Follow up

Here we will upload minutes and all follow up information.

Questions that are not answered in the sessions **can be answered here** by the speakers after the workshop.

Please use the **comment function** to add questions, if possible indicate to which speaker the question is dedicated.

Apart from questions we want to encourage you to give comments on the inputs and **use this space for further discussion**.

On the following sites, **more detailed information** on the projects and sessions can be accessed. Also the **presentations** can be found there.

Session 1 - Topic 1 - Carbon Benefits Project, LandPKS and WOCAT

Session 1 - Topic 2 - Monitoring using the SALM approach and integration in national monitoring programs

Session 2 - Topic 1 & 2 - CarbASIA-Project - Carbon Storage Assessment and Interaction with National Institutions in Kyrgyzstan

Session 3 - Topic 1 - Landscape Scale Assessments of Soil Organic Carbon and other Key Indicators of Land and Soil Health (Land Degradation Surveillance Framework)

Documentation

Day 1, 27 Apr 2021

Introduction by Juliane Wiesenhütter, GIZ, and Paul Luu, 4p1000

Carbon Benefits Project, LandPKS and WOCAT (Eleanor Milne, Colorado State University, Tatenda Lemann, WOCAT Executive Team and Jeff Herrick, Global Lead LandPKS)

Monitoring using the SALM approach and integration in national monitoring programs (Mamadou Batiene, REDD+ Focal Point Burkina Faso and Georges Kuate, REDD+ Consultant)

Day 2, 28 Apr 2021

Introduction to the CarbASIA Project by Steffi Mallinger (GIZ program on Capacity Development for Climate Policy in the countries of South East, Eastern Europe, the South Caucasus and Central Asia, Phase III, IKI, BMU)

An adapted method to assess soil organic carbon stocks in a high mountain region: A LDN case study from Kyrgyzstan (results of the project Carb-Asia), Margarete Korintenberg, HU-Berlin

Interaction with and support to national institutions in the field of LDN reporting (results of the CARB-ASIA project), Klaus Eisenack, Anastasiya Gotgelf, Ulan Kasymov, HU-Berlin

Day 3, 29 Apr 2021

Landscape Scale Assessments of SOC and other Indicators of Land and Soil Health -Land Degradation Surveillance Framework, Leigh Ann Winowiecki, World Agroforestry ICRAF

Wrap up and continuation of the Community of Practice

Number of participants (including the organizers)

Day 1 – max. 95 people, 60 people during the second input and discussion

Day 2 – between 70 and 80 people

Day 3 – between 60 and 70 people

Day 1

Carbon Benefits Project, LandPKS and WOCAT

These three projects are individual projects, which recently developed close interactions under the Sustainable Land Management and Climate Change Mitigation Co-benefits (SLM-CCMC) Project (cf. https://wedocs.unep.org/bitstream/handle/20.500.11822/35890/CCMC.pdf). The World Overview of Conservation Approaches and Technologies (WOCAT) is a global network on Sustainable Land Management (SLM) that promotes the documentation, sharing and use of knowledge to support adaptation, innovation and decision-making in SLM. The Global SLM Database contains over 1500 SLM practices (Technologies and Approaches) from all over the world and is the primary recommended database by the United Nations Convention to Combat Desertification (UNCCD) for the reporting of SLM best practices (https://qcat.wocat.net/en/wocat/). It contains information ranging from technical specification over natural and human environment to on- and offsite impacts of the SLM technologies and approaches . The Carbon Benefit Project (CBP) developed a tool, which allows the calculation of changes of greenhouse gas emissions and carbon stocks in soils and biomass as a result of shifts in land management practices (http://www.carbonbenefitsproject.org/). Finally, LandPKS (https://landpotential.org/), offers a suite of tools to assess soils and vegetation in the field through mobile phone based applications.

The main motivation of land users to adopt a new (e.g. SLM) land use practice often is to increase productivity and eventually farm income, while co-benefits for the public, such as CO2 removal from the atmosphere or providing more regular water flows of good quality, are often not accounted for and reimbursed to land users. The Sustainable Land Management and Climate Change Mitigation Co-benefits (SLM-CCMC) Project acknowledges that the primary motivation to adopt SLM is indeed to increase productivity, but wants to make the co-benefits for the climate visible and quantify them as a first step to being able to give land users recognition.

