



## Paleofloods and ancient fishing weirs in NW Iberian rivers



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### ARTICLE INFO

#### Article history:

Received 13 September 2013

Available online 10 May 2014

#### Keywords:

Miño River

Minho

OSL dating

Geoarchaeology

Fish trap

### ABSTRACT

A 15-m-thick, fluvial sedimentary record of the NW Iberian lower Miño River was studied. Grain-size analyses were performed and twelve samples were dated using optically stimulated luminescence dating techniques, documenting a 1300-yr-old reconstructed fluvial record that does not match with known climate fluctuations in the area, but is linked instead to the construction of a series of ancient fishing weirs (*pesqueiras*). The sedimentation phases are in agreement with known episodes of increased population density, which suggests active use of the *pesqueiras*. A number of sedimentation hiatuses in the fluvial record point towards damage to the *pesqueiras* during large-scale flooding in the Miño River basin, and a sudden drop in population probably due to the arrival of the plague in the 13th century AD. The oldest sedimentation phases started just after 700 AD, and we infer that the first *pesqueiras* were constructed around this time. This timing coincides with the transition of the NW Iberian landscape towards a more intensively used agricultural landscape, as evidenced from other geo-archaeological investigations. The results demonstrate that the *pesqueiras* are several hundreds of years older than known from historical records, but not so old as to date back to the Roman occupation.

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### Introduction

Fishing weirs or fish traps are amongst the oldest man-made structures in the archeological record. Weirs world-wide date back to hunter-gatherer societies in the Mesolithic and Neolithic (Petersen et al., 1994; Pedersen, 1995; Out, 2008; McNiven et al., 2012), and also to the Bronze Age and historic times (O'Sullivan, 2003; Takahashi, 2009). The basic idea of fishing weirs is very similar globally, although building materials and design may vary. Weirs are normally constructed near river outlets or in lakes as a series of wooden stakes with a net or basket to trap the fish (O'Sullivan, 2003; Tveskova and Erlandson, 2003), or as a series of stone walls that either trap fish or guide them towards a system of channels in which the fish are trapped (Leite, 1999; Kemp et al., 2009; Langouët and Daire, 2009). The age of the wooden structures is normally dated by means of radiocarbon or dendrochronology dating (Nayling, 1999; Hall and Clarke, 2000; Tveskova and Erlandson, 2003) or by dating pollen records or shell middens that can be correlated to usage of the weirs (Newby and Webb, 1994; Colaninno, 2011). When organic components are not available, the age of the weirs can sometimes be deduced by dating fluvial channel

