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ORIGINAL ARTICLE

Normative scenario approach: a vehicle to connect adaptation planning and development needs in developing countries

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Abstract Climate change adaptation is one of the many development challenges impacting livelihoods in developing countries. Scenario approaches are useful in adaptation planning by putting together projected climate change and socioeconomic trends with broader development needs when identifying associated priorities—and using them to develop appropriate strategies, plans and initiatives. To date, explorative scenario approaches have been largely adopted in adaptation planning. In this paper, we determine the benefits of using normative scenario approaches. They include a process known as "backcasting," which is particularly useful for areas where adaptation planning and actions are strongly intertwined with development planning, and considerable efforts are needed to improve the well-being of the people living in those areas. We show the relevance of backcasting by presenting three case study applications in the following developing countries: Ghana, Honduras and Tajikistan. The results of these case studies indicate that backcasting has specific relevance for adaptation planning, including capacity building and awareness raising to contextualize information on climate impacts with stakeholders' development needs. Our results also indicate that the developed scenarios provided benefits in promoting horizontal and vertical integration, thus bringing together diverse sectorial and sub-national priorities—adaptation options can thereby be aligned with these needs. Finally, use of the scenarios advances countries' participation in national and multi-country adaptation projects by targeting actions that provide multiple benefits.

Keywords Normative scenario approach · Backcasting · Adaptation planning · Stakeholder participation · Development

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Introduction

Policy-makers worldwide are recognizing the importance of tackling adaptation to climate change not only by identifying potential adaptation options but also by developing targeted adaptation strategies, projects and initiatives (Brown 2011; Adger et al. 2011). According to the United Nations Intergovernmental Panel on Climate Change's reports (Adger et al. 2007; IPCC 2012), governments need to consider a range of decision-making support tools and approaches to identify actions that reduce climate risks by connecting these to the broader context and patterns of stressors that affect countries and regions. This indicates that such adaptation planning processes and implementation efforts need to both provide a broad diagnosis of the development choices available and identify a range of responses from capacity building and institutional changes to infrastructure development and ecosystem-based

Table 1 Overview of relevant applications of scenario approaches to adaptation planning

Study location	Goals of the scenario approach	Scenario approach				Scale		
		Approach taken (E = exploratory, N = normative)	Climate change impacts advancement[a]	Stakeholders' involvement	Quantification of scenarios	National	Sub-national	Local/ municipal
Canada (Langsdale et al. 2009)	To raise awareness and to improve understating of consequences of climate change on water resources and of possible policy choices	E	X	X	X			X
Canada (Shaw et al. 2009)	To build capacity of policy-makers to understand the implications of climate change in the local context and to explore ways of downscaling global climate and socioeconomic scenario to the local levels and developed novel commutation tool e.g., visualizations	E	X	X	x			X
Canada (Bizikova and Hatcher 2010)	To identify adaptation options, synergies and trade-offs between development priorities and adaptation and explore institutional measures to facilitate the integration of adaptations into policies	N		X			X	
The Netherlands (Valkering et al. 2011)	To raise awareness and explore perspectives on water management in the past, present and future	E		X	x		X	
Finland (Carter et al. 2005)	To identity adaptations to climate change and their consequences for society, economy and environment	E	X	X	X	X		
Sweden (Carlsen et al. 2012)	To facilitate the engagement of decision-makers working on climate change adaptation and to help analyze impacts of climate change and responses in a structured way	E		X			X	X
United Kingdom (Tompkins et al. 2008)	To use scenario to guide stakeholders' engagement and to assist in identifying trade-offs associated with coastal planning in the context of climate change	E		X	x		X	
Europe (Harrison et al. 2013)	To build capacity and to help identify adaptations consistent with the socioeconomic scenarios	E	X		X	X[b]		

[a] To provide input for the scenario process, additional work on estimating climate change impacts was conducted

[b] Continental focus on whole Europe

measures (Birkmann 2011; Næss et al. 2005; World Bank 2009). This will require integrating not only the expected changes in climate, but also the expected socioeconomic trends and environmental conditions at various scales (van Aalst et al. 2008; Brown 2011; OECD 2006).

