SOIL CARBON SEQUESTRATION – WAYS OF MONITORING AND IMPLEMENTATION

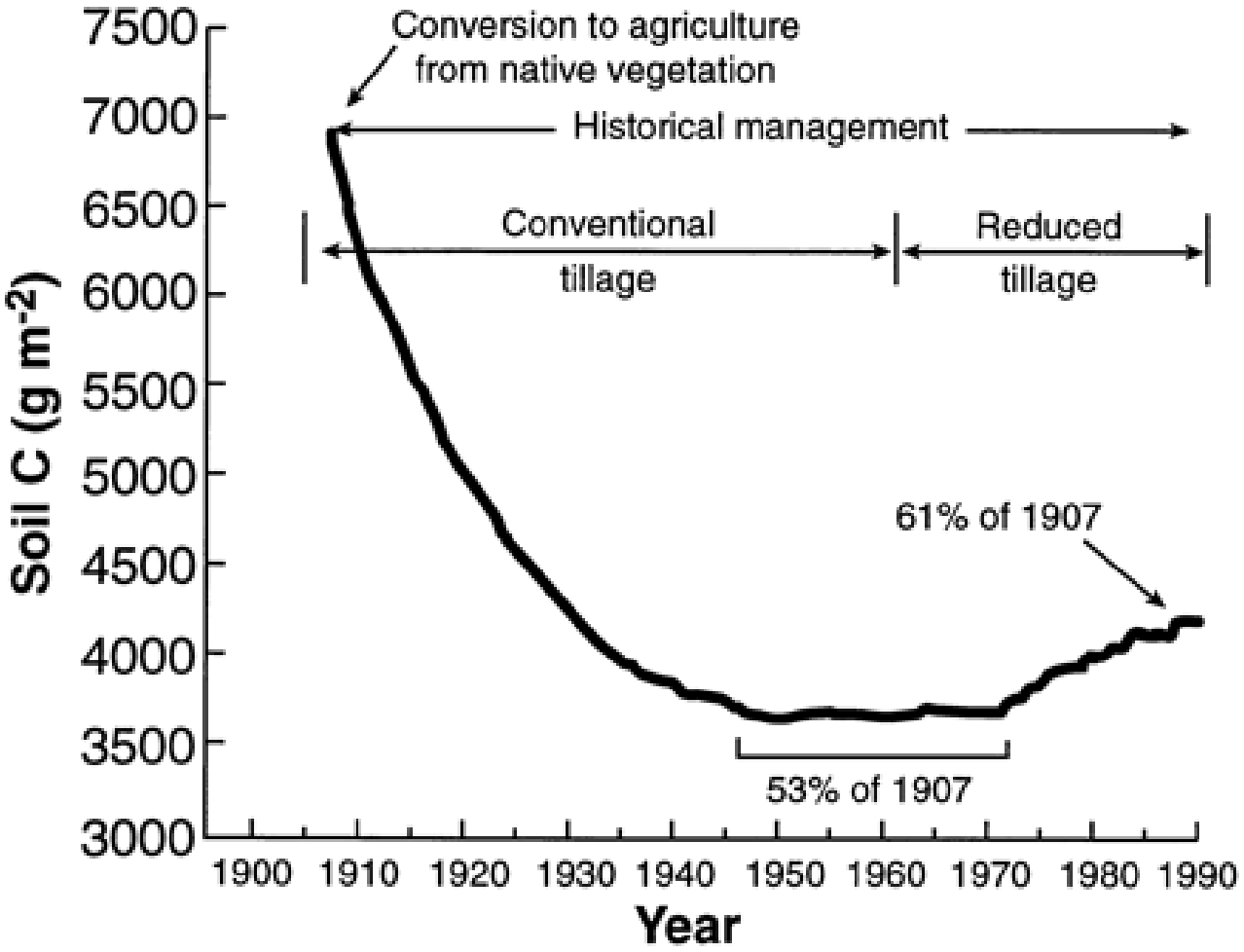
José Grünzweig

Faculty of Agriculture, Food and Environment

Hebrew University of Jerusalem, Rehovot, Israel

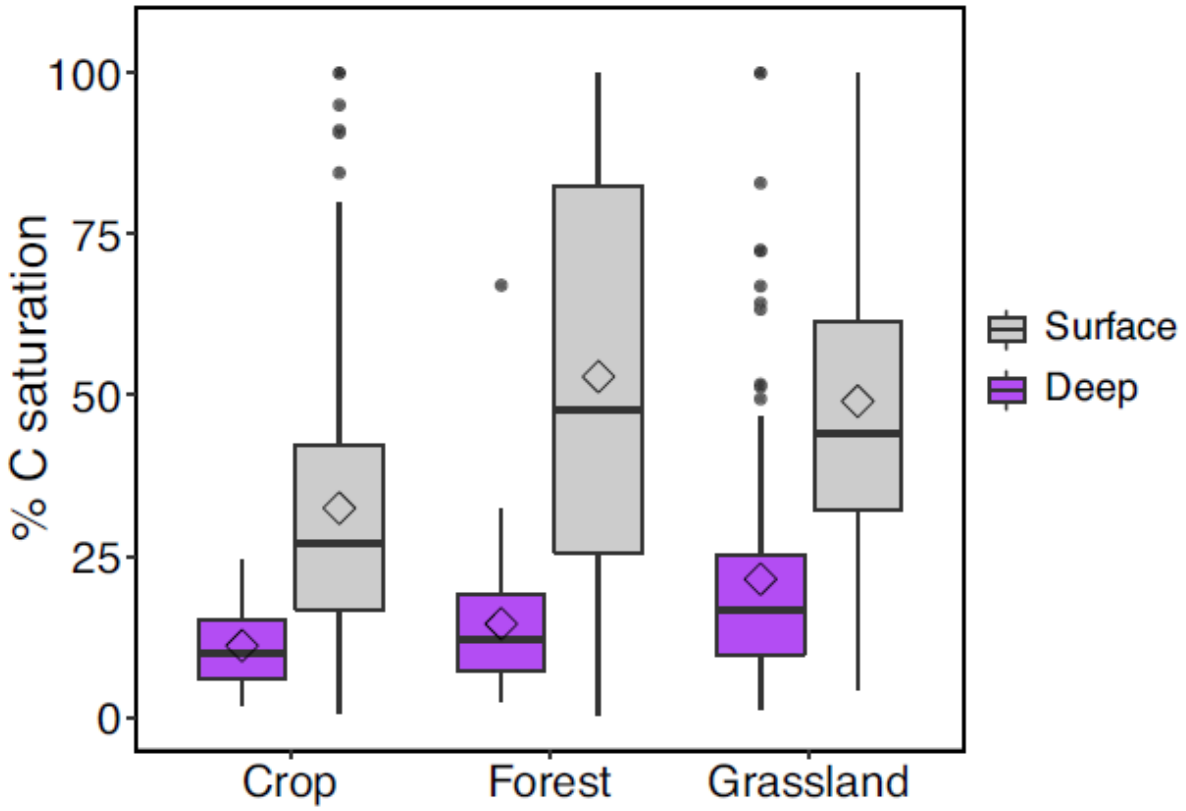
The 14th Dahlia Greidinger International Symposium, Haifa, Israel, March 2023

Conversion of natural land to agriculture and consequences for soil organic carbon stocks



Matson et al. 1997 *Science*

Soil organic carbon sequestration potential



Georgiou et al. 2022 Nature Comm.

