SSS5.6 Organo-mineral associations and microaggregate in soil: Dynamics and function

Land use effects on geochemical properties and their control on organic carbon in volcanic soils near Bandung area (Indonesia)

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Introduction

Volcanic soils are susceptible to a land use change, esp. to agriculture land. Consequently, it will accelerate the weathering and lead to the change in geochemical properties and possibly to soil organic carbon

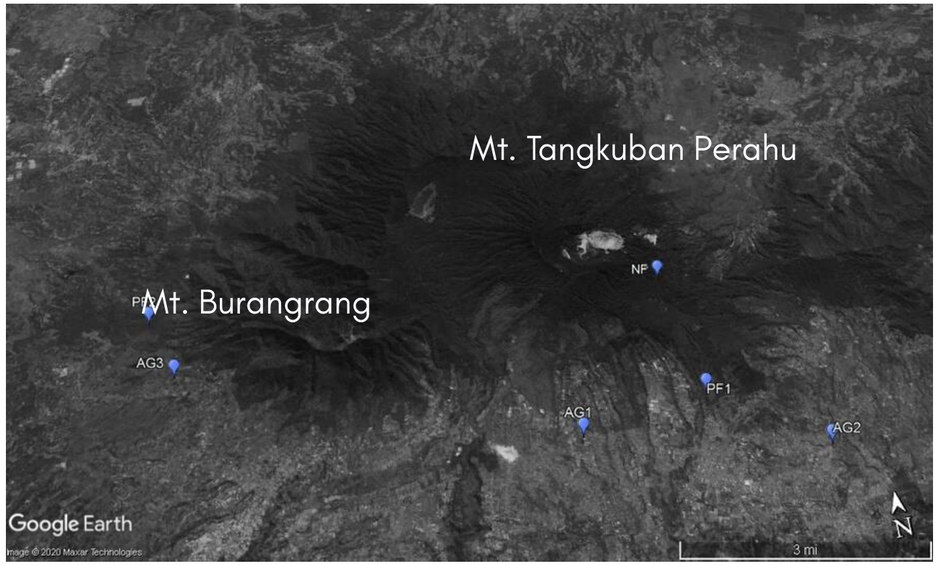
Land use history

Forest → **Forest**
< 1900 — 2019

Forest → **Pine forest**
< 1900 — ± 1960 - 2019

Forest → **Unmanaged coffee plantation** → **Cultivated land**
< 1900 — ± 1940 - 1950 — ± 1970 - 2019

Study site



Location: Mt. Tangkuban Perahu and Mt. Burangrang (Sunda volcanic complex)

Parent material : Andesite

Mean precipitation: 2000-3000 mm/year

Mean temperature: 19-25° C/year

Lithology: Qyd (young), Qyt (intermediate), Qvu (old)

Land use: forest, pine forest, agricultural land

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Objectives

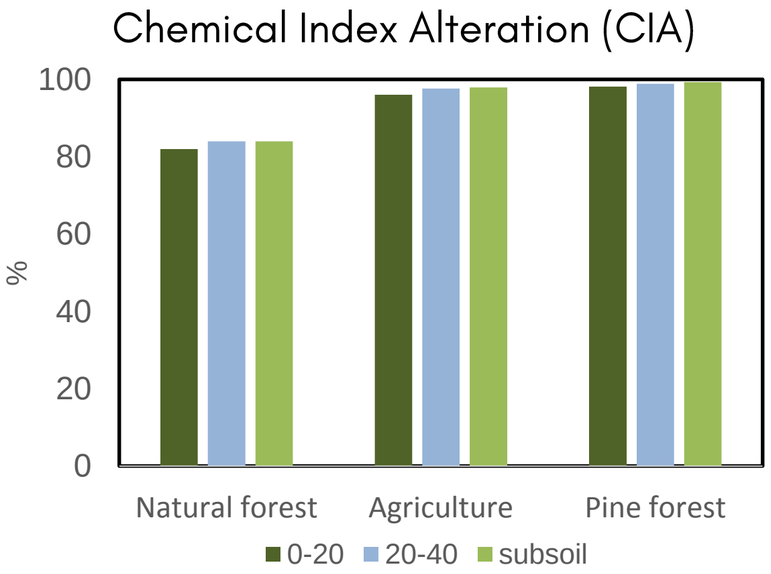
This study aims to find out:

- The weathering stage affected by land use
- The relation between geochemical properties and organic carbon
- Organic carbon and its distribution within fractions

