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# "Cultural Heritage Landscape and Natural Landforms Study of The Valley of Wadi Abiod – Aures, Algeria"

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## *Abstract*

This thesis, inserted within a research in landscape, settlement and spatial archaeology, proposes over the very long run the study of spatial dynamics of settlements in an intermountainous territory constituted by a massif hardly offering passages, but partially crossed by a north-east, south-west syncline depression at the bottom of which flows a river.

The behavioral perspective of this study being dependent on a decisive environmental context, although unstable and little known, wishes to draw attention to the Holocene chrono-cultural potential of the Aures region and more specifically in the Wadi Abiod valley in the Saharan Atlas, in terms of heritage presence, by the use of new and more in-depth studies and investigations to support archaeological research and to boost the interest and significance on its important antecedents currently unprotected, endangered and, to a certain extent, complicated to manage and promote.

Therefore, the research aims to provide a support for the enhancement and valorization of this natural and cultural landscape, and its affiliated values, in a sustainable way, based on a scientific and historic documentation, knowledge, and fruition by the application of an integrated approach of research-combined methodologies, and technologies to make more immersive the idea of rediscovery of cultural heritage in a multidisciplinary way by underlining the coexistence of the different cultural assets and focusing on the complex relationships between habitat e biome.

These last ones are studied in their natural and historical contexts with an integrated approach combining archaeological, anthropological and geomorphological parameters, to foster the knowledge of the natural sites and the numerous manifestations of material and immaterial culture. From this point of view, it was indispensable the implementation of meticulous and precise procedures to generate useful results on the above described premises, in particular in the case of problem-oriented territorial investigations.

In fact, the best results are attained when using a research methodology that consists of two parts. One part regarded the assessment of the environmental data, while the other part focused on the extraction of an anthropic evidence from these data. This portion constituted

the purposefulness phase of the procedure: through the application of different methods, it evidenced the posed historical - archaeological question.

The proposed research procedure was applied on this particular case- study that regards a natural and cultural landscape, from the Neolithic to modern times (19th century). This chronological interval was necessary for the analysis of society-environment interactions, that have been noticeable since prehistory. In addition, This diachronic approach stemmed from the need to understand the contribution of past legacies in the processes observed at different times: these processes underlined the importance of understanding the occupation of the territory in ancient times in order to discern the extent of the modifications, or continuities observed. Whereas, the archaeological method in this case was based on a regressive analysis, which studies the most recent periods in order to go towards the oldest. By starting at the state of the best known landscape (the traditional or the 19th century one), an attempt to reconstruct in reverse the past stages of the evolution of this landscape from available sources (maps, parcels, written sources) was performed. Functional and chronological hypotheses were then established for elements of the landscape that made it possible to compensate for the lack of documentation for older societies. While, The emergence of the environmental question has taken place through the notion of occupation of space by ancient societies. From then on, the work has focused on studying the social construction of the environment through the identification of the modes of exploitation of natural resources, and the analysis of processes by the study of trajectories, and their effects on past legacies, by the application of GIS-based procedures and a three-dimensional representation, that provided an understanding of the complex morphology of the territory, in combination with the settlement theory, that highlighted the expected spatial patterns, facilitated the correlation of the anthropic and climatic modalities of environmental evolution, and grasped the impacts for the ancient societies that inhabited and exploited the space in the valley of Wadi Abiod, long been considered isolated.

# 1. INTRODUCTION AND STATE OF THE ART

The common and widespread sense of the term landscape is "what I see " (Neuray 1982) , that is to say, the "physiognomy of a space that one looks at or of a region that one crosses, travels through or flies over" (Noirfalise 1988). A very widespread definition is contained in the European Landscape Convention, adopted under the auspices of the Council of Europe in 2000, after some twenty years of debate fueled by these developments in the conception of landscape, it: "refers to a part of the territory as perceived by populations, whose character results from the action of natural and/or human factors and their interrelationships" (Convention of Florence, N 176).

Therefore, it is defined as an area or space, as perceived by local inhabitants (or visitors), whose appearance and character result from the action of natural and/or cultural factors. This definition takes into account the idea that landscapes evolve over time as a result of both natural forces and the action of human beings. It also emphasizes the idea that the landscape forms a whole in which natural and cultural elements are considered simultaneously. This definition thus integrates the two characters that everyone today agrees to attribute to it: an objective character (geographical and structural dimension) and a subjective character (sensitive, personal, and social dimension) (Bertrand, Beroutchachvili 1978).

In addition, three components are constitutive of a landscape as defined in the European Landscape Convention (see https://rm.coe.int/168008062a):

- “A part of territory” composed of multiple interacting elements organized in space.

According to the classical definition in geography, a portion of space subject to view that can be analyzed and mapped in its extension (i.e. independently of a point of view). It is a concrete space, filled with material objects, and structured by forces. This complex spatial system has been described by Georges Bertrand as a geo-system (Bertrand, Beroutchachvili 1978):

- ‘’as perceived" is also in motion. Many authors (Plieninger et al. 2015; Luginbühl et al. 2016; Ernoul et al. 2018) have shown, through various studies, that social representations are also multiple, interacting, and organized in a multi scalar system (at different scales: global, continental, national, regional, and local for example). According to Jean-Claude Wieber's definition, "the landscape is first of all a spectacle,

perceived from within, in upright, changing images that touch the intimacy of each person; the continuous series of landscapes nevertheless exists and constitutes a visible space that can be completely mapped "(Wieber 1987).

- Finally, are "populations" also composite, made up of different social groups that interact with each other. In this potential visible space, the mind makes a certain number of selections and sorts, valorizes certain images and abandons others, according to an individual and social history and culture, and above all according to the practices that the observers of the space may have, that is to say, of their lived space, of their territory.

Thus, the landscape is not the simple addition of disparate geographical elements, it is, over a certain portion of space, the result of the dynamic combination of physical, biological and anthropic elements which, by reacting dialectically on each other, make the landscape a unique and inseparable whole in perpetual evolution.

That is to say that a global definition of landscape will have to take into account, as Georges Bertrand pointed out, three components (Bertrand, Tricart 1968):

- An ecological potential that includes all the abiotic elements: the geological substratum, the shape, the climate, the water, etc.;
- Biological or biotic exploitation which includes all plant communities and the soil;
- Anthropic action that interferes with the first two components.

This does not touch only the natural landscape, but the total landscape that integrates all the after-effects of anthropic actions.

Hence, the multiplicity of definitions testifies to the complex nature of the notion of landscape and is perceived as an object still difficult to apprehend, because of the many factors which intervene in its composition.

On the one hand, as Claude and Georges Bertrand say: "the simplest and most banal of landscapes is at once social and natural, subjective, and objective, spatial and temporal, material and cultural, real and symbolic, etc." (Claude, George Bertrand 2002), and on the other hand, it is situated at the hinge between an object: space, place, and a subject: the observer (Nijhuis 2011).

As a result, landscape becomes a field that encompasses several sectors and sciences, and with its interdisciplinary nature becomes advantageous since it encourages the creation of links between the different spheres of knowledge. However, this interdisciplinarity has contributed to making the concept of landscape blurred and its application difficult (Meier 2012). The methods of apprehension of the landscape are diverse. Each method takes the landscape from a definition angle, be it geographical, ecological, economic, archaeological… etc. According to its conceptual definition or to the domain it corresponds to, the analysis of the landscape is based on the glances that can be either objective or subjective (Langschwager 2018) and which defines the method of its study.

This being said, and over the last decades, landscape studies have been the focus of extensive multidisciplinary research based on the development of archaeological and environmental investigations. Archaeology has demonstrated the importance of natural environments for ancient societies where resources such as water, vegetation, aquatic and livestock supplies are available (Hudson 2012). Moreover, this form of ecosystem may be a true source of data that is valuable for the reconstruction of archeological landscapes and the history of evolution of such environments (Carson 2016). The study insights have grown as a consequence of these inquiries. Most of the previous research works carried out have demonstrated that, since the Neolithic period onwards, human use of environmental capital has led to its transformation (Smith, Wishnie 2000; Ellis et al. 2013): thus, there is no longer a "natural" environment, but rather anthropized ecosystem: anthropo-systems (Ershova 2012) . From then on, research is no longer just concerned with reconstructing the history of a given environment, but with retracing the history of the complex interdependent relationships between societies and their environment: the socio-environmental interactions (Ingold 2000).

The present thesis is in line with this theme. I propose to study over the very long run the spatial dynamics of settlements in a territory constituted by a massif hardly offering north / south passages, but partially crossed by a north-east south-west syncline depression at the bottom of which flows a river. The behavioral perspective of this study being dependent on a decisive environmental context, although unstable and little known, wishes to draw attention to the Holocene chrono-cultural potential of the Aures region and more specifically in the Wadi Abiod valley in the Saharan Atlas, in terms of heritage presence, by the use of new and more in-depth studies and investigations to support archaeological landscape research and

to boost the interest and significance on its important antecedents currently unprotected, endangered and, to a certain extent, complicated to manage and promote.

The research in question was applied on a segment from the territory of the Aures, already known to ancient authors; in fact, the current name "Awras" dates back to the sixth century, when it was mentioned by the Byzantine historian Procopius as "Mount Aurasius" in his book from the war against Vandals '' Bellum Vandalicum'' (Procopius, Book II, Ch. XIII), and before that, Ptolemy refered to Aures in the second century by calling it "Mount Audus" (Zouzou 2011), and according to Shaw, the Ottomans named it" Evress "(Shaw 1830), while Ibn Khaldun in the fourteenth century (Ibn Khaldūn, Kitāb al-'ibar wa-dīwān al-mubtada' wa-al-Khabar fī ayyām al- 'Arab wa-al-'Ajam wa-al-Barbar, wa-man 'āṣarahum min dhawī al-sulṭān al- akbar, Vol VI) described the region as "The space that separates the date-tree lands of the mountains that surround the tell consists of plains whose climate, waters, and vegetation sometimes remind the aspect of the tell, and sometimes that of the desert. This region contains the city of Kairouan, Mount Awras, which cuts it through the middle and the Hodna country" (Mac-Guckin 2011).

Such as is the situation in the case study, the valley of Wadi Abiod (Fig. 1), an ancient settlement, testimony of a millennial evolution and an important transit route of caravans that connected the desert and the Mediterranean Sea. The valley on its flanks is formed of a traditional Berber (local) habitat in "staircase" and, on its steep walls, by troglodytic dwellings. The Berber of the Aures integrated perfectly and wonderfully its habitat to the natural site, not having sought to modify anything, and exploiting to the maximum the configuration of the terrain (Busson 1900), the natives gave birth to a spatial organization of a rare originality where its prosperity was linked to the close relationship with the surrounding territory and to its water and food autonomy (Fig. 2).

These old vernacular centers, a cradle of traditional architecture have always been recognized for their architectural, aesthetic and historical features. The valley has been indexed first in 1928 and later on in 2005 as a natural site (Journal Officiel De La Republique Algerienne N°30, of the 5th may 2010, https://www.joradp.dz/JO2000/2010/030/FP6.pdf) under the Algerian Law 98-04 on the protection of cultural heritage, and Figures on the United Nations Educational, Scientific and Cultural Organization's (UNESCO) Tentative List of World Heritage Sites as a cultural landscape, in the mixed category, since 2002.

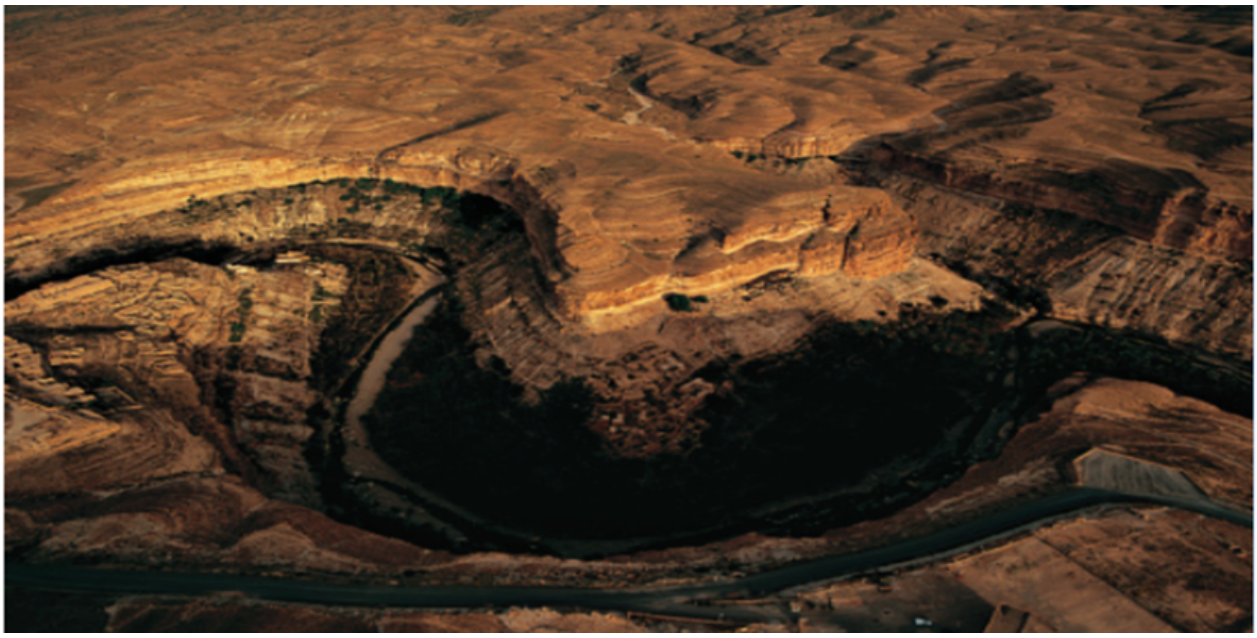


Fig. 1 - A segment from the valley of Wadi Abiod in the Saharan Atlas. (source: yannarthusbertrand2.org).

Stepped habitat | Stepped habitat on the cliff of the Gourges | Semi troglodytic habitat

Fig. 2 - Some of the examples of the habitat's configuration in the valley that appear abandoned and deserted.

This landscape is described by UNESCO as the following: ''This region has an undeniable human originality; it is the Chaouia country and presents a great unity of behavior: traditional Berber society that has preserved its language, its customs and its terraced habitat. This specificity is due in part to the fact that the Aures has long been a closed world. It is protected by its high walls and little open valleys. The settlement in villages packed on the slopes (Dechras) and the terraced cultivated land supported by stone walls are evidence of an ancient human settlement well adapted to the mountain environment. Nature and human settlement combine here to make the Aures an original world." (Parc des Aurès avec les

établissements oasiens des gorges du Rhoufi et d'El Kantara, Ref. 1777, source: https://whc.unesco.org/).

Nevertheless, this territory hasn't benefited from any type of examination to this day because of the absence of a clear scientific comprehension about the valleys of the Aures. This convinced me of the urgent need to contribute to the knowledge of this heritage site by a multidisciplinary approach. I hope that my work may inspire a reflection on several questions on the future of this legacy. A successful rehabilitation requires a multidisciplinary intervention at different scales especially since no similar studies have been carried out before in the area.

Thus the aim of the research is to provide a support for the enhancement and valorization of this natural and cultural landscape, and its affiliated values, in a sustainable way, based on a scientific and historic documentation, knowledge, and fruition by the application of an integrated approach of research-combined methodologies, and technologies applied to heritage with a view to make more immersive the idea of rediscovery of cultural heritage in a multidisciplinary way by underlining the coexistence of the different cultural assets. These last ones are studied in their natural and historical contexts with an integrated approach combining historical, architectural, archaeological, geomorphological, topographical and anthropological parameters, to foster the knowledge of the natural sites and the numerous manifestations of material and immaterial culture.

From this point of view, it seems indispensable the implementation of meticulous and precise procedures to generate useful results on the above described premises, in particular in the case of problem-oriented territorial investigations (see work flow 1 at the end of this section). In fact, the best results are attained when using a research methodology that consists of two parts. One part regards the assessment of the environmental data, while the other part persues to extract an anthropic evidence from these data. This portion constitutes the purposefulness phase of the procedure: through the application of different methods, it seeks to put light to the posed historical - archaeological question (Parcero-Oubiña et al. 2014).

The procedure's phase is composed of three concurrent, although interdependent, analytical steps. The first one being a priori analysis in which a theoretical model is used as testable hypothesis on settlement scheme and location preferences for that particular territory, and

which is confronted with a survey dataset. As a second step, a posteriori analysis is performed to highlight patterns in sites distribution with respect to local environment, and from which unexpected elements can emerge. The third step, being the final, constitutes the results of the confrontation of both analyses for the reconstruction of the landscape. It is however important to stress that the two analyses are complementary and should be combined together to achieve a reliable interpretation (Gillings et al. 2020).

Throughout the joint application of a priori and a posteriori evaluations, it was possible to acquire new knowledge from the theoretical model and the data. A more detailed description of each of the three steps of the study process follows.

The first step being the speculated descriptive approach (a priori analysis), consists of testing an existing theory on ancient settlement patterns including survey data: using the theoretical method, a widely shared principle of landscape processual analysis. This model projects lines on the selected natural environment, traces the plausible anthropic-related sites, and provides indications on settlements' patterns. Then, survey data should manifest themselves in correlation with the model. The applied model plays a crucial role in verifying the survey's data and is a potential pointer of the existence of certain configuration of settlements. To determine the scheme of the model, a suitable Geographical information system (GIS) and spatial analysis tools are applied to systematically analyze the selected plot.

The second step being an exploratory procedure (a posteriori analysis), the data are tested in relation with the natural patterns. The goal here is to inspect the possible relationships between survey data and a set of local landscape parameters (i.e. natural and cultural factors marking the local context). This enables further understanding on the logical settlement, and thus, enrich the initial theory on ancient establishments systems, and assesses how they functioned with respect to the specific landforms in the area under consideration.

The final step which includes the results of the research method, aims to propose an accurate territorial reconstruction. The full integration of GIS methods involved in regional surveys, is the greatest strength of the proposed methodology. These tools will allow the calibration of the interpretation by assessing the degree of completeness of the datasets related to settlements patterns for a safe historical reconstruction (Howey 2011).

As mentioned before, the proposed research procedure was applied on a particular case-study that regards a natural and cultural landscape situated in the Aures, Algeria, from the

Neolithic to modern times (19th century). This chronological interval is necessary for the analysis of society-environment interactions, that were noticeable since prehistory (Roubet 2003, 2012a,b). In addition, This diachronic approach stems from the need to understand the contribution of past legacies in the processes observed at different times: this underlines the importance of understanding the occupation of the territory in ancient times in order to discern the extent of the modifications, or continuities observed.

Usually, the archaeological or historical method is chronological; it studies phenomena (even spatial ones) from the oldest to the most recent ones. Certainly this approach has been applied while reconstructing the history of the landscape. However, there is also a complementary approach: regressive analysis, which studies the most recent periods in order to go towards the oldest (Orengo & Martínez 2016). By starting at the state of the best known landscapes (the 19th century one, also referred as historical or tradionaol landscape in this study), an attempt to reconstruct in reverse the past stages of the evolution of these landscapes from available sources (maps, parcels, written sources) was performed. Functional and chronological hypotheses are then established for elements of the landscape that make it possible to compensate for the lack of documentation for older societies.

This approach is not without its difficulties because the documentation concerns only a few elements of the landscape, leaving most of it to be informed by the archaeological and environmental disciplines. The reason why, I have resorted to documenting also toponyms and their spatial displacement to explore traces of past societies. However, the absence of dating of toponyms strongly limited the deductions, and per consequence I have resolute to conserve them as a documentation material for the safeguarding of intangible traditional culture of the territory under study.

Furthermore, it is important to stress that the emergence of the environmental question in archaeology has taken place through the notion of occupation of space by ancient societies. These modes of occupation are visible in three main entries: buildings, roads, and parcels (Chevallier 1978). From then on, the work has focused on studying the social construction of the environment by societies through the identification of the modes of exploitation of natural resources. The aim was therefore to analyze processes by studying trajectories, thresholds, and bifurcations taken by the socio-environmental system, and to understand the effect of past legacies in these evolutionary landscape processes.

The region under study (Wadi Abiod), is a territory that has been strongly marked during millennia. Its heritage has left a permanent trace on the local landscape, reflecting not only an economic and social but also a cultural organization (Younsi et al. 2020a). Many vernacular village sites in Algeria are now abandoned and their production systems have radically changed, with direct repercussions not only on the traditional architecture but also on the landscape. This is particularly evident in regions with a historical character such as this one. Consequently, in terms of landscape and vernacular architecture, the cultural heritage remains under serious threat not only from neglect and abandonment but also and above all from new rehabilitation for residential purposes, which implies obvious risks for the historical buildings and the landscape such as it is the case for this particular territory. It is therefore important to ensure that all forms of heritage are respected, studied, conserved and transmitted to future generations. This is how the question of the consideration of the landscape is approached here as heritage, based on the idea that knowledge of the cultural values of one of Algeria's most characteristic landscapes, based in the Aures region, can become a resource for its local and regional development.

To understand this dynamic it was necessary to work over a long period of time, and correlate the anthropic and climatic modalities of environmental evolution and to grasp the impacts for the ancient societies that inhabited and exploited the space (Van Der Leeuw 1995; Burnouf et al. 1997; Richard, Vignot 2002; Fisher, Feinman 2005). With its ethnographic particularities, the grace and grandeur of its natural scenery, the charm of the Aures lies in its climate: "Geographically, no province in the whole of Africa is more diverse than the Aures; nowhere, in such a short space of the planet are there so many contrasts as in this mixed region, Saharan on one side and European on the other; one passes a pass, and the face of the world changes with the climate. In transhumance from south to north and from north to south, following the example of the caravans, one lived in the Aures in earthly paradise, since today it only takes a few hours on horseback, and tomorrow it will only take twenty minutes by car to migrate from the great sun to the always cool shade, from the palms of Amentane to the walnut trees of Bouzina, and upwards, from the walnut trees of Bouzina to the cedars of Chelia" (Robert 1938).

It is generally considered that the Aures was not urbanized, and the image that one has of the ancient occupation of the Aures is distorted by the gaps that are also found on the Archaeological Atlas of Algeria (an ancient publication that must be used with precaution).

Moreover, The research in Aures was almost completely interrupted after the 80's, creating an important gap in our knowledge: The region suffers from fragmented prehistoric research and a full picture of the richness and diversity of local developments is still lacking (Mulazzani et al. 2016). In many cases a thorough revision at the light of new methods need to be done. Even so, the few existing data point to an important anthropic frequentation between the 9th and 3rd millennia BC during the Holocene (Alimen et al. 1979; Arlette et al. 1997; Aumassip 1986; Balout 1955; Camps 1963, 1966, 1975; Cote 1991; Grebenart 1971; Roubet 1966, 1968, 1969, 1971, 1979, 1985, 2003).

The most known deposit since the beginning of the 21th century that has been the subject of a modern excavation is situated on the northern slope of the Aures and which is identified as the Capeletti cave. It has revealed Neolithic facies of Capsian tradition dated to 5929-4928 BCE (Roubet 1979). However, in regards to the particular nature of the Aures, the overall occupation of the massif is not limited only to this cave nor to this only period. In fact, other surveys carried out by Jean-Louis. Ballais have revealed 43 sites (Ballais, Roubet 1981, 1982).

The lack of archaeological knowledge on the occupation of the massif during antiquity was not different either. A priori, the massif of the Aures, formerly part of the territory of ancient Numidia, is a region that invaders bypass because it is not only impregnable but its inhabitants are always quick to wage war, has long been a subject of controversy among archaeologists. In reality, the space produced a mosaic where the Berbers and the Romans were side by side. In this demarcation, the massif, retaining its height and its insularity, gave arguments to an ethnic opposition which is therefore implied by the rejection of the Romanization. Therefore, this refusal suggests an exclusive tendency to be a belligerent. Because to read the writings relating to this situation, the relationship between the local groups and the Romans was a warlike interlude. However, neither epigraphy, historiography nor even archaeology was directed at such an assertion.

Nevertheless, in 100 A.D Trajan set up a military colony in Thamugadi (actual Timgad) (see https://whc.unesco.org/en/list/194/), thus ensuring the control and surveillance of the roads that run through the valleys. It has to be said that the Romans displayed a certain indisposition when it comes to invading mountainous areas. The evidence that in Algeria, compared to the surrounding plateaus, the Aures seems to have remained on the fringes of Romanization. The framing of its reliefs was speculated in order to avoid any disturbance or incursion.

The Roman political growth as empire could not have been achieved without a skillful maneuver system, which fostered economic exchange and information transfer. Therefore, the reconstruction of ancient roads system is important for the investigation of the Roman mobility and control of a given territory that could be driven by past economic, social, political and military factors (Carreras, De Soto 2013). The purpose of this contribution does not pretend to escape this controversy. Moreover, it is useful to present another reading of this ancient history by focusing on the territorial development of this segment located in the southern part of the massif considering that the ancient cartography that is available is still considered insufficient in order to comprehend the situation in the valley of Wadi Abiod and its position in the Roman road layout that was designed to favor contact between Roman citizens and colonies.

With this research goal in mind, and in order to obtain answers to the various questions posed by the problematic, to confirm or not to confirm the hypotheses put forward, it is important to acquire a variety of information resources. My work therefore is organized in three main parts:

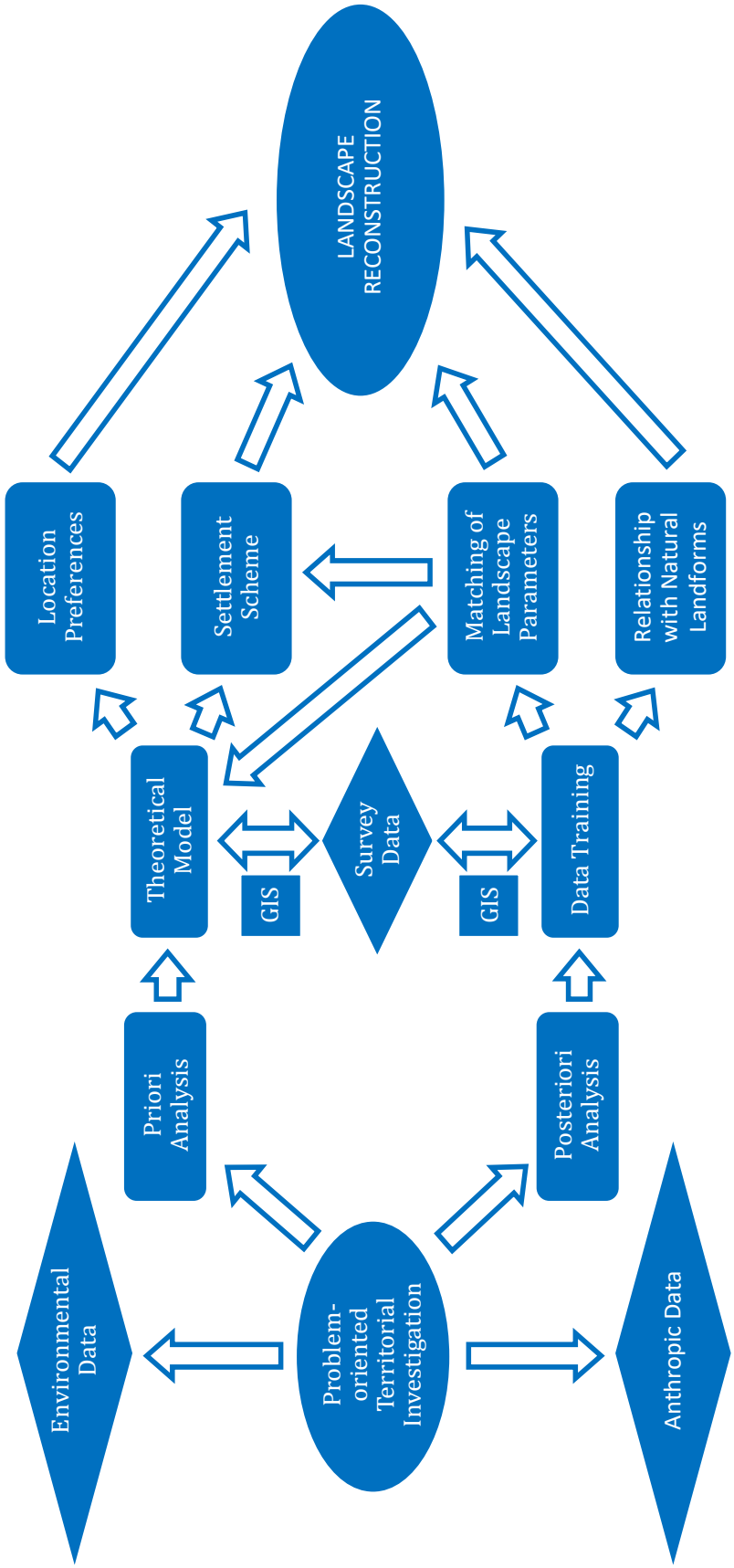
First a material and methods section in which all the collected materials that served for the thesis were listed along with the methodological approach, in order to list the elements that define the landscape of the case study, contribute to its reading and to present its main characteristics, facets, components and the different approaches. In this section the feasibility of existing settlement theories was also assessed. It is important to note that the theme of the environment was developed in parallel with archaeology. The implementation of interdisciplinary research has been carried out thanks to the work of geomorphology, archaeology carried out on sites, and ancient history (sources, ancient maps, epigraphy). This section, indeed highlights also the GIS-based procedure and the three-dimensional representation to understand the complex morphology of the region under study, in combination with the settlement theory to evidence the expected spatial patterns.

Then, the core unprecedented findings derived from the methods applied, to gather and analyze information along with the obtained data from materials, were reported based on the upon methodology, and were arranged in a logical sequence inside the results section. In this section new parameters emerged. Finally, a discussion section, a fruitful dialogue between archaeological, historical and environmental disciplines was made possible thanks to this interdisciplinary work. In particular, this dynamic has led to understanding the anthropic and

climatic modalities of environmental evolution and to grasp the impacts for ancient societies in shaping or modeling this landscape that was made visible through the proposed reconstruction. Field survey methods have their implicit limitations and can offer only a fragmentary image of ancient landscapes. However, the settlement data recorded actually displayed representative evidence to detect significant regional patterns and large-scale trends in settlement location preferences. These patterns and trends can be highly informative of the social use of space in ancient times.

It is especially through this feedback between a priori and a posteriori reasoning that further understanding on settlement patterns in such landscapes could be gained. It showed that the impact of anthropic factor on a intramountainous area of the Saharan Atlas may not have been as harsh as previously imagined. It is possible that, the mode of establishment of population either local or Romans did not immediately lead to radical transformations in the organization of previous landscapes. The pre-colonial and colonial periods (19th century) site clustering displayed in distribution maps, whether representing villages or other types of settlement agglomerations, grew organically and complementary.

Moreover, the work was supplemented with four annexes: a first one bearing the inventory files, where all the attributes (both material and immaterial) of the survey were reported (related to the Traditional/historical agglomerations of the 19th century). From this stems the regressive approach that was described above for reading the landscape. A second annex containing a full description of all the archaeological findings and discoveries in diverse villages along the valley during the campaigns of prospection. And a third annex where I reported a computer-aided design (CAD) that illustrates all the features of a segment from the valley that concerns the historical villages. This segment corresponds to the only evidences that are still visible today in the valley due to an impressive re-organization of the landscape that, in most cases, destroyed previous historic settlements, or driven off native people into marginal zones where they continued settling in villages. The surviving evidences of the historical landscape, even if they are in a deplorable state of conservation, were meticulously documented. Finally, two articles were added, one related to the prehistorical period and another to the Roman one. These articles were published in an international open access, peer- reviewed journal during the course of the PhD, and some others are awaiting publication.




Work flow 1- The proposed research procedure

# 2. MATERIALS AND METHODS

## *2.1 Landscape Identification and Configuration*

The preliminary phase of characterization of the landscape context involved the identification, through the analysis of literature and processed cartographic and descriptive sources, of all the elements that structure this landscape.

At the territorial scale, in order to fully catch the significance and value of the settlement's system particularities under investigation, it was necessary to identify and characterize its shape and predominant typology within the context, paying particular attention to the settlement structures, the main relationships established between other components of the settlement arrangement, and the boundary elements. These are often related to the morphology of a given territory, as well as, conversely, are necessarily connected to a pathway network due to its important role on past movement processes. These past dynamics were strongly influenced by geological, geomorphological and topographical attributes such as rock deposits, spatial extensions of watercourses, drainage networks, and slope profiles. Thus, a comprehensive evaluation of the past movement circuit should include a multidisciplinary approach, in which lithological, morphological, and hydrological study should be confronted with the archaeological analysis (Younsi et al. 2020).

### *2.1.1 Environmental parameters of the region*

In order to highlight the multiple controls of geological and morphological features on the selection of past human movements during the Holocene in this intramountainous landscape, a territory constituted by a massif hardly offering north / south passages, but partially crossed by a north-east / south-west syncline depression at the bottom of which flows the river, a geological and geomorphological analysis of the region were performed with a view to identify the possible lithological, morphological, and hydrological influences on the selection of past movements' circuit in the region. These factors were analyzed at a regional

(Aures) and at a local scale (Wadi Abiod valley) in parallel with a broad study of the scientific literature, and documents recovered from the administrative authorities of Algeria, such as the Algerian National Agency of Water Resources (ANRH) and the Archives Library (Bastion 23).

Therefore, a deep investigation based on a detailed geological mapping was performed in order to verify the relations between the different stratigraphic features of rocks and the distribution of deposits.

For the study of the lithological part, no one can not refer to the outstanding thesis of Robert Laffitte (1939) who thoroughly scrutinized the Aures massif from top to bottom in the 1930s, a little old certainly but which remains relevant today: The lithological series are surmounted in concordance by more recent formations belonging essentially to the Miocene and Pliocene, characterized by conglomerates, clays and sands. The latter are mainly located towards the south of the Wadi.

The lithological features are strictly correlated to the factor of erosion. In this regard, I have investigated and resumed the resistance of rocks, present in the valley of Wadi Abiod, to erosion based on the indices set by SONATRACH exploitation division (Société Nationale pour la Recherche, la Production, le Transport, la Transformation, et la Commercialisation des Hydrocarbures -Algeria), where the National geophysical department undertook an electric prospecting campaign (in 2000) through the region of Wadi Abiod including Ichmoul, Arris, and Tkout in the city of Batna.

Another parameter that plays an essential role in the landscape's dynamic and which was documented in the valley of Wadi Abiod taking into account its natural setting, was the vegetation as it exerts a direct mechanical protection on the river flow, by reducing the force of water, and promoting its infiltration. Therefore, the denser the vegetation cover, the greater the resistance to flow. This parameter was correlated with topography, erosion, flood and land use in order to understand the changes in the landscapes' evolution. Indeed, deep infiltration is facilitated by the cracks prepared in the soil by the root network, after saturation of the soil, the run-off water encounters obstacles that force it to slow down its speed, resulting in a laid spread of floods. The vegetation formations therefore protect the soil, but do not totally prevent the so-called natural erosion.

Whilst to high spot the principal landforms during the Holocene of the studied area and their possible influence on the path system, a geomorphological analysis has been realized, from which a 3D schematic geological cross-section highlighting the valley geometry and the surrounding landscape was derived.

The Wadi Abiod river basin has been analyzed by a multiscale approach: a first general regional overview of the network and then a focus on the Wadi Abiod valley. These two studies were carried out based on the definition of the drainage network proposed by Benoit Deffontaines and Jean Chorowicz (1990): they defined the drainage network as a set of topographic surface which are bordered by uphill slope on all sides except for the direction of the water flux.

By using such statement, I have defined and extracted the drainage network starting from a Digital Elevation Model (D.E.M with a 30 meters resolution derived by the Shuttle Radar Topography Mission - SRTM) with the use of QGIS software.

To extract the main rivers and their tributaries a parameter suitable to define the network density has been set. I have chosen two values identifying the regional and local scale rivers pattern: for a regional scale the parameter used was suggested by the QGIS User Guide, then the parameter was reduced in the local scale to have more information about the tributaries.

In order to extract the drainage network, the Fill Sinks tool available on QGIS release "3.8" was applied on the D.E.M obtained by "dwtkns.com": this procedure allowed to clean up the D.E.M by removing sinks and peaks that are usually related to the noise relevant to the used D.E.M and would capture the flow of water. A second step foreseen the application of hydrogeological analysis procedure included in the QGIS used release (https://docs.qgis.org/3.10/en/docs/user_manual/).

To better understand the morphology of the area, topographic data in a well-defined spatial and temporal scale are indispensable for the characterization of the hydrological regime. However, the topographic maps available are of low resolution. In the framework of this study, I processed an ASTER MNT map with a resolution of 30*30m freely available on the internet. The information obtained was essential for the investigation of the possible factors for settlement preferences. For this purpose, I have realized the topographic map with a focus on the Wadi Abiod valley by plotting a total of five transects crossing along and through the valley: three 2D profiles (AA'; CC'; DD'); and two 3D sections (BB'; EE'). The 2D profiles were

realized by using QGIS Software through a QGIS Profile Tool which extracts profiles starting from a raster layer with an elevation field; whereas the 3D surface views were realized using ENVI software (Fig. 3) starting from 2 input files: a D.E.M and a satellite image where the base layer D.E.M acts as a wireframe. The RGB bands of the image (ASTER image in this case) were selected and draped over the surface data.

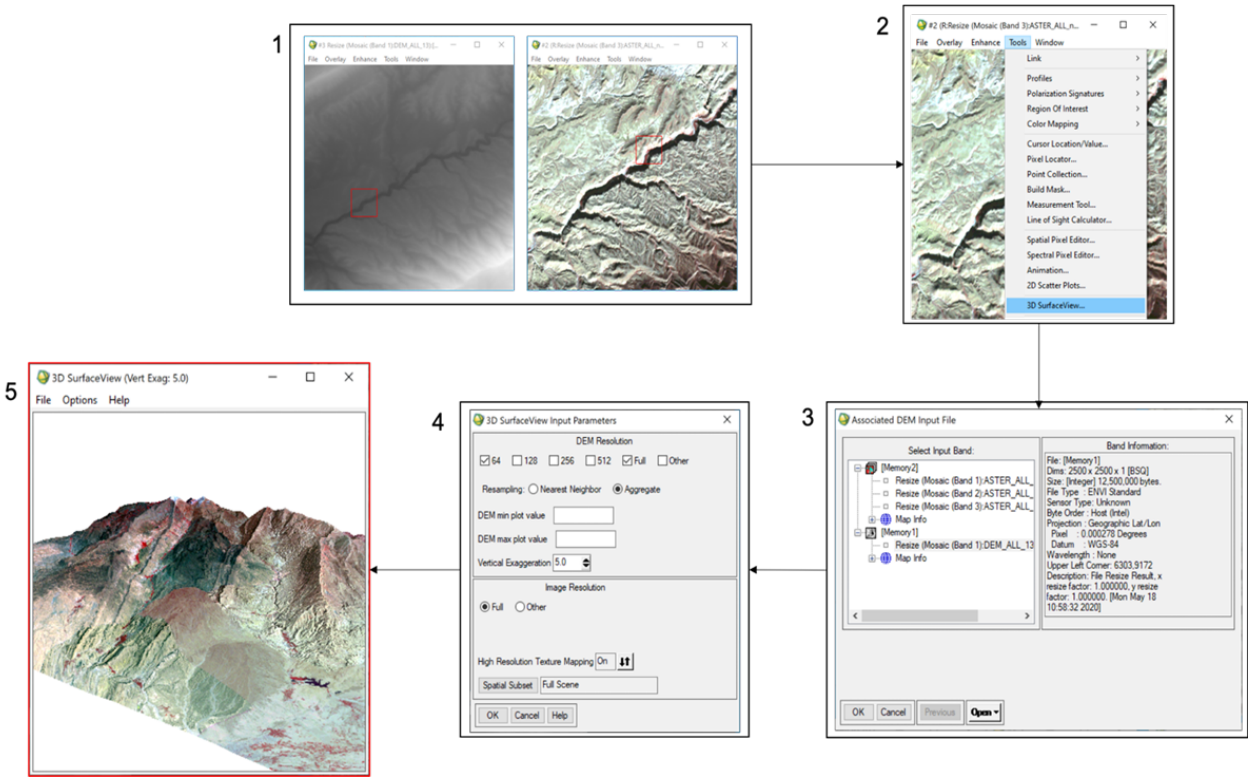



Fig. 3 - The main steps followed for the obtention of the 3D Surfer View in ENVI: (1) Uploading the two files (D.E.M and ASTER image); (2) Running the 3D Surface View in the ASTER image toolbox, (3) Associating a Digital Elevation Model to the ASTER Image, (4) Setting the resolution qualities, (5) 3D Result of the process.

The combination of human activities and climate factors in Wadi Abiod had notable consequences for the distribution and dynamics of communities and landscapes. For this purpose, it was important to gather climatic characteristics both modern and ancient in which the landscape is inscribed.

The pluviometric data allowed to give a brief overview of their distribution over time and space: the meteorological grid used as reference, consisted of stations that bypass and cover the area under study and are distributed over the northern and southern parts of the valley of Wadi Abiod (Fig. 4) based on the report of the ANRH, and other data sources from (Seltzer

1946; Abdessemed 1981; M'hirit 1982); and the Bioclimatic map of Mediterranean zone (UNESCO-FAO 1963).

The measurement and assessment of the main physical parameters of the climate requires a satisfactory number of weather stations, well distributed in the study area, and annual and continuous observations over long periods of time. Unfortunately, these conditions, in most cases, are not verified and therefore constitute a major handicap of this synthesis given the consequences of interpretation that can result. In respect to that, a number of 5 meteorological stations within the sub-watershed (along the Wadi) were investigated: Medina, Arris, T'Kout, M'Chouneche and Tifelfel. Other 3 considered stations are located downstream, at the level of the Foum El Gherza dam and Biskra, and another one upstream on the mountain of Chelia. The data correspond to average interannual precipitations (Table 1) recorded by the stations and average seasonal precipitations of the most complete recorded information (Table 2).

Furthermore, the precipitations were documented according to the altitudes in which the meteorological stations are located with the aid of the contour map derived from D.E.M produced with an interval of 100m between the isolines. This operation has revealed the distribution of the rainfall along the valley.

The temperature, for its decisive role in shaping the landscape, was also investigated. It is considered as a limiting factor of the utmost importance (Ramade 1984): it controls, in fact, all metabolic phenomena and thus conditions the distribution of all living species and communities in the biosphere (Lacoste, Salanon 1969; Ozenda 1982; Ramade 1984). Thus, an increase in temperature of 3°c, in principle, would cause an upward shift in the average vegetation belts of about 545 m (Le Houérou 1990). Thermal criteria have been shown to be the most constant and significant and have been used to interpret vegetation-climate relationships (Rivas-Martínez 1981).

It is important to note that thermal readings, especially in the Aures region, are rare and present either anomalies or gaps. Indeed, temperature data were extracted from only the stations of M’Chouneche and Medina both recorded between 1971 and 1991 i.e 20 years (Table 3).The station of T'Kout has been assigned the average between the two stations, since it is located halfway between the two to achieve a global view on the temperature oscillation in the valley (Table 4).

Additionally, in order to assess the climatic conditions of the region, a known and reliable method based on the Gaussen and Bagnouls ombro-thermal diagram, was applied according to the available data. In fact, as stated by Gaussen and Bagnoul, the climate is dry when the average rainfall expressed in (mm), is less than or equal to twice the temperatures recorded during the same period.

$$P \text{ mm} \leq 2T \text{ °C}$$

Where:

P = precipitation in mm;

T = temperature in °C.

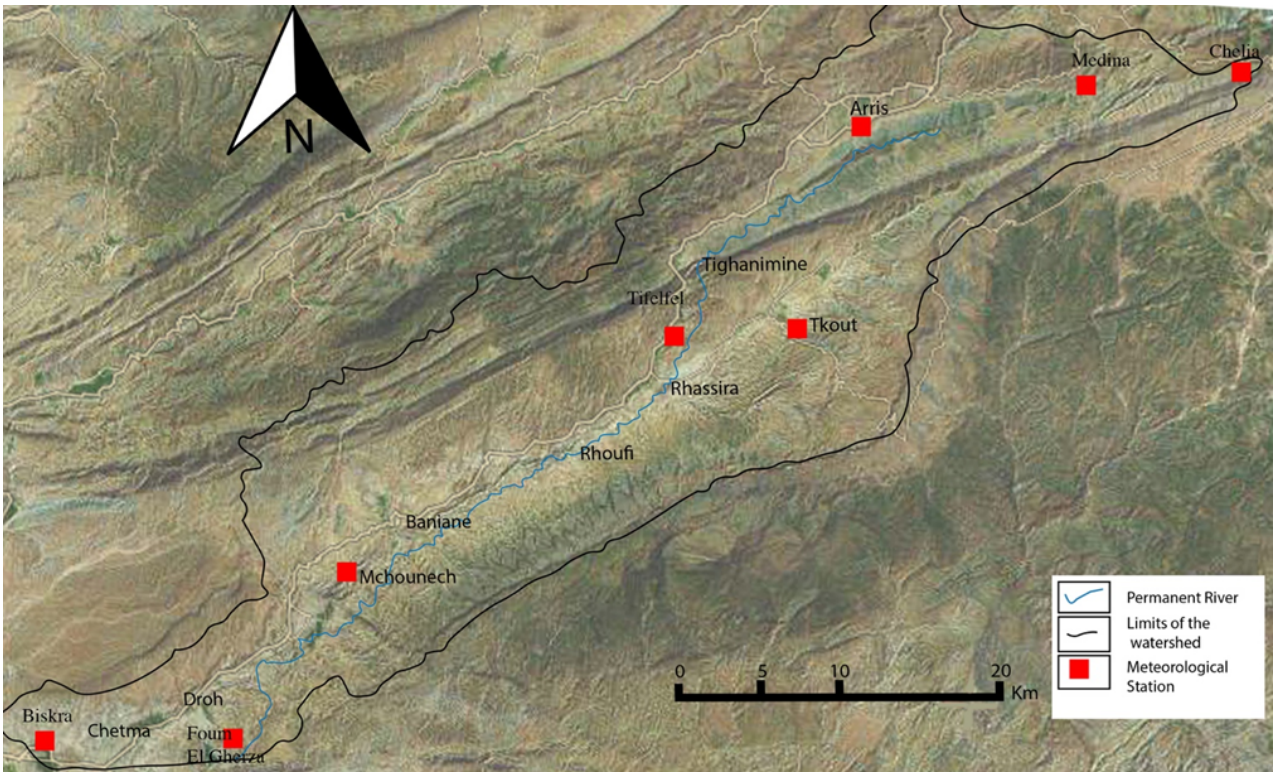



Fig. 4 - Repartition of the meteorological stations along the valley of Wadi Abiod.

| Pluviometric station | Geographical coordinates | | | Average interannual rainfall | Observation periods |
|---|---|---|---|---|---|
| | Longitude | Latitude | Altitude | | |
| Medina | 6° 31’ 02’’ E | 35° 19’ 46’’ N | 1451 | 417.34 | 1969 – 2004 (35 years) |
| Arris | 6° 21’ 11’’ E | 35° 15’ 59’’ N | 1100 | 274.90 | |
| T’Kout | 6° 18’ 22’’ E | 35° 08’ 42’’ N | 980 | 260.35 | 1969 – 2007 (38 years) |
| M’Chouneche | 6°0 0’ 25’’E | 34° 56’ 49’’ N | 330 | 121.24 | 1925 - 1951 (26 years) 1973 – 1979 (06 years) |
| Tifelfel | 6° 13’ 57’’ E | 35° 06’ 53’’ N | 740 | 153.07 | 1974 – 2003 (29 years) |
| Biskra | 5° 43’ 48’’ E | 34° 51’ 40’’ N | 120 | 117.20 | 1974 – 2007 (33 years) |
| Foum El Gherza | 5° 55’ 53’’ E | 34° 51’ 12’’ N | 100 | 106.12 | 1970–2007 (37 years) |
| Chelia | 6° 39’ 00’’ E | 35° 22’ 12’’ N | 1650 | 533,6 | 1975-2006 (31 years) |

Table 1 - Characteristics of pluviometric stations and average interannual rainfall in the valley of Wadi Abiod based on collected data from A.N.R.H.

| Pluvio Station | Sep. | Oct. | Nov. | Déc. | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Medina (1969-2004) | 48.05 | 38.43 | 42.14 | 37.75 | 36.11 | 29.14 | 40.16 | 39.21 | 39.80 | 25.46 | 8.50 | 32.58 | 417.34 |
| | 128.62 mm | | | 103 mm | | | 119 mm | | | 66.54 mm | | | |
| T’Kout (1969-2007) | 31.23 | 26.04 | 26.38 | 21.86 | 20.55 | 19.23 | 23.59 | 23.16 | 25.73 | 18.07 | 7.26 | 17.26 | 260.35 |
| | 83.65 mm | | | 61.64 mm | | | 72.48 mm | | | 42.59 mm | | | |
| Tifelfel (1974-2003) | 17.73 | 16.34 | 15.02 | 11.51 | 11.15 | 15.84 | 13.33 | 16.26 | 12.46 | 6.97 | 1.9 | 14.56 | 153.07 |
| | 49.09 mm | | | 38.5 mm | | | 42.03 mm | | | 23.43 mm | | | |
| M’Chouneche (1925-1951 & 1973-1979) | 9.21 | 13.37 | 12.96 | 14.36 | 11.40 | 10.30 | 18.74 | 13.39 | 9.52 | 4.22 | 1.26 | 2.51 | 121.24 |
| | 35.54 mm | | | 36.06 mm | | | 41.65 mm | | | 7.99 mm | | | |
| Foum El Gherza (1970-2007) | 10.35 | 9.50 | 15.99 | 8.18 | 11.65 | 9.64 | 13.17 | 11.46 | 7.36 | 4.58 | 0.54 | 3.71 | 106.12 |
| | 35.84 mm | | | 29.47 mm | | | 31.99 mm | | | 8.83 mm | | | |

Table 2 - Repartition of average seasonal pluviometric data (expressed in mm) along the valley of Wadi Abiod based on collected of the most complete data from A.N.R.H.

| | Medina | M’chouneche |
|---|---|---|
| September | 20,25 | 28,50 |
| October | 15,00 | 22,30 |
| November | 9,90 | 16,20 |
| December | 5,75 | 11,90 |
| January | 5,35 | 11,60 |
| February | 6,55 | 13,70 |
| March | 8,80 | 15,70 |
| April | 13,15 | 19,80 |
| May | 15,80 | 24,60 |
| June | 22,30 | 29,20 |
| July | 24,60 | 33,50 |
| August | 23,65 | 32,80 |

Table 3 - Monthly temperature data recorded from the stations of M'chouneche and Medina (expressed in C°) based on the report of A.N.R.H.

| | **Sep.** | **Oct.** | **Nov.** | **Dec.** | **Jan.** | **Feb.** | **Mar.** | **Apr.** | **May.** | **Jun.** | **Jul.** | **Aug.** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T’Kout | 24.4 | 18.7 | 13.1 | 8.8 | 8.5 | 10.1 | 12.3 | 16.5 | 20.2 | 25.8 | 29.1 | 28.2 |

Table 4 - Monthly temperature data for the region of T’Kout resulted as the average from the stations of M'chouneche and Medina (expressed in C°).