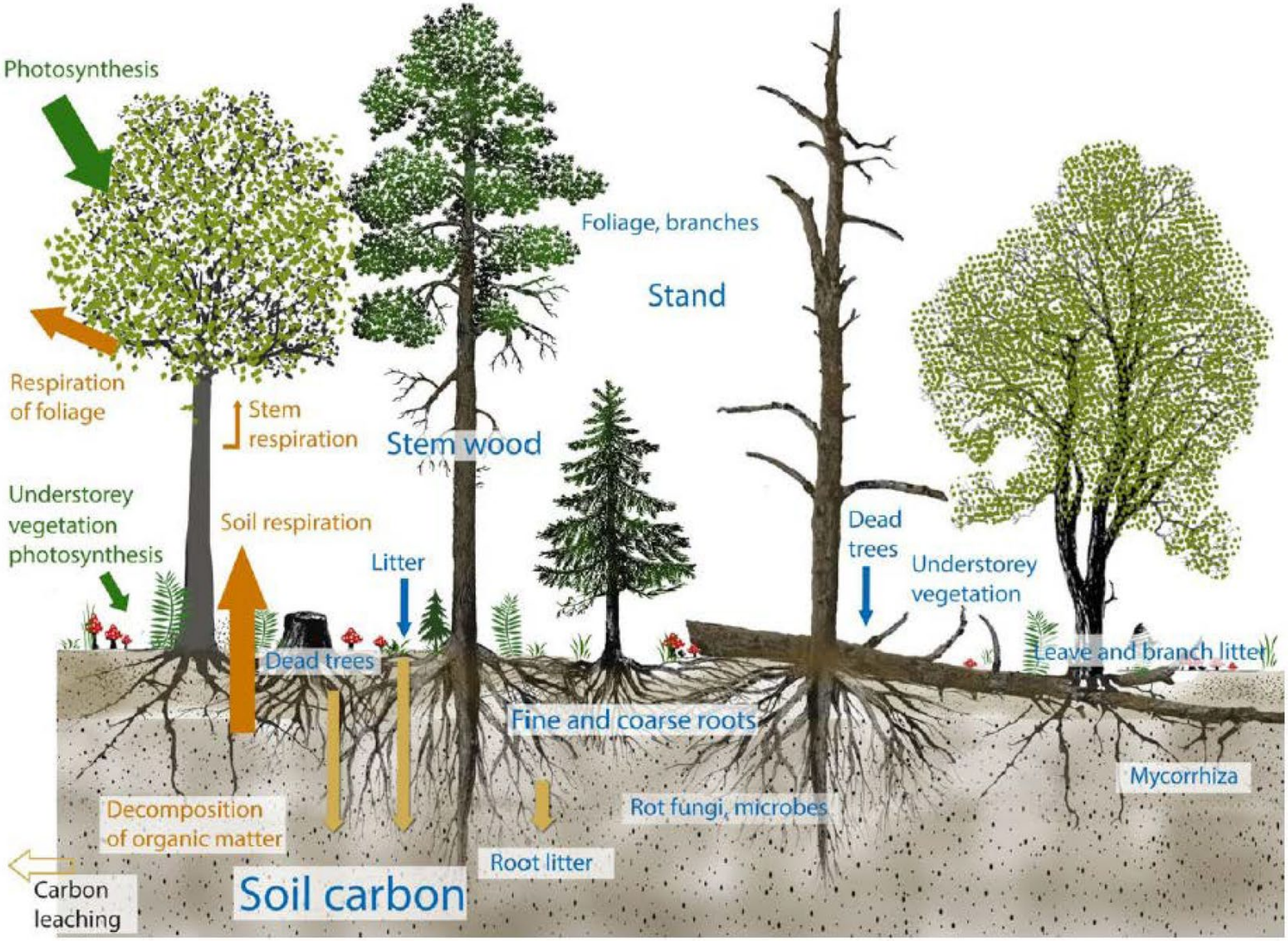
Can this potential be realized?

How can soil carbon sequestration be quantified?

What are land use effects on soil carbon stocks in extreme environments?