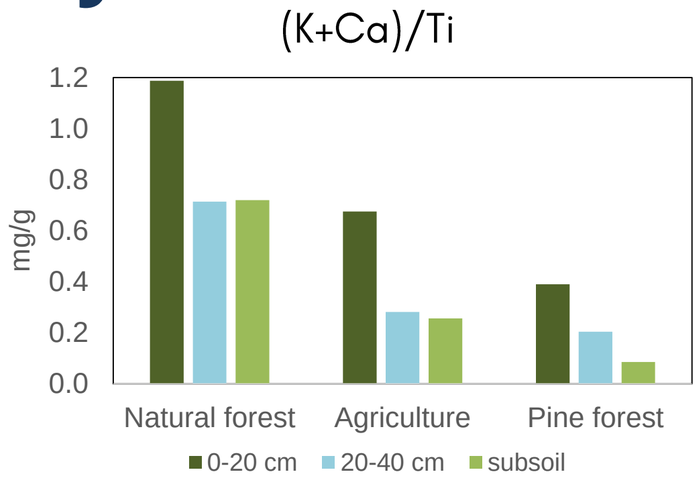
Soil characteristics

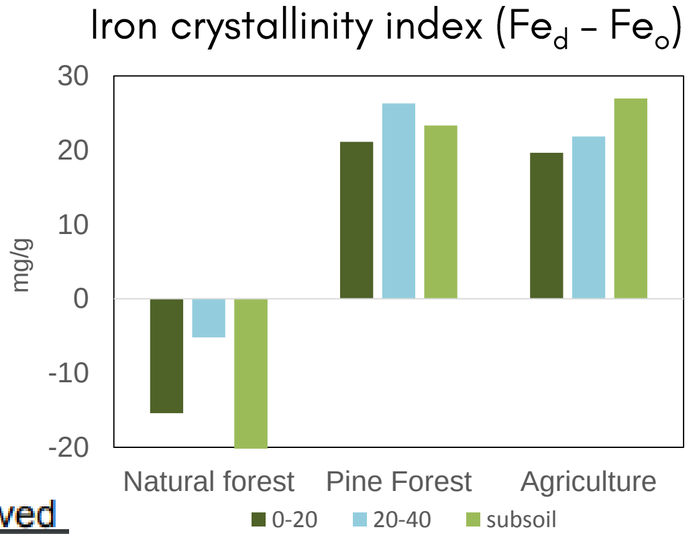
- The study soils have Andosols soil type with mainly aluandic properties.
- Acidic pH (4 – 5.9) and low basic cations

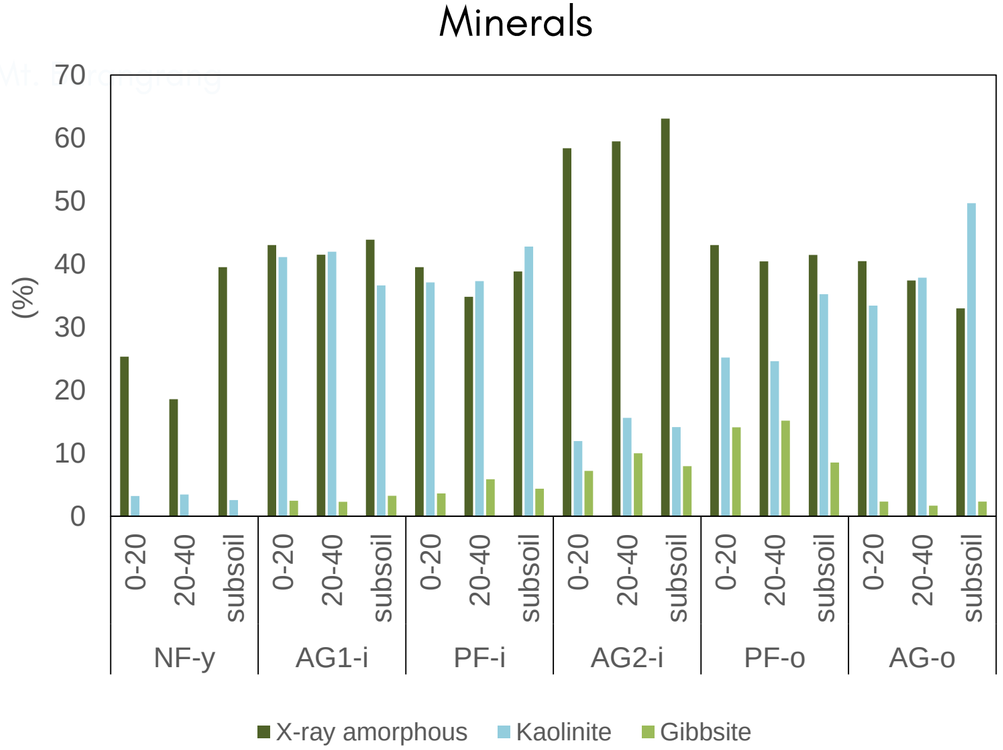
Weathering intensity



- Natural forest = 70–80% (moderately weathered
- Pine forest and agriculture = 80 – 90% (extremely weathered)







