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CONTRIBUTION TOWARDS UNDERSTANDING THE CATEGORISATION OF LANDFORMS

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ABSTRACT

Categorisation in the geographic domain, including landform categorisation, is more subject to influence by cultural, linguistic, environmental and individual factors, than other domains. The study presented in this dissertation investigates the influence of landscape variation on the landform categories used by non-experts.

Video-elicitation methods were used in interviews with inhabitants of two distinct landscape types, in Portugal. One study site was mountainous and topographically varied, while the other consisted of more homogenous, gently undulating terrain. Interview responses indicated that participants used more landform terms in descriptions of familiar landscapes. Specific place recognition was another stimulant for an increase in landform categorisation detail. Additionally, the participant group from the more homogeneous landscape had a smaller landform vocabulary, and primarily used variations on a core set of landform terms to describe topographic eminences. The other group had a much larger and more varied vocabulary.

A Digital Elevation Model (DEM)-based landform classification compared well with participant landform categories at a macro scale. A qualitative analysis of participant responses suggested that their drivers for categorisation are the salient features of the landscape (such as elevation and land cover), as well as utilitarian motivations (such as land-use, context and familiarity).

This dissertation demonstrates the use of Geographic Information Systems (GIS) as a tool in the study of landscape in language. It also provides a contribution towards the development of formal landform concept representations in conceptual spaces and ontologies.

KEY WORDS

Cognitive geography

Ethnophysiography

Geographic Information Systems (GIS)

Landform categorisation

Landform terms

Landscapes

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1 INTRODUCTION

1.1 Context

With the ever broadening use of Geographic Information Systems (GIS) and the greater access to GIS-based tools by both geographic information experts and other non-expert users, there is the need to consider the impacts of this expansion. Advances in geographic domain awareness have been made with the help of web-based applications such as GoogleMaps, and correspondingly the use of GIS-based data analysis and presentation has developed for use within and between domains, cultures, languages and locations. The communication and sharing of spatial information has grown in response to recognition of the importance of knowing what is (happening) where, and there is great demand for Geographic Information Science (GIScience) developments (BESR, 2007). As GIS is being adapted and modified to fit into all conceivable applications and domains, a critical look at how effectively this is being done is required. While the technological possibilities race ahead it is important to stand back and question: what lies beneath, what is the meaning of all this spatial information people so desire? The data we use to make our decisions with, called the objective scientific truth; does it actually make sense whenever and wherever we want it to? (Goodchild, 2010; Mark, 2000)

1.2 Geographic concepts

There is the need to examine the conceptualisations of the fundamental objects or phenomena which provide the basis for geographic information analysis and representation within a GIS. A conceptualisation is a simplification, an abstraction, of the real world which we use to refer to what is there (Gruber, 1993). The geographic objects in question in this dissertation are the concepts such as mountain, hill and valley which are commonly used to describe landscapes. These categories are called landforms and describe the features of the earth's surface. There is the need to understand both how the conceptualisations of different geographic features relate to each other, but also the variations of these conceptualisations according to the cultural, linguistic, environmental and individual influences which form them.

It is important to determine and define the extent of the non-universality of geographic conceptualisations for the process of developing geographic domain ontologies (Levinson, 2008). In GIScience applications ontologies are commonly defined using Gruber's (1993) explanation of them being an 'explicit specification of a conceptualisation'. They are used to describe, formally, the relationships between concepts understood to belong to a particular domain. Before this process of formalisation can be performed, or rather, in order for the resultant ontology to be useful, the variations in the conceptual space each concept occupies must be understood. The limits within which a concept is thought to exist or be understood must be defined based on empirical studies (Smith and Mark, 2001).

The critical examination of the assumptions which form the foundations of GIS is central to research conducted within the field of ethnophysiography. Work in this area aims to explore the variations in the terms (and meanings of the terms) people use to refer to parts of natural landscapes (Mark and Turk, 2003a). By observing the categories people form and the drivers for their formation, the relationships between the concepts can be better understood and the geographical domain ontology enriched. This is an important step towards achieving the interoperability of GISs across cultural, linguistic and domain boundaries (Kuhn, 2011).

1.3 Research questions

The inter-cultural and inter-linguistic variations in geographic domain conceptualisations have been explored from both GIScience and linguistic perspectives (Burenhult and Levinson, 2008; Levinson, 1996; Mark and Turk, 2003b). Another important driver to consider is that of the variations in the physical landscape itself. The question of if, and how, the type of landscape people live in effects the categories of landforms they conceive, is the motivation for this dissertation.

In order to investigate, the following research questions are posed, and will be explored:

1. Do people identify categorisations with greater degrees of detail in landscapes they are very familiar with, compared to lesser known landscapes?

2. How do the categories people identify compare with elevation-based automated landform classification?

3. Is there any evidence suggesting that landscape categories are developed according to utilitarian factors more than salient features?

1.4 Conceptual framework

A simple conceptual model has been designed to address the research questions of this dissertation (see Figure 1). There are two major components to the model: (1) landform categorisations given by participants from two study sites and (2) automated landform classifications derived from a Digital Elevation Model (DEM). This provides landform category data for the same two regions of Portugal, from an individual, non-expert human perspective and a predefined, automated elevation-based method. The information extracted from participant responses is compared between the two study sites, as well as against the automated classification. The first of the research questions will be addressed with a quantitative explanatory analysis. The other two aspects of the study will be presented descriptively. Additional exploratory analysis of the participant responses and the extracted data will be discussed where relevant.

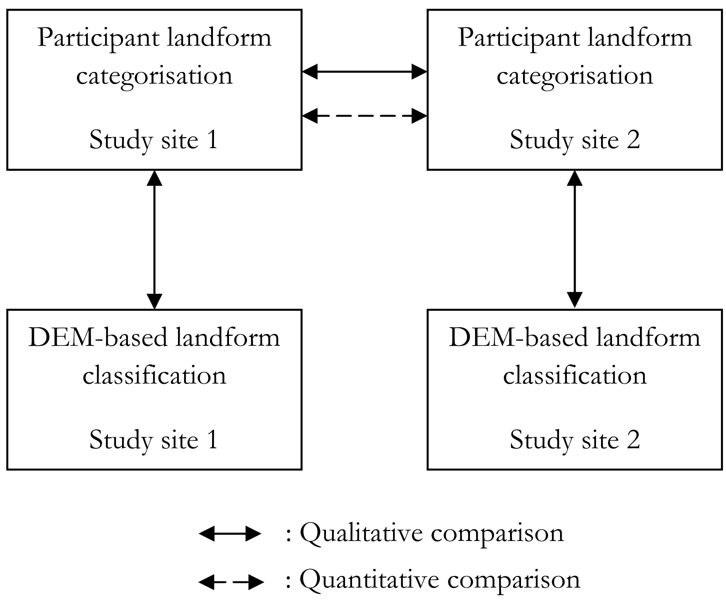

Figure 1. Conceptual framework

1.5 Research design

The research design for this dissertation is based on the above-mentioned conceptual framework. The most important aspect of the research design was site selection: in order to meet the study objectives two topographically distinct landscapes were required as study sites. The details of the chosen study sites are presented in Chapter 3. Following site selection, data was collected using a combination of interviews and Geographic Information System (GIS) analyses. An extensive literature review provides justification for the methods implemented and places the research in context. The interviews were conducted with residents of the study sites, using video-elicitation techniques. They were recorded to allow for landform information extraction at a later date. The DEM landform classification was performed using Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) 30m resolution data with a well known deterministic method. The data extracted from interviews is presented as an aggregated dataset to minimise the effects of data incompleteness and individual variation.

1.6 Study scope

The scope of the project is limited to a small section of the greater field of cognitive geography, and more specifically landform category development. The project has been designed to consider primarily the effects of landscape on the categorisation process, separately from cultural and linguist influences, as has been the focus of previous research in the area. Although language and cultural practices are not separate from landscapes and are not constant across a country, for the purposes of this study the influence of these variations and inter-relationships have been assumed to be minimal.

This study is concerned with the processes of categorisation as opposed to those of delineation. Categorisation is the more general process which includes the step of delineation. The terms used to describe landforms and the range of landforms which are grouped under the same term is being examined, not the variable positioning of the (fiat or bona fide) boundaries between landforms.

2 LITERATURE REVIEW

2.1 Overview

In this Chapter the key findings of relevant areas of research are explored. Research on categorisation, and specifically the categorisation of landforms, is presented first as it is the major focus of this dissertation. Following on, work on landscapes and the human-environment relationships which contribute to the understanding of landscapes, is presented. This is important because the effect of these relationships on the categorisation of landforms is in question. The following body of work is about mountains specifically, as they are such prominent features in landscapes and cultures, yet so conceptually elusive.

The next area of work is the category norms research which has identified some common landform terms at a country scale. This is followed by a discussion of the value of multidisciplinary GIScience and linguistic approaches to research. The final body of work is about the concept of place, and the naming of places across a landscape.

2.2 Categorisation

2.2.1 In general

The general process of categorisation involves grouping similar objects or events into a category and treating them as the same. This process is one of the most basic tasks performed by people and animals. Categorisation has become a research area in many fields – psychology, anthropology and philosophy, largely – and researchers have aimed to answer questions about the formation of category boundaries, similarity of category members and level of abstraction required to perform the categorisation process (Mervis and Rosch, 1981).

It is important to note the difference between categorisation and classification. The two information structuring systems share many similarities and are often referred to synonymously, however they are distinctly different. Classification is the rigorous process of assigning 'things' to classes based on a set of predefined characteristics. These classes are mutually exclusive and there is no room for variations in their definition due to context. The formation of landform types from the DEM is a classification process.

Categorisation on the other hand is an ordering mechanism which is based simply on a perceived similarity of category members within a given context. It is a much more flexible system and the borders between categories are often changeable and fuzzy (Jacob, 2004). The study presented in this dissertation is concerned with the processes of cognitive categorisation.

In the *Principles of Categorization* of 1978, Rosch proposes two major principles of categorisation which account for both the vertical and horizontal growth of taxonomic categorisation (tree) structures formed around basic-level categories. They are simply: (1) 'the task of category systems is to provide maximum information with the least cognitive effort' and (2) 'the perceived world comes as structured information rather than as arbitrary or unpredictable attributes' (Rosch, 1978). The basic level categories at the centre of these structures are those which we learn at a very young age, and which are formed as a balance between informativeness and cognitive cost (Smith and Mark, 2003). The balance of informativeness versus cognitive cost varies as one moves up or down from more to less detailed levels of the categorisation structure.

Another method of organising the possible different levels of categorisation structures is by the primary and secondary theories of anthropologist Robin Horton. Smith and Mark (2001) describe Horton's primary theory as consisting of the basic theoretical beliefs which 'relate to mesoscopic phenomena in the realm that is immediately accessible to perception and action'. His secondary theories, on the other hand, consist of beliefs which 'are characteristic of different economic and social settings.' They suggest that at the level of primary theory, there are likely to be universally consistent categories, while differences due to cultural, linguistic and individual influences are evident at the secondary level categories.

2.2.2 Categorisation of landscapes into landforms

Similar ideas have been referred to by many authors, using various scales of observation. It should first be clarified that geographic space, as defined by Egenhofer and Mark (1995), is what 'contains objects that we humans do not think of being manipulable objects'. Within geographic space landscapes exist. They can be split into categories in different ways according to the purpose (for example, land cover, land-use, ecosystems, broad-scale landscape types), and one way is into landforms. Although it is not always the case, for the purposes of this dissertation it is assumed that categorisation of landscapes refers to the categorisation of the form of the landscape, into distinct landform types.

