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Data Article

A heritage dataset of soil and water salinity in Bardenas, Spain

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ABSTRACT

This article presents the results of soil and water analysis plus the plans —or "maps"— from the Report [1] issued 1974 on salt-affected soils in a new irrigation district located in the semi-arid Bardenas area of Aragón, northern Spain (Fig. 1). The survey was carried out by the now defunct Institute for Agrarian Reform and Development (i.e., IRYDA by its Spanish acronym). Work began in January 1972, with a preliminary reconnaissance survey on 53,000 ha using aerial photographs at a scale of 1:32,000 from the USAF photogrammetric flight of 1956-57 which covered almost the whole of Spain. Photographs from this flight are available on the Spanish aerial photograph viewer (https://fototeca.cnig.es/fototeca/). At that time, levelling for irrigation had not yet begun. This reconnaissance allowed the selection of an area of 32,300 ha (Fig. 1) with relevant salinity symptoms, like irrigated fields with irregular or no crop growth. A more detailed photo interpretation of the area was carried out at 1:12,000 scale from a flight in August 1971.

The new irrigation district is fed by high quality water from the Pyrenees, but soon faced salinity problems that were well known to the farmers and echoed by the media [2, 3, 4] in an environment of great social concern about increasing agricultural production [5]. The Report, written in Spanish, is dated July 1974, but the soil profiles were described and sampled between April 1972 and March 1974. The Report [1] consists

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of two volumes, the first is a Memoria containing data from the surveys, laboratory analyses, pedological descriptions and some photographs of the soils and other land features of agricultural importance, as well as data and calculations for designing the drainage of selected plots. The second volume consists of five folded plans: a) location of the surveyed area at the scale of 1:200,000, and four plans at the scale of 1:25,000, b) soil-geomorphologic units, c) soil units describing their characteristics, d) land use, and e) locations of the described soil profiles and other field observations. Taken together, these data, improved by our orthorectification, gives a picture of the salinity and other soil properties in this area. The reuse of the data for comparisons with the evolution of agriculture in subsequent years —especially soil salinity and sodicity— will help to evaluate the agricultural practices over the last fifty years, particularly after intensive land levelling and irrigation.

Specifications Table

Subject	Agricultural sciences
Specific subject area	Improved data about the salinity of an irrigated district in 1974-1974.
Data format	The formats of the raw data are - Report [1]: pdf - Orthorectified maps: tif and shp - Lab analytical determinations: xlsx
Type of data	Tables, Images and Figs
Data collection	The data collected by the Report [1] include the following numbers of analytical determinations: 1399 on soil samples, 215 on phreatic waters, and 43 on irrigation waters. All samples were collected from 1972 to 1974. This Report also contains the description of pedological horizons and other soil layers plus several plans: geomorphologic, soil, land use, and soil observations location. This information has been reviewed and digitized.
Data source location	Institution: Institute for Agrarian Reform and Development (IRYDA). Location: Bardenas Canal Irrigation System in Aragón, province of Zaragoza. Ebro River Basin. Country: Spain. The centroid coordinates of the study area: X-642274; Y-4670414 (ETRS 89/UTM Zone 30N, EPSG: 25830).
Data accessibility	1. Repository name for data: Mendeley Data, doi: 10.17632/c9cryjc53k.4. Direct URL to data: https://data.mendeley.com/datasets/c9cryjc53k/4 2. Repository name for the IRYDA Report: Provincial Historical Archive of Zaragoza, Spain. Direct URL to the IRYDA Report: https://dara.aragon.es/opac/app/attachment/ahpz?a1=pdf&a=3f/07/AHPZ_A_025621_0001.pdf&l0=pdf&l1=3f/07/AHPZ_A_025621_0001.pdf&c0=Imagen+Vista&c1=File+Download&a0=Resultados

