



Carbon implications of cropland dynamics in the Eurasian black soil belt

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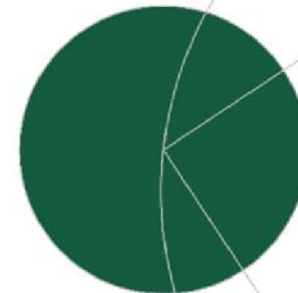
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Kazakhstan and Russia

- Land-use changes are characterized by institutional changes (Virgin Lands Campaign, collapse of the Soviet Union)
- Massive cropland expansion 1954 - 1963
- Widespread agricultural land abandonment after 1990
- Re-cultivation after 2000
- Implications to soil organic carbon (SOC) balance are unknown



Goal

To understand the implications of massive land-use changes during 20th century in the former Virgin Lands Campaign area on SOC dynamics



Objectives

1. Reconstruct land-use change 1953-2010
2. Estimate SOC dynamics due to land-use change



Dynamics of land use in Russia and Kazakhstan

Cropland expansion

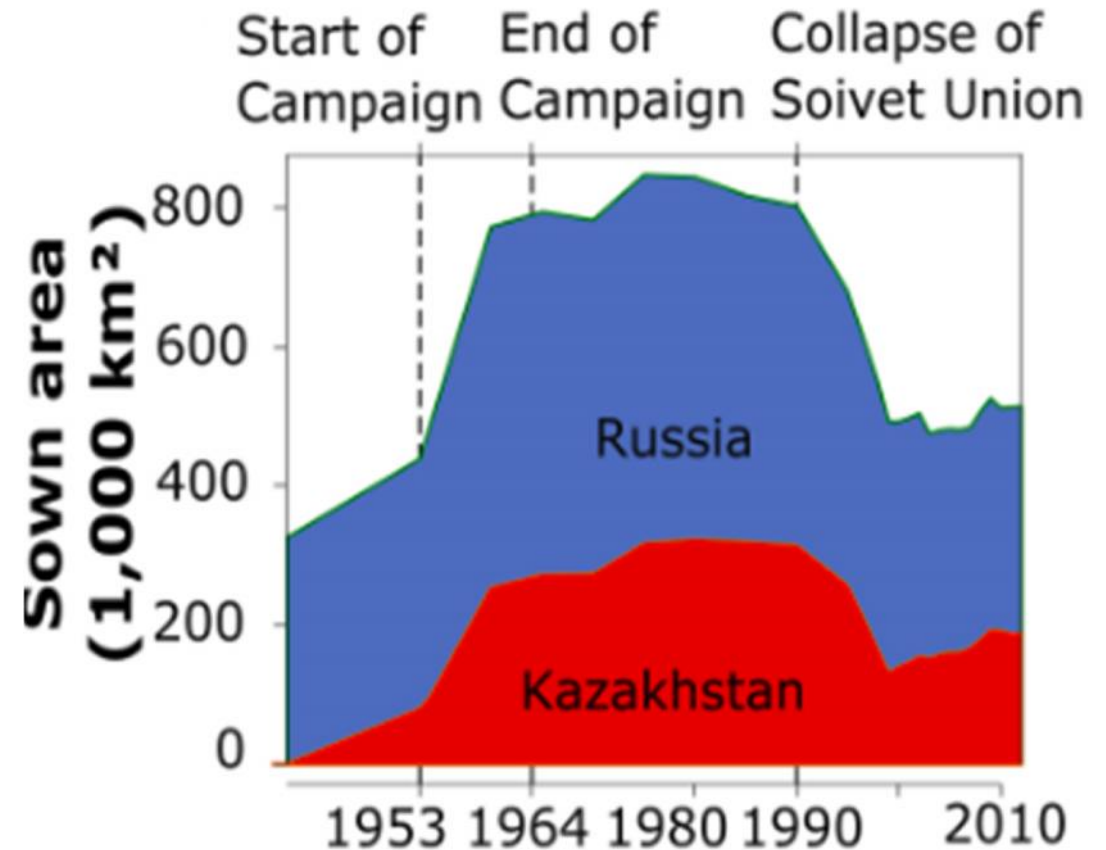
during the Campaign
(1954-1963) - 45 Mln ha

