nature climate change

PERSPECTIVE

PUBLISHED ONLINE: 25 APRIL 2014 | DOI: 10.1038/NCLIMATE2199

Strategies for improving adaptation practice in developing countries

Declan Conway[1]* and Johanna Mustelin[2]*

The international community's support for adaptation in developing countries has proliferated through numerous complementary funding mechanisms. A range of serious practical issues are emerging, however, as adaptation moves from theory and international negotiation to implementation. We identify three areas deserving greater scrutiny: in-country priorities, entry points and delivery systems, and provide recommendations for improving adaptation practice. These concerns, if not addressed, have the potential to hamper attempts at effective delivery and to increase the vulnerability of intended beneficiaries of the adaptation agenda.

The international community's commitment to helping developing countries to adapt has proliferated through many funding mechanisms including those under the United Nations Framework Convention on Climate Change and a range of bilateral and multilateral venues[1]. Large sums have been promised for both adaptation and mitigation through fast-start financing under the Copenhagen Accord to secure support for climate adaptation and vulnerability reduction[2]. Of the present 21 climate change funds, five focus exclusively on adaptation, with sub-Saharan Africa (44.1%), Asia and Pacific (27.2%) and Latin America and Caribbean (14.4%) commanding most of these funds[3]. There is no doubt that financing for adaptation is intensifying: the funding through the Green Climate Fund under Article 11 agreed at the seventeenth session of the Conference of Parties (COP 17) in Durban could even exceed total official development assistance[4] (ODA). COP 18 in Doha advanced these commitments with the aim of also fast-tracking the distribution of allocated funding to enable developing countries to undertake adaptation actions with heightened urgency. COP 19 in Warsaw recently negotiated these commitments further for the Adaptation Fund and Green Climate Fund with discussions on an additional institutional mechanism that could deal with loss and damage accruing from climate change.

Although concerns have been expressed about exactly what this money will be spent on[1], the pressing challenge for policymakers and practitioners is now to ensure that the process of adaptation implementation promotes robust and equitable outcomes. Furthermore, if additional funding is to be responsive to adaptation needs and priorities, practical considerations on the ground are crucial for effective delivery. Communities are already relocating from the Torres Islands in north Vanuatu[5] and the Carteret Islands in Papua New Guinea[6] owing to increases in the extent of diverse hazards, including rising tide levels. Adaptation challenges are unfolding as the agenda moves from theory and negotiation to implementation; they are unlikely to diminish in scale or importance, making practice paramount to adaptation. Discussion of practical issues concerning the actual implementation of adaptation is emerging yet it remains surprisingly rare. Here, we draw on recent literature and our own observations and experiences as adaptation researchers in East Africa[7–9], China[10] and the Pacific[11] to illustrate emerging concerns about how the adaptation agenda is being implemented in practice. We identify three broadly defined areas deserving greater scrutiny: addressing priorities through participation; identifying appropriate entry points and actors; and ensuring effective delivery. In doing so, we provide recommendations for improving adaptation practice and implementation processes with a particular focus on developing countries.

Addressing priorities through consultation and participation

Experiences of community-based adaptation in rural Vanuatu revealed situations where climate stress was not always judged to be a priority concern, resulting in low levels of interest in participatory activities[12]. As climate change is just one of many challenges in the developing world, it is entirely rational that immediate needs for wellbeing will take precedence over long-term risks. Although national adaptation programmes of action have increased the focus on urgent country priorities, it is unclear whether these display shared perceptions of urgency; a recent review of adaptation projects notes that some project consultations on national adaptation programmes included only experts and high-level government officials and hence did not necessarily align with or represent priorities and needs among the communities[13]. This raises the question of what is to be done in cases where an external organization's focus and funding differs from the priorities identified by communities[12]. Such situations can be addressed by allowing space for deliberation and wide participation when setting and implementing adaptation agendas. This has been widely argued for on the grounds of equity and fairness[14]; furthermore, we see many instances where, in practice, it is also critical for enhancing project delivery and acceptance. For instance, in the Pacific, there is an increasing realization that children and youth can and should be active actors in adaptation policy processes and that their participation has the potential to enhance the equity and intergenerational justice aspects of adaptation[11]. Such inclusion could be facilitated, for example, through requirements to include a youth representative in project and programme advisory boards and steering groups, committing a particular percentage of funds to specifically target youth engagement and participation, and having final project outcomes and associated products with youth-focused sections and content.