- More amorphous fractions and kaolinite in agriculture land

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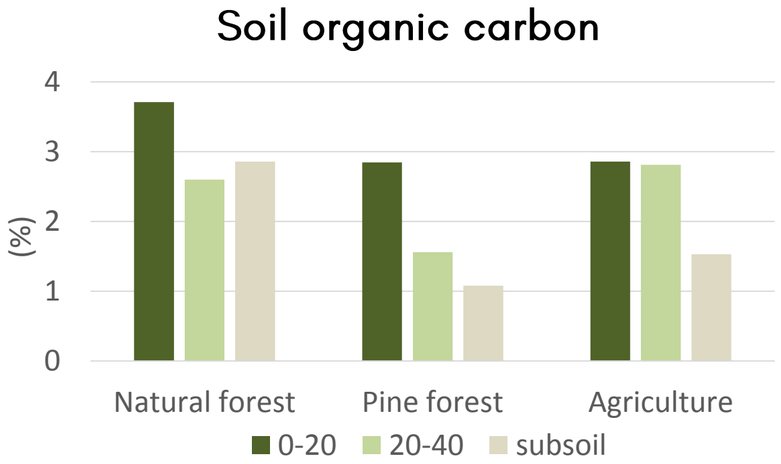
The relation between geochemical properties and soil organic carbon



Soil organic carbon is higher in top soils than subsoil in all study sites

	Amorp	Total C	Al_{ox}	Al_o+ 1/2Fe_o	Al_2O_3	SiO_2	TiO_2	CaO	MgO	P_2O_5	SSA	Kaolinite
Amorp*	1.00											
Total C	.308	1.00										
Al_{ox}	**.855****	.267	1.00									
Al_o+1/2 Fe_o	**.858****	.270	**.874****	1.00								
Al_2O_3	.136	**-.490***	.356	.228	1.00							
SiO_2	**-.713****	-.113	**-.891****	**-.833****	**-.617****	1.00						
TiO_2	**-.531***	-.352	-.448	-.181	.304	.099	1.00					
CaO	-.680	**.664****	-.195	-.174	**-.880****	**.513***	-.427	1.00				
MgO	.097	**.598****	.093	.221	**-.724****	.162	-.277	**.801****	1.00			
P_2O_5	**.546***	**.672****	**.652****	**.502***	-.131	**-.475****	-.431	.303	.269	1.00		
SSA	**.677****	-.227	**.724****	**.641****	**.644****	**-.790****	-.214	**-.649****	-.394	.179	1.00	
Kaolinite	-.107	**-.766****	-.079	-.307	**.564***	-.076	-.022	**-.591****	**-.817****	-.228	.269	1.00

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

- Amorphous fractions has positive correlation with Al_o, Al_o+1/2Fe_o, and specific surface area. In contrast, it has negative correlation with SiO_2
- Soil organic carbon has positive correlation with CaO, MgO, sand (r=.575; p <0.05) and silt (r=.532; p<0.05), but negative correlation with kaolinite. However, we found high correlation between organic carbon with Al_o+1/2Fe_o and SSA in subsoil (r=.820)