Abandonment

(1990-2000) – 45 Mln ha

Recultivation after 2000

- 8 Mln Ha



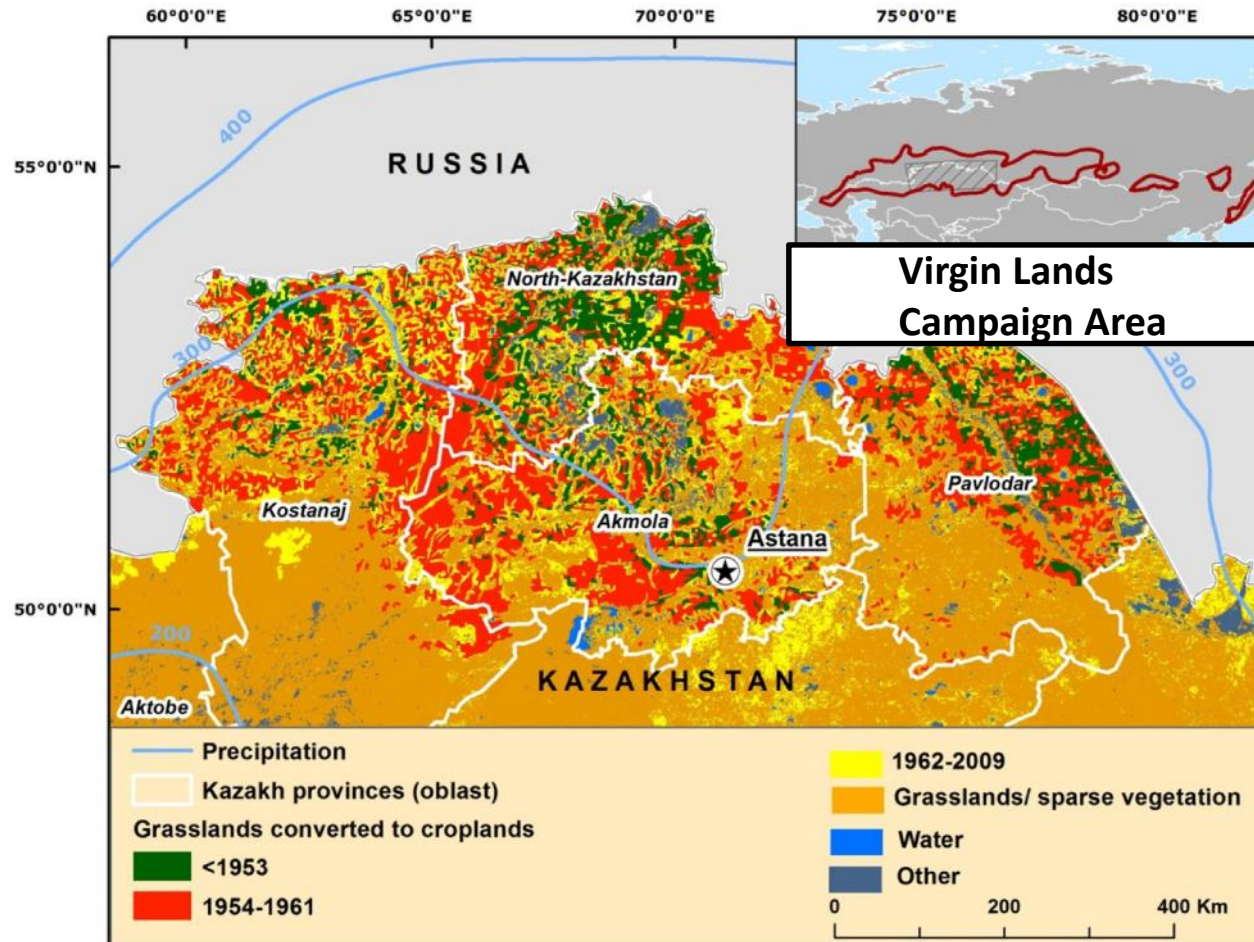
Objective I. Reconstruct land-cover change 1953-2010

Methods

- Establish relationship between rain-fed wheat suitability and detailed patterns of land-use change in Northern Kazakhstan
- Develop cropland mask - remote sensing maps circa 2009
- Spatially allocate sown area statistics 1953-2010 (province level) in dynamic way



Detailed patterns of cropland expansion in Northern Kazakhstan, 1953-1961



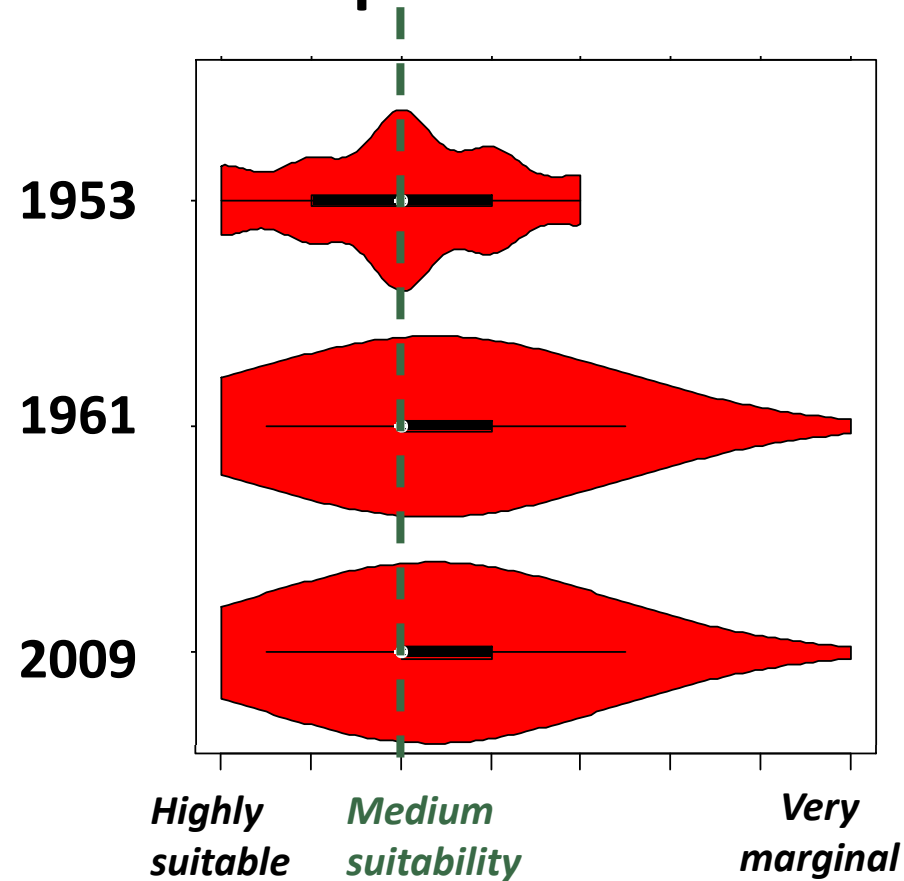
Source: Prishchepov et al., in prep.



