

Si fluxes exported from volcanic islands: A case study from Kawah Ijen volcano, Indonesia

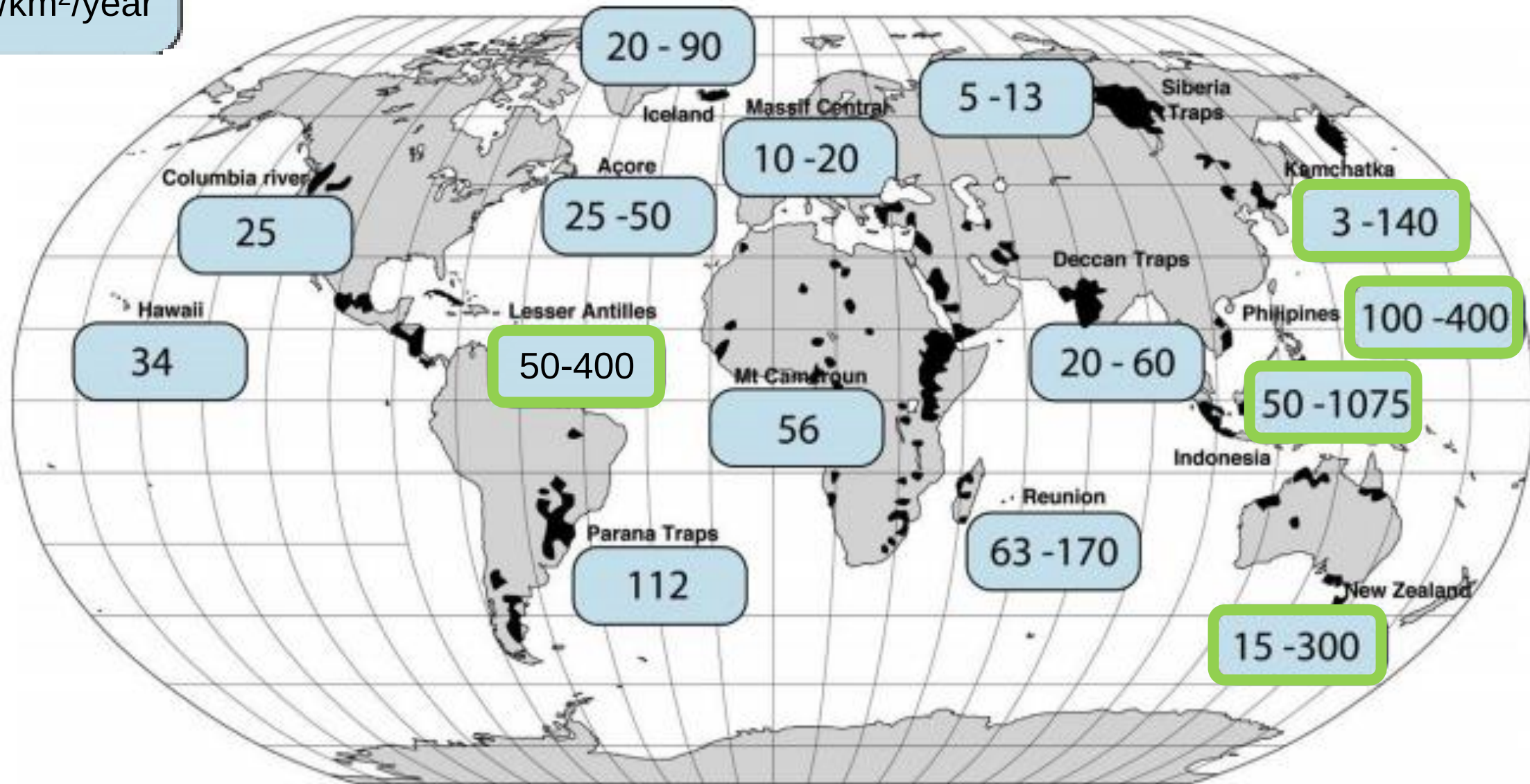
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Volcanic island arcs have the highest chemical weathering rates on Earth

t/km²/year



Modified from Rad *et al.*, 2013



Volcanic island arcs contribute disproportionately to dissolved Si delivery to ocean

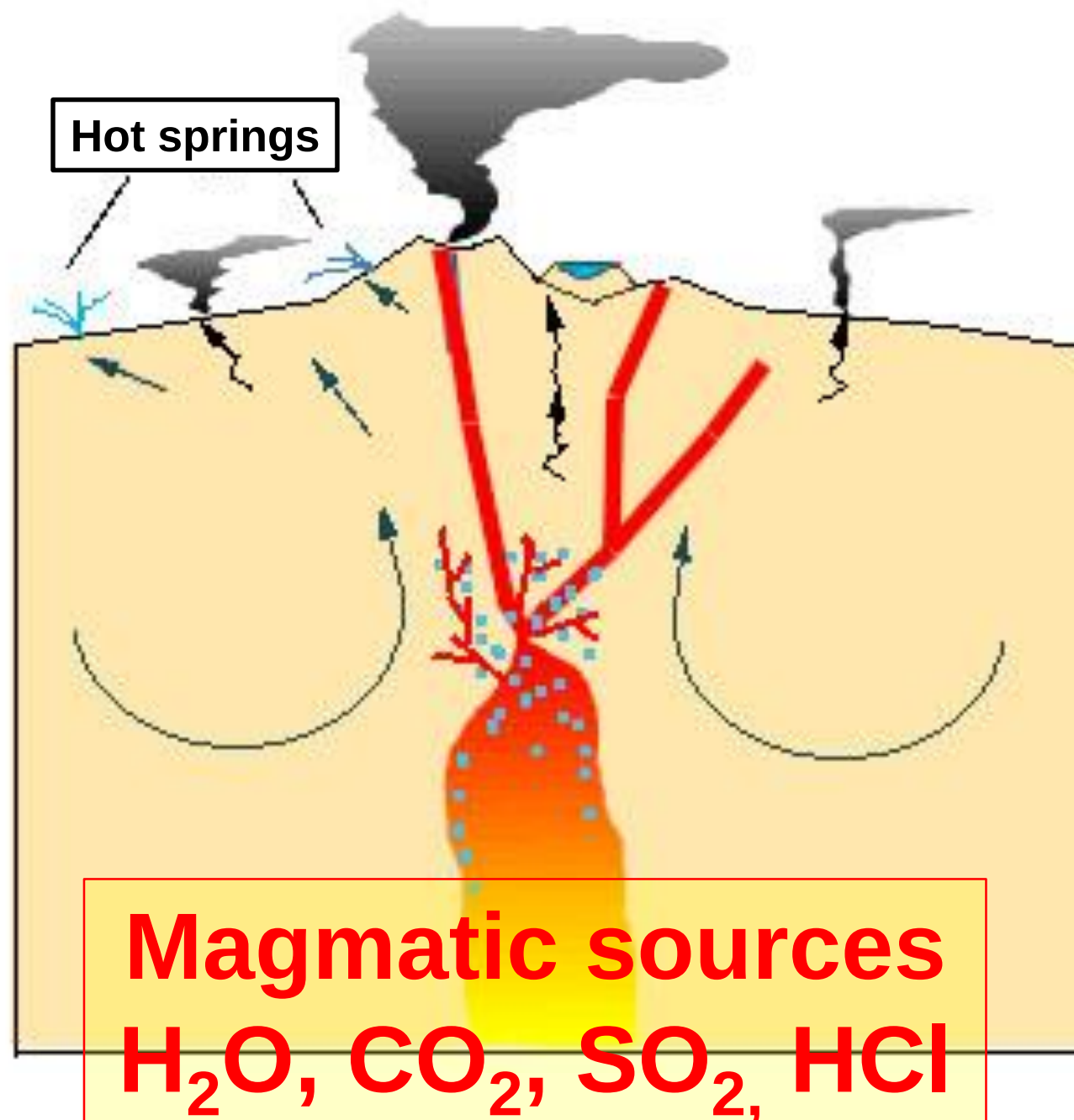


Global mean DSi for coastal catchments : $3.3 \text{ t DSi.km}^{-2}.\text{yr}^{-1}$

