Adaptation in practice

Increasing adaptive capacity through participatory mapping

IFAD

Enabling poor rural people
to overcome poverty

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Increasing adaptive capacity through participatory mapping

Purpose of this paper

Climate change is transforming the context of smallholder agriculture. Over centuries, smallholders have drawn on indigenous knowledge and historical observations to manage the effects of a variable climate. Today, the speed and intensity of environmental change is outpacing their capacity to do so. As our world is warming and the nature of risk is changing, historical averages are no longer a sufficient guide for the future. Many smallholder farmers in developing countries are experiencing losses and damages from extreme weather events on an unprecedented scale. While the patterns of droughts, floods and tropical storms are becoming more unpredictable, rural livelihoods also get undermined by the creeping effects of water stress, land degradation and loss of biodiversity. Existing vulnerabilities are being aggravated and new ones are created.

The ability to understand and manage risks in a changing environment is a prerequisite for poor rural people to move out of poverty. Poor rural people are less resilient because they have fewer assets to fall back on when shocks occur. Resilience is often correlated with access to institutions which are able to transfer relevant information, knowledge and technologies to appraise and manage climate-related risks. This access to assets, institutions, knowledge and information, innovation and decision-making is widely referred to as 'adaptive capacity' (Jones, Ludi, and Levine 2010).

As part of its corporate learning strategy on climate change adaptation, IFAD has analysed case studies from Sudan, India, Rwanda, Mali and Swaziland to find out whether participatory mapping – used in combination with other participatory methods – has had measurable effects for the development of local adaptive capacity. The results of this analysis are presented in this paper to provide general principles and orientation for practitioners and policymakers involved in adaptation programmes.

The role of participatory mapping

Participatory mapping[1] is the most widespread participatory method developed since the 1980s to support and promote a more active role of communities in rural development projects. In participatory map-making a group of non-experts with a shared interest visualises their association with a landscape and its resources in a given locality (IFAD, 2009). Participatory maps range from ephemeral maps drawn on the ground to paper sketch maps, and from three-dimensional relief models to aerial and satellite orthophoto maps. They not only display geographical features but also information normally excluded from conventional maps, such as household characteristics and vulnerability, traditional agricultural and environmental knowledge, as well as cultural and historical heritage. IFAD has a long history of deploying participatory mapping tools and approaches, including ground mapping, paper sketch mapping and participatory three-dimensional modelling (variably combined with Global Positioning System [GPS] and Geographic Information System [GIS] technologies) within the context of natural resource management. Many of these approaches have facilitated community-based land use planning, the participative management of productive landscapes and climate-sensitive resources, and the mitigation of resource-related conflicts in rural communities.

Against the backdrop of IFAD incorporating climate change adaptation more explicitly and systematically in its programming,[2] the case studies featured in this paper illustrate how participatory mapping has contributed to reducing vulnerability, strengthening resilience and building adaptive capacity in areas prone to climate hazards.

The links between participative mapping and adaptive capacity

Assessing the adaptive capacity of smallholder farming systems goes beyond an appraisal of their physical asset base. Local adaptive capacity does not only depend on what a system *has* to enable climate change adaptation, but also on what it *does* and *how* it does it (Jones, Ludi, and Levine 2010). Consequently, adaptive capacity needs to be understood in light of the interrelations between the asset base of smallholders, the local institutions, the knowledge and information these institutions disseminate, and the existence of innovative processes that favour flexible and forward-looking decision-making (Jones, Ludi, and Levine 2010).

Assets

The resilience of local communities to the effects of climate change is strongly reliant on access to and control over livelihood assets. These include both tangible (natural, physical and financial) as well as intangible (human and social) capital. Mapping has been widely used by IFAD to facilitate access of different community groups to natural capital (such as land, forest and water), and to resolve corresponding conflicts.[3] The joint display and interpretation of a physical landscape, which has been accompanied by designated training and expert facilitation, has allowed many community members to better understand

[1] See the Annex to this document, and IFAD (2009).

[2] In 2012, IFAD launched its 'Adaptation for Smallholder Agriculture Programme (ASAP)', which serves as IFAD's flagship initiative to integrate climate resilience within its investment portfolio. Online: http://www.ifad.org/climate/asap.

[3] See case studies for Mali and Sudan.

the sensitivity of the asset base and identify possible joint actions to ensure its continued protection. These processes have strengthened natural resource conservation and introduced alternative livelihood systems.[4] Participatory mapping has also played a critical role in building human and social capital as it has, inter alia, helped demonstrate the interconnection and interdependence of individually held elements in the asset base of communities. Working together on a shared issue has promoted community cohesion and a sense of pride.[5]

Institutions

Institutions that establish and moderate local norms, rules and behaviours can profoundly influence the type and quality of local decisions to manage climate-sensitive assets and resources. Institutions and organizations[6] mediate such access on the basis of both formal and informal norms, which is particularly relevant for climate change adaptation in developing countries. Informal rules are often more flexible and equitable than formal ones and can have advantages in enabling and fostering adaptation to a changing natural environment. In such a context, participatory mapping can be a key instrument to bring out the norms, rules and behaviour that govern local institutions and review how they affect communal resilience. By directly affecting the scope and quality of participation in community development and reflecting the power dynamics both within communities (e.g. between gender and social groups) as well as between communities and development practitioners, government authorities and experts, participatory mapping can influence the inclusivity, equity and local ownership of adaptation decisions and contribute to new, pluralistic approaches to natural resource management such as, for example, co-management.

Knowledge and information

Effective adaptation decisions require access to appropriate, accessible and timely information about climate-related risks. At the same time, traditional knowledge and local experience with environmental change can teach important lessons. Participatory mapping processes provide a platform for different stakeholders to share their knowledge about climate hazards and help bridge the gap between 'top-down', scientific and expert-based knowledge of climate change with 'bottom up' community understanding of risk and vulnerability (Dessai and Hulme 2004; IISD/TERI 2006). For example, GPS and GIS technologies allow combining 'informal' community-generated information with 'formal' information related to topography and geomorphology. By complementing 'top-down' scenario-based approaches based on general circulation models (GCMs), regional climate models (RCMs) and impact assessment models (IAMs), participatory mapping can add the necessary ground truthing to local adaptation planning efforts and ensure that people affected by climate change are kept at the centre of vulnerability analysis and decision-making.

Innovation

At its heart, climate change adaptation is about innovation and social learning. Although adaptation is often considered as a discrete outcome of specific adaptation projects, it is closer to a continuous process in which smallholder farmers and local institutions absorb information about their natural environment, appraise the implications of changes in this environment, and take decisions which ideally accommodate, reduce or transfer the adverse effects of such changes. The process of innovating can be fostered by complementing and nurturing scientific and expert-based

[4] See case studies for India, Rwanda and Swaziland.

[5] See case studies for Sudan, Mali and India.

[6] On a conceptual level there is some overlap between organizations and institutions. For the purpose of this paper, the definition of institutions from North (1990) is used. He defines them as rules and norms that constrain human behaviour. North emphasises that a crucial distinction must be made between institutions and organizations, describing institutions as "rules of the game" and organizations as "the players" (North 1993). Organizations have a structure and function; they are designed to achieve specific goals; they have identifiable boundaries; they work within or are influenced by the institutional context, while usually also attempting to influence those "rules of the game".

knowledge with traditional knowledge and vice versa. In such a context, participative mapping can facilitate the "co-creation of experiences between particular stakeholders around a shared purpose" (CCAFS 2012), which can take behavioural change from the individual level to higher levels of policy dialogue, advocacy coalitions, and public and private investment planning. Through an open-ended and community-driven process, participatory mapping is often associated with other innovative paths to problem-solving such as the development of inventive institutional processes[7] or the transfer of new technologies.