Change of cropland area 1953-2009

Suitability for rain-fed wheat production

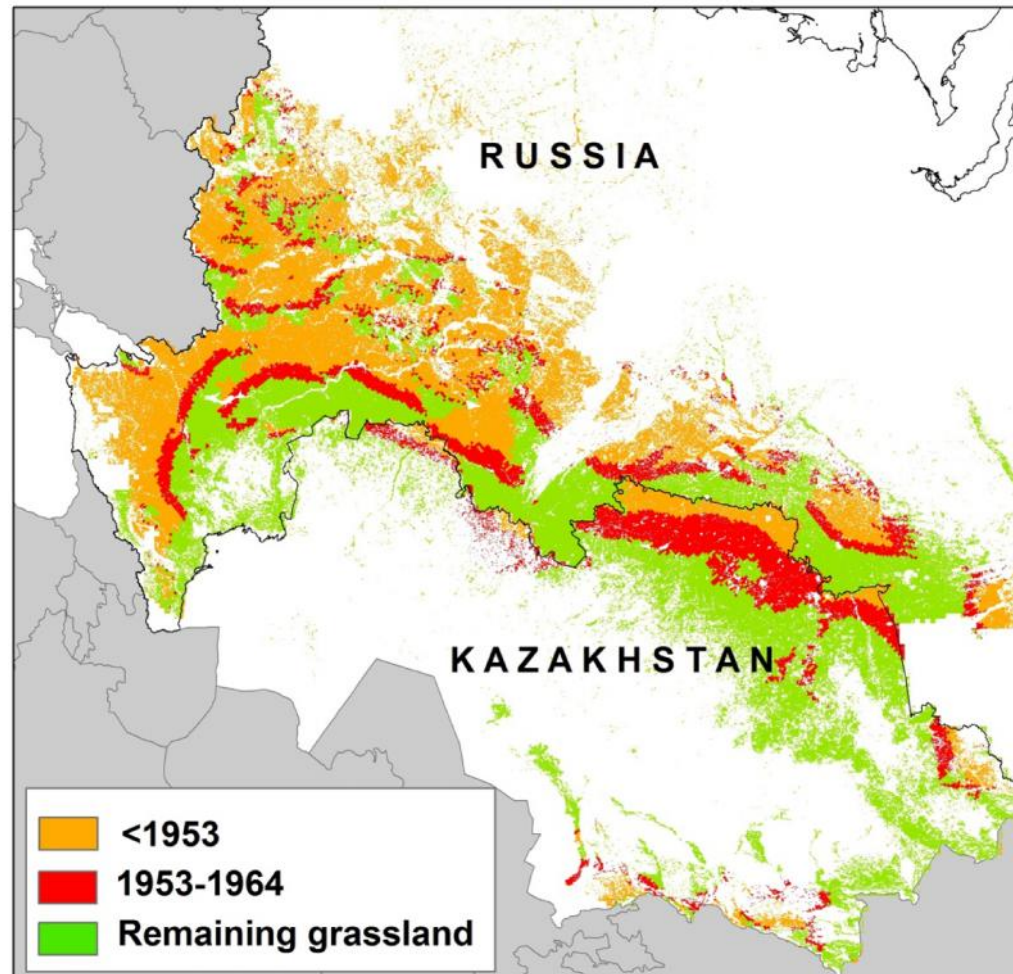
Cropland expansion during Virgin Lands Campaign (1954-1963) and post-Campaign period (1963-1980) went at the expense of marginal lands



