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Mesopotamia Beyond Tells: Documenting Agro-Pastoral Landscapes in the Zagros Piedmont (Kurdistan Region of Iraq)

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ABSTRACT

Agro-pastoral landscapes have long shaped Upper Mesopotamia, yet their dispersed, low-visibility, and often feature-dense archaeological traces remain poorly documented, especially in upland and piedmont zones beyond tell-centered research traditions. This article presents the methodological framework developed by the CArE Project of the Universities Ca' Foscari Venice and Udine for documenting the rich, endangered agro-pastoral landscapes recorded in the Zagros piedmont of the Kurdistan Region of Iraq. Conceived as a two-year pilot project, CArE integrates diachronic remote sensing, UAV photogrammetry, pedestrian survey, feature-level geodatabase recording, heritage-risk assessment, and targeted OSL sampling. Applied to the area between the towns of Faida and Sheikhan, this workflow enabled the systematic documentation of cairns, enclosures, terraces, walled fields, and modern conflict-related features within a multi-period archaeological continuum. CArE offers a scalable and reproducible model for recording, analyzing, and protecting agro-pastoral landscapes increasingly threatened by agriculture, settlement, infrastructure, and extractive development.

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Introduction

Agro-pastoral landscapes have shaped the cultural and environmental history of Upper Mesopotamia for millennia, yet they remain among the least systematically investigated archaeological contexts in the region. Scholarly research has traditionally privileged tells, urban centers, and monumental architecture, leaving upland zones, piedmont belts, and landscapes structured by mobility and seasonal land use largely underrepresented in modern archaeological narratives.

Over the last two decades, the Kurdistan Region of Iraq has witnessed a remarkable resurgence of archaeological research, with the launch of numerous international missions and large-scale survey projects (Kopanijs and MacGinnis 2016; Ur 2017). This renewed scholarly engagement has significantly advanced our understanding of urbanism, state formation, and settlement dynamics in the major fertile plains of northern Mesopotamia (Ur 2017, 183–185). However, despite methodological innovations and the widespread adoption of extensive/intensive survey and remote sensing, this new wave of research has largely continued to prioritize lowland plains and tell landscapes. Upland and piedmont zones, particularly those shaped by agro-pastoral and mobile land use strategies, have so far remained secondary to research agendas in Iraq (with few exceptions, such as Beuger et al. [2018] and, especially, Doro [2024, 2026], the latter with a profound theoretical and methodological reflection on archaeological survey in piedmont and mountainous environments) and are often treated as peripheral or marginal areas rather than as integral components of long-term socio-ecological systems (Vandam 2019, 408–411; Hammer 2025, 100–102). As a result, vast portions of the

archaeological record associated with non-urban, mobile, and mixed subsistence practices remain poorly documented, even as these landscapes are undergoing rapid and often irreversible transformation. Addressing this imbalance requires not only new datasets but also a rethinking of survey strategies and analytical frameworks that can engage with continuous, feature-dense piedmont landscapes beyond the still largely practiced traditional site-based paradigm (Ur and Hammer 2009, 53–54). This imbalance is indeed related not only to research agendas but also to methodological issues. Agro-pastoral landscapes are rarely characterized by large, stratified, easy-to-identify archaeological sites. Instead, they consist of dispersed, low-relief, and often low-visibility features, such as cairns, enclosures, walled fields, and terracing systems, embedded within complex topographies and repeatedly reused and transformed over long time spans. Conventional site-based survey strategies struggle to capture such continuous and feature-dense archaeological fabrics.

In northern Mesopotamia, particularly in the Kurdistan Region of Iraq, these challenges are further amplified by the rapid transformation of upland landscapes driven by demographic pressure, agricultural intensification, infrastructure development, and resource extraction (Mardas 2017; Morandi Bonacossi and Tonghini 2018; Morandi Bonacossi 2021; Glatz et al. 2024, 73–74; Morandi Bonacossi, Simi, and Hasan 2025, 75–78). As a result, vast portions of the archaeological record associated with agro-pastoral practices are currently at risk of irreversible loss, often before being adequately documented and studied. The Community Archaeology of Endangered Agro-Pastoral Landscapes (CArE) Project (jointly carried out by the Universities of Ca' Foscari Venezia and Udine) was conceived in response to these methodological and preservation challenges.

Designed as a pilot project, CArE aims to develop and test a scalable, replicable methodological framework to document, analyze, and protect complex agro-pastoral landscapes. The project adopts an explicitly diachronic and multiscale approach, integrating historical and modern remote sensing, UAV-based photogrammetry, systematic pedestrian survey, targeted sampling for chronological anchoring, and an integrated geodatabase infrastructure. CArE also includes an ethnographic component, developed in collaboration with local community members, to explore contemporary relationships with the landscape and, where possible, to document memories of earlier land use practices. This aspect of the project falls beyond the scope of the present article and will be discussed in a separate publication. This article presents the methodological framework developed within CArE and discusses its application to the Zagros piedmont zone in the Duhok Governorate, Kurdistan Region of Iraq. Rather than focusing on results, the article emphasizes workflow design, data integration strategies, and methodological outcomes, aiming to provide a transferable model for field archaeology in similar agro-pastoral landscapes across western Asia and beyond.

Agropastoral Landscapes of Southwestern Asia

Pastoralism and agro-pastoralism are now widely recognized as central to the social, economic, and political history of ancient southwestern Asia (Cribb 1991; Bar-Yosef and Khazanov 1992; Wilkinson et al. 2014), and recent syntheses have challenged the older assumption that pastoral communities were either materially “invisible” or structurally separate from agricultural and urban societies (Hammer 2025, with further references). At the same time, the archaeology of upland, mountainous, and so-called marginal landscapes (Orengo 2023) has expanded substantially in recent years, both in southwestern Asia and beyond (Pelisiak, Nowak, and Astaloş 2018; Garcia-Molsosa 2023; Carrer et al. 2024). However, the archaeology of agro-pastoral landscapes in southwestern Asia has developed unevenly across regions, ecological zones, and research traditions. Arid, basaltic, and desert-steppe environments in parts of Syria, Jordan, and, more generally, the southern Levant and Arabia have generated a substantial and growing literature (e.g., Abu-Azizeh 2013; Rosen 2017; Akkermans 2020), whereas the agro-pastoral piedmonts of northern Mesopotamia and the Zagros foothills remain comparatively underexplored.

At the scale of the Fertile Crescent, agro-pastoral strategies have been shown to be integral rather than peripheral to early trajectories of settlement expansion and socio-political complexity. Wilkinson and colleagues (2014) have argued that Late Chalcolithic and Early Bronze Age (but also subsequent 2nd millennium B.C.) settlement systems cannot be understood solely in terms of agricultural lowlands and urban cores but must also be understood in relation to animal husbandry, textile production, pasture, connectivity, and the exploitation of “marginal zones.” These zones should not be considered residual margins but rather historically productive landscapes in which mobility, herding, and agricultural expansion were closely intertwined. Within northern Mesopotamia, however, the direct archaeological investigation and identification of pastoral and agro-pastoral landscapes has remained more limited. One of the few directly comparable investigations comes from the Upper

Tigris in southeastern Turkey, where Ur and Hammer’s Hirbemerdon Tepe Survey demonstrated that low-density pastoral campsites, enclosures, cisterns, and related features can be documented when survey strategies are designed to capture non-mounded, dispersed, and ephemeral remains (Ur and Hammer 2009). Hammer’s subsequent work further developed this perspective by interpreting campsites, corrals, cisterns, caves, cairns, check dams, pasture zones, and water sources as elements of local landscape organization rather than as isolated features and by introducing the concepts of landscape anchors (Hammer 2012, 2014).

Comparable approaches have been more extensively developed in the steppe, basalt, and desert landscapes of Syria and the southern Levant. In the Middle Euphrates and Jebel Bishri regions, the Finnish SYGIS project (Lönnqvist et al. 2009, 2011) and the Syria–Japan investigations treated desert-steppe and piedmont environments as key contexts for understanding the long-term relationship between mobile pastoral groups and settled communities along the Euphrates. Although these studies are more explicitly concerned with pastoral and tribal landscapes than with agro-pastoral systems *sensu stricto*, they provide important comparanda because they document cairn fields, stone enclosures, campsites, and other related features through combinations of remote sensing, GIS, field survey, ethnoarchaeology, and environmental analysis (e.g., Lönnqvist et al. 2009, 2011; Ohnuma et al. 2010; Silver 2023). Similarly, work in the Homs basalts of southern Syria has shown how landscapes once described as “sub-optimal” (Bradbury and Philip 2011, 171) can preserve dense evidence for cultivation, herding, mobility, and non-tell occupation. In the Homs region, survey and remote sensing revealed a complex agro-pastoral landscape characterized by enclosures, cairns, field systems, and other stone-built features associated with Chalcolithic and Bronze Age occupation and land use beyond the Orontes Basin and tell landscapes (Philip and Bradbury 2010; Bradbury and Philip 2011).

