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Resilience through soil and water management

Background

Soils and water are the basis of global food security and provide important sources of livelihoods, especially in the predominantly agrarian economies of many developing countries. Particularly in rural areas they are the foundation of economic development. Land-use practices in arid regions have been changing significantly since the middle of the 20th century as a result of population growth and climate change. In the Sahel for example, the massive expansion of arable farming into, amongst other areas, former pasturelands is destroying the natural savanna vegetation and restricting nomadic livestock herding. Moreover, changing precipitation patterns force the herders to move southwards into arable regions, thus leading to land-use conflicts. Large expanses of arable land are being degraded as a result of inappropriate land use: fallow periods necessary for regeneration are no longer being observed, over-exploitation and inappropriate land-use practices lead to nutrient depletion, erosion and other forms of degradation. Rising average temperatures increase crop water demand. In many areas, the increasing variability of precipitation has resulted in less dependable growing periods which, combined with more frequent flooding and droughts, heightens the risk of crop failure. The increasing desertification results in infertile land on which hardly anything grows anymore. Soil degradation processes are not limited to the Sahel and can be observed in many other regions, especially in arid zones. Worldwide, approximately six million hectares of land are being degraded every year – an area twice the size of Belgium. Soil degradation leads to greater vulnerability towards risk factors such as extreme weather conditions, climate change, and socio-economic crises which in turn find expression in recurrent famines and conflicts over resources.

In this setting, measures to improve resilience to risk factors are needed which stabilise or improve rural populations' living conditions. This is true for both the resilience of rural households and of ecosystems, i.e. the natural resource base on which life depends. Resilience refers to the capacity to absorb or adapt to shocks or to undertake changes in significant areas of life (see: 'Resilience as an issue in development cooperation: Definition and characteristics'[1]). A key component in this context is improved management of natural soil and water resources.

Action mechanisms of soil and water management measures

As early as the 1980s a wide range of resource management measures was developed with the intent to combat desertification. Starting points were the transfer, adaptation and advancement of technical approaches used in other geographical contexts whilst also drawing on and improving established measures used in traditional cropping systems. These approaches deliver substantial benefits in terms of soil and water productivity.

The participation of local people in developing potential solutions is a vital element. With the aid of land-use planning and, where collectively used lands are concerned, local land-use agreements, resource management is established more firmly in the administrative and normative setting and is coordinated by local resource users. Elements of crisis preparedness are taken up explicitly in spatial planning so as to establish a basis for systematic intervention in crisis situations.

Soil and water management measures developed in the 1980s and 1990s in response to the major droughts in the Sahel continue to prove useful today in view of increased land-use pressure and climate change, as the following examples show.

1 This is a commonly accepted definition. There are also other definitions; please refer to the briefing note entitled 'Resilience as an issue in development cooperation: Definition and characteristics'.

Stone contour bunds:

Stone contour bunds are mostly constructed as a communal effort. They are built on contour and help control erosion where land is gently sloped. They slow down water runoff, improve infiltration and soil wetting, and reduce erosion of organic material and nutrient-rich topsoil. Water availability and soil fertility are thus increased. The system provides something of a buffer against both dry periods and heavy rains.

Yields increase significantly as a result. Crop yield security also increases as even in dry years yields can be obtained while unprotected fields may suffer total crop losses. The planning consultation needed for the construction of the stone contour bunds as well as the construction process itself strengthen local self-help capacities.

Planting pits:

Planting pits, i.e. planting holes approximately 30 x 30 x 30 cm in size, are used to bring degraded areas back into production. The planting pits are dug prior to the rainy season and filled with dried manure or compost. They are laid out in a staggered grid pattern which helps catch rainwater run-off and makes the pits available for sowing crops. The planting pits are renewed every two years. They significantly increase fertiliser efficiency as fertilisers simply spread on the soil surface are often washed away by rains.

Planting pits may double yields compared to control plots and can also bring abandoned land back into production. One advantage is the improved fertiliser efficiency as nutrients are concentrated and delivered exactly to the plants' roots where they are needed. The digging of planting pits is however labour-intensive.