While to highlight the originality (Riser 1979) of the Quaternary hinge and the role of climatic variations in Quaternary evolution, I have relied on works performed in the Aures piedmont: the passage is generally from levelling forms to accumulation forms. Indeed, covered ablation glacis or less frequently, pediments are replaced by terraces, alluvial fans and spills. Changes in lacustrine levels during the Quaternary are related to paleoclimatic variations (Petit-Maire et al. 1991; Damnati 2000; Damnati, Taieb 2003). Methods for reconstructing these changes are based on stratigraphic, sedimentological, geochemical and palaeo-ecological studies. In fact, in semi-arid regions, high lacustrine levels are frequently recorded by terraces, or by exposures of lake sediments around watershed margins (Fekri 2007). Changes in the nature of sediments (facies) and sedimentation rates also provide an important source of

information on past water levels. The presence of erosion surfaces or drying slits is correlated with low or very low water levels. Laminated deposits in some lakes reflect water stratification and high lake levels (Damnati 1993).

### *2.1.2 Typo-morphological approach for modeling past movement*

A hypothetical model was applied using the typo-morphology method, a widely shared and a reliable principle of landscape processual analysis, which resides in the decomposition of the landscape into its elementary components, and the subsequent identification of the structures and their relationships. This method is based essentially on the diachronic reconstruction of the human settlement sequences and look into the comprehension of the logic in their organization, to shed light on the location preferences and settlement strategy of communities.

The natural structure divides the territory into several territorial units, its boundaries are relatively impassable obstacles due to large rivers and sharp ridges. Many authors have emphasized the influence of the ridgeway for modeling the movement and it is what I applied in this study to track down the itineraries followed since prehistoric times.

In fact, for the conceptualization of past mobility hypothesis, an initial work for the determination of the principal crest line has been performed in the region of Wadi Abiod based on the typo-morphological approach of the territory. This crest line (main ridgeway) corresponds to the watershed line between two basins (it is the most continuous and prolonged line) more significantly depending on the consistency of the underlying basins since the course along the watershed allows access to an area.

This initial phase is correlated with the itinerary that past population has followed in order to better control the environment and to better understand the natural structure of the territory (Caniggia 2000) and corresponds to the period when man lived from gathering and hunting, moving on the main crest line dominating the territory and what makes of it, the path of the first anthropic occupation of the landscape.

A second task was performed to reveal the secondary crest line and which is located on the watershed branching off from the main crest course. It delimits tributary or sub-tributary

basins within a larger river basin (Caniggia 2000). What characterizes this phase is the sedentism of man, that also corresponds to the appearance of the high promontory settlements which are implanted in the high points of the mountains; at the lowest level are the water sources. It is a system of direct connections between the relevant establishments in the same altimeter band and which also offers the possibility of access to promontories of lower altitude (Caniggia 2000).

For each elaboration of a work, one proceeds to a specific method while using the tools necessary for this last. In this case, I had to refer to the already processed models of orography and hydrography in order to have a clear idea on the location of the different itineraries such as the course of the crest line and the course of the secondary crest using the typo-morphological method of the territory (Caniggia et al. 1986) as well as Geographic Information System (GIS) tools.

## *2.2 Archaeological Data Acquisition and Parametrization*

The obtained environmental data were confronted, with parallel fieldwalking surveys of the whole territory of the studied area to gather information on Holocene chrono-cultural ensembles. The multi-millennia occupations that they attest will help to clarify the motivations of the populations to settle near rivers, springs and lagoons, notably in a geographical sector marked by a climatic disturbance and periods of drought and which had a strong impact across the Mediterranean basin without sparing the Saharan Atlas territories. In this regard, I resorted to regression analysis, by the study of the most recent periods to go towards the oldest. Starting from the best-known landscape (the present one or from the 19th century), I attempted to reconstruct in reverse the past stages of the evolution of this landscape from available sources (ancient cartography, and written sources). Functional and chronological hypotheses (terminus ante quem / post quem) are then established for elements of the landscape (parcels, watercourses, paths, terraces or otherwise) that make it possible to compensate for the lack of documentation for ancient societies.

The lack of chronological, functional or geographical information in this context (also during the recent periods) was the starting point for a methodical work of data acquisition (several campaigns from 2018 to 2020) by archaeological pedestrian prospection on the territory of

about 50 km along the valley of Wadi Abiod using a GPS, so that the data can be easily imported into a GIS.

In Fact, in spite of the difficulties imposed by this territory, pedestrian surveys constitute a preferred technique for the study of the settlement, thanks to the large amount of spatialized archaeological information they generate. The objective was twofold: to acquire new data and to verify the relevance of information on already known sites, the approach generally aiming to have typo-chronological information to understand the settlement dynamics of this sector from Prehistory onwards.

### *2.2.1 Inventory and data classification*

The overall data was based on archaeological surveys and chance discoveries. This phase is divided into two stages conducted in parallel with continuous combination: the synchronic and diachronic inventory and application of analytical and interpretative tools.

In the first step, an initial inventory was carried out of the whole zone with a count of 11 sites that were recorded (see Annex 1). Terrain survey provided crucial information as to the why of a site's specific location and possible function. The files included information on:

- The original toponymy of the conglomerates (names of locations that are no longer in use), as well as lands including hydronyms (water features), oronyms (relief features), and places of natural vegetation growth (meadows, glades, groves);
- An operation of recording of all the elements composing the valley both anthropological and physical was conducted with a GPS (Garmin GPSMAP 66i) through waypoints, track, and route (Fig. 5);
- Geographical coordinates and GPS coordinates of each conglomerate;
- Social lineage;
- Fabric of the conglomerates;
- Economical mode used;
- Logic of implantation of the houses and conglomerates;
- Roadway system and boundary demarcation;
- Land use;

- Basic frame;
- Water management system;
- Rites.

A second inventory of ancient data was derived from the first inventory. This one corresponds to chance discoveries of scattered indicators that evoke a diffuse human presence from the Roman period and that I resumed and described in sheets (see Annex 2).

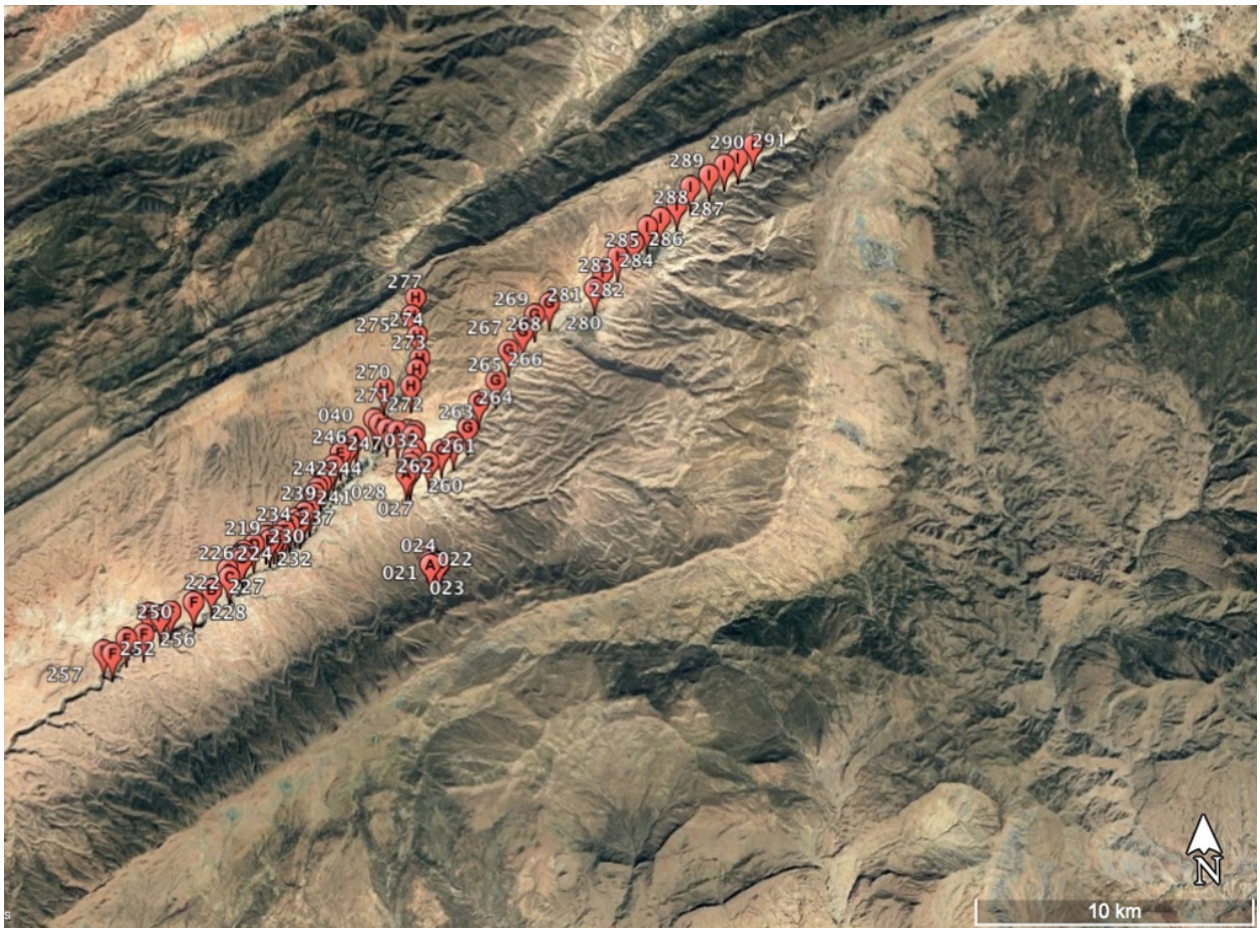



Fig. 5 - The GPS track followed during the archaeological pedestrian survey along the valley of Wadi Abiod (source: Google Earth).

### *2.2.2 Resource materials and data arrangement*

- Computer cartography and Computer-Aided Drafting (C.A.D)

As previously mentioned, due to the absence of cartographical documentation, most of the digital information used has been processed from databases available free of charge on the internet, from which spatial analysis have been performed such as topography, slope, orography, hydrography, landforms, and hillshade.

To best present and store information including all the features of the studied area from the terrain investigation, a C.A.D database was processed: the GPX file recovered from the GPS device were converted to a DXF file recognized by AutoCAD using myGeoData converter (free online software). Then an application of the shapefiles (SHP) which include terrain Contour lines extracted from the D.E.M were imported and overlapped on the CAD drawing using Spatial ManagerTM plugin for AutoCAD. This last one, allows to set the elevations of the imported objects by reading them from the numeric value in a field of the associated data table. The built CAD database, constituting a multi-source documentation support, renders in detail the studied valley and the elements composing it both physical and anthropic (see annex 3).

- Ancient cartography (Table of Peutinger)

One of the sources that this study has investigated was the ancient Roman map copied by a monk of Colmar in 1265 (Encyclopædia Britannica 2020) and which is known today by the table of Peutinger (Fig. 6). This map depicts the Roman itineraries in its colonized territories from which I have identified the region of the Aures in order to trace any plausible passage of the Romans in the studied area.

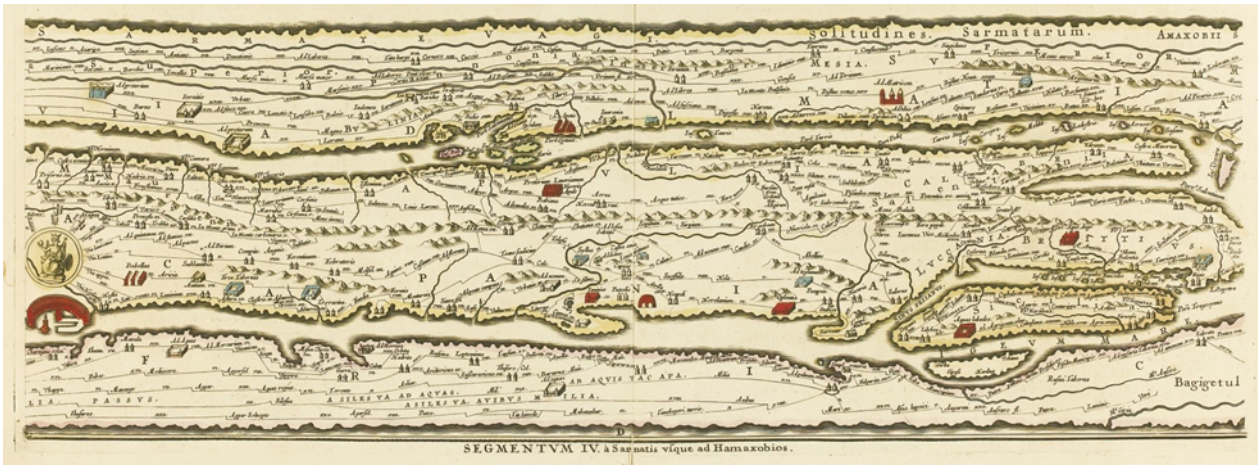


Fig. 6 - Table of Peutinger portraying the Roman itineraries within Rome and its colonized territories. (Source: https://www.euratlas.net/cartogra/peutinger/ ).

- Epigraphical Latin sources in the region

It has to be said that the Romans displayed a certain indisposition when it comes to invading mountainous areas. The evidence that, compared to the surrounding plateaus, the Aures seems to have remained on the fringes of Romanization due to the framing of its reliefs that was speculated to avoid any disturbance or incursion. Yet it appears that the valley of Wadi Abiod did not escape the Roman interest. Probably the most famous of the Roman inscriptions remains the one carved on a rock at the exit of the Tighanimine gorges (Corpus Inscriptionum Latinarum (CIL.) VIII 2446) (Fig. 7), testifying to the colossal work carried out by the Legio VI Ferrata in 145 A.D (CIL. VIII 10230). Archaeologists see it as just a work of development of the passage in the gorges, however it is for a big interest to investigate if these efforts hadn't concerned the layout of a whole path along Wadi Abiod.

Fig. 7 - The latin inscription of the gorges of Tighanimine by the Legio VI Ferrata in 145 A.D under the reign of Antoninus Pius. (Source: https://www.legio6.com/9655/ ).

## *2.3 Geoarchaeology for the Analysis and Interpretation of Changes in Landscape Signs*

The core materials come from a broad range of disciplines such as geology, geomorphology, rural landscape planning, archaeology, anthropology, and several of which contain relevant features. Because the volume of data that has to be included in this study would appear massive, the incorporation of the information into repositories should make it easier to comprehend and represent them. The management of the geoarchaeological information was made possible thanks to the Geographic Information System and Digital Elevation Model tools.

In order to address the potential of the geoarchaeological mapping of the territory, the investigations were based on a conceptual model including the evaluation of data requirements with regard to the scale of the landforms as well as the selection and acquisition of appropriate data sources. The multi-level approach focused on the pre-processing and exploration of individual datasets followed by data integration. The first level of investigations in a GIS environment combines DEMs, satellite imagery and ground truth. While the second level of investigations was based on the fusion of datasets, and spatial analysis to study the relationship between the morphological features of the territory and archeological attributes.

To acquire spatially comprehensive information, all the data were georeferenced to UTM WGS 84 coordinates system (zone 31 north).

To verify and evaluate the quality of the digital results, the structures were mapped by means of field surveys (GPS tracking of ground control points), and the resultant data were used in comparison to the digital outputs and helped in assessing the morphologic conditions in the territory along with their controlling variables and the distribution of landforms. In addition to that, GPS coordinates were applied to the cross-checking of the height accuracy of the DEMs used.

The integrated interpretation of the results obtained from the computation of a multi-modality set of parameters determined at a sector with controversial archaeological

evidences , using all the processed cartographic and documentation sources, including those that were not directly used by definition, allowed to more accurately detail the evolutionary processes of human occupation in the territory, to complement and enrich the data obtained from the analysis and provide information for prehistorical and historical periods in the valley of Wadi Abiod.

Indeed, the geoarchaeological study exposed the potential in revealing the diversity of settlement strategies within this territory based on the reconstruction and analysis of ancient paths systems. It also designed a model for the investigation and the support of past human dynamics in intramountainous areas such as the Aures region during the Holocene. Based on detailed mapping of physiognomic features of the study area in relation with a typo-morphology theoretical model that was confronted with data from archaeological research, the results suggest that the choice of the human movement processes has been driven by the outcrop of some deposits and the presence of specific landforms, such as high and low-relief areas. This integrated approach can help archaeologists to understand and then discover ancient courses crossing complex in impervious landscapes such as the intramountain Lands and consequently reconstruct the historical evolution of a given territory.

# 3. RESULTS

## *3.1 Environmental settings*

### *3.1.1 Geological and geomorphological context*

Backed to the north to high plateaus which often exceed 1,000 meters above sea level (m.a.s.l), the massif of the Aures (Fig. 8) literally plunges into steep and rugged waterfalls and escarpments, towards the south-east and south-west, that is to say towards the Saharan depression.

According to the geological works carried out in the Aures and neighbouring regions (Laffitte 1939; Cornet 1951; Bellion 1976; Alimen et al. 1979; Ballais, Vogt 1980; SONATRACH 1999); and according to the bibliographical analysis of several works recently carried out (Rerboudj 2005; Menani 2008; Benmessaoud 2009; Hamel 2009; Baala 2012) concerning the geology of the Aures massif and its main hydrogeological valleys from which the Wadi Abiod:

The Massif is an eastern continuation of the Atlas Mountain System and is placed at the hinge of two large ensembles that constitute the Algero-Tunisian Saharan Atlas in northeastern Algeri made up of a set of chains with very contrasting relief (Benmessaoud et al. 2009). It is composed of a series of tight folds which draw long rectilinear edges, made of narrow ridges and separated by deep valleys. The highest peak in this massif is located at Chelia Mtn. and exactly at " Irfen'Keltoume " with an altitude of 2326 m. The region has undergone different orogenic phases that gave rise to synclinal and anticlinal structures. The most important are the Atlasic (Upper Lutetian) phase and the Upper post-Miocene phase.

The Atlas Mountains are made up by a Meso-Cenozoic sedimentary sequence that, from Trias to Quaternary has gone through a series of deformational events (folds and faults) related to tectonic stress, which resulted in the development of the mountain range (Bracéne et al. 1998; Askri et al. 1995).

This long tectonic history has drawn a geological limit corresponding to a multi-kilometer tectonic accident, marking the end of the North Saharan Pliocene (Marmi, Guireaud 2006). This flexure gives the entire territory a general south-west / north-east direction serving as a major benchmark (Frizon de Lamothe et al. 1990). It generated the main morphological

features (e. g. ridges, saddles, valleys, paths river) and influenced the natural landscape and environment of the area, and also these features were probably, used as a natural pathway for moving people toward comfortable places.

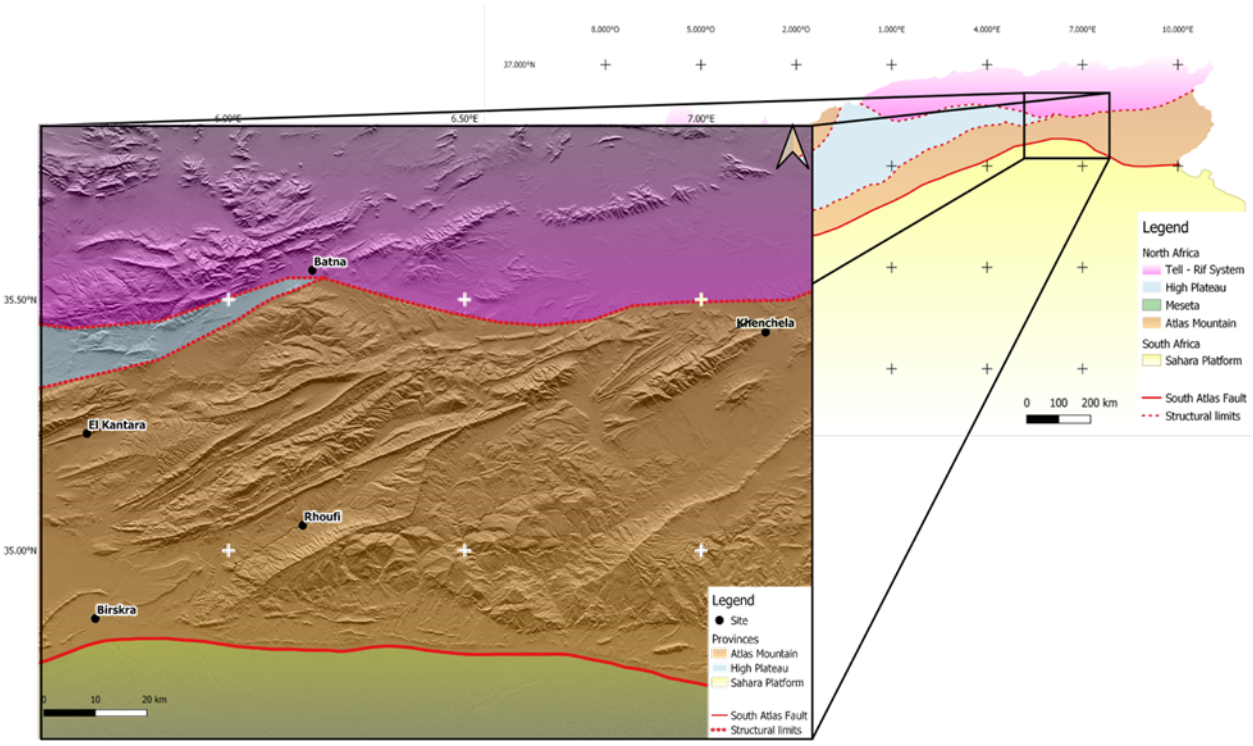



Fig. 8 - Overview of the position of the Aures in the Saharan Atlas of eastern Algeria.

The valley of Wadi Abiod (Fig. 9), that constitutes our case study, is one of the valleys of this massif, located just north of the southern Atlasic Fault, in the transitional region with the High Plateaus. It belongs to the large hydrological basin of Chott Melghir, and is formed by the union of torrents descending from the steep slopes of the highest point in the Aures of which is Chelia Mtn. and Ichemoul Mtn. (2100m). After crossing Tighanimine, it cashes in the canyons of Rhoufi and the gorges of M'chouneche, then opens a path towards the Saharan plain to the gorges of Foum el Gherza.

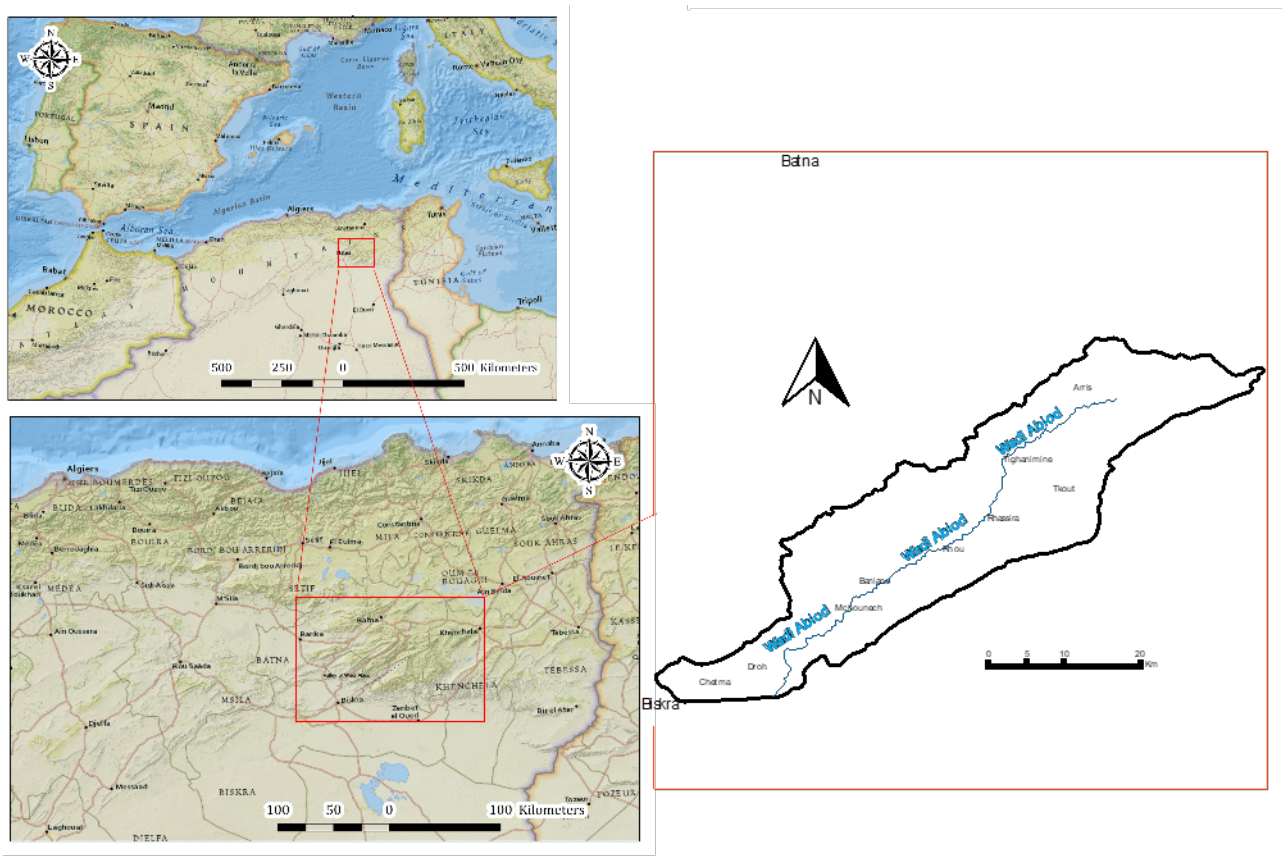



Fig. 9 - QGis basemap illustrating the position of the studied area and its delimitation.

### *3.1.2 Altimetry and slope context*

In order to better understand the morphology of the area, I have realized from a D.E.M (Fig. 10) with a resolution of 30*30m (https://earthexplorer.usgs.gov/), the topographic maps, reported in (Fig. 11) .

The area is characterized by a wide range of altitudes, with the highest point above the 2000 m.a.s.l, and the lowest below the 0 m.a.s.l. Attention was focused on the Wadi Abiod valley by plotting a total of five transects (Fig. 11) crossing along and through the valley: three 2D profiles (AA'; CC'; DD'); and two 3D sections (BB'; EE').

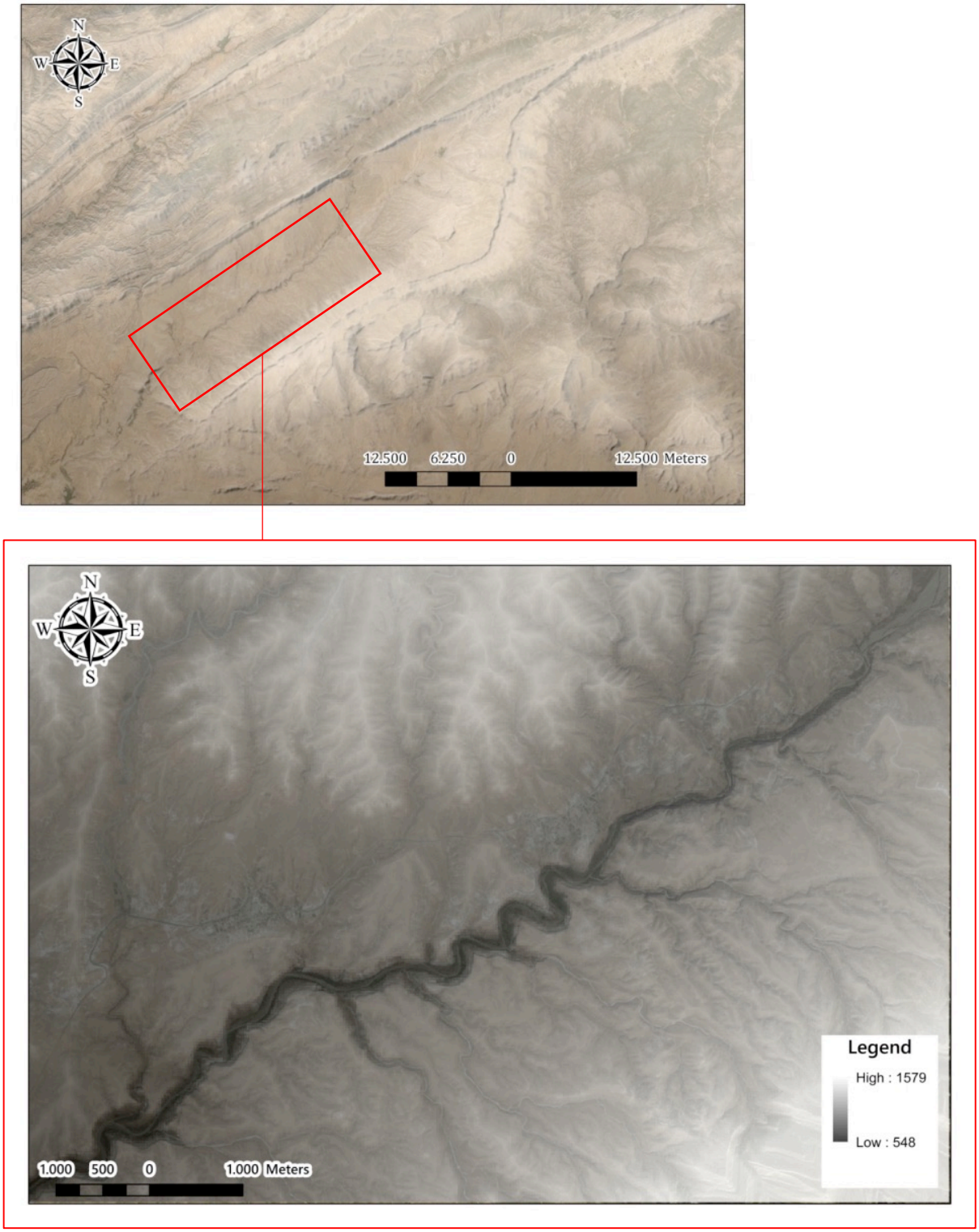



Fig. 10 - A Digital Elevation model illustrating the valley of Wadi Abiod with a resolution of 1200 DPI, and scale1:35000. (Source: https://earthexplorer.usgs.gov/).

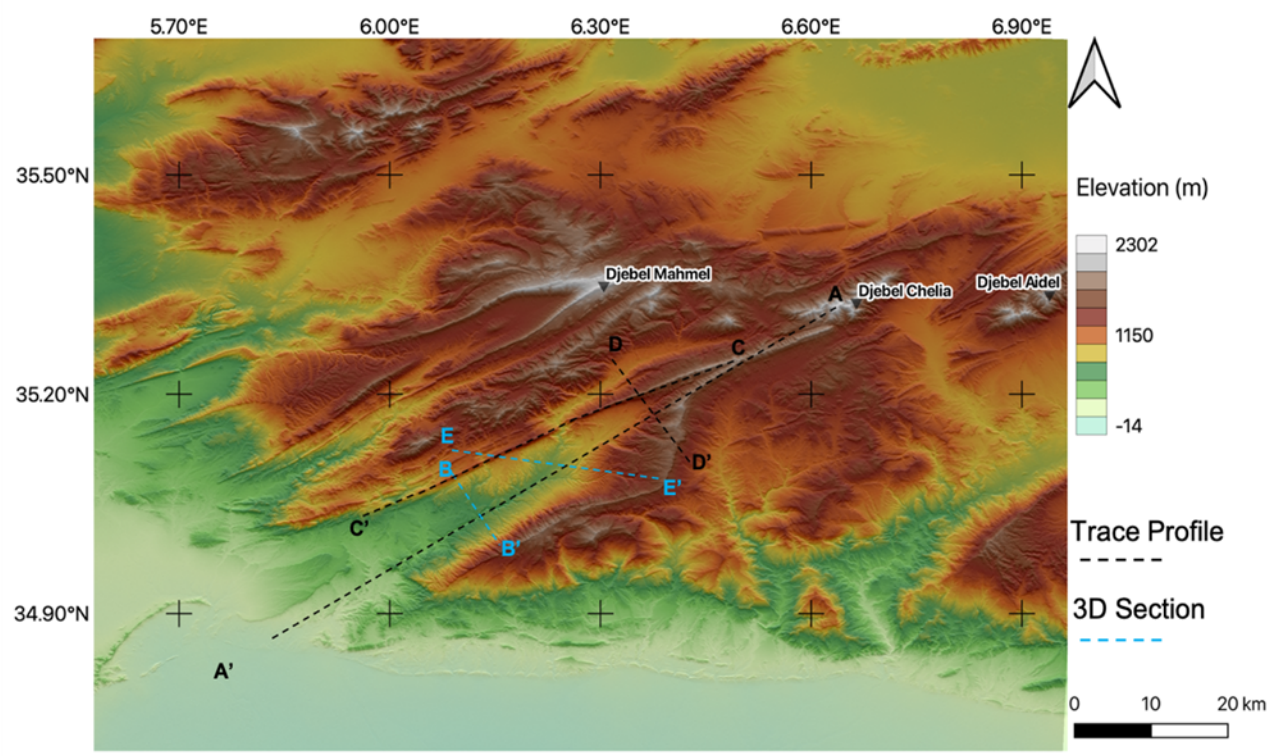



Fig. 11 - Topographic map showing the location of the five transects.

By analyzing the profile trending NE-SW (AA') and running parallelly to the entire valley (Fig. 12), it is possible to divide the section into seven different parts: the first one "a", is the higher most area, Chelia Mtn which exceeds the 2000 m.a.s.l.; the second sector "b" is a little depression that connects the Chelia to the second higher zone of the area, the third sector "c", is prevalently flat region with an almost constant altitude of about 1700m. The limit to the sector "c" is located at the edge of the flat region and it represents the entrance to the valley, the sector "d", characterized by a constant downslope towards the south-west until the end of AA'. With a focus on the bottom part of the profile, from the sector "d" to the end, it is possible to see some distinctive traits: the sector "e", characterized by a very undulatory segment because of the river meandering in this sector; the sector "f", represents a high structure related to the Eastern edge of the valley; and the sector "g", the profile is very low and flat because it reaches the Saharan Platform limit.

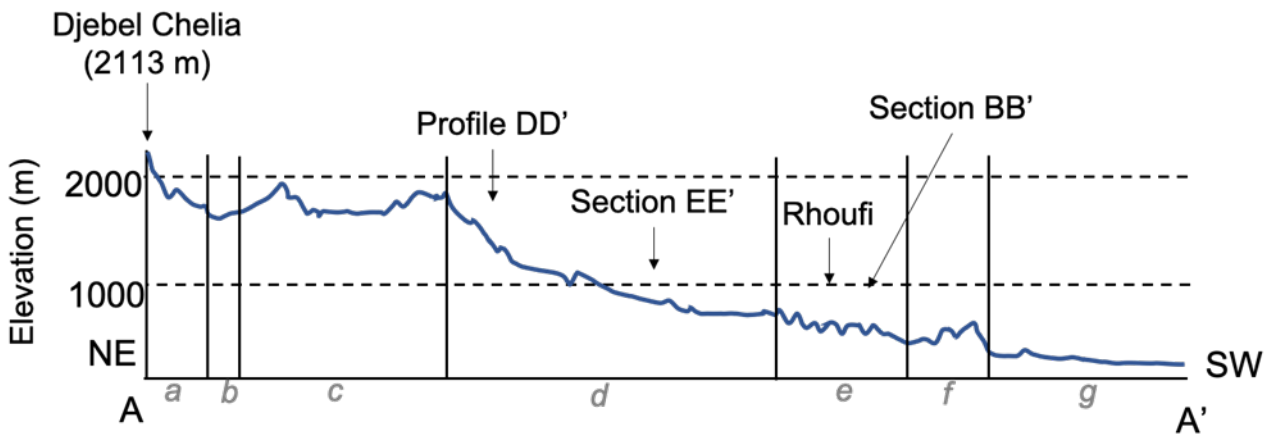



Fig. 12 - Topographic profile A-A' with a NE-SW trend running parallel to the valley. it's subdivided in seven sectors, form "a" to "g".

From D-D' profile (Fig. 13) and from the 3D section (Fig. 14) it is possible to observe how the valley of the Wadi Abiod is a large valley characterized by a steep and narrow ridge, to the left side and a high wide ridge to the right side.

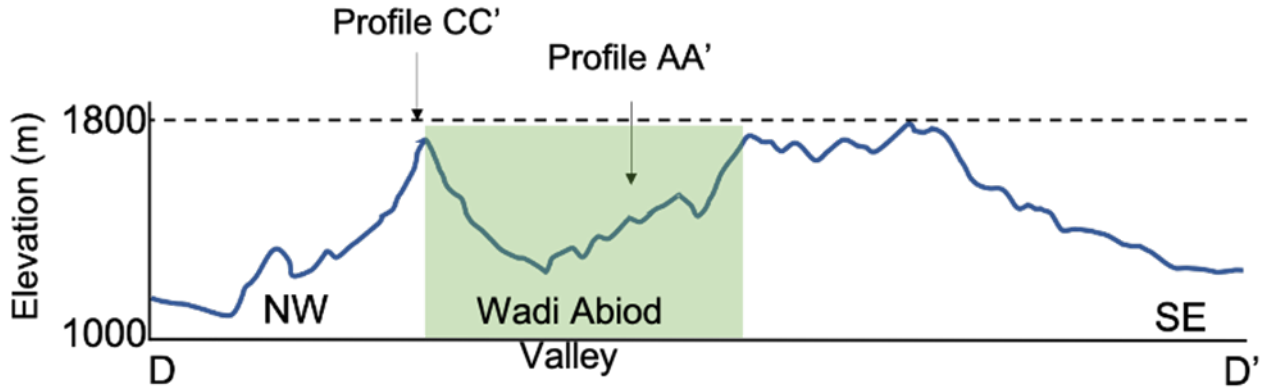



Fig. 13 - Topographic profile D-D' with a NW-SE trend that cuts the valley. The valley of Wadi Abiod has been highlighted in green.

Furthermore, considering a north-west / south-east 3D section, the transversal geometry of the Wadi Abiod valley (Fig. 14) was emphasized by reporting a 3D schematic geological cross-section highlighting the valley geometry and the surrounding landscape.

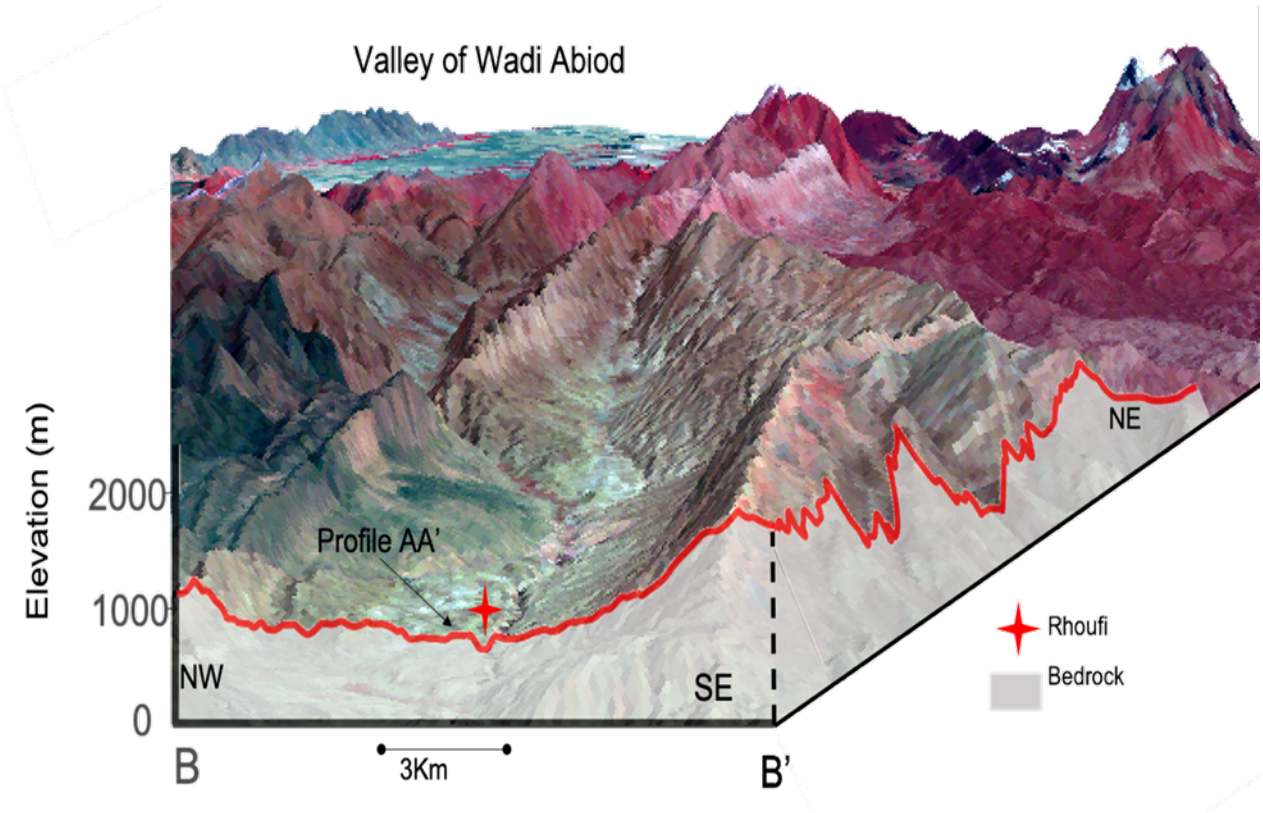



Fig. 14 - 3D view of the Wadi Abiod valley with a topographic profile (B-B')

Based on the orthogonal section with respect to the main axes of Wadi Abiod valley (B-B'), the river flows and cuts the bedrock. According to the geological map (Laffitte 1939) and to the topographic profile, the valley is characterized mainly by a carbonate series with an age ranging from the Trias up to the Miocene, that include a large variation of calcareous rocks, from limestone to marl. From Laffitte (1939), the valley outcrops minor continental deposits (debris slope) on the north-western side of the valley.

From an altimetric point of view, it turns out that the sectors of altitude above 1300 m present more than 41% of the total watershed. It generally corresponds to the mountainous massifs of the Aurès. The zones of altitude between 400 and 1300 m cover approximately 52% of the total area. Finally, the sectors, with an altitude of less than 400 presents more than 7% of the basin, mainly the Saharan plains in the south of the basin (Fig. 15). These observations are more detailed on the slope class map (Fig. 16).

It should be noted that the slopes in the study area vary from less than 4% to a value of more than 60%. The slopes are generally very steep, exceeding 20% in the mountainous areas of the Aures to the north of the watershed. Between these areas of high relief, there are gentler

slopes (between 0 and 13%). These more or less flattened zones are located on either side of the Abiod wadi and to the south of the watershed which corresponds to the Saharan plains.