Looking at the wider Levantine and eastern Mediterranean literature, research in the Negev, the Jordanian Badia, the Black Desert, and the steppe and arid margins of Syria has demonstrated that environments once considered archaeologically poor or, again, “marginal” can preserve rich records of mobile and pastoral land use, including desert kites, funerary monuments, campsites, corrals, enclosures, rock art, water installations, and other stone-built features (e.g., Braemer and Sapin 2001; Rosen 2008, 2011, 2017; Gatier, Geyer, and Rousset 2010; Abu-Azizeh 2013; Rousset et al. 2016; Akkermans 2020). In Lebanon and Syria, large-scale approaches have likewise shown how fields, terraces, enclosures, buildings, villages, and burial places can be brought into archaeological analysis through remote sensing and heritage-oriented landscape recording (e.g., Morandi Bonacossi and Iamoni 2012; Flohr, Bradbury, and ten Harkel 2021). Farther north, the Sagalassos Archaeological Research Project offers a useful Anatolian comparison: its work in the western Taurus has shown how highland landscapes long perceived as agriculturally marginal can be investigated through integrated survey, geoarchaeology, bioarchaeology, isotopic analysis, and modeling, revealing diachronic patterns of cultivation, pastoralism, terracing, erosion, vulnerability, and resilience (e.g., Vandam, Willett, and Poblome 2019; Vandam et al. 2019, 2023). Recent work in Arabia provides a particularly clear example of how large-scale remote

sensing, aerial survey, ground verification, and excavation are transforming the archaeology of landscapes that were only partially known until recently. In northwestern Saudi Arabia, especially in AlUla, Khaybar, and related harrat and oasis landscapes, new projects have documented extensive archaeological landscapes, including *mustatils* (large rectangular stone features), funerary avenues, pendant tombs, desert kites, stone circles, and other similar stone-built features (e.g., Thomas et al. 2021; Barge et al. 2022; Dalton et al. 2022; Repper et al. 2022). These studies are important not only because they reveal previously underexplored landscapes but also because they show how different classes of stone-built features can be detected, classified, dated, and interpreted at very large spatial scales within well-resourced research programs.

While pastoral and arid landscape archaeology has become increasingly developed in several parts of western Asia, comparable approaches remain less systematically applied to the agro-pastoral piedmonts of northern Mesopotamia. Seen from this perspective, the agro-pastoral landscapes of the Zagros foothills occupy a distinctive position within the regional state of the field. The contribution of CARe is therefore not simply to add new data from an underexplored area but to test how methods developed for remote sensing, feature-based survey, and landscape-scale documentation can be adapted to a different ecological and archaeological context.

Study Area and Project Background

The CARe Project operates in the piedmont belt of the Zagros Mountains, located in the Duhok Governorate of the Kurdistan Region of Iraq. This zone forms a transitional landscape between the high Zagros ranges and the fertile plains of northern Mesopotamia, characterized by marked topographic variability, seasonal and perennial water availability, and long-term agro-pastoral exploitation. Archaeologically, the Zagros piedmont preserves a dense, multi-period palimpsest of anthropogenic features, including cairns, enclosures, terracing systems, field boundaries, and pathways spanning from prehistory to the modern era. These features reflect the long-term coexistence and interaction among sedentary, semi-mobile, and mobile communities, as well as mixed subsistence strategies that combine cultivation, herding, and seasonal mobility.

CARe builds on more than a decade of research by the Land of Nineveh Archaeological Project (LoNAP), coordinated by the University of Udine, which conducted the first extensive archaeological survey of the eastern half of the Duhok Governorate (Morandi Bonacossi and Iamoni 2015; Morandi Bonacossi 2018a, 2018b). Due to the vast spatial extent of LoNAP (ca. 3000 km²) and the methodological challenges posed by feature-dense upland environments, the Zagros piedmont remained only partially explored. Morandi Bonacossi (2020) focused on the funerary landscape, while Conati Barbaro and Moscone (2020) focused on the chert mines and prehistoric activities of the Jebel Zawa. CARe was therefore conceived as a focused pilot project to address this gap by developing a dedicated methodological framework tailored to complex agro-pastoral landscapes. The study area selected for CARe lies between the modern towns of Faida and Sheikhan (Figure 1), where a particularly well-preserved, archaeologically dense piedmont

landscape survives. This sector lies within the northwestern Kurdistan Region of Iraq, a landscape whose geomorphological organization reflects the combined effects of Zagros compressive tectonics, lithological variability, Quaternary climatic fluctuations, and long-term human occupation (Forti et al. 2021, 2022, 2023a).

In this area, three major mountains cross the land from west to east: Ciya Daka, or Jebel Daka in Arabic, rising to 760 masl, Jebel Alqosh, reaching 1000 masl, and Jebel Essyan, rising to 730 masl. The first two have a west–east orientation, while the latter has a northwest–southeast orientation, in line with the broader structural organization of the Zagros Fold-Thrust Belt in this part of northern Iraq (Forti et al. 2021, 2023a). Ciya Daka and Jebel Essyan are characterized by the presence of a summit plateau, while Jebel Alqosh lacks this feature. The geology of these anticlinal structures is primarily composed of Eocene limestone formations (Forti et al. 2021), commonly referred to as the Pila Spi sequence (Jassim and Goff 2006). This formation is characterized mainly by well-bedded chalky and crystalline limestones, interspersed with bands of chalky marl (Kadhim and Hussein 2016; Conati Barbaro and Moscone 2020). The high solubility of these carbonate rocks has favored the development of marked karst processes, including caves, rock shelters, and springs, some of which remain seasonally active (Stevanović, Turkiewicz, and Maran Stevanović 2009; Forti et al. 2021, 2023b). Wadis descending from the mountains have carved deeply incised valleys with steep, eroded slopes. These valleys are filled with rock debris and colluvial deposits that are seasonally mobilized and transported toward the foothills by wadi floods (Conati Barbaro and Moscone 2020, 55). Similar processes have been documented in the nearby Shaikhan and Khinis area, where the interaction between anticlinal slopes, seasonal runoff, colluvial infilling, and human infrastructures shaped the post-abandonment history of the Assyrian canal system (Forti et al. 2023b). More broadly, lithology and structural deformation strongly influenced drainage organization, valley incision, and the distribution of slope and fluvial processes across the Kurdistan Region of Iraq (Forti et al. 2021, 2022, 2023a).

This geological and geomorphological setting is fundamental to understanding the character of the archaeological landscape. The abundance of locally available limestone, combined with steep slopes, shallow and discontinuous soils, and the seasonal mobilization of colluvial deposits, created both the material conditions and the practical need for extensive stone-built features (Figure 2). The region is characterized by a warm and temperate climate (classified as CSA in the Köppen-Geiger classification; Geiger 1961) and a mean rainfall of 516 mm per year (Faida Weather Station information provided by the Directorate of Meteorology and Seismology of Duhok), making the area suitable for dry farming. Following Wilkinson's formulation for southwestern Asia (2003, 41–43), this piedmont zone may be understood as a “landscape of survival,” where preservation conditions are ideal and archaeological features and relict landscapes can be best recognized. This condition, however, is rapidly changing. Although the impact of unsustainable development has been limited so far compared with other contexts, the number of agents of risk has grown rapidly over the last 20 years. The various conflicts that have affected the area in the last decade (the civil war in Syria, the establishment of the Islamic State, turmoil in

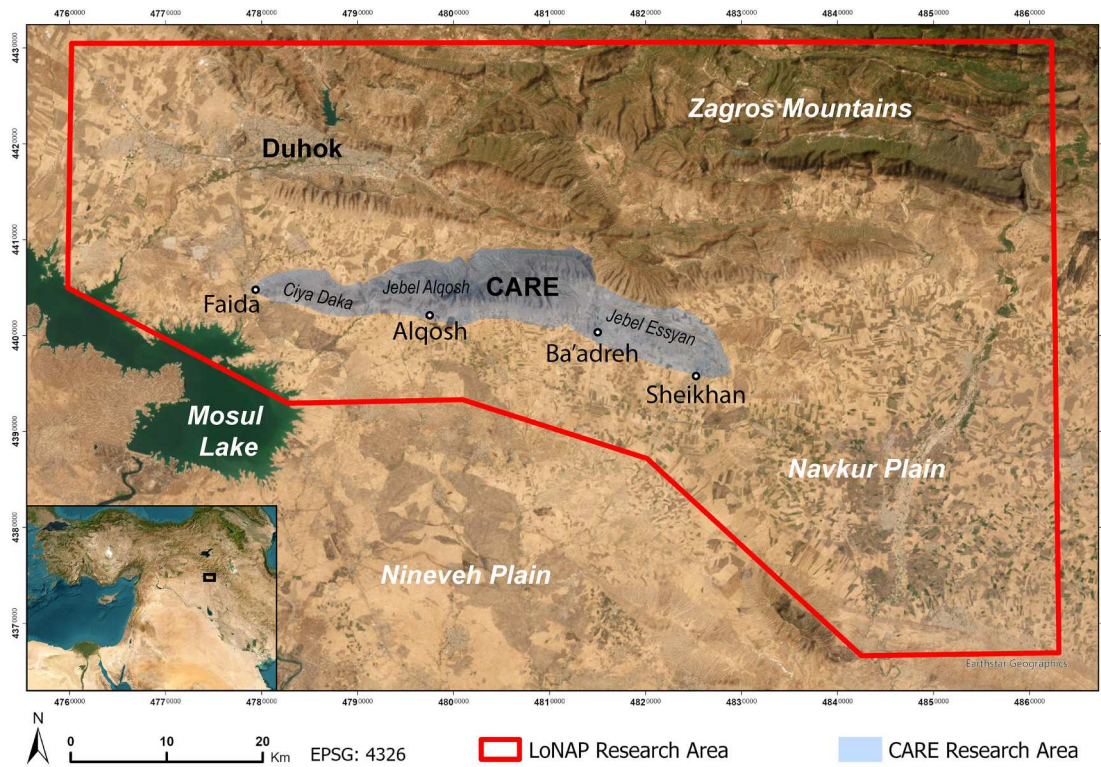


Figure 1. CARE project research area (basemap ESRI Satellite, map: F. Simi).

southeastern Turkey, etc.) have created a massive displacement of population toward the Kurdistan Region of Iraq and are putting this relatively small territory under unprecedented pressure (International Organization for Migration 2025, 10–11). Many of the new refugee camps were built in the piedmont areas to safeguard arable land and exploit the

rocky landscapes considered wasteland. An example is the Essyan Camp established in 2014 to host internally displaced people (IDP), mostly, in this case, Yazidi families who fled ISIS.¹

This area also exemplifies the rapid transformations currently affecting the region, including agricultural



Figure 2. Jebel Alqosh foothills (UAV photo: F. Simi).

intensification, infrastructural development, and resource extraction, underscoring the urgency of systematic documentation and protection. The rapid expansion of oil fields is particularly affecting this piedmont region and rapidly erasing its features. Only 59 km northwest of our research area, the southern foothills of the Jebel Bikheir, stretching between Dairabun and Hasan Hawa, which once preserved a very rich agro-pastoral landscape, were severely damaged from 2017 onward by the construction of a series of new oil extraction plants and their related infrastructure. This process can be clearly traced through the time-lapse imagery available in Google Earth Pro (Figure 3) and was also observed firsthand during fieldwork carried out by the authors in the region at the time. In this context, CArE responds to an urgent methodological and heritage need: to document and interpret a rapidly changing piedmont landscape in which exceptionally well-preserved traces of long-term agro-pastoral activity are increasingly threatened by agricultural and settlement expansion, as well as by new infrastructure and extractive development.

