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A preliminary approach to Early Iron Age demography. Testing paleodemographic methodologies on a microspatial scale: The case of Punta de Muros (NW Iberia)

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ABSTRACT

This paper presents an approach to the paleodemography of the Iron Age in the northwest of the Iberian Peninsula, choosing a microspatial study focused on the settlement of Punta de Muros. This settlement provides an excellent context for paleodemographic analysis, given the extent of its archaeological record, the chronological studies of its occupational dynamics and its condition as a fully excavated settlement. This work aims to review several demographic techniques in order to assess their weaknesses and strengths and their applicability to the case of study. Thus, the data obtained will be analysed from the point of view of their appropriateness and precision for Early Iron Age societies of the northwest, relating the results by means of several demographic markers and the archaeological data known for the settlement.

1. Introduction

Paleodemography in an archaeological context was one of the most popular disciplines between the 1960 s and 1980 s (*e.g.* Hassan, 1981; Naroll, 1962), perhaps because of the take-off of quantitative analysis in archaeology and the rise and spread of New Archaeology, Processualism and Cultural Ecology Studies. Interestingly, these approaches have lost ground since the 1980 s, probably as a result of certain analytical excesses which aimed to identify universal "constants" that could be generally applied in order to quantify any type of human habitat. Indeed, this caused some inaccuracies and determinism by disregarding the specificities of each cultural context (Fletcher, 1981), since expressing architecture and space, divergences between kinship systems or mere cultural diversity among communities prevent assuming a general rule for human demographic dynamics (Chamberlain, 2006: 10). Still agreeing, I believe that this should not make paleodemography fall into oblivion: with the arsenal of available techniques and the capacity to model the organisation of the domestic space taking cultural diversity into account, a demographic analysis can provide useful information, which is already doing from other approaches (Crema, 2022).

This paper proposes a paleodemographic approach to the Early Iron Age (EIA), adopting a microspatial focus on the fortified settlement of Punta de Muros (Arteixo, A Coruña) (see Fig. 1). It should be highlighted that, in this study, the term "paleodemography" is used as a synonym for the study of demography in archaeological contexts, but it will not be related to any kind of study based on skeletal paleodemography. Inhabited between the 9th and 4th centuries BC, Punta de Muros offers an excellent framework: it has not only been completely excavated (Cano Pan, 2012) (see Fig. 2), but also has a particularly extensive record, with a remarkable amount of radiocarbon dates. Thus, its phases of occupation could be identified and linked with the social dynamics of the settlement in a robust temporal framework (Nión-Álvarez, forthcoming). Furthermore, this work presents a remarkable opportunity for the region of study, according to the absence of paleodemographic works (beyond a few tangential approaches: Carballo Arceo, 2002; González-Ruibal, 2006-7: 172). Therefore, Punta de Muros provides a suitable context for a paleodemographic approach, which also avoids common problems in demographic calculations, such as the need to estimate the potentially habitable space or the average size of the dwellings (Kintigh and Peeples, 2020; Porčić, 2011).

This paper aims to set a paleodemographic study applied to this site, relying on different estimation techniques, and to understand the results according to the social dynamics of the settlement. However, given the state of paleodemographic studies in NW Iberian Iron Age, the purpose is not so much to obtain truly representative results, but rather to observe

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the application of techniques used in other approaches. In this sense, all these methods will also be assessed according to the results provided and their coherence with different paleodemographic markers. These indicators are based on basic anthropological data defined in wide-ranging cross-cultural studies of agricultural and sedentary societies, assuming broad limits to recognise social heterogeneity within certain limits which, if exceeded in the case of agricultural and sedentary societies, would indicate several flaws in the methodological application. These conclusions may provide some useful insights to explore further applications of the methods, but they should be considered as mere coments about their archaeological implementation in ths context, as the analysis, of course, could not be contrasted with precise demographic data.

2. Punta de Muros and EIA societies in NW Iberia

The dawn of the first EIA societies meant the dawn of fortified settlements in NW Iberia, which shows a significant break with Bronze Age social strategies, defined by semi-nomadism, wide circulation of bronze objects or large-scale mobility (Méndez Fernández, 1994; Parcero-Oubiña et al., 2020), among others. Through the EIA, the hillfort became the main and exclusive unit of habitation (González-Ruibal, 2006-7: 160), usually placed on conspicuous locations of small dimensions (less than 1 ha) with a great defensive potential and sharp long-distance visibility (Parcero-Oubiña, 2000: 86-87). Semi-nomadism also gave way to a fully sedentary way of life, hinting at new patterns of rationality (Blanco-González, 2011). Early Iron Age societies were usually defined as undivided and non-hierarchical, showing a remarkable uniformity among domestic units, objects, and practices.

The first phases of occupation at Punta de Muros are a representative example of these dynamics. During Phases 1A and 1B, the settlement is defined by small dwellings (see Fig. 3), with an internal multifunctional space and lacking divisions or spaces dedicated to a particular task Nión-Álvarez, (forthcoming). The settlement is characterised by its disorganised network and lacks planning criteria. Both phases reproduce very similar patterns, differentiated only by a likely demographic growth during Phase 1B, which can be inferred by an increase in roofed space (see Table 3). A chronostatistical analysis with Bayesian models (see Fig. 4) allowed to date Phase 1A between 850 and 750 BCE and Phase 1B between 750 and 525 BCE. In this case, however, the chronological issues raised by the Hallstatt Plateau should be considered (Calvo Trías et al., 2020).Table 4.

