Documentation of Arid Land Soilscapes in Southwestern Europe

Juan José Ibáñez[1], Rufino Pérez-Gómez[2], Cecilio Oyonarte[3], and Eric C. Brevik[4]

1 –National Museum of Natural History, Spanish National Research Council (CSIC), Madrid, Spain 2 – Departamento de Ingeniería Topográfica y Cartografía, Universidad Politécnica de Madrid (UPM), Madrid, Spain 3 – Departamento de Agronomía, Campus Universidad de Almería, Almería, Spain 4 – Dept. of Natural Sciences, Dickinson State University, USA

Introduction

- The southeastern portion of the Iberian Peninsula is the most arid area in Europe
- Land aridity results from the natural conditions as well as from millenary land use
- The role of soil erosion and of past and present land use in causing land degradation are still a matter of debate
- However, little attention has been paid to the information that can be obtained from studying soil landscapes or soilscapes
- The purpose of this study was to analyse the spatial patterns of soils in Almería province, Spain using pedodiversity/biodiversity procedures and mathematical tools to determine if the soil assemblages are typical of arid land conditions

Materials and Methods

- The soil dataset used was the digital soil map of Almería at the scale 1:100,000
- Statistical analysis was conducted on the digitized soil map using geographic information system tools
- The statistical analyses were performed using the drainage basins as basic spatial units
- Each basin was assigned a rank according to the Horton–Strahler method (Figure 1)
- The final layer is made up of 19 complete drainage basins, with ranks between 1 and 4, plus two small portions of the Guadalquivir (rank 6) and Segura (rank 5) river basins, which were not considered relevant for the study
- Soil richness and Shannon's index values were computed for each drainage basin
- Pedotaxa were classified as: (i) dominant soils (not absent in more than 2 drainage basins); (ii) abundant soils (not absent in more than 5 drainage basins); (iii) common soils (not absent in more than ½ the drainage basins); (iv) rare soils or soil minorities (only appeared in 2 drainage basins); (v) endemic or unique soils: (only occurred in one drainage basin); (vi) diosyncratic soils (only present in the 8 basins of greater extent and/or higher Hortonian rank); and (vii) other soils

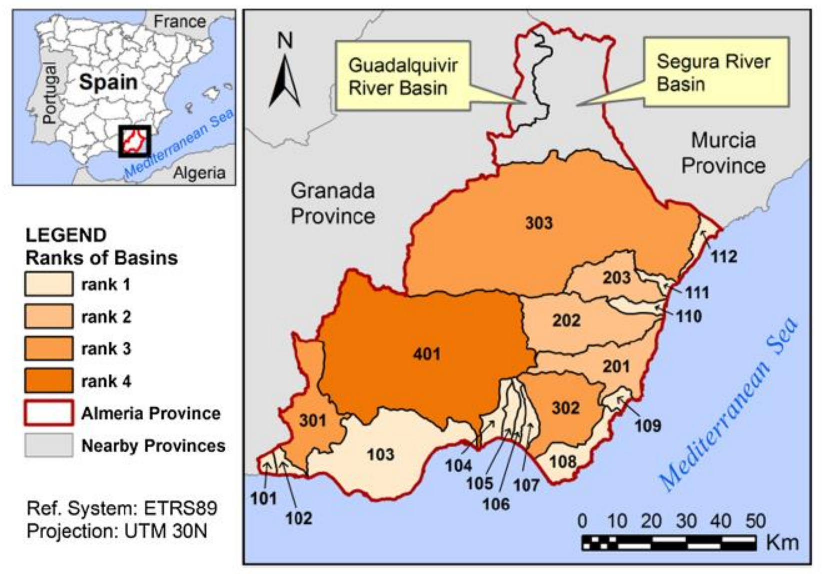

Figure 1. The Almería province study area with the drainage basins and their Hortonian ranks.