The process of categorising a landscape into meaningful categories, which can be used to understand and communicate knowledge about that landscape, is a complex one. In comparison to the categorisation of other domains into entities (or things or objects), landscape categorisation is highly subject to the influences of cultural, linguistic, environmental and purely individual factors. This is because unlike many other domains (for example, table top objects or plants), a landscape is essentially a continuous surface. The geomorphology of the land varies and there are physically similar types of landscapes reoccurring around the world due to similar climatic and geological processes, however there is little inherent organisation of this surface into obvious categories or kinds. The landscape does not impose an order within an individual's conceptualisation and hence there is room for interesting variations due to factors beyond the shape of the land (Levinson, 2008; Mark et al., 2010).

When a landscape is categorised, the resultant landform categories (concepts) take a much more abstract form than that of plant or animal species categories, for example. While the categorisation of natural kinds or artefacts is driven by the presence of easily perceived bona fide boundaries, the division of a landscape is more similar to the conceptual division of a human body, as there is usually no clear visual line or parameter which can separate one section from another (Levinson, 2008; Smith and Mark, 2003).

It was initially proposed that the categorisation of both bodies and landscapes followed the expected whole-part theory of mereology (Mark, Smith et al., 1999). However later work has found that in some languages different types of relationships exist between landforms and bodies at different levels of categorisation (Enfield et al., 2006; Levinson, 2008). These studies are important for the understanding of human cognition and categorisation processes in general, simply because they do not conform consistently to the categorisation structures of other domains.

The influences on landscape conceptualisation have been explored by both ethnophysiography researchers and linguists (see next sections). The research aims to investigate the cross-cultural and cross-linguistic variations in landform categorisations, exploring the existence, if any, of universal categories, as well as determining the drivers and motivations for the formation of landscape categories. This work is not only important for the development of informed and inclusive geographic domain ontologies, and GIS applications, but also for the progression in understanding of cognitive categorisation processes in general (Smith and Mark, 1998).

The potential drivers for the formation of landscape categories have been summarised by Burenhult and Levinson (2008) as being (1) 'perceptual or cognitive salience', (2) 'affordances…or…constraints [the categories] impose on human activities' and (3) the presence of 'conceptual templates and cultural beliefs'. The first refers to the formation of landform categories due to physically observable (or perceivable) features of the landscape, such as specific shapes in the relief, or changes in land cover type. The second driver leads to landforms grouped according to utilitarian motivations; that is, what the members of that category can offer to a person. The third driver refers to the presence of categories formed according to cultural beliefs related to the landscape, such as myths and legends that are connected with specific parts of the landscape.

Levinson's ideas are supported by the work of Mark and Turk (2003b) and Smith and Mark (2001). In their work on developing ontologies of the geographic domain Smith and Mark investigated the applicability of Rosch's basic-level categories to geographic (including landform) categories. They proposed that the development of geographic basic level categories occurs at the mesoscopic scale – the scale at which we can take in objects in a single glance – as in other domains, and according to what the parts of that view can afford us. Despite the later finding that these basic level categories are not universally consistent as Horton's theory suggests (Levinson, 2008), the recognition of affordances driving the formation of categories remains consistent. The notion of affordances is credited to Gibson (1986) who stated that 'The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill.' Burenhult and Levinson (2008) further describe the affordance of a part of the landscape as the 'utilitarian significance' of the area.

The third driver is a reflection of the often strong link between cultures and landscapes. This link is particularly evident in the culture of Indigenous Australians and Mark and Turk (2003b) state that for many groups 'spirituality and topography are inseparable'. This is reinforced by Anschuetz et al.'s (2001) claim that the term landscape can be thought of as encompassing different elements along the 'culture-nature continuum'. Somewhere along this continuum lies the connection between the physical landscape and the culture of the people who live there, and this connection exerts its influence on the conceptualisation of landform categories.

It is unlikely, however, that any one of these drivers acts independently. Burenhult and Levinson (2008) suggest that the interesting areas of investigation lie in determining the interactions between the three mechanisms, rather than trying to isolate their contribution.

An important finding from the cross-linguistic comparison of landform vocabularies of people living in similar environments, was that although different groups had similar types of terms, the delineation of the categories varied. Burenhult and Levinson (2008) suggest that this is evidence of drivers of categorisation other than salient environmental features. They have not, however, discussed the variations of lexica within cultures across different landscapes.

Another approach to understanding the drivers for the categorisation of continuous environments into 'object-like spatial regions' has been proposed by Bian (2007). She is more concerned with the drivers for delineation and suggests that five factors are important: 'spatial scale, boundary, attributes, process, and mobility.' She explains regions as being defined by what is in them (properties) and their behaviour, and they can be mobile as they follow changes in attributes and processes. The delineation of landforms is likely to be governed by a number of these factors.

2.3 Ethnophysiography

Ethnophysiography is the branch of ethnoscience dedicated to the examination of the 'categories that people use when conceptualising and communicating about the landscape' (Mark and Turk, 2003a). The categories in question are those of landforms and water bodies. The field was proposed as a distinct area of research, separate from the related sciences of ethnobiology, ethnozoology and ethnoecology because of the importance of understanding landform conceptualisation as a process with different drivers, compared to that of natural kind categorisation. These specialized fields can be grouped together under the area of landscape ethnoecology, each giving contributions to the understanding of 'ecotopes' – the term used to denote the categories of landscape ethnoecology – which incorporate biological, geological and ecological factors into the delineation of 'kinds of land' (Hunn and Meilleur, 2010). The methods of investigation of the conceptualisations of each field are comparable however, as they all seek to learn from the variations across cultures, languages, landscapes and individuals (Mark and Turk, 2003b).

2.4 Landscape

2.4.1 The concept

The word 'landscape' means different things in different contexts and people are required to be explicit about which landscape they refer to, for example: natural landscape, cultural landscape, urban landscape or spiritual landscape. This indicates the complexity of the concept. The term arose out of physical geography and it was Russian geographer Lev Semenovich Berg who first attempted to form a standard definition in the early 20th century. He opted for a broad definition which saw geographical landscapes as the units of the study of geography, 'repetitive groupings not only of forms of relief, but also of other objects and phenomena at the earth's surface.' (Shaw and Oldfield, 2007).

The recognition of landscapes going beyond the physical, was first introduced to geography as Geosophy by Wright (1947), as he introduced the idea of perceptions of landscape. He explored the 'influence of imagination upon the creation of geographical knowledge' and spoke of the individually variable and subjective views of landscapes (Keighren, 2005). These ideas retain their importance, and current definitions of landscape are inclusive of the relationships between people and their land, the meaning of place, and the cultural and spiritual influences which affect individual perceptions of the earth's surface (Aikenhead and Ogawa, 2007).

The understanding of landscape adopted for this dissertation is that of landscape ethnoecology. This is a 'landscape perceived and imagined by the people who live in it' where 'the relationship between land and classification or understanding of land is a feedback loop that takes in both the potential of the land and human ways of making a living, including human technologies, cosmologies, and knowledge systems' (Johnson and Hunn, 2010).

2.4.2 Landscape in Portugal

The study of landscapes in Europe (including Portugal) has a focus on understanding the perceptions of land-users and stakeholders in the face of land-use change. Research is being conducted from both sociological and land-use management perspectives, however all with an understanding of the dynamic and subjective nature of landscape (as described in the previous section) (Pedroli et al., 2006). Pedroli et al. state that landscape studies in Europe are all similar in that their methods include considerable stakeholder consultation and focus on people's 'perceptions and images' rather than solely objective approaches.

This is evident in Surová and Pinto-Correia's (2008) study of landscape perceptions and preferences amongst the different stakeholders of the Montado (cork oak) region in the Alentejo, Portugal. They found that in a time of rapid land-use change in this region there was considerable diversity in the perceptions of different user groups - hunters, mushroom pickers, beekeepers, landowners, Portuguese walkers and foreign walkers - depending on their interaction with the landscape. For example, landowners preferred the open landscapes with little shrub cover, as this would provide better access for farm machinery, whereas walkers preferred the more vegetated parts of the landscape. An awareness of these differences in perception is important for achieving sustainable land-use management practices within such multifunctional landscapes. Although the purpose of that study was different to that of this dissertation, their findings are relevant in that they highlight the variability of perceptions of landscapes due to utilitarian motivations.

2.5 Mountains

Mountains have long been the landform, the entity, the concept which most intrigues and captivates people. Discussion about the difficulties in defining and understanding landforms has largely centred upon mountains. Some of this discussion is due to the scale of mountain landscapes and hence the influence they exert on many other ecological and social domains. Mountain landscapes are highly variable (in topography, weather, vegetation) and dynamic environments, which effect the culture, language and lifestyles of mountain people. The UNEP World Conservation Monitoring Centre (2002) dedicates much work to understanding mountain environments and their people. They state that 'people would know a mountain when they see one', yet agreeing upon definitions of what constitutes a mountain is incredibly difficult. The lack of globally understood definitions hinders integrated research on mountain environment sustainability.

Debarbieux (2004) presents a history on the many approaches taken in attempting to define what mountains are. Again the conclusions are that knowing elevation and slope are not enough and that factors like land cover are equally important in understanding what a mountain is.

The enigma of the mountain is explored from the ontological perspective by Smith and Mark (2003). They investigate just how difficult it is to extract the concept of a mountain, in contrast to the ease with which people refer to them and recognise them.

2.6 Category norms research

An interesting body of work, which is concerned with the broader concepts of geography (as opposed to specifically landforms), is based around the category norms studies conducted by Smith and Mark (1998; 2001). Their work makes an important contribution towards defining the non-expert understandings of geographical categories, for use in constructing useful geographic domain ontologies. They modified the category norms elicitation methods used by Battig and Montague (see (Van Overschelde et al., 2004)), and focused only on the sections of the norms survey relevant to the geographic domain. Their experiment involved asking (non-expert) participants to give examples of 'a kind of geographic feature, a kind of geographic object, a geographic concept, something geographic, [and] something that could be portrayed on a map' (Smith and Mark, 2001). They found that the most common responses were landscape scale physical features such as mountain, river and lake. Repetition of this experiment in the United States of America, the United Kingdom, Finland and Croatia yielded very similar results. The similar responses suggested the existence of a universal basic-level folk geographic categorisation (or ontology) as has been found to exist in other domains (Rosch, 1978). As discussed previously, this result was later challenged by the findings of ethnophysiography and linguistic studies.

An interesting aspect of the results was that there were significant differences in responses to the five sections, which means that non-expert common sense understandings of the ontological terms (object, feature, concept *etc.*) exist. These understandings do not necessarily match that of experts, however their existence is an important consideration for the development of useful geographic domain ontologies for widespread use amongst GIS-based applications.

A similar category norms experiment was conducted in Portugal by Pires (2005) and the results generally corresponded to the American responses. They concluded that, as with previous cross-cultural comparisons, no significant differences could be claimed. Methodological differences meant that the total occurrence of responses were not comparable, but responses to 'something geographical' were very similar, with both surveys finding that river, mountain and ocean were listed in the top 5 most common responses.

