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Monitoring Spatio-Temporal Changes of Soil Carbon in Java Using Legacy Soil Data

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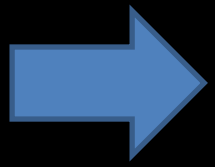
Introduction

- Many studies showed that soil can serve as carbon sink, but its ability differs among region and among soil depth within a region.
- In assessing the capability of soil to sequesters carbon, soil carbon stock should be first quantified for accounting SOC change
- To account such change, long-term research may provide such comprehensive data, however in Indonesia no soil monitoring network exists yet



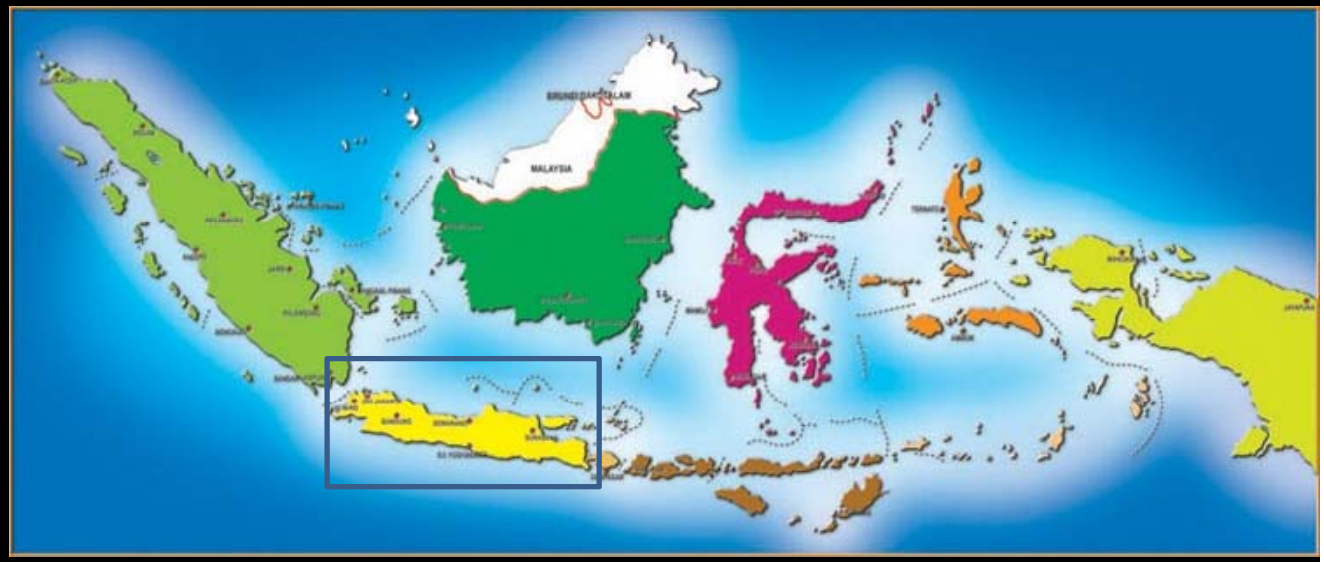
LEGACY SOIL DATA

- Our knowledge of the amount of C lost from soils clearly affects our characterization of the global carbon budget
- This work provides the **first estimates** of spatio-temporal changes of soil organic carbon (SOC) over time in Java

Methods

Peter Lendert's Database + ICALRRD

60 % Inceptisols
Intensively farmed



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Home | CV | Data and Estimates | Papers | Research

Data and Estimates

- Allard-Lindert OECD data sets 1950-2001
- Britain's social tables 1688 on
- English probates 1670-1875.xls
- Go and Lindert data Working paper
- Lindert data for CUP book
- "Revealing Failures in the History of Education Finance"
- Sovereign debt historical data (Lindert-Morton)
- Soil Data, China 1930s-1980s
- Soil Data, Indonesia,

Stage-1 Indonesia Soils

- Aceh 1931-1940.xls
- Aceh 1941-1950.xls
- Aceh 1961-1970.xls
- Bengkulu 1931-1940.xls
- Bengkulu 1951-1960.xls
- Irian 1931-1940.xls
- Irian 1941-1950.xls
- Jambi 1931-1940.xls
- Jambi 1941-1950.xls
- Jambi 1951-1960.xls