The settlement underwent a significant transformation during Phase 2 (525–390 BCE): the dwellings significantly increased their size, either through the merger of single domestic units or through the construction of large buildings *ex novo* (see Fig. 5). In both cases, new buildings would imply greater internal complexity, tripling the dimensions of the dwellings in previous phases (see Table 1). The domestic space began to be compartmentalised and to present storage areas and others for productive activities such as metalworking (Nión-Álvarez, 2022b: 494) or the processing of food or raw materials (Cano Pan, 2012: 355). A notable increase in the capacity to accumulate and store goods can also be observed both in the presence of storage spaces and in the exponential increase of the storage containers in each domestic unit (Nión-Álvarez, 2022a). The amount of roofed space during this period is significantly increased (almost doubling, see Table 3). Although it could be related to the existence of storage and specialized areas within the dwellings, it is also due to a demographic growth, as some of the formulae that considers these aspects will propose below.Table 2.

These changes in the dwelling match a new configuration of the settlement, which, from this phase onwards, follows an axial grid perpendicular to the wall.

The archaeological and chronological sequence of Punta de Muros represents the complete span of the EIA in NW Iberia. Phases 1A and 1B suggest a common EIA hillfort (for a synthesis of the features of early Iron Age hillforts, see Parcero-Oubiña et al., 2020) and a significant social homogeneity within the village; however, Phase 2 shows considerable transformations, especially within the household (Nión-Álvarez, forthcoming). This process, together with other factors, has been understood as part of a significant rupture with the previous social *ethos* of the settlement in favour of new strategies of internal hierarchisation. At this point, this brief review of Punta de Muros can be useful to contextualise and ponder the potential of paleodemographic studies in the NW Iberian Iron Age, as well as to explore to what extent it could be coherent with the data provided.

3. Materials and methods

As mentioned above, this work is focused on the assessment of different demographic analysis techniques (mostly focused on the calculation of the living space of invididuals according to different possibilities) and on the review of the applicability, coherence, and accuracy of the results. Most of the data related to the domestic space and chronological proposals were considered following Cano Pan (2012) and Nión-Álvarez (forthcoming). Therefore, a review of the delimitations of each domestic unit was individually performed, verifying the characteristics of their habitability and storage strategies. This review aims to define the roofed space, a significant feature by itself when analysing housing dynamics and essential to the demographic estimation techniques applied in this work.

From the plethora of available techniques (Drennan et al., 2015: 13-49), the work has been focused on those based on the measurement of the inhabited domestic space, one of the most common proxies within

Fig. 1. Location.

paleodemographic studies (Birch-Chapman et al., 2017), due to the characteristics of the case study: a perfectly delimited settlement that preserved almost all their original domestic space. Moreover, the vast amount of data regarding the domestic sphere contrasts with the complete absence of funerary evidence, a common issue for NW Iberia Iron Age (Vilaseco Vázquez, 1999) that hinders demographic calculations based on burial space.

Therefore, a total of 5 formulae, based on the domestic space, have been applied. Most of them have recurrently been used in different cases and as a reference in several paleodemographic approaches; some, as we shall see, have been slightly modified, restructured, or even built from scratch to consider other recently available parameters (an explanatory example of how they work can be found on the Supplementary Materials). By applying them to an agrarian, fortified, and sedentary society, we will further assess their applicability according to different demographic parameters such as population density, annual growth, or the average number of inhabitants per household.

3.1. Naroll's "Constant"

The most important reference in terms of paleodemography is the seminal work of (Naroll 1962), whose cross-cultural approach with more than 30 societies aimed to establish a general pattern for all types of human societies. Popularly known as "Narroll's Constant" (NC) for its wide use in anthropology and archaeology (Porčić, 2011), these calculations proposed a standard amount of 10 m^2 of averaged roofed space by person (Naroll, 1962: 588). Over the years, this estimate has received considerable criticism, both for its simplicity and its deterministic assumptions (Brown, 1987; Fletcher, 1981). NC implies assuming different ways of inhabiting space under one single parameter, as well as not allow to quantify the presence of infants or elderly people. Currently, its application is hardly considered valid; in this case, it has been applied as a control technique, which will highlight the strengths and weaknesses of other methods.

3.2. Kolb-Brown estimation

The works of Kolb (1987) and Brown (1987) brought a major revision and correction of population estimations in paleodemographic terms. Under different focuses, both researchers pointed out the impossibility of establishing linear or allometric relationships between the number of inhabitants and roofed space in general for all human societies; thus, it is necessary to identify several cultural architectural and kinship patterns from an ethnographic, archaeological, and anthropological perspective in order to address each specific case of study. In this case, we found relevant to explore different kinship patterns as the significant change in the domestic sphere of Punta de Muros may have implied either a change in residence patterns (perhaps to a

Fig. 2. Aerial image of the site (Cano Pan, 2012: 102).

