Journal of Archaeological Science: Reports 57 (2024) 104659

Contents lists available at ScienceDirect

Journal of Archaeological Science: Reports

journal homepage: www.elsevier.com/locate/jasrep

The kurgans of the Alazani Valley in Eastern Georgia: A new assessment via remote sensing and targeted field survey

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A R T I C L E I N F O

Keywords:
Landscape archaeology
Spatial analysis
Satellite imagery
Burial mounds
Southern Caucasus
Georgia

A B S T R A C T

This paper presents the results of a landscape archaeological investigation conducted on the kurgans in the Alazani Valley, Eastern Georgia. Recognized for its remarkable kurgans, some exceeding 100 m in diameter, this region emerges as a pivotal area for the examination of burial mounds. The study highlights the effectiveness of integrated survey methods in mapping burial mounds within extensively exploited environments, facilitating the reconstruction of the archaeological landscape and the identification of areas with more preserved information. Utilizing remote sensing techniques, encompassing historical satellite imagery from the 1960s and recent data, coupled with a comprehensive four-year field survey, the research successfully mapped previously unrecorded kurgans. The analysis of historical and recent satellite imagery offers valuable insights into land use changes over the past six decades, enabling an assessment of the impact of human activity on the archaeological landscape.

1. Introduction

During the late 5th millennium BC, the Southern Caucasus underwent significant socio-cultural shifts, characterized by the widespread adoption of metallurgy and the development of specialized craftsmanship (Sagona, 2017). These transformations were notably reflected in burial customs, particularly with the introduction of the practice of interring the deceased within kurgans, or burial mounds, throughout the region (Lyonnet et al., 2008). This tradition persisted until the 1st millennium BC, profoundly shaping the archaeological landscape of the region. The Alazani Valley is renowned for harbouring a considerable number of relatively large kurgans (Dedabrishvili, 1979; Japaridze, 1992; 1998; Kushnareva, 1997; Makharadze et al., 2016; Makharadze and Murvanidze 2014b; Orthmann et al., 1998,2000; Pitskhelauri et al., 1994). Excavations have primarily dated these kurgans to the Late Early Bronze Age (2600/2500–2200/2100 BCE) during the spread of the Martqopi and Bedeni cultures. Some kurgans also seem to date to the Late Bronze/Early Iron Age (1500–1000 BCE) (Abramishvili and Abramishvili, 2008; Dedabrishvili, 1979). The near absence of settlements specifically dated to the Late Early Bronze Age contrasts sharply with the significant presence of monumental kurgans. These burial mounds, due to the scarcity of other contemporary archaeological evidence, emerge as the sole elements enabling an investigation into the relationship between local communities and the landscape.

This paper reveals the findings from the inaugural landscape archaeological investigation of kurgans in the Alazani Valley, Eastern Georgia. While similar studies have demonstrated the efficacy of this method in various regions, including Moldavia, Ukraine (e.g. Topal et al., 2019; Poletaev, 2020), the Northern Caucasus (Reinhold and Korobov, 2007; Reinhold, 2019), and diverse areas of Central Asia (Gheyle et al., 2004; Goossens et al., 2006; Balz et al., 2017; Caspari, 2020), this research marks one of the firsts application of the methodology to kurgans located in the Southern Caucasus (Ricci et al., 2024).

The study demonstrated the effectiveness of integrated surveys in mapping burial mounds in heavily exploited environments, such as the fertile lands of the Alazani Valley. By combining cutting-edge survey techniques and the analysis of multi-temporal satellite imagery, this study not only advances our knowledge of burial practices in Eastern Georgia but also sets a methodological precedent for future landscape archaeological investigations in similarly difficult environments. Through the initial step of remote sensing analysis and field survey, 36 kurgans were successfully identified, enriching our understanding of this specific area and addressing hypotheses regarding feature localization in this expansive alluvial plain. The analysis of historical and

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https://doi.org/10.1016/j.jasrep.2024.104659
Received 29 February 2024; Received in revised form 31 May 2024; Accepted 24 June 2024
Available online 28 June 2024

recent satellite imagery provided insights into land use changes over the past 60 years, facilitating an assessment of the impact of human activity on the archaeological landscape. Conducted as part of the Georgian-Italian Lagodekhi Archaeological Project (GILAP) from 2018 to 2022, this research's initial phase was integrated into the first author's master's thesis (Fiori, 2020).

2. The study area: geographic framework

The Alazani plain is a major intermountain valley, located between the Greater Caucasus and the Gombori Range, which extends through the Kakheti region of eastern Georgia and into Azerbaijan. The eponymous river forms the border between Azerbaijan and Georgia in its lower course (Fig. 1). The plain has an altitude that ranges between 64 and 700 m a.s.l. (Fig. 2).

The highest quantity of precipitation is received in spring and early summer (Bliedtner et al., 2018,p. 62). During these periods the plain is subject to cyclical floods caused by the melting of the snow that accumulates in the mountains during winter (UN 2007, p. 57). Because of this, the deposition of sediments is still ongoing and very intensive in some parts of the Valley (Tielidze 2019, p. 222). Recent studies have proven that this process has been active in the upper parts of the valley for the entire Holocene period (Bliedtner et al., 2018; von Suchodoletz et al., 2018; von Suchodoletz et al., 2020).

The Alazani plain is one of the most fertile areas of Georgia, both because of its optimal climatic conditions and its alluvial soil and, by consequence, one of the most heavily cultivated. The areas that have escaped cultivation in the recent past are mainly located along the river and in the foothills of the Greater Caucasus mountains, where woodland is present. In addition, portions of this landscape have traditionally been dedicated to pasturing, foraging and hunting (UN 2007, p. 8).

During the Soviet Period, the plain was subjected to collectivization and mechanized farming, which rapidly transformed the landscape. The previous land subdivisions, which consisted of smallholdings maintained through manual labour, were replaced by large state-owned lands. The introduction of the first mechanical ploughs rapidly transformed the landscape, for instance, by flattening mounded archaeological features such as smaller kurgans (Hopper et al., 2018,p. 14; Wegren, 1998). Agricultural activities, along with seasonal flooding, have significantly impacted the landscape and the survival of archaeological deposits. Additionally, the accumulation of several sediment layers may have obscured some parts of the valley, affecting site visibility (Rova et al., in press (a)).

3. Kurgans: characteristics and context

In the Alazani Valley, the oldest kurgans documented so far are associated with the spread of the Martqopi/Bedeni cultural complexes during the Late EBA (2600/2500–2200/2100 BCE) (Makharadze et al., 2016; Orthmann, 2017; For an assessment on the chronology of the Southern Caucasus see Sagona, 2017). These kurgans generally have diameters of over 35 m, have a regular shape, are constructed of a combination of stones and earth, and reach c. 10 m in height. However, only a handful of the kurgans known in this region have been excavated and dated. Tsnori kurgan no. 1 (dimensions = 168 × 136 m) is the largest. It was investigated in the 1960s and 1970s by the Kakheti Archaeological Expedition (Dedabrishvili, 1979). It contained a rich inventory which included gold, silver and bronze objects, and many pottery vessels. The second is Ananauri kurgan 3, excavated in 2012 by Z. Makharadze and his team (Makharadze et al., 2016). This monumental burial mound measured more than 100 m in diameter, contained two wooden wagons, several rich metal objects, and pottery vessels. In addition, ^{14}C dates confirmed the construction of this burial mound at c. 2400 BCE (Boaretto et al., 2016,pp. 284-288). Other kurgans in the proximity, Ananauri kurgan n. 1 and 2, were excavated in the 1990s and revealed very rich material that can also be dated to the mid-3rd millennium BC (Orthmann et al., 1998 and 2000; Orthmann, 2017).

