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Study of the access routes to the Castilian plateau through the Sella River valley (Asturias, Spain) during the end of the Upper Palaeolithic

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ABSTRACT

The Sella River valley (Asturias, Spain) has been and is currently a benchmark in Palaeolithic discoveries and research. The location and the number of archaeological sites along its orography certify a significant human presence in the valley throughout all of Prehistory.

The mobility that these human groups exercised and developed along the fluvial valley and its geographical location, invites the study of access routes to the exploitation of existing resources, as well as the exploration of territories, such as access to the valley of the Duero River, during the Late Glacier.

The use of auxiliary tools such as Geographic Information Systems (GIS) for the study and tracing of prehistoric transit routes, have meant enormous progress in this field, although they are not the definitive solution. In this work we verify the existence of errors generated by these tools. The superimposition of the routes calculated on the real orography of the territory subject to study in this article, reflect certain paths that are impossible to carry out.

A verification on the ground is necessary, which serves to elaborate the best route in this case, referring to the Azilian period.

1. Introduction

Research on the occupations of the Cantabrian region and the routes of penetration into the Iberian Peninsula have been a concern on the part of different authors, as shown by the work carried out, among others, by Clark and Straus, (1986) partially for Asturias, García Moreno, (2010) for Cantabria or Arrizabalaga et al., (2014) for the Basque Country.

The occupation of the Asturian territory during Prehistory was formed through a continuous process throughout the Middle Pleistocene and with greater intensity during the Upper Pleistocene. Approximately 300,000 years ago, *Homo heidelbergensis* colonized the region during the Acheulean period (Lower palaeolithic), as evidenced by the data obtained from the Asturian site of Cabo Busto (Álvarez Alonso and Rodríguez Asensio, 2014).

During the Upper Palaeolithic, the continuous incursions carried out by groups of modern humans taking advantage of this coastal corridor, allowed them not only to settle on the seacoast, but also to access the inland river valleys where they would develop a more seasonal population, exercising exploitation of the plant and lithic hunting resources that these places offer you.

The steep orography of the Cantabrian area in general and of the territory of Asturias in particular, meant that these river valleys became the main passageways to inland areas such as the Castilian plateau (Bernaldo de Quirós and Neira Campos, 1993).

The Sella River valley is witness to this human activity, both the prehistoric sites that populate its orography and its orientation perpendicular to the coast, confirm the penetration and circulation of these groups of hunter-gatherers towards the interior of the peninsula. These dynamics of occupation and transit have generated, in our case, an interest in investigating these valleys on the southwestern slope of the Asturian region and their possible access to the northern slope of León (Fig. 1).

This article is part of a more exhaustive study of the access routes to the plateau in eastern Asturias and in it, we submit to consideration the

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Fig. 1. Left: Location of the Sella river valley. Detail of the course of the river and its tributaries (Confederación Hidrográfica del Cantábrico). Right. Route of the river Sella (Map of Asturias 3D, courtesy of Miguel Angulo. https://miguelangulo3.wordpress.com/maps/3d-panoramics-views/).

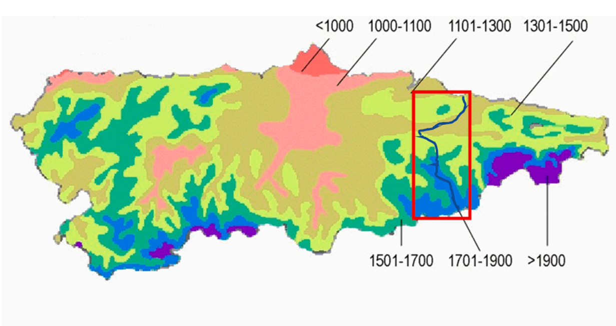

Fig. 2. Map of mean annual rainfall in the central-eastern area of Asturias, highlighting the valley of the river Sella (modified from Felicísimo Pérez, 1990).

possible transit routes through the Sella River valley between its sites during Prehistory; dedicating special interest to mountain routes as possible routes of penetration to the Castilian plateau, relying on the Geographic Information Systems (Gassiot Ballbè et al., 2020).

2. Study area

The Sella River is born in Leon, bordering the province of Asturias, in the surroundings of the Sajambre Valley, very close to the town of Vierdes de Sajambre; on a geology marked by Devonian and Estefanian materials, in the place called Fuente del Infierno and at a height of 1600 m. with a total distance of approximately 73 km and with an extension of its basin of about 1,246 km2. It enters Asturian territory with a marked downward slope, digging a deep and narrow canyon (the Los Beyos gorge), in materials made up of carboniferous limestone with steep walls through which the river meanders. This characteristic is repeated along the upper course until after the town of Ceneya, where the valley widens allowing the river to widen its course (Fernández-Irigoyen and Ruíz-Fernández, 2007; Fernández Irigoyen and Ruíz Fernández, 2008). At the height of the town of Santillán (middle-high course of the river), its first tributary, the Ponga River, joins the Sella on its western bank and further north, downstream from Miyares on its eastern bank, its second tributary appears, the Dobra River.

2.1. Geology

The lithological study in the Sella River basin supposes a geological division into three sections of the river that will coincide with its upper, middle and lower course.

The Sella River with its main tributaries in the upper course (Ponga on the left and Dobra on the right), cut a stratigraphic sequence characterized by Cambrian and Ordovician successions, in which the limestones of the Láncara Formation and the slates of the Formation Láncara-Oville, as well as the quartzites of the Barrios Formation.

In its upper section, the river runs through a canyon deeply embedded in Carboniferous, Devonian and Permian materials, mainly represented by limestone, while its tributary, the Ponga River, provides slates, radiolarites, as well as limestone and dolomites from the Láncara Formation or slates, quartzites and sandstones of the Oville Formation. Its other tributary, the Dobra, flows over limestone massifs and carboniferous rocks, among which those of the Picos de Europa Formation predominate, crossing in its last section of incorporation into the Sella, the lithological series previously assigned to the Ponga River.

In its middle course and up to the incorporation of its third tributary, the Güeña, the Sella River flows over the predominance of the Barrios and Oville formations, up to the town of Cangas de Onís.

In its lower course, between Cangas de Onís and Arriondas, where its fourth tributary, the Piloña, joins, conglomerates and Cretaceous sandstones dominate as lithic materials, Carboniferous and Ordovician materials once again predominating in its final section up to the mouth (Álvarez-Alonso et al., 2013).

The places through which the river passes are marked by a geology in which Carboniferous limestone and Ordovician quartzite belonging to

	January	February	March	April	May	June	July	August	September	October	November	December
Medium temperature (ºC)	7.9	8.3	10.9	13.3	16.8	21.6	24.3	24.2	20.6	16.9	11.4	8.6
Minimum temperature (ºC)	4.2	4.4	6.5	8.8	12	16.5	19.5	19.9	16.8	13.3	7.9	5.2
Maximum temperature (ºC)	12.4	12.9	15.7	18	21.5	26.6	29.4	29.1	25.1	21.1	15.4	12.8
Rainfall (mm)	38	33	37	46	35	14	5	15	53	54	49	39
Humidity (%)	70%	66%	63%	61%	60%	55%	57%	60%	67%	71%	70%	73%
Rainy days	4	4	4	5	4	2	1	3	6	6	6	4
Hours of sun	7.4	7.9	9.2	10.4	11.7	12.6	12.2	11.0	9.3	8.3	7.6	7.0

Fig. 3. Historical climatic data in the Sella river valley, in terms of temperature, humidity, precipitation and insolation (CLIMATE-DATA.ORG).