Methodological Framework

Conceptual approach: from sites to continuous landscapes

As mentioned, the CArE area had already been extensively surveyed by the LoNAP team between 2012 and 2018. Their approach, primarily utilizing remote sensing and vehicular surveys, aimed to analyze over a 3000 km² territory from prehistory through the Ottoman period (Morandi Bonacossi *in press*). While LoNAP identified and documented some archaeological sites, mainly cairn fields (Morandi Bonacossi 2020), the overall density and extent of archaeological features remained beyond the reach of such broad survey methods. The methodological framework developed within CArE responds to a long-standing challenge in landscape and survey archaeology: how to document

archaeological contexts in which evidence does not occur as discrete, bounded sites but as continuous, low-visibility, and functionally ambiguous distributions of features. This issue is particularly relevant in agro-pastoral landscapes, where material traces are dense, often dispersed across extensive areas, and where the boundaries between enclosures, walled fields, funerary cairns, and other features are difficult to define.

For southwestern Asia, Wilkinson's work provided a fundamental framework for moving beyond settlement-focused approaches and for treating landscapes as historically produced, materially complex, and taphonomically selective archaeological palimpsests. His discussion of the "continuous landscape" drew attention to the fact that archaeological evidence is not limited to discrete places but may form an almost continuous record across the terrain, including off-site artifact scatters, roads, tracks, fields, irrigation systems, quarries, wine presses, threshing floors, and other traces of land use (Wilkinson 2003, 37–39). A comparable formulation is found in southern Levantine landscape archaeology, as Gibson defines landscape archaeology as the study of the chronological and spatial transformation of a continuous distribution of large and small man-made features across a given landscape. In this model, the entire landscape effectively becomes the site, while settlements are only one category of feature within a broader landscape mosaic (Gibson 2003, 1–3). In the southwestern Asia context, however, this discussion has often remained closely tied to field scatters, manuring practices, and the relationship between mounded settlements and their surrounding agricultural landscapes (Ur 2010; Simi 2019, 2020).

The problem becomes particularly acute in mountainous and piedmont environments, where archaeological visibility is shaped not only by artifact density but also by the survival of low-relief, non-mounded, and often ephemeral features. Ur and Hammer's work in the Upper Tigris explicitly recognized this difficulty. They showed that Mesopotamian survey traditions, historically oriented towards tells, alluvial plains,



Figure 3. The impact of new oil extraction and processing infrastructures (Peshkabar Oil Fields DNO ASA) in the foothills of the Jebel Bikheir in Duhok Governorate. A) August 2015 and B) September 2022 (source: Google Earth Pro, map: F. Simi).

and vehicular reconnaissance, were poorly suited to the recovery of low-density and non-mounded traces associated with mobile or semi-mobile groups (Ur and Hammer 2009, 52–53). Their discussion of continuous landscapes is relevant but again focuses on sherd-density recovery, with small, low-density concentrations within a broader background scatter, potentially representing ephemeral campsites, isolated farmsteads, or disassembled settlements. This emphasis on sherd-density recovery remains, of course, important. In projects such as the Homs Regional Survey, intensive artifact collection and the analysis of off-site surface-material densities have been central to distinguishing genuine concentrations of activity from broader background noise distributions (Philip et al. 2002, 2005). The limitation arises only when surface artifact density becomes the primary threshold for recognizing archaeological significance, as, in mountainous and piedmont environments, many relevant traces of past activity are not expressed primarily through pottery or lithics distribution.

Building on decades of intensive survey, off-site archaeology, and non-site approaches, parallel debates in Mediterranean landscape archaeology have more explicitly addressed this problem through the concept of the archaeological continuum. In a recent reappraisal, Campana (2018, with further references) argues that archaeological evidence should be understood as a continuum of variable density and visibility rather than as a set of isolated sites separated by archaeologically empty space and that apparently “empty” landscapes may in fact reflect limitations of visibility, detection, preservation, and recording rather than the genuine absence of past human activity. This approach is particularly important for rural and agro-pastoral landscapes, where paths, terraces, field boundaries, cairns, enclosures, artifact scatters, installations, and activity areas often form cumulative, overlapping, and intertwined evidence. CARÉ builds on these debates but applies them to a particularly challenging, dense, stone-built

agro-pastoral landscape in the Zagros piedmont of Iraqi Kurdistan, where funerary cairns, enclosures, terraces, walls, field boundaries, and stone-clearance features form a continuous and multi-period palimpsest (Figure 4). Their density, overlap, poor chronological data, and functional ambiguity make conventional site-based recording inadequate. Rather than attempting to impose artificial site boundaries on a landscape that does not present itself as a series of discrete sites, CARÉ takes another approach to the archaeological continuum.

The project adopts feature-level documentation as its basic recording strategy. Individual features are recorded as discrete analytical units, but they are interpreted within broader spatial configurations that include clusters of related features, hydrological basins, slopes, and plateaus. This approach allows the analysis to move between the morphology, preservation, and possible function of single structures and the larger organization of agro-pastoral landscapes. The CARÉ approach is not only multi-scalar but also diachronic. It addresses long-term transformations in land use, settlement, resource exploitation, and landscape organization from prehistory through the Islamic period and into the 20th century A.D. Over millennia, different communities repeatedly occupied, modified, reused, and reinterpreted the same piedmont landscapes, producing a stratified archaeological palimpsest in which features of different dates and functions often coexist. Given the project’s limited duration (two years) and funding, this methodology was designed to be targeted, scalable, replicable, and cost-effective. This flexibility is essential in a landscape characterized by high feature density, low visibility, poor preservation, functional ambiguity, and rapid modern transformation.

CARÉ is not intended as a model to be transferred unchanged to every upland, marginal, or agro-pastoral landscape. Rather, it proposes a transferable workflow whose



Figure 4. The foothills area between Khuzra and Gabara (basemap Pléiades Neo, April 2024, map: S. Palalidis).

individual components need to be calibrated to local conditions. In the Zagros piedmont, this meant adapting the protocol to a dense stone-built landscape with limited associated surface material, complex topography, and uncertain chronology. The broader value of the approach lies in this flexibility: remote sensing, field verification, UAV documentation, feature-level recording, targeted sampling, and heritage-risk assessment can be combined in different ways according to the composition, visibility, preservation, accessibility, and research questions of each study area. The following sections outline the integrated workflow developed to translate this conceptual framework into practice, combining geodatabase design and implementation, diachronic remote sensing, UAV photogrammetry, pedestrian survey, GIS-based feature-level recording, OSL sampling, and heritage-risk assessment (Figure 5).

Geodatabase design

All spatial, archaeological, and photogrammetric data collected and produced for the project were integrated into a custom-designed geodatabase. The platform used to collect and analyze the main bulk of spatial data is an ESRI ArcGIS Pro geodatabase (version 3.6). The software was primarily selected for its built-in functionality to host an online database accessible to and usable by multiple users across different locations, enabling simultaneous data entry and consultation by the two university teams. This function proved very useful at different stages of the project, in particular during the preliminary desk-based survey of satellite and aerial imagery to identify potential sites of interest and during the intensive desk-based data entry of archaeological features. As already mentioned, the area under study, and the piedmont belt in particular, is characterized by a very high

density and an almost uninterrupted trail of human activity remains, or anthropic evidence. In such complex situations, it proves tricky to determine the actual extent of sites and to disentangle the stratification of archaeological features with different functions occurring in the same space. Interpretation of contexts without proper archaeological excavation is often unreliable, especially in the more complex and articulated areas. For this reason, each entry in the geodatabase records a single archaeological feature.