Source: FAO IIASA GAEZ



Spatial allocation of agricultural statistics



Objective II. Estimate SOC dynamics due to land-use change

- Bookkeeping approach, reported Soil Organic Carbon (SOC) estimates from chronosequences (pairwise plots)
- Henin&Dupuis model with *ExpFun* approach
- Calculation of SOC for soil types from 1:4,000,000 maps (Roskartografiya, 1993)

$$\Delta\text{SOC} = \text{SOC}_{\text{equilibrium level B}} - \text{SOC}_{\text{equilibrium level A}}$$

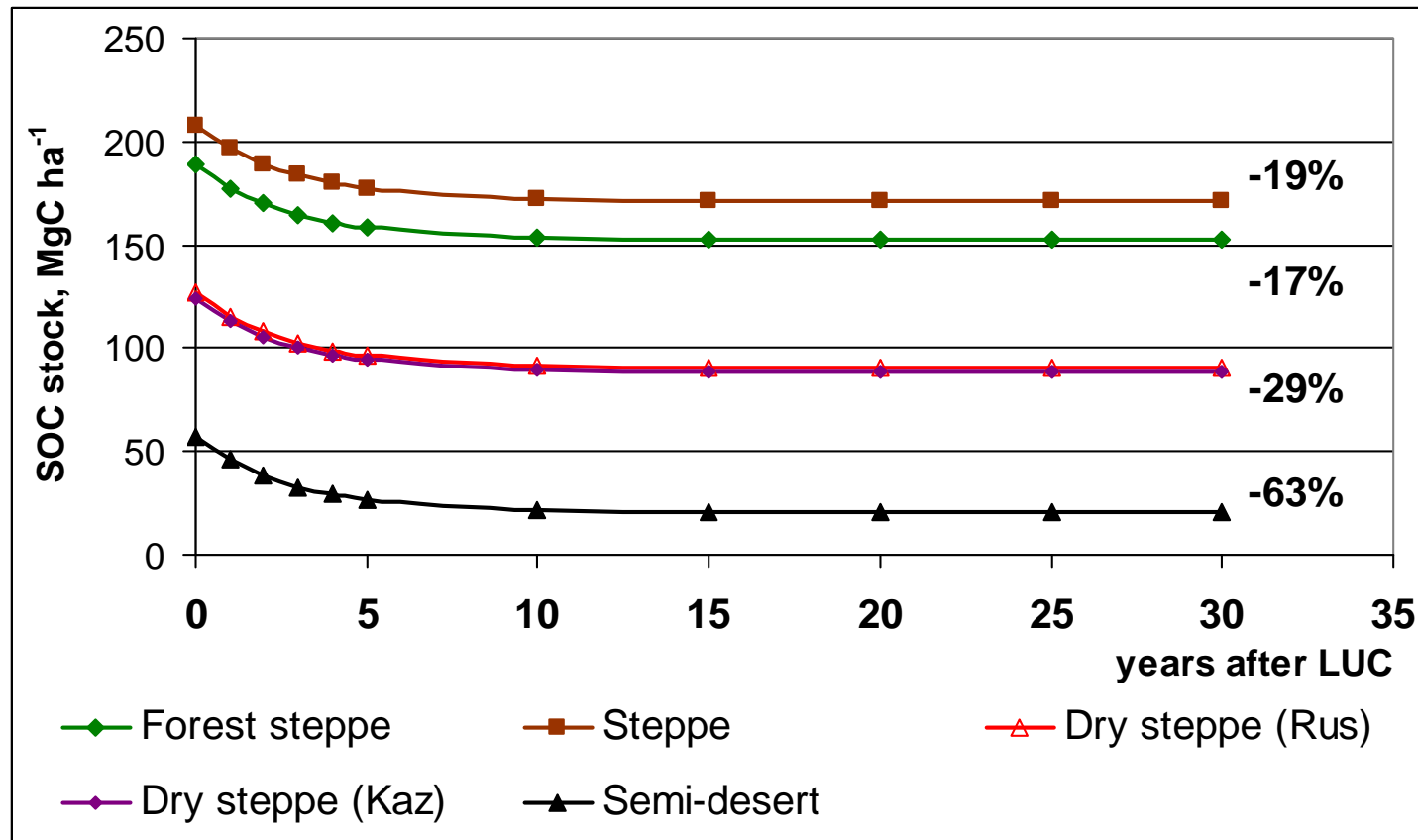
Conversion of management A (grassland) to management B (cropland)

$$\text{Mean Annual Rate}_{\Delta\text{SOC}} = \Delta\text{SOC} [1 - \exp(-kT)] / T$$