In the valley, settlement remains possibly dating to the same phase

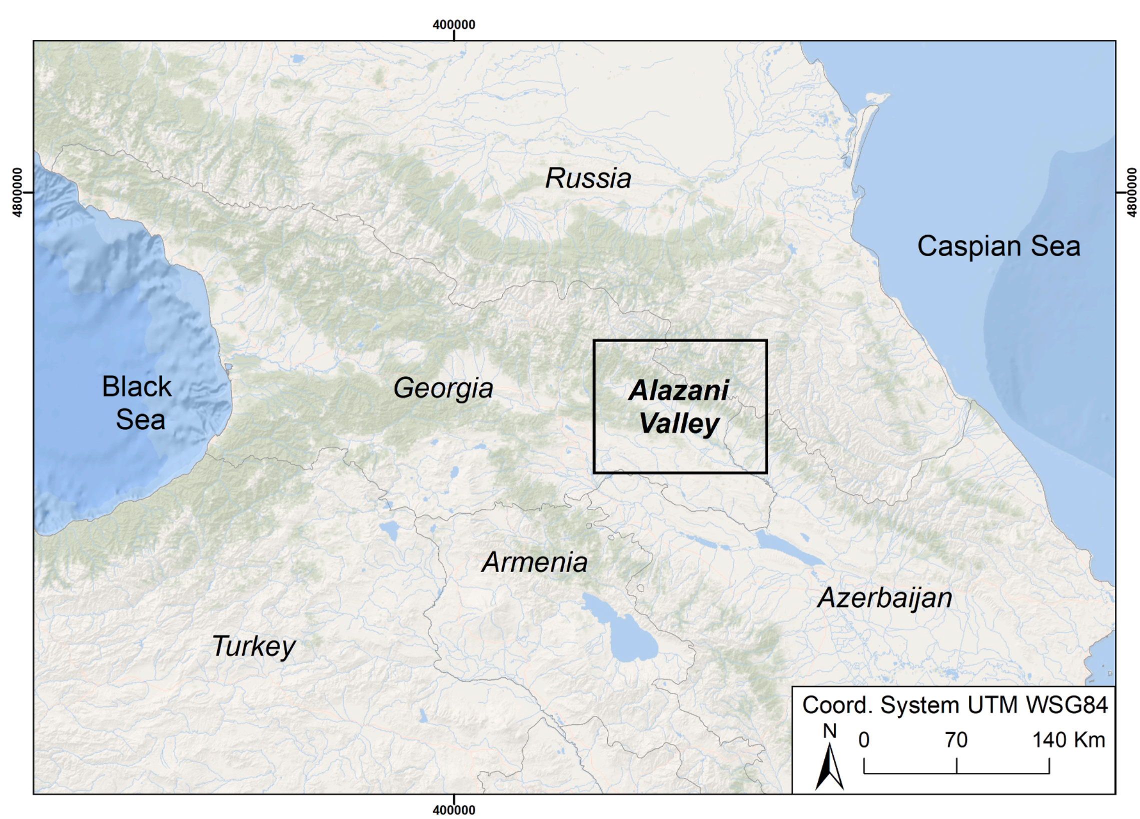

Fig. 1. Map showing the location of the study area (basemap © ESRI).

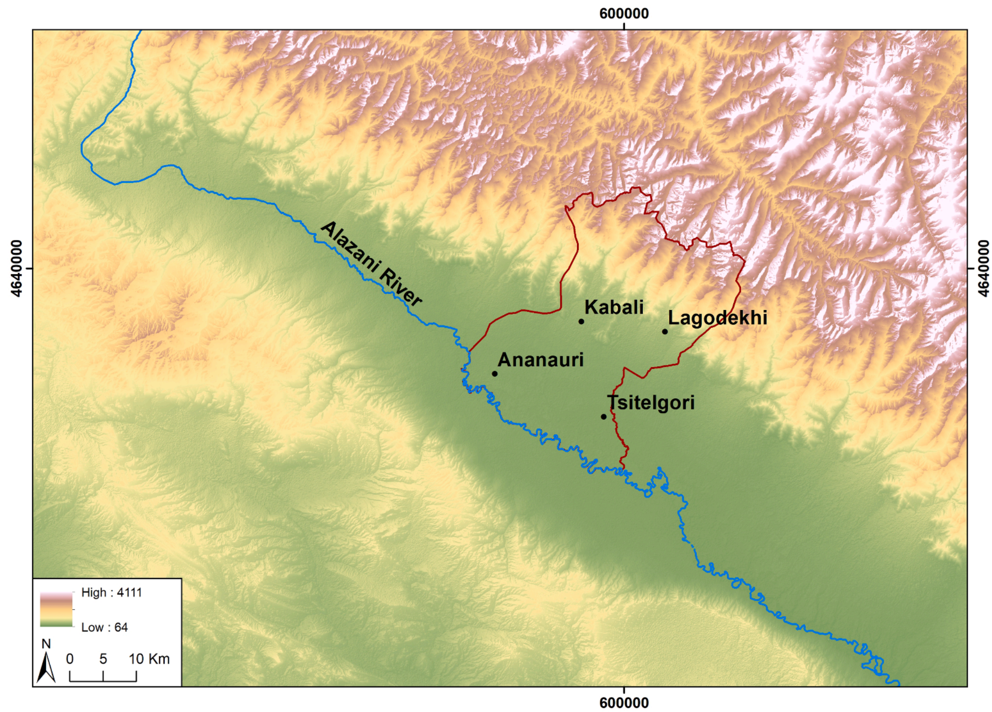

Fig. 2. DEM view of the investigated region along the Alazani valley (basemap © SRTM 3arc data, NASA).

have been found at Didi Gora and Tqisbolo Gora (Narimanishvili and Amiranashvili, 2010; Kastl, 2008; Korfmann et al., 2002) on the right side of the river. Apart from these examples, no other contemporary archaeological sites have been identified so far in the Alazani Valley, even through field survey mapping. This aligns with the broader pattern, as settlements from the Late Early Bronze Age are exceptionally rare across the entire Southern Caucasus.

However, this scarcity of settlements does not apply to other chronological phases. Recently investigated sites such as Tsiteli Gorebi 5, attributed to the Chalcolithic phase, and the LBA sites of Tchiauri 1 and 2 (Rova et al., in press (b)), as well as sites of later archaeological periods, like Gumbati (Thiesson et al., 2019) indicate a different pattern. This pattern also differs in neighbouring regions, such as the Shiraki Plain, the Dedoplistskaro area, and the Iori Valley (e.g. Arnhold et al., 2020; Bertram and Pitskhelauri, 2005; Pitskhelauri et al., 2016; Varazashvili, 1980), where archaeological evidence shows a distinct signature. This topic will not be further investigated in this paper and will be part of a more comprehensive publication.

The construction of kurgans in the Alazani Valley takes on a different pattern in the subsequent phase, with the presence of Late Bronze/Early Iron Age (1500–1000 BCE) kurgans also documented in the region. In the Lagodekhi Municipality near Tsitelgori, a group of 20 kurgans of this period was identified in the 1960s. They have smaller diameters than the ones mentioned above, ranging between 10 and 35 m. Among these, only two were excavated. Their contents were attributed to the Lchashen-Tsitelgori culture (1500–800 BCE) (Abramishvili and Abramishvili, 2008; Pitskhelauri et al., 1982). The settlements of Didi Gora and Tqisbolo Gora (Narimanishvili and Amiranashvili, 2010; Kastl, 2008) continued to be occupied during these periods. Recent investigations carried out in the Lagodekhi Municipality have also identified the settlements of Tchauri 1 and 2 as belonging to this period (Rova et al., in press (b)).

4. Methodology

4.1. Desk-based assessment

The first step in our data collection involved the collation of published information on the locations of known kurgans in the Alazani Valley (e.g., Dedabrishvili, 1979; Kushnareva, 1997; Sagona, 2017; Makharadze et al., 2016). In some cases, their coordinates or map locations were available. Often, however, exact coordinates were not available, and a kurgan's location was only mentioned in relation to the nearest village (e.g., two kilometres east of the village of Apeni). In these cases, a buffer of 2 km was established around the named village to provide a reasonable search radius for the remote sensing study.

Secondly, we analysed these locations on satellite imagery to see if kurgans could be identified, after which we conducted a systematic remote sensing survey over the entire area. For this study, we used freely available high-resolution images on Google Earth and Bing (Lesiv et al., 2018), and historical CORONA photographs. This provided us with a snapshot of the same landscape in the late 1960s and again at intervals from the mid-2000s to present. The results, including information on dimensions, morphology, and visibility, were integrated into a database. In addition, the research benefited from the use of topographical maps to cross-reference the collected data. These maps were produced during the Soviet period in the early 1960s, utilizing aerial photographs taken between 1954 and 1955. Created on a scale of 1:25,000, these maps document changes in elevation, rendering them valuable for identifying larger features.

Every possible kurgan, or group of kurgans, was marked and named with a progressive alphanumeric code (starting from AS001), then recorded into a spreadsheet together with additional information. In this landscape, three categories of features were recognised as potentially significant: a) soil discolorations; b) areas of vegetation growth that differ from that of the surrounding area; c) raised features (or mounds) visible when the angle of the sun causes a shadow on one side of the mound due to its height above the surrounding land surface (Ceraudo 2013, p. 29) (Fig. 3, Table 1).

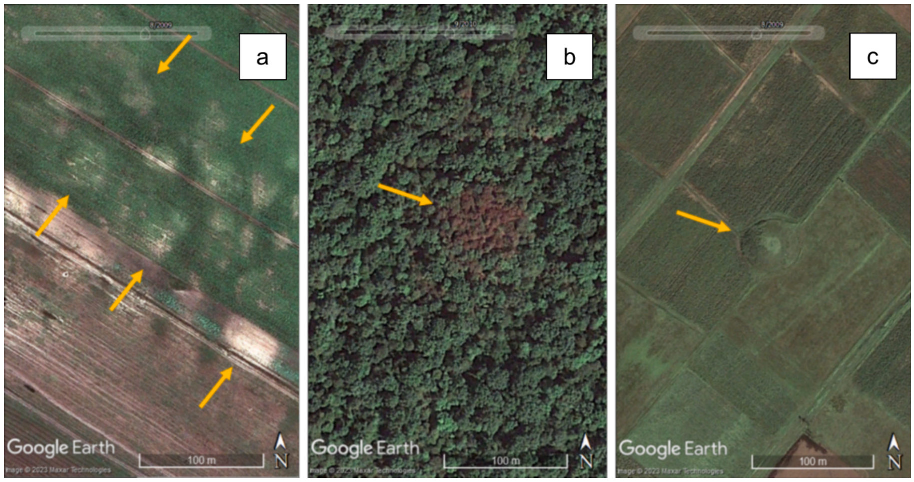

Fig. 3. Types of features identified as kurgans on satellite imagery in the Alazani Valley; a) soil discolourations, b) vegetation growth, c) raised features (Images © 2023 Maxar Technologies).

