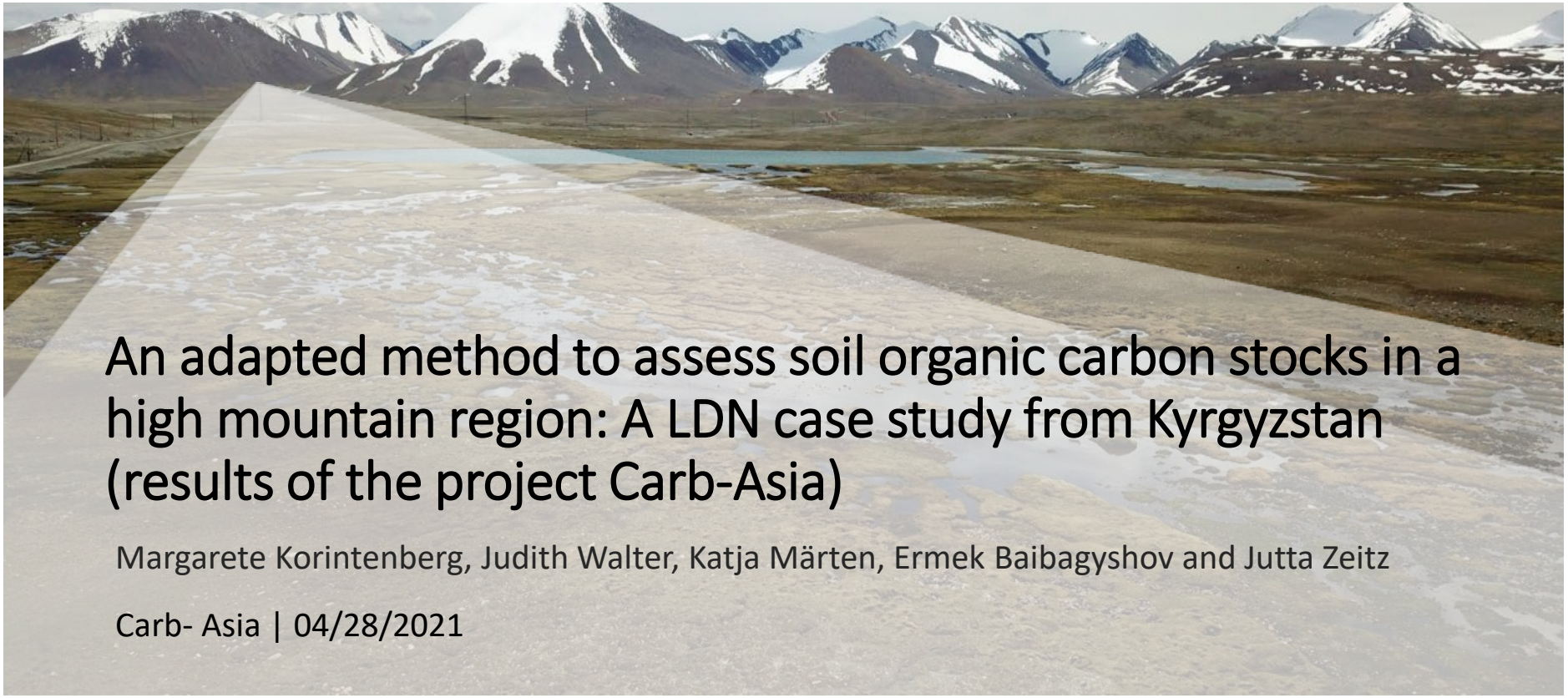

An adapted method to assess soil organic carbon stocks in a high mountain region: A LDN case study from Kyrgyzstan (results of the project Carb-Asia)

Margarete Korintenberg, Judith Walter, Katja Märten, Ermek Baibagyshov and Jutta Zeitz

Carb- Asia | 04/28/2021

Capacity development for climate policy in the countries of South-East and Eastern Europe, the South Caucasus and Central Asia, Phase III (CDCPIII)

This project is part of the International Climate Initiative (IKI). The German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) supports this initiative on the basis of a decision adopted by the German Bundestag.

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On behalf of:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

of the Federal Republic of Germany

Общество почвоведов Кыргызстана им. академика А.М.Мамытова

КЫРГЫЗ РЕСПУБЛИКАСЫ

Background

- **SDG 15: Life on Land**
  LDN 15.3: Contains the objective to strive towards Land Degradation Neutrality (LDN) by 2030 relative to a reference state (baseline)
- Member states are encouraged to set a baseline of LDN-Indicators → changes (positive or negative) must be reported at regular intervals
- Situation in Kyrgyzstan: National data on LDN-Indicators, in particular Soil Organic Carbon (SOC), are not available and global default data are not appropriate

Project Aim

To develop a science-based method for the analysis of spatially distributed SOC stocks adapted to a high mountain region, which enables to model the national baseline.

