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LOW–FLOW PARAMETERS IN RELATION TO SPECIFIC SOIL TYPES AND GEOLOGY THROUGH LONG–TERM HYDROLOGICAL ANALYSIS

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Motivation

- Nonlinearity of runoff is related to the soil and geological conditions in a basin as well as rainfall, basin scale, and topography.
- The nonlinearity of low flow has been expressed in the storage-discharge relationship.

$$Q = K S^N \text{ (Horton, 1936)} \qquad Q = K^N S^N \text{ (Ding, 2011)}$$

- The equation is now used in many hydrological models for various purposes such as water resources planning and the assessment of projections of climate change impact on runoff.

Motivation

$Q = K^N S^N$ (Ding, 2011) $K = \frac{1}{\alpha N^{\beta}}$ (Fujimura *et al.*, 2015)

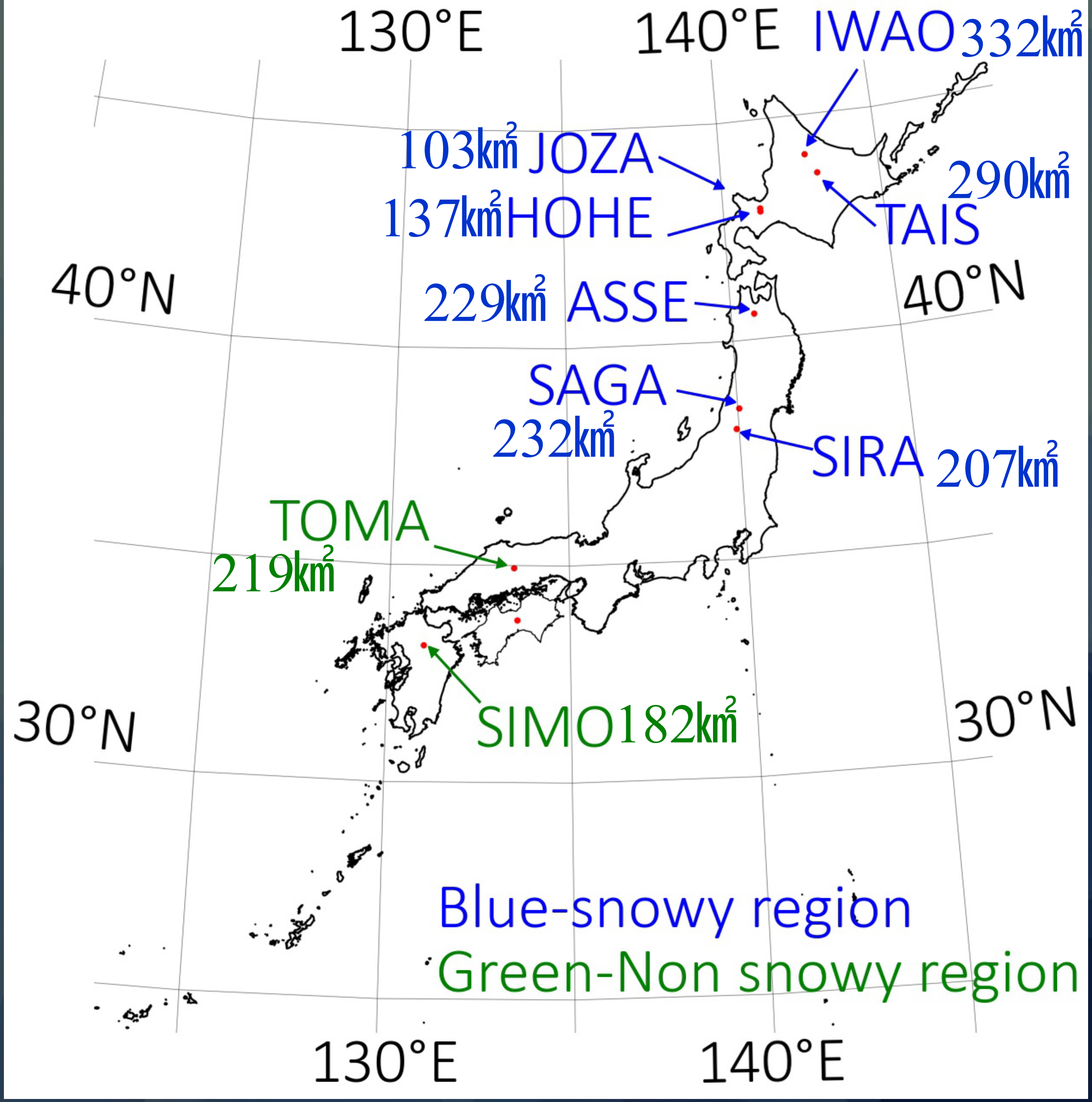
- The relationship between the recession constant *K* and the exponent value *N* was indicated as an inversely proportional equation, and the exponent *N* is presented as the value of 100 for practical use.
- Although the understanding of the storage–discharge equation has been developed, the uncertainties of the parameters have not been resolved, especially for the recession constant *K*.