WOCAT's SLM technology entries serve as a repository to inform land users on potential SLM technologies, which may improve their livelihoods. These entries can be exported into the CBP tool where, with some additional information, the benefits for the climate are calculated when a given SLM technology is being adopted. Thus, CBP informs WOCAT entries about their co-benefits for the climate, as it calculates changes in SOC stocks and changes in other GHG emissions associated with land use. Finally, LandPKS is a tool which improves the information on soils, which improves the input data into CBP for the calculation of climate co-benefits.

LandPKS allows the assessment of soil color and texture in the field. Soil color through cell phone camera with a color reference. Soil texture with guidance. Land PKS is linked with spatial data, which allow to identify soil types after FAO. That soil type then tells the user about potential C storage and helps to support land use planning.

CBP, as well as WOCAT, is mainly used by project managers and/or extension officers. Or, project managers collect data and information from extension officers and develop knowledge products for extension officers, who carry this on to single land users.

The questions from the audience targeted mainly technical aspects of the three tools presented and were largely answered, as listed in the annex below.

Monitoring using the SALM approach and integration in national monitoring programs

Burkina Faso had developed a data management system to monitor REDD+ projects. One component of this is SOC monitoring, which has been expanded to land use beyond forests. This whole system is still in its initial phase and is not yet filled with much data.

The integration of SALM into the national program is essentially done at two levels, (i) the configuration of the SALM extension system that capitalizes on the REDD+ implementation bodies created by decree and having representations at the regional and communal levels and (ii) data processing that will not only use the tools developed under the national program but also capitalize on the information produced to strengthen the parameterization of the RothC model and vice versa.

Capacity building focuses on data collection and management and on training in good practices for sustainable agricultural land management.

VCS group project. The whole thing is registered as a group project for the almost the whole country (12 regions over 13). Afterwards, single activities can be registered more easily. It's like a national platform.

Day 2

CarbASIA Project

The Carb Asia project had the objective to develop a system for the country Kyrgyzstan to provide data on the country's carbon stock to support national climate reporting, SDG and LDN reporting. The project developed an approach where representative areas (units) concerning variability in soil organic carbon (SOC) were identified for sampling. Representative units were defined through elevation, precipitation, and land cover, all available through open access spatial data sets. Thereby, it turned out that elevation and precipitation played a more important role than land use, as large areas of the country are grasslands and no significant differences in SOC between grassland and cropland were observed. In total 21 units were selected that cover more than 80 % of the carbon-accumulating surfaces in Kirgizstan. Each representative unit was sampled at least 3-fold to calculate means and standard deviations. In order to derive reliable SOC stocks, organic carbon, bulk density, root content and amount of coarse soil were determined in the field and in national labs. Resulting SOC stocks for representative units were extrapolated for Kirgizstan. In a final step a regression tree was calculated to identify the most important factors that determine the variability in SOC. It turned out that in a high mountain region such as Kirgizstan elevation, followed by clay, precipitation, aspect and slope were the main controlling factors. This regression tree is further used to model (random forest approach) and predict a national baseline for entire Kirgizstan. Determination of SOC stocks were analyzed according to international standards (SOC stock of the fine soil was calculated by using the bulk density of the fine soil and correction for the content of roots and coarse soil). Only the content of soil organic carbon (in %) was analyzed according to national standards and analysis protocols, which were not the most advanced methods technically spoken, but were nationally recognized. The main idea was that using national capacities would increase the acceptance and the chance that the proposed approach would be applied in practice. However, in a pilot project national soil analysis methods were compared with international standardized methods where it turned out that local SOC analysis methods lead to quite similar results. Currently, the whole system is checked by the government for official approval.

Carb Asia also analyzed the national institutions with regard to climate, SDG, and LDN monitoring and found that there was fragmentation and limited capacity. Furthermore, data for reporting cannot be used for planning, local decision making, or farm management advice. Therefore, the motivation to collect such data is limited.

In response to the first presentation, questions from the audience concentrated on technical aspects as well as the prevalence of soil erosion, overgrazing, and land use practices to possibly counteract land degradation. After the second presentation, questions centered around barriers, acceptance, and opportunities (e.g. institutionalization, practical implementation) of such methods and how the acceptance of such methods could be increased among national experts and governments. The questions and specific answers are listed in the annex, while the main findings are given above.