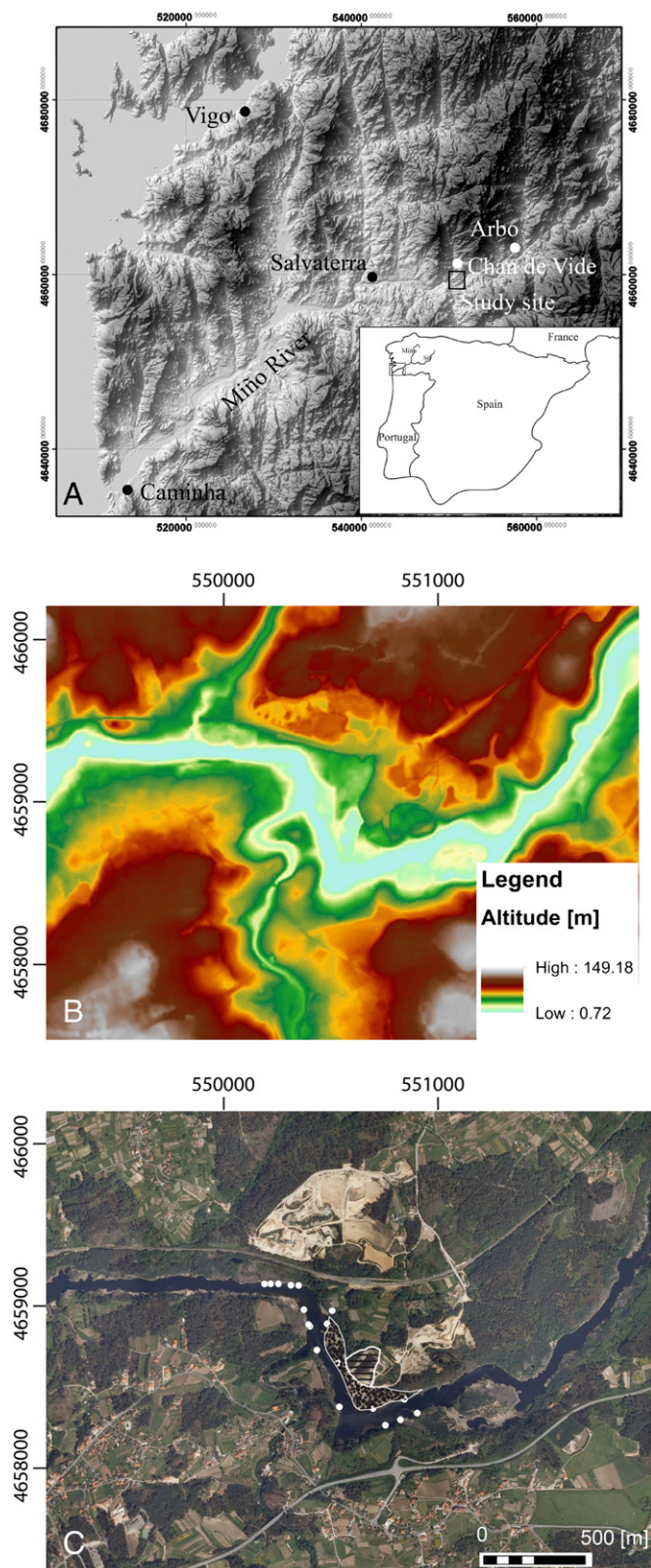
fills (e.g. Ellis and Brown, 1998). This is a common strategy in the case of stone weirs, because the stones cannot be dated directly (McNiven et al., 2012), although recent developments in optically stimulated luminescence (OSL) dating may provide a tool for dating stone surfaces (Sohbati et al., 2012).

In this paper, we discuss the age and origin of a series of stone fishing weirs (named *pesqueiras*) in the NW Iberian peninsula. Their age is unknown because of the absence of datable organic materials and other evidence of early occupation that can be directly related to the weirs. Their age can be inferred by dating a fluvial deposit directly in front of the weirs. We demonstrate (i) that the deposit is very likely related to the weirs as they created sediment accumulation space due to the partial damming of the river; then, (ii) sedimentological analysis allows identification of the periods in which the *pesqueiras* were used. We use OSL dating and grain-size analysis and link the sediment ages to the historical record.

### Ancient fishing weirs (*pesqueiras*) in NW Iberia

In NW Iberia a large number of ancient fishing weirs or *pesqueiras* are found. They occur solely in the rivers Tambre, Ulla, with the highest number in the lower Miño River (Fig. 1A). Here, over 700 *pesqueiras* were found in 1963, but only 500 survived the construction of a large water reservoir (Molinero-Llorente and Tarrago-Cid, 1978). The 25-km reach between Arbo and Salvaterra (Fig. 1A) has the largest

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**Figure 1.** A) Overview of the study area. Coordinates are given in UTM N29, ED50. B) Digital Elevation Model of the study area. The Miño River makes a sharp 90 degree turn, which is caused by the intersection of two faults. C) Aerial photo of the study area. The location of the studied deposit is marked by the white polygon with dashed fill. The gravel beds of the current river plain are marked by black dots. The white dots indicate the locations of remnants of the fishing weirs (*pesqueiras*). Coordinates of the studied deposit are 550610 N, 4658837 E (UTM N29, ED50).

number of *pesqueiras*, estimated at 400 (Molinero-Llorente and Tarrago-Cid, 1978). They are typically located in narrow parts of the rivers, such as bedrock gorges or river bends, where the currents are strongest. The *pesqueiras* were preferably built where natural obstructions such as rock outcrops occur. The weirs were used to capture upstream-migrating fish such as salmon, trout, eels and lamprey (Ladra-Fernandez, 2008). These fish are abundant here, but less common elsewhere. This may be a reason why the *pesqueiras* are only found in this corner of Iberia.

