

Review of key initiatives and approaches to adaptation planning at the national level in semi-arid areas

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Abstract Semi-arid areas are found in a large number of countries and regions of Africa and South and Central Asia. They display high vulnerability to climate change with considerable adaptation needs. In this paper, we review country-level and multi-country projects supported by international agencies. We examine the priorities and goals presented in national adaptation planning documents and in sectorial planning documents. Through this analysis, we seek to compare adaptation needs with current trends in national, regional and global projects and collaborations. Our results suggest that initiatives supported by international agencies play a considerable role in achieving national adaptation priorities, especially in areas such as agriculture and water management. However, compared with specific adaptation options such as drought-resistant species and irrigation (which tend to be the scope of the projects), the analyzed documents tend to see challenges in agriculture more in the contexts of food security, livestock and rural development. They emphasize the strong connection between rural livelihoods and sustainable land and ecosystem management. Priorities listed in the national

documents but not captured in current initiatives include human health, pastoralism, security and migration. Our results also show high levels of mainstreaming adaptation into sectorial planning documents, especially those on poverty reduction; however, compared with the focus on the project level, they here emphasize adaptations focused on institutional development and governance. Finally, the outcomes indicate that global, regional and national initiatives are distributed unequally and that countries in Central and West Africa and Central Asia currently exhibit low participation, especially in national projects.

Keywords Semi-arid · Arid · Adaptation · Global · Regional · National

Introduction

Home to approximately 15 % of the world's population and covering about 15 % of the world's land area (UN 2011), the semi-arid regions of Africa, Asia and Latin America and the Caribbean are characterized by ecological and cultural diversity, climatic variability and reliance on traditional livelihood activities. In many of these areas, the population is poor and marginalized—highly dependent on livelihoods derived from the surrounding natural resource base, mostly through plant and livestock production (Safriel and Adeel 2005; World Bank 2007; Sietz et al. 2011; Conway 2011). This results in close interrelationships between humans and the natural environment. However, these relationships are being adversely impacted by multiple stressors, including the expansion in the amount of land under agricultural production, population growth, the loss of native species (particularly forests) and climate change (Fischlin et al. 2007; Sietz et al. 2011). The

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ongoing process of climate change constitutes an additional stressor for semi-arid areas—one that is increasingly affecting the lives and livelihoods of the people living in these vulnerable eco-regions (Kilroy 2014; Fischlin et al. 2007; Hassan et al. 2005; Lioubimtseva 2009; Lioubimtseva et al. 2005; Reenberg et al. 2013).

Efforts to adapt to climate change can, if appropriately designed, assist semi-arid populations to reduce adverse impacts while improving their own well-being and promoting empowerment, particularly of poor people (Mortimore 2010). Adaptation to climate change is defined as an “adjustment of natural or human systems in response to actual or expected climatic stimuli or their effects, in order to reduce harm or take advantage of opportunities” [Intergovernmental Panel on Climate Change (IPCC) 2007, p. 869]. Adaptation actions include both planned/anticipatory adaptations focusing on preparing for impacts of climate change and autonomous adaptation triggered in response to changes in natural and/or human systems, which then also build capacity to address climate impacts (IPCC 2007). Current approaches to adaptation planning encompass specific, targeted adaptation measures to prepare for climate change impacts (Eriksen et al. 2011), steps to build adaptive capacity to enable autonomous actions, and policy and planning efforts such as strengthening climate change projections, establishment of adaptation policies, and mainstreaming adaptation considerations into national and sectorial strategies (IPCC 2012; Organisation for Economic Co-operation and Development [OECD] 2009).

The international community, consistent with its obligations under the United Nations Convention on Climate Change (UNFCCC),¹ has been actively engaged in supporting adaptation actions at the project and policy levels, such as through bilateral initiatives (e.g., the E.U.’s Global Climate Change Alliance and Japan’s Africa Adaptation Programme) and multilateral funds (e.g., the Least Developed Countries Fund and the Adaptation Fund) (Birdsall and de Nevers 2012). These international initiatives and funds remain the primary source of funding for adaptation action in developing countries (OECD 2011; Buchner et al. 2012; Sovacool et al. 2012). Respecting the internationally agreed upon principle of taking a country-driven approach to adaptation action, it is important that this funding accounts for the priorities identified by developing countries, such as by financing adaptation needs and priorities identified in national communications to the UNFCCC, National Adaptation Programmes of Action (NAPAs),

national and district level adaptation plans, and sectorial strategies that incorporate consideration of climate change. However, while considerable analysis has been undertaken of the gap between available financial resources and estimated need, such as how funding is allocated and the evaluation mechanisms used by international funds (for example by Smith et al. 2011; Schalatek et al. 2012; Birdsall and de Nevers 2012), less attention has been given to how international financing aligns with developing countries’ identified needs and priorities. Both Benitez (2012) and Fransen and Nakhooda (2012), for example, suggest a need for more attention to be devoted to country-level and thematic assessments of the portfolio of projects undertaken in a particular country and/or the types of interventions being made, particularly in key sectors.

In this paper, we focus on addressing this research gap by specifically looking at international support for adaptation actions semi-arid regions—reflecting the understood vulnerability of these countries to the impacts of climate change. In particular, we compare the focus (e.g., agriculture) and type (e.g., capacity-building) of adaptation projects financed through bilateral and multilateral sources with the adaptation goals and priorities articulated by developing country governments in national documents such as NAPAs, national communications and sector plans. The key research questions framing the work are (1) What are the key foci and types of adaptation projects being implemented in semi-arid areas financed predominantly by international development organizations? (2) What is the geographical scope—national, regional or global—of these adaptation projects? (3) What are the key foci and types of adaptation needs and priorities outlined in national documents such as NAPAs and climate change policies, and how are they mainstreamed into key sectorial strategies relevant for vulnerable populations? (4) Based on these comparisons, what are the key gaps in country participation and in the foci and types of projects underway?

We first outline the methodological approach used in the study, followed by a presentation of the research results grouped around the four research questions identified above. We conclude with a discussion of present trends and gaps in implementing adaptations actions and policies in semi-arid countries at the global, regional and national levels.

Methodology

The research methodology uses a systematic literature review, which involves reviewing documents according to clearly formulated criteria, using systematic and explicit methods to select and critically appraise relevant information (Lesnikowski et al. 2011; Berrang-Ford et al. 2011;

¹ Article 4.4 of the Convention, for example, requires developed country parties to assist “the developing country parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects.”