Day 3

Landscape Scale Assessments of SOC and other Indicators of Land and Soil Health -Land Degradation Surveillance Framework

Monitoring is critical not only to assess changes in SOC, but to assess interventions in the field of land use with regard to their impact on soils, land, and land degradation. At World Agroforestry (ICRAF) infrared based approaches were developed to be applied in soil analytics. This includes lab based infrared scanning, which reduces costs and time compared with wet chemistry analysis, and remote sensing based mapping approaches, which allow mapping of large and heterogenous areas. Now, the soil mapping is part of a more comprehensive suite, the Land Degradation Surveillance Framework (LDSF), which adds modules on e.g. vegetation and hydrology to provide comprehensive basis to assess land health and a basis for land management decisions (http://landscapeportal.org/).

The remote sensing as well as the lab infrared scanning need calibration with wet chemistry analysis. Over the past 20 years, ICRAF has been building up a spectral library of soil samples, which makes the calibration for new mapping projects much easier and faster. Furthermore, this library allows to calibrate and improve hand held infrared sensors, which would enable much more people to collect soil data for their specific needs. The field sampling for those calibrations are done by local partners, who are trained beforehand to do the sampling, but also to better understand soils. The models that calculate the soil mapping results from remote sensing data are written in R so that they are open access. Along with the development of the LDSF, training course for sampling and data analysis have been developed.

The questions afterwards related mainly to technical aspects, as listed in the annex.

For further reading, these publications are recommended:

Vågen, T.-G.; Winowiecki, L.A. Predicting the Spatial Distribution and Severity of Soil Erosion in the Global Tropics using Satellite Remote Sensing. Remote Sens. 2019, 11, 1800. https://www.mdpi.com/2072-4292/11/15/1800.

Vågen, T., L. A. Winowiecki, W. Twine, and K. Vaughan. 2018. Spatial Gradients of Ecosystem Health Indicators across a Human-Impacted Semiarid Savanna. J. Environ. Qual. 0. https://doi.org/10.2134/jeq2017.07.0300. https://acsess.onlinelibrary.wiley.com/doi/full/10.2134/jeq2017.07.0300.

Vågen, Tor-G., Winowiecki, L., Tondoh, J.E., Desta, L.T. and Gumbricht, T. 2016. Mapping of soil properties and land degradation risk in Africa using MODIS reflectance. Geoderma. http://dx.doi.org/10.1016/j.geoderma.2015.06.023.

Winowiecki, L., Vågen, T-G. and Huising, J. 2016. Effects of land cover on ecosystem services in Tanzania: A spatial assessment of soil organic carbon. Geoderma. http://www.sciencedirect.com/science/article/pii/S0016706115000816.

Annex

Q&A during the sessions:

Day 1

Carbon Benefits Project, LandPKS and WOCAT

Most of the questions below were answered during the session. We have repeated some of the answers here and responded to those we missed. For additional information, please visit our websites, where you can also find contact information.

- Is anyone familiar with Restor and how it fits or will fit in with the tools being discussed?
- We haven't interacted with them but looks like we should!
- Is there a mobile version too?
  Answer: LandPKS is a mobile app; access to over 100 WOCAT technologies
- Is there any moment to input or inform soil type?
  Answer: Soil type can be determined with LandPKS

A WOCAT offline App is currently being linked with the WOCAT database to document a technology or approach via app.

- Are the emission factors for each management regime publicly available?
- Yes, in the CBP Detailed Assessment when you click on Emission Factors for each land use, it will bring up a list of every EF used in the calculations, a link to the relevant source table in the IPCC document and a link to a measurement protocol you can use if you want to replace the factor.
- Does this tool cover the particularities of any geography or is it focused on specific areas?

- The CBP tool is globally applicable. Very occasionally we encounter places where data, we usually work with projects to fill these gaps if they arise.
    - WOCAT is not focusing on specific areas. The technology questionnaire contains a chapter on natural and human environment including information on climate, topography, soils, water availability, biodiversity, land ownership, etc.