Flexible forward-looking decision-making and governance

Adaptation to climate change requires anticipatory decision-making and inclusive local governance. Participatory mapping processes can support such local governance structures by reviewing and reflecting on whose voice is heard and whose interests count in a community. They can also illustrate to 'outsiders' complex intra-community tenure rights and issues that relate to control over, access to, and use of natural resources, as well as the 'multi-use' dimension of some natural resources, which is of particular importance to many of the poorest individuals who have only secondary and tertiary access and use rights. Participants in local mapping processes become agents of change. When undertaken in a participatory and iterative way, the community planning process itself can become an adaptive process that is better able to cope with changing circumstances and assimilate new information as it becomes available. From a technical perspective, participatory maps are particularly suitable for understanding change over time and for supporting informed responses. When baseline maps are available, participatory maps can show the extent of occurred changes. The latter can be assessed also depicting historical maps from mental recollections. When baseline maps are not available, the participatory map can provide a baseline scenario on the basis of which future changes can be measured. The use of maps for visioning purposes to determine what communities would like to see or expect to happen in their local environment, can highlight weaknesses and vulnerabilities as well as opportunities. Experiences from the field show that community maps can be updated periodically and the related plans can be adjusted to changing circumstances as time passes.[8]

Five characteristics of the local adaptive capacity framework and their features

Key factors for local adaptive capacity	
Asset base	Availability of key assets that allow the community to respond to evolving circumstances.
Institutions and entitlements	Existence of an appropriate and evolving institutional environment that allows fair access and entitlement to key assets and capitals.
Knowledge and information	The community has the ability to collect, analyse and disseminate knowledge and information in support of adaptation activities.
Innovation	The community creates an enabling environment to foster innovation, experimentation and the ability to explore niche solutions to take advantage of new opportunities.
Flexible forward-looking decision-making and governance	The community is able to anticipate, incorporate and respond to changes with regard to its governance structures and future planning and ensure the 'good governance' of natural resources under its formal and informal authority.

Adapted from Jones, Ludi, and Levine 2010.

[7] See the Council of Implementing Partners from the Sudan case study.

[8] See case studies for Rwanda, Sudan and Swaziland.

MALI

Title: Northern Regions Investment and Rural Development Programme (PIDRN)

Duration: 2006 - 2013

Cost: US$34.61 million

IFAD Financing: US$15.4 million

Beneficiaries: 489,000 individuals

Mapping Type: Ground and sketch mapping, GPS, GIS

SUDAN

Title: Western Sudan Resource Management Programme (WSRMP)

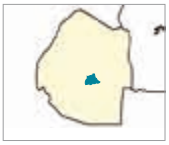
Duration: 2005 - 2013

Cost: US$49 million

IFAD Financing: US$25.5 million

Beneficiaries: 38,000 households

Mapping: Sketch mapping, GPS, GIS



SWAZILAND

Title: Lower Usuthu Sustainable Land Management Project (LUSLM)

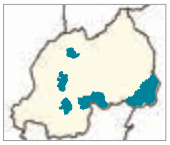
Duration: 2010 - 2014

Cost: US$10.6 million

IFAD Financing: US$6.1 million (IFAD loan), US$1.9 million (IFAD grant)

Beneficiaries: 4,200 households

Mapping: Sketch mapping, aerial photography, GPS, GIS



RWANDA

Title: Kirehe Community-based Watershed Management Project (KWAMP)
Support Project to the Strategic Plan for the Agriculture Transformation (PAPSTA)

Duration:
2009 - 2016 (KWAMP)
2006 - 2013 (PAPSTA)

Cost:
US$49.3 million (KWAMP)
US$30.4 million (PAPSTA)

IFAD Financing:
US$26.7 million (KWAMP)
US$13.9 million (PAPSTA)

Beneficiaries:
22,500 households (KWAMP)
10,000 households (PAPSTA)

Mapping: Ground and sketch mapping, satellite imagery, GIS

INDIA

Title: North Eastern Region Community Resource Management Project for Upland Areas (NERCORMP)

Duration: 1999 - 2008

Cost: US$33.2 million

IFAD Financing: US$22.9 million

Beneficiaries: 36,161 households

Mapping: Ground and sketch mapping, P3DM

The designations employed and the presentation of the material in this map do not imply the expression of any opinion whatsoever on the part of IFAD concerning the delimitation of the frontiers or boundaries, or the authorities thereof. Map compiled by IFAD 23-05-2013

Mitigating conflicts and strengthening local capacity in Sudan

The big picture

Sudan's socio-economic and political instability is intertwined with climate risk and vulnerability, resource scarcity and environmental degradation. The **Western Sudan Resources Management Programme (WSRMP)** addresses these linkages through a focus on participatory natural resource management (NRM). The programme uses participatory mapping to bring together a diverse range of people and interests. It aims to reduce land and water conflicts between nomadic pastoralists and settled farmers.

> "In the past, the rain came in May and we finished sowing in May. In June we did weeding, because the rain stopped for a little bit. But this year, the rain came on the 20th July, and it stopped after August. Agricultural production has dropped and we don't have enough grass for our livestock. Due to successive droughts, households have lost livestock – some lost 10 head. Our incomes drop and we cannot educate our children."
>
> Smallholder farmer, North Kordofan

In North and South Kordofan, rainfed agricultural systems are affected by erratic rainfall, drought and extreme flooding along seasonal watercourses. Changes in weather patterns have an impact on both farmers and pastoralists. Since mechanized farming has expanded in the immediate proximity of traditional stock routes, livestock resting areas are located close to farms. The shifting of seasons affects pastoralists' migration calendars and routes, which often results in livestock encroaching farmland and farmers and pastoralists competing over water resources.

Resource-based conflicts are likely to exacerbate in a changing climate. The Government of Sudan highlights in its National Adaptation Programme of Action (2007) that by 2060 average temperatures during the month of August are expected to rise from between 1.5° C to 3.1° C above the baseline (1961-1990). Average rainfall is expected to decline by about 6 mm per month during the rainy season, compounded by greater soil evaporation and water stress during the dry period. Dust storms, heatwaves and flooding are expected to intensify and increase in frequency. These changes will increase the risk of crop failure, diseases and mortality of livestock, loss of biodiversity, migration and greater dependency on food aid.

The resources management programme has used a series of participatory methods and approaches, including the development of community environmental action plans (CEAPs), to analyse the livelihoods of local farmers and herders and devolve decisions over natural resource management to local communities. In developing the CEAP process, the programme has built on similar experiences in East Sudan and benefited from the expertise of the International Union for Conservation of Nature (IUCN), which provided training and capacity-building in participatory mapping. The programme incorporated different mapping processes such as sketch mapping, GPS and GIS.

The mapping process

Demarcation of stock routes using GPS and GIS

Mobile extension teams accompanied nomadic pastoralists along stock routes in their movement from dry season grazing areas in the North to wet season grazing areas in the South. Traditional stock routes were demarcated using GPS coordinates and GIS technology. During this trip, the extension teams facilitated a participatory needs appraisal and supported decisions over the allocation of services and resources along these routes (such as water points, veterinary check points, crush pens and livestock resting areas). During this process, pastoralists were briefed and prepared for negotiating with farmers.

Sketch mapping for environmental planning

The participatory mapping process was based on a 'training of trainers' approach with two landmark training events, one in El Gedarif and the other in El Obeid in 2010. The trainings included farmers and pastoralists, community leaders, extension team members and representatives from government authorities. At the same time, technicians from the Range and Pasture Department were trained in the use of GIS technology to assess vegetation densities and plot wildfire lines (strips of land to be left free of grass) on the most risky areas.