A strong external narrative of urgency around adaptation can also lead to maladaptation and hasty decisions given substantial uncertainties regarding the scale, timing and effectiveness of adaptation actions[15–18]. Slow-onset impacts can mean some communities are not immediately vulnerable, suggesting urgency to be a place-based and contextual factor. Uncertainty and the wide range of future climate

[1]Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science, Houghton Street, London WC2A 2AE, UK, [2]Postdoctoral Research Fellow Griffith Climate Change Response Program, School of Environment, Gold Coast Campus, Griffith University, Queensland 4222, Australia. *e-mail: d.conway@lse.ac.uk; j.mustelin@griffith.edu.au

change impacts, often fully understood or interpreted by only a small number of technical experts, allow future climate risks to be interpreted in various ways with potential for misuse. Those with power, such as governments, may use the threat of certain risks to justify policy objectives such as reservoir construction and even coercive actions including forced migration from areas at risk of inundation or in marginal environments. A growing concern is that adaptation policies can become more significant drivers of change than climate change impacts *per se*[11,19–20]. Moreover, in climate change hotspots such as Kiribati and Ethiopia, research fatigue is already evident where adaptation projects are mushrooming, based on the narrative of adaptation urgency with increased competition among actors. For example, overlapping research projects in Vanuatu are putting an additional strain on non-governmental organizations that are expected to have the time available to support different research initiatives. Care needs to be taken to ensure that rapid upscaling of research and programme activity builds on existing knowledge and is responsive to local priorities that are most pertinent to the beneficiaries in question.

Actors new to adaptation can easily underestimate its complexity as a policy- or agency-specific problem in their requirements for simplified messaging and information. Our experiences indicate that actors may expect climate modelling to show clear impacts so that they can channel their resources to those sectors and areas with certainty. This requires adaptation practitioners, in consultation with climate modellers and beneficiaries, to co-design carefully tailored information and data products, and reconcile end-users' expectations of certainty while being honest and explicit about the range of uncertainties associated with different climate scenarios. Knowledge brokers and boundary-level organizations are important in this process[21]. Safeguards and explicit mechanisms for consultation need to be designed into adaptation programmes, followed up by monitoring and evaluation of proposed policies and activities to ensure legitimacy and effectiveness, and help counter the potential for unintended consequences.

Identifying appropriate entry points and scales

Adaptation is: multiscalar, relevant at local, national and international levels; multi-actor, comprising actions throughout society[22]; and multitemporal, therefore requiring carefully structured responses. However, it is often framed as a local-level issue[15] and hence the responsibility for and implementation of adaptation is understood to rest with local governments, communities and households. Local priorities are often concerned with present climate hazards and, although we recognize this is a critical entry point for adaptation programmes, the likelihood of significant rapid warming and climatic disruption is increasing, such that incremental adaptation may be insufficient or in some cases even maladaptive. Yet, the longer term and most severe climate risks may lie beyond the capacity of individuals or communities to act on: they rest primarily with higher level agencies and the state. For example, sustainable risk-reduction efforts require the interest, engagement and commitment of the government[23]. Developing strategic long-term policy on coastal protection, early warning systems for large-scale hazards and building infrastructure are ultimately government-led or facilitated processes. These tensions over scale underscore the need to treat adaptation as a multilevel strategy that can consider both present variability and longer time scales and system transformation[24–26] where it moves beyond incremental adjustments.