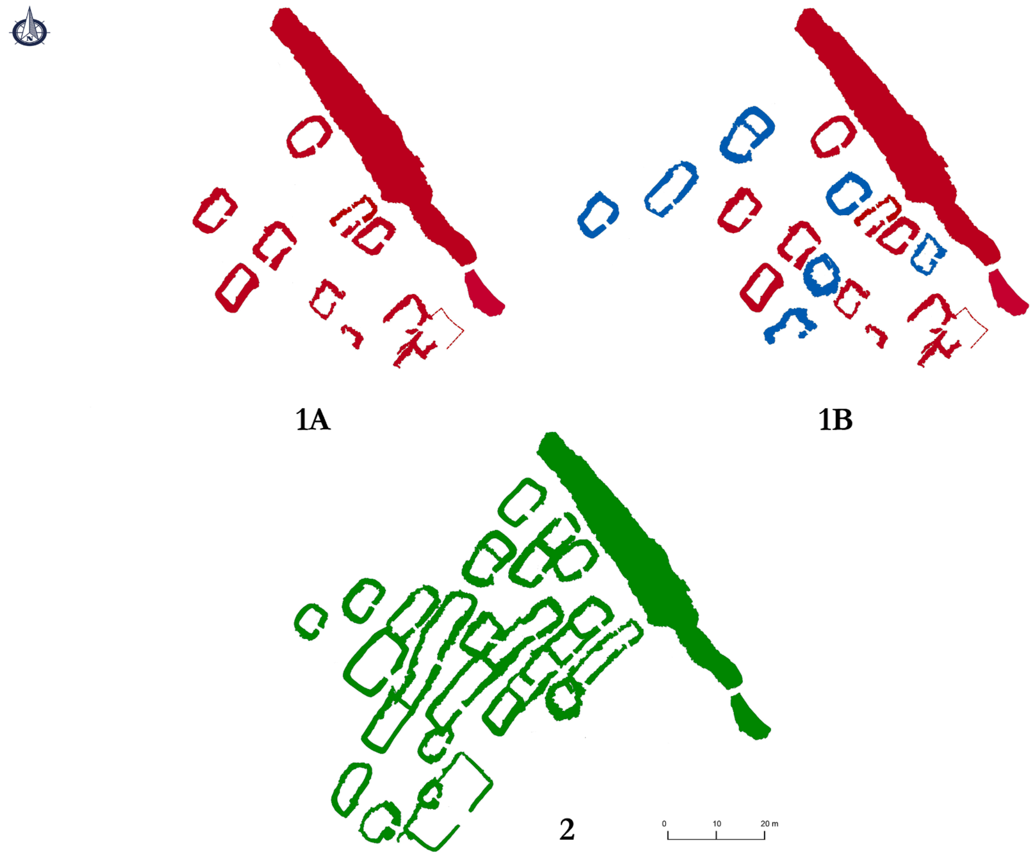

Fig. 3. Phases of occupation of Punta de Muros.

matrilocal model, which usually requires dwellings larger than 45–60 m^2: Porčić, 2010) or in the family model (maybe a shift from nuclear to extended family system, as recently suggested: Nión-Álvarez, 2023). Small and multifunctional dwellings of the Phases 1A/1B were coherent with nuclear houses, as it has ben usually stated for Early Iron Age of Northwest Iberia (González-Ruibal, 2006-7: 199), but large and compartmentalized dwellings of the Phase 2 require considering new forms of kinship and society.

Hence, estimations made by Kolb and Brown have been synthesised as part of the same formula (KBE) so as to take advantage of the data provided by both researchers, focusing, specially, on the results offered for agrarian and sedentary communities. In this case, Kolb (1985: 587) suggests an average space per inhabitant of 6.12 m^2, coherent with Casselberry studies (1974: 119-120). However, aiming to introduce the kinship factor, it is necessary to assess until what extent these numbers could be appliable in extended families (Brown, 1987: 32-33). In this regard, Brown's analysis (1987: 33-34) were focused on verifying whether there really is a lower housing density in these cases, ruling out the possibility of them having a higher housing density, but without analysing the average space per inhabitant.

In this sense, and focusing on the case studies collected by Brown (1987: 18-19), all the samples whose dwellings were coherent with extended family patterns (that is, larger than 55 m^2) were identified and quantified (data are available as Supplementary Material, as well as their statistical validity through a Mann-Whitney *U* test). After that, two measures have been established: one corresponding to the mean area of all of these dwellings, and the other related to the average number of inhabitants per dwelling. Both data have been crossed, providing a mean area of 9.64 m^2 of dwelling floor area per inhabitant for these kinds of households. Hence, with this formula, living space of each dwelling has been divided by 6.12 m^2 for dwellings smaller than 55 m^2 and by 9.64 m^2 for those larger than 55 m^2.

3.3. Late-Iberian estimation

The Late-Iberian-Estimation (LIE) is based on paleodemographic data obtained in several studies of the NE Iberian Iron Age. LIE has been developed according to demographic calculations drawn during the last decades (e.g. Gracia et al., 1996; Py, 1996; Sinner and Carreras Monfort, 2019), which have been put together in order to offer a method that provides archaeological and ethnographic-based estimations. Although a correlative estimation may be troubling, it has been considered due to the possibility of obtaining support data very close in time and space, especially if a discrimination between different ways of inhabiting the household is possible.

Paleodemographic studies of the Iberian world have mainly been focused on estimated calculations of the space of each hillfort. A certain recurrence of 60 % of domestic space versus 40 % of "common or collective" space has been pointed out (Gracia et al., 1996: 182), although it is true that this figure must be nuanced in certain contexts (Belarte, 2010: 120). Data on the domestic space generally suggest the existence of nuclear family dwellings inhabited by 4.5 people on average, with little variation (Belarte, 2010: 121). Recent works have also highlighted an average area of 24.4 m^2 for Iberian nuclear dwellings (Sinner and Carreras Monfort, 2019: 307), excluding courtyard-houses and other complex households.

In this case, an estimation related to the inhabited space has been proposed following two different procedures and using previous data as a reference. Firstly, we assume the Iberian average of 4.5 inhabitants per nuclear family in a dwelling with an average size of 24.4 m^2. These data are considered in the calculations as a constant, establishing a relationship in which the estimated number of inhabitants of each dwelling expresses a proportional relationship with the dimensions and number of inhabitants per household in the proposed model. Secondly, given the lack of solid data about the density of occupation of large households, a