-average data 0-10 cm
-agregated data per decade
-exploration data analysis:
grouping per regency, median
-Calculate soil carbon stocks
-plot on administration/regency map

Bulk Density

ρ om = 0.224 g/cm3

$$\rho_b = \frac{100}{\frac{OM\%}{\rho_{om}} + \frac{(100 - OM\%)}{\rho_m}}$$

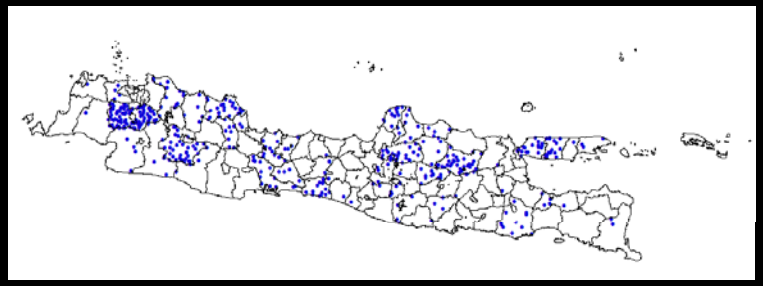
ρ_m = 0.935 + 0.049 Log(depth) + 0.0055 Sand – 0.0000653 (Sand - 38.96)^2

Carbon stock in 10 cm depth or C density (kg m^{-2}) was calculated as:

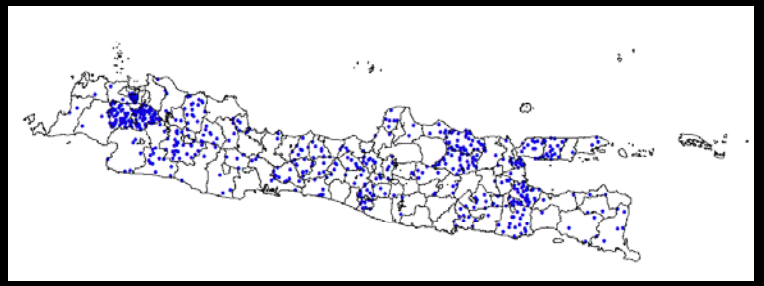
C density (kg m^{-2}) = (C%/100) x ρ_b (kg m^{-3}) x soil depth (m)

Carbon stock for each kabupaten (in kg) was calculated as:

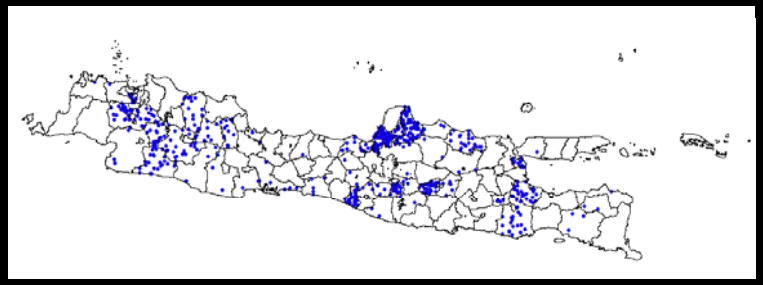
C stock (kg) = C density (kg m^{-2}) × Area of the kabupaten (m^2)