from Dürr *et al.*, 2011

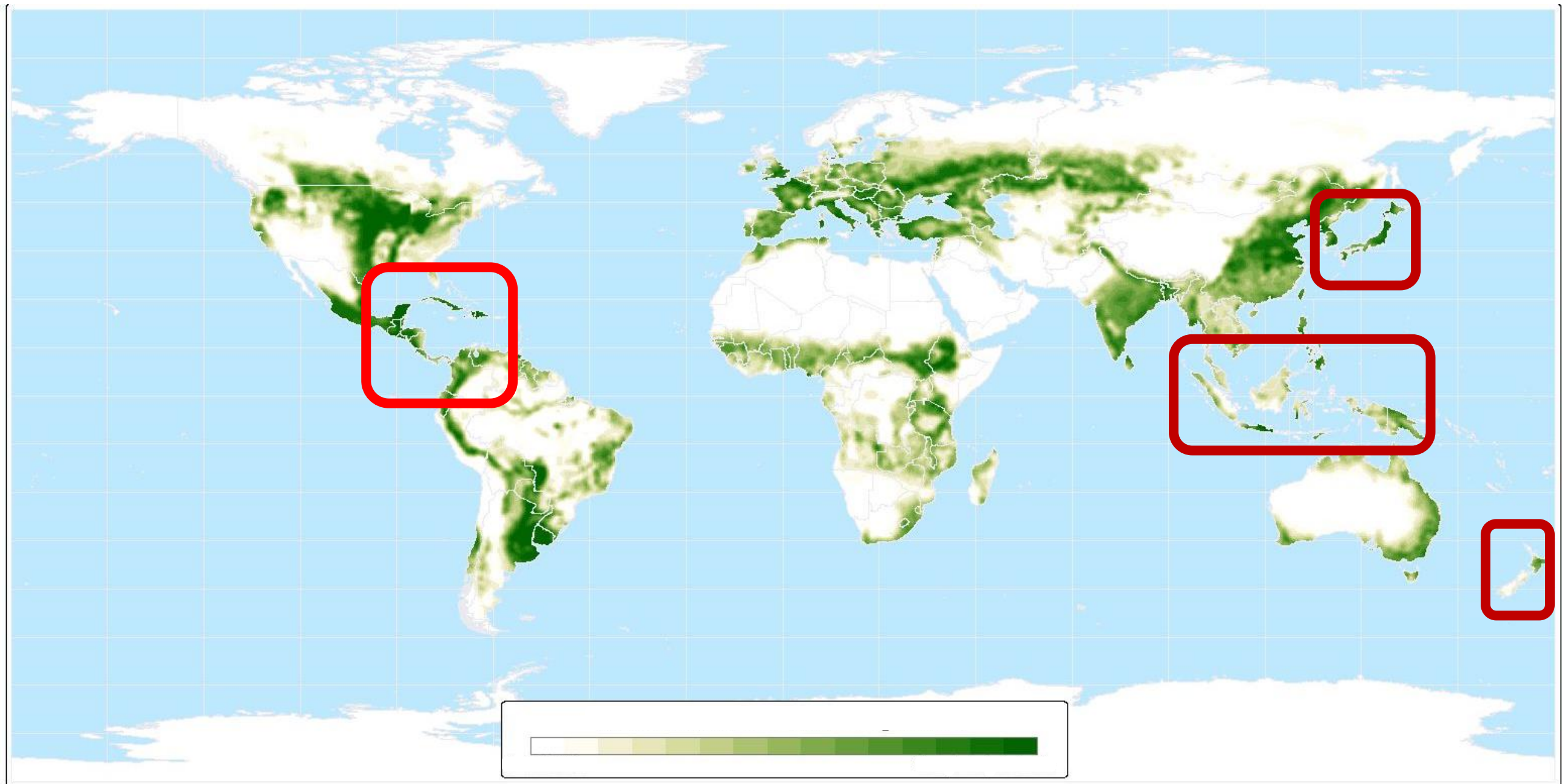


Volcanic island arcs may contain volcanic-hydrothermal system





Volcanic island arcs present soils highly suitable for agriculture

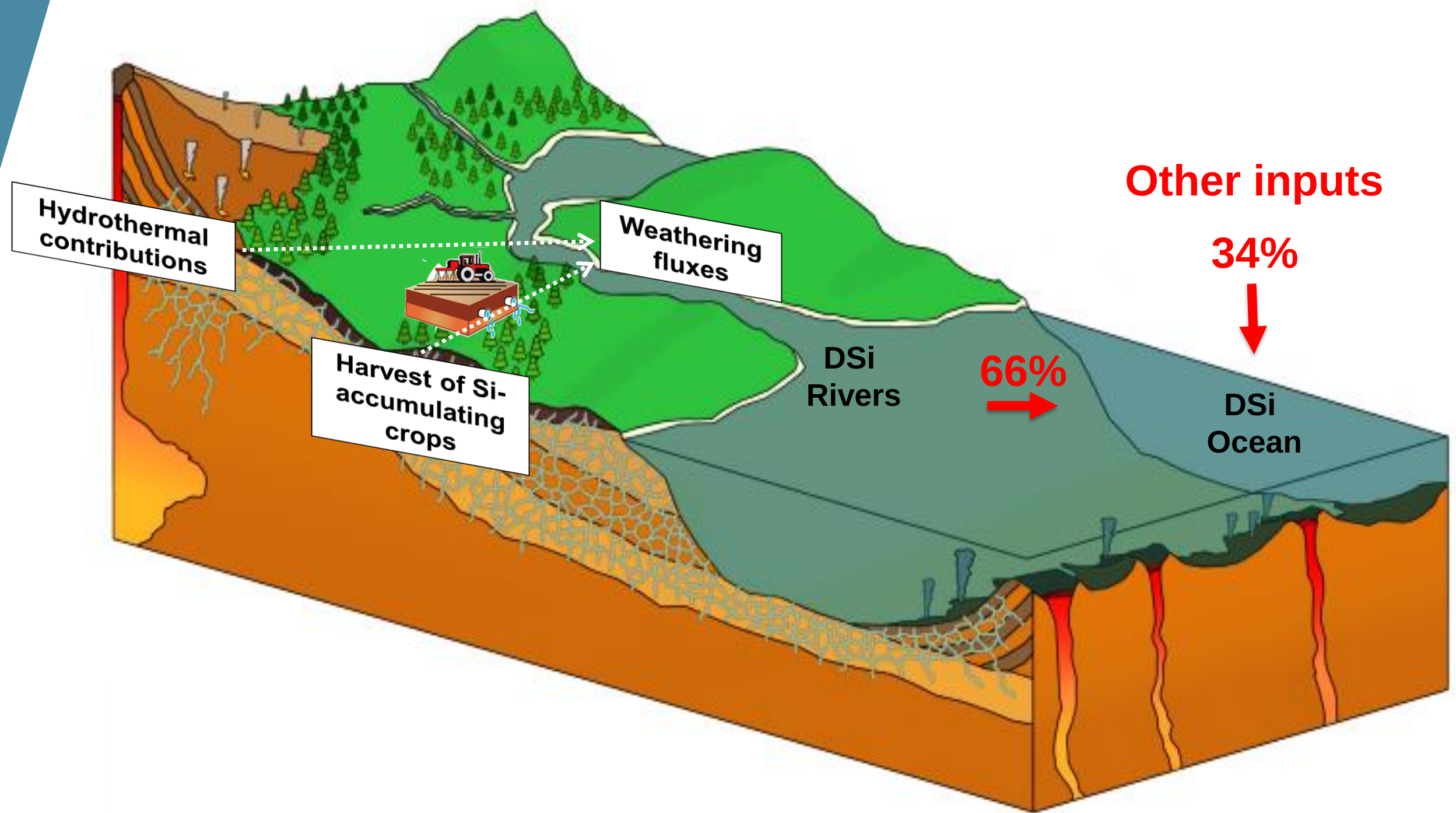


Not Suitable

Completely Suitable

Fraction of Gridcell Suitable for Agriculture

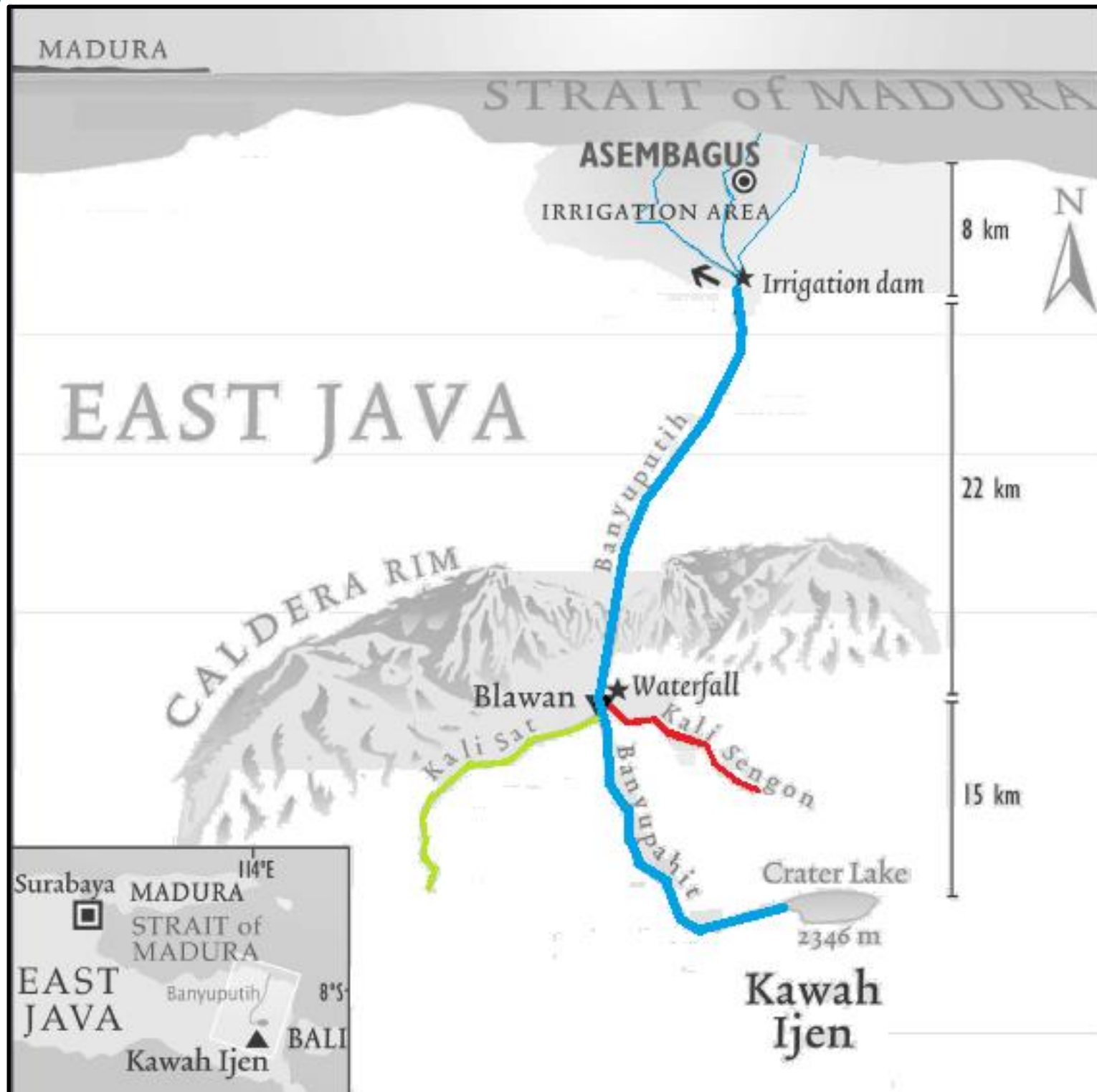
from Ramankutty *et al.*, 2002