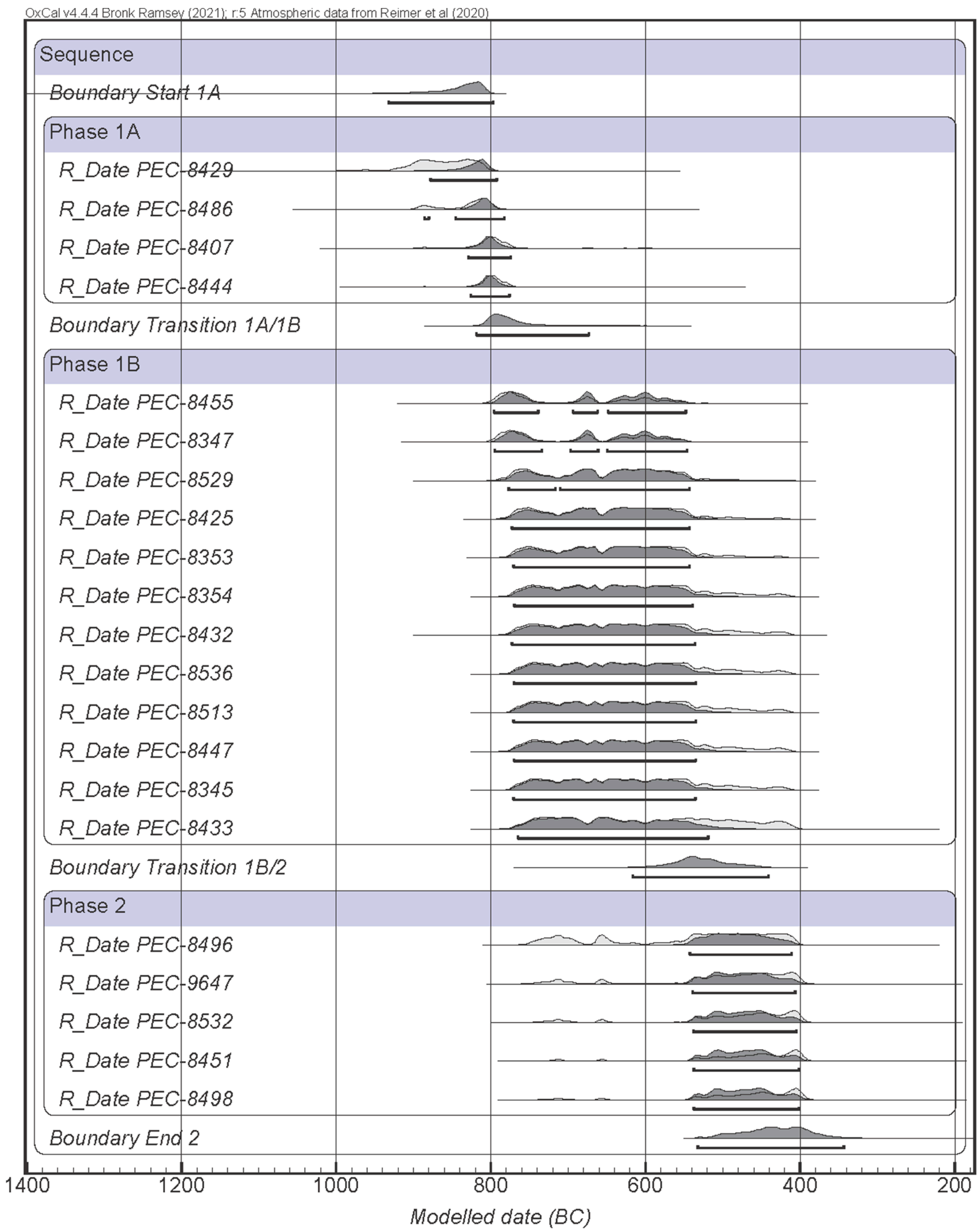

Fig. 4. Radiocarbon dates of Punta de Muros (calibrated and modelled) (Nión-Álvarez, forthcoming).