Pires' (2004) survey also included a section on natural earth formation where, again, respondents were asked to list five examples. The same question was posed in Battig and Montague's survey in America. A comparison of the results showed both groups listing mountain, river, valley and rock in the top five most common responses. More interesting are the responses in the top 10 which are *not* common to both countries: canyon, cliff and cave for the Americans; and water, sea and plain for the Portuguese. It is likely that these categories reflect the presence of these features in each country. Similarly, five out of the top 10 Portuguese responses were water bodies (water, river, lake, ocean and sea) reflecting the fact that 'Portugal is a wealthy country in terms of water bodies, which are a constant presence in…everyday life and history' (Pires, 2004).

The results of this dissertation will be considered in light of Pires' geographic category norms findings. Despite different approaches, it is expected that commonalities in results will be evident. Certainly this research will contribute towards the 'exploration of differences…according to geographical origin of the subjects' that Pires et al. (2005) have called for.

2.7 Linguistics and GIScience

The study of geographic concepts, categorisations and terms is interesting to linguists as well as GIScientists and, in fact, forms the link between the two disciplines. It is important for these two disciplines to be cognisant of each other, not only for the contribution of knowledge to common areas of interest, but for the definition of the vocabularies of space which each group employs. Weibel (2009) discusses the connections in a position paper presented at the 2009 workshop on Language, Space and Geography. There are two main components to the relationship: the role language plays in the distinction between space and place; and the investigation of the conceptual categories people use to describe both space and place. When referring to the latter, he states that there is 'tremendous potential for future collaboration between linguistics and GIScience in this area' (Weibel, 2009). In looking to the future collaboration between the disciplines Weibel suggests that an interesting research problem is that of making comparisons between linguistic variation and changes in physical (or otherwise) geography (for example, topography). This dissertation will make a contribution towards investigating this research problem, through the comparison of differences in geographic lexicon between study locations.

There is evidence of complimentary research agendas working well together, in the work of Mark and Turk (2003b) and Burenhult and Levinson (2008) at the Max Planck Institute of Psycholinguistics. Both groups converged upon the finding that 'there are many degrees of freedom between, on the one hand, the continuous geological surface, and on the other, culturally recognized landform features and principles of toponymy' (Levinson, 2008). There is a common understanding of the importance of considering the non-universality of geographic categorisations and lexicons in the context of global GIS use, and the linguists' focus on determining the mechanisms driving these differences is an important contribution.

Further suggestions for the collaboration of linguistics and GIScientists are proposed by Kuhn (2011). He calls for the incorporation of 'computational approaches to knowledge representation and reasoning' into language studies via the use of ontologies. By creating ontologies of domain vocabularies a formal documentation is achieved, allowing for testing and comparison within and between lexica. Kuhn suggests this application of ontology-based reasoning is particularly relevant to the study of landscape in language, given the propensity for concept and lexicon variability within and between cultures.

Although ontology development is beyond the scope of this dissertation, the results could form the basis for regionally specific landform ontologies. Reasoning with such ontologies could be a method by which to address the research problem Weibel (2009) mentions – that of the correlation between linguistic and geographic variability (Kuhn, 2011).

2.8 Place and place names

Toponymy is the study of place names, the proper nouns people use to refer to specific locations. The study of place names and what constitutes 'a place' is a highly complex and multi-faceted area of research. In the context of ethnophysiography it is the relationships between landscape terms (names of categories) and place names which is of particular interest (Burenhult and Levinson, 2008; Mark and Turk, 2003a). The findings of studies of nine different language groups did not yield consistent patterns between the delineation and identification of landform categories, and the assignment of individual names, nor the structure of the names where given. In the Jahai language of Malaysia, place names are consistently linked to hydrological features in the landscape, and apply to catchment areas (as opposed to the watercourses themselves). This is particularly interesting because there is no general term for 'catchment' in their language (Burenhult, 2008). This lack of overlap of landscape terms and place names is quite different compared to other languages (including English) where there is a combination of monomorphemic (single part) place names which are independent of landform type and binomial (two part) names which include the landform type being referred to, for example Lisbon and Tagus River, respectively (Levinson, 2008). The relationships between place names and landform terms will be noted during the course of this dissertation.

Another aspect of place which is relevant to the current study is that of familiarity and recognition. In her study exploring the idea of a 'sense of place', Agarwal (2005) found that this sense of familiarity plays a role in the spatio-temporal reasoning processes. That is, they are not independent. This is an interesting finding as it suggests that a concept of place and having a sense of belonging, impacts people's cognition of geographic space. The potential influence of participants' connections with places, on the categorisation of landforms (or communication of that categorisation) will be considered in this dissertation.

3 STUDY SITES

3.1 Serra da Lousã

The first study site is situated in the Pinhal Interior Norte region of Portugal and includes the town of Lousã as well as several villages in the Serra da Lousã mountain range. These villages are situated in both the Lousã and Góis *concelhos* (municipalities). The area, covered by the two *concelhos* is 402 km^2, shown in Figure 2.

This location was chosen due to the mountainous nature of the landscape and the useful network of rural development organisations (Dueceira, Lousitânea and Agência para o Desenvolvimento Turístico das Aldeias do Xisto) who could help find interview participants. The Serra da Lousã is a mountain range which rises steeply to the south east of Lousã town and has an elevation range of 200 to 1204 m (Câmara Municipal da Lousã, 2008). The mountains are largely covered in both natural (various oak species and chestnuts) and plantation (pine and eucalyptus) forests, with great variability due to the abrupt changes in elevation and climatic conditions throughout the area. There are also significant areas of open heather which are particularly important for the production of the honey for which the area is known (Lousitânea, 2010). The area receives a total annual precipitation of 1200 to 1600 mm/year and has an average daily temperature of 7.5 – 15 °C (Agência Portuguesa do Ambiente, 2007).

The underlying geology consists of a schist and greywacke complex, cut through by multiple quartz veins (Câmara Municipal da Lousã, 2008). It is from this rock that mountain inhabitants have long fashioned their homes, creating the unique schist villages.

The schist villages of the Lousã *concelho* (Candal, Cerdeira, Talasnal, Casal Novo and Chiqueiro) have very few permanent residents remaining because people left in recent decades due to the difficult lifestyle. Tourism is now being promoted to keep the villages alive and retain their important cultural significance (Agência para o

Desenvolvimento Turístico das Aldeias do Xisto, 2008; Carvalho, 2004). The schist villages of the Góis *concelho* (Comareira, Aigra Nova, Aigra Velha and Pena) are, interestingly, more populated and inhabitants still keep gardens and animals. They are also a part of the schist village network which promotes tourism in the area.

3.2 Odemira

The second study site covers a portion of the Odemira *concelho* which lies in the Alentejo Litoral region, and is the biggest *concelho* in Portugal. Participants from this study area live in a number of different towns, namely: Odemira, São Luís, Boavista dos Pinheiros, Relíquias, Cabo Sadão, Zambujeira do Mar, São Teotónio, Azenha do Mar and Moitinhas Sabóia. The Odemira *concelho* covers 1697 km^2.

The location was chosen due to the gently undulating landscape, and the different climate and land cover compared to the first study site. As with the first study site there is an active rural development organisation in the area (TAIPA – Organização Cooperativa para o Desenvolvimento Integrado do Concelho de Odemira), which was helpful in finding interview participants. The area consists largely of lowlands and small hills with a number of higher elevation ranges (such as the Serra de Cercal, 341 m) and one major river course (Rio Mira). The area also includes the mouth of the Rio Mira and a large stretch of coastline from Vila Nova de Milfontes to Azenha do Mar.

Like Lousã the underlying geology consists of schist and greywahcke, however in this region the substrate is folded into repeating elevations. There are also areas of sandstone and dune formations along the coast. The majority of the Odemira *concelho* falls into the *Colinas de Odemira* (Hills of Odemira) landscape unit, excluding the Serra de Cercal. The soils in the area are at high risk of erosion (d'Abreu et al., 2004; Direcção Regional do Ambiente do Alentejo, 1998).

The area is a part of the Montado region which consists of cork oak and holm oak trees interspersed with cultivated and grazing land. There are also areas of eucalyptus and pine plantations (Agência Portuguesa do Ambiente, 2007; Câmara Municipal de Odemira, 2007). The area receives between 600 – 1000 mm/year with an average daily temperature of 12.5 – 17.5 °C (Agência Portuguesa do Ambiente, 2007).

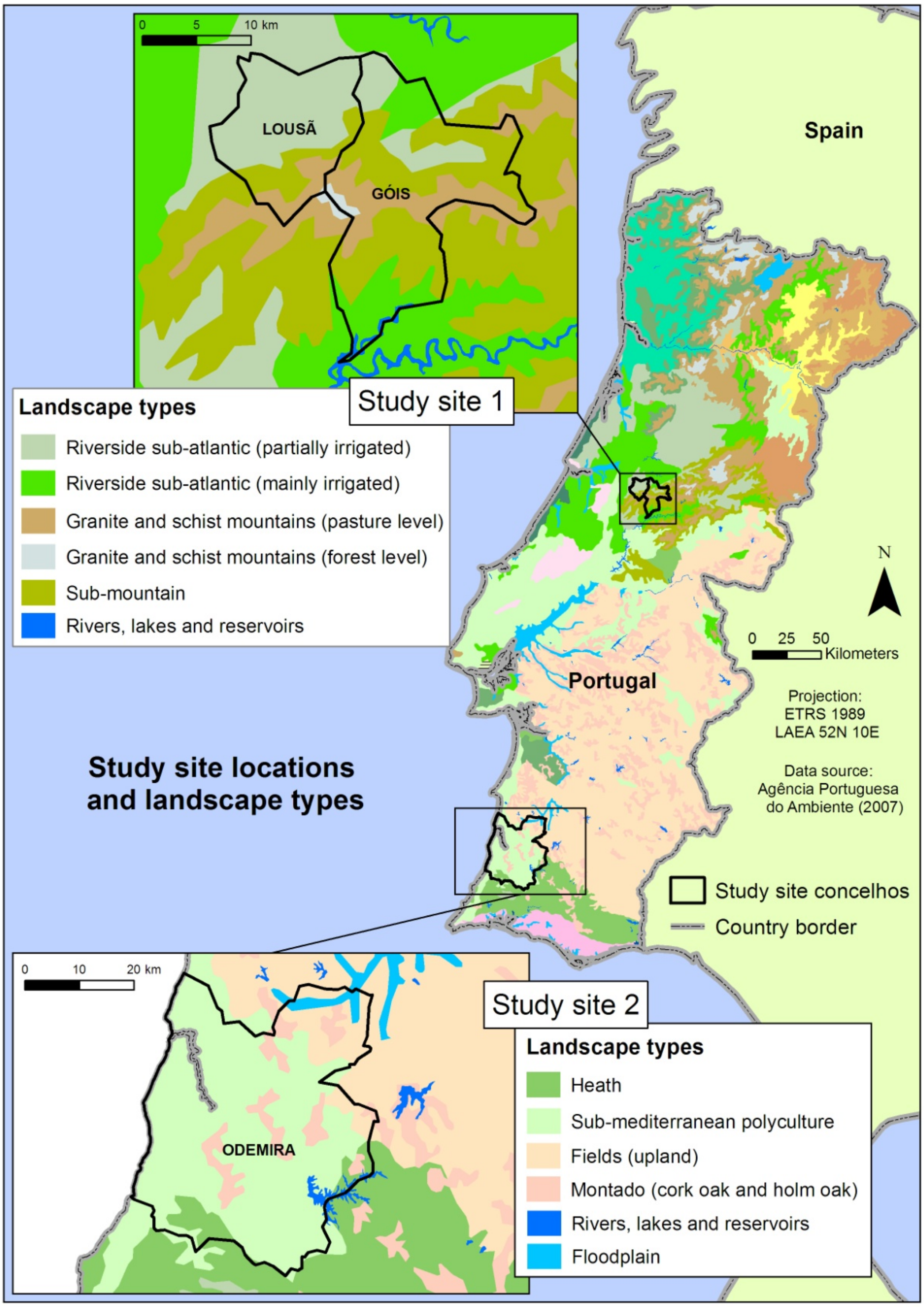

Figure 2. Study site location map

4 METHODOLOGY

4.1 Interviews

There are two major components to the methodology implemented for this study: the collection and interpretation of landscape descriptions by study site residents (study participants), and the calculation of a landform classification using a DEM, in ArcGIS.