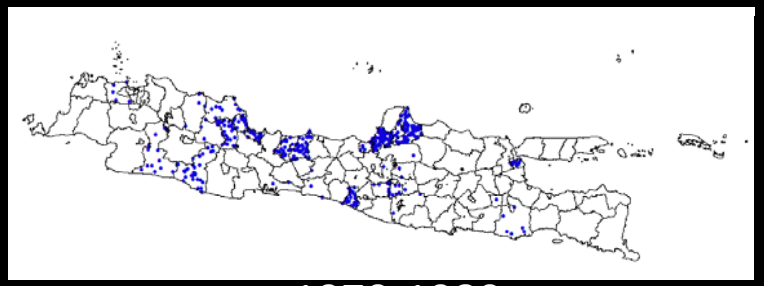
1920-1950



1950-1960



1960-1970



1970-1980

1980-1990

1990-2010

Fig 1.Soil Observation Density per Regency in Java

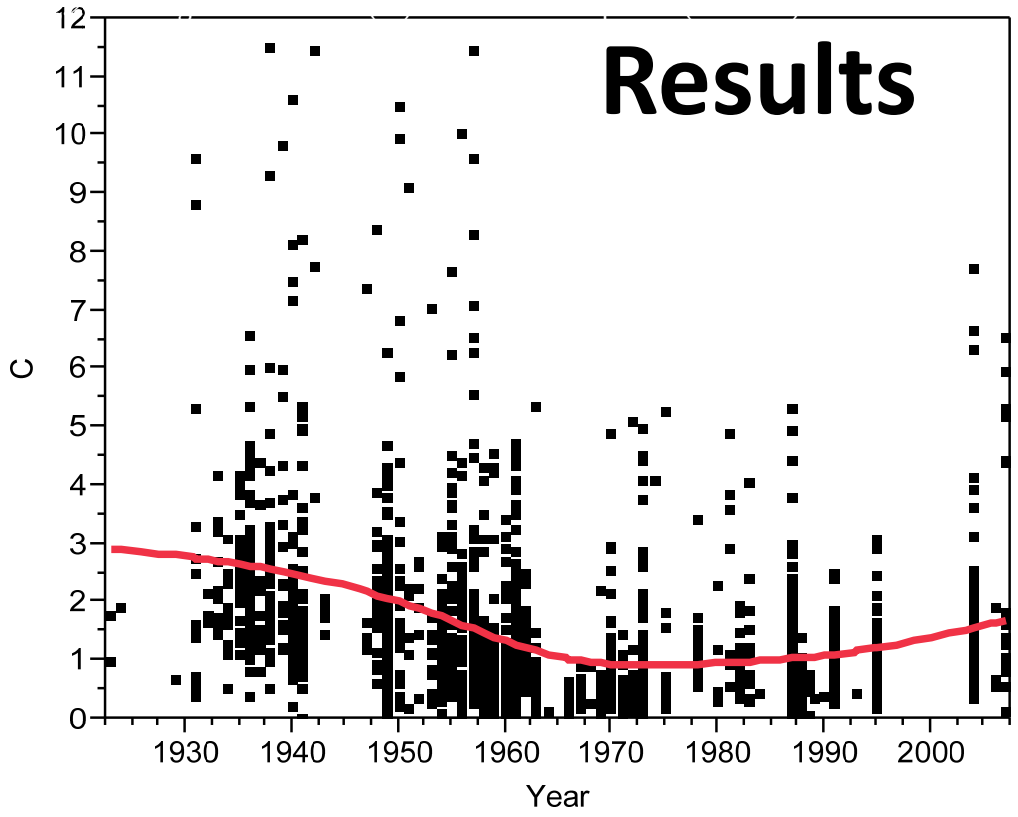


Fig.2. Soil organic C content (%) over time for top soils (0-10 cm) in Java

Initial drop due to high conversion to plantation & food crops==rapid decline SOC 1, 5 % to 1960/70

Inrease SOC after 1970 due to: Goverment program & farmer effort to remediate soil fertility: fertilizer addition, resiude management, etc ===SOC rise to 1,1% in 2000

1930-1940, median SOC 2,11 % and decrease 0,75 % in 1970-1980

Then Median SOC increase 1,18 %; The rapid SOC loss during initial period to 1970—SOC slowly stabilize since 1970

Table 1. Soil C content and C stock (in 0-10 cm depth) of Java soils, grouped by decades

Obs.year	No.obs	C content (g^{-1})			C stock ($kg.m^{-2}$)
		Minimum	Median	Maximum	Median
1930 - 1940	282	0.35	2.11	11.64	2.04
1940 - 1950	183	0.13	1.79	11.58	1.84
1950 - 1960	437	0.04	1.15	11.58	1.14
1960 - 1970	434	0.07	0.76	5.47	0.73
1970 - 1980	223	0.09	0.75	5.40	0.70
1980 - 1990	209	0.06	0.79	5.44	0.80
1990 - 2000	77	0.31	1.08	3.20	1.09
2000 - 2010	157	0.24	1.18	7.82	1.21