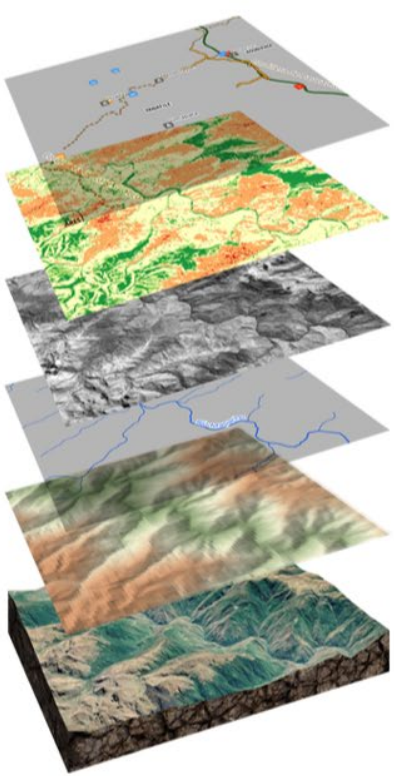
Methods

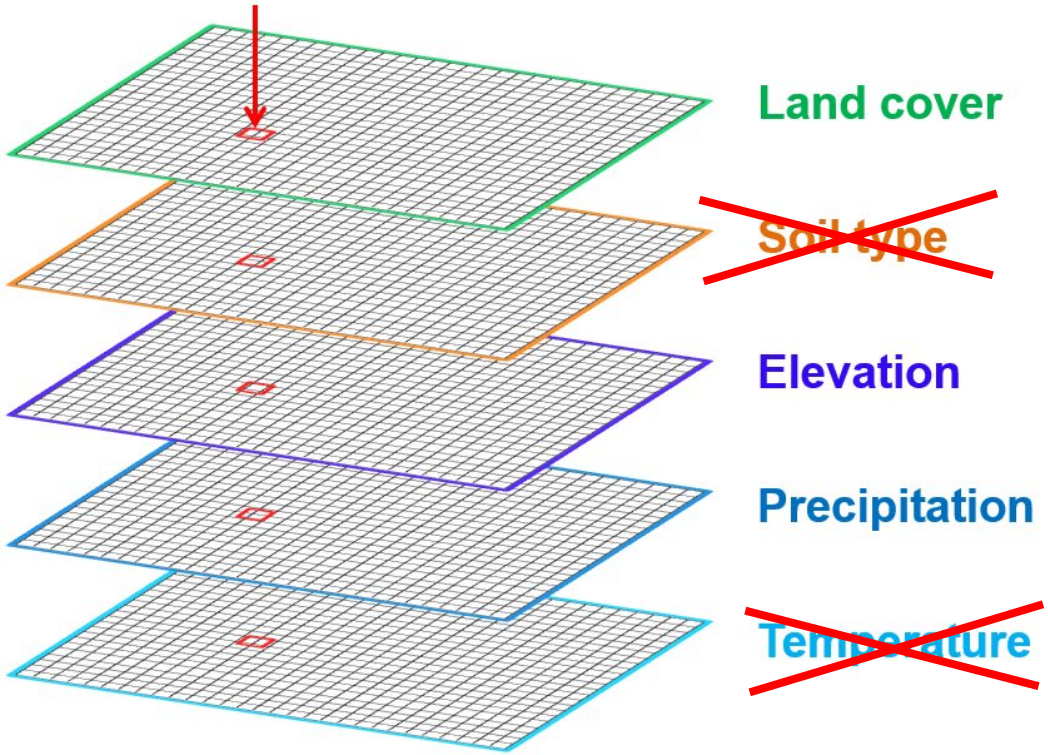
1. Identification of **representative** units (sites) for field survey
   → enables prediction of unsampled locations and upscaling for Kyrgyzstan
2. Representative sites were sampled **at least 3-fold**
   → reliable data including **errors**
3. Consideration of **spatial variability** in SOC within a unit by additional sampling
4. Recording of **reliable stock values** by considering the bulk density (BD) of the fine soil, coarse soil and root content

Methods

Spatial variability in SOC is captured by **representative units:**

- Overlay of digital maps on land cover, soil, elevation and climate

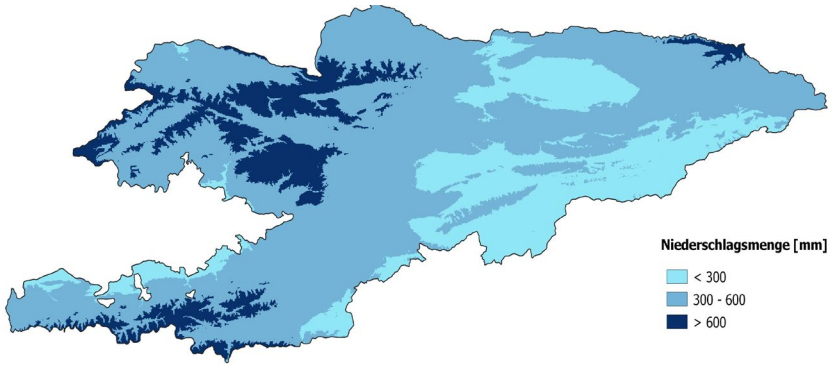




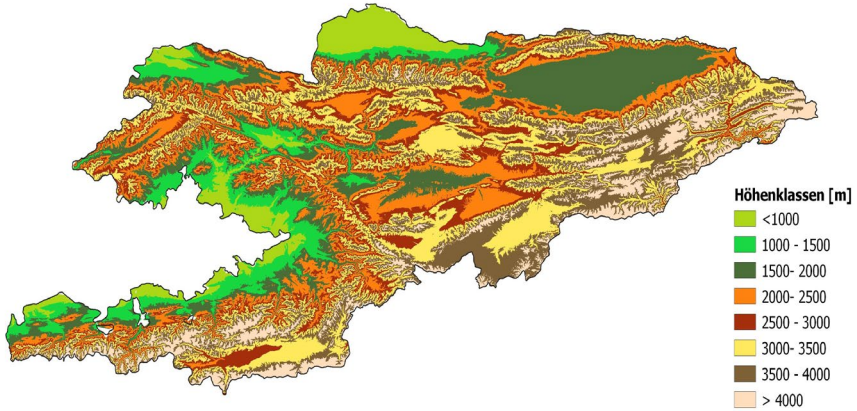
Methods

GLOBAL DATA

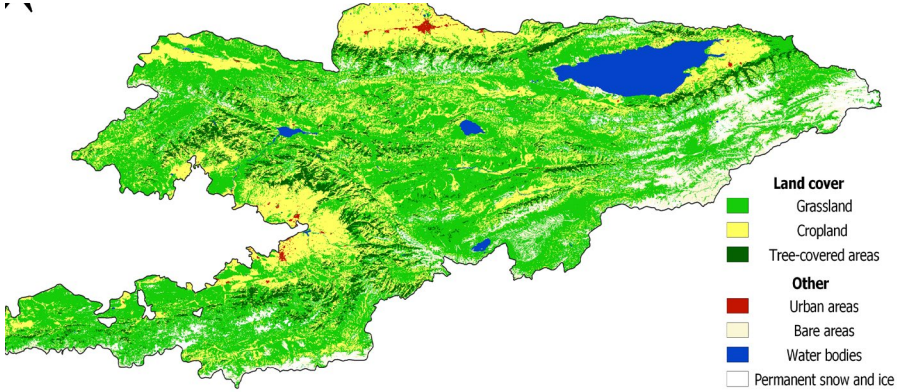
WorldClim (1970-2000) 1x1km



NASA-SRTM DEM 90x90m



UNCCD (ESA) Land Cover 300x300m



AGREGGATED CLASSES

(3) Precipitation [mm/a]