Higher level institutions and planning processes therefore need to play an important role in design and coordination of multilevel and multisector actions. Most examples from the developed world show that potential adaptations identified by member countries of the Organisation for Economic Co-operation and Development focus on sector-based programmes with some cross-cutting areas and the establishment of formal co-ordinating mechanisms (high-level steering groups and lower level co-ordination units) with responsibility generally in environment ministries[27]. Examples of governance approaches in ten Organisation for Economic Co-operation and Development countries have been mainly soft and voluntary ways of steering, coordinating and addressing horizontal and vertical integration, knowledge management and wider participation[28]. New institutional structures are being created; in Ethiopia for example, responsibility for climate change has moved from the National Meteorological Agency into the Environmental Protection Agency, recently upgraded to a ministry, and framed in a cross-cutting programme entitled 'Ethiopia's Climate Resilient Green Economy'. However, the effectiveness of institutional structures in developed and developing countries has yet to be established as most strategies have only recently been introduced[29]. Indeed, reviews of actual adaptation actions in developed countries show that in most cases adaptation remains at the stage of policy and strategy development[30–32], highlighting a pressing need for practical examples. This has not prevented an explosion of policy frameworks, climate risk assessment guidelines and toolkits. End-users have expressed difficulty with tool access, selection and comparison, suggesting that there is a need for training and facilitation and that gaps exist between assessment and action[33]. There is a very real danger that large funding streams targeted specifically at adaptation may disrupt delivery pathways for ODA, which have the established sectoral expertise (agriculture, forestry, water, energy) essential to achieve effective outcomes. For example, there is a need to reconcile ODA investments in water resources development projects with adaptation investments in climate resilient water resources. Most adaptation actions rarely address just climate change; they are responding to many influences. Therefore entry points need to align with existing policy and management portfolios and, depending on context, delivery should be through channels with recognized expertise.

Strengthening delivery systems for sustainable adaptation

An index of the countries most vulnerable to climate change shows that many rank poorly on a widely used global corruption index[34]. Moreover, some of the sectors most likely to attract adaptation programmes such as forestry and water, are also those subject to higher rates of corruption[34]. Evidence of extensive corruption in post-disaster response in Bangladesh provides a cautionary tale about the design and delivery of adaptation programmes[35] and supports calls for "checking how the money is spent; and to checking the checkers"[34]. The risk of corruption, the narrative of urgency and the rapid disbursement of funding highlight the need for, but relative absence of, indicators and means for monitoring, reporting and verification of adaptation[36]. This is compounded by its fuzzy nature, to the extent that scholars are still discussing what successful adaptation might look like[37]. Progress is being made[38], but a pragmatic balance needs to be found between the complexity of deriving counter-factuals for avoided costs and damages, and the practical realities of decision-making on the ground.

In terms of sustainability it should be a basic principle that adaptation options are assessed in terms of their carbon cost in both developing and developed countries. We call for the development and prioritization of metrics that incorporate adaptation emissions intensity, whereby a ratio of project costs or benefits relative to greenhouse gas emissions should strongly influence the selection of adaptation options, alongside other criteria. Accounting should include and challenge, for example, the high number of flights often associated with technical assistance and frequent project workshops, embedded emissions in infrastructure and operational energy requirements (for example, desalination, air conditioning). These considerations could even stretch to the design of adaptation offset opportunities, mirroring carbon offsets but for adaptation purposes, designed to provide a greater impact on poverty reduction than can be easily achieved through mitigation in developing countries, where emissions are generally low and closely linked to essential aspects of wellbeing.