The first component involved interviewing participants from both study sites, using video-elicitation techniques. The purpose of these interviews was to gather data about the landform terms and place names residents use to describe both their local landscape, and the less familiar landscape of the other study site. The methods used to prepare for and conduct the interviews were based on techniques implemented by a number of different authors, and modified to suit this current study.

4.1.1 Justification for using video

Interview methods involving photographs as prompts, have been used by ethnophysiographers and linguists in their work on understanding the language used to describe landscapes, and are well documented in Turk et al. (in press) and Bohnemeyer et al. (2004). The method was also used by Surová and Pinto-Correia (2008) in their study of landscape perceptions and preferences.

Photo-elicitation is the method of conducting interviews based around the participant's description of a photograph (or video) or using the photograph as a prompt, and is termed a 'reflexive' method because it is the participant not the researcher who defines and describes the photograph contents (Emmison and Smith, 2000). It is a method used primarily in anthropology, ethnography and sociology research. The most common reason for using photographs during interviews about landscapes, is as a time saving alternative to walk-through, in-situ field interviews. The most ideal method of conducting interviews about landscapes is to speak to the participant while moving through the landscape, as the interviewee is able to easily gauge perspective and scale, and take in all the sensory cues which influence the way they talk about the place. However, this is often not possible due to time, cost and resource constraints, and hence other visual alternatives are used to prompt interviewee's responses. Surová and Pinto-Correia (2008) noted that the 'recognition of different landscape patterns on …photographs, and their association with … activities, was relatively easy for respondents'. This is an important observation, and particularly relevant to the current study due to the mention of 'activity', because the utilisation of the landscape is a possible driver for categorisation.

Not only are visual cues a useful means of showing participants the locations they are asked to describe, but additionally it has been found that using photographs during interviews has an effect on the type of information people give. Photographs evoke people's feelings and memory, which helps them to engage in the interview topic and speak with more depth (Harper, 2002).

Considering the language, time and location constraints of this study, the use of visual cues during interviews was deemed an appropriate method. Rather than using photographs as the above mentioned authors have done, video was considered a more useful medium. It allows for a sense of movement through the landscape, and a continuous view of a wider landscape scene (compared to, even, a panoramic photograph). This has the benefit of giving the viewer a greater sense of perspective, scale and context. It takes into consideration the understanding of Smith and Mark (1998), who state that '[o]bjects of geographic categorization are too large to be taken in within a single act of perception…and much…contextual knowledge will be required for categorization purposes'. Video allows for the relative positioning of landforms and the variations of land cover upon them to be seen, thus providing the viewer with more of the context they require to form their categorisations.

Turk et al. (in press) suggest that a video of a person moving through a landscape would be ideal, as it would provide the sense of movement and activity which is important in eliciting people's knowledge of an area (Lauer and Aswani, 2009). This was not possible to achieve for the current study due to the inaccessible terrain. Similarly, Surová and Pinto-Correia (2008) suggested the use of digitally modified photographs to remove the influences of weather and sun aspect. These factors were not expected to introduce bias into the results of this study, and so that technique was not implemented.

4.1.2 Preparation

The preparation stage of the interview methodology corresponds to Turk et al.'s (in press) Stage 1: 'Dictionary work and photo collection – scoping the domain and preparing 'instruments''. A vocabulary list of landform, landscape and vegetation terms in Portuguese and English were assembled to familiarise the author with expected terms and aid in interview interpretation. The final list of terms and their definitions (sourced from the online dictionary/encyclopaedia www.infopedia.pt) are given in Table A 1, Appendix 1.

Two preliminary field trips were conducted (one to each study site) to take video footage and photographs of the landscape, and form contacts with the local organisations and individuals mentioned in Chapter 3. A range of film sites were selected to provide a set of images which give a good representation of the common landscape features of the area. Locations with an uninterrupted wide view across the landscape were chosen, and short (~30 second) pan shots were taken. Care was taken to maintain a similar distance from the major landforms in order to retain a consistent scale of view. Ten sites were filmed and photographed in each study area, with five subsequently used for the final film montage. The photographs and video were captured with a Panasonic Lumix DMC-LX3 wide-angle digital camera with 10 mega pixel resolution. The wide-angle was important for capturing the horizontal extent of the landscape. The coordinates of the film sites and direction of view were recorded using a GPS and a compass.

The videos and photographs of the five selected sites (for each study area) were combined into a 4 minute movie montage. The movie was organized such that the video image of each view was followed by a still photograph of the same scene. This was done in order to give the participants a chance to see how the parts of the landscape within the moving pan shot fitted together, before using the static image to describe the scene without being hurried by the movement. Windows Movie Maker software was used to create this movie montage.

Interview participants were selected according to purposeful criterion sampling, a qualitative research method outlined by Patton (1990). The requirement being that the person had lived in the study area for more than 5 years, with greater preference given to people who had lived their whole lives in the region. No limitations on age, occupation or sex were placed due to the limited capacity of the author to find suitable participants within the timeframe of this study. See Chapter 8 for suggestions of modifications to participant selection criteria for future studies.

4.1.3 Interview structure

The approach used for this study differs slightly from Turk et al.'s methods due to differences in objectives. For example, Turk et al. (in press) follow the steps: '2. Field interviews – identifying the set of landscape terms and distinctions' and '3. Photo interpretation sessions – clarifying existing terms and collecting new ones'. Their interview methods involve direct questioning about, and comparisons of, specific landforms to form an understanding of the definitions of landscape terms according to the interviewee. The intention of the author of this dissertation however, was not to elicit definitions of terms and details of differences, but rather to compare the terms (and range of terms) used by interviewees from different locations, thus the interview process could be simplified.

The interviews consisted of two parts. Firstly, the purpose and format of the interview was outlined and the interviewees watched an introduction video which helped explain what was required of them. Secondly, two requests were made of the interviewees: they were asked to watch the two videos and name the landforms they could identify; and give the specific names (place names) of any places they recognised. They were then free to describe the landforms of their choosing with no prompting or questioning unless they were hesitant about what was expected of them. Additionally, interviewees were asked if they recognised the views in the video. The intention was to capture participants' unbiased, natural ways of talking about landscapes, rather than asking them to carefully separate the landforms into mutually exclusive consistent categories.

Interviewees all watched the movie from the unfamiliar study area first in order to capture their instinctive naming of landforms, rather than giving a 'calibrated' opinion which may have occurred had they described a familiar landscape first. Similarly, participants were not informed of the study site locations prior to watching the videos.

The interviews were conducted in people's homes, workplaces and study places, and where possible, alone. The video descriptions were recorded using CamStudio software which records the video image as well as voice, to allow for interpretation following the interview. Observations about the participant and the interview were noted by the author directly after the interview. Interviewees were asked to fill in an information sheet which included: name, age, occupation, length of time in current residence, and contact details. As previously explained these details were not considered in the interpretation of the results, but were collected as metadata records.

This simple approach reduced the influence of the interviewer's (author's) language difficulties and ensured the ease of participants while meeting the study objectives through the capture of useful information.

4.1.4 Interview interpretation and data extraction

Both qualitative and quantitative approaches were used to examine the study results and observations. The quantitative treatment of the results was designed to give an explanatory response to the first research question. The second and third questions were discussed descriptively with the extracted landform terms and additional interview observations.

With the aid of translators the interview recordings were studied and landform terms and place names extracted. A systematic approach was used to record this information: each of the major landforms (named by at least one participant) in the videos was numbered and the term used by each participant was recorded against that number. This allowed for tallies of the number of terms used by each participant as well as the number of people who used a certain term, to be formed. The resultant dataset is of nominal discrete primary data with a sample size too low to permit the use of statistical significance tests. Frequencies of occurrence are used for data analysis.

Turk et al. (in press) recommend Stage 4: 'Semi-structured follow up – clarifying confusions, probing for extra meanings, evaluating quality of interpretations'. Due to the simplicity of the current study (as well as time limitations), follow up clarification with participants was not deemed necessary. Evaluating the correctness of place names mentioned by participants was performed sufficiently by consulting topographic maps and Google Earth. Participants will however, be provided with a summary of the study findings upon completion, as most indicated they would be interested to receive some further information. Thus Turk et al.'s (in press) Stage 5: 'Reporting the initial results back to community members' will be completed.

4.2 DEM-derived landform classification

4.2.1 Choice of method

The second part of the methodology involves a deterministic landform classification of the study areas using a Digital Elevation Model (DEM). It is interesting to compare the human landform categorisation with a computed landform classification which uses only parameters derived from changes in elevation. The results of such a comparison are useful for understanding the drivers of categorisation (Smith and Mark, 2003), as the computational method has no influence from utilitarian, cultural or individual factors. The classification produced was used in the response to the second research question posed.

The implemented classification method is based on a macro landform classification system developed by geographer Edward Hammond in the 1950s and 60s (Dikau et al., 1991). It has since been modified into a deterministic analysis which can be computed using elevation data and performed in a GIS (Dikau, 1989; Dikau et al., 1991). More recently a step by step approach to the pixel-based analysis using ArcGIS tools was published (Morgan and Lesh, 2005). The method has been widely used and tested (Brabyn, 1998; Drescher and Frey, 2009; Gallant et al., 2005; Sayre et al., 2009).

It should be noted that a pixel-based method, which uses only a DEM as input data, is by no means the ideal method for deriving an accurate landform classification (compared to manual geomorphology assessments or general human cognition). Being pixel based it means that each cell of the earth's surface (corresponding to the DEM raster cell) is classified individually, as opposed to a landform (or feature) being identified (delineated) and then assigned a category, as is the process of human categorisation. However, at this time there are no alternative computational landform classification methods available, as the object-based approaches are still in development (Sinha and Mark, 2010; Straumann and Purves, 2008).

4.2.2 Classification methodology

The analysis methodology published by Morgan and Lesh (2005) has been followed, with the inclusion of corrections noted by Drescher and de Frey (2009) where necessary. The analysis was performed using the ArcGIS Model Builder function, implementing a number of Spatial Analyst tools from the ArcInfo toolbox. The models are shown in Appendix 4. The elevation data was the 30m ASTER DEM - tiles ASTGTM_N40W009 and ASTGTM_N37W009 (NASA, 2009). The DEM data is shown in Appendix 3.

The analysis is split into three sub-sections, the results from which are then combined to form the final landform classification. The sub-sections are slope, relief and profile, and they are combined to form Landform type = Slope + Relief + Profile.

Slope

The slope map gives the percentage of near-level land for each pixel (which is the value calculated for a 20 pixel radius circular neighbourhood and a near-level threshold of 8% slope) split into four classes (Table 1). A correction to Morgan and Lesh's (2005) slope calculation was published by Drescher and de Frey (2009) – that the total pixel sum (percentage calculation denominator) be counted within a 20 pixel radius circle not a 1.5 km radius circle.