- < 300
- 300 - 600
- > 600

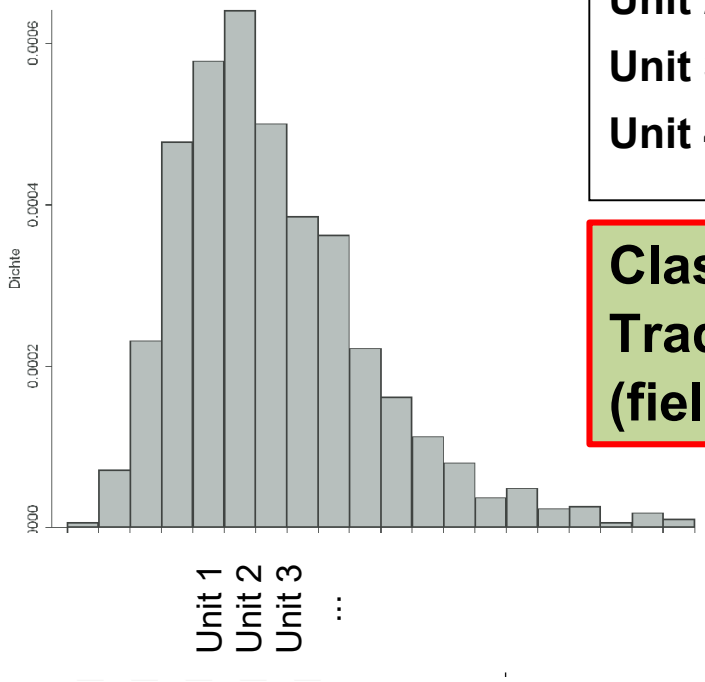
(7) Elevation [m]

- <1000
- 1000 - 1500
- 1500- 2000
- 2000- 2500
- 2500 - 3000
- 3000- 3500
- 3500 - 4000

(3) Land Cover

- Grassland
- Cropland
- Tree-covered areas

Methods



Unit 1: Grassland + <300 mm + <1000 m

Unit 2: Grassland + <300 mm + 1000-1500 m

Unit 3: Grassland + <300 mm + 1500-2000 m

Unit 4: …

Classification of SOC-controlling factors: Trade-off between accuracy and feasibility (field surveys)

Identification of most frequent units (>1% of area) for sampling

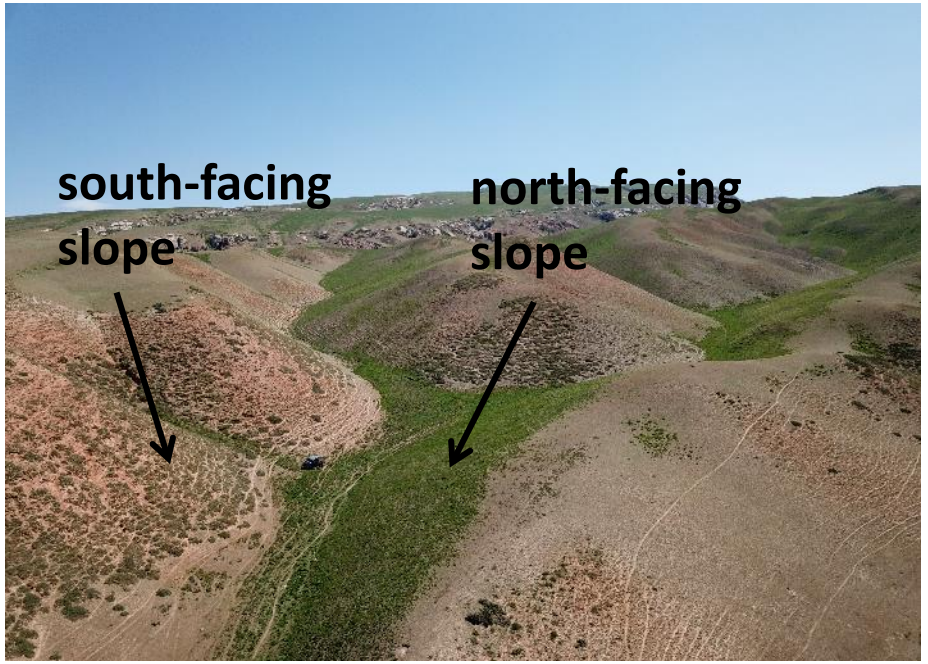
Methods

Unit	Land cover class	Elevation class [m]	Precipitation class [mm a^{-1}]	Proportion of land surface [%]	Sampling [n]
1	Grassland	3,000 – 3,500	300 – 600	8.05	4
2	Grassland	2,500 – 3,000	300 – 600	7.23	3
3	Grassland	2,000 – 2,500	300 – 600	6.94	4
4	Grassland	1,500 – 2,000	300 – 600	5.92	5
5	Grassland	3,500 – 4,000	300 – 600	5.80	3
6	Cropland	< 1,000	300 – 600	4.53	3
7	Cropland	1,000 – 1,500	300 – 600	4.32	3
8	Grassland	3,500 – 4,000	< 300	4.19	4
9	Cropland	3,000 – 3,500	300 – 600	3.98	-
10	Cropland	1,500 – 2,000	300 – 600	3.62	3
11	Grassland	1,000 – 1,500	300 – 600	3.41	4
12	Grassland	3,000 – 3,500	< 300	3.27	3
13	Cropland	2,500 – 3,000	300 – 600	3.18	1
14	Cropland	2,000 – 2,500	300 – 600	2.41	4
15	Grassland	3,000 – 3,500	> 600	2.40	5
16	Grassland	2,000 – 2,500	< 300	2.39	4
17	Tree-covered areas	2,500 – 3,000	300 – 600	2.09	3
18	Grassland	3,500 – 4,000	> 600	2.07	2
19	Grassland	1,500 – 2,000	< 300	1.86	5
20	Tree-covered areas	2,000 – 2,500	300 – 600	1.70	4
21	Grassland	2,500 – 3,000	< 300	1.26	4
				∑80.62	**∑71**

