

Measuring adaptive capacity: towards a conceptual framework to analyse adaptive capacity of Maldives

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Abstract— This paper reviews the concept of adaptive capacity and various approaches to assessing it, particularly with respect to climate variability and change. It will also suggest a framework to analyse adaptive capacity for the Maldives. Adaptive capacity is a relatively under-researched topic within the sustainability science and global change communities. However, it is uniquely positioned to improve linkages between vulnerability and resilience research. We identify opportunities for advancing the measurement and characterization of adaptive capacity by combining insights from various adaptive capacity analysis frameworks, and we suggest several assessment approaches for possible to analyse adaptive capacity for the Maldives. Those methods identified include those that draw from both frameworks and focus on analysing the governance, institutions, and management that have helped foster adaptive capacity.

Index Terms— Climate Change, Climate Change Adaptive Capacity, Adaptation, Resilience, Adaptive Capacity Analysis, Maldives, Small Island Development States, Adaptive Capacity Analysis Framework

1 INTRODUCTION

Climate change is a reality. The impacts are observed and felt. Moreover, the effects of climate change on physical and ecological systems over the past century are a fore-runner of things to come (W. Neil Adger, Arnell, & Tompkins, 2005). Of the most vulnerable to these global changes in environment are people residing in small island states. Located almost on the equator from 70N to 0.50S in the Indian Ocean, the Maldives is among the most vulnerable and least defensible countries to the projected impacts of climate change and associated sea level rise. Khan et al. (2002) have described Maldives as the flattest country on the earth and also called it extremely vulnerable to climate change, so much that 85% of its geographic area could be underwater by the year 2100 if sea levels rise. The Global Environment Facility has stated that 'no settlement on the Maldives is entirely safe from the predicted impacts of climate change' (Undp, 2012). The biggest vulnerabilities faced by the Maldives is in conjunction with its low elevation with almost 80% of its tiny 1190 coral islands lying 1m above sea level and none lying 3m above sea level. Apart from the elevation, the small size of the islands, their narrow width, the dispersed nature of coral reefs and the atolls make it susceptible to various climatic changes. The Maldives is already facing multiple and interacting impacts of climate change, which include sea level rise, ocean acidification, changes in extreme weather events and reduced freshwater availability. Maldives has to fast recognise and prepare for the predictable and unforeseen impacts of climate change in a manner that balances various challenging social interests for

the provisioning of ecosystem goods and services which takes into account the myriad pressures of multiple environmental stresses.

Within the past few decades Maldives must have possibly devoted over a hundred billion dollars for climate change mitigation and adaptation, which mostly come in the form of development aid. However, there is question if these development aid has met the adaptation needs of the Maldives. At this point and with the work done so far, there is a need to define what adaptation looks like. And answering the question if Maldives is more adaptable to climate change with the efforts it has put in so far is much needed. The need to track climate change adaptation is highly recognised in the Maldives, however there is no attempt to track adaptation so far. Characteristics of success need to be identified to capture the effectiveness of adaptation measures implemented in the past and currently being implemented to reduce vulnerability. This review article therefore attempts to find ways to judge if and how adaptation is occurring through a proposed method to assess the adaptive capacity of Maldives. This is achieved through a review various approaches on measuring climate change adaptive capacity and proposing a contextually suitable framework to follow for the Maldives.

The remainder of this paper is organised as follows: first will review some concepts which revolve around the term 'adaptive capacity' and then a review of methods to assess adaptive capacity and finally a conceptual framework to assess adaptation and conclusions.

2 ADAPTATION

In its very basic and literal terms, adaptive capacity is the ability to adapt. Though there are various definitions of this term, most authors consider adaptation as an adjustment. Table 1 layout several definitions as suggested by various authors.

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The term 'adaptation' initially appeared in evolutionary biology dating back to Darwin's seminal work on evolution and natural selection (Engle, 2011). Though the term is widely used in global change field, adaptation applied to humans root to anthropology. And in recent years it has been extensively used beginning with the second but particularly the third climate change assessment report of the Intergovernmental Panel on Climate Change (Houghton JT et al., 2001). Up until that time, the policy and scholarly efforts focused on climate change mitigation. However, in 2001 the USA refused to support the greenhouse gas emission goals of the Kyoto Protocol, and hence adaptation emerged as the only viable option for furthering climate change policy" (Schipper, 2009).

