

Policy brief – May 2022

Knowledge-based soil management for a sustainable ecological and economic development of Central Asia

Main Findings

Soil degradation is widespread and cross-border in Central Asia with multiple symptoms

This impairs the provision of ecosystem services, including food production, climate change mitigation, biodiversity, and human health

The soil health concept links soil management to broader sustainable development goals

Soil knowledge and its application has to be invigorated, for instance by establishing a Central Asian Soil Competence Network

Introduction

Soils are similarly important for the wellbeing of our societies as is water. Soils are a critical resource for ensuring global food security as well as for providing other ecosystem services, especially in light of the challenges posed by climate change and a growing population. Improper land use leads to deterioration and loss of this almost non-renewable resource, endangering the stability of societies. The collapse of ancient Mesopotamia due to soil salinization is just one prominent example of improper soil management. Today, soil degradation is also a major driver for forced migration.

Land degradation means soil degradation

Central Asia, with its arid to semi-arid climate, is particularly vulnerable to land degradation,

being accelerated by improper management (Krasilnikov et al., 2015). Hot spots of cross-border land degradation are covering northern and eastern Kazakhstan and the southern part of Central Asia, including Kyrgyzstan and parts of Uzbekistan, Tajikistan, and Turkmenistan (Figure 1). About 100 million hectares of land in Central Asia are degraded by wind and water erosion, more than 40% of

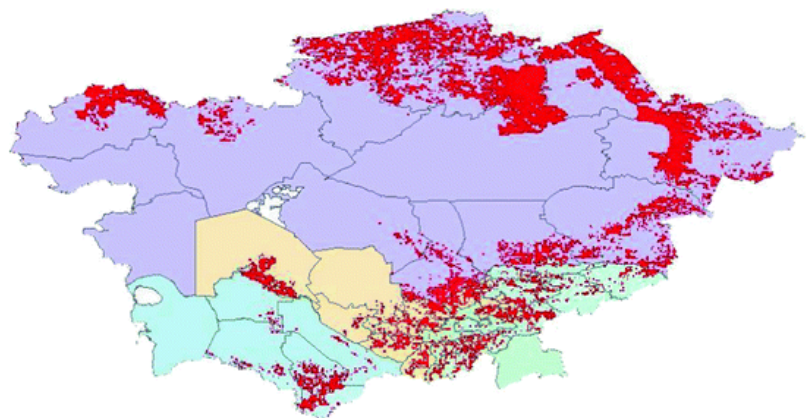


Figure 1: Hot spots of land degradation in Central Asia, obtained by a negative change in NDVBI between 1982-84 and 2006 (from Mirzabaev et al., 2015).

Kazakhstan and Uzbekistan are affected by

secondary salinization, and improper rangeland management fosters desertification in large parts of southern Central Asian lowlands (Numyngereyev and Thompson, 2018).

Soil health and ecosystem services

In order to define measures of good soil governance we have to overcome the narrow terms of soil fertility with its pure focus on crop production. Instead, soil quality description has to depict the soil in its functioning for agriculture and its effects on other ecosystem components. For the sustainable development of societies, the concept of soil health is even more relevant, as here the health of humans, animals, plants and the environment are connected and linked to broader sustainable development goals. Finally, the term soil security addresses soil services as a common good similar to water and air and, hence, as a human right (Koch et al., 2013). The soil-health concept