- 21 representative units cover >80% of the carbon-accumulating land surface
- 71 sites were sampled in total

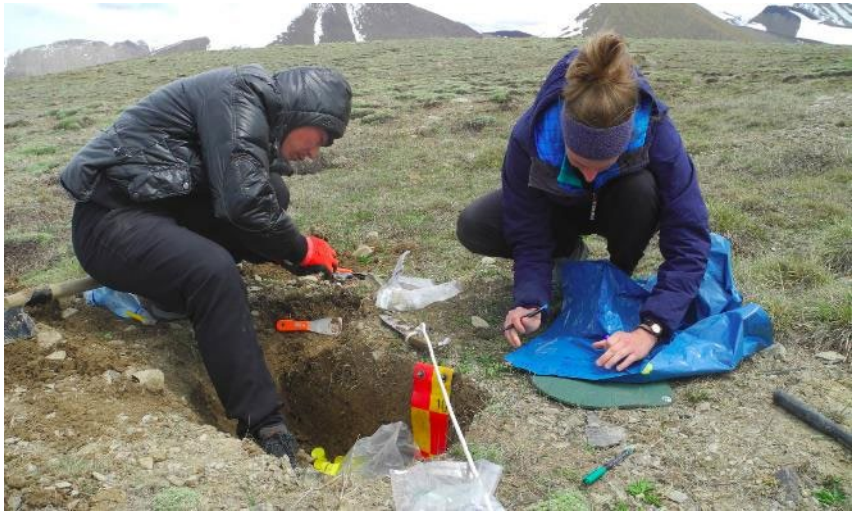
Methods: Field Work

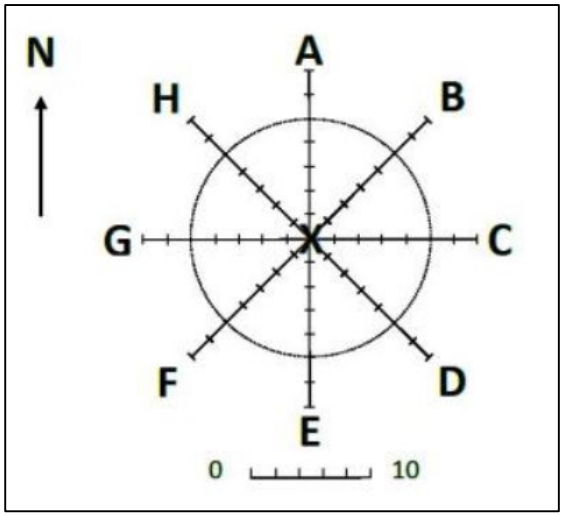
- Identification of representative sampling locations using a drone within single units



Methods: Field work

- Field sampling for laboratory analysis
  - SOC content (+ spatial variability, n=5)
  - Bulk density (BD_{tot}, BD_{fine})
  - Coarse soil and root content
  - Soil texture
  - pH
  - Electrical conductivity (EC)





(Jacobs et al., 2018)

Methods

Calculation of SOC stocks:

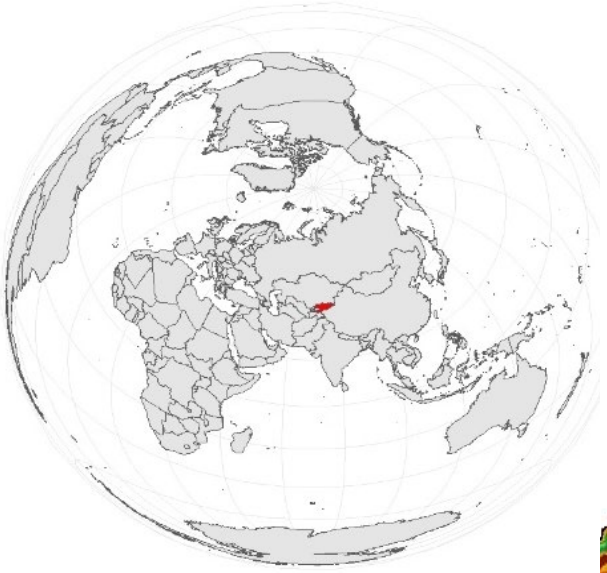
$$SOC\ [t/ha] = stock_{fine\ soil}\ (< 2\ mm) \times SOC_{concentration}$$

Bulk density of the fine soil ($BD_{fine\ soil}$)

