Catena 144 (2016) 56–64

Contents lists available at ScienceDirect

Catena

journal homepage: www.elsevier.com/locate/catena

Peatland ecosystems in Kyrgyzstan: Distribution, peat characteristics and a preliminary assessment of carbon storage

Maria Aljes [a,*,1], Thomas Heinicke [b,1], Jutta Zeitz [b]

[a] Northwest German Institute of Forest Research, Grätzelstr. 2, D-37079 Göttingen, Germany
[b] Albrecht Daniel Thaer-Institute of Agricultural and Horticultural Sciences, Humboldt-Universität zu Berlin, Albrecht-Thaer-Weg 2, D-14195 Berlin, Germany

ARTICLE INFO

Article history:
Received 22 December 2015
Received in revised form 2 April 2016
Accepted 23 April 2016
Available online 16 May 2016

Keywords:
Peatland inventory
Mountain ecosystems
High altitude peatlands

ABSTRACT

The peatland ecosystems of Central Asia have received little attention from scientific research to date. In the continental, predominantly semi-arid to arid climate of Kyrgyzstan they represent rare biotopes that are crucial for maintaining special ecosystem functions within the vulnerable mountain areas. In this study, we present an assessment of the distribution and total area of peatlands in Kyrgyzstan derived from Soviet topographic maps. About 64,500 ha of peatlands were detected after digitizing special wetland signatures from maps at a scale of 1:100,000. The relevance of these signatures was tested with ground truth data and in most cases these signatures matched with peatlands.

Ground truth data were collected for 13 peatlands, and brief descriptions of the vegetation and soil characteristics for these peatlands are provided. A gradient from plains to high mountains was detected with regard to peat thickness, each associated with their own distinct plant communities. Greatest peat (average 64 cm thick) accumulation occurred at low altitudes (<1000 m a.s.l.) and the thinnest peat (average 14 cm) occurred at high altitudes (above 3500 m a.s.l.). By combining data on the total area of peatlands with results from laboratory analysis of soil samples, we were able to investigate the potential carbon storage of peatlands in Kyrgyzstan. Depending on the location and peatland type, we found levels of carbon storage equating to 152 to 465 tons carbon per hectare, which scales up to an estimated national carbon storage equating to *c.*16.4 Mt for the entire country.

1. Introduction

As a mountainous country comprising approximately 90% high mountains and 10% inner mountain valleys and plains, the vast majority of agricultural land (on mineral as well as organic soils) in Kyrgyzstan is used as pastures (Bussler, 2011). Due to the continental, mainly semi-arid to arid climate (Troll, 1941), water supply is sparse and agriculture is mainly dependent on the large streams that are fed by glacial water from the mountain ridges. These water resources are the basis for the formation of peatlands on the slopes and slope toes of mountains, in depressions and along streams, where periodic flooding leads to peat formation. The peatlands provide very important ecosystem functions, such as water retention, water filtration, carbon sequestration, regulation of micro climate, biomass production and habitat provision for animals, plants and fungi. These factors make peatlands unique and rather exceptional ecosystems in the mountains of Central Asia. Information about distribution and characteristics of peatlands is, however, largely limited to a few old publications from Soviet times. The characteristics of organic soils were investigated by Druzhinin et al. (1954); Druzhinin and Kharakoz (1959) and Dzholdoshev (1970), while Korovin (1962); Sobolev (1972) and Golovkova (1990) reported on peatland vegetation. The distribution and total area of peatlands were investigated by Isaev (1956); Isaev (1958) and Dzholdoshev (1970). Isaev (1958) also developed a classification of peatlands in Kyrgyzstan.

Assessment of the total area of peatlands in Kyrgyzstan markedly differs within the literature. Isaev (1958) reported an area of about 70,000 ha, of which only about 30,000 ha had peat depths of at least 20–30 cm. Druzhinin and Kharakoz (1959) only considered an area of about 55,000 ha, while Dzholdoshev (1970) concluded that there was a total of 85,000 ha of peatlands and classified them into 15,300 ha of typical peatlands (peat layer of >30 cm), 13,000 ha of peaty hay meadows, 41,500 ha of peaty pastures and about 15,000 ha that were lost due to peat cutting, drainage and transformation into arable fields.

More recent studies, during the 1990s (Mrotzek, 1996; Zemmrich, 1997; Heinicke, 1999, 2003, 2004; Gottschling, 2006), investigated landscape scale ecological features of different peatland types. However, to date, no study has dealt with the carbon storage of Kyrgyzstan peatlands. All recent studies indicate that peatland ecosystems in the Kyrgyz Mountains are highly threatened by their intensive use as pastures. Khuzamov et al. (2009) report that 25% of pasture land was already degraded, which includes peatlands currently used as pastures.

* Corresponding author.
E-mail addresses: m.aljes@posteo.de (M. Aljes), thomas.heinicke@agrar.hu-berlin.de (T. Heinicke), jutta.zeitz@agrar.hu-berlin.de (J. Zeitz).
[1] Equal contributors.