1. Value of the Data

- These data are valuable because the methods used in the IRYDA Report are still in use. This allows multi-temporal comparisons. The data are, to our knowledge, the oldest quantitative and comparable data available for these irrigated soils and can illustrate the challenge of irrigation sustainability.
- The time-variable data include electrical conductivity and ionic content and other less variable data, such as pH, exchange properties, and organic matter. The time-invariant data,

like calcium carbonate equivalent and particle-size distribution are also useful for control purposes in future comparative soil sampling. The data on irrigation water and phreatic water illustrate the environmental status of these lands.
- Farmers, environmentalists, and agricultural engineers interested in appraising the results of the irrigated soil management will benefit from the data.
- These data can be reused by researchers to compare and interpret successive surveys produced by classical field reconnaissance and proximal portable sensors like electromagnetic as well as by remotely sensed information.
- The retrospective detection of salinity symptoms by remote sensing has been possible since at least 1994 [6] even in small irrigated plots, which are common in Bardenas. Salinity monitoring has become increasingly feasible in recent years, with the development of advanced sensors and the abundance of satellite imagery. In all cases, the dataset [1] will be helpful for the interpretation and assessment of salinity and landscape evolution.

2. Background

The motivation was to rescue and document valuable data useful for agricultural, ecological, and land use changes monitoring. These data were buried in grey literature in the current context of degradation, mislaying or disposal of paper documents [7]. The rescued data are useful and understandable because they were collected with state-of-the-art methods of soil studies in the field. Moreover, the laboratory determinations followed the soil analysis methods of [8] adopted by the Spanish Ministry of Agriculture [9]. In addition, a few years later a PhD Thesis [10] carried out in a partially overlapping area used the same methods which are still the world standard today (Fig. 1).

The rescue and public accessibility of the data is necessary because of the difficulty of appraising the long-term effects of land management and soil degradation [11], and because, as stated by [12] "model development and meta-analysis studies [can] now spend the bulk of their time honing hypotheses instead of cleaning data."

The permanence and availability of the raw data is entrusted to the official archive of Aragón, Spain (https://dara.aragon.es). The repository Mendeley Data (doi:10.17632/c9cryjc53k.4) hosts the data arranged for their easy use.

3. Data Description

The repository Mendeley Data (doi:10.17632/c9cryjc53k.4) contains three Excel files with the recovered compositional data.

The file "Bardenas 72-74 soils.xlsx" contains 1399 analytical data. These are: particle size separates, calcium carbonate, organic matter, pH in water, pH in KCl, and electrical conductivity measured from a 1:5 dilution. The analytical data of the saturation extract are: electrical conductivity, (Ca^{2+} plus Mg^{2+}) and Na^{+}. The exchangeable cations (Ca^{2+} plus Mg^{2+}) and K^{+} were also determined in 14 soil samples.

The file "Bardenas 72-74 phreatic water.xlsx" contains data from 43 phreatic water samples. These data are: geomorphic units in the Report, geographical coordinates according to ETRS 89/UTM Zone 30N georeferencing, and depth of the water table. The data also include a total of 215 determinations of dry residuum, electrical conductivity, and Na^{+}, K^{+}, (Ca^{2+} plus Mg^{2+}) contents.

The file "Bardenas 72-74 irrigation water.xlsx", contains data from 4 samples of irrigation water with a total of 43 chemical determinations of dry residuum, Cl^{-}, $CO_3{}^{2-}$, CO_3H^{-}, $SO_4{}^{2-}$, (Ca^{2+} plus Mg^{2+}), Na^{+}, K^{+}, Ca^{2+} electrical conductivity, and pH.

The same Mendeley repository contains the references [2-5]; the five plans of the IRYDA Report as tif files; the "Shapefiles Bardenas" folder with three files for (i) the study area, (ii)