The geodatabase is designed to record archaeological evidence based on its geometry: polygonal features that can be defined by a closed polygon (stone cairns, buildings, or enclosures) and linear features which cannot (trenches, walls, or terraces). Both types are documented in the same fields in a detailed attribute table. The table is structured in fields devoted to both the remote survey and the fieldwork phase and is an adaptation of the structure and vocabulary used in the EAMENA project (Endangered Archaeology in the Middle East and North Africa of the Universities of Oxford, Leicester, and Durham, see Rayne et al. 2017; Rouhani and Huet 2024), which developed the largest archaeological database for the region. Using the same registration methodology and vocabulary could enable future integration of this data into the EAMENA database and/or facilitate data comparison. Archaeological features are documented in the geodatabase by their visibility on historical imagery, topographical location and land cover, shape and size, typology of structure, and possible function and interpretation, as well as by an assessment of their state of preservation, evidence for disturbance (damage and/or looting), and probable date of the latter events according to the available historical sources (Figure 6). The research area was divided into four sectors (A–D), further subdivided into lower and upper zones (AU, AL, BU, BL, etc.), to distinguish the foothills

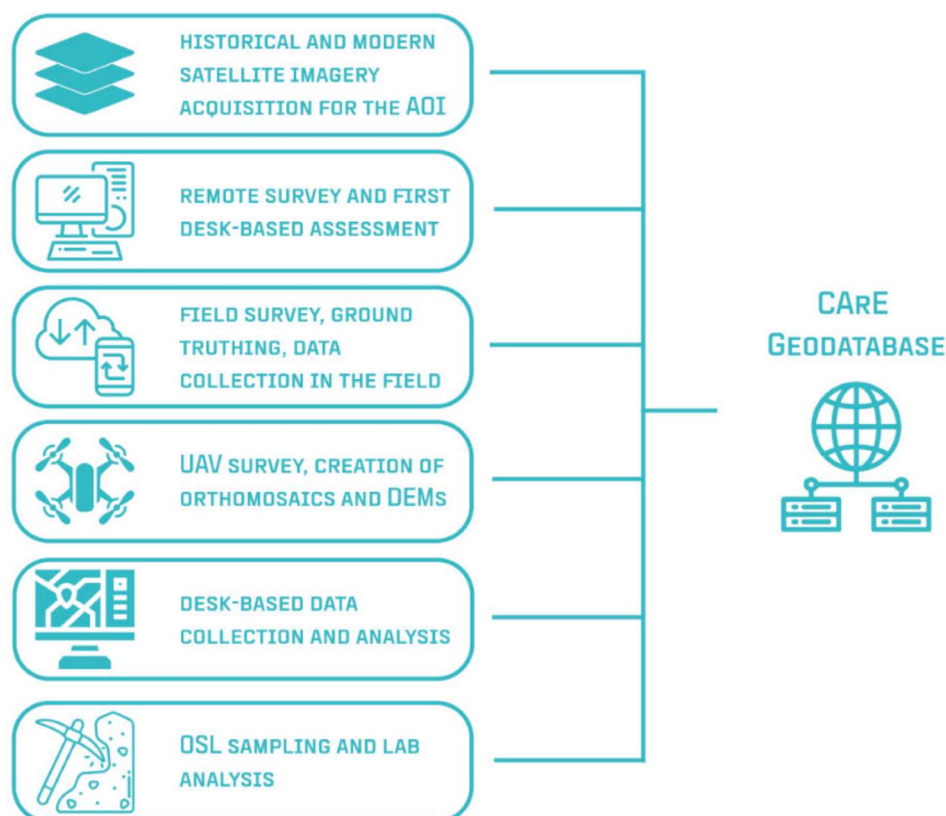


Figure 5. CARE workflow (F. Simi).



Figure 6. Example of a documented record (images from upper left, clockwise: photo, orthophoto, and digital elevation model; F. Simi/S. Palalidis).

from the mountain slopes and the plateaus above (Figure 7). This subdivision provided a systematic framework for remote and ground surveys and allowed for immediate comparative analysis across different environmental contexts.

Diachronic remote sensing strategy

Remote sensing constituted the backbone of the CARE methodology and provided the primary framework for both

spatial analysis and fieldwork planning. A diachronic archive of historical and modern aerial and satellite imagery was assembled and georeferenced, spanning approximately seven decades (Table 1). Historical sources include aerial photographs produced by Hunting Aerosurveys Ltd in 1955 and declassified imagery from the CORONA (1962–1972) and HEXAGON (1971–1984) reconnaissance satellite programs. The Hunting aerial imagery is the oldest available source for the region and presents good spatial resolution

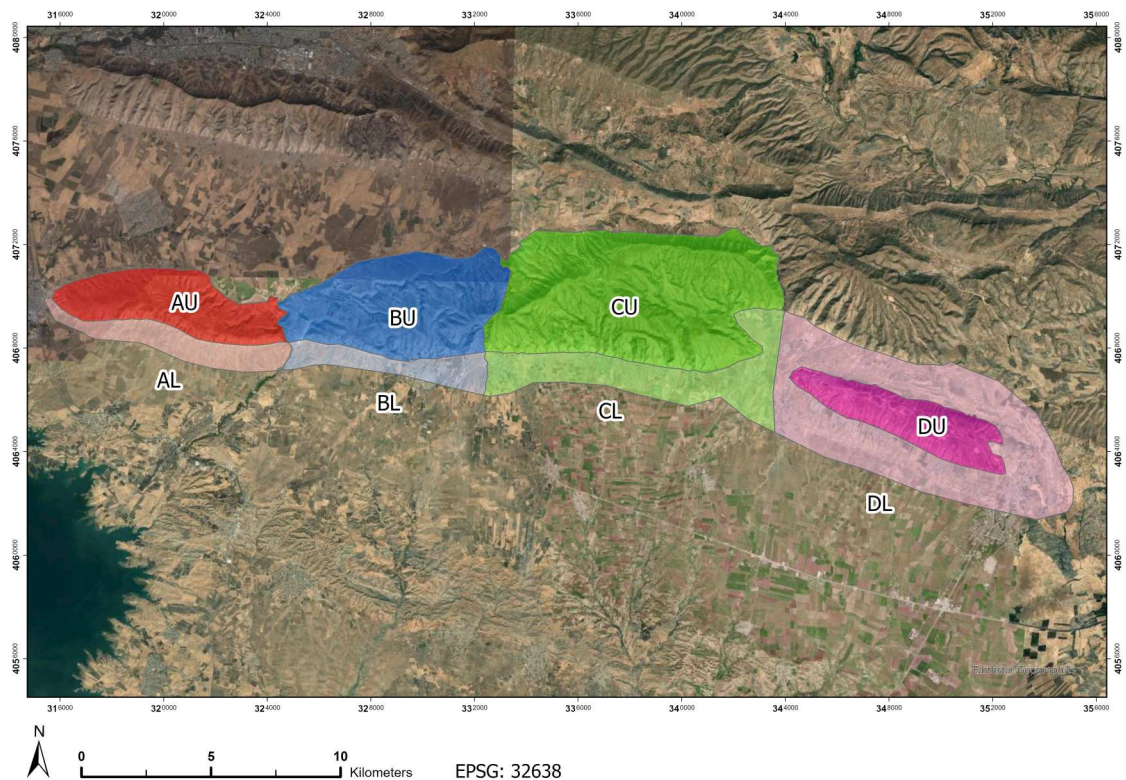


Figure 7. CARÉ sectors (basemap ESRI Satellite, map: S. Palalidis).

and low distortion thanks to the low flight altitude of the reconnaissance airplane, resulting in good visibility of the features. While the Corona imagery suffers from poor spatial resolution and overexposure, and is therefore less effective for detailed feature identification (Casana, Cothren, and Kalayci 2012; Ur 2013; Casana 2020), the Hexagon imagery provides higher resolution and visibility; however, it also exhibits some distortion, especially on rocky slopes (Hammer, FitzPatrick, and Ur 2022). Together, these datasets were used to identify archaeological features no longer visible in the contemporary landscape and to reconstruct and document the landscapes damaged or destroyed by modern anthropogenic activity, such as construction, agriculture, looting, or conflict (Figure 8).

Contemporary satellite imagery was sourced from freely available commercial providers (ESRI, Google, Bing, etc.) and generally offers a resolution of 0.6–1.2 m in rural areas, which might not be sufficient to recognize and draw most archaeological features. The dataset was thus complemented by very high-resolution (VHR) Pléiades Neo imagery (from Airbus) obtained through the European Space Agency’s Third Party Mission program. The ESA grant allowed the acquisition of 150 km² of new tasking imagery (April 2024) and 150 km² of archived imagery (June 2023).² Pléiades Neo imagery was provided at a ground resolution of 0.3 m for panchromatic spectral bands and 1.2 m for multispectral bands, and through pansharpening, we obtained very high-resolution colored imagery ideal for the

Table 1. Remote-sensing datasets used for the identification, mapping, and diachronic assessment of archaeological features and recent landscape transformations in the CARÉ study area.

Dataset/imagery source	Date/acquisition period	Type	Spatial resolution	Coverage	Main use in CARÉ
Hunting Aerosurveys aerial photographs	1955	Historical aerial photography	high/ND	Northern Iraq	Earliest baseline for landscape preservation and pre-modern land use traces
CORONA	1963–1972	Declassified historical satellite imagery	ca.1.8–2.7 m, depending on mission	Regional	Diachronic comparison
HEXAGON	1971–1984	Declassified historical satellite imagery	ca. 0.6–1.2 m, depending on mission	Regional	Mapping archaeological features and past landscape configuration
Modern commercial imagery (mostly from Maxar and CNES/Airbus)	2004–present	Satellite imagery	ca. 0.5–1.2 m	Full study area	Basemap, recent land use change, and identification of disturbances
Pléiades Neo	June 2022 archive; April 2023 new tasking	Very high-resolution satellite imagery	30 cm pansharpened color imagery	150 km ² archive + 150 km ² new tasking	Detailed feature mapping
UAV orthomosaics	May/October 2024 field campaigns	Drone-derived imagery	up to ca. 3 cm/pixel	Selected high-density areas	Detailed mapping and documentation
UAV DEMs/3D models	May/October 2024 field campaigns	Photogrammetric topographic products	up to ca. 3 cm/pixel	Selected high-density areas	Identification of more subtle features