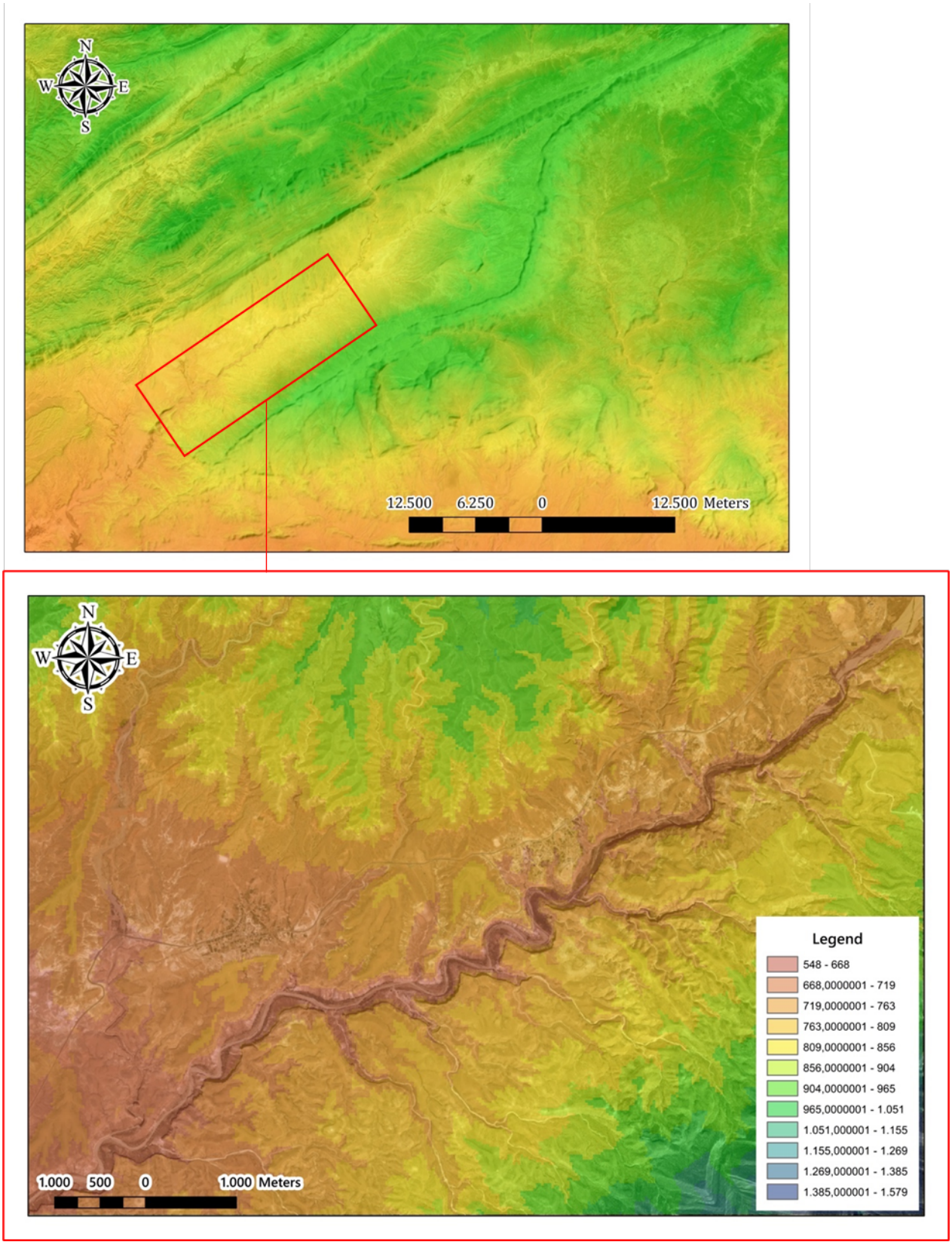



Fig. 15 - Altitude distribution map of the valley of Wadi Abiod.

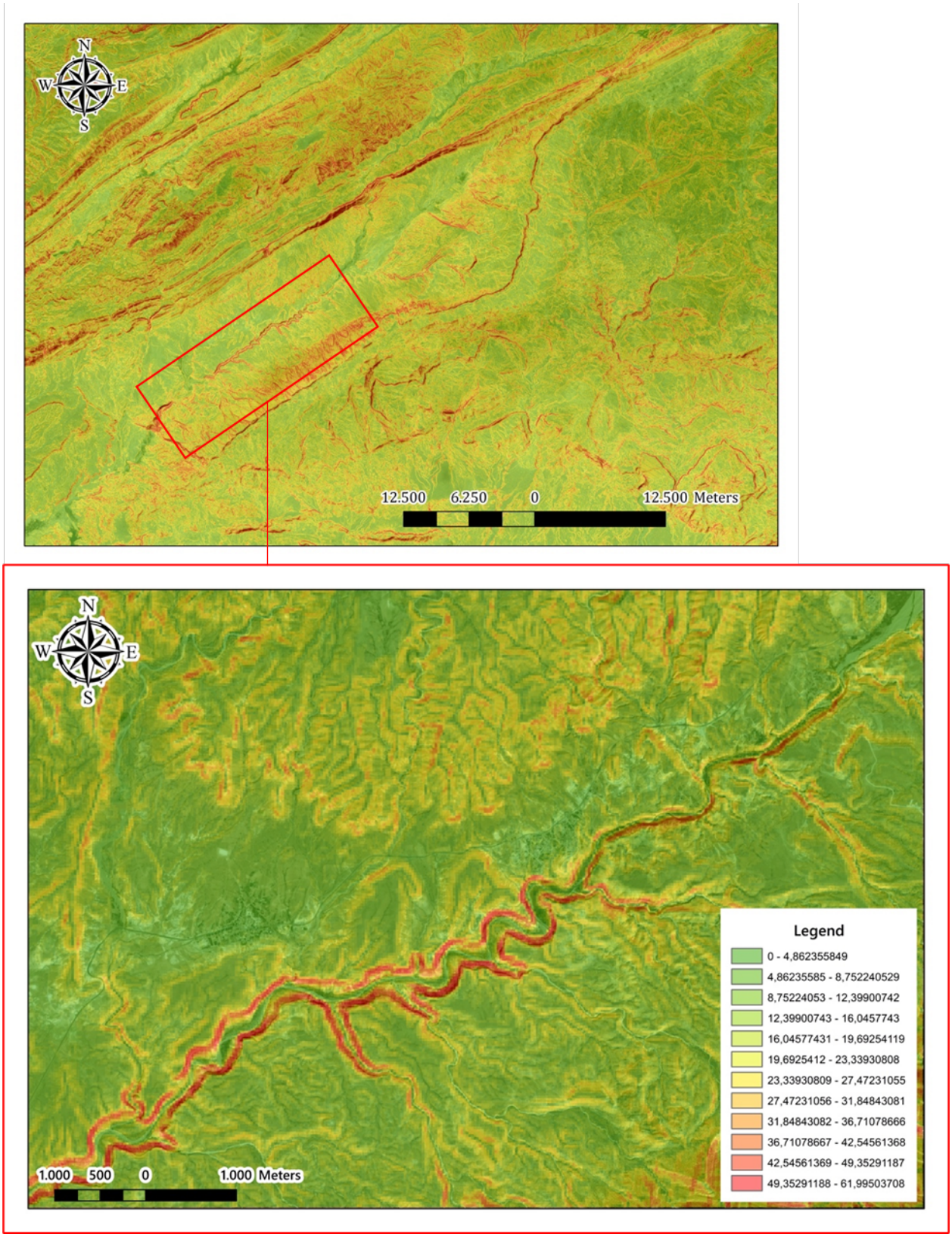



Fig. 16 - Slope classes map of the valley of Wadi Abiod.

It can be noted that the slopes from 15% to 50% represent more than 55% of the surface of the basin. Whereas the class of slopes from 0 to 5% represents only about 8% of the total watershed surface. These results show the accidental nature of the Wadi Abiod valley

### *3.1.3 Fluvial context*

The Wadi Abiod river basin has been analyzed by a multiscale approach: a first general regional overview of the network and then a focus on the Wadi Abiod valley (Fig. 17).

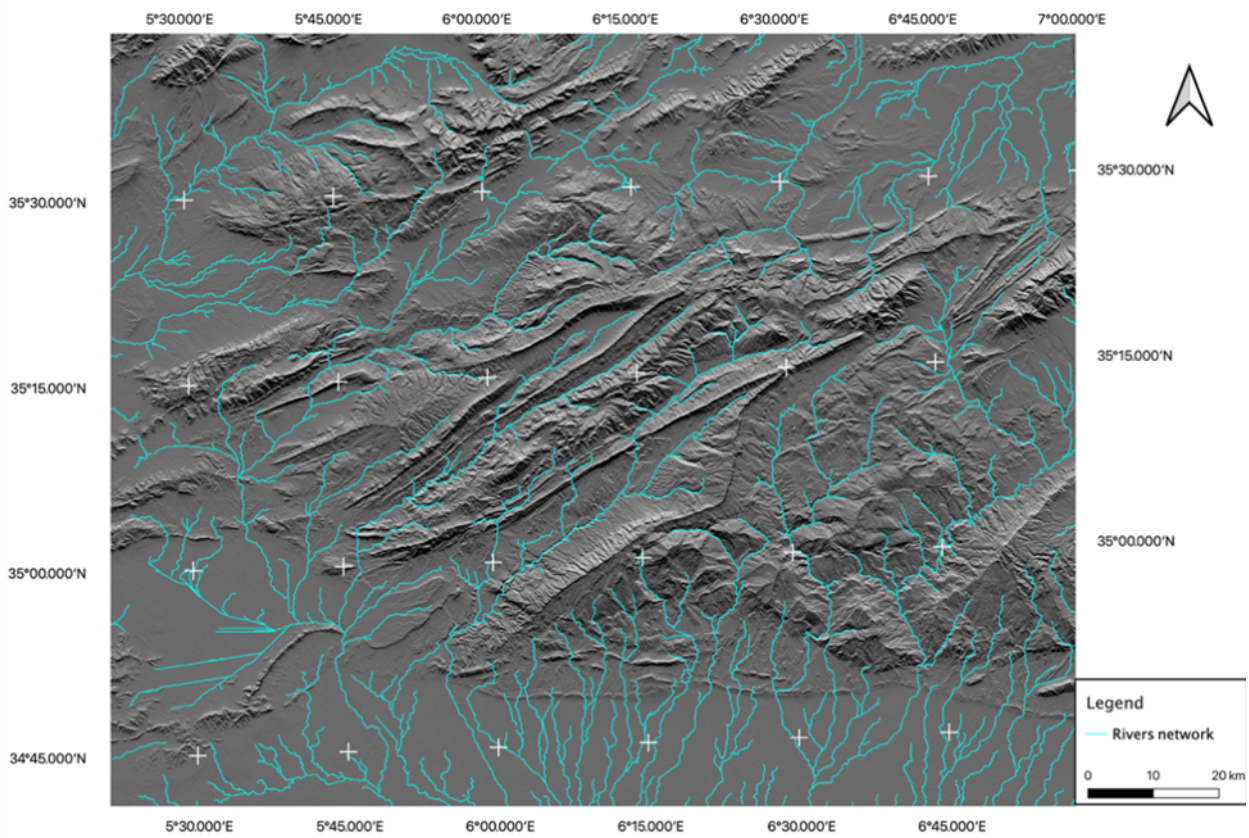



Fig. 17 - Channel network map at a regional scale with a DEM as basemap.

Comparing (Fig. 17) with the topographic map (Fig. 11) it is possible to derive that the upper limit of the drainage network corresponds to the most elevated zone and it trends towards north – north-east and south – south-west zones respectively.

At a smaller scale (Fig. 18) I have also identified the NE-SW trend of the main rivers (Wadi Abdi and Wadi Abiod) with a number of tributaries orthogonal to them.

The analysis performed highlights that the tributaries are characterized by longer paths and their orientation depends on the transversal tectonic elements which drives the topography in this region.

A particular N-S deviation of the Wadi Abiod river has to be highlighted (red circle in Fig. 19). With a closer observation, we may see how the previous mentioned deviation is not the only one in the valley of Wadi Abiod.

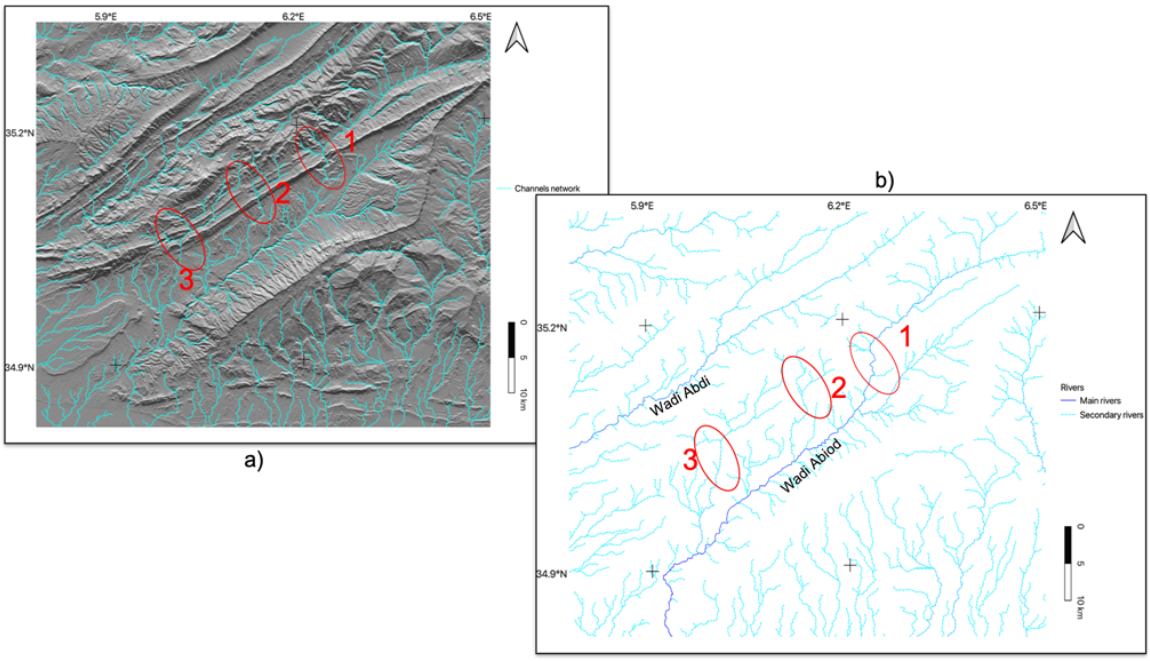



Fig. 18 - Channel network map focused on the Wadi Abiod valley. The three red circles reveal the main N-S deviations.

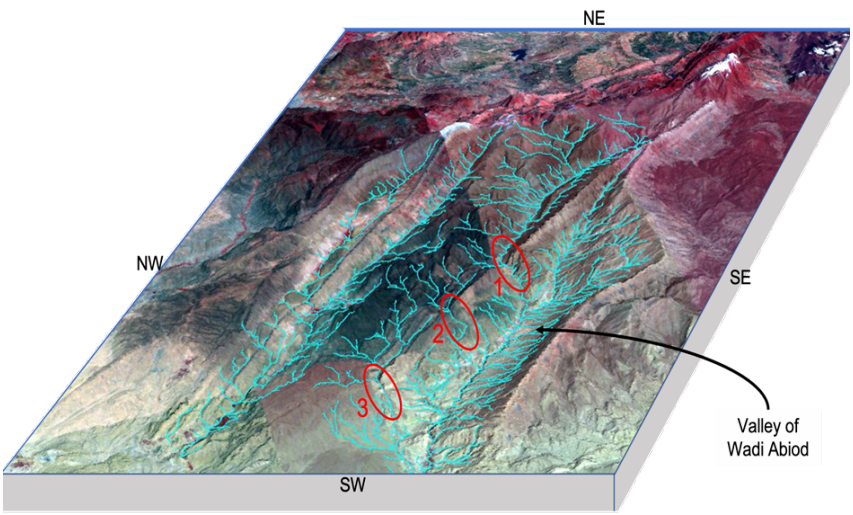



Fig. 19 - 3D view of the Wadi Abiod valley with the overlay of the drainage network (in red the three N-S trend deviations of the main river Wadi Abiod).

In (Fig. 19) I overlay the shapefile of the drainage network on an ASTER image in a 3D view. This Fig. shows three main N-S deviations of the river Wadi Abiod that depend on the tectonic element.

These N-S deviations are recognizable tracing a NE-SW topographic profile (trace C-C' on Fig. 13) along the crest that borders the valley on the left side (Fig. 20) cut by the three deviations previously mentioned.

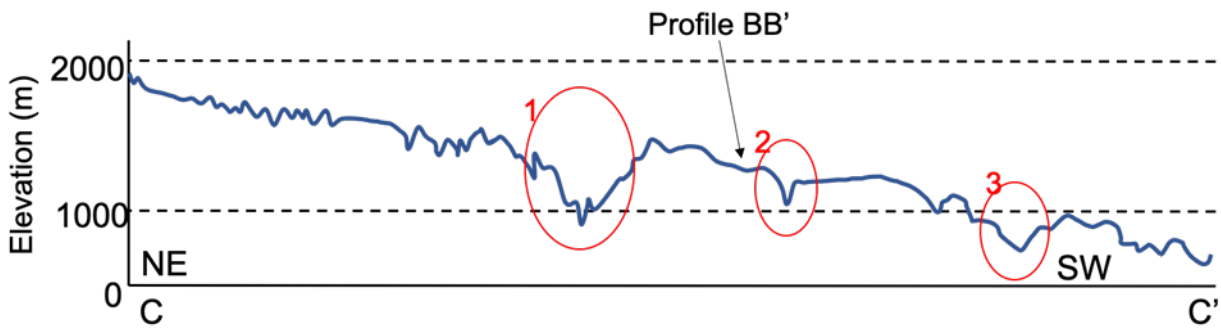



Fig. 20 - Topographic profile C-C' with a NE-SW trend running along the crest that borders the valley on the left side. Within the red cirlces the three valleys formed by the river emerge.

It is useful to focus the attention on the northern one (red circle 1 in Fig. 18, Fig. 19, and Fig. 20). Up to us it is the most important because conversely for the others (circles 2 and 3) it connects two rivers of the Wadi Abiod (Fig. 21).

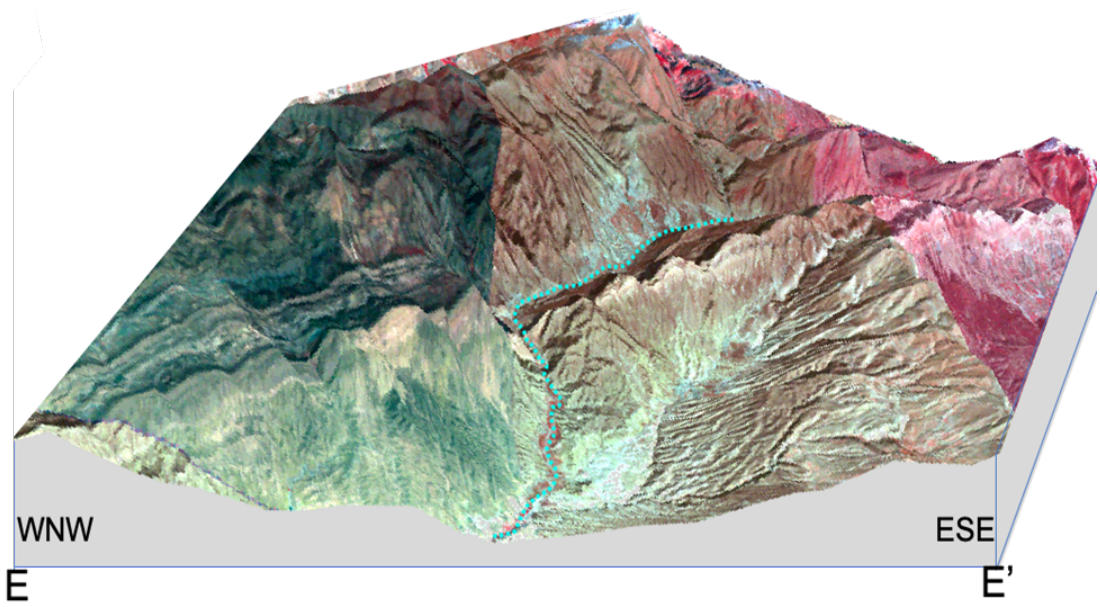



Fig. 21 - 3D view of the Wadi Abiod valley (section E-E' in' Fig. 12) with a focus on the most important N-S deviation of the Wadi Abiod River.

### *3.1.4 Lithological characteristics*

The lithological features are strictly correlated to the factor of erosion, based on the indices set by SONATRACH exploitation division (Société Nationale pour la Recherche, la Production, le Transport, la Transformation, et la Commercialisation des Hydrocarbures -Algeria), the National Geophysical Company undertook an electric prospecting campaign (in 2000) through the region of Wadi Abiod including Ichmoul, Arris, and Tkout in the city of Batna. below is a table (Table 5) that resumes the resistance of rocks, present in the valley of Wadi Abiod, to erosion:

| **Formations** | **Erosion resistance** |
|---|---|
| Fissured limestone | Resistant |
| dolomite | Very resistance |
| Sandstone | Very resistance |
| Calcareous sandstone | Resistant |
| Marly limestone | Resistant |
| Quaternary | Resistant |
| Marl | Non resistant |
| Pebbles | Resistant |
| Gravels | Resistant |
| Screes | Resistant |

Table 5 - Resistance scale to erosion of the lithology of the valley of Wadi Abiod.

Theoretically, the lithological distribution reveals areas of medium to low erodibility in the north and other areas of high erodibility in the south due to the predisposed lithology that coincides with the absence of vegetation cover, and which favors violent runoff and therefore erosion will be more or less important

### *3.1.5 Land use and vegetation*

The vegetal landscape of the basin of wadi Abiod has been largely degraded and faded in the mountains of the Aures with a rate of afforestation estimated at 50% (Quezel 2000). This regression is induced, above all, by a very marked anthropic action due to overexploitation of this very fragile environment (permanent overgrazing, illegal logging and forest fires), which are moreover subject to locally severe natural constraints, in addition to the devastating effects due to the consequences of the war of independence that is to be noted (Boudy 1955; Ramade 1997; Hammi et al. 2007).

The forests are located on the northern slope between 1600m and 2000m composed of cedar on about 1400 hectares. The rest of the wooded area is divided between Aleppo pine, holm, oaks particularly between 1400m and 1000m (Bentouati et Bariteau 2006; Bentouati 2008). As for the lower valleys, they already oppose their ribbons of palm groves arranged in terraces to the nakedness of the Desert, while oasis gardening is associated with other cultural practices notably, cereal cultivation whose irrigation is ensured by diversions from the Wadi and flood spreading (inventory files in Annex 1 as reference to the latter) (Delartigue 1904). The absence of vegetation cover in some areas favors violent runoff and therefore erosion will be more or less important.

### *3.1.6 Regional and local climate patterns*

From the meteorlogical dataset drawn from the National Agency of Water Resources (Algeria), the pluviometric repartition both average monthly and seasonal along the valley of Wadi Abiod are represented in the following diagrams (Diagram 1 and 2):

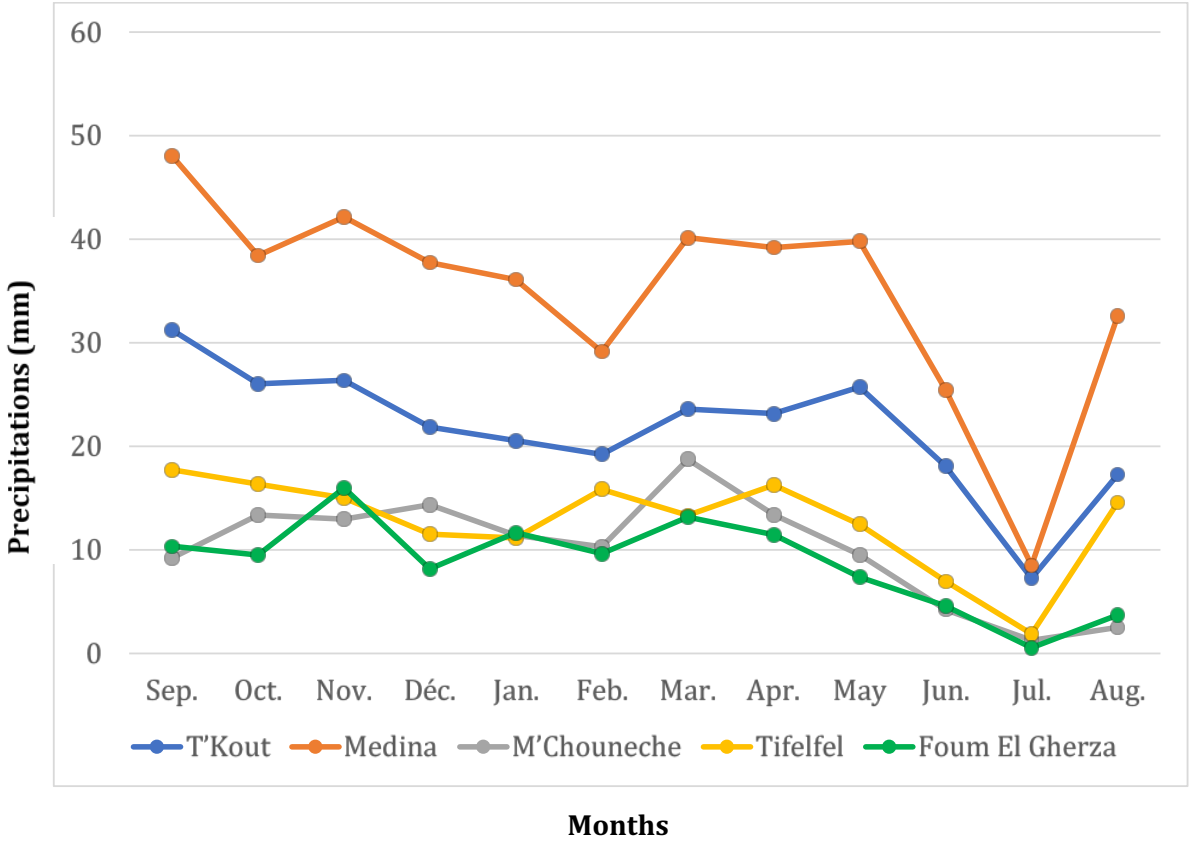



Diagram 1 - Average monthly repartition of pluviometric data along the valley of Wadi Abiod.

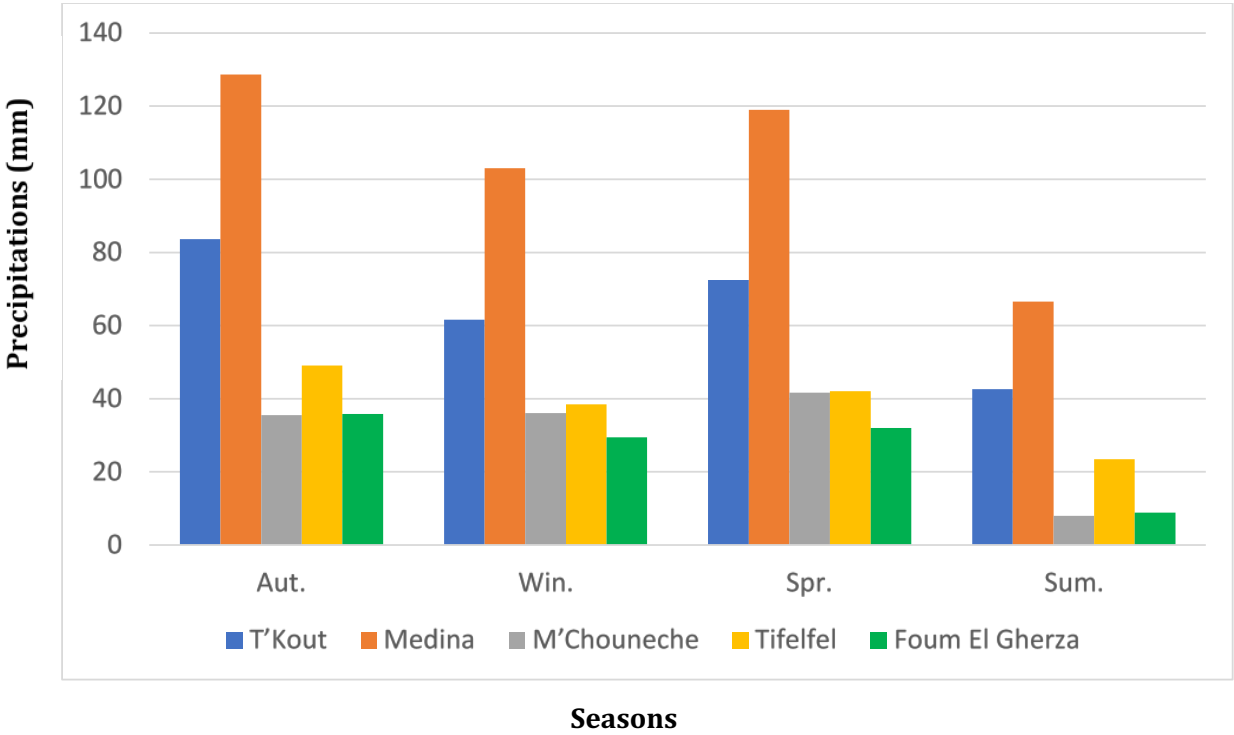



Diagram 2 - Seasonal repartition of pluviometric data along the valley of Wadi Abiod.

Based on the meteorological data (Table 4), the study area is subject to three types of climate. In the north (Arris and Ichmoul), a Mediterranean-type climate prevails, with rainfall of the order of 450 mm. On the median part (T'Kout and Rhassira), a sub-Saharan climate prevails (200 to 300 mm of rainfall). The southern part (M'Chounech and Droh) is subject to an arid climate, with rainfall not exceeding 200 mm (Diagram 1).

It also appears that the wettest seasons are spring (March, April, and May) and autumn (September, October, and November) and finally two thirds of the winter season (January-December) (Diagram 2).

The correlation of the above data in function of altitudes reported in (Table 1) together with the contour map achieved from D.E.M (Fig. 22) of the valley of Wadi Abiod, has made it possible to visualize the relation between the rainfalls and the altitudes characterizing the valley (Diagram 3):

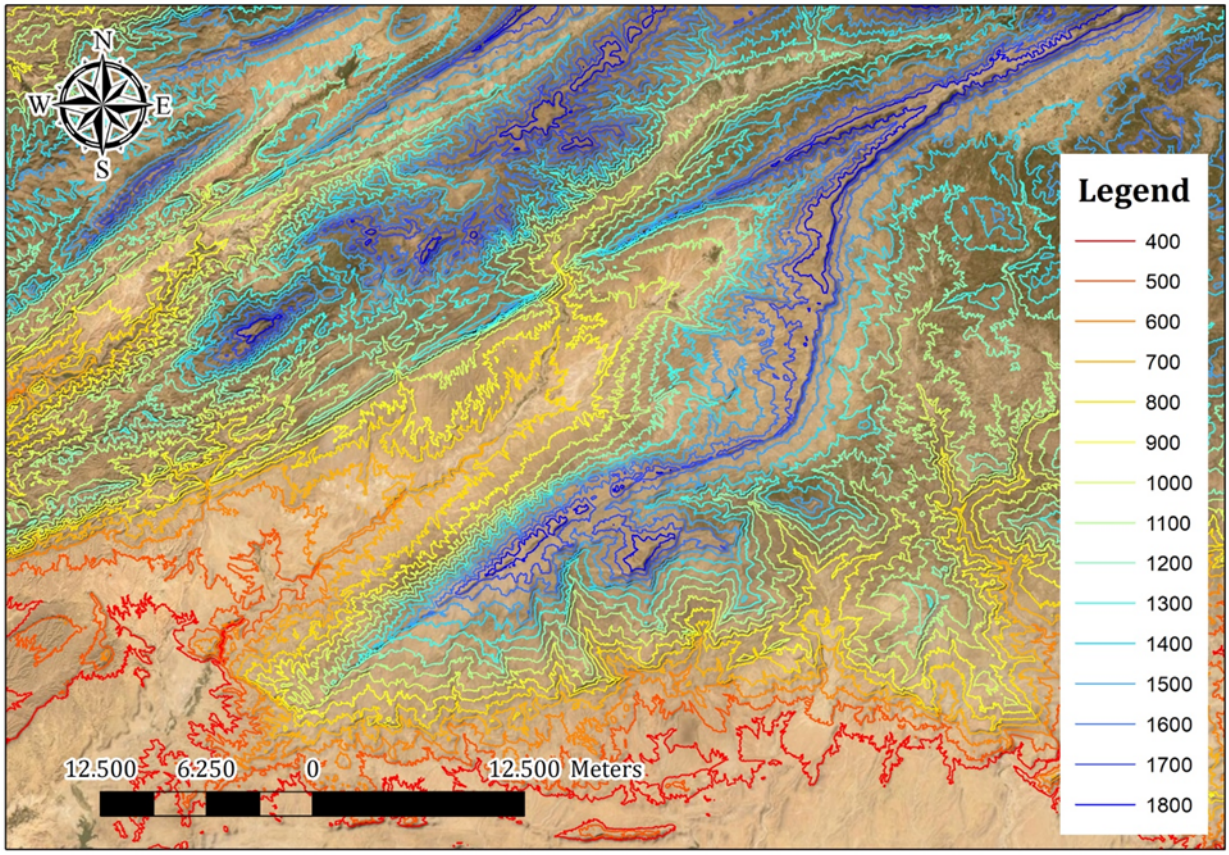



Fig. 22 - Contour map where the valley of Wadi Abiod is circumscribed with a 100m distance between the isolines.

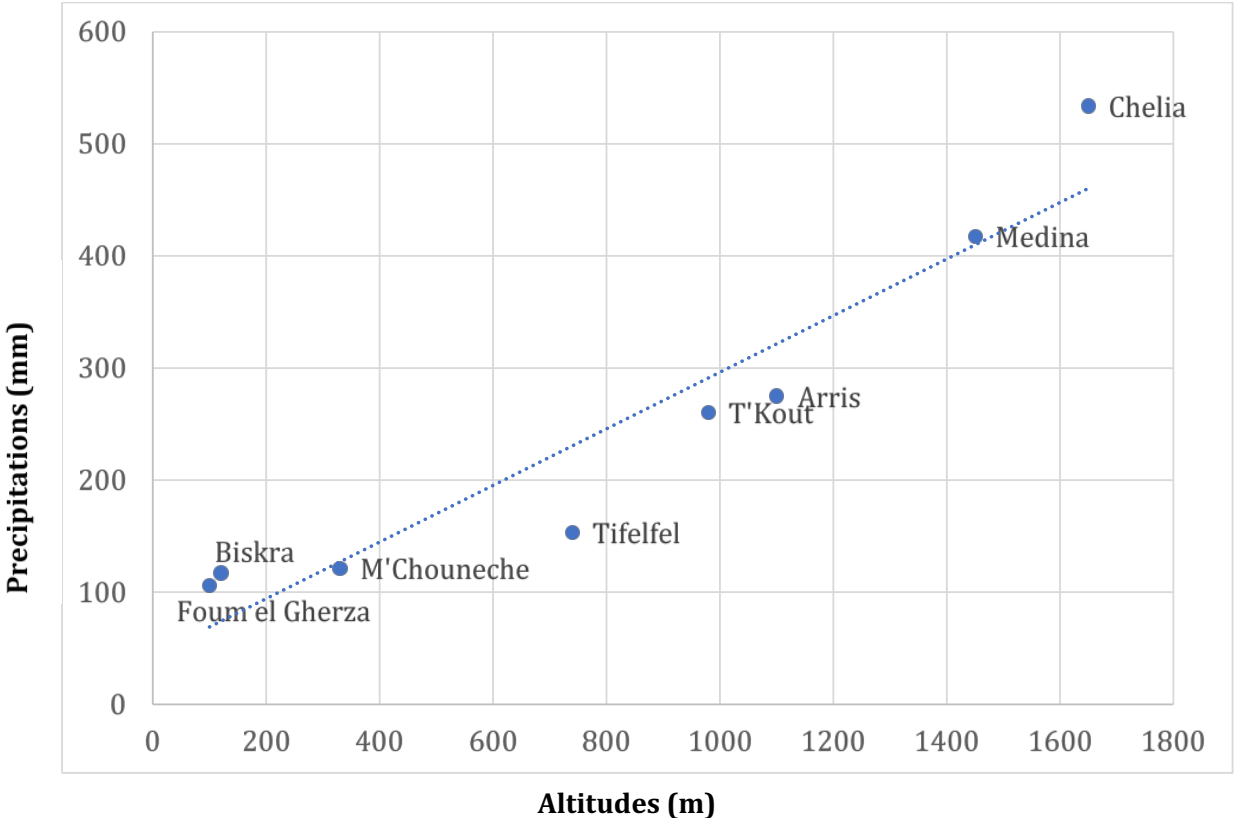



Diagram 3 - Precipitations and altitudes relationships in the valley of Wadi Abiod.

The above (Diagram 3) illustrates the relationship between rainfall and altitude and shows a decrease in rainfall from northeast to southwest. The areas with the highest rainfall are those located at altitude, in the northeastern part of the sub-basin.

Furthermore, the temperature record in both stations of Medina and M'chouneche has given the trends illustrated in the (Diagram 4). Considering that Medina is in the northern part and M'chouneche in the southern one of the valley of Wadi Abiod, and to cover the whole area, T'kout has been chosen and assigned the average of the values recorded in the two previously mentioned stations (Diagram 5).

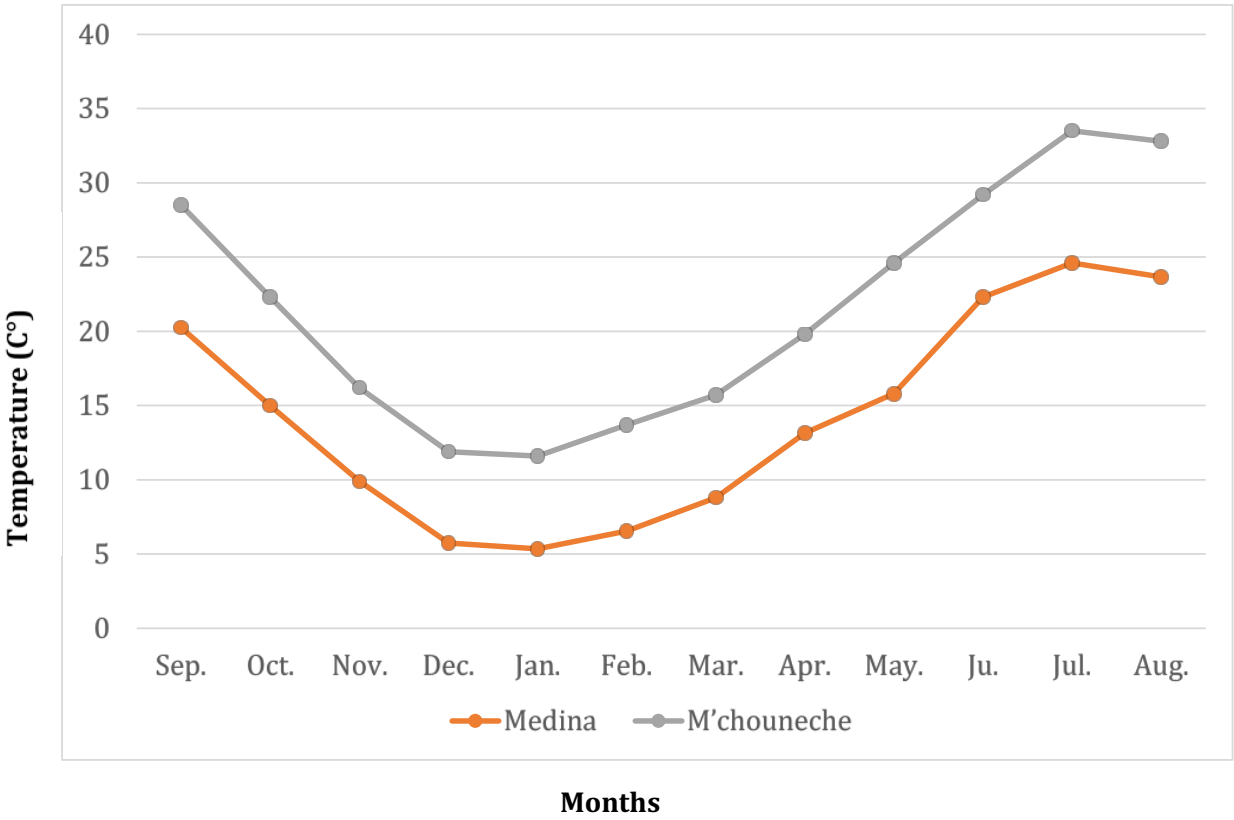



Diagram 4 - Monthly temperature oscillations along the Medina and M'chouneche.

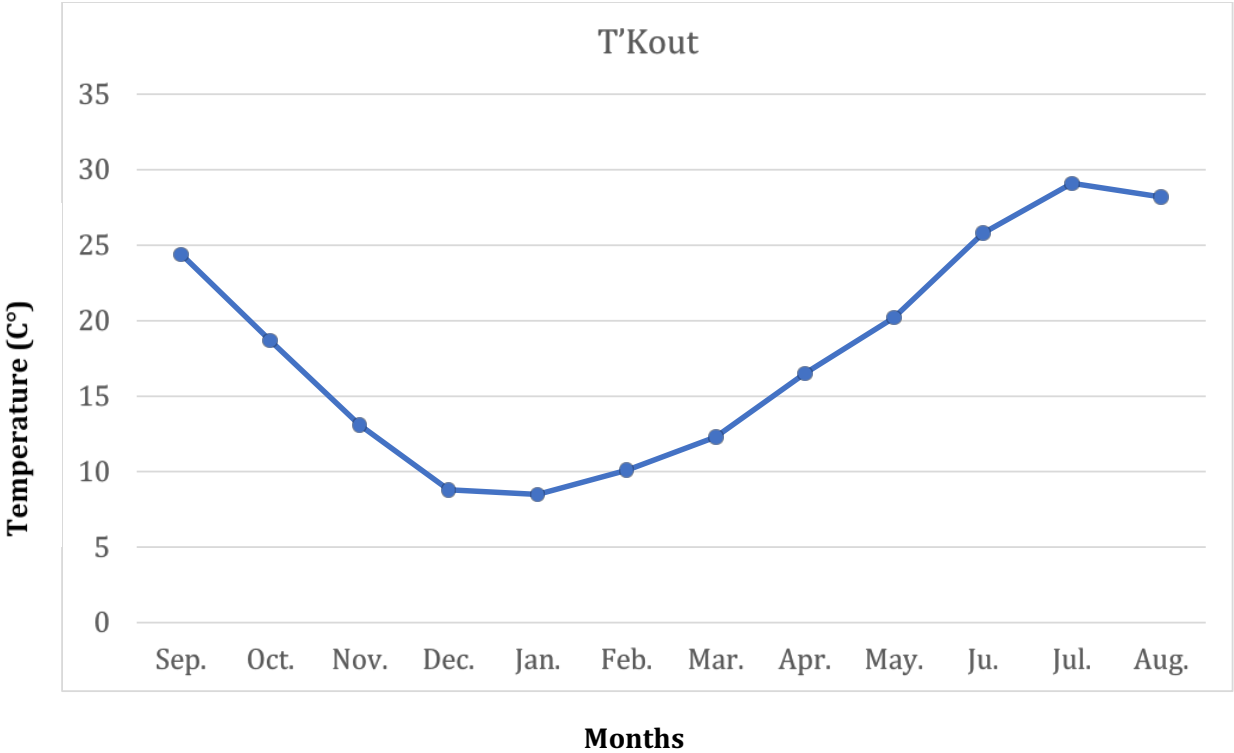



Diagram 5 - Monthly temperature oscillations in T'kout.

The superposition of both Diagrams (4 and 5) has given the following result (Diagram 6):

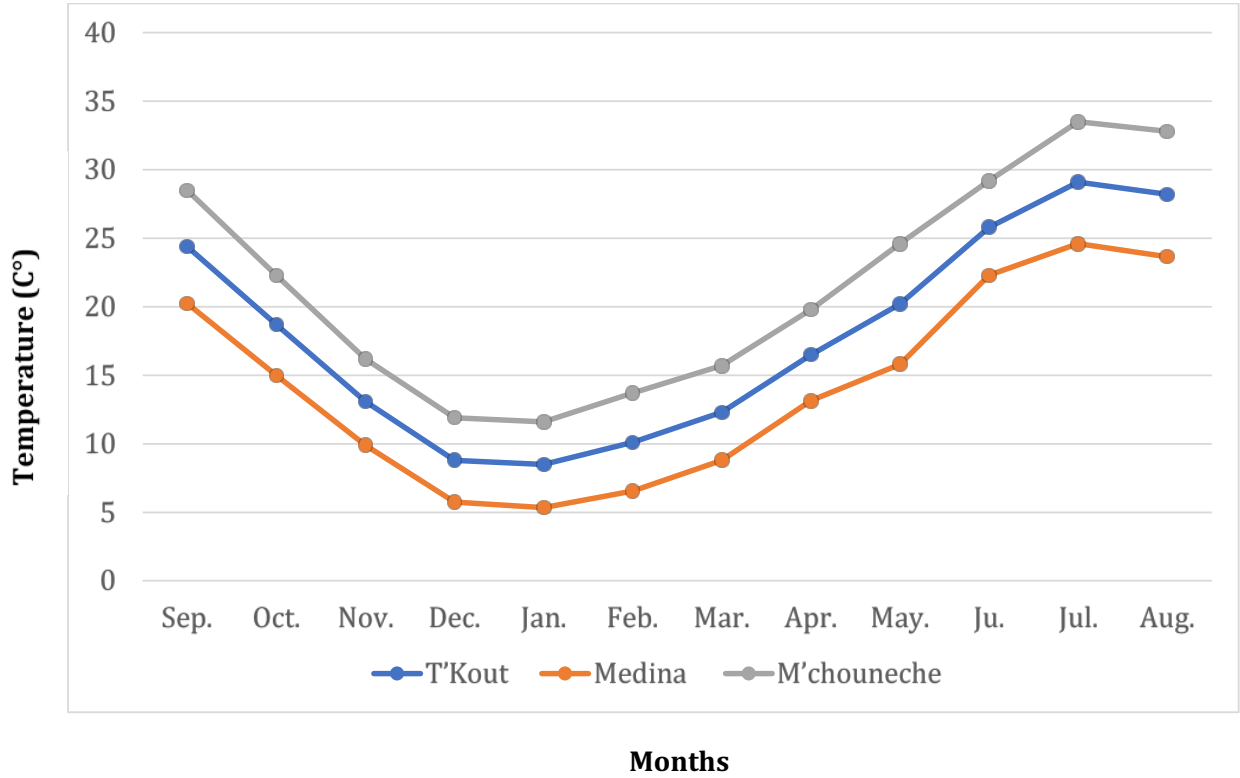



Diagram 6 - Monthly temperature oscillations in the valley of Wadi Abiod.

From the (Diagram 6) it appears that the coldest months are: December, January and February, with a minimum value in January with 5.35°C in Medina, 11.6°C in M'chouneche and 8.5°C in T'kout.

The hottest months are June, July, and August, with a maximum value in July with 24.6°C in Medina, 33.5°C in M'chouneche and 29.1°C in T'kout.

The application of the method of Gaussen and Bagnouls by the superposition of the data from both pluviometry and temperature, the following ombro-thermal diagrams for all of Medina, T'kout and M'chouneche were derived (Digram 7,8, and 9):

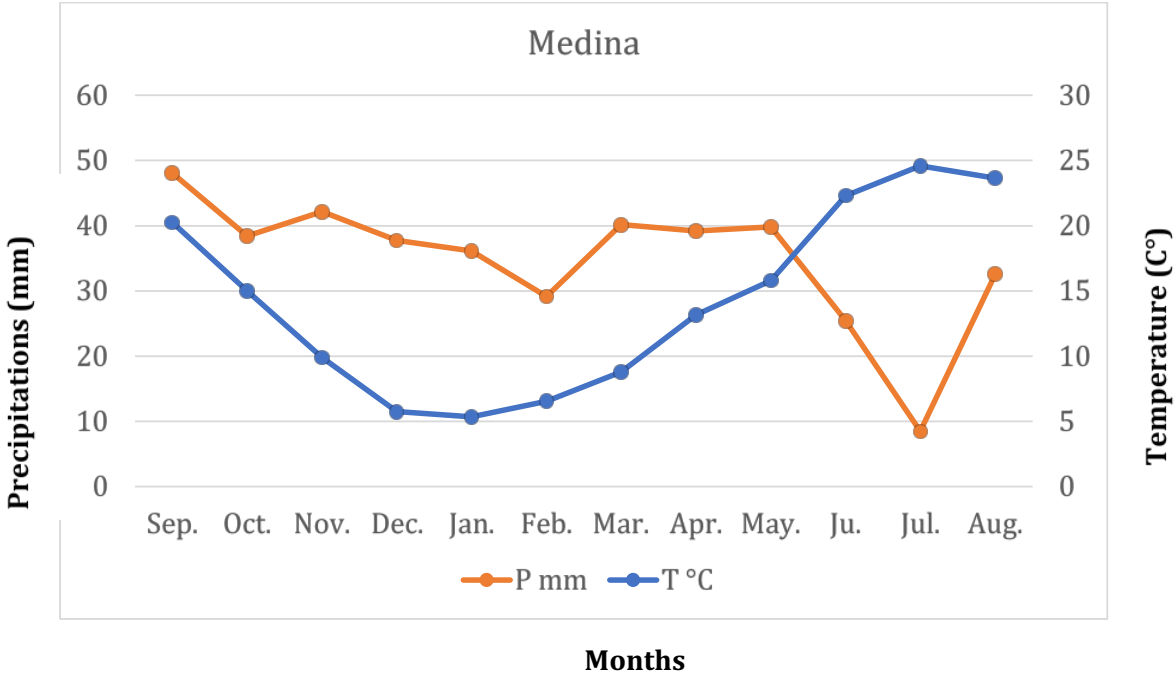



Diagram 7 - Ombro-thermal diagram for Medina (upstream the Wadi Abiod).