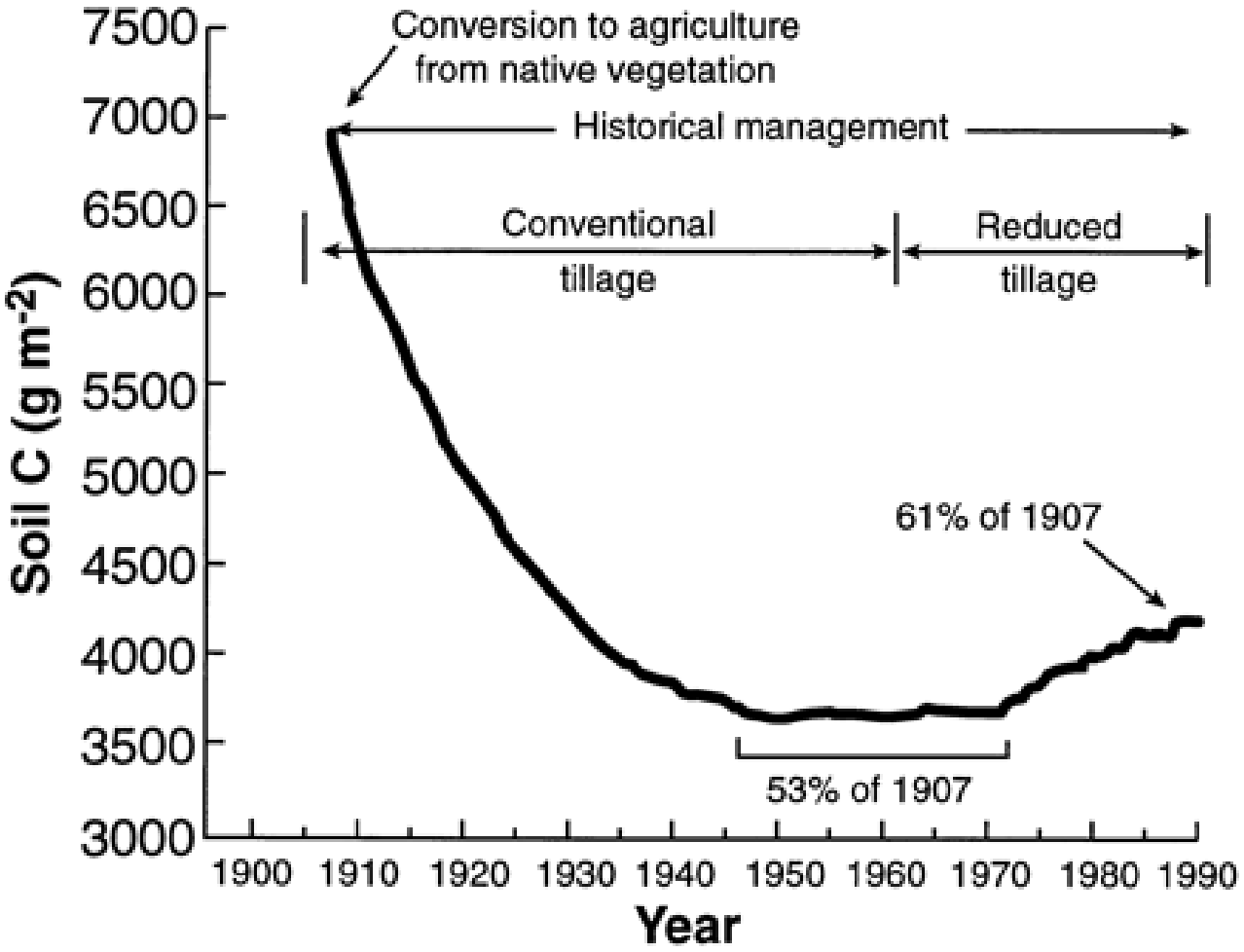
Ecosystem carbon stocks and fluxes

Soil carbon sequestration derived from changes in soil carbon stocks rather than by monitoring carbon fluxes



Bartlett et al. 2020. NINA Report 1774b. Norwegian Institute for Nature Research

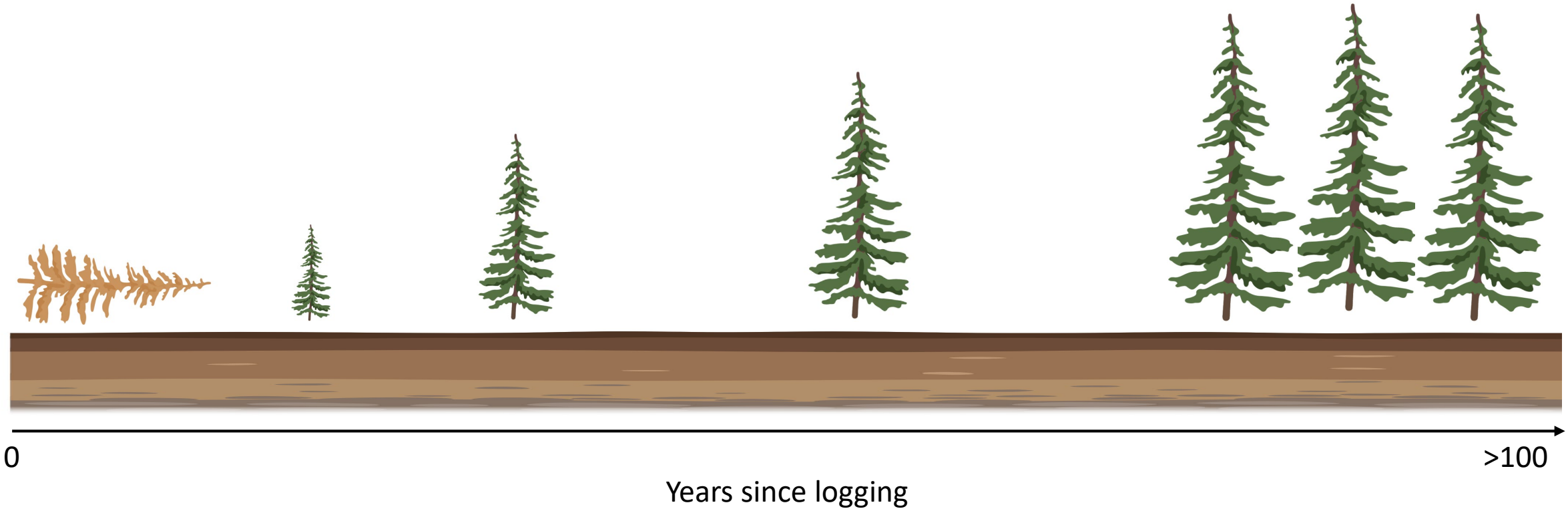
Sequential approach – sampling in time to quantify soil carbon sequestration