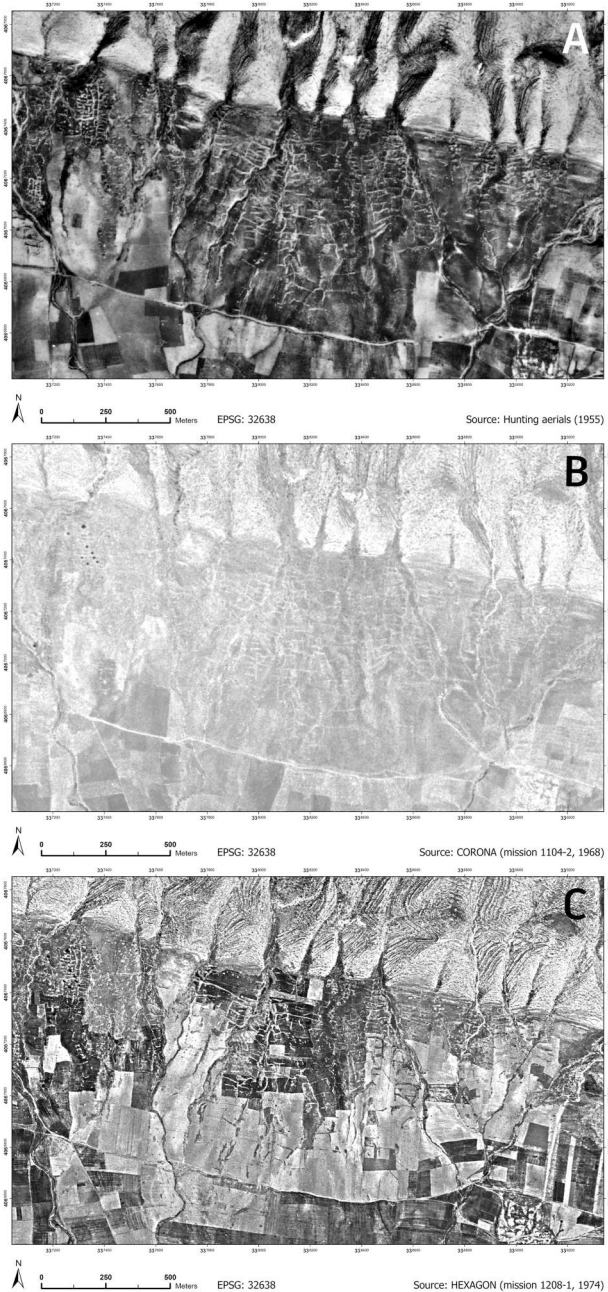


Figure 8. Comparison, from top to bottom, between A) Hunting Aerials Photos, B) CORONA, and C) HEXAGON satellite imagery (S. Palalidis). Courtesy of Durham Informatics Lab and USGS.

identification and drafting of archaeological features (Figure 9). The dataset, acquired in both summer and spring, presented significantly different vegetation cover, resulting in varying visibility of the archaeological features. Stone cairns, for example, stand out more against the green spring grass due to their color and light reflection, while at the same time lower structures, such as enclosures, tend to be covered by thick vegetation and are generally more visible during summer.

During the initial stage of the project, the research area was thoroughly scouted for anthropogenic features through historical and contemporary satellite and aerial imagery. Identified features were documented by assessing their shape, size, orientation, and tentative functional interpretation. The use of VHR imagery was particularly important for feature identification before fieldwork. In the areas selected for ground verification, this preliminary remote survey proved effective, as no significant false-positive features

were identified. The resulting preliminary mapping provided an overview of the main distribution, variability, and clustering of archaeological features across the eight sectors and guided the team in selecting priority areas that preserve the greatest diversity of archaeological features for pedestrian survey and UAV-based documentation.

Pedestrian survey and ground-truthing strategy

Fieldwork was conducted in two survey campaigns in May and October 2024 in collaboration with the Duhok Directorate of Antiquities and Heritage. The field surveys aimed to ground-truth the features identified through remote sensing while integrating field observations and assessing their state of preservation, as well as documenting previously undetected features. Surface materials were recorded through a grid-based system of 50×50 m survey units. This strategy was adopted because pottery and lithics were generally sparse and could rarely be associated securely with individual features. Recording artifacts by survey unit therefore allowed us to document their spatial distribution systematically without assigning them to specific structures where such an association would have been methodologically improper (see below). Diagnostic finds of particular interest (small finds/objects) were recorded separately as spot finds with precise spatial coordinates using ArcGIS Field Maps and the GPS receiver of a mobile device (see below). Had discrete pottery or lithic clusters been identified, they would have been recorded as individual features; however, no such clusters were observed during the survey. Overall, surface artifacts were extremely limited: only 89 pottery and/or lithic specimens were recorded, distributed across 32 survey units. Because surface finds were scarce, widely dispersed, and rarely associated with specific structures, they were not used as a basis for inferring the chronology or function of individual features.

The initial objective was visiting all eight sectors for ground-truthing; however, the mountainous area above the villages of Bozan, Khuzra, and Gabara (sector CU) lacked accessible paths for ascending the rocky slopes, while the plateau of Ciya Essyan proved off-limits due to the strict security protocols of a foreign private oil company working in this area. Primary areas of interest, characterized by a high density and variety of archaeological features, were previously identified remotely through the analysis of aerial and satellite imagery. During the field survey, the team contemporaneously carried out three different tasks: 1) the aerial photogrammetric documentation with a drone, 2) the ground-truthing of features already identified from satellite and aerial imagery, and 3) the identification and documentation of previously unidentified features. For ground-truthing and documentation of new features, the team relied on the ESRI ArcGIS Field Maps mobile app (version 25.3.1), which enables users to access the online geodatabase across multiple mobile devices and to edit or register new records in real time during ground surveys. The software provides offline functionality, allowing users to download and store any raster or basemap locally on their devices and have them available even if the connection to the servers is interrupted. This feature proved essential for the field survey, as many of the areas under study lacked network coverage or internet access. Entries registered in no-network areas are stored locally on the user's

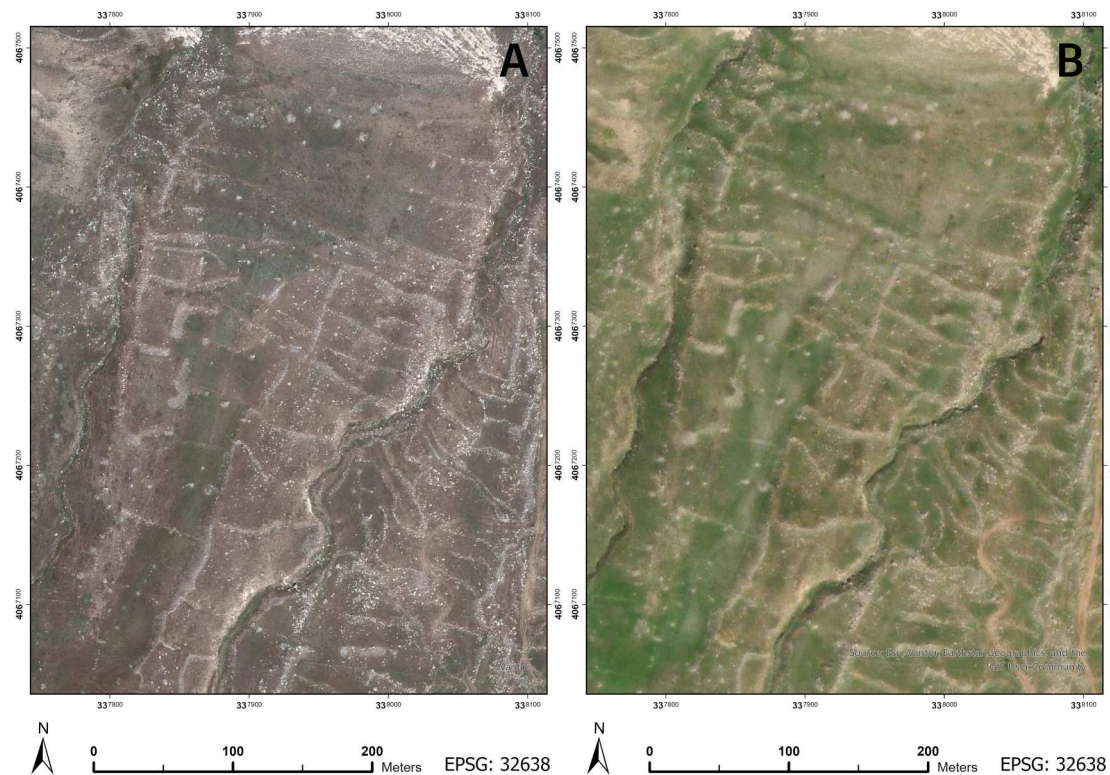


Figure 9. Comparison of the same area between A) Pléiades Neo (Airbus/ESA TPM) and B) Esri Satellite imagery (S. Palalidis).

device and synchronized with the online geodatabase when the internet connection is reestablished. During ground-truthing, the features were photographed, measured, and a series of field observations were added to the database, including the degree of moss/lichen cover, soil infill, and the state of preservation, with particular attention to the types and causes of damage.

While the drone survey was able to cover large portions of the territory completely, the ground documentation, even with multiple teams working on different features at the same time, could not keep pace with the sheer amount of archaeological evidence closely packed in some areas. Ground documentation thus followed a sampling strategy due to time constraints and the abundance of features, aiming to record at least one feature for each of the main attested typologies (stone cairns, enclosure, terrace, etc.) in each of the visited areas. The full drone photogrammetric coverage of most of the visited areas enabled the desk-based remote documentation.

UAV photogrammetry and topographic documentation

UAV-based photogrammetric surveys were employed to document selected areas characterized by high feature density or subtle topographic variations at high spatial resolution. Operations were conducted using a lightweight UAV (DJI Mavic Air 2) with a combination of automated flight plans (utilizing the Dronelink app)³ to cover broader stretches of territory and manual flights for smaller but often more complex areas. With the acquisition of the drone photogrammetric documentation, the work proceeded with the elaboration of Digital Elevation Models and high-resolution orthomosaics. The datasets, with a high resolution of up to 3 cm per pixel, were essential for mapping and documenting features in the most densely populated areas (Figure 10).

Drone documentation covered all of the piedmont belt with preserved archaeological features in sectors A–C, namely between Daka (small) and Bandawai and between Bozan and Gabara, as well as two areas northeast and northwest of Ba'adreh and selected areas on the Ciya Daka plateau. In regions not covered by the drone survey, very high-resolution pansharpened Pléiades Neo images were used as the primary source for mapping in the geodatabase.

