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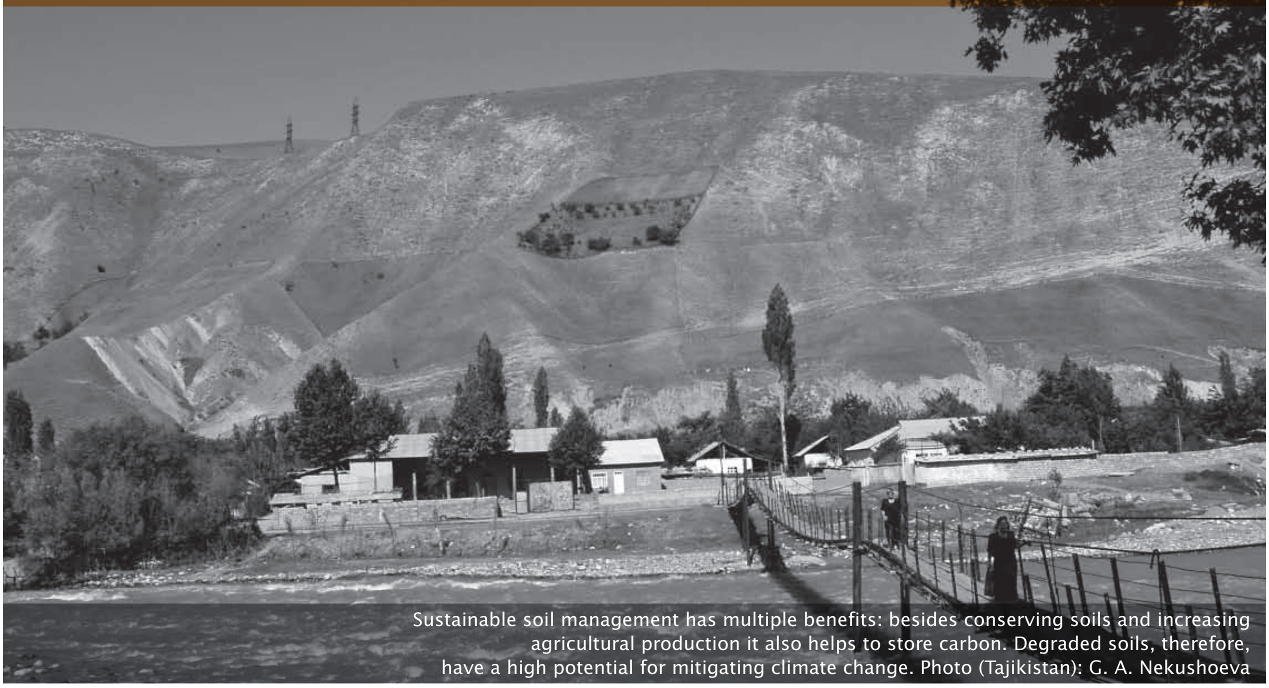
research evidence for policy



Sustainable soil management has multiple benefits: besides conserving soils and increasing agricultural production it also helps to store carbon. Degraded soils, therefore, have a high potential for mitigating climate change. Photo (Tajikistan): G. A. Nekushoeva

NCCR north south

Natural resources: the climate change challenge

Research featured here was conducted in: Ethiopia, Kenya, Kyrgyzstan, Tajikistan

Policy Message

Countries in the South have a potential both to mitigate climate change and to adapt to its effects through good natural resource management:

- Sustainable land management (SLM) systems can be suitable for buffering weather extremes and storing carbon in degraded soils.
- Conserving headwater forests can help to reduce the impact of climate change by sustaining dry season flows downstream.
- Good water management is of increasing importance as rain patterns change and glaciers recede.
- Predicting and anticipating geographic shifts in agricultural zones is vital for adapting future agricultural production.

The effects of a changing climate are felt most acutely in the countries least equipped to deal with them. Developing and transition countries are particularly vulnerable through their high dependence on natural resources: much of the population is occupied in the primary sector, as farmers or pastoralists. The view that the "North" should mitigate and the "South" must adapt has dominated discussions on climate change, with developing countries seen as bearing the brunt of the negative effects of global warming primarily caused by industrialisation. However, as this issue of evidence for policy will attempt to show, effective natural resource management in developing and transition countries can contribute to both mitigation of and adaptation to climate change and to a more sustainable development.