from Tréguer and De La Rocha, 2013



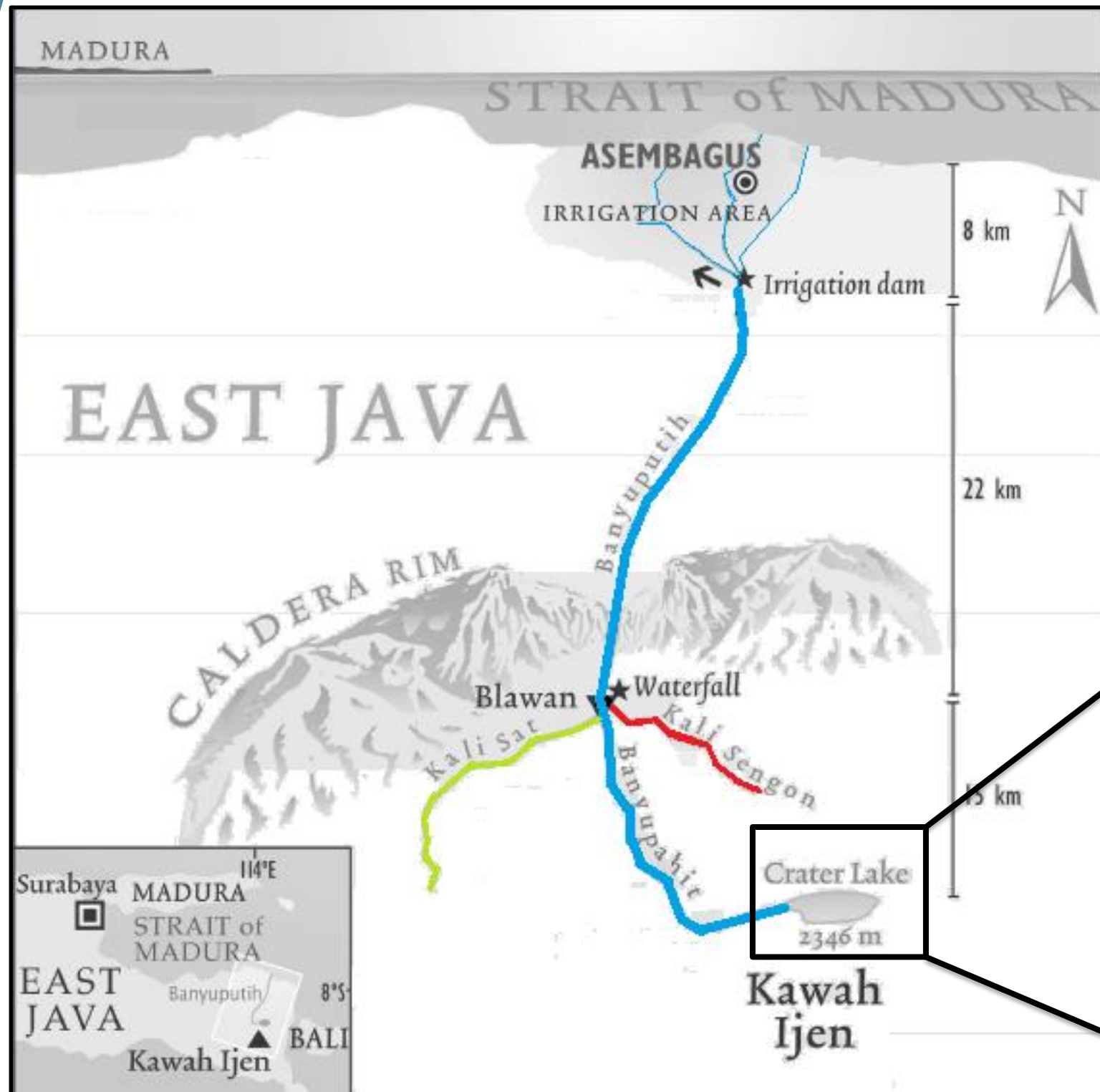
Kawah Ijen, Java Island, Indonesia



Modified from Lörh *et al.*, 2005



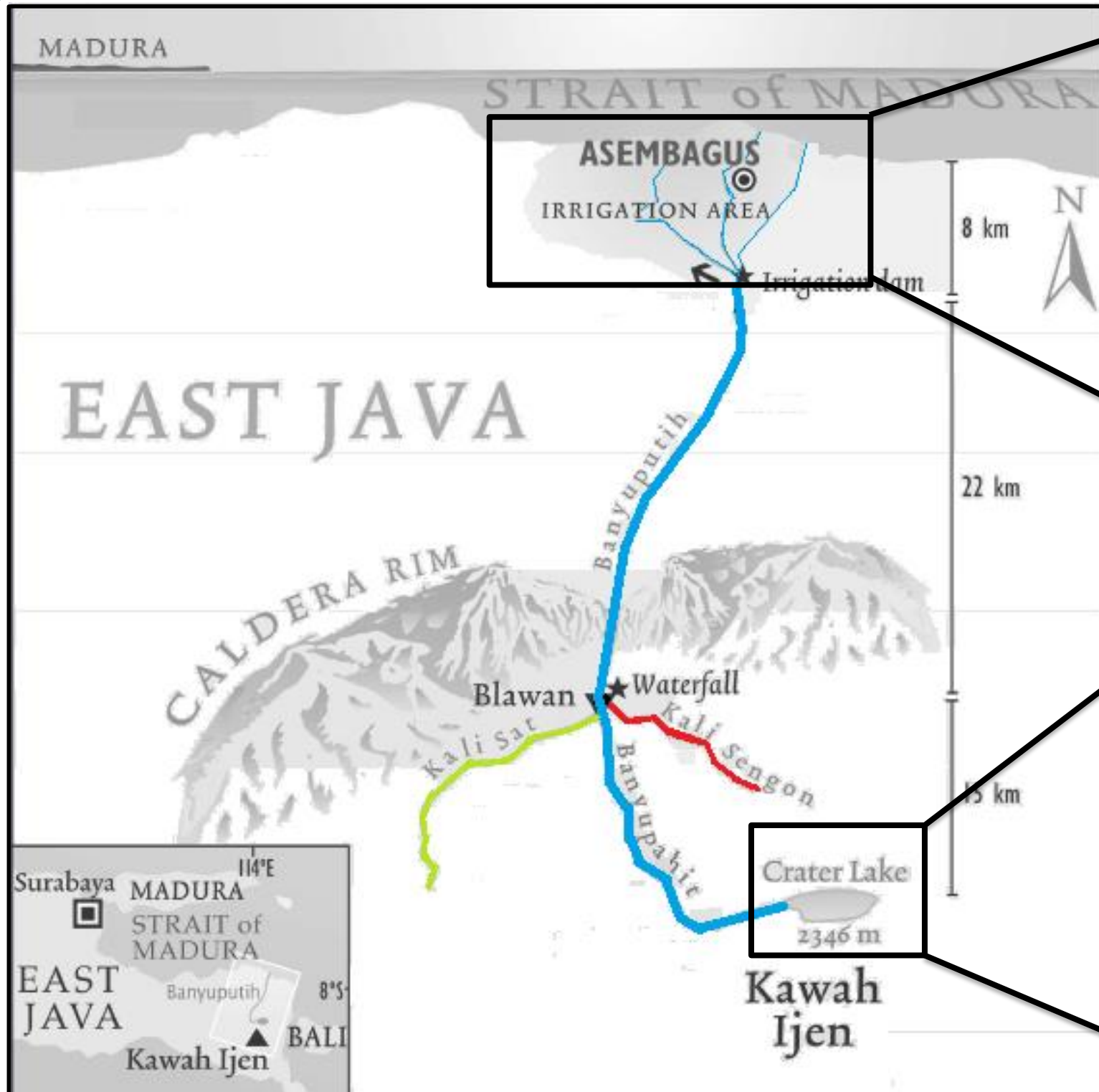
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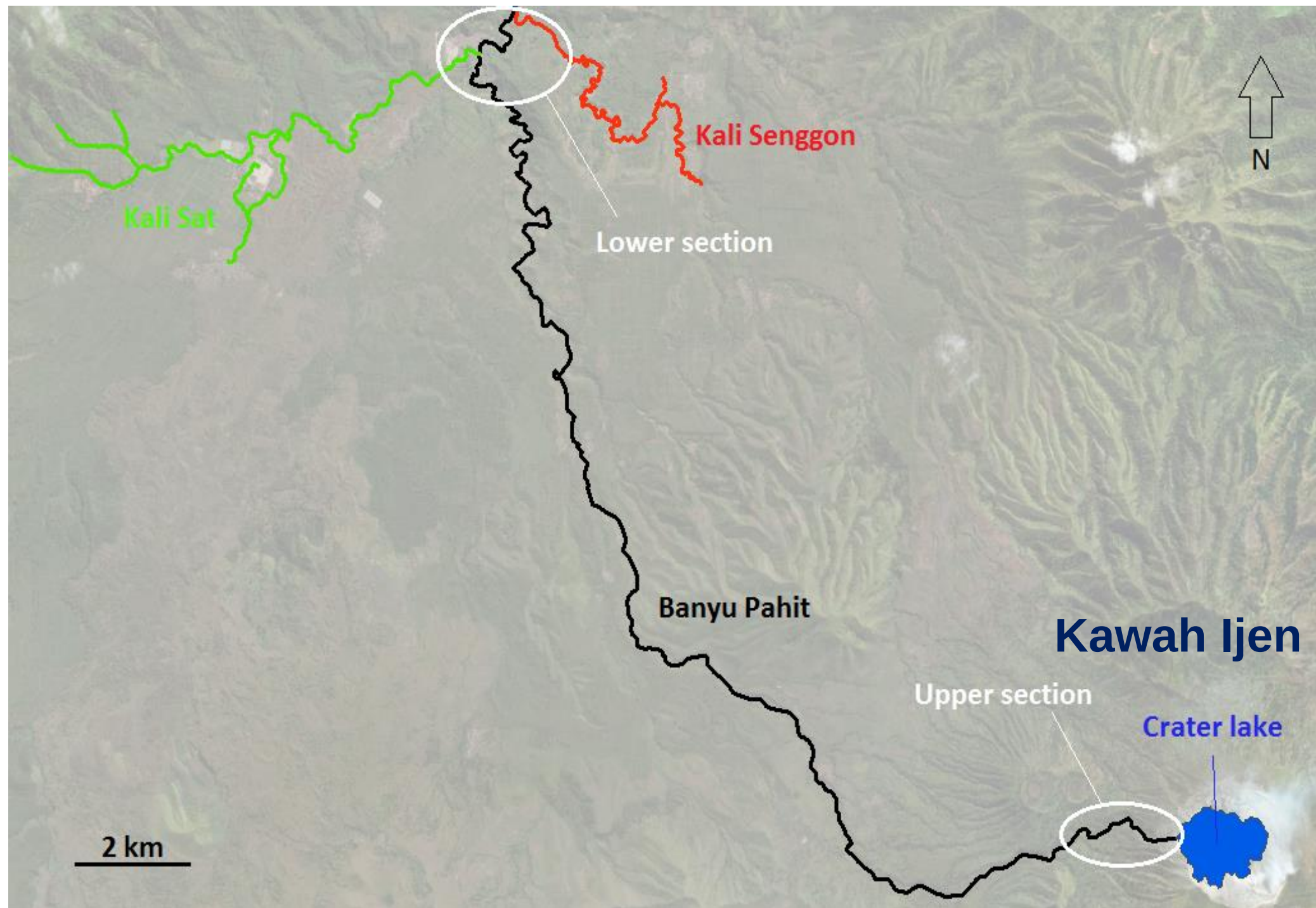
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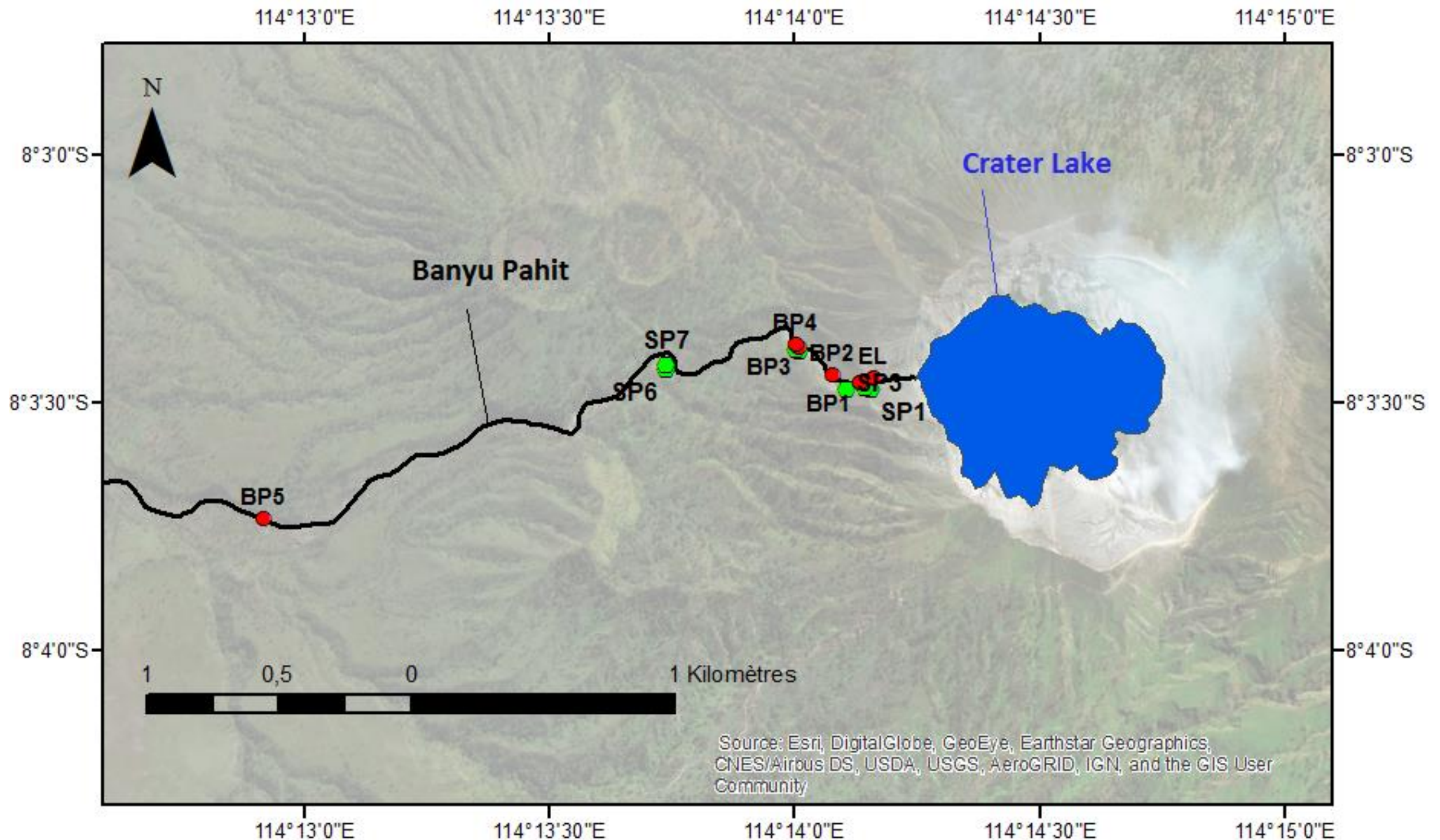