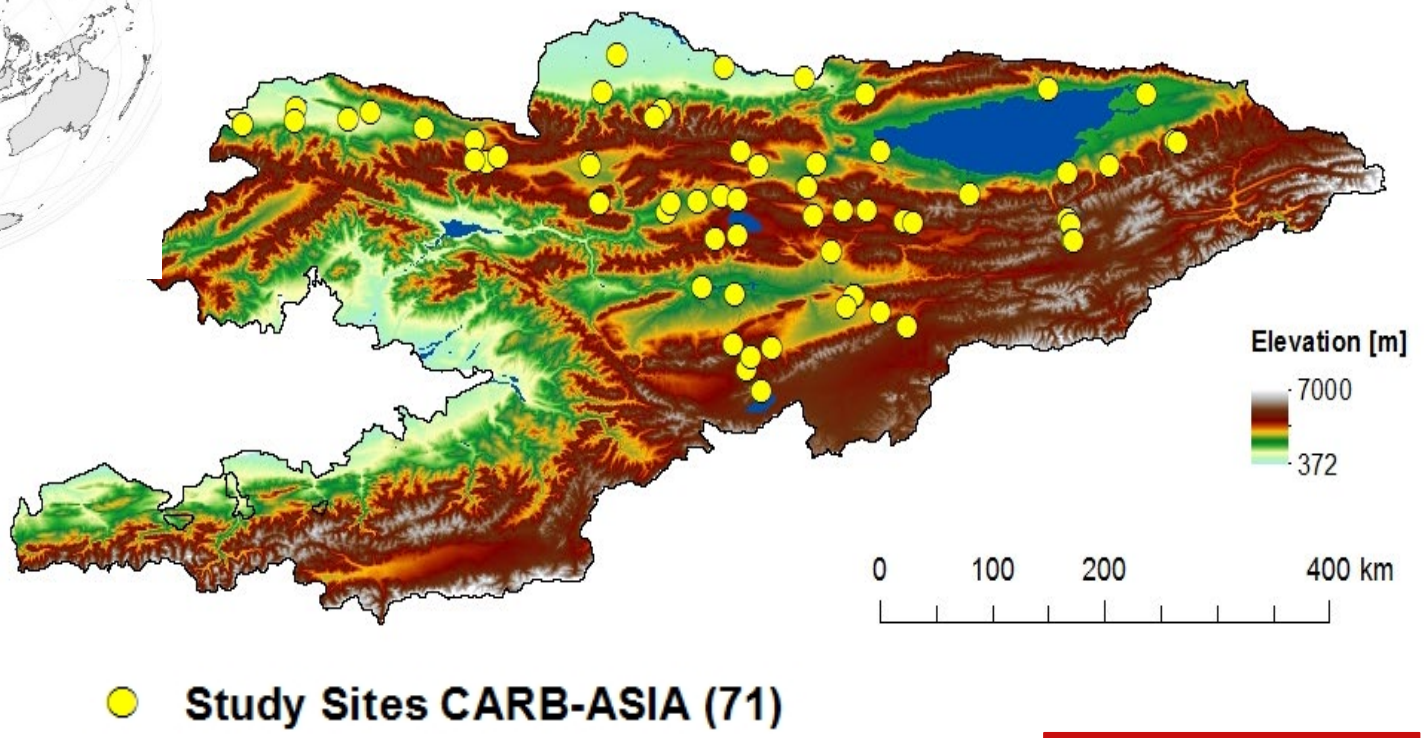
Root mass

Coarse soil (> 2 mm)