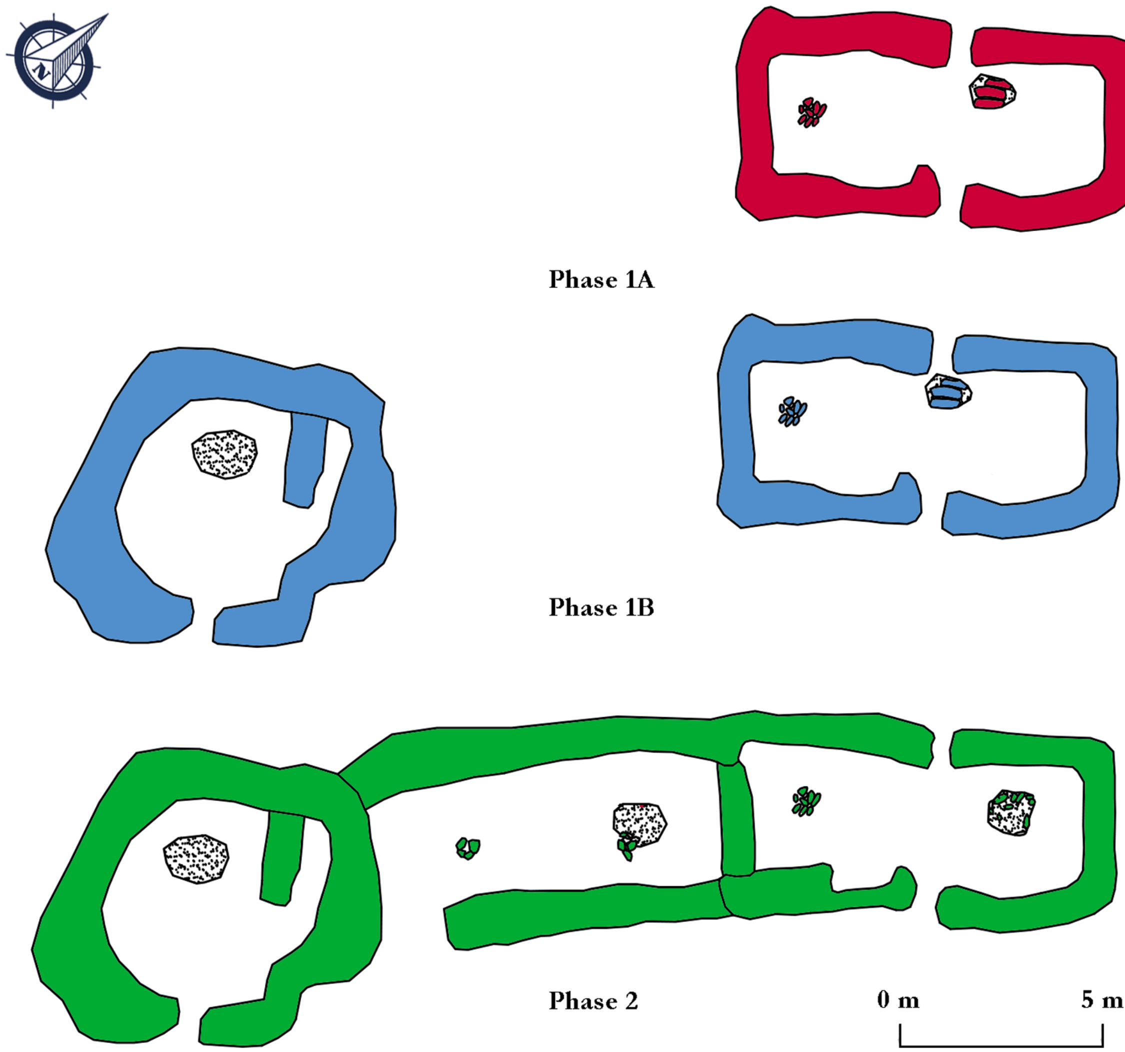

Fig. 5. Constructive dynamics of the households according to X-XI structures (based on Nión-Álvarez, forthcoming)..

calculation that differentiates between nuclear and extended family houses has been proposed, following the shift in residence patterns during Phase 2, previously explained. According to Brown (1987: 34), the relationship in terms of population density between different kinship patterns that generate architectural forms of different sizes is usually proportional; thus, we have extrapolated this proportionality by considering the difference quantified for the KBE in relation to the space occupied per person in each domestic unit (6.12 m^2/inhabitant in nuclear families and 9.64 m^2/inhabitant in extended families). Assuming this proportionality, an occupation of 8.54 inhabitants per m^2 is estimated for dwellings coherent with extended families. These data provide the necessary information to calculate the living space per household unit, following the procedures previously explained for KBE (for further details, see the Supplementary Materials).

3.4. Residential area density Coefficient method

The Residential Area Density Coefficient (RADC) is a measure of the average amount of residential area occupied by each person (Birch-Chapman et al., 2017: 5). Usually, the RADC residential calculation involves estimating the floor area of a settlement through various calculations, either based on the potential extent of a settlement or on the density of dwellings in each settlement. In this case, the RADC is only applied to potential sleeping areas, which reflects the resident populations more accurately, especially if we consider that domestic data are particularly precise. The habitational density ranges proposed by Hemsley (2008: 131) for the Levantine Pre-Pottery Neolithic have been followed, considering 1.77 m^2 as the minimum range per inhabitant, 3.33 m^2 for the mean and 5 m^2 for the maximum. The RADC does not provide new information, in this case, when compared to the previous methodologies. However, it is pertinent to take it into consideration in terms of density calculations of the existing settlement and of subsequent demographic approximations.

3.5. Storage Provision formula

The Storage Provision Formula (SPF) is a methodology developed by Hemsley to calculate the number of sleeping occupants accommodated within a dwelling, according to different factors (hearths, accesses, internal transit) and three different degrees of personal annual storage provisions. Following Hemsley (2008), three formulae were proposed correlating the maximum number of sleeping occupants to the available residential floor area. "*dp*" represents the average number of occupants per dwelling and "*drs*" represents the estimated residential floor area:

- No personal storage ($dp = 0.3944drs – 0.375$)
- Moderate degree of personal storage (0.46 cu m: $dp = 0.2477drs + 0.0339$)
- High degree of personal storage (0.92 cu m: $dp = 0.1903drs + 0.3976$)

Table 1
Household data, ordered by phase of occupation.

Domestic unit Phase 1A	Area (in m^2)	Has dedicated storage space	Radiocarbon Dating
III	28.1		
VIII	18.8		
XI(b)	27.5		2620 ± 40 BP (PEC 8407)
XII	20.9		
XIV	27.7		2710 ± 40 BP (PEC 8429)
XXIV	23.4		
XXV	28.0		2425 ± 35 BP (PEC 8496)
TOTAL	174.4		
MEAN	24.9		
STD	3.9		
Phase 1B			
III	28.1		
VI	18.1		2480 ± 35 BP (PEC 8345)
VIII	18.8		
X	21.8		2500 ± 35 BP (PEC 8425)
XI(b)	27.5		2620 ± 40 BP (PEC 8407)
XII	20.9		
XIV	27.7		2710 ± 40 BP (PEC 8429)
XVI	26.9		2480 ± 35 BP (PEC 8447)
XXIV	23.4		
XXV	28.0		2425 ± 35 BP (PEC 8496)
XXVIII	36.8		
XXX	34.3		2510 ± 35 BP (PEC 8529)
XXXII	19.3		2480 ± 35 BP (PEC 8536)
TOTAL	331.6		
MEAN	25.5		
STD	5.8		
Phase 2			
X-XI	68.8	X	518–401 BCE (PEC 9647)
XII-XVI	114.3	X	
XXVII-XVIII-XIX-XXIV	154.2	X	
XXI	20.4		
XXII	25.8		
XXIII	130.5	X	517–399 BCE (PEC 8498)
XXV-XVII	89.8		
XXVIII	36.8		
XXIX-XXX	108.4		
TOTAL	749.0		
MEAN	83.2		
STD	48.1		

These formulae were successfully applied by Birch-Chapman et al. (2017) to a case study of Levant PPN Neolithic, a methodological approach based mostly on archaeological evidence and empirically derived from values that represent human sleeping space (Birch-Chapman et al., 2017: 6). In addition to avoiding assumptions, it also understands the uses of domestic space apart from resting and cooking, introducing other activities such as storage in order to ponder dwelling size (Birch-Chapman et al., 2017: 6). This focus offers functionality to manage information about different uses of households (available in our case) and the existence of storage areas. However, its reluctance to consider cultural factors results in an allegedly universal approach that could be troubling when applied to other areas, leading to a certain degree of inaccuracy by ignoring issues of social organisation and kinship.