Kawah Ijen, Java Island, Indonesia



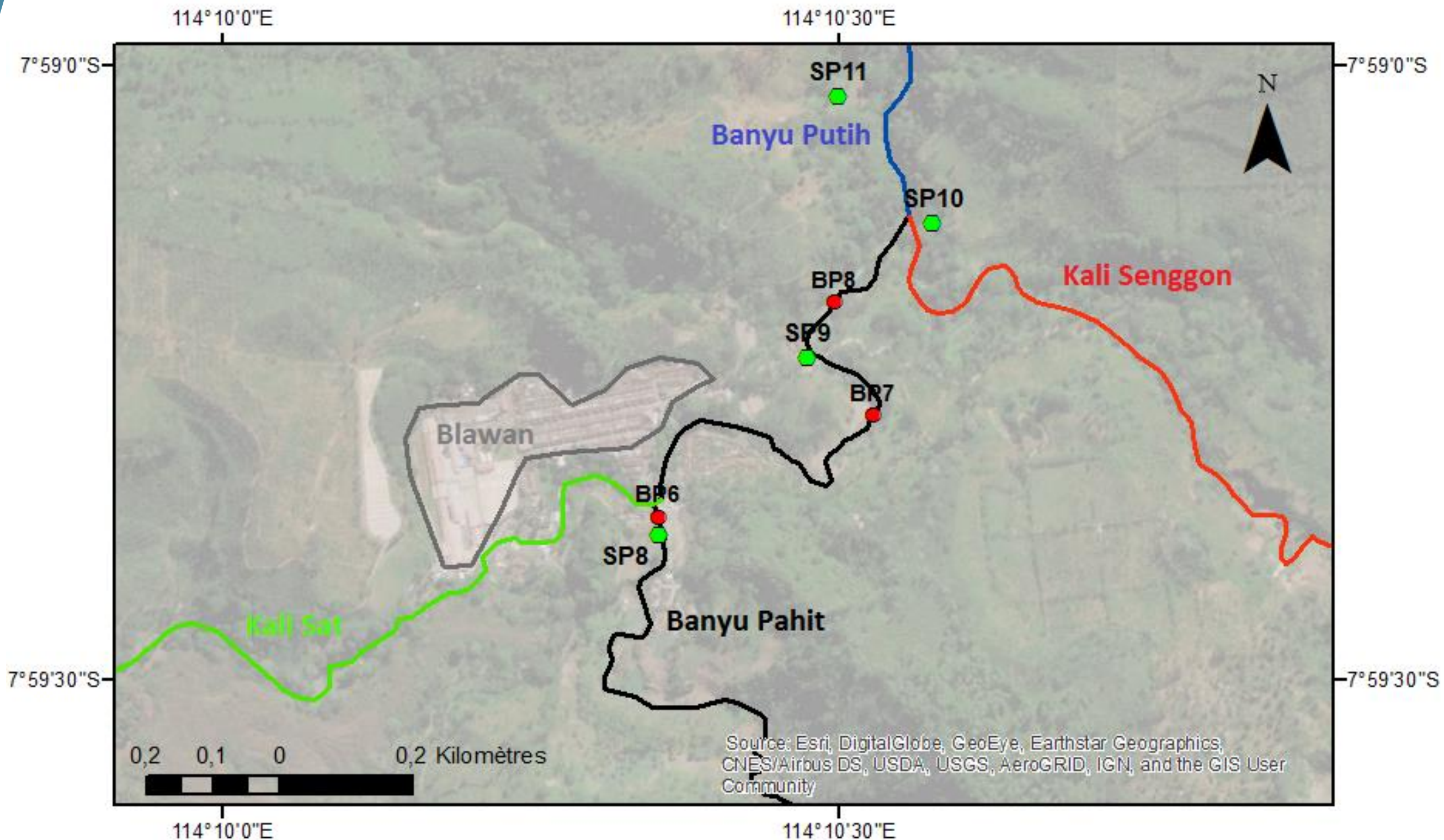


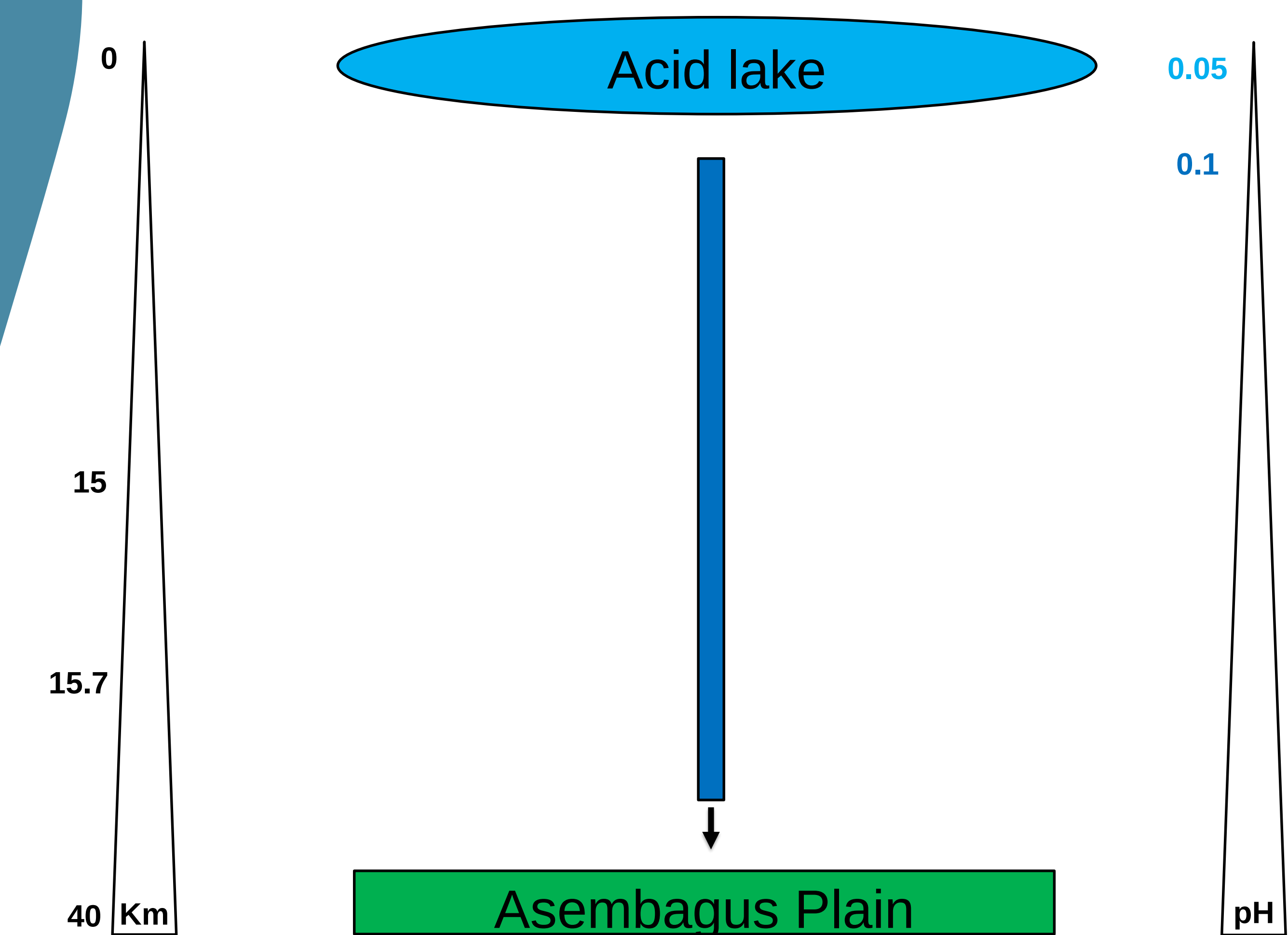
Kawah Ijen, Java Island, Indonesia

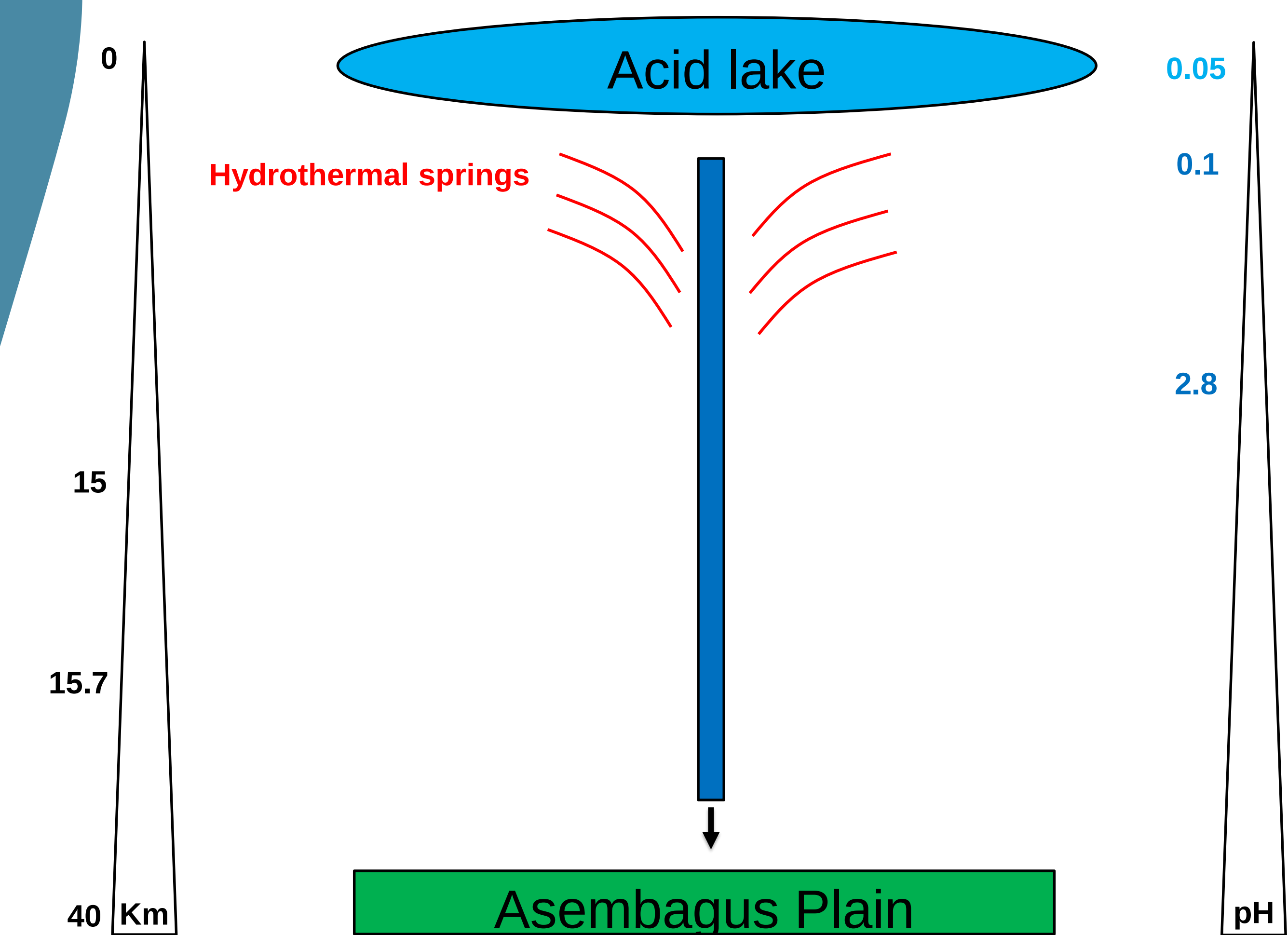


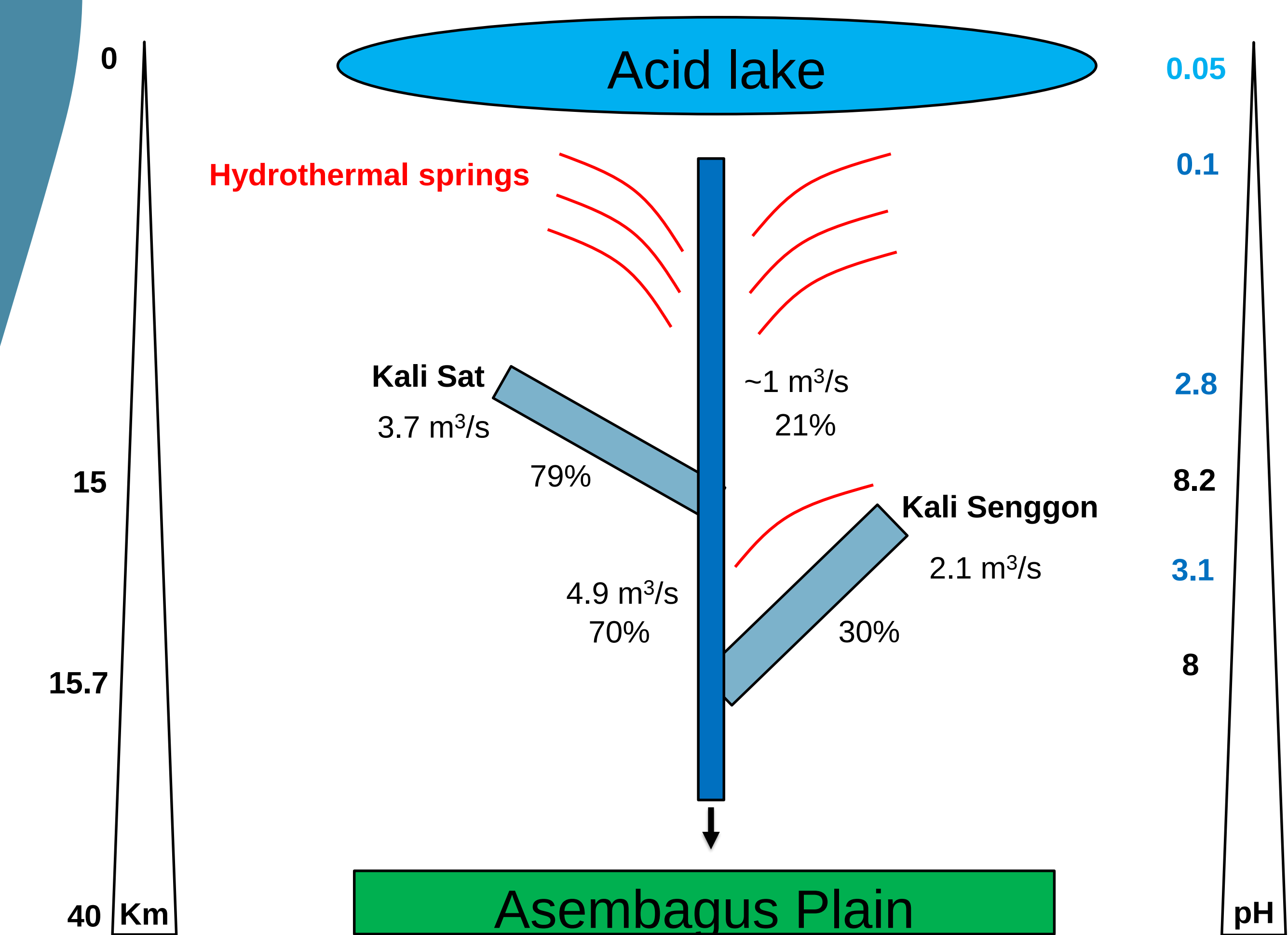


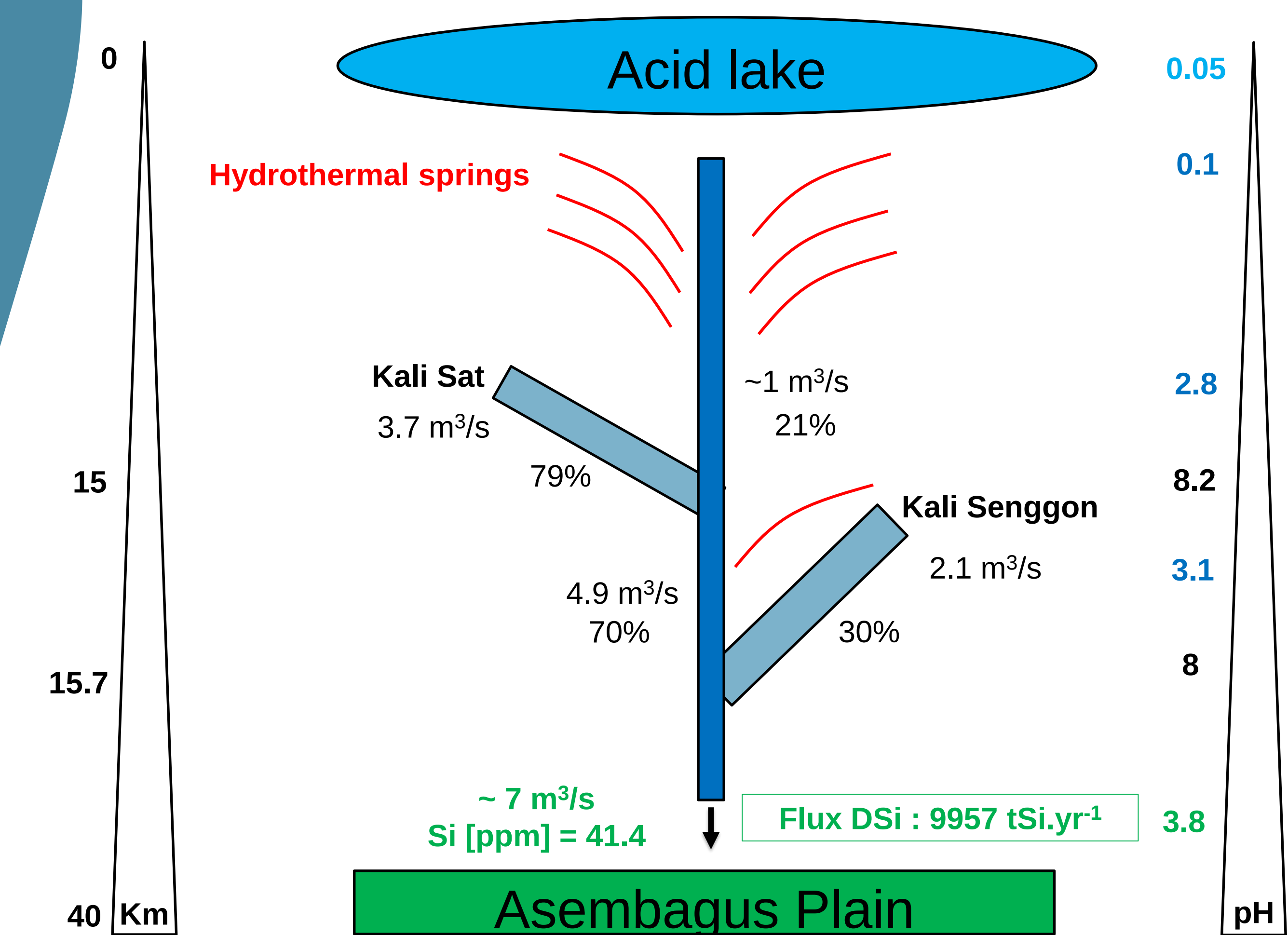
Kawah Ijen, Java Island, Indonesia

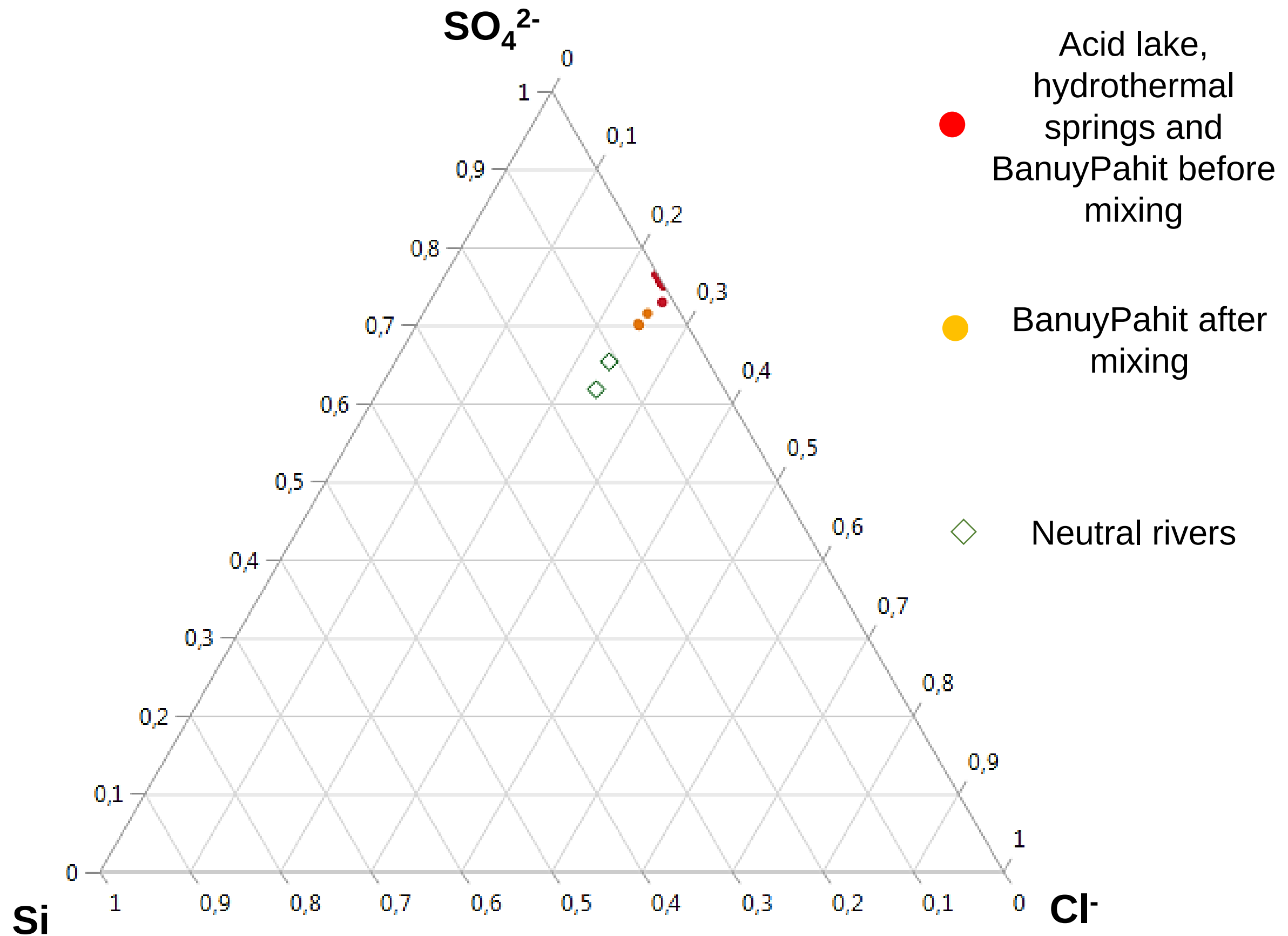


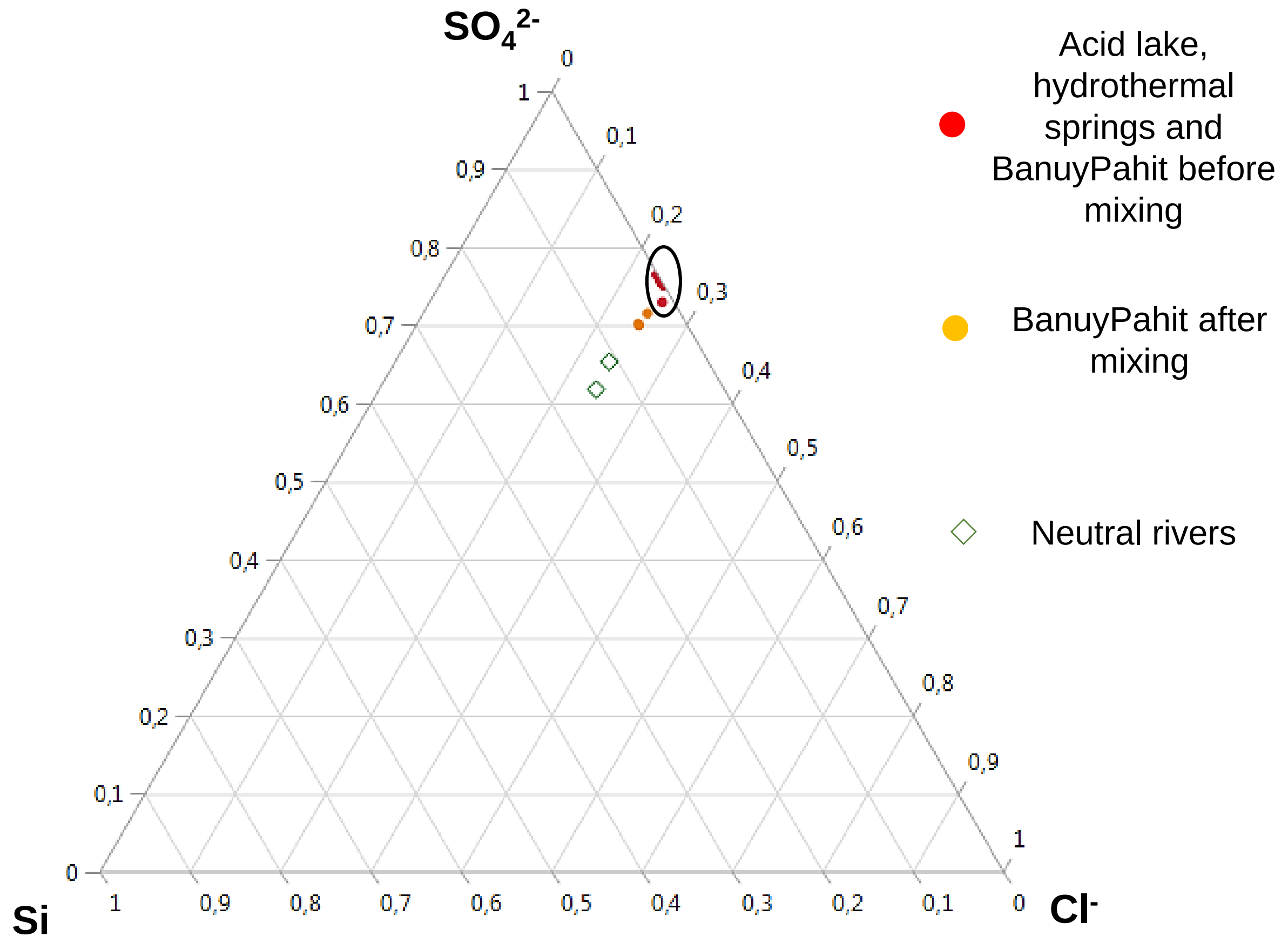