We note that the upstream region of the Wadi Abiod sub-basin (Medina station) is characterized by a wet period during the months of September to May while during the period from June to the end of August a dry climate prevails.

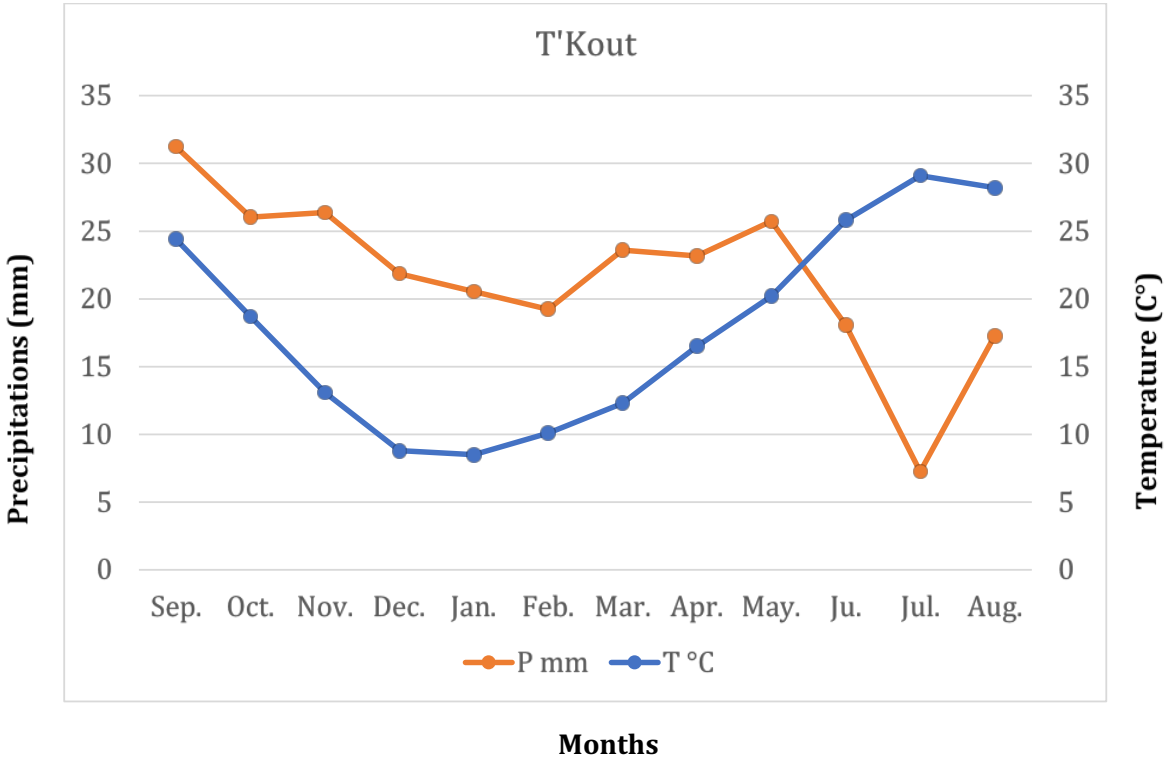



Diagram 8 - Ombro-thermal diagram for T'Kout (middle of the Wadi Abiod).

The climate in the central region (T'Kout station) is characterized by a dry period from June to September and a wet period from September to June.

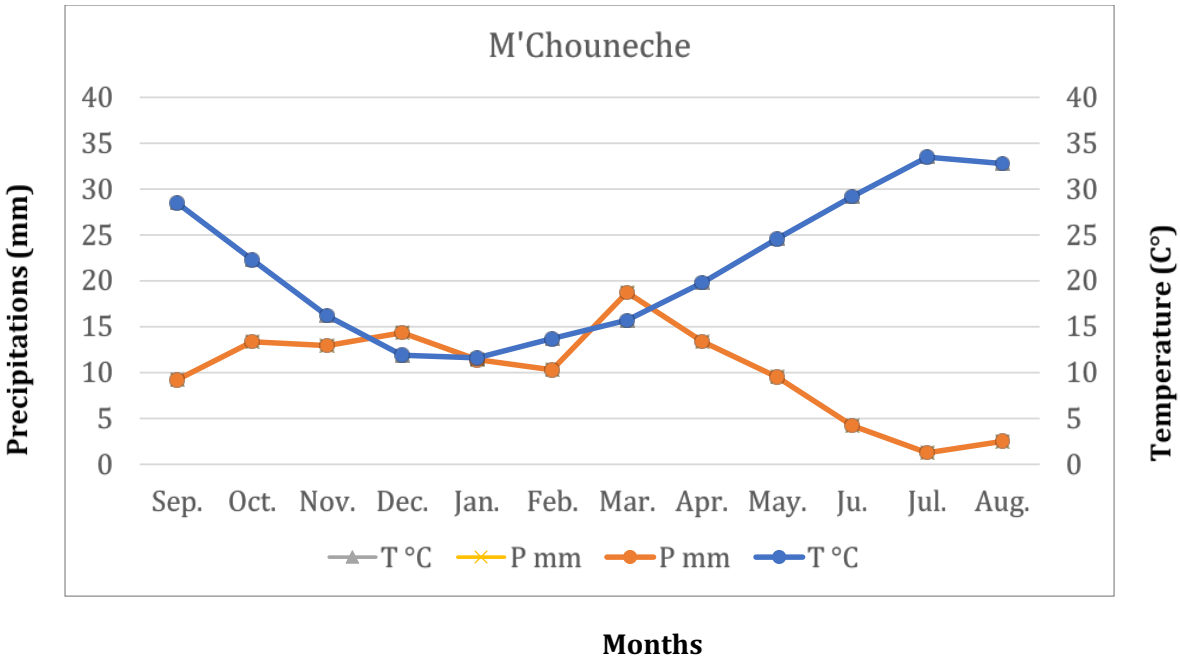



Diagram 9 - Ombro-thermal diagram for M'Chouneche (downstream of the Wadi Abiod).

In the downstream part of the sub-basin (M'Chouneche station), it appears that the climate is dry all year round

## *3.2 Archaeological Features*

To begin this section, a reminder of the main features of the Holocene in the area between 9500-2000 BP, based on multidisciplinary studies (Ballais 1991; Mulazzani et al. 2016; Roubet, Amara 2015) was performed in order to give a temporal context that will be correlated afterwards with the archaeological data. These studies have highlighted a series of at least four climatic episodes. A first one during the early Holocene, with a first significant arid phase (Gastropods dating gives 9500-6320 cal BP) marked by eolian sandy deposits (Ballais et al. 1979). The second record is marked by a humid Neolithic phase (6320 ± 120 cal BP) (Roubet 1979) of a slow and regular river flow and a Mediterranean vegetation. At the same time for the Eastern Chotts, the rise of their less saline waters could rise and approach the Aures foothills, also watered, making it difficult to go around the massifs (Aures). The third episode is marked by a dry phase starting from (4320 ± 120 cal BP) (Ballais

1979) where eolian deposits reappear accompanied with a mechanical weathering. Finally, a sub humid phase (2700 ± 120 cal BP) (Ballais 1979) marked this episode with a fine, brownish deposit on the slopes where it constitutes most of the silt in Wadi Abiod, followed by erosion of soils and emergence of tilbutaries due to anthropic activities. By the end of the accumulation of the terrace from the Neolithic period, the Roman age of the end of the accumulation can be established based on deposits containing shards of pottery from the Terra sigillata class, or come to fill an irrigation canal. In most cases, Roman structures, especially dams, are to be founded in the upper fine deposit and remain suspended above the current bed of the wadis (Ballais 1991).

It was the Roman colonization which, by developing agriculture and sheep and goat breeding for five centuries, that allowed the destruction of a forest made fragile by the post-Neolithic drying up (Ballais 1991). However, this does not exclude other phases of Eolian depositions in the last centuries (Barades 1949).

### *3.2.1 Typo-morphological model of the human occupation*

For the study of the territory I had to refer to the already processed models of orography and hydrography. Two main phases were depicted from the typo-morphological analysis: a first phase that corresponds to the main ridgeway which is that of Chelia Mtn. and which corresponds to prehistorical periods (Fig. 23); from this main route, two crest routes emerge, one on the chain of Takroumt Mtn. and Krouma Mtn. in the north-west and the other on the Ahmar Khadou Mtn. in the south-east. A second phase follows and which corresponds to the settlements, where there is an emergence of structures on the secondary crests, as well as, on high promontories and which are strictly connected with the source of water (the river Abiod) that is located at lower levels (Fig. 24).

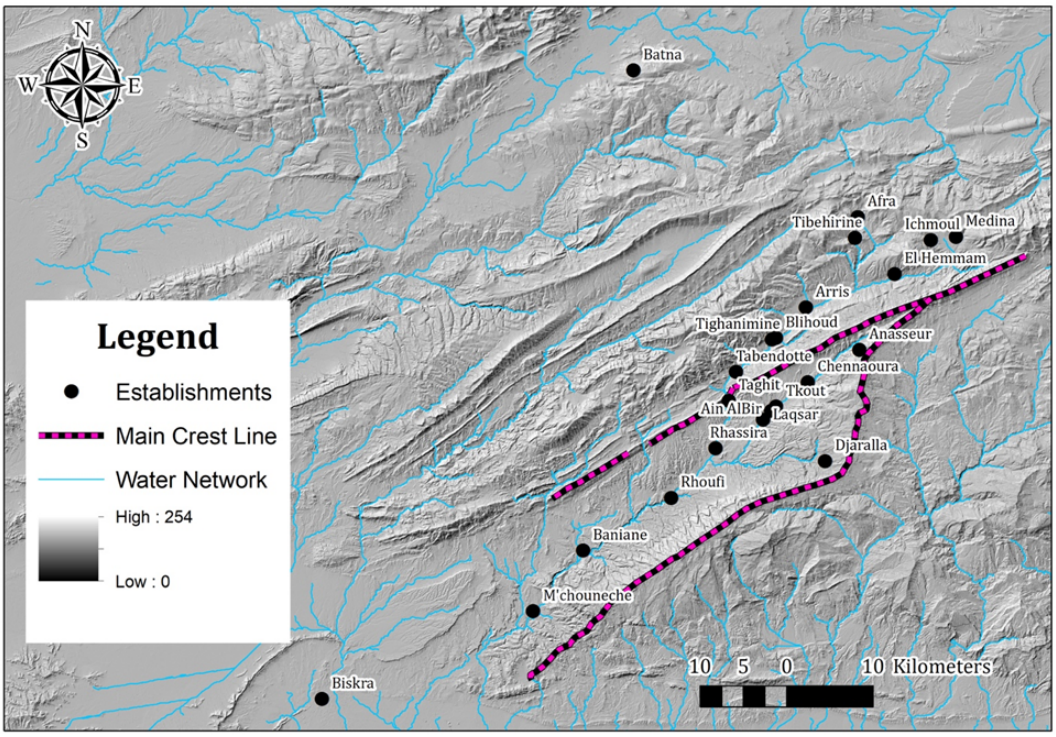



Fig. 23 - An oro-hydrographical map illustrating the main ridgeways (crest lines) of the studied area processed on QGis.

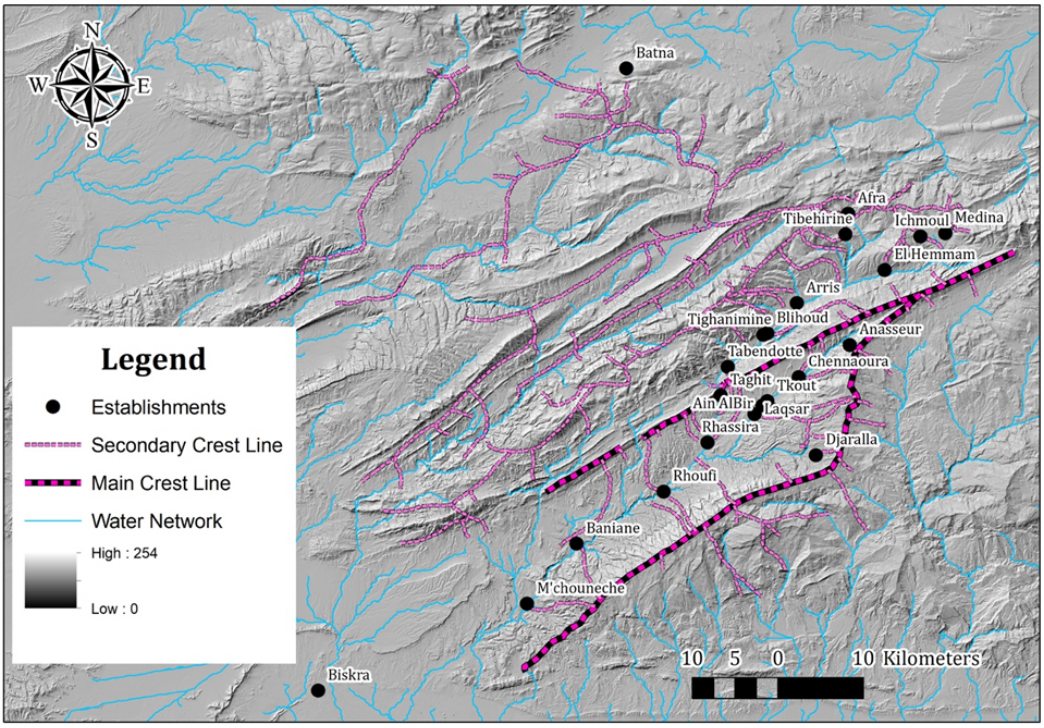



Fig. 24 - An oro-hydrographical map illustrating the secondary crest lines and the high promontories of the studied area processed on QGis.

### *3.2.2 Application of archaeological data and sources on the model*

The prehistorical period (9000-3000bc), which corresponds to the first phase based on the typo-morphological model, has been confirmed by overlapping the natural and anthropic layers for what it revealed concerning the distribution of patterns along the area: the data gathered, through field and bibliographical research, indicate an undifferentiated Epipaleolithic with abundant lamellae is more evenly distributed in the large valley. The Capsian was recognized in the vicinity of M'chouneche, but is much better represented in the north, in relation to the massive occupation of the High Plains by this culture. Whereas the Neolithic, outside the major site of Capeletti cave, remains poorly represented. The uninterrupted occupation of caves since this period does not facilitate prospecting and it is therefore difficult to draw any conclusions from the currently known distribution of the deposits. Their localization along and within the valley was represented in the following Fig. (Fig. 25).

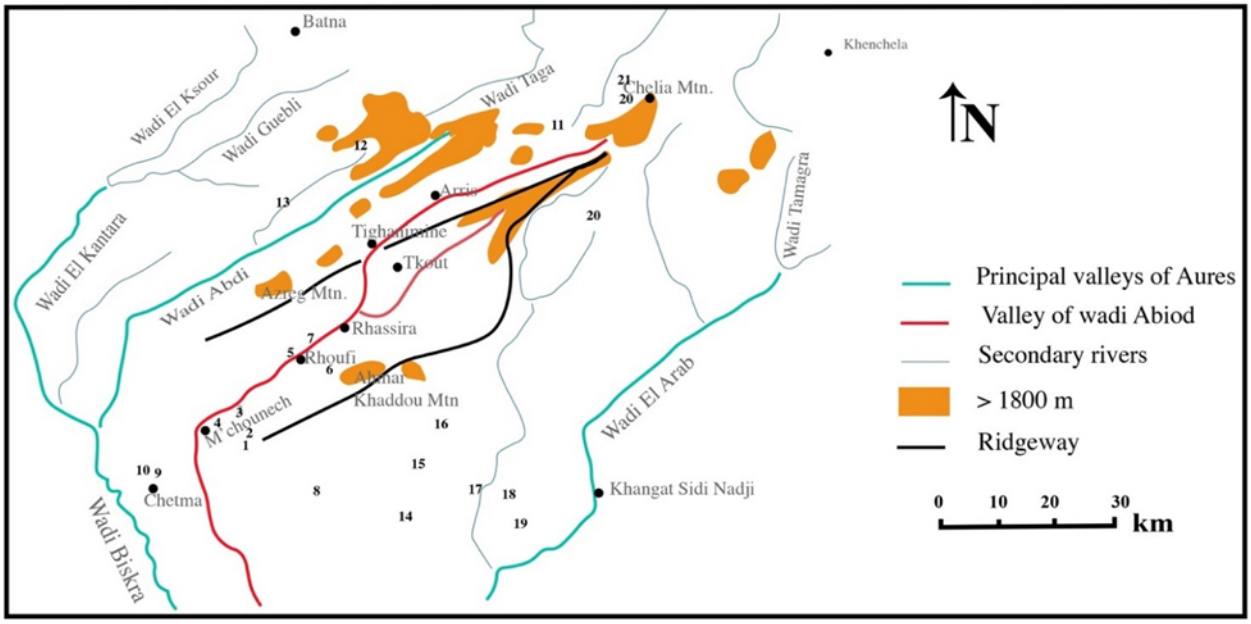



Fig. 25 - Prehistorical sites discovered within the valley of Wadi Abiod and its surroundings: Lamellae industry: 1; Epipaleolithic: 3,4, 9,11, 12,13,15,16,20,22; Capsian: 2,14,21; Neolithic: 8,19; Funeral monuments: 5,6, 7.

The investigation of the southern region of the Aures through a prospection along the Wadi has also revealed archaeological founds from which seven funeral monuments of a circular or elliptical aspect (Fig. 26) that could be assigned to the proto-historical period (around

3000BC), these monuments almost completely destroyed, can be quite easily confused with the Chouchet provided with a circle of stones at their base (Camps 1991). Nevertheless, the difficulty of doing a proper field survey due to the escarpments, and the constant occupation of the area constitute another reason for opting for geospatial analysis for a more thorough sediments and landforms analysis that could reveal new insights on past settlements and formation processes in the versant during that period.

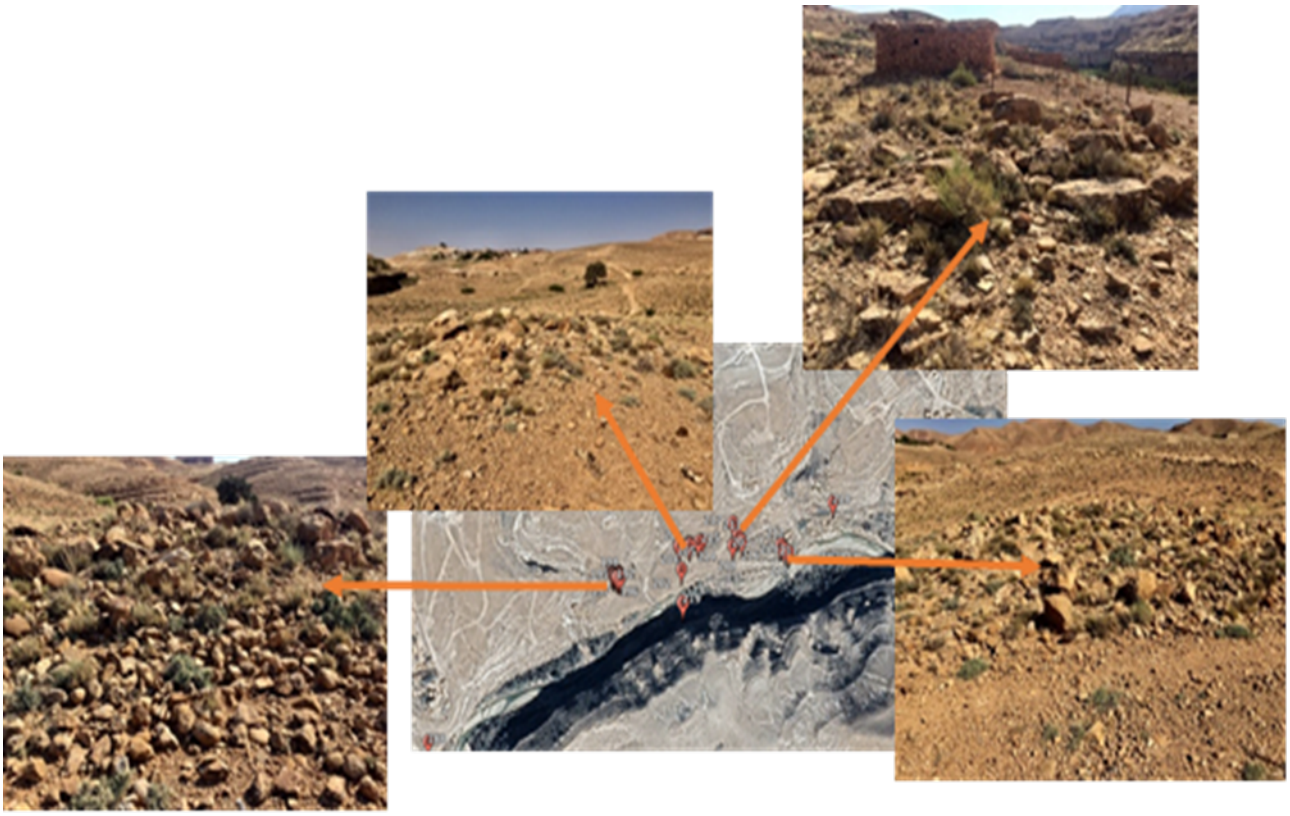


Fig. 26 - Funerary monuments with a circular frame discovered in the area.

From the study of the table of Peutinger (Fig. 27), epigraphy and bibliography, it was possible to draw that the Romans adopted a strategy based on the framing of the massif of the Aures by routes marked out by military settlements. Thus, from Theveste, a road was built along the northern foothills to Lambaesis, the final settlement of the Legio III Augusta. They applied the same formula on the southern foothills; from Ad Majores (near Negrine), a road went south from Vescera (Biskra) to Thabudeos (Tobna). During the reign of Hadrian, Gemellae (Kasbat) an important post, was established further south in 126 A.D, extending to Castellum Dimmidi (near Messaad) by the vexillations of Septimius Severus. Completing them with the longitudinal line that connected Thabunae to Lambaesis, these routes circumscribed the massif (Fig. 27) (Bouchareb 2011).


Fig. 27 - Table of Peutinger illustrating the Roman road network with a focus on the southern part of the Aures. (Source: https://omnesviae.org/fr/#TPPlace204).

Based on the map of Peutinger the valley of Wadi Abiod is not represented. The closest places that were identified were Biskra (antique Vescera or Ad Piscinam) and EL kantara (antique Calceus Herculis) (Fig. 27). That would stipulate that the road from Batna to Biskra has followed another track that does not pass by the valley of Wadi Abiod.

However, the valley under study did not escape the Roman interest. The presence of Latin commemorative inscriptions found in all of the sites of M'chouneche (CIL VIII 2485), Ichmoul

(CIL VIII 2445), and El Hammam (CIL VIII 2444), refer to Roman names of individuals who were exploiting the lands of those regions either for military or agricultural purposes. Raoul-Julien-François Delartigue (1904) attributes the last one to members of the Roman army from the Praetorian division who settled in that region and became its owners and defenders.

Philippe Maurizot (2008) has retrieved another inscription in the gorges of Tighanimine (CIL VIII 2446) related to hydraulic works where its emplacement is visible in the aerial photography (Fig. 28).

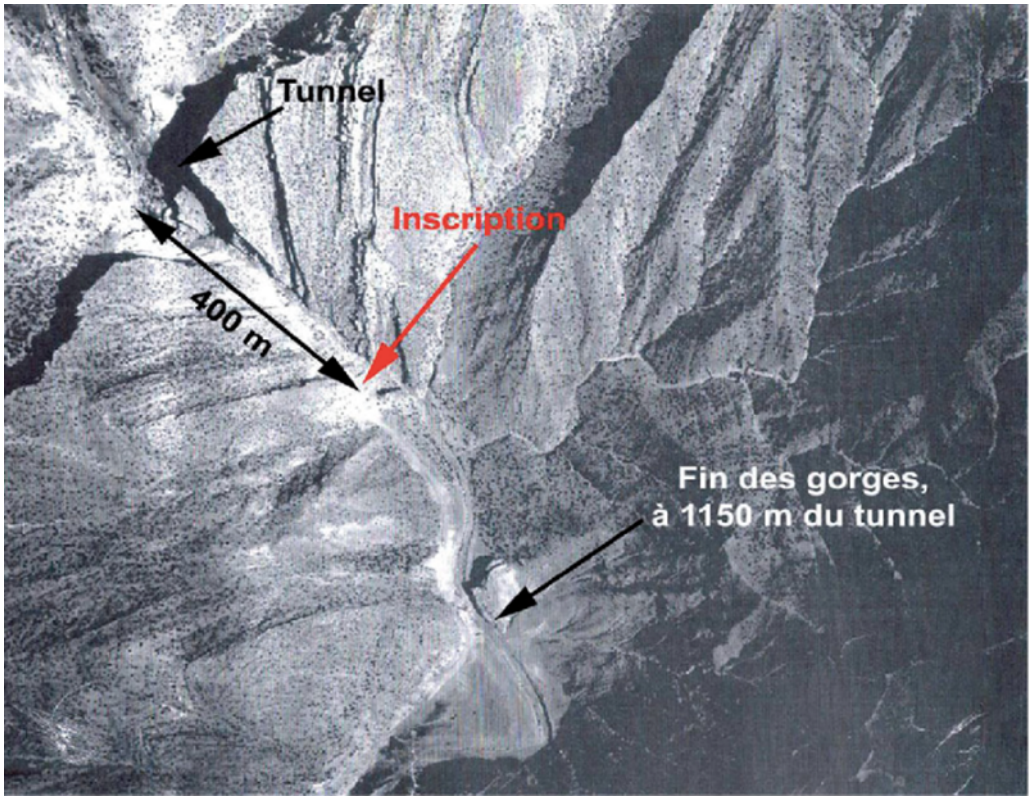



Fig. 28 - Aerial photography showing the emplacement of the inscription in the gorges of Tighanimine. (Source: P. Morizot, Comptes rendus des séances de l'Académie des Inscriptions et Belles-Lettres, 2008, p. 1620).

This inscription is placed on top of a water channel and is related to hydrological engineering.

Yet, probably the most famous of the Roman inscriptions remains the one engraved on a rock at the exit of the Tighanimine gorges, testifying the colossal work carried out by the legio VI Ferrata (CIL VIII 10230) in 145 (Fig. 7).

The text of the Latin inscription placed at the gorges is as the following:

**IMP(eratore). CAES(are) . T(ito). AELIO.**

**HADRIANO . ANTONINO**

**AVG(usto) . PI0 . P(atre). P(atriae). IIII . ET M(arco)**

**AVRELIO . CAESARI . II**

**CO(n)S(ulibus) . PER . PRASTINA(m)**

**MESSALINVM . LEG(atum)**

**AVG(usti) . PR(o) .PR(aetore) . VEXIL(latio) .**

**LEG(ionis) . VI . FERR(atae) . VIA(m)**

**FECIT.**

The inscription would translate to : Under the reign of the Emperor Caesar Titus Aelius Hadrianus Antonius Augustus Pius, Father of the Fatherland, Consul for the fourth time, and of Marcus Aurelius Caesar, consul for the second time, by order from Prastina Messalinus, Imperial Legate and pro-praetor, the vexillatio of the Sixth Legio Ferrata built this route.

Previous studies see it as just a work of development of the passage in the gorges, nevertheless, it is possible that these efforts had concerned the layout of an entire routes network.

Furthermore, to verify this hypothesis and based on the typo-morphological model, during prospection, the presence of Roman elements along the high promontories and on the secondary crests has extended geographically without exception in all the valley of Wadi Abiod, even at the most remote sites. The amount of founds was abundant (see annex 2) and some of them were exemplified in (Fig. 29).

In fact, during the second to the middle of the third century A.D., mountainous areas and their inhabitants became the focus of Roman exploitative policy (Benabou 1976) due to the expansion of the population that was in need of new lands especially under the reign of the Severans who paid attention to the rural areas (Bouchareb 2011). These circumstances made Romans realize the importance of these mountains that offered lands and a human potential (Bouchareb 2011) and encouraged the inhabitants to settle in and invest in agriculture (an example is illustrated in Fig. 30).


Fig. 29 - Repartition of Roman founds in the valley of Wadi Abiod.

Fig. 30 - Graded agriculture in the Anasseur region within the valley of Wadi Abiod.

Regarding ancient roads, previous archaeological research has not given sufficient evidence to form a clear idea on this matter except the already mentioned inscription of the crossing of Tighanimine. That may be due to their disappearance over time, or that these roads were made following the natural landforms of the region.

Nevertheless, traces of a Roman route at Jaralla (Fig. 31) were discovered during prospection.


Fig. 31 - Traces of a Roman road in Jaralla, within the valley of Wadi Abiod.

Therefore, to form an idea about the ancient viability's potential in the valley, the sites in which the Roman founds were discovered are reported on a hillshade along with a channel network and landforms maps (with the use of Latin toponomy to facilitate the lecture) (Fig. 32, 33 and 34) to better understand the features that could have influenced the Roman penetration in the valley.

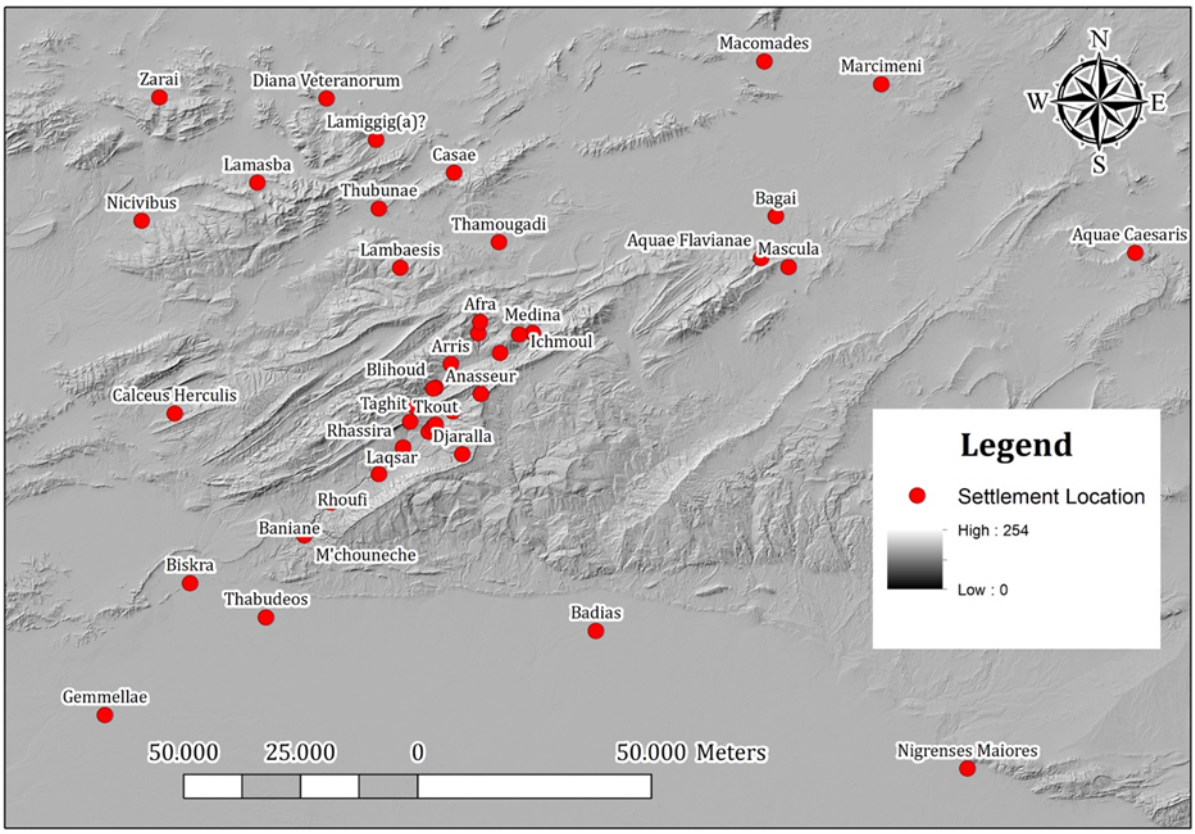



Fig. 32 - Hillshade of the study area showing the emplacement of archaeological founds, from the Roman period, along the valley of Wadi abiod inserted within the red rectangle. Courtesy of the U.S., 2009. Africa Land Surface Forms. Available online: rmgsc.cr.usgs.gov - /outgoing/ecosystems/AfricaData/ .

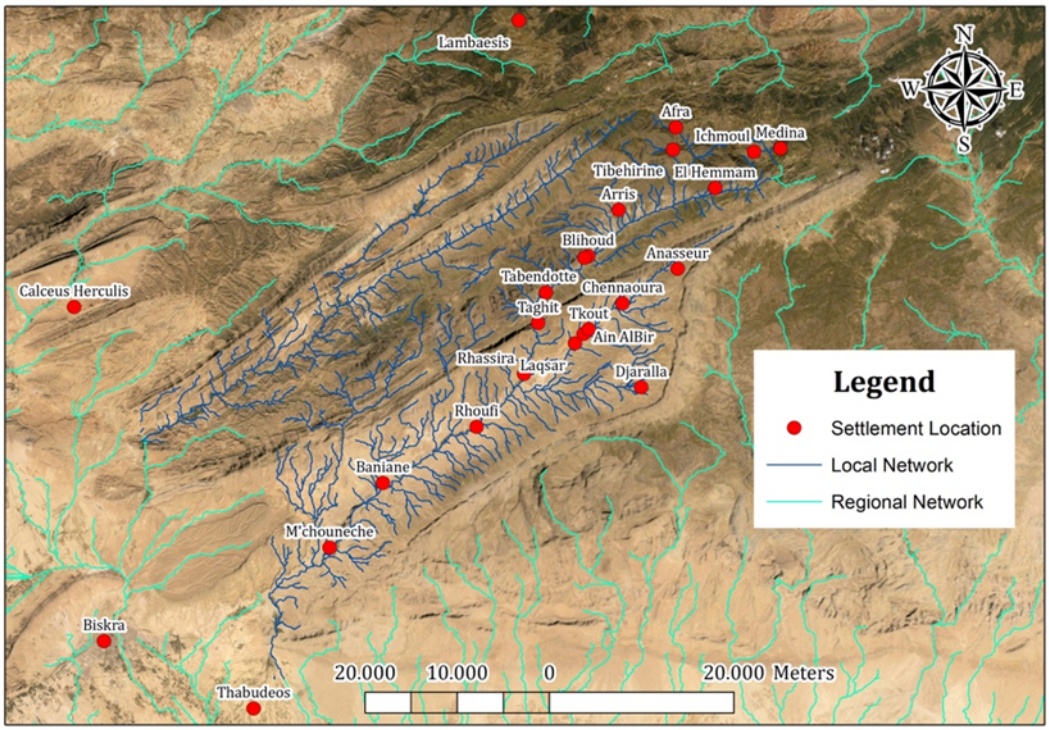



Fig. 33 - Channel network map with a focus on the regional scale of the valley of Wadi Abiod processed on Qgis.

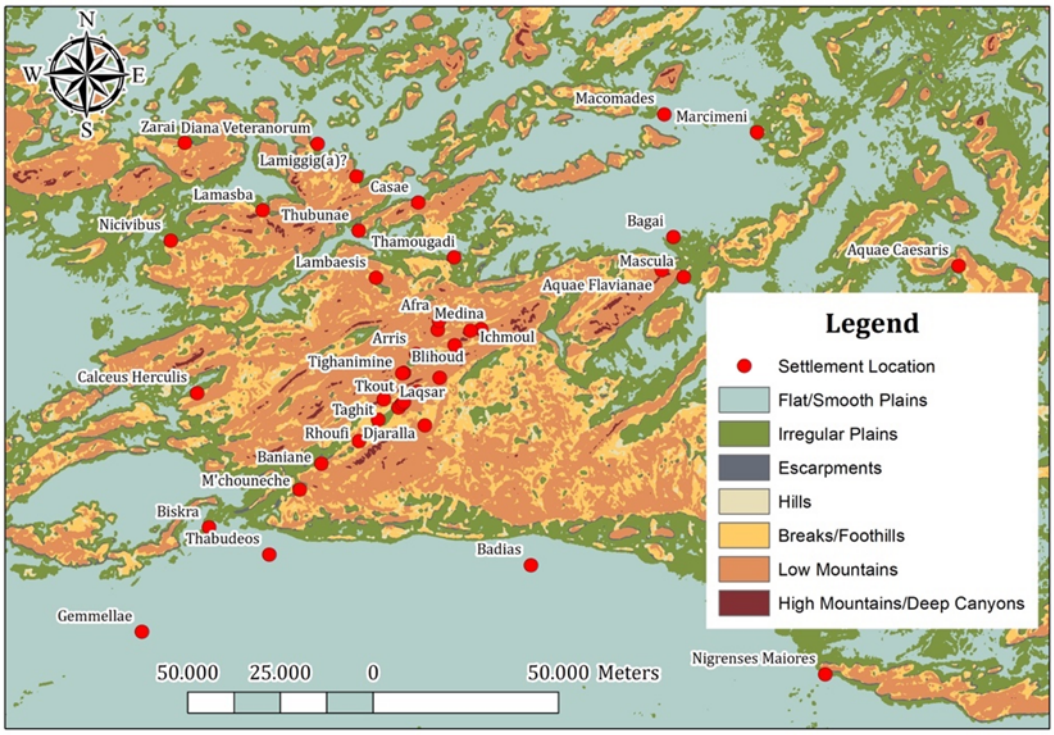



Fig. 34 - Landforms map processed on QGis, courtesy of the U.S., 2009. Africa Land Surface Forms. Available online: rmgsc.cr.usgs.gov - /outgoing/ecosystems/AfricaData/.

## *3.3 Formation of the Actual Landscape and its Legacy Data*

Based on the typo-morphological model, the high promontories are the place where the first human establishments emerge: each one of these establishments are connected with the neighboring ones, by no longer passing over the secondary crest to join the adjacent promontory, but more directly, by passing junctions and keeping to the level of the sources.

The actual landscape is the result of the passage of these human establishments to the urban establishment, and which is called the proto-urban nucleus. Indeed, the need for exchange between high promontories settlements has given rise to the local counter-crest route at the level of water source, to avoid passing through the secondary crest route.

In this phase, the establishment of the marketplace, generally next to the water source, is the place of exchange for the establishments of the upper promontory, this is visible in Arris.

These establishments are connected to each other thanks to the continuous counter-crest route.

Another phase follows and which concerns the global occupation of the territory: “A phase of anthropic possession of a territory can be assumed as the hierarchization of pre-existing settlements, in order to realize a system of locations, exchange and manufacturing nuclei constituted by proto-urban and urban nuclei, starting from the "market" nuclei up to the current metropolises” Gianfranco Caniggia (2018). This is to say that the urban centers that emerge constitute the principal points of exchange inside the territorial unit, these last ones are connected together by the synthetic counter-crest course (i.e Batna and Biskra).

The following picture (Fig. 35) best illustrates what was previously said for the formation of the landscape starting from the main crest routes until the complete anthropisation of the landscape.

From this, an operation of documenting and reconstructing the historical establishments and their features was performed along the valley and reported in (annexes 1 and 3): dozens of villages are characterized by a polarized structure that, from the edge and walls of the canyon, in its oldest parts, is positioned on the terraces of the border. During the last century, the

villages expanded with episodes of urban division very pronounced until the road connecting the cities of Batna and Biskra in the Algerian Atlas.

The historic built heritage, perfectly integrated with the natural characteristics of the site, constitutes an exceptional landscape value and consists mainly of stone houses with types of structured elementary cells with courtyards, adjoining gardens and terraces for drying products.

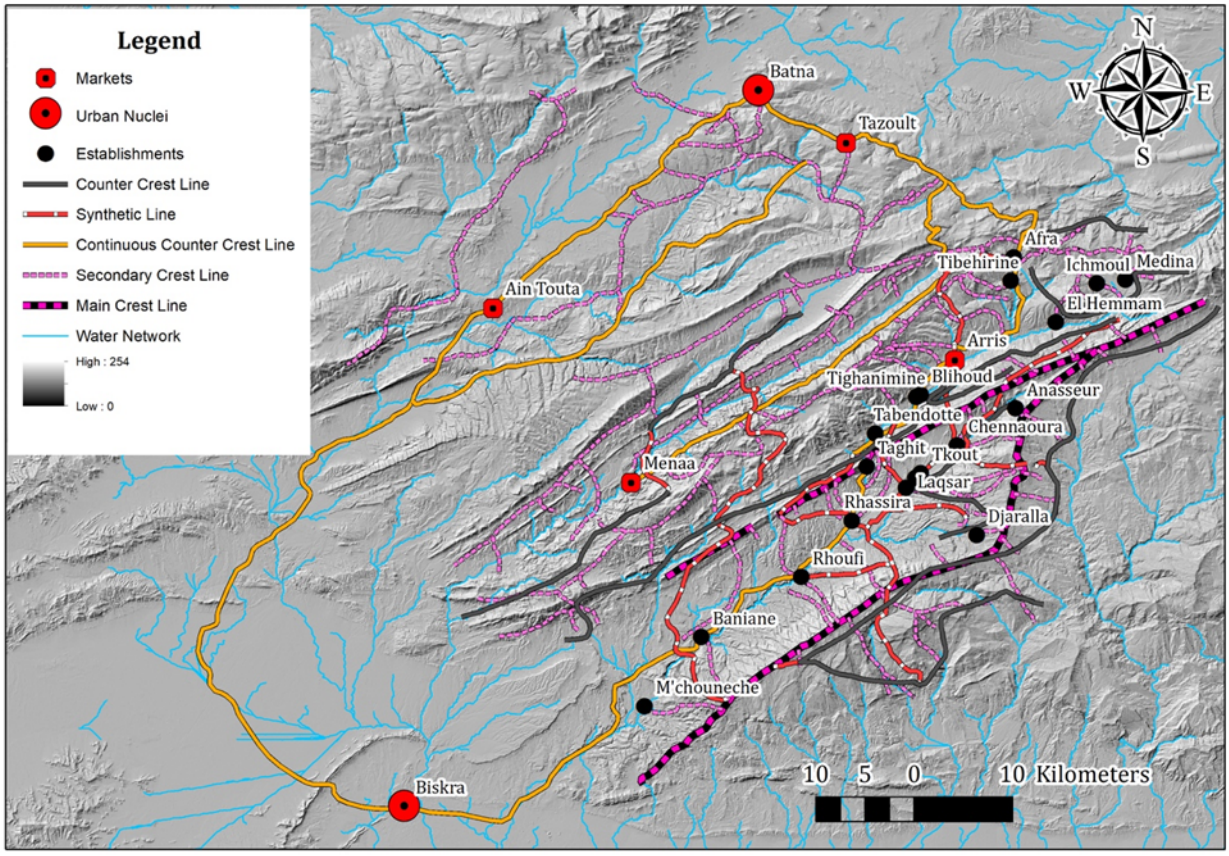



Fig. 35 - An oro-hydrography map representing the formation of the landscape in the valley of Wadi Abiod processed on Qgis.

# 4. DISCUSSION

The Aures, this block of approximately 11000 km$^2$ (according to the schematic section dressed by Philippe Thiriez in 1986), is a point of contact between two atmospheric poles (Atlasic and Saharan zones). It appears in its general form as a single mountainous mass, as a natural fortress that cannot be penetrated and which is extremely compartmentalized cut by long deep and roughly parallel valleys, oriented north-east / south-west. Even if there are a few flat interior spaces; very quickly are the valleys incised, the basins closed, the wadis cut into the crests in gorges. In former times, the massif shielded itself for its safety, but nowadays it presents obstacles to modern traffic due to its high peaks, the severity of its slopes, and the narrowing of its paths trapped between deep refractive grooves.

The geomorphology, presents massive parts where the highest peaks exceed 1700m (El Mahmel, Ichmoul, Aïdel, Chelia, Lazreg, Ahmar Khaddou) delimited by a Saharan platform and high plains: The region is affected by fault-related tectonic activity with dominant features of the tectonics are south-west/north-east oriented and the relief is sufficiently evolved so that its main lines, valleys and consequently ridges, are also oriented in the same direction. However, on one hand the adaptation of the forms to tectonics is far from complete, and superimposed water gaps (such as in Tighanimine) remain numerous. On the other hand, the north-west/south-east tectonic accident along with the west-east one complicates the overall landforms design. In fact, this last one meets to the north and the south: in the north it creates on the ledge a succession of parallel ridges and plains where the ridges are cut by perpendicular gorges, and further inland, an overall rise especially from the Mahmel to the Chelia, interferes with the south-west/north-east folds and carries almost all the regions of the massif higher than 1800m, while in the south, one can also distinguish a quite west-east alignment at the edge, and between this alignment and the sinuous Ahmar Khaddou - Arhane ridge, a very confused massif of forms, separated from the northern ridge by a long continuous plain.

Consequently, the topographic contrasts in the Aures is manifested by a double opposition, The east-west opposition and the north-south opposition (Ballais 1982).

From this arrangement results a consequent composition of geographical sub-groups, but the fundamental distinction must be here, as in the border regions, between the north and the

south, with really different climates. The North is a country with a harsh climate, with severe winters, with forests of either holm, oaks, and junipers or Aleppo pines, with crops that enable livestock to be reared in fallow land (see annex 2) because of the few meadows, and with plantations of fruit trees (walnut and apricot). The south is semi-desert, sometimes even much more desert-like than the neighboring Saharan plains, with dominant reg soil and palm oases. The boundary between these regions, which is far from being straight, passes roughly south of the Metlili, then goes roughly north-south, with zigzags from the vicinity of Maafa, to Jebel Tafrount, pushing a point to the north east, in the broad synclinal cradle of Rhassira and after the meridian of Baniane, it heads again from west to east, splitting the confused massif in two from the southeast, up to the crests of the right bank of the Wadi el Arab which it follows from southwest to northeast. But, on either side of this theoretical line, there are fairly wide transitions, so that by combining the nuances of climate and relief, one can assume that on either side of this axis, the backbone of the central Aures, two important valleys develop, from which being: the valley of  Wadi Abiod and of Wadi Abdi.

In the transitional region with the High Plateaus, Wadi Abiod valley, is located just north of the southern Atlasic Fault. It belongs to the large hydrological basin of Chott Melghir, and is formed by the union of torrents descending from the steep slopes of the highest point in the Aures. It waters the plains of Medina and communicates with the interior of the country through a secondary valley through the gorges of Tighanimine (Fig. 36). After crossing Tighanimine gorges, it crashes in the canyons of Rhoufi (Fig. 37) and the gorges of M'chouneche (Fig. 38), then opens a path towards the Saharan plain to the gorges of Foum el Gherza (Fig. 39).

Fig. 36 - Gorges of Tighanimine in the valley of Wadi Abiod.

Fig. 37 - Gorges of Rhoufi in the valley of Wadi Abiod.

Fig. 38 - Gorges of M'Chouneche in the valley of Wadi Abiod.

Fig. 39 - Foum El Gherza gorges by the end of the valley of Wadi Abiod.

The north-south oppositions of the valley exhibit variations in altitude and latitude. In fact, the northern piedmont, is dominated, abruptly, proudly, by the highest peak of the Aures, while on the southern piedmont, the peak is only about 122 m.a.s.l. at Biskra. This variation makes the slopes very contrasted, the northern slope, joining a Mediterranean climate, and the southern slope, with a Saharan climate. This topography will create a particular situation

for the valley, since its corridor will receive the climatic influences of the two foothills, and combine to this its own topography, in particular the sudden drop in altitude from upstream to downstream, as for the rest of the massif.