Once extension team members and community leaders had grasped the participatory mapping concept and its potential applications in land use and natural resource management planning, they were ready to apply their acquired skills to develop participatory sketch maps at the village level. Two sets of resource maps were drawn on flipcharts, depicting the current landscape (status quo) and the envisioned future landscape (vision). Resource maps were used to represent land cover and land use all over the village territory. The maps depicted the location of villages, forests, rangelands, cropping areas, backyard gardens, stock routes, livestock resting areas and water points. The visioning maps illustrated how community members envisioned their landscape to look like in 10 years' time. Based on these maps, the participants delineated problem areas and developed a CEAP which defined roles and responsibilities of different stakeholders in attaining the shared vision. Other participatory tools were applied to complement and reinforce the mapping. For example, a matrix of 'bad and good things' was developed that highlighted community deficits and assets. In the village of Banat, this matrix acknowledged persistent problems of water scarcity, distance of water points, desertification, shortage of land and absence of a plan for the management of scarce natural resources. Conversely, on the 'good' side, the matrix referred to the practice of agroforestry as well as crop and forest diversity. Stakeholder analysis clarified the use of different resources by different community groups and delineated areas with open and potential conflict. Starting from only a few villages, the development of CEAPs has been rapidly scaled up. Over the course of the programme, it became evident that training in disaster risk reduction and the provision of access to weather and climate information are critical ingredients to capitalize on participatory mapping and prepare for climate shocks and stresses. As a consequence, six programme staff members have been trained in community-managed disaster risk reduction at the International Institute for Rural Reconstruction in the Philippines.

> **"Working in groups (during the mapping) makes negotiations and consensus building easier."**
>
> Workshop participant, El Obeid 2010

> **"Developing a community environmental action plan helps focus action on natural resource management and brings out coping adaptation strategies during times of difficulty."**
>
> Workshop participant, El Obeid 2010

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How has participatory mapping strengthened adaptive capacity?

Key factors for local adaptive capacity	
Asset base	• **Strengthening equitable access and control by local communities over natural capital and ecosystem services** Identified conflict areas as basis for negotiating and agreement of shared access and control, e.g. around water points, croplands, range and forest lands, livestock resting areas, stock routes. • **Prioritizing measures to increase the climate resilience of agroecosystems** – adoption of early maturing crops – expansion of afforestation, reforestation and rehabilitation of degraded land through agroforestry – dissemination of water harvesting technologies for both crop and rangeland – rangeland reseeding – investment in agro-biodiversity (with special reference to climate resilient varieties) – investment in high-value fruit producing trees such as Gudaim (*Grewia tenax*) and Sidr (*Ziziphus spina-cristi*) in the farmlands for income generation as safety net to address frequent failures in cash crop production.
Institutions	• **Changing the rules, behaviours and power dynamics in natural resource management and land use decision-making** Empowered disenfranchised actors and facilitated peer-to-peer dialogue among farmers and pastoralists. • **Reviving existing institutions** Inclusion of the Native Administration in the resource mapping process through the Council of Implementing Partners restored the traditional role of the Native Administration in natural resource decision-making (see Innovation section below). • **Establishing new institutions and gender dimension** Participatory mapping associated with the development of community-based organizations such as community development committees (CDCs) allowed at the grass roots to take a leading role over the community development process. In almost every village women held at least one of the main elected positions in the CDC.
Knowledge and Information	• **Providing an innovative mechanism for gathering, codifying and sharing local information** Women and men able to visualize problems in NRM and develop practical remedial actions. • **Providing an opportunity for mutual learning** Mapping and visioning captured both women and men's divergent views providing an opportunity for them to learn from each other. • **Consolidating information about community assets and deficits** Information consolidated through maps of the status quo and visioning maps, matrix of 'bad and good things' and stakeholder analysis.
Innovation	• **Introducing social innovations** – Engagement of traditional leaders through the Council of Implementing Partners. The participation of the Native Administration in the Council was an important innovation after the government dissolved it in the 1970s. The Council favoured the harmonization of government and community thinking with regard to natural resources. – Mixed mobile extension teams – with members from both North and South Kordofan – accompanied nomads along the migratory routes, discussed and understood their needs and priorities and prepared them to negotiate with farmers.
Flexible forward-looking decision-making	• **Raising awareness about the temporal dimension of a changing environment** – Through the development of CEAPs, community members became more aware of the existing degree of both climate and human-induced degradation, their own impacts and responsibilities. – Greater enthusiasm and commitment to preserve the environment and sensitive natural resources. • **Continuity, monitoring and follow up** – Having two maps, one for the current situation and one with a long-term vision, has helped participants to envision landscape changes over time, plan adaptation strategies and monitor the attainment of these plans. To date, the maps are still conserved by the CDCs. They are showed to visitors with pride and are often consulted. In some villages, maps are updated and the CEAPs regularly revised accordingly by the community to assess progress, challenges and constraints and to suggest new actions. In other villages, follow up is more inconsistent.

Transforming shifting cultivation in India

The big picture

Smallholder farmers living on the steep hills and slopes of North-East India are highly reliant on shifting cultivation, locally known as jhum. Strongly rooted in local tradition and culture, jhum is often practised through slash-and-burn, which involves clearing vegetation cover, drying and burning it with the aim of cropping. Plots of land are cultivated temporarily, then abandoned and allowed to revert to their natural vegetation. The practice of leaving land fallow after harvest allows its reuse for the same purpose in a cycle. In the past, the jhum cycle lasted about 20 years. Excessive pressure on land in some areas – indiscriminate felling and burning of forest, free cattle grazing and erratic jhum practices without fire line protection – had reduced the duration of the jhum cycle, with varying degrees of dependence and time within the six districts (10-12 years in Ukhrul, 3-4 years in Meghalaya, 5-6 years in Assam). The shortened cycles and depleted fertility of soil negatively affected the vegetation regeneration capability and crop productivity.

Additional challenges, including the impacts of more erratic rainfall and climate-induced delays in both growing and harvest seasons have led to the net effect of greater food insecurity. Climate change projections for the region are rather negative. In India, annual mean surface air temperature is projected to rise between 3.5° C and 4.3° C with respect to the 1961-1990 baseline by the end of the century (Government of India 2012, vii). The number of extreme rainfall events per year is expected to increase (Government of India 2012, 141) and the destructive interplay between drought periods and flooding events will intensify.

The **North Eastern Region Community Resource Management Project for Upland Areas (NERCORMP)** was launched in 1999 in three states – Assam, Manipur and Meghalaya – and focuses on two target districts with a high level of dependence on shifting cultivation in each state. The first element of the project strategy was the introduction of participatory planning processes to formulate community resource management plans (CRMPs). These processes pursued the double objective of increasing agricultural

> **"We had a good harvest in the past but now our harvest has become poorer every year. This may be due to short jhum cycle and climatic change. However, we are lucky that the project has come at a time when we were all looking for alternatives and other opportunities."**
>
> Rockson, Headman, Tusom Village

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productivity while protecting the environment and ensuring the sustainable use of natural resources. Participatory mapping contributed to enhancing local adaptive capacity by strengthening and expanding the resource base as well as promoting a participatory governance system.

The mapping process

The North Eastern region project promoted two types of mapping: natural resource mapping, which was conducted in the early stages of the project as part of the Participatory Rural Appraisal (PRA) process; and Participatory 3-D Modelling (P3DM), which was undertaken in five selected localities after the resource mapping. The result was the development of a landscape relief model (made of rubber sheets) of the village territory.