Metrics are also important for debates about loss and damage, which gained official status in the United Nations Framework

Convention on Climate Change following the COP 16 in 2010, although it lacks a clear official definition and has been framed both as a technical concept (relating to tools and processes) and as political dimension of the negotiations[39]. As separation of anthropogenic climate change and climate variability is difficult to establish[40] and data are often unavailable, inaccessible or unusable, it is extremely challenging to quantify costs of and attribute responsibility for adaptation alone[41]. The emerging mechanisms and discussions around loss and damage demonstrate the difficulty of understanding and evaluating what exactly has been lost, or may be potentially lost, and what part adaptation can realistically play in tackling some of these processes of irreversible change. Such mechanisms need to avoid generating perverse incentives where climate change is blamed for damages or problems resulting from other causes or interactions thereof, something we believe is already happening. Constructing baselines and defining attribution with due consideration of uncertainties are therefore key issues that loss and damage must address to provide a robust mechanism that enables countries to choose what should be maintained and how to account for losses accruing from anthropogenic climate change.

Effective delivery is also dependent on the capacity both of actors on the ground and the processes through which adaptation is designed. Stronger incorporation of country representatives in adaptation projects can increase the capacity of actors to ensure that the set priorities are relevant. Greater involvement in project preparation processes can also reduce confusion around core concepts and climate–society interactions, as has been found in Jakarta and Vietnam[42]. Owing to its somewhat fuzzy nature, the capacity of state and non-governmental organization field staff to understand the practical implications of adaptation deserves more attention in terms of their day-to-day roles and how to measure success therein. Poorly communicated and unfocused new policy and management agendas, with badly targeted training and capacity-building efforts, can generate low task specificity, undermining job satisfaction and productivity[43]. This requires careful alignment between theory and agency operating procedures, for example, to address mismatch between how state agencies are designed and how proposals for adaptive governance are framed at present[44]. Our experiences indicate that, in some cases, the adaptation agenda is strongly driven by external actors other than governments. This has resulted in many—at times, confusing and overlapping—messaging frameworks about vulnerability, adaptation and risks, which are not context-sensitive, do not support a coordinated approach and are not necessarily based on country priorities and needs. The responsibilities and duties surrounding the communication of climate change issues are very important and contain a strong ethical dimension[45]. In communicating climate change risks, greater focus is required on enhancing the capacity to act and providing opportunities to respond.

Many projects include capacity-building components that are supposed to contribute to the ability within countries to deliver adaptation. Unfortunately several experiences indicate that such capacity-building receives a relatively low role in project and programme budgets compared with technical assistance, which equates to external assistance delivered by consultants[46]. This imbalance poses a further problem as assessments and projects conducted by external consultants often lack the time to develop a stakeholder-oriented understanding of present vulnerabilities and cultural context, and hence adaptation remains detached from local realities and ownership. Part of this dilemma results from terms of reference as these often require short turnaround for deliverables and insufficient time to allow for participatory processes and credible capacity-strengthening. Experience from community-based adaptation projects in Fiji suggests that local researchers and facilitators play a more effective role than visitors in engaging communities, owing to the existing familiarity in terms of language skills and greater awareness and understanding of how to conduct culturally sensitive research and the implications of governance arrangements[47]. An emerging problem relates to data-sharing agreements, where data following project completion often remain with the external funding body and are not available to country representatives. Experiences demonstrate the reluctance of external actors to release indicators used in constructing national vulnerability assessments, leaving stakeholders puzzled as to how the results have been derived and on what basis. Longer timeframes may be required for adaptation project design and initiation, as well as clear agreements on what constitutes capacity-building and how data and results are managed and shared after project or programme completion.

Towards more effective adaptation practice

Practical issues are becoming increasingly important in the delivery of a robust climate change adaptation agenda. Yet so far only limited attention has been paid to how these issues percolate and manifest themselves in the design and implementation of adaptation on the ground. Here we offer several strategies to address some of these problematic issues in adaptation research and practice. Ensuring effective delivery may require longer timeframes for adaptation project design and initiation, counter to narratives of urgency. This requires the development of longer term strategies and programmes rather than the present project-based approach, which expects adaptation to happen within the one- to three-year project cycle. The commitment of all parties to long-term partnerships is crucial. In climate change hotspots, overcoming project fatigue and duplication of efforts could be managed through the establishment of clearing houses, which provide a platform to gather past and ongoing adaptation initiatives and examples of adaptation in practice, and emphasise country- and region-specific adaptation priorities (for example, AidData, a programme used to geocode and map development projects by development agencies: http://go.nature.com/sJkJDQ). Such clearing houses enable the measurement and evaluation of past initiatives, provide information on present and planned activities, and make data and information available. With sustained support, learning cycles can be used to improve future initiatives.