It is in these places that developed humans establishments in perfect symbiosis with their environment along the valley of Wadi Abiod and over a length of approximately eighty five kilometers, three landscapes follow one another, overlapping at their limits, but creating three totally different situations, as much at the vegetal level as at the mineral level. The extreme zones are related to the northern and southern foothills with, in each case, an inherent bioclimate: cold, temperate, and warm. This is what induced the perpetual movement of groups following a seasonal nomadism visible today.

The climatic regime is marked by two main characteristics relative to the altitude which also exerts an influence on the natural and anthropic activities. From September to May, the season is cold and rainy, which makes the valley in its northern part a relatively humid region. In the summer, however, the heat is overwhelming.

The mountain acts as a barrier, which causes precipitation and feeds powerful wadis since it is calcareous. Therefore, the South, which receives very little rainfall, is supplied with water by its rivers causing powerful floods during the wet season, which bring fertile alluvium. They do not dry up completely during the dry season.

The region can be divided into three bands, from north to south: The high regions in the north are of agriculture and livestock. Cereals are cultivated, arboriculture, gardening, and livestock farming, especially sheep and goats. In the center, crops are grown on terraces along the valley. The heat associated with the water makes this rather poor soil fertile. Finally, in the South, the climate is very dry. But the wadis that come down from the mountain allow the existence of large oases and gardening.

The climate is an essential element and regulator of anthropic dynamics, since it determines along with the pedology all the internal migrations of populations through the valley. It also involves transhumance, since the soil never freezes because the temperature during winter is 10 to 20 degrees.

Today's climatic tiering determines natural areas with extremely diverse agricultural potentialities. Therefore, it is possible to schematize three major natural areas,

corresponding to three modes of organization of agricultural activities, with precise repercussions on the mode of spatial organization (see annex 2):

- The upper valley:

This part starts from the southern side of Mount Chelia from the Wadi takes its source and ends at gorges of Tighanimine. It includes several urban areas, in each one of them there is one or more ancient archaeological sites in Medina, Afra, Ichmoul, Arris, Belihoud, Tebandout and Tighanimine. this area is characterized by a high altitude (2000 m – 1500m).

The historical or traditional habitat is located at the junction of the foothills of the mountains. The importance of this location lies in the fact that it places the shepherds 'homes close to the side to the upper pasture lands that are at the top of the mountains, and on the other hand they oversee their farms and orchards that spread at the bottom of the villages.

It is an area of mountain culture and pastoralism. The plots are mainly cereal farms and orchards, in addition to walnut trees.

- The middle valley:

This part begins on the southern side of the Tighanimine crossing, and ends at south Rhassira. It extends towards the east to include T'kout basin, Anasseur, and Jaralla. It is more steep and forms several meanders. The wadi, further downstream, crosses, sometimes in deep gorge, in the form of faults in the high mountains. It is an area with diverse archaeological founds and the historical habitat is always grouped together overlooking orchards composed of a range of fruit trees.

- The lower valley: a zone that integrates both the mineral and the vegetal

This side starts from Rhoufi and ends in M'chouneche, which is characterized by its flood and frequently eroded soils. Confined between Al-Azraq Mtn. from the west and Ahmar Khaddou Mtn. from the east, it opens towards the southwest and crosses the middle of the Wadi Abiod Valley.

The course of the valley has several oases, the most important of which are Rhoufi, Banian, El-Habel and M'Chouneche. The agglomerations, completely folded up at the bottom of the wadi, grouped together, are characterized by a stronger integration to the vegetal tissue.

The landscape of the overall valley is bordered on its length by rectilinear crests, which are profiled in a chain that is difficult to cross. The contact and relations between this valley and the neighboring ones are practically non-existent. Therefore, the valley offers the only set of reference to the population's groups concerned.

The understanding of the evolution of this natural and cultural landscape (long been considered deprived of anthropic dynamic) was made possible by the application of spatial analysis tools and typo-morphological model. In fact, within the data presumably relating to the prehistorical period, there appear to be morphological differences in types of sites and settlement patterns.

The main ridgeways so far recognized are linked to cultural choices involving successful adaptation phenomena to local environmental diversity and Holocene climatic fluctuations, and suggests that the settlement was probably not a permanent one: in the early periods, humans in the region were mobile. Therefore, the settlement was not habitable, but more likely practical.

This river artery of the southern pre-Saharan territories of eastern Algeria, played a decisive role during the upper Pleistocene and Holocene. Tectonic activity transformed the landscape, giving an orientation to this river, which continues to feed the western chotts.

The Lower Pleistocene after the major tectonic phase, is characterized by an alternation of glacis and mudflows. The covered ablation glacis-fan changes locally into a glacis accumulation or fan. Mudflows of several kilometers long and several tens of meters are subsequently emplaced. The second glacis is generally an ablation glacis-fan covered by blocks and pebbles sometimes strongly consolidated by a calcareous cement. A second generation of mudflows is emplaced with the same characteristics as the first (Ballais 1984). During the middle Pleistocene, the glacis achieve their maximum prolongation. The accumulation forms (accumulation glacis in the Aures) begin to replace ablation forms (covered ablation glacis) (Ballais et al. 1985). In the Upper Pleistocene-Holocene, this trend becomes generalized (terrace, alluvial cone and spreading) (Coque, Gachelin 1975). Furthermore, the granulometry of the deposits, coarse in the lower and middle Pleistocene, become fine in the upper Pleistocene and predominantly fine in the Holocene.

Finally, this evolution highlights the existence of a fundamental climatic break at the end of the middle Pleistocene (Lacustrine phase) and other less important ones at the beginning of the lower Pleistocene and at the end of the upper Pleistocene (Ballais 1991).

From a hydrological point of view, the Wadi constitutes the water reservoir that aliments the adjacent plains: in its southern part it is distinguishable by its abundance in periods of rain and a total drought in the rest of the periods of the year, unlike its northern part which has an abundant level of water with a long flowing period due to the continuous precipitations. In addition to what was said, the valley has several springs, found in the form of headwaters flowing between the rocky layers of refractory facades and lower areas of the valley. These sources are characterized by the persistence of waterflow throughout the year (see annex 1).

The hydrographic network consists mainly of the Abiod Wadi and its tributaries, namely the Medina wadi in the north west and the Chennaoura and Tkout wadi in the north east. The Wadi is formed towards the southern foothills of the Ichmoul and Chelia massifs, by the confluence of several streams which flow parallel or perpendicular to the folds; this perpendicular path seems to be due to the numerous transverse accidents which affect the anticlines of the region (Hamel 2009).

The wadi Abiod becomes permanent with a more consistent flow from the Tighanimine gorges, it flows from north east to south west through Rhassira, Rhoufi, M'chouneche and Droh. After Droh, it enters the periclinical termination of the anticline of Ahmar Khaddou Mtn. which it begins in a deep gorge that opens into the Saharan plain at Foum El Gherza which is its natural outlet (Hamel 2009).

It is one of the most representative rivers in the region with a relief characterized by imposing mountains broken by fault systems of different directions, either parallel to the relief axis or transversal, giving rise to an intense hydrographic network.

This waterway has remained a traffic route linking the foothills and valleys of the South Atlas Mountains to the southern grassy plains. It has facilitated and directed the movements of men and fauna towards the interior and exterior of the massif of the Aures. The archaeological evidence that has been recovered from previous studies and from the field consist of visible surviving and recorded materials (Lithic industry, Sepultures) with an important prehistoric variability. The prehistoric sites are located downstream and, on the mountains, a long-term trend, with special emphases on preferred locations becomes comprehensive with the

climate fluctuations. The culturally identified context show that these displacements date back to the end of the Lower Pleistocene (Acheulian), and that they continued to vivify these territories during the Holocene. Thanks to dated settlements, a strong anthropic presence was noted during the Holocene phases. The presence of abundant and varied lithic testimonies that these societies have left are excellent indirect evidences of varied and abundant local resources. Finally, we underline the paucity of our knowledge of the periods after the 2nd millennium BC. This period is relative to the development of high promontories and the settlement of man: the presence of numerous funerary monuments bears witness to human presence, but the traces of their daily life and those of their chosen camps remain to be discovered in order to confirm a continuity of occupation during protohistoric times.

Whereas for the historic times, the Roman political growth as empire could not have been achieved without a skillful maneuver system. The linear arrangements for the control of an entire massif mark a need for militarization linked to circumstances of a progressive tightening of the Roman Empire's border relations or to unrest in mountainous areas within the empire that were more difficult to control. But there may be zonal filtering rather than actual barrier (Acolat 2007).

Therefore, the reconstruction of ancient roads system is important for the investigation of the Roman mobility and control of a given territory that could be driven by past economic, social, political and military factors (Carreras, De Soto 2013). These networks that are often related to the morphology of a given territory were strongly influenced by geomorphological and topographical attributes such as spatial extensions of watercourses, drainage networks, and slope profiles.

At the beginning of the second century, the Romans entered the foot of the Aures mountains, and this occurred in many phases. Throughout these periods, many changes and additions have taken place in the North African landscape.

There is not enough evidence to tell us about the state of the Aures and its residents during the first century, but it appears that it was the same as long as the expansion of the Roman occupation had not yet attained the slopes of the Aures mountains. All these hypotheses put forward by contemporary historians are likely to be considered insufficient. However, it should be pointed out that too often the lack of precision and confusion complicates the reading of the data: this is the case of the local people who practiced transhumance and who

were attributed to either Gaetuli or Musulam tribes. It should also be remembered that these tribes when their customary law was disrupted, the revolt was quickly adopted. This fact reveals not only the attachment of these tribes to their freedom but also to their land (Bouchareb 2011). The Roman progression took place in a total groping process, ignoring the tribal mentality. In fact, during the reign of Tiberius, the presence of the Legio III Augusta in the region was accompanied by the reduction of the tribes' grazing lands and rangelands. The conflict ended with the redistribution of land on both sides. However, the Romans, probably understood the vital importance of the grazing lands for the transhumant populations and this consecrated relationship to territoriality was also well thought out afterwards.

Consequently, the Romans adopted a strategy based on the framing of this massif by routes marked out by military settlements (Fig. 40).

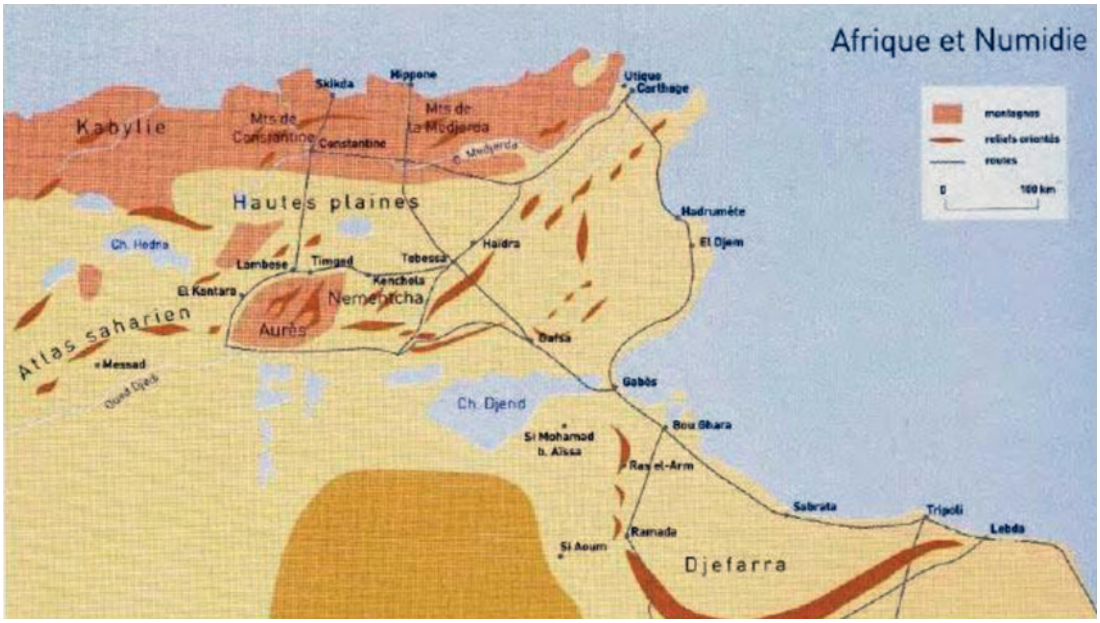



Fig. 40 - Map of the defensive system of North Africa surrounding the massif of the Aures. (Source: Le Bohec, 2001. inhttps://www.cairn.info/revue-strategique-2007-1-page-9.htm#no83).

Regarding ancient roads in the valley, and as mentioned before, archaeological research based on the analysis of bibliographic, archival, literary, archaeological, and historical sources has not given us sufficient evidence to form a clear idea on this matter except the inscription of the crossing of Tighanimine that stipulates a road's project on that spot and traces of a road at Jaralla during the prospection. That may be due to their disappearance over time, or that these roads were made following the natural landforms of the region.

However, Jean Baradez (1949) and Morizot (1941) believe that the Romans have followed the pre-existing traditional paths alongside the valley. Besides, this interpretation does not apply to all sites because there are many ancient archaeological sites in high areas such as the sites of Jaralla and Anasseur.

Consequently, to infer the Roman road path, which is quite different from previous hypotheses, analysis based on the detailed mapping of lithological and geomorphological features of the study area suggest that the choice of the road path has been driven by the outcrop of some deposits and the presence of specific geomorphological landforms, such as high- low relief areas in this mountainous landscape. In fact, the nature, frame and situation of the terrain condition the efficiency of the tactical patterns and determine success or failure. A hilly area amplifies the difficulty of advancement, but it can also become an entrenchment, a monitoring site, a cover-up of manoeuvres, or a strong point (Pedech 1964).

In effect, looking closely to the emplacement of the rock cut inscription that was found in the gorges of Tighanimine, that is situated south the crossing, two probabilities would rise: if the road's project was completed, this would mean that the Roman army started its work from the north, and in the case that it wasn't, this would mean that the project started from the south, and therefore the inscription was made before the completion of the project.

Hypothesizing that the work has started from the southern side would be compatible with the military camps that are spread all along the southern part of the Aures such as the camp established before 126 in Gemellae, thus the necessity of linking these camps in short ways to the northern camps in the Aures, perhaps the first of which was through the Wadi Abiod. This also would mean that they settled in Rhassira and considered the completion of the short road's distance through the crossing of Tighanimine to the northern cities of the Aures. Perhaps, they might have stopped due to the natural difficulties they have encountered, considering the narrowing of the crossing, the depth of the valley and the severity of its slope, and only settled an inscription perpetuating their project without completing it. Consequently, their arrival in the Aures was a precedent for the completion of the road, and they depended in their movements on following other routes that were previously used by the local population.

In Jaralla instead, the road was completed in a form of a solid and continuous gravel streak. This road departs from Lower Jaralla through the middle of the upper site, then proceeds to

the east and possibly towards Anasseur, with a width of 2.5 meters. The characteristics of this road is coherent with the theoretical conditions for the completion of the roman roads according to Pierre Salama (Salama 1951): the Romans are forced to follow routes across heights instead of depressions in areas of insecurity in order to supervise the adjacent suburbs surrounding the region so that the enemy can't perceive or restrict them. Albert Grenier states also that Roman engineers were always avoiding the slopes, canals of valleys and depressions, and areas with severe inclination (Grenier 1985). The theory of these two researchers is very consistent with the characteristics of Jaralla's site.

Based on the overall data, an attempt was made to re-construct this road networks along the valley of Wadi Abiod, with the possibile Roman path that goes from Jaralla, crossing the site of the Anasseur, mount Al-Hara to Medina, then to Tkout, and from it to Rhassira that is connected to the south with M'chouneche (Fig. 41).

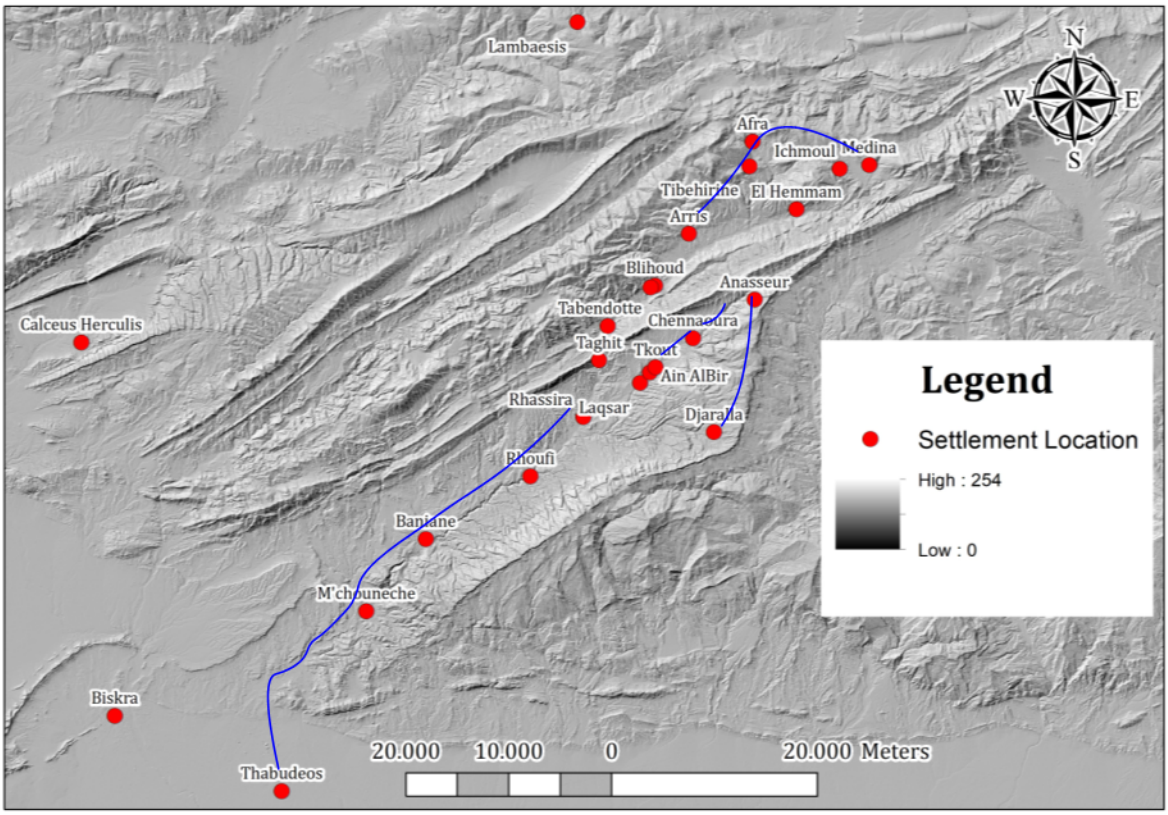



Fig. 41 - Map illustrating the reconstruction of the Roman road paths along the valley of Wadi Abiod (in dashed blue lines).

Geological and geomorphological analysis of the archaeologically reconstructed road path and surrounding, that were applied to infer the possible influence of possible dualism factors in the road planning, such as local lithological, morphological, and hydrological features concorded with that hypothesis. Therefore, all these factors have been analyzed in the complex geoarchaeological setting of the valley, where archaeologists do not suggest any road paths.

Nevertheless, the presence of archaeological sites means that there are communicating roads in which we find relay points, provided with towers to guard them, and which are established around 60 km of distance equivalent to a daily journey of a horse ride.

This interpretation is consistent with Baradez' suggestion, who considers them to be part of the annexes of this road as long as it is next to it. He also mentioned that M'chouneche had an ancient tower set up to monitor the human movement that was traveling its way, in addition to the sites of Rhassira, Arris, and Medina that were annexed to a principal Roman road.

Per consequence, the Aures remained in the margin of the interest of the Roman occupation, long considered as a poor land. However this didn't last for long as from the second century Rome began its expansion's project in the Aures by military operations that were represented in the construction of roads, from which we count the road Lambaesis- Biskra through EL-Kantara, and thus, another across the course of Wadi Abiod that was provided with military centers for observation. It is what constitutes the beginning of its entry under the Roman rule. However, the presence of these roads is not sufficient proof to say that the Aures entered under direct Roman colonialism, since they may have been established in order to shorten the distance between the military camps and the Roman cities between the north and the south of the Aures.

The incorporation of geospatial technologies in archaeology has resulted in productive advances in the analysis of past behavioral processes. This integrated approach can help archaeology to understand and then discover ancient road paths crossing complex and impervious landscapes such as the intramountain lands. Using a series of GIS tools, a comparative analysis was conducted of the density and spatial distribution of sites dating to both prehistoric and historic periods, together with legacy data related to settlements collected by previous large-scale, intensive, site-oriented field surveys to test the validity of the typo-morphological model along with the physical attributes of the study area.

The synchronic and diachronic study of the evolution of the physiognomy of the settlements proved useful to support the reconstruction and the description of this landscape, being an object still difficult to apprehend, because of the many factors that intervene in its composition. Taking into account the idea that landscapes evolve over time and is always in motion, as a result of both natural forces and the action of human beings and form a whole in which natural and cultural elements are considered simultaneously.

Finally, the landscape has inherited the indelible marks, natural and anthropic, endogenous and exogenous, which testify the formation and transformation and development of the valley as an ecological potential that includes all the abiotic elements: the geological substratum, the morphology, the climate, the waters, etc., biological or biotic exploitation which includes plants and the soil, and anthropic action that interferes with the first two components. It is not only a question of the natural landscape, but of the total landscape integrating all the after-effects of anthropic action in the valley of Wadi Abiod.

# 5. CONCLUSIONS

The high spatial- and time-resolution study of the evolution of the physiognomy of the actual landscape proved useful to support its description, planning, and meta-design, and to improve the definition of the development policies and planning tools on the local scale. This landscape refers to a part of the territory as perceived by the locals, whose character results from the action of natural and/or human factors and their interrelationships. It is a changing and dynamic reality, inscribed in time as much as in space. It is constantly evolving and is constantly modified by the cultural imprints left by man, specific to each epoch.

The structuration and organization of all the historical, archaeological, environmental and climatic data allowed the analyses of the landscape of Wadi Abiod valley and to produce a long-term interpretation of it. Using a series of GIS tools, a comparative analysis of the density and spatial distribution of sites, along with the legacy settlement data collected by large-scale, intensive, site-oriented field surveys to complement the validity of the theoretical model was achieved.

The interdisciplinary comparison of archaeology and geology introduced new elements of analysis and could support archaeological analysis to understand underestimated aspects of the settlement. The following synthesis gives an account of the complexity of the system that unites societies with the environment they occupy:

The Aures Massif, morphologically, is made up of a succession, from east to west, of several valleys with a general northeast, southwest orientation. The wadi Abiod is one of the most representative rivers of the Aures. With a relief characterized by imposing mountains broken by fault systems with different directions, either parallel to the relief axis or transversal, giving rise to an intense hydrographic network, characterized by a sub-humid climate upstream and a semi-arid climate downstream.

This major river artery of the southern pre-Saharan territories of eastern Algeria, played a decisive role during the upper Pleistocene and Holocene. Tectonic activity transformed the landscape, giving an orientation to this river, which continues to feed the western chotts. This waterway has remained a traffic route linking the foothills and valleys of the South Atlas Mountains to the southern grassy plains. The combination of human activities and climate factors in Wadi Abiod had notable consequences for the distribution and dynamics of

communities and landscapes. This was visible within the data presumably relating to the prehistorical and proto-historical periods, where it appears to be morphological differences in types of sites and settlement patterns.

The knowledge of society- environment interactions remains approximate at the micro-regional scale of the valley of Wadi Abiod. However, the different ridgeways so far recognized from the priori analysis, are linked to cultural choices involving successful adaptation phenomena to local climatic and environmental diversity.

In fact, the climatic phase known as the big wet phase began around the eighth millennium BC. Human groups invaded the Atlas zones and reoccupied the Sahara. The different sites reveal a Neolithic culture. These nomadic men/hunters roamed the great arid expanses from East to West and from South to North. The agricultural activity seems random in an environment which knows drought. The lithic industry shows a maintenance of the Epipaleolithic. Then an arid phase followed, that favored the settlement of populations in more clement areas such as the Capsian populations who settled on the Algerian High Plains, the Constantine and Saharan Atlas. The oldest of the Capsian habitats date back to the eighth millennium BC and lasted until the fifth millennium BC, that it is to say ancient and mid Holocene. This Capsian population can be recognized by its lithic tools made of blades and lamellae and by the abandoned use of finely cut geometric microliths. They lived from hunting, fishing, snail gathering, and occupied the numerous shelters under the Atlas. The lagoon territory favored their establishment in these regions.

Around the sixth millennium, the first ceramics appeared in Capsian sites (such as the Capeletti Cave in the Aures). The domestication of animals became widespread in the north and the Sahara. The Great arid mid-Holocene ends and the phase of the Humid Neolithic succeeds it. This mild climatic period favors the development of grassland and sub-desert steppe. These territories will be inhabited by populations integrated into a Neolithic culture and their economy will be marked by an intense pastoral activity. A new climatic episode, this time arid, succeeds the Humid Neolithic. The vegetation cover is reduced because of this climatic change. This would have consequences on human behavior: The sites are abandoned; the lakes are dried up and the current dunes invade the Sahara. But the Neolithic of Capsian tradition is maintained. The reduction of water points and pastures will result in the disruption of the lives of nomadic pastoralists. The end of the Neolithic is marked by the first contacts with the Mediterranean world. North Africa opens up to Mediterranean

influences with a timid humid pulsation and by a change in human behavior. The peaceful hunter / shepherd shares his territory with the warrior on foot or on a horseback. It is likely that the same ethnic groups specialized in maintaining pastoral activity and in the defense of the group by armed men. This period marks a turning point history not only in the Aures but of all the North of Africa that opened up to Mediterranean maritime competition and its consequences. The paucity of our knowledge of the periods after the 2nd millennium BC is unquestionable. The large groups that were better structured politically, economically and militarily (Phoenicians, Romans and Arabs) stood out for their superiority over the Palaeo-berber populations. This marks the end of cultural autonomy and the end of a "prehistoric golden age".

This period is relative to the development of secondary ridgeways, high promontories and marks the settlement of man. Although the paucity of our knowledge of the periods after the 2nd millennium BC is unquestionable, the presence of numerous funerary monuments bears witness to human presence, but the traces of their daily life and those of their chosen camps remain to be discovered. Nonetheless, funerary monuments in North Africa are divided into several groups, thus expressing a certain regionalism in terms of identity. Each of these large regions offers structures with its own style.

The Atlas has long been in contact with the Mediterranean world, and important exchanges develop between the Italian Peninsula and North Africa on its east side. One discovers on both sides, through pottery and funerary monuments, influences of Mediterranean origin undergone by these regions.

The Sahara offers numerous funerary monuments where the Mediterranean influence is diminishing, and the African features are increasing. The drying up of this vast territory has pushed the populations to the last points where life was possible such as it is the case of the region under study. These points of life prolong the activity of the populations who maintain little exchange with their neighbors. The late arrival of the camel will help to break this isolation. It becomes the only animal able to cross the large, deserted areas.

Funeral or cult structures are numerous and varied in the Aures. Their study is of great interest for the knowledge of the funerary practices and rites of the cultural groups that built them. The numerous funerary monuments already excavated in the Aures have yielded an important collection of pottery, ornaments...etc. These objects deposited in these burials

testify to the presence of funerary rites. Through these objects, these populations granted a particular interest to the dead, as they reflected a way of life specific to the populations who were 'sedentary'. They adopted different behaviors from one region to another, where each one of them reveals local identities visible through material culture.

Between antiquity and modern times, the best documentation of human and environmental dynamics has enabled to shed light on the complexity of the relations between society and the environment. From this point of view, understanding the nature of Roman roads is particularly critical for the establishment of settlements because it is a key factor in Roman expansionist and imperialist strategies developing in that period. Due to the lack of written evidences, it was necessary to resort to field work to search for the effects of these dynamics during these periods in the valley, through observation and sampling.

The archaeological study has reached the discovery of many ancient sites, monuments, water channels connecting agglomerations ( such as the one found in Blihoud and T'kout), even though scattered, but an idea was formed thanks to spatial analysis tools and GIS. It has also revealed that not all sites where military but many of them had agricultural backgrounds. As it indicated a wide spread of ancient civilizational influences. The Roman period took a large part of this research, for the availability of data and which resulted in the framing of a road inside the valley.

From the second century Rome began its expansion's project in the Aures by military operations. That was represented in the construction of roads, from which the one across the course of Wadi Abiod which was provided with military centers for observation. However, various types of establishments were in the form of farms (farms and fortified towns), often established over rivers and at the level of mountain passes such as the theoretical model suggested.

With regard to this fact, this research has revealed that the Valley of Wadi Abiod has enhirited human prints since prehistory, and continued to the present times, visible today through the local situation marked by a predominantly semi-nomadic rural population, in a region that has experienced the strengthening of tribal structures framed by a large brotherly network. The historical habitat of the valley represents an extraordinary system of habitat space through the integrated management of water resources. The structure of this installation, which stretches for tens of kilometers along the river that carries the waters of the last Atlas

mountains in the region of the Aures to the Sahara, is constituted by villages and a linear system of palms and gardens connected one another through the same traditional paths that were used during ancient times.

A complex social structure linked tribal communities and a system of management of individual property, the community of villages and the whole habitat. This governed the equilibrium of a region in which the seasonal rhythms of cereal crops grown in the surrounding mountains were combined with grazing transhumance. The alternation between the mountain and the valley has generated a network of special collective structures, including granaries and crushers, linked to the storage and processing enriched with agricultural products. Villages are the nerve centers of this network and have marked the pace of long-term human presence in the region.

Currently, dozens of villages are characterized by a polarized structure that, from the edge and walls of the valley, in its oldest parts, is positioned on the terraces of the border. The high-rise construction of these historical structures ensures two essential functions: protection against invasions, as well as primary access to water. During the last century, the villages expanded with episodes of urban division very pronounced until the road connecting the cities of Batna and Biskra in the Algerian Atlas.

The historic built heritage, perfectly integrated with the natural characteristics of the site, constitutes an exceptional landscape value and consists mainly of semi troglodytic, and stone houses with types of structured elementary cells with courtyards, adjoining gardens and terraces for drying products. The relationship with the water of the river was the basis of the genesis of the whole structure of this dynamic since the early times, which constitutes a significant case of cultural heritage, material and immaterial.

Finally, the landscape of today is the result of the arrangement of natural elements and the sum of the transformations carried out by the man over time within the framework of his multiple activities. Man lives and travels the vast expanses of the Aures. He has developed his own way of life which has adapted to a changing environment. He had to modestly fit out living spaces to create a summary habitat and build especially large funeral structures, making today difficult and confusing the interpretation of these places. The rural landscape currently is an ensemble formed by rural constructions, grouped in villages or dispersed, which form built landscapes, fields or orchards that form agrarian landscapes; plus woods,

water bodies, roads and paths. It is largely shaped by agriculture and serves as a living space that testifies of a continued practice. The beauty of the natural and archaeological sites, but also the urban traditional planning model that adapts to the environment and the costum of the Berber community make of them one of the emblematic landscapes of the Aures and in Algeria.

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# 7. ANNEX 1

*INVENTORY/REGISTER OF A CULTURAL INTEREST LANDSCAPE*

## Sheet N 1

| | | | | |
|---|---|---|---|---|
| **Card index N° :**<br>**1** | **N° of the Entity:**<br>**1** | **Date :**<br>**22/06/2019** | **Commune :**<br>Rhoufi | **Place known as:**<br>Ath Ouriache |
| **Geographical coordinates:**<br>Latitude 35° 03′ 29″ N<br>Longitude 6° 10′ 07″ E | | **GPS coordinates:**<br>Latitude: 35° 3'42.09"N<br>Longitude:6°10'50.35"E<br>Altitude: 706m | | **Social Linage:**<br>Ath Ouriache |
| **The fabric of the village** | | | | |
| **Regular :** Yes | | **Dense :** No | | **Position:**<br>Dispersed habitats on the anticlinal mount<br>**River stream:**<br>Straight |
| **Economical mode** | | | | |
| **Organization:** Ighoussar (Ghouassir) | | **Fraction:** Ath Ouriache | | **Land:** Ath Ouriache |
| **Logic of implantation of the villages** | | | | |
| Machta: yes | | Perched: No | | |
| | | Stepped: Yes | | |
| Dachra: No | | Semi-troglodytic: No | | |

**Situation of the village:**

**North:** The new agglomeration of the actual Rhoufi

**South:** River

**East :** Arkiouene Village ( not included in Rhoufi )

**West:** Anar el Henni

| **Roadway system** | | **Boundary Demarcation** |
|---|---|---|
| **Roadway** | **Usage** | Topographic : Typical in the region, the boundaries are marked topographically |
| Principal : No | Pedestrian: yes | Vegetative : No |
| Secondary: No | Mechanical: No | Fence : No |
| Impasses: Yes | Animals: donkeys, mules, hinnys , horses. | Water : From the southern part , since the village end is an abrupt wall, at the bottom of it we find the thalweg. |

**Landuse**

| **Landuse category %** | <10 | 10-35 | 35-50 | 50-75 | 75-100 | **Landuse activity** |
|---|---|---|---|---|---|---|
| Agricultural | | x | | | | Cropland : is rotating as the lands are in Saghida |
| Natural vegetation | | | x | | | Pasture: is grazing and animals are limited to goats only |
| Residential | | | | x | | Dwellings : Are multiple in a way that a room is always added to the primary nucleus once a new person is added to the family : wedding for example, and don't follow a specific orientation. |
| Commercial | x | | | | | Gardens : yes with fruit. bearing trees like plum, apricot, fig trees , in addition to prickly pears and olive trees. |
| Ranching | x | | | | | |

<table>
<tr><th colspan="3">Basic frame</th></tr>
<tr><td>Number of houses:<br>Around 40</td><td>State of conservation of the houses:<br>Moderate</td><td>Causes of dégradation:<br>Abandon</td></tr>
<tr><th colspan="3">Specialized buildings</th></tr>
<tr><td>Mosque : Yes</td><td>Mill : yes</td><td rowspan="5"></td></tr>
<tr><td>Zaouia : No</td><td rowspan="4">Other:<br><br>Tumuli: 4 of them were observed on the route to Ath Ouriache, ( gps points: 195, 199, 203, 206 ), exhibiting previous looting operations as shown on the pictures.</td></tr>
<tr><td>Mederssa :No</td></tr>
<tr><td>Oil mill : yes</td></tr>
<tr><td>Cemetery: The presence of 2 cemeteries gps points : 215 , 217.</td></tr>
<tr><th colspan="3">Water management systems</th></tr>
<tr><th colspan="2">Waterworks</th><th>Natural sources</th></tr>
<tr><td colspan="2">Saguia: 2 seguia at points : 219 ( the first low seguia is dedicated to aliment the gardens of southern Rhoufi villages until Bouali ) while the second one is at around 1.5m up the first one and which is served to aliment the small perched villages ( Thaioust, Alaoua and Taidit )</td><td>Springs: No</td></tr>
<tr><td colspan="2">Water channels: No</td><td>River: yes</td></tr>
<tr><td colspan="2">Wells : No</td><td></td></tr>
</table>

| | |
|---|---|
| Dam : yes , at gps points : 210,211,212. This little dam is made of cement, stocks the water to aliment the region of Rhoufi from the northern part until Tajmount where there will be another system to aliment Ath mimoun and Idharen) while Ath ouriache is alimented from the region of Hiza. | |

| **Rites** | |
|---|---|
| Liturgical : Not specified in this region | Linked to marriage: This practice is common to the Ighoussar, on the first day, the spouse has to water the plants in the garden. Emblematically could this be assigned to fertility? , or more literally to prove that she is capable to help with domestic labors ? |
| Linked to agriculture: Not specified in this region | Linked to burial : the graves are surrounded by rocks to mark their borders, and on the top there is either one rock standing or 2 rocks converging in one point at the summit forming a sort of pyramid, this is to differentiate between a man ( one rock) and a woman ( 2 rocks) |
| Linked to Pastoralism: Not specified in this region | Other: The presence of a tree called tassat'a n sidi mimoun which translates by the tree of his grace Mimoun, where the practice is to put a rock on top of another for every passage through that tree in order to have the blessing from Mimoun ) |

## Sheet N2

| | | | | |
|---|---|---|---|---|
| **Card index N° :**<br>**2-1** | **N° of the Entity:**<br>**2** | **Date :**<br>**22/06/2019** | **Commune :**<br>Rhoufi | **Place known as:**<br>Taioust |
| **Geographical coordinates:**<br>Latitude 35° 03′ 29″ N<br>Longitude 6° 10′ 07″ E | | **GPS coordinates:**<br>Latitude: 35° 3'31.17"N<br>Longitude: 6°10'31.43"E<br>Altitude: 680m | | **Social Linage:**<br>Ath Slimane ou Mansour |
| **The fabric of the village** | | | | |
| **Regular :** yes | | **Dense :** no | | **Position:**<br>Grouped habitats on the wall of the canyon<br>**River stream:**<br>Straight |
| **Economical mode** | | | | |
| **Organization:** Ighoussar (Ghouassir) | | **Fraction:** Ath Slimane ou Mansour | | **Land:** Azekkak el maaden, Tikeriatine. |
| **Logic of implantation of the villages** | | | | |
| Machta: No | | Perched: Yes | | |
| | | Stepped: Yes | | |
| Dachra: Yes | | Semi-troglodytic: No | | |

**Situation of the village:**

**North:** River

**South:** Mountain Ahmar khadou

**East :** -

**West:** Nath Khellaf Tikeriatine

| **Roadway system** | | **Boundary Demarcation** |
|---|---|---|
| **Roadway** | **Usage** | Topographic : Typical in the region, the boundaries are marked topographically |
| Principal : No | Pedestrian: yes | Vegetative : No |
| Secondary: No | Mechanical: No | Fence : No |
| Impasses: Yes | Animals: donkeys, mules, hinnies , horses. | Water : From the northern part , since the village end is an abrupt wall, at the bottom of it we find the thalweg. |

**Landuse**

| **Landuse category %** | <10 | 10-35 | 35-50 | 50-75 | 75-100 | **Landuse activity** |
|---|---|---|---|---|---|---|
| Agricultural | | x | | | | Cropland : is rotating as the crop lands are supposed to be in the mount of Dinar and some on the mountain of Ahmar khadou ( fourche and hithodil) |
| Natural vegetation | | | x | | | Pasture: Grazing |
| Residential | | | | x | | Dwellings : Are multiple in a way that a room is always added to the primary nucleus once a new person is added to the family : wedding for example, and don't follow a specific orientation. |
| Commercial | x | | | | | Gardens: yes |
| Ranching | x | | | | | |

| Basic frame | | |
|---|---|---|
| **Number of houses:**<br>9 | **State of conservation of the houses:**<br>Moderate but seeing the location of the village it is hardly accessible. | **Causes of dégradation:**<br>Abandon and rock crawling |

| Specialized Buildings | | |
|---|---|---|
| Mosque: Not visible during the survey | Mill: Not visible during the survey | |
| Zaouia : Not visible during the survey | Other: | |
| Mederssa : Not visible during the survey | | |
| Oil mill : Not visible during the survey | | |
| Cemetery:Not visible during the survey | | |

| Water management systems | |
|---|---|
| **Waterworks** | **Natural sources** |
| Saguia: yes , the one that comes from ath ouriache (the upper one) | Springs: yes at point gps 221. |
| Water channels: no | River: yes |
| Wells: no | |
| Dam :no | |

| **Rites** | |
|---|---|
| Liturgical: Not specified in this region during the survey | Linked to marriage: This practice is common to the Ighoussar, on the first day, the spouse has to water the plants in the garden. Emblematically could this be assigned to fertility? , or more literally to prove that she is capable to help with domestic labors ? |
| Linked to agriculture: Not specified in this region during the survey | Linked to burial: Not specified in this region during the survey |
| Linked to Pastoralism: Not specified in this region during the survey | Other: |

## Sheet N3

| | | | | |
|---|---|---|---|---|
| **Card index N° :**<br>**2-2** | **N° of the Entity:**<br>**3** | **Date :**<br>**23/06/2019** | **Commune :**<br>Rhoufi | **Place known as:**<br>Alaoua |
| **Geographical coordinates:**<br>Latitude 35° 03′ 29″ N<br>Longitude 6° 10′ 07″ E | | **GPS coordinates:**<br>Latitude: 35° 3'21.99"N<br>Longitude: 6°10'29.31"E<br>Altitude: 702m | | **Social Linage:**<br>Ath Slimane ou Mansour |
| **The fabric of the village** | | | | |
| **Regular : yes** | | **Dense :** No | | **Position:**<br>Grouped habitats on the summit.<br>**River stream:**<br>Straight |
| **Economical mode** | | | | |
| **Organization:** Ighoussar (Ghouassir) | | **Fraction:** Ath Slimane ou Mansour | | **Land:** Alaoua |
| **Logic of implantation of the villages** | | | | |
| Machta: No | | | Perched: No | |
| | | | Stepped: Yes | |
| Dachra: Yes | | | Semi-troglodytic: No | |

**Situation of the village:**

**North: River**

**South: Ahmar Khadou mountain**

**East : Nath khallaf Tikeriatine**

**West: Taidit**

| **Roadway system** | | **Boundary Demarcation** |
|---|---|---|
| **Roadway** | **Usage** | Topographic : Typical in the region, the boundaries are marked topographically |
| Principal : No | Pedestrian: yes | Vegetative : No |
| Secondary: No | Mechanical: No | Fence : No |
| Impasses: Yes | Animals: donkeys, mules, hinnys , horses. | Water : From the northern part. |

**Landuse**

| **Landuse category %** | <10 | 10-35 | 35-50 | 50-75 | 75-100 | **Landuse activity** |
|---|---|---|---|---|---|---|
| Agricultural | | x | | | | Cropland : Rotating |
| Natural vegetation | | | x | | | Pasture: Grazing |
| Residential | | | | x | | Dwellings : Are multiple in a way that a room is always added to the primary nucleus once a new person is added to the family : wedding for example, and don't follow a specific orientation. |
| Commercial | x | | | | | Gardens: yes |
| Ranching | x | | | | | |

**Basic frame**

| | | |
|---|---|---|
| **Number of houses:**<br>Around 9 | **State of conservation of the houses:**<br>Moderate | **Causes of dégradation:**<br>Abandon |
| | **Specialized Buildings** | |
| Mosque : Not specified in this region during the survey | Mill: Not specified in this region during the survey | |
| Zaouia : Not specified in this region during the survey | Other:<br>The presence of ruins of a granary | |
| Mederssa : Not specified in this region during the survey | | |
| Oil mill : Not specified in this region during the survey | | |
| Cemetery: Not specified in this region during the survey | | |

**Water management systems**

| **Waterworks** | **Natural sources** |
|---|---|
| Saguia: yes , the one that comes from ath ouriache (the upper one) | Springs: no |
| Water channels: no | River: yes |
| Wells:no | |
| Dam: no | |

| **Rites** | |
|---|---|
| Liturgical: Not specified in this region during the survey | Linked to marriage: This practice is common to the Ighoussar, on the first day, the spouse has to water the plants in the garden. Emblematically could this be assigned to fertility? , or more literally to prove that she is capable to help with domestic labors ? |
| Linked to agriculture: Not specified in this region during the survey | Linked to burial: Not specified in this region during the survey |
| Linked to Pastoralism: Not specified in this region during the survey | Other: |

## Sheet N4

| | | | | |
|---|---|---|---|---|
| **Card index N° :**<br>**2-3** | **N° of the Entity:**<br>**4** | **Date :**<br>**23/06/2019** | **Commune :**<br>Rhoufi | **Place known as:**<br>Taidit |
| **Geographical coordinates:**<br>Latitude 35° 03′ 29″ N<br>Longitude 6° 10′ 07″ E | | **GPS coordinates:**<br>Latitude: 35° 3'21.99"N<br>Longitude: 6°10'29.31"E<br>Altitude: 702m | | **Social Linage:**<br>Ath Slimane ou Mansour |
| **The fabric of the village** | | | | |
| **Regular : No** | | **Dense :** yes | | **Position:**<br>Grouped habitats on the summit.<br>**River stream:**<br>Straight |
| **Economical mode** | | | | |
| **Organization:** Ighoussar (Ghouassir) | | **Fraction:** Ath Slimane ou Mansour | | **Land:** Taidit |
| **Logic of implantation of the villages** | | | | |
| Machta: No | | Perched: yes | | |
| | | Stepped: Yes | | |
| Dachra: Yes | | Semi-troglodytic: yes | | |

**Situation of the village:**

**North:** River

**South:** Ahmar Khadou mountain

**East :** Alaoua

**West:** River

| Roadway system | | Boundary Demarcation |
|---|---|---|
| **Roadway** | **Usage** | Topographic : Typical in the region, the boundaries are marked topographically |
| Principal : No | Pedestrian: yes | Vegetative : No |
| Secondary: No | Mechanical: No | Fence : No |
| Impasses: Yes | Animals: donkeys, mules, hinnys , horses. | Water : From the northern part. |

**Landuse**

| **Landuse category %** | <10 | 10-35 | 35-50 | 50-75 | 75-100 | **Landuse activity** |
|---|---|---|---|---|---|---|
| Agricultural | | x | | | | Cropland : is rotating as the crop lands are supposed to be in the mount of Dinar and some on the mountain of Ahmar khadou ( fourche and hithodil) |
| Natural vegetation | | | x | | | Pasture: Grazing |
| Residential | | | | x | | Dwellings : Are multiple in a way that a room is always added to the primary nucleus once a new person is added to the family : wedding for example, and don't follow a specific orientation. |
| Commercial | x | | | | | Gardens: yes |
| Ranching | x | | | | | |

| Basic frame | | |
|---|---|---|
| **Number of houses:**<br>Around 25 | **State of conservation of the houses:**<br>Moderate, some houses are still standing which allows us to understand the structure of the village | **Causes of dégradation:**<br>Abandon and rock crawling |
| **Specialized Buildings** | | |
| Mosque : yes | Mill: yes | |
| Zaouia : Not specified in this region during the survey | Other: | |
| Mederssa : Not specified in this region during the survey | | |
| Oil mill : yes | | |
| Cemetery: Not specified in this region during the survey | | |

| Water management systems | |
|---|---|
| **Waterworks** | **Natural sources** |
| Saguia: yes , the one that comes from ath ouriache (the upper one) | Springs: no |
| Water channels: no | River: yes |
| Wells:no | |
| Dam: no | |

| Rites | |
|---|---|
| Liturgical: Not specified in this region during the survey | Linked to marriage: This practice is common to the Ighoussar, on the first day, the spouse has to water the plants in the garden. Emblematically could this be assigned to fertility? , or more literally to prove that she is capable to help with domestic labors ? |
| Linked to agriculture: Not specified in this region during the survey | Linked to burial: Not specified in this region during the survey |
| Linked to Pastoralism: Not specified in this region during the survey | Other: |

## Sheet N5

| | | | | |
|---|---|---|---|---|
| **Card index N° :**<br>**2-4** | **N° of the Entity:**<br>**5** | **Date :**<br>**24/06/2019** | **Commune :**<br>Rhoufi | **Place known as:**<br>Araouene |
| **Geographical coordinates:**<br>Latitude 35° 03′ 29″ N<br>Longitude 6° 10′ 07″ E | | **GPS coordinates:**<br>Latitude: 35° 3'26.48"N<br>Longitude: 6°10'25.66"E<br>Altitude: 684m | | **Social Linage:**<br>Ath Slimane ou Mansour |
| **The fabric of the village** | | | | |
| **Regular :** No | | **Dense :** yes | | **Position:**<br>Grouped habitats<br>**River stream:**<br>Straight |
| **Economical mode** | | | | |
| **Organization:** Ighoussar (Ghouassir) | | **Fraction:** Ath Slimane ou Mansour | | **Land:** Zakkak merouene |
| **Logic of implantation of the villages** | | | | |
| Machta: No | | Perched: yes | | |
| | | Stepped: Yes | | |
| Dachra: yes | | Semi-troglodytic: No | | |