Relief

The relief map gives the change in elevation for each cell, based on the maximum and minimum elevation within a 20 pixel radius circular neighbourhood. Morgan and Lesh (2005) defined the relief classes with intervals rounded to the nearest 10m, however Hammond's original relief classes (Gallant et al., 2005) were used in this analysis (Table 1).

Profile

The profile map gives the percentage of near-level ground in upland and lowland areas of the landscape, again with a 20 pixel radius circular neighbourhood. The boundary between upland and lowland is defined as the midpoint between the maximum and minimum elevation for the target pixel's neighbourhood. The four profile classes are shown in Table 1.

Sub-section	Morgan and Lesh Sub-class (Morgan and Lesh, 2005)
Slope (%)	
> 0.8 % 0.5 – 0.8 % 0.2 – 0.5 % < 0.2 %	400(1) 300 200 100
Relief (m)	
< 30 30 – 91 91 – 152 152 – 305 305 – 914 > 914	10 20 30 40 50 60
Profile (%)	
> 75 50 – 75 25 – 50 < 25	1 2 3 4

(1) There is an error in the numbering of these classes in Morgan and Lesh's (2005) publication (pg 3), noted by Drescher and de Frey (2009). The corrected class numbering is shown here.

Table 1. Class thresholds of landform classification sub-sections

The final landform map is produced by adding together the three sub-section maps. The result is a map with 96 possible classes. These classes were aggregated into 24 meaningful super-classes developed by Dikau et al. (1991) (which differ from Hammond's original classes by the inclusion of more sub-classes to three of the super-classes (Gallant et al., 2005)). Not all of Morgan's classes are meaningful and hence not all are aggregated into Dikau's classes. The complete list of aggregated classes is shown in Appendix 5.

Morgan and Lesh (2005) suggest smoothing the final map, however this was deemed unnecessary for this application. An additional note for successful use of Morgan and Lesh's method, is that care must be taken to not use the 'Change missing values to NoData' option during the reclassification steps.

The final landform classification map does not indicate landform elements such as water bodies, crests and summits, escarpments and valley sides (Dikau et al., 1991). These features will always need to be added manually to an automatically computed landform map.

5 RESULTS

5.1 Landform categorisation by participants

5.1.1 Participant interview information

The data presented in this section has been extracted from interviews with ten and eleven participants in the Lousã and Góis, and Odemira *concelhos*, respectively. The Lousã participants ranged in age from 44 to 64 and had lived in the area for 5 to 64 years. Their occupations ranged from restaurant and bar owners, to architects and farmers. The Odemira participants had an age range of 25 to 44 and had lived in the Odemira *concelho* for 8 to 41 years. They were rural development professionals, students and business employees. The complete information sheet of each participant is given in Appendix 8. Participants are not identified by name in this dissertation.

The photographs and video footage used to make the movie montage were taken between 31 October and 3 November 2010. The interviews were conducted between 13 and 19 November 2010.

5.1.2 Notes on the collation of results

The results are comprised of specific landform terms and toponyms extracted from the interview recordings, as well as observations of the way participants described the landscapes. During the information extraction process a number of decisions were made regarding the similarity of terms and descriptions, and their inclusion as landforms. Firstly, due to the frequent reference to water features and water bodies, despite there being no visible water in the films shown to participants, they have been included as landforms. Secondly, it was decided that the following landforms be treated as distinct: *vale* (valley), *vale com ribeira* (valley with stream) and *vale com rio* (valley with river). On the other hand *vale com água* (valley with water) was considered the same as *vale* because the type of water body was not indicated. Thirdly, *terreno cultivada* (cultivated land)*, semeada* (seeded), *semeio* (planted), *pasture* (pasture) or *campo* (field) were not considered, despite their common occurrence in participants' descriptions, as they describe land-use not landforms. There are a number of other terms which were difficult to distinguish as distinctly land-use or landform. They were included as landforms, based on the context in which the participant used them: *terreno chão e alagadiço* (flat and flood prone land) and *lezíria* (flood plain).

Finally, variations on basic landforms such as s*errazinha/serra pequena* (small mountain) were included as distinct landforms as they indicate the modification of words to provide terms for perceived categories.

Another important aspect of the quantitative results to note, is that only aggregated counts of terms used within the full video description are given. Individual participant's terms or the distribution of terms used to describe a specific landform have not been compared. Presenting the results on an individual basis would not be correct or meaningful, due to the incompleteness of the data set.

The low counts for each landform term (even after term aggregation) and the nominal nature of the data mean that no statistical significance testing could be applied. So, although quantitative results are presented, they should be considered an indication of possible trends only, not as definitive results.

5.1.3 Results from descriptions of Lousã video

The images shown in Figure 3 are the views used in the movie montage of the Serra da Lousã site. The landforms which were named or described by at least one participant have been labelled. A total of 17 landforms were given terms and/or place names by participants.

Appendix 2 contains a summary of the terms used by participants to describe the landforms. The Odemira participants used a total of 18 different terms and the Lousã participants used 30. The Odemira participants used between 4 and 6 terms each (an average of 4.7), while the Lousã participants used between 3 and 14 terms (an average of 6.7).

There is a positive relationship between the number of views the participant recognises and the number of terms they use to describe the video. The number of views recognised and the number of landform terms a participant uses has a positive correlation coefficient of 0.55. The data for the Lousã participants watching the Lousã movie is shown in Table 2, ordered from the most number of terms to the least. None of the Odemira participants recognised the views in the Lousã video.

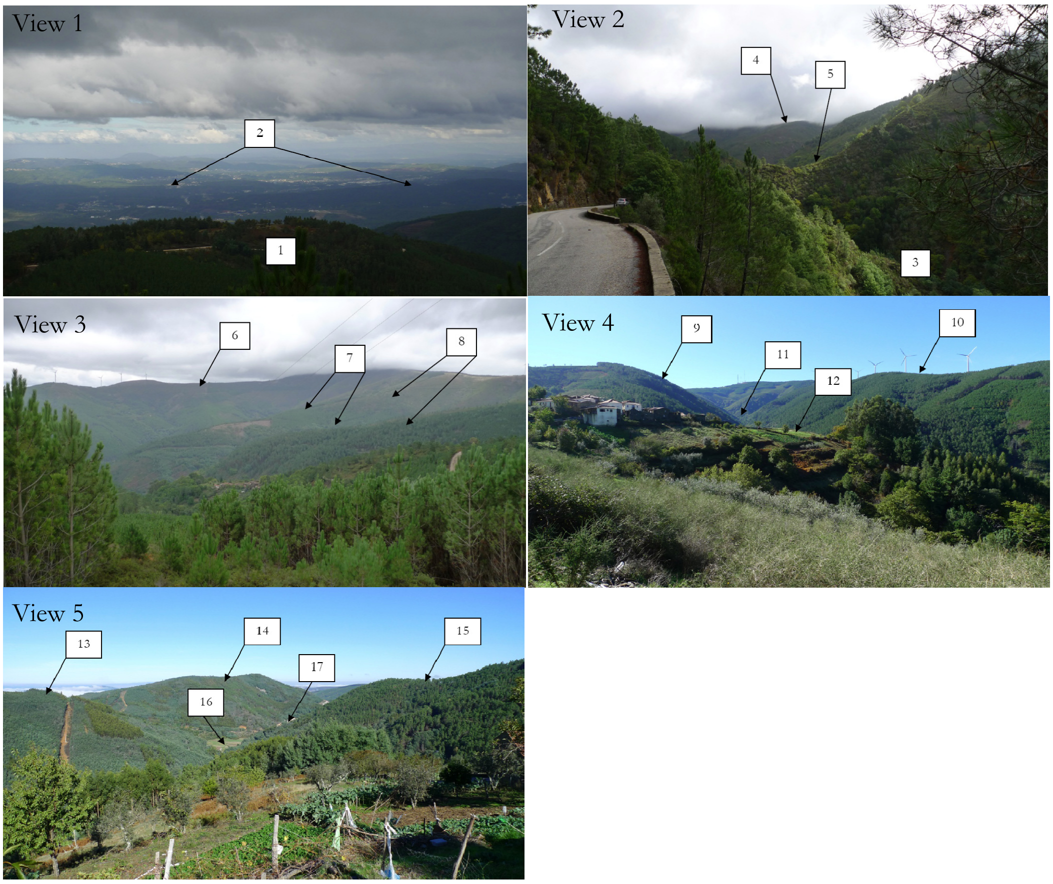

Figure 3. Video views 1 - 5, Lousã

Participant	No. views recognised	No. of terms used
H	4	14
G	2	11
B	3	7
I	2	7
K	3	6
J	1	6
C	2	5
A	3	4
F	2	4
E	1	3

Table 2. Recognition and number of landform terms for Lousã participants - Lousã video

5.1.4 Results from descriptions of the Odemira video

The images shown in Figure 4 are the views used in the movie montage of the Odemira site. The landforms named or described by at least one participant have been labelled. A total of 18 landforms were given terms and/or place names by participants.

A summary of the terms used by participants to describe the landforms in the Odemira video is given in Appendix 2. The Odemira participants used a total of 26 different terms and the Lousã participants used 27. The Odemira participants used between 4 and 10 terms each (an average of 7.5), while the Lousã participants used between 4 and 9 terms (an average of 6.1).

There is a positive relationship between the number of views the participant recognises and the number of terms they use to describe the video. The number of views recognised and the number of landform terms a participant uses has a positive correlation coefficient of 0.74. The data for Odemira participants watching the Odemira video is shown in Table 3 below, ordered from the most number of terms to the least. Many of the Lousã participants recognised the Odemira views as showing the typical Alentejo landscape but did not know the actual location.