- Does the program have a function to insert SOC values zone mapping?
- No but you can change the SOC reference factor.
- Is there also a French version of the CBP Tool?
- Yes, the CBP is available in French, English, Chinese, Russian, Spanish and Portuguese.
- Which sites in Kenya did you carry out the study?
- For the CBP example we showed, Western Kenya around Lake Victoria
- Do the emission factors in the tool are default one? Is there a possibility to enter specific emission factors?
- Yes the Detailed Assessment allows you to change the emission factors yourself so you can use a combination of default factors and site specific ones where you have them.
- Do you account for global warming and related loss of soil carbon to be expected? How long is the projection time of the model into the future?
- No the CBP does have provision at the moment to put in different climate scenarios. The projection period is up to the user with a minimum of 1 year.
- How is the data integrated with the monitoring and data collection processes of projects using X and Y carbon accounting methodologies? Are there examples of such integration?
- If you collect data for a specific certification scheme you will have to ensure data is collected in a way that meets their criteria and that an IPCC based model is acceptable to them.
- How far is this tool capable to calculate Biochar implementation, especially in terms of different feedstock categories?
- Biochar is not specifically considered as yet. You can change some emission factors associated with livestock which can change enteric and manure based emissions however CBP doesn't do secoandary categorisation of livestock so you cant change feedstocks etc.
- Can we calculate the carbon benefit only through a periodic assessment? Since in the periodic assessment a lot of things change especially for C calculation, if so then the other parameters like floods and rains have also been considered in the calculation.
- You can reset and rerun the CBP as often as you like. Usually users will do an exante assessment at the start of the project and then either make changes or set up a new project when they have some measured data/information as and when.
- How realistic is the adaptation of the tool by farmers on the global scale?
- The tool is typically used by project managers who rely on extension workers and farmer interviews to supply the activity data needed. We have a set of forms on the website to collect information and users can also collect compatible info using LandPKS. Typically the kind of data required is the sort of management information farmers would have anyway. The CBP tools have been used in 150 countries to date.
- Climate change effects are not included in CBP, right?
- Right climate effects are not included.
- Is there a paper on the level of agreement between the "LandPKS" method of soil colour assessment and standard methods? Do you relate soil colour directly to C content within the app?
- How are you planning to bridge the gap with remote farmers who have a very "limited" educational background or do not know how to read? The LandPKS app and WOCAT use a lot of graphics; however all of the tools do require some literacy.
- Does the accuracy of the smartphone's camera have no effect on the results of the app? Soil color is automatically corrected for camera and lighting based on a reference card (e.g. yellow post-it note) that is included in each photo.
- Is it possible (or will it be possible) to add some data using non-smartphones, e.g. via SMS to a database?
- Is there any help from App to know soil classification based on World resource Base system?

Monitoring using the SALM approach and integration in national monitoring programs

- I have a question regarding the monitoring of social and economic benefits for local populations: are the approaches and indicators developed in the REDD+ program integrated into the SALM program?

Answer: The SALM program is part of the REDD+ process and will help fight against the development of bad agricultural practices as drivers of deforestation. Thus, the national REDD+ strategy has identified socio-economic benefits, among other benefits, to be monitored, through defined indicators, for the implementation of REDD+ strategic options. As a REDD+ project, the implementation of SALM integrates the monitoring of these indicators thanks to the monitoring system put in place.

- Is there also an integration of social and environmental safeguards mechanisms?
- Answer: In the same dynamic, the SALM program follows the guidelines for environmental and social safeguards prescribed in the REDD+ national strategy.
- What kind of data base are you using to manage all this data and how do you manage access and modification permissions for different stakeholders?

Answer: We are using the RothC model for data management. Only the coordination unit has permissions to manage the data inside the model.

- Do you collaborate with the BUFACAP project?

Answer: The SALM program is the BUFACAP (Burkina Faso Carbon Agricultural Project).

- Do you have any data on the costs of monitoring?

Answer: SALM monitoring will cost 15 million USD for 150 000 ha of land and in 10 years.

- Do you have any information on the barriers/impediments to farmers' adoption of the practices?

Answer: Abandonment of the land followed by natural regeneration is hampered by the increasing human population pressure on land use and the deep-rooted culture of open livestock grazing including on crop fields. These prevailing social conditions do not permit abandoning land and natural regeneration (without active protection of the concerned sites).

Also, adoption of SALM practices faces two main barriers: investment and technological barriers - with the technological barrier particularly important.

Technological: The project requires a written commitment from farmer groups to participate in the project, and a robust farm monitoring system engaging the farmer to monitor their performances.

Investment: there is growing pressure on the land due to growing population resulting in intensive farming, short or no fallows and growing trends of land degradation.

- Does the SALM model capture well what is happening on the ground? What exactly did the process of "integration into national monitoring programmes" look like, what kind of capacity building was necessary and what is the level of acceptance?

Answer: SALM is built on country and regional specificities both in terms of the choice of practices and the monitoring system. Practices will vary from one region to another and the choice of actors in the monitoring system is based on the local dynamics of actors and relationships between producers and support structures.

The integration of SALM into the national program is essentially done at two levels, (i) the configuration of the SALM extension system that capitalizes on the REDD+ implementation bodies created by decree and having representations at the regional and communal levels and (ii) data processing that will not only use the tools developed under the national program but also capitalize on the information produced to strengthen the parameterization of the RothC model and vice versa.

