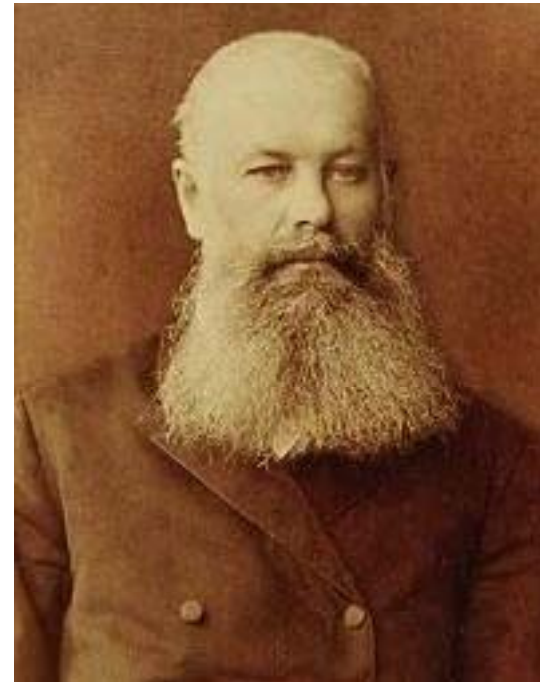


*Resampling Studies in Russia:
Following in the Footsteps of
Dokuchaev and Rizpolozhensky*

Andrei Lapenas
University at Albany

Vasily Vasil'evich
Dokuchaev
1843-1903



Vasily Vasil'evich Dokuchaev (1846-1903)

- 1846- born in Smolensk in poor family of priest
- 1871- first scientific paper
- 1883 – “Russian Chernozem”
- 1882-1900 – collection of soil samples
- 1899 – collection of Russian soils received gold medal at Exposition Universelle in Paris
- 1890-1900 – work at Kamennaya Steppe Preserve (theory of optimum ratio in the system: agricultural fields/ponds/forest)

Dokuchaev in Kamennaya Steppe with peasants.

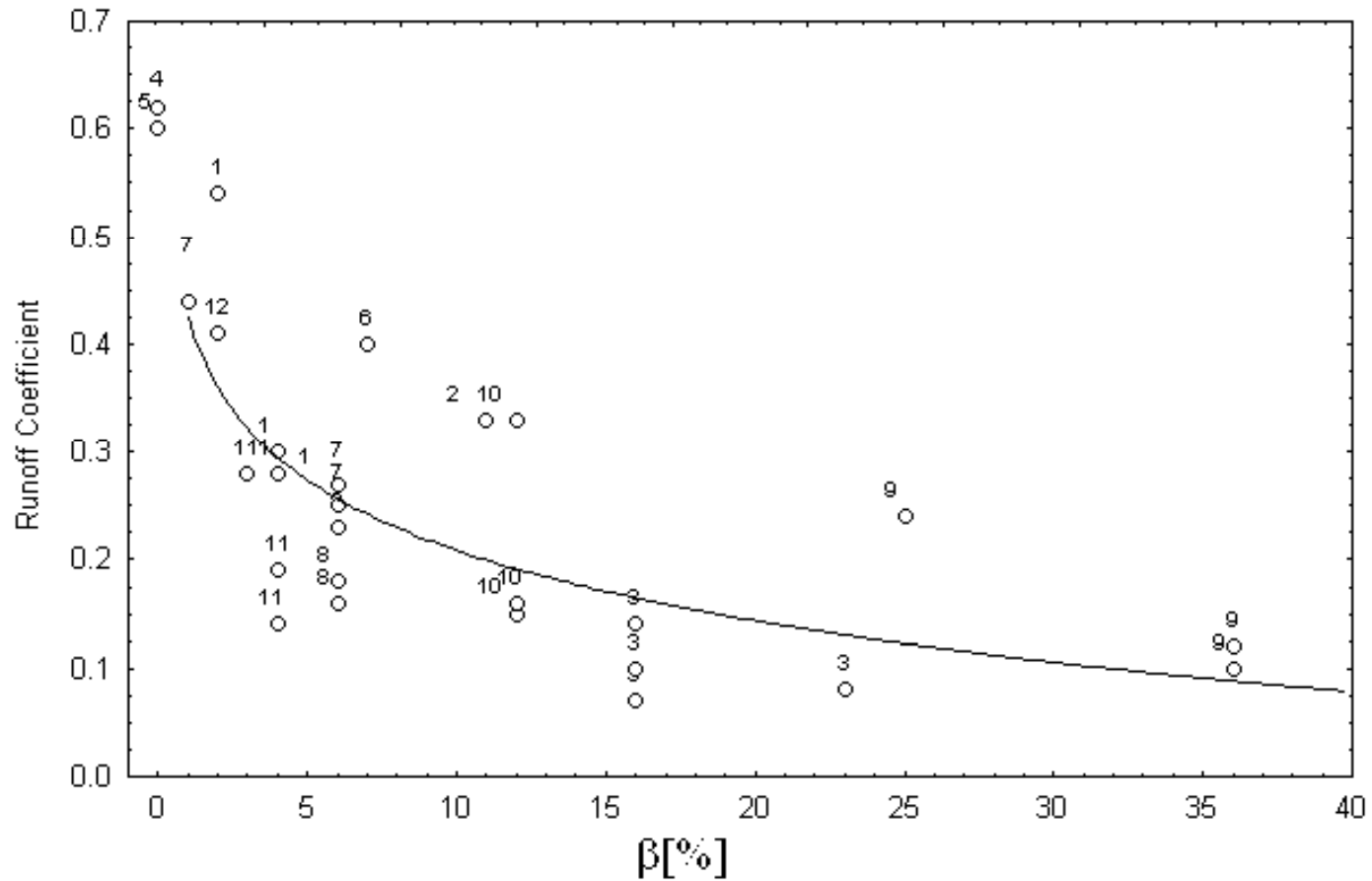
G. A. Goncharov (oil on canvas).