Ford et al. 2010). This approach, common in health sciences, has recently been applied to climate change studies to assess current knowledge about climate change impacts and adaptation measures and relies on peer-reviewed literature and national adaptation planning documents focused on water (Plummer et al. 2012), human health (Lesnikowski et al. 2011, 2013), the Arctic regions of Canada (Ford and Pearce 2010), within climate change hotspot regions (see articles in this special edition), and in general, regarding the governance of adaptation (Biesbroek et al. 2014). In this study, we build on these applications and analyze national documents such as national communications to the UNFCCC (NCs), NAPAs and strategic planning documents. We then extend the analysis by focusing on project descriptions and sectorial planning documents.

Identification of countries for inclusion in the study

Countries within the world's semi-arid regions of Africa, Central Asia and South Asia are the focus for the paper. Inclusion of these countries in the review was primarily framed by the needs of the Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA) program. CARIAA was launched in 2012 by the United Kingdom's Department for International Development (DFID) and Canada's International Development Research Centre (IDRC). It aims to provide evidence to support decision-making for adaptation in selected highly vulnerable

“hotspots,” defined as eco-regions in which the fragility of poor people's livelihoods is most likely to be exacerbated by a changing climate. These hotspots are the following: the semi-arid regions and large deltas of Africa and Asia and the densely populated river basins of South Asia (De Souza et al. 2015).

The world's semi-arid areas form part of the broader dryland eco-region encompassing hyper-arid, arid, semi-arid and dry sub-humid areas, divided based on their increasing level of aridity or moisture deficit (Safriel and Adeel 2005). Of these four types of dry lands, the semi-arid areas are home to the largest number of people and cover the largest area (UN 2011). They were selected as the focal area of this study as their ecological sensitivity and higher population levels mean that loss of ecosystem services in semi-arid areas has the potential for significantly greater impacts on people's livelihoods compared with, for example, hyper-arid and arid areas with very low populations (UN 2011).

A total of 42 developing countries were identified that met the study's criteria of having semi-arid characteristics and being located within Africa and South and Central Asia—the interest areas of the CARIAA initiative—as listed in Table 1. Of the included 42 countries with semi-arid eco-regions, ten were identified as also being included in the two other “hotspot” regions of the CARIAA initiative (IDRC and DFID, this issue). To avoid double counting, when choosing projects in these ten countries for inclusion in this semi-arid study, we reviewed the foci of

Table 1 Countries selected for inclusion in the study, divided by subregion

Africa (33 countries)			Asia (9 countries)	
Central	East and Southern	West	Central	South
Cameroon	Angola	Benin ^a	Kazakhstan	Bangladesh ^a
Chad	Botswana	Burkina Faso	Kyrgyzstan	India ^a
DR of the Congo	Eritrea	Ghana ^a	Tajikistan	Pakistan ^a
Gabon	Ethiopia	Liberia	Turkmenistan	Sri Lanka
Niger	Kenya ^a	Mali	Uzbekistan	
	Lesotho	Mauritania		
	Madagascar ^a	Nigeria ^a		
	Malawi	Senegal ^a		
	Mozambique	Sierra Leone		
	Namibia			
	Rwanda			
	South Africa			
	South Sudan			
	Sudan			
	Swaziland			
	Tanzania ^a			
	Uganda			
	Zambia			
	Zimbabwe			

^a Countries that belong to multiple CARIAA “hotspots”

the projects and exclude them if they focused on issues relevant to deltas or glacier-fed basins.

Data sources

The methodological approach used in this review was built on our focus on internationally funded projects and national policy documents directly aimed at adaptation. Hence, to be included in the review, adaptation to climate change had to be identified as a key goal of the project, policy or strategy examined (see Table 2). For example, although projects and policies aiming to promote integrated water resource management often help to improve adaptive capacities and support autonomous adaptations, such projects and policies were excluded from the assessment if they did not explicitly identify direct support for adaptation actions as one of their major objectives. Such explicit focus on adaptation in the reviewed materials has already been tested by Lesnikowski et al. (2011), reviewing national communications and Berrang-Ford et al. (2011) focusing on peer-reviewed literature.

A large number of projects and policy documents were identified in the studied countries that explicitly identified supporting adaptation to climate change as their major objective. Additional parameters were therefore introduced to further limit the number of projects and policy documents examined. For the projects, we focused on those supported by major international agencies that fell into three categories: global projects, or those involving countries from around the world; regional projects, or those only involving countries in either Africa or Asia; and national projects, or those undertaken exclusively in one of the 42 countries in the review. Additionally, we focused the review on projects supported by 22 major funding agencies, including:

- Bilateral and multilateral development organizations [e.g., the United Nations Development Programme (UNDP)] and United Nations Environment Programme (UNEP); Food and Agriculture Organization (FAO); Organisation for Economic Co-operation and Development (OECD).
- Dedicated funds established under the UNFCCC that target adaptation (i.e., the Adaptation Fund, the Least Developed Countries Fund and the Special Climate Change Fund).
- Major multilateral development banks (e.g., the World Bank and the African and Asian Development Bank).
- Selected national and regional development agencies in Canada (IDRC), the UK (UKaid, DFID), the USA [United States Agency for International Development (USAID)], Germany [Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)], Japan [Japan

International Cooperation Agency (JICA) including Japan's Africa Adaptation Programme], the European Union's Global Climate Change Alliance (GCCA).

- Agencies active in semi-arid areas (e.g., the Asia Pacific Climate Change Adaptation Network, Global Agricultural Research Consortium, World Agroforestry Centre (ICRAF), AGRHYMET Regional Centre (ARC), International Center for Agricultural Research in the Dry Areas and The International Crops Research Institute for the Semi-Arid Tropics).

These funding agencies were selected because of their major role in supporting projects in the studied countries and regions and because of accessibility of information on the internet.

In terms of national-level policy and strategic documents, we identified national adaptation priorities by reviewing NAPAs prepared by least developed countries, current national communications and national adaptation policies and strategies as available. We also reviewed key sectorial and cross-sectorial documents and plans focused on agriculture and water management, development and/or rural development strategies, and poverty-reduction strategies. Finally, reflecting the study's focus on semi-arid areas, we also reviewed submitted national action programs under the United Nations Convention to Combat Desertification.²

Moreover, only projects and national documents implemented or published between 2006 and 2012 were considered within the analysis, consistent with the observation by Berrang-Ford et al. (2011) that most of the literature on adaptations dates from 2006 and after and has been synthesized in the IPCC's Fourth Assessment Report (released in 2007). Finally, we reviewed only documents published in English and in French. Documents outside of this time period or written in other languages were excluded. Detailed definitions of the search processes and collected documents are listed in the supplementary material.