Matson et al. 1997 *Science*

Chronosequence – space-for-time approach to quantify soil carbon sequestration

1. Chronosequence of sites treated at different times in the past



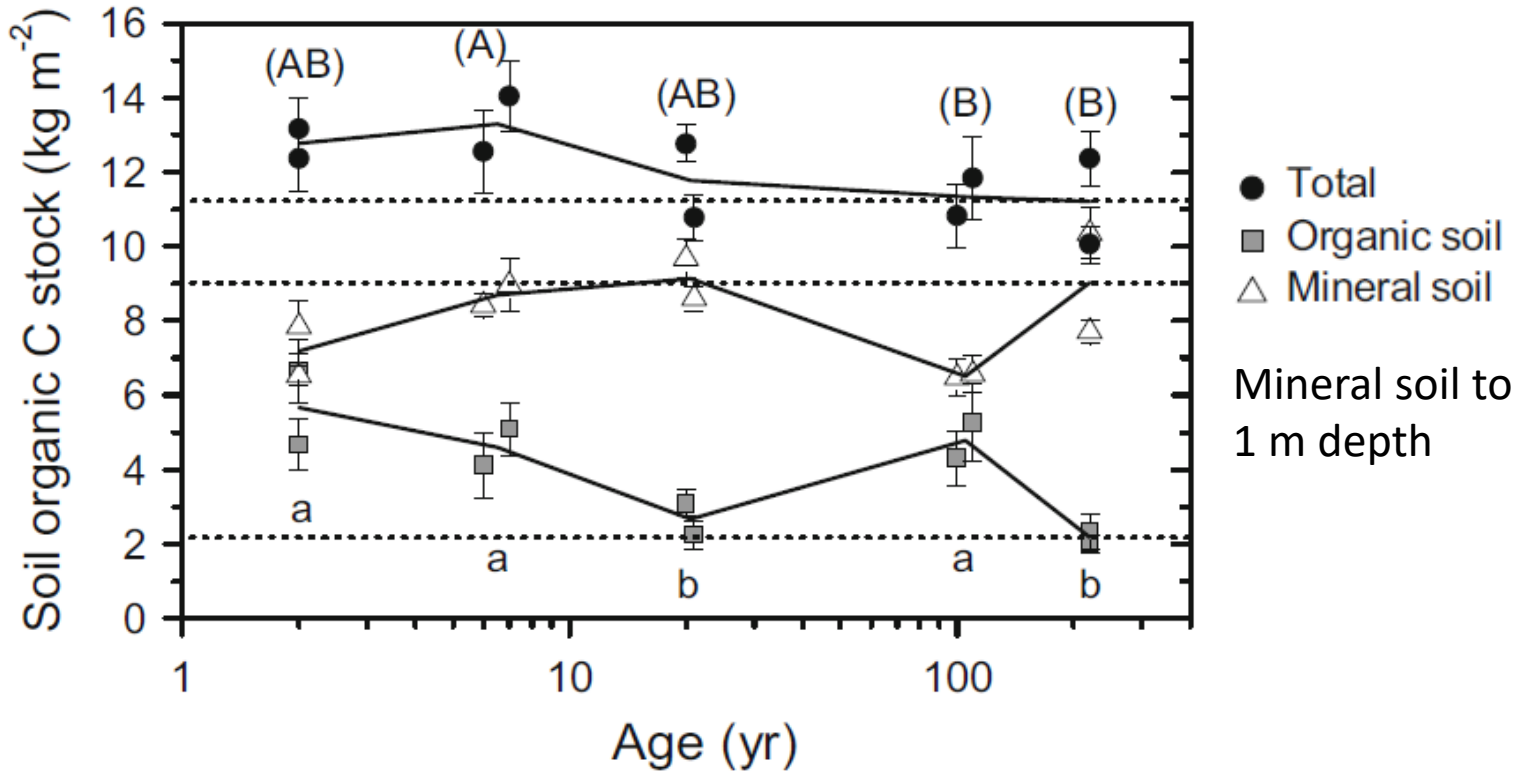
BioRender.com

1. Chronosequence of sites treated at different times in the past

Time after harvest (years)	Sampling year	Location	Coordinates
2	1999	Cache Creek	64°54′ N, 148°23′ W
2	2000	Standard Creek	64°48′ N, 148°40′ W
6	1999	Standard Creek	64°48′ N, 148°35′ W
7	2000	Standard Creek	64°48′ N, 148°35′ W
21	1999	Standard Creek	64°49′ N, 148°30′ W
20	2000	Standard Creek	64°48′ N, 148°32′ W
100	1999	Chena Ridge	64°47′ N, 147°59′ W
110	2000	Chena Ridge	64°47′ N, 148°03′ W
Mature	1999	Bonanza Creek	64°45′ N, 148°15′ W
Mature	2000	Standard Creek	64°49′ N, 148°30′ W

Grünzweig et al. 2015 Ecosystems

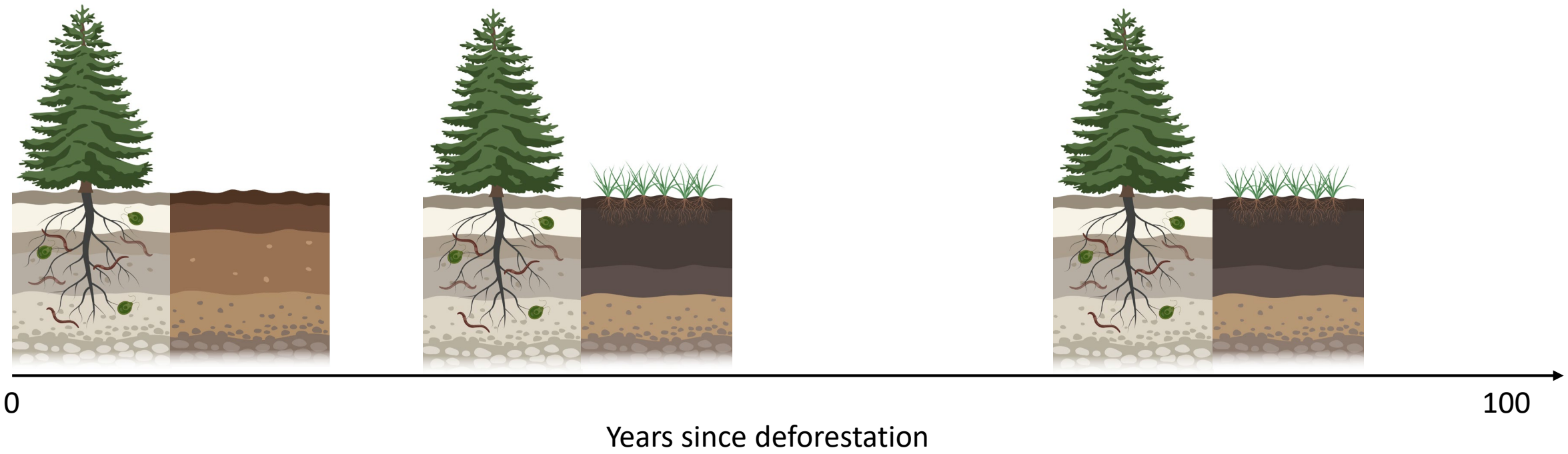
1. Soil organic carbon stocks 2-100 yr following logging of boreal white spruce forests in Interior Alaska, as compared to mature, non-logged forests