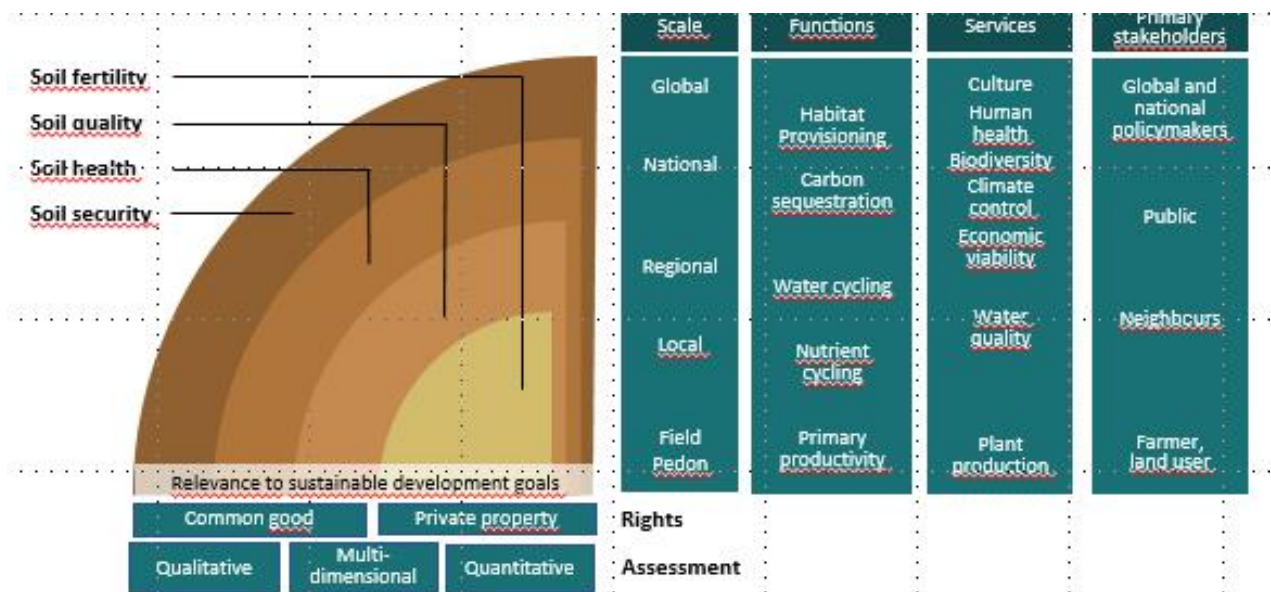
sustainable development goals (Fig. 2) and should be the basis for decision makers (Lehmann et al., 2020).

This soil health concept can be well applied to sustainable crop production, where provision of agrochemicals is not enough to secure food production. Importantly, the soil health concept primarily includes biological parameters and processes in agricultural production. Establishment of biodiverse crop rotation, e.g. as intermediate crops and including legumes, increases the soil organic carbon and the biodiversity of soil microbiome crop harvest (Gentsch et al., in preparation), and likely soil resilience (Chen et al., 2020).

Similarly, the concept of soil health can also be applied to other ecosystem services such as water quality, human health, and climate change (Lehmann et al., 2020).

Appropriate soil management needs soil knowledge

Figure 2: Concept of integration of soil fertility, quality, health and security to functions, ecosystem services and stakeholders they capture at different relevant spatial scales (from Lehmann et al., 2020).



allows soil management to be aligned with

Central Asia has a huge soil resource, which is threatened and degraded, but can also be sustained and rehabilitated following the soil health concept. However, for this detailed soil knowledge it is necessary to consider the huge variability of soil properties, symptoms of soil degradation, and the implementation of appropriate technological and management solutions. In crop soils, this shall be based on Conservation Agriculture, which is now in practice over more than 11 million hectares in Eurasia (Muminjanov et al., 2022). Conservation Agriculture is an ecosystem approach to sustainable land use management based on the application of interlocked principles of no or minimum soil disturbance (no-till), soil mulch cover (crop biomass, cover crops), and diversified cropping (rotations, sequences, associations) (Kassam, 2020).

Considering the severe soil degradation and the rising challenges due to population growth and climate change, a resurgence of Central Asian soil science is necessary to secure and improve soil health in order to provide its necessary services also in the future.

Central Asian Soil Competence Network

Modern soil science education, the establishment of new and harmonized standards in soil analysis and connection to global research is a fundamental prerequisite for the necessary contributions of soil science for sustainable development and ensuring food security of Central Asia in the 21st century.

To achieve this, soil science in Central Asia has to be aligned to recent theoretical

concepts and equipped with modern analytical tools including:

- 1) Education
 - Joint Central Asian development of modern study courses
 - Integration of international lecturers in teaching
- 2) Capacity building
 - Education of technical and scientific staff
 - Establishment of common Central Asian standards
- 3) Technical and scientific innovation incl. digitalization and artificial intelligence
 - Integration of conventional soil analysis, lab-on-a-chip methods, and hyperspectral analysis
- 4) Economic relevance
 - Increasing yield at less (because optimized) input
 - Assurance of functioning of other ecosystem services
 - Payment for provision of ecosystem services (e.g. carbon trading)

To this end, establishing a Central Asian Soil Competence Network is crucial. The investments for such actions would be substantially lower than the ecological and economic benefits obtained by assuring the provision of ecosystem services by healthy soils.