Mapping Soil Carbon Dynamics

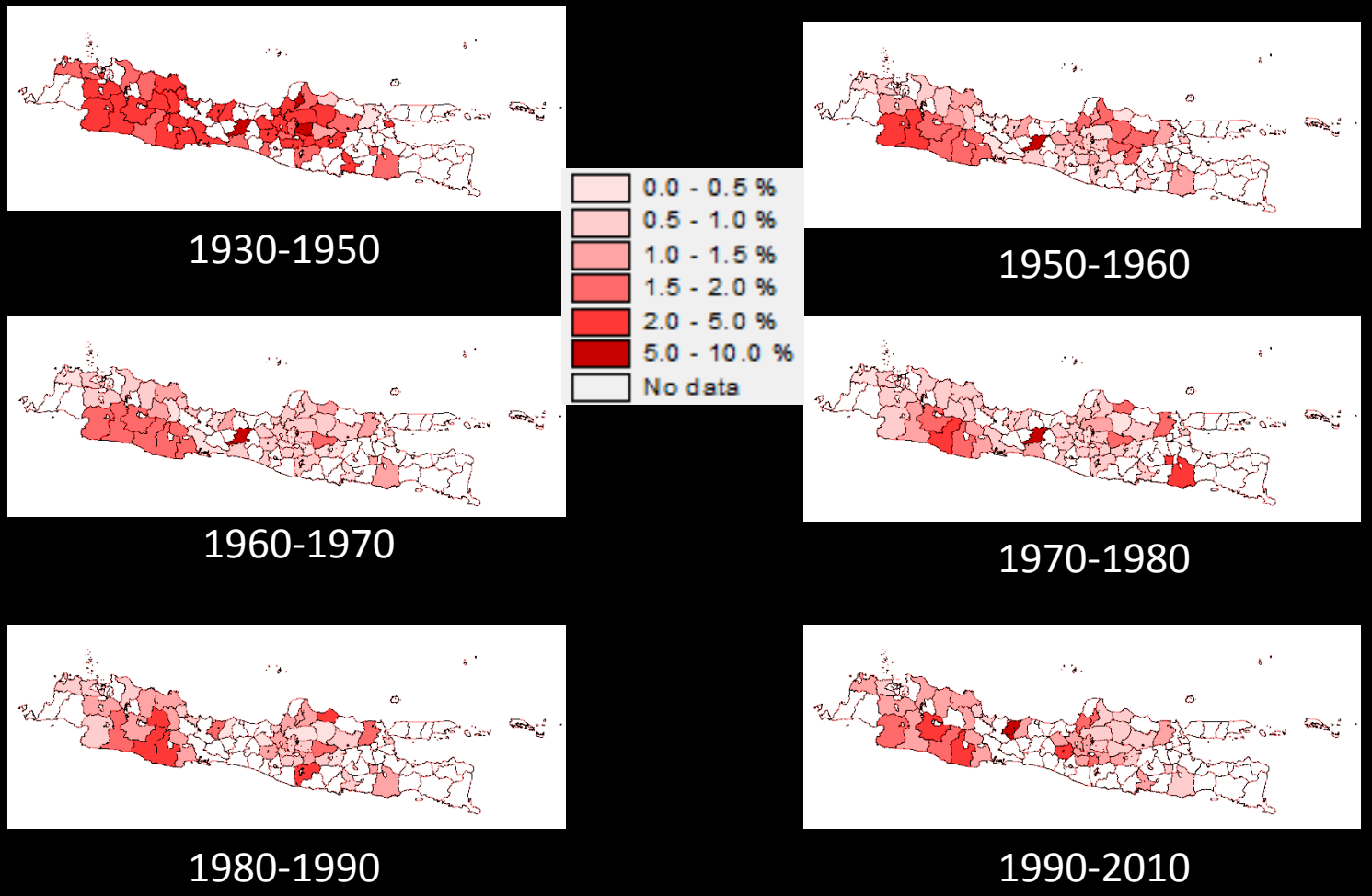


Fig. 3. The evolution of organic C content for the top 10 cm soil in Java

Mapping Soil Carbon Stock Dynamics

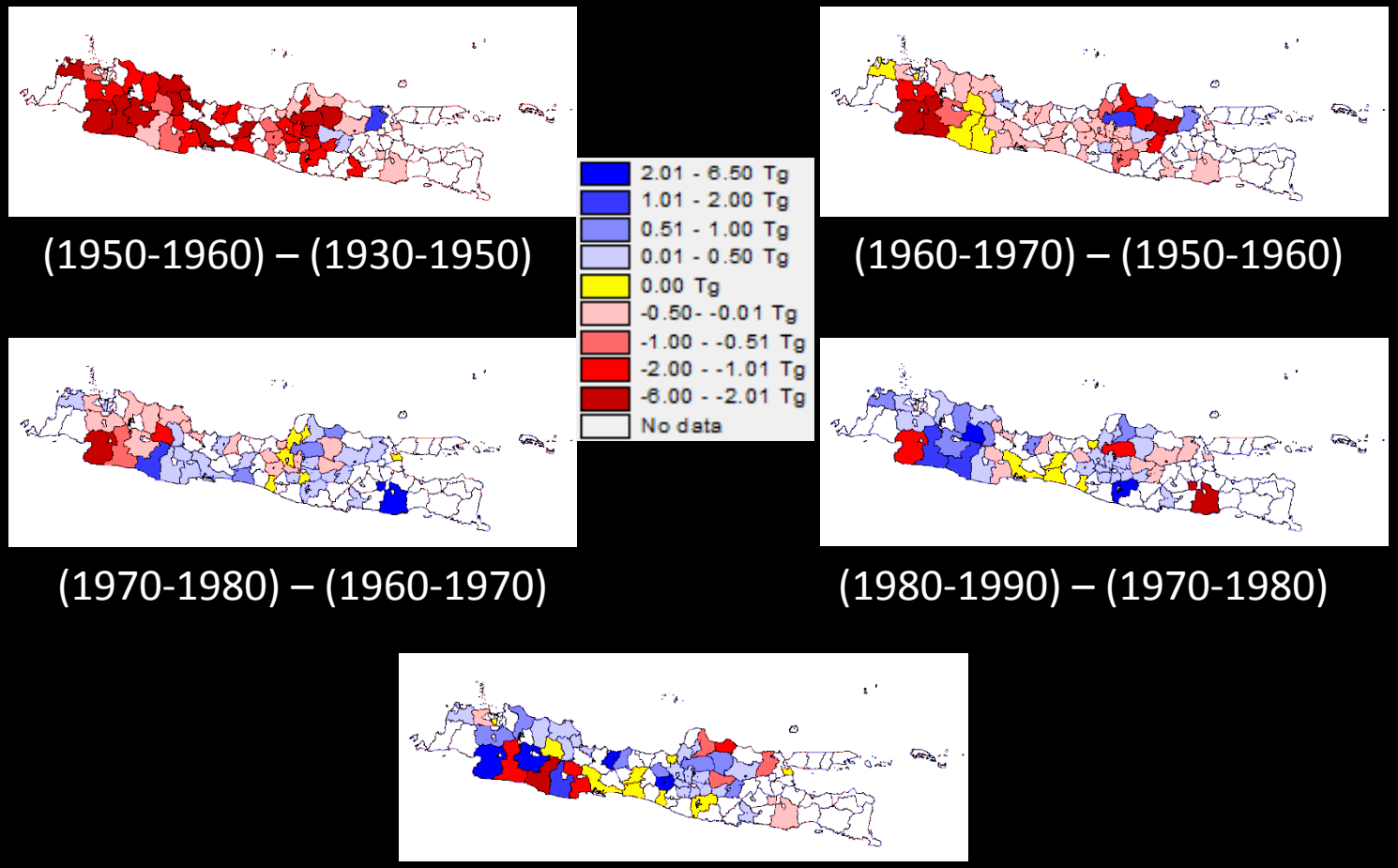


Fig.4. The changes in C stock over successive period for the top 10 cm soil in Java

Summary & Conclusion

- Our study has demontrated the use of legacy soil data particular point soil obervation in monitoring spatio-temporal dynamic of SOC in Java.
- Making, improving and populating soil information system that manage legacy soil data should be promoted so that assesment soil carbon budget can be improved and extended.
- There need to be a coordinated effort to compile all existing soil databases into a national database.

Summary & Conclusion

- SOC in Java decrease upto 1970 and then increase after that time. There is also found that carbon stock change differ among region kabupaten in time and in magnitude refllecting diferent time addoption on best land management practices in addtion to land use.
- Our analysis suggests that the human influence and agricultural practices on SOC in Java have been a stronger influence than the environmental factors.
- **SOC for the top 10 cm has a nett accumulation rate of 20-30 g C m^{-2} $year^{-1}$ (0.2 – 0.3 ton C/ha.year) during the period 1990-2000. These findings raise optimism for increased soil carbon sequestration in Indonesia.**

Thank You