The *pesqueiras* are constructed as a series of stone dams that protrude from the river bank at a right or slightly oblique angle to the flow direction, depending on the currents (Figs. 2A and B). They are always made of large blocks of granite, which is the dominant rock type in NW Iberia. The blocks are not cemented, so they have to be sufficiently large to withstand the strong river currents (Portela, 1985; Fig. 2C). The *pesqueiras* consist of two main structures: (i) a series of stone walls, called *poios* in Galician and Portuguese, that are usually 2 m broad, 4–5 m long and 4–6 m high (Figs. 2A and C). They are constructed in parallel formation with a gap of 0.70–0.90 m between them (Molinero-Llorente and Tarrago-Cid, 1978). The *poios* slow down the currents and generate a pathway of least resistance, which the fish will follow. Between the *poios* a funnel-shaped net is placed, in which the fish are trapped. The nets are anchored to the *poios* with a chain. Because of the highly variable water level of the Miño River, the *poios* are partly submerged in winter and only emerge in summer (Molinero-Llorente and Tarrago-Cid, 1978). The second (ii) structure of the *pesqueiras* is a tall wall, *rabo*, which may be up to 20 m long and 3 m high (Fig. 2A). It will extend maximally halfway into the river and is not connected to the river bank (Portela, 1985). It is placed slightly upstream of the *poios* and is normally submerged. Its function is to guide the currents towards the *poios* (Molinero-Llorente and Tarrago-Cid, 1978). Both the *poios* and the *rabo* are constructed directly on top of the bedrock to ensure their stability. To facilitate access to the *poios*, the first *poio* is connected to the river bank by means of a stone wall built on top of the granitic river bank. This wall may be even higher than the *poios* (Leite, 1999). Several sub-types of *pesqueiras* exist (Leite, 1999), but a full account of these is beyond the scope of this paper.

Very little is known about the early origins of the *pesqueiras* in the study area, mainly because there is little written evidence and an extensive archeological inventory is lacking (Reboreda, 2005). Similarity of architecture suggests construction within an interval of 1–2 centuries (Molinero-Llorente and Tarrago-Cid, 1978).

There are indications that the Romans were already using the NW Iberian fish stocks for consumption. Most fish species were used in a special sauce, *garum*, made of oily fish, aromatic herbs and wine, which was in such a high demand that there were even buildings erected locally for their production (Suárez-Piñeiro, 2003); fish and especially the lamprey, were used in main dishes, or as a cure for ailments such as ulcers or ear-related problems (Huerta, 1624). The trade in these fish stocks intensified from the late 1<sup>st</sup> century BC onwards, when the Cantabrian Wars came to an end and the region was brought under control of Rome (Rodríguez-Colmenero, 2011). The interest of the Romans in the fish stocks and their well-known building skills suggest that the *pesqueiras* originate from then, but no direct evidence for this exists (Leite, 1999). There is written evidence that the *pesqueiras* were used in the late Middle Ages, because the fish were in high demand by the nobles (Andrade-Cernadas, 2009). Privileges were granted to build *pesqueiras* and they were initially owned by monasteries, but later on also by families (Portela, 1985). The first reference to *pesqueira* dates from the year 991 AD, when King Bermundo II made a donation in the village Pesqueira to the church of Santiago de Compostela (Ávila y la Cueva, 1852). In the year 1000 AD, a certain Odoario Tedoniz donated all his villages and *pesqueiras* to the monastery of Celanova, just east of Cham de Vide (Andrade-Cernadas, 1995). Around that time, more references to the *pesqueiras* appeared in various texts (Andrade-Cernadas, 1995). Nowadays the *pesqueiras* are still in use for lamprey fishing.

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