Table 1
The relationship between feature types, landcover and visibility conditions.

Feature Type	Land cover	Best visibility
Soil discolorations	Cultivated plains and alluvial fans	After the harvest, when the crops are not covering the surface.
	Uncultivated plains, alluvial fans, and foothills	During dryer periods, when the soil presents different humidity conditions.
Vegetation growth different to surrounding area	Forested riverbanks	Autumn, but sometimes visible July through February (Hopper et al., 2023; Titolo et al. in prep).
Mounds	Cultivated/ uncultivated plains and alluvial fans	All seasons, but more visible when light conditions are optimum for creating shadows (e.g., early morning or late afternoon), or when a modern feature, like a road, clearly detours around it.

4.1.1. *Corona satellite images*

The CORONA satellite program was launched to photograph areas of American military interest through the 1960s and 1970s, and the images from it were declassified in the 1990s (Hritz, 2014, p. 19; Ur 2013, p. 22). The cameras on these satellites provided high-resolution (c. 2 and 5 m) black and white images, each one covering 20 × 80 km of ground area (Hritz, 2014, pp. 19–20). The employment of these photographs in archaeological research had a beneficial impact on landscape investigations because of their high resolution, low cost, and the fact that many were collected prior to or during the spread of modern urbanisation and intensive cultivation, in certain regions (particularly in parts of SW Asia) (Casana and Cothren 2013, p. 34; Philip et al., 2002,p. 109).

We used the CORONA imagery to verify possible kurgans detected on Google Earth, and to identify kurgans (either previously unknown or mentioned in literature) which may have been destroyed by the time the imagery on Google Earth was taken. This ensured a higher rate of detection for features that modern landscape alterations may have obscured. The CORONA imagery used for this research came from missions 1046 of 18th March 1968 and 1103 of 11th May 1968. The images were subjected to the same systematic survey techniques. If a new anomaly was detected on CORONA, its location was also inspected on Google Earth, and annotations were made on the visibility of both sets of imagery. The locations of features found on the CORONA imagery were also checked on the imagery available on Microsoft Bing Maps. This increased the possibility of detecting the site on modern imagery if it was still extant.

4.1.2. *Certainty*

A level of certainty was assigned to each potential kurgan located on the satellite imagery. The certainty categorization used in this study was developed by the Fragile Crescent Project (Lawrence 2012, pp. 63-64), and variations are used by other large landscape projects focused on ancient southwest Asia (Hopper, 2017; Lawrence et al., 2012,pp. 353-359; Rayne et al., 2017).

In assigning a certainty (from negligible to high – see Table 2) to a potential kurgan we considered:

- how the feature interacts with clearly modern landscape (e.g., does the feature respect modern field boundaries? If so, then the possibility of it being modern is increased)
- the visibility of the feature across multiple images representing different years and seasons of the year.

Only if a feature was confirmed by on-the-ground investigation it could then be classed as 'definite'.

4.2. *Ground truthing in Lagodekhi municipality*

We chose to test the effectiveness of our remote sensing analysis by ground-truthing all the potential kurgan sites located within the Lagodekhi municipality, which covers approximately 20 % of the total Alazani Valley in Georgia (Fig. 4). This was done in the framework of the Lagodekhi Archaeology Survey (LAS), which was carried out as part of the GILAP project between 2018 and 2022 (Hopper et al., 2023). The

Table 2
Levels of certainty and their definitions.

Level of certainty	Characteristics
Definite	Confirmed by field checking.
High	Visible on more than three available images, taken in different seasons; Visible on CORONA; Distinct from modern structures common to the area.
Medium	When only two of the previous characteristics are satisfied.
Low	When only one of the previous characteristics is satisfied.
Negligible	Visible in less than three images; No parallels on CORONA; Near to and showing characteristics similar to modern structures.
Excluded	Could not be located and confirmed in the field during the Lagodekhi Survey expedition.

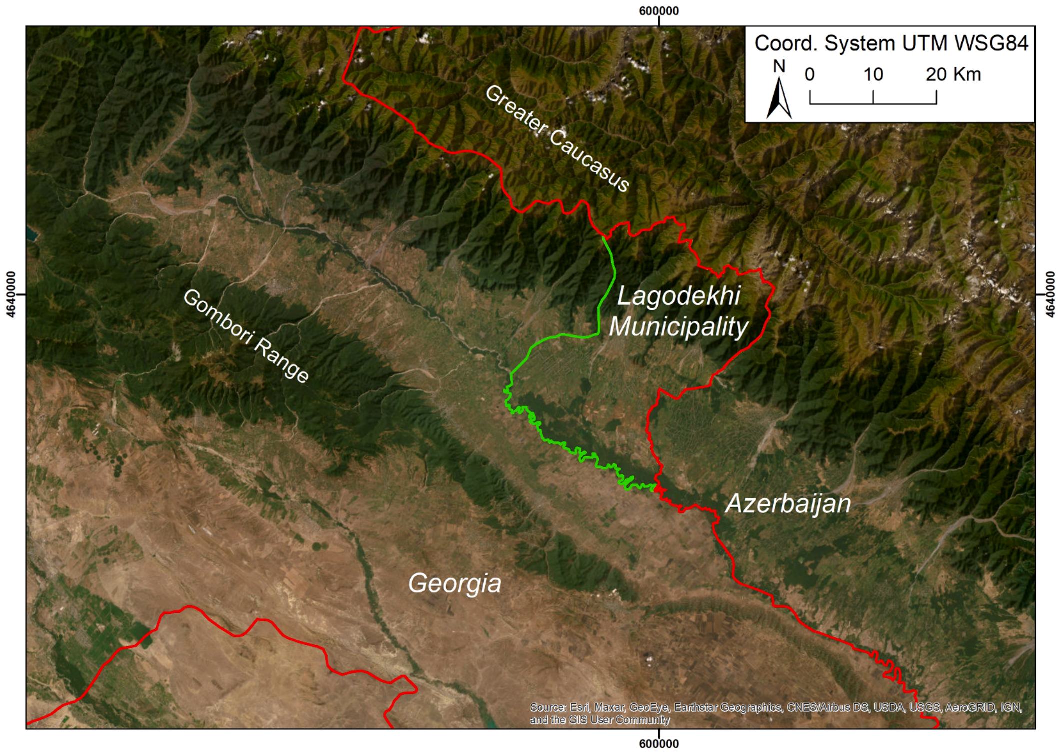

Fig. 4. Location of Lagodekhi Municipality in the Alazani Valley (basemap © ESRI).

first season of the LAS aimed to visit all archaeological sites that were listed in published sources (reports, maps), identified on remote sensing, as well as previously unrecorded sites known to locals. In the following seasons, we made a concerted effort to visit any remaining potential kurgan features identified on the Soviet topographical maps and to ground-truth any further anomalies identified in the remote sensing study. In total, 36 kurgans were recorded in the field.

5. Results

5.1. Kurgans mentioned in published literature

We were able to find published location information for 11 sites (each containing at least one kurgan) in the Alazani Valley (Abramishvili and Abramishvili, 2008; Makharadze and Murvanidze 2014a, 2014b; Makharadze et al., 2016; Pitskhelauri et al., 1982; Dedabrishvili, 1979, Orthmann et al., 1998,2000, Orthmann, 2017). Only five of these sites could be located with accuracy on satellite imagery. Table 3 lists these sites and compares the number of kurgans originally recorded at the site with the number that were detectable on satellite imagery (either historical or modern). All of them were visible as mounded or partially mounded sites on Google Earth and CORONA, except for the Tsitelgori cemetery. The latter kurgans were only visible as mounds on the CORONA image, while by the time the imagery on Google Earth was taken, they only appeared as soil discolorations (due to having been ploughed over in intervening years). Furthermore, the 5 kurgans at Tsnori, described by Dedabrishvili in 1979, were difficult to definitively identify because of limited contextual information. However, using a combination of the Soviet topographical maps and CORONA imagery, we were able to deduce the locations of Tsnori kurgans n. 1 and n. 2.

Table 3
Kurgans mentioned in published literature and relocated on satellite imagery.