Recommendations

In order to improve the soil health in Central Asia, by providing all soil services concerning security of food production and ecosystem services including climate change mitigation, and by assuring a prosperous development of Central Asia, the following immediate actions are suggested. The recommendations

differentiate between management measures and needs for capacity building.

Recommendations for soil and land management

- 1) Definition of Conservative Agriculture as the standard agricultural management
- 2) Identification and realization of optimum stocking densities of cattle, specifically for different grasslands (mountain, dry lowlands)
- 3) Provision of financial support to provide for the realization of (1) and (2), with the help of international funding institutions
- 4) Conservation of native land and rehabilitation of degraded land to secure biodiversity and other soil and ecosystem services
- 5) Value quantification and promotion of soil carbon sequestration and other soil services

Recommendations for capacity building in education and science for sustainable development of Central Asia

- 1) Development of common Central Asian soil-health standards and indicators as guidance for decision makers
- 2) Benchmarking of Central Asian soil science education programs against international standards and development of harmonized curricula
- 3) Negotiation with international funding institutions and involvement of Central Asian and international soil scientists for preparing the envisaged soil competence network

References

Chen XD et al. (2020) Soil biodiversity and biogeochemical function in managed ecosystems. *Soil Research* 58, 1-20.

Kassam A (ed) (2020) *Advances in Conservation Agriculture 1 – Systems and Science, Volume 2 – Practice and Benefits*. Burleigh Dodds. Cambridge, UK.

Koch A et al. (2013) Soil security: solving the global soil crisis. *Global Policy* 4, 434-441.

Krasilnikov P et al. (2015) Regional assessment of soil changes in Europe and Asia. In L Montanarella (ed) *Status of the World's Soil Resources: Mail Report*. FAO and ITPS, Rome.

Lehmann J et al. (2020) The concept and future prospects of soil health. *Nature Reviews Earth & Environment* 1, 544-553.

Mirzabaev A et al. (2016) Economics of land degradation in Central Asia. In: E Nikonya et al. (eds) *Economics of Land Degradation and Improvement – A Global Assessment for Sustainable Development* Springer, p. 261-290.

Muminjanov H et al. (2022) Conservation Agriculture in Eurasia. In A. Kassam (ed) *Advances in Conservation Agriculture 3 - Adoption and Spread*. Burleigh Dodds, Cambridge, UK., pp. 429-490.

Nuryngereyev K, Thompson TL (2018) Taking stock of human capital in soil science for Central Asia and the South Caucasus. Report. Eurasian Center for Food Security, Moscow.

Authors

Georg Guggenberger, Olga Shibistova

Leibniz Universität Hannover
guggenberger@ifbk.uni-hannover.de
shibistova@ifbk.uni-hannover.de
soil.uni-hannover.de; rekks.eu

Peter Liebelt

CASIB – Central Asia Sustainable
Innovation Bureau
peter.liebelt@geo-uni-halle;
casib.eu

Hafiz Muminjanov

FAO, Rome, and Tajik Agrarian
University
hafiz.muminjanov@fao.org

Amir Kassam

University of Reading
amirkassam786@googlemail.com

Theodor Friedrich

FAO, Rome (retired)
Theodor.friedrich@gmail.com

With contributions of

Kanat Akshalov
Zhanna Almanova (
Alexander Barnewitz
Tatyana Bragina
Morizt Koza
Viktoriya Krylova
Kairat Kunanbaev
Maira Kussainova
Gerd Schmidt
Samat Tanirbergerov
Kristina Toderich
Shahlo Turdikulova
Baizhan Ualkhanov
Vadim Yapiev
Bulat Yessekin

Please cite this Policy Brief as:

Guggenberger, G., Shibistova, O., Liebelt, P., Muminjanov, H., Kassam, A., Friedrich, T.: Knowledge-based soil management for a sustainable ecological and economic development of Central Asia. Policy Briefs of the Green Central Asia Initiative. DOI: 10.48440/GCA.2022.005