Data collection and analysis

In total, 101 multi-county and 201 national projects were included in the analysis (Table 3). We excluded 24 multicounty and 32 national projects because of their focus on issues relevant to deltas or glacier-fed basins. We also analyzed 112 national policy and strategic documents. Details of the projects and national policy and strategic documents were analyzed using excel spreadsheets. For the collected material, descriptive and basic statistics were used to summarize quantitative trends in the data. We

² <http://www.unccd.int/en/Pages/default.aspx>.

Table 2 Inclusion and exclusion criteria for the selection of the documents and projects

	Inclusion criteria	Exclusion criteria
Relevance to the theme	<p>Keywords used: adaptation, adaptive capacity, resilience to climate change, vulnerability reduction and climate change. These keywords were used in combination with the specific country name</p> <p>In the 10 countries that also have areas that represent deltas and/or glacial-fed river basins, we reviewed the collected projects and documents to make sure that they were relevant for arid environments</p>	<p>Documents and projects were excluded if they did not mention at least one of the keywords</p> <p>In the 10 countries with areas representing deltas and glacial-fed river basins, projects focusing on deltas, glacier-fed rivers and excess moisture were excluded</p>
Types multi-county and national projects	Project brief includes project title, objectives, funder, countries involved and abstract/description	Project brief provides limited information omitting details such as the countries involved, objectives and description
Types of national policy and strategic documents	<p>Only full policy documents in the selected areas for the 42 countries were considered. National policy documents published by the country's government agencies for the following categories were included:</p> <p>National Communication—if available for the country it was included</p> <p>NAPA—if available it was included</p> <p>Adaptation plans—if available it was included</p> <p>Two of the following documents listed in the order of priority were included^a</p> <p>Agricultural strategy/plan</p> <p>Development plans also with focus on rural areas</p> <p>Other resource plans (such as on water, livestock, food security)</p> <p>Poverty-reduction strategies—if available it was included</p> <p>National actions plans to combat desertification—if available it was included</p> <p>In total a maximum of seven documents were collected per country</p>	Incomplete and/or excerpts from national policy documents were excluded
Types of documents and projects	<p>Project brief includes project title, objectives, funder, countries involved and abstract/description</p> <p>Only full policy documents in the selected areas for the 42 countries were considered. National policy documents published by the country's government agencies for the following categories were considered: national communications, NAPAs, adaptation plans, agricultural and development plans, other resource plans (such as on water, livestock, food security and poverty-reduction strategies) and national actions plans to combat desertification. One document per category was considered, to a maximum of seven documents being collected per country. Incomplete/excerpts from national policy documents were excluded</p>	<p>Project brief provides limited information omitting such things as the countries involved, objectives and description</p> <p>Incomplete/excerpts from national policy documents were excluded</p>
Relevance to the theme	<p>Keywords used: adaptation, adaptive capacity, resilience to climate change, vulnerability reduction and climate change. These keywords were used in combination with the specific country name</p> <p>In the 10 countries that also have areas that represent deltas and/or glacial-fed river basins, we reviewed the collected projects and documents to make sure that they were relevant for arid environments</p>	<p>Documents and projects were excluded if they did not mention at least one of the keywords</p> <p>In the 10 countries with areas representing deltas and glacial-fed river basins, projects focusing on deltas, glacier-fed rivers and excess moisture were excluded</p>

^a Because documents published prior 2006 were excluded <20 % of the countries had more than two documents available in this category, and thus, we prioritize them in the order as listed above

Table 3 Overview of projects, policy and strategic documents analyzed in the studied countries

Types of projects/documents	Number of initiatives/documents	
	Total number	
Total multi-country projects	101	
From which		
Global projects	33	
Regional projects on specific continents	Africa	Asia
Total of 68 regional projects from which:	47	21
National projects	156	45
Total national policy and strategic documents	93	19
Total of 112 documents from which:		
Total of 44 national planning documents directly focusing on adaptation (A + B + C) from which	35	9
Total of 68 national sectorial documents relevant for semi-arid areas (D + E + F + G) from which	58	10
Number of national policy and strategic documents per category		
(A) Latest national communications	11	5
(B) National adaptation strategies/plans	2	4
(C) NAPAs	22	0
(D) Agricultural and rural development documents	17	3
(E) Other relevant development documents ^a	15	2
(F) Poverty-reduction strategies	23	5
(G) Strategies to combat desertification	3	0

^a Such as water-management plans, livestock development plans, low-carbon and climate resilience strategies

focused on analyzing the collected information by region (Africa and Asia), scale of the project (i.e., national, regional or global), focus of the projects, priorities stated in policy documents and by the level of mainstreaming of adaptation into sectorial policy documents.

For the policy and strategic documents, the content was organized using the following categories: title, year of publication, full citation/web link, geographical focus, thematic focus, suggested adaptations, types of adaptations and lessons learned. For the multi-county and national projects, we used the following categories to organize the gathered information: title, full citation/web link, objectives, funder, implementing agency, type of adaptations, thematic focus, geographical focus, duration and lessons learned. To describe the project's thematic focus (e.g., agriculture, coastal-zone management) and type of activities (e.g., research, community-based adaptation), we used categories suggested by international agencies working in the field of adaptation, such as the adaptation learning mechanism, IPCC and UNEP. The categories used

to describe the projects and policies examined by geographical focus, thematic focus and types of activities are listed in the first column of Tables 4 and 5. Detailed definitions of the coding system are listed in the supplementary material.

The authors of this paper jointly contributed to the collection and coding of the projects and documents. The team met regularly to identify potential data sources and develop the coding system, followed by a preliminary data collection. Based on the results of this process, the coding system was finalized, including all the categories, their definitions and sub-categories. Specifically, for the actual data collection and coding, one team member was responsible for collecting the national documents; another team member was responsible for coding them. For the projects, the third team member was responsible for the projects' collection and coding. The coding of the projects and national documents were then reviewed by the team member not directly involved in the coding part.

In terms of the actual coding process, we observed differences in the details of the project activities and priorities listed in the policy documents. Project activities tend to be brief with focus on potential differences in their implementation for the different countries. On the other hand, activities listed in national documents often provide additional details about the types of the relevant technologies and approaches, potential institutional and stakeholders' involvement and key steps in their implementation. To address these differences, we used the same coding system for the themes listed in the projects and policy documents with an option to provide additional details if they were available in the coded material.