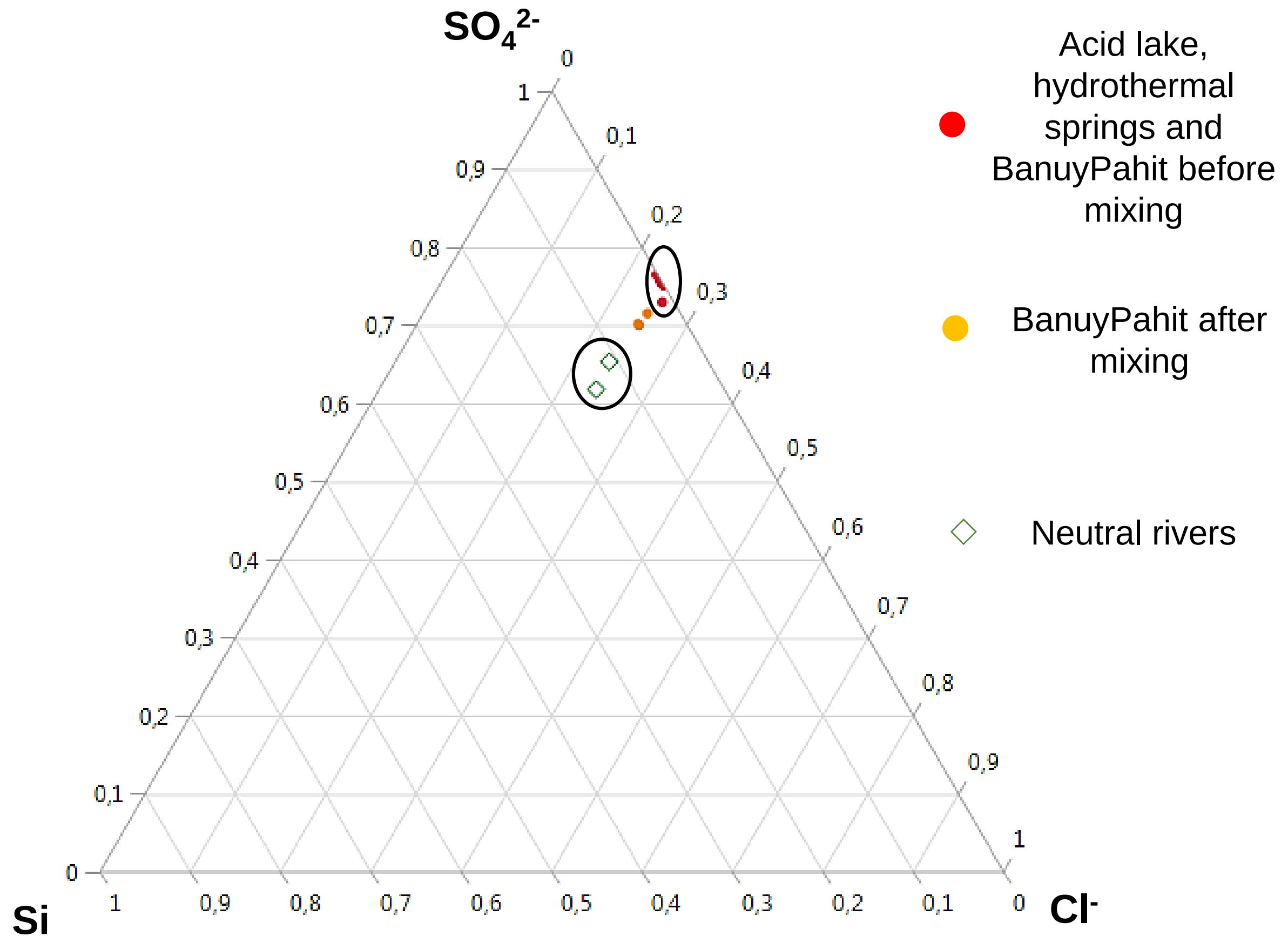


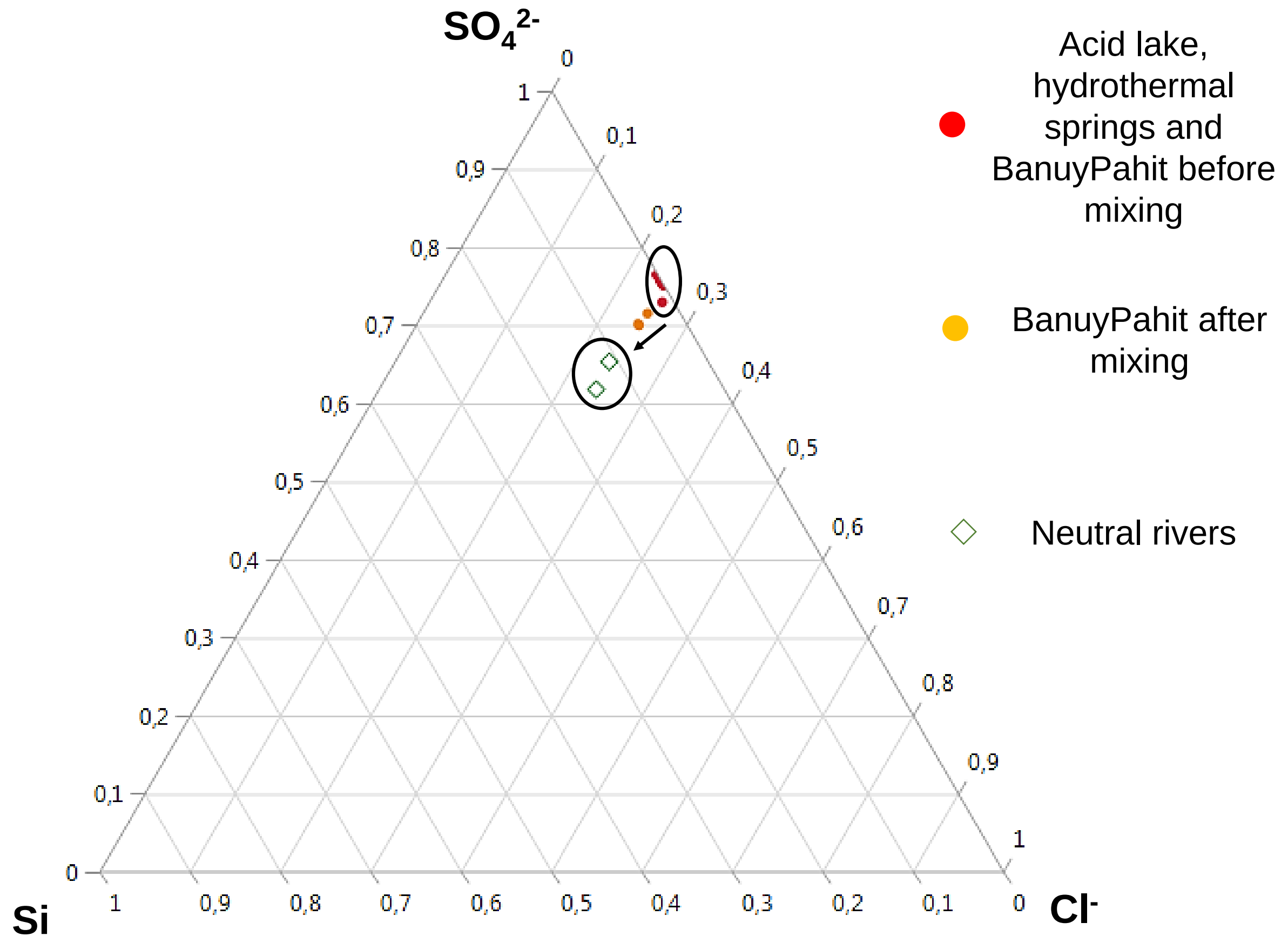














Ge/Si ratio to trace hydrothermal contribution

Si		Ge
Chemical weathering of silicate minerals	Hydrothermal input	Incorporation in secondary minerals
Formation/dissolution of secondary clay minerals		Presence of rich non-silicate crustal materials
Biological cycling by diatoms and phytoliths		Fly ash