“k” is the rate of C storage decrease, T=20 years



Change in SOC stocks after the conversion from grassland to cropland



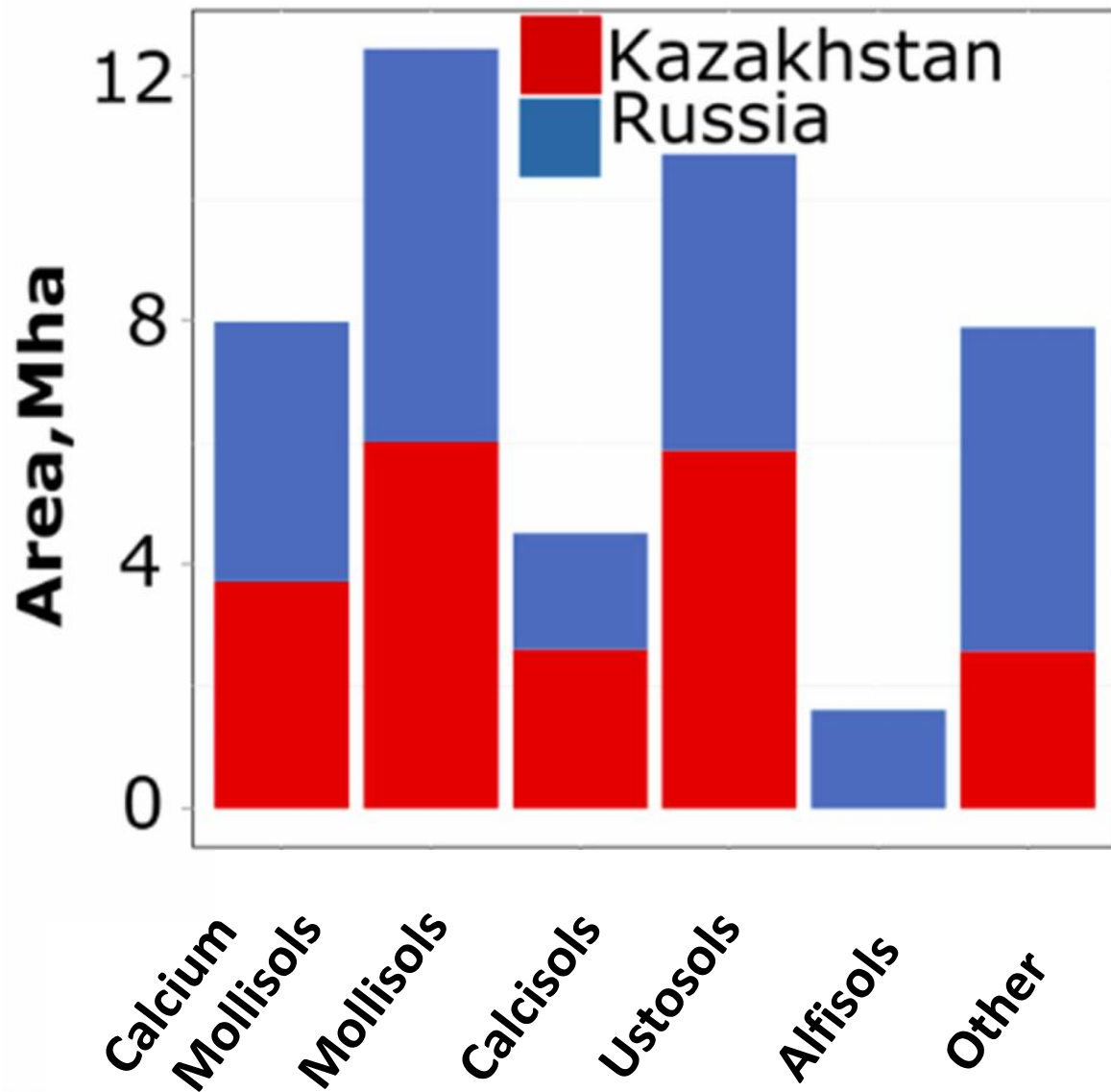
Source:

Poeplau et al 2011, Kurganova et al. 213



Results

Cropland expansion during the Campaign (1954-1963) by major soil types



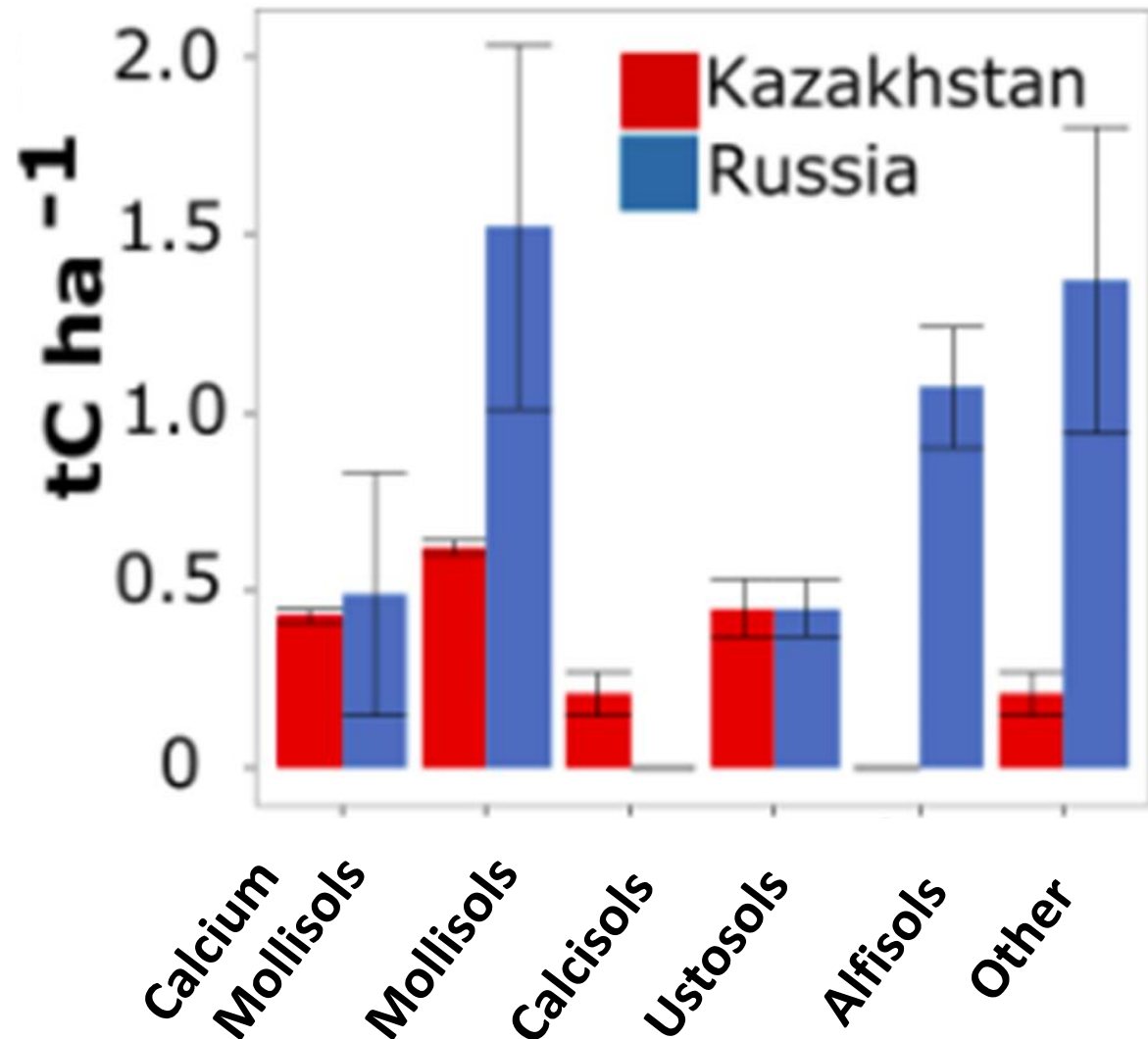
Initial SOC loss during the Campaign

Russia

611±47 Mt C
(23 Mha)

Kazakhstan

241±11 Mt C
(22 Mha)



SOC sequestration on abandoned lands from 1990 to 2010 in the Campaign area

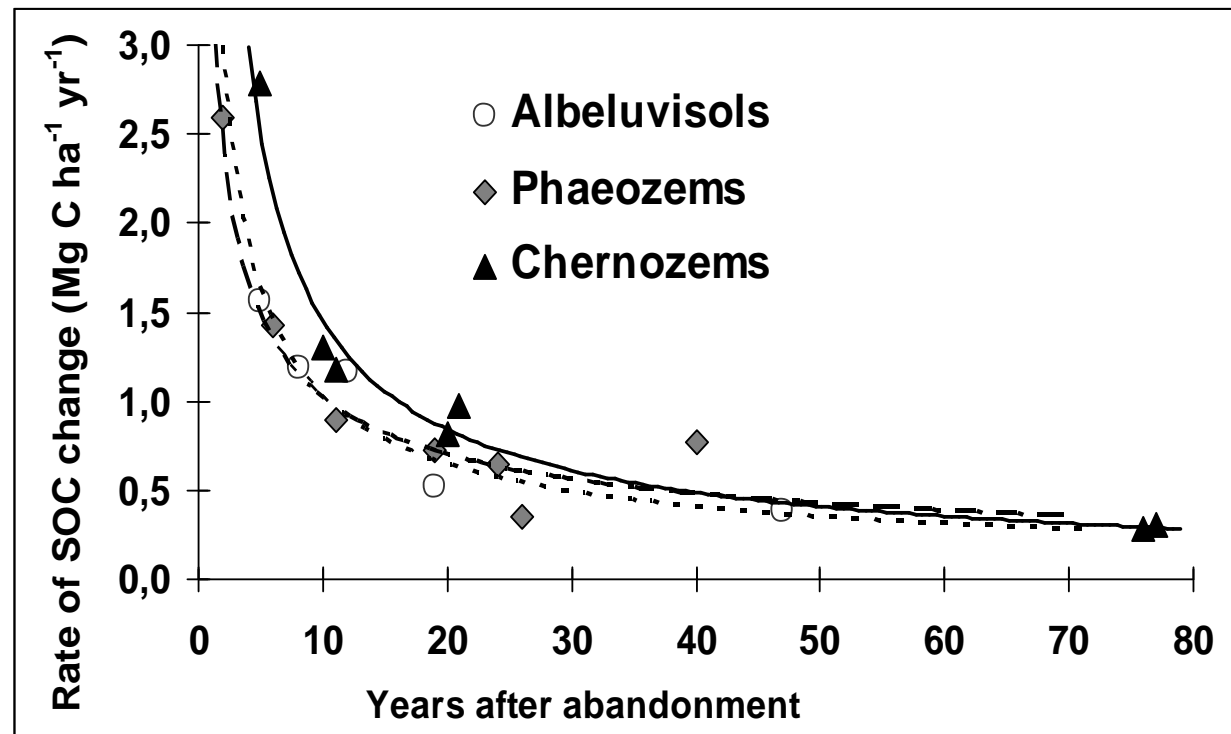
Change in SOC stocks after the conversion from cropland to grassland