Name	Reference	Number of kurgans mentioned in original publication	Kurgans relocated on satellite imagery
Tsitelgori	Abramishvili and Abramishvili, 2008; Pitskhelauri et al., 1982.	c. 20	7
Tchintchrianis Gora	Makharadze and Murvanidze 2014b.	1	1
Ananauri	Makharadze and Murvanidze 2014a; Makharadze, 2016.	3	Kurgans n. 2 and 3
Bakurtsikhe	Japaridze, 1992	1	1
Tsnori	Dedabrishvili, 1979.	5	Kurgans n. 1 and 2

An impediment to the identification of the remaining kurgan sites on satellite imagery is the size of the individual kurgans they contain, i.e. Qistauri, Khirsa, Nukriani, Mashnaari, Anaga, Sakobo (Dedabrishvili, 1979; Japaridze, 1992; Kushnareva, 1997; Mindiashvili, 2012; Pitskhelauri et al., 1982; Pitskhelauri et al., 1994). We could not identify through remote sensing also the location of Ananauri kurgan 1 and Tsnori n. 3–5 (Dedabrishvili, 1979; Orthmann et al., 1998 and 2000). Indeed, all the kurgans at the remaining 6 sites are under 20 m in diameter, while kurgans at the sites we identified were all more than 50 m in diameter. In addition, some are described as being in agricultural areas, and therefore are likely to have been subjected to repeated ploughing through time. This may have resulted in their attenuation or complete erasure from the landscape. Others are in or near villages and may have been impacted by settlement expansion.

5.2. Kurgans identified by remote sensing

The analysis of satellite images resulted in the identification of 83 further possible kurgan features (Table 4, Fig. 5). To our knowledge, the locations of these features have not been discussed in any previously published study. The majority were in the central part of the valley, mainly on the left side of the Alazani River (69 %).

Most of them are marked by soil discolorations (42 %), followed by

Table 4
Possible and verified kurgans identified by remote sensing and field survey.

ID remote sensing	ID field survey	Site name	Surface	ZONE	E	N	Certainty	Mentioned in published literature	Located in field survey
AS0001	–	–	Soil discoloration	38T	613,227	4,591,343	Low	–	–
AS0002	–	–	Mound	38T	614,323	4,592,004	High	–	–
AS0003	–	–	Mound	38T	616,892	4,590,087	Low	–	–
AS0004	–	–	Soil discoloration	38T	637,652	4,577,523	Low	–	–
AS0005	–	–	Mound	38T	634,031	4,581,262	Medium	–	–
AS0006	–	–	Mound	38T	630,282	4,583,093	High	–	–
AS0007	–	–	Soil discoloration	38T	608,585	4,595,521	Negligible	–	–
AS0008	–	–	Soil discoloration	38T	595,283	4,600,703	Low	–	–
AS0009	–	–	Soil discoloration	38T	601,202	4,604,055	Medium	–	–
AS0010	–	–	Soil discoloration	38T	578,254	4,613,320	Low	–	–
AS0011	–	–	Mound	38T	603,500	4,614,352	High	–	–
AS0012	LS024	–	Mound	38T	599,593	4,613,979	Medium	NO	YES
AS0013	LS030	Tsitelgori	Soil discoloration	38T	597,834	4,615,823	High	YES	YES
AS0014	–	–	Soil discoloration	38T	593,444	4,617,650	High	–	–
AS0015	–	–	Different veg. growth	38T	597,196	4,617,945	High	–	–
AS0016	–	–	Soil discoloration	38T	594,041	4,618,404	Low	–	–
AS0017	–	–	Soil discoloration	38T	594,337	4,618,991	Low	–	–
AS0018	–	–	Soil discoloration	38T	594,668	4,618,914	Low	NO	NO
AS0019	LS031	–	Soil discoloration	38T	594,901	4,619,956	Low	NO	YES
AS0020	–	–	Different veg. growth	38T	591,810	4,619,000	Low	NO	NO
AS0021	LS055	–	Different veg. growth	38T	589,523	4,620,883	High	NO	YES
AS0022	LS062	Ananauri k. 19	Different veg. growth	38T	581,665	4,621,874	Low	NO	YES
AS0023	–	–	Mound	38T	597,758	4,622,160	Medium	–	–
AS0024	LS007	Tchinchirianis Gora n. 1	Mound	38T	584,005	4,622,360	Medium	YES	YES
AS0025	LS006	Tchinchirianis Gora n. 2	Mound	38T	584,074	4,622,636	High	NO	YES
AS0026	LS060	Ananauri k. 17	Different veg. growth	38T	581,816	4,622,412	Medium	NO	YES
AS0027	LS061	Ananauri k. 18	Different veg. growth	38T	581,757	4,622,169	Low	NO	YES
AS0028	LS065	Ananauri k. 21	Different veg. growth	38T	580,900	4,622,314	Medium	NO	YES
AS0029	LS005	Ananauri k.4	Different veg. growth	38T	581,067	4,622,727	Medium	NO	YES
AS0030	LS036	Ananauri k. 11	Different veg. growth	38T	581,532	4,622,799	Medium	NO	
AS0031	LS037	Ananauri k. 12	Different veg. growth	38T	581,563	4,622,927	Low	NO	YES
AS0032	LS038	Ananauri k. 13	Different veg. growth	38T	581,642	4,623,036	Medium	NO	YES
AS0033	–	–	Different veg. growth	38T	577,735	4,622,536	Low	–	–
AS0034	–	–	Different veg. growth	38T	577,716	4,623,803	Low	–	–
AS0035	LS004	Ananauri k. 3	Mound	38T	580,687	4,623,450	High	YES	YES
AS0036	LS039	Ananauri k. 14	Different veg. growth	38T	581,658	4,623,130	Medium	NO	YES
AS0037	LS034	Ananauri k 9	Different veg. growth	38T	580,795	4,623,740	Medium	NO	YES
AS0038	LS035	Ananauri k. 10	Different veg. growth	38T	580,831	4,623,868	Medium	NO	YES
AS0039	–	–	Soil discoloration	38T	582,596	4,623,209	Medium	NO	NO
AS0040	LS057	–	Soil discoloration	38T	582,765	4,623,344	Low	NO	YES
AS0041	–	–	Soil discoloration	38T	583,142	4,623,221	Low	NO	NO
AS0042	–	–	Soil discoloration	38T	583,480	4,623,261	Low	NO	NO
AS0043	–	–	Soil discoloration	38T	584,131	4,623,634	Low	NO	NO
AS0044	–	–	Different veg. growth	38T	587,449	4,623,596	High	NO	NO
AS0045	LS063	–	Soil discoloration	38T	580,720	4,624,644	Low	NO	YES
AS0046	LS008	Ananauri k. 2	Different veg. growth	38T	580,387	4,624,263	High	YES	YES
AS0047	–	–	Soil discoloration	38T	598,294	4,626,387	Low	–	–
AS0048	–	–	Mound	38T	579,287	4,630,017	Low	–	–
AS0049	–	–	Soil discoloration	38T	596,173	4,631,538	Low	–	–
AS0050	LS042	–	Mound	38T	591,754	4,631,341	High	NO	YES
AS0051	LS072	–	Soil discoloration	38T	595,248	4,632,079	Medium	NO	YES
AS0052	LS074	–	Soil discoloration	38T	593,400	4,634,006	Medium	NO	YES
AS0053	–	–	Mound	38T	593,299	4,635,524	Low	NO	NO

(*continued on next page*)

Table 4 (*continued*)