Limitations of the methods

The findings of this paper are built on information accessed through multiple sources, including the websites of international agencies and national-level websites for national-level planning documents. During this review, we evaluated neither the actual success, appropriateness (and/or effectiveness) of the projects' activities, nor the priorities suggested in the national planning documents. Such issues could be explored by looking more closely at the actual implementation of adaptations actions, which tends to happen at the local level performed by local organizations. However, in the review, we did not include local institutions and organizations because of the large number of such entities in the studied areas and lack of accessible documentation of their adaptation projects. In future, it would be important to review project evaluations and final reports to gain insight into how the projects were implemented at the local level and conduct in-depth comparisons

Table 4 Overview of global, regional and national projects supported by international organizations in the semi-arid regions of Africa and Asia

	Global projects	Regional Projects		National projects	
		Africa	Asia	Africa	Asia
Total number of projects	33	47	21	156	45
Thematic focus of the projects					
Agriculture (subsistence agriculture, commercial agriculture and livestock)	12	23	12	57	15
Water resources (drinking water, water management and infrastructure, groundwater resources)	10	14	13	41	13
Forestry (e.g., afforestation, reforestation, agroforestry)	5	3	5	8	4
Human health (human health, diseases, prevention, monitoring)	8	2	1	11	1
Coastal zones (managing land and water resources, developing coastal infrastructure)	7	2	0	8	6
Biodiversity and ecosystems (efforts to maintain/improve the health of particular ecosystems, such as wetlands, grasslands, forests)	3	9	10	25	12
Disaster risk management (emergency response, preparation for extreme events, early warning systems)	10	3	3	27	10
Pastoralism (use of domestic animals as a primary means of livelihood to obtain resources from habitats)	2	3	1	4	1
Human settlements (urban, rural and peri-urban areas)	8	9	4	27	8
Infrastructure (transportation, telecommunication, energy)	3	4	0	7	1
Governance capacity (building the capacity of government officials, assisting with the development of adaptation plans/strategies, providing funding for national climate change trust funds, etc.)	9	5	6	41	15
Climate information services (short and long-term forecasts, including climate change projections)	8	5	7	2	4
Civil society (building the capacity of the public and/or non-governmental organizations)	4	2	0	10	0
Social protection (poverty reduction, labor market interventions social assistance)	0	2	1	1	0
Types of actions listed in the project					
Research (including climate modeling, discipline specific and interdisciplinary)	11	28	13	22	13
Policy formation and integration (including planning efforts)	19	17	11	54	14
Capacity-building (training, technical assistance, institutional strengthening, improved governance, education)	21	28	17	126	28
Community-based adaptation (projects implemented with strong community engagement)	6	11	5	34	17
Field implementation (infrastructure and technology development, pilot projects, resource management)	4	7	1	35	18
Knowledge communication (including awareness raising)	14	11	9	23	6
Assessment (includes risk, impact, and vulnerability assessments and monitoring)	3	8	2	14	3

between the undertaken activities and needs listed in the planning documents at different levels of governance.

Furthermore, we focused on key policy documents relevant for semi-arid areas (such as agriculture, water, livestock and poverty in the countries) to better understand the level of mainstreaming. This resulted in a set of 112 policy and strategic documents. We limited the number of documents to seven documents per country; however, in some countries, additional documents (especially those focusing at the sub-national level) were identified. For future analyses, it would be useful to select some of these countries and extend the review to additional sectorial planning documents. It would also be valuable to analyze how adaptation is mainstreamed vertically from the national to sub-national in local planning and strategic documents.

Results

Multi-country and national projects

Global and regional projects: foci and types

Our review of the projects indicates that addressing adaptation in agriculture is the most prevalent focus. More than 45 % of assessed multi-country including global and regional projects (Table 4) is centered on agriculture and aims to assist with development and use of drought-resistant and other relevant species and varieties better suited to climate change and variability such as rice, potatoes and sweet potatoes, cassava, wheat and barley. Other foci of these projects aim at land

management and seek to develop and build capacity to promote practices suited to semi-arid conditions (especially recurring droughts) such as changing planting cycles and rotation practices. Since 2008, there have been an increasing number of projects that focus not only on promoting adaptation practices in terms of chosen planted species and management practices, but rather take an integrated approach covering vulnerability assessment and integrated land management by building on practices used at the local level. They include, for example, projects focused on providing evidence-based advice on sustainable management practices for decision-makers by integrating current regional/local knowledge, on mapping and evaluating farm-level land-management responses to reduce the impacts of climate variability and on assessing impacts of drought-management options on conservation of natural resources—including water, soils and biodiversity—and moving toward an ecosystem approach.

The second major focus of these projects is water management (32 %). Here, the key interests lie in supporting access to water for irrigation and livestock in semi-arid areas by well management and the building of water storage systems, terraces, channels and different types of irrigation systems. Approximately half of the projects that focus on water also list objectives to address sustainable land-management practices, especially for crop production. Beyond these strong linkages between agriculture and water, the rest of the projects directly focus on ensuring access to clean drinking water and sanitation for people. These projects often aim at infrastructure assessment and development, ensuring that existing structures are adaptable to the impacts of climate change. Finally, in Central and South Asia, we identified that a quarter of the projects implemented in this region focused on addressing transboundary water-management challenges (as suggested by Lioubimtseva 2009) by bringing together regional hydrological modeling to predict the impacts of climate change on water availability and vulnerability assessments, identifying regional adaptation (especially on rural drinking water supply), on agricultural water efficiency, small-scale hydropower solutions and capacity-building for water-management organizations in the region.

In the analyzed focal projects, little interest is devoted to projects whose major focus is pastoralism, food security, social protection and skill development, critical factors for vulnerable people. Pastoralism is a significant livelihood type in semi-arid areas (Sietz et al. 2011); however, only approximately 6 % of the projects focus on this livelihood in Africa (and one project in Central Asia) mostly in the areas of community-based adaptation and research and support for policy development to improve pasture management. It should be noted that some of the large number

of project focusing on agriculture could indirectly contribute to the broader issue of food security, but this outcome was not explicitly listed as one the project's intended objectives.

At the global and regional levels, most of the supported projects aim to help improve capacities relevant to policy development on issues such as land and water management, drought-monitoring systems and disaster risk reduction that aim to share experiences on adaptation practices. These initiatives are largely targeted at members of government agencies, resource managers and community members. At the regional level, key research projects focus on developing capacities to predict climate change impacts, seasonal forecasts and monitoring/early warning systems.