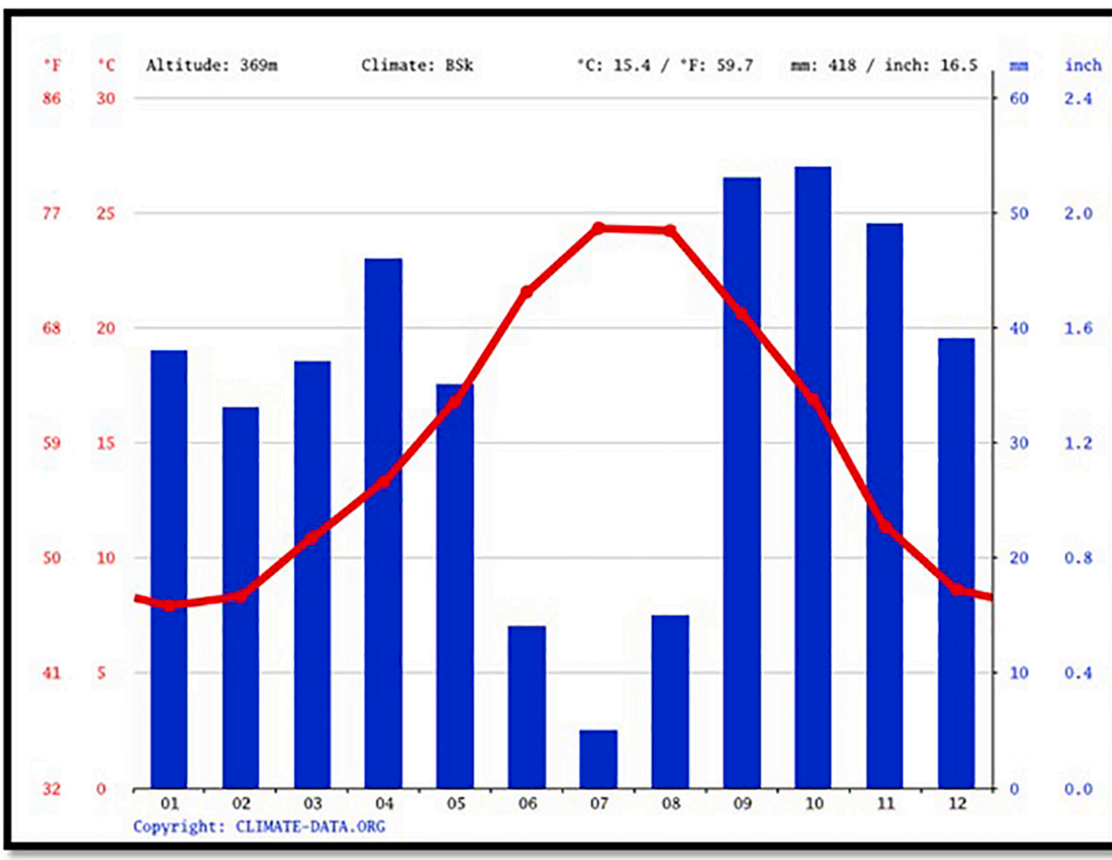

Fig. 4. Climogram corresponding to the Sella river valley (CLIMATE-DATA.ORG).

the Barrios Formation alternate, this characteristic being a constant until its mouth. This alternation of geological materials has been one of the main premises for the successful proliferation of human settlements in this river valley, since on the one hand it would facilitate the creation of cavities and karstic shelters and on the other it would allow the proliferation of hydrographic basins with possible lithic deposits. to obtain raw materials (Duarte Matías et al., 2016; Martín-Jarque et al., 2019; Santamaría Álvarez et al., 2011; Tarriño Vinagre et al., 2013).

2.2. Climatology

In relation to the current climate, the Sella Valley is influenced by several key factors: the first, the proximity of the Cantabrian coast; the second, the great unevenness existing in a space very close to the coast; and finally, the third, belonging to the temperate-humid climate zone (Ortega Villazán and Morales Rodríguez, 2015).

The first of the factors explains why there is an Atlantic-type climate characterized by abundant rainfall well distributed throughout the year, thermal amplitude and intense and abundant vegetation.

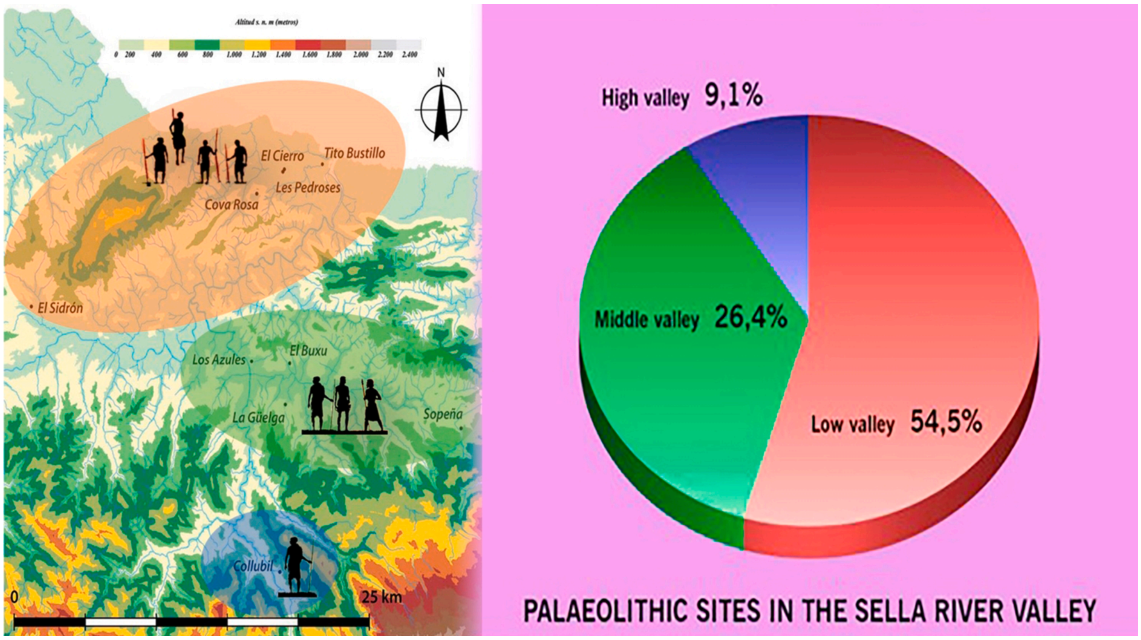

Fig. 5. Location of Palaeolithic sites in the Sella river valley.