Han *et al.*, 2015



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Evans and Derry, 2002



Hydrothermal springs have higher Ge/Si ratio than rivers



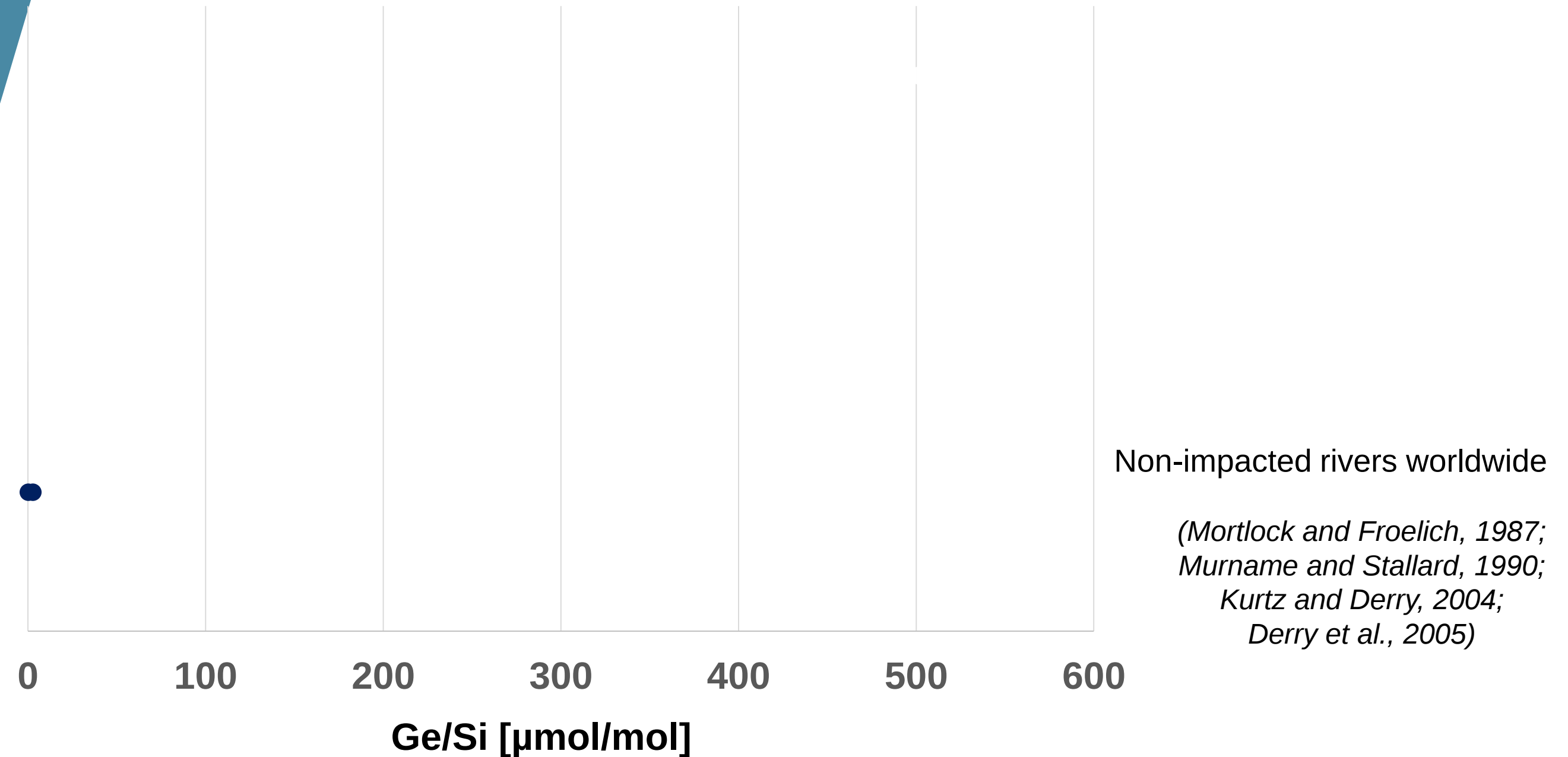
● **River waters** : 0.16 – 2.72 $\mu\text{mol/mol}$