Ground and sketch mapping

The PRA process was intended to raise community members' awareness of their resource base and bring out perceived strengths, weaknesses, opportunities, needs and aspirations. Resource mapping started from ground maps that were later translated into paper sketch maps. After visualizing the distribution of natural resources in the community, participants tried to determine the extent of environmental pressure and damage. Starting from an appraisal of current conditions, a vision for the next six years was developed and translated into a concrete CRMP.

At the outset of the planning process, ground and sketch maps helped communities to identify the extent of forest cover under shifting cultivation, and define potential new sites. The maps showed where it was no longer possible to practise jhum and where fallow or biodiversity conservation should have taken place instead. It was through the visioning exercise that villagers started to rethink jhum cultivation practices in the context of longer-term sustainable development. The PRA process was conducted in an inclusive manner and involved women, elders and young people. Today, village members still go back to the maps to assess the changes that have occurred in their community and to verify compliance with community plans.

Participatory 3-D Modelling

With the introduction of P3DM, participatory mapping was taken to the next level. Through the use of P3DM, the community identified and delineated various land uses and colour-coded the present use of land and potential areas for development (terraces, expansion of conservation areas, water catchment protection). P3DM capitalized on community participation and provided a credible tool for both community sensitization and advocacy.

Initially, the Philippine Association for Intercultural Development and the International Centre for Integrated Mountain Development provided a P3DM training followed by field testing in Sasatgre village in the State of Meghalaya. Lessons learned from this pilot experience informed the P3DM exercise in other locations. It was evident that the mapping process was not only about defining boundaries and resource domains, but also about mapping traditional environmental knowledge. While selected representatives from women's groups, young people, churches, village councils and local NGOs took a leading role in mapping traditional environmental knowledge, its validation and corroboration was an inclusive process involving the community as a whole. The 3-D models are still stored in the village community halls and Authority Courts. Results were mixed in terms of continuity in their use and follow up on the action plans. Although more villages requested support with 3-D modelling exercises, financial and time constraints prevented comprehensive scaling up beyond the project's lifetime.

How has participatory mapping strengthened adaptive capacity?

Key factors for local adaptive capacity	
Asset base	• **Strengthening access and control of key assets** – Site selection for the planning of infrastructure, services and protection from climate hazards, e.g. in Hundung Godah the P3DM assisted in defining areas for household resettlement to reduce risks of isolation and water shortages. In Ngainga the P3DM defined water catchment protection areas and safe location for a freshwater pipeline. – Mapping clarified jhum land allocations reducing the risk of conflicts. • **Strengthening resilience of agroecosystems** P3DM was used to demarcate and allocate new conservation areas and to help plan modifications to sensitive jhum practices. Many conservation areas have been increased (Ngainga forest reserve was expanded by more than 10 hectares). To date, the jhum area has been reduced to one-third of its size and its cycle was increased from 5-6 years to 7-8 years. In the village of Ngainga, jhum modification activities have led to prolonged cultivation of up to 3 years with the support of bio compost over an extension of 121.58 hectares.
Institutions	• **Changing the rules, behaviours and power dynamics in natural resource management and land use decision-making** Clarified Do's and Don'ts in a strengthened NRM system. New norms included the adoption of a strict fining system for wildfires; promotion of tree plantations along roadsides; maintenance of nurseries for local tree species; and installation of controls for cattle grazing, hunting, use of chemical fertilizers, pesticides and the sales of wild edible plants. • **Reviving existing norms** Inconsistently applied informal rules governing NRM – including the prohibition of timber cutting by outsiders, rules to control wildfires and land-related dispute settlements – were improved or revised. • **Establishing new institutions and gender dimension** Participatory mapping was accompanied by a parallel process of institution-building. Natural resource management groups (with equal representation of men and women from each household) and self-help groups (made up of women) eased gender balance in the participatory process. With NRM groups all households were involved in decisions that had once been confined to clan representatives.
Knowledge and Information	• **Deeper understanding of the village geography and resources** Mapping enabled community members to understand the interconnected dimensions of the natural landscape and extrapolate the implications of current land use practices in the future. • **Easing communication with outsiders** P3DM worked as an advocacy tool: helped communicate needs and aspirations to policymakers and development practitioners. • **Favouring the consolidation and dissemination of existing traditional agricultural and NRM practices** – Revived and added value to traditional environmental knowledge that had accumulated for years through the observation of weather, ecosystems and landscape change. – Promoted the scaling up of traditional crops (alder tree, bamboo, Flemingia vestita, soya bean). • **Intergenerational transmitting of knowledge** P3DM made it easy to explain to young people NRM rules and regulations.
Innovation	• **The mapping process helped the planning of technical innovations such as:** – Permanent terrace cultivation established where water was available – Diversified livelihood activities set up to secure self-reliant livelihoods and minimize the impact of crop failure: integrating bee-keeping as buffer activities, backyard livestock-keeping (pigs, poultry and ducks) and off-farm activities (weaving, handicrafts, small shops, tailoring and small-scale cottage industries) – Crop diversification formed through kitchen gardens (onions, cabbages, potatoes, mustard and coriander) – 'High value, low volume crops' (medicinal and aromatic plants) introduced – New horticulture crops (banana, orange and pineapple) introduced to reduce cultivation on landslide-prone steeper slopes.
Flexible forward-looking decision-making	• **Raising awareness about the temporal dimension of a changing environment** – Through the development of CEAPs, community members became more aware of the existing degree of both climate and human-induced degradation, their own impacts and responsibilities. – Greater enthusiasm and commitment to preserve the environment and sensitive natural resources. • **Continuity, monitoring and follow up** – Having two maps, one for the current situation and one with a long-term vision, has helped participants to envision landscape changes over time, plan adaptation strategies and monitor the attainment of these plans. In some villages, maps are updated and the CRMPs regularly revised accordingly by the community to assess progress, challenges and constraints and to suggest new actions. In other villages, follow up is more inconsistent.

Reducing smallholders' vulnerability in East Rwanda's watersheds

The Big Picture

One of the major environmental protection issues in Rwanda is the imbalance between a growing population and the pressure it is exerting on natural resources. These resources have been degrading for decades as a result of deforestation, depletion of biodiversity, erosion, pollution of waterways, and the degradation of fragile ecosystems, such as swamps and wetlands.

> "Before protecting the watershed communities used to have floods in the marshland, but now since the watershed was completely protected they are no longer facing that problem. They understand that this is because they have protected the watershed. They realize that something that was affecting them has been controlled."

Janvier Gasasira, Project Coordinator

Human-created pressures on natural resources are compounded by climate-related factors. Rwanda is highly vulnerable to climate change as it is reliant on rainfed agriculture both for rural livelihoods and exports of tea and coffee. A study by the Stockholm Environment Institute (2009) found that existing climate variability has significant economic costs in Rwanda. The future economic cost of climate change could be equivalent to one per cent of GDP per year if not addressed. These costs are associated with losses from more extreme weather events, including floods and droughts, which create major socioeconomic impacts. The agricultural sector is expected to be the hardest hit, as rural households rely heavily on climate-sensitive resources such as local water supplies and agricultural land, rainfed crop and livestock production, and the collection of fuelwood. A changing climate is projected to have serious impacts on the quality, availability and distribution of these resources, limiting options for poor rural households.

The **Kirehe Community-based Watershed Management Project** (KWAMP) and the **Support Project for the Strategic Plan for the Transformation of Agriculture** (PAPSTA), both operating in East Rwanda, have adopted a poverty-focused approach based on the participatory restoration and management of degraded watersheds. Participatory watershed management plans and the development of community-based institutions in affected communities have created a sense of responsibility and ownership necessary for effective joint decision-making on community development issues. The projects have shown that a focus on inclusive governance and community-based organizations has empowered local communities, reduced smallholder farmers' vulnerability to climate-induced shocks and stresses, and enhanced their capacity to adapt to climate change.