Optimum ratio between forest and agricultural land

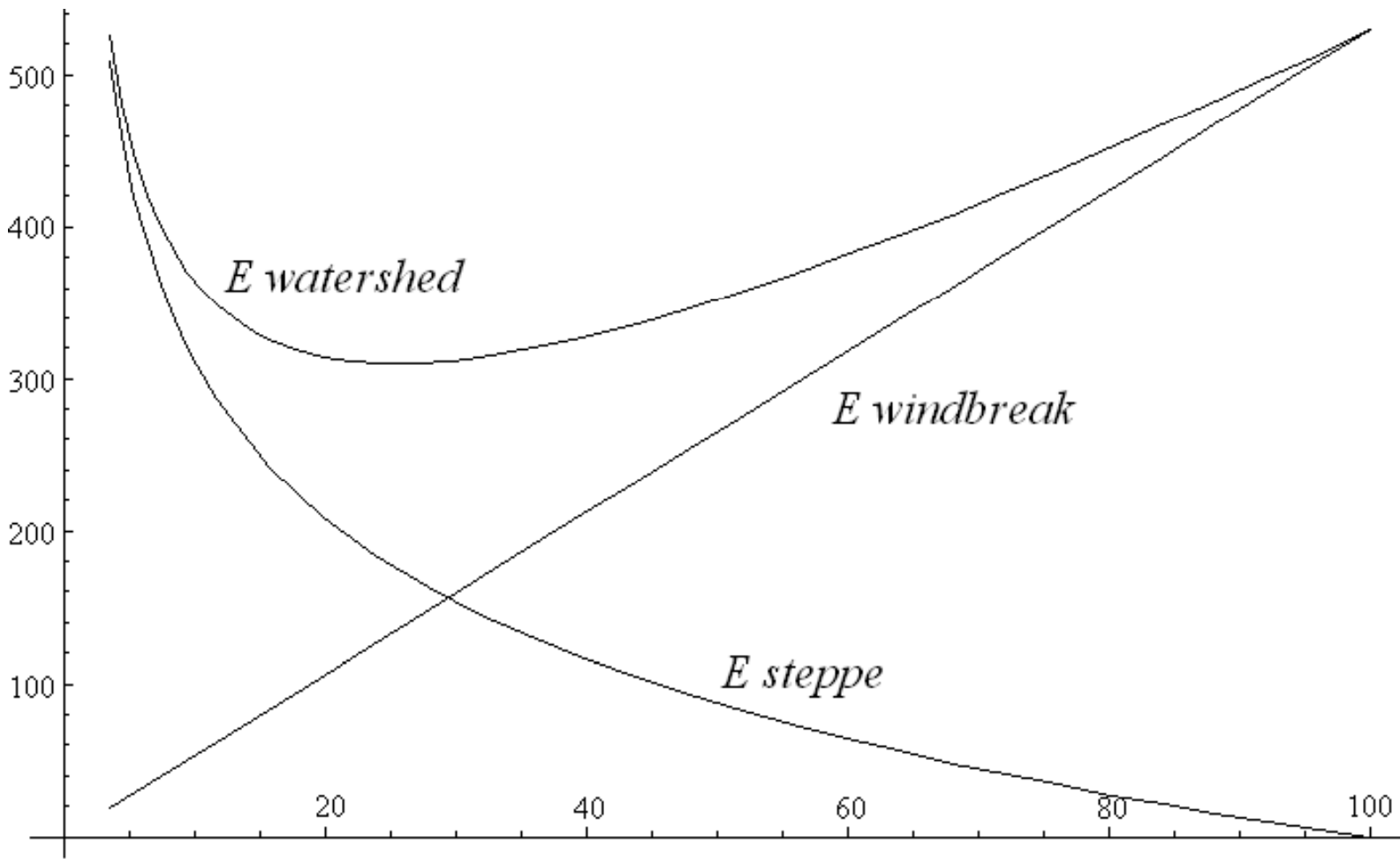
- Russian soil sciences often reference on windbrakes as “Dokuchaev’s Fortresses”
- Dokuchaev proposed that 10% of all agricultural land in steppe region will be planted with trees (~30 years to reach mature windbrake).
- Two major impacts : 1) reduction of total evapotranspiration, 2) reduction in runoff ratio (R/P ratio)

Data from Kamennaya Steppe watersheds



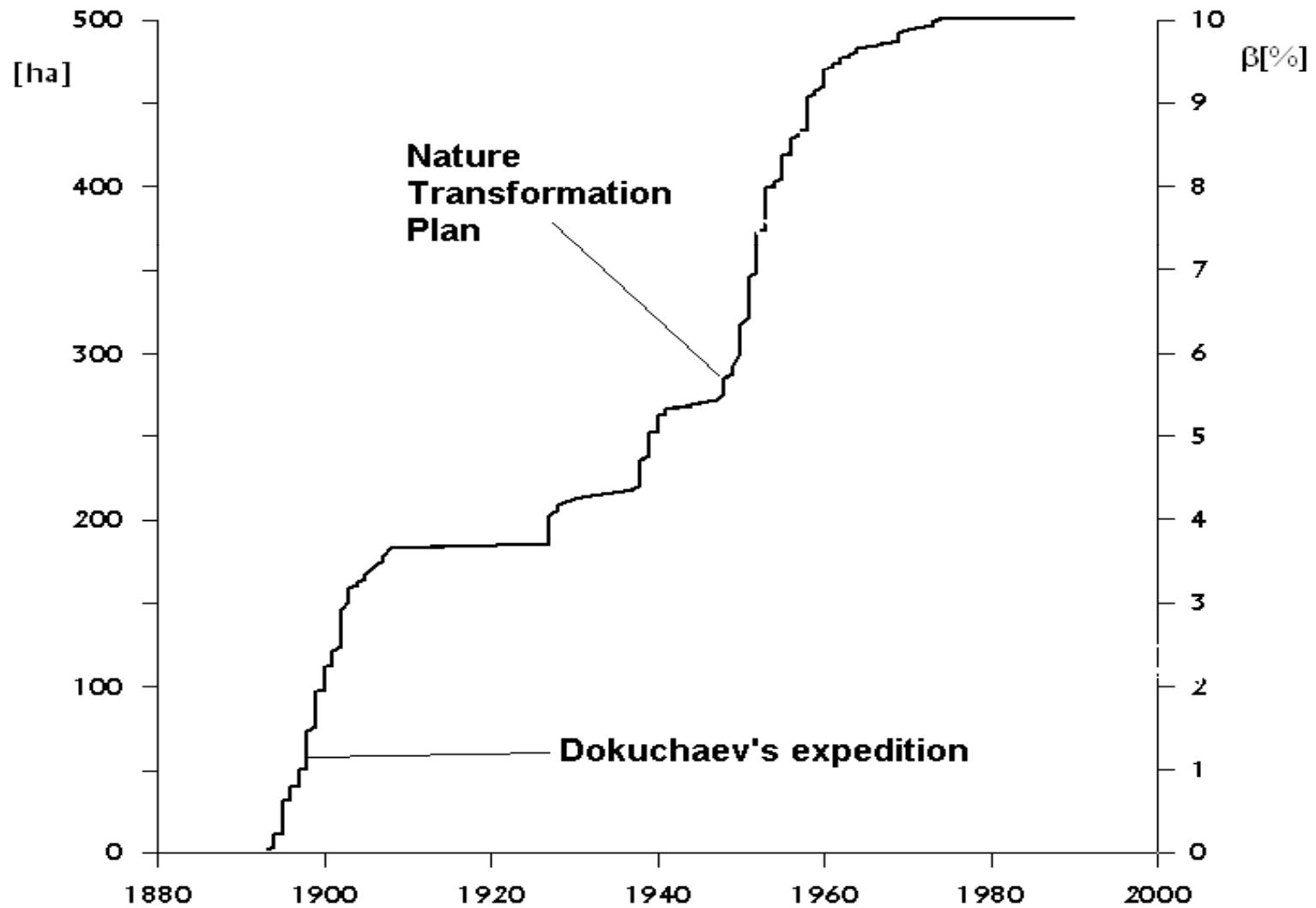
Modern models of evapotranspiration from partially forested watershed