Objective

- To investigate the statistical correlations between the recession constant K and the coverage rates of specific soil types and the geology in a basin.

Study basins

Basins areas : 103 to 332 km^2



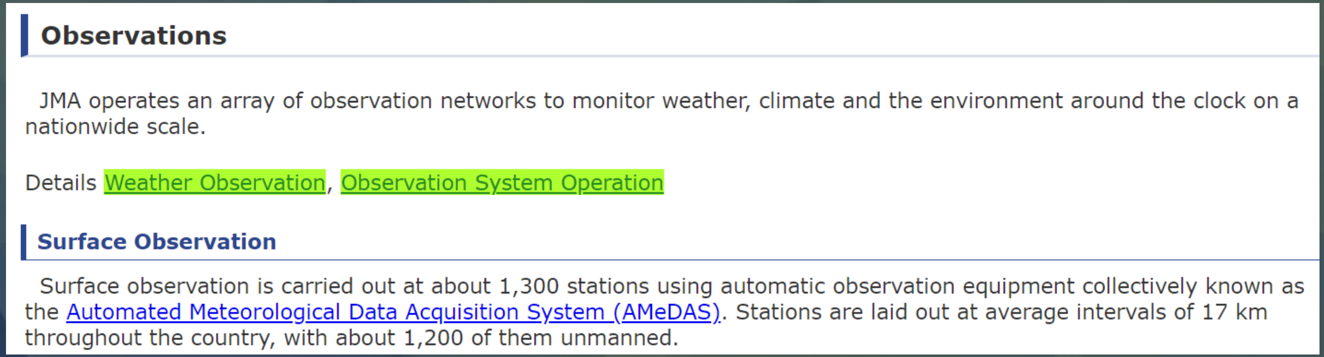
Hourly hydrological data, 14 to 17 years

Study basin	Period, Years
Iwaonai Dam (IWAO)	1 Oct. 2002 – 30 Sept. 2019, 17 Y
Taisetsu Dam (TAIS)	1 Oct. 2002 – 30 Sept. 2019, 17 Y
Hohekyo Dam (HOHE)	1 Oct. 2002 – 30 Sept. 2019, 17 Y
Jozankei Dam (JOZA)	1 Oct. 2002 – 30 Sept. 2019, 17 Y
Asase-Ishikawa Dam (ASSE)	1 Oct. 2002 – 30 Sept. 2019, 17 Y
Shirakawa Dam (SIRA)	1 Oct. 2003 – 30 Sept. 2019, 16 Y
Sagae Dam (SAGA)	1 Oct. 2002 – 30 Sept. 2019, 17 Y
Tomata Dam (TOMA)	1 July 2005 – 30 Sept. 2019, 14.25 Y
Shimouke Dam (SIMO)	1 July 2002 – 30 Sept. 2019, 17.25 Y

Databases

Hourly hydrological data

- *Water Information System* by the Ministry of Land, Infrastructure and Transport
- *AMeDAS* (Automated Meteorological Data Acquisition System) by the Meteorological Agency



Observations

JMA operates an array of observation networks to monitor weather, climate and the environment around the clock on a nationwide scale.

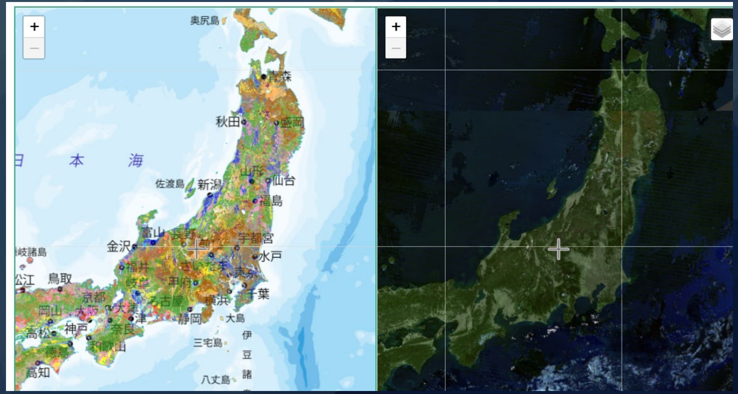
Details Weather Observation, Observation System Operation