The mapping process

In both PAPSTA and KWAMP, participatory mapping has become an integral part of watershed management planning. Mapping has provided a process to delineate existing problems and establish a road map for implementing solutions.

From satellite imagery to sketch mapping

The participatory watershed management process in Rwanda started with a ground mapping exercise. In the targeted watersheds, many farmers were familiar with the drawing of maps and considered it an easy way to express their point of view. In ground mapping, it was evident that only a limited number of farmers could "hold the stick", actually drawing at a given time. Since numerous groups were involved in the planning process, orthophoto maps printed on A0 format were transferred on tracing paper to ease wider participation on the theme of watershed planning. These orthophoto maps were derived from a GIS system through the use of high resolution satellite images and served as a working document. Sketch mapping on tracing paper was used to represent the baseline scenario

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to depict the current status of the watershed. Upon completion, farmers were asked to draw a second sketch map to represent their objectives and aspirations as a community: a map of the future, to depict the desired status of the watershed. The themes of watershed planning included social and public infrastructure, land cover, agriculture and livestock. In this stage of the participatory planning process, sketch mapping enabled communities to reflect on measures related to erosion control (such as construction of waterways and areas for reforestation) and measures necessary to respond to erratic rainfall (such as the construction of small dams and irrigation systems).

GIS mapping

Through a digitization process led by GIS specialists, the sketches of both situations (current status and desired future scenario) were inserted into a GIS system. At the end of this process, farmers were asked to validate the GIS maps. They received technical assistance and acquired the skills necessary for interpreting geo-referenced maps. Their active participation in this phase of the process was crucial to avoid technological overload and ensure that community experience and inputs were not lost throughout the process. The GIS mapping process concluded with the delineation of a road map to achieve the desired watershed management plan.

The maps were laminated and stored in the Community Centre for Innovation (CCI). The centre was established to support farmers' organizations in market-oriented business plan consolidation, NRM planning and education for farmers. It is a place for rural dwellers to meet and share experiences and to address problems that arise during project implementation. At present, maps are updated at the end of each fiscal year to monitor the implementation of the plans and the level of development of the watershed. On a regular basis new maps are sketched to measure how far agreed actions have been realized, turning the mapping process into a tool for participatory monitoring and evaluation.

The watershed management plans were summarized and translated into the national language (Kinyarwanda), handed over to the different strata of the watershed community who participated in the planning process. Integral watershed management plan documents are kept in the library of CCI and used as a repository of information to be consulted when needed. They are under the responsibility of the Rwanda Agriculture Board, which is an office of the Ministry of Agriculture and Animal Resources. As a result of the positive impact of these activities, neighbouring communities indicated their desire to undergo a similar exercise and, therefore, the number of villages involved in participatory mapping exercises was significantly higher than initially planned.

How has participatory mapping strengthened adaptive capacity?

Key factors for local adaptive capacity	
Asset base	• **Strengthening access and control of natural, physical, human and financial capital** Communities depicted natural assets (land, water, forest areas) and physical assets (irrigation infrastructure). • **Strengthening resilience of agroecosystems** Participatory mapping supported communities in planning and prioritizing: – Actions for soil and water conservation on farmland, e.g. through progressive terracing, contour trenches and anti-erosion hedging of farmland – Irrigation systems to reduce dependency on increasingly erratic rains and farm higher value, off-season crops – Marshland protection measures in response to annual floods – Properties of a crop intensification programme cultivating different crops (bananas, beans, pineapple, potatoes, sorghum) in each of the 29 watersheds (18 for KWAMP and 11 for PAPSTA) according to soil suitability.
Institutions	• **Strengthening resilience of agroecosystems** Participatory mapping supported communities in planning and prioritizing: – Actions for soil and water conservation on farmland, e.g. through progressive terracing, contour trenches and anti-erosion hedging of farmland – Irrigation systems to reduce dependency on increasingly erratic rains and farm higher value, off-season crops – Marshland protection measures in response to annual floods – Properties of a crop intensification programme cultivating different crops (bananas, beans, pineapple, potatoes, sorghum) in each of the 29 watersheds (18 for KWAMP and 11 for PAPSTA) according to soil suitability.
Knowledge and Information	• **Providing an innovative system for gathering, codifying and sharing local information** – The combination of community maps with GIS clarified the relationship between human and climate-related pressures, with climate change acting as a threat-multiplier. – Mapping provided a tool for updating information, monitoring changes and project achievements over time.
Innovation	• **Dedicating attention to innovative aspects** The involvement of efficient farmers in the mapping process who were ready to share lessons learned from local innovation created a conducive environment for social learning. • **Achieving agronomic innovations** Visualizing resource scarcity and progressive degradation through the mapping process provided incentives for farmers to: use waste and agricultural by-products to minimize the need for costly fertilizer and energy; employ conservation techniques and recycle nutrients on-farm; introduce biogas to reduce fuelwood consumption; develop kitchen gardens in households and schools.
Flexible forward-looking decision-making	• **Raising awareness and promoting a sense of responsibility** Facilitated a self-discovery process and clarified roles, responsibilities and timing of interventions. The participatory mapping process helped clarify the links between deforestation, erratic rainfall patterns, soil erosion and flooding. Starting from an auto-evaluation, participants learned how to contribute to solve their problems. • **Continuity, monitoring and follow up** – Maps have become a tool for participatory monitoring and evaluation. – Maps have become a repository of information which are consulted when needed.

Tackling conflicts over climate-sensitive resources in Mali

The big picture

In the northern region of Mali, high prevalence of poverty is aggravated by a harsh natural environment. Drought, desertification and limited access to water are typical features of rural landscapes. Impacts of climate change are projected to worsen the already difficult environmental conditions.

Mean annual temperature in Mali is projected to increase by 1.2˚ C to 3.6˚ C by 2060, and by 1.8˚ C to 5.9˚C by 2090 (McSweeney, New, and Lizcano 2010). Although it is difficult to identify long-term trends in Sahelian rainfall due to its high variability, projections of mean annual rainfall point towards an overall decrease (McSweeney, New, and Lizcano 2010). Proportionally, the largest decreases are expected in the north of Mali.

Water scarcity has already led to high levels of competition over natural resources. Rice farmers have expanded into so-called 'bourgou' areas, which are traditionally used and managed by pastoralist groups. Bourgou is a type of grass growing in wet delta regions, typically along the River Niger, where it is commonly used as forage for livestock. Due to growing delays in the onset of the rainy season, livestock is grazing for prolonged periods of time close to the river, in the proximity of cultivated areas. This has increased the potential for conflict between herders and farmers.

The **Northern Regions Investment and Rural Development Programme (PIDRN)** supports the development and implementation of landscape management schemes (*Schéma Communal d'Aménagement du Territoire* – SCAT), which use participatory rural appraisal tools, such as seasonal calendars, problem trees, Venn diagrams and participatory mapping, to develop community land management plans and address conflicts between farmers and herders in borgou growing areas. In line with Mali's decentralization policy,[9] the programme engages with local authorities at the *commune*-level[10] and operates in five *communes* in the *Cercle* of Bourem and nine *communes* in the *Cercle* of Gourma-Rharous.