P (mm/yr)

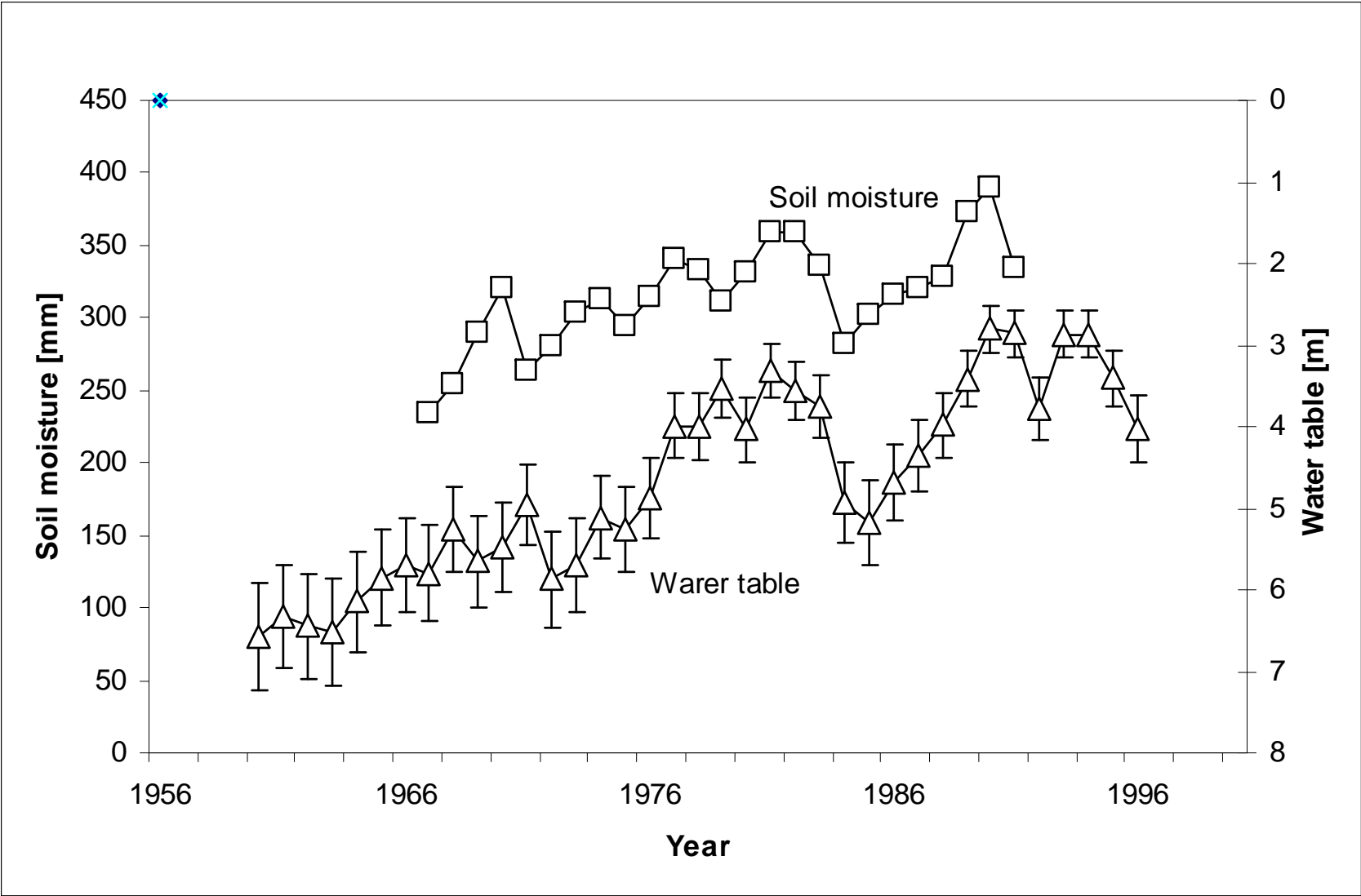


% of watershed covered with windbrakes

Planting windbrakes in Kamennaya Steppe



Long-term observations in Kamennaya Steppe



Kamennaya Steppe National Preserve



The Exposition Universelle 1899-1900



Central Dokuchaev's Soil Museum St. Petersburg



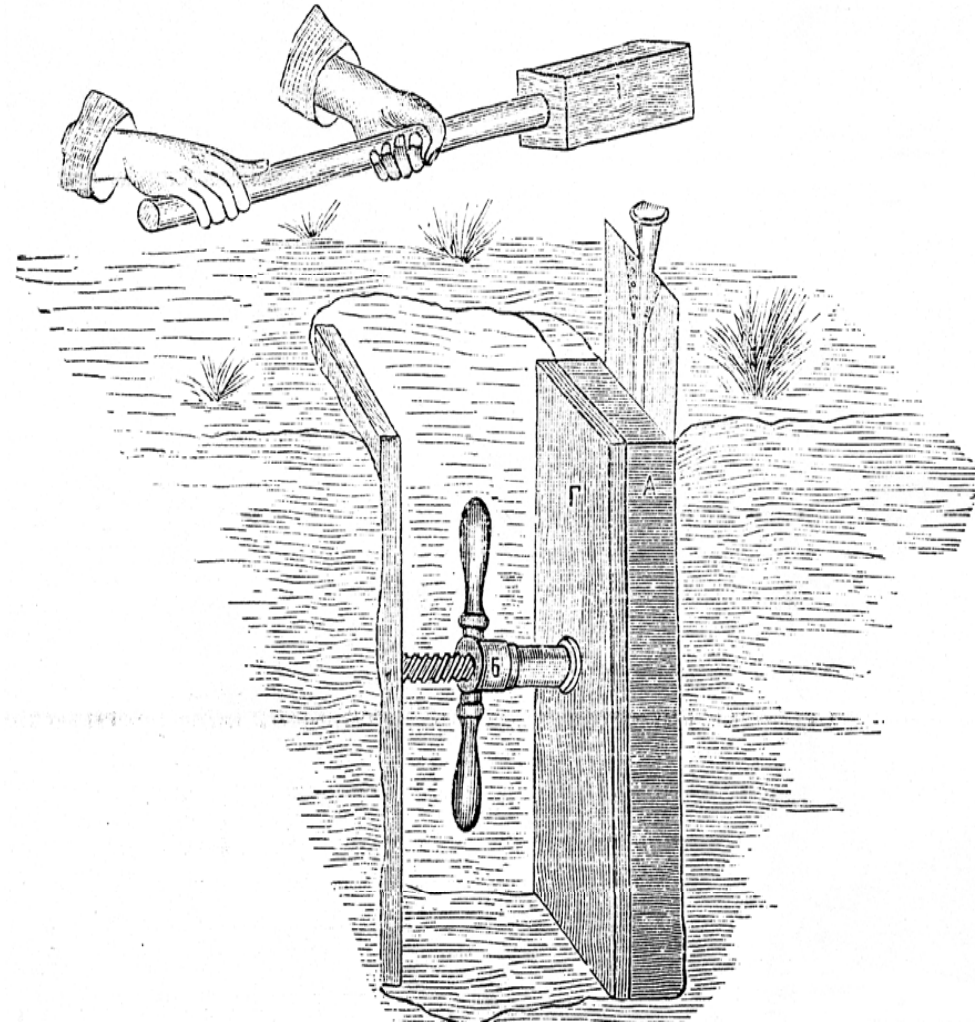
Rafail Vasil'evich Rizpolozhensky

(1847-1918?)



***“Soil is the border between two Worlds:
the World of Chaos, and the World of
Order”***

Patented mechanism for extraction of soil monoliths by R.V. Rizpolozhensky



Collection of East European Soils by R.V. Rizpolozhensky



This collection consists of 46 representative soil profiles (each profile characterizes specific soil).

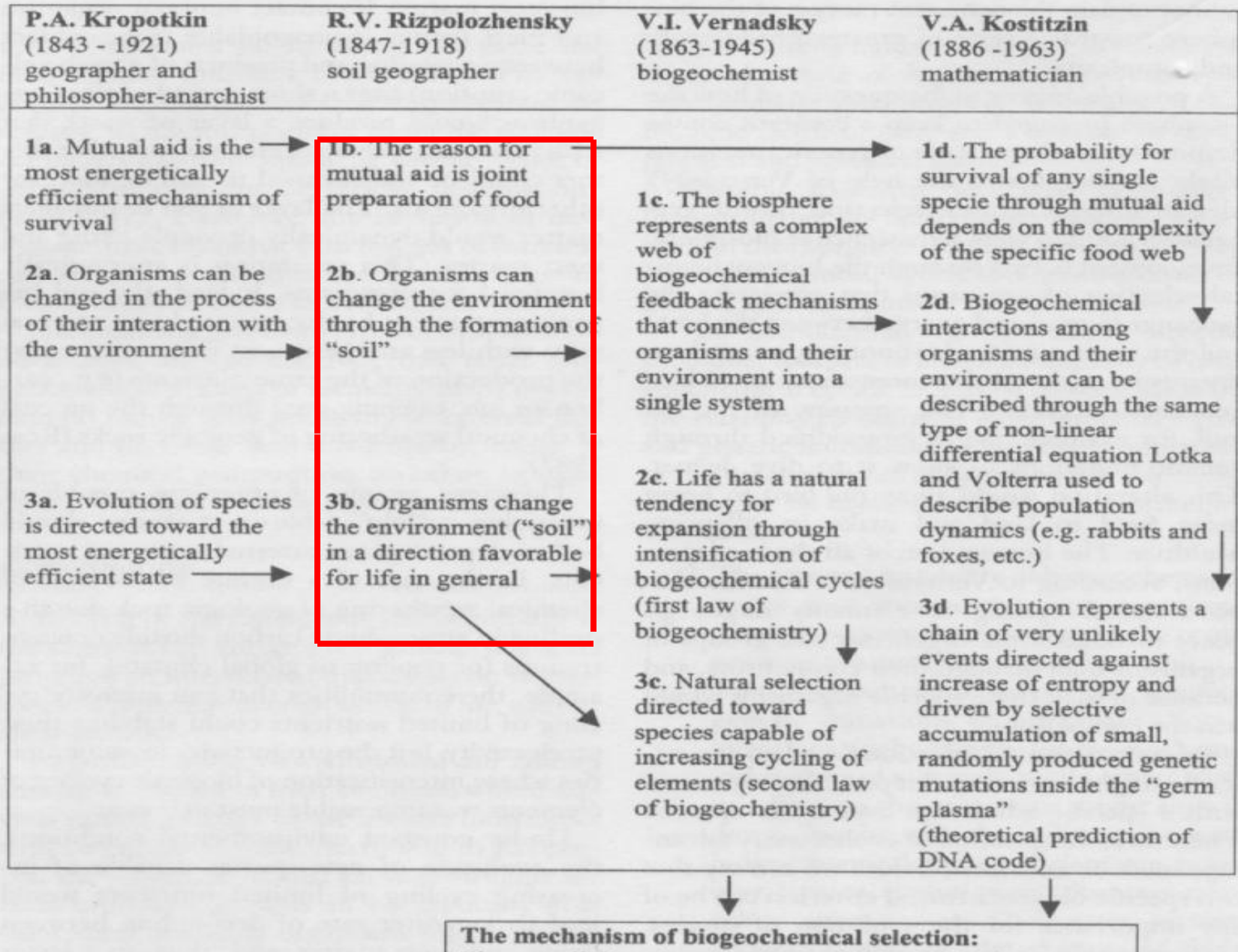
Rizpolozhensky made 24 “copies” of this collection! Yes, $24 \times 46 = 1104$ monoliths.

These collections were sent to colleges and institutions of Russian Empire as illustrations of soil taxonomy.

According to our filed work it takes about 1 day to take one good monolith!

Rizpolozhensky's soil is more than just a soil...

- Any border between “world of chaos and world of order”
- **Solid soils** (terrestrial soils) – conventional soils
- **Aquatic soils** – bottom sediments (bioturbation, layers)
- **Gaseous soil** (boundary layer in the atmosphere, again, life (land cover) dictates its characteristics)
- Soil (in general context) is a result of climate (he agreed with Dokuchaev) as much as biota
- Soil organisms transform “soil” into very specific direction: direction towards more favorable conditions for life!