Table I. Major soil groups (WRB, 1998) of the Almería province

MSG	Soil types for MSGs in soil map: Number	Area (km²)	Area (%)	Soil types for MSGs including other sources
Regosols	7	4,044·77	52·41	11
Leptosols	3	1,246·12	16·15	6
Calcisols	4	756·53	9·80	5
Cambisols	6	611·73	7·93	9
Fluvisols	4	466·13	6·04	5
Solonchaks	2	154·19	2·00	4
Luvisols	2	146·30	1·89	1
Phaeozems	3	119·09	1·54	3
Anthrosols	1	91·58	1·19	1
Sands[a]	1	26·86	0·36	1
Arenosols	2	24·72	0·32	2
Gypsisols	2	11·39	0·15	4
Salinas[a]	1	10·07	0·13	1
Vertisols	1	3·01	0·04	2
Umbrisols	1	2·34	0·03	1
Water bodies[a]	1	1·35	0·02	1
Gleysols	1	0·69	0·01	1
Urban soils	1	0·50	0·01	1
Kastanozems	1	0·02	<0·01	2
Chernozems	1			1
Total	44	7,717·42		62

MSG, major soil group; WRB, World Reference Base.
[a]Miscellaneous units that are not soil but are included in the soil map legend.

Table II. Abundance, or area covered, by each soil type (WRB, 1998) in Almería province

Soil types (acronyms)	Area (%)
Calcaric Regosol (RGca)	27·44
Lithic Leptosol (LPli)	14·04
Leptic Regosol (RGle)	13·41
Eutric Regosol (RGeu)	10·78
Aridic Calcisol (CLad)	5·64
Calcaric Cambisol (CMca)	5·16
Calcaric Fluvisol (FLca)	4·82
Eutric Cambisol (CMeu)	2·15
Rendzic Leptosol (LPrz)	1·96
Aridic Solonchak (SCad)	1·83
Haplic Calcisol (CLha)	1·69
Chromic Luvisol (LVcr)	1·44
Luvic Calcisol (CLlv)	1·36
Terric Anthrosol (ATtr)	1·19
Epipetric Calcisol (CLptp)	1·11
Luvic Phaeozem (PHlv)	1·01
Eutric Fluvisol (FLeu)	0·70
Skeletic Arenic Fluvisol (FLsk_ar)	0·52
Chromic Cambisol (CMcr)	0·51
Calcic Luvisol (LVcc)	0·46
Dystric Regosol (RGdy)	0·38
Leptic Phaeozem (PHle)	0·37
Sands (Mare)[a]	0·35
Gypsiric Regosol (RGgp)	0·33
Albic Arenosol (ARab)	0·20
Calcaric Phaeozem (PHca)	0·17
Gleyic Solonchak (SCgl)	0·16
Umbric Leptosol (LPum)	0·14
Salinas (Msal)[a]	0·13
Aridic Arenosol (Arad)	0·12
Dystric Cambisol (CMdy)	0·09
Aridic Gypsisol (GYad)	0·07
Hypergypsic Gypsisol (GYgyh)	0·07
Anthric Urbic Regosol (RGah_ua)	0·05
Chromic Vertisol (VRcr)	0·04
Leptic Umbrisol (UMle)	0·03
Water bodies (Memb)[a]	0·02
Gleyic Cambisol (CMgl)	0·01
Dystric Gleysol (GLdy)	0·01
Anthric Spolic Regosol (RGah_sp)	0·01
Vertic Cambisol (CMvr)	0·01
Urban Soils (Mnuc)[a]	0·01
Dystric Fluvisol (FLdy)	0·01
Calcic Kastanozem (KScc)	<0·01

WRB, World Reference Base.
[a]Miscellaneous units that are not soil but are included in the soil map legend.