ID remote sensing	ID field survey	Site name	Surface	ZONE	E	N	Certainty	Mentioned in published literature	Located in field survey
AS0054	–	–	Mound	38T	592,398	4,636,804	Low	NO	NO
AS0055	–	–	Mound	38T	596,634	4,635,803	Low	–	–
AS0056	–	Tsnori k.1	Mound	38T	594,674	4,610,050	Medium	YES	NO
AS0057	–	–	Soil discoloration	38T	584,531	4,614,776	Low	–	–
AS0058	–	–	Soil discoloration	38T	580,594	4,617,681	Low	–	–
AS0059	–	–	Mound	38T	574,108	4,624,404	Medium	–	–
AS0060	–	–	Soil discoloration	38T	568,029	4,630,396	Low	–	–
AS0061	–	–	Soil discoloration	38T	568,732	4,631,168	Low	–	–
AS0062	–		Different veg. growth	38T	568,836	4,636,906	High	–	–
AS0063	–	–	Mound	38T	551,007	4,647,879	Low	–	–
AS0064	–	–	Soil discoloration	38T	582,937	4,623,525	Low	NO	NO
AS0065	LS059	Ananauri k. 16	Different veg. growth	38T	582,370	4,622,486	Medium	NO	YES
AS0066	–	–	Soil discoloration	38T	637,912	4,577,866	Medium	–	–
AS0067	–	–	Soil discoloration	38T	610,221	4,597,271	Low	–	–
AS0068	–	–	Soil discoloration	38T	598,634	4,601,656	Medium	–	–
AS0069	–	–	Soil discoloration	38T	592,480	4,601,833	Medium	–	–
AS0070	–	–	Mound	38T	582,435	4,606,362	High	–	–
AS0071	–	–	Soil discoloration	38T	588,159	4,608,107	Low	–	–
AS0072	–	–	Mound	38T	596,574	4,608,656	Low	–	–
AS0073	–	Tsnori k.2	Soil discoloration	38T	592,589	4,610,698	Low	YES	NO
AS0074	–	–	Soil discoloration	38T	600,880	4,611,724	Medium	–	–
AS0075	–	–	Mound	38T	582,492	4,606,306	Low	–	–
AS0076	LS058	Ananauri k. 15	Different veg. growth	38T	582,419	4,622,645	Medium	NO	YES
AS0077	–	Bakurtsikhe	Mound	38T	573,372	4,616,182	High	YES	NO
AS0078	–	–	Soil discoloration	38T	600,098	4,615,778	Medium	–	–
AS0079	–	–	Mound	38T	580,575	4,628,534	Medium	NO	NO
AS0080	–	–	Different veg. growth	38T	585,652	4,632,944	Low	–	–
AS0081	–	–	Mound	38T	592,839	4,633,954	Low	–	–
AS0082	–	–	Different veg. growth	38T	576,017	4,637,587	Low	–	–
AS0083	–	–	Different veg. growth	38T	553,867	4,648,941	Low	–	–
–	LS003	Ananauri k. 1	–	38T	580,328	4,624,052	–	YES	YES
–	LS009	Ananauri k. 5	–	38T	580,358	4,624,230	–	–	YES
–	LS010	Ananauri k. 6 (Gorebi)	–	38T	578,725	4,625,801	–	–	YES
–	LS012	Ananauri k. 7 (Gorebi)	–	38T	578,949	4,625,515	–	–	YES
–	LS013	Ananauri k. 8 (Gorebi)	–	38T	579,082	4,625,015	–	–	YES
–	LS023	Unknown	–	38T	598,973	4,613,839	–	–	YES
–	LS029	Unknown	–	38T	596,222	4,615,948	–	–	YES
–	LS064	Ananauri k. 20	–	38T	581,090	4,622,838	–	–	YES
–	LS066	Ananauri k. 22	–	38T	580,433	4,622,542	–	–	YES
–	LS068	Unknown	–	38T	595,810	4,615,459	–	–	YES
–	LS091	Unknown	–	38T	585,244	4,619,703	–	–	YES
–	LS096	Chertlis Kurgan	–	38T	595,062	4,612,739	–	–	YES
–	LS097	Ananauri k. 23	–	38T	580,596	4,623,234	–	–	YES
–	LS098	Ananauri k. 24	–	38T	580,886	4,622,072	–	–	YES
–	LS099	Ananauri k. 25	–	38T	581,008	4,622,450	–	–	YES
–	LS102	Ananauri k. 26	–	38T	580,269	4,623,884	–	–	YES
–	LS103	Gorebi k. 1	–	38T	578,928	4,624,782	–	–	YES
–	LS104	Gorebi k. 2	–	38T	578,985	4,624,671	–	–	YES
–	LS105	Gorebi k. 3	–	38T	579,574	4,625,271	–	–	YES

shadow marks related to the presence of mounds (29 %), and differences in vegetation growth (29 %). Both land cover/geomorphology and modern land use clearly impact on where each of these types are most frequent. Soil discolorations are scattered all over the area of analysis, but more highly concentrated in cultivated fields where regular ploughing occurs, and on fallow ground. Mounds are more commonly found in locations where they have been protected from agricultural activities or soil removal. Differences in vegetation growth are located primarily in the forest on the left bank of the Alazani River; that is, in areas of heavier vegetation.

It was not possible to derive any reliable statistics on the dimensions, shape, or orientation of the overall sample. Soil discolorations are likely larger in size than the original kurgan they represent as they have been altered by modern human activities such as ploughing. Still extant mounds (less than a third of the overall sample) could be used to provide some indication. However, when comparing recent images with historical ones, 10 of the mounded features showed that they had been modified in shape or size between the acquisition of the CORONA images and the modern images available on Google Earth. Of these, 6 were destroyed in the period between the two sets of images and are no longer extant today. Overall, this makes estimating their original size difficult.

5.3. *The efficacy of remote sensing for detecting kurgans*

The integration of the remotely sensed data with newly obtained field data from Lagodekhi Municipality allowed us to evaluate the

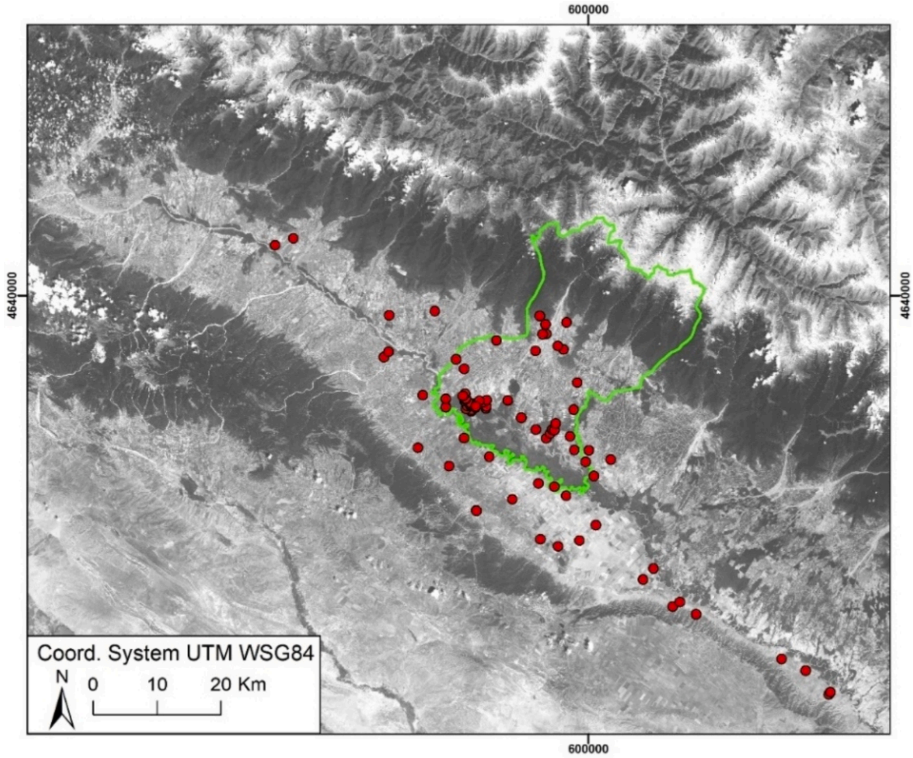

Fig. 5. Locations of all possible kurgans (red dots) in the Alazani Valley identified on satellite imagery. In green the border of the Lagodekhi Municipality (Landsat 8 available from the USGS). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

efficiency of remote sensing techniques for the detection of kurgans in this sub-area of the Alazani Valley. In total, we were able to confirm that 26 of the 38 features we had identified on the imagery in this sub-zone were indeed kurgans (See table 4). Fig. 6 shows their location.

Interestingly, most of the verified kurgans had been given an archaeological certainty of medium to high in the remote sensing survey. Only a few (n = 5) were categorized with a low level of certainty, and this was mainly because they could not be verified on multiple images. In addition, those assigned a medium and high certainty on imagery, and later confirmed, were almost exclusively located in the central, low-lying parts of the Lagodekhi Municipality (i.e., the base of the Alazani Valley). In two cases, the survey allowed us to link the evidence to kurgans already known from literature: that is, the Tsitelgori kurgans and Tchintchrianis Gora Kurgan 1.

In addition, we were able to exclude 11 features (i.e., to deem them not archaeologically significant):

– 3 mounds: 2 were soviet-period water reservoirs covered in earth, which were very similar in size and shape to kurgans (Fig. 7). However, they were in the foothills of the Greater Caucasus where no kurgans were previously known or located. This strengthened their association with modern activity. The last was situated in an area of cultivated fields and proved to be the remains of a destroyed modern building.
– 6 soil discolorations – these consisted of sub-circular depressions filled with clayish soil, typical of alluvial plains. However, on satellite imagery they were not clearly distinguishable from a ploughed-out kurgan. Therefore, features which present this signature are the most difficult to verify from satellite imagery alone (Fig. 8).
– 2 subcircular features caused by a difference in vegetation – These were located under dense forest and deemed to be the results of modern activities, in particular military training exercises (Fig. 9). However, these would not have been distinguishable from kurgans in the same environment without ground-truthing or further analysis on multispectral satellite imagery.[1]

In sum, in the Lagodekhi area c. 70 % of the features we identified as possible kurgans on satellite imagery were verified. We also gained valuable insight into the types of false positives we might encounter, which would allow us to improve our interpretations in the future. This exercise emphasised that an in depth understanding of the local environment and land use practices is essential to photointerpretation in this region.

6. Discussion

6.1. Kurgan location in Lagodekhi municipality

The results of our combined desk-based and field study in the Lagodekhi region suggest that most kurgans can be found within 5 km of the Alazani River.