Researchers and practitioners should pay attention to how the goals of adaptation become formulated and by whom; this includes examining who is best placed to lead or facilitate adaptation and who has the responsibility to communicate climate change information. Countries experiencing fast growth in research initiatives on climate adaptation should consider integration with existing national research frameworks, which clearly articulate needs but also provide guidelines on entry points and preferred channels for initiating activities within the country.

Closer alignment of adaptation priorities may also be achieved through the use of regional advisory groups for discussions about project and programme needs. In cases where such regional representative bodies exist, such as the Melanesian Spearhead Group (http://www.msgsec.info/), these could provide grounded views on member country priorities and a venue for broader scale negotiation between the many stakeholders concerned with the delivery, implementation and design of adaptation policies and programmes. Regional roundtables, such as the Pacific Roundtable on Climate Change, can also provide an important venue for multipartner discussions and increase coordination and partnership approaches. Multipartner, multisectoral initiatives such as the Choiseul Province project (http://go.nature.com/TiicyA), which bring together partners through landscape approaches (ridge-to-reef), show promise for changing the present siloed and overlapping approaches. At the country level, coordination bodies such as the Vanuatu National Advisory Board on Climate Change and Disaster Risk Reduction (http://www.nab.vu/) and Ethiopia's Climate Resilient Green Economy also offer promise. Such mechanisms have the potential to reduce overlap, enhance cross-sectoral policy coherence and

provide more certainty in terms of agreed priorities; however, as soon as possible, lessons need to be identified from experiences in governance and institutional approaches to adaptation. Wider insights from international development are also useful, as in the case of designing climate finance[4]. Increased focus also needs to be paid to capacity on district and local levels as this is where the responsibility for implementation is channelled owing to the present perception of adaptation being a local issue. Greater consideration of project and programme budgets is required on in-country capacity-building such as training of policy officers/public servants charged with implementation. This entails careful targeting, as universal training may not be cost-effective and demands credible forms of support to achieve demonstrable outcomes in staff capacity. Entry points also need to be multilevel, as many examples of adaptation involve planning and strategic-level action.

Prioritization of the aspirations and needs of beneficiaries in adaptation is not guaranteed. It requires strong political will and alignment of aims. However, it can be promoted through sustained international effort and embedded in programme design. Providing space for a more measured approach to making the adaptation agenda operational, with greater consideration of policy fit and entry points, supported by more robust indicators that incorporate adaptation emissions intensity, will go some way to ensure that the resources spent secure numerous goals and rights in a just and sustainable manner.