National projects: key foci and types

We collected 201 national projects supported by international institutions and agencies. The projects mostly focused on agriculture, government institutions, fresh water and ecosystem management and biodiversity (Table 4). In most countries, half of the projects are focused on agriculture, dealing with such things as: drought management; promoting integrated approaches to sustainable land management in the context of protecting ecosystems and biodiversity; working with farmers to build on their experiences with adapting to climate variability and developing adaptation measures; and developing strategies for the agricultural sector to increase its resilience in the context of climate change. The second major focus is on freshwater resources, mostly dealing with integrated water management, developing land-use practices that improve water storage and access while reducing erosion and runoff.

In terms of the types of national-level projects being implemented, more than two-thirds have significant focus on capacity-building, working with government institutions and agencies. In half of the projects focused on capacity-building, the focus is on strategy and policy development, which often includes assistance with developing NAPAs and adaptation strategies, and starting processes of mainstreaming climate change adaptation into sectorial strategies and development plans. In the national projects, it appears that agencies leading the projects in the country are less inclined to involve municipal and local government representatives, civil society members and other stakeholders' groups beyond government agencies and departments. Finally, approximately one quarter of the projects are aimed at community-based adaptation and field implementation to adopt adaptation practices. These projects tend to be more recent—most of them began after 2010.

Table 5 NC and NAPA priorities across the studied countries; In total, 43 documents were analyzed

	Total	Africa			Asia	
		Central	West	East, Southern	Central	South
Agriculture (subsistence agriculture, commercial agriculture and livestock)	44	5	9	21	5	4
Water resources (drinking water, water management and infrastructure, groundwater resources)	34	3	7	16	4	4
Forestry (e.g., afforestation, reforestation, agroforestry)	29	2	6	15	4	2
Human health (human health, diseases, prevention, monitoring)	31	4	8	11	5	3
Coastal zones (managing land and water resources, developing coastal infrastructure)	15	1	4	6	2	4
Biodiversity and ecosystems (efforts to maintain/improve the health of particular ecosystems, such as wetlands, grasslands, forests)	19	1	3	8	5	2
Disaster risk management (emergency response, preparation for extreme events, early warning systems)	16	3	2	6	2	3
Pastoralism (use of domestic animals as a primary means of livelihood to obtain resources from habitats)	11	1	5	4	1	0
Human settlements (urban, rural and peri-urban areas)	8	1	1	4	1	1
Infrastructure (transportation, telecommunication, energy)	9	1	0	6	1	1
Governance capacity (building the capacity of government officials, assisting with the development of adaptation plans/strategies, providing funding for national climate change trust funds, etc.)	5	0	1	4	0	0
Climate information services (short- and long-term forecasts, including climate change projections)	4	1	1	1	0	1
Civil society (building the capacity of the public and/or non-governmental organizations)	2	0	0	1	0	1
Social protection (poverty reduction, labor market interventions social assistance)	2	0	1	1	0	0

Global, regional and national projects: countries' participation and collaboration

In terms of collaborations across regions and continents, we assessed 101 multi-country projects from which we identified 33 global projects and 68 regional projects (supplementary material 2). The global projects include participating countries from at least two continents, often with countries from Africa, Asia, the Pacific and, more recently, the Caribbean and Europe. In these projects, we observed a strong participation in all of the studied semi-arid countries in South and Central Asia, with the highest involvement from Bangladesh and India. In terms of participation, countries from Africa are very active, especially Kenya, Uganda, Mali, Mozambique, Rwanda, Senegal and Tanzania.

Within these global projects, we also looked at those that bring together the semi-arid countries of Asia and

Africa. Overall, collaboration between these areas is very low, and we reviewed only three projects on land management, adaptation in agriculture and water management that bring the two regions together. There are more projects building on regional collaboration in Africa and in Asia. In Africa, we identified 47 projects that brought together three or more semi-arid countries with a focus on agriculture, food security, water, ecosystem management and biodiversity. In Asia, there are 21 regional projects relevant for the studied countries and the focus on semi-arid areas. These projects deal with water and land management, transboundary water issues and capacity development regarding climate change impacts, adaptation policy and strategy development.

In terms of per-country participation in the analyzed projects and initiatives, the average number of projects per studied regions of Africa and Asia is relatively equal. The lowest average number of projects per country is in Central

Africa (8.8) and Central Asia (10.6), with higher levels in West Africa (12), East and South Africa (13) and South Asia (15.3). Even though the average level of the projects is similar, there are considerable differences in the number of projects per country (supplementary material 2). In Asia, Bangladesh, India and Kazakhstan are at the forefront of international project participation, with from 13 to 21 projects. The country with the lowest involvement is Turkmenistan, with eight. Many of the projects being implemented in Central Asia are relatively recent, having started in 2010 and later. In Africa, countries such as Kenya, Tanzania, Uganda, Ethiopia and Senegal have participated in over 25 projects. Countries with very low involvement in international projects include Chad, Angola, Botswana, Gabon, Sierra Leone, Swaziland and Liberia, with fewer than three projects each. These countries lag behind all the countries in semi-arid areas across the two continents.

Compared with global and regional projects where participation is fairly balanced, at the national level, there are considerable differences in participation. The average number of projects per country in each region ranges from 9.3 in South Asia, 5.8 in West Africa and 5.2 in Southeast Africa down to 1.8 in Central Africa and 1.6 in Central Asia. There are eight countries with as few as three projects, including South Sudan, Sierra Leone, Liberia, Gabon, Botswana, Angola, Lesotho, and Swaziland. As suggested by Barr et al. (2010), the focus in these countries should be on improving their management and implementation capacities to participate in projects. The review shows that while this is occurring in these countries (and in countries with a low number of projects), their foci is overwhelmingly on supporting capacities of the government (and other agencies) to improve their understanding of adaptations and develop NAPAs, freshwater resources and ecosystems management and biodiversity. In this context, most of the projects focus on capacity development and strategy design and development.

National policy and strategic documents

To better understand a country's approach to adaptation planning and priorities, we reviewed 112 policy and strategic documents. From this number, 44 were national planning documents that directly aimed to support adaptation and adaptation planning, such as sections of national communications, NAPAs, adaptation strategies and plans. We analyze these documents in this section. The other 68 policy and strategic documents focused on key sectors relevant for semi-arid areas such as agricultural and development strategies, poverty-reduction strategies and action plans to combat desertification. The content of these documents is analyzed in the next section to identify the

level of mainstreaming of adaptation into these sectorial strategies.