Capacity building focuses on data collection and management and on training on good practices for sustainable agricultural land management.

- Is the SALM model a standard that can be used for carbon credits to be sold on the voluntary market?

Answer: Yes, SALM is a VERRA methodology (VCS VM0017 "Adoption of Sustainable Agricultural Land Management", Version 1.0) that is a voluntary carbon market standard.

- Is there a possibility to access electronic modules for this topic to be used for in house practice?

Answer: There is extensive documentation and online courses on SALM. Also, the RothC model that measures the amount of carbon sequestered through SALM practices is available online. However, SALM practices are highly dependent on national and local specificities. Therefore, they are not developed on all lands. A feasibility study and a RothC model parameter are usually required before the implementation of a SALM carbon initiative.

- Madagascar is a sovereign country, but it is rich in natural resources and rich in carbon. So, the Madagascar forest is managed by national and international NGOs. Therefore, the minorities that earn the benefits (carbon credits) that they promised us at that time (when he signed the contract) to the World Bank.

My question is, how do you take in charge the amendment of this law so that all the Malagasy populations can gain from this advantage?

For a long time, it is the forest which had the source of carbon, then this time, thanks to the collaboration with 4p1000, it had the carbon of the ground, how to exploit it, basic formula to measure its volumes.

For us, Valazomby we are rich in primary forest not to say that we are the guardian of this forest whose surface is about 650 km2. But until our days we did not gain the impact of our heritage. Can we know, how to calculate our carbon volume and our lost benefit per year? Please ask for an exact answer.

Through collaboration, what solution you have proposed to solve this problem? (so that the population of the commune of Antsahamena, our commune can gain from this advancement)

Answers: This issue is about carbon benefit sharing, especially in the context of the Madagascar's government program. This is not directly linked to the subject of my communication. Reflections on this can be made in the context of another dedicated event.

The basic formula for calculating sequestered carbon volumes is to multiply activity data by emission factors. Within the SALM framework, there is a model (RothC) that already contains formulas (with the possibility of improvement depending on the availability and robustness of the data) and in which just the activity data are entered to generate the carbon volumes.

See previous answer.

This concerns an internal stakeholder consultation process within the program of the government in Madagascar.

Day 2

CarbASIA Project

- Which kind of farming was performed in the cropland fields that were sampled?
  - During filed surveys we observed: Irrigated and non irrigated fields and as crops mainly legumes, such as potatoes, leguminous crops (mainly as fodder crops), wheat and maize
- Is it fresh or dry root biomass factor used in SOC stock calculation?
  - Dry root biomass, fresh biomass is not part of the soil (from a soil scientist perspective)
- I think land cover is not important in your regression because the area is mainly dominated by grasslands. This would be different if there is variability in land cover?
  - Yes, of course grassland was dominant land cover, thus we sampled with N=49, cropland N=15 and forest N=7, but SOC stocks between grassland and cropland were not significantly different. I think this and the dominance of elevation and clay are the main reasons why land cover was not important in the regression. But yes, if we had a higher number of observation for forest (which is clearly different to grassland and cropland) land cover would presumably be more important