Received 26 October 2013; accepted 19 March 2014; published online 25 April 2014

References

1. Law, E. A., Thomas, S., Meijaard, E., Dargusch, P. J. & Wilson, K. A. A modular framework for management of complexity in international forest-carbon policy. *Nature Clim. Change* **2,** 155–160 (2012).
2. World Resources Institute *Summary of Developed Country 'Fast-Start' Climate Finance Pledges* (World Resources Institute, 2012); http://go.nature.com/ce5LoP
3. http://www.climatefundsupdate.org/.
4. Donner, S. D. *et al.* Preparing to manage climate change financing. *Science* **334,** 908–909 (2011).
5. Ballu, V. *et al.* Comparing the role of absolute sea-level rise and vertical tectonic motions in coastal flooding, Torres Islands (Vanuatu). *Proc. Natl Acad. Sci. USA* **108,** 12967–12968 (2011).
6. Connell, J. Population resettlement in the Pacific: Lessons from a hazardous history? *Aust. Geogr.* **43,** 127–142 (2012).
7. Conway, D. From headwater tributaries to international river basin: Adaptation to climate variability and change in the Nile River basin. *Glob. Environ. Change* **15,** 99–114 (2005).
8. Mustelin. *et al.* Understanding current and future vulnerability in coastal settings: Community perceptions and preferences in Zanzibar, Tanzania. *Popul. Environ.* **31,** 371–398 (2010).
9. Conway, D. Adapting climate research for development in Africa. *WIREs Clim. Change* **2,** 428–450 (2011).
10. Ju, H. *et al. Adaptation Framework and Strategy Part 3: An Adaptation Strategy for Agriculture in Ningxia, Northwest China* (AEA Group, 2008).
11. Burton, D. *et al. Climate Change impacts on Children in the Pacific: Kiribati and Vanuatu* Technical Report (UNICEF, 2011).
12. Reid, H. *et al.* in *Understanding Climate Change Adaptation: Lessons from Community-Based Approaches* (eds Ensor, J. & Berger, R.) 11–30 (Practical Action, 2009).
13. Sherman, M. & Ford, J. Stakeholder engagement in adaptation interventions: An evaluation of projects in developing nations. *Clim. Policy* http://doi.org/r45 (2013).
14. Adger, W. N., Paavola, J., Huq, S. & Mace, M. J. (eds) *Fairness in Adaptation to Climate Change* (MIT Press, 2006).
15. Preston, B., Mustelin, J. & Maloney, M. Climate adaptation heuristics and the science/policy divide. *Mitig. Adapt. Strat. Glob. Change* http://doi.org/r46 (2013).
16. Barnett, J. & O'Neill, S. J. Maladaptation. *Glob. Environ. Change* **20,** 211–213 (2010).
17. Barnett, J. & O'Neill, S. J. Islands, resettlement and adaptation. *Nature Clim. Change* **2,** 8–10 (2012).
18. Patt, A. Multi-level climate adaptation policy and causation narratives. *Geogr. Tidsskr.* **112,** 174–182 (2012).
19. Mortreux, C. & Barnett, J. Climate change, migration and adaptation in Funafuti, Tuvalu. *Glob. Environ. Change* **19,** 105–112 (2009).
20. Birkmann, J. First- and second-order adaptation to natural hazards and extreme events in the context of climate change. *Nat. Hazards* **58,** 811–840 (2011).
21. Hedger, M. M., Connell, R. & Bramwell, P. Bridging the gap: Empowering decision-making for adaptation through the UK Climate Impacts Programme. *Clim. Policy* **6,** 201–215 (2006).
22. Adger, W. N., Arnell, N. W. & Tompkins, E. L. Successful adaptation to climate change across scales. *Glob. Environ. Change* **15,** 77–86 (2005).
23. World Bank *Reducing the Risk of Disasters and Climate Variability in the Pacific Islands, Papua New Guinea Country Assessment* (World Bank/SOPAC/GFDRR, 2009); http://go.nature.com/qkE2Ei
24. Kates, R. W., Travis, W. R. & Wilbanks, T. J. Transformational adaptation when incremental adaptations to climate change are insufficient. *Proc. Natl Acad. Sci. USA* **109,** 7156–7161 (2012).
25. Smith, M. S., Horrocks, L., Harvey, A. & Hamilton, C. Rethinking adaptation for a 4 C world. *Phil. Trans. R. Soc. A* **369,** 196–216 (2011).