4. Results: testing demographic estimates

The results of demographic estimates are shown in Table 2 and 3, while demographic indicators calculated according to the results are shown in Table 4, focused on the number of inhabitants per dwelling (with an average defined by each technique applied), population density (inhabitants/hectare) and estimated annual growth rate.

The **number of inhabitants per dwelling** has been calculated based on the average number of inhabitants per dwelling for each domestic unit inhabited in each phase. The results suggest that phases 1A and 1B of Punta de Muros were most probably inhabited by nuclear families, as it was suggested above. It is usual for a nuclear family to be comprised of between 3 and 8 people (Kolb, 1985: 590), even in relatively small dwellings. As Düring and Marciniak (2006: 172-173) stated for the Anatolian Neolithic, households of 12 m^2 can host up to 5 individuals. The results provided by NC are excessively low for these standards, while those provided by SPF are slightly higher. KBE, LIE and SPF offer coherent values within this average.

Regarding Phase 2, it appears that the complex dwellings with large internal compartmentalisation have housed large families. Most studies agreed that extended families accommodated about 15–20 members (Flannery, 2002: 424), but this figure may be even higher (Hemsley, 2008: 105). In this case, NC offers data too narrow to be considered, while KBE and LIE provide results slightly lower than the proposed average. Even discarding the results for nuclear houses still in use at Phase 2, the averages of inhabitants/m^2 roofed space (11.51 and 12.99, respectively) seems a bit lower than expected, especially for KBE. On the other hand, RADC data (even choosing the average of three ranges) seems particularly excessive.

Regarding **population density**, calculations were based on the built area of the site (0.938 ha). A range between 30 and 160 people per hectare is assumed (Curet, 1998; De Roche, 1983), with an average density of about 100 inhabitants (Storey, 1997). According to a built area of 0.938 ha, NC, KBE and LIE, estimations fit well all phases, but RADC and SPF (albeit slightly) data seem too high, especially for Phase 2. While the SPF's 166 inhabitants per hectare might be feasible, the 242 inhabitants per hectare provided by the RADC are completely excessive for Iron Age societies and closer to highly complex pre-contemporary societies or even industrial towns (Chamberlain, 2006: 128).

Finally, the **annual growth rate** is calculated through arranging a basic population growth formula (following Weiss, 1973: 7): $(ln(n1/n2)/t)$; where $n1$ is the population at the end of the Phase, $n2$ is the population at the beginning and t is the time span of the analysed phase. The span of each phase was calculated according to the results of a Bayesian chronometric model (Nión-Álvarez, forthcoming), estimating the length of Phase 1B in 210 years and Phase 2 in 150 years. It is worth noting that it is not possible to efectively correlate estimations with a particular moment of each Phase. In this sense, it has been considered that the estimation refers to the final moment of each phase. The reason for that is simple: on the one hand, it is coherent with the calculation strategies previously developed, as it refers to the total number of occupied dwellings in each phase. On the other hand, data indicate a continuous and consistent increase in roofed space during the entire life of the settlement, so it is more likely that all occupied dwellings of each phase were still in use at the end of each phase. According to that, it is only possible to make an approach to the annual growth rate between phases (1A to 1B and 1B to 2).

In this case, the estimated annual growth rate between 1A and 1B

Table 2
Inhabitants per dwelling according to applied methods and phases (differentiated by colours).

DOMESTIC UNITS	P1A	KBE	LIE	SPF	P1B	KBE	LIE	SPF	P2	KBE	LIE	SPF
III		4.59	5.31	6.99		4.59	5.31	6.99				
VI						2.95	3.34	6.76				
VIII		3.07	3.46	7.04		3.07	3.46	7.04				
IX												
X						3.56	4.02	8.22				
XI(B)		4.49	5.08	10.5		4.49	5.08	10.5				
XII		3.41	3.86	7.87		3.41	3.86	7.87				
XIV		4.52	5.11	10.6		4.52	5.11	10.6				
XVI						4.39	4.96	10.2				
XXI										3.33	3.76	7.67
XXII										4.21	4.76	9.8
XXIII										13.53	15.3	25.23
XXIV		3.82	4.32	8.85		3.82	4.32	8.85				
XXV		4.57	5.16	10.7		4.57	5.16	10.7				
XXVIII						5.99	6.79	9.15		5.99	6.79	9.15
XXX						5.6	6.33	13.2				
XXXII						3.23	3.65	7.43				
X-XI										7.13	8.06	13.49
XII-XVI										11.85	13.4	22.15
XVII-XVIII-XXIX-XXIV										15.99	18.1	29.74
XXV-XVII										9.31	10.5	17.49
XXIX-XXX										11.25	12.7	21.02
Total		28.47	32.3	62.4		54.2	61.39	117		82.59	93.3	155.7

Table 3
Population estimations per method and roofed space.

	P1A	P1B	P2
NC	17.4	33.1	74.9
KBE	28.47	51.19	82.59
LIE	32.3	61.39	93.9
RADC	52.9	100.5	226.9
SPF	62.44	117.4	155.7
Roofed Space (in m^2)	174.4	331.6	749.0

provides very similar results in all methods, but the results between 1B and 2 present more differences: SPF shows an almost identical annual growth rate, LIE and KBE have a slight increase and NC and RADC presents a significant increase. Annual growth rate tend to be a stable value in pre-industrial societies, usually ranging between 0,25 % (for hunther-gatherer or non-stable agrarian societies: Eshed et al., 2004: 318-320) and 1 % (for stable agrarian-based societies: Bandy, 2010: 20). In several contexts, higher growth rates may be expected (Chamberlain, 2006: 65), but mostly related with conjunctural situations or exceptional contexts. All obtained rates seem coherent with these markers and shows a similar trend: a continuous growth during the Phase 1B that seems to be sligthly increased during Phase 2. The higher rates of NC and RADC during Phase 2 seems symptomatic of their greater imprecision when facing contexts with social, cultural and/or kinship changes in the domestic space.