Surface Observation

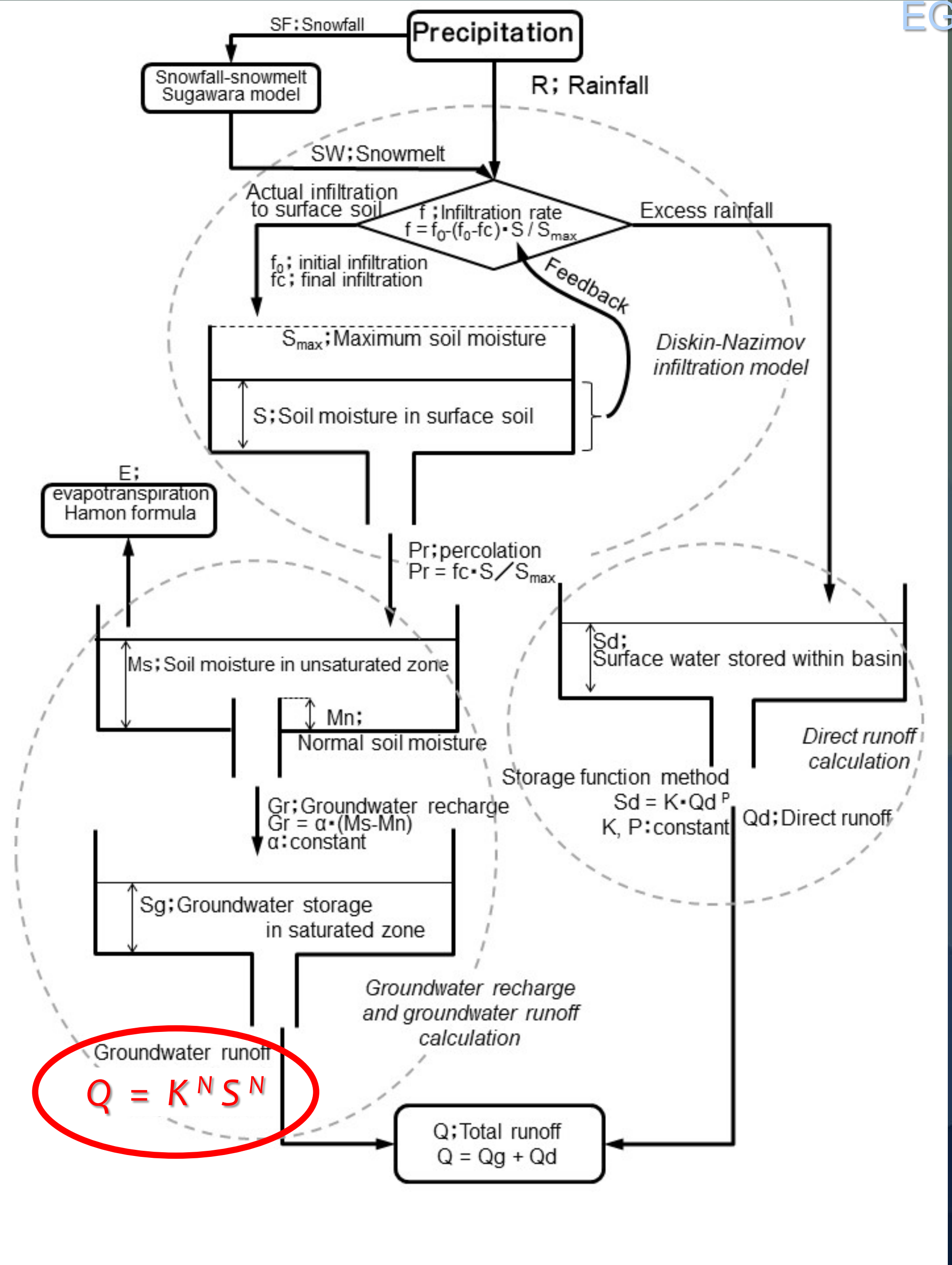
Surface observation is carried out at about 1,300 stations using automatic observation equipment collectively known as the Automated Meteorological Data Acquisition System (AMeDAS). Stations are laid out at average intervals of 17 km throughout the country, with about 1,200 of them unmanned.