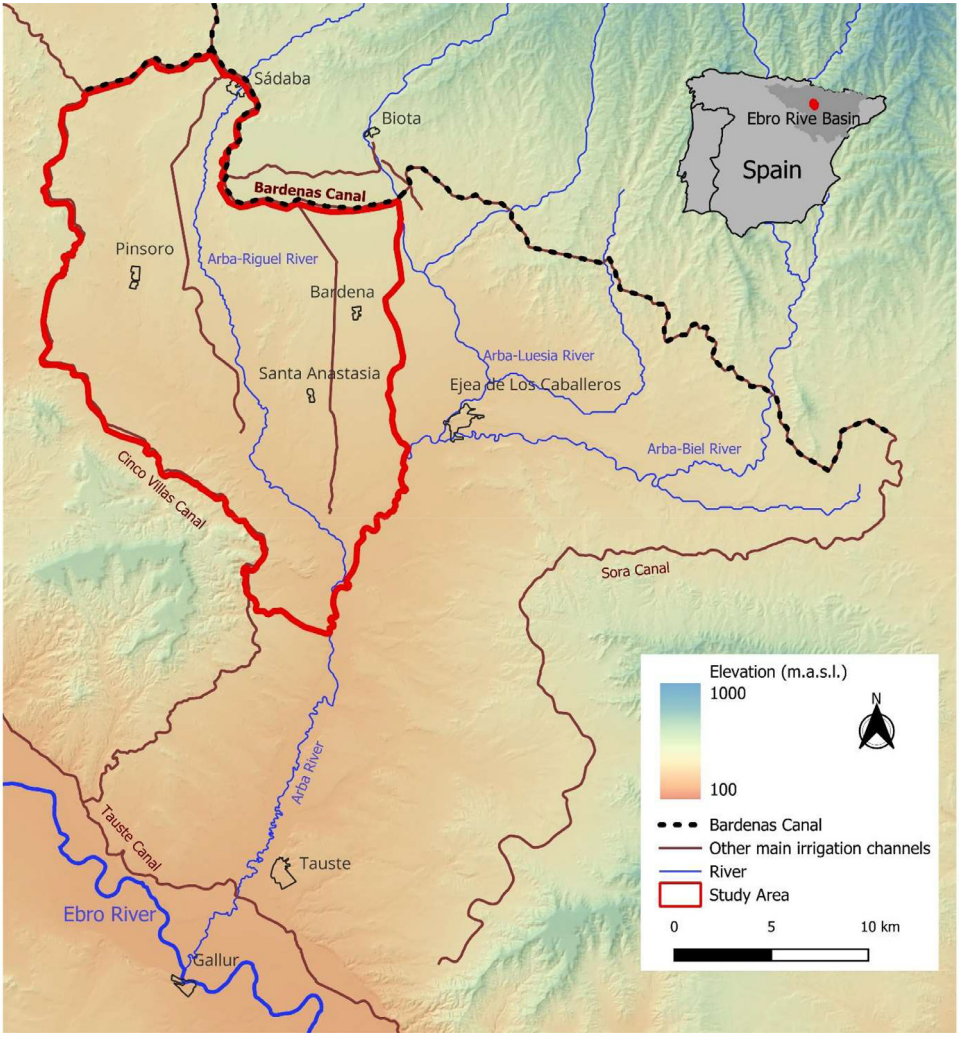

Fig. 1. Study area located in the central Ebro River Basin, NE Spain. The Bardenas Canal conveys the irrigation water from Pyrenees.

the location of the total observations made in the study, and (iii) the location of the soil profiles with soil information in the Report (soil taxonomy, textural classification and horizons). All these plans were digitized and georeferenced by QGIS-raster georeferencer tool using linear or polynomial algorithmic transformations (resampling method: nearest neighbor). More information can be found in the file "Maps Bardenas Process.docx" at the Mendeley repository doi:10.17632/c9cryjc53k.4.

We have created the following two tables to summarize the soil data of the IRYDA Report [1] and to facilitate searches. Table 1 shows the list of the soil profiles described, sampling date, location of the nearest village or new settlement, and UTM coordinates, obtained from Map 4-Observation localizations using Q-GIS raster georeferencing, plus the soil classification after [13].

Table 1
Soil profiles having chemical analyses, plus the pages and dates of their description in the IRYDA Report, location in the municipality or new settlement, geolocation (ETRS 89/UTM Zone 30N), and classification.

