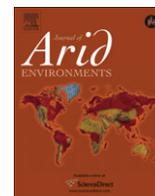


Contents lists available at [SciVerse ScienceDirect](http://www.sciencedirect.com)

Journal of Arid Environments

journal homepage: www.elsevier.com/locate/jaridenv

Editorial

Special issue: The Iberian Southeast

This special issue of the *Journal of Arid Environments* features reviews and recent research advances on diverse aspects of the abiotic and biotic environment of the Iberian Southeast drylands, as well as the impact of human land use, its management and historical evolution. This warm semi-arid region is located in the southeast corner of Spain, mostly including the provinces of Almería and Murcia, and surrounding areas (Fig. 1). It is delimited by the Mediterranean Sea and a chain of mountains over 2000 m in elevation (the Betic Ranges) that surround the area from southwest to northeast, covering an area of approximately 15 000 km² including coastal areas and an inland strip of around 70 km in width (Carrión et al., 2010; Machado et al., 2011; Peinado et al., 1992).

The Iberian Southeast is the most arid region of continental Europe. The low rainfall is direct consequence of its geographical isolation occasioned by the Betic Ranges, a mountain system formed during the Alpine orogeny which acts as a natural barrier to precipitation, blocking the Atlantic fronts that sweep the rest of Spain, and triggering singular environmental conditions (IGME, 1999). Aridity has been a feature of SE Spain ever since the Middle Miocene, 16 million years ago (Carrión et al., 2010). Current annual precipitation is below 350 mm in most of this territory and some sites receive less than 200 mm (e.g., Cape of Gata, Almería, Fig. 1). The area is characterized by a warm dry Mediterranean climate, with mean annual temperatures between 16 and 18 °C in coastal areas and 12–14 °C inland, with potential evapotranspiration ranging between 1000 and 1500 mm (Capel, 1981; Machado et al., 2011). Extreme summer temperatures are not uncommon, with daily maxima of up to 46 °C, while soil surface may reach 80 °C. It is, however, important to note the existence of hidden precipitations near the coast (dew and fog condensation), and the fact that high air humidity in coastal areas may cause an important decrease in evapotranspiration (Domingo et al., 2011). Rainfall occurs predominantly in autumn and early winter, between September and December, with a second peak in early spring. There is also marked inter-annual rainfall variability (up to 40% variation) which often comes in the form of torrential events (Lázaro et al., 2001) that may cause extreme floods with great erosive power (Cantón et al., 2011; Machado et al., 2011).

The landscape in the region is very diverse due to an intricate topography and extremely complex and diverse lithological composition (Cantón et al., 2011). Lithology ranges from Palaeozoic high-grade metamorphic rocks (mica schists, quartzites, and marble) to Neogene soft sedimentary rocks (marls and clays infilling most depressions between mountain ranges, a main feature in this region, as well as gypsum layers), and volcanic outcrops (e.g., Cabo de Gata Range). Intermediate lithological types include low-

grade metamorphic rocks (e.g. slates), and hard sedimentary rocks like sandstones and limestones. A main characteristic is the widespread presence of poorly developed soils with low levels of organic matter, aggregate stability and nutrients, and also low water holding capacity, all of which amplify drought conditions for plants. Changes brought about by human land use along with climate, steep slopes, and fragile soil make the region very prone to surface sealing, runoff generation and water erosion (Cantón et al., 2011). Nevertheless, SE Spain is among the richest regions of Europe in plant species (~3000 sp, including mountain ranges) with abundant local or Iberian-North African endemic species, and hosts a diverse and singular fauna, perhaps due to the region's extensive bioclimatic gradients and geological diversity (Alados et al., 2011; Carrión et al., 2010; Sánchez-Piñero et al., 2011). It has, however, relatively low vertebrate diversity (Valera et al., 2011). Sánchez-Piñero et al. (2011) highlight the fact that arid areas of SE Spain harbour invertebrate species-rich assemblages, a feature also shown in other arid regions such as North American deserts and the semi-arid environments of Namibia. These data cast a doubt on the traditional conception of these systems as low diversity, impoverished habitats. Moreover, between 8.4 and 9.6% of the arthropod species in these environments are local or Iberian SE endemics (Sánchez-Piñero et al., 2011).