Adaptation planning documents (NAPAs): focus and types of actions

Overall, the focus in the analyzed policy documents and strategies targeting adaptation is on identifying specific sectorial challenges in the context of climate change, such as in agriculture, water management, human health and forestry and then identified needed adaptation priorities and actions. In terms of the documents focusing on adaptation, key priority was given to agriculture and water resources in all geographical areas (Table 5). In most of the documents, this covers adaptation priorities at the national level (including planting crops that are less vulnerable to drought) and looking at how to improved land-management practices reduce erosion and improve the quality of agriculture land. These activities are typically the focus of national-level activities instead of targeting community-level and small-scale subsistence production. Overall, high priority is given to water management in the region, especially in Asia and West, East and Southern Africa. These priorities are mostly focused on improving water availability for people and agriculture, promoting integrated water management and building water reservoirs.

In terms of other important priorities, human health, and forestry are both listed in the analyzed documents. Human health is mentioned across all the semi-arid areas, but with high interest in Central Africa and Central and South Asia. Many countries in these areas face severe challenges in delivering health care services, challenges which are exacerbated by climate change impacts (Lioubimtseva 2009). The priorities are on addressing inadequate training and equipment for health care staff, improving public awareness about the health impacts of climate change and improving disease surveillance, data collection and monitoring, especially in rural areas. The other high priority listed in national-level documents is forestry [because of its role in addressing land degradation, desertification and erosion reduction prevalent in the semi-arid areas (Fischlin et al. 2007)], and specific priorities regarding agroforestry, reforestation and improving forest plantation.

The national policy and strategic documents have only a very limited focus on the institutional aspects of management, decision-making and the capacities of government institutions to design, implement and monitor adaptation initiatives. Most of the types of actions include improving research capacities and other resources for monitoring of climate change impacts, for developing forecasts to support agriculture and water management, and for creating climate change projections and scenarios developed at the national and regional scales for the studied countries.

National sectorial documents: mainstreaming adaptation into sectorial strategies

Berrang-Ford et al. (2011) observed a strong focus on mainstreaming adaptation to climate change into national development documents. Our review found this to be the case mostly in the documents focusing on agriculture and poverty reduction. Approximately 90 % of the analyzed sectorial documents included climate change adaptation needs and listed specific measures within their strategic focus. In the majority of these cases, climate change impacts were presented among other environmental challenges, such as increasing loss of biodiversity, land degradation and pest infestations. Within this context, a number of adaptation measures were listed, often linked to the need to improve the governance of environmental resources, including sustainable land and water management, biodiversity protection and disaster reduction. This perspective emphasized the importance of developing and maintaining institutions capable of implementing these measures, and the need for further ecosystem-based adaptation of sectorial strategies and improving capacities of policymakers to do so.

In policy and strategic documents that focus on agriculture, water, livestock and food security, climate change adaptation is seen as part of a group of challenges that influence agricultural and food production, a group that also includes population growth, market prices and infrastructure. In these documents, adaptation is seen mostly as a need to improve yields, agricultural processing and overall output from the sector to limit further land-cover change while addressing food security of an often fast-growing population (as discussed in Fischlin et al. 2007; Sietz et al. 2011). The importance of monitoring, weather projections, and improving extension services to provide information on agricultural production to the farmers is also emphasized.

In those documents that focus on poverty reduction, vulnerable groups—and the adaptation needs relevant to them—are often identified. They include female-headed households, children, low-skilled labor and people affected by HIV/AIDS. The challenges of these groups are discussed in the context of climate change impacts (especially droughts), the loss of agricultural production, increasing food insecurity and the lack of resources to cope with these challenges (similarly to Tucker et al. 2014). These documents present climate change in the context of poverty, and thus, adaptation measures also include improving safety nets, rural investments, infrastructure and skill training. However, along with the development strategies, they also emphasize the importance of using sustainable land and pasture management to ensure that poor people have access to these resources rather than further marginalized as described in Tucker et al. (2014).

Finally, we also looked at documents that countries developed based on their commitments under the United Nations Convention to Combat Desertification.³ However, most of these documents were produced prior to 2006, and only roughly 15 % were included in the analysis. In these documents, adaptation was included in the context of pasture management suggested ecosystem-based approaches and the adaptation actions were suggested to be implemented through community-based management practices. These activities are highly relevant for the semi-arid areas, although available information is very limited.

Discussion

Based on the review of the multi-county and national projects and national planning documents on adaptation and other key sectors, a series of common observations and gaps can be identified across the semi-arid regions that could help in guiding future adaptation planning and project design. Beyond the strong similarity (between focusing on agriculture and water resources at both the project and strategic adaptation planning levels), the major gaps lie in the following: the types of responses focused on ecosystem-based approaches to water and land management expressed in the policy documents; the stronger importance of institutional support and governance aspects of adaptations presented in sectorial documents compared with efforts at the project level; and, finally, the significant differences between national and stakeholders' involvement in implementing projects and strategies—and efforts devoted to improve their capacities. Along with each of these gaps, we summarize key recommended actions below.

At the project level, more than half focus on agriculture and water management recognized as adaptation priorities for semi-arid areas in the literature (Kilroy 2014; Thomas 2008; Conway 2011; supplementary material 3). This fact is mirrored in the priorities in national adaptation and other analyzed policy and strategic documents. However, it seems that—compared with specific adaptation options such as drought-resistant species, irrigations systems and drought-monitoring (which tend to fall within the scope of the projects)—the analyzed documents tend to see adaptation needs in agriculture more in the context of broader challenges such as market prices, population growth, ecosystem degradation (with focus on ensuring food security), and aligning sustainable practices with managing ecosystems. From these broader foci, the analyzed sectorial documents focus on agriculture, food security, livestock and rural development, explicitly emphasizing the strong

³ Available at <http://www.unccd.int/en/Pages/default.aspx>.

connection between rural livelihoods, agricultural plant and livestock practices, sustainable land and ecosystem management. Such strong connections have been described in the literature as key for ensuring the livelihoods of people in the semi-arid areas (Mortimore 2010; Fischlin et al. 2007; Sietz et al. 2011). At the project level, however, this focus tends to be lost—the focus is narrower, taking a sectorial perspective that often focuses only on plant production without looking at other sectors or a broader systems approach. For future projects and initiatives we would suggest that more effort needs to be made:

- To better align sectorial project focus with priorities expressed in national policy and strategic documents such as those focused on agriculture, livestock, rural development and poverty reduction.
- To consider taking a broader, more holistic approach in project development and implementation by focusing on the broader role of agriculture in semi-arid areas and identifying its contribution to food security, biodiversity conservation, pastoralism and the rural and national economy. This can help to identify a suite of robust adaptation options and policies that can be adjusted to particular contexts at the ecosystem, community, and regional and national levels.