Most of the kurgans (n = 33 as of 2022) were located on the flat lands of the valley, near the villages of Ananauri/Onanauri (see Fig. 6). Previous investigations had published the location of at least 5 of these kurgan sites and had established naming conventions by identifying those closest to the village of Ananauri as Ananauri 1 – 3, and the remaining ones as Tchintchrianis Gora 1 – 2 (Makharadze et al., 2016; Makharadze and Murvanidze 2014a and 2014b). However, these names do not necessarily indicate distinct meaningful temporal or spatial groups. As the number of mapped kurgans in the area has increased significantly, we have now given unique identifiers to each feature with the prefix LS (Lagodekhi Survey) in line with the site IDs for all sites in

[1] Full details of the methodology and results will be published in Titolo, A., Hopper, K., and Hewitt, Z., in prep (expected 2024). Remote sensing of burial mounds in forested zones using freely available multispectral medium resolution satellite imagery.

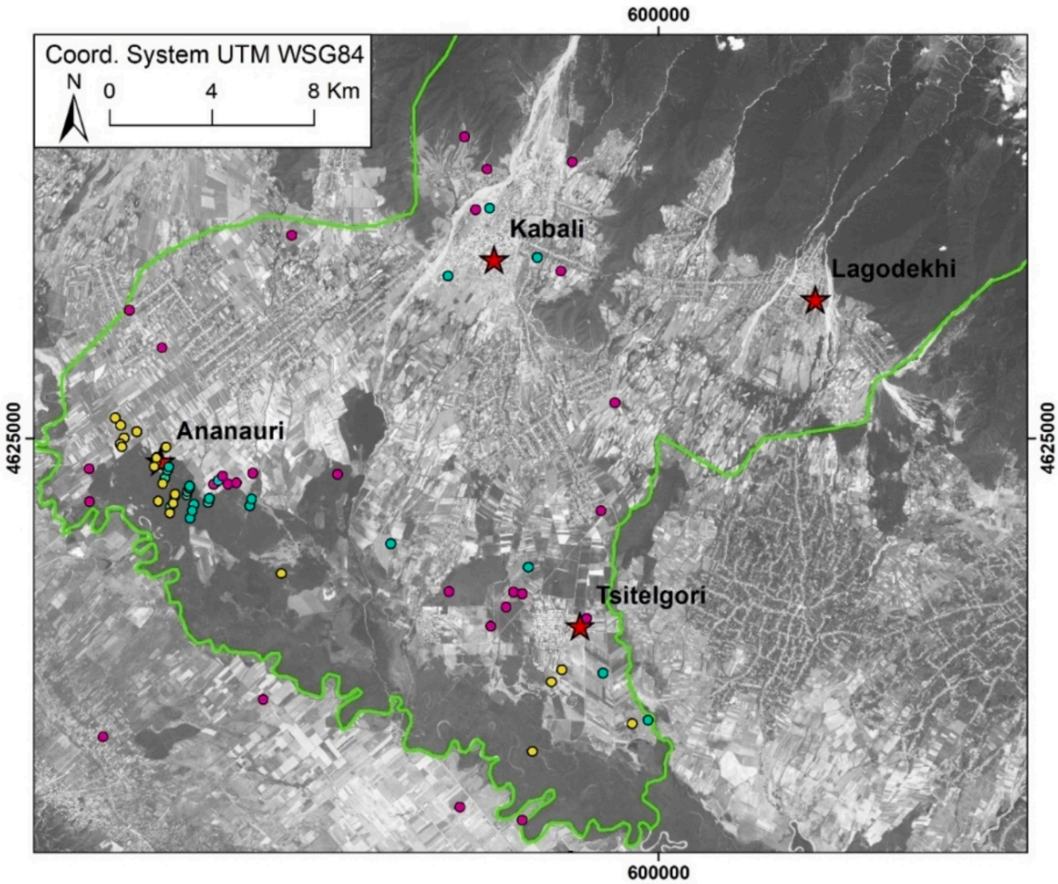

Fig. 6. Location of the kurgans in the Lagodekhi Municipality and of the modern towns and villages mentioned in the text. In – light blue: the kurgans that were detected with remote sensing and survey, in – yellow: those located only during the field survey and in – violet: those detected only with remote sensing (Landsat 8 available from the USGS). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

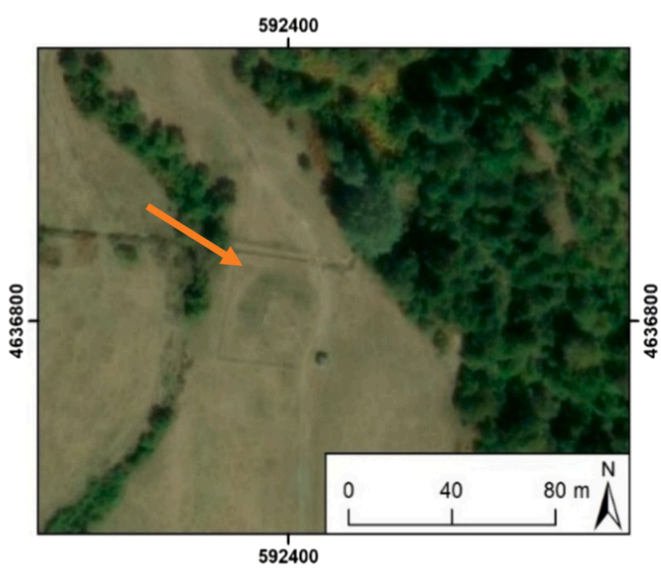

Fig. 7. Feature AS0054. Example of a mound recorded with remote sensing and excluded via field survey. It is a water reservoir covered in earth (basemap © ESRI).

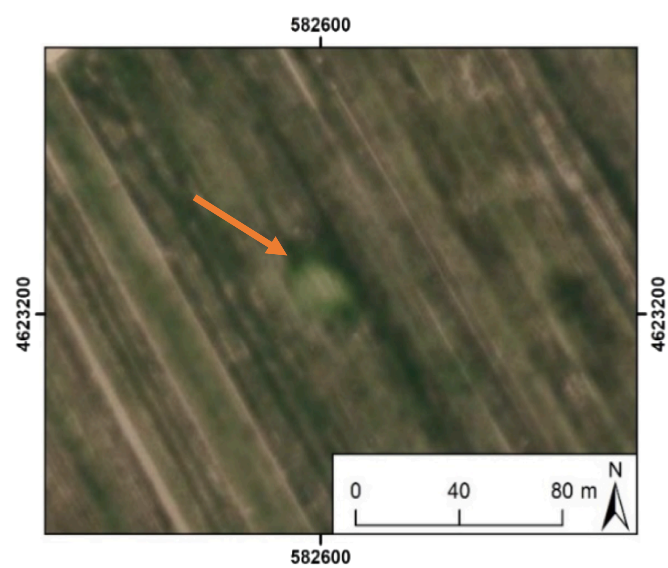

Fig. 8. Feature AS0039. Example of a soil discoloration recorded with remote sensing and excluded via field survey. It is a sub-circular depression filled with clayish soil (basemap © ESRI).

the survey.

These kurgans are spread under the alluvial forest, over an area of ca 6 km^2 but every kurgan is within 100–150 m of at least one other kurgan. Spatial subgroups may be apparent, as some of the kurgans appear to follow a linear pattern. The reasons at the roots of the location of these features in sort of alignments are still unclear and surely will require further investigation to confirm and clarify their pattern of distribution. This will be the topic of another, forthcoming contribution.

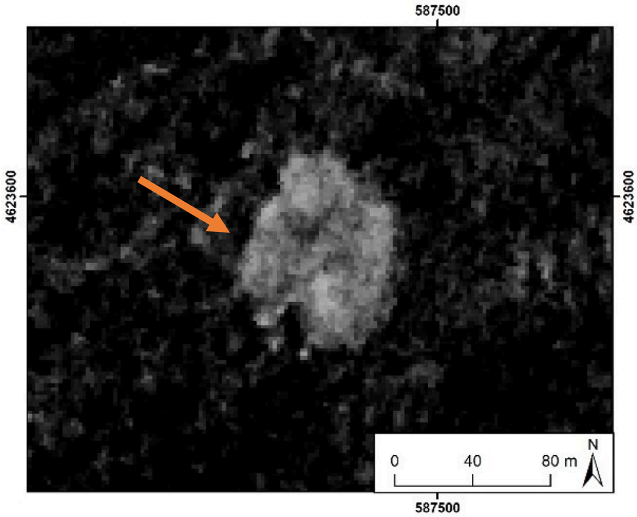

Fig. 9. Feature AS0044. Example of a different vegetation growth detected with remote sensing and excluded via field survey. It is the result of modern human activity (CORONA image from 11 May 1968. Courtesy of the USGS).

It is difficult to determine the relationship between these kurgans and the Alazani River at the time they would have been constructed. Their clustered location, close to the river, may suggest a close relationship between them and the river. The Alazani is very active in this section of the valley, with clear evidence for palaeomeanders visible on satellite imagery. Currently, the kurgans lie at a distance between 1.5 and 4.5 km from the modern river's edge. Moreover, the presence of the dense forest complicates the understanding of the interrelations among this group of kurgans. While it is assumed that both forest and cultivated fields existed at the time of construction, the exact arrangement of this landscape remains unclear (Rova et al., in press (b)). This ambiguity hinders an assessment of the intervisibility among features and the estimation of whether the size of each kurgan is linked to its visibility to others.