5. Discussion

Following the twofold approach of this paper, the discussion will be focused on tho main issues: the assesment of the applied techniques and the analysis of the social processes of the settlement according to the results. First of all, it should be emphasised that the following reflections do not pretend to assert definitive conclusions. This work has an empirical basis, and it is facing an unexplored and untestable context, so there will necessarily be many uncertainities in this regard. The introduction of demographic markers may be useful for contextualise some of the results, but only for understand what techniques may be out of the range, not to raise strong assertions based on them.

In this regard, a global analysis of the results shows that both NC and RADC seems to be less effective than the other techniques in this case. Their calculations seem particularly low when analysing the number of inhabitants per household or the settlement's population density. This could be reflecting several flaws to estimate changes in population from a diachronic perspective, as well as less permeability to comprehend certain cultural factors. Despite these limitations, it is worth emphasising that, in the case of RADC, it could be particularly useful for applying calculations to settlements in which the total inhabited space is unknown, although the methods for analysing the number of inhabitants per dwelling require better formulae and to introduce cultural conditionings.

The rest of the applied methods seems more coherent with the demographic indicators, but none of them provided truly satisfactory results. Two of them (KBE and LIE) introduce cultural and kinship context as a basis for analysis, while the third (SPF) rejects them in favour of a detailed universal formula. In the case of the KBE, data provided seem a

Table 4
Demographic indicators according to results. Colours show the level of accuracy of each parameter.

	P1A	Inhabitants	Inhabitants per dwelling (mean)	Population density (hab/ha)	P1B	Inhabitants	Inhabitants per dwelling (mean)	Population density (hab/ha)	Annual growth rate	P2	Inhabitants	Inhabitants per dwelling (mean)	Population density (hab/ha)	Annual growth rate
NC		17,4	2,49	18,6		33,1	2,55	35,3	0.31%		74,9	8,32	79,8	0.54%
KBE		28,47	4,07	30,4		54,19	4,17	57,8	0.31%		82,59	9,18	88,1	0.28%
LIE		32,3	4,62	34,4		61,39	4,72	65,4	0.31%		93,3	10,37	99,5	0.28%
RADC		52,9	7,56	56,4		100,5	7,73	107,1	0.30%		226,9	25,2	241,9	0.54%
SPF		62,44	8,92	66,5		117,4	9,03	125,2	0.30%		155,7	17,3	165,9	0.19%

bit conservative for the estimation of the number of inhabitants per household, especially for extended families. The other indicators are consistent, although the number of inhabitants in each phase seems to be relatively tight. LIE poses similar issues, although its results are slightly higher than KBE when estimating the average of inhabitants per household. In any case, both methods present relatively consistent parameters according to demographic markers. It is true that the average of people per dwelling and the total number of inhabitants in the settlement seems to be lower than expected, especially for KBE (it would not reach 100 people at its peak). This could be a consequence of the aforementioned lack of accuracy in quantifying the inhabitants of extended family dwellings, although the impossibility to assess the real amount of population and the absence of comparable studies does not allow us to provide more insights in this regard.

Finally, SPF provides figures bordering on the reasonable for the number of inhabitants per dwelling (especially in phases 1A and 1B), as well as slightly exceeding indicators of population density (although, given the characteristics of the enclave, the number could be feasible). SPF accurately weights population and architectural change; however, although it is potentially applicable to fortified habitats, it should be revised to consider variables specific to simple domestic units and reformulated accordingly in order to understand storage and task-specialising strategies.

Finally, and focusing on the three techniques that have given "less inaccurate" results, two are based on ethnographic and archaeological data (KBE and LIE) and the third on a basic formula of general application (SPF). The main flaw of the first two is their approximate nature and the potential failure of correlations. Both techniques may fail in quantifying the number of people per dwelling: more precise parameters should be sought, especially for extended families. It is also possible that the proportionality between nuclear and extended family dwellings, following Brown (1987: 34), has not been as applicable as expected, making it necessary to explore other models. In the case of the SPF, its formulation is certainly of interest, but its general approach does not permit discriminating between factors such as kinship or social organisation, which causes a certain degree of determinism by assuming general behaviour for occupational strategies. A possible example could be the slightly excessive density of occupation, especially for Phase 2.

Moving forward, we can contrast well-known archaeological dynamics with the data offered by the "less inaccurate" methods (LIE, SPF and KBE). Between Phases 1A and 1B, it is possible to appreciate a slow but constant demographic increase. This demographic increase does not indicate a significant change in the dynamics of the settlement, since simple and multifunctional dwellings are maintained, reflecting a stable and non-hierarchical system (Nión-Álvarez, forthcoming). Population estimates also report a particularly reduced number of inhabitants, which rules out previous proposals that stated, during this Phase, the existence of complex social models related to bronze metalworking (Cano Pan, 2012: 744), as already refuted by other approaches (Nión-Álvarez and González García, 2023).

However, this dynamic underwent notable changes between Phases 1B and 2. There was a remarkable transformation of the settlement, with large and compartmentalised dwellings and task specialisation, related with a significant increase of roofed space. It is possible that these changes reflect a shift towards the individualization of certain colectives and family units (Roymans and Gerritsen, 2002) and towards a more hierarchical social model (Nión-Álvarez, forthcoming). This concentration of power might have been expressed through the emergence of complex domestic units, perhaps related with a process of appropiation of the symbolic knowledge of prestigious activities such as metalworking (Nión-Álvarez and González García, 2023), although it is a broader process that must have been influenced by several factors. In contrast to the previous non-hierarchical model, different power groups emerged, perhaps several family lineages able to hold a greater weight in the decision-making of the settlement. Given the current data, these changes, although widespread across Europe (Fernández-Götz, 2017: 120-124), does not present significant parallels in NW Iberia. The only known exception might be the case of the hillfort of A Cidá (Ribeira, A Coruña), which presents significant architectural transformations in the domestic sphere in similar chronologies (Vidal Lojo and Naveiro López, 2020). Unfortunately, the absence of absolute dating prevents for a reliable comparative study between the two cases.