    - Grassland indicated already a high variability in SOC stocks due to its strong correlation with elevation; grassland in higher regions revealed much higher stocks than grasslands at lower elevations, moreover, SOC stocks of cropland is mainly determined by anthropogenic factors and only to a minor extent by natural site characteristics – this may explain why we did not observe a difference between these two land covers
- Could you say something about the costs of this method compared to others?
    - I cannot express it monetary, however, the approach we proposed is a tradeoff between on the one hand more time-consuming but more precise field and laboratory work and on the other hand more cost-effectiveness by choosing representative sampling areas which can be used to predict SOC stocks at unsampled locations
    - The idea was also to provide data for a valid baseline, thus, reliable SOC stocks (corrected for coarse fragments and fresh root contents) were determined, but we are aware that this approach is more time-consuming
    - However, using this precise approach leads to significant lower stocks when compared to stocks without considering these factors
- Could you repeat what your approach underestimates and overestimates (it was part of your conclusion)?
    - We compared different approaches of SOC stock calculation: in our project we used the most precise approach, which is also internationally recognized, where the SOC stocks of the fine soil is determined corrected mainly for coarse fragments (which do not store SOC). Using this approach, the bulk density of the fine soil has to be calculated. We **firstly** compared our approach with SOC stocks were only the bulk density of the total soil is considered and no correction for coarse fragments is applied. These data lead to strong overestimation of SOC stocks, in particular at stony high mountain regions. We **secondly** compared our approach with modelled SOC stock data provided by the UNCCD via the soilgrid project (https://soilgrids.org/). These modelled data are on average similar to our data, however in a spatial pointwise comparison it turned out that the modelled data overestimate the real measured SOC stocks at low values and strongly underestimate the real stocks at high SOC stocks. Thus, extreme values cannot be modelled correctly, though in particular high stocks which are mainly the forest areas are extremely important to indicate as these are hot spots which should not be converted
- A bit scientific: Why are you including all three clay, silt, and sand? Are they not high negatively correlated? Why remove one of the three?
    - Yes, thanks a lot for this note, you are completely right, maybe it would be more straightforward to use the sum of clay and silt (as Leigh Winowiecki did in her correlations) and exclude sand from the regression
- It reminds me of SOTER the soil and terrain database managed by ISRIC. Are you collaborating with them?
    - No, and we even did not know this project, I just checked it, very interesting for us, thanks a lot for this comment
- Why did you exclude coarse soil and roots? They are also representing C stored in the soil. And they are partly also pretty stable.
    - We excluded the coarse fragments because they do not store noteworthy amounts of soil organic carbon as far as we know, they can store of course significant amount of anorganic carbon, but in this project and in the context of LDN the target parameter was SOC.
    - Only the fresh roots were excluded as they are not defined to belong to the soil, dead root biomass were of course considered as SOC.
- How accurate is the extrapolation from the representative units to the whole area?
    - The main idea was to capture a high proportion of variability in SOC using the approach of representative units, in fact, we did not expect that each unit is significantly different to each other, because we know that not all factors which potentially influence soil organic carbon could be considered. For example clay content could not be involved due to lack of spatial data. In addition, some influences may be covered by another, for instance: grassland at high elevations may show similar organic carbon stocks when compared to forest at lower regions
    - Thus, as not all representative units are signiifcantly different to each other, extrapolating is limited, however, our data covered a large proportion of the land
    - In addition, the main idea was to demonstrate the approach, but we recommend to use finer classifiactions of input data, or if available to use addiotional input data, such as soil information, to enhance the prediction at unsampled locations
    - Prediction of unsampled location is presumably more precise when data of representative units were used in a model, such as random forest, which we are currently preparing
- Do you use cover crops like legumes to improve soil carbon and organic material level?
    - Improving soil organic carbon or provide recommendation for improving SOC stocks was not part of our project, the main focus was on the development of a methods to provide reliable data on SOC stocks, but as far as we know are cover crops (legumes or leguminous crops) widely used at the cropland sites
- How much did you differentiate between different levels of degradation at the same elevation?
    - we observed degradation mainly at the grassland sites which is a result of severe overgrazing and degradation was clearly different between south and north exposed slopes, we therefore sampled both positions
- Question: Perhaps this will be mentioned in the next presentation, but I would like to know whether this assessment was intended as a once-off assessment, or are there plans to repeat the sampling and analysis over time to track possible changes in SOC over time as a function of management? This would also related to an earlier question on the costs of this analysis?
    - This is a quite important question how to proceed with these data? first of all in Kirgistan a national baseline for SOC was lacking, thus a main aim was to develop a method which precisely measure the SOC stocks and which deliver data for a reliable baseline. This is already at the level of tier 3, the most detailed measurements at the field scale
    - But of course we are aware that reporting on changes are not suitable at this tier 3 level, approaches where satelite data were used to report on changes are presumably more practical
    - in this context it was a promising result that degradation that we observed in the field were confirmed by amounts of belowground SOC stocks, and degradation can be mapped using remote sensing apporaches
    - If the monitoring should be done in the future at the tier 3 level, setup of permanent soil observation fields would be more adequat, where however consideration of small-scale variability in SOC is absolutely necessary
- What will be annual total rain and distribution in a year in Kyrgyzstan?
    - The average precipitation in kyrgyzstan is 300 to 600 mm per year (State Agency for Environment Protection and Forestry 2012). The maximum rainfall is 1,000 m per yaer and occurs in the Fergana Mountains in the west of the country and on the southern border with Tadjukistan. Significantly lower amounts of precipiation with 100 to 400 mm anually fall mainly occurs in the Tienschan Mountains
- Which model do you use? RothC or others?
    - To calculate the SOC stocks, the percentage SOC content was converted into mass content (g/kg) and then multiplied by the fine soil content (Wolff and Riek 2006; Jacobs et al. 2018)
    - To calculate the fine soil stock according to Jacobs et al. 2018 modified according to GAFA A2.8 2009 the bulk density of the fine soil (BD finesoil), coarse soil content root mass were used. The BD finesoil was multiplied with the depth and the coarse soil content and root mass were subtracted from the whole soil
- Which method did you use to determine bulk density?
    - The bulk density, a parameter for soil density, is the mass of an undisturbed soil sample, dried at 105 °C, in relation to its volume. Its determination can be incorrect in soils with high coarse content or strong root penetration. In order to minimize these errors, the BD of only the fine soil (BD fine soil) should be determined by subtracting the coarse soil content and root mass from the BD of the whole soil.