Degraded soils for carbon storage

Worldwide, agricultural soils are being heavily degraded by inappropriate cultivation and grazing practices. Intergovernmental Panel on Climate Change (IPCC) figures show that even without adding deforestation, agriculture accounts for up to 12% of total global anthropogenic emissions of greenhouse gases. Halting soil degradation will therefore also reduce emissions. Even better, rehabilitating degraded soils by restoring their fertility and increasing their soil organic carbon (SOC) levels would thus not only benefit farmers directly: soils could act as a carbon sink until they are restored.

While rehabilitating degraded areas is technically feasible, it is an economic burden on poor farmers, whose investment into soil protection needs to be supported. This problem could partially be solved by carbon trading, despite the fact that prices have so

Mitigation

"In the context of climate change, a human intervention to reduce the sources or enhance the sinks of greenhouse gases. Examples include using fossil fuels more efficiently for industrial processes or electricity generation, switching to solar energy or wind power, improving the insulation of buildings, and expanding forests and other 'sinks' to remove greater amounts of carbon dioxide from the atmosphere."

Adaptation

"Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities."

Source: United Nations Framework Convention on Climate Change (UNFCCC) *http://unfccc.int/essential_background/glossary/items/3666.php*

far been volatile. In the example of Ethiopia, introducing simple measures such as earth walls, drainage gutters or terracing has led to significant improvements in yield, as research by the NCCR North-South, CDE and WOCAT* has shown. Initially, the main aim of this kind of sustainable land management (SLM) was to restore agricultural soils and to reduce the dependence of the Ethiopian population on food aid. But the measures have the additional advantage of being relevant to the debate on climate change. While SLM measures help to conserve soils and increase agricultural production, they also increase carbon stored in the soil. This makes the soils more resilient to climate extremes, for example longer periods of drought, as soil organic matter helps to conserve moisture.

The objective of the current NCCR North-South research by Bettina Wolfgramm's group is to identify SLM systems that make the most effective use of land resource potentials for increased agricultural production, are more resilient to climate change and suitable for carbon sequestration. Initial research results obtained in the loess hills of Tajikistan by Erik Bühlmann have shown that technically more demanding measures such as terracing and afforestation are more effective in preventing loss of the SOC-rich topsoil layer than agronomic measures such as contour ploughing, but are often too costly for subsistence farmers. Additionally, implementing labour-intensive land conservation measures is not feasible for the majority of rural households, as many young men leave for Russia in search of work, leaving women, children and the elderly to carry out the field work. Here, models integrating social, economic and ecological aspects are needed to find sustainable land management solutions.

In order to provide a sound decision base for planning, monitoring and accounting of SLM systems, quantitative data at a local as well as at a regional scale are needed. This requires new tools (and a new combination of tools) such as soil reflectance spectrometry for rapid and cheap laboratory analysis of SOC in soils (used in combination with remote sensing; Figure 2). Of course, maintaining healthy soils assumes an appropriate use of other natural resources, such as water. Good water management speeds up carbon sequestration by improving vegetation cover.

Fewer, earlier, heavier rains

In Kenya, changing rainfall patterns and difficulties in predicting when the rains will start have made it increasingly difficult for farmers to plan their crop-planting. Whereas the rains used to be expected in mid-March, the past decades have seen a greater variability in rainfall patterns. This shift has become more marked in recent years, with rainfall starting as early as February or as late as April. It may rain very intensively for a week. And then, instead of raining over a period of three months, it may only rain for a total of three weeks.

Apart from waiting for the rains to come, the only available strategy is to abstract water from rivers – an action which, despite often being illegal, would no longer be possible under a scenario for climate change in which many rivers dry out completely during the forecast prolonged dry season.

Conserving headwater forests may provide a partial answer to this. NCCR North-South studies conducted around Mt Kenya by Benedikt Notter have shown that forests – particularly those at higher elevations (from 2000 metres above sea level) – can help to sustain dry season flows. Forests enable a higher infiltration of rainfall into the soil than bare land or degraded soils. Higher-level forests are also more suitable than those at lower levels as they have a lower rate of evaporation. Conserving the forests takes on an added significance when bearing in

* WOCAT: World Overview of Conservation Approaches and Technologies (www.wocat.net); CDE: Centre for Development and Environment (www.cde.unibe.ch).