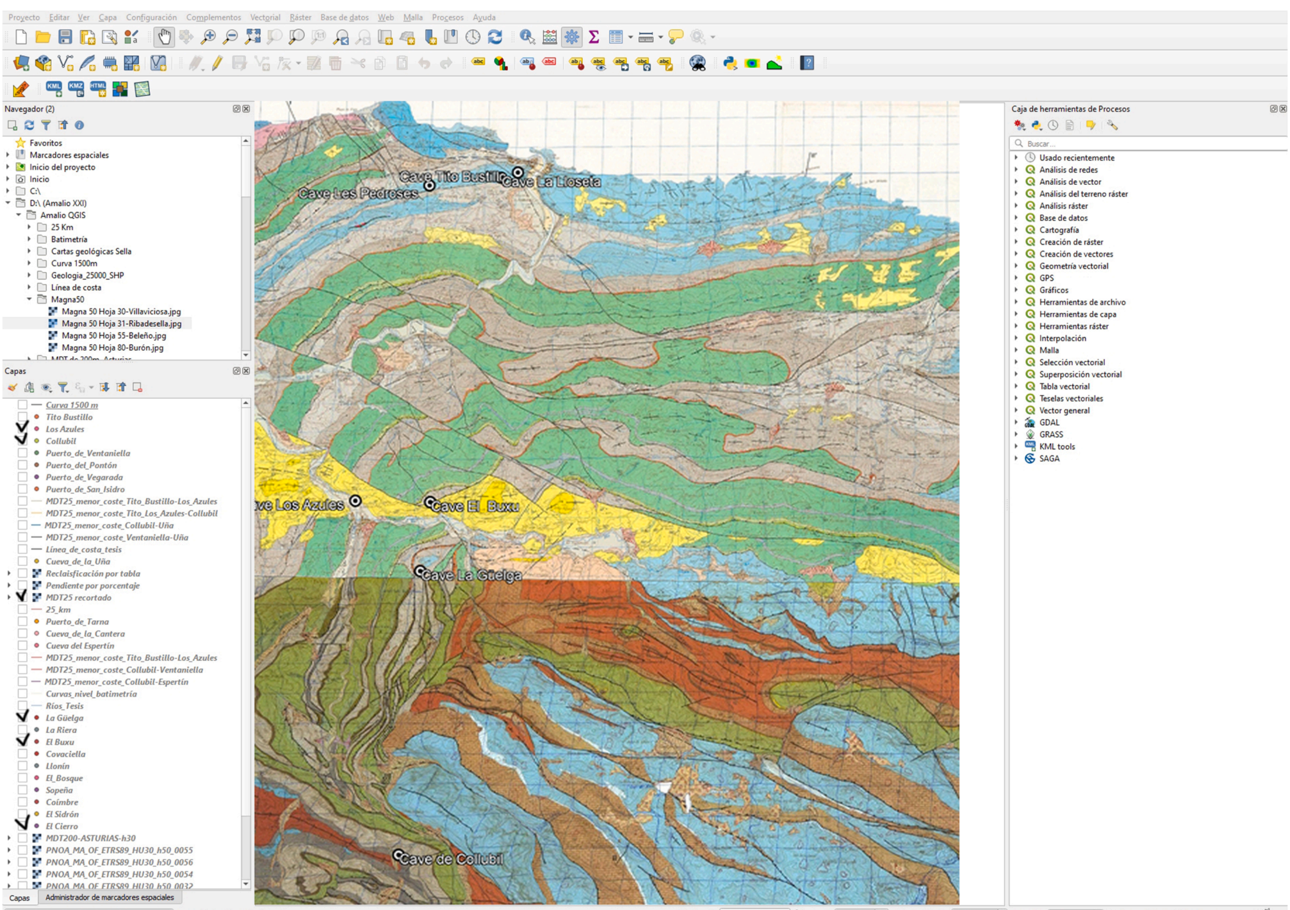

Fig. 6. Superposition of prehistoric sites on the geological maps of the Sella valley (Software: QGIS. National Geological Map IGME: Geological maps 1:50.000).

The unevenness allows us to distinguish several bioclimatic soils:

- In the area of the valleys, of the Sella, Dobra and Güeña rivers, annual rainfall is around 1000 mm/year.
- The mountain area, with rainfall between 1,300 and 1,500 mm/year.

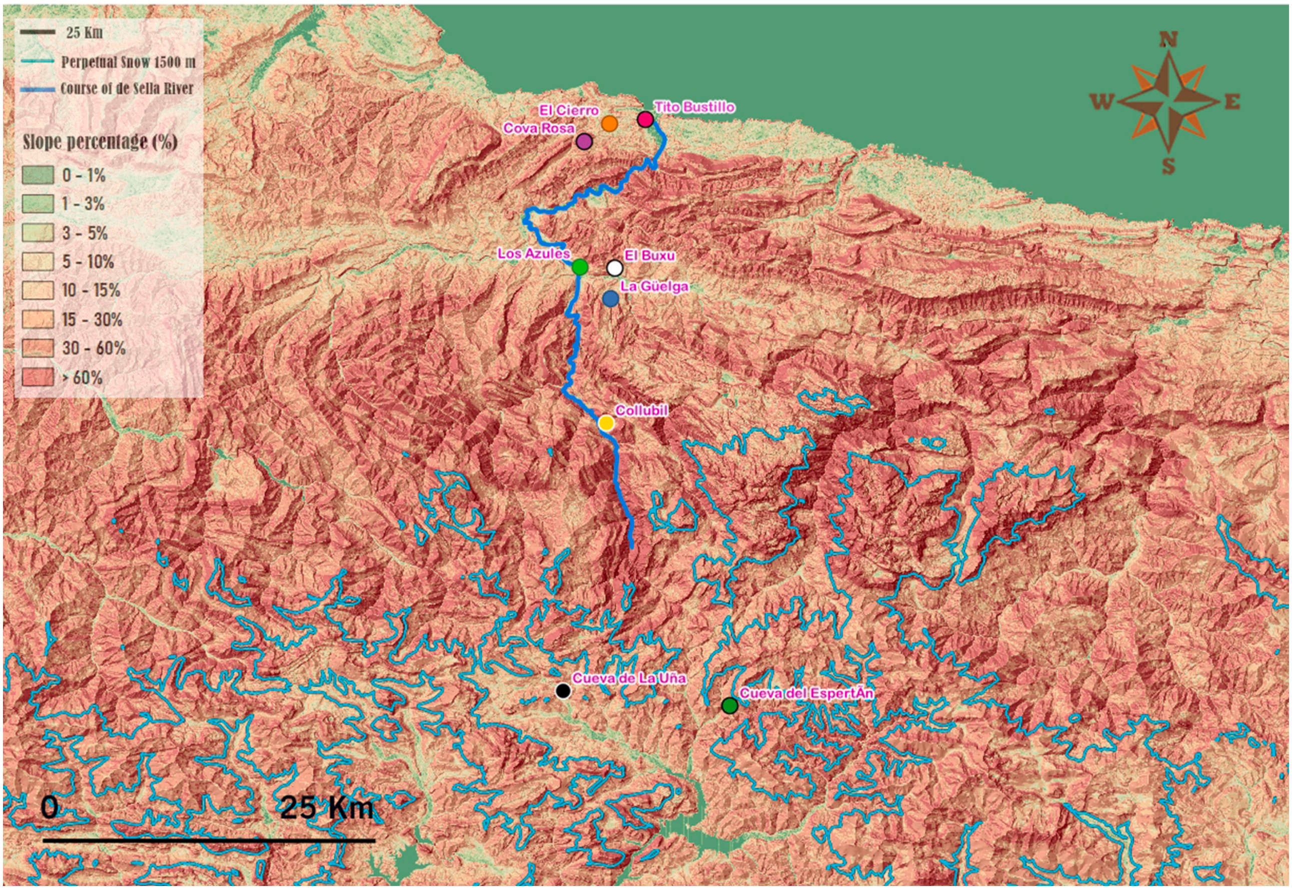

Fig. 7. Slope map of Eastern Asturias and the Leonese plateau, made in QGIS, highlighting some sites.