Profile identifier	Page of the description	Sampling date	Location	X	Y	Classification*
C-9	79	08/05/1972	Sádaba	641923	4680823	Typic Xerofluvent
C-12	81	12/05/1972	Santa Anastasia	643589	4666470	Typic Xerofluvent
71	83	13/03/1974	El Bayo	*	*	Typic Xerofluvent
C-11	85	12/05/1972	Sabinar	645815	4661420	Typic Xerofluvent
C-10	87	24/01/1973	El Bayo	644054	4668015	Non saline
PR-27	89	25/01/1973	Santa Anastasia	643705	4665753	Slightly saline
C-16	91	24/05/1972	Pinsoro	638105	4670515	Eutric Xerochrept
C-5	93	24/04/1972	Santa Anastasia	646145	4669308	Xerollic Calciorthid
C-20	95	25/05/1972	Pinsoro	634809	4672861	Xerollic Calciorthid
C-17	97	18/05/1972	Valareña	640670	4668012	Typic Xerochrept
C-51	99	19/10/1972	Sádaba	638412	4681911	Typic Xerorthent
C-78	101	16/03/1974	Sádaba	*	*	Typic Xerorthent
C-75	103	14/03/1974	El Bayo	*	*	Typic Xerofluvent
C-73	105	14/03/1974	El Bayo	*	*	Typic Xerofluvent
PR-15	107	24/01/1973	Pinsoro	636111	4671483	Aquic Ustorthent
C-27	109	21/06/1972	Pinsoro	637347	4668064	Typic Xerofluvent, saline phase
C-22	112	23/05/1972	Valareña	638627	4667309	Typic Xerofluvent, saline phase
C-29	114	05/07/1972	Valareña	643357	4664020	Typic Xerofluvent, saline phase
77	116	16/03/1974	Sádaba	*	*	Aquic Ustorthent, saline phase
PR-6	118	23/01/1973	Sádaba	636973	4681712	Aquic Ustorthent, saline phase
79	120	17/03/1974	Alera	*	*	Lithic Xerorthent
C-21	122	23/05/1972	Pinsoro	635070	4676184	Typic Xerofluvent, saline phase
PR-8	124	23/01/1973	Sádaba	634732	4680660	Typic Xerofluvent, saline phase
C-38	126	06/07/1972	Sabinar	641866	4663280	Aquic Xerofluvent, saline phase
C-23	128	24/05/1972	Valareña	639086	4664951	Typic Xerofluvent, saline phase
PR-24	130	25/01/1973	Valareña	640718	4679783	Typic Xerofluvent, saline phase
C-35	132	04/07/1972	Valareña	643009	4663376	Typic Xerofluvent
C-45	134	12/07/1972	Sabinar	645064	4657430	Very saline

* There is no clear evidence of soil profile localization for the March 1974 observations.

Table 2 shows the number of analytical data for each soil profile and the page of the Report where they appear.

4. Experimental Design, Materials and Methods

The main purpose of the Report [1] was the diagnosis of soil salinity using the methods then available. The prospectors relied on photointerpretation of aerial photographs for the opening of field pits in locations representative of salt-affection problems. The pits allowed soil description and sampling of the different pedological horizons and other soil layers. The analyses of soil and water samples were focused on salinity and used the methods described in [8,9]. The taxonomical classification of the soils in the Report, which is now obsolete, is not used in the present

Table 2
Number of compositional data for each of the 28 profiles described in the IRYDA Report.

Profile identifier	Number of horizons sampled	PSD, particle size distribution	Calcium carbonate equivalent, %	Organic matter, %	pH H_2O	pH KCl	EC1:5, dS/m	ECe, dS/m	$(Ca^{2+} + Mg^{2+})$ in the saturation extract, meq/L	Na^+ in the saturation extract, meq/L	Exchangeable-sodium-percentage	Sodium-adsorption-ratio	$(Ca^{2+} + Mg^{2+})$ exchangeable, meq/L	Na^+ exchangeable, meq/L	K^+ exchangeable, meq/L	Cation-exchange-capacity, meq/L per 100 g	Page number of the analytical data
		Number of analytical data															
C-9	4	4	4	4	4	4	4										80
C-12	4	4	4	4	4	4	4										82
71	3	3	3	3	3	3		3	3	3	3	3	3	3	3	3	84
C-11	3	3	3	3	3	3	3										86
C-10	7	4	7	4	7	7		7	7	7	7	7					88
PR-27	7	7	7	7	7	7		7	7	7	7	7					90
C-16	5	5	5	5	5	5											92
C-5	4	4	4	4	3	3		1	1	1	1	1					94
C-20	5	5	5	5	5	5		5	5	5	5	5					96
C-17	4	3	3	3	3	3											98
C-51	4	4	4	4	4	4	4	4	4	4	4	4					100
C-78	4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	102
C-75	3	3	3	3	3	3		3	3	3	3	3	3	3	3	3	104
C-73	4	4	4	4	4	4		4	4	4	4	4					106
PR-15	7	2	7	2	7	7		7	7	7	7	7					108
C-27	9	9	9	9	9	9	9	9	9	9	9	9					111
C-22	6	6	6	6	6	6		6	6	6	6	6					113
C-29	5	5	5	5	5	5	5	5	5	5	5	5					115
77	3	3	3	3	3	3		3	3	3	3	3	3	3	3	3	117
P-6	6	5	6	5	6	6		6	6	6	6	6					119
79	1	1	1	1	1	1		1	1	1	1	1					121
C-21	5	5	5	5	5	5		5	5	5	5	5					123
PR-8	5	4	5	4	5	4		5	5	5	5	5					125
C-38	5	5	5	4	5	5	5	5	5	5	5	5					127
C-23	7	7	7	7	7	7		7	7	7	7	7					129
PR-24	6	3	6	3	6	6		6	6	6	6	6					131
C-35	6	6	6	6	6	6	6	6	6	6	6	6					133
C-45	3	3	3	3	3	3	3	3	3	3	3	3					135
Total	135	121	134	120	133	132	43	112	112	112	112	112	13	13	13	13	-