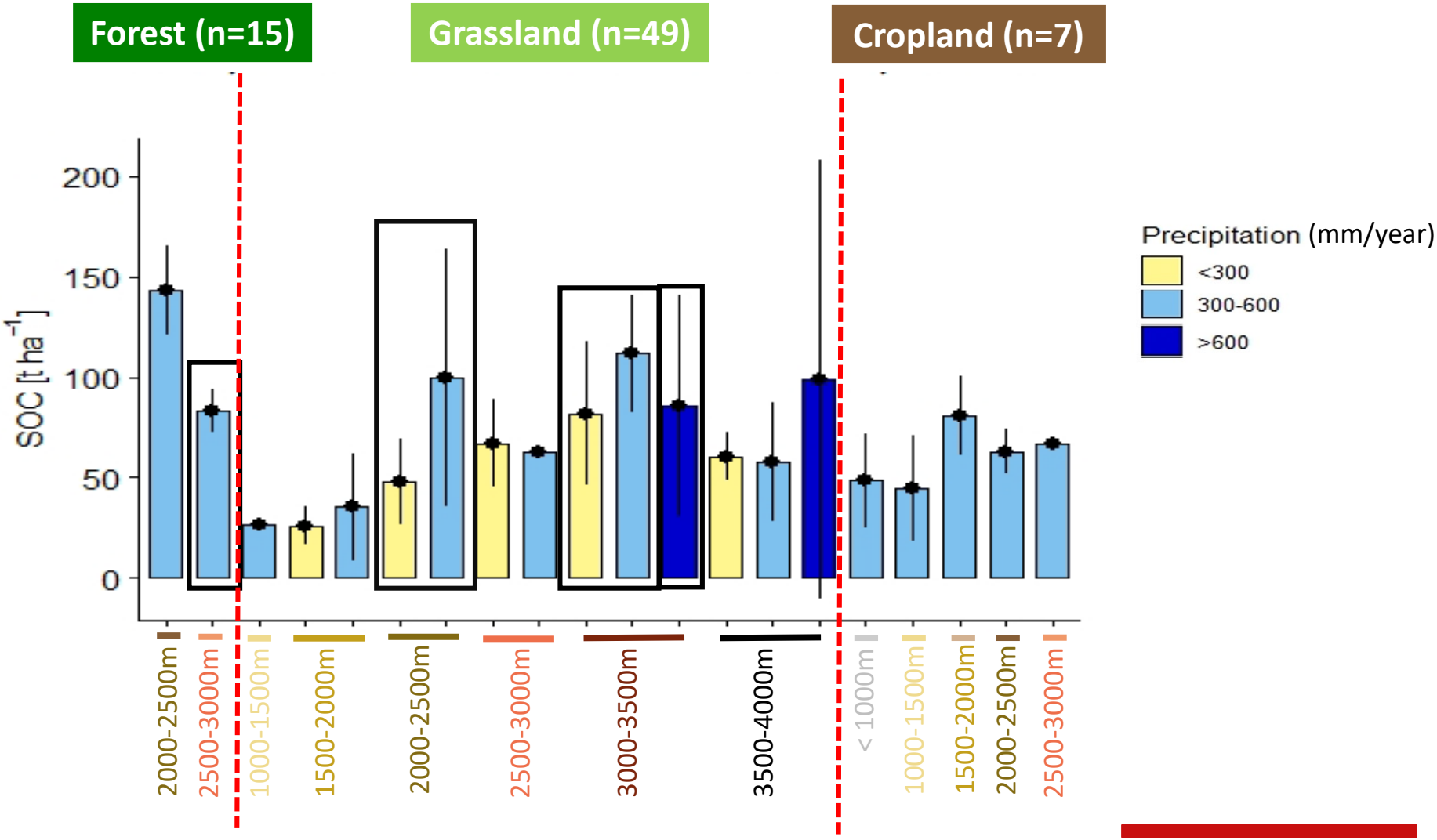
Results



Kyrgyzstan

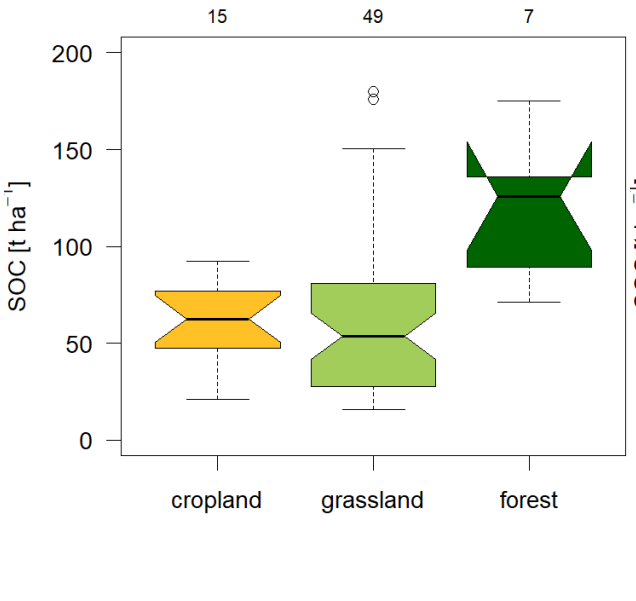


Results


Forest (n=15)
Grassland (n=49)
Cropland (n=7)
SOC [t ha^{-1}]
200
150
100
50
0
2000-2500m
2500-3000m
1000-1500m
1500-2000m
2000-2500m
2500-3000m
3000-3500m
3500-4000m
< 1000m
1000-1500m
1500-2000m
2000-2500m
2500-3000m
Precipitation (mm/year)
<300
300-600
>600

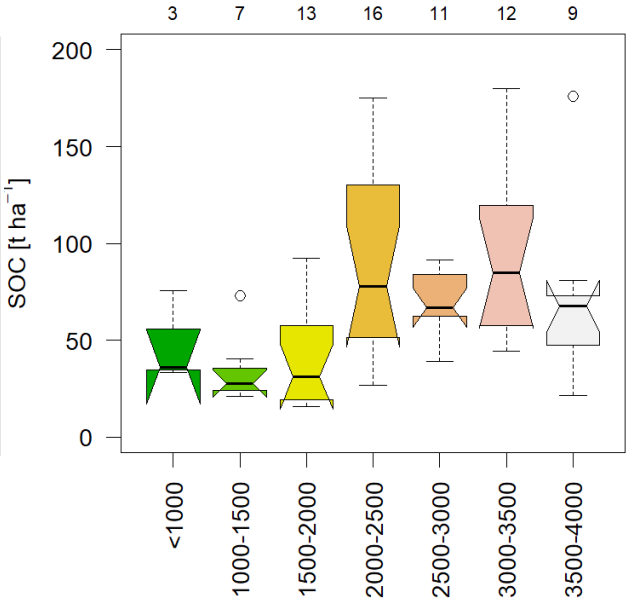
Results

Land Cover



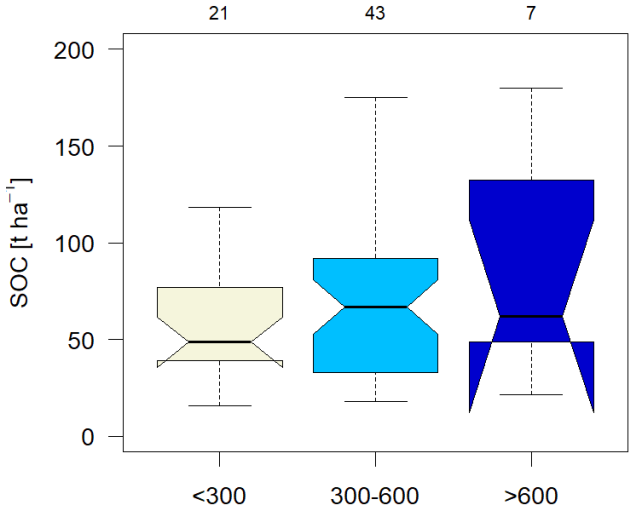
Land cover

Elevation



Elevation [m]