Data processing and desk-based remote intensive data entry

Following the completion of field survey activities and the production of Digital Elevation Models (DEMs) and high-resolution orthomosaics, the team undertook the systematic desk-based mapping and recording of all visible archaeological features in the geodatabase. Upland plateau areas of Ciya Daka, Ciya Al-Qosh, and Ciya Essiyan were mapped extensively, and the majority of their archaeological features have been documented and described in detail within the database. By contrast, the piedmont zones between Daka (small) and Bandawai and between Bozan and Gabara are characterized by an exceptionally high density of features, making complete coverage impossible within the limited timeframe of the project. In these areas, a structured sampling strategy was therefore adopted.

Desk-based mapping of foothill areas proceeded systematically along the rocky slopes of the mountains, documenting archaeological features by hydrological basin, effectively subdividing lower sectors into smaller units delimited by wadis. This approach stemmed from both field- and desk-based observations, which indicated that the greatest variability in feature typologies and functions occurs along altitudinal gradients rather than across areas at comparable elevations. By prioritizing hydrological units as sampling targets, the assembled

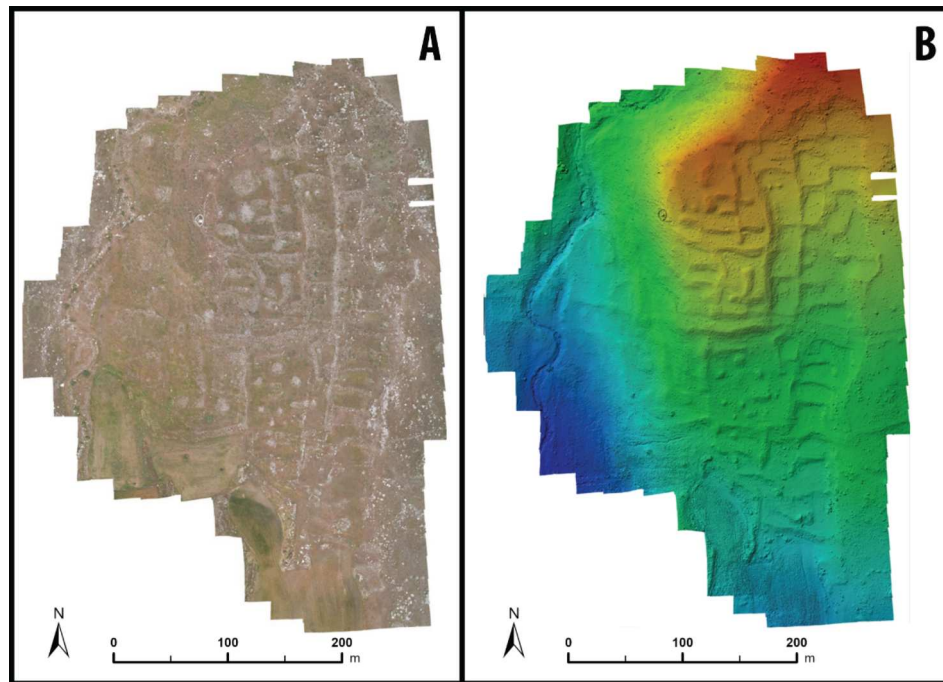


Figure 10. A) Orthophoto and B) DEM of a large area characterized by the presence of several features (S. Palalidis).

dataset provides a representative cross-section of functional variability and landscape organization. This strategy highlights the shift in land use practices and landscape management and organization across topographic zones while ensuring analytical robustness, despite partial spatial coverage.

Chronological anchoring

Given the complexity and limited knowledge and understanding of these agro-pastoral contexts, CARe incorporated a dedicated 2025 campaign focused on Optically Stimulated Luminescence (OSL) sampling to provide chronological anchors for selected features. Field survey confirmed that surface materials are generally scarce across the research area, but that is not the main issue. As noted above, directly associating surface ceramic material with individual archaeological features is methodologically problematic. In agro-pastoral landscapes, pottery fragments are often residual or redeposited, resulting from a wide range of processes such as ancient and modern manuring practices, plowing (Gibson 2015), and large-scale earth-moving activities, including recent interventions related to geophysical prospection for oil and gas. In such contexts, surface materials generally do not provide reliable chronological association with neighboring stone-built structures. Detailed archaeological investigations would provide a better context for associating finds with archaeological features. A program of systematic excavations, however, falls outside the funding available for this research project, and many contexts, such as stone walls or terraces, might not provide sufficient material for conventional absolute dating methods. To approach similar contexts, Optically Stimulated Luminescence (OSL) has been applied as a reliable dating method to establish chronologies for stone-built features such as terraces, stone tumuli, and enclosures, in western Asia and the Mediterranean (Gadot et al. 2018; Akkermans et al. 2020; Turner et al. 2021; Reed et al. 2023).

OSL offers a broad chronological range, from the last century to several hundred thousand years, with typical

precision of 5–10% (Feathers 2008), and even if not as precise as radiocarbon dating, it has proven especially effective in contexts where stratified deposits and diagnostic artifacts are scarce or absent. OSL dating targets mineral grains in the sediments, such as quartz or feldspar, and by measuring their accumulated radiation, determines their last exposure to sunlight. This makes it particularly suitable for dating soil movement events associated with the construction, use, or maintenance of stone structures, whether natural or anthropogenic. The soil sampling campaign for OSL dating was conducted in November 2025 in collaboration with the State University of Milan (A. Zerboni and L. Forti).

The campaign aimed to investigate three case study areas where a stratification of archaeological features with different functions was observed, with the objective of clarifying their chronological attribution and reconstructing the occupation history of those three areas. The three areas are located on the Ciya Daka plateau, in the piedmont belt east of Khuzra, and on the rising slopes northwest of Ba'adreh, and present a landscape of stone cairns, corrals, terraces, stone walls, and structures. Twelve features were selected for investigation, and small trial excavations were conducted to clarify the stratigraphy and assess the suitability of each context for OSL sampling. A total of 19 samples were collected, and they are now under analysis for OSL dating (at the Department of Materials Science of the University of Milano-Bicocca). While not intended to produce exhaustive dating sequences, this strategy is expected to provide the first absolute chronological data for selected feature types and to support the construction of preliminary relative sequences based on morphology and spatial relationships.

Preliminary Results

The methodological framework described above enabled the establishment of a substantial and coherent dataset that provides a first systematic overview of the agro-pastoral archaeological landscape of the Zagros piedmont. While the project

was conceived as a methodological pilot, the scale and structure of the data already allow for preliminary observations on the distribution and typological classification of the features and the organization of the landscape.

At present, the CARÉ geodatabase comprises 3072 polygonal features and 308 linear features recorded across eight survey sectors (Figure 11). While all upland sectors were mapped extensively, the piedmont and foothill zones are characterized by an exceptionally high feature density and could be mapped only partially through a structured sampling strategy. Even with partial spatial coverage, a sharp contrast is apparent between upland and foothill areas, with the latter displaying a significantly higher density of archaeological features. This differentiation is strongly influenced by the location of stone cairn clusters, which make up the majority of features documented and are more often found on foothills rather than on plateaus. The only exception to this pattern is sector D, where stone cairns are mostly located on the plateau of the Ciya Essiyan, thus reversing the trend.

Feature typologies and spatial patterning

Only a general overview of the dataset will be provided in this article. The analysis and categorization of the archaeological features documented in the mountain range between Faida and Sheikhhan will be the focus of a dedicated article. Four main types of features make up 91% of the features documented in the research area (Figure 12). These percentages refer only to the areas investigated by CARÉ and should not be read as representing the absolute composition of the archaeological landscape. They reflect the project's survey coverage, sampling strategy, and preservation conditions, but, nevertheless, they provide a useful indication of the agro-pastoral character of the investigated landscape

Stone cairns account for 78.3% of the dataset and clearly dominate the foothill landscape while being almost absent from the upland plateaus, with a few exceptions on the Ciya Essiyan (DU) and, to a lesser extent, the Ciya Daka (AU). Often documented in large concentrations, with clusters of up to 80 features, they are generally circular and small, 2–8 m in diameter and 0.5–1.5 m in height. Few of them exceed a diameter of 10 m and a height of 2 m, while even fewer exhibit an elongated shape. Although some of these features may have functioned as clearance stone piles, created to clean agricultural fields or improve pasture areas (Hammer 2014, 276), field observations suggest that the majority were deliberately constructed rather than simply accumulated. On the ground, these features can often be distinguished by their construction techniques, the presence of stone curbs, soil infilling, and lichen cover, although such attributes are less easily recognizable in aerial and satellite imagery. From above, their identification relies primarily on shape, spatial organization, clustering, and location. No stone cairn in the research area has yet been archaeologically excavated, but ground observation repeatedly documented features with clear structural definition, frequent association with stone walls, and surface conditions consistent with long-term exposure. These characteristics suggest both their antiquity and an intentional act of construction rather than the casual accumulation of cleared stones. Furthermore, a few monuments damaged by illegal excavations or natural erosion reveal a stone cist beneath the stone cover, suggesting a funerary function for most of these features (Figure 13). Similar features are, indeed, often interpreted as funerary cairns and/or territorial markers, are well documented in other regions of southwestern Asia, and are often associated with mobile or semi-mobile communities (Lönnqvist et al. 2006, 2009; Philip and Bradbury 2010; Bradbury 2011; Bradbury and Philip 2011; Morandi Bonacossi