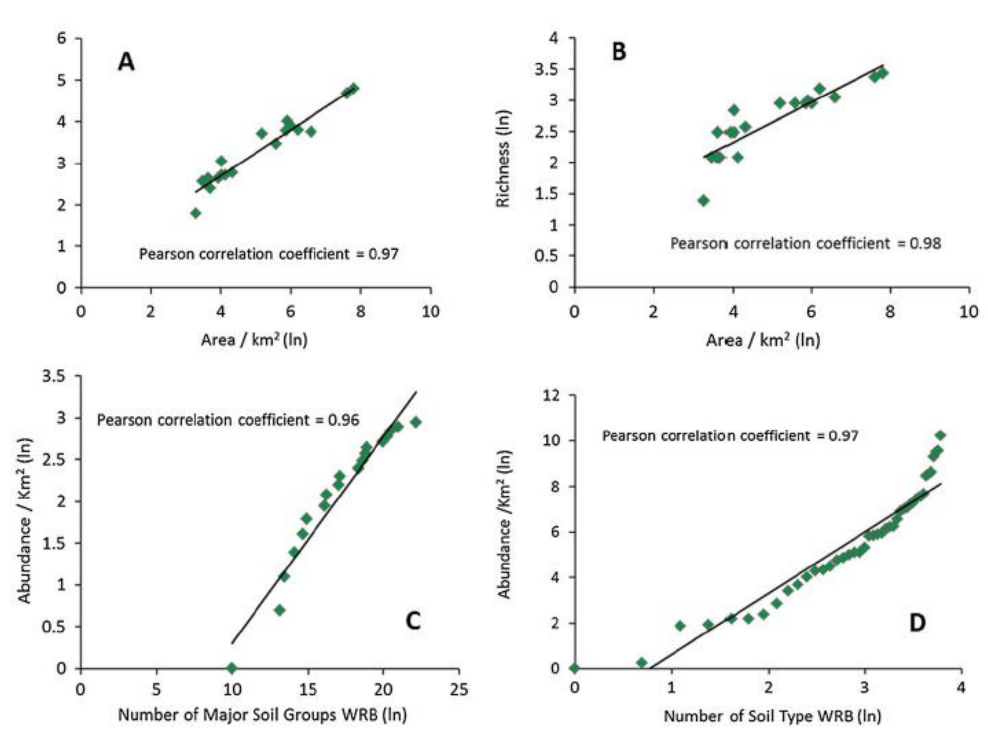

Figure 2. A Power law fit of the number of soil associations mapped according to the surveyed area increase. B Power law fit of the number of soil types by the surveyed area increase. C Power fit of the major soil groups according to the rank abundance. D Power fit of the soil types according to the rank abundance, all log transformed.

Table III. Mean pedorichness and Shannon index of the drainage basins grouped according to their Hortonian rank

Hortonian basin rank[a]	Soil richness	Shannon index
1	11·83	1·73
2	20·67	2·06
3	23·33	2·14
4	29·00	2·35

[a]According to the Horton–Strahler method (Strahler, 1963).

Materials and Methods (continued)

- Nested subset analysis was used to check whether variations were random as the result of the area increase in larger drainage basins exclusively or followed a spatial pattern driven by the structure of the drainage basins

Results

- The major soil groups that appear in the Almería province are shown in Table I, whereas the soil types are listed in Table II
- The most abundant pedotaxa in the study area are the shallow and weakly developed soils (Regosols and Leptosols)
- Figure 2A and B show the power fits of pedorichness per drainage basin size and 2C and D show that the soil assemblages of Almería province fit well to a power law
- Table III shows the results of soil richness and soil diversity (Shannon index) analyses
- The nested matrix analysis demonstrated a very strong nestedness for the soil assemblages of each drainage basin, showing that the increase of pedotaxa within the area is not random but follows a clear predictive geographical pattern

Discussion and Conclusions

- The results obtained for the Almería province are typical of mountainous arid lands
- There are eight provinces in Andalusia. In those eight provinces, about 19% of the land area in Almería is covered by Xerosols, while Andalucia has a 2%Xerosols cover, Cadiz and Granada have <1% Xerosols cover and there are no mapped Xerosols in the other four provinces
- Natural and anthropogenic driving forces have worked together over many millennia in the genesis of Almería's soils, but there is a definite natural arid component to Almería's soils that does not exist in other areas of Europe, including other parts of the Andalusian coast
- Thus, the study area is a singular site in the framework of the European continent deserving to be preserved as part of its geological heritage or geodiversity