The recent research emphasizes the important role of scenario approaches in adaptation planning (e.g., Carlsen et al. 2012; Tschakert and Dietrich 2010; IPCC 2012). We define a scenario as a story about the future that can be told in both words and numbers, offering a plausible and internally consistent explanation of how events might unfold over time (Raskin et al. 2002). The literature distinguishes two types of scenarios: explorative, which envision how the future may evolve, and normative or backcasting, which develop solutions necessary to achieve a specific, preferred future (Kanyama et al. 2008; Robinson et al. 2011). Current uses of scenarios in adaptation planning are mostly focused on explorative approaches in developed countries at the national and sub-national levels, including Canada, Finland, the Netherlands, Spain, Sweden, the United Kingdom and Europe (Carter et al. 2005; Shaw et al. 2009; Langsdale et al. 2009; Tschakert and Dietrich 2010; Carlsen et al. 2012; Kok et al. 2007; Valkering et al. 2011; Harrison et al. 2013; Tompkins et al. 2008; Bizikova and Hatcher 2010). These scenario approaches combine stakeholder participation with considerable information on climate change impacts and other quantitative approaches to provide inputs to adaptation planning (Table 1). In terms of relevance to adaptation planning, Carlsen et al. (2012) distinguished three major roles for scenarios: (1) identifying future socioeconomic challenges; (2) identifying socioeconomic changes important for dealing with climate change impacts; and (3) identifying appropriate adaptation options. From these three broad categories, recent applications have mostly focused on identifying socioeconomic challenges, such as growing population, urbanization and demand for food (Shaw et al. 2009; Langsdale et al. 2009; Tompkins et al. 2008; Harrison et al. 2013), changes in tourism (Carlsen et al. 2012), policy development and governance (Valkering et al. 2011) and identifying appropriate adaptation strategies in the context of future climate scenarios and these challenges. In these applications, scenarios were built on strong quantitative foundations and repeated stakeholders' participation to serve as learning and capacity-building tools for stakeholders and decision-makers to improve their understanding of consequences of climate change at the local level and to help identify potential policy choices in the future (Tompkins et al. 2008; Shaw et al. 2009).

Many developing countries face significant challenges in advancing their adaptation efforts while improving well-being. There is a growing need to mainstream adaptation into projects on infrastructure, resource management and other projects and initiatives often supported by international agencies (OECD 2006; Biesbroek et al. 2011). In this context, mainstreaming is seen as an informed inclusion of relevant climate change impacts and adaptation concerns into the decisions of institutions that drive national, local and sectoral development policy, rules, plans, investment and action (Kok and de Coninck 2007). So far, adaptation policies of least-developed countries have been guided by priorities outlined in National Adaptation Programs of Action (NAPAs), which adopt a sectoral approach without explicitly indicating how mainstreaming of these actions into development planning will be achieved. Such an approach to adaptation policies and actions may impact other sectors and have negative (or positive) spillover effects on other sectors and at other scales (Osbahr et al. 2010) and in the context of other stresses. In this context, normative scenario approaches can help bridge development priorities and planned adaptation options. Schröter et al. (2005), van Aalst et al. (2008) and Tschakert and Dietrich (2010) already stressed the importance of normative scenario approaches that improve the current practice by including socioeconomic trends and development challenges when designing adaptation strategies. Finally, some developing countries have already started using normative scenario approaches to explore future development pathways. For example, future development visions were developed in Rwanda (*Rwanda Vision 2020* in Republic of Rwanda 2000), at the national and community level in Kenya (*Kenya Vision 2030* in Government of the Republic of Kenya 2007; Ambani M Percy 2012), and at the regional level for Africa as a whole on food security (Chaudhury et al. 2013); however, these scenarios do not consider mainstreaming climate change and adaptation into development priorities and potential future pathways.

Explorative scenario approaches tested in developed countries can provide useful insights into mainstreaming development and sectorial priorities with adaptation needs; however, these applications were developed with access to modeling tools and data capacity, as well as access to significant resources. The aim of this paper is to present a normative scenario approach and to explore its relevance as a tool well suited to prioritizing and mainstreaming climate change adaptation and development measures to guide adaptation planning in data-scarce environments. We illustrate this relevance by synthesizing lessons learned from three case studies focused on Ghana, Tajikistan and Honduras where this normative approach was applied. Specifically, we focus on exploring the contribution of this scenario approach to mainstreaming climate change adaptation in (1) assisting in communication, knowledge exchange and capacity building; and (2) facilitating the establishment of linkages between climate change impacts

and adaptation and development needs both at the horizontal (e.g., from the national to sub-national and vice versa) and vertical (e.g., across sectors) levels. We conclude this paper by summarizing future research needs for the applications of scenarios in adaptation planning in developing country contexts.

Methodological approach and its applications in the three cases

Compared to other recent initiatives that focused on the use of explorative scenarios to better understand what can happen based on assumptions about key drivers (Carlsen et al. 2012), the methodology in the three cases was based on a normative, backcasting approach, which is well suited to exploring the desired development requirements, pathways and adaptation needs relevant for different stakeholders groups. In this context, the purpose of our methodological approach was to help local stakeholders anticipate and understand the consequences of climate change in the context of desired and plausible socioeconomic futures and development needs, and to identify adaptations in the participating countries. In order to achieve this purpose, we built on a number of sources outlining key methodological steps in backcasting (Kok et al. 2007; Patel et al. 2007; Volkery et al. 2008; Robinson et al. 2011). We evolved these existing normative approaches in order to construct a qualitative scenario process in the absence of sufficient data and technical resources. In this section, we present our methodological approach to backcasting by illustrating each step and then providing specific details on its application in the three countries.