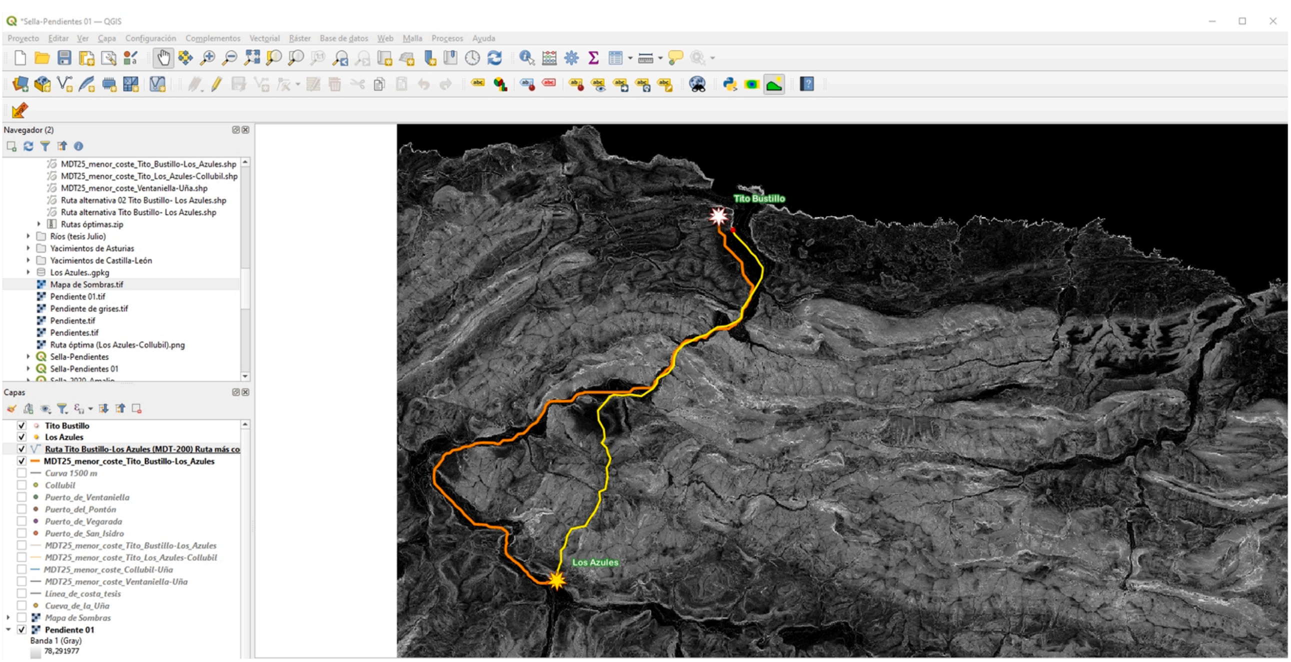

Fig. 8. Optimal routes between Tito Bustillo and Los Azules, calculated with QGIS.

– The area of the peaks where rainfall is around 2000 mm/year (Climate-Data.org). (Fig. 2).

Regarding the temperature, in the valleys the annual average is 13.3 °C, in the mountains it is 8 °C and in the peaks, with average temperatures below 3 °C, the minimum is −7 °C and the maximums do not exceed 0 °C in winter.

In the Sella Valley climate table, we see that historical data confirms

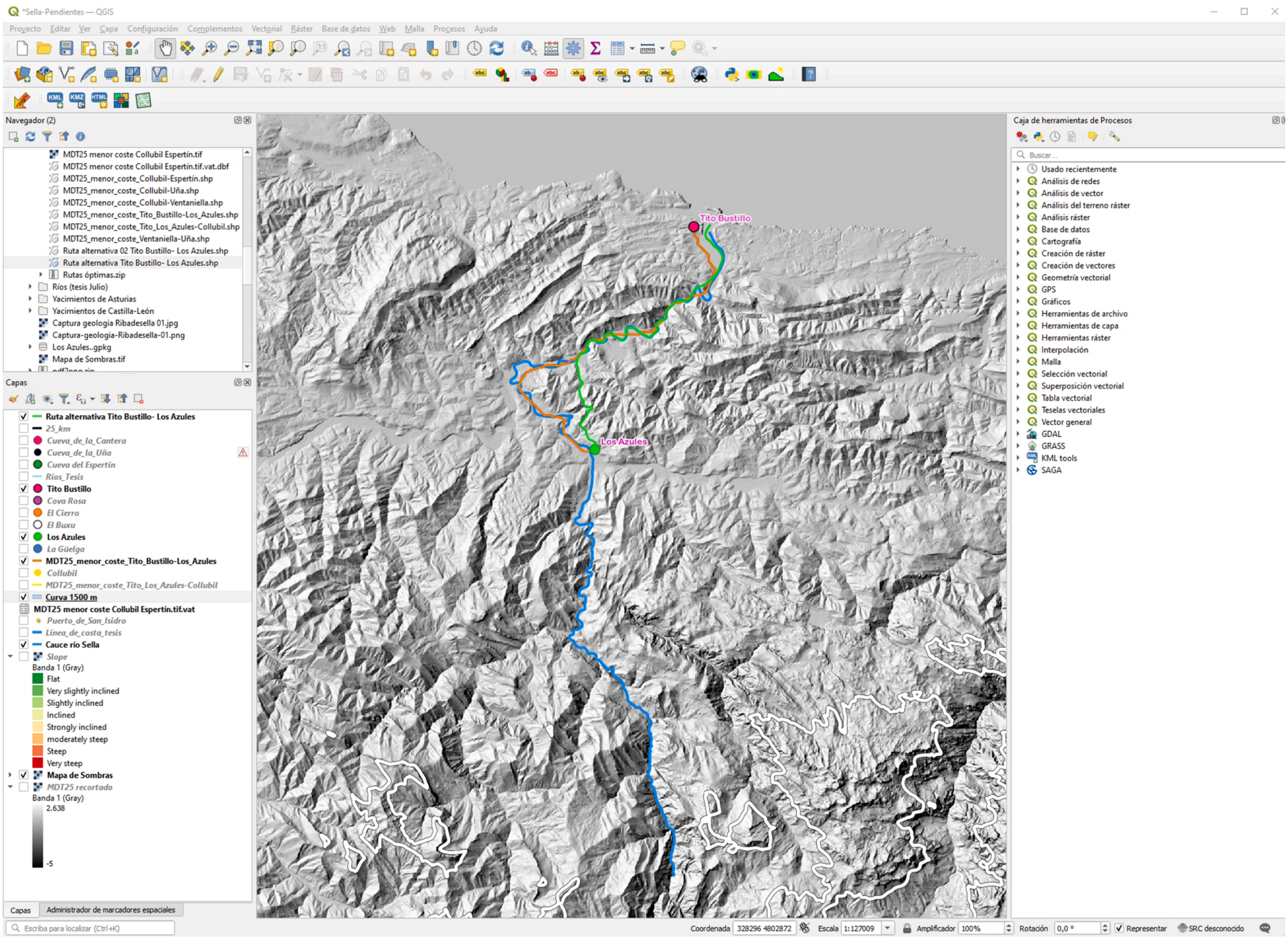

Fig. 9. Representation of optimal routes between sites in the course of the river Sella integrated in the Hillshade map with a 1500 m elevation line.

August as the warmest month with an approximate average of 24.3 °C and January and February as the coldest months with an average of 8 °C (Climate-Data.org) (Fig. 3).

These data clearly confirm the Atlantic character of the climate of this valley as they generate a typical climograph for this climate (Climate-Data.org) (Fig. 4).

Once the current climatic parameters have been observed, through pollen, anthracological and small mammal data, a comparison could be made with the paleoclimatic data obtained in the different Palaeolithic sites of this valley and establish an evolutionary hypothesis of the climate in different prehistoric times.

Although it is a fascinating task, we understand that it is better to address it in the future, within the framework of a broader investigation, since it would exceed the objectives of this article. (Álvarez-Fernández et al., 2020; Álvarez-Vena et al., 2020; Leroi-Gourhan, 1986; Munuera, 2015; Uzquiano, 2015).

3. Methodology

As we have already mentioned, the present study is part of a more detailed investigation that requires a series of observations that consider different variables: geographic, geological, climatological, or faunal, to answer the questions posed. In this article, we will focus more on the investigation of geographical variables.

The choice of habitat sites by these hunter-gatherer groups is one of the questions to be answered. This answer will be provided by a GIS zonal study of the concentration of archaeological sites in the territory under investigation (Fig. 5).

The observation of variables such as the orientation and choice of habitat sites, depending on the wide spaces of the riverbank, is a fundamental point; it requires the elaboration of a longitudinal profile of the river, in which the degree of inclination or slope of the riverbed and its real length are represented.

Another question to be answered is the search for areas where raw materials could be collected to develop a lithic industry (Carrión Méndez et al., 2006). For this purpose, we will consult the geological maps corresponding to the study area provided by the Spanish Geological and Mining Institute (IGME) in its national geological map at a scale of 1:50,000 (Julivert and Navarro, 1984; Navarro, 1986; Navarro and Leyva, 1986), on which we will superimpose the location of the different Palaeolithic sites in the valley and their proximity to the raw material collection areas, using QGIS software and the 25-metre DTM for Asturias as a base (Fig. 6).