> **"Drought due to rare and poor rainfall has led to severe changes in landscapes and degradation of natural resources, including extinction of some plant and wildlife species, silting of the Niger river valley, lakes and ponds, early drying of water points, and outbreak of new diseases."**
>
> Mohamed Maiga, Responsible for Land Management) (AFRICONSULT)

The mapping process

In the context of Mali, participatory mapping was applied to enhance the capacity of local communities to engage, plan and manage shared challenges at the landscape level. Maps were used to solicit information about natural resources and socioeconomic features of a landscape, asking questions such as: What natural resources are available? How are they distributed, and which groups have access to them? What current resource gaps need to be addressed? The objective of developing participatory land management plans was to create a discussion forum for all community groups, including marginalized groups – women who do not normally take part in public debates – and map out a shared vision

[9] Following the 1999 decentralization policy, *communes* are local focal points for rural development. They are responsible for planning, executing and maintaining public investments.

[10] Mali is divided into regions and one capital district. Regions are in turn divided into cercles. Finally, *communes* are the third administrative unit.

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of a common future. Towards this end, three mapping tools were sequentially introduced as cornerstones for the dialogue: sketch mapping, data validation with GPS and transfer of data into GIS maps.

Sketch mapping

Sketch maps were developed on the basis of simple ground maps. These were later transferred onto big sheets of kraft paper to facilitate the display and archiving of information. Sketch maps were drawn by village representatives under the supervision of a trained facilitator. Village members supported the drawers with great enthusiasm, and heated debates developed around the choice of the legend and the boundaries of landscape units. The final sketch maps were later presented at the village assembly for data validation, as well as synthesizing and harmonizing different positions. To add a temporal dimension with a view on adaptive landscape management, participants were asked to draw both historical and visioning maps, the latter delineating the desired changes in a 20-year time frame. The contrast between historical maps and the maps that displayed the status quo helped to put the proportions of landscape changes into perspective and clarified the need for forward-looking and anticipatory planning.

GPS and GIS mapping

The second phase of the participatory mapping process entailed transect walking with a small group of community members with in-depth knowledge of the territory. During the field walk, GPS coordinates were collected with the purpose of validating the information represented on the sketch maps so that scaled maps could be prepared. In a subsequent step, GIS technology was used to combine 'bottom-up', community-generated layers of information with 'top-down' layers displaying vegetation cover, infrastructure, geological features and soil characteristics. Each village council received a set of GIS maps which were made accessible to the general public as well as *commune* development partners.

How has participatory mapping strengthened adaptive capacity?

Key factors for local adaptive capacity	
Asset base	• **Strengthening access and control of natural capital and ecosystem services** Depicted the availability, distribution and control of natural resources (water points, vegetation cover, pasture and crop lands, bourgou areas). • **Strengthening resilience of agroecosystems** – Highlighted the need for better adapted seeds – Highlighted the need and locations suitable for water conservation – Highlighted the need and locations for agropastoralism. • **Fund raising** – Maps and community land management plans were used as advocacy tools to raise public financing for the management of irrigated perimeters, dune fixation and improved livestock management. – GIS maps have provided a useful document to help community leaders and elected representatives to communicate their future development needs.
Institutions	• **Changing the rules, behaviours and power dynamics in natural resource management and land use decision-making** – Involvement of women and marginalized groups such as the Bella tribes in decision-making. The planning process was dominated by literate members of the community. – During the discussions generated by the mapping process, participants agreed on the adoption of sustainable resource management rules, e.g. introduced limitations on the clearance of woody species and measures to avoid the encroachment of animals on cropland.
Knowledge and Information	• **Providing an innovative system for gathering, codifying and sharing local information** Improved understanding of local geography and environment (location of water points) through visualization on maps and community discussions, e.g. only certain nomadic pastoralists ventured far enough to report the existence of water resources that others were not aware of. • **Consolidating and disseminating traditional agricultural and NRM practices** Revival of traditional techniques of water conservation such as tillage at the end of the agricultural cycle.
Innovation	The layering of different maps that depicted historical, current and future conditions in the *commune* provided an important innovation and set the basis for the use of these maps to anticipate and assess future changes (see below).
Flexible forward-looking decision-making	• **Raising awareness about the temporal dimension of a changing environment** – Trends of environmental degradation made visible and urgency of action communicated. – Projected potential and likely future changes in the natural and built environment, e.g. through visioning maps that identified potential impacts of the Taoussa dam in Bourem on water plains, rice-growing zones and local households. • **Flexible and open-ended decision tool** Participatory mapping provides an open-ended process whose applications can adapt to changing circumstances. Future uses of the maps may include identification of the location for solar power plants and biogas plants, as well as irrigation requirements.

Enhancing the capacity to respond to the impacts of climate change in Swaziland

The big picture

More than 70 per cent of Swaziland's population depends on subsistence agriculture and livestock farming for its survival. A growing population in rural farming areas and increasing livestock on poorly managed rangelands have contributed to severe land degradation and deforestation of the Lower Usuthu Basin. A large part of this deforestation is linked to high reliance on wood fuel.

> "Sometimes when I get to the river after a long journey, I find no water but dry sand. I am then forced to use my hands to dig into the sand until I get to water level. Even if this water is dirty, I have no choice. I have to use it with my children."
>
> Woman from Swaziland

In addition, a number of irrigation projects have unintentionally increased pressure on grazing lands. Because of the high social value of livestock in Swaziland, many herders have shifted their herds to new grazing lands rather than adopt farming as an alternative livelihood.

In the last few years, extreme climatic episodes have intensified, accelerating human-induced trends of land degradation. Recent changes in rainfall distribution have increased the frequency and duration of droughts, which affect supplies of freshwater and aquifer recharge. Greater water scarcity forces many people to walk exceedingly long distances to fetch water, and in some instances share water with their livestock. Climate models indicate a dramatic decline in agricultural production in Swaziland and a multiplication of threats to the rich biodiversity and agroecosystems of the country. In the worst-case scenario, temperatures could rise by 2° C to 2.5° C, and precipitation may decrease by 200 mm by 2050 (Manyatsi et al. 2012).

The **Lower Usuthu Smallholder Irrigation Project (LUSIP)** aims to reduce land degradation, biodiversity loss and greenhouse gas emissions through the adoption of sustainable land management practices and energy production. The project works to enhance the resilience and capacity of smallholder farmers in the Siphofaneni, Sithobela, Mtfongwaneni and Lubulini constituencies to cope with the adverse impacts of climate change. Participatory rural appraisal methods, which include participatory mapping, are used to assist local communities in the development of chiefdom development plans.

The mapping process

The LUSIP project draws on participatory mapping to prepare inventories of natural resource availability and use in different localities. Based on an assessment of present day vulnerability it helps to increase the understanding of climate-induced changes in the landscape across different timescales.

Resource mapping using GPS and GIS

Communities prepared resource maps to depict the current distribution of natural resources and to envision community aspirations for a 5-year horizon. The starting point for this resource mapping was the drawing of boundaries for the chiefdom. Community elders, including traditional authorities, walked along the chiefdom boundaries accompanied by project staff who collected GPS coordinates, which were then plotted on an aerial photo of the area. During the transect, discussions with community representatives were rather informal. More formal and detailed information was shared during the envisioning exercises where participants agreed upon a shared vision for future development. The boundary map was used to geo-reference all spatial

features within the boundary including homesteads, schools, clinics, grazing and arable land, conservation areas, water sources and access roads. The GPS coordinates were then inserted into a GIS system. Finally, the digitized resource maps were presented to the community for validation.

Land use mapping

On the basis of the information visualized on resource maps and through the envisioning exercise, participants formulated sustainable local economic development strategies to achieve the desired future development outcomes. Land-use plans that depicted economic strategies were developed as a component of the chiefdom development plans. These plans encompassed requirements for grazing and arable land, areas for local business development, residential areas and communal infrastructure (such as schools).