Small-scale irrigation systems

Small-scale irrigation systems are predominantly used in the cultivation of cereals, tubers and vegetables. From a higher-placed reservoir, water gravity-flows into a distribution system delivering it to individual plots, or engine-powered or manual pumps are used to move the water into the system. During the dry season, systems may be as basic as manually hauled water from simple wells which is used to water small crop beds.

Irrigation allows for several production cycles per year, leading to increases in both productivity and incomes. Dry-season vegetable production in particular allows for a more varied and richer diet as well as bringing additional income. The relative independence from precipitation allows for secure yields even in dry years. The planning, establishment, operation and maintenance of irrigation systems is premised on the users being well organised. Moreover, other actors such as local municipalities must be involved as these are the developers and formal owners of the installations where public funding has been used for their construction. Successful marketing is a precondition of the installations' cost-effectiveness.

Promoting the natural regeneration of trees

When fields are developed after fallowing or during soil cultivation and weeding, existing naturally regenerated trees are protected, leading to the development of a light tree cover in the fields (agroforestry). The recommended density is 60 to 80 trees per hectare. In the initial years these young trees must be protected from browsing livestock. Species such as *Acacia (Faidherbia) albida* are particularly well suited as they produce leaves and fruit during the dry season and drop their leaves during the rainy season.

The tree cover provides wind shelter and shade in the dry season and improves soils by contributing organic matter (mulch) and, depending on the tree species, by fixing nitrogen; the trees' root systems help combat erosion; livestock seeking shade under the trees deposit dung as well as seeds for further tree regeneration; wood, leaves and fruit can be used by both humans and livestock. Forestry products provide food security for families and strengthen their resilience, especially in times of emergency. An important determinant of the success of such systems are usage rights and ownership rights to the trees for the land users concerned.

In addition to these examples there is a range of other measures for improving soil and water management. The following measures in particular have proven useful in the Sahel: Vegetation strips, mulching, natural regeneration , demi-lunes, Nardi trenches, contour dams, manually dug contour ditches, fire breaks, dune stabilisation, micro-dams , and water-spreading weirs. Some of these measures can be implemented on individual holdings (e.g. mulching) while others are more suited to communal lands (e.g. demi-lunes). The measures improve water availability for crops, pastures and tree crops and protect soils from erosion and degradation, thus increasing yields and crop yield security. Crop farming can be diversified and intensified, reducing risks and creating opportunities for employment and income genera-

tion. Numerous advanced training measures, support for community self-governance, and access to market and administrative structures contribute to capacity-building in the local communities. The measures increase resilience at the levels of both agro-ecosystems (e.g. improved crop growth as a result of greater capacity for soil water retention) and rural households (e.g. higher yields, food security, higher incomes). Key to improving resilience are not only the individual measures taken but their meaningful combination and adaptation to local production and household systems as well to site conditions. It is therefore necessary to conduct nuanced evaluations of the different population groups' household strategies and production systems.

Approaches in development cooperation

Due to the fact that technical and methodological approaches have been refined in the context of long-term programmes, there is now a wealth of experience of how to implement tangible soil and water management measures. Country-specific experiences have been documented and, as part of knowledge management efforts, they have been organised and prepared for implementation, including implementation in other regions. Knowledge management tools such as WOCAT (World Overview of Conservation Approaches and Technologies) and Agriwaterpedia play an important role in these efforts.

The following approach has proven useful in implementing soil and water management measures:

As a first step, land-use planning should be undertaken, including a participatory appraisal of the spatial distribution of natural resources as well as their condition and existing uses. Under-utilised potentials and unsolved problems are identified and used to infer and prioritise development opportunities. Land-use planning should be a component of municipal development planning. As an element of public participation it serves to determine the strategy for natural resource development. The plans serve as references for activities within development programmes in this field. The municipality acts as coordinator and also as the developer where measures on communal lands are concerned.

Ideally measures are implemented at the water catchment level, i.e. as part of a landscape approach. Measures adapted to different areas of the water catchment are combined in a meaningful way. In the individual water catchments, the different sectors' land-use claims are considered as part of integrated land and water resource management (ILWRM). In order to complete all land-use planning phases and implement the most essential sustainable resource management measures, the duration of intervention per village is estimated to be five years as a minimum.