The stratigraphic succession of limestone with quartzite throughout the Sella basin, and more specifically in the area surrounding the river valley, provides the proliferation of karst shelters as habitat sites and deposits for the collection of primary materials to produce lithic industries; the river itself being one of the best sources of material.

In order to calculate the optimal routes between the different sites, it is necessary to previously create a friction surface (Bosque Sendra and García, 2000). To do this, we will use the slope of the terrain as the main cost variable, so we will have to draw up a map of slopes that we will reclassify into degrees of inclination (Fig. 7). For this analysis, in addition to the QGIS software, a DTM of the IGN (Centro de Descargas del CNIG del Instituto Geográfico Nacional (Spain)) for 25 and 200 m will be used. The reason for using these different scales is that depending on the pixel size, the program can calculate the route differently between two points, using the least possible effort (López Romero, 2006), helping us

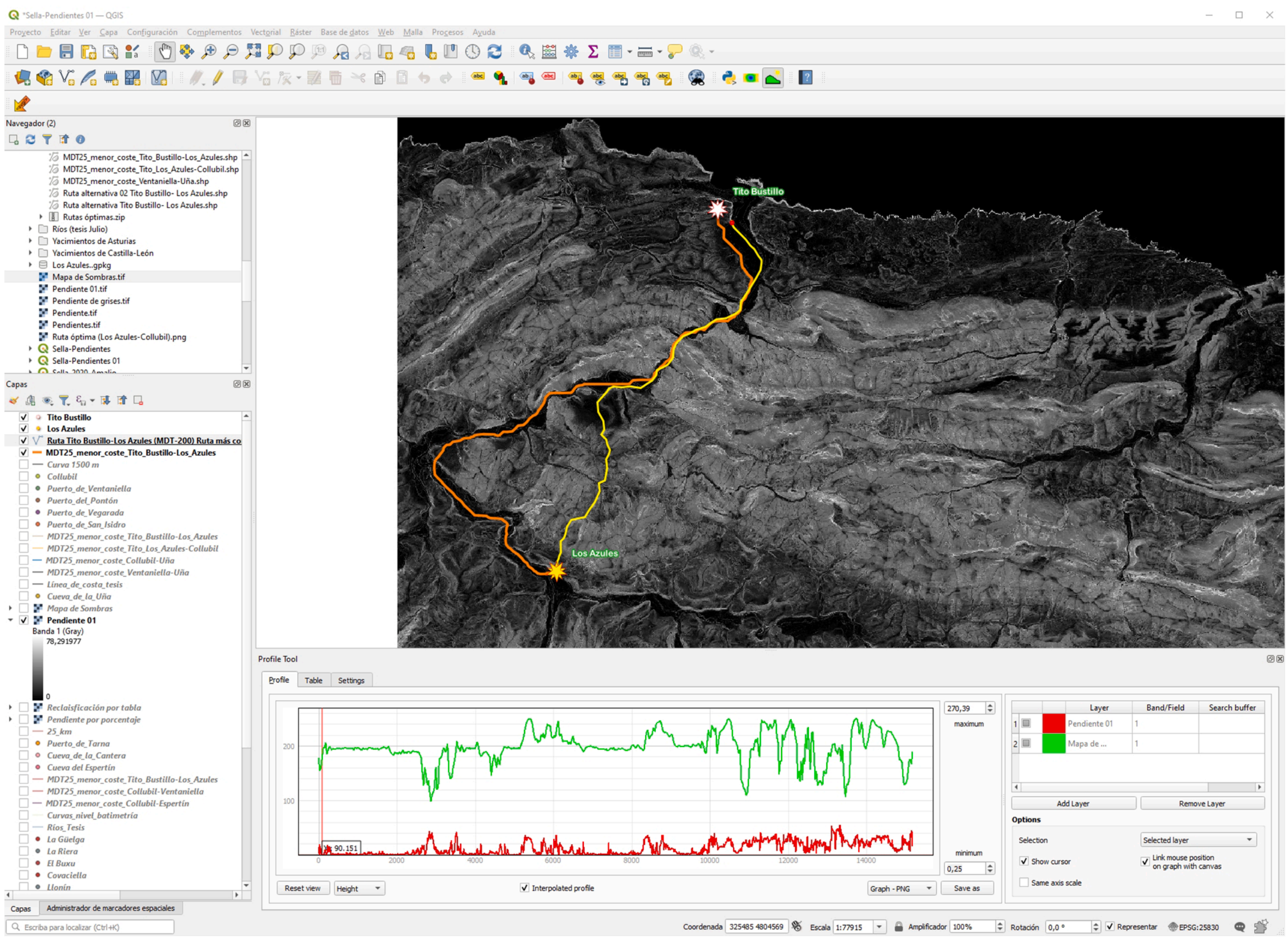

Fig. 10. Optimal routes between Tito Bustillo and Los Azules, using the Profile tool for the calculation and comparison of topographic profiles.

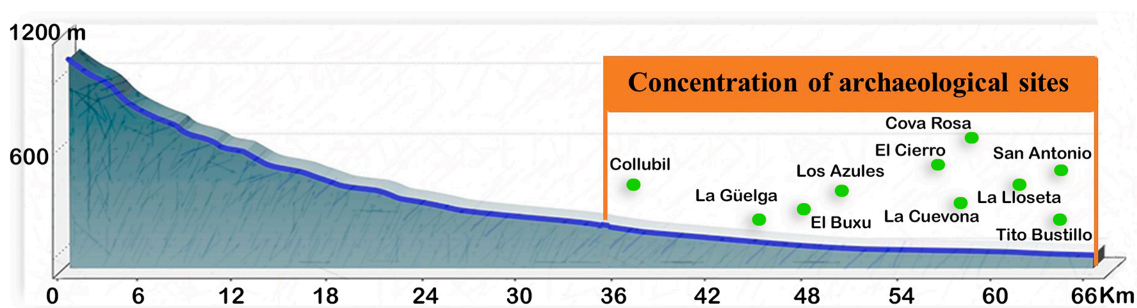

Fig. 11. Longitudinal profile of the river Sella showing the slope of the river from its source to its mouth, including the concentration of sites (modified from Confederación Hidrográfica del Cantábrico).

for more artistic representations of the Google Earth program and its more visual features.

Using the Hillshade complement of QGIS, we will produce a map of shadows that, in addition to helping us in the elaboration of the friction surface, will allow us to evaluate the orientation of the different locations of the sites, as well as the areas of insolation or irradiance.

The use of the Cost Distance algorithm based on topography will be another fundamental tool in this research (Lucero et al., 2014; Mignone, 2021), as well as the Cost Path algorithm, very interesting contributions for the calculation of optimal routes and models (Fig. 8). From these tools, we will obtain the efforts generated in one day of walking, in about 12.5 km.

The presence of high-altitude terrain, free of perpetual snow that facilitates the transit through the mountain passes, will be a necessary premise to consider for this methodology. Therefore, we will mark the elevation line 1500 m, as the limit of thaw and presence of perpetual snow (Fig. 9). In this sense, knowledge of the current climatology and the comparative study with previous paleoclimatic states will make it possible to highlight changes in the climate of the territory studied (Cerdá, 1998; Jiménez and Farias, 2005).

The Profile tool will allow us to draw up the profile of a route, as well as to explore alternatives to it depending on the topography (Fig. 10).

4. Results

Archaeological evidence in the Sella River valley suggests intense

Fig. 12. Integrated Google Earth representation of the calculated optimal route and the alternative between Tito Bustillo and Los Azules.

anthropic activity throughout prehistory. We must emphasize that the distribution of its archaeological sites confirms a much more intense population pattern in the territory surrounding its lower valley and mouth, progressively decreasing in the middle valley and today being almost testimonial in the upper valley of the river (Fig. 11).