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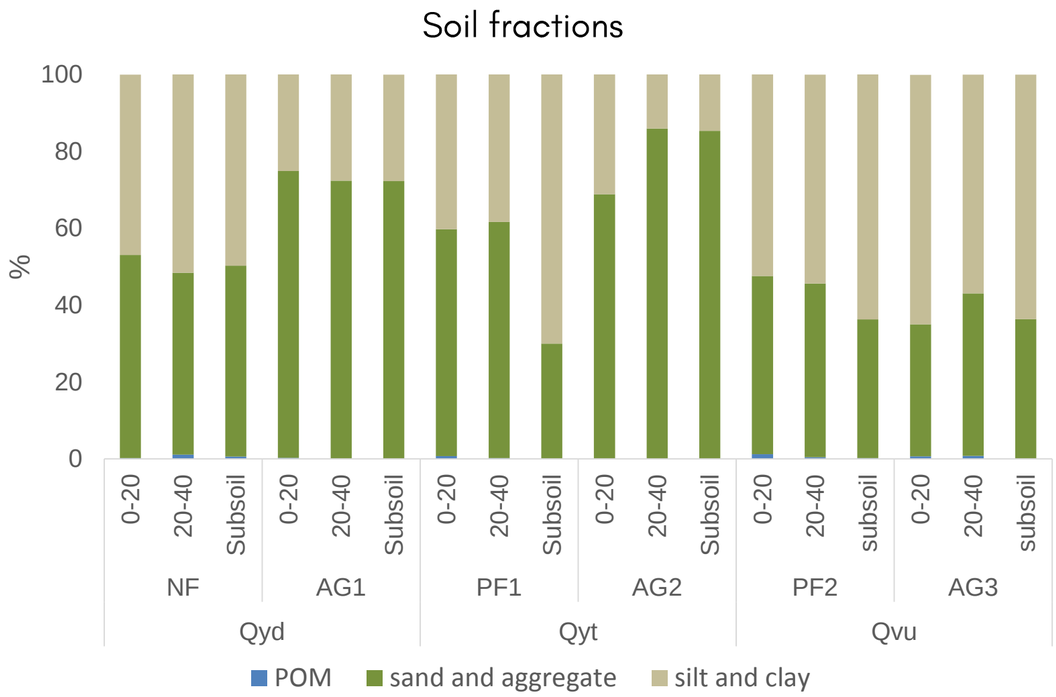
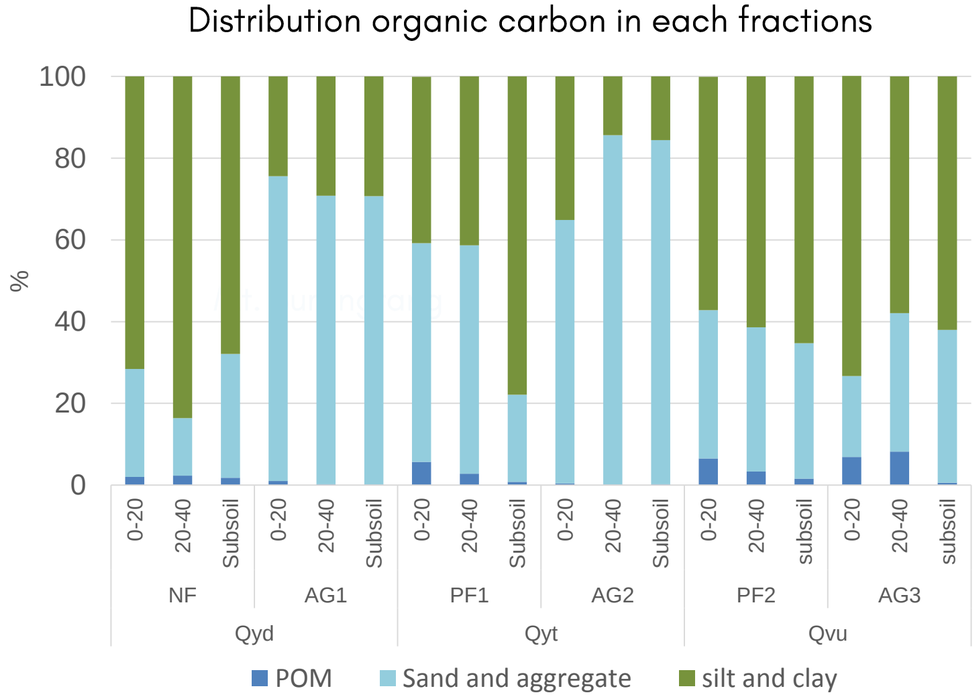
Distribution soil organic carbon within fractions



Agricultural land had > 50% aggregate fractions while other land use had more silt and clay fractions



Organic carbon in silt and clay are the largest carbon pool (>50%).
Organic carbon associated with sand and aggregate fraction is higher in agricultural land

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Summary

- Land use conversion enhances the weathering rate of soils. Agricultural activities trigger the formation of non- and crystalline minerals. Mixture of non-crystalline mineral and kaolinite can be an indication advanced stage of weathering.
- Organic carbon retained in top soils is more influenced by organic input and land use management, while minerals may likely stabilize OC in subsoils
- High OC stored in sand and aggregate fractions in agricultural land reflects the stability of macro aggregates

Thank you

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