Mineral soil to 1 m depth

Grünzweig et al. 2015 Ecosystems

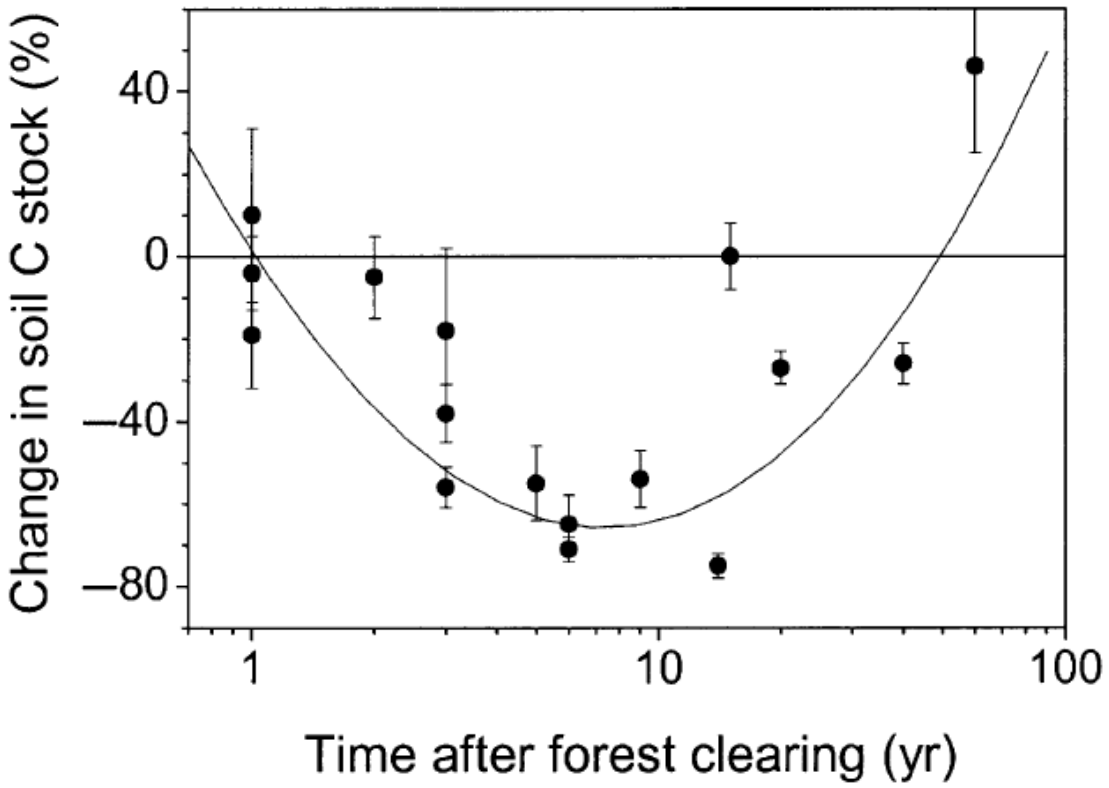
2. Chronosequence of pairwise comparisons along a time series since treatment



BioRender.com

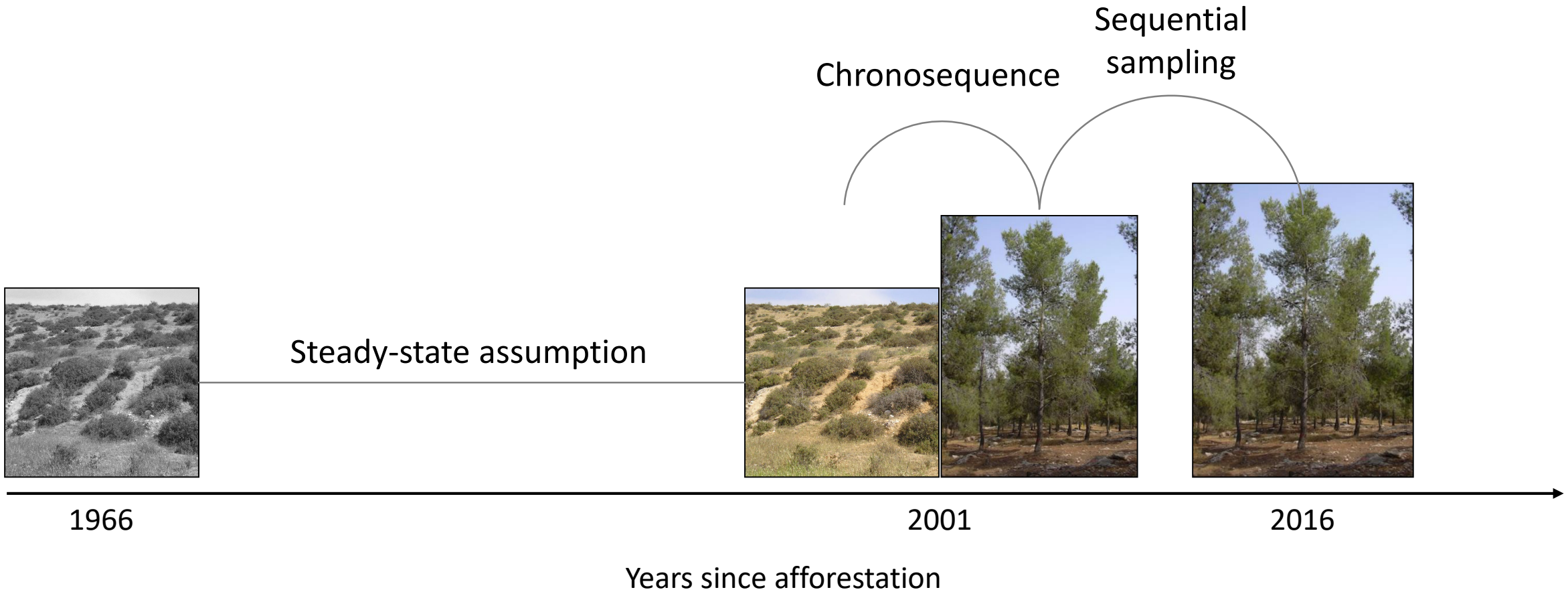
2. Changes in soil organic carbon stocks 1-60 yr following deforestation of boreal black spruce and establishment of crop fields in Interior Alaska

Pairwise comparison of crop field and nearby forest for carbon stocks in the mineral soil