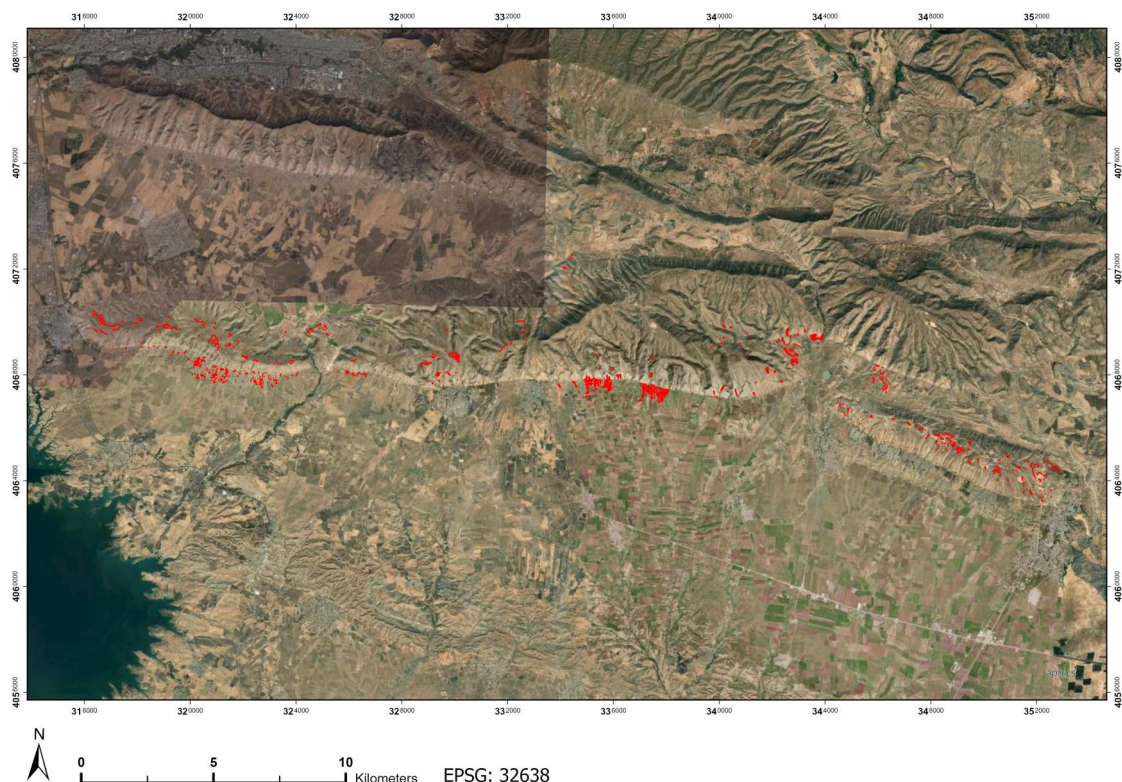


Figure 11. In red, all identified and mapped features by CarÉ (basemap ESRI Satellite, S. Palalidis).

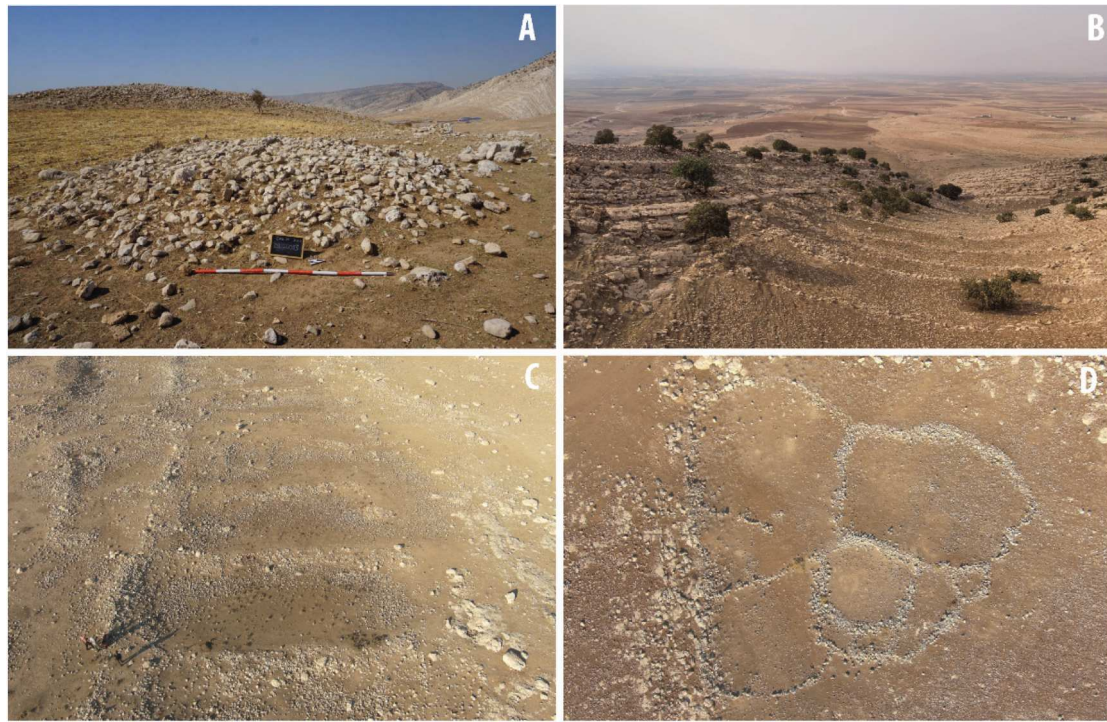


Figure 12. The most attested features in the research area: A) a cairn, B) terraces, C) walled fields, and D) enclosure (photos: F. Simi and S. Palalidis).

2020; Silver 2023). However, in some cases, features interpreted as funerary cairns appear to have been secondarily modified through the addition of stones cleared from nearby fields. In these cases, an earlier stone mound may have provided a convenient nucleus for later agricultural clearance, gradually transforming the original cairn into a single feature with both funerary and clearance functions (see, for instance, Figure 6). Concerning the cairns' chronological attribution, further investigation is needed, but according to data coming from neighboring regions (e.g., the Late Neolithic in the

Palmyra desert [Iamoni 2014], the Late Chalcolithic–Early Bronze Age in the Homs region [Bradbury 2011], the Middle Bronze Age in Jebel el Bishri [Fujii and Adachi 2010], the Iron Age in western Iran [Nazari and Sha'rbaf 2016], and the Hellenistic–Roman in Jebel Qurma [Akkermans 2019]), they could possibly date from the 6th millennium B.C. to the Islamic epoch.

Stone enclosures (7.2% of the dataset) are primarily concentrated on upland plateaus, often in slightly depressed and well-vegetated areas. Their morphology and location suggest



Figure 13. Evidence of the presence of a cist in a badly eroded cairn (photo: S. Palalidis).

a strong association with pastoral activities, likely serving as animal pens used for the temporary corralling of flocks in seasonal pastures (Lönqvist et al. 2009; Philip and Bradbury 2010). A few of them are large, nucleated enclosures (up to 60 × 50 m, see Figure 12D) which have close comparisons in the Hibermerdon Tepe region (Hammer 2014, 277–278, fig. 4g) and the Jebel Bishri (Lönqvist et al. 2006, 217–218, figs. 10–11). Terraces (4.4% of the dataset) occur predominantly in foothill zones, where stone-built walls retain soil along slopes that lead into narrow, steep gorges. Such areas benefit from enhanced soil deposition and water accumulation, creating favorable micro-environments for cultivation (Gibson 2003). Their presence is mostly attested between Alqosh and Ba’adreh and is possibly related to a broader system of production activities documented in this specific area characterized by a large concentration of walled fields. None of the agricultural terraces are in use anymore. Agricultural terraces have been extensively investigated in the southern Levant, both in Mediterranean highland contexts and in arid runoff-agriculture systems, where research has addressed their construction, maintenance, chronology (at least from the 4th millennium B.C. up to the Ottoman period), and role in soil and water management (Gibson 2001, 2003, 2015; Turner et al. 2021; Avni 2022; Srivastava et al. 2023). In northern Mesopotamian uplands and the Zagros piedmont, by contrast, comparable systems, including, for instance, the unique terraced slopes of Jebel Sinjar, remain virtually undocumented.

Larger walled fields (1.1% of the dataset) are instead generally associated with flatter or gently sloping terrain. Their stone boundaries, sometimes massive, may have served multiple purposes, including demarcating plots or protecting cultivated areas from grazing animals. In some cases, these walled fields appear to enclose clusters of cairns, as in the Khuzra area (see Figure 10), while in others, cairns seem to have been constructed later along their boundary walls. Comparable features are discussed in the southwestern Asia literature using a range of terms, including field walls, enclosure walls, boundary walls, rectilinear fields, or simply part of field systems (on ancient fields in southwestern Asia, see Wilkinson 2003, 52–55). Complex relict field systems defined by stone boundaries are known from several regions and periods across southwestern Asia (e.g., Syria [Philip and Bradbury 2010, 141, 149, fig. 1], Lebanon [Flohr, Bradbury, and ten Harkel 2021, 332, fig. 11], and the Iranian Zagros [Schmidt 1940, pl. 117]). Other rarer types of features are related to seasonal occupation, like a group of cave dwellings with external stone wall structures surveyed in the Ba’dreh area (of possible Late Islamic age). Two previously unidentified settlements were also identified: one from the Late Islamic period was located in the area of Bozan and one multiperiod settlement, probably occupied in the Late Bronze and Iron Ages, was identified in the valley of the Wadi Bandawai.

Beyond agro-pastoralism: conflict landscapes

Although the CArE workflow was developed primarily to document agro-pastoral features, its application also revealed a more recent layer of the archaeological palimpsest associated with conflict-related activity. This material is discussed here not as a separate research theme but as a methodological test of the project’s recording strategy. The

conflict-related features provide an important example of how feature-level documentation can register multiple and temporally distinct forms of landscape use within the same survey area. Contemporary conflict archaeology is a new field of study that has its origins in the research carried out in Europe in World War I and World War II contexts (Stichelbaut and Cowley 2016; González-Ruibal 2019; Saunders and Cornish 2021). More recently, this new discipline has also begun to investigate the remains of conflicts in western Asia, with particular methodological and theoretical developments in Jordan (Saunders and Faulkner 2010; Winterburn 2021).