Generally one must distinguish between soil and water management measures at the level of individual holdings and at the level of village communities and municipalities. In both cases, initial measures are undertaken with a view to mobilisation, motivation and training so as to ensure the technical quality of construction measures and their long-term maintenance. While the organisational implementation of measures at the level of individual holdings tends to be unproblematic, steering in the collective sphere requires additional efforts to promote self-governance in the communities concerned. Self-governance is necessary to ensure controlled use and prevent conflict resulting from potential changes in land use. It is important to involve all users, including temporary users. This often gives rise to difficult procedural issues in the planning process and leads to delays. Where normal conduct and customs as well as the existing legal framework do not suffice, participating user groups enter into local land-use agreements. Such agreements regulate peaceful usage and serve to maintain the resources' yield capacities. They therefore also have social and institutional impacts.

The sustained development of the measures implemented is supported by accompanying measures. These include support for sustainable farming practices, support for livestock farming, improved access to farm inputs, and market access. They improve the measures' cost-effectiveness and further contribute to resilience.

With a view to sustained impact, ideally governmental and private service providers, ministries as well as regional and international organisations will be supported with advice. The role of service providers is to ensure the long-term availability of advice to farmers on the establishment, maintenance and economic utilisation of the measures. Ministries and supranational organisations are to ensure that supportive political and legal framework conditions (e.g. incentive mechanisms, infrastructure development, land rights) are in place.

Monitoring

Monitoring systems are used to track agricultural, ecological and social impacts of measures with a view to assessing their impact on living conditions and resilience. These monitoring systems comprise a record of the baseline situation, the systematic recording of key information, and supplementary selective investigations of specific aspects. Information sources may be very diverse, ranging from satellite data on vegetation development, agricultural yield surveys, household surveys on agricultural practices, eating habits and nutritional status, to the collation of qualitative evidence of changes in household systems.

Ideally, monitoring systems should be embedded in partners' systems. The assessment of resilience as a characteristic of human–environment systems necessitates observation of the overall system. In order to be able to assess the impact of soil and water management measures on improvements in living standards and on the resilience of the overall system, the significance of the utilisation of natural resources must be assessed within the context at hand.

Box: A real world example

Niger is one of the world's poorest nations. In this semi-arid country water is scarce. The short rainy season allows for rain-fed cropping of cereals and legumes. Climate change is resulting in increased dry periods and periodic heavy rainfall events. The rains however often remain unutilised, draining away in wadis and causing erosion. German development cooperation has established long-term sustainable resource management projects aimed at improving soil fertility and water availability. Water catchments were systematically fitted with erosion protection measures. Initially these were based on a Food-for-Work approach which later became obsolete as land users saw the success of the measures.

With the help of KfW financing (Kreditanstalt für Wiederaufbau) 20,000 hectares of land per year were improved. Over the course of twenty years a total of more than 400,000 hectares in 340 villages were developed for forestry, pasturing and cropping at a cost of approximately 30 Euro/ha, not including the inhabitants' own contribution.

The measures have delivered significant results: Cropping security in rain-fed agriculture was increased and in some instances yields more than doubled. Favoured areas in valleys were reclaimed and post-flood cropping and irrigation cropping now not only bring two or three harvests instead of just one but have also increased yields per crop. Additional production of vegetables has improved the families' vitamin intake and, moreover, it allowed many farmers to move from subsistence farming to also supplying the market. Every hectare of land now feeds one additional person. Therefore the food supply for an additional 400,000 people has been secured. An important factor in the success of the programmes was their long-term nature.

Further reading

GIZ (2012): Good Practices in Soil and Water Conservation - A contribution to adaptation and farmers´ resilience towards climate change in the Sahel

GIZ (2012): Water-spreading weirs for the development of degraded dry river valleys – Experience from the Sahel

WOCAT (World Overview of Conservation Approaches and Technologies) – An online database of best practice examples of Sustainable Land Management: www.wocat.net

Agriwaterpedia – Knowledge Platform on Agricultural Water Management: www.agriwaterpedia.info

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