18 anomalies representing kurgans of the Ananauri/Tchintchrianis group were located via inspection of CORONA or modern imagery on Google Earth and confirmed in the field. Many were under thick forest canopy and so identified as possible kurgans by a difference in vegetation colour only visible on imagery taken during dryer seasons. The reason behind this is being further explored via analysis of spectral indices derived from medium resolution multispectral imagery in a forthcoming publication (see above, fn. 1). The remaining 8 features were not visible on these imagery sources but were located in the field.

Further east, but still near the valley bottom (within 5 km of the river) are the kurgans of the well-known Tsitelgori cemetery, dating to the Late Bronze/Early Iron Age (Abramishvili and Abramishvili, 2008). They are still visible on satellite imagery as soil discolorations; a few of them are also still visible on the ground as very low mounds. Beyond this, the other possible kurgans identified in field survey in this portion of the valley appear to be spread rather randomly in the landscape. All of them, including the Tsitelgori group, are much smaller (<45 m) in dimensions than the Ananauri group, except for one with a diameter of 75 m (LS037).

Very little evidence for kurgan features was found in the western part of the valley or in the foothills. While these areas may have been deemed less preferable for the building of such features, there may also be natural and anthropogenic factors at work that may have obscured the location of such features (see the following paragraph). However, in the area of Lagodekhi we did find one very well-preserved kurgan on the alluvial fan near the village of Kabali, in the upper part of the valley (Fig. 10). This pattern for the rest of the valley surely requires further investigation to determine whether it is due to limitations in the visibility of available imagery, the results of fluvial activities, or an actual pattern of distribution.

Fig. 10. Regarding the presence of settlements, the survey in the Lagodekhi municipality did not recognize any settlements dated to the same phase as the excavated kurgans. The distribution pattern of settlements from other phases, however, showed that these sites usually have very low mounds and a certain amount of material on the surface (see Rova et al., in press (b)). The entire archaeological signature of the Alazani Valley will be discussed in a future publication. Fig. 10 Kurgan near Kabali.

6.2. *The impact of modern landscape transformations*

On its face, the current evidence from Lagodekhi would suggest that ancient communities in the Alazani Valley favoured the vicinity of the river for burial. However, we should also consider the impact that modern landscape transformations have had on the distribution of these archaeological features. The agricultural policies applied across the region in the Soviet period have already been noted to have had a significant impact on the archaeological landscape (Hopper et al., 2018; Lindsay et al., 2018). The dismantling of private property in favour of collectivization resulted in significant alterations to field boundaries, while the introduction of mechanical ploughing aimed at intensifying agricultural production (because of its higher capacity to reach deeper levels than the manual plough) hastened the flattening of small mounds, both natural and anthropic (Prokhorov, 1978). After the collapse of the Soviet Union, the landscape underwent further transformations; field systems were again rearranged, while villages were enlarged.

Our satellite imagery analysis, representing snapshots of the landscape over the last c. 60 years, supports these observations. Of the 24 possible kurgans in the Alazani Valley that were classified as mounds (as opposed to soil discolorations or vegetation differences) on satellite imagery, 10 showed a decrease in visible size, or had been destroyed between the acquisition of the CORONA images and of the images available on Google Earth (Fig. 11). Unsurprisingly, all these mounds were located in cultivated areas. In fact, the majority of the possible kurgan features situated in cultivated fields were classified as soil discolorations (n = 35). This seems likely to reflect the impact of ploughing over much of the second half of the 20th and into the 21st centuries. Similarly, the expansion of settlement on the alluvial fans and in the lower portions of the valley may also have had an impact. The data thus suggests that further kurgans may have existed, for which we now have no evidence.

In addition, natural processes have also impacted the survival of archaeological features in the Alazani Valley. Imagery analysis shows that even over a relatively short period of time (*c.* 60 years) the Alazani River has modified its course with frequency. The same processes have also impacted many of the Alazani's tributaries. In addition, the plain experiences seasonal floods. This happens especially in spring when the snow melts, or on the occasion of heavy rains, and results in the

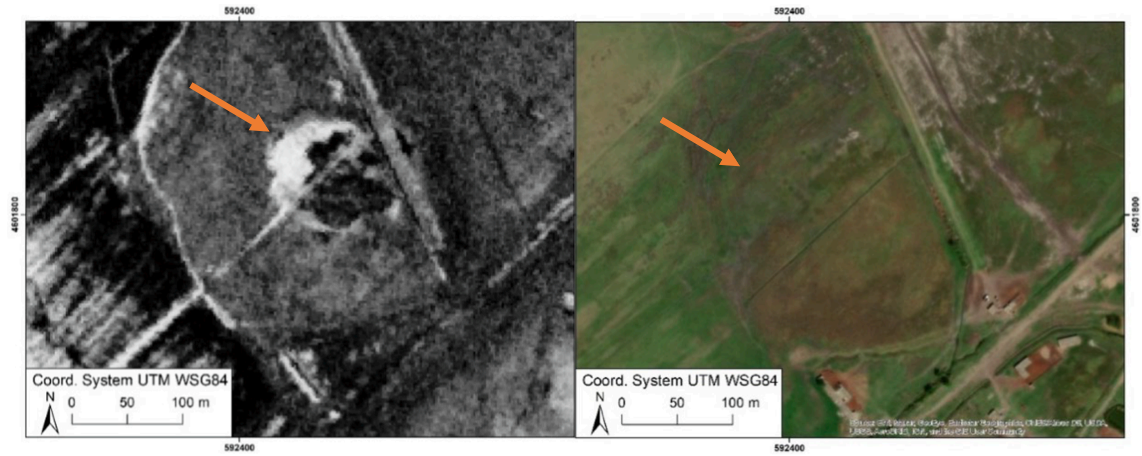

Fig. 11. A kurgan AS0069 is seen here on a CORONA image, but is no longer visible on the corresponding image available on Google Earth (on the left CORONA image from 11 May 1968. Courtesy of the USGS. On the right Worldmap –Esri, Maxar, Earthstar Geographics, and the GIS User Community).

accumulation of fluvial deposits on the alluvial fans and in some areas of the the lower reaches of the valley.

Paleoclimate reconstructions have shown that this process has been occurring in this valley repeatedly throughout the Holocene period (von Suchodoletz et al., 2018). Consequently, small kurgans and other archaeological sites near the river or on the alluvial fans may have been destroyed by the formation of new meanders or covered by deposits. To clarify this phenomenon, some investigations have been carried out by G. Boschian in the Lagodekhi Municipality. The topic will be addressed in a future publication, but it can be anticipated that in the Ananauri area deposition rates seem to have been very moderate, if not close to null, after the Early Chalcolithic period (a preliminary report can be found in Rova et al., in press (b)).

While both natural and anthropogenic forces have negatively impacted on the preservation of archaeological features over much of the Alazani Valley, there are areas of exception. In fact, the dense forest that covers the left bank of the Alazani River in the southern part of the Lagodekhi study area had the opposite effect. Here, where dense forest covered the riverbanks for at least the last 60 years, kurgans have been protected from ploughing and development.

Therefore, kurgans may be somewhat overrepresented nearer to the Alazani River (especially in the forested areas of Lagodekhi) and underrepresented on alluvial fans and cultivated plains. However, the sheer number that we have found in proximity to the river in the Lagodekhi region suggests that these few square kilometres were of particular importance for funerary practices of this type.

6.3. *Funerary landscapes of the south caucasus*

Unlike that of settlements, the location of burials is not necessarily determined by primary needs, such as proximity to essential supplies or a defensive advantage. On the contrary, it is a direct reflection of the meanings attributed to the funerary sphere by the living. By defining a specific and recurrent rituality, a social group can affirm or renegotiate its cultural identity (Ballmer, 2018; Kuna, 2006; Semple and Brookes, 2020). Therefore, the choice underlying the location of a kurgan may be a practical or a symbolic one. On the one hand, building visible structures may express territoriality, that is, putting a very clear "signature" on a specific environment, or defining the limits of 'ownership' of a place (Borgna and Müller Celka 2012; Laneri et al., 2019; Renfrew, 1983; for the area under examination see also Carminati 2018, pp. 274-275). On the other hand, the location may be chosen due to its relative proximity to meaningful elements, such as rivers, earlier funerary monuments, etc. (Harding 2012, p. 28).

To better understand the locations of the kurgans of the Alazani Valley, we need to consider them in the context of their environment and contemporary landscape occupation pattern. Most of the kurgans that we have thus far identified in the valley on remote sensing are located near the Alazani River or its tributaries. In the Lagodekhi region of the Alazani Valley, especially, most kurgans are concentrated relatively close to the Alazani River (i.e., the Ananauri/Tchintchrianis group). The material recovered from the excavations of 3 kurgans of this cluster has primarily been dated to the Late EBA (2400–2100 BCE) (Makharadze et al., 2016; Orthmann, 2017). This suggests that part of the other kurgans of this group could also be of similar date. Even if a precise chronology of the features detected cannot be proved without excavating them, as all the three excavated kurgans (Ananauri, 1, 2 and 3) in this circumscribed area are dated to the second half of the 3rd millennium BC, it is possible to presume a certain level of contemporaneity for the whole cluster. This assumption can be also asserted by the choice of location of these features, that seems somehow respecting a pattern, as well as by the very large dimensions, that are typical of this phase (Dedabrishvili, 1979; Kushnareva, 1997; Makharadze et al., 2016; Sagona, 2017). If we consider the evidence from other phases, specifically for the LBA, it is clear that their pattern of distribution follows completely different rules, as proved, for instance, by the Tsitelgori Kurgans (Abramishvili and Abramishvili, 2008). The later kurgans usually tend to be grouped together, forming sort of cemeteries, but also have much smaller dimensions, whit only very few exceptions, that really rarely exceed 40 m of diameter.