CArE documented an extensive and stratified conflict landscape, particularly on the plateau areas (Figure 14). This includes military trenches, forts, foxholes, and more recent military installations, forming a complex palimpsest that dates at least to the Late Ottoman period and extends into contemporary conflicts. These landscapes were documented on the plateaus of the Ciya Daka and the Ciya Essiyan. Most of these features are already visible in the 1955 Hunting aerial photographs, indicating that they predate the mid-20th century A.D. Their morphology and spatial organization suggest a plausible association with the First World War and the Mesopotamian Campaign (A.D. 1914–1918; see Wilcox 2022), which also marks the only trench warfare activity in the region prior to 1955. A smaller number of features can instead be attributed to later conflicts, particularly the Iran-Iraq War (1980–1988) and subsequent military activity, as suggested by comparison with recent conflict landscapes documented at Khorsabad (Mura and Herr 2024, 293). The identification of these features underscores the capacity of the CArE methodology to capture multiple historical layers within a single analytical framework. It also highlights the urgent need for heritage protection strategies that extend beyond ancient remains to include material evidence of recent historical events that are rapidly disappearing from both the landscape and collective memory (Mura and Herr 2024, 293).

Documenting landscapes at risk

A defining characteristic of the agro-pastoral landscapes investigated by CArE is their acute vulnerability to ongoing processes of transformation. Urban expansion, agricultural extensification, infrastructure development, and large-scale resource extraction (particularly oil and gas activities) are rapidly reshaping the Zagros piedmont, often through interventions that reach across extensive areas and directly intersect with archaeological features. From a methodological perspective, these dynamics fundamentally shape both research priorities and survey strategies. In many cases, archaeological features documented during remote sensing analysis were found to be partially damaged or entirely erased by the time of field verification. The integration of historical aerial photography and declassified satellite imagery was therefore essential not only for diachronic analysis but also for identifying features that no longer survive in the contemporary landscape.

Crucially, the effectiveness of this approach was reinforced through close collaboration with the Duhok Directorate of Antiquities and Heritage (DDoA). All datasets produced by the project were systematically shared with the Directorate, with particular emphasis on identifying and



Figure 14. Multiple archaeological features related to recent conflicts on the Ciya Daka (UAV photo: S. Palalidis).

mapping areas requiring protection and monitoring. This collaborative process contributed to the recognition of archaeological landscapes that had previously remained largely unperceived, including by local communities and heritage authorities themselves. Many of the areas documented by CArE consist of barren upland zones and extensive stone-covered surfaces, where archaeological features are ephemeral, low-relief, and constructed almost exclusively of stone. Such features are often difficult to detect and interpret through ground observation alone and can easily be mistaken for natural formations or recent disturbances. For this reason, it was crucial to show and share our data with our colleagues from the DDoA.

The major damage recorded by CArE is connected with the creation of the oil extraction facilities and related infrastructures, in particular on the plateau of the Jebel Essyan, where a series of plants were built by foreign companies from 2004 onward, almost completely destroying the rich archaeological landscape preserved on its plateau (Figure 15). A further area of approximately 12 ha between the villages of Bozan and Gubara has been heavily disturbed by a regular bulldozed grid, cutting through the archaeological features preserved in the area, likely associated with exploratory or preparatory work for oil and gas development.

Another frequent and highly destructive form of disturbance is stone clearance and mechanical leveling associated with agricultural expansion. This process has probably had one of the greatest impacts on the lower foothills of the Zagros since the introduction of heavy machinery and mechanized cultivation. The present distribution of archaeological features suggests that the agro-pastoral landscape now preserved as a relatively narrow belt along the foothills may once have extended farther towards the plain. In many areas, however, stone-built features are likely to have been destroyed by cultivated fields through repeated clearance, plowing, and leveling. This is particularly visible immediately

west of Al-Qosh, where agricultural fields now reach almost to the mountain slopes, severely reducing the extent of preserved archaeological evidence.

Looting does not appear to be a widespread form of disturbance within the areas investigated by CArE. However, several burial cairns showed evidence of intentional disturbance, including possible looting. This was observed in a group of cairns near Ba'adre, in the largest cairn documented by the project in the Gubara area, and in a large cairn field near Daka, where recent and apparently systematic disturbance involved the use of mechanical machinery. In other cases, the evidence is less clear. Some cairns may have been opened or robbed in antiquity, a common issue for funerary features of this kind, while others may have been affected by more recent stone removal, collapse, or erosion.

For the near future, the major threats are represented by the expansion of agriculture and by the establishment of new houses and farms, primarily by internally displaced families (mostly Yazidi from the Sinjar region), at the interface between cultivated fields and rocky mountain slopes. Today, this zone is extensively used as pastureland for sheep grazing. During our fieldwork, however, we observed only local herders moving daily from nearby villages and newly established farms; no modern mobile shepherd camps were recorded. This absence could be interpreted as an indication of a recent reconfiguration of mobile pastoralism. Since the war against ISIS, mass displacement, the reorganization of settlements, and the creation of new physical barriers along the boundary between KRG-administered areas (a large trench now largely dismantled) and the rest of Iraq are likely to have disrupted former seasonal routes. In this context, some Yazidi and Arab herders may have abandoned or reduced long-distance transhumance, shifting instead towards more localized forms of herding, either as hired shepherds or as independent settled herders. Comparable dynamics have been documented elsewhere in Iraqi



Figure 15. Ciya Essayan plateau in a A) Hunting Aerials photo from 1955 and B) Pléiades Neo image from April 2024 (S. Palaidis).

Kurdistan, where mobile and semi-mobile pastoralism persists but is increasingly constrained by militarized borders, land tenure insecurity, mined areas, agricultural expansion, urbanization, and the contraction of pastoral territories (Thevenin and Giraud 2019; Thevenin 2020).

Conclusions

This article has presented the methodological framework developed by the CArE Project for documenting dense agro-pastoral landscapes in the Zagros piedmont of the Kurdistan Region of Iraq. Conceived as a two-year pilot project with limited funding, CArE was not designed to produce an exhaustive regional survey. Its aim was instead to test a targeted, scalable, and cost-effective strategy for working in landscapes where archaeological evidence is continuous, feature-dense, difficult to interpret and date, and increasingly at risk. The project shows that such landscapes cannot be

adequately understood through conventional site-based approaches alone. In the area between Faida and Sheikhan, cairns, enclosures, terraces, walls, fields, paths, and other stone-built features form a multi-period archaeological continuum rather than a series of clearly bounded sites. By adopting feature-level documentation within an integrated geodatabase, CArE provides a practical way to capture this complexity without imposing artificial boundaries on the landscape. At the same time, the multi-scalar structure of the workflow allows individual features to be analyzed from the single-feature level to the cluster level to the regional level.

The combination of diachronic remote sensing, UAV photogrammetry, pedestrian survey, desk-based mapping, and targeted OSL sampling proved especially effective in addressing the practical constraints of this type of archaeology. Historical aerial and satellite imagery enabled identification of features that have since been damaged or erased,

while VHR satellite imagery and UAV-acquired datasets supported detailed mapping of stone-built features. Field survey and ground-truthing provided essential data on morphology, preservation, disturbance, and surface conditions, while making clear that complete ground coverage was not feasible in such a feature-dense landscape. The resulting dataset is therefore selective rather than exhaustive, but it remains systematic and internally consistent, providing a reliable basis for assessing the density, variability, and vulnerability of the agro-pastoral evidence. Chronology remains one of the most difficult issues, but the results of the OSL analyses are expected to provide the first absolute anchors for selected features and to help establish preliminary sequences of construction, use, and reuse within the landscape.

Beyond its regional contribution, CARÉ offers a transferable model for documenting agro-pastoral landscapes elsewhere in western Asia and in comparable upland or piedmont environments. Its main contribution is not only the production of new data but the development of a workflow suited to archaeological evidence that is dispersed, overlapping, difficult to classify, and vulnerable to rapid loss. In the Zagros piedmont, where agricultural expansion, new settlement, infrastructure, and extractive development are reshaping the landscape at increasing speed, such documentation is urgent. As a pilot project, CARÉ is also intended to provide a basis for further research in this region and to encourage comparable initiatives in other upland and piedmont areas of the Kurdistan Region of Iraq, where agro-pastoral landscapes remain largely unexplored. At the same time, the dataset produced by CARÉ opens the way for more focused studies of specific components of this landscape, including terrace systems and walled fields, funerary cairns and pastoral enclosures, and the stratified conflict landscapes documented on the upland plateaus.

Ultimately, the CARÉ Project highlights the need for field methods capable of engaging with archaeological evidence that does not conform to the conventional Mesopotamian site. Agro-pastoral landscapes have long been central to the history of Upper Mesopotamia, yet their material traces often remain dispersed, low-visible, repeatedly reused, and difficult to date. These landscapes were shaped over millennia by cultivation, herding, movement, clearance, construction, abandonment, and return, often without producing monumental structures. In this sense, CARÉ contributes to a field archaeology better equipped to recognize, record, analyze, and protect the complex landscapes that lie beyond the tells.

Endnotes

1. UNHCR 2024 report available at <https://reliefweb.int/node/4137307>, accessed 16/02/2026.
2. To access Pléiades Neo Data through the European Space Agency (ESA), Third Party Mission, visit: <https://earth.esa.int/eogateway/missions/pleiades-neo> (accessed 12/03/2026). The acquired images for the CARE project are now available to users after ESA approval.
3. DroneLink LLC: <https://www.dronelink.com/> (accessed 12/03/2026).

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