TABLE 1
ADAPTATION DEFINED BY AUTHORS

Adjustment of a system to moderate the impacts of climate change, to take advantages of new opportunities or to cope with the consequences	(W N Adger, Huq, & Brown, 2003)
A process, action or outcome in a system (household, community, group, outcome in a system) in order for the system to better cope with, manage or adjust to some changing condition, stress, hazard, risk or opportunity.	(Pelling & High, 2005)
Adjustments in a system's behaviour characteristics that enhance its ability to cope with external stress"	(W Neil Adger, Brooks, Bentham, & Agnew, 2004)
Adjustments in individual groups and institutional behaviour in order to reduce society's vulnerability to climate.	(Pielke, Prins, Rayner, & Sarewitz, 2007)
Adjustments in ecological-socio-economic systems in response to actual or expected climatic stimuli, their effects or impacts.	(Daly & Wilson, 2000)
Adaptations are manifestations of adaptive capacity, and they represent ways of reducing vulnerability	(Smit & Wandel, 2006)
An adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates, harms or exploits beneficial opportunities	(IPCC, 2013)

3 ADAPTIVE CAPACITY

Moving on to 'adaptive capacity', the literal meaning here is the capacity to adapt. Similar to the term adaptation, several authors defined the term in various different ways. We tabulate some in Table 2. Adaptive capacity is an important part of vulnerability assessments and it also underlies and enables to inform decision makers on adaptation policies and govern adaptation activities. It revolves around a host of other common concepts such as adaptability, coping ability, management capacity, stability, robustness, flexibility and resilience (Smithers & Smit, 1997). It is also context specific and varies from country to country, from community to community and among social groups and individuals and over time (Smit & Pilifosova, 2003). Moreover, the scales of adaptive capacity are not independent or separate: the capacity of a household to cope with climate risks depends to some degree on the enabling environment of the community, and the adaptive capacity of the community is reflective of the resources and process of the region (Yohe & Tol, 2002). Most communities can cope

with normal climatic conditions and moderate deviations from the norm, however exposure to extreme events may lie outside the coping range, or may exceed the adaptive capacity of the community (Vogel, Moser, Kaspersen, & Dabelko, 2007). Some authors consider 'coping ability' as shorter term capacity or simply the ability to just survive and employ 'adaptive capacity' for the longer term or more sustainable adjustments (Watts & Bohle, 1993).

TABLE 2
ADAPTATIVE CAPACITY DEFINED BY AUTHORS

A latent property of an individual, community, or social ecological system, which is activated in response to a crisis or opportunity	(Engle, 2011)
The ability of a system to evolve in order to accommodate perturbations or to expand the range of variability within which it can cope.	(W. N. Adger, 2003)
An aspect of resilience that reflects learning, flexibility to experiment and adopt novel solutions, and development of generalised responses to broad classes of challenges.	(Walker et al., 2002)
An attribute of socio-ecological systems that permits coping with disturbance and change while retaining critical functions, structures, and feedback mechanisms.	(Armitage & Plummer, 2010)
An adjustment in ecological, social or economic systems in response to observed changes in climatic stimuli and their effects and impacts in order to alleviate adverse impacts of change or take advantage of new opportunities. Adaptation involves building adaptive capacity thereby increasing the ability of individuals and also implementing adaptation decisions, i.e. transforming capacity into action.	(Houghton JT et al., 2001)
The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with consequences"	(IPCC, 2013)
A closely related to a variety of other commonly used concepts, including adaptability, coping capability, stability, robustness, flexibility and resilience.	(Smit & Wandel, 2006)
The ability of social actors to make deliberate changes that influence the resilience of their complex social-ecological systems. It is also defined as preconditions necessary for adaptive actions, comprising both social and physical elements and the ability to mobilise them	(Ensor, Park, Hoddy, & Ratner, 2015)

4 ADAPTIVE CAPACITY ASSESSMENTS IN MALDIVES

The grim risk to climate-change has led to several efforts in Maldives to adapt and mitigate to climate change. This section will elaborate on the various climate change adaptive capacity analysis carried out in the Maldives up to date. One major problem is the lack of academic research undertaken in the Maldives. The main literature reviewed here are from various sectors such as tourism, but they inadequately consider measuring adaptive capacity at the level of islands or atolls. The adaptive capacity assessments thus far have been on particular systems and to specific types of hazards.