Initiating the scenario process

Similarly, to other participatory processes, such as community-based adaptation (CbA), scenario processes need to be planned in advance, including decisions about how qualitative information will be generated and used, and how the different stages of the process build on each other (e.g., see Dumaru et al. 2010). An initial set of local stakeholders need to be consulted to provide advice and contact information on other local experts, similar to a "snowballing" interview process, to help identify local sites for qualitative data collection by using, for example, interviews or surveys. Stakeholders may also point out available climate projections and other local data needed for modeling, and preferred ways of conducting scenario development. Prior to the launch of the scenario approach, qualitative and quantitative background information was collected. Overview of the collected information per case study is presented in Table 2. Specifically, projections for basic climatic variables were provided by local organizations in Tajikistan, experts from a local university provided vulnerability maps and inputs for climate change impacts assessment on crop production in Honduras, and potential climate change impacts on infrastructure in Ghana. Additional information on experience with coping and adaptation strategies in Honduras and Ghana, as well as information on institutional capacity in Tajikistan was collected prior the scenario process. Finally, key sectors and socioeconomic trends for the scenarios were identified at the beginning and modified during participatory workshops (Table 2).

In all the countries to improve the quality of the results, multiple workshops were conducted. To make such scenario process effective, the workshops need to follow the same methodology with skilled facilitators. In most countries, local organizations, facilitators and consultants are available with experience in facilitating various participatory methods, such as running local consultations, poverty appraisals and livelihood assessments. We worked with such facilitators through a weeklong 'training of trainers' event to review the workshop methodologies in detail, to train facilitators in the various details of scenario workshop delivery, to discuss possible outcomes and to review the reporting and documentation of results. During this week, the would-be backcasting workshop facilitators also participated in a mock-up workshop with participants, to help them anticipate and successfully handle a variety of possible situations in a no-risk learning environment.

Applying backcasting in participatory sessions

Qualitative scenarios were developed based on participants' understanding of the system, as discussed in small groups and plenary sessions and guided by input from relevant experts and facilitators. Secondary data was used to describe current development trends and climate change projections to help inform participants' desired future as well as adaptation pathway. During the design of the scenario process, we focused on creating opportunities to identify trends that are not only related to climate change, but which might strongly affect the severity of future impacts and needs for adaptation (e.g., deforestation in upper watersheds; migration of particular social groups from the community; possible changes in market prices of key corps and land). The scenario framework was applied in various workshop settings, including national and sub-national workshops in each country. The length of the workshops ranged from 1 to 3 days. Each workshop had anywhere between 15 and 65 participants, including policy-makers, academics and researchers, community leaders, civil society, government and donor representatives.

Table 2 Overview of key goals, input information and applied quantitative and qualitative methods within the scenario development in the three case studies

Case study	Goals for the scenario process	Inputs for the scenarios including key constraints		
		Development trends	Climate change impacts	Experiences with adaptation
Ghana	To help anticipate and understand the consequences of climate change in the context of desired and plausible socioeconomic scenarios and development needs (Yaro 2011) To provide context for stakeholders to identify and prioritize relevant adaptation options over time (Yaro 2011) To validate and complement analysis and estimates provided by the sectoral economic analyses assessing the costs of adaptation (World Bank Group 2010)	Population projections; urbanization rate	Climate change projections on key climatic variables (temperature, precipitation, hydrological changes and changes in growing seasons) and impacts on crops, flooding and impacts of infrastructure	Surveys on vulnerability and adaptation, coping strategies in vulnerable areas "hotspots" of the country
Honduras	To identify goals and priorities for sustainable agricultural development with focus on crop production in the context of climate variability and change To prioritize possible climate risk management options (infrastructure, ecosystems-based, technology, capacity) that are most relevant for the development To discuss the feasibility of those options (possible consequences and trade-offs) and identify policies, programs and plans and intervention are needed (UNDP, BCPR 2012; Rivera Sosa 2009)	Populations, life expectancy, agricultural supply and demand, urbanization rates and resource demands (water, land)	DSSAT focused on key crops such as maize and beans for 14 municipalities across Honduras using information on land-use, soil temperature and water availability, and planting practices such as row spacing, planting depth and climate projections.	Review of planning documents Assessments of local vulnerabilities, current and potential future adaptations in 20 villages using CRiSTAL (IISD 2011)
Tajikistan	To assist in linking development needs with adaptation priorities in the context of climate change To validate the priority areas in the SPCR to ensure that the identified priorities are in-line with the needs and capacities of the communities and identify capacity gaps To complement the SPCR with activities that are considered crucial from the stakeholders' perspective to increase capacities to adapt and in the context of other development priorities (Bizikova 2012)	Population projections, agricultural supply and demand; life expectancy and poverty levels	Climate change projections on basic climatic variables such as temperature and precipitation and impacts on glaciers	Review of institutional capacities on adaptation Series of interviews to review current adaptation projects, available capacities and gaps

SPCR strategic program for climate resilience, *DDSAT* decision support system for agrotechnology transfer

Although the nature of each backcasting workshop differed slightly, reflecting the different case studies, all followed a similar overall structure. This included eight key steps, moving from the identification and discussion of development challenges and drivers of desired future scenarios to the identification and discussion of impacts of climate change and relevant adaptation options and pathways.