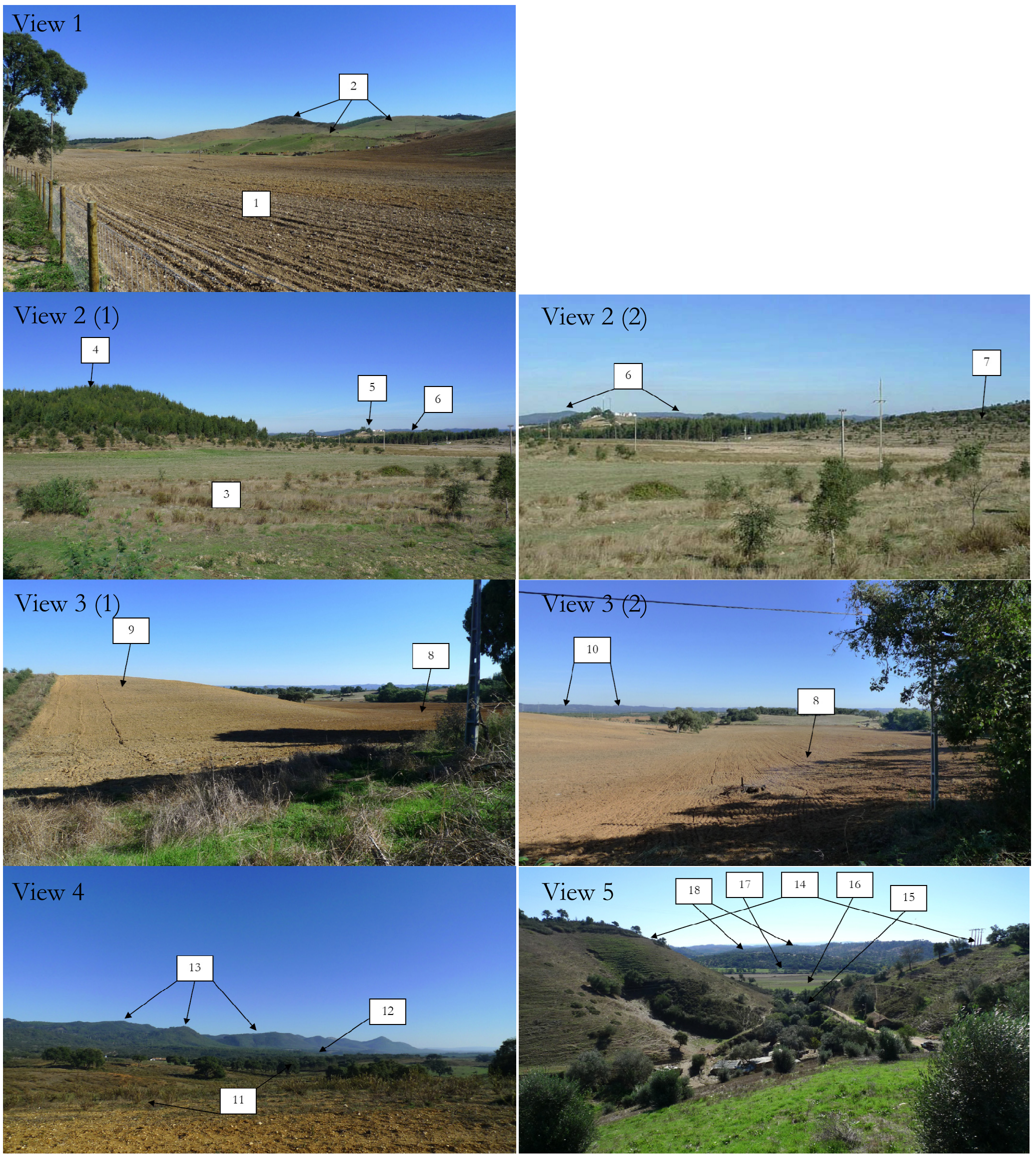

Figure 4. Video views 1 - 5, Odemira

Participant	No. views recognised	No. of terms used
J	4	10
H	2	10
A	2	9
K	2	9
G	0	9
C	0	7
E	0	7
I	0	7
F	0	6
B	0	5

Table 3. Recognition and number of landform terms used, Odemira participants - Odemira video

5.1.5 Combined results

The following, Table 4, shows the complete list of terms used by at least one participant, and the categories they were aggregated into for the remainder of the analysis. A total of 58 terms were aggregated into 18 meaningful categories. The aggregated counts for each category are given. The percentage frequency of occurrence for each category was calculated using the sum of counts for each participant group. These frequencies show the distribution of terms within each group.

			Lousã video				Odemira video			
			Lousã participant (Total: 10)		Odemira participants (Total: 11)		Lousã participant (Total: 10)		Odemira participants (Total: 11)	
No.	Category	Terms	Count	% Freq.	Count	% Freq.	Count	% Freq.	Count	% Freq.
1	Low lands	Várzea Várzea grande Baixio Baixa Terreno chão e alagadiço Lezíria Planalto Pequeno planalto Plana	6	9	7	13	8	13	16	19
2	Planicie	Planicie	2	3	3	6	7	11	9	11
3	Vale	Vale Vale fundo	9	13	11	21	7	11	11	13
4	Arriba	Arriba	1	1	0	0	0	0	0	0
5	Monte	Monte	5	7	8	15	9	15	8	10
6	Monte variations	Montezinhas Pequeno monte Monte grande	0	0	2	4	2	3	5	6
7	Hills	Colina Morro Cabeço Penedo Elevações Elevaçãozinha	6	9	0	0	6	10	2	2
8	Slopes	Encosta Encostazinha Encosta abruptas Ladeira Inclinado Poco inclinado Inclinação Rampa	6	9	1	2	2	3	3	4
9	Serra	Serra	8	12	6	12	5	8	8	10
10	Serra Variations	Pequena serra Serrazinha Serrinha Serra maior Serra alta	0	0	1	2	2	3	7	8
11	Montanha	Montanha	7	10	7	13	4	7	6	7

(Continues on next page…)

			Lousã video				Odemira video			
			Lousã participant (Total: 10)		Odemira participants (Total: 11)		Lousã participant (Total: 10)		Odemira participants (Total: 11)	
No.	Category	Terms	Count	% Freq.	Count	% Freq.	Count	% Freq.	Count	% Freq.
(Continued from previous page…)										
12	Montanha variations	Mini-montanha Montanha baixa Montanhas suave Montanha pequena Montanha alta	0	0	2	4	2	3	2	2
13	Ridge/ peak	Cumeeira Cume da montanha Cume da serra Cume da encosta Cumeada Pico da montanha	7	10	2	4	0	0	0	0
14	Lombo	Lombo	4	6	0	0	0	0	0	0
15	Cordilheira	Cordilheira	0	0	1	2	1	2	0	0
16	Perfil de montanha	Perfil da montanha	1	1	0	0	0	0	0	0
17	Rio and ribeiro	Rio Ribeiro	3	4	0	0	2	3	5	6
18	Water-related	Margens do rio Passagem de água Linhas da água Bacia	2	3	1	2	4	7	1	1
		Total	67	100	52	100	61	100	83	100

Table 4. Aggregation of the landform terms into generalised categories, counts and percentage frequencies of occurrence

A summary of the above percentage frequency of occurrence results, listed in order of highest to lowest total frequency (summed across all participants) is shown in Table 5. Figure 5 shows the graph of this data.

	Lousã video		Odemira video		
	Lousã participant	Odemira participant	Lousã participant	Odemira participant	Total
Category	% Freq.	% Freq.	% Freq.	% Freq.	Sum of % Freq.
Vale	13	21	11	13	59
Low lands	9	13	13	19	55
Monte	7	15	15	10	47
Serra	12	12	8	10	41
Montanha	10	13	7	7	38
Planicie	3	6	11	11	31
Hills	9	0	10	2	21
Slopes	9	2	3	4	18
Ridge/peak	10	4	0	0	14
Rio and Ribeiro	4	0	3	6	14
Serra variations	0	2	3	8	14
Monte variations	0	4	3	6	13
Water-related	3	2	7	1	13
Montanha variations	0	4	3	2	10
Lombo	6	0	0	0	6
Cordilheira	0	2	2	0	4
Arriba	1	0	0	0	1
Perfil da montanha	1	0	0	0	1
	100	100	100	100	400

Table 5. Term distribution within each participant group ordered from most to least common

The following table (Table 6) shows a percentage frequency of occurrence for each term category, calculated using the sum of counts across participant groups. This shows the relative proportions of term use for each participant – video combination. The data is ordered (top to bottom) from the most to least common terms for Lousã participants, with a secondary ordering of least to most common for Odemira participants. The graph of this data is shown in Figure 6. The left columns of the graph show the terms used predominantly by the Lousã participants, in the middle are the terms most common to both groups and to the right are those used predominantly by the Odemira participants.

	Lousã video		Odemira video			
	Lousã participant	Odemira participant	Lousã participant	Odemira participant	Lousã participant total	Odemira participant total
Category	% Freq	% Freq	% Freq	% Freq	Sum of % Freq	Sum of % Freq
Arriba	100	0	0	0	100	0
Lombo	100	0	0	0	100	0
Perfil da montanha	100	0	0	0	100	0
Hills	43	0	43	14	86	14
Ridge/peak	78	22	0	0	78	22
Water-related	25	13	50	13	75	25
Slopes	50	8	17	25	67	33
Rio and Ribeiro	30	0	20	50	50	50
Cordilheira	0	50	50	0	50	50
Serra	30	22	19	30	48	52
Monte	17	27	30	27	47	53
Montanha	29	29	17	25	46	54
Planicie	10	14	33	43	43	57
Vale	24	29	18	29	42	58
Low lands	16	19	22	43	38	62
Montanha variations	0	33	33	33	33	67
Monte variations	0	22	22	56	22	78
Serra variations	0	10	20	70	20	80

Table 6. Term distribution between participant groups, ordered from most to least common for Lousã participants (and least to most common for Odemira participants)

The following table (Table 7) shows the total counts and proportion (as a percentage) of terms used by participants per video. The Lousã participants used 44 terms in total, over both videos, using 86% of these when describing the Lousã video and 61% when describing Odemira. The Odemira participants used 34 terms overall, and used 76% of them to describe Odemira and only 53% to describe Lousã. This shows that both groups used a higher percentage of their terms when describing the landscape familiar to them, compared to the less familiar site.

	Lousã participants		Odemira participants	
	Term Count	Term Proportion (%)	Term Count	Term Proportion (%)
Lousã video	30	68	18	53
Odemira video	27	61	26	76
Total number of terms	44		34	

Table 7. Total term counts and frequencies of occurrence per participant group

5.1.6 Water and vegetation in the results

The two most consistently observed commonalities in participants' descriptions, were the references to water, and the desire to describe the vegetation and land-use. None of the video scenes included any water – no visible sea, rivers, streams, lakes, dams or mud. Despite this, the majority of participants included water-related descriptions of the landscape as an element in the identification of landforms. Many used the water flow paths to describe the shape of the landscape or speculated about where water features may be or may flow, even in landscapes unfamiliar to them. Where used to describe the form of the landscape, the water references have been included in the list of landform terms presented in the previous section [for example, *Linhas da água* (water lines), *bacia* (basin), *várzea* (plain next to a river), *terreno chão e alagadiço* (flat and flood prone land) and *lezíria* (flood plain)]. Additional references included: speaking of certain vegetation as an indication of the presence of water, noting a green patch in a ploughed field as a water point, describing the land cover as *lameiro* (marsh, swamp), and guessing that the sea was beyond a background mountain, or that a river flowed in the lowlands.

The second observation was that of participants' consistent inability to describe the landforms in the video scenes without also describing the land cover and occasionally the land-use. All participants described the vegetation they saw and noted the presence (and stage) of agriculture. Examples of the terms used are shown in Table A 2, Appendix 1.