Despite of this processes of social complexity, the annual growth rate does not express a significant demographic expansion. Although the settlement was more populated during its last Phase, this is a consequence of a progressive trend occurred throughout its 500 years of occupation. In opposition to cultural-ecological perspectives, this recalls that there is no inextricable correlation between demography and social change. The demographic increase does not explain by itself any change in the development of unequal social strategies (Chamberlain, 2006: 183). These issues are also combined with a certain increase in housing density and with a domestic strategy that implies more inhabitants per dwelling, probably related with some kind of extended family model.

6. Conclusion

This paper has provided a microspatial paleodemographic approach to the population dynamics of a settlement in the EIA of the northwestern Iberian Peninsula. Its aim was to apply different techniques of paleodemographic estimations to provide data about long-term occupation of the settlement. Moreover, the applicability, flaws, and strenghts of these techniques have also been assessed, exploring how could be improved and applied to other comparable case studies.

In this regard, LIE and SPF (perhaps also KBE) seems more useful and appliable in this case, although they all need correction for certain biases to produce a truly representative result. Thus, seeking further enhancements of paleodemographic studies applied to NW Iberian Iron Age, there are two possibilities:

- To propose a detailed analysis at a local scale (maybe introducing new proxies, such as material density per dwelling area: Drennan et al., 2015: 29-31) to refine in detail the estimated number of inhabitants per m^2, especially for larger dwellings and extended families.
- To propose a revised SPF formula for northwest Iberia, including functional specialisation and introducing family organisation and kinship criteria.

In both cases, an in-deep analysis of the domestic sphere and a multidisciplinary approach is required. Through the analysis of the forms of social organisation and the structure of the domestic space, it is possible to refine these methods and to provide a solid paleodemographic approach.

Finally, the provided results may be relatively useful in comparative terms for other contemporary EIA settlements, especially if we look at the absence of approaches in this regard. However, the specificity of the case of Punta de Muros means that some demographic changes, especially concerning the last phase of occupation, may not express correlations with other examples. On the other hand, the vast majority of NW Iberian EIA settlements lack a broad record like this one. Indeed, this archaeological scarcity may prove useful in the application of a RADC analysis in large-scale studies. As mentioned above, this would require a comparative review of dwelling density across the territory to identify trends and minimise bias. Moreover, a RADC analysis of dwelling density within the settlement could be combined with a reformulation of LIE and/or SPF parameters that may provide a truly representative hab/m^2 estimation. Both techniques together could help to develop a methodology at a broader scale, opening the door to exploring new lines of research and to recovering paleodemographic analysis for the Iron Age.

7. Formulae

7.1. Nc

$$p = \frac{rs}{NC}$$

When p is the average population of the settlement, rs is roofed space and NC is Naroll Constant (10 m^2).

7.2. KBe

In case of dwellings which fits in the nuclear family model:

$$ndp = \frac{drs}{nfc}$$

When *ndp* is the average number of occupants per nuclear dwelling, *drs* is the roofed space per dwelling and *nfc* is the constant for the density of nuclear family dwellings (6.12 m^2).

In case of dwellings which fits in the extended family model:

$$edp = \frac{drs}{efc}$$

When *edp* is the average number of occupants per extended dwelling, *drs* is the roofed space per dwelling and *efc* is the constant for the density of extended family dwellings (9.64 m^2).

All dwellings were finally summed based on the data of each phase in order to obtain the total settlement estimate.

7.3. LIe

In case of dwellings which fits in the nuclear family model:

$$ndp = \frac{drs \times 4.5}{LIE}$$

When *ndp* is the average number of occupants per nuclear dwelling, *drs* is the roofed space per dwelling and *LIE* is the mean of iberian single domestic units (24.4 m^2).

In case of dwellings which fits in the extended family model:

$$edp = \frac{drs}{LIEe}$$

When *edp* is the average number of occupants per extended dwelling, *drs* is the roofed space per dwelling and *LIEe* is the constant for the density of extended family dwellings (in this case, 8.54 m^2).

All dwellings were finally summed based on the data of each phase in order to obtain the total settlement estimate.

7.4. RADc

$$dp = \frac{drs}{ra(x)}$$

When *dp* is the average number of occupants per dwelling, *drs* is the roofed space per dwelling and *ra* express the constant habitational density ranges. Employed ranges could be A (1,77 m^2), B (3,33 m^2) or C (5 m^2). All ranges were calculated and summed to obtain the total settlement estimate. Only *rb*, understood as a mean of all, were used for demographic calculations.

7.5. SPf

SPF were calculated following to Hemsley (2008) and Birch-Chapman et al. (2017). Three formulae are proposed, which should be chosen according to the characteristics of the occupation of each dwelling, mostly related with the presence of storage places or specialised activities.

- No personal storage ($dp = 0.3944drs - 0.375$)
- Moderate degree of personal storage (0.46 cu m: $dp = 0.2477drs + 0.0339$)
- High degree of personal storage (0.92 cu m: $dp = 0.1903drs + 0.3976$)

When *dp* represents the average number of occupants per dwelling and *drs* represents the roofed space. All dwellings were finally summed based on the data of each phase in order to obtain the total settlement estimate.

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Samuel Nión-Álvarez: Conceptualization, Data curation, Methodology, Formal analysis, Investigation, Resources, Visualization, Software.

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.

Data availability

No data was used for the research described in the article.

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Appendix A. Supplementary material

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