1. *Introductions, context setting and overview of the day*: The workshops opened with an introduction to the overall focus of the workshop and a detailed review of the planned activities.
2. *Review of the current situation*: Participants were invited to discuss the driving forces of current development within their country/region, including agricultural change, urbanization and use of natural resources. Depending on the perceived magnitude of current climate-related issues, key drivers of change often included existing levels of flooding, drought and extreme weather events. From this, key sectors and/or geographic regions of greatest concern to participants considering current and future changes in climate were identified.
3. *Develop a vision of the future*: Participants were then divided into groups based on either geographic region or economic sector (e.g., forestry, fisheries, agriculture) and asked to develop a detailed future vision of their region/sector using their expert and/or local knowledge (e.g., see Kok et al. 2007). Usually, one scenario was developed during the sub-national workshop and up to two scenarios in the national workshops. Participants were encouraged to develop their desired futures without specific consideration of climate change but rather their knowledge and awareness of all development trends and challenges in their targeted region or sector. Using a process of backcasting, participants worked backwards from their desired future identifying a series of policies and actions that can be used to achieve the vision (Robinson 2011).
4. *Challenge the vision with a set of contains—climate and socioeconomic*: This step is centered on the recent advances in scenario planning which emphasize the importance of bringing together diverse type of relevant information and data to be assessed by groups of stakeholders for needed actions from their perspective (Chaudhury et al. 2013). In this context, the identified scenarios, or visions, were carefully examined by the workshop participants for their resilience and ability to stand up to "What if?" questions that raised the specter of significant and hard to foresee shocks to the system that can be considered 'black swans' from the perspective of the current knowledge of future climate and socioeconomic trends. For example, what if annual rainfall declines over the next 20 years? Or what if twice as many people will be living in the area/city compared to the present? The ensuing discussion encouraged participants to identify first-, second- and third-order impacts of such changes, creating a number of plausible impact chains for each scenario. In order to inform this discussion, participants were provided with summaries of available information through expert presentations and handouts. The result was an evaluation of the attainability of the desired future conditions given a set of identified constraints.
5. *Identify, review and evaluate impacts and adaptation options*: We continued working with the impact chains created for each scenario, and participants focused on identifying adaptation options to reduce or minimize any adverse impacts, as well as on strengthening any positive impacts. Recommended adaptation options were meant to increase the resilience and reduce the vulnerability of the constructed development pathways under the presented constrains, for example, in the context of projected changes in rainfall because of climate change, expected population growth and urbanization rate, as relevant for a specific case study. If the impacts were considered too severe within a particular scenario, the scenario was considered unsustainable i.e., not resilient enough in the context of the impacts over the applied time horizons. The case studies applied a different timescale on an average horizon from 2040 to 2050, within which short-term measures were considered as those required within the next 5 years (up to 2015), medium-term measures were those required the next 10–15 years (up to 2030), and the long-term horizon included measures required up until 2050.
6. *Develop adaptation pathways*: After identifying adaptation options, groups focused on extracting a series of actions that they deemed to be crucial for the future resilience of each scenario in the context of projected socioeconomic and climate change. These actions can include the adaptation options identified in the previous step, but also the elements of the created future scenarios important for the overall resilience of the scenario. During this step, we compiled the actions across all the groups based on plenary group reports to create a set of actions that were robust across all different scenarios. The participants were then asked to identify short-term priorities linked to current or ongoing initiatives within the region/country that they were aware of, followed by recommended actions that are needed to achieve the longer-term goals.

7. *Reporting back from groups and discussion*: In this session, participants presented their prioritized adaptation options at different timescales as developed in respective groups. The purpose of the session was to help create cross-sectorial adaptation pathways to demonstrate priority interventions across regions or sectors. Participants were encouraged to then cluster similar actions and explore synergies and minimize trade-off in related sectors such as agriculture, water management and food security.
8. *Plenary discussion and reflection on the process*: The final session provided opportunities for the participants to reflect on the process and discuss issues that emerged during the workshop. We concluded the workshop with participants completing a workshop evaluation questionnaire.

Scales and scope of backcasting applications in the three case studies

The case studies in all three countries took place between 2010 and 2012 were supported by international donors such as by the World Bank in Ghana, and UNDP in Honduras and Tajikistan; the scenario approach was led by the International Institute for Sustainable Development (IISD) in collaboration with a number of organizations in each of the countries and the funders. The case studies were implemented in partnerships between the international donors, the IISD and relevant ministries and academic, non-governmental organizations in the three countries. Overview of the applications in the three case studies is summarized in Table 2.

In each of the countries, the workshop focused on key sectors related to land-use, resource management, agriculture and access to basic services. Every case study required special attention to assess the situation of the poor and vulnerable people's specific adaptation needs pertaining to the created scenarios. The methodology was applied at different scales and with different foci in the three case study areas that are presented in Table 3.

In terms of specific application, two national and two sub-national scenario development workshops were conducted in Ghana. In each of the workshops, a scenario was produced. Each workshop had approximately 20–40 participants, including representatives of the national and sub-national governments and of local and international organizations. As well, community members, chiefs, farmers, academics and experts in resource management attended. In Honduras, scenarios centered on agricultural development that brought together climate projections with the results of crop modeling and local consultations. The two workshops—national and regional—involved approximately 60 stakeholders, including farmers, academics, resource managers, decision-makers and sector experts at the sub-national and national levels. Two scenarios were developed at the national workshop as well as two scenarios during the regional workshop. In Tajikistan, six scenario workshops took place. Two national scenarios were developed during the national workshop, and five regional scenarios were developed during each of the five regional workshops. In the workshop, about two-thirds of the participants represented local, sub-national or national government, academics or other research staff affiliated with a university or institute. In addition, there were managers or experts, often with a focus on water, land management or agriculture. The rest of the participants were farmers and producers or representatives of business, and non-governmental or other civil society organizations as well.