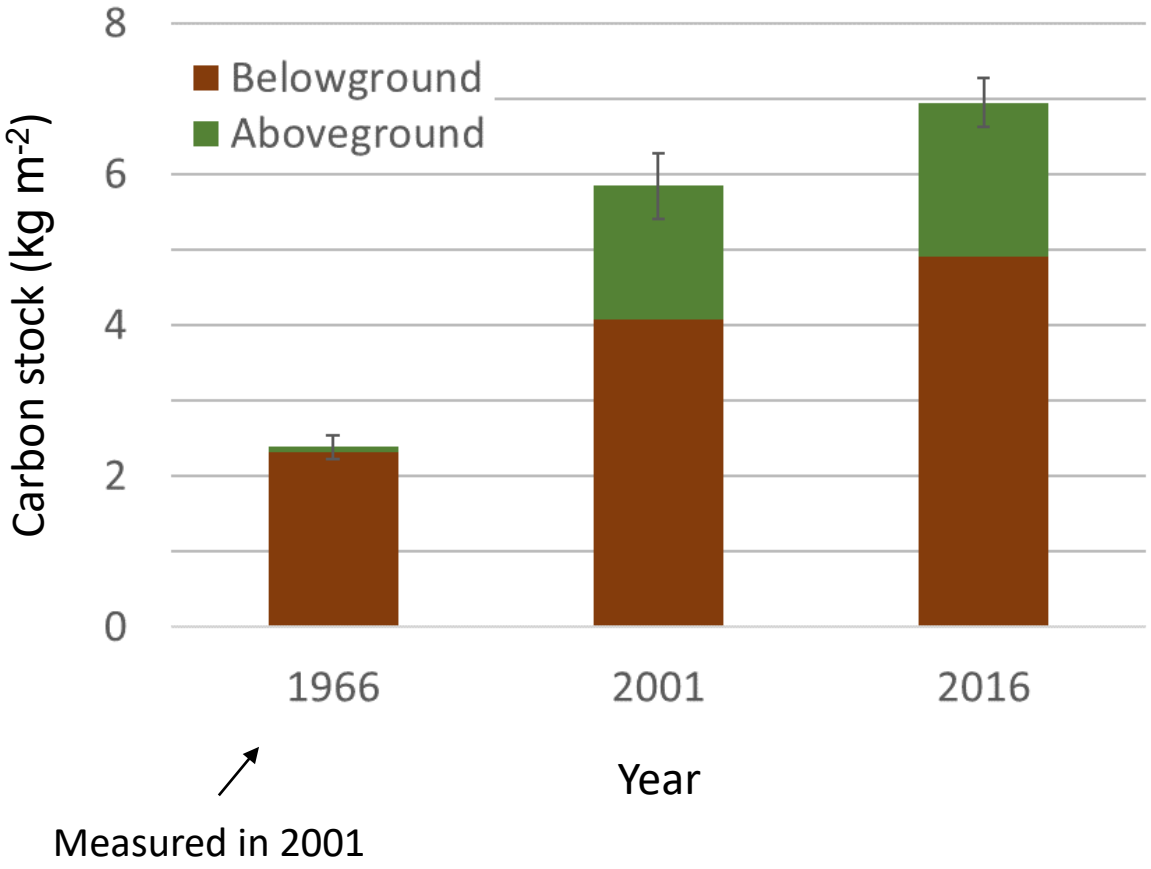


Grünzweig et al. 2004 Glob. Change Biol.

3. Chronosequence and sequential sampling at fixed sites



3. Changes in soil organic carbon stocks 35 and 50 yr following afforestation of a semi-arid shrubland in the northern Negev region of Israel



Mean annual soil organic carbon sequestration:

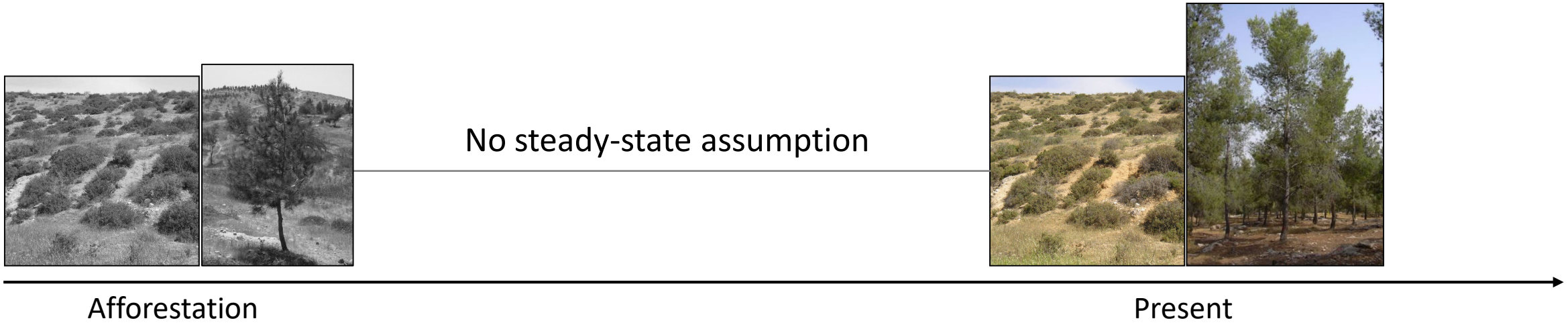
1966-2001 50 g C m^{-2} yr^{-1}

2001-2016 57 g C m^{-2} yr^{-1}

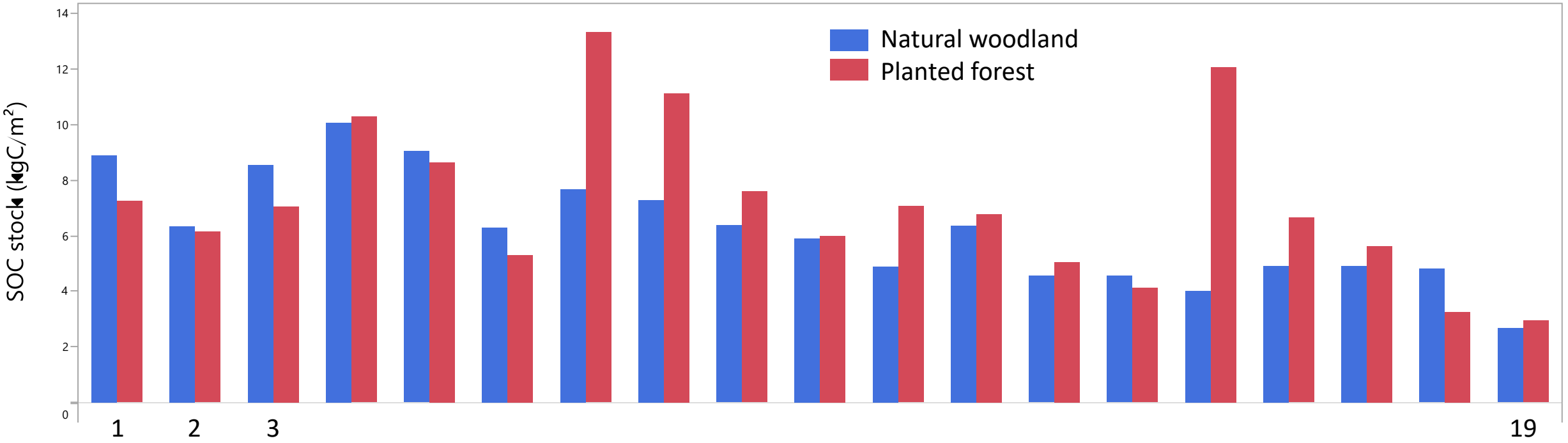
Grünzweig et al. 2007 Biogeosciences,
Qubaja et al. 2020 Glob. Change Biol.