GIS data of soil and geology

- *Japan soil inventory (1:200,000)* by the National Agriculture and Food Research Organization (*NARO*)
- *The Seamless Digital Geological Map of Japan (1:200,000)* by the National Institute of Advanced Industrial Science and Technology (*AIST*)



Hydrological model and Sensitive analysis



Fujimura *et al.* (2011)

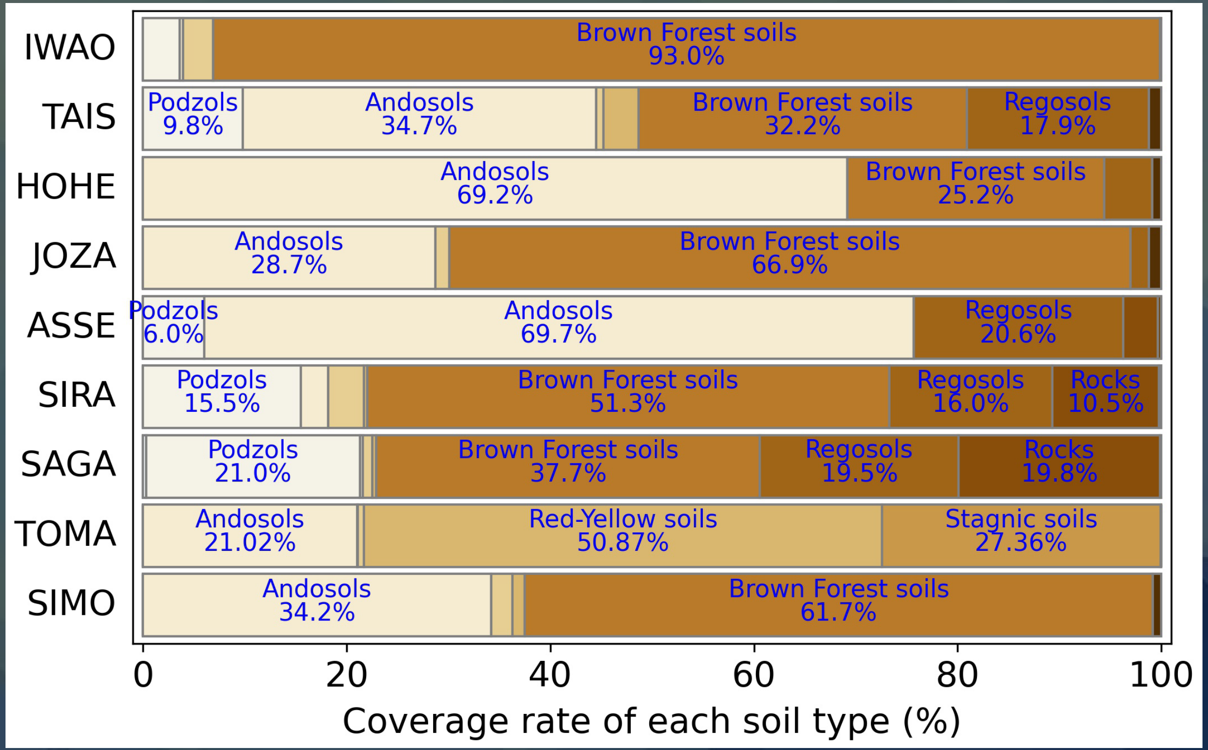
Low flow

$$Q = K^N S^N$$

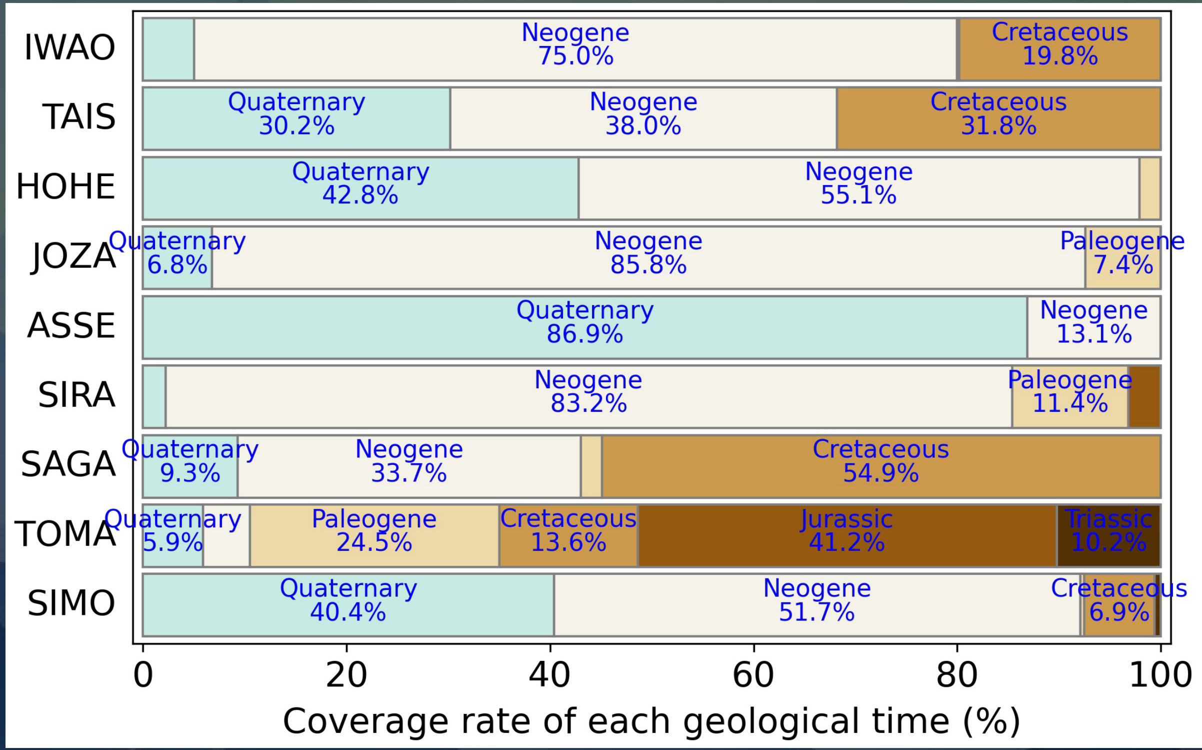
K: recession constant

N: exponent value

The specific soil types and geological information

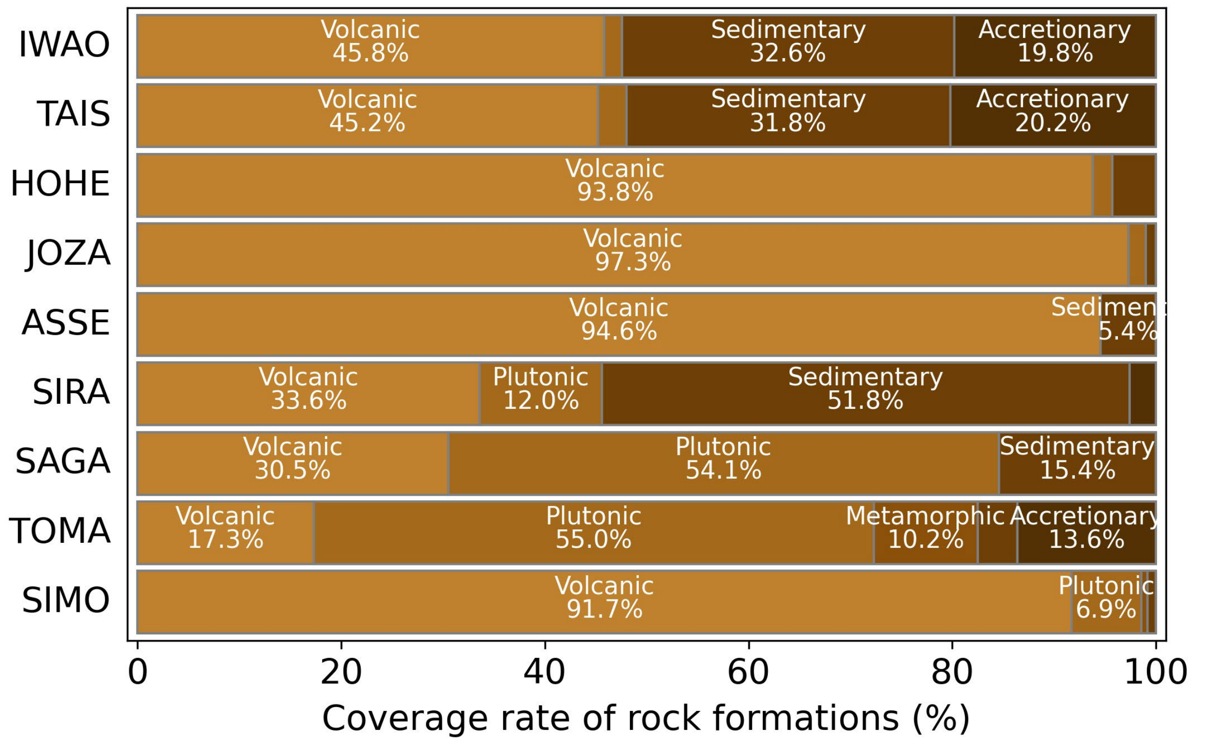


Soil types



Geological time

The specific soil types and geological information

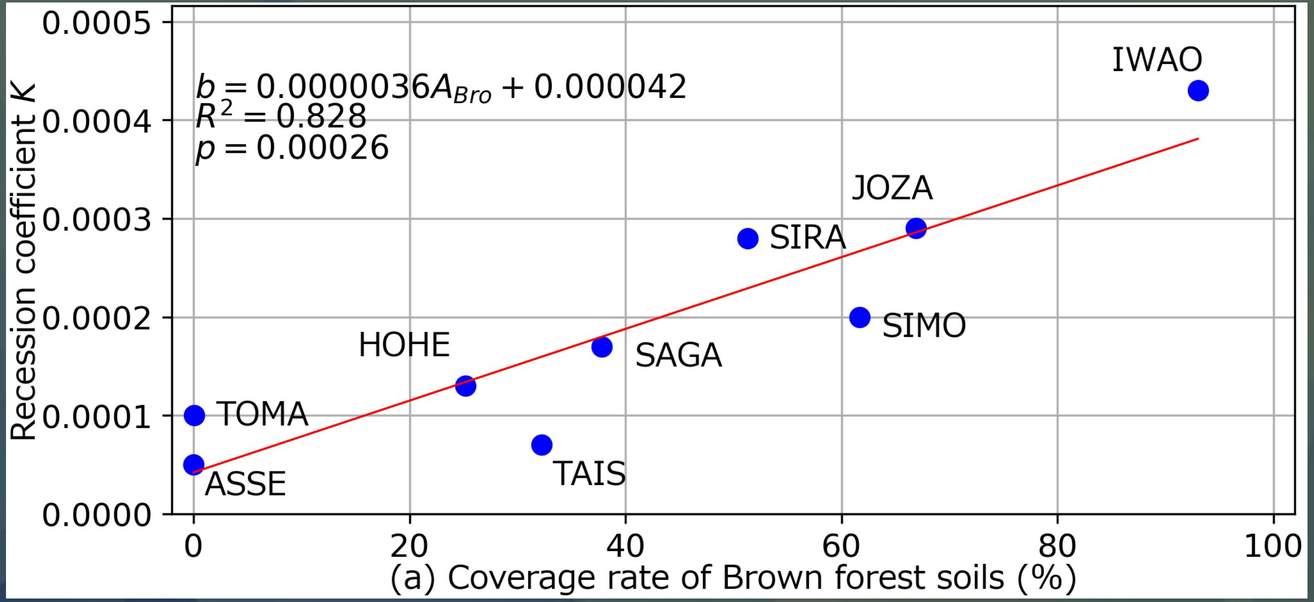