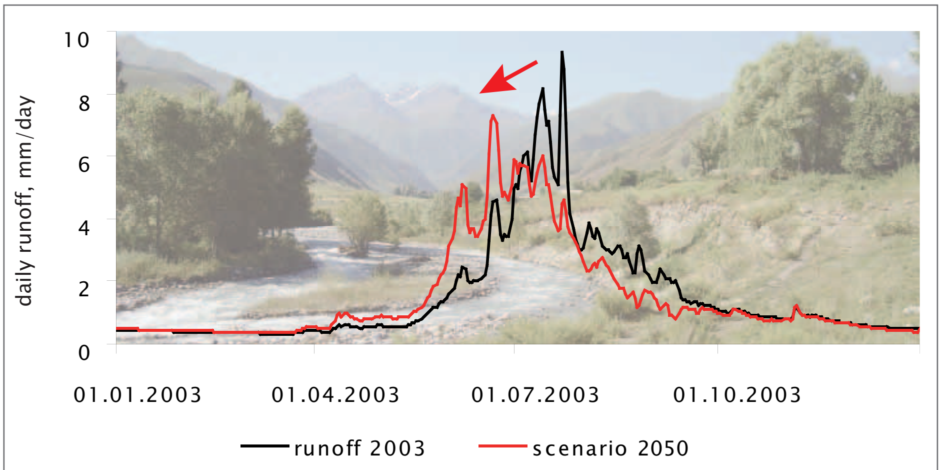


Figure 1: A comparison of the river flow of Sokuluk Watershed, Kyrgyzstan, for 2003 with the modelled river flow for 2050 predicts that the main water discharge will shift towards spring. It is based on a scenario of glacier decrease by 14%. Source: Natalia Ershova

mind that forests and moorlands of Mt Kenya contributed to about 65% of the dry season flow between 1985 and 1999, with glaciers accounting for only 8% of the dry season flow during the same period, according to Boniface Kiteme and others. This is in marked contrast to the situation in Central Asia and in other mountain areas of the world, where the disappearance of glaciers will have a much larger impact on water supply than on Mt Kenya.

Melting glaciers

In Central Asia, for example, irrigation is largely dependent on melt water from snow and glaciers. In a scenario for 2050, even a small reduction of glaciers by 14% would reduce the total volume of water (Figure 1), although an increase in precipitation would make up for some of the loss. It would have the major effect of pushing peak runoff into the spring season – when irrigation water is not yet needed downstream – and could lead to a lack of water during the period of peak water consumption. River flow modelling by Natalia Ershova suggests a shift of main water discharge from the end of July to June in future, with possible negative effects for agriculture.

More efficient irrigation techniques and improving time management will therefore be required as part of a major adaptation strategy in this example from the Sokuluk Watershed near Bishkek, Kyrgyzstan. A significant problem is the state of infrastructure: in the Sokuluk district, only 23% of the initially abstracted water reaches its final destination due to the poor state of earth and concrete canals.

Shifting production zones

Adaptation is required where climate change results in shifts in production zones. In Ethiopia, coffee production will move upwards into the mountains over the next 70 years, presenting new opportunities at higher elevations. Current small-scale coffee producers, however, risk losing their main source of income and face the challenge of finding new agroforestry crops for their fields, as current production areas become unsuitable for coffee cultivation. The most vulnerable area is the transition zone between the highlands and the lowlands (Figure 3).

Policy implications

- Promoting SLM at the farm level creates multiple benefits: it provides the possibility to mitigate climate change by carbon sequestration, while making land use systems more resilient to climate extremes and increasing agricultural production.
- Protecting headwater forests is particularly important in arid and semi-arid regions such as around Mt Kenya. As the variability in rainfall patterns increases due to climate change, forests

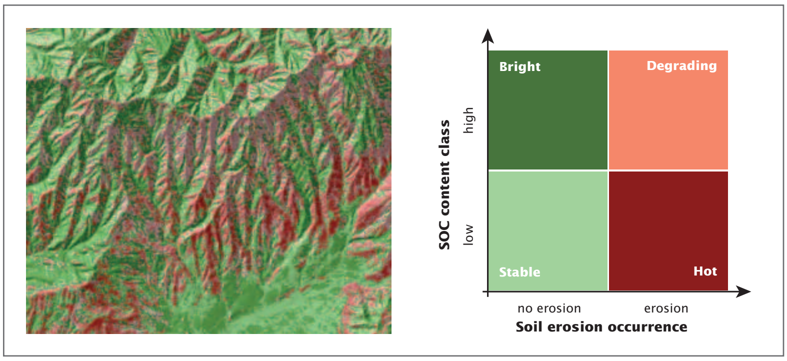


Figure 2: Spatial data on soil organic carbon levels as well as the stage of degradation of soils are suitable for planning conservation measures at a regional scale. The data are generated from a soil reflectance library in combination with satellite imagery – in this example, the loess hills of Tajikistan. Source: Bettina Wolfgramm