4.1. Orography

4.1.1. Lower course and mouth of the Sella River

Both the shape that the mouth of the river acquires in the Bay of Biscay, through the coastal plain and the proximity to it of the Macizo de Ardines, an extensive underground karstic complex with a network of caves pierced by the erosive action of the San Miguel River; facilitated the settlement of human groups in the area. Caves such as La Cuevona and La Lloseta (de Balbín Behrmann et al., 2007), or Tito Bustillo with chronologies ranging from the Epipaleolithic to the Aurignacian (de Balbín Behrmann et al., 2009; de Balbín Behrmann and Alcolea González, 2013), to cite those in the eastern area, closer to the riverbed, are clear examples of archaeological sites in which there is evidence of almost permanent habitat activity throughout Prehistory.

By drawing a longitudinal profile of the Sella River, the model shows a notable decrease in the fluvial slope after about 30 km from its source (Fig. 11). This characteristic, together with the flow contribution of its two tributaries in this section (Güeña and Piloña), produces an increase in the sedimentary action of the Sella, extending its channel transversally. Erosive activity throughout the Quaternary favored the formation of fluvial terraces and wide meanders in which to create habitat camps and successfully practice hunting (Fernández-Irigoyen and Ruíz-Fernández, 2007; Fernández Irigoyen and Ruíz Fernández, 2008).

Regarding the possible optimal routes between deposits, the model suggests two paths:

1. Following the course of the river upwards direction through its wide fluvial terraces, where the daily walking effort decreases considerably (Fig. 12, Route-1). This result is obtained by applying the 25 m DTM, but there are inaccuracies generated by the program itself, represented in those saw teeth, in the topographic profile, produced by accumulated errors in the calculation.
2. Applying the 200 m DTM, the model provides us with a substantial change in the itinerary. going up the riverbed from its mouth in the first 14,7 km and crossing the first hills, where the elevation does not exceed 430 m to reach the Güeña river valley. (Fig. 12, Route-2).

4.1.2. Middle course of the Sella River

In the middle section of the river, archaeological evidence indicates that there is no longer as much human activity as in the lower course. The Güeña Valley is home to Paleolithic cave sites: Los Azules (Fernández-Tresguerres and Rodríguez Fernández, 1990; Fernández-Tresguerres Velasco and Junceda Quintana, 1992), El Buxu (Menéndez Fernández, 1990; Menéndez, 1999), La Güelga (Fuente Fernández et al., 2018; Jordá et al., 2013; Menéndez Fernández et al., 2008; Menéndez et al., 2014) and shelters such as Sopeña (Pinto-Llona et al., 2009, Pinto-Llona et al., 2005). Chronologies of these mid-river valley sites range from Azilian to Mousterian. These groups of hunter-gatherers would focus their hunting activity in the valley itself and would surely access the main valley of the River Sella largely through its lower course and mouth.

However, a high-altitude site is located that corresponds to the Collubil cave, which until its surroundings, from the Güeña valley, the orography implies a change in strategy, since the narrowing of the valley would not always allow transit in an itinerary parallel to the river valley (Fig. 13). The model would present an alternative route to the most logical, but not as feasible as tracing the main course of the Sella (Fig. 14, Route-1 and Route-2).

4.1.3. Upper course of the Sella River

The incursions to the upper Sella would possibly be punctual, hunting and fishing during the summer since the orographic difficulties, together with the rigors of winter, would prevent permanent settlements or regular circulations at high levels.

The model for calculating optimal routes in this section suggests circulation at height, since penetrating through the channel itself would mean failing in the attempt, due to the depth and sinking of the river. To date, the archaeological evidence of this section is very scarce, only the Collubil cave site shows traces of an Upper Palaeolithic habitat activity with a chronology that covers the Magdalenian and Solutrean levels (Quesada López, 2022, 2013). On this site a small valley opens in a southerly direction and parallel to the course of the Sella that enters Leonese lands through the so-called Senda del Arcediano. This route leads to Puerto del Pontón, the main access to the plateau in this section and allows linking the Palaeolithic sites of Cueva del Espertín (Neira-Campos et al., 2001; Neira Campos and Fuertes Prieto, 2009), de la Uña (Herrero, 2014) and La Cantera (Neira Campos et al., 2006) in Castilian lands with Azilian and Mesolithic remains (Fig. 14).

The chronologies presented here are the result of a general analysis of the radiocarbon dates used, so it is necessary to take them with caution. Thus, our information is fragmented by several factors, among which we highlight the absence of a continuous sequence that covers the Upper Pleistocene and the beginning of the Holocene in its entirety (Jordá Pardo et al., 2014).

Several sites along the valley are analysed, classifying them according to their proximity to the coast, thus distinguishing two types:

- Coastal deposits, those located between the coast and the pre-coastal mountains (El Cierro, Tito Bustillo).
- Interior deposits, those located between the aforementioned mountains and the Cantabrian Mountains (Sidrón, La Güelga. Sopeña, Buxu, Collubil).

The paleoclimatic conditions of the Cantabrian region at the beginning of OIS 5 coincide with a Ris/Würm interglacial period, also called Eemian, characterized by temperatures higher than the current ones