The first example, I would like to present is a research on environmental vulnerability, of freshwater scarcity of Maldives. Turton and Ohlsson's (1999) theory of adaptive

capacity was used to present the importance of second order adaptive capacity when dealing with the first order natural resource scarcity (Millar, 2002). This study was focused on examining the issue of environmental vulnerability, specifically freshwater scarcity, on Small Island Developing States and Maldives was chosen as a case study.

The second example is an adaptive capacity assessment of the tourism sector in the Maldives. The main objectives here were to determine the vulnerabilities existing adaptation responses and gaps in response to climate change, awareness and vulnerability of the tourism operators and dependent communities and to determine the readiness of the government institutions to tackle the issues to address the climate change vulnerabilities (Ministry of Tourism Maldives, 2013). Main methods deployed were surveys and expert judgement.

The last example I would like to present is an analysis of the adaptive practices and capacities of local inhabitants and one resort in Laamu atoll, Maldives. The main theme researched was regarding beach erosion problems. The method used include investigations on how the Laamu community has adapted in the past, current adaptive capacity and how they in the future adapt to beach erosion. Wamsler's theory was used as an analytical framework to analyse the result in this study. The Wamsler's theory make capacity analysis, which is an effective tool for institutions, so that they in a comprehensive and practical way work with risk reduction and adaptation measures (Borgudd, 2014).

5 MEASURING ADAPTIVE CAPACITY

The IPCC was the first to characterise the determinants of adaptive capacity which appeared on the chapter 18 of the third assessment report of the working group II (Houghton JT et al., 2001), outlining eight determinants of adaptive capacity namely economic resources, technology, information and skills, infrastructure, institutions, and equity. With this initial ingenuity, more recent research has come up with determinants of adaptive capacity. To name some Brooks, Adger, & Kelly, (2005) presented an empirical analysis of mortality from climate hazards determining eleven key indicators of adaptive capacity and Mosello (2015) with a research combining theory and data driven approach to identify five categories of determinants. This section will discuss selected methods to identify generic determinants of adaptive capacity at which is deemed suitable for practice in the Maldivian context. To achieve this aim, this section will dig deep into various research methods and research designs that has been used to quantify adaptive capacity. The focus is to capture a simple but not too generic or too specific method and to derive a conceptual framework which is not a panacea, which in fact could be used for policy advice.

5 TOWARDS A CONCEPTUAL FRAMEWORK FOR MALDIVES

The Strategic National Plan for Disaster Risk Reduction and Climate Change Adaptation Action Plan (SNAP) 2010-2020 was fully endorsed by the government of Maldives in June

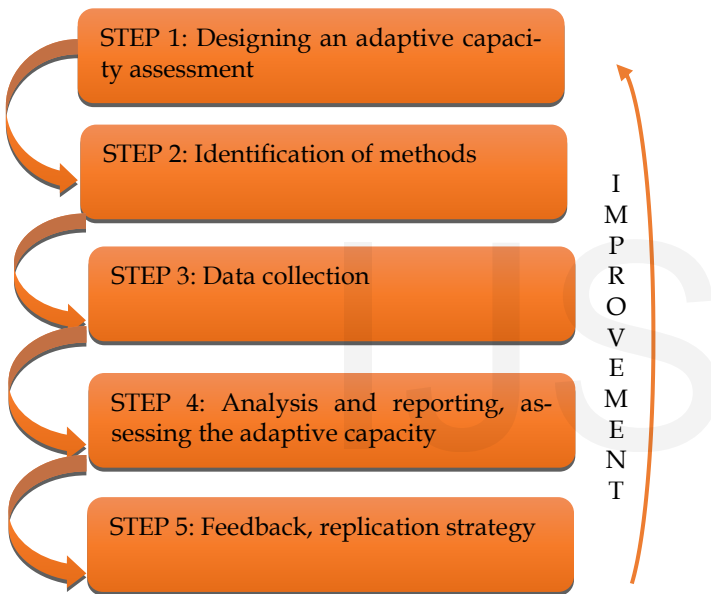
2011. It is the strategic framework, complementing the National Adaptation Plan of Action (NAPA) and the National Sustainable Development Strategy (2009), to orient actions to reduce the risk of disasters and enhance climate change adaptation in the Maldives. However, the bottleneck found in all these plans and strategies is that there no mechanism to track any adaptation that might occur from their manifestation or implementation. Therefore, it is as crucial in ensuring that these policies and strategies are effectively applied into practice that their effectiveness be measured concurrently. The need to adapt to unavoidable impacts of climate change is increasingly evident. The main aim of this segment of this document is to formulate a simple framework to measure adaptive capacity for the Maldives.