They were sketched on top of the original resource maps now turned into land use maps. On some occasions, GPS and GIS technology was used to geo-reference the corresponding land allocations. Chiefdom development plans presented timelines for each strategy and defined roles and responsibilities for all stakeholders, including development partners and public institutions that could be approached for assistance. At the time of writing (April 2013) two communities in the project area, covering about 400 homesteads completed their land-use plans.

How has participatory mapping strengthened adaptive capacity?

Key factors for local adaptive capacity	
Asset base	• **Strengthening access and control of natural and physical capital** – Identified and spatially depicted natural assets (grazing and arable land, conservation areas, water sources) and physical assets (homesteads, schools, clinics, access roads). – Allocated future land use, such as grazing land for livestock, arable land for crop farming, areas for local business development and areas for community infrastructure. • **Illustrating the vulnerability of natural assets to human- and climate-induced stresses** Maps displayed the actual size of grazing lands and their carrying capacity, as well as the extent of alien invasive species. • **Improving access to financial capital** Identified funding gaps and financing needs. • **Enhancing resilience of agroecosystems** – Reduced land degradation, e.g. mapping dongas (steep-sided gullies created by soil erosion) raised awareness on the rapid rate of land degradation and suggested the adoption of donga rehabilitation measures; identified priority sites for reforestation and for the establishment of tree nurseries. – Reduced wood depletion, e.g. visualization of land and forest degradation during the participatory planning process suggested the adoption of fuel efficient stoves, solar cookers and water heaters. – Diversified livelihoods, e.g. participatory mapping provided a space for deciding on alternative livelihood systems such as rearing of the local breed of chickens, bee-keeping, rabbit keeping, indigenous poultry production (also to reduce dependence on the sale of fuelwood). Women started growing vegetable gardens for income generation.
Institutions	• **Changing rules and behaviours in natural resource management and land-use decision-making** – Enabled involvement of community members in project and investment design. • **Strengthening existing institutions** – Engaged traditional leadership of rural chiefdoms (chiefs who administer Swazi Nation Land on behalf of the King and indvunas) in the community planning process.
Knowledge and Information	• **Helping to fill gaps in environment and climate information** Enlarged and strengthened community knowledge base by combining informal community-generated knowledge with national geo-information.
Innovation	The use of aerial photography combined with GIS and GPS technology itself provided a substantial innovation in community planning.
Flexible forward-looking decision-making	• **Raising awareness and promoting a sense of responsibility** Raised climate change awareness, e.g. during the mapping it was evident that the rate of land degradation was rising as a result of the increased intensity of rains after longer dry spells. This suggested that anticipatory measures should be undertaken such as erosion control and more intensive watershed management efforts. • **Continuity, monitoring and follow up** – Timelines presented for each development strategy and the roles and responsibilities defined of all stakeholders. – The participatory mapping process kick-started an iterative process of planning, monitoring and revising land-use plans.

Key lessons

The case studies presented in this publication have illustrated the value of participatory mapping as a tool for enhancing local adaptive capacity. Spatial visualization through mapping and the participatory character of the process have come in support of climate-related decision-making in many different ways. Key lessons learnt are summarized below.

Participatory mapping provides a dynamic tool for understanding change over time

All the cases entailed a visioning exercise which strengthened the capacity of communities to view their collective actions in a prism of flexible, informed and forward-looking planning. Mapping has shifted from a static visualization of spatial features to reflecting the temporal and use-dependent dimensions of a changing environment. In Mali, the use of maps of the past, present and future capitalized on the dynamic character of participatory mapping. In India, Rwanda and Swaziland, the iterative design of maps and associated plans provided the basis for participatory monitoring and evaluation. Continued monitoring and updating of maps has shown the flexible, open-ended and adaptive character of the method, and the potential to serve as an exit strategy for rural development projects with limited duration and investment capital.

Participatory mapping helps to mitigate conflicts over climate-sensitive resources

Conflicts on ownership, access and use of natural resources is increasing as resources become more scarce. As the cases of Sudan and Mali show, participatory map-making has provided a platform for different groups to understand each other's needs and perspectives, work together, learn from each other and finally strengthen community cohesion. In Mali, participatory processes assisted in tackling the management of bourgou areas, the livestock passage as well as women's positions in relation to access and control over resources. In Sudan, mapping was used for demarcating traditional stock routes and highlighted areas for potential conflicts over water sources. Through participatory mapping stakeholders with different and often conflicting interests worked side by side on a common vision of the future.

Participatory mapping at the landscape level helps to better understand complex relationships between natural and human systems

Maps have been used to illustrate the interconnectedness among ecosystems and between these and human activities. Engaging clusters of villages with shared ecosystems and social interconnections seems particularly valuable when dealing with environmental and climate change. In fact, only by adopting a landscape approach is it possible to coordinate action and capitalize on the synergies between improved food security and rural livelihoods, enhanced climate resilience as well as climate change adaptation and mitigation (Scherr, Shames, and Friedman 2012). As in the cases of Sudan and Rwanda, landscape level planning provided a comprehensive outlook of vulnerabilities, hotspots and solutions. In Rwanda, the mapping process resulted in a number of sustainable watershed management initiatives, which played an important role in strengthening community resilience.

Participatory mapping gives voice to the most marginalized members of the community who are also those most likely to be affected by climate and environmental change

It can facilitate change in the power relations between actors, both horizontally and vertically, and reverse a common tendency to delegate important decisions to prominent community members. Participatory mapping can empower people to exercise their rights and engage in pro-poor policy lobbying (e.g. for better access to public information, policy dialogue, participatory budgeting, and co-management of common resources and investments). For example, in the case of Swaziland, chiefdom development plans were prepared by ordinary people. Government authorities came into the picture at a later stage when they were asked to review and provide their inputs to the plan. In India, from the very beginning, the project invested time and resources in equitable and inclusive community mobilization. In Rwanda, embedding the mapping exercises in local community organizations supported the inclusive nature of the process. The case studies clearly show that empowerment and rights complement each other – and different types of empowerment (social, economic and political) actually translate into sustainable adaptive capacity.

Participatory mapping is key for bridging top-down and bottom-up approaches to adaptation to climate change

In the absence of adequate and updated weather and climate information, integrating bottom-up information in climate-related planning seems not only useful but necessary. For example, weather stations with long-term climatic records are unevenly distributed in southern Swaziland thus making the long-term analysis of climatic trends, time series and patterns difficult. The long-lasting local experience of climate variability and change provided an invaluable source of historical data to complement scientific records. As the case of Mali shows, GIS technology can be used to combine community-generated layers of information with 'formal' information displaying vegetation cover, infrastructure, geological features or soil characteristics. The biggest limitation in bridging top-down and bottom-up aspects lies in the difficulty of keeping the community centrality throughout the process. For example, in Mali project staff and facilitators failed to adequately convey the nexus between GIS and community maps. The use of intermediate levels of technology such as Participatory 3-D Modelling (P3DM) may have helped to fill this mismatch.

Participatory mapping provides an invaluable tool to strengthen community resilience. However, there is plenty of space to improve it under both the technical and procedural perspective, especially in the face of future challenges linked to climate change.