Results: contribution of scenario-based adaptation planning in the three case studies

The application of the outlined methodology in the three countries led to tangible support for adaptation planning in several ways. Such support included improving the capacities of policy-makers in prioritizing climate change adaptation measures across sectors and development needs, promoting mainstreaming of local adaptation measures and priorities to inform planning at the national level, and finally assisting in mainstreaming at the horizontal level by making sure that adaptation efforts in different sectors are synergistic and/or trade-offs are explicitly identified in the context of other development priorities.

Assisting in communication, knowledge exchange and capacity building

In the case studies, scenario development was designed as a flexible methodology that can incorporate information from a variety of fields, including qualitative information (for inspiring, people thinking about approaches to adaptation) and quantitative information, focusing on climate change impacts, urbanization, crop yields and the predicted changes in population along with the possible technological choices.

The literature recognizes the importance of awareness raising and capacity building on climate change and adaptation among policy-makers as it is often a new area for their sectorial expertise (Moser and Luers, 2007). The workshop provided the opportunity for stakeholders to improve their knowledge and to share coping and adaptation-related experiences similarly as it is done in other participatory approaches such as CbA (Gero et al. 2011; Ruijs et al. 2011). In the presented case studies, the scenario approach provided opportunities to use knowledge specific to a given case study. For example, stakeholders

Table 3 Overview of the characteristics of the scenarios in the three case studies

Case study	Time frame	Key sectors	Modes of participations	Number and types of scenarios
Ghana	2050 with focus on short-term (up to 2015) and medium-term actions (2015–2030)	Agriculture Pastoralism Forestry Water Resource governance Migration	Two national and two sub-national workshops; approx. 120 participants	Two national scenarios Two sub-national scenarios
Honduras	2040 with focus on short-term actions (up to 2015 and 2015–2020)	Agriculture (subsistence, cash crop) Water Health Resource governance	National and sub-national workshops; approx. 60 participants	Two national scenarios Two sub-national scenarios
Tajikistan	2040 with focus on short-term (up to 2015) and medium-term actions (2015–2020)	Agriculture (subsistence and cash crop farming) Water Energy and infrastructure Education Health Migration	Five sub-national and one national workshops; approx. 124 participants	Two national scenarios Five sub-national scenarios

worked with targeted information (such as access to land, technology, seed choice and climate change impacts on relevant crops in Honduras and Tajikistan) that combined both development and climate change with examples of local strategies for coping and adapting to different impacts of climate variability. The opportunity to provide access to new scientific and cross-sectorial information in an understandable way was reported by the participants as one of the most important benefits of the workshops (Table 4).

From this point of view, the *process* of participatory scenario development is an end in itself (as suggested by Stirling 2006). It helps raise awareness and builds capacity through the active integration of diverse information on development challenges and projected climate change impacts. Stakeholders were concerned as much about impacts of climate change and adaptation as they were about other development needs, socioeconomic and environmental changes. Compared to CbA approaches that tend to focus on current development and overlay it with projected climate change and related vulnerabilities (Dumaru et al. 2010; van Aalst et al. 2008), stakeholders in each case valued the scenario approach that allowed making explicit linkages between climate change and future development, visions and goals. For example, besides climate change, participants were concerned with the interplay with new farming practices such as linkages between access to irrigation technologies and food security in Honduras; land tenure structure in Ghana with market access and infrastructure for improving the situation of poor and vulnerable groups; migration in Tajikistan with its consequences on agricultural production; and agroforestry.

Finally, to achieve the expected benefits of the scenario approach in terms of its ability to bring together different types of research outputs, stakeholders' knowledge and experience, we spent time to work with researchers to shape their inputs for the workshops. This, for example, included pointing out issues in their presentation such as using jargon or providing too many details on recent advances on global climate modeling and on climate change impacts not relevant for the case study area. The participants also received the presentations in advance so they had time to review them. There was also considerable amount of time provided for questions to the researchers. Our experience shows that these steps are necessary, as otherwise the presentations of the researchers—who are most accustomed to presenting to their peers—are hard to grasp in sufficient depth for policy-makers so that they can work with the information during the workshop.

