The effects of climate and soil properties on the magnitude of the visual soil quality indicators: a logistic regression approach

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Annexe 1.

Table A1. Logistic regression models in reading form. Models with 2 possible outcomes. Prior probabilities were set as equal.

	Acid Soils	**Alkaline soils**
STR	−3.52835 + 0.24765 x T + 0.06775 x GCI − 0.00522 x (GCI x T) + 0.25819 x LOC	13.09208 – 0.00289 x P + 0.80768 x LOC − 1.57471 x pH
POR	4.60889 − 0.00752 x PET + 1.42841 x SOM − 0.68347 x PR	12.56869 – 0.40961 x T − 0.00724 x PET + 0.00044 x (PET x T) – 0.8099 x pH
STA	−3.69065 + 0.03354 x SILT + 0.63395 x PR + 0.6268 x AI	−5.22783 + 0.0185 x NPP + 0.01467 – 0.00002 x (NPP x PET) + 0.64755 x SOM – 1.74462 pH
PAN	0.23819 + 1.5971 x AI – 0.04696 x SILT – 0.15887 x LOC	21.12372 – 0.00909 x PET – 0.39648 x T + 0.00053 x (PET x T) – 1.88009 x pH
COL	2.51794 – 0.06814 x CLAY – 0.34145 x LOC + 0.04093 x SILT – 0.07547 x GCI	13.82683 – 1.08255 x T – 0.01771 x PET + 0.00107 x (PET x T) + 0.79356 x SOM
EAR	-14.5888 + 0.10028 x GCI + 1.55278 x T – 0.02054 x (GCI x T) + 0.07652 x SAND	2.38052 – 1.41965 x AI – 0.8275 x LOC – 0.04398 x SILT + 0.41356 x PR
ERO	- 3.99222 + 0.0041 x P + 0.09586 x CLAY	-6.77838 + 2.70081 x AI + 0.16633 x SILT + 0.09868 x SAND - 0.00363 x (SAND x SILT)
PON	17.35498 – 19.3623 x AI – 0.5256 x GCI + 0.67869 x (GCI x AI) – 0.11875 x CLAY	18.0547 + 0.00473 x P – 0.09005 x CLAY – 2.31244 x pH

Example of how to use the models

Consider the following record (an actual record of the dataset):

Table A2. Example of a record (recorded in Greece).

ID	Sand	Silt	Clay	PR	pH	LOC	SOM	T	P	PET	AI	NPP	GCI
44c	46.6	41.9	11.5	-	6.9	1.00	7.50	18.7	500	1507	0.33	848	21.1

Soil texture fractions (%); PR= soil penetration resistance (Mpa); pH (-Log[H^+]); LOC=labile organic carbon (mg g^{-1}); SOM= soil otrganic matter (%); T= mean annual temperature (°C); P= mean annual precipitation (mm); AI= Aridity index=P annual mean/PET annual mean; NPP=net primary production potential (g (DM) m^{-2} yr^{-1}), NPP lim= limiting value (NPP temperature or NPP precipitation); GCI=Gorczyński Continentality Index.

To calculate the status of the visual indicator "soil colour", use the model for "soil colour" for the acid soils group (Table A1).

$$logit\ (p) = ln\left(\frac{p}{1-p}\right) = 2.51794 - 0.06814\ x\ CLAY - 0.34145\ x\ LOC\ +\ 0.04093\ x\ SILT - 0.07547\ x\ GCI$$

When we fill in the equation with the record's values (Table A2) and do the calculations, the result is:

$$logit\ (p) = 1.51543$$

Using the logistic transformation:

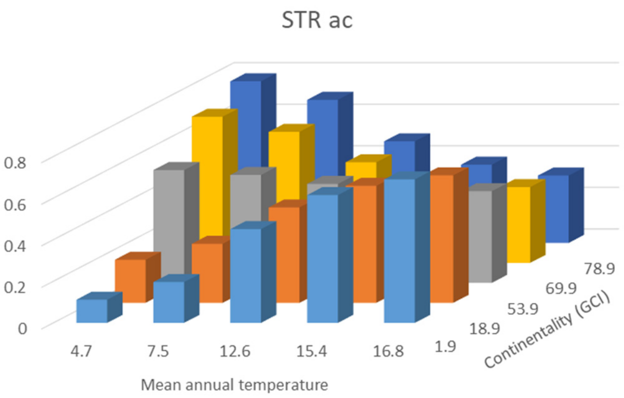
$$p = \frac{e^{1.51543}}{1+e^{1.51543}} = 0.819864539$$

Thus, the probability that this observation has a "soil colour" score of 1 (good) is 82%, or, and this is the same, the probability that the score is 0 (poor + moderate) is 18%. The model correctly classified the observed "soil colour" as belonging to the group "good".

To calculate the probabilities of new records, with high accuracy, do not round the coefficients because small coefficients may hide big effects.

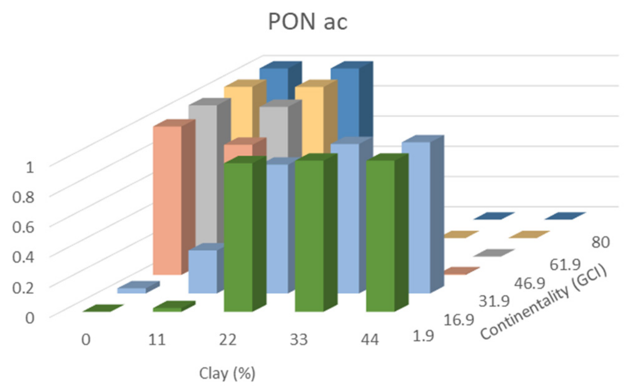
Example of how to interpret the interaction models

The interpretation of the coefficients of the terms of interaction models is not direct. To interpret the interaction effect, the approach proposed consists of calculating the probability of the outcome by varying the value of the main effects interacting, while holding other variables constant (if they exist) and representing it graphically (Figure A1).



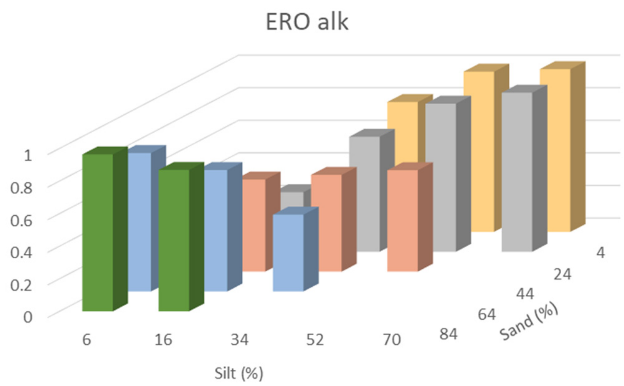
$$-3.52835 + 0.24765 \times T + 0.06775 \times GCI - 0.00522 \times (GCI \times T) + 0.25819 \times LOC$$

a)



$$-12.3737 + 0.51975 \times GCI + 0.75945 \times Clay - 0.03059 \times (GCI \times Clay)$$

b)



$$-6.77838 + 2.70081 \times AI + 0.16633 \times SILT + 0.09868 \times SAND - 0.00363 \times (SAND \times SILT)$$

c)

Figure A1. Interaction models (right column); a) probability of the score good of “soil structure and consistency” in acid soils- interaction between mean annual temperature and continentality (LOC was kept constant); b) probability of the score good of “surface ponding” in acid soils- interaction between clay and continentality (this is not the selected model); c) probability of the score good of “soil erosion” in alkaline soils- interaction between sand and silt (%) (AI was kept constant).