★ **Terrestrial hydrothermal springs** : 2 – 1000 $\mu\text{mol/mol}$

▲ **Oceanic hydrothermal springs** : 0.7 – 60 $\mu\text{mol/mol}$

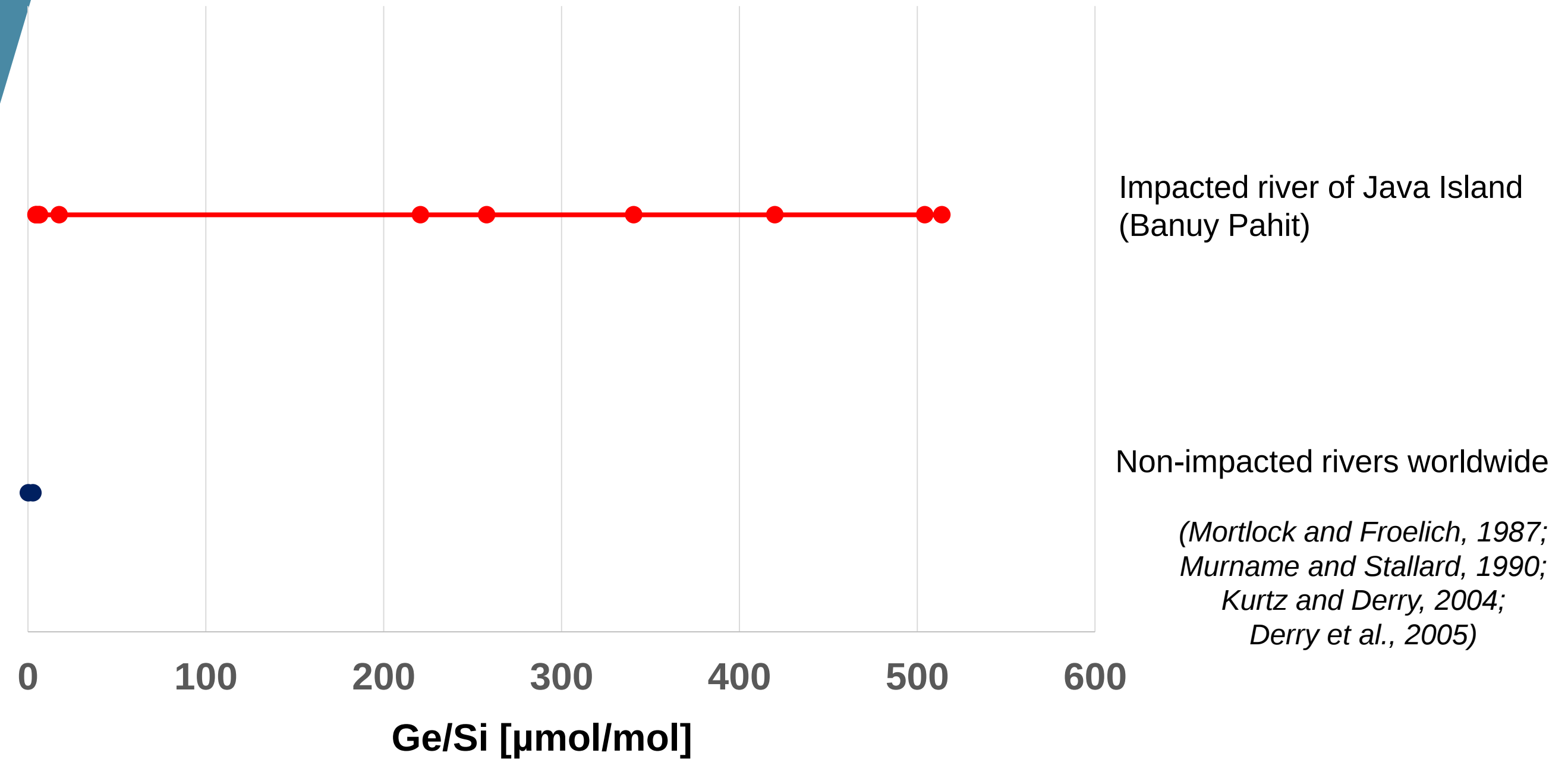


Ge/Si variations in different surface water of Java Island and worldwide



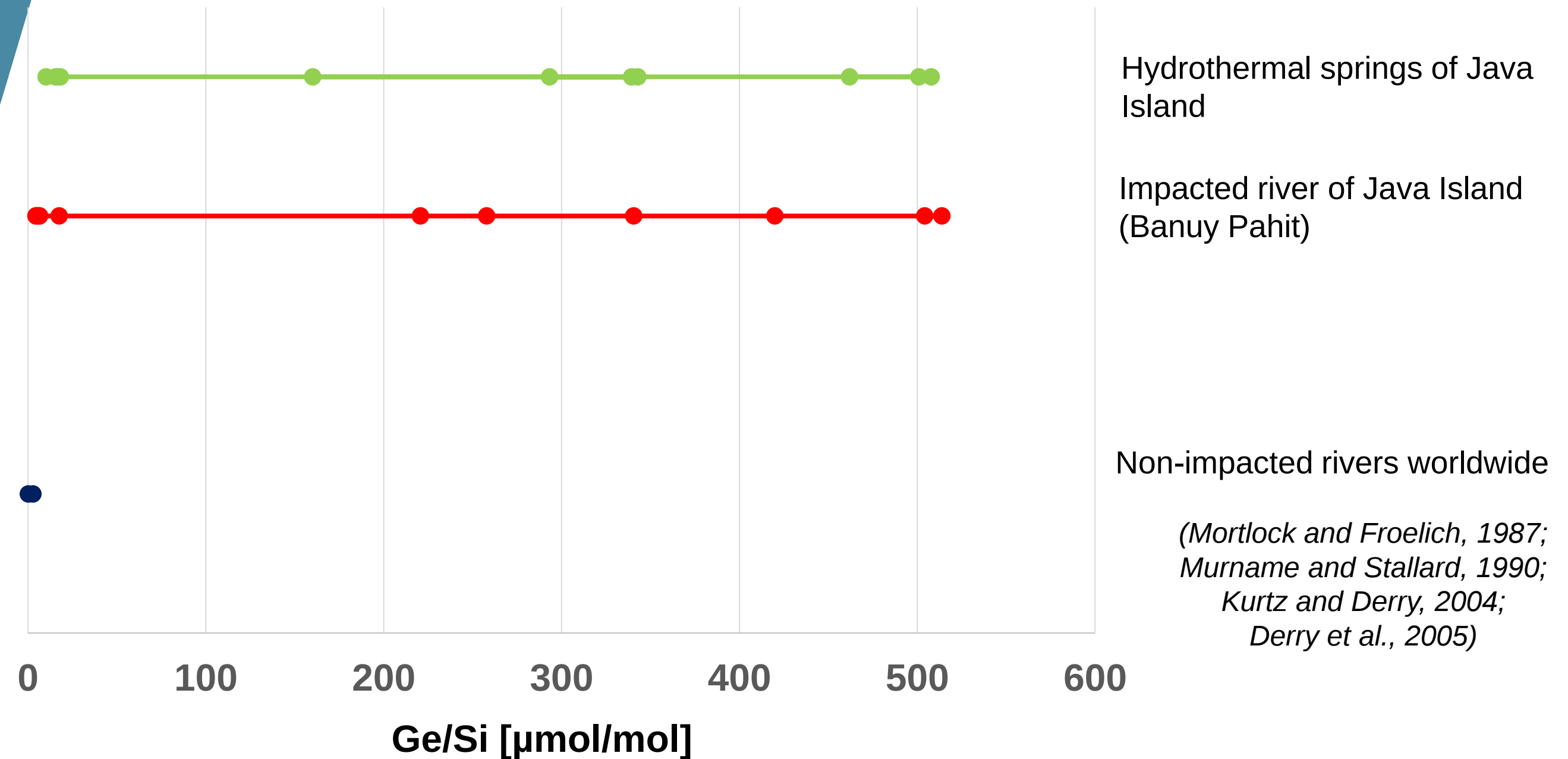


Ge/Si variations in different surface water of Java Island and worldwide



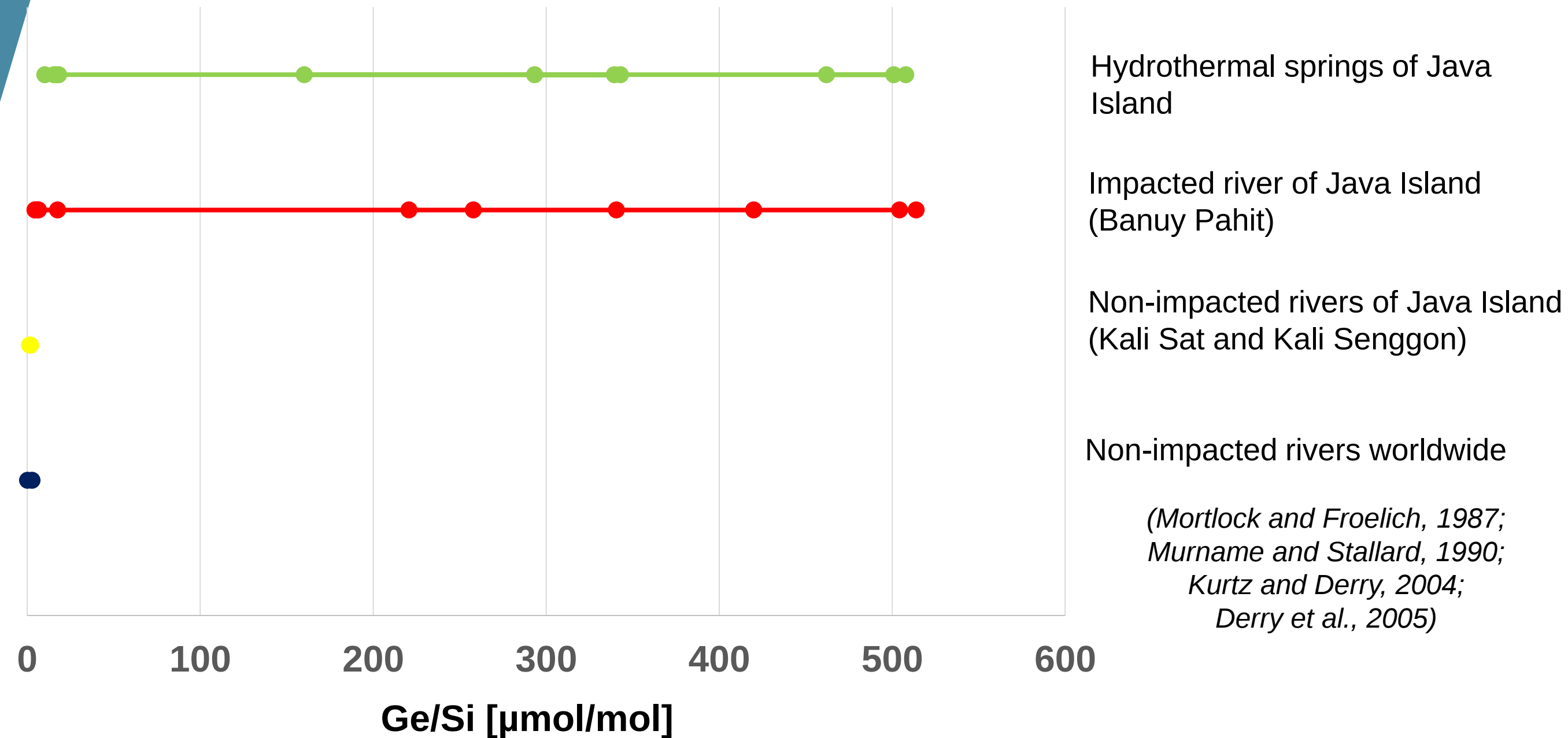


Ge/Si variations in different surface water of Java Island and worldwide



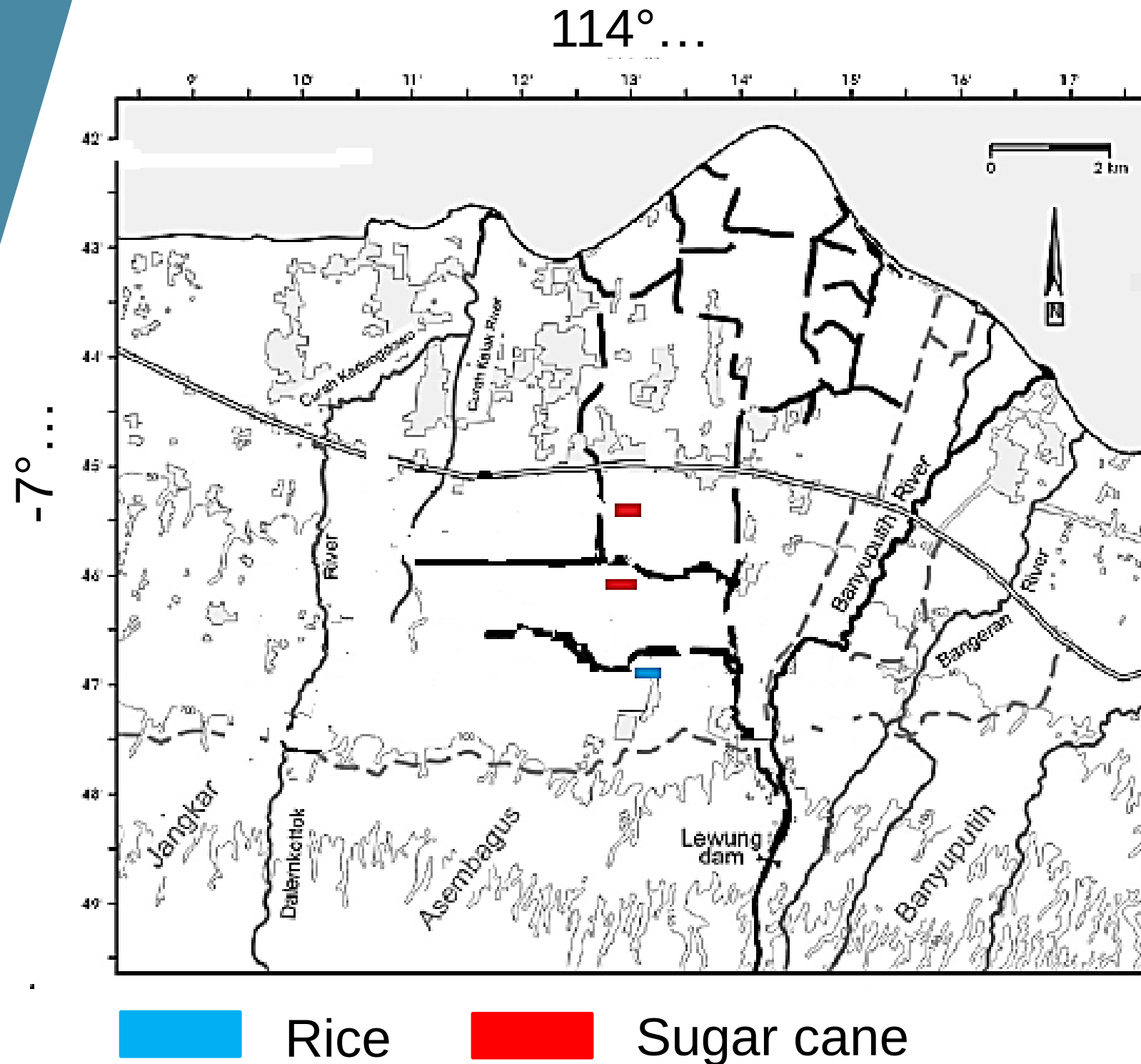


Ge/Si variations in different surface water of Java Island and worldwide





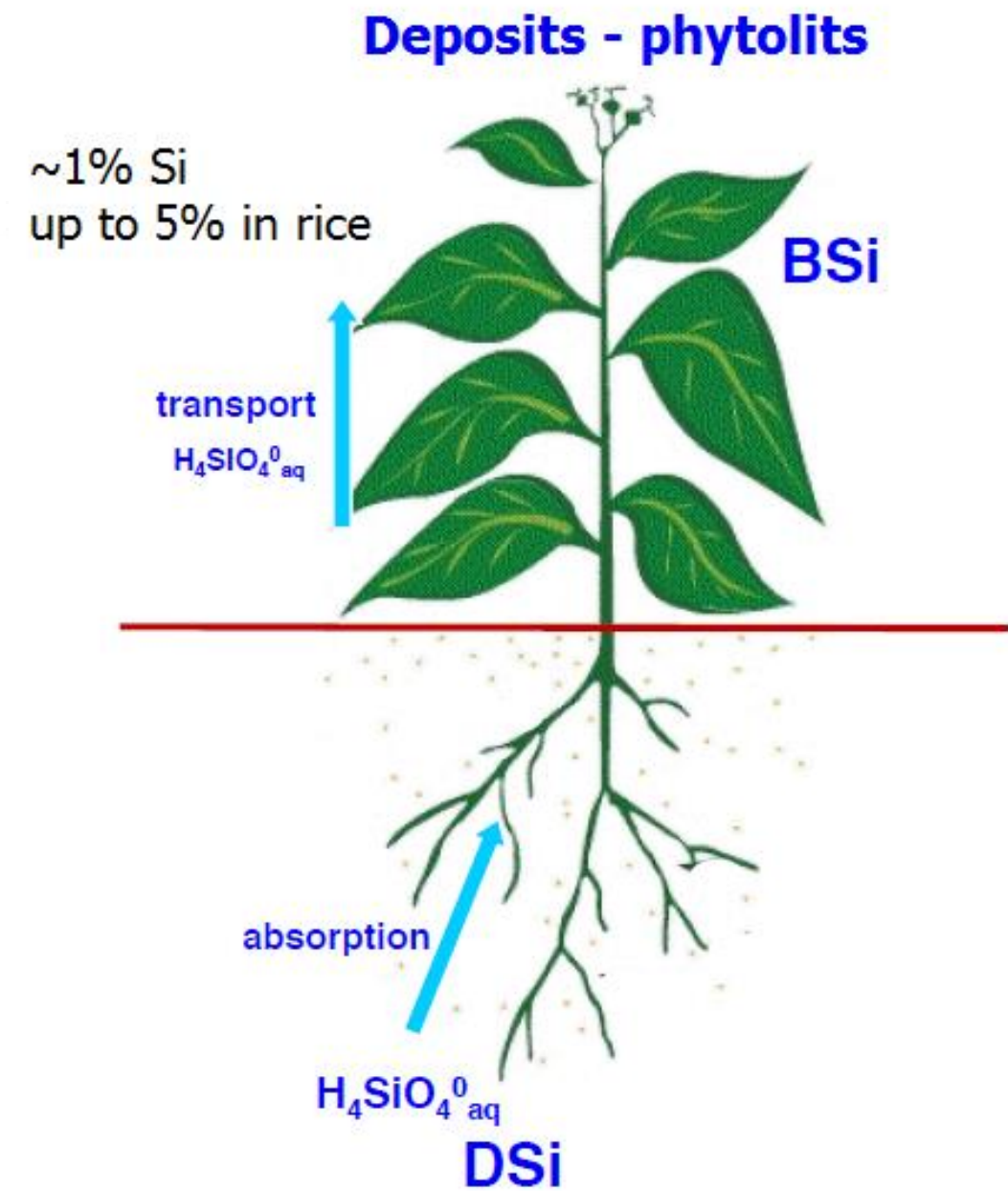
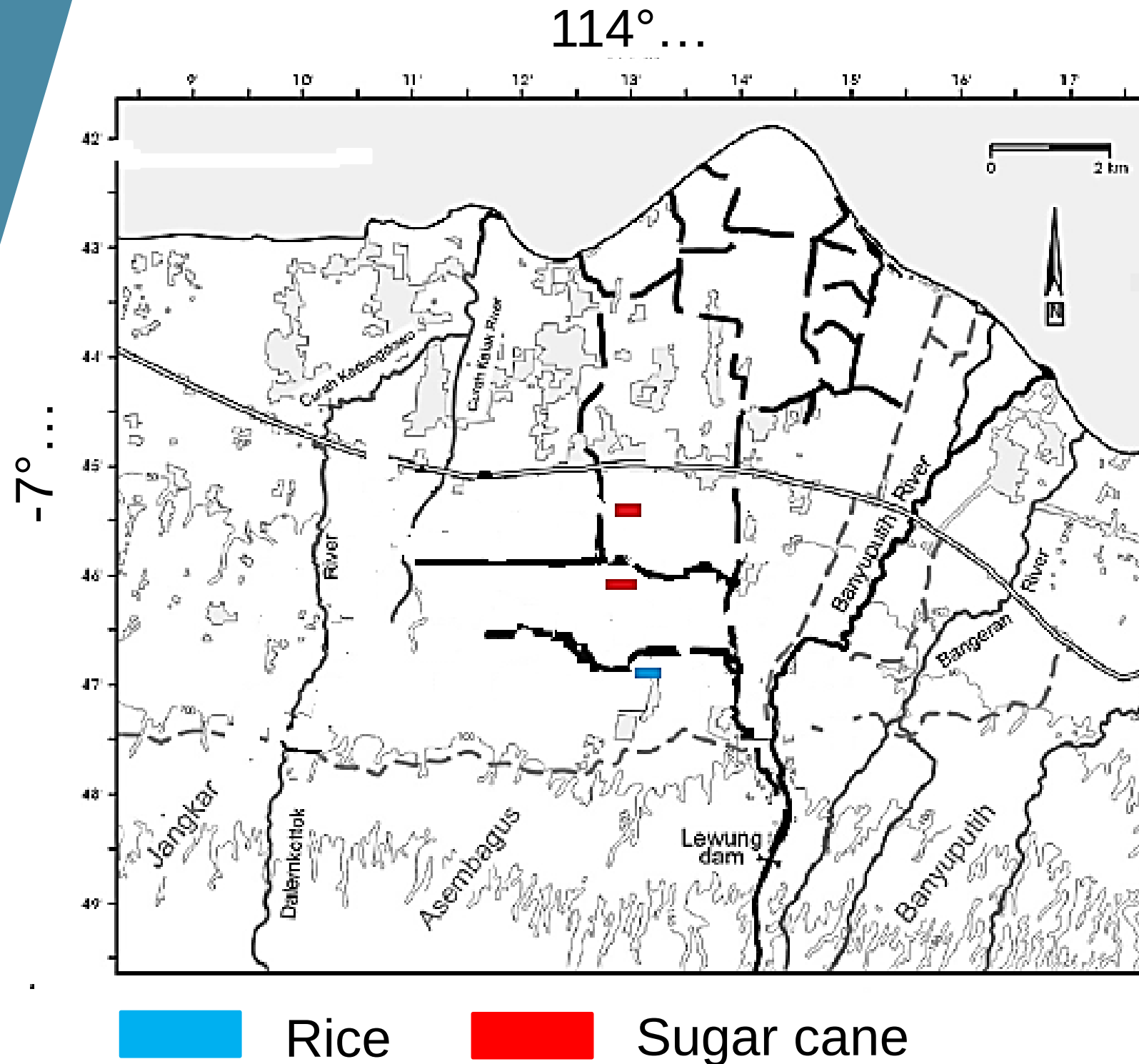
Asembagus Plain is an intensively cultivated zone with Si-accumulating crops