Rock formations

Statistical significance

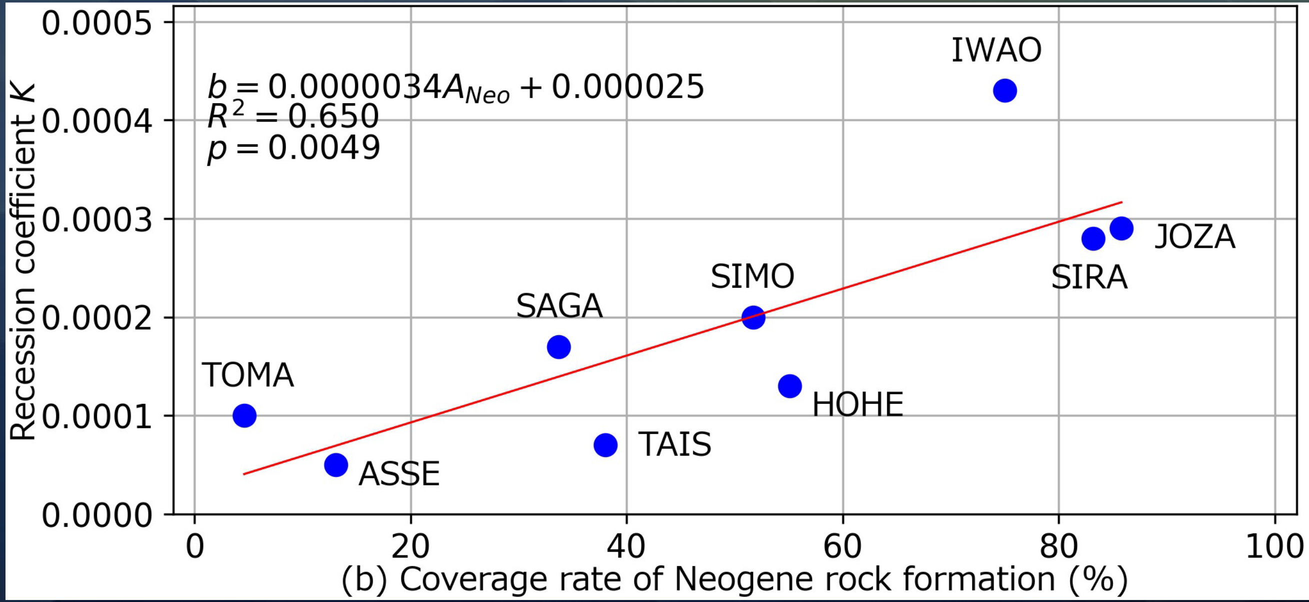
Brown forest soils

p=0.00026



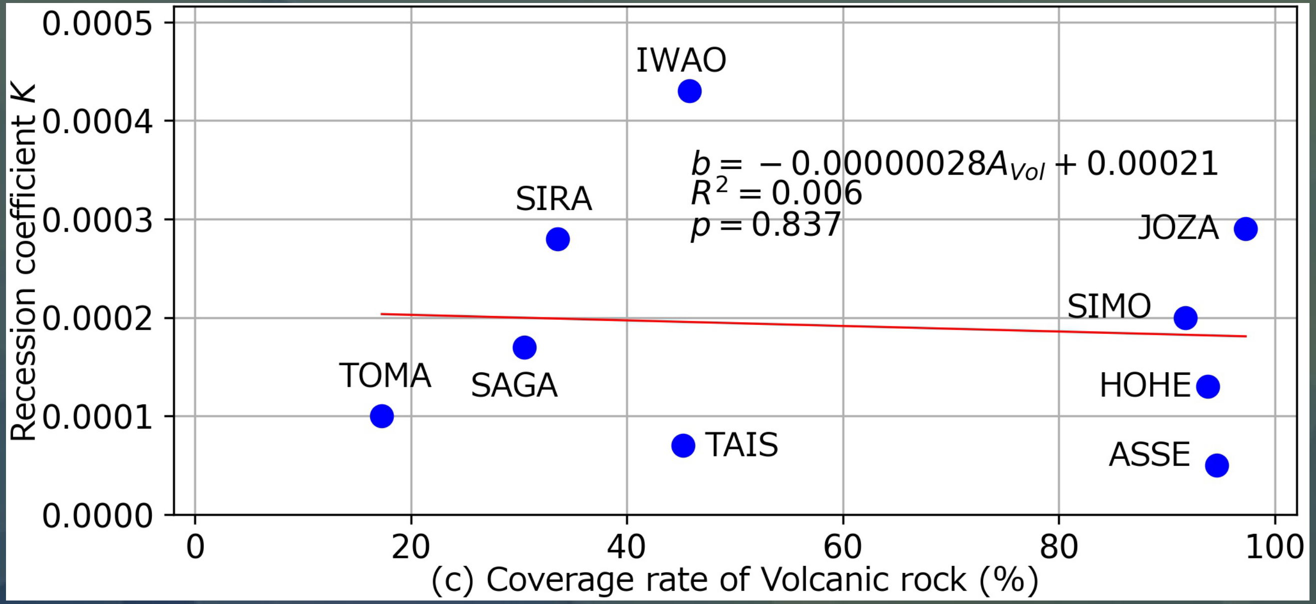
Neogene rock formation

p=0.0049

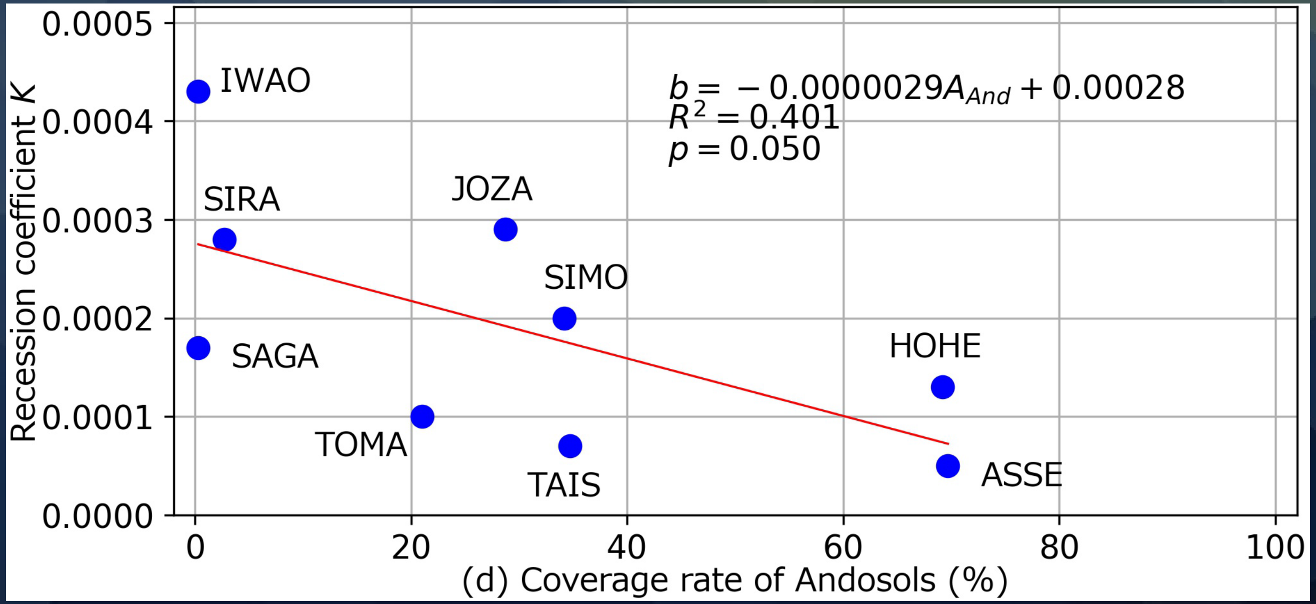


Statistical significance

Volcanic rock
p=0.837



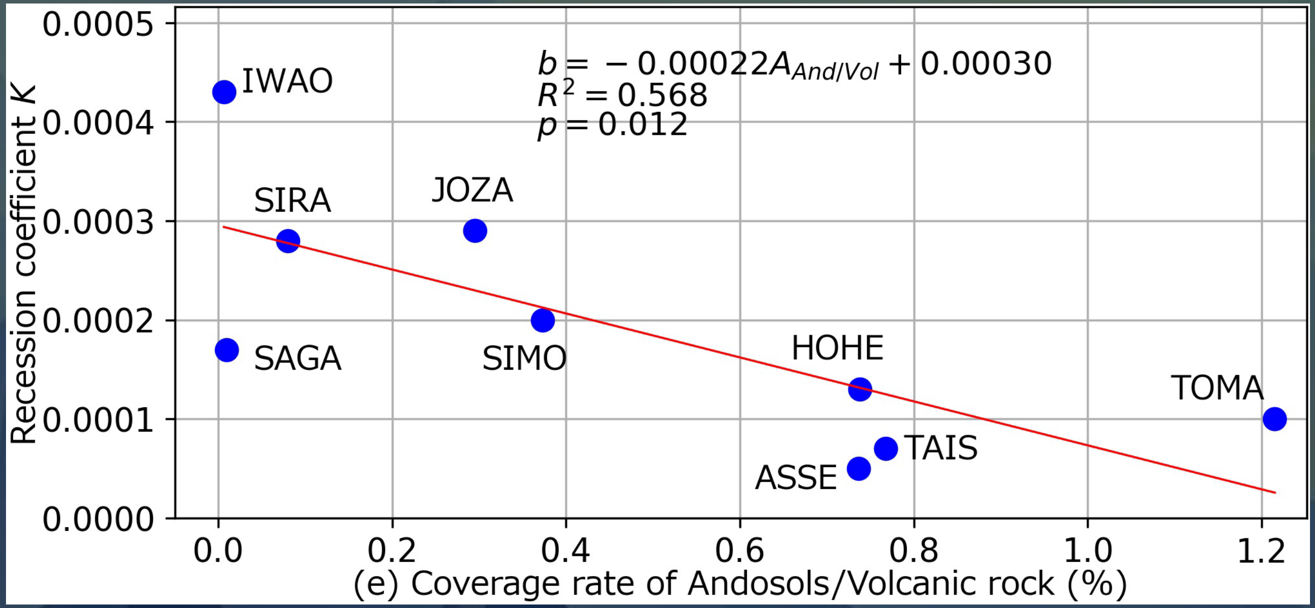
Andosols
p=0.050



Statistical significance

Andosols / Volcanic rock

p=0.012



Results

The results indicate that the recession coefficient K has correlations and significant differences (significance level alpha of 0.05) with the coverage rates

(a) Brown forest soils (p value of 0.00026),

(b) Neogene rock formation (p value of 0.0049), and

(c) Andosols / Volcanic rock formation ratio (p value of 0.012).

The Andosols formation depends essentially on human activity as well as volcanic ash. The volcanic ash and volcanic rock might have been produced in the same geological time. To show the effect of human activity and other environmental factors, the area of Andosols is divided by the area of volcanic rock.