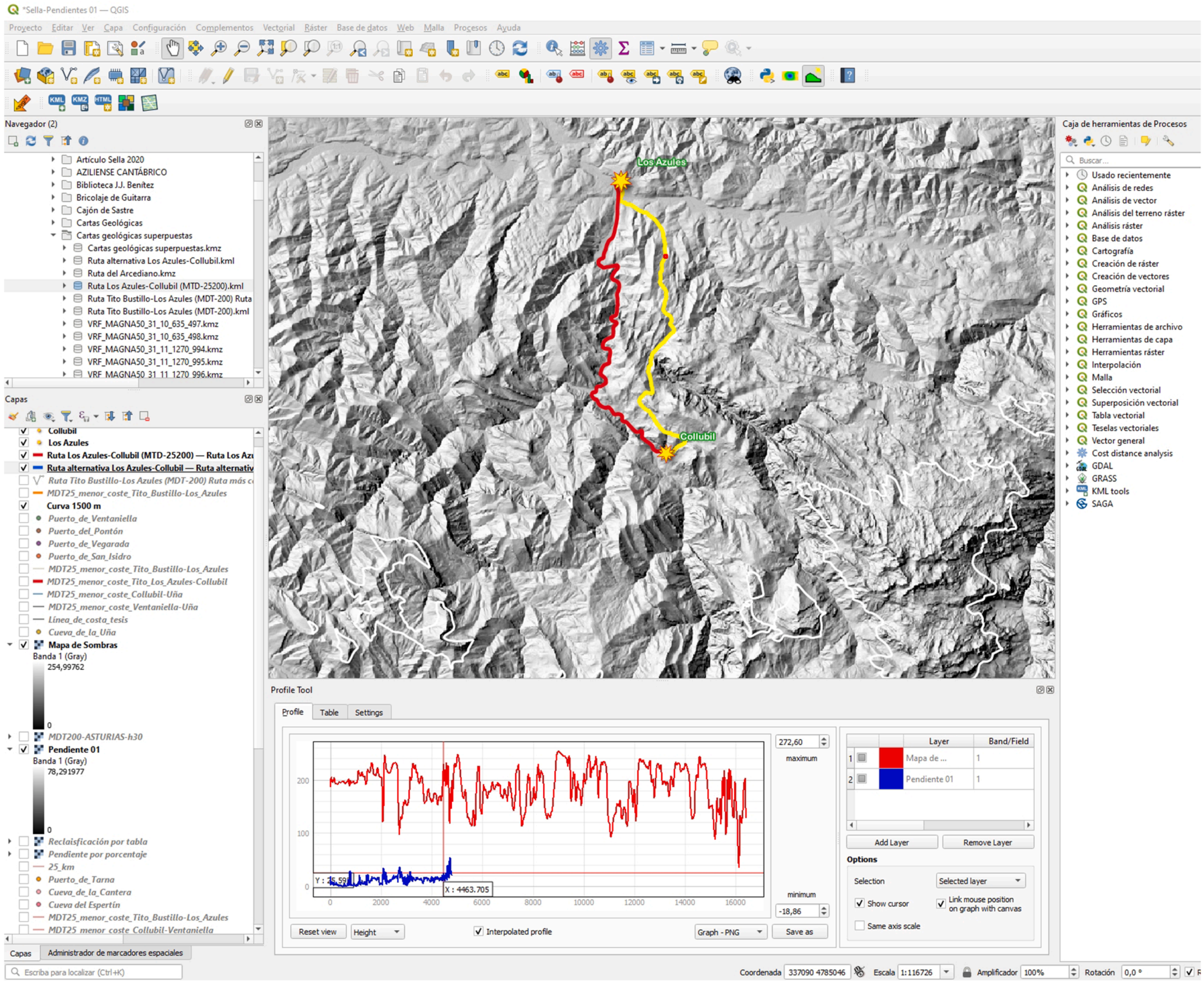

Fig. 13. Calculation of the topographic profiles in QGIS for the least-cost route and the alternative, between Los Azules and Collubil Cave.

(Silva Barroso et al., 2017). These features in OIS 5e resulted in a rise in sea level due to melting of the polar ice caps and continental glaciers, and a significant increase in tree and herbaceous mass. The OIS 4, brings as a characteristic a considerable drop in temperature since we entered a period of extreme cold in the middle of the Würm glaciation. The conditions of the OIS 3 isotopic stage (Fig. 15) are tempered with respect to OIS 4, being more similar to the current ones.

During periods of cold pulses, rainfall and temperatures were lower than the current ones, around 400 mm and between 6 °C and 13 °C (Bradley, 1999; Fernández Fernández and García-Sánchez, 2006; Jordá Pardo et al., 2014; Rivera Arrizabalaga, 2005). However, the multiple temperate periods will cause conditions similar to the current ones, causing rapid and important alternations in climatic variability (Fuente Fernández et al., 2018; Gómez-Orellana et al., 2008; Hoyos Gómez, 1995; Iriarte-Chiapusso, 2017; Ramil-Rego et al., 2005).

5. Discussion

Connecting with these temperate climatic conditions, it was necessary in this investigation to create a history that would act as a common thread of occupation throughout the valley and in the deposits beyond the mountain range. This history is built with a specific chrono cultural moment, the Azilian.

The data produced by the different investigations carried out to date confirm that the Azilian appears and develops in a short space of time (approximately 2,000 years), specifically in the last episodes of the Tardiglacial, at the most favorable climatological moment of the Alleröd (Hoyos Gómez, 1995; Vázquez-Rodríguez and Hevia Carrillo, 2018). This climatic improvement translates into a notable increase in humidity, and the development of plant species; the presence of the Atlantic Forest dominates, which will attenuate but will not disappear in the climatic period after the Younger Dryas. This climatic characteristic also affects the installation of animal species such as deer, roe deer or chamois and especially wild boar (Fernández-Tresguerres Velasco, 2006). Another climatic consequence caused by this increase in temperatures was the retreat to higher levels of the perpetual snow line, reaching heights of approximately 1,500 m, even above them in certain places (Jiménez-Sánchez, 1996). This characteristic ended up facilitating the opening of passes in the mountains towards the Castilian plateau, especially towards the Duero River valley.

In all the Palaeolithic sites located along this river valley, there archaeological evidence ascribed to this Azilian chrono cultural moment (Fig. 16). On the other hand, the first Palaeolithic sites found on the Leonese slope that could be related to those in the Sella Valley are the Espertín cave and La Cantera (Neira Campos and Fuertes Prieto, 2009) and La Uña (Herrero, 2014). These deposits present a collection of materials, assigned rather to a Mesolithic, dated in the Espertín by a C14 sample of 7,790 ± 120 BP (Neira-Campos et al., 2001), but that in the first studies carried out in this regard confused researchers, with the presence of certain defining elements of the Azilian classic (Fernández-

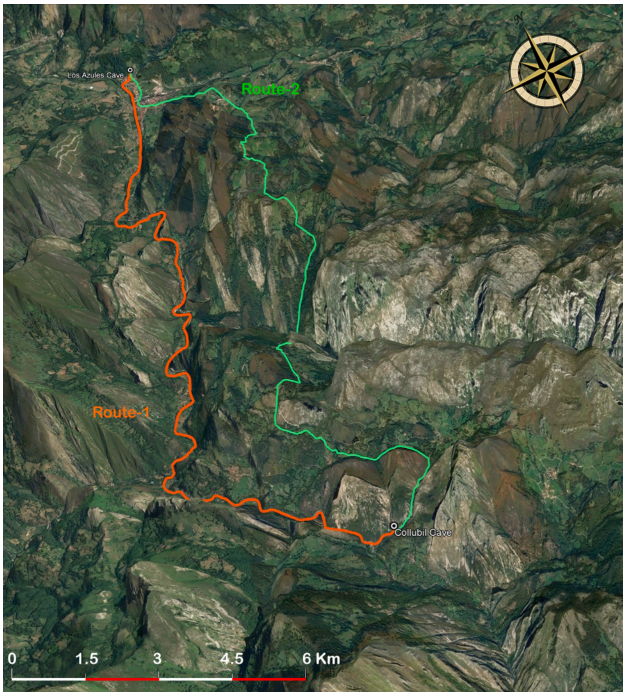

Fig. 14. Google Earht representation of the routes between Cueva de los Azules and Collubil.

Tresguerres Velasco, 2006) in their lithic and material collection (Neira Campos et al., 2006).

All this evidence points to a flow of mobility experienced by these groups of hunter-gatherers along the Sella River valley, with surely seasonal incursions to the Castilian slope of the northern plateau throughout Prehistory. This itinerant flow would be limited during periods of cold and glaciation, where mobility would be limited to the valley itself, concentrating more settlements in the lower course of the river and its mouth.

6. Conclusions

Although it is true that this work is oriented to the Azilian chrono cultural period, it is no less true that these conclusions could be applied to the entire Upper Paleolithic, considering that the climatic conditions at sometimes would be more adverse, which would mean that the mountain passes they were closed.

The use of computer tools such as Geographic Information Systems (GIS), are essential when investigating patterns of territorial mobility, as is the objective of this research. Yes, we must consider its limitation and the errors that it can generate in the designs. The use of Google Earth Platform, as an auxiliary visualization tool to integrate the routes calculated by the GIS, is shown as a fundamental support when weighing its viability.