Modified from Van Rotterdam *et al.*, 2008



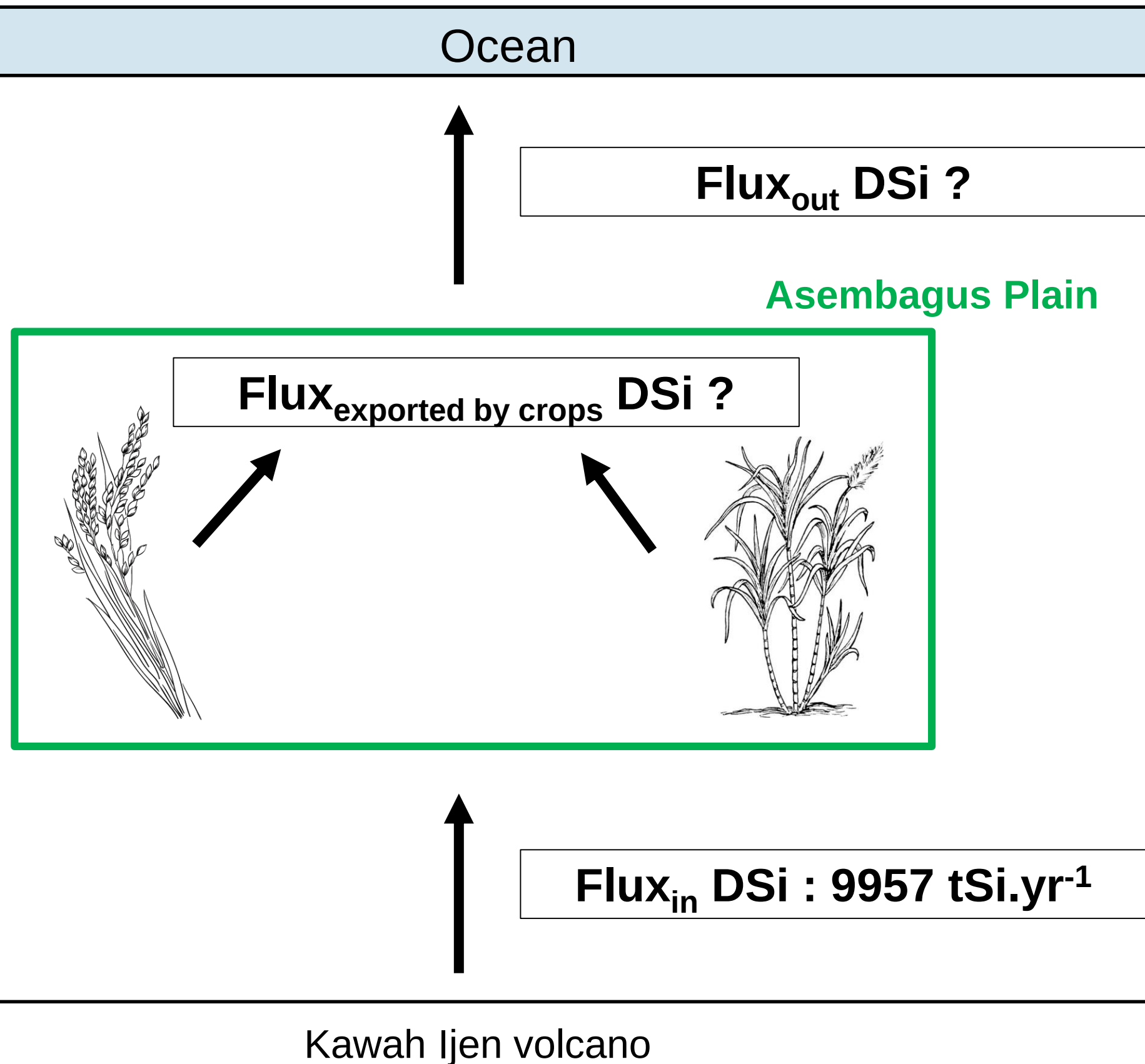
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Methodology on the field



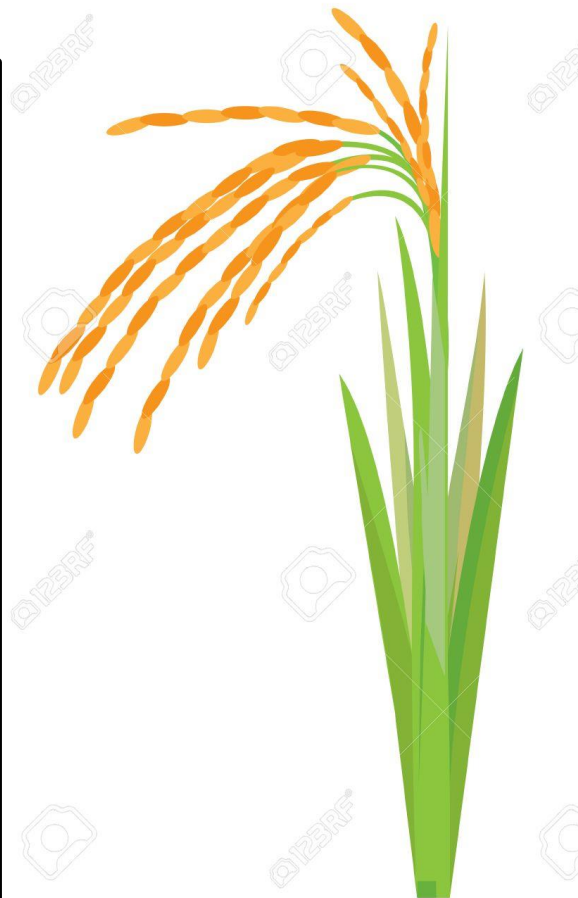


Methodology on the field





Methodology on the field



1. Fresh weight [kg] : total and parts



Methodology on the field



1. Fresh weight [kg] : total and parts
2. Yield [kg/hectare]



Methodology on the field



1. Fresh weight [kg] : total and parts
2. Yield [kg/hectare]
3. Dry weight [kg] : total and parts





Methodology on the field



1. Fresh weight [kg] : total and parts
2. Yield [kg/hectare]
3. Dry weight [kg] : total and parts
4. Si concentration [ppm] by ICP-AES after alkaline fusion





Ocean

Estimated $\text{Flux}_{\text{out}} \text{DSi} : 7579 \text{ tSi.yr}^{-1}$

Asembagus Plain

$\text{Flux}_{\text{exported by crops}} \text{DSi} = 23.9\%$

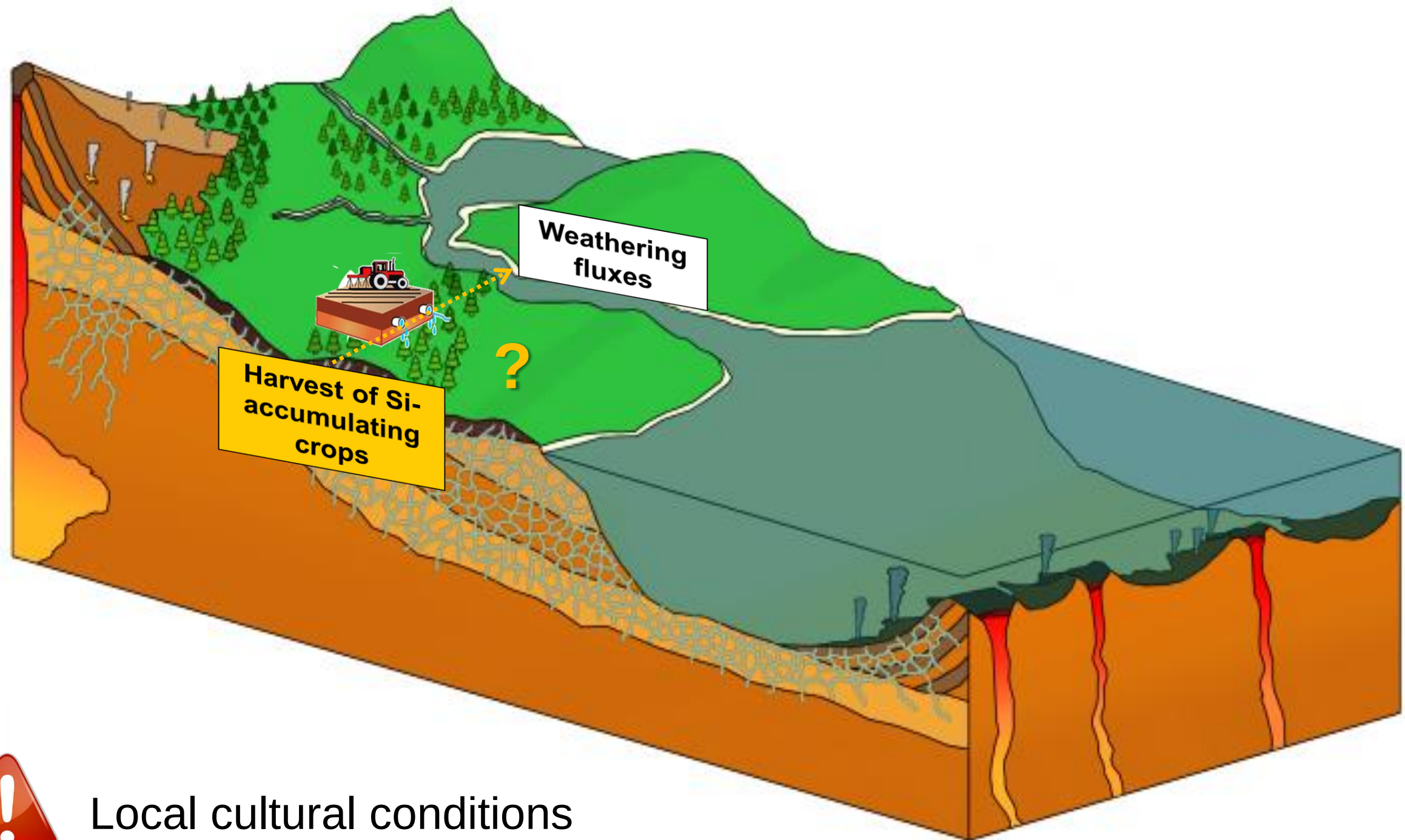


$\text{Flux}_{\text{in}} \text{DSi} : 9957 \text{ tSi.yr}^{-1}$

Kawah Ijen volcano



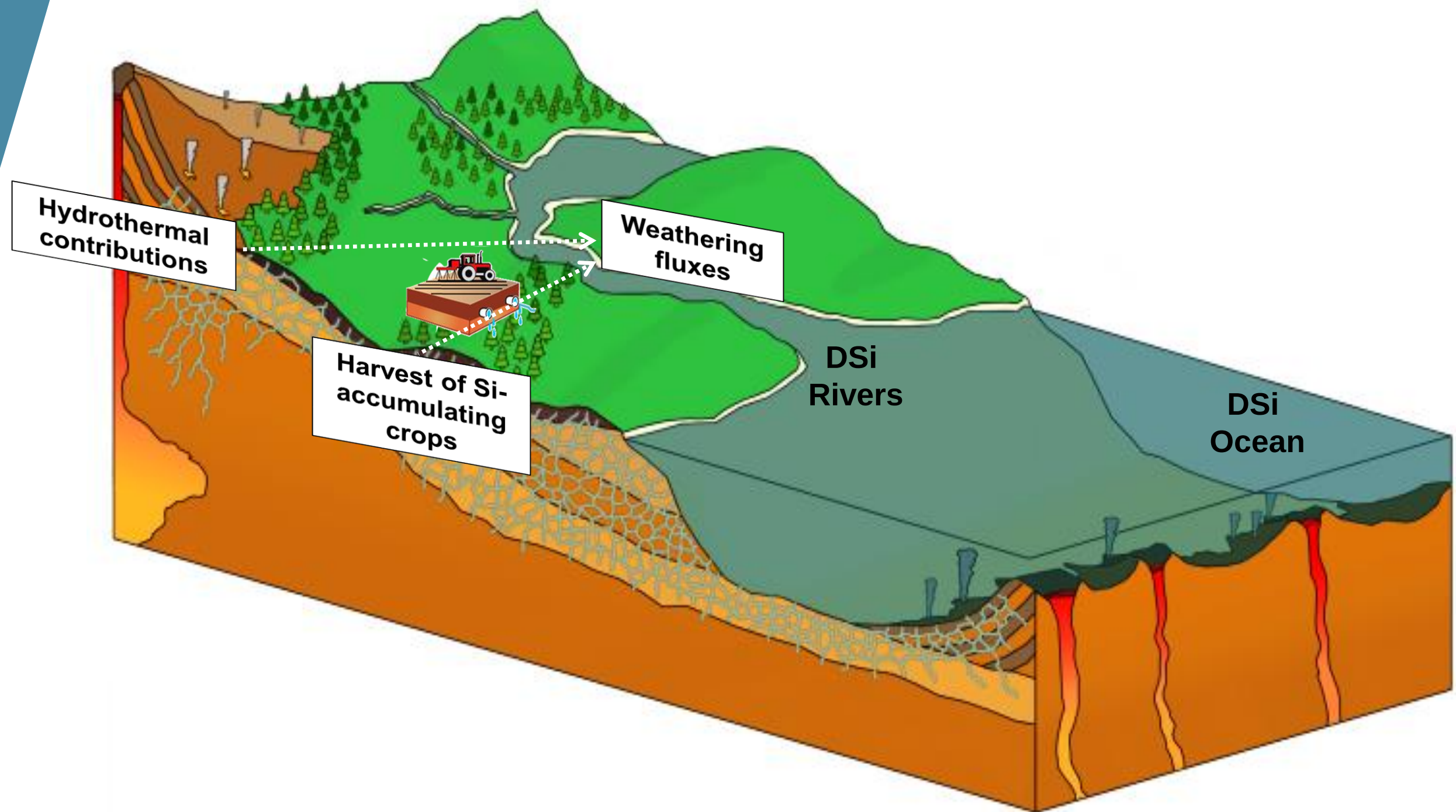
Si fluxes from volcanic island arcs at global scale ?



Local cultural conditions



Conclusions





Thanks for your attention !



Thanks to Antoine de Wasseige, Julien Brack, Corentin Caudron, Alain Bernard.

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