Land use/treatment effects on carbon storage

Comparison among land use types at some point in time following afforestation to compare soil organic carbon stocks



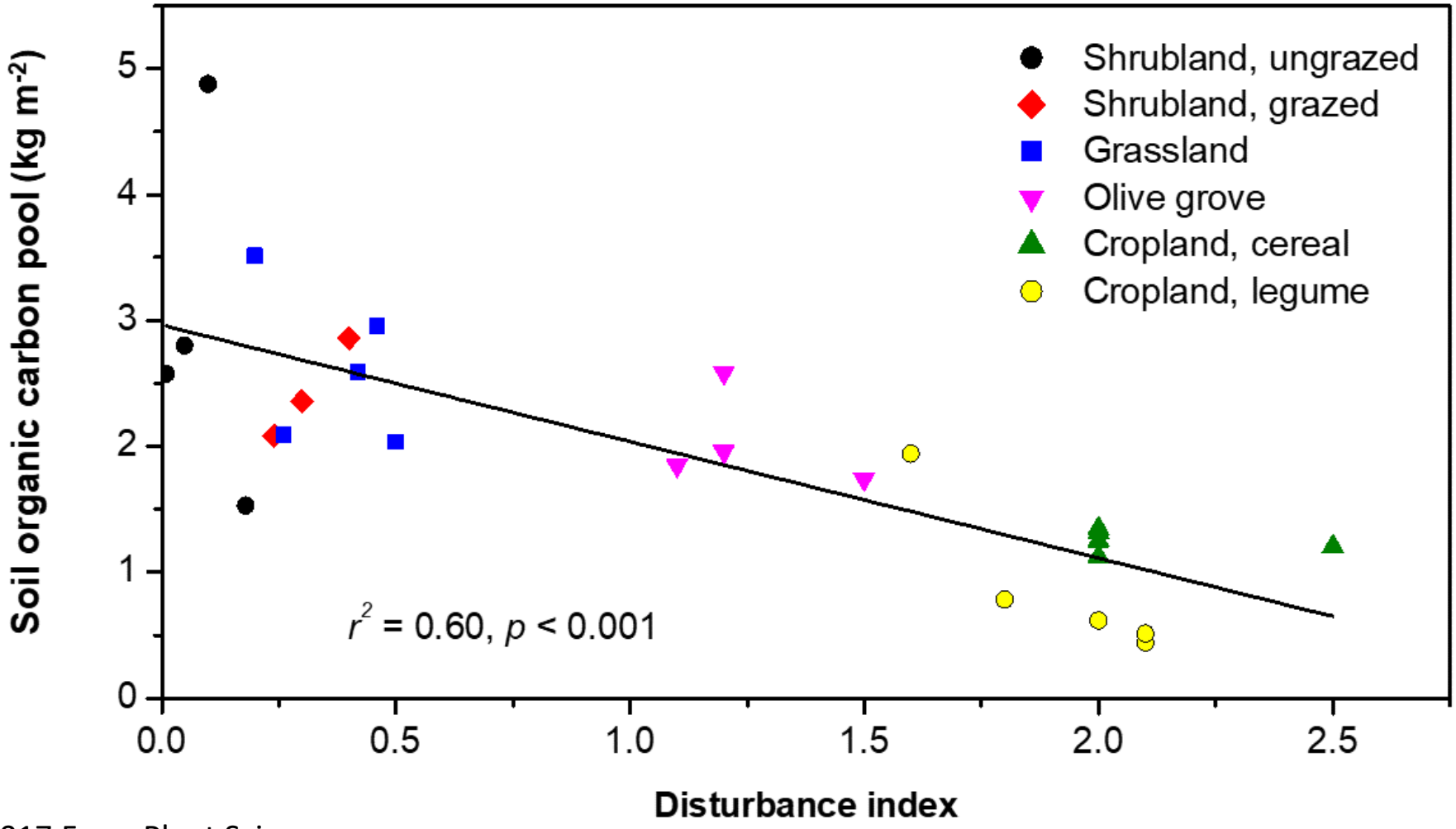
Differences in soil organic carbon between natural woodland and planted forest plots >50 yr following afforestation along an aridity gradient in Israel



Site 1: least arid
Site 19: most arid

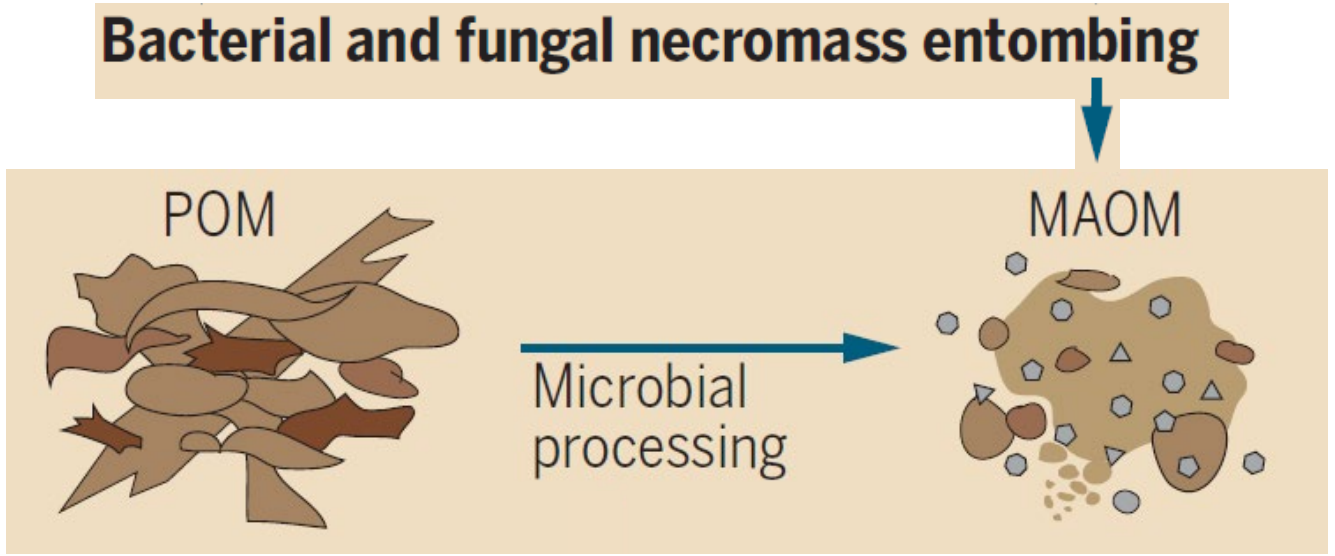
Main effects	*F* ratio	*P* value
Land use type	2.8582	0.1110
Precipitation	7.4545	0.0136
Slope	0.2908	0.5936
Elevation	2.1986	0.1574

Soil organic carbon stocks in the Judean Foothills, Israel along a land use gradient



Dirks et al. 2017 Fron. Plant Sci.