work. The description of the methods is brief, according to the utilitarian purpose of the Report, which focused on fulfilling the immediate needs of farmers.

The analytical data were acquired by scanning the Memory and Plans of the Report [1]. These numerical data were manually copied and organized in three files: "Bardenas 72-74 soils.xlsx", "Bardenas 72-74 phreatic water.xlsx", and "Bardenas 72-74 irrigation water.xlsx". The above Tables 1 and 2 summarize the recovered data. The file "Maps Bardenas Process.docx" outlines the methods we used to georeference the scanned paper plans from the Report, and to locate the field observations marked on the plans. All these files are hosted at doi:10.17632/c9cryjc53k.4.

Having in mind the "*localization paradox*" [14], inherent in any destructive sampling, the mapping limitations referred to in the Section below are admissible for the multitemporal comparisons between individual observations, especially if modern techniques for quantifying soil salinity in the field are used in the new surveys. This is the case for electromagnetic induction, a technique successfully used in nearby irrigated districts. These limitations would be negligible, as potential georeferencing errors would be compensated when the observations are processed together in order to evaluate the salinity changes in the studied area over successive years. Similarly, as acquired in the same study design along with salinity, soil organic matter data would be relevant for local multitemporal comparisons and could be incorporated into databases of worldwide coverage [15].

Limitations

Where possible, the consistence of the data was checked using simple calculations. For the EC we regressed ECe on EC1:5 for the 32 soil samples with both determinations. Ordinary least squares and non-parametric regression methods gave the same coefficients of determination, $R^2 = 0.911$ when calculated for individual samples, and $R^2 = 0.957$ when ECe and EC1:5 were weighted by the depth of the samples. The 43 analyses of phreatic waters were also coherent as shown by $R^2 = 0.999$ in the regression between the dry residuum (mg/L) and the sum of Ca^{2+}, Mg^{2+}, K^{+}, and Na^{+}. One sample of irrigation water was collected at each season, winter, spring, summer, and autumn. The four samples show agreement in their ratios of dry residuum to ions, ions to EC, and dry residuum to EC. The obvious errors in the soil composition data and the incoherent data, e.g. discrepancies between the sodium adsorption ratio (SAR) [8] reported and the SAR calculated by us from the ionic data, have been corrected to produce the file "Bardenas72-74 soils.xlsx" hosted in Mendeley Data (doi:10.17632/c9cryjc53k.4).

Mapping in the 1970s was not as accurate as it is today. Some error must be assumed in the precise georeferencing of the maps and the locations of the observations (Fig. 2). Efforts have been made to reduce this error. In this way, the map was divided into six parts, and each one georeferenced separately.

Manual transcription of the data was labor-intensive and error-prone [11], two classic drawbacks for the recovering of data from old sources.