**Situation of the village:**

**North:** The new agglomeration of the actual Rhoufi

**South:** River

**East :** Anar el Henni

**West:** Ifri

| **Roadway system** | | **Boundary Demarcation** |
|---|---|---|
| **Roadway** | **Usage** | Topographic : Typical in the region, the boundaries are marked topographically |
| Principal : No | Pedestrian: yes | Vegetative : No |
| Secondary: No | Mechanical: No | Fence : No |
| Impasses: Yes | Animals: donkeys, mules, hinnys , horses. | Water : From the southern part , since the village end is an abrupt wall, at the bottom of it we find the thalweg. |

**Landuse**

| **Landuse category %** | <10 | 10-35 | 35-50 | 50-75 | 75-100 | **Landuse activity** |
|---|---|---|---|---|---|---|
| Agricultural | | x | | | | Cropland : is rotating as the crop lands are supposed to be in the mount of Dinar and some on the mountain of Ahmar khadou ( fourche and hithodil) |
| Natural vegetation | | | x | | | Pasture: is grazing and animals are limited to goats only |
| Residential | | | | x | | Dwellings : Are multiple in a way that a room is always added to the primary nucleus once a new person is added to the family : wedding for example, and don't follow a specific orientation. |
| Commercial | x | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Ranching | x | | | | | Gardens : yes with fruit. bearing trees like plum, apricot , fig trees , in addition to prickly pears. |

**Basic frame**

| | | |
|---|---|---|
| **Number of houses:**<br>Around 15 | **State of conservation of the houses:**<br>Moderate | **Causes of dégradation:**<br>Abandon |

**Specialized buildings**

| | | |
|---|---|---|
| Mosque : Not visible | Mill : yes | |
| Zaouia : No | Other: | |
| Mederssa :No | | |
| Oil mill : yes | | |
| Cemetery: yes | | |

**Water management systems**

| **Waterworks** | **Natural sources** |
|---|---|
| Saguia: yes, the one coming from Ath Ouriache's dam, the water is brought to the village by a system which consists in orienting the water using rocks and guide it to the seguia. | Springs: No |
| Water channels: No | River: yes |
| Wells : No | |
| Dam : No | |

| Rites | |
|---|---|
| Liturgical: Not specified in this region during the survey | Linked to marriage: This practice is common to the Ighoussar, on the first day, the spouse has to water the plants in the garden. Emblematically could this be assigned to fertility? , or more literally to prove that she is capable to help with domestic labors ? |
| Linked to agriculture: Not specified in this region during the survey | Linked to burial: Not specified in this region during the survey |
| Linked to Pastoralism: Not specified in this region during the survey | Other: |

## Sheet N6

| | | | | |
|---|---|---|---|---|
| **Card index N° :**<br>**2-5** | **N° of the Entity:**<br>**6** | **Date :**<br>**24/06/2019** | **Commune :**<br>Rhoufi | **Place known as:**<br>Ifri |
| **Geographical coordinates:**<br>Latitude 35° 03′ 29″ N<br>Longitude 6° 10′ 07″ E | | **GPS coordinates:**<br>Latitude: 35° 3'23.42"N<br>Longitude: 6°10'22.95"E<br>Altitude: 686m | | **Social Linage:**<br>Ath Slimane ou Mansour |
| **The fabric of the village** | | | | |
| **Regular :** No | | **Dense :** yes | | **Position:**<br>Grouped habitats<br>**River stream:**<br>Straight |
| **Economical mode** | | | | |
| **Organization:** Ighoussar (Ghouassir) | | **Fraction:** Ath Slimane ou Mansour | | **Land:** Ourthou Nakkache |
| **Logic of implantation of the villages** | | | | |
| Machta: No | | Perched: yes | | |
| | | Stepped: Yes | | |
| Dachra: yes | | Semi-troglodytic: No | | |

**Situation of the village:**

**North:** The new agglomeration of the actual Rhoufi

**South:** River

**East :** Arouane

**West:** Thawrirth

| **Roadway system** | | **Boundary Demarcation** |
|---|---|---|
| **Roadway** | **Usage** | Topographic : Typical in the region, the boundaries are marked topographically |
| Principal : No | Pedestrian: yes | Vegetative : No |
| Secondary: No | Mechanical: No | Fence : No |
| Impasses: Yes | Animals: donkeys, mules, hinnys , horses. | Water : From the southern part , since the village end is an abrupt wall, at the bottom of it we find the thalweg. |

**Landuse**

| **Landuse category %** | <10 | 10-35 | 35-50 | 50-75 | 75-100 | **Landuse activity** |
|---|---|---|---|---|---|---|
| Agricultural | | x | | | | Cropland : is rotating as the crop lands are supposed to be in the mount of Dinar and some on the mountain of Ahmar khadou ( fourche and hithodil) |
| Natural vegetation | | | x | | | Pasture: is grazing and animals are limited to goats only |
| Residential | | | | x | | Dwellings : Are multiple in a way that a room is always added to the primary nucleus once a new person is added to the family : wedding for example, and don't follow a specific orientation. |
| Commercial | x | | | | | Gardens : yes |

| | | | | | | |
|---|---|---|---|---|---|---|
| Ranching | x | | | | | |

**Basic frame**

| | | |
|---|---|---|
| **Number of houses:**<br>Around 10 | **State of conservation of the houses:**<br>Moderate | **Causes of dégradation:**<br>Abandon |

**Specialized buildings**

| | | |
|---|---|---|
| Mosque : Not visible | Mill : yes | |
| Zaouia : No | Other: | |
| Mederssa :No | | |
| Oil mill : yes | | |
| Cemetery: No | | |

**Water management systems**

| **Waterworks** | **Natural sources** |
|---|---|
| Saguia: yes, the one coming from Ath Ouriache's dam, the water is brought to the village by a system which consists in orienting the water using rocks and guide it to the seguia. | Springs: No |
| Water channels: No | River: yes |

| | |
|---|---|
| Wells : No | |
| Dam : No | |

| Rites | |
|---|---|
| Liturgical: Not specified in this region during the survey | Linked to marriage: This practice is common to the Ighoussar, on the first day, the spouse has to water the plants in the garden. Emblematically could this be assigned to fertility? , or more literally to prove that she is capable to help with domestic labors ? |
| Linked to agriculture: Not specified in this region during the survey | Linked to burial: Not specified in this region during the survey |
| Linked to Pastoralism: Not specified in this region during the survey | Other: |

## Sheet N7

| | | | | |
|---|---|---|---|---|
| **Card index N° :**<br>**2-6** | **N° of the Entity:**<br>**7** | **Date :**<br>**25/06/2019** | **Commune :**<br>Rhoufi | **Place known as:**<br>Thawrirth |
| **Geographical coordinates:**<br>Latitude 35° 03′ 29″ N<br>Longitude 6° 10′ 07″ E | | **GPS coordinates:**<br>Latitude: 35° 3'16.70"N<br>Longitude: 6°10'14.02"E<br>Altitude: 656-720m | | **Social Linage:**<br>Ath Slimane ou Mansour |
| **The fabric of the village** | | | | |
| **Regular :** yes | | **Dense :** yes | | **Position:**<br>Very compact habitats<br>**River stream:**<br>Sinuous |
| **Economical mode** | | | | |
| **Organization:** Ighoussar (Ghouassir) | | **Fraction:** Ath Slimane ou Mansour | | **Land:**<br>Khef Nouadar<br>Azekak Moumen<br>Alagh n'taioust<br>Thizourine |
| **Logic of implantation of the villages** | | | | |
| Machta: No | | | Perched: yes | |
| | | | Stepped: Yes | |
| Dachra: yes | | | Semi-troglodytic: No | |

**Situation of the village:**

**North:** The new agglomeration of the actual Rhoufi

**South:** River

**East :** Ifri

**West:** ath mimoun

| **Roadway system** | | **Boundary Demarcation** |
|---|---|---|
| **Roadway** | **Usage** | Topographic : Typical in the region, the boundaries are marked topographically |
| Principal : No | Pedestrian: yes | Vegetative : No |
| Secondary: Yes because a new road was opened that takes to the location of Thawrirth which is placed on the first balcony of the gorges of Rhoufi, a touristic attraction on the road to Biskra.<br>We note that there is a new route that takes also around the buildings of the village, and it starts from the granary which should not be taken into consideration since the granary is always put in a place guarded naturally and physically. The old route was surveyed with gps device | Mechanical: No | Fence : No |
| Impasses: Yes | Animals: donkeys, mules, hinnys , horses. | Water : From the southern part at the bottom of it we find the thalweg. |

**Landuse**

| **Landuse category %** | <10 | 10-35 | 35-50 | 50-75 | 75-100 | **Landuse activity** |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| Agricultural | | | | | x | Cropland : is rotating as the crop lands are supposed to be in the mount of Dinar. |
| Natural vegetation | x | | | | | Pasture: is grazing and animals are limited to goats only |
| Residential | | | | | x | Dwellings : Are multiple in a way that a room is always added to the primary nucleus once a new person is added to the family : wedding for example, and don't follow a specific orientation. |
| Commercial | | | | | x | Gardens : yes, with plum, figs, apricot,olive trees |
| Ranching | x | | | | | |

**Basic frame**

| | | |
|---|---|---|
| **Number of houses:**<br>Around 100 | **State of conservation of the houses:**<br>Good | **Causes of dégradation:**<br>- |

**Specialized buildings**

| | | |
|---|---|---|
| Mosque : yes at point 160 | Mill : yes | |
| Zaouia : No | Other:<br>Granary: this village has the biggest granary standing.<br><br>Tachamast : balconies perched on the summit, facing the river and where fruits and vegetables were put to dry.<br><br>Market: The most important market of the gorges. | |
| Mederssa :yes | | |
| Oil mill : yes | | |
| Cemetery: Yes at point 155. | | |

| Water management systems | |
|---|---|
| **Waterworks** | **Natural sources** |
| Saguia: yes, the one coming from Ath Ouriache's dam, the water is brought to the village by a system which consists in orienting the water using rocks and guide it to the seguia. | Springs: No |
| Water channels: No | River: yes |
| Wells : No | |
| Dam : No | |

| Rites | |
|---|---|
| Liturgical: Not specified in this region during the survey | Linked to marriage: This practice is common to the Ighoussar, on the first day, the spouse has to water the plants in the garden. Emblematically could this be assigned to fertility? , or more literally to prove that she is capable to help with domestic labors ? |
| Linked to agriculture: Not specified in this region during the survey | Linked to burial: Not specified in this region during the survey |
| Linked to Pastoralism: Not specified in this region during the survey | Other: |

## Sheet N8

| | | | | |
|---|---|---|---|---|
| **Card index N° :**<br>**2-7** | **N° of the Entity:**<br>**8** | **Date :**<br>**26/06/2019** | **Commune :**<br>Rhoufi | **Place known as:**<br>Bouali |
| **Geographical coordinates:**<br>Latitude 35° 03′ 29″ N<br>Longitude 6° 10′ 07″ E | | **GPS coordinates:**<br>Latitude: 35° 3'8.43"N<br>Longitude: 6°10'6.75"E<br>Altitude: 676-697m | | **Social Linage:**<br>Ath Slimane ou Mansour |
| **The fabric of the village** | | | | |
| **Regular :** no | | **Dense :** yes | | **Position:**<br>Grouped habitats<br>**River stream:**<br>Sinuous |
| **Economical mode** | | | | |
| **Organization:** Ighoussar (Ghouassir) | | **Fraction:** Ath Slimane ou Mansour | | **Land:**<br>Timoulalin<br>Azekak Thineguerassine<br>Thefekhsit<br>Taioust<br>Lahsa<br>Tadjmout<br>Souf n'dechar<br>Thighougaline<br>Tefaouet<br>Nais si Tahar<br>Ref Anidji<br>Ifri Bousaid |

| Logic of implantation of the villages | |
|---|---|
| Machta: No | Perched: yes |
| | Stepped: Yes |
| Dachra: yes | Semi-troglodytic: yes |

**Situation of the village:**

**North:** River

**South:** Ahmar Khadou

**East :** Taidit

**West:** Gherine (Ath mimoun)

| **Roadway system** | | **Boundary Demarcation** |
|---|---|---|
| **Roadway** | **Usage** | Topographic : Typical in the region, the boundaries are marked topographically |
| Principal : No | Pedestrian: yes | Vegetative : No |
| Secondary:No<br>. | Mechanical: No | Fence : No |
| Impasses: Yes | Animals: donkeys, mules, hinnys , horses. | Water : From the northern part at the bottom of it we find the thalweg. |

**Landuse**

| **Landuse category %** | <10 | 10-35 | 35-50 | 50-75 | 75-100 | **Landuse activity** |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| Agricultural | | | | | x | Cropland : is rotating as the crop lands are supposed to be in the mount of akarkar |
| Natural vegetation | x | | | | | Pasture: is grazing and animals are limited to goats only |
| Residential | | | | | x | Dwellings : Are multiple in a way that a room is always added to the primary nucleus once a new person is added to the family : wedding for example, and don't follow a specific orientation. |
| Commercial | | | | | x | Gardens : yes, with plum, figs, apricot, olive trees |
| Ranching | x | | | | | |

**Basic frame**

| | | |
|---|---|---|
| **Number of houses:**<br>Around 40 | **State of conservation of the houses:**<br>Poor | **Causes of dégradation:**<br>Abandon, tourists (for the hotel). |

**Specialized buildings**

| | | |
|---|---|---|
| Mosque : yes and was destroyed at around point gps 176 | Mill : yes | |
| Zaouia : Yes at point 225 | Other:<br>Granary: this village had the first bombed granary by French troops, and it its ruins are located at point 226.<br><br>Hotel: A transatlantic hotel that was constructed during French colonization, semi-troglodytic. At point gps 183 | |
| Mederssa :no | | |
| Oil mill : yes | | |
| Cemetery: Yes, the particularity of its position is that it is on the summit ( on the anticlinal) and to go to it, sharp stairs were | | |

| | | |
|---|---|---|
| dug into the wall and only some traces remain from them. | | |

| Water management systems | |
|---|---|
| **Waterworks** | **Natural sources** |
| Saguia: yes, the one coming from Ath Ouriache's dam, the water is brought to the village by a system which consists in orienting the water using rocks and guide it to the seguia. | Springs: Yes, one at nah brahim and another at nais si Tahar , gps points respectively 180 and 227. |
| Water channels: No | River: yes |
| Wells : No | |
| Dam : No | |

| Rites | |
|---|---|
| Liturgical: Not specified in this region during the survey | Linked to marriage: This practice is common to the Ighoussar, on the first day, the spouse has to water the plants in the garden. Emblematically could this be assigned to fertility? , or more literally to prove that she is capable to help with domestic labors ? |
| Linked to agriculture: Not specified in this region during the survey | Linked to burial: graves are delimited using flagstones put horizontally and joined together with an earth mortar, and one central rock, the practice here is to dig into the ground then cover the body with flagstones then earth on top of them. The idea behind it is first to protect the body from the hyena, and also for the landslide during winter. |
| Linked to Pastoralism: Not specified in this region during the survey | Other: |

## Sheet N9

| | | | | |
|---|---|---|---|---|
| **Card index N° :**<br>**3-1** | **N° of the Entity:**<br>**9** | **Date :**<br>**27-28/06/2019** | **Commune :**<br>Rhoufi | **Place known as:**<br>Aourir Mimoun |
| **Geographical coordinates:**<br>Latitude 35° 03′ 29″ N<br>Longitude 6° 10′ 07″ E | | **GPS coordinates:**<br>Latitude: 35° 3'6.28"N<br>Longitude: 6° 9'58.51"E<br>Altitude: 640-726m | | **Social Linage:**<br>Ath Mimoun |
| **The fabric of the village** | | | | |
| **Regular :** no | | **Dense :** yes | | **Position:**<br>Grouped and very compact habitats<br>**River stream:**<br>Sinuous |
| **Economical mode** | | | | |
| **Organization:** Ighoussar (Ghouassir) | | **Fraction:** Ath Mimoun | | **Land:**<br>Gherine<br>Anar<br>Ighebirene<br>Tinoukratine |
| **Logic of implantation of the villages** | | | | |
| Machta: No | | | Perched: yes | |
| | | | Stepped: Yes | |
| Dachra: yes | | | Semi-troglodytic: no | |

**Situation of the village:**

**North:** Road

**South:** River

**East :** Thawrirth

**West:** Idharen

| **Roadway system** | | **Boundary Demarcation** |
|---|---|---|
| **Roadway** | **Usage** | Topographic : Typical in the region, the boundaries are marked topographically |
| Principal : No | Pedestrian: yes | Vegetative : No |
| Secondary: yes, the same for the village of thawrirth even though this one is inaccessible but there is a road that brings to the balcony which is number3 . . | Mechanical: No | Fence : No |
| Impasses: Yes | Animals: donkeys, mules, hinnys , horses. | Water : From the southern part at the bottom of it we find the thalweg. |

**Landuse**

| **Landuse category %** | <10 | 10-35 | 35-50 | 50-75 | 75-100 | **Landuse activity** |
|---|---|---|---|---|---|---|
| Agricultural | | | | x | | Cropland : is rotating as the crop lands are supposed to be in the mount of akarkar |
| Natural vegetation | | x | | | | Pasture: is grazing and animals are limited to goats only |
| Residential | | | | | x | Dwellings : Are multiple in a way that a room is always added to the primary nucleus once a new person is added to the family : wedding for example, and don't follow a specific orientation. |

| | | | | | | |
|---|---|---|---|---|---|---|
| Commercial | | x | | | | Gardens : yes, with plum, figs, apricot,olive trees |
| Ranching | x | | | | | |

**Basic frame**

| | | |
|---|---|---|
| **Number of houses:**<br>Around 60 | **State of conservation of the houses:**<br>intermediate | **Causes of dégradation:**<br>Abandon |

**Specialized buildings**

| | | |
|---|---|---|
| Mosque : yes at point 118 | Mill : yes | |
| Zaouia : Yes at point 127 | Other:<br>Granary: this village is located at point 95-97. | |
| Mederssa : no | | |
| Oil mill : yes | | |
| Cemetery: Yes, near the Zaouia at point 110 | | |

**Water management systems**

| **Waterworks** | **Natural sources** |
|---|---|
| Saguia: yes, the one coming from Ahsa, Tajmount ( thawrirt) and which provides Aourir Mimoun and Idharen with water ( which are the villages of Ath Mimoun) | Springs: No |
| Water channels: No | River: yes |

| | |
|---|---|
| Wells : No | |
| Dam : No | |

| Rites | |
|---|---|
| Liturgical: Not specified in this region during the survey | Linked to marriage: This practice is common to the Ighoussar, on the first day, the spouse has to water the plants in the garden. Emblematically could this be assigned to fertility? , or more literally to prove that she is capable to help with domestic labors ? |
| Linked to agriculture: Not specified in this region during the survey | Linked to burial: graves are delimited using flagstones put horizontally and joined together with an earth mortar, and one central rock, the practice here is to dig into the ground then cover the body with flagstones then earth on top of them. The idea behind it is first to protect the body from the hyena, and also for the landslide during winter. |
| Linked to Pastoralism: Not specified in this region during the survey | Other: |

## Sheet N10

| | | | | |
|---|---|---|---|---|
| **Card index N° :**<br>**3-2** | **N° of the Entity:**<br>**10** | **Date :**<br>**29/06/2019** | **Commune :**<br>Rhoufi | **Place known as:**<br>Idharen |
| **Geographical coordinates:**<br>Latitude 35° 03′ 29″ N<br>Longitude 6° 10′ 07″ E | | **GPS coordinates:**<br>Latitude: 35° 3'1.18"N<br>Longitude: 6° 9'46.84"E<br>Altitude: 645-683m | | **Social Linage:**<br>Ath Mimoun |
| **The fabric of the village** | | | | |
| **Regular :** no | | **Dense :** yes | | **Position:**<br>Grouped and very compact habitats<br>**River stream:**<br>Sinuous |
| **Economical mode** | | | | |
| **Organization:** Ighoussar (Ghouassir) | | **Fraction:** Ath Mimoun | | **Land:**<br>Braim<br>Souf n'Taiazit |
| **Logic of implantation of the villages** | | | | |
| Machta: No | | Perched: yes | | |
| | | Stepped: Yes | | |
| Dachra: yes | | Semi-troglodytic: yes | | |

**Situation of the village:**

**North:** River

**South:** Ahmar khadou

**East :** River

**West:** River

| **Roadway system** | | **Boundary Demarcation** |
|---|---|---|
| **Roadway** | **Usage** | Topographic : Typical in the region, the boundaries are marked topographically |
| Principal : No | Pedestrian: yes | Vegetative : No |
| Secondary: No<br>. | Mechanical: No | Fence : No |
| Impasses: Yes | Animals: donkeys, mules, hinnys , horses. | Water : From the southern part at the bottom of it we find the thalweg. |

**Landuse**

| **Landuse category %** | <10 | 10-35 | 35-50 | 50-75 | 75-100 | **Landuse activity** |
|---|---|---|---|---|---|---|
| Agricultural | | | x | | | Cropland : is rotating as the crop lands are supposed to be in Mezghanane |
| Natural vegetation | | | x | | | Pasture: is grazing and animals are limited to goats only |
| Residential | | | | | x | Dwellings : Are multiple in a way that a room is always added to the primary nucleus once a new person is added to the family : wedding for example, and don't follow a specific orientation. |
| Commercial | x | | | | | Gardens : yes with plumand olive trees |
| Ranching | x | | | | | |

<table>
<tr><th colspan="3">Basic frame</th></tr>
<tr><td>Number of houses:<br>Around 40</td><td>State of conservation of the houses:<br>intermediate</td><td>Causes of dégradation:<br>Abandon</td></tr>
<tr><th colspan="3">Specialized buildings</th></tr>
<tr><td>Mosque: yes but too much accidental to be marqued</td><td>Mill : yes</td><td rowspan="5"></td></tr>
<tr><td>Zaouia : No</td><td rowspan="4">Other:<br>The granary in this village does not exist however in here we find population from Ath Mimoun and another from Ath Mansour , so some people have rooms in the granary of Aourir Mimoun while others have rooms in Ath Mansour ( the granary of Selloum which is represented also on our map but it does not make part of our region of study but just to have an overview of the settlements, I traced the whole plan)</td></tr>
<tr><td>Mederssa : no</td></tr>
<tr><td>Oil mill : yes</td></tr>
<tr><td>Cemetery: was not visible</td></tr>
<tr><th colspan="3">Water management systems</th></tr>
<tr><th colspan="2">Waterworks</th><th>Natural sources</th></tr>
<tr><td colspan="2">Saguia: yes, the one coming from Ahsa, Tajmount ( thawrirt) and which provides Aourir Mimoun and Idharen with water</td><td>Springs: yes, maarqued with point gps 130.</td></tr>
</table>

| | |
|---|---|
| Water channels: No | River: yes |
| Wells : No | |
| Dam : No | |

| **Rites** | |
|---|---|
| Liturgical: Not specified in this region during the survey | Linked to marriage: This practice is common to the Ighoussar, on the first day, the spouse has to water the plants in the garden. Emblematically could this be assigned to fertility? , or more literally to prove that she is capable to help with domestic labors ? |
| Linked to agriculture: Not specified in this region during the survey | Linked to burial: graves are delimited using flagstones put horizontally and joined together with an earth mortar, and one central rock, the practice here is to dig into the ground then cover the body with flagstones then earth on top of them. The idea behind it is first to protect the body from the hyena, and also for the landslide during winter. |
| Linked to Pastoralism: Not specified in this region during the survey | Other: |

## Sheet N11

| | | | | |
|---|---|---|---|---|
| **Card index N° :**<br>**4** | **N° of the Entity:**<br>**11** | **Date :**<br>**30/06/2019** | **Commune :**<br>Rhoufi | **Place known as:**<br>Titchelt |
| **Geographical coordinates:**<br>Latitude 35° 03′ 29″ N<br>Longitude 6° 10′ 07″ E | | **GPS coordinates:**<br>Latitude: 35° 2'48.70"N<br>Longitude: 6° 9'29.75"E<br>Altitude: 631-647m | | **Social Linage:**<br>Ath Mansour |
| **The fabric of the village** | | | | |
| **Regular :** no | | **Dense :** yes | | **Position:**<br>Grouped and very compact habitats<br>**River stream:**<br>Sinuous |
| **Economical mode** | | | | |
| **Organization:** Ighoussar (Ghouassir) | | **Fraction:** Ath Boultef | | **Land:**<br>Titchelt |
| **Logic of implantation of the villages** | | | | |
| Machta: No | | Perched: yes | | |
| | | Stepped: Yes | | |
| Dachra: yes | | Semi-troglodytic: No | | |

**Situation of the village:**

**North:** River

**South:** Ahmar khadou

**East :** Souf N'Taiazit

**West:** River

| **Roadway system** | | **Boundary Demarcation** |
|---|---|---|
| **Roadway** | **Usage** | Topographic : Typical in the region, the boundaries are marked topographically |
| Principal : No | Pedestrian: yes | Vegetative : No |
| Secondary: No<br>. | Mechanical: No | Fence : No |
| Impasses: Yes | Animals: donkeys, mules, hinnys , horses. | Water : From the southern part at the bottom of it we find the thalweg. |

**Landuse**

| **Landuse category %** | <10 | 10-35 | 35-50 | 50-75 | 75-100 | **Landuse activity** |
|---|---|---|---|---|---|---|
| Agricultural | | | x | | | Cropland : is rotating as the crop lands are supposed to be in Mezghanane |
| Natural vegetation | | | x | | | Pasture: is grazing and animals are limited to goats only |
| Residential | | | | | x | Dwellings : Are multiple in a way that a room is always added to the primary nucleus once a new person is added to the family : wedding for example, and don't follow a specific orientation. |
| Commercial | x | | | | | Gardens : yes with plum. olive trees |
| Ranching | x | | | | | |

| Basic frame | | |
|---|---|---|
| **Number of houses:**<br>Around 40 | **State of conservation of the houses:**<br>intermediate | **Causes of dégradation:**<br>Abandon, Rock crawling |
| **Specialized buildings** | | |
| Mosque: was not visible | Mill : yes | |
| Zaouia : No | Other: | |
| Mederssa : no | | |
| Oil mill : yes | | |
| Cemetery: was not visible | | |

| Water management systems | |
|---|---|
| **Waterworks** | **Natural sources** |
| Saguia: yes, the one coming from Souf n'Taiazit supplied the village with water. We notice also the presence of a river channel on the summit and which forms a cascade and gives on Souf N'taiazit. | Springs: yes, marqued at point 228 |
| Water channels: No | River: yes |
| Wells : No | |

| | |
|---|---|
| Dam : No | |

| Rites | |
|---|---|
| Liturgical: Not specified in this region during the survey | Linked to marriage: This practice is common to the Ighoussar, on the first day, the spouse has to water the plants in the garden. Emblematically could this be assigned to fertility? , or more literally to prove that she is capable to help with domestic labors ? |
| Linked to agriculture: Not specified in this region during the survey | Linked to burial: graves are delimited using flagstones put horizontally and joined together with an earth mortar, and one central rock, the practice here is to dig into the ground then cover the body with flagstones then earth on top of them. The idea behind it is first to protect the body from the hyena, and also for the landslide during winter. |
| Linked to Pastoralism: Not specified in this region during the survey | Other: |

# 8. ANNEX 2

*DESCRIPTIVE FILES OF THE DISCOVERED ROMAN FINDS DURING PROSPECTION ALONG THE DIFFERENT LOCATIONS OF THE VALLEY OF WADI ABIOD*

The prospection and organization of data is following the three major natural areas, corresponding to three different categories highly influenced by the climate, topography and spatial organization i.e Northern, middle, and southern parts of the valley. This work has been carried out for the purpose to document locations in which archaeological founds from the Roman period were present during prospection:

1. Northern part of the valley

This part starts from the southern side of Mount Chelia from the Wadi takes its source and ends at gorges of Tighanimine. It includes several urban areas, in each one of them there is one or more ancient archaeological sites in Medina, Afra, Ichmoul, Arris, Belihoud, Tebandout and Tighanimine.

1.1. Afra

This location is characterized by a hilly relief and a few flat lands. It is bounded on the east by Boutlaghmin Mtn. with a height of 2178 meters, on the north by Ras al-Maris Mtn., from the east by Ichmoul Mtn., and from these mountains stems Afra, one of the tributaries of Wadi Abiod.

This area develops medium-density forests with predominantly oak trees spread in the form of a strip green which occupies areas whose height ranges between 1200 and 1500 m, below the strip there are agricultural fields, and above it, extensive pastures are spread.

The traditional village is located at the junction of the mountains foothills where the shepherds 'homes are close to the upper pastures and oversee the farms and orchards at the bottom of the village.

With regard to the archaeological aspect, an archaeological site has been discovered adjacent to the west, to the traditional habitat, unfortunately many of which have been destroyed by agricultural projects, with the exception of a few remains.

The site appears to be an unclear area, neither in its shape nor in its dimensions, and is widely scattered with pottery sherds. In addition to this, an upper part of an old mill with dimensions estimated at 40 cm in diameter and 60 cm in height was found.

### 1.2 Tibehirine

Located 500 meters from the village of Afra, between the slopes of Mount Arzaz (1647 m) from the east, and El-Qattar (2018m), Between these mountains stems wadi Tibehirine, which flows into the Wadi Abiod Valley. Since it is a region close to Afra, there is similarity and convergence in terms of climatic characteristics and location: with adequate water resources, the dense spread of forests in the vicinity of the village, and the vast pastures that extend to the borders of the water division line with the Wadi Abdi basin in the west, and fertile plains on the eastern side.

In this area there is an archaeological site located on the western side not far from the National road. The archaeological remains are not clear as it is at an advanced level of damage and nothing remains of the archaeological landmark except the lower parts of the stone blocks that form a wall support that looks from the O. Africanum technique.

Through the remaining evidence, it was made possible to determine the quadrilateral shape of the building, with a side of 3.40 m, and the distance between each of the two pillars of about 1.30 m.

Thin stone blocks are used in the construction of these pillars, and with regard to the walls built between the supports, nothing is visible.

On the western side of this landmark there is a plateau that overlooks the village of Tibehirine, in which several blocks appear carved emanating from the surface of the earth vertically, scattered and distributed unevenly without being subject to any clear architectural planning, as it follows in its distribution the directions of the topographic inclination of that land in terraces.

### 1.3 Ichmoul

The construction of this area is distributed over two sites called the first Medina and it is currently the headquarters, and which is located at the northeastern slope of Mount Ichmoul, while the old one is located in the east, about 2 km from the first. In this latter, there was a funerary Latin inscription with the following text (Found in CIL VIII 2445):

D(is)M(anibus)S(acrum)

PRIMULAE ANDERICAE V(ixit)A(nnos) XXXV

CONIVGI PIISSIMAE PRIMVLVS MARCELLVS

FECIT

Among the most important monuments in this region are the ruins of a tower located in the middle of Medina's plain, with dimensions estimated at 50 m / 30 m. Several other sites are also mentioned in the suburbs near the first site (Ballais 1989).

This area is also distinguished by its military importance, as it overlooks all the trasitional lanes and roads the connects the east and west of Aures, through the Tishtiwen Depression.

It also overlooks the roads linking the north and south of Aures through the basin of Taga and the Foum El-Toub to the outskirts of Batna, and which was a corridor of the old road that crossed the Aures and linked between Tamougadi (Timgad), Lambaesis (Lambese) and Thabudios (T'houda) , and according to Delartigue (1904), the Medina's tour was built to guard the roads crossing the valley of Wadi Abiod.

### 1.4 El Hammem

This area is located at an average distance between Arris and Ichmoul.

It is an urban area whose residential units are scattered in line with the length of the banks of the Valley of Wadi Abiod, in a narrow plain strip. It is surrounded on the west by Mount Ichmoul and on the east by Mount Zalato.

The lands of this area are fertile, especially at the proximity to the valley, and extensive pastures, the most famous of which is the Tafrant pastures in Mount Zalato. Archaeologically, there are several sites in this region dating back to the Roman period. Stephane Gsell (AAA 1911) has mentioned in the Archaeological Atlas of Algeria a Latin inscription that bears Roman names of people who used to exploit the lands of that region most likely for agricultural purposes, and were buried there (Morizot 1997). Delartigue (1904), considers that they were part of the ancient Roman army of the Praetorian division (Cohortes praetoriae), who setteled in the area.

Some ruins were also found along this area, characterized by a lack of clarity, and were divided into two consecutive sites: the first is located about 400 meters east of the course of

Wadi Abiod and occupies the top of a small hill overlooking the El Hammem and surrounded by the forest. Currently in a very advanced state of deterioration and as a result, it has become unclear due to reconstruction and reuse of its materials in a traditional rural building, the latter covering most parts of the archaeological building, and which in turn has become abandoned and destroyed. The remains of the ancient site appear in rough, imperfectly shaped stone blocks.

In a natural block there are two rectangular shapes dug regularly in the horizontal face of the rock, similar in shape and dimensions, and each one is 1.20 m long and 40 cm wide.

At first glance, the two pits appear to be excavated tombs or two water basins that may have been used for animals, or they were basins for filtering liquids, such as oil.

East of El Hammem to the western façade of Mount Zalato, agricultural lands and forests extend. Then pastures, and some traditional houses inhabited by shepherds are widely dispersed on a seasonal basis, and they belong to the inhabitants of the T'kout basin. To arrive to these lands, the locals used to travel the road via Mount Zalato and Jabal El-Harrah following their own traditional paths and did not cross Tighanimin as is the case in our present time due to the difficulty of that passage that is characterized by the narrow and deepness of its gorges. In this area, an archaeological monument was found located in the upper outskirts of this region. It is at 1.5 km from the first to the east, at about 1500 m of altitude. A traditional path passes beside this monument that still exists connecting the northeastern side of the T'kout basin and Wadi Al-Harrah to the Medina basin via Mount Zalato.

Currently the monument is in an advanced state of deterioration due to intentional human factor.

### 1.5 Arris

Located at 50 km south of Batna and currently considered the capital of the Aures Mountains, its mountainous habitats are located on a 1200 m height and on the right side of the Valley Abiod on a sloping land.

This city is located in a transition zone between a humid and arid climate, which receives the effects of the arid climate from the south and the other wet from the north. Thus, the

distribution of vegetation cover is uneven as it increases in density as we head towards the north.

In the vicinity of this city there is a varied vegetation cover dominated by wormwood. As for forests, they are characterized by a lack of density, dominated by thorn trees and decrease towards the south. As for the north and east, there is a gradual emergence of more dense forests in which oak trees are predominant.

Most of the inhabitants of Arris subsist on the cultivation practiced on agricultural lands surrounding this city, especially on the banks of the valley or in the neighboring lands and some of them depend on trade as well.

From an archaeological point of view, this area contains several sites. Gsell (1911) states that there are ancient ruins around Arris' Hospital (cut- stones) and on the southern side of the city from which the remains of a large reservoir.

In the southern district of Arris there is an archaeological site with several sections not very clear besides the central part of it, with a rectangular shape that leads to the assumption of being an agricultural site.

In the vicinity of this site there are many cut rocks, some of them have been re-used in modern and traditional construction, and others are scattered negligently.

Gsell mentioned the existence of these archaeological evidences but probably the present ones are different since they have been recently moved away. Perhaps those that Gsell was referring to, were destroyed by the urban expansion in the area. The most famous archaeological evidence in Arris is the inscription of Masties, also called the Inscription of Mastigas, discovered in 1941, today in the National Museum of Antiquities of Algiers. It was first interpreted by the historian Jérôme Carcopino and has been the subject of several studies and interest among scientists from which Pierre Morizot who said that Masties established his territory in Numidia with Arris as his residence. In order to legitimize his reign with the Roman Provincials, he accepted the title of *Imperator* and declared himself openly as a Christian after 476, as part of a rebellion against the Vandal king Huneric (Morizot, sur l'élogium de Masties, 1989).

In addition, Jean Birebent (1962) reports that several water installations were found on the outskirts of Arris, on the southern side where there are three water basins, one of them is large in size, 20 m in length, 10 m in width and depth.

The presence of a monument, where most of its dressed blocks were uprooted and only the northern part of it remained clear of about 15 meters long. As for the other walls, they are incomplete, as the external parts of them ceased to exist due to the recent re-exploitation of the place. This is what caused most of the blocks to be pulled from the old site and reused in traditional buildings, represented by a traditional house built on the southwestern edge of the archaeological site.

Depending on the description of the parts and evidence that are still clear, it can be distinguished that it has two components: the first is the outer wall, where the lower parts of its pillars are visible, and it was built in a straight line that ends at a right angle on both sides. Starting from the northeast corner, the foundations of the wall pillars are shown at a right angle. The southern wall begins and exceeds 20 m in length, and the dimensions between the pillars in both walls are unequal, ranging between 80 and 100 cm, as they are close to each other, which allows building a high and solid wall.

The second section occupies the southwest corner and consists of several internal divisions characterized by the convergence of dimensions between the pillars as they do not exceed 50 cm and their blocks are characterized by their large sizes. This gives the idea that the wall on this side is thick and strong. In the center of this part there is a reservoir built with stone slabs about 10 cm thick. Its side is approximately 3 m, its depth exceeds 50 cm. *Opus. Africanum* technique was used in the construction of the walls of this building.

### 1.6 Blihoud

This agglomeration is located at 7 km south of Arris, and currently made up of two tissues (traditional and modern). The first is located on a medium-rise plateau that directly overlooks the adjacent lands to the left of the valley stream. The second is modern and is located between the right bank of the valley and the national road.

The area is characterized by a hilly configuration opposite at the pine forests on its eastern side, which extends to the height of 1500 m, and on the western side are the heights of Mount Kroma, which extends towards the north.

A semi-humid climate prevails in this region, which tends to be arid with a weak vegetation cover in terms of growth and density, while the forests of the region consist mainly of juniper trees, and in its northern side grow forests of pine trees whose density increases in the upper levels. These forests are exploited as pasture. The inhabitants of this region live on farming and herding in addition to orchards cultivation on the banks of the Abiod Valley.

In this area there are several sites of ancient monuments, where two sites were found, the first one to the right of the course of Wadi Abiod and the second to the left of it.

The first has an east-west direction and has several adjacent sections, but all of them are not clearly visible except for the northeastern part.

The general length from the eastern side of this site is 30 m. As for the north and west side, its boundaries are unclear, because many of its parts are not visible and not straight, as they appear as separate units. The suffixes have been added to the central building.

This building contains internal divisions bounded by well-trimmed stone blocks.

The dimensions between them are characterized by extreme variation. They exceed 2 m, especially in the walls of the northeastern part, while they decrease to less than 50 cm in the walls of the internal divisions.

On the northern side of the site, traces of walls appear, forming a different quadruple room. The direction is towards the east with a 40-degree rotation, which made its northern wall protruding from the outside to form a balcony-like shape that overlooks the course of the valley.

On the west-east side of the monument there are signs of the site's expansion that could be annexes to the main building. It is also in a very advanced state of deterioration, which does not allow for measurements to be taken or to determine its shape.

The second site, instead, is located on the left side of the valley and towards the east, about 200 meters away from the first. It is located in the middle of groves of dense trees that surround it on all sides.

The site appears in the form of a flat ground devoid of archaeological evidence. However, there is a quadrangular monument with a side of 30 m, and all the stone blocks that formed the center of the building were collected in a pile on the eastern side and another on the northern side of the site with some of the lower foundations that are still in their original

places. In its northwest corner a part of the water drainage channel made of stone and has a quadruple shape was found open from the top.

The stone blocks are remarkable for their great size and length of sizes, as they have been cut in a very tight and elaborate manner, respecting parallel measures and suggesting that they were made by a professional.

It is not unusual to find these elaborate stones in ancient archaeological sites.

In Aures, especially in the southern and western regions, this makes believe that it is a strong and important building.

The shape of the building's floor is square, and its side's size is estimated at 30 m, as it is similar to the shape of quadruple buildings that were found in Gemellae or in Leqsar and which are considered military and defensive sites (Morizot 1997) .

Moreover, it has a strategic geographic location through which it is possible to monitor all the surrounding area, as it overlooks the forests on the eastern side of the village of Blihoud, pastoral pathways present its vicinity, and orchards and water sources next to it.

A tributary of Wadi Abiod passes by the archaeological site, connected to it there is a water channel that appears fragmented along the course of this valley towards the archaeological site. The strongest possibility suggests that it was specially developed to supply the site with water.

### 1.7 Tabendot

This one is located about 10 km south of Arris, and its construction extends on either side where modern urbanization has taken the place of traditional one.

It is similar to climatic and vegetation conditions with Blihoud, and in terms of anthropic activity, its residents live on agriculture mostly visible in orchards located on the banks of the Abiod Valley.

From an archaeological point of view, there is an archaeological site that takes its name from the name of this village and is located in the region. The western part of the national road is about 10 meters away from it, and it is currently in a very poor state of preservation and most of its parts are destroyed for a modern establishment.

Pottery remains, bricks, and a facade from which remains the eastern wall of the building, a part of which is 3 m long appears, while the rest is underground, about half a meter high, consisting of stone blocks of various sizes, some of which appear as if they were reused. The building technique used is an *Opus.Quadratum*. A section of another wall that faces the eastern wall about 10 meters away from it appears.

It has a shape of a vertical facade built with rectangular stone tiles placed vertically, using a method of building characterized by the lack of mastery and control over their sizes, and these stones were not refined except in a very simple way.

Gsell, has mentioned its existence and reffered to it as a military *Fortin* or a *Vigie* (watchtower) located between Wadi Abiod and the village of Chir (Gsell 1911).

### 1.8 Tighanimine

This village is the southern border of the Arris basin of about 20km far from it , where it is closed by mountain blocks: mount Kroma from the west and Mount Zalato from the east, and between them there is a very narrow opening representing a crossing of the course of the Abiod valley, which has become very deep and narrow on this side. Claude-Maurice Robert (1938) spoke about it and described it as the most beautiful crossing, its depth is about 500 meters from the top of the mountain to the bottom.

At the northern entrance to this narrow space is the village of Tighanimine, which is a modern residential tissue, built on the ruins of the traditional and ancient buildings. Its current development overlooks directly the course of the Abiod.

A semi-humid climate prevails in this region, which is not different from its neighbors, Tabendot and Blihoud, and in its vicinity there is a lot of thorns, and wormwood, which is the most common plant.

From the archaeological point of view, there are two ancient sites in this area, the first at the entrance of the agglomeration in the north and the second is in its center.

The first is located at the northern entrance to the village on a sloping fast-drifting land that enhanced the disappearance of many of its evidences, the remains of which are walls built with *Opus Africanum* technique represented by foundations and stone pillars.

These stone blocks form features of the shape of the site, which consists of several adjacent sections with different directions that have unorganized shapes and dimensions.

Gsell states that he saw these remains, describing them as a group of scattered Roman stones.

Seeing the unclarity, it may be perhaps, an agricultural site because the remaining evidence indicates this, especially the presence of a basin in the middle of the building, but it remains only a suggestion because it is not clear enough.

A section of a road paved with natural stones emerges from this site, not exceeding 1.5 m in width. Its length exceeds a few meters and ends near the foot of a rocky hill taking southwestern direction. It could be a remnant of the old road that crossed the Basin of the Abiod Valley or it was a road connecting this site to the other one which crosses the center of the village of Tighanimine and flows into the valley.

This second site exhibits traces of a cubic pit dug in the horizontal surface of an original room, with a side of 40 cm and a depth of more than 15 cm.

2. Middle part of the valley

This part begins on the southern side of the Tighanimine crossing, and ends at South Rhassira and extends towards the east to include T'kout basin, Anasseur, and Jarlla.

2.1 Taghit

This agglomeration is located on the edges of the course of the Wadi Abiod valley, and it is a small village characterized by the narrowness and depth of its configuration that copies the course of the Wadi, as we head towards the south it becomes wider. This narrow crossing is formed at the meeting point of both Mount Kroma in the west and Zalato to the east, and on the banks of the valley there is a narrow strip of fertile lands in which irrigated agriculture is established.

This region is considered the northern limit for the arid climate that gets drier towards the south as it is an open area to the dry climatic effects that come from the desert. It is also the beginning of the northern borders for the emergence of oases, so it is often called the Taghit Oasis.

From the archaeological point of view, Taghit has many evidences, as it is famous for its Latin inscription and the traces of a water channel from Taghit's ''mouth'' about a kilometer towards the south.

Regarding the inscription, many researchers, including Gsell (AAA 1911) and Louis-Marie Rinn (1885), talked about it. Both of them agree that there was an ancient road through this strait, and it was linking Lambaesis in the north of Aures to Thabudios in the south. The text of the inscription if the following (Morizot, l'Aurés ou le mythe de la montagne rebelle, 1991):

IMP(eratore) CAES(are) T(ito) AELIO

HADRIANO ANTONINO

AVG(usto) PIO P(atri) P(atriae) IIII ET M (arco)

AVRELIO CAESARE II

CO(n)S(ulibus) PER PRASTINA

MESSALINUM LEG(atum)

AVG(usti) PR(o) PR(aetore) VEXIL(latio)

LEG(ionis) VI FERR(atae) VIA(m)

FECIT

As for the effects of the canal, the French military commander Saint-Arnaud was the first to talk about it, and he believed that it was the effects of the valley's runoff power (Morizot 1988).

There are traces of the water transmission channel near the place of the inscription and can be seen from the lower edge of the valley, and appears on both edges as if there are two channels, one on the left edge and the other in the right one.

The remains of the left channel are more pronounced and extended than the other one. It is carved in the front of the vertical rocky formation, and extends in a horizontal manner relatively inclined towards the mouth of the water stream and rises from the valley floor by about 2 meters at its beginning and about 1.5 meters at its end. The channel path appears in two continuous shapes between them, the first representing the part excavated in the rock and the second carried on columns.

The length of the first part is about 20 meters, its internal width is 40 cm, and many of its parts have been exposed to fragmentation and refraction, nothing was left of it except the

lower pillar. As for the second part of it, nothing was left of it except holes dug in the rock face formed in two parallel horizontal rows.

The holes are similar in their quadrangular shape, but they differ in size. The upper group is 15 cm, while it is 10 cm in the lower, and with regard to the dimensions between the holes, it may reach between each two holes about 80 cm horizontally, and between the upper and lower holes 50 cm.

The second part of the channel ruins is located in the right rock face of the valley course: A group of holes were drilled similarly to those of the left façade, but fewer in number. Currently only four of these holes remain, and the distance between each two holes is distinguished by their unevenness.

There is the possibility that the project of this channel was interrupted before its completion. The reasons for that could be attributed to the insufficient space in the rocky façade to enable the supply of the water channel to its end. Also, that rock mass is afflicted with many cracks and fissures, and it is not solid enough and which allows reliance on the construction of the canal and cannot bear its weight, so they were forced to abandon it and pay attention to the completion of the channel on the left side.

### 2.2 Tifelfel

Tifelfel starts in the south of Taghit and has similar climatic and vegetation characteristics as the previous one.

Its inhabitants share the right to exploit the water and the oasis lands that extend on the banks of Wadi Abiod from Taghit to Rhassira.

From an archaeological point of view, no clear evidence has emerged, because modern urbanization has expanded greatly in different places. Carved stone blocks can be seen sprawling out during the modern construction work.

Rinn mentioned two inscriptions found in this area that he thinks are from the Byzantine period. They were written during the reign of the Byzantine commander Salomon to commemorate the souls of the soldiers who died in the war against the Moors in Taghit. Both of them were in the municipality square, but they no longer appear there.

### 2.3 Rhassira:

This village consists of three neighborhoods, namely the village of Ouled Yadir, Rhassira in the center, and then Ouled Abed (see annex 3) in the South. This area is characterized by the abundance of fertile lands and available water.

Next to the modern urban neighborhoods, there are traditional rural sites, along with old sites. This indicates the continuation of human development in them since ancient times.