Lapenis 2002

Purpose of soil collections by Rizpolozhensky

- Document all variety of East European soils
- Show significant impact of biota on soil formation (was criticized by Dokuchaev's "bulldog" Simbirtsev (for useless soil classification and naïve view on role of biota))
- Attempt to show how soil morphology changes with soil *age* and fertility (about at the same time as Eugenius Bülow Warming developed concept of repeating succession stages in forest).

Nature Transformation Plan

- Next push for soil collections was given in early 1950s during the so-called “Nature Transformation Plan”
- “Soviet people should not wait for gifts from nature, we should take these gifts ourselves!” (*Josef Stalin*)

“Nature Transformation Plan”
~5x10 meters mosaic



Nature Transformation Plan: 1950-1970

- However,...collective farms were instructed to plant ~15 million ha of windbrakes in steppe and forest steppe region of Russia (~10% of area of Chernozems...)
- In 1930, under presidency of Franklin Delano Roosevelt, USDA planted ~190,000 miles of windbrakes (~5 times less than in USSR in 1950-1970)
- More than 50% of planted in 1930s windbrakes in the US were removed by farmers in ~1950s as cheap electricity and electric motors become available for irrigation

Nature Transformation Plan

soil profiles
209, 210
and 211

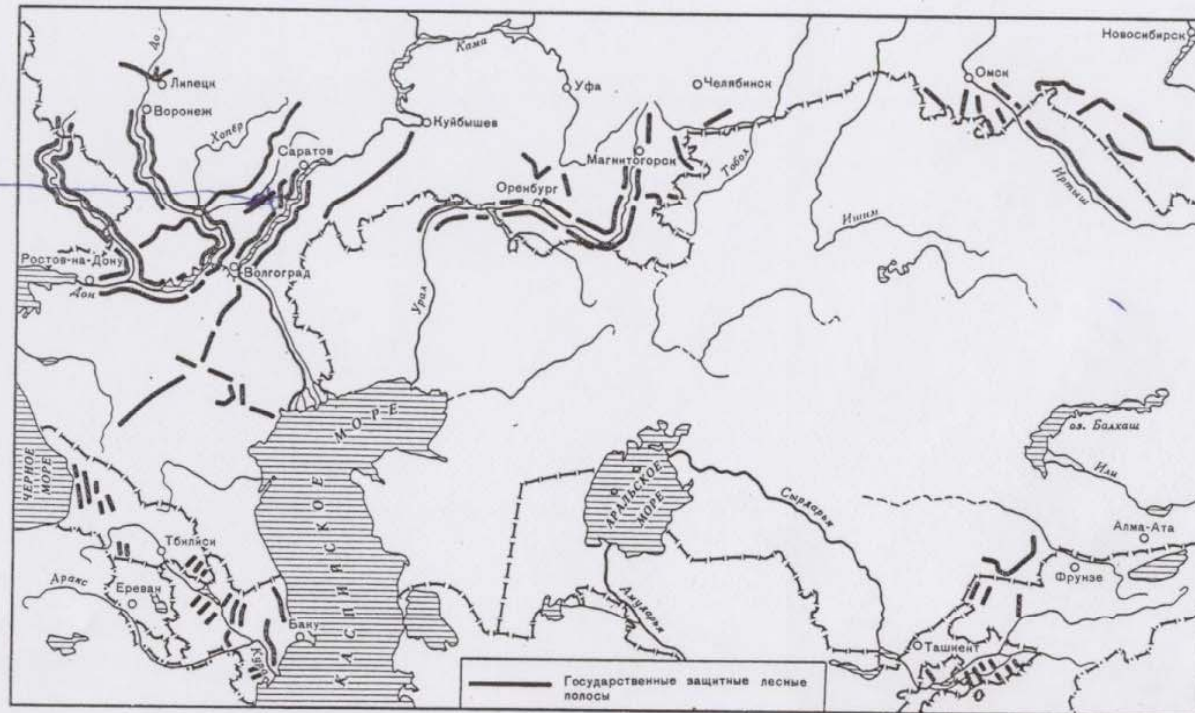


Рис. 26. Схема размещения государственных лесных полос в СССР

scheme of State Shelter Belts System
in USSR.

Soil sampling to document impact of windbrakes on soil








Study of soil organic matter turnover time with “bomb”
radiocarbon

- Torn, M., Lapenis, A.G., Harden, J., Timofeev, A., Babikov, B.V., Savitzkaya, S. 2002. “Soil carbon cycling in the Russian Steppe: Radiocarbon analysis of modern and historic Russian soils.” ***Global Change Biology***. **8**, 941-953.
- In the upper 10cm, most of the SOM had a turnover time of 6 ± 10 years, according to a model fit to the radiocarbon content. Below about 10cm, the organic matter was almost all passive material with long (millennial) turnover times.