The more favourable orography of the lower course of the Sella River, translated into a transversal width of the valley, as well as the limited altitude of its hills, facilitated the penetration of human groups in the valley during Prehistory; either following the course of the river

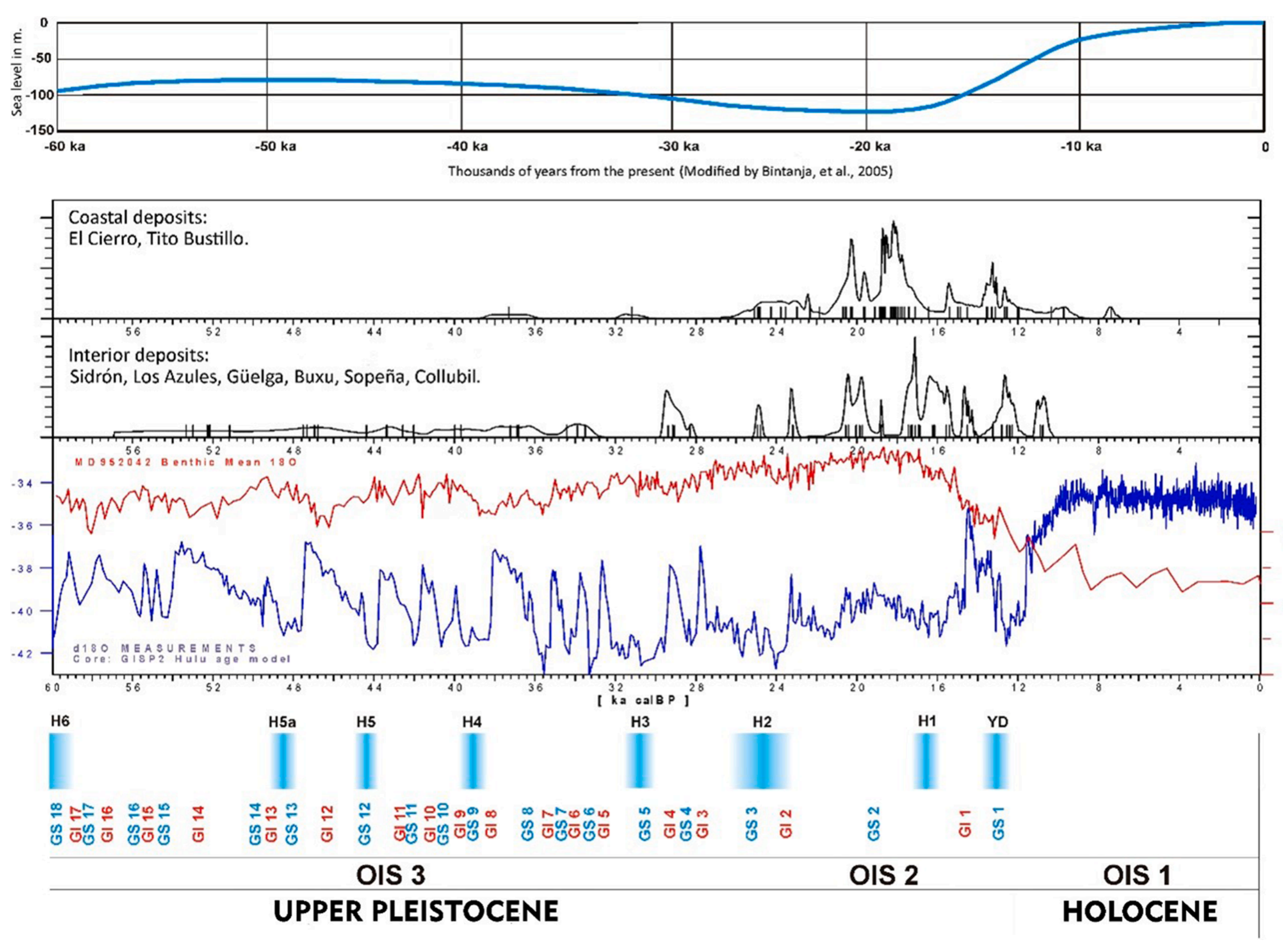

Fig. 15. Climatic data for the period analysed using the δ 18O GISP2 Hulu Age and MD 952,042 Benthic Mean 18O curve as a model (modified from Jordá Pardo et al., 2014), marine regression curve (modified from Bintanja et al., 2005) and dating of the sites cited for calibration using the CalPal2007_HULU curve (modified from Fuente Fernández et al., 2018).

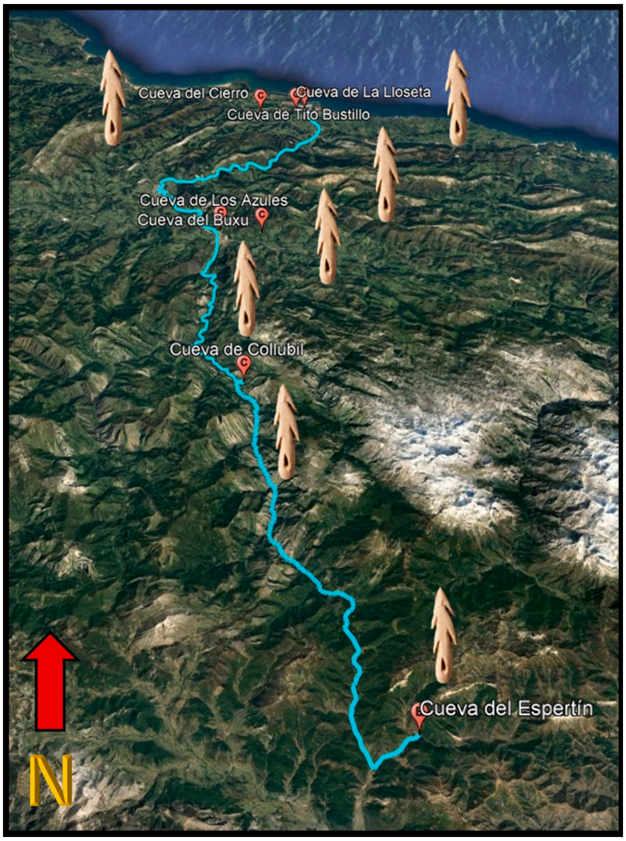

Fig. 16. Google Earht representation of the sites studied in the Sella river valley and on the Leonese side of the river with Azilian cultural evidence (Google Maps).

itself or by easily negotiating certain orographic features at altitude to access the secondary valleys.. The presence in its estuary and mouth of important karstic formations such as the Ardines Massif, facilitated the creation of permanent habitats, as evidenced by the archaeological evidence found.

The morphological change of the valley in the middle course of the river and the geographical position of the deposits it houses, makes it necessary to propose mobility hypotheses in the development of new access routes to resources.

The itinerary calculation software between deposits proposes two routes to explore this territory.

The first is a route parallel to the riverbed, to try to access the Cueva de Collubil, which would be feasible in a first section to the town of Santillán, adopting an ascending itinerary in the direction of Sames and Amieva, going up to the town of Cardes and following the route to San Román to then descend to the Collubil cave.

The second is more plausible, since it conveniently forms the backbone of the Güeña Valley and Cueva de Los Azules sites, proposing a high-rise access to the Collubil cave from north to south of the Güeña Valley, ascending to Següenco following the mountain divide, until descending to the Dobra River valley through the so-called Hoya de San Vicente, crossing again uphill to access the San Román valley and from there descending to the Collubil cave. Either of the two routes proposed by the GIS would be viable with variations depending on the time in which they were carried out, since the landscape would not be the same and neither would the climatic conditions, although due to the length of the itinerary, it would be perfectly acceptable for a hiking day.

The topographic aggressiveness of the upper course of the Sella River until it crosses the Los Beyos gorge, which is more of a canyon than a gorge, where the river fits considerably, forces us to play with a fundamental variable such as height. For this itinerary crossing the Asturian slope and entering the Leonese slope to access the Pontón pass and from there connect with the Palaeolithic sites of Espertín and La Uña, the software proposes three routes, of which the first is discarded. It would be impossible to assume that at some point in prehistory, access to the Leonese slope would be through the riverbed, due to its narrowness and the verticality of its walls.

The second, from the Collubil cave, ascending to the San Román valley in a southerly direction to take the Senda del Arcediano pass and passing through the towns of Soto de Sajambre and Oseja de Sajambre, going south along the east face of the valley to the Collado del Pontón and from there to the Cueva del Espertín descending until facing the valley of the Orza River (tributary of the Esla) where this site is located.

The third is very similar to the second until it reaches Oseja de Sajambre, but here it crosses the valley and continues south through the town of Pio, ascends the southwest face until it reaches the Pontón pass and continues downhill in a southerly direction, reaching to the confluence of the Orza River valley where the Espertín cave is located.

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

The data that has been used is confidential.

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