Human impact has been a primary feature in the region, affecting the main ecological processes. Yet water scarcity has discouraged exploitation by humans to some extent, leading to well preserved spots with xerophytic plant communities which have remained similar to those described by Simón de Rojas 200 yr ago (Alados et al., 2011; Peinado et al., 1992). The singular environmental conditions of this region limit plant growth and thus shrubs and perennial grasses are the dominant species. Forests are restricted to the tops of mountains and to microsites with high humidity and deep soil profiles, while in the rest of the region, namely coastal mountains and depressions, sclerophyllous shrublands prevail (Carrión et al., 2010; Mota et al., 2004).

This special issue on the Iberian Southeast is organized in three sections: the first is devoted to different abiotic and biophysical aspects; the second characterizes the main biotic components and processes; and the third analyzes different aspects of human impact and land use management in the Iberian SE environments. The special issue starts with an analysis of 500 years of direct or proxy data – historical and sedimentary records-covering rainfall variability and extreme flood events (Machado et al., 2011). Data show a decreasing trend in mean annual rainfall with a shift in maxima from autumn to winter, as well as a tendency towards longer dry periods and increased inter-annual rainfall variability.

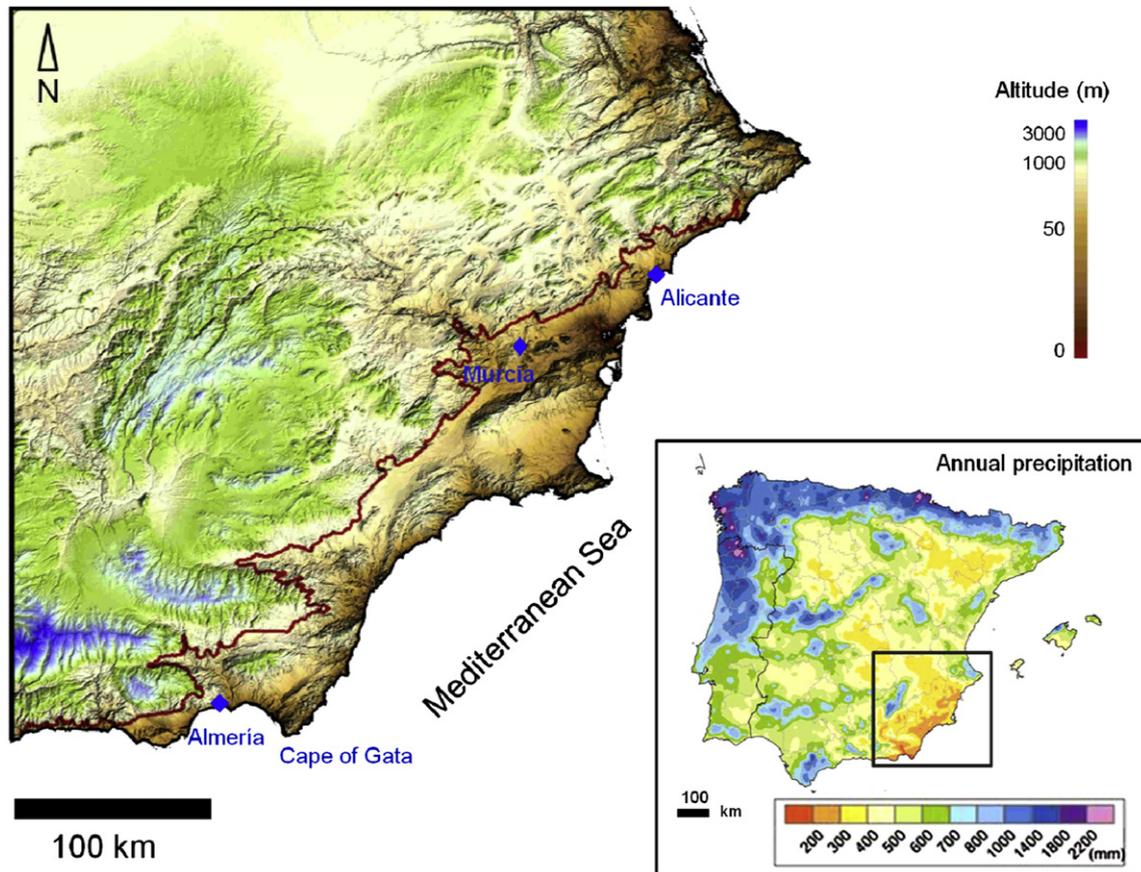


Fig. 1. The semi-arid Iberian Southeast (border in red). The inside panel shows mean annual precipitation in the Iberian Peninsula (modified from Agencia Estatal de Meteorología, AEMET, with permission). The online version of this manuscript has the figure in colour. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Cantón et al. (2011) review key factors and processes influencing runoff generation and water erosion processes from patch to catchment scales, reviewing predictions regarding runoff and soil erosion oriented towards mitigation of their negative impacts. Andreu et al. (2011) characterize the spatial and temporal patterns of recharge of mountain carbonated aquifers. These aquifers are the most important groundwater reservoirs in SE Spain and the main source of freshwater for human use. The first section of the special issue ends with a review of current knowledge regarding biogeochemical cycles of water and carbon (Domingo et al., 2011).