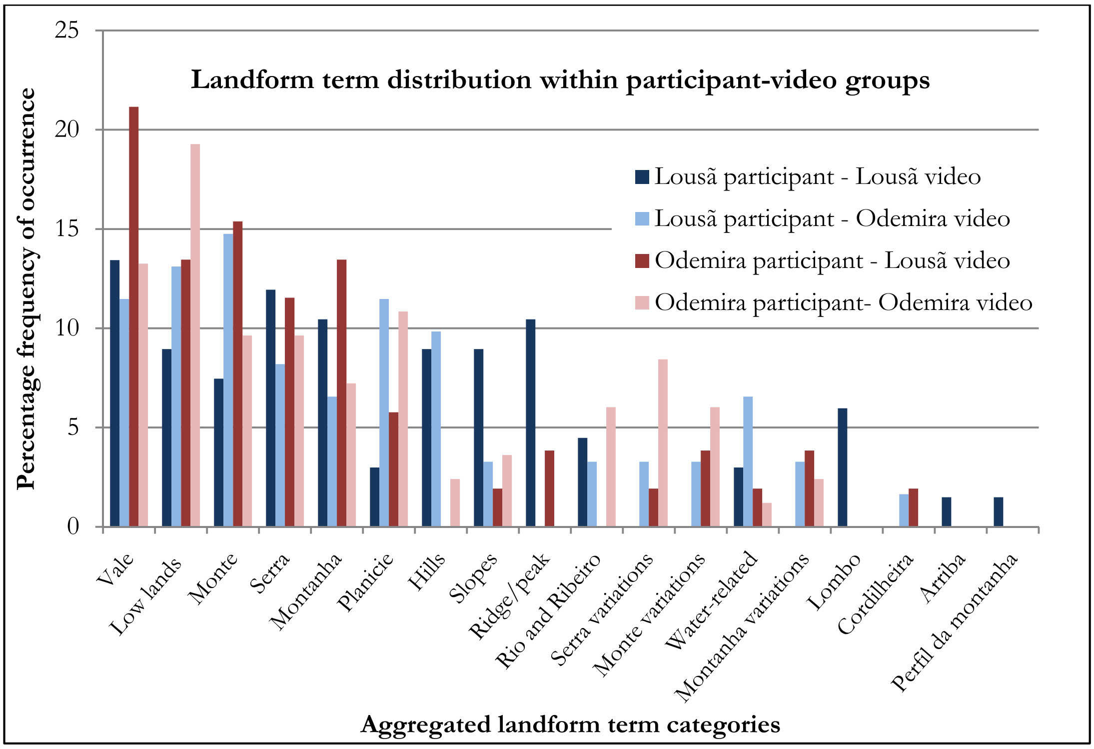

Figure 5. Landform term distribution within participant – video groups as percentage frequency of occurrence

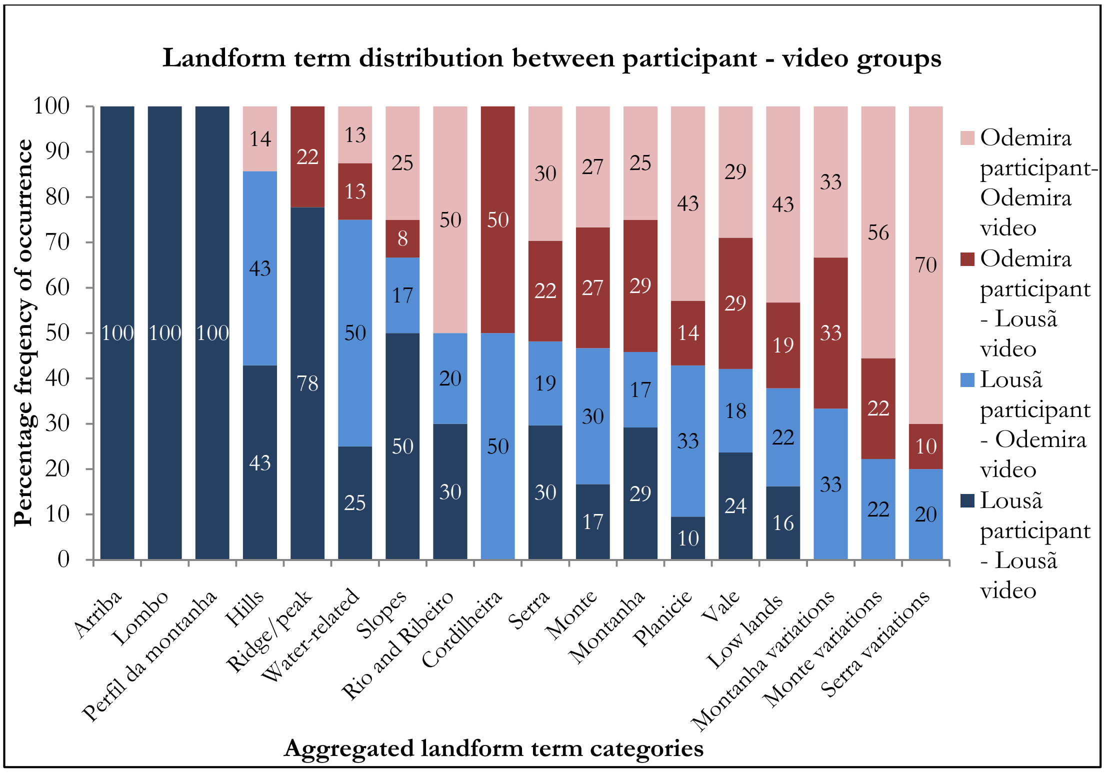

Figure 6. Landform term distribution between participant - video groups as percentage frequency of occurrence

5.2 DEM-derived landform classification

The following maps (Figure 7 and Figure 8) show the results of the computation of Hammond's macro landform classes using Morgan and Lesh's (2005) method. The Model builder models used to complete this analysis are shown in Appendix 4.

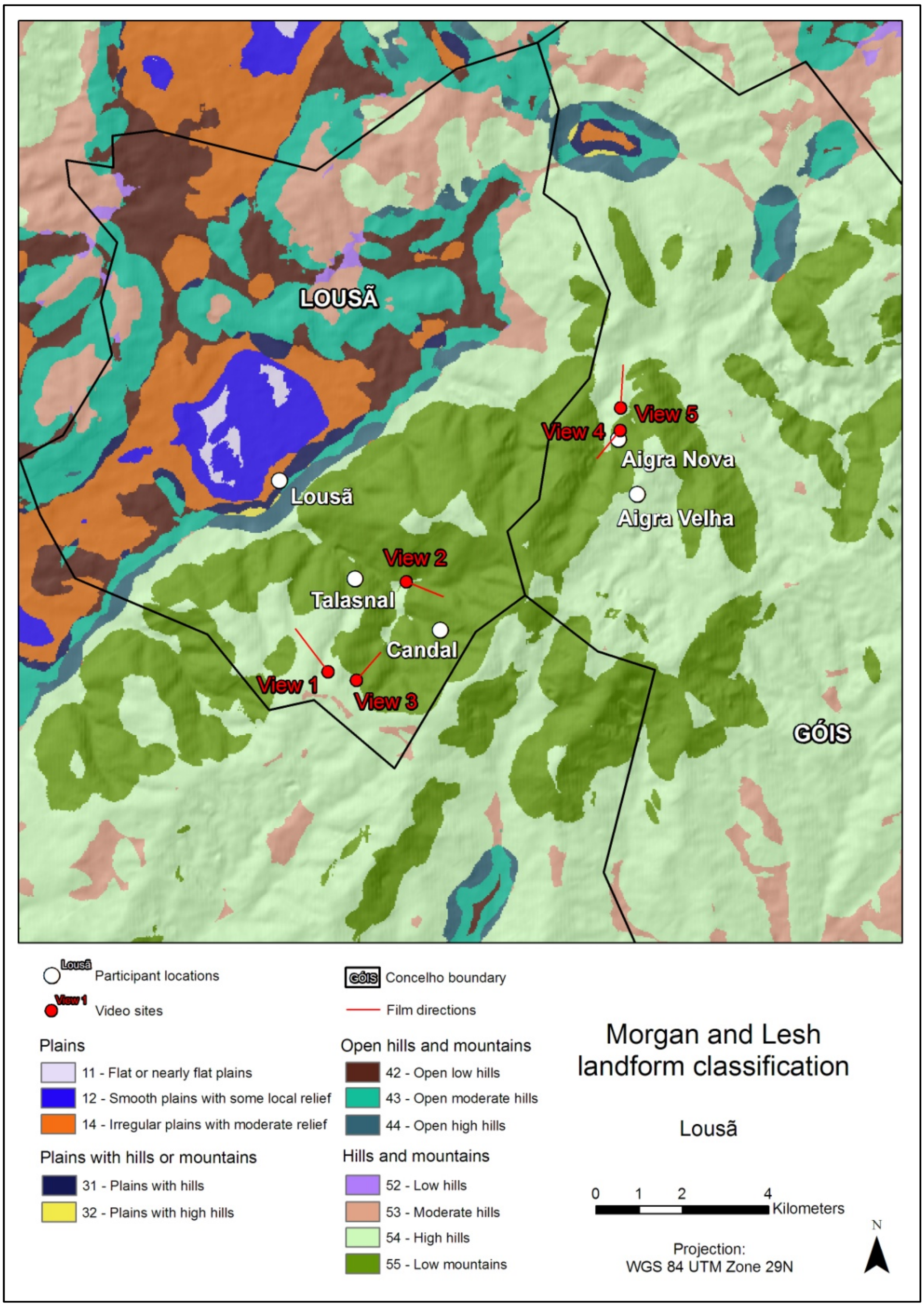

Figure 7. Morgan and Lesh landform classification map with video view sites and participant residence locations, Lousã

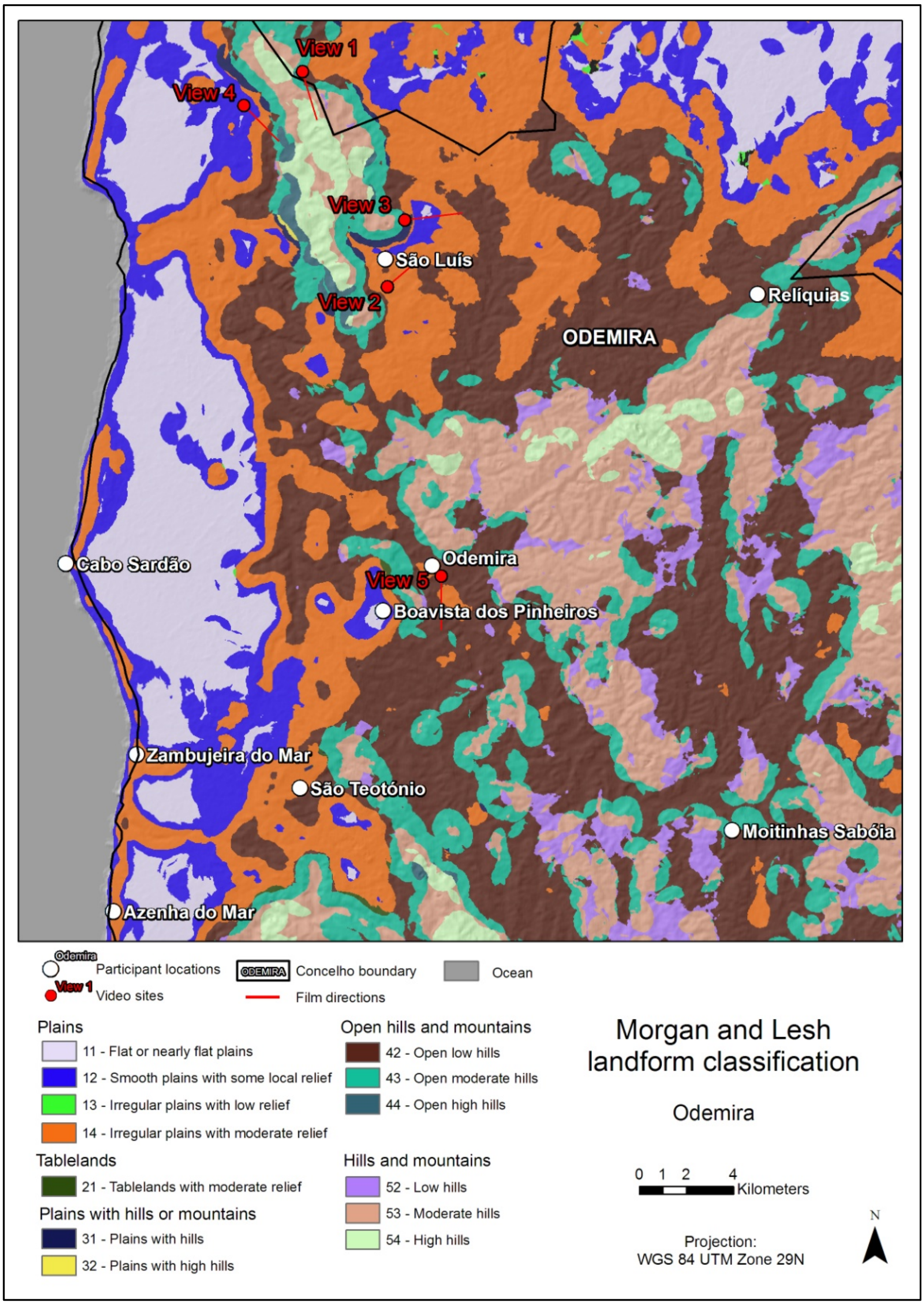

Figure 8. Morgan and Lesh landform classification map with video view sites and participant residence locations, Odemira

The tables in Appendix 7 show a comparison of the most common terms used by participants to describe each landform, against the Morgan and Lesh landform class of the same landscape view. The Morgan and Lesh classes present in each video view were identified with the help of a 3D visualisation. The views of the landform classification draped over the DEM 2 1/2 D model are shown in Appendix 6.