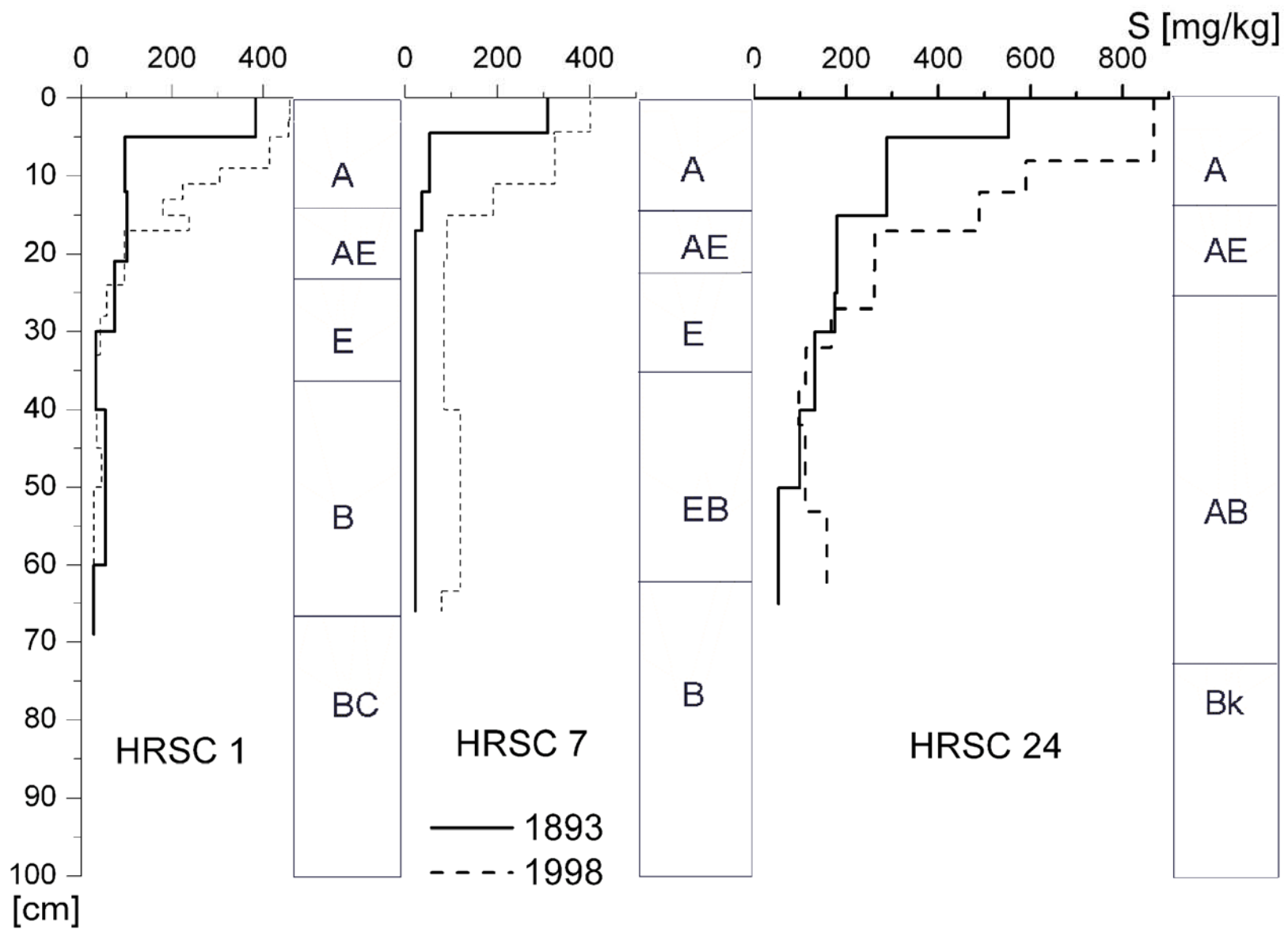
Study of acidic deposits impact on fine texture soils

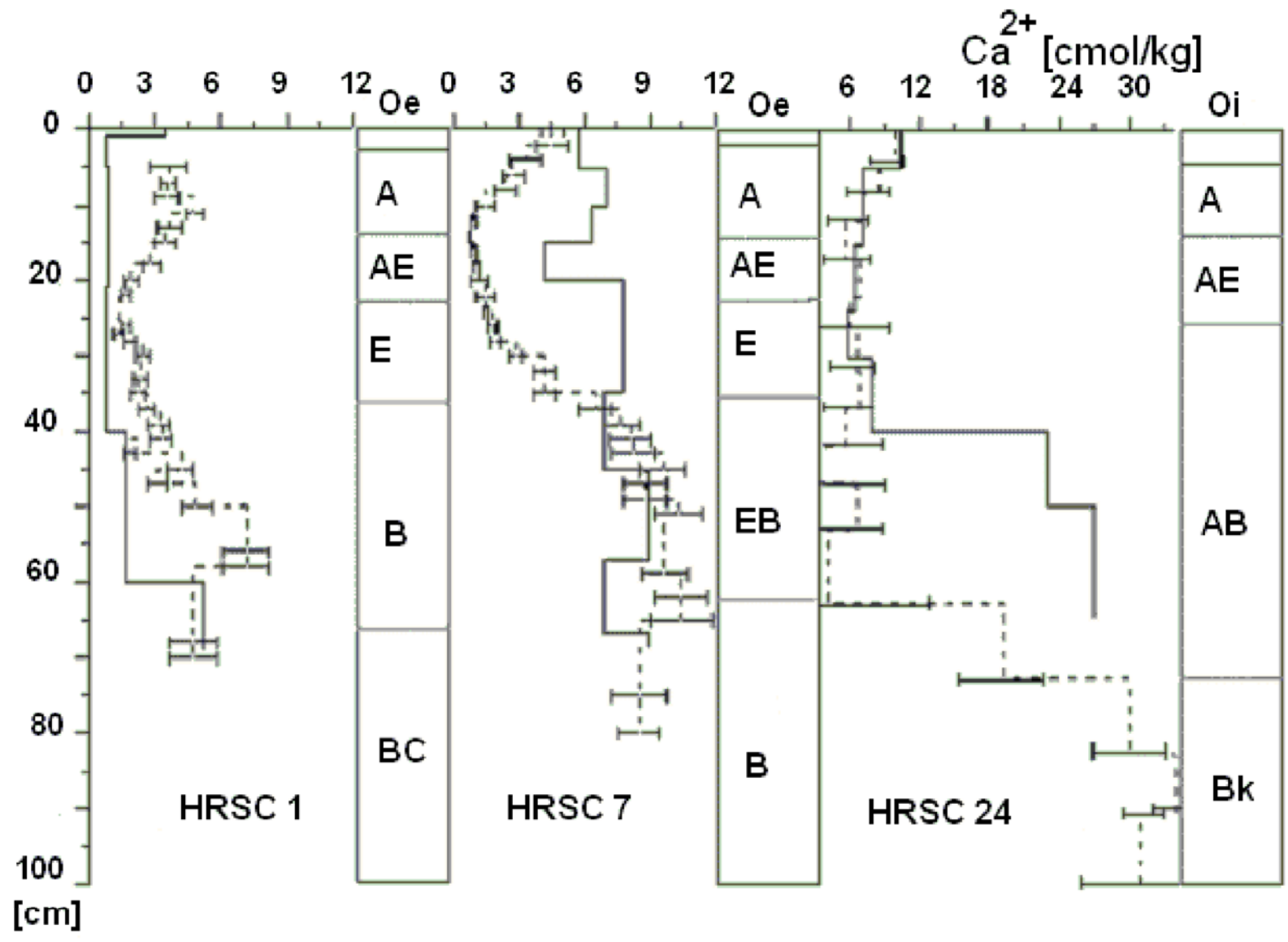
- Lapenis, A.G., Lawrence, G.B., Andreev, A. A., Bobrov, A.A, Torn, M.S. W. Harden Acidification of forest soil in Russia: From 1893 to Present. ***Global Biogeochemical Cycles***. V 18. GB1037, doi:10.1029/2003GB002107



-  Prevailing winds
-  Boreal forests / taigas
-  Temperate broadleaf and mixed forests
-  Temperate grasslands, steppes
-  State border