On the other hand, there are differences between focus of projects and policy and strategic documents in addressing capacity needs and in the types of stakeholders' collaborations. Policy and strategic documents focusing on adaptation and projects are largely presented as government documents and initiatives targeted toward government and academic agencies. They may include broader consultation processes during their development (Ireland and Mckinnon 2013) but much less during their implementation. In terms of specific capacity-building actions, national policy and strategic documents on adaptation do not specifically address the need to improve the capacities of the targeted governmental agencies and ministries to address adaptation. Except for the focus on research, the policy and strategic documents focus more on concrete measures such as agricultural production, irrigation systems, and reforestation rather than on available and needed capacities for policy development. Yet at the project level, there was considerable focus on improving the capacities of government institutions in particular to address these needs. However, even in this case, the target audiences are government agencies and academic institutions with the aim to improve their capacities in identifying climate change impacts, and in both policy and strategy development in the context of climate change. When developing planning documents and implementing projects it seems that more attention needs to be devoted to assessing and

addressing capacity gaps and broadening stakeholder participation:

- To understand the capacities available to implement measures at the different national and sub-national agencies and broaden the groups of involved stakeholder groups, especially by involving local and sub-national groups and agencies.
- When resources from international agencies are used in national projects, it would be important to encourage participation of diverse sub-national actors and agencies, including government and non-government agencies and civil society in project design and implementation.

There has been a rise in recognition of institutional strengthening, improving and revising governance systems managing resources vulnerable to climate change as critical parts of adaptation actions and strategies (IPCC 2012; Eriksen et al. 2011). In this review, we observed that the institutional aspects of implementing adaptation are particularly stressed when focusing on poverty reduction and sectorial strategies, but are less prominent in strategies that directly focus on adaptation. This a critical distinction, as vulnerable people are significantly impacted by malfunctioning institutions and failing governance systems, such as in accessing communally pooled resources as mentioned by Tucker et al. (2014). When focusing on vulnerable populations, the analyzed poverty-reduction strategies emphasize the institutional aspects of adaptations, such as the importance of improving governance systems over pastures, land and water because malfunctioning institutions disproportionately affect poor people, who derive most of their livelihood from land. Again, such institutional aspects of resource management are not addressed sufficiently in the global, regional and national projects or in national adaptation planning documents. For future initiatives it would be crucial to:

- Focus on soft adaptation measures, such as governance systems and rules and institutions when planning and implementing adaptations at the project level. This would ensure that the actual adaptations focused on specific sectors such as land/water management and pasture rotation are linked with functioning institutional systems.
- Understand, both at the project and policy document level, the role of institutions in securing vulnerable peoples' livelihoods, making sure that any changes/revisions due to adaptation needs will not further marginalize these groups.
- Take a cross-sectorial perspective in both adaptation planning documents and projects to address other needs of vulnerable people, including issues such as

migration, access to basic services and safety nets and security issues.

Overall, this review of the projects indicates that initiatives supported by international agencies play a considerable role in achieving national adaptation priorities and reducing vulnerability to climate change in the studied countries. However, analysis of these projects also shows this contribution to be highly unequal, with significant differences in projects' participation and in their focus. For example, Central and West Africa and Central Asia (and countries in these regions) tend to have much lower involvement in these projects. Even in regions with relatively high project involvement, such as East and South Africa, participation at the country level is fairly unequal. This finding is consistent with other studies in this special edition (e.g., Ford et al. 2014) and other publications (Barr et al. 2010), indicating that projects allocated by international agencies not only depend on a country's vulnerability, but also its implementation capacity to manage the funds. For example, countries such as Botswana, Chad, Gabon, Liberia, Uzbekistan, Turkmenistan and Zimbabwe share high vulnerability, a low adaptive capacity and a limited capacity to implement projects (Barr et al. 2010). To address this limited capacity, these countries and regions tend to get involved in larger multi-country regional (and global) projects in which they are but one of many implementers. At the national level, these countries do not seem to be able to develop successful proposals to obtain projects. In future initiatives, it will be important to ensure that these countries get targeted support to improve their capacities to develop successful proposals and implement national-level projects, either through the direct intervention of international agencies or during their participation in regional and global projects.

Concluding remarks

The findings of this paper are derived from information accessed through multiple sources, including national-level websites (for national-level planning documents) and the websites of international agencies. Our results indicate that there is a need to better align international support and national priorities by promoting better monitoring of implemented projects across multiple funding agencies. For example, there are large differences in countries' involvement in national, regional and global projects, and the lack of focus on vulnerable people, institutional and capacity challenges, and ecosystem-based adaptations become obvious only after working through a large number of information sources. This may not be possible for development of each project. Presently, there seems to be a

strong focus in the literature on adaptation financing (for example Smith et al. 2011; Fransen and Nakhoda 2012; Schalatek et al. 2012), but less on the issues of financing and geographical allocation of resources.

Finally, many of the needs of vulnerable people regarding climate change overlap with their development needs. It seems that the key to improving their situation is in better coordination with the resources allocated to development assistance, mainstreaming adaptation into these efforts and coordinating with national strategies.