The aim of the second section is to analyze the main biotic components and processes in Iberian SE environments. The topics covered include (1) the analysis of ecology, diversity, functional roles and associated ecological processes of organisms such as soil biological crusts, mycorrhizal fungi, vertebrates and arthropods, and the biota of saline streams (Barea et al., 2011; Maestre et al., 2011; Millán et al., 2011; Sánchez-Piñero et al., 2011; Valera et al., 2011), and; (2) ecological processes affecting plant communities such as responses to changes in rainfall patterns (Miranda et al., 2011), plant–plant interactions (Pugnaire et al., 2011), and above- and below-ground trophic interactions (Megías et al., 2011). Most of these reviews also analyze current conservation status and the threats to living organisms and habitats. Several also address community structure and their ecosystem functioning, pointing to specific needs for future research. Finally, although not included in this Special Issue, we want to highlight the recent and comprehensive review by Carrión et al. (2010) already published in the *Journal of Arid Environments* which analyzed the historical origins

of aridity in the Iberian Southeast and the plant communities and degradation processes involved.

All the above-mentioned papers highlight the intense impact of human land use on many areas of this region. Since there are indications of human presence for at least 1.2 million years (Gil-Romera et al., 2009), the Iberian Southeast has witnessed one of the highest rates of long-term land degradation in continental Europe (Alados et al., 2011; Puigdefábregas and Mendizabal, 1998). Sánchez-Picón et al. (2011) show that during the Copper and Bronze ages, two societies appeared in the Southeast of the Iberian Peninsula, the *Los Millares* culture (between 5000 and 4200 BP) and later the *El Argar* culture (which ended around 3600–3500 BP). Both were agricultural societies with metallurgical production that achieved a considerable level of technological and organizational development, but both disappeared suddenly. Human-induced environmental disturbances resulted in environmental degradation and this seemed to have played a decisive role in their disappearance (Sánchez-Picón et al., 2011). This long-term, intense human pressure on the environment is the general framework of the third section of this special issue, which is devoted to the history, economy, demographic evolution and land use of the territory up to the present (Sánchez-Picón et al., 2011). Included are ecosystem impacts, as well as land degradation processes (Alados et al., 2011; Sánchez-Picón et al., 2011). Alados et al. (2011) review the resilience of dryland areas in SE Spain, focussing on plant–soil interactions and spatial self-organization of vegetation at different scales, using methods that work as early warning signs of desertification. They evaluate the importance of transition shifts in dryland ecosystems

that result in irreversible desertification processes. The special issue ends with a review of restoration programs and recent advances in restoration ecology of semi-arid environments (Cortina et al., 2011).