    - For the analysis of BD fine soil, we took samples with cores with a defined volume. In the laboratory all living root mass was sorted out of the sample. Then the samples were dried at 105 °C until the weight remained constant. All core samples were further weighed and sieved with a 2 mm mesh. Soil adhering to stones was brushed off and the weight of the fine soil mass was determined. Having the relationship between the mass of the fine soil and the volume of the cores we then could calculate the BD finesoil.
- I think the direct planting will be best to Kyrgyzstan farmlands?
    - Yes, thanks for this suggestions, we are not the experts in management practices, but we forwarded it to our local partner and colleague Ermek Baibagyshov
- How mechanization affect soil carbon? And which is the best method to store more carbon in soil?
    - Again, we must admit that we are not experts in this field, so unfortunately we cannot answer this question
- What are the common crops on croplands?
    - According to our local partner and colleague Ermek Baibagyshov: mainly legumes, such as potatoes, leguminous crops (mainly as fodder crops), wheat and maize
- Do you have an observation on the variation you observed within the three land use types you sampled? And how would you use this information to guide further sampling? and did I miss the sampling of grasslands?
    - Yes of course there is variation within single the land cover classes, for instance grassland can consist of pure grassland or shrubland, shrubland itself could be evergreen or deciduous etc., also tree-covered areas can vary in degree of coverage and may consist of deciduous or evergreen trees or both
    - We tried to meet this challenge in representative sampling by using the drone to identify the dominant type of vegetation cover within a single unit
    - And yes, we sampled grassland sites most frequently, because it is the main land cover in Kirgistan (>50%), here we additionally sampled north and south facing slopes because degradation was obviously quite different between these two aspects
- Are there no tillage practices in farmer conditions in Kyrgyzstan and which percentage in total arable land?
    - Unfortunately, we cannot answer this question because we are not the experts in management practices, but as I remember correctly our local partner and colleague Ermek Baibagyshov answered on this question that no tillage practice is used in Kirgizstan
- Is the concept "mob-grazing" familiar there?
    - No, we are not familiar with this term, would be nice to learn more about it
- Which percentage of your county have no tillage on arable land?
    - Unfortunately, we cannot answer this question because we are not the experts in management practices
- Do you have wind and rain erosion problems in cropland and pastures in Kyrgyzstan?
    - There is in fact wind erosion and regions with high rates of precipitation also water erosion mainly at the degraded grassland sites
    - that means mainly at lower elevations and most frequently at the south facing slopes which are often bare and as a result very stony because the finer material, namely also SOC is blown off.
- Do you have any soil conservation tillage methods on farmlands?
    - Unfortunately, we cannot answer this question because we are not the experts in management practices
- I mean do you have minimum tillage, direct planting, cover crops and suitable crops rotations etc? And do you care soil fertility and biodiversity in farmlands?
    - Unfortunately, we cannot answer this question because we are not the experts in management practices
- What about a global data sharing platform- including perhaps with a citable doi and authorship? A second question- I think this idea of demand side of data is really interesting- can you elaborate on what types of outputs, products, dissemination campaigns could stimulate this demand?
    - A global data platform would be a great idea, we would fully support such an approach, in particular as we already used a variety of free globally available data sources
    - We will publish our data in an open access journal and plan to provide our data as well, presumably in an online tool where all data can be displayed also spatially (maybe via the R package R Shiny)
    - Second part of the question: In our analysis of informational governance in Kyrgyzstan we observed a strong focus on the information supply side when a certain information/data need to be produced, with little attention paid to the future use of data. In this sense, it is recommended to develop the capacity to deliver demand-driven data with particular attention to data users and future usability of data. In the case of LDN assessment, generation of data should not only be guided by the objective of complying with international reporting obligations (e.g. LDN or climate reporting), but also represent a visualization of the situation that should be available to national and regional authorities: the data obtained from the LDN assessment and its future monitoring provides evidence for land degradation policy development. UNCCD recommends viewing LDN assessment and future monitoring as a vehicle for learning as it provides the basis to evaluate the decisions and interventions implemented and to plan future land management and the knowledge to inform adaptive management. For this to happen, mechanisms for data exchange between the different actors involved in reporting and in land governance issues need to be ensured (e.g. by strengthening participation processes and stakeholder involvement), which has not always been the case in Kyrgyzstan.
- What are the results and suggestions to stake holders for improving the soil carbon and biodiversity in Kyrgyzstan's agricultural lands at the end of this interesting research?
    - Our main focus was on the development of the method to measure SOC stocks and to outline ways to set up a national baseline to enable national reporting on changes in SOC in the context of LDN. Ggiving suggestions and recommendations would be the next step
    - However, a main suggestion would be to reduce the grazing pressure at lower elevations close to the villages where degradation due to overgrazing is extremely high, thus using more summer pastures at higher altitudes would reduce this problem
- In addition, conversion of forest should be an absolutely no-go, as these ecosystems store more than double of cropland and grasslandsHow is willingness and engagement of actors in private sector on financially support SOC projects there?
    - Financial support for SOC analysis by the private sector may be motivated by the benefits these data could provide. For instance, SOC data can be used for economic valuation of land in the private sector, for example by demonstrating that sites with high SOC values are more productive. Small and large farmers have also begun to take an interest in soil quality and soil analyses in recent years. The demand for such analyses has increased every year. However, there is a lack of funds to finance such analyses, especially in subsistence farming
- How to convince private sector to fund the project about land restoration?
    - We assumed in our project that the improvement of LDN data quality and access to it will not only improve reporting to UNCCD, but also support the informed decision-making by land managers in the public and private sectors. For instance, information about links between land degradation and land use would motivate managers to adapt their practices and implement projects to prevent degradation or restore the degraded land.