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References

- Barr R, Fankhauser S, Hamilton K (2010) The allocation of adaptation funding. Policy paper. Centre for Climate Change Economics and Policy, Grantham Research Institute on Climate Change and the Environment, London
- Benitez L (2012) Monitoring and evaluating the 100 billion green climate fund. A reflection on the challenges ahead. ADMN 598 project report; School of Public Administration, University of Victoria
- Berrang-Ford L, Ford JD, Paterson J (2011) Are we adapting to climate change? *Glob Environ Chang* 21:25–33
- Biesbroek GR, Termeer CJAM, Klostermann JEM, Kabat P (2014) Analytical lenses on barriers in the governance of climate change adaptation. *Mitig Adapt Strateg Glob Chang* 19(7):1011–1032
- Birdsall N, de Nevers M (2012) Adaptation finance: how to get out from between. Centre for Global Development, Washington, DC
- Buchner B, Falconer A, Hervé-Mignucci M, Trabacchi C (2012) The landscape of climate finance 2012. CPI report, Climate Policy Initiative, Venice
- Conway D (2011) Adapting climate research for development in Africa. *Wiley Interdiscip Rev Clim Chang* 2(3):428–450
- De Souza K, Kituyi E, Leone M, Harvey B, Murali KS (2015) Vulnerability to climate change in three hot spots in Africa and Asia: key issues for policy-relevant adaptation and resilience building research. *Reg Environ Chang*. doi:10.1007/s10113-015-0755-8
- Eriksen S, Aldunce P, Bahimipati CS et al (2011) When not every response to climate change is a good one: identifying principles for sustainable adaptation. *Clim Dev* 3:7–20
- Fischlin A, Midgley FG, Price TC, Leemans R, Gopal B, Turley C, Rounsevell MDA, Dube OP, Tarazona J, Velichko AA (2007) Ecosystems, their properties, goods, and services. In: Parry ML et al (eds) *Climate change 2007: impacts, adaptation and vulnerability*. Contribution of working group ii to the fourth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge
- Ford JD, Pearce T (2010) What we know, do not know, and need to know about climate change vulnerability in the western Canadian Arctic: a systematic literature review. *Environ Res Lett* 5. doi:10.1088/1748-9326/5/1/014008
- Ford JD, Berrang-Ford L, Paterson J (2010) A systematic review of observed climate change adaptation in developed nations - A letter. *Clim Chang* 106:327–336. doi:10.1007/s10584-011-0045-5

- Ford JD, Berrang-Ford L, Bunce A, McKay M, Irwin M, Pearce T (2014) The status of climate change adaptation in Africa and Asia. *Reg Environ Change*. doi:[10.1007/s10113-014-0648-2](https://doi.org/10.1007/s10113-014-0648-2)
- Fransen T, Nakhooda S (2012) Shedding light on fast-start finance. World Resources Institute (WRI). <http://insights.wri.org/open-climate-network/2012/05/shedding-light-fast-start-finance>
- Hassan R, Scholes R, Ash R (eds) (2005) *Ecosystems and human wellbeing: current state and trends*, vol 1. Island Press, Washington, DC
- IPCC (2007) Summary for policymakers. In: Parry M et al (eds) *Climate change 2007: impacts, adaptation and vulnerability. Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change*. Cambridge University Press, Cambridge
- IPCC (2012) In: Field CB, Barros V, Stocker TF et al (eds) *Managing the risks of extreme events and disasters to advance climate change adaptation. A special report of working groups I and II of the intergovernmental panel on climate change*. Cambridge University Press, Cambridge
- Ireland P, McKinnon K (2013) Strategic localism for an uncertain world: a postdevelopment approach to climate change adaptation. *Geoforum* 47:158–166. doi:[10.1016/j.geoforum.2013.01.005](https://doi.org/10.1016/j.geoforum.2013.01.005)
- Kilroy G (2014) A review of the biophysical impacts of climate change on ecosystem services of three hotspot regions in Africa and Asia: semi-arid zones, mega-deltas and glacial-fed river basins. *Reg Environ Chang*. doi:[10.1007/s10113-014-0709-6](https://doi.org/10.1007/s10113-014-0709-6)
- Lesnikowski AC, Ford JD, Berrang-Ford L, Paterson JA, Barrera M, Heymann SJ (2011) Adapting to health impacts of climate change: a study of UNFCCC Annex I parties. *Environ Res Lett* 6:1–9
- Lesnikowski A, Ford J, Berrang-Ford L, Barrera M, Berry P, Henderson J, Heymann SJ (2013) National-level factors affecting likelihood to adapt to the health effects of climate change. *Glob Environ Chang* 23(5):1153–1163. doi:[10.1016/j.gloenvcha.2013.04.008](https://doi.org/10.1016/j.gloenvcha.2013.04.008)
- Lioubimtseva E (2009) Human dimensions of climate change in arid and semi-arid environments: a case study of post-Soviet Central Asia. *Ann Arid Zone* 47(3–4)
- Lioubimtseva E, Cole R, Adams JM, Kapustin G (2005) Impacts of climate and land-cover changes in arid lands of Central Asia. *J Arid Environ* 62(2):258–308
- Mortimore M (2010) Adapting to drought in the Sahel: lessons for climate change. *Wiley Interdiscip Rev Clim Chang* 1(1):134–143
- Organisation for Economic Co-operation and Development (OECD) (2009) *Integrating climate change adaptation into development cooperation—policy guidance*. OECD, Paris
- Organisation for Economic Co-operation and Development (OECD) (2011) *Development perspectives for a post-Copenhagen climate financing architecture*. OECD, Paris
- Plummer R, de Loë R, Armitage D (2012) A systematic review of water vulnerability assessment tools. *Water Resour Manag* 26:4327–4346
- Reenberg A, Maman I, Oksen P (2013) Twenty years of land use and livelihood changes in SE-Niger: obsolete and shortsighted adaptation to climatic and demographic pressures? *J Arid Environ* 94:47–58
- Safriel U, Adeel Z (2005) Dryland systems. In: Hassan R, Scholes R, Ash N (eds) *Ecosystems and human well-being: current state and trends*, vol 1. Island Press, Washington, DC
- Schalatek L, Nakhooda B, Barnard S, Caravani A (2012) *Climate finance thematic briefing: adaptation finance*. Heinrich Böll Stiftung North America and Overseas Development Institute (ODI), Washington, DC
- Sietz D, Ludeke MKB, Walther C (2011) Categorisation of typical vulnerability patterns in global drylands. *Glob Environ Chang* 21(2):431–440
- Smith JB, Dickinson T, Donahue JBD, Burton I, Haites H, Klein RJT, Patwardhan A (2011) Development and climate change adaptation funding: coordination and integration. *Clim Policy* 11(3):987–1000
- Sovacool BK, D'Agostino AL, Rawlani A, Meenawat H (2012) Improving climate change adaptation in least developed Asia. *Environ Sci Policy* 21:112–125
- Thomas RJ (2008) Opportunities to reduce the vulnerability of dryland farmers in Central and West Asia and North Africa to climate change. *Agric Ecosyst Environ* 126(1–2):36–45
- Tucker J, Few R, Conway D, Daoud M, Oates N, Mtisi S, Matheson S (2014) Social vulnerability in three high poverty climate change hotspots: What does the climate change literature tell us? *Reg Environ Chang*. doi:[10.1007/s10113-014-0741-6](https://doi.org/10.1007/s10113-014-0741-6)
- United Nations (UN), Environment Management Group (2011) *Global drylands: a UN system-wide response*. UN, Environment Management Group, Geneva
- World Bank (2007) *World development report 2008: agriculture for development*. World Bank, Washington, DC