Many ancient archaeological evidences in this region are present, which appear in separate places indicating a large gathering during the ancient period, and most of these evidences are located between Al-Kef Al-Hamra and the Ouled Abed between them, a group of hills.

Starting with the village of Ouled Yadir, where a group of archaeological remains were found, represented by pillars in addition to stone blocks represented by doorsteps of large doors, full-part mill, and bases for columns.

On the southern side of this village there is the traditional neighborhood, and on its eastern side there is a quarry that probably were used during also during ancient times.

The agglomeration of Ouled Abed is located in the south of Rhasira, at the confluence of T'kout and the Abiod Valley. The traditional houses are all empty and neglected, and they are also built on the ruins of an ancient archaeological site whose ruins are located above a hill. The evidences are not clearly visible on this site, except for indistinct features of walls of different directions and dimensions and a hexagonal vase that has been carved with perforated norms.

The evidences in Rhassira occupy a large area and are distinguished by their abundance and diversity. Traces of large-scale facilities accompanied by funerary, agricultural and artistic artifacts, a testimony of a high level in the quality and perfection of their structures. That could be due to the ancient pathways that passed. The presence over this area of a large number of water exploitation facilities is represented by two channels to transport water, that start From Taghit and another from Chenaoura.

From these specifications, one can imagine that Rhassira was a large residential agglomeration during the ancient period.

## 2.4 T'Kout

This area is made by mountain ranges, and its head is formed at the meeting of the mountain Zalato from the west and Ahmar Kheddou from the east. The two chains diverge while heading to the southwest, the first ends in the mouth of Taghit and the second in the south of M'Chouneche and the upper part of this triangle is called the basin of T'Kout.

This area crosses a watercourse that starts from the heights of El Harrah and meets the course of Wadi Abiod in the middle of Rhasira, the upper part of it is called Wadi El-Harah, and from the village of Chennaoura, it is called Wadi Chennaoura.

A semi-arid climate prevails in this region, but it gets closer to humid whenever we get closer to the region of Chennaoura from the north east. Dense forests grow and end at an altitude of 1500 m, and at the top there are pastures spread.

From Chennaoura to the south, the semi-arid climate prevails, characterized by poorly developed and dense forests.

There are many communities in this area, the most important of which is the city of T'Kout, and Chennaoura, which are bordered by villages that have preserved the traditional rural style, some of them empty of inhabitants. Individual houses are also spread in pastoral areas and these facilities are attached to the ancient sites that are described as follows:

### 2.4.1 Anasseur

This area is located 10 km east of the village of Chennaoura and is distinguished by its high topographical level.

Its proximity to the Ahmar Khaddou Mountain are constitutes the seasonal pastures placed on its summits. There are no residential communities except for some traces of individual houses, agricultural terraces and the remnants of towers built on the ruins of the ancient site.

In this area there is an ancient archaeological site whose remains are spread on sloping land along the eastern side of the course of the Valley, little evidence remains of it, because most of the stone blocks have been moved away such as the rebuilt of a traditional castle from the northern side. Beside it, there is a grain threshing space, the floor of which is paved with stone slabs taken from the same site.

As a result of these reasons, the site is in a very advanced state of deterioration, and most of its original foundations have disappeared.

Next to the site, there are traces of agricultural exploitation, mainly consisting of large areas above the site.

The archaeological site from the south and east side, in which the agricultural terraces were built, there are two adjacent pits having the same dimensions, which are estimated at 40 cm long, and 20 cm in depth, and in front of each one there is a small circular hole with a concave depth of 10 cm in diameter.

It is not easy to discover the role of this site due to its poor preservation but it has to be said that it is characterized by its location in a high mountainous area that overlooks a large part of the mountains, which are pastoral areas with traditional paths leading to various directions, as well as water sources.

### 2.4.2 Chennaoura

This village is located 5 km north-east of T'Kout . It is characterized by the abundance of its sources and its continuous flow throughout the year. Plain strips of orchards grow in its wild forests where there are many thorns. It increases in density towards the northeast.

Urbanization in Chennoura is characterized by the proximity of traditional and modern buildings and many military centers.

The availability of water resources and the abundance of settlement evidence indicate the continuation of human activity in the region from ancient times to today.

From the archaeological point of view, the region is characterized by the abundance of archaeological evidence and its diversity, which appears in the foundations of old buildings in the traditional ones, and parts appear also under the modern buildings.

In the northeast of this village, a group of 15 holes were carved in a row on the walls of the valley. They are straight and bends on its western side to the left. Three of them are quadrangular, with a side of 20 cm, and the rest are circular in shape with a diameter of 20 cm. The distance between each two holes is between 30 and 40 cm. These holes were dug in an intersecting direction to the Wadi Al-Harrah stream in a rocky face relatively inclined to the right, covers the whole bed of the valley, and the erosion factor that results from the runoff has had an effect on the right side of the valley.

On the eastern side from these holes, there is a circular shaped archaeological testimony whose northern part was destroyed because of the paved road: a well that has a diameter of 2 meters and a wall 40 cm thick appears on the outside with traces of burning.

The walls of this well are made of cement, gypsum, stone blocks of small sizes were used using *opus Insertium* technique, which is usually used to build insulating walls, it can be a reservoir for water or non-liquid materials, and if you take into account the effects of burning, it is believed that it is a furnace. In the middle of the orchards of Chennaoura, there is a water reservoir that is still used to irrigate the orchards, and several modifications have been brought to it. Morizot spoke about it and described it as the largest ancient reservoir in the Aures, with a length of 75 meters and a width of 31 meters, which is built on a natural rock base (Morizot 1997).

There is no previous study of this basin and some of the measurements may be presented as approximate because the reservoir is filled with water, so it is difficult to take the actual measurements accurately, especially for the submerged parts.

Limestone tiles are used in the construction of its walls, with unequal dimensions, as they range between 80 and 60 cm, their lengths are equal to the height of its original walls, which is about 2 m. The longitudinal edges of the tiles are carved in the form of thin edges, and each one is placed between the two tiles, semi-cubic stone pillars of equal sizes and held together by interlocks dug in both sides.

The tank is provided with two holes, one on the northwestern side, the length of which is equivalent to the height and width of the wall. The width of one slab is equivalent to about 80 cm, and the second is located in its northeastern corner.

Halfway between Chennaoura and T'Kout, traces of a quadrangular building with a side of about 5 m are visible at the top of one of the hillocks, with a side of about 5 m, of which only the foundations of the walls are built with natural stone blocks, and some of them are trimmed with holes.

It is possible that it was a watchtower for guarding the road that connected between Chennaoura and T'Kout. The Toponymie of the region leads to the same assumption since the locals call it ''Akebaruz Nel asath'', meaning the guard house, and not far from it, and near the riverbed of Wadi Chennaoura, some traces of stone blocks appear partially trimmed and look to be counterweight stones for a press.

### 2.4.3 T'Kout

This area is located 10 km north-east of Rhassira, and it crosses the middle of the Chennaoura valley. On the eastern side, this area is surrounded by mount Aouza, 1722m high, and Zerzira Mountain, 1573 m high, covered by forests of pine.

Above this level are pastoral areas in Jaralla and in the peaks of Ahmar Khaddou Mountain.

From the western side, the foot of Mount Zalato begins, where a weak vegetation cover grows, mainly from juniper and wormwood.

Its urbanization has expanded to become a small city, and an administrative and economic center. In the social context of this region, and on its southwestern side, is the Laqasr neighborhood, where there are vast orchards spread on both sides of the valley.

From an archaeological point of view, this area is characterized by the scarcity of evidences in the center of T'kout, while it becomes widespread in the Ain el-Bir and Laqsar neighborhoods, in the first, the phenomenon of urban expansion did not leave any space in which the monuments that were there could be found.

Gsell was the only one who mentioned the existence of an ancient basin 27 m in diameter that collects water source, but it has not been completed.

### 2.4.4 Ain El Bir

Located at the southern entrance of T'Kout, the archeological evidences are a group of large stone blocks placed on the western edge of the national road. They were pulled out as a result of the urban development process, and among them appear blocks carved with protrusions.

### 2.4.5 Laqsar

This agglomeration is located 1.5 km south of T'kout. It consists of modern houses scattered among the orchards, distributed on both sides of the valley. Originally a small village, with traces of its traditional castles built on the ruins of ancient buildings.

A lot of archaeological evidence was found in this area, including a well-cut stone block 60 cm long and 40 cm wide. It bears on its facade a half-raised bunch of grapes, the length of the subject is 20 cm. There are also traces of a square-shaped building from which only its features can be seen.

Early researchers had previously talked about this building and agreed that there would be a military structure among them Rinn and Delartigue who consider the fortress of Zarbouli who Salomon has invaded in the fifth century (Rinn 1985).

Gsell, instead, doesn't see any correlation with the fortress of Zarbouli and its geographical descriptions. However, Morizot provided a theoretical description on which he relied on an aerial photography.

The most important ruins that appear widely in this area are evidences of water exploitation facilities represented by water transmission channel in line with the course of the valley from Chennaoura to Rhassira. Holes dug in rock masses found on the eastern side of Rhassira but it is not sure that they all represent traces of water exploitation facilities and a further study needs to be done.

### 2.4.6 Jaralla

The connection between Jaralla and T'Kout is done throughout a mountainous road of 15 km long. The lands of Jaralla are characterized by steepness, and are confined to the summit of Mount Buyigd to the east, with a height of 1779 m, while mount Zarzira from the north, with a height of 1573 m, and mount Kaf Afarjan from the south, and in the middle of these mountains Jaralla is located, the altitude of its lands starts from 1300m and ends at 1700 m. And below this level, forests grow and pastures.

This region is surrounded by large areas of agricultural terraces, today devoid of its inhabitants, since all of them migrated to the cities, except for a few who spend the grazing season there, and its development is gradually deteriorating due to natural factors, and its orchards have also been automatically neglected.

The traditional habitat is adjacent to many ancient archaeological evidence spread sporadically and far apart, and two ancient archaeological sites can be distinguished.

In the first appear many of the trimmed stone blocks, remains of doorsteps, and stone blocks of rectangular shapes, some of which protrude from the soil vertically, and others were uprooted from their original places.

The second site is located in the east of Jaralla, at 1.5 km from the first site, and it consists of two buildings: two adjacent squares close in dimensions, the side of each building is about 5

m, and each one consists of a single section, separated by a flat floor that looks like an area on which the two buildings open up.

There is also a path in Jaralla that starts from Lower part of the region and crosses the middle of the upper site, then continues its extension eastward through the ridges and heights of the mountain range of Ahmar Khaddou to mount El Hara and probably to Medina . This route still links Jaralla and the Anasseur. It cannot cross to the eastern side of these mountains because it is a refractive facade. However, it continue to the end of Ras Tazgaghin. Rinn mentioned the existence of a road that was originally a traditional one used by the Romans and then the Turks to collect taxes and chase the people of the mountains not subject to their rule, linking Rhassira, Laqsar and Jaralla.

It is possible that the actual Jaralla's path an extension of this road. By virtue of the presence of transit roads in this region, it is necessary to place suffixes for them, and this is due to the need to guard them.

The area is connected to commercial transportation, especially since Jaralla is an agricultural area that needs transportation linking it to the markets, and Gsell considered Jaralla's ruins having an agricultural role. This is also true with one of the results of the field investigation where remains of the counterweights of a mill were found at the upper site.

## 3. Lower part of the valley

This side starts from Rhoufi and ends in M'chouneche

### 3.1 Beniane

Located at 10 km north of M'chouneche, its urban areas are distributed separately and continuously between the course of the Abiod Valley and the National road, this region and its environs are distinguished by the abundance of topographic changes because the lands adjacent to the course of the valley has a flooded soil.

From an archaeological point of view, the ruins that Baradez spoke about couldn't be found, represented by an ancient archaeological site located 1.5 kilometers on the right-hand edge of the Wadi Abiod.

This site occupies a place with dimensions estimated at 400 m by 200 m, containing various evidences of walls remains and counterwights of a press and much of pottery shards.

However, on the edges of the rocky façade of the valley, there are traces of a group of holes in which the cranks are fixed to hold a water channel and traces of two quadrangular buildings.

### 3.2 M'Chouneche

M'Chouneche is located in the southwestern foothills of Aures. It was originally an oasis. It is a limited agricultural area with traditional habitat, and today it has become an important and wide agglomeration that transcends the borders of the oasis.

From an archaeological point of view, it contains a Latin funerary inscription (CIL VIII 2485) which is as follows:

D(is)M(anibus)S(acrum)
HOMVL(la) RAVI
LINA VIX(it)AN(nos).
N. XXV OB[…]/[…]
NM

At a distance of 3 km north of M'chouneche there are traces of a rectangular building whose name is attributed to Mount Iconia, which is located to the east of that area, this building overlooks the passage leading to the Aures across the Basin of the Abiod Valley. Morizot has suggested that it was a *Git d'etape* however, Gsell has described it as a watchtower.

Baradez, is the only one who reached it and studied it in the field, where he stated that its dimensions are estimated by 42 / 50m, it has an external door but it is not clear, it is likely to be on the southern side and contains internal divisions in the form of rooms, one of which has dimensions of 5.30 m by 4 m and all rooms are built on the sides and In the center of it is a central square. From the outside, there are traces of towers built on its four corners.

And because it is located in a low area between Mount Aslaf in the east and Mount Rous in the west, its visibility was obscured, so several forward posts were placed, one on Mount Iconia, another from the northeast, and another from the south at a distance of 1 km. This is what made these researchers consider it a military site.

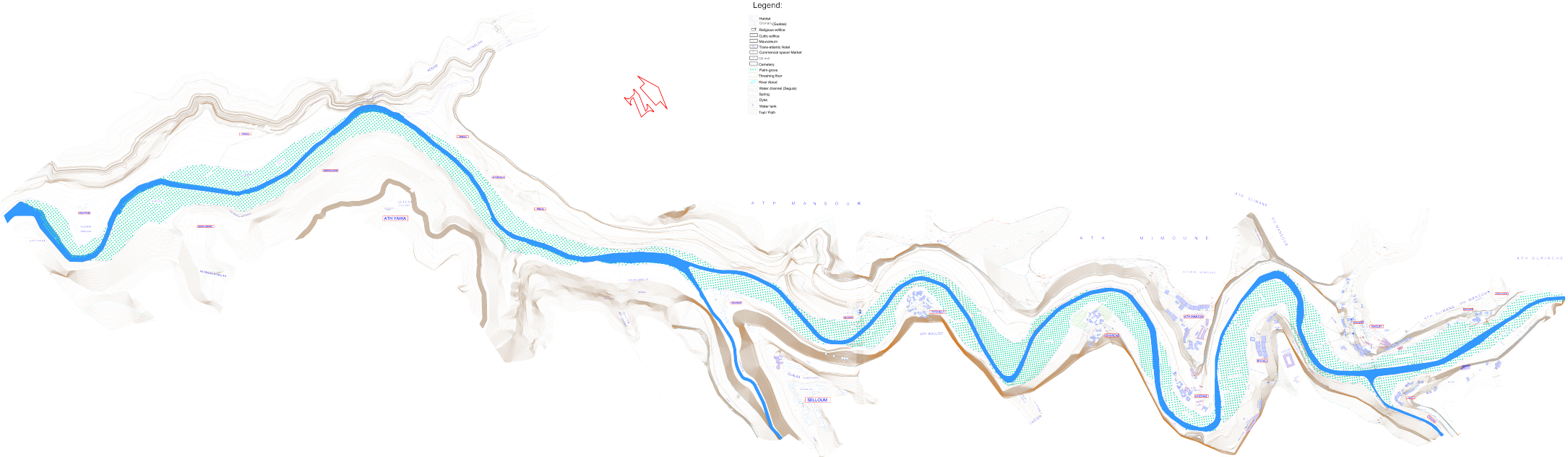
# 9. ANNEX 3

*COMPUTER ADDED DRAWING OF THE HISTORICAL SECTION FROM THE VALLEY OF WADI ABIOD*

Scale : 1/2000

Legend:

- Habitat
- Grain's (Gadas)
- Religious edifice
- Cultic edifice
- Mausoleum
- Trans-atlantic Hotel
- Commercial space/ Market
- Oil mill
- Cemetery
- Palm-grove
- Threshing floor
- River Abiod
- Water channel (Seguia)
- Spring
- Dyke
- Water tank
- Trail/ Path



# 10. ANNEX 4

*PUBLISHED ARTICLES WITHIN THE PH.D RESEARCH TOPIC*

*IOSR Journal of IOSR Journal of Humanities and Social Science (IOSR-JHSS)*
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# Survey archaeology and regional analysis: A conceptual model on the selection of past dynamics during the Holocene in Wadi Abiod, Aures, Eastern Algeria.

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***Abstract:***
***This paper inserted within a geoarchaeological study, provides a model for the investigation and the support of past dynamics of a mountainous landscape in the Aures region (Algeria) during the Holocene. It introduces the first analysis based on the detailed mapping of morphological features of the study area in relation with a typo-morphology theoretical model that was confronted with data from archaeological research. Our results suggest that the choice of the prehistorical movement processes has been driven by the outcrop of some deposits and the presence of specific landforms, such as high and low-relief areas. This approach was applied to a sector with controversial archaeological evidences (the valley of Wadi Abiod), where geological and morphological analyses support archaeological research in the reconstruction of the ancient pathways during the Holocene. This integrated approach can help archaeologists to understand and then discover ancient courses crossing complex in impervious landscapes such as the intramountain Lands.***

***Key Word***: *Geoarchaeology, Typo-morphology, North Africa, Aures, Mobility, Holocene..*

## I. Introduction

The reconstruction of past human movement's dynamics is an important issue that is often related to the morphology of a given territory, as well as, conversely, is necessarily connected to a pathway network due to its important role on past behavioral processes. These past dynamics were strongly influenced by geological, geomorphological and topographical attributes such as rock deposits, spatial extensions of watercourses, drainage networks, and slope profiles. Thus, a comprehensive evaluation of the past movement circuit should include a multidisciplinary approach, in which lithological, morphological, and hydrological study should be confronted with the archaeological analysis (Ramazzotti, 2013, 2014 a & b).

Our work aims to investigate the multiple influences of geological and morphological features on the selection of past human movements during the Holocene in an intermountain landscape. A territory constituted by a massif hardly offering north / south passages, but partially crossed by a north-east / south-west syncline depression at the bottom of which flows the river. The behavioral perspective of this study being dependent on a decisive environmental context, although unstable and little known, wishes to draw attention to the Holocene potential of the Aures region and more specifically in the Wadi Abiod valley in the Saharan Atlas.
A preliminary geological and geomorphological analysis of the region were performed in order to investigate the possible lithological, morphological, and hydrological influence on the selection of past movements' circuit in the region. These factors were analyzed at a regional (Aures) and at a local scale (Wadi Abiod valley) in parallel with a broad study of the scientific literature. Therefore, a deep investigation based on a detailed geological mapping was performed in order to verify the relations between the different stratigraphic features of rocks and the distribution of deposits.

Then, a hypothetical model of what was applied using the typo-morphology method, a widely shared and a reliable principle of landscape processual analysis, which consists in the decomposition of landscape into its elementary components and the subsequent identification of the structures and their relationships. This method is based essentially on the diachronic reconstruction of the human settlement sequences and look into the comprehension of the logic in their organization, to shed light on the location preferences and settlement strategy of communities.
In order to highlight the principal landforms during the Holocene of the studied area and their possible influence on the path system, a geomorphological analysis has been realized, from which a 3D schematic geological cross-section highlighting the valley geometry and the surrounding landscape was derived.

Topographic data have been extracted from a Digital Elevation Model (DEM) with a spatial resolution of 30 m. The information obtained was essential for the investigation of the possible factors for settlement preferences.
The above obtained data were then confronted, with parallel fieldwalking surveys of the whole territory of the studied area, to gather information on Holocene chrono-cultural ensembles. These were preserved in sheltered sites and open-air campsites, with numerous traces related to funeral tombs. The multi-millennia occupations that they attest will help to clarify the motivations of the populations to settle near rivers, springs and lagoons, notably in a geographical sector marked by a climatic disturbance and periods of drought and which had a strong impact across the Mediterranean basin without sparing the Saharan Atlas territories.

## II. History of fieldwork and research context

The research in Aures (Figure1) was almost completely interrupted after the 80's, creating an important gap in our knowledge of recent prehistory. The region suffers from fragmented prehistoric research and a full picture of the richness and diversity of local developments is still lacking (Mulazzani et al., 2016). In many cases a thorough revision at the light of new methods need to be done. Even so, the few existing data point to an important anthropic frequentation between the 9th and 3rd millennia BC during the Holocene (Alimen et al., 1979; Arlette et al., 1997; Aumassip,1986; Balout, 1955; Camps, 1963, 1966, 1975; Cote, 1991; Grebenart, 1971; Roubet, 1966, 1968, 1969, 1971, 1979, 1985, 2003).
The most known deposit since the beginning of the 21th century that has been the subject of a modern excavation is situated on the northern slope of the Aures and which is identified as the Capeletti cave. It has revealed Neolithic facies of Capsian tradition dated to 5929-4928 BCE (Roubet, 1979). However, in regards to the particular nature of the Aures, the overall occupation of the massif is not limited only to this cave or to this period. In fact, other surveys carried out by J.-L. Ballais have revealed 43 sites (Ballais & Roubet, 1981, 1982).
The data indicates an undifferentiated Epipaleolithic with abundant lamellae is more evenly distributed in the large valleys. while The Capsian was recognized in the vicinity of Mchouneche, but is much better represented in the north, in relation to the massive occupation of the High Plains by this culture. Whereas the Neolithic, outside the major site of Capeletti cave, remains poorly represented. The uninterrupted occupation of caves since this period does not facilitate prospecting and it is therefore difficult to draw any conclusions from the currently known distribution of the deposits.
Wherefore, for the comprehension of these past dynamics we have started by investigating the south region of the Aures through a prospection along the Wadi Abiod in order to gather as much data as possible related to archaeological founds from which we count seven funeral monuments of a circular or elliptical aspect, these monuments can be quite easily confused with the tumuli provided with a circle of stones at their base (Camps, 1991). Nevertheless, the difficulty of doing a proper field survey due to the escarpments, and the constant occupation of the area constitute another reason for opting for geospatial analysis for a more thorough sediments and landforms analysis that could reveal new insights on past settlements and formation processes in the versant.

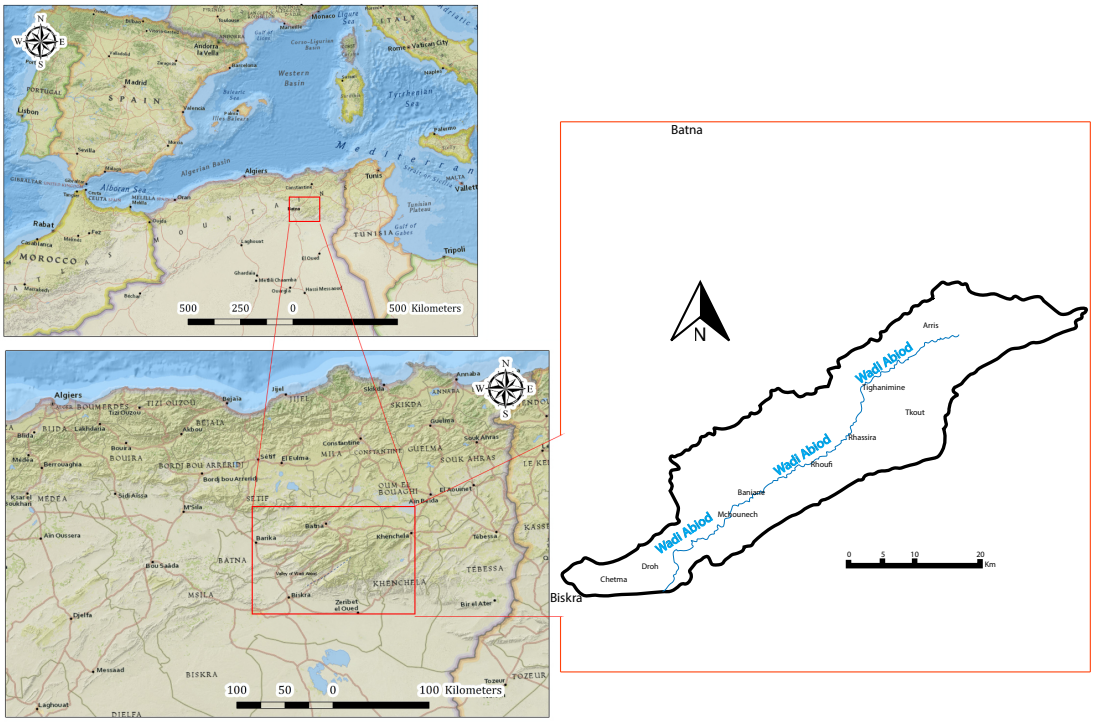


**Figure 1.** QGis basemap illustrating the position of the studied area and its delimitation.

## III. Regional geological and geomorphological context

Backed to the north to high plateaus which often exceed 1,000 m above sea level (a.s.l), the massif of the Aures (Figure2) literally plunges into steep and rugged waterfalls and escarpments, towards the south-east and south-west, that is to say towards the Saharan depression which does not reach 150 m.a.s.l.

The Massif is an eastern continuation of the Atlas Mountain System and is placed at the hinge of two large ensembles that constitute the Algero-Tunisian Saharan Atlas in northeastern Algeria (Figure.1). It is made up of a set of chains with very contrasting relief (Benmessaoud et al., 2009). It is composed of a series of tight folds which draw long rectilinear edges, made of narrow ridges and separated by deep valleys. The highest peak in this massif is located at Chelia Mtn. and exactly at " Irfen'Keltoume " with an altitude of 2326 m. The region has undergone different orogenic phases that gave rise to synclinal and anticlinal structures. The most important are the Atlasic (Upper Lutetian) phase and the Upper post-Miocene phase.

The Atlas Mountains are made up by a Meso-Cenozoic sedimentary sequence that, from Trias to Quaternary has went through a series of deformational events (folds and faults) related to tectonic stress which resulted in the development of the mountain range (Bracéne et al., 1998; Askri et al. 1995). This long tectonic history has drawn a geological limit corresponding to a multi-kilometer tectonic accident, marking the end of the North Saharan Pliocene (Marmi & Guireaud, 2006). This flexure gives the entire territory a general south-west / north-east direction serving as a major benchmark (Frizon de Lamothe et al., 1990). It generated the main morphological features (e. g. ridges, saddles, valleys, paths river) and influenced the natural landscape and environment of the area, and also these features were, probably, used as a natural pathway for moving people toward comfortable places.

The region of Wadi Abiod, that constitutes our case study, is one of the valleys of this massif, located just north of the southern Atlasic Fault, in the transitional region with the High Plateaus. It belongs to the large hydrological basin of Chott Melghir, and is formed by the union of torrents descending from the steep slopes of the highest point in the Aures of which is Chelia Mtn. and Ichemoul Mtn.(2100m). After crossing Tighanimine, it cashes in the canyons of Rhoufi and the gorges of Mchouneche, then opens a path towards the Saharan plain to the gorges of Foum el Gherza. The geological formations consist of detrital deposits of the Lower Cretaceous; argilo-carbonate deposits of the Upper Cretaceous and Jurassic; the Tertiary sediments are predominantly carbonate from the Paleocene to the

Middle Eocene, while the Neogene is essentially detrital. Lateral variations in facies are very frequent and concern all levels. While the Plio-Quaternary is characterized by the persistence of Tertiary sedimentation with the development of ablation forms, presence of crusts and the formation of a lacustrine system (Ballais, 1984).

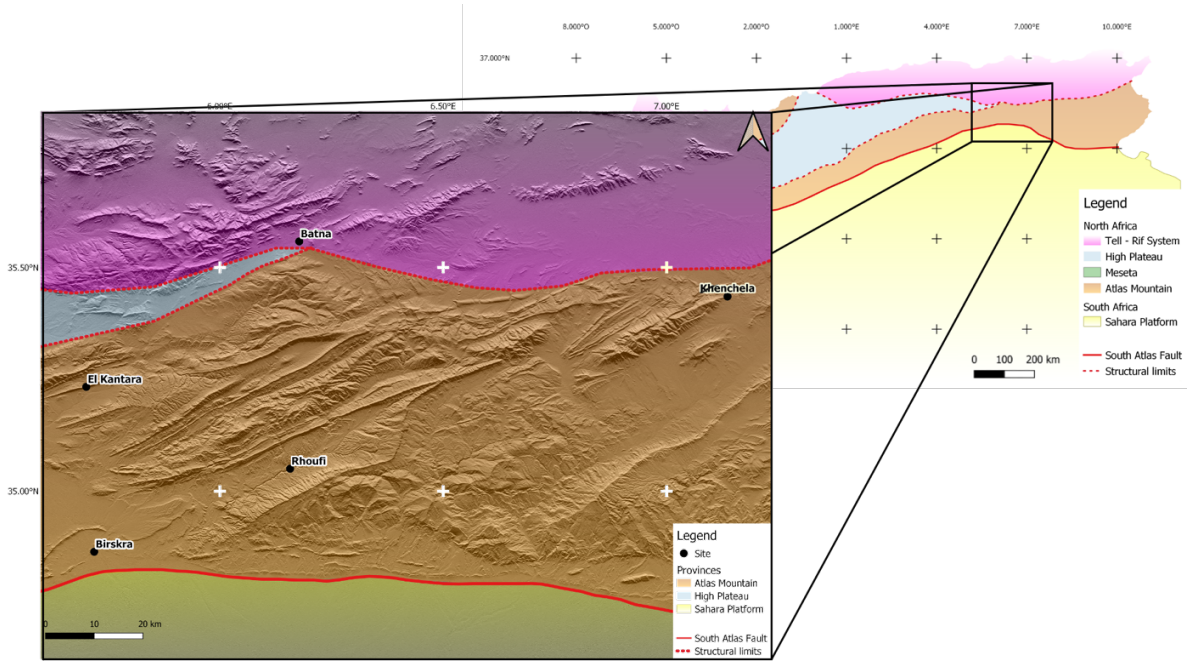


**Figure 2.** Overview of the position of the Aures in the Saharan Atlas of eastern Algeria

## IV. Slope context

In order to better understand the morphology of the area, we have realized the topographic map, reported in (Figure 3). The area is characterized by a wide range of altitudes, with the highest point above the 2000 m.a.s.l., and the lowest below the 0 m.a.s.l. We focused our attention on the Wadi Abiod valley by plotting a total of five transects (Figure 3) crossing along and through the valley: three 2D profiles (AA'; CC'; DD'); and two 3D sections (BB'; EE'). The 2D profiles were realized by using QGIS Software through a QGIS Profile Tool which extracts profiles starting from a raster layer with an elevation field; whereas the 3D sections were realized using ENVI software.

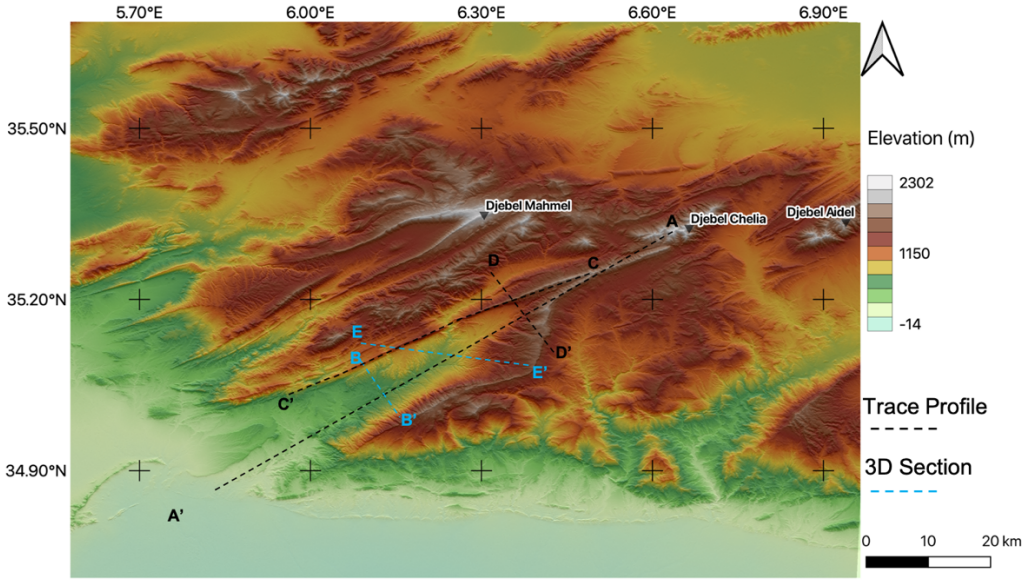


**Figure 3.** Topographic map showing the location of the five transects.

By analyzing the profile trending NE-SW (AA') and running parallelly to the entire valley (Figure 4), it is possible to divide the section into seven different parts: the first one "a", is the higher most area, Chelia Mtn which exceeds the 2000 m.a.s.l.; the second sector "b" is a little depression that connects the Chelia to the second higher zone of the area, the third sector "c", is prevalently flat region with an almost constant altitude of about 1700m. The limit to the sector "c" is located at the edge of the flat region and it represents the entrance to the valley, the sector "d", characterized by a constant downslope to SW until the end of AA'. With a focus on the bottom part of the profile, from the sector "d" to the end, we can see some distinctive traits: the sector "e", characterized by a very undulatory segment because of the river meandering in this sector; the sector "f", that represents a high structure related to the Eastern edge of the valley; the sector "g", where the profile is very low and flat because it reaches the Sahara Platform limit.

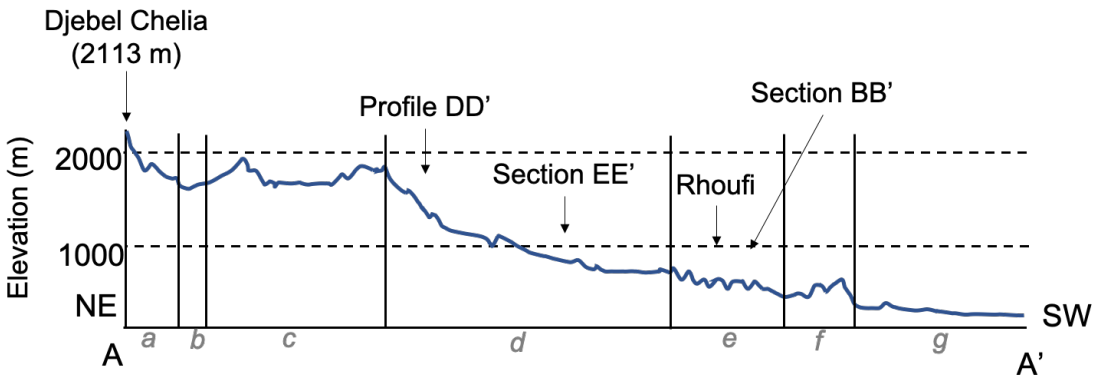


**Figure 4.** Topographic profile A-A' with a NE-SW trend running parallel to the valley. it's subdivided in seven sectors, form "a" to "g".

From D-D' profile (Figure 5) and from the 3D section (Figure6) it is possible to observe how the valley of the Wadi Abiod is a large valley characterized by a steep and narrow ridge, to the left side and a high wide ridge to the right side.

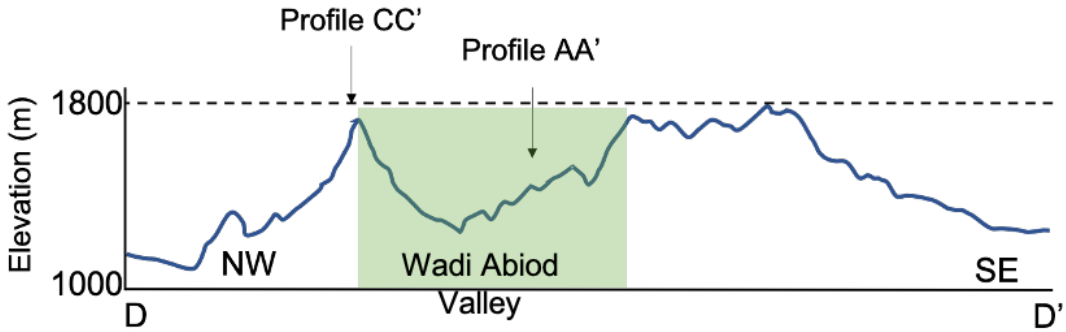


**Figure 5.** Topographic profile D-D' with a NW-SE trend that cut the valley. The valley of Wadi Abiod has been highlighted in green.

Furthermore, considering a NW – SE 3D section we emphasize the transversal geometry of the Wadi Abiod valley (Figure 6) where we report a 3D schematic geological cross-section highlighting the valley geometry and the surrounding landscape.

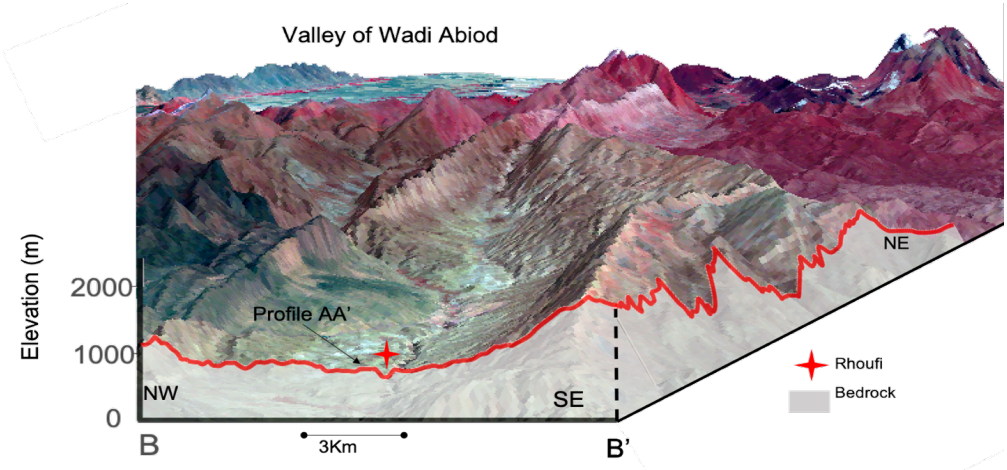


**Figure 6.** 3D view of the Wadi Abiod valley with a topographic profile (B-B' fig 1)

We focused on the orthogonal section with respect to the main axes of Wadi Abiod valley (B-B'). The river flows and cuts the bedrock. According to the geological map (Lafitte, 1939) and to the topographic profile, the valley is characterized mainly by a carbonate series with an age ranging from the Trias up to the Miocene, that include a large variation of calcareous rocks, from limestone to marl. From Lafitte (1939), the valley outcrops minor continental deposits (debris slope) on the NW side of the valley.

## V. Fluvial context

The Wadi Abiod river basin has been analyzed by a multiscale approach: a first general regional overview of the network and then a focus on the Wadi Abiod valley. These two studies are carried out based on the definition of the drainage network by Deffontaines and Chorowicz (1991): they defined the drainage network as a set of topographic surfaces which are bordered by uphill slope on all sides except for the direction of the water flux.
By using such statement, we have recognized and extracted the drainage network starting from a DEM (with a 30 meters resolution derived by the Shuttle Radar Topography Mission - SRTM) by the use of QGIS software.
To extract the main rivers and their tributaries, a parameter suitable to define the network density has to be set (Figure 7). We have chosen two values identifying the regional and local scale rivers pattern: for a regional scale we have used the parameter suggested by the QGIS User Guide, but we have changed the parameter reducing it into the local scale in order to have more information about the tributaries.

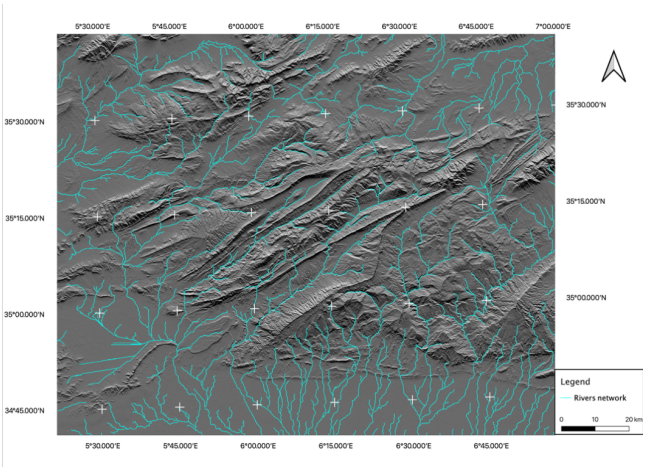


**Figure 7.** Channel network map at a regional scale with a DEM as base map.

Comparing (Figure 7) with the topographic map (Figure 3) it is possible to derive that the upper limit of the drainage network corresponds to the most elevated zone and it trends towards North – North-East and South – South-West zones respectively.

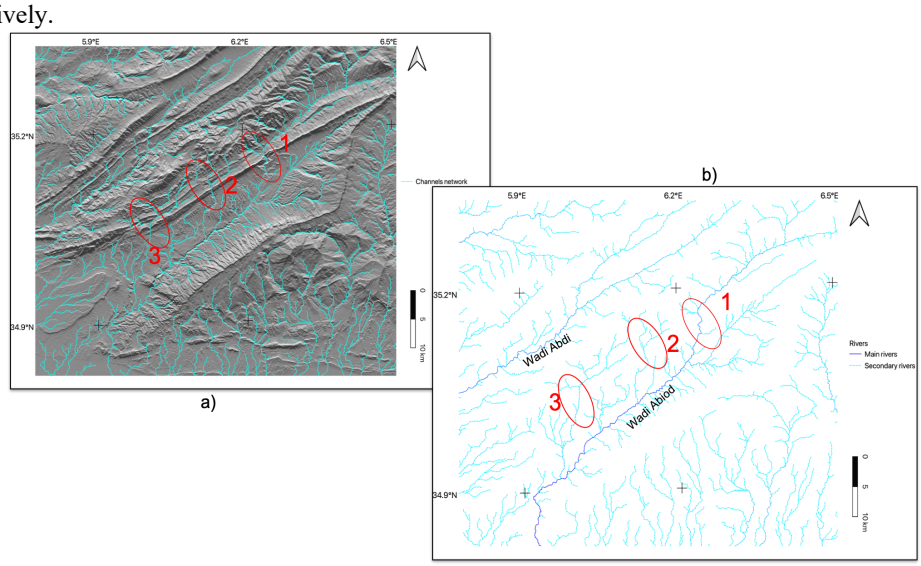


**Figure 8.** Channel network map focused on the Wadi Abiod valley. The three red circles shoe the main N-S deviations.

At a smaller scale (Figure 8) we have also identified the NE-SW trend of the main rivers (Wadi Abdi and Wadi Abiod) with a number of tributaries orthogonal to them.
The analysis performed highlights that the tributaries are characterized by longer paths and their orientation depends on the transversal tectonic elements which drives the topography in this region.
A particular N-S deviation of the Wadi Abiod river has to be highlighted (red circle in Figure 8). By a closer observation (Figure 9), we may see how the previous mentioned deviation is not the only one in the valley of Wadi Abiod.

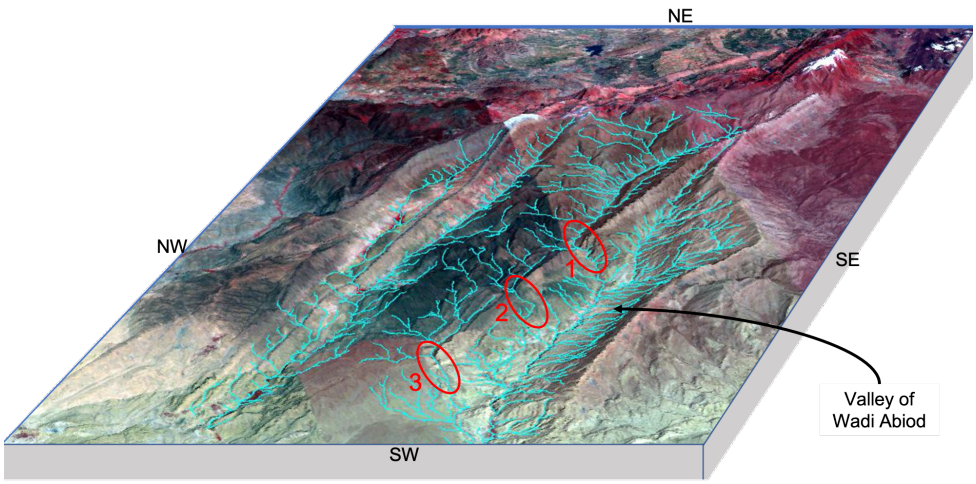


**Figure 9.** 3D view of the Wadi Abiod valley with the overlay of the drainage network (in red the three N-S trend deviations of the main river Wadi Abiod).

In (Figure 9) we overlay the shapefile of the drainage network on an ASTER image in a 3D view. This figure shows three main N-S deviations of the river Wadi Abiod that depend on the tectonic element.
These N-S deviations are recognizable tracing a NE-SW topographic profile (trace C-C' on (Figure 3) along the crest that borders the valley on the left side (Figure10) cut by the three deviations previously mentioned.

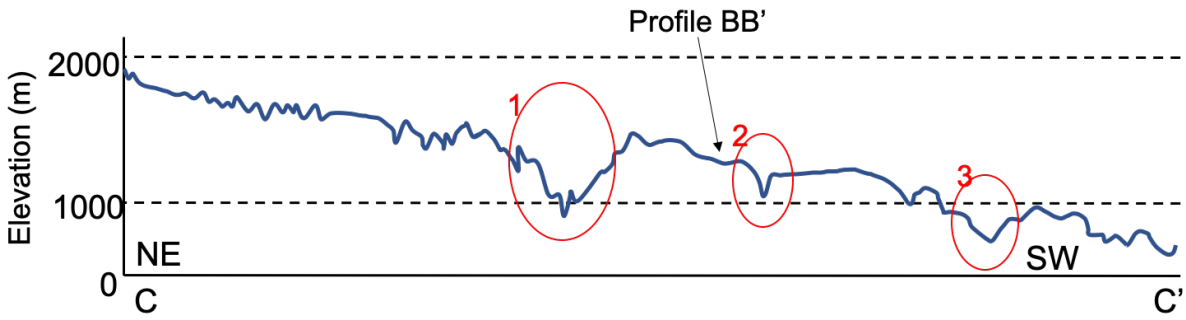


**Figure 10.** Topographic profile C-C' with a NE-SW trend running along the crest that border the valley on the left side. Circled in red are shown the three valleys formed by the river.

It is useful to focus the attention on the northern one (red circle 1 in Figure 8, Figure 9 and Figure 10). Up to us it is the most important because conversely for the others (circles 2 and 3) it connects two rivers of the Wadi Abiod (Figure 11).

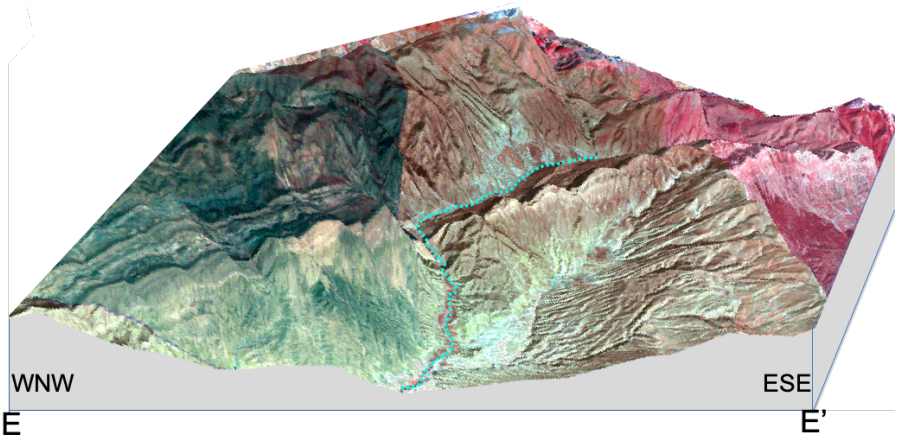


**Figure 11.** 3D view of the Wadi Abiod valley (section E-E' in' Figure 3) with a focus on the most important N-S deviation of the Wadi Abiod River

In order to extract the drainage network, we applied the Fill Sinks tool available on QGIS release "3.8" on DEM obtained by "dwtkns.com": this procedure allows to clean up the DEM by removing sinks and peaks that are usually related to the noise relevant to the used DEM, and that would capture the flow of water. A second step foresees the application of hydrogeological analysis procedure included in the QGIS used release (https://docs.qgis.org/3.10/en/docs/user_manual/).