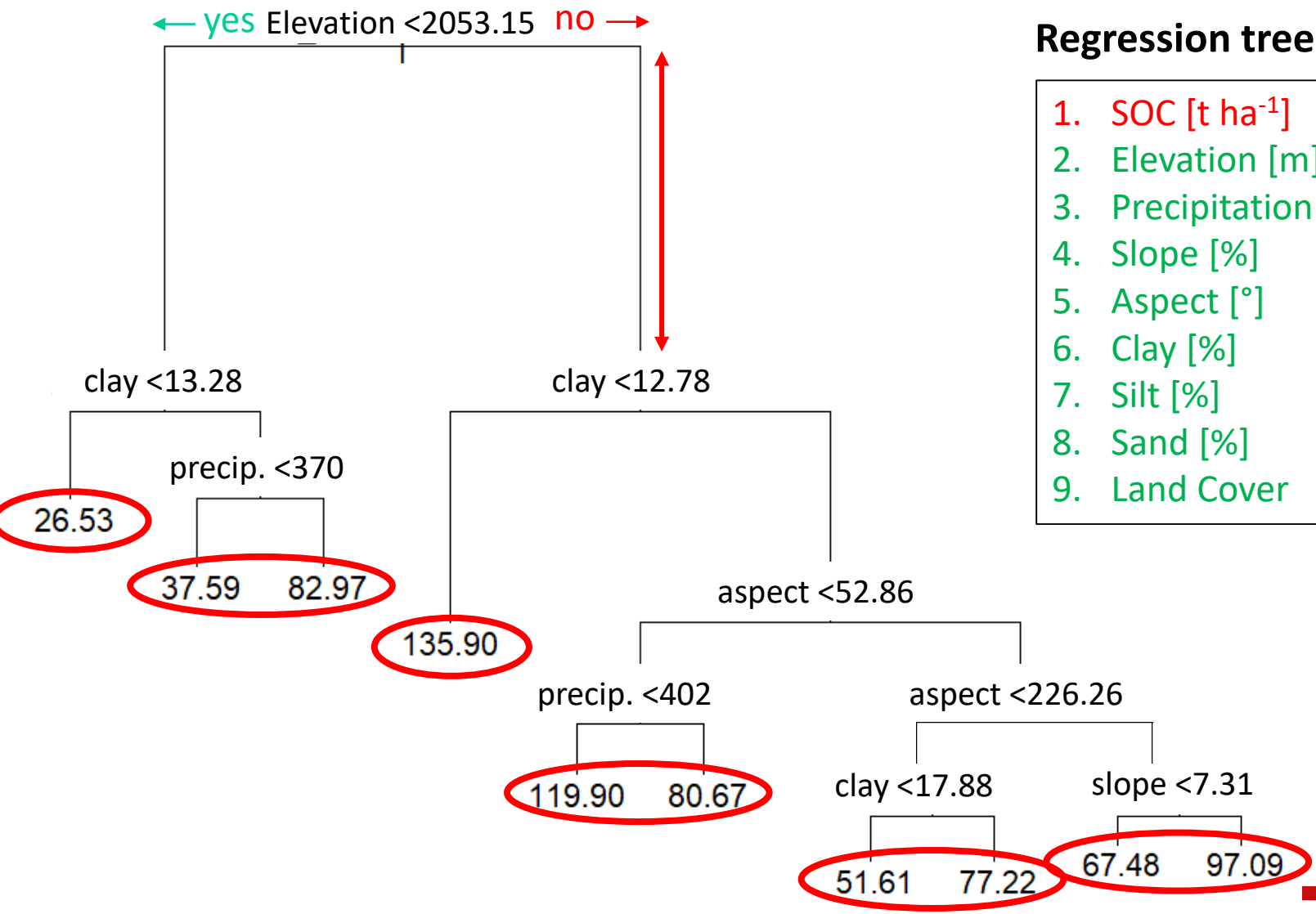
Precipitation



Precipitation [mm a^{-1}]

Results

Results



Regression tree input:

1. SOC [t ha^{-1}]
2. Elevation [m]
3. Precipitation [mm a^{-1}]
4. Slope [%]
5. Aspect [°]
6. Clay [%]
7. Silt [%]
8. Sand [%]
9. Land Cover

Results

SOC stock fine soil (Carb-Asia)

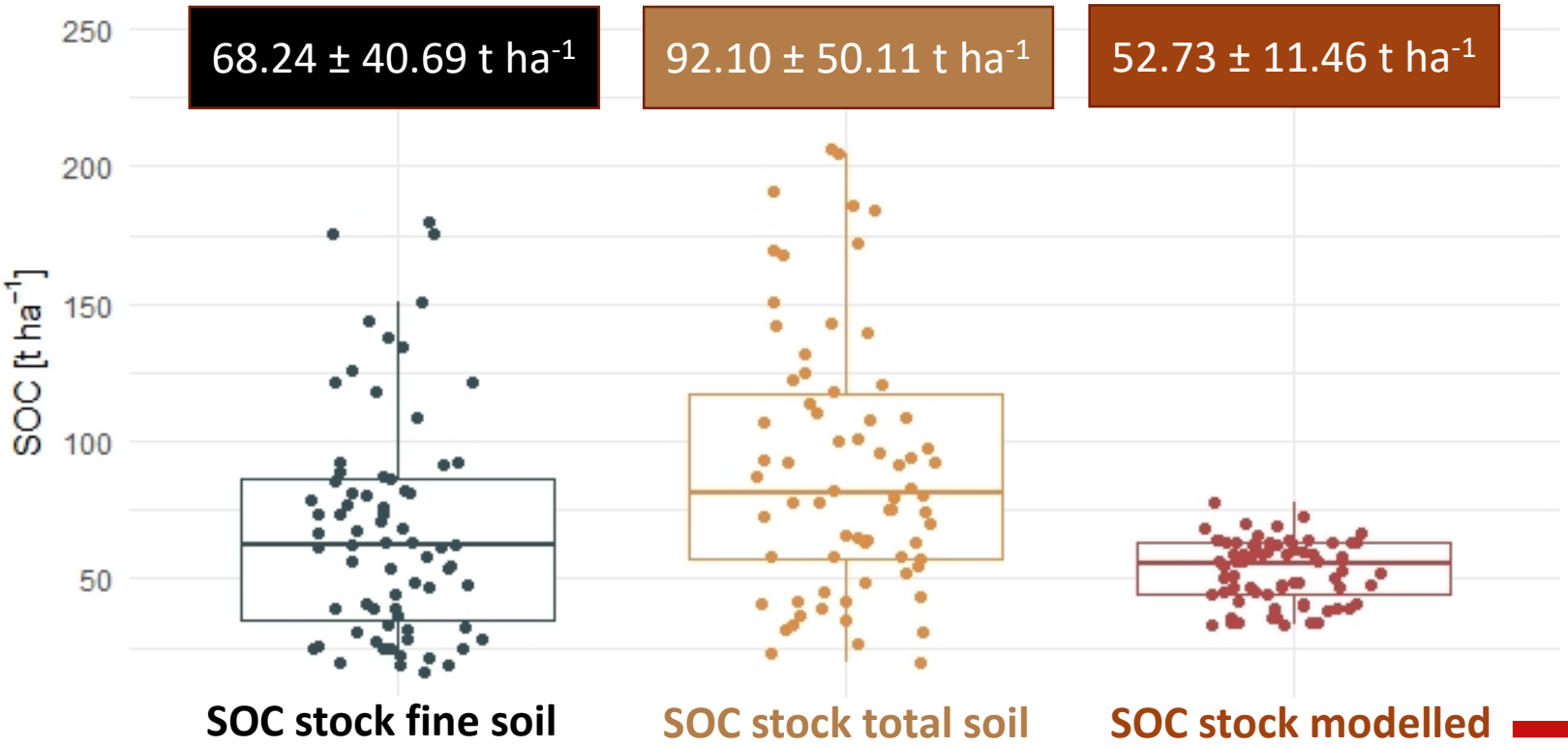
- Use of BD fine soil
- Coarse soil and root content are subtracted form the total soil volume