Research reviewed in this Special Issue shows that although the Iberian Southeast is a small area in the context of the Iberian Peninsula, it has drawn attention of many researchers from disparate disciplines who have contributed to a better understanding of how arid systems function globally. Multidisciplinary research conducted in this area is flourishing now and should help us manage these fragile habitats, preventing environmental risk and securing the supply of ecosystem services, while making sure their natural values are preserved for future generations.

Acknowledgements

We would like to acknowledge the contributing authors and reviewers for their interest and dedication in making this special issue possible. Yolanda Cantón and Emilio Rodríguez-Caballero kindly helped us in building Fig. 1. We thank Dr. Harriet Whitehead for editorial corrections. CA was supported by a post-doc I3P grant from CSIC, and FMP by a post-doc grant of the Spanish Ministry of Education.

References

- Alados, C.L., Puigdefábregas, J., Martínez-Fernández, J., 2011. Ecological and socio-economical thresholds of land and plant-community degradation in semi-arid Mediterranean areas of southeastern Spain. *Journal of Arid Environments* 75, 1368–1376.
- Andreu, J.M., Alcalá, F.J., Vallejos, A., Pulido-Bosch, A., 2011. Recharge to mountainous carbonated aquifers in SE Spain: Different approaches and new challenges. *Journal of Arid Environments* 75, 1262–1270.
- Barea, J.M., Palenzuela, J., Cornejo, P., Sánchez-Castro, I., Navarro-Fernández, C., López-García, A., Azcón, R., Ferrol, N., Azcón-Aguilar, C., 2011. Ecological and functional roles of mycorrhizas in semi-arid ecosystems of Southeast Spain. *Journal of Arid Environments* 75, 1292–1301.
- Cantón, Y., Solé-Benet, A., de Vente, J., Boix-Fayos, C., Calvo-Cases, A., Asensio, C., Puigdefábregas, J., 2011. A review of runoff generation and soil erosion across scales in semiarid south-eastern Spain. *Journal of Arid Environments* 75, 1254–1261.
- Capel, J., 1981. *Los climas de España*. Oikos-tau, Barcelona, Spain.
- Carrión, J.S., Fernández, S., Jiménez-Moreno, G., Fauquette, S., Gil-Romera, G., González-Sampériz, P., Finlayson, C., 2010. The historical origins of aridity and vegetation degradation in southeastern Spain. *Journal of Arid Environments* 74, 731–736.
- Cortina, J., Amat, B., Castillo, V., Fuentes, D., Maestre, F.T., Padilla, F.M., Rojo, L., 2011. The restoration of vegetation cover in the semi-arid Iberian southeast. *Journal of Arid Environments* 75, 1377–1384.
- Domingo, F., Serrano-Ortiz, P., Were, A., Villagarcía, L., García, M., Ramírez, D.A., Kowalski, A.S., Moro, M.J., Rey, A., Oyonarte, C., 2011. Carbon and water exchange studies in semiarid ecosystems in SE Spain. *Journal of Arid Environments* 75, 1271–1281.
- Gil-Romera, G., Carrión, J.S., McClure, S., Schmich, S., Finlayson, C., 2009. Holocene vegetation dynamics in Mediterranean Iberia: historical contingency and climate-human interactions. *Journal of Anthropological Research* 65, 271–286.
- IGME, 1999. *Atlas del medio natural de la Región de Murcia*. Consejería de Política Territorial y Obras Públicas. Instituto Geológico y Minero, Madrid.