Facilitating vertical mainstreaming of adaptation and development planning

The scenario approach can be a useful in helping to foster linkages between development and climate change and to

Table 4 Overview of major benefits and challenges listed in the evaluations by the workshop participants across the three countries ($n = 180$; in percentage) (the scores are based on a scale from 5 indicating highly relevant to indicating not relevant)

	Mean	SD
Key benefits		
Linking climate change with relevant development trends	4.77	0.54
Highlighting cross-sectoral linkages both benefits and trade-offs	3.6	0.94
Opportunity to develop collaboration of groups working on climate change with other stakeholders/experts and sectoral policy-makers	4.11	0/73
Useful platform to initiate adaptation planning in a policy-relevant yet engaging way	4.48	0.77
Access to new scientific and cross-sectoral information presented in an understandable way to participating decision-makers	4.7	0.68
Clear linkages between adaptation measures and development pathways/scenarios to highlight the contributions of adaptations to development priorities	3.54	0.89
Key challenges		
Time (intensive participation over a number of days)	4.18	0.69
Lack of/low interests of high-level decision-makers to maintain the momentum in the planning process after the scenario process	3.38	0.74
Scenarios are not integral part of planning	3.68	0.86
Lack of good climate change data	3.34	0.74
Lack of information on development trends (past, present)	4.33	0.84

help policy-makers and other stakeholders highlight development choices and decisions that address the impacts of climate change at the national, sub-national and local levels. Scenarios provide a framework for connecting diverse adaptation needs at the local and sub-national levels, and thus they can inform national adaptation planning about cross-scale linkages. National-level adaptation needs may not be equally relevant for all regions of the country, or they would need to be designed and implemented differently due to specific conditions at the sub-national and local levels (in terms of the physical environment, socioeconomic challenges, different institutional structures and ongoing initiatives, etc.).

In the case studies, we conducted multiple workshops and/or collected data to ensure in-depth understanding of place-specific challenges. The results were then brought together at the national level and aggregated across the analyzed sub-national administrative units. For example, Table 4 outlines adaptation needs for five sub-national units in Tajikistan. It was important to conduct scenarios focusing on different scales in a country, because stakeholders at different levels have different perspectives; groups and numbers of winners and losers may vary; and different sets of issues and opportunities come into focus (Kok et al. 2007). There also were important cross-scale linkages, from the perspectives of both vulnerability and adaptation. Furthermore, identifying adaptation options at a lower level and then scaling them up to the national level help to identify robust actions relevant across all the created desired futures and point out how national agencies can facilitate and enable adaptation locally. In this context, adaptation may require new forms of collaboration between higher-level and local organizations, especially in developing countries where local organizations that are the closest to those who directly experience vulnerability often have very limited capacity.

When combining outputs from sub-national and national scenarios (as presented in the examples from Tajikistan), clear differences and similarities across the regions can be identified and used to inform national planning (Table 5) Improving irrigation infrastructure and access to drinking water are high priorities across all five regions. Such results provide more precise information for targeting funding as well as projects on climate change adaptation which is often guided by higher-level, generic priorities and decisions at the national level.

Facilitating horizontal-level mainstreaming of adaptation into development planning

The scenarios were also used to provide context in which stakeholders can identify and prioritize relevant adaptation options for transition pathways over time, to identify diverse types of actions in various sectors, and to discuss synergies and trade-offs between them. Given the desired futures (as identified by stakeholders), the scenario approach helped relevant stakeholders to explore adaptation measures and to map out alternative, robust adaptation pathways that combined a variety of adaptation options based on their type (including e.g., institutional and capacity-building measures, infrastructure development and ecosystem-based measures) and sectors (including in water management, energy, health).

When identifying adaptation options that can be part of the adaptation pathways, participants were encouraged to think about hard measures such as infrastructure development but also soft interventions, such as the design of relevant educational and training programs, changes to existing governance and institutional structures, and the adaptations (and revisions) of policies and management options. During the backcasting process, stakeholders prioritized measures that covered these categories (see e.g., Table 5). Such adaptation measures recognize not only the need e.g., to upgrade infrastructure, but also to explore opportunities to develop ecosystem-based measures that can supplement or replace it. Changes in governance are

Table 5 Overview of adaptation measures to drought in key sectors such as water, land management and agriculture suggested by the participants in Tajikistan

Adaptation	Prioritised adaptation options in each of the five sub-national administrative units in Tajikistan				
	No. 1	No. 2	No. 3	No. 4	No. 5
Infrastructure					
Address distribution of land resources	**X**	**X**	**X**	**X**	**X**
Create additional water reservoirs	*X*			*X*	*X*
Create small-scale or community-level water storage		*X*	*X*	*X*	
Conduct vaccinations	*X*	*X*	*X*		
Improve access to and use of the seeds of climate-resistant crop varieties			*X*	*X*	*X*
Create food and forage reserves				X	
Promote food storage at the community level				X	X
Ecosystem-based					
Plant forests to increase moisture retention	**X**	**X**	**X**	**X**	**X**
Promote cultivation of exiting drought-resistant varieties cultures	**X**	**X**	**X**	**X**	**X**
Plant forests in drought-sensitive areas			*X*	*X*	*X*
Encourage agroforestry to produce both food and fodder		*X*	*X*		*X*
Use mountain streams glaciers/ snowfields in dry years		X		X	
Improve control of overgrazing by cattle				X	
Introduce new drought-resistant plant species				X	
Institutions, strategy and capacity					
Analyze the reasons for droughts and their cycles	**X**	**X**	**X**	**X**	
Increase adaptive capacity through education (practical trainings)	**X**	**X**	**X**	**X**	**X**
Draft development strategies	*X*		*X*	*X*	
Develop a viable emergency response strategy for infectious diseases	*X*	*X*	*X*		
Provide support to farmers (financing)	*X*		*X*	*X*	
Establish centers to grow climate-resistant crop varieties	*X*	*X*		*X*	
Inform farmers about weather changes such as hail		*X*		*X*	*X*
Conduct local monitoring	X		X		
Regulate the use of glaciers and snowfields (for use only in exceptional or emergency cases)	X			X	
Establish information centers to provide agricultural extension support and assist with market access				X	
Create a seed reserves for dry years					
Provide practical assistance to the poor population			X	X	
Organize pest-control groups				X	