Russia

416 Mt C (20 Mha)

Kazakhstan

266 Mt C (14 Mha)

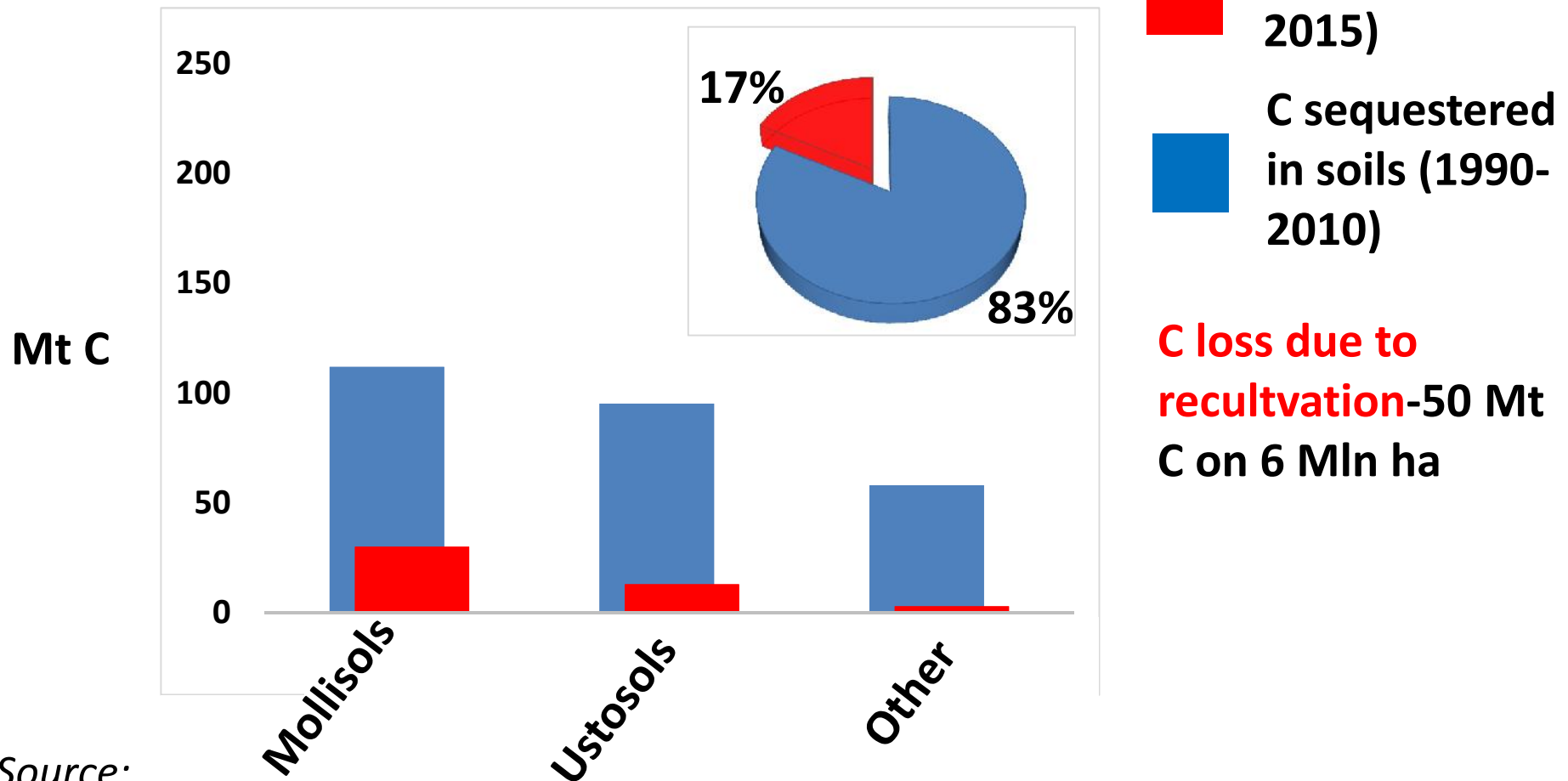


Source:

Prishchepov et al. (in prep); Kurganova et al. 2013,2015

Changes in SOC stocks due to recultivation after 2000

Kazakhstan

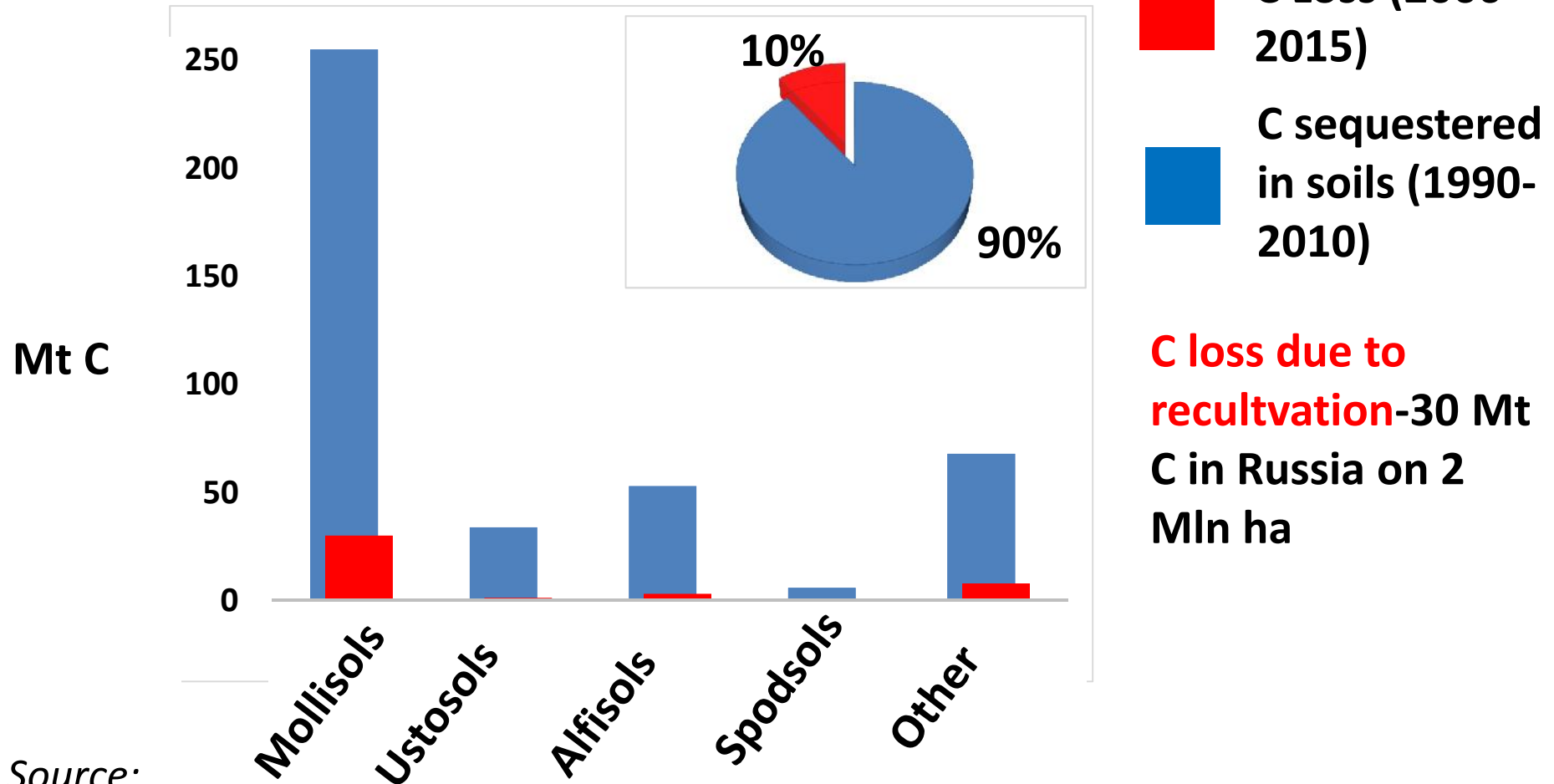


Source:

Prishchepov et al. (in prep); Kurganova et al. 2015

Changes in SOC stocks due to recultivation after 2000

Russia



Source:

Prishchepov et al. (in prep); Kurganova et al. 2015

Summary

- Rapid cropland expansion (1954-1980), following massive abandonment 1990 and ongoing recultivation
- The Campaign caused unprecedented release of SOC
- Significant C sequestration in the soils on abandoned lands
- Yet SOC sequestration in post-Soviet period area did not compensate SOC losses during the Campaign
- Ongoing recultivation already caused SOC losses

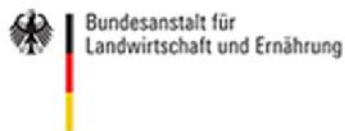


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ИНСТИТУТ СТЕПИ УРО РАН

Thank you!

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