http://dx.doi.org/10.1016/j.catena.2016.04.021
0341-8162/

Therefore Kyrgyz peatlands need to be investigated as a basis for conservation measures and sustainable development. This also includes an assessment of the extent of carbon stocks in peatlands to provide information about the climate protection potential of these ecosystems in Kyrgyzstan. With the adoption of the Kyoto activity "Wetland drainage and rewetting" at the climate conference in Durban 2011, a first step was made towards taking account the emissions of greenhouse gases from wetlands into national reports under the Kyoto protocol. Furthermore the climate finance mechanism NAMA (Nationally Appropriate Mitigation Action) was launched to promote cooperation projects in the AFOLU sector (Agriculture, Forestry and Land Use) that aim at the reduction of emissions from (degraded) wetlands. So far, extensive data connecting specific site conditions, such as peat depths and organic carbon content, to geographic location, are lacking. Overview assessments of national carbon storage have been carried out in many countries, as well as for large ecoregions. Comprehensive studies on the extent of carbon storage in organic soils exist for example for Germany (Roßkopf et al., 2015), Switzerland (Leifeld et al., 2005), Russia (Alexeyev and Birdsey, 1998), Europe (Byrne et al., 2004), the northern hemisphere (Yu, 2012), as well as for peatlands of the tropics (e.g. Page and Banks, 2007, Rieley et al., 2008). For Central Asia, however, data on peatlands in general and specifically their carbon storage potential are sparse (Minayeva et al., 2005; Joosten, 2010). Joosten (2010) estimated a storage of about 15.0 Mt carbon for the year 1990 in Kyrgyzstan (based on an area of 15,300 ha peatlands) and 13.2 Mt for the year 2008 respectively, considering a net loss of 1300 ha of peatlands during the period 1990–2008.

This article presents the first results from new investigations on peatlands in Kyrgyzstan, which include an assessment of the distribution and total area of peatlands and a preliminary estimate of the carbon storage capacity in Kyrgyz peatlands.

2. Materials and methods

2.1. Study area

While GIS data on the distribution and total area of peatlands in Kyrgyzstan were collected for the whole country, the field work was concentrated in six geographical locations in northern and central Kyrgyzstan from 700 m to 3800 m a.s.l. Sites for detailed investigation were chosen according to the criteria altitude, size (>10 ha) and accessibility (Table 1).

In general, Kyrgyzstan has a continental climate with predominantly semi-arid to arid conditions (Troll, 1941; Walter and Breckle, 1994). As a consequence, the precipitation in the lower and middle parts of the mountain ranges and plateaus reaches barely 200 mm during summer and 100 mm during winter months. Nevertheless, annual precipitation increases with altitude and can reach up to 900 mm in easternmost Kyrgyzstan (Kungey and Terskij Alatoo) and 1000 mm in western Kyrgyzstan (Fergana range, Kyrgyz range), with most precipitation in summer months (Atlas Kyrgyzskoi Respubliki, 1987).

Daily mean temperatures range from 25 °C (−16 °C) in the valleys of Bishkek and Toktogul (800 m a.s.l.) to 12 °C (−20 °C) in the high mountain ranges above 3000 m a.s.l. during summer (winter). Above 3000 m a.s.l. cold nights and frosts are to be expected all year round, which means that there is a high variability in temperature during the day in the summer months (Atlas Kyrgyzskoi Respubliki, 1987).

Due to the low precipitation rates, peatland formation in Kyrgyzstan is always dependent on ground or melt water supply. The characteristics of Kyrgyz peatlands are therefore strongly connected to the properties of the underground rock.

2.2. Analysis of geographical data

The first step towards identifying peatlands was to digitize special wetland signatures, represented by horizontal broken blue lines on the Soviet 1:100,000 scale topographic maps (TM 100). According to Sirin and Minayeva (2001), such signatures are good indicators for the occurrence of peatland ecosystems. According to Isaev (1956), peatlands were classified into peatlands with >30 cm peat depth (торфянно-болотные почвы) and peatlands with <30 cm peat depth, called "sasy" (лугово-болотные почвы). Those are likely to be represented in wetland signatures of the topographic maps as well. Heinicke (1999) already demonstrated that those wetland signatures show a good correlation with peatland borders in the field. Taking into account the rapid degradation of peatland ecosystems in Kyrgyzstan (e.g. Heinicke, 1999), it can be assumed that the delineation is partly outdated as the topographic maps used were mostly created in the 1970s. Although large scale mapping of soils has been done by the institute KIRGIZGIPROZEM during soviet times (e.g. Gottschling, 2006), those maps are very difficult or impossible to obtain and could thus not be included in any of our investigations. Under the given circumstances, topographic maps provided the best possible material with which to start.

Peatland polygons derived from the maps were transferred into a geographic information system (GIS). Wetland signatures were

Table 1
General characteristics of studied peatlands with the number of soil profiles and vegetation plots analysed at each site. The study sites are ordered by altitude.

Site nr.	Study site	*Oblast*	Altitude	Area [ha]	Protection status	Land use	Latitude [DD]	Longitude [DD]	Number of soil profiles and vegetation plots
1	Tokmok	Tschuy/Bishkek	800	1400	Nature protection site (*Zakaznik*)	Hay meadow	42.83	75.22	10
2	Kotchkor 3	Naryn	1920	800		Pasture (all year)	42.2	75.52	14
3	Kotchkor 1	Naryn	1940	170		Pasture (all year)	42.16	75.49	23
4	Kotchkor 2	Naryn	1950	30		Hay meadow	42.17	75.53	20
5	Suusamyr 1	Talas	2180	450		Hay meadow/Pasture (all year)	42.21	73.85	24
6	Suusamyr 8	Talas	2420	65		Summer pasture	42.18	73.46	36
7	Suusamyr 5	Talas	2550	25		Summer pasture	42.22	73.66	14
8	Suusamyr 4	Talas	2600	20		Summer pasture	42.22	73.66	20
9	Soltonsary 1	Issyk-Kul	2900	950		Summer pasture	41.8	76.21	28
10	Soltonsary 2	Issyk-Kul	2900	30		Summer pasture	41.79	76.22	27
11	Sonkul 1	Naryn	3020	1100	Nature protection site (*Zapovednik*)	Summer pasture	41.78	75.26	41
12	Sonkul 2	Naryn	3020	3800	Nature protection site (*Zapovednik*)	Summer pasture	41.81	75.34	28
13	Arabelsuu	Issyk-Kul	3800	70		No current use	41.83	77.83	37