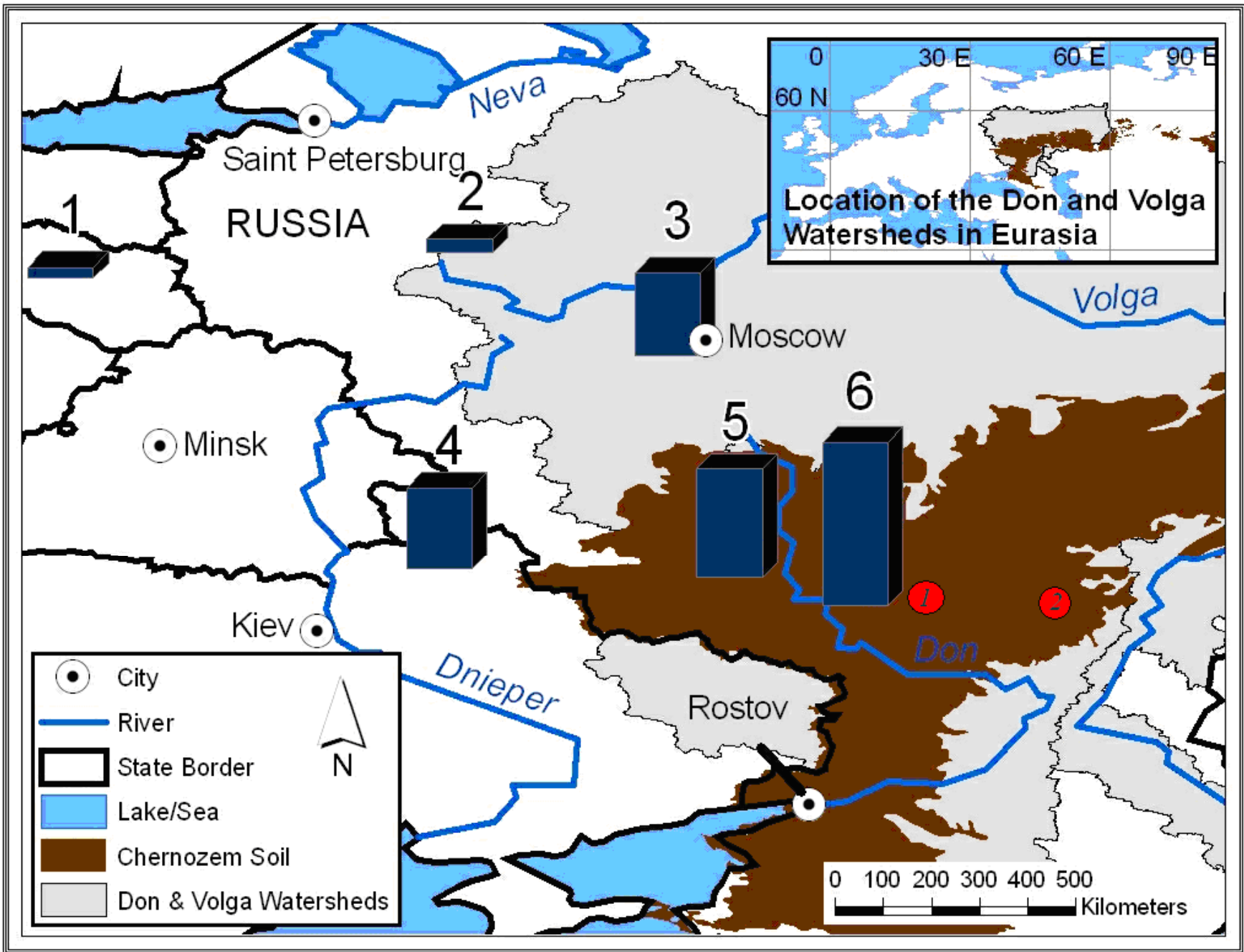


Study of forest soil response to acidic deposits and climate change

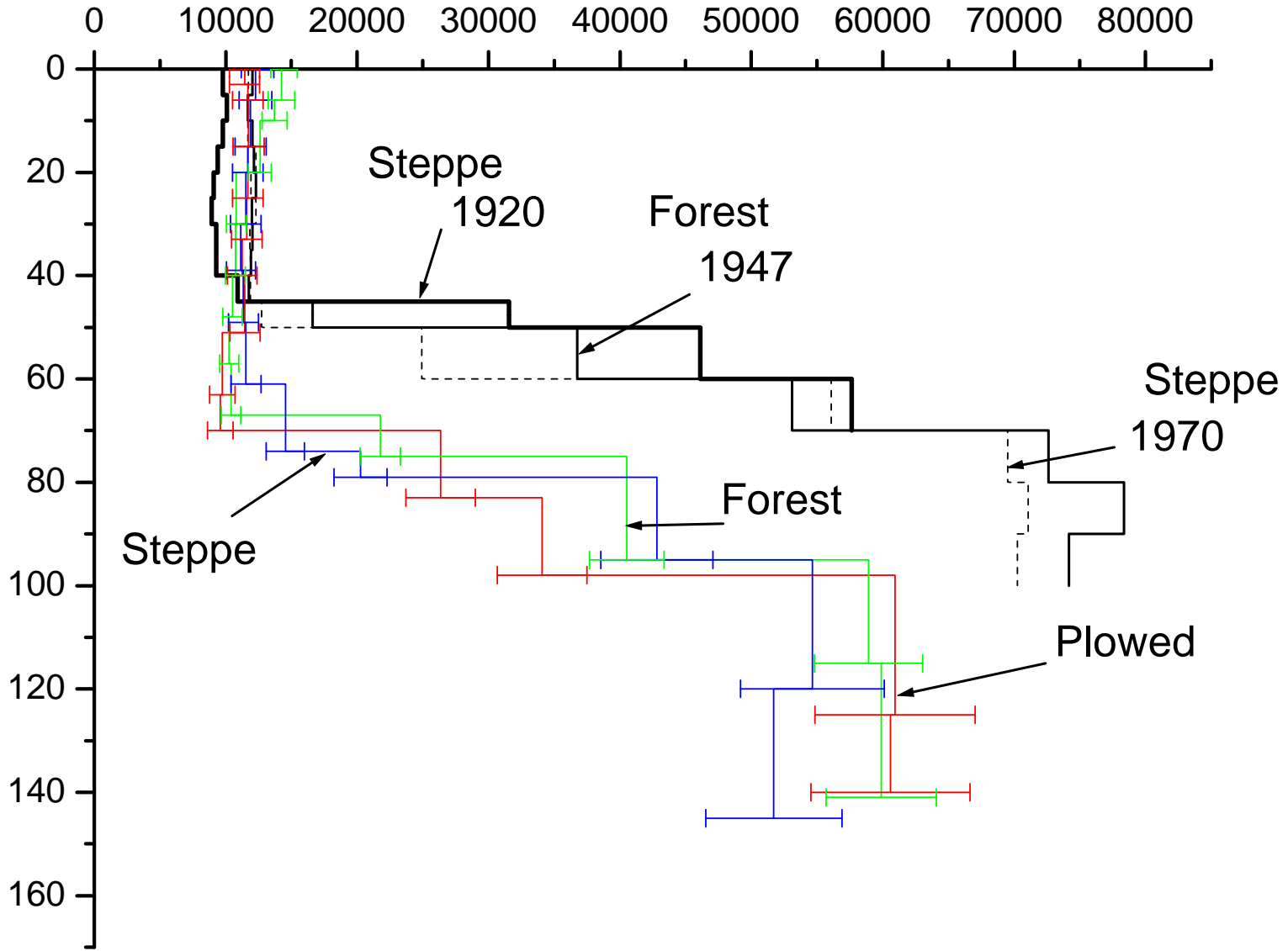
- Lawrence, G. B., Lapenis, A.G., Berggren, D., Aparin, B., Smith, K., Shortle, W.C., Balley, S. W., Varlyguin, D.L., Babikov, B. 2005. Climate Dependency of Tree Growth Suppressed by Acid Deposition Effect on Soils in Northwest Russia. *Environmental Science and Technology*, **39**, 2004-2010.
- Response of trees to climate variability was suppressed by acidic deposits (depletion of exchangeable calcium)