## VI. Typo-morphological model of the human occupation

Several authors have emphasized the influence of the ridgeway for modeling the movement and it is what we apply in this study to track down the itineraries followed during prehistoric times. Indeed, the territory corresponds to the superposition of the anthropic structure (the built and non-built settings, the system of their formations and their connections which are the itineraries) on the natural structure that conditions the formation and transformation of the first. The latter is defined as a set of morphological and climatic characteristics assembled by the oro-hydrography produced using GIS tools and DEM representing the individualization of each territorial segment.

In fact, for the conceptualization of past mobility hypothesis, an initial work for the determination of the principal crest line has been performed in the region of Wadi Abiod based on the typo-morphological approach of the territory. This crest line corresponds to the watershed line between two basins (it is the most continuous and prolonged line) more significantly depending on the consistency of the underlying basins since the course along the watershed allows access to an area. This initial phase is correlated with the itinerary that past population has followed in order to better control the environment and to better understand the natural structure of the territory (Caniggia & Maffei, 2000). It corresponds to the period when man lived from gathering and hunting, moving on the main crest line dominating the territory, which makes of it the path of the first anthropic occupation of the landscape.

A second task was performed to reveal the secondary crest line, and which is located on the watershed branching off from the main crest course. It delimits tributary or sub-tributary basins within a larger river basin (Caniggia & Maffei, 2000). What characterizes this phase is the sedentary lifestyle of man, that also corresponds to the emergence of the high promontory settlements. They are implanted on hilltops; at the lowest level are the water sources. It is a system of direct connections between the relevant establishments in the same altimeter band and which also offers the possibility of access to promontories at lower altitude (Caniggia & Maffei, 2000).

In our case, for the study of the territory we had to refer to the already processed models of orography and hydrography (Figure3;7; 9) in order to have a clear idea on the possible location of the different itineraries such as

the course of the crest line and the course of the secondary crest using the typo-morphological method of the territory (Caniggia & Malfroy, 1986) as well as GIS tools.

Two main phases were depicted from the typo-morphological analysis: a first phase that corresponds to the main ridgeway which is that of Chelia Mtn. ; from this main route, two crest routes emerge, one on the chain of Takroumt Mtn. and Krouma Mtn. in the north-west and the other on the Ahmar Khadou Mtn. in the south-east. A second phase follows and which corresponds to the settlements, where there is an emergence of structures on the secondary crests and on high promontories and which are strictly connected with the source of water (the river Abiod) that is located at lower levels (Figure 12).

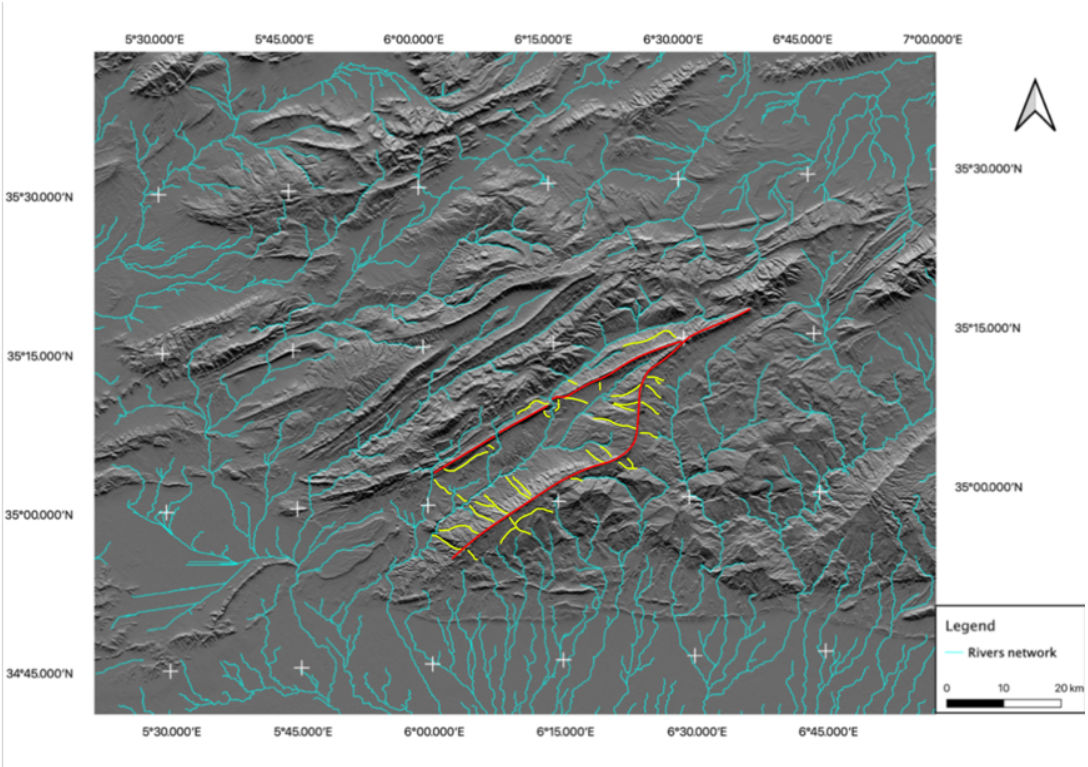


**Figure 12.** An oro-hydrographical map illustrating the main ridgeways (in red) and secondary crest paths (in yellow) of the studied area.

Consequently, by overlapping the natural and anthropic layers we observe the distribution of patterns along the area (Figure 13)

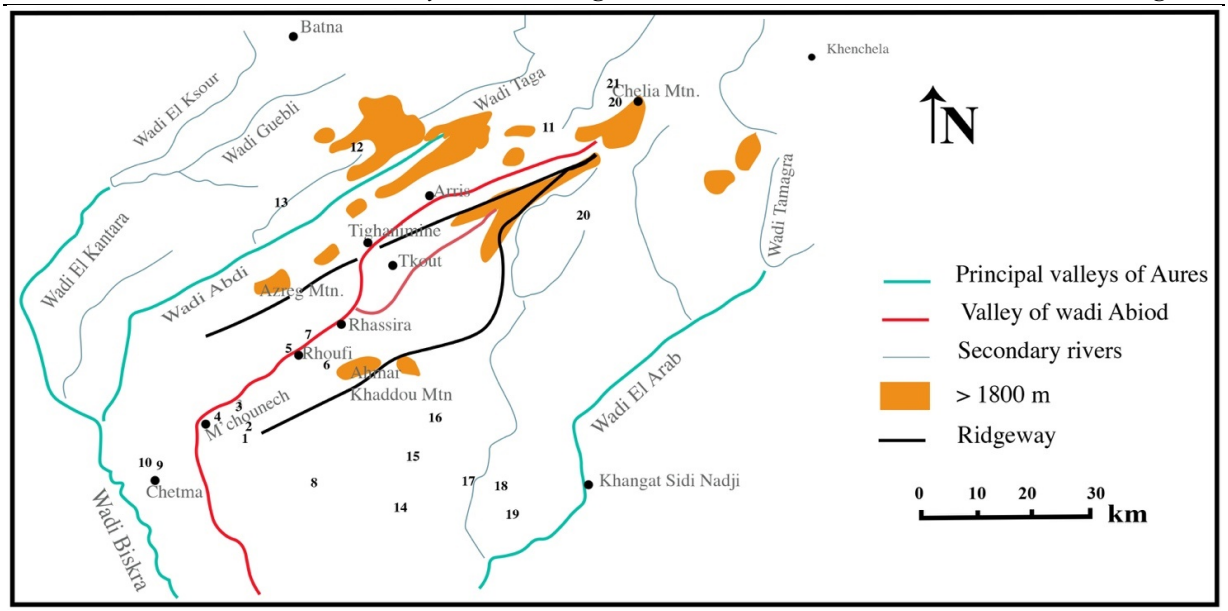


**Figure 13.** Prehistorical sites discovered within the valley of Wadi Abiod and its surroundings: Lamellae industry: 1; Epipaleolithic: 3,4, 9,11, 12,13,15,16,20,22; Capsian: 2,14,21; Neolithic: 8,19; Funeral monuments: 5,6, 7.

## VII. Valleys, terraces and alluvial plains

Changes in lacustrine levels during the Quaternary are related to paleoclimatic variations (Petit-Maire et al., 1991; Damnati, 2000; Damnati & Taieb, 2003). Methods for reconstructing these changes are based on stratigraphic, sedimentological, geochemical and palaeoecological studies. In fact, in semi-arid regions, high lacustrine levels are frequently recorded by terraces, or by exposures of lake sediments around watershed margins (Fekri, 2007). Changes in the nature of sediments (facies) and sedimentation rates also provide an important source of information on past water levels. The presence of erosion surfaces or drying slits is correlated with low or very low water levels. Laminated deposits in some lakes reflect water stratification and high lake levels (Damnati, 1993).

To highlight the originality (Riser, 1979) of the Quaternary hinge and the role of climatic variations in Quaternary evolution, we have relied on works performed in the Aures piedmont: the passage is generally from levelling forms to accumulation forms. Indeed, covered ablation glacis or less frequently, pediments are replaced by terraces, alluvial fans and spills.

The Lower Pleistocene after the major tectonic phase, is characterized by an alternation of glacis and mudflows. The covered ablation glacis-fan changes locally into a glacis accumulation or fan. Mudflows of several kilometers long and several tens of meters are subsequently emplaced. The second glacis is generally an ablation glacis-fan covered by blocks and pebbles sometimes strongly consolidated by a calcareous cement. A second generation of mudflows is emplaced with the same characteristics as the first (Ballais, 1984). During the middle Pleistocene, the glacis achieve their maximum prolongation. The accumulation forms (accumulation glacis in the Aures) begin to replace ablation forms (covered ablation glacis) (Ballais et al., 1985). In the Upper Pleistocene-Holocene, this trend becomes generalized (terrace, alluvial cone and spreading) (Coque & Gachelin, 1975). Furthermore, the granulometry of the deposits, coarse in the lower and middle Pleistocene, become fine in the upper Pleistocene and predominantly fine in the Holocene.

Finally, this evolution highlights the existence of a fundamental climatic break at the end of the middle Pleistocene (Lacustrine phase) and other less important ones at the beginning of the lower Pleistocene and at the end of the upper Pleistocene (Ballais, 1991).

## VIII. The main features of the Holocene

Between 9500-2000 BP, multidisciplinary studies (Ballais, 1991; Mulazzani, et al., 2016; Roubet & Amara, 2015) have highlighted a series of at least four climatic episodes. A first one during the early Holocene, with a first significant arid phase (Gastropods dating gives 9500-6320 cal BP) marked by eolian sandy deposits (Ballais et al., 1979). The second record is marked by a humid Neolithic phase (6320 ± 120 cal BP) (Roubet, 1979) of a slow and regular river flow and a Mediterranean vegetation. At the same time for the Eastern Chotts, the rise of their less saline waters could rise and approach the Aures foothills, also watered, making it difficult to go around the massifs (Aures) . The third episode is marked by a dry phase starting from (4320 ± 120 cal BP) (Ballais, 1979) where eolian deposits reappear accompanied with a mechanical weathering. Finally, a sub humid phase (2700 ± 120 cal BP) (Ballais, 1979) marked this episode with a fine, brownish deposit on the slopes where it constitutes most of the silt in Wadi Abiod, followed by erosion of soils and emergence of tilbutaries due to anthropic activities. This doesn't exclude other phases of Eolian depositions in the last centuries (Barades, 1949).

## IX. Conclusion

The combination of human activities and climate factors in Wadi Abiod had notable consequences for the distribution and dynamics of communities and landscapes. In fact, within the data presumably relating to the prehistorical period, there appear to be morphological differences in types of sites and settlement patterns.
The different ridgeways so far recognized are linked to cultural choices involving successful adaptation phenomena to local environmental diversity and Holocene climatic fluctuations, and suggests that the settlement was probably not a permanent one: in the early periods, humans in the region were mobile. Therefore the settlement was not habitable, but more likely practical.

The Wadi Abiod, a major river artery of the southern pre-Saharan territories of eastern Algeria, played a decisive role during the upper Pleistocene and Holocene. Tectonic activity transformed the landscape, giving an orientation to this river, which continues to feed the western chotts. This waterway has remained a traffic route linking the foothills and valleys of the South Atlas Mountains to the southern grassy plains. It has facilitated and directed the movements of men and fauna towards the interior and exterior of the massifs. The archaeological evidence that has been recovered from previous studies and from the field consist of visible surviving and recorded materials (Lithic industry, Sepultures). Current data show an important prehistoric variability. The prehistoric sites are located downstream and on the mountains, a long term trend, with special emphases on preferred locations becomes comprehensive with the climate fluctuations. The culturally identified context show that these displacements date back to the end of the Lower Pleistocene (Acheulian), and that they continued to vivify these territories during the Holocene. Thanks to dated settlements, a strong anthropic presence was noted during the Holocene phases. The presence of abundant and varied lithic testimonies that these societies has left are excellent indirect evidences of varied and abundant local resources. Finally, we underline the paucity of our knowledge of the periods after the 2nd millennium BC. This period is relative to the development of high promontories and the settlement of man: The presence of numerous funerary monuments bears witness to human presence, but the traces of their daily life and those of their chosen camps remain to be discovered in order to confirm a continuity of occupation during protohistoric and historic times of the territory of the Aures that is not disputable.

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# Landscape archaeology and ancient establishments strategy: Spatial analysisfor the investigation of Roman colonial territories in Wadi Abiod, Aures, Eastern Algeria

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**Abstract:**
The present article exposes the potential of a geo-archaeological approach in revealing the diversity of settlement strategies within the colonized areas according to an intramountainous landscape conditions.It attempts to understand the Roman expansion in the valley of Wadi Abiod, an important fluvial artery in the eastern Atlas based onthe reconstruction and analysis of ancient roads systems. The nature of Roman colonization in the area is currently heavily debated, therefore the paper aims to contribute to this discussion by investigating the non-urban aspect of this segment in the Aures region through a combination of all information provided from extensive fieldsurveys (from 2018 to 2020) and Geographical Information System-based analysis that were confronted with geological and geomorphological controls of the territory. the preliminary results ofthis integrated approach reveal the importance of the roads in expanding the scope of Romanization in a land crossing complex that seems at the margin of interest to the Romans.

**Key Word**:Geo-archaeology; GIS;Roman expansion; Ancient roads; South Aures;North Africa.

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## I. INTRODUCTION

The Roman political growthas empire could not have been achieved without a skillfulmaneuver system, which fostered economic exchange and information transfer. Therefore, The reconstruction of ancient roads system is important for the investigation of the Roman mobility and controlof a given territory that could be driven by past economic, social, political and military factors (Carreras, C.; De Soto, P., 2013). These networks that are often related to the morphology of a given territory were strongly influenced by geological, geomorphological and topographical attributes such as rock deposits, spatial extensions of watercourses, drainage networks, and slope profiles. Thus, a comprehensive evaluation of the past movement circuit should include a multidisciplinary approach, in which lithological, morphological, and hydrological study should be confronted with the archaeological analysis (Younsi et al., 2020).

TheAures, amassif that invaders bypass because it is not only impregnable but its inhabitants are always quick to wage warhas long been a subject of controversy among archaeologists. In reality, the space produced a mosaic where theBerbers(the Aures' inhabitants)and the Romans were side by side. In this demarcation, the range, retaining its height and its insularity, gavearguments to anethnic opposition which is therefore implied by the rejection of the Romanization.But does this refusal mean an exclusive tendency to be a belligerent? Because to read the writings relating to this situation, the relationship between the local groups and the Romans was a warlike interlude. However, neither epigraphy, historiography nor even archaeology was directed at such an assertion.

It has to be said that the Romans displayed a certain indisposition when it comes to invading mountainous areas. The evidence that in Algeria, compared to the surrounding plateaus, the Aures seems to have remained on the fringes of Romanization. Nevertheless, the framing of its reliefs was speculated in order to avoid any disturbance or incursion. Yet had it been introduced for defensive purposes?

The purpose of this contribution does not pretend to escape this controversy. Moreover, it is useful to present another reading of this ancient history by focusing on the territorial development of a segment located in the southern part of the massif considering that the ancient cartography of peutingerthat is available is still considered insufficient.

If the first Roman road layout was designedto favor contact between Roman citizens and colonies so how was the situation in the valley of Wadi Abiod?

Toinvestigate the possible Roman expansion in the valley a geo-archaeological approach has been applied on this sector. A preliminary geological and geomorphological analysis of the region were performed to investigate thelithological, morphological, and hydrological influence on the selection of the mobility's circuit in the region. These factors were analyzed at a regional (Aures) and at a local scale (Wadi Abiod valley) in parallel with a broad study of the scientific literature. Therefore, a deep investigation based on a detailed geological mapping was performed in order to verify the relations between the different distribution of deposits and the archaeological founds.

Topographic data have been extracted from a Digital Elevation Model (DEM) with a spatial resolution of 30 m. The information obtained was essential for the investigation of the possible factors for settlement preferences.

The above obtained data were then confronted, with parallel and thorough prospection along the Wadi Abiod in order to gather as much data as possible related to archaeological evidences from the Roman period and which were confronted with literature and documents such as Peutinger's table of the Roman road networks as well as epigraphical data found in the Corpus InscriptionumLatinarum(CIL. VIII)related to North Africa.

Data collection and management, were also conducted using spatial analyses and Geographical information System (GIS) that were applied to shed light on the location preferences and settlement strategy of communities for the understanding of past social processes.

## II. RESEARCH CONTEXT:

At the beginning of the second century, the Romans entered the foot of theAuresmountains, and this occurred in many phases. Throughout these periods , many changes and additions have taken place in the North African landscape.

There is not enough evidence to tell us about the state of the Aures and its residents during the first century, but it appears that it was the same as long as the expansion of the Roman occupation had not yet attained the slopes of theAures mountains. All these hypotheses put forward by contemporary historians are likely to be considered insufficient. However, it should be pointed out that too often the lack of precision and confusion complicates the reading of the data: this is the case of the local people who practiced transhumance and who were attributed to either Gaetuli or Musulam tribes. It should also be remembered that these tribes when their customary law was disrupted, the revolt was quickly adopted.Thisfactreveals not only the attachment of these tribes to their freedom but also to their land (Bouchareb, 2011). The Roman progression took place in a total groping process, ignoring the tribal mentality. In fact,during the reign of Tiberius, the presence of the Legio III Augusta in the region was accompanied by the reduction of the tribes' grazing lands and rangelands. The conflict ended with the redistribution of land on both sides. However, the Romans, probably understood the vital importance of the grazing lands for the transhumant populations and this consecrated relationship to territoriality was also well thought out afterwards.

Consequently, theRomans adopted a strategy based on the framing of this massif by routes marked out by military settlements. Thus, from Theveste, a road was built along the northern foothills to Lambaesis, the final settlement of the Legio III Augusta. They applied the same formula on the southern foothills; from Ad Majores (near Negrine), a road went south from Vescera (Biskra) to Thabudeos (Tobna). During the reign of Hadrian, Gemellae (Kasbat) an important post, was established further south in 126 A.D, extending to CastellumDimmidi (near Messaad) by the vexillations of Septimius Severus. Completing them with the longitudinal line that connected Thabunae to Lambaesis, these routes circumscribed the massif(Bouchareb, 2011). The valley of Wadi Abiodhas not escaped the Roman interest. Probably the most famous of the Roman inscriptions remains the one engraved on a rock at the exit of the Tighaniminegorges, testifying the colossal work carried out by the legioFerrata IV(CIL VIII 10230) in 145. Historians see it as just a work of development of the passage in the gorge, however it is possible to conclude that these efforts had concerned the layout of an entire route. Moreover, the road continued as far as Vescera and the remains of a fortress have been found at Tkout (Figure 1).

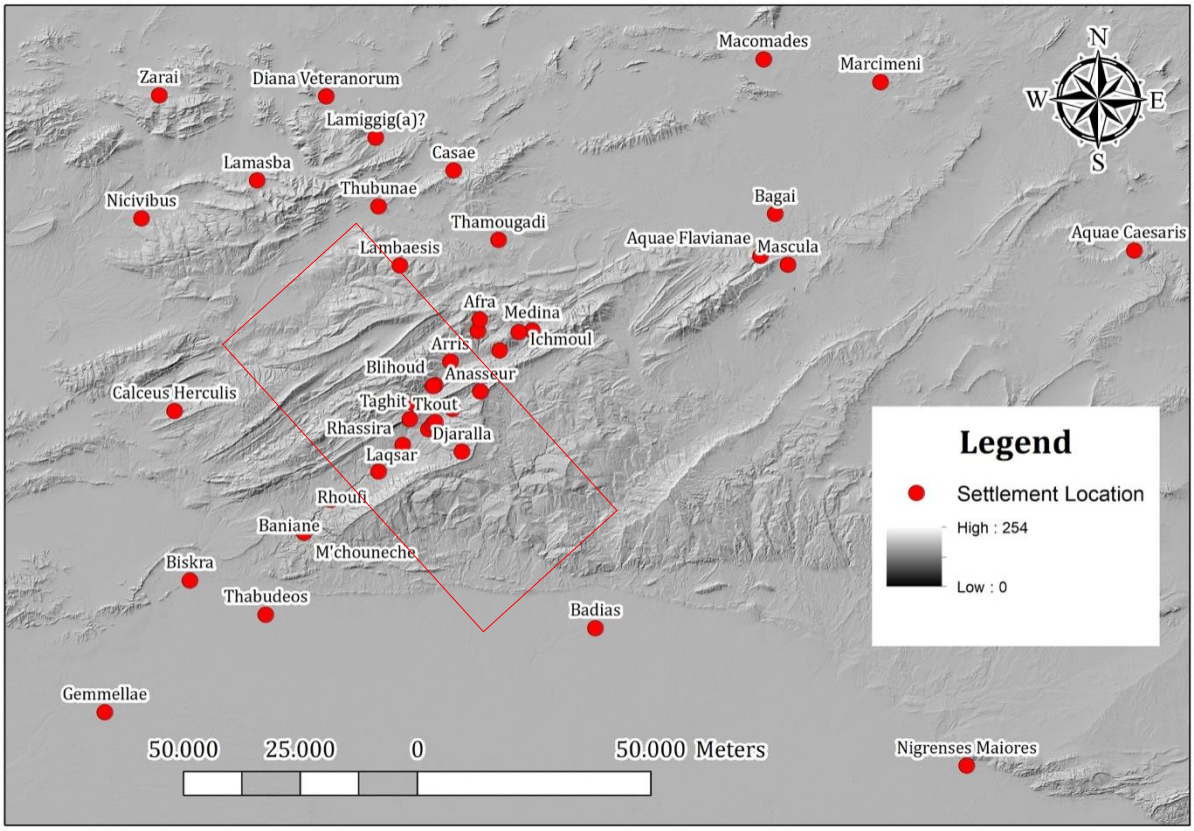


**Figure 1.**Hillshade of the study area with showing the discovered archaeological founds along the valley of Wadi abiod inserted within the red rectangle.

## III. REGIONAL GEOLOGICAL AND GEOMORPHOLOGICAL CONTEXT

The valley of Wadi Abiod (Figure 2), is inserted between Ahmar khadou and Arhan mountains (Mtns.) in the Aures. This latter is placed at the hinge of two large ensembles that constitute the Algero-Tunisian Atlas Saharan. It is limited to the North by the plain of Timgad, to the East by the Nememcha Mtns., to the South by the Saharan plains, and to the West, the Aures gradually decreases towards the basin of Hodna and its annex the basin of the Outaya.

The Atlas Mountains (Figure 3) are made up by a Meso-Cenozoic sedimentary sequence that, from Trias to Quaternary has went through a series of deformational events (folds and faults) related to tectonic stress which resulted in the development of the mountain range (Bracéne et al., 1998; Askri et al. 1995). This long tectonic history has drawn a geological limit corresponding to a multi-kilometer tectonic accident, marking the end of the North Saharan Pliocene (Marmi&Guireaud, 2006). This flexure gives the entire territory a general south-west / north-east direction serving as a major benchmark (Frizon de Lamothe et al., 1990). It generated the main morphological features (e. g. ridges, saddles, valleys, paths river) and influenced the natural landscape and environment of the area.

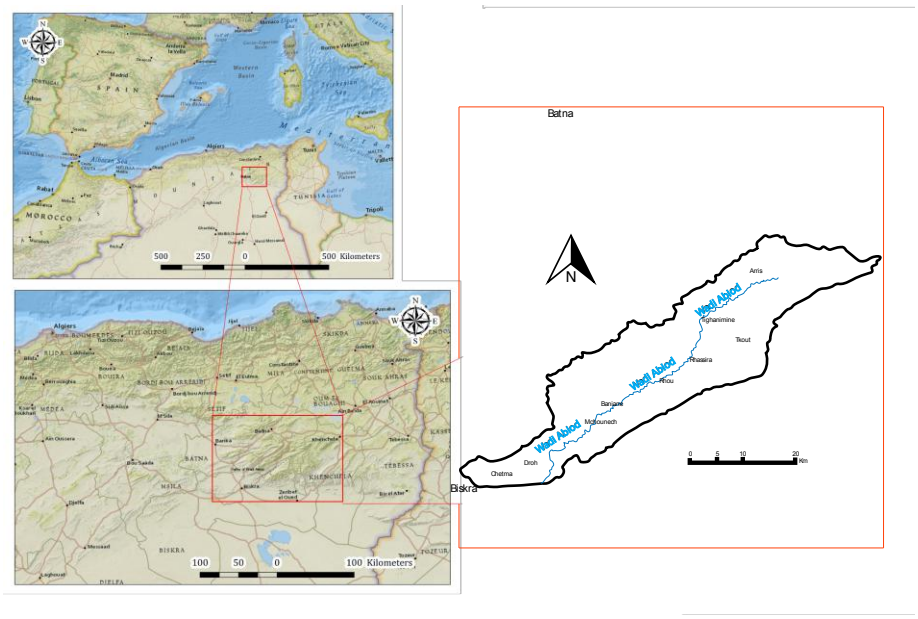


**Figure 2.**QGisbasemap illustrating the position of the studied area and its delimitation.

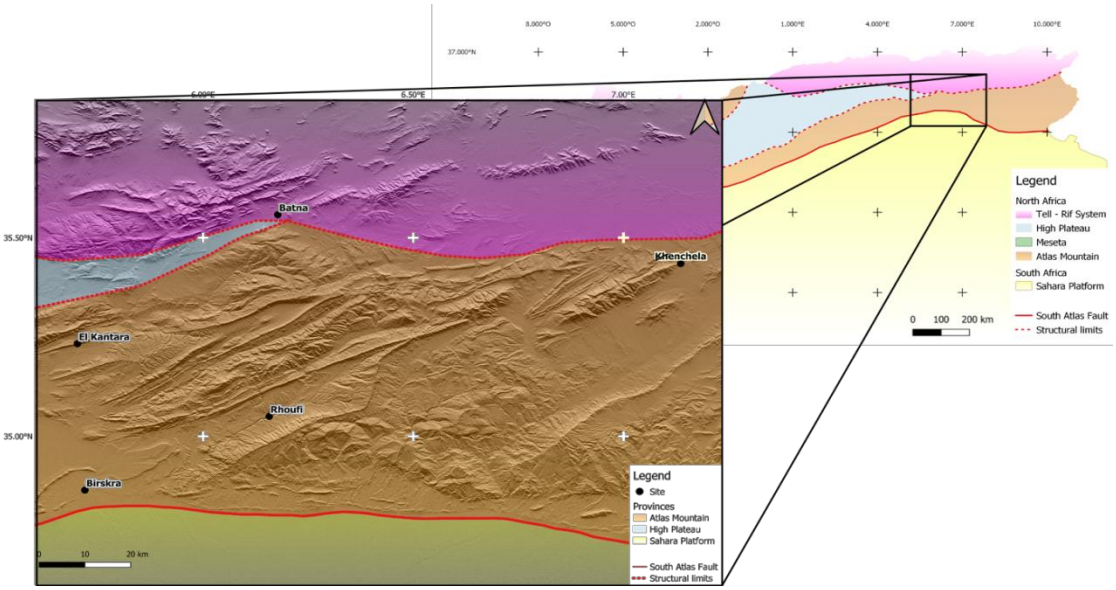


**Figure 3.** Overview of the position of the Aures in the Saharan Atlas of eastern Algeria.

The valley Wadi Abiodis one of the valleys of this massif, located just north of the southern Atlasic Fault, in the transitional region with the High Plateaus. It belongs to the large hydrological basin of ChottMelghir, and is formed by the union of torrents descending from the steep slopes of the highest point in the Aures of which is Chelia Mtn.

and Ichemoul Mtn.(2100m). After crossing Tighanimine, it crashes in the canyons of Rhoufi and the gorges of Mchouneche, then opens a path towards the Saharan plain to the gorges of Foum el Gherza.

The geological formations consist of detrital deposits of the Lower Cretaceous; argilo-carbonate deposits of the Upper Cretaceous and Jurassic; the Tertiary sediments are predominantly carbonate from the Paleocene to the Middle Eocene, while the Neogene is essentially detrital. Lateral variations in facies are very frequent and concern all levels. While the Plio-Quaternary is characterized by the persistence of Tertiary sedimentation with the development of ablation forms, presence of crusts and the formation of a lacustrine system (Ballais, 1984).

From a hydrological point of view (Figure 4), The Auresconstitutes the water reservoir that aliments the adjacent plains.The valleys in its southern part are distinguishable by their abundance in periods of rain and a total drought in the rest of the periods of the year,unlike the valleys of the northern partwhich have an abundant

level of water with a long flowing period due tothe continuous precipitations. In addition to what was said, the Auras has several springs, found in the form of headwaters flowing between the rocky layers of refractory facades and lower areas of valleys. These sources are characterized by the persistence of waterflow throughout the year.

The hydrographic network in the valley is not very dense, it consists mainly of the Abiod wadi and its tributaries, namely the Medina wadi in the North West and the Chennaoura and Tkout wadi in the North East. The wadi is formed towards the southern foothills of the Ichmoul and Chelia massifs, by the confluence of several streams which flow parallel or perpendicular to the folds; this perpendicular path seems to be due to the numerous transverse accidents which affect the anticlines of the region(Hamel, 2009).

The wadi Abiod becomes permanent with a more consistent flow from the Tighanimine gorges, It flows from North East to South West through Rhassira, Rhoufi, M'chouneche and Droh. After Droh, it enters the periclinical termination of the anticline of Ahmar KhaddouMtn. which it begins in a deep gorge that opens into the Saharan plain at Foum El Gherza which is its natural outlet (Hamel, 2009).

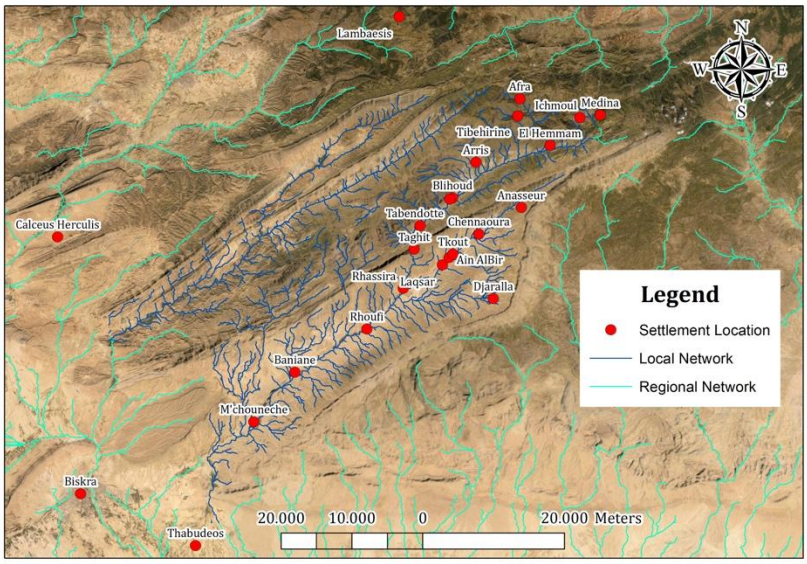


**Figure 4.** Channel network map with a focus on the regional scale processed with Qgis.

## IV. RELIEF, TERRACES AND LANDFORMS OF THE VALLEY

The Aures appears in its general form as a single mountainous mass, as a natural fortress that cannot be penetrateddue to its high peaks, the severity of its slopes, and the narrowing of its paths trapped between deep refractive grooves(2) (Figure 4).

The area is characterized by a wide range of altitudes, with the highest point above the 2000 m.a.s.l., and the lowest below the 0 m.a.s.l: it is possible to divide the valley into seven different parts: the first one "a", is the higher most area, Chelia Mtn which exceeds the 2000 m.a.s.l.; the second sector "b" is a little depression that connects the Chelia to the second higher zone of the area, the third sector "c", is prevalently flat region with an almost constant altitude of about 1700m. The limit to the sector "c" is located at the edge of the flat region and it represents the entrance to the valley, the sector "d", characterized by a constant downslope to SW until the end of AA'. With a focus on the bottom part of the profile, from the sector "d" to the end, we can see some distinctive traits: the sector "e", characterized by a very undulatory segment because of the river meandering in this sector; the sector "f", that represents a high structure related to the Eastern edge of the valley; the sector "g", where the profile is very low and flat because it reaches the Sahara Platform limit (Figure 5) (Younsi et al, 2020).

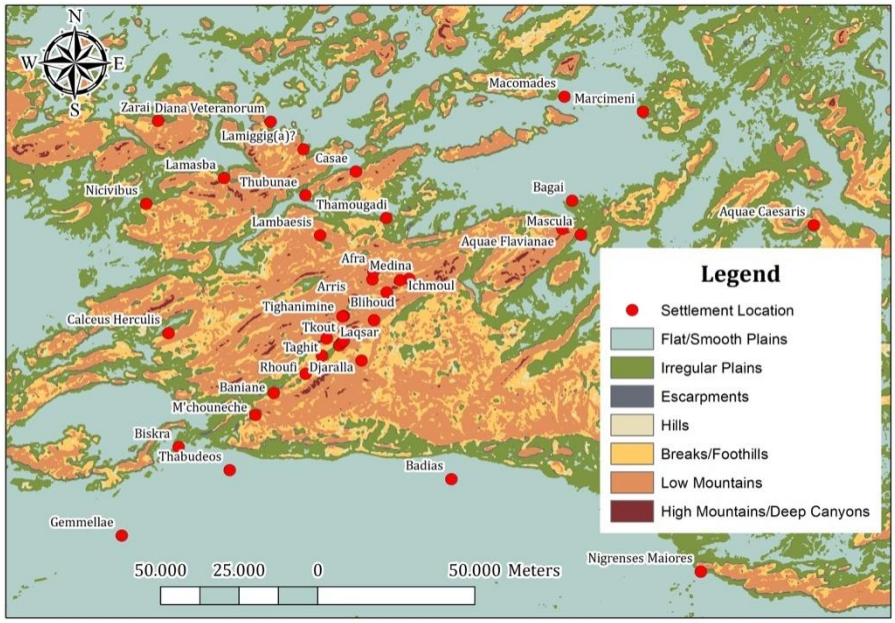


**Figure 4.**Landforms map processed on QGis, courtesy of the U.S., 2009. Africa Land Surface Forms. Available online: rmgsc.cr.usgs.gov - /outgoing/ecosystems/AfricaData/ (accessed on 12 July 2020)

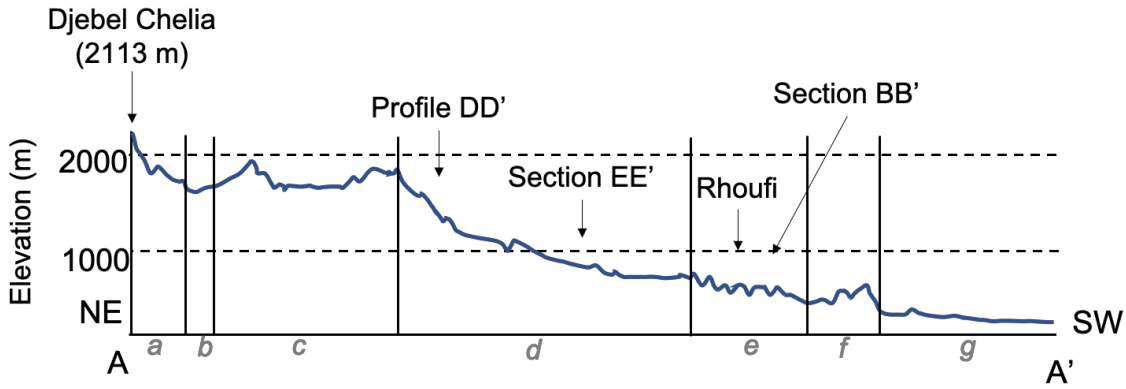


**Figure 5.** Topographic profile A-A' with a NE-SW trend running parallel to the valley. it's subdivided in seven sectors, form "a" to "g".

The terracesare accumulated on the course of a humid phase During this accumulation, pediments, fans and mudslides are formed. Then, when aridity appears, calcretes, eolian sands and gypsum crusts settle. In the Aures mountains, the Holoceneis a period of a complex deposition (ballais, 1986) characterized by the built up of new eolian accumulations. Compared to the Neolithic, the climate was following a direction of drought, eitherdue to an increase in temperature, since the frost appeared very discrete or to cultivation by transforming the natural vegetation(Ballais, 1991)around 2270 ± B.P.

By the end of the accumulation of the terrace from the Neolithic period, the Roman age of the end of the accumulation can be established based on deposits containing shards of pottery from the sigille class, or come to fill an irrigation canal. In most cases, Roman structures, especially dams, are to befounded in the upper fine deposit and remain suspended above the current bed of the wadis.(Ballais, 1991)

It was Roman colonization which, by developing agriculture and sheep and goat breeding for five centuries, that allowed the destruction of a forest made fragile by the post-Neolithic drying up (Ballais, 1991)

From the lithological point of view,the valley of Wadi Abiodhas a lithology consisting of marls, limestones, sandstones and conglomerates from the Lower and Upper Cretaceous (figure 6)

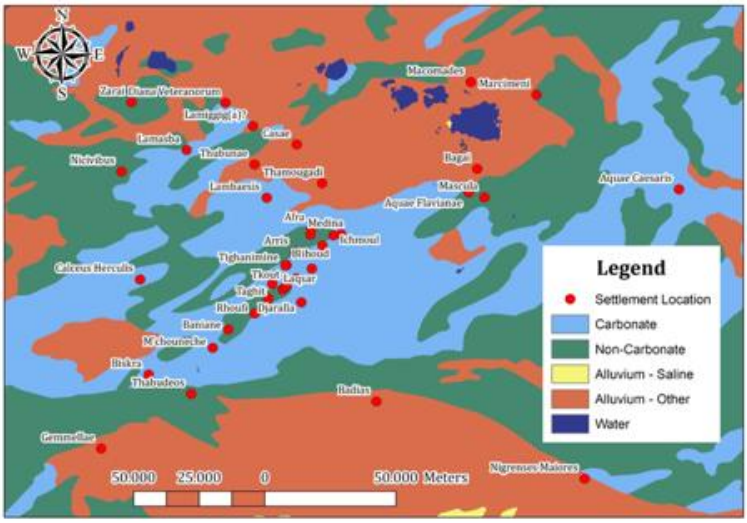


**Figure. 6**Landforms map processed on QGis, courtesy of the U.S., The Nature Conservancy, 2009. Africa Surficial Lithology. Available online: rmgsc.cr.usgs.gov - /outgoing/ecosystems/AfricaData/ (accessed on 12 July 2020)

## V. ARCHAEOLOGICAL ANALYSIS

During the second to the middle of the third century, mountainous areas and their inhabitants became the focus of Roman exploitative policy (Benabou, 1976) due to the expansion of the population that was in need of new lands especially under the reign of the Severanswho paid attention to the rural areas (Bouchareb, 2011). These circumstances made Romansrealize the importance of these mountains that offered lands and a human potential (Bouchareb, 2011)and encouraged the inhabitants to settle in and invest in agriculture. Indeed, this can be explained by the large number of agricultural sites at the expense of the military sites.

Regarding ancient roads, archaeological research has not given us sufficient evidence to form a clear idea on this matter except the inscription of the crossing of Tighanimine that stipulates a road's project on that spot and traces of a road at Jaralla (CIL VII.10230). That may be due to their disappearance over time, or that these roads were madefollowing the natural landforms of the region.

However, Baradez (Baradez, 1949)and Morizot (Morizot, 1941) believe that the Romans have followed the pre-existing traditional paths Alongside the valley. Besides, this interpretation does not apply to all sites because there are many ancient archaeological sites in high areas such as the sites of Jaralla and Anasseur.

Consequently, if we look closely to the emplacement of the epigraphical inscription that was found in the gorges of Tighanimine, that is situated south the crossing, two probabilities would rise : If the road's project was completed, this would mean that the Roman army started its work from the north, and in the case that it wasn't, this would mean that the project started from the south, and therefore the inscription was made before the completion of the project.

Hypothesizing that the work has started from the southern side would be compatible with the military camps that are spread all along the southern part of the Auressuch as the camp established before 126 in Gemellae, thus the necessity of linking these camps in short ways to the northern camps in the Aures, perhaps the first of which was through the Wadi Abiod. This also would mean that they settled in Rhassira and considered the completion of the short road's distance through the crossing of Tighanimine to the northern cities of the Aures. Furthermore,they might have stopped due to the natural difficulties they haveencountered,considering the narrowing of the crossing, the depth of the valley and the severity of its slope,and only settled an inscription perpetuating their project without completing it. Consequently, their arrival in the Aures was a precedent for the completion of the road, and they depended in their movements on following other routes that were previously used by the local population.

In Jaralla instead, the road was completed in a form of a solid and continuous gravel streak.This road departs from Lower Jaralla through the middle of the upper site, then proceeds to the east and possibly towardsAnasseur, with a width of 2.5 meters. The characteristics of this road is coherent with the theoretical conditions for the completion of the roman roads according to Salama (Salama, 1951):The Romans are forced to follow routes across heights instead of depressions in areas of insecurity in order to supervise the adjacent

suburbs surrounding the region so that the enemy can't perceive or restrict them.Grenier states also that Roman engineers were always avoiding the slopes, canals of valleys and depressions, and areas with severeinclination(Grenier, 1985). The theory of these two researchers is very consistent with the characteristics ofJaralla's site.

Based on these data, an attempt was made to re-construct this road networksalong the valley of Wadi Abiod, with the possibile of crossing a Roman path that goes from Jaralla, crossing the site of the Anasseur, Jabal Al-Hara toMedina, thento Tkout, and from it to Rhassirathat is connected to the south with M'chounech (Figure 7).

Nevertheless, the presence of archaeological sites means that there are communicating roads in which we find relay points,provided with towers to guard them, and which are established around 60km of distance equivalent to a daily journey of a horse ride.

This interpretation is consistent with Baradez' suggestion, who considers them to be part of the annexes of this road as long as it is next to it. He also mentioned that M'chounech had an ancient tower set up to monitor the human movement that was traveling its way, in addition to the sites of Rhassira, Arris, and Medina that were annexed to a principal Roman road.

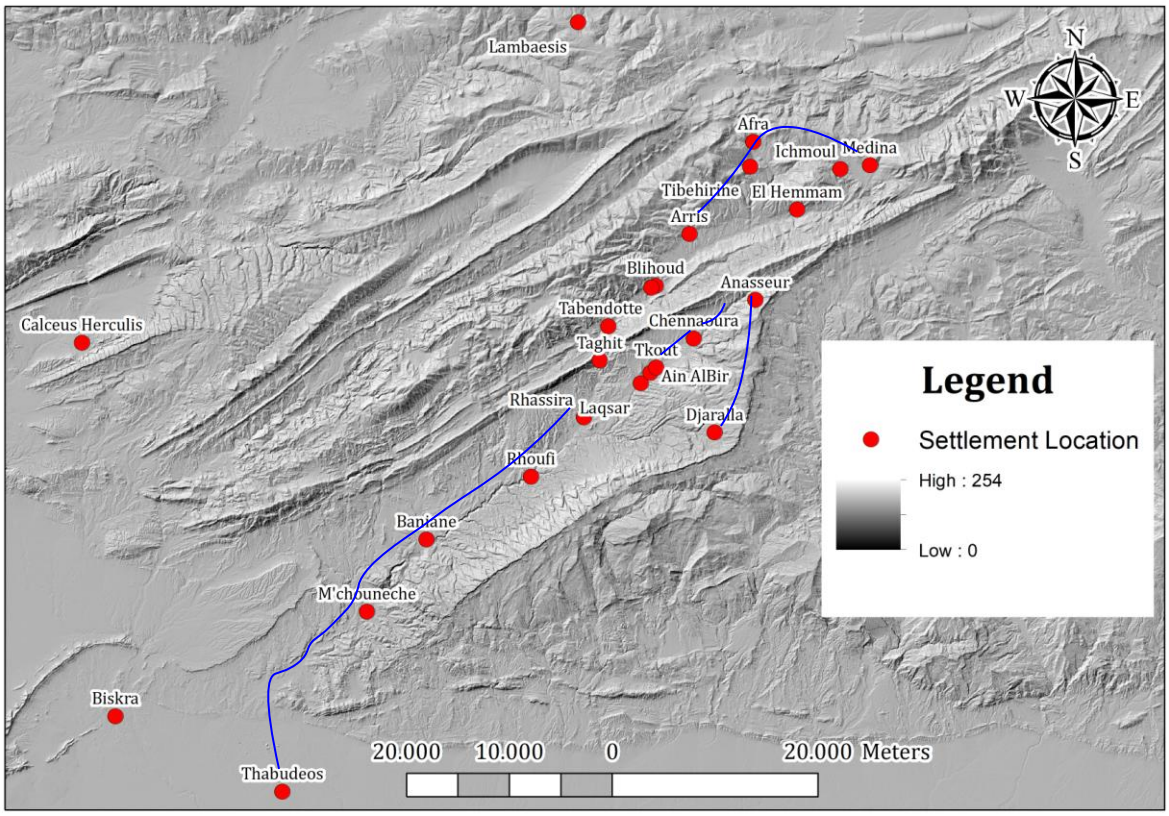


**Figure 7.** Map illustrating the reconstruction of the Road paths along the valley of Wadi Abiod ( in dashed blue lines)

## VI. CONCLUSION

Morphologically, the Aurès Massif is made up of a succession, from east to west, of several valleys with a general northeast, southwest orientation. The wadiAbiod is one of the most representative rivers of the Aurès. With a relief characterized by imposing mountains broken by fault systems of different directions, either parallel to the relief axis or transversal, giving rise to an intense hydrographic network. The semi-arid climate in the valleys and subhumid climate on the peaks activate water erosion, despite the presence of vegetation cover.

Understanding the nature of Roman roads is particularly critical for the establishment of colonies because it is a key factor in Roman expansionist and imperialist strategies developing in that period. The Aures remained in the margin of the interest of the Roman occupation, long considered as a poor land. However this didn't last for long as from the second century Rome began its expansion's project in the Aures by military operationsthat was represented in the construction of roads, from which we count the roadLambaesis-Biskrathrough EL-Kantara and then another across the course of Wadi Abiod that was provided with military

centers for observation. It is what constitutes the beginning of its entry under the Roman rule. However, the presence of these roads is not sufficient proof to say that the Aures entered under direct Roman colonialism, sincethey may have been established in order to shorten the distance between the military camps and the Roman cities between the north and the south of the Aures.

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