Table 8 and Table 9 show the summary of participants' terms for each Morgan and Lesh class present in the video views. They show the range of participant landforms identified within the zones of each macro scale landform class.

Morgan and Lesh class	Participant terms (most to least common)
14 - Irregular plains with moderate relief	Vale, Montanha, Monte
43 - Open moderate hills	Vale, Montanha, Monte
53 - Moderate hills	Vale, Montanha, Monte
54 - High hills	Montanha, Serra, Vale, Ladeira, Cume, Encostas abruptas
55 - Low mountains	Montanha, Serra, Cume/cumeada, Montes

Table 8. Morgan and Lesh landform classes with corresponding participant terms, Lousã video

Morgan and Lesh class	Participant terms (most to least common)
12 - Smooth plains with some local relief	Planicie, Planalto
14 - Irregular plains with moderate relief	Várzea, Planicie, Planalto, Monte, Serra, Rio
31 - Plains with hills	Planicie, Monte
42 - Open low hills	Serra, Montanha, Monte, Vale
43 - Open moderate hills	Monte, Serra, Montanha
52 - Low hills	Serra, Montanha
53 - Moderate hills	Serra, Montanha
54 - High hills	Montanha, Serra

Table 9. Morgan and Lesh landform classes with corresponding participant terms, Odemira video

6 DISCUSSION

6.1 Comparison of participant landform categorisations

6.1.1 Differences in categorisations due to landscape familiarity and recognition of place

There are two aspects of familiarity and recognition which have been explored in this dissertation. The first is in response to the research question: 'Do people identify categorisations with greater degrees of detail in landscapes they are very familiar with, compared to lesser known landscapes?' Here the familiarity is considered as recognition of the type of landscape, of the general forms and features of relief and land cover. The assumption made during the course of this research was that familiarity is gained through the length of time spent in a particular landscape, and this became the criteria for participant selection. Naturally the degree of familiarity will vary due to other factors (such as occupation and interests), however these were not considered within the scope of this project. It was therefore assumed that participants from the Odemira *concelho* were familiar with the Odemira landscape and that Serra da Lousã participants were familiar with the landscape of their area, but not vice versa. When participants expressed some recognition of the landscape of the other study site [for example, *tipicamente Alentejano* (typical from Alentejo) or *zona interior pinhal* (interior pine area)] it was not considered familiarity at a sufficiently local scale.

At this broad level of familiarity there is evidence of differences in the detail of landform categorisations performed by participants. The results suggest that participants used more terms to describe the landscapes they are familiar with, compared to the less familiar. Lousã participants used 68% of their total list of terms to describe the Lousã video, but only 61% for the Odemira video. The effect is more pronounced for the Odemira participants, as they used 76% of their terms to describe Odemira, but only 53% to describe Lousã (Table 7).

These results suggest that there is a positive relationship between the detail of the landform categorisations and landscape familiarity. Perhaps more importantly however, is the difference in the degree to which the effect is observed in each group of participants. The Lousã participants not only used more terms in total (44 compared to 34) but they used more terms to describe the Odemira site, than the Odemira participants themselves (Table 7). This suggests that their vocabulary of landform categories is not only larger but more diverse, therefore suitable for describing a range of different landscapes. In contrast the Odemira vocabulary of landform terms does not seem to cater well for describing the Lousã landscape, as they used only 53% of their terms. The author suggests the reasons for this lie in the variability and range of landforms which comprise the familiar landscapes for each participant group. While the Serra da Lousã landscape consists of many different shapes, elevations, contours and profiles, the Odemira landscape is less variable consisting predominantly of plains with occasional convex eminences which are usually of similar shape (even if not elevation). It is expected that inhabitants form landform categories which are sufficient to describe what surrounds them. Thus inhabitants of less variable landscapes may have a smaller and less versatile landform vocabulary, while people from areas of greater topographic variability have detailed and widely applicable sets of landform categories. In Sections 6.1.2 and 6.1.3, results are presented in further support of this proposition, by examining in more detail the differences in term use between each participant – video combination.

The next 'level' of familiarity considered in the data analysis, was the recognition of individual views in the videos. Here a participant's familiarity was expressed by naming the place or describing very specifically where it was located. This has been considered as the recognition of place. This type of familiarity only occurred when participants watched the video of their own landscape, as was expected. The research methods were not designed to ensure that participants would recognise places, however the observed rates of recognition at this level are interesting when compared to the detail of the landform categorisations used.

A positive correlation was found between the number of views (out of five) recognised and the number of landform terms used to describe the video. The relationship was stronger for Odemira participants (0.74) than Lousã participants (0.55) due to the different ranges in the numbers of landform terms used by individuals from either group (Table 2 and Table 3). These variations are likely due to the different ages, occupations and lifestyles of participants, and the degree to which they understood the interview requirements.

Regardless of the strength of the relationship, the fact that it exists is of interest. It suggests that the recognition of place influences a person's conceptualisation of landform categories. This could be due to an effect noted by Agarwal (2005) in her research on the sense of place. She noted a correlation between people experiencing a sense of place and their spatial reasoning. She further stated that '…'a cognitive sense of place' can be operationalised as a factor of spatial knowledge, degree of familiarity and conceptualisation of boundaries'. This may be the same relationship observed in the data of this study. It could be interpreted as participants using their sense of place and familiarity to trigger their spatial knowledge and conceptualisations of where the boundaries (in this case of landforms) lie in the landscape.

This is further supported with observations of how participants described the video scenes. When people did not recognise the views in the videos, they tended to follow the direction of the video pan, describing the landforms as they came into view. When participants recognised the place however, their descriptions followed their own understanding of landform connectivity, regardless of the video pan movement. That is, their descriptions included landforms outside the field of view, recalled from memory, and progressed continuously through the landscape, telling how all the parts fit together. They appeared to be following their own mental map of the area, which prompted them to include more detailed landform descriptions; for example, the deep valley or water flow line between mountains which was not actually visible, or the slope (or ramp) between the plain and the mountain proper. This is to be expected because, as Egenhofer and Mark (1995) describe, 'We explore geographic space by navigating in it, and we conceptualize it from multiple views, which are put together (mentally) like a jigsaw puzzle'. Referring to a previously made puzzle is probably a more effective way of experiencing the landscape, than through a video image.

This type of place recognition appears to have 'zoom in' effect and the participant observes the landscape from a closer view point. The ability to connect a cognitive map to the shown video, allows participants to describe the landscape at different scales and perspectives to those presented in the image. This apparent zooming in to a finer scale serves to make more boundaries visible and hence has an effect on the delineation of regions (landforms) in the otherwise continuous earth surface. This observation supports Bian's (2007) inclusion of spatial scale and boundary as factors in landscape region delineation.

The desire to recognise and name the scenes in the videos was observed amongst all participants. None of the participants were able to describe the landforms (or even the land cover) without first trying to recognise the location. Given that our understanding of geographic space is often based on the relative location of places, and the knowledge of landmarks and routes which connect those locations (Mark, Freksa et al., 1999), it is expected that recognition of parts of a landscape would be important for communicating about it at all.

All participants guessed the location of the unfamiliar landscape, sometimes referring to a general region or sub-region of Portugal, other times specific mountain ranges. If they did not know the region, then the next most popular guesses were of places closer to their homes, but of (apparently) similar landscape types. For example, many Odemira participants thought that the Serra da Lousã video was of the Serra de Monchique, a mountain range south of the Odemira *concelho*.

In Montello and Golledge (1999) Tim McNamara asks 'Are spatial judgements easier….from familiar views than from unfamiliar views?' and suggests that if they are, it indicates that the perception and understanding of a view is orientation-dependant. The results of this dissertation suggest this to be so, that people prefer to orientate themselves in the landscape and describe it with an egocentric relative reference frame.

Another consideration is that the recognition of places markedly increased the participants' personal interest in the task, and encouraged them to offer a greater level of detail. Surová and Pinto-Correia (2008) noted in their work that using photographs of landscape scenes, which participants could easily recognise or relate to, stimulated their interest and curiosity. Certainly there was an element of excitement for participants when recognising places close to their homes, triggering a willingness to share what they knew about that place, and resulting in a detailed delineation of landforms.

It is understood that geographic categories are formed with different degrees of detail at different scales of observation (Lloyd et al., 1996; Smith and Mark, 1998). For landforms in particular, the relationships between categories at different levels do not appear to consistently follow either taxonomic or partonymic relationships as was initially predicted. This is partially due to the fact that parts of landscapes are often inconsistently and ambiguously referred to as places (with place names) or objects (with type terms) (Burenhult and Levinson, 2008). This effect was certainly evident in the landscape descriptions given by participants who recognised the video views. These participants gave categorisations with more detail, but not with an evident whole-part or taxonomic relationship to the more general categories identified by all participants. They inconsistently gave combinations of place names, what happens at specific locations (for example, 'there is a farm') and the type of landform.

6.1.2 Commonalities in landform vocabulary

A number of landform terms were used with almost equal frequency by both participant groups, and were amongst the most commonly used of all the terms (within the total term distribution). The terms *serra, monte, montanha, planicie* and *vale* are shown in the centre of Figure 6, with percentage frequency of occurrence splits ranging from 48% - 52% (*serra*) to 42% - 58% (*vale*) between Lousã and Odemira participants, respectively (Table 6). They are also shown in Figure 5 towards the left of the graph, showing that they are five of the top six most frequently used terms. The sixth being an aggregated category made up of many like terms.

These results are expected, and fit well with previous geographic category norms research findings. When Pires (2005) asked participants to name natural earth formations three of the top eight responses were *montanha, vale* and *planicie*. The top three responses of American participants to the same question were mountain (*montanha/serra*), hill (*monte*) and valley (*vale*).

The common occurrence of these terms suggests they are candidates for universal geographic categories, common across cultural and landscape boundaries. This universally understood landform vocabulary is likely to be limited however, as these are only five terms out of the 58 used by the participants of this study.

6.1.3 Differences in landform vocabulary

There are not only differences in the number of terms the two participant groups used (as described in Section 6.1.1), but differences in what these terms are. In this section the differences in the types of terms used by each participant