Annex

Participatory mapping tools

Mapping method	Description	Strength	Weakness
Ground mapping	A basic mapping method that involves community members drawing maps on the ground from memory, using locally available materials (such as plants, rocks or household tools).	– Useful to engage non-expert users – Low cost and not technology dependent – Provides tangible short-term outcomes – Can be easily facilitated – Tactile (can walk around and interact with the product) favouring engagement, self-realization and sense of ownership	– Product ephemeral and fragile – Lacks accuracy and precision – Consequently lacks credibility as a formal decision-making document – Only a few people can draw on the ground at the same time with limited impacts in terms of community empowerment
Sketch mapping	Sketch maps are freehand drawings. They are drawn from memory on large pieces of paper. They involve drawing community identified features (crop and land, water points, households, schools, protected areas) to show their relational size and position.	– Useful to engage non-expert users – Low cost and not technology dependent – Provides tangible short-term outcomes – Can be easily facilitated – More detailed and permanent than ground maps – Easily adopted and replicated at community level	– Outputs are not geo-referenced but can be transposed onto a scale map, although with difficulty – Inadequate when accuracy in the location and size of features is required – Lack of accuracy undermines credibility with government officials – Only a few people normally draw the maps with limited impacts in terms of community empowerment

Mapping method	Description	Strength	Weakness
Participatory 3-D Modelling (P3DM)	P3DM integrates local spatial knowledge with data on land elevation and sea depth to produce stand-alone, scaled and geo-referenced models. Different sheets of cardboard or rubber sheets (corresponding to different altitudes) are cut following the contours of a topographic map. Rubber sheets are often preferred to cardboards because of their greater durability (e.g. they are waterproof). The sheets are traced, cut and assembled by the community. Once the blank model is ready, community informants are asked to add their traditional knowledge, based on mental recollections. Informants are called to depict human and natural features with the use of pushpins (points), yarns (lines) and paints (polygons). The application of a geo-referenced grid and digital photography allow digitization of the model and the export or import of data into GIS.	– Reusable for multiple planning exercise and low cost – Effective in portraying relatively extensive areas in detail – The information on the model can be easily transposed and replicated in GIS – Allows overlaying several layers of information – Easy to make, fun and engaging – 3D stimulates memories and elicits tacit knowledge – Particularly useful in remote areas – The bird's eye view allows visualizing and capturing information without the need to go to the field – By being scaled and geo-referenced, P3DM is considered more precise than other p-mapping methods – Consequently it is credible and can be used for advocacy – Cannot be easily removed from the community – community ownership – Proved to strengthen community cohesion, favour sense of pride and community empowerment – Can be updated over time	– Storage and transport can be difficult, hence makes immediate communication of community information to decision makers difficult – The information must be transferred to another medium (paper maps, photos or preferably GIS) to make it portable – Labour intensive and relatively time consuming when compared to the use of existing scale maps – Requires expert facilitators – In some developing countries access to accurate topographic maps is regulated and difficult
Global Positioning System (GPS) mapping	GPS is a satellite-based positioning system. A GPS receiver is carried to a position in the field and used to capture an exact location on the earth, using a coordinate system such as latitude and longitude. Data are stored in digital format. It is increasingly used by communities to survey large areas or demarcate routes (stock routes) and make scale maps, which are recognized by official agencies. When done in a participatory way, community members are asked questions on their needs, priorities and capacity during a sort of transect walk.	– Provides accurate (within 15 metres accuracy) geographic data – After initial training, receivers are relatively easy to operate – Increasingly affordable – Relatively lower technology requirements than other computer-based mapping techniques and therefore lower cost	– Still relatively expensive for many communities – Training is required to understand the equipment as well as formal cartographic protocols (scale, orientation, coordinate systems, projections) for its use – Equipment requires batteries (which is an additional expense – GPS receivers can be monopolized by the most authoritative members of the community (e.g. men) – Getting direct line of site to satellite sometimes hard in heavily forested areas

Mapping method	Description	Strength	Weakness
Using aerial and remote sensing images	Aerial photography and remote sensing involves gathering pictures (images if they are in a digital form) from around the earth's surface using cameras on airplanes and satellite sensors from space. These images can be geo-referenced and turned into maps: orthophoto maps. Distortion in the image is corrected and the height data (topography) can be interpolated. Scale, orientation, coordinate system and contour lines are shown, which make air photo maps excellent base maps for participatory mapping activities. Mylar transparencies or tracing paper can be overlaid to delineate land use and other significant features. Information on transparencies can be scanned or digitized and geo-referenced later.	– Effective in mapping relatively large and difficult to access areas – Can provide broad overview of community land use at the watershed level – Increasingly easy and cheap to access and download from the Internet – Can be engaging, offering community members views and perspective of their area that they may never have experienced before. Landmarks may even be recognizable	– Still can be expensive if images are not readily available. May be difficult to obtain permission for access in some countries (may be under military control) – No legend – to read and interpret certain images may be difficult – Does not always depict the features that are important for the community members (certain forest types or individual trees) – Sources of data could be difficult for some community members to relate to (orbiting satellites far outside the atmosphere)
Geographic Information System (GIS) mapping	GIS is a computer-based system that captures, manages, analyses, stores and presents geo-referenced spatial information. It includes spatial data management tools that can work with aerial photographs, satellite imagery, GPS and other digital data (including digital photos of Participatory 3-D Models). Since the 1990s, the PGIS movement has sought to integrate local knowledge and qualitative data into GIS for community use. GIS practitioners are increasingly working with communities to democratize its use – placing control for access and use of culturally sensitive spatial data in the hands of communities.	– Good at displaying precise geo-referenced information (either on-screen or as part of tailored paper-based maps) – Can use sophisticated database tools to analyse data and generate precise quantitative information. This information can be very important to manage natural resources and traditional lands – Maps and data produced by GIS communicate information easily, convey a sense of authority and are often highly convincing – Allows integration of expert knowledge with locally generated knowledge – Gives maps the authority necessary for advocacy and influencing policymaking	– Has long been regarded as an elite technology – complicated and costly that is primarily used by experts – Training is required to understand the equipment as well as formal cartographic protocols (scale, orientation, coordinate systems, projections) for its use – Steep learning curve (even for people with extensive computer knowledge) – Requires continual updating of software and retraining (long-term operating costs) – Expensive for many communities – The persuasiveness of the GIS can create a false sense of legitimacy – GIS data are only as accurate as the data used to create them – Often relies on experts – risk of focusing on the technology to the detriment of community participation – Allows exporting sensitive community information – need for Free Prior and Informed Consent (FPIC)

For more information on mapping methods, read *Good Practices in Participatory Mapping* (IFAD 2009).

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List of interviewees					
Surname	**Name**	**Role in the programme/ project**	**Interview date**	**Country**	**Project name**
Marbaniang	Adrian	M &E Officer	23/01/2013	India	North Eastern Region Community Resource Management Project for Upland Areas (NERCORMP)
Lungharwo	Thingreiphi	NRM organizer	28/01/2013		
Arban	Yolando C.	M &E Officer	23/01/2013		
Adam	Abdel-Hamid	Project Director	29/01/2013	Sudan	Western Sudan Resources Management Programme (WSRMP)
Abdel-Gadir	Mohammed	IFAD Country Programme Manager	17/01/2013		
Muhati	Godwin	MKEPP-GEF Component Project Manager	21/01/2013	Kenya	Mount Kenya East Pilot Project for Natural Resource Management (MKEPP)
Maiga	Mohamed	Responsible for Land Management (AFRICONSULT)	11/02/2013	Mali	Northern Regions Investment and Rural Development Programme (PIDRN)
Firmian	Ilaria	IFAD KM Officer	05/02/2013		
Dagnew	Alehegne	Project coordinator for the CBNRM	26/02/2013	Ethiopia	Community-based Integrated Natural Resources Management in Lake Tana Watershed (CBNRM) – GEF
Gasasira	Janvier	Project coordinator	29/01/2013	Rwanda	Support Project for the Strategic Plan for the Transformation of Agriculture (PAPSTA) and Kirehe Community-based Watershed Management Project (KWAMP)
Kota	Lynn	Project Manager GEF LUSIP	08/02/2013	Swaziland	Lower Usuthu Sustainable Land Management Project (LUSIP)
Dlamini	Vusi	Officer working with communities	12/02/2013		

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