Coffee cultivation areas in Ethiopia: current and projected

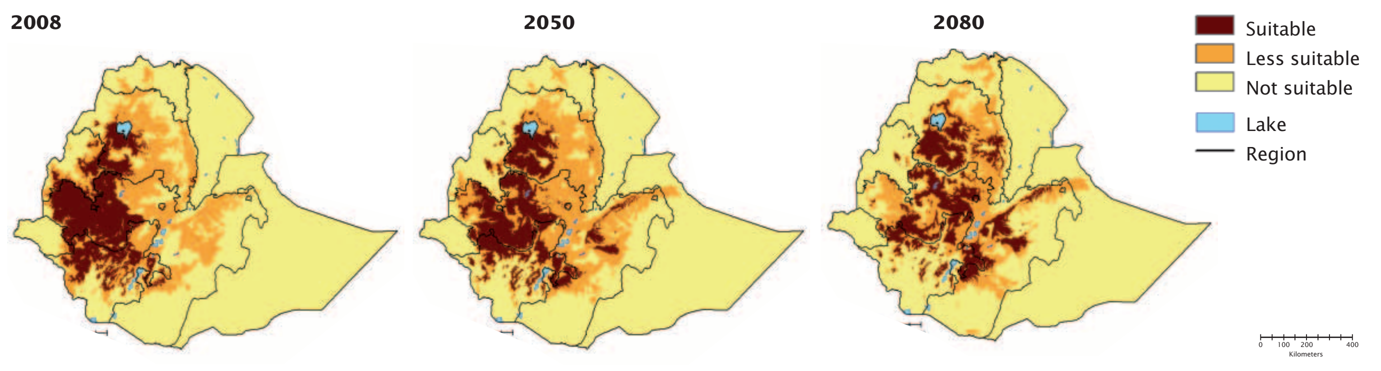


Figure 3: Projected change of coffee cultivation areas in Ethiopia over the next 70 years. Data: Worldclim and IFPRI. Map algebra: Michael Rüegsegger 2008. More details: www.cde.unibe.ch, search entry "Michael Ruegsegger".

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NCCR north south

NCCR North-South case studies on the link between climate change and development in Africa and Central Asia

Assessing local conservation measures in Tajikistan

Soil erosion on sloping agricultural land poses a serious problem for the environment as well as for production, particularly in highly erodible soils, such as the loess zones in Tajikistan. A study carried out in Faizabad evaluated the potential of local conservation measures on cropland to provide decision support for planning sustainable land use in a spatially explicit manner. It revealed that current average soil loss could be reduced by low-cost measures such as contouring (by 11%), fodder plants (by 16%) and drainage ditches (by 55%). More expensive measures such as terracing and agroforestry can reduce erosion by as much as 63% (for terracing) and 93% (for agroforestry combined with terracing). More details: www.north-south.unibe.ch, search entry “Erik Buehlmann”.

Improving irrigation systems in Kyrgyzstan

The organisational structure of water distribution in Kyrgyzstan dates back to Soviet times and is largely outdated. NCCR North-South research in Kyrgyzstan has brought forward arguments for alleviating the water distribution problem by introducing new water discharge stabilisers, which reduce the fluctuation range of water levels upstream. The improved technology, which has been patented, also has economic benefits. More details: www.north-south.unibe.ch, search entry “Bakyt Askaraliev”.

Coffee: a high mountain crop?

Coffee cultivation in Ethiopia will be heavily influenced by climate change mainly due to rising temperatures and, to a lesser degree, due to changing precipitation. Research predicts that the lower critical value of the optimal cultivation zone – currently at 1000 metres – will rise up to around 1800 metres above sea level. The most important coffee-growing region in Ethiopia is Oromia. By the end of the century, the optimal cultivation area there will be reduced by up to one third.

support the infiltration of rainfall water in the highlands, which in turn sustains dry season flows.

- Improving the state of irrigation systems and technologies ensures that melt water is efficiently used for cultivation. It is a necessary adaptation strategy in Central Asia where global warming is causing a reduction in melt water and a shift in water discharge patterns.
- Predicting geographic shifts in agricultural zones is vital for determining which production areas will become unsuitable for currently cultivated crops. Maps on current and future production areas support affected farmers in assessing production risks. These maps are based on the agroecological conditions of crop production as well as on regional climate change scenarios.

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evidence for policy

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The NCCR North-South is a worldwide research network including seven partner institutions in Switzerland and some 160 universities, research institutions and development organisations in Africa, Asia, Latin America and Europe. Approximately 350 researchers worldwide contribute to the activities of the NCCR North-South.

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