Options prioritized in four to five sub-national workshops are highlighted in bold, and those prioritized in at least three workshops are in italics

important to ensure that there won't be constraints on putting in place adaptive and coping strategies. Finally, the importance of training and skill development are emphasized; in that, farmers can learn how to use various technologies relevant for adaptation, such as planting different crops or changing food storage and processing to better prepare for climate change impacts. Future scenarios provide opportunities to identify trends that are not directly related to, while strongly affecting the future risk from climate change (e.g., deforestation in upper watersheds or migration of certain groups from the community).

Scenario development provided opportunities to identify the diversity of adaptive measures and the linkages between them. In the evaluations conducted at the end of the scenario workshops, such adaptative measures were regarded as one of the contributions to the scenario process (Table 4). By creating packages of adaptation activities across sectors, they allow the exploration of synergies between the actions, which then build on each other, thus increasing the effectiveness of the specific actions. Such actions include closely linked changes in land management practices with changes in planted crops, irrigation development and pest monitoring. Similarly, linkages can include developing food storage facilities. They would, however, need to be developed in conjunction with supporting local governance and administration, so that the facilities will be maintained, food is stored and distributed to those most in need, and monitoring is available to provide information for communities about when possible

Table 6 Connecting adaptation responses focused on water management, agriculture and social security in Ghana

Current actions	Short term 2010–2015	Medium term 2015–2030	Long term 2030–2050	Desired future 2050
Local water harvesting	Infrastructure status assessments	Infrastructure renewal plans	Flood proof roads and railways to ensure market access for the products	Flood proofed roads to ensure market access and emergency management
Programs of water harvesting are already a priority	Increasing the extent of current programs on water harvesting	Rainwater harvesting (runoff capture) and building dams	Market research and product development support	Water harvesting and access for drinking and irrigation is ensured
Changes in planted crops	Small-scale water harvesting programs (household, community)	Building dams for irrigation (small-scale community management dams)	Developing crops and livestock that are pest and drought resistant, early yielding and culturally acceptable	Diversification of rural livelihoods (planting, production, storage)
Migration to urban areas	Post-harvest management (silos, food banks, training on food processing)	Social safety nets and food banks to elevate significant impacts on food production	Community-level support for planting, storage processing (rural, peri-urban)	Community-based storage systems
	Access to microcredit			Land access security is ensured in rural areas
	Land tenure security (including access to land for women)			Migrants are included in the safety net's systems

shortages can occur because of either local or external impacts that result in shortage or increases in food prices.

Finally, the linkages across sectors and between types of measures were further explored by the creation of adaptation pathways with sequences of actions over time (Table 6). While creating the pathways, the desired future vision served as an end point that a series of critical adaptation actions were supposed to reach. Naturally, adaptation options that were subject to study in this research are just part of the required measures, and other development actions will also be needed. When developing the pathway, stakeholders had the opportunity to realize that not all of the adaptation actions were critical. The adaptive measures may become more relevant once climate change risks are higher. Prior to that, preparatory actions may also be needed, such as changes in legislation, capacities and skills; assessment to understand current and emerging risks such as integrated environmental assessment (IEA); and collaboration between communities and stakeholders.

Discussion

Approaches to climate change adaptation often focus on the climate of the future and the required adaptations. However, adaptations related to climate change do not necessarily coincide with scenarios of plausible changes and preferences in socioeconomic and environmental issues relevant for stakeholders. The backcasting approach described here can help outline a dynamic adaptation pathway in a particular country context and identify both adaptation and not necessarily climate-related development priorities to address climate impacts. When surveying the human needs that are vulnerable to climate change, overall improvements in living conditions, skill development and access to basic services are considered crucial for pro-poor adaptation. Regardless of climate change, disadvantaged communities across the globe lack access to basic services such as healthcare, water and sanitation, and housing or face the consequences of food shortages. Many of these challenges contribute significantly to the development deficit that is already apparent in much of the developing world (or vulnerable segments of advanced societies) and will be exacerbated by climate change over time. As a result, preferred adaptation pathways must be in-line with desired development pathways to avoid compromising aspects of living conditions and economic development consistent with the requirements of sustainability.

Planning for adaptation includes the identification and analysis of diverse types of possible responses, ranging from infrastructure construction to institutional change or rethinking overall development choices and pathways. Backcasting can help frame the discussion about development choices, such as future allocation of sectors, size of urban centers, demand for and provision of services, poverty reduction strategies etc. and thus provide an end point and context for the required adaptation options. Furthermore, backcasting-based scenarios can provide an indication of the types of appropriate (e.g., Carlsen et al. 2012) and preferred adaptations by stakeholder groups, such as needed changes in infrastructure, actions to develop institutions and promote collaboration between agencies, and measures improving ecosystem services. In this context,

scenarios can also provide specific contributions to adaptation strategies and initiatives by complementing adaptations included e.g., in sector assessments, and national and sub-national priorities for funding allocations. In this context, a number of challenges can be identified including ensuring sufficient stakeholder involvement, relevance of the scenario beyond the often narrow objectives of project-based initiatives and available information especially on climate change impacts at the relevant scale for scenario application.