Although we do not know the exact course of the Alazani River during the 3rd mill. BC, there does seem to be a high degree of connection between the river and the kurgans. In the Southern Caucasus, the presence of a river has already been noted as an important attractor for kurgan construction, as seen at Berikldeebi (Jalabadze et al., 2012, p.90). Here kurgans (6 of which are dated to the second half of the 3rd mill. BC) are located in the immediate vicinity of the confluence between the Prone and the Mtkvari river and are arranged in two rows along the course of the waterflows over a distance of 70–80 m.

Other examples from the 3rd mill. BC, have less clear, but possible, associations with water courses. On the Bedeni Plateau there are two clusters of kurgans located on the borders of the plateau: the first group of burial mounds is placed on the northern profile of the plateau, forming a rough East-West alignment, overlooking the Algeti River valley, but not in close proximity to the watercourse; on the contrary, the second group is located in its south-eastern part, along the edges of the Kelakhchai stream gorge (Carminati, 2018). However, in other areas of the Southern Caucasus like Irganchai and Martqopi (Kakhiani and Ghlighvashvili, 2008), there is no clear association between kurgans and water courses in this period. While water may have been an attractor for kurgan construction, it is unlikely that it was the only factor in deciding where to build kurgans.

Interestingly, no evidence for contemporary settlements has been found in the close vicinity of Late EBA kurgans of the Ananauri group or elsewhere in the territory of Lagodekhi Municipality. This may suggest that during this period burial mounds were built in locations specifically separate from living spaces, with the clear intention to create circumscribed *lieux de mémoire,* i.e. cemeteries. As already anticipated, on the right side of the Alazani River, only two settlements have been detected so far: Didi Gora and Tqisbolo-Gora, also not in close proximity to Ananauri. This evidence may indeed be partially due to a lack of information, considering the settlements are generally rare for this period, and usually consist of very low mound, a fact that s doesn't ease their tracking by means of remote sensing. However, the general scarcity of evidence for settlements dating to the same period in the Southern Caucasus has led many scholars to suggest that these communities were semi-nomadic, or more likely transhumant agro-pastoralists (Kushnareva, 1997; Sagona, 2017; Smith, 2019).

The Alazani Valley is highly productive agriculturally and is evidenced to have been so for millennia (Kvavadze 2016, p. 168; Makharadze et al., 2016; Rova et al., in press (a)). Palynological analyses from the relatively recent excavation of the Ananauri Big Kurgan 3 (first half of 24th century BCE) allow to presume that agriculture was probably developed in the region when this was constructed (Kvavadze 2016, p. 168). Similar practices are also supported by the palynological profiles of excavated Late EBA kurgans in other parts of the Southern Caucasus (e.g. the Tkemlara kurgan, the Paravani Kurgans, and the Bedeni kurgans) (Kvavadze et al., 2004; Kvavadze and Kakhiani, 2010; Kvavadze and Sagona, 2015).

Environment and topography will have, undoubtedly, had an influence on the choice of burial mound location. In this case, agriculturally productive land use zones, often near to water sources, appear to have played an important factor in that choice. Visible and enduring marks, such as the burials of prominent community members, could have conferred a sort of ownership over the land that sustained the community. They could also have marked important congregation points for a seasonally mobile community. Certainly, the presence of these kurgans testifies the presence in the Southern Caucasus of complex communities, capable of organizing the construction of monumental structures.

As previously mentioned, the kurgan phenomenon endures in the South Caucasus for thousands of years. However, in the Alazani Valley, the only other period for which we currently have evidence for the construction of kurgans is the LB/EIA as, for instance, there is until now no evidence for kurgans of the MBA in this area. However, by the LB/EIA, kurgans are not the only funerary practice used by local communities. In fact, starting from this period, it appears that the kurgan tradition was progressively abandoned (Sagona 2017, p. 380). The known Late Bronze Age examples from the Lagodekhi study area, the so-called Tsitelgori kurgans, are also different in character from the Late EBA examples. Indeed, they appear to represent a designated cemetery area with clear boundaries. In addition, they are much smaller in size than the Late EBA examples, with diameters not exceeding 35 m. Similar arrangements and sizes characterize LBA/Early Iron Age kurgan necropolises in other parts of the Southern Caucasus, such as at Lčašen and Golovino near Lake Sevan (Castelluccia 2018, p. 224), and Gegharot (Badalyan and Smith, 2017). Sagona (2017, p. 380) argued that these characteristics indicate an end to the monopoly on the burial type by élites of the community; a potentially long-held tradition. The overall decrease in the size of the kurgans may in fact reflect a change in social organization, which is evident in all other fields od landscape occupation and material culture (Sagona, 2017; Smith, 2019), and/or funerary ideologies. Despite a potential change in whom kurgans are being constructed for, it is still very common to find LB/EIA cemeteries built close to older kurgans, reinforcing these locations as a *lieux de mémoire*: examples come from the necropolises of Nerkin-Getašen, Berikledeebi, Natsargora, Okherakhevi, Tsaghvli, Samtavro, Treligorebi, and from Western Azerbaijan (Castelluccia, 2018; Jalabadze et al., 2012; Laneri et al., 2019a, 2019b, 2019c, and Laneri et al., 2020; Ricci et al., 2024; Rova, 2014; Sagona, 2017). This suggests that LB/EIA communities may have recognized the earlier kurgans as “sacred”, perhaps associating them with their ancestors, and therefore creating a link with them through the building of their own monuments.

7. Conclusions

Overall, the analysis of the data collected through remote sensing allowed us to make a first step towards the understanding of the kurgan phenomenon of this region from a landscape point of view. The application of further similar research in different geographical areas will contribute to expanding the discussion.

The systematic mapping of the kurgans in the Alazani Valley provided valuable insights into the potential factors that may have influenced the placement of these burial mounds in the landscape. The Ananauri cluster, for example, suggests that proximity to flowing water was in some way important, as all the kurgans associated with this cluster are located within 70–80 m of the river or streams. However, other factors such as the presence of earlier funerary monuments of important individuals, or the desire to mark ownership of the land, may have also played a role in determining where communities chose to build kurgans.

The study highlights the effectiveness of an integrated methodology that makes use of remote sensing, legacy data, and field survey for studying regional-scale land use phenomena, and for identifying areas of archaeological potential. The use of both historic and modern satellite imagery also allowed us to better ‘read’ the modern landscape and identify how recent land use may have influenced the archaeological patterns we recover. This is particularly relevant in the Southern Caucasus, where the origins and distinctive features of the burial mound tradition are still debated.

Ultimately, to better understand the societies that constructed kurgans in the Alazani Valley and the role of these burial mounds in their cultural practices, further research is needed in the form of solid dating evidence from excavations of kurgans, and detailed landscape surveys from across the wider region. Indeed, it is only by integrating different scales of analysis, that the study of this wide-ranging burial practice can make further advances.

Funding

This research did not receive any specific funding. The field seasons from 2018 to 2022 of the ’Georgian-Italian Lagodekhi Archaeological Project’ were supported by Ca’ Foscari University of Venice through the ’Fondo Ateneo Scavi Archeologici’ grants for 2018 and 2019, the ’SPIN-2 2018′ project, and the Department of Humanistic Studies. Additionally, the ’Ministero degli Affari Esteri e della Cooperazione Internazionale’ provided funding under the ’Contributi missioni archeologiche, antropologiche e etnologiche italiane all’estero’ initiative. Furthermore, the author’s study trip to Lagodekhi in 2022 was funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) under Germany’s Excellence Strategy – EXC 2150 – 390870439.

CRediT authorship contribution statement

Stefania Fiori: Writing – original draft, Visualization, Validation, Software, Project administration, Investigation, Formal analysis, Data curation, Conceptualization. **Kristen Hopper:** Writing – review & editing, Validation, Supervision, Methodology, Investigation, Data curation, Conceptualization. **Elena Rova:** Writing – review & editing, Supervision, Project administration, Investigation, Conceptualization. **Davit Kvavadze:** Project administration, Investigation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgments

The authors extend heartfelt appreciation to the individuals and organizations who contributed to the successful completion of this research project, conducted from 2018 to 2022 as part of the GILAP project (Georgian-Italian Lagodekhi Archaeological Project). Furthermore, thanks are extended to all the members of the expeditions for their invaluable and enthusiastic support, as their dedication and collaboration were instrumental in the success of this research project.

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