maladaptation. The need for quantitative and objective indicators was emphasized in the IPCC's Fifth Assessment Report (volume II, chapter 14): "Five dimensions of maladaptation were identified by Barnett and O'Neill (2010) [that] are useful pointers to the potential for maladaptation but their application depends on subjective assessments." (Noble *et al.*, 2014: 29). The challenge of enhancing objectivity is crucial for at least two reasons: first, to assess to what extent (mal)adaptation is happening on the ground; and secondly, because of the need to provide funding bodies and practitioners with common references, *i.e.* the eleven guidelines and their related indicators. In addition, such an assessment grid could represent a powerful tool to allow funding bodies to make the best decisions in terms of supporting adaptation initiatives (*i.e.* by assessing their potential for maladaptation), and practitioners to design robust adaptation initiatives (*i.e.* building initiatives with a low risk of maladaptation).

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