- Lázaro, R., Rodrigo, F.S., Gutiérrez, L., Domingo, F., 2001. Analysis of a 30-year rainfall record (1967–1997) in semi-arid SE Spain for implications on vegetation. *Journal of Arid Environments* 48, 373–395.
- Machado, M.J., Benito, G., Barriandos, M., Rodrigo, F.S., 2011. 500 Years of rainfall variability and extreme hydrological events in southeastern Spain drylands. *Journal of Arid Environments* 75, 1244–1253.
- Maestre, F.T., Bowker, M.A., Cantón, Y., Castillo-Monroy, A.P., Cortina, J., Escobar, C., Escudero, A., Lázaro, R., Martínez, I., 2011. Ecology and functional roles of biological soil crusts in semi-arid ecosystems of Spain. *Journal of Arid Environments* 75, 1282–1291.
- Megías, A.G., Sánchez-Piñero, F., Hódar, J.A., 2011. Trophic interactions in an arid ecosystem: From decomposers to top-predators. *Journal of Arid Environments* 75, 1333–1341.
- Millán, A., Velasco, J., Gutiérrez-Cánovas, C., Arribas, P., Picazo, F., Sánchez-Fernández, D., Abellán, P., 2011. Mediterranean saline streams in southeast Spain: What do we know? *Journal of Arid Environments* 75, 1352–1359.
- Miranda, J.D., Armas, C., Padilla, F.M., Pugnaire, F.I., 2011. Climatic change and rainfall patterns: Effects on semi-arid plant communities of the Iberian Southeast. *Journal of Arid Environments* 75, 1302–1309.
- Mota, J., Cabello, J., Cerrillo, M.L., Rodríguez-Tamayo, M.L., 2004. *Los subdesiertos de Almería: naturaleza de cine*, Sevilla. Junta de Andalucía, Consejería de Medio Ambiente, Spain.
- Peinado, M., Alcaraz, F., Martínez-Parras, J.M., 1992. *Vegetation of Southeastern Spain*. J. Cramer, Berlin-Stuttgart.
- Pugnaire, F.I., Armas, C., Maestre, F.T., 2011. Positive plant interactions in the Iberian Southeast: Mechanisms, environmental gradients, and ecosystem function. *Journal of Arid Environments* 75, 1310–1320.
- Puigdefábregas, J., Mendizabal, T., 1998. Perspectives on desertification: western Mediterranean. *Journal of Arid Environments* 39, 210–224.
- Sánchez-Picón, A., Aznar-Sánchez, J.A., García-Latorre, J., 2011. Economic cycles and environmental crisis in arid southeastern Spain. A historical perspective. *Journal of Arid Environments* 75, 1360–1367.
- Sánchez-Piñero, F., Tinaut, A., Aguirre-Segura, A., Miñano, J., Lencina, J.L., Ortiz-Sánchez, J., Pérez-López, J., 2011. Terrestrial arthropod fauna of arid areas of SE Spain: diversity, biogeography, and conservation. *Journal of Arid Environments* 75, 1321–1332.
- Valera, F., Díaz-Paniagua, C., Garrido-García, J.A., Manrique, J., Pleguezuelos, J.M., Suárez, F., 2011. History and adaptation stories of the vertebrate fauna of southern Spain's semi-arid habitats. *Journal of Arid Environments* 75, 1342–1351.

C. Armas^{*}, J.D. Miranda¹, F.M. Padilla², F.I. Pugnaire
*Estación Experimental de Zonas Áridas, Consejo Superior de
Investigaciones Científicas, Carretera de Sacramento s/n,
La Cañada de San Urbano, E-04120 Almería, Spain*

* Corresponding author. Tel.: +34 950 281 045;
fax: +34 950 277 100.

E-mail address: cris@eeza.csic.es (C. Armas)

8 July 2011

¹ Present address: Estación Experimental del Zaidín, Consejo Superior de Investigaciones Científicas, C/Profesor Albareda 1, E-18008 Granada, Spain.

² Present address: Radboud University Nijmegen, Experimental Plant Ecology, Heyendaalseweg 135. 6525 AJ Nijmegen, The Netherlands.