A fundamental challenge in backcasting-based scenario exercises is that the same adaptation outcomes in the future can result from many different combinations of actions. Similar levels of water supply conditions can be achieved through different combinations of supply and demand side measures; heat stress can be avoided through various patterns of heat avoidance behavior, relocation to less affected areas, the construction of better ventilated buildings or increasing green space. This challenge appears in each time step, and the preferred preceding actions in the backcasted pathway must be both consistent with the immediate future condition and serve as a realistic starting point for the immediately preceding step without veering too far off track on the pathway to the starting point in the present.

In terms of stakeholders' participation—which is crucial to these processes—there are challenges that we observe as well listed in the literature (e.g., van Aalst et al. 2008; Carlsen et al. 2012; Shaw et al. 2009). These include the increasing interest in stakeholder involvement in adaptation and other types of planning efforts by decision-makers, researchers, donor agencies and diverse local and national groups. While groups like these are increasingly consulted, their time and capacity to provide input is limited. Therefore, it is important to inform and possibly connect with a broader set of organizations working in the region and ideally to link the scenarios and backcasting with other relevant planning processes (such as sector or overall development planning mechanisms, strategic policy outlooks and assessments, budget planning). Scenarios can thus directly feed into strategic documents or other projects and thereby limit the demand on stakeholders' time and resources. Integrating the scenario process in routine mechanisms of governance can also help ensure that the adaptive responses considered in the construction of transition pathways are realistic and have a direct relevance for implementing agencies through processes and policy instruments they are already familiar with.

Scenarios were developed in the three countries described here to address specific thematic areas within a given project, which can limit their application elsewhere with different adaptation issues and unique technological, policy and economic conditions. To address this challenge, multi-purpose scenarios would be needed. This would require a transparent, well-prepared scenario development process involving national and international agencies, and other agencies and stakeholders working in the selected regions of the country. The scenario templates can refer to both the conceptual architecture and the step-by-step process of the scenarios as well as the scenario outputs. These higher-level, yet more generic scenario templates can provide a basis for an integrated analysis of climate change adaptation issues and possibly other planning processes. Such multi-agency and stakeholder involvement, with groups that are often involved in the development of adaptation projects and initiatives, can also help ensure that the developed scenarios can be used to inform planned adaptation projects and initiatives.

Finally, obtaining up-to-date information on climate change is still challenging at finer spatial resolution (e.g., 10–50 km^2) and with relevance for key livelihood types, especially for many developing countries (Carlsen et al. 2012; van Aalst et al. 2008). This includes both the ability to access projections with a clear indication of uncertainties and to conduct downscaling of key climatic parameters. The availability of information on climate change impacts has improved during recent years, thanks to efforts to provide information on climate change projections, hazards and other impacts. Efforts at the national scale, such as The Climate Change Knowledge Portal (CCKP) developed by the World Bank Group, the Adaptation Learning Mechanism (ALM) launched by the United Nations Development Program (UNDP) and the online climate data directory by the National Oceanic and Atmospheric Administration (NOAA), have helped. However, better-tailored information is needed on the projected impacts across key sectors that can be better linked with socioeconomic scenarios, adaptations practices and gaps. Furthermore, much of the baseline data such as higher resolution landcover maps necessary for preparing more detailed analyses are available only at considerable cost, even though the information was gathered using public funds.

Concluding remarks

In this paper, we discussed the application of backcasting to adaptation planning in three developing country case studies. These case studies offered a number of lessons learned that can aid in future scenario applications related to adaptation. Furthermore, the case studies have shown that scenarios can have specific roles in adaptation planning by building on the horizontal and vertical aspects of mainstreaming, by providing a platform for bringing together diverse types of quantitative and qualitative information and by creating a structured process for stakeholder interactions.

However, there are a number of research and policy gaps that need further attention especially when it comes to providing data and information on relevant issues for adaptation planning in the context of vulnerable livelihoods to both climatic and other challenges.

Our experience shows that while considerable efforts have been made to provide information on climate change projections, hazards and impacts at the national scale, more work is needed on impacts on livelihoods in natural resource-related sectors such as agriculture, fisheries, tourism and extractive industries over the medium-term horizons, i.e., from 2030 to 2050. Further information is also needed on linking global socioeconomic projections to those at national and sub-national scales. Thematic projections and trends for demographics, agricultural production, land-use change, urbanization and other trends can help countries explore linkages between future trends in socioeconomic and environmental systems and climate change.

While this research showed the value of backcasting in the construction and use of adaptation-related scenarios, more work is needed on refining the process and conceptual approach of backcasting. While backcasting holds promise as a useful approach to constructing policy-relevant transition pathways connecting present starting points with desired future outcomes, making the results of such exercises credible will require the combined use of quantitative modeling and qualitative, participatory methods around practical decision problems and the promise of actual implementation.

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