TABLE 3
METHODS TO ASSESS ADAPTIVE CAPACITY

Author	Methods
(Brooks and Adger, 2012)	A set of 8 questions are answered to capture if a system is adaptive: What is the nature of the system/population being assessed? 2. What are the principal hazards faced by this system/population? 3. What are the major impacts of these hazards and which elements/groups of the system/population are most vulnerable to these hazards? 4. Why are these elements/groups particularly vulnerable? 5. What measures would reduce the vulnerability of these elements/groups? 6. What are the factors that determine whether these measures are taken? 7. Can we assess these factors in order to measure the capacity of the system population to implement these measures? 8. What are the external and internal barriers to the implementation of these measures.
(Pahl-Wostl, 2009)	A multilevel learning process conceptualising change in institutions as social and societal learning presenting a framework with a normative and an analytical component, where the analytical component captures the key attributes of the governance regimes and the normative associating with characteristics of governance regimes with higher resilience and adaptive capacity.
(Gupta et al., 2010)	The Adaptive Capacity Wheel: an analytical structuring tool consisting of six dimensions namely, variety, learning capacity, room for autonomous change, leadership, availability of resources and fair governance.
(Ensor et al., 2015)	A right based approach which enables identification of constraints on adaptive actions and links this analysis to actions that can be planned in support of building adaptive capacity
(Tinch et al., 2015)	This research presents the integrated assessment platform of CLIMSAVE to develop an index of adaptive and coping capacities.
(Sherman, Ford, Llanos-Cuentas, Valdivia, & Bussalleu, 2015)	Participatory rural appraisal (PRA) qualitative methods were used to examine community adaptive mechanisms to climate change. community members worked in partnership with researchers.
(Swanson, Hiley, Venema, & Grosshans, 2007)	A theoretical framework presented by Smit et al., (2001) was used to measure adaptive capacity. This method used determinants and indicators to assess adaptive capacity.
(Schneiderbauer, Pedoth, Zhang, & Zebisch, 2013)	Adaptive capacity at 3 levels of specificity: impact specific, sector specific, regional or generic. At all 3 levels adaptive capacity is evaluated through indicators representing relevant and feasible adaptation measures.
(Ford, Berrang-Ford, Lesnikowski, Barrera, & Jody Heymann, 2013)	This research presents 2 methods to track adaptation: outcome evaluation approaches and systematic approaches. Outcome evaluation approaches measure adaptation progress and effectiveness in relation to avoided climate change impacts (i.e., the ultimate goal of adaptation). Systematic approaches focus on the process through which interventions are developed and implemented in pursuance of a desired outcome or objective

The literature reviewed above indicates that adaptive capacity could be assessed at several levels, example at individual, institutional, national regional etc. The proposed dimensions and criteria found in the literature could be clustered together

to form a context specific analytical tool for assessment in the Maldives. The framework we are trying to formulate would form an analytical tool for a single unit in the Maldives. A single unit in this case could be considered considered to be an island or an atoll or any regional divisions depending on the level of research chosen. The decentralised governance system divides the twenty-six natural atolls and few island groups on isolated reefs, into twenty-one administrative divisions. Hence islands are the smallest administrative unit in the Maldives. Each atoll is administered by an elected Atoll Council or a city council and similarly, all islands have an elected island council. These councils hold the guardianship and the vested responsibility to protect the natural resources available in their jurisdiction. They also form part of the first responders in any disaster situations. The conceptual diagram below highlights the key steps in achieving the adaptive capacity of at an island level.