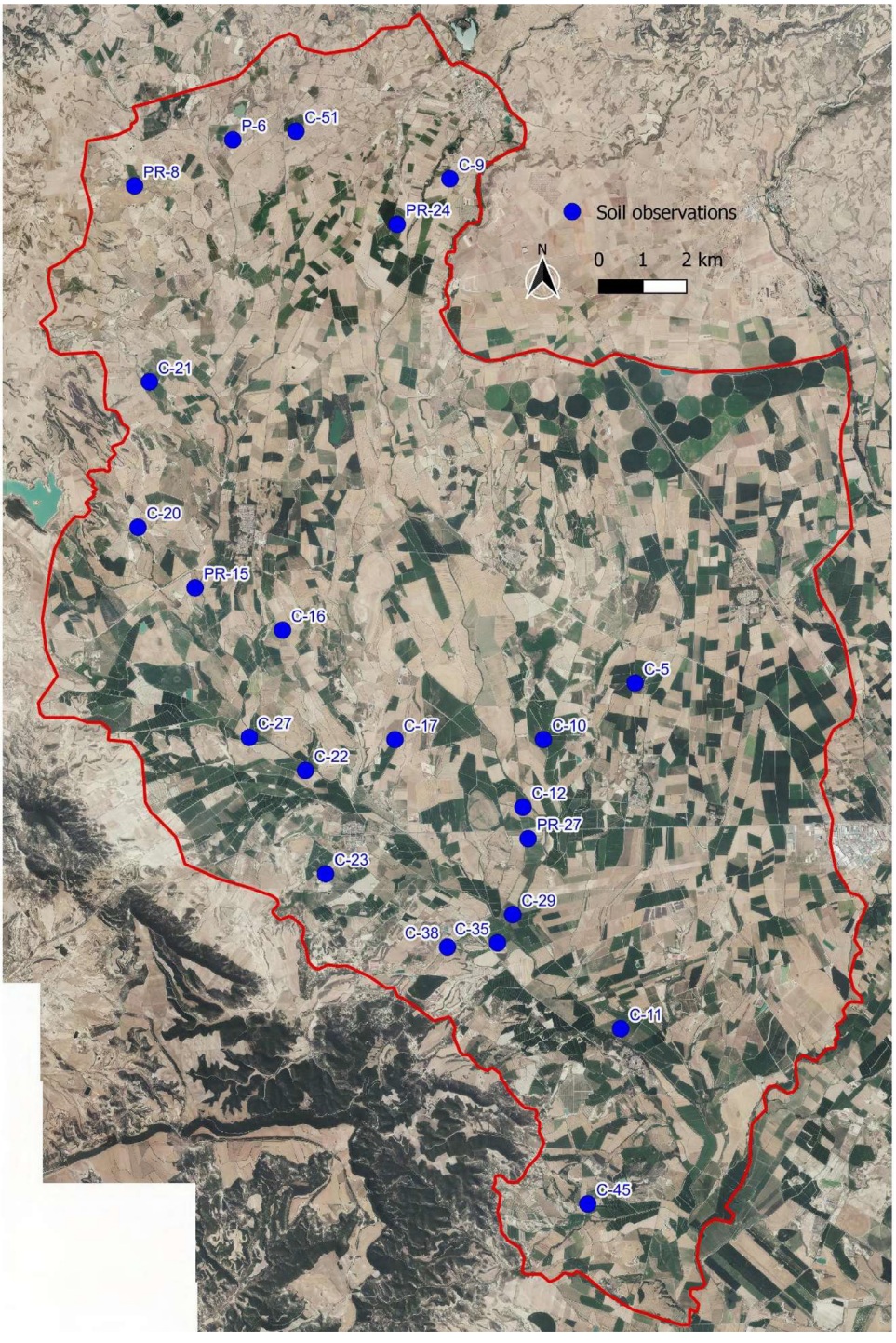

Fig. 2. Location of the described [1] soil profiles whose analytical data are in "Bardenas72-74 soils.xlsx". Background: PNOA® Project orthophotograph (Spanish National Geographic Institute) from a 2021 flight.

Ethics Statement

The authors have read and follow the ethical requirements for publication in Data in Brief, and the current work does not involve animals, or any data collected from social media platforms.

Data Availability

DOI 10.17632/c9cryjc53k.3 (Original data) (Mendeley Data)
A 1974 agronomic report on salinity in Bardenas, Spain, plus some outreach brochures (Original data) (Mendeley Data)

CRediT Author Statement

María A. Lorenzo-González: Data curation, Writing – review & editing; **Juan Herrero:** Conceptualization, Methodology, Writing – original draft; **Carmen Castañeda:** Visualization, Writing – review & editing.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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