Response of pedogenic carbonates to recent climate change

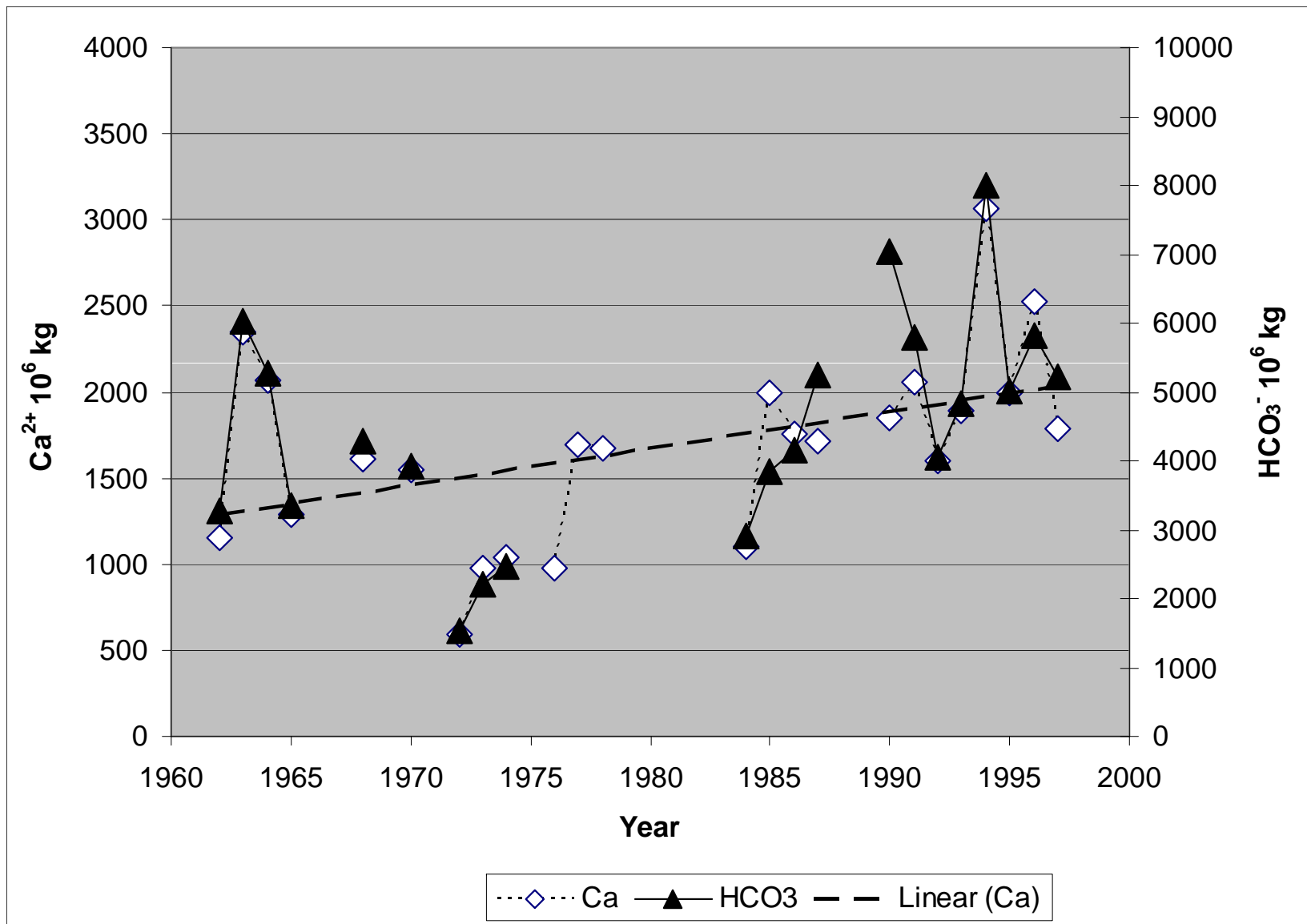
- Lapenis, A.G., Lawrence, G., Baily, S., Torn, M, Speranskaya, N, Calef, M. 2008 Climatically Driven Loss of Calcium in Steppe Soil. *Global Biogeochemical Cycles*.



Total Ca [mg/kg]



Export of carbonates by Don River



Study of black carbon turnover in steppe soil

- Hammes K., Torn M.S., Lapenis A.G Schmidt M.W.I. 2008 Centennial black carbon turnover observed in a Russian steppe soil. *Biogeosciences*
- Turnover time of black carbon in Russian steppe soil is ~100 years (not 1000).

Conclusions and suggestions

Archives soil samples can be used to study variety of soil processes and soil responses to external factors such as climate, acidic depositions, other types of pollution.

Collection of new soil samples for soil archives should target collection of representative SOIL PROFILES, rather than bulk soil samples.

100 years ago Dokuchaev and Rispolozensky did not know about acidic deposits, isotopic methods of study etc. They just did their best to collect representative samples of soils for their studies. We should do the same.