26. Park, S. E. *et al.* Informing adaptation responses to climate change through theories of transformation. *Glob. Environ. Change* **22,** 115–126 (2012).
27. Mullan, M., Kingsmill, N., Kramer, A. M. & Agrawala, S. *National Adaptation Planning: Lessons from OECD Countries* No. 54 (OECD, 2013).
28. Bauer, A., Feichtinger, J. & Steurer, R. The governance of climate change adaptation in 10 OECD countries: Challenges and approaches. *J. Environ. Policy Planning* **14,** 279–304 (2012).
29. Huntjens, P. *et al.* Institutional design propositions for the governance of adaptation to climate change in the water sector. *Glob. Environ. Change* **22,** 67–81 (2012).
30. Preston, B., Westaway, R. & Yuen, E. Climate adaptation planning in practice: An evaluation of adaptation plans from three developed nations. *Mitig. Adapt. Strat. Glob. Change* **16,** 407–438 (2011).
31. Tompkins, E. L. *et al.* Observed adaptation to climate change: UK evidence of transition to a well-adapting society. *Glob. Environ. Change* **20,** 627–635 (2010).
32. Berrang-Ford, L., Ford, J. D. & Paterson, J. Are we adapting to climate change? *Glob. Environ. Change* **21,** 25–33 (2011).
33. Hammill, A. & Tanner, T. M. *Harmonising Climate Risk Management: Adaptation Screening and Assessment Tools for Development Co-operation* OECD Environment Working Paper 36 ENV/WKP 6 (OECD, 2011).
34. Petherick, A. Dirty Money. *Nature Clim. Change* **2,** 144–145 (2012).
35. Mahmud, T. & Prowse, M. Corruption in cyclone preparedness and relief efforts in coastal Bangladesh: Lessons for climate adaptation? *Glob. Environ. Change* **22,** 933–943 (2012).
36. Brooks, N. *et al. Tracking Adaptation and Measuring Development* (IIED, 2011).
37. Moser, S. & Boykoff, M. (eds) *Successful Adaptation to Climate Change: Linking Science and Policy in a Rapidly Changing World* (Routledge, 2013).
38. Lamhauge, N., Lanzi, E. & Agrawala, S. The use of indicators for monitoring and evaluation of adaptation: Lessons from development cooperation agencies. *Climate and Development* **5,** 229–241 (2013).
39. Surminski, S. & Eldridge, J. *Observations on the Role of the Private Sector in the UNFCCC's Loss and Damage of Climate Change Work Programme* Working Paper 142 (Grantham Research Institute on Climate Change and the Environment, 2013).
40. Hulme, M., O'Neill, S. J. & Dessai, S. Is weather event attribution necessary for adaptation funding? *Science* **334,** 764–765 (2011).
41. Hartzell-Nichols, L. Responsibility for meetings the costs of adaptation. *WIREs Clim. Change* **2,** 687–700 (2011).
42. Van Aalst, M. K., Cannon, T. & Burton, I. Community level adaptation to climate change: The potential role of participatory community risk assessment. *Glob. Environ. Change* **18,** 165–179 (2008).
43. Hepworth, N. *A Progressive Critique of IWRM in Sub-Saharan Africa: Beyond Capacity Towards Self-Determined Regulatory Personality* PhD thesis, Univ. East Anglia (2009).
44. Wyborn, C. & Dovers, S. Prescribing adaptiveness in agencies of the state. *Glob. Environ. Change* **24,** 5–7 (2014).
45. UNESCO *World Commission on the Ethics of Scientific Knowledge and Technology: A Framework of Ethical Principles and Responsibilities for Climate Change Adaptation* Adopted at the 7th ordinary session of the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) in Doha, Qatar (9–12 October, 2011).
46. Mustelin, J. *et al.* Climate adaptation research for the next generation. *Climate and Development* **5,** 189–193 (2013).
47. Dumaru, P. Community-based adaptation: Enhancing community adaptive capacity in Druadrua Island, Fiji. *WIREs Clim. Change* **1,** 751–763 (2010).

Additional information

Reprints and permissions information is available online at www.nature.com/reprints. Correspondence and requests for materials should be addressed to D.C. and J.M.

Competing financial interests

The authors declare no competing financial interests.