Step 1: Planning and preparation

As a very first step in designing an adaptive capacity assessment it is important to identify the scope or the level of analysis intended (for example: institutional, regional or national). Followed by a detailed desk research on demographics, climatic vulnerabilities, institutional capabilities, funding for adaptation and any necessary information. The plan of execution including objectives, budgets and timeframes should be formulated. Stakeholders and collaborators for the research should also be identified during this step. At this step the set of 8 questions proposed by Brooks and Adger (2012) would be an eye-opener for the assessment (see table 2).

Step 2: Method identification

Literature shows various methods of measuring adaptive capacity for different levels. The level chosen in step 1 should be guided through table 2 to decide on a method to carry out the research. For example, an institutional analysis of the adaptive capacity could be carried out through a multi-level learning process (Phal-Wostl, 2009)

and adaptive capacity wheel (Gupta et al, 2010). Since there are various methods to carry out the assessment, a theoretical triangulation involving more than one method could be used to interpret a more accurate result.

Step 3: Data collection

This is the most crucial step in any research. The quality of data collected reflects on the credibility of the research work plus would enhance decision making. The participation of stakeholders at local level, such as the involvement of community representatives, and Atoll and Island Authorities during data collection is strongly advisable.

Step 4: Analysis and reporting

Adaptive capacity analysis is important for climate policy and decision making. It would serve multiple purposes including and not limited financing for adaptation as well as self-appraisal mechanism for on-going adaptation measures. Hence the analysis and following report should include informational summaries and meaningful insights which allows stakeholders to monitor and recognise the adaptation performance. This segment should include answers for questions such as what is happening, why it is happening and what you can do about it. These questions and answers should form basis further adaptation measures.

Step 5: Feedback, prospects of sustainability and replicability

Adaptation is an ongoing process and hence collecting actionable feedback from stakeholders is important to carryout future adaptive measures. Feedback allows researchers to identify gaps in the process helps to make adjustments. Stakeholder feedback could be obtained through consultation meetings letting the data analysis speak for itself. Other methods include surveying, interviewing and also use of social media. Stakeholder feedback should yield better strategies to plan for future research and hence to obtain great results. Considering the fact that there only a few available scholarly work on tracking adaptation in the Maldives, the replicability of the method deployed for the assessment is imperative.

6 CONCLUSION

Essentially, the purpose of any adaptation analysis in climate change field is to estimate the degree to which modelled impacts of climate change scenarios could be mitigated by adaptation to the impacts. Adaptive capacity has been analysed in multiple ways, including and not limited to measurements via thresholds and coping ranges such as the conditions that a system can deal with, accommodate, adapt and recover from. Theoretically, adaptive capacity is identifiable and measurable at various scales, from individual level to national and regional as well. Adaptive capacity assessments are heavily dependent on the determinants and the human actions of adaptation. These determinants build adaptive capacity. For example, generic adaptive capacity at the national level, could be postulated as being dependent on health, governance and political rights, and literacy, and economic well-being. Determining adaptive capacity is a multidimensional task: it involves complex inter-relationships of a number of factors at

various scales. If we consider measuring adaptive capacity at the country level, the availability of financial resources, the degree of organisation and institutional capacity for targeting those resources effectively to the areas and groups of people that are most vulnerable among factors that would need mapping. At household level, whether or not a person can adapt to climate change depends on factors such as their knowledge base, which may enable them to anticipate change and identify new or modified livelihood opportunities (Vincent, 2007). The biggest challenges faced in measuring adaptive capacity arises due to the nature of the determinants which are not quantifiable and most of them can only be qualitatively described. Moreover, methods for measuring adaptive capacity is not well established within adaptation research which makes it further more difficult to quantify. Together with these challenges, social, political, economic, technological and institutional factors and the specific interaction between these factors differing from scale of analysis: from country down to the individual levels are various other challenges which has to be fraught with in measuring the adaptive capacity. This conceptual paper, complementing various literature was designed to obtain a framework to measure adaptive capacity of the Maldives at various levels. The main aim of the six step framework was to maintain a simple mechanism to track adaptation and to obtain a basic idea for researchers, institutions and policy makers to have an understanding of the current performance of the adaptive measures in place. Maldives being very susceptible to climatic changes require extensive knowledge and ability to adapt which would indeed be obtained through capturing success of current adaptive measures and learning to improve where necessary and to overcome challenges.

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