Day 3

Landscape Scale Assessments of SOC and other Indicators of Land and Soil Health -Land Degradation Surveillance Framework

- Question about accuracy slide: are those graph the result of the validation after the calibration (total sample size 160 samples)?
- Which soil sampling design did you use? And how did you come up with that design?
- If you had to form a group of people that shall map soils according to the LDSF approach, how much time / resources would you need to build the capacity needed to run the lab analysis, R analysis, etc.?
- Many thanks for the interesting presentation. Exciting work! I was wondering how you bring socio-economic restoration potential/suitability and biophysical potential together.
- Has this methodology been used in Europe? Is your spectral library calibrated for European soils for example? To implement your methodology in countries like France with very variable landscapes, would you increase the number of locations for soil sampling?
- Is the classification of severely eroded sites through visual observations or measured in some way?
- Using remote sensing data measures only the upper surface layer, I guess, so if you set up your calibration models to predict SOC from spectra for which soil depth are these models valid?
- Yesterday we learned that the data and maps provided by Carb Asia were readily accepted by national institutions, as the soil analyses were made after the national standards, right? Consequently, were the data already used for a reporting? Moving on to today's presentation, how did you solve the issue of recognition of your remote sensing based results by national governments?
- First part of question: Determination of SOC stocks were analyzed according to international standards (SOC stock of the fine soil was calculated by using the bulk density of the fine soil and correction for the content of roots and coarse soil). Only the content of soil organic carbon (in %) was analysed according to national standards and analysis protocols. The main idea was that using national capacities would increase the acceptance and the chance that the proposed approach would be applied in practice. In a pilot project national soil analysis methods were compared with international standardized methods where it turned out that local SOC analysis methods lead to quite similar results. Data were not used for reporting yet, because they were mainly provided to set up a reliable baseline which was not existent until now. However, the approach of using freely digital data to identify representative units and further to use these data and the analysed SOC stocks for upscaling and modelling will also be an issue of recognition as it is new.
- To lead over to the nice and interesting presentation of Leigh Winowiecki, I really could imagine to combine both approaches for high mountain regions by using representative units for field sampling and determination of reliable stock values which can be further used for ground thruthing of SOC inferred from spectral data, I think that mainly for reporting on changes, techniques of remote sensing or modelling strategies are mandatory in particular for remote regions such as high mountain areas in Kyrgyzstan.
- Do you have a reference paper for this? Would very appreciate it.
- I was wondering how you bring socio-economic restoration potential/suitability and biophysical potential together.