SOC stock total soil

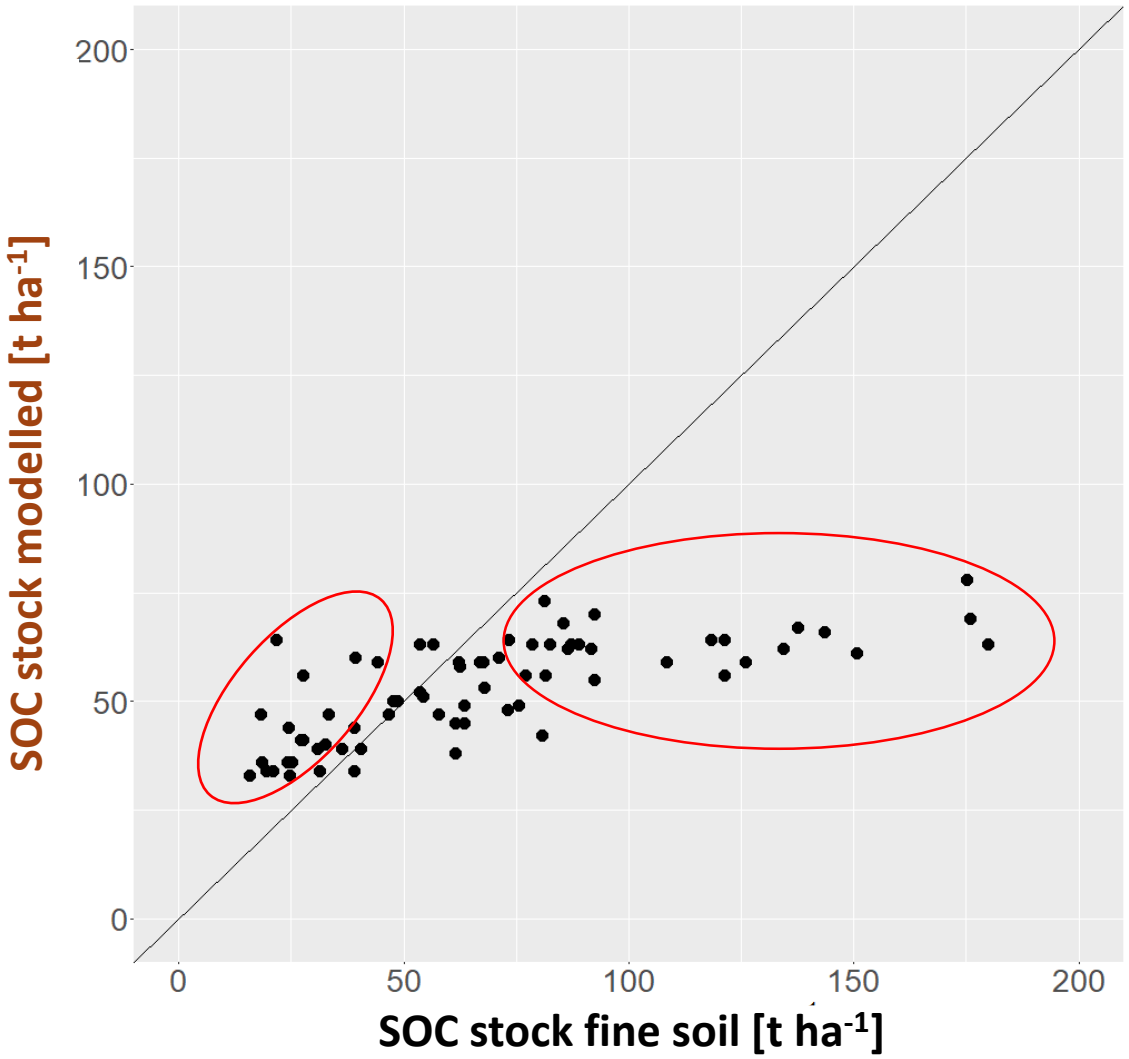
- Use of bulk density total
- No consideration of coarse soil and root content

SOC stock modelled (Soil Grid)

- Data based on global soil profiles and environmental covariates



Results



Comparison of **precise SOC stocks** of the fine soil (our approach) with **modelled SOC stocks** (soilgrid)

Conclusions

- By using **representative units** a broad range of variability in SOC stock is captured
- In a high mountain region SOC stocks are mainly determined by **elevation**, **texture** (clay), **precipitation** and to a minor extent in **land cover** → using change factors only based on land cover is not sufficient
- In-field observation and SOC stocks indicated: **Degradation** due to **overgrazing** is severe in Kyrgysztan and strongly depends on elevation → needs to be considered in SOC stock monitoring
- For **precise spatial** SOC stock estimation the **SOC stock** of the **fine soil** is mandatory

Thank you very much!

On behalf of:

Federal Ministry
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and Nuclear Safety

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Общество почвоведов Кыргызстана
им. академика А.М.Мамытова

Contact

Prof. Jutta Zeitz

Lead Project

Department of Soil Science, Berlin

jutta.zeitz@agrar.hu-berlin.de

Phone +49 (030)2093 46486

Margarete Korintenberg

Researcher

Department of Soil Science, Berlin

margarete.korintenberg.1 @hu-berlin.de

Phone +49 (030)2093 46489

Dr. Judith Walter

Researcher

Department of Soil Science, Berlin

judith.walter.1@hu-berlin.de

Phone +49 (030)2093 46484

Dr. Ermek Baibagyshov

Researcher

Naryn State University, Kyrgyzstan

nsu0896@yahoo.de

Katja Märten

Master´s student

University of Leipzig

HUMBOLDT-UNIVERSITÄT ZU BERLIN

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КЫРГЫЗ РЕСПУБЛИКАСЫ

Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Sitz der Gesellschaft
Bonn und Eschborn

Friedrich-Ebert-Allee 36 + 40
53113 Bonn, Deutschland
T +49 228 44 60 - 0
F +49 228 44 60 - 17 66

E info@giz.de
I www.giz.de

Dag-Hammarskjöld-Weg 1 - 5
65760 Eschborn, Deutschland
T +49 61 96 79 - 0
F +49 61 96 79 - 11 15

On behalf of:

Federal Ministry
for the Environment, Nature Conservation
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