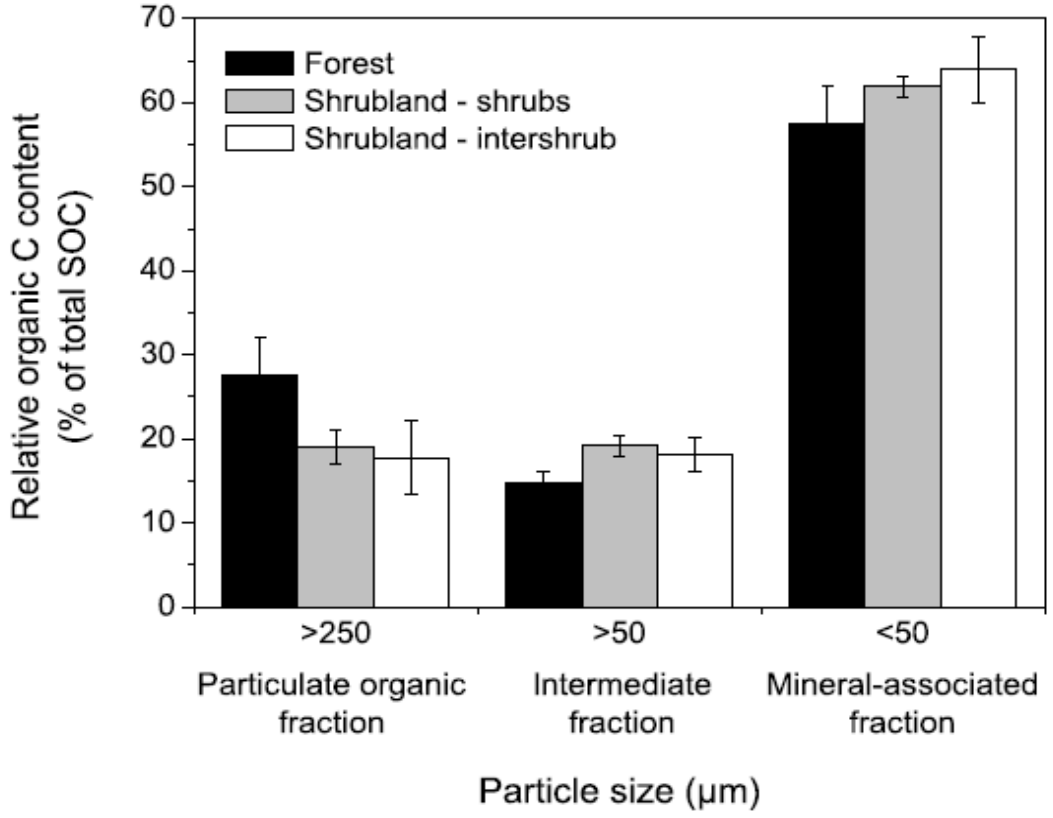
Soil organic carbon fractions and residence time

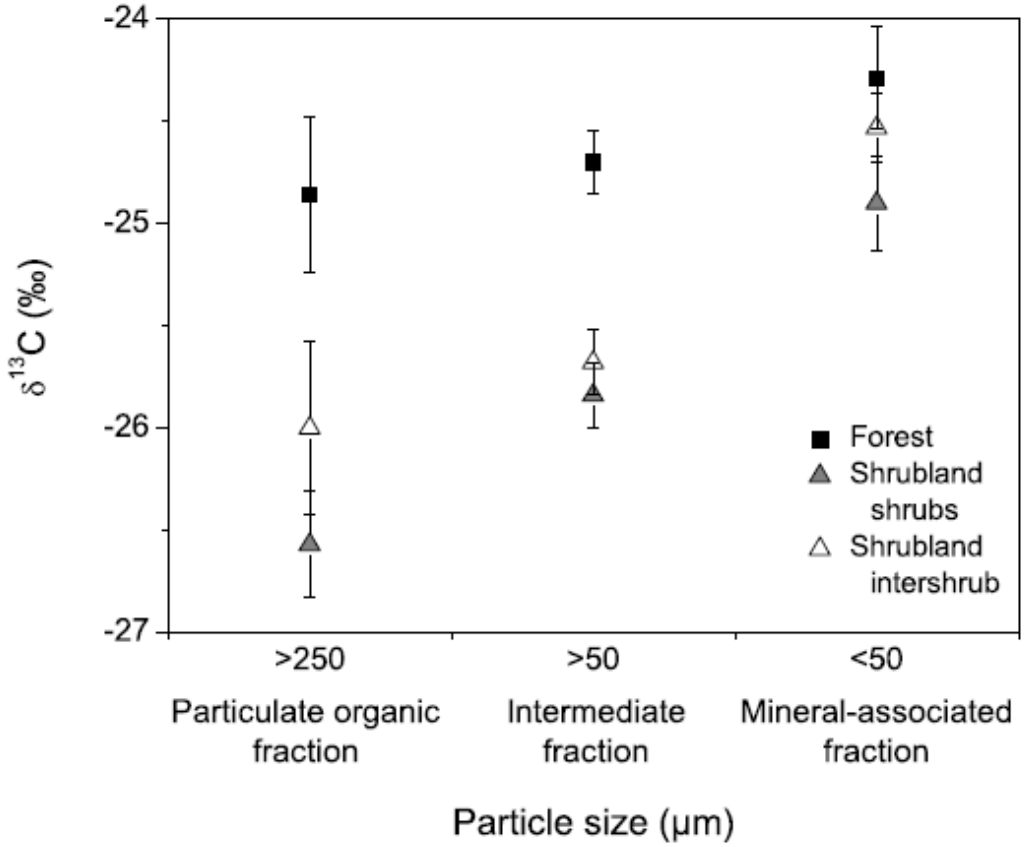


POM, particulate organic matter
MAOM, mineral-associated organic matter

Bai & Cotrufo 2022 Science

Residence time of soil organic carbon following afforestation of a semi-arid shrubland in the northern Negev region of Israel





35 yr after afforestation:

Fraction of original shrubland soil organic carbon 32%

Mean residence time of original shrubland soil organic carbon 56 yr

Grünzweig et al. 2007 Biogeosciences

Conclusions

- Soil organic carbon sequestration is mostly quantified by sequential sampling or chronosequence.
- Sampling sites at one point in time enables comparisons among land use/treatments for differences in soil organic carbon sequestration over time.
- Both cold & wet and hot & dry environments are sensitive to land use change, but have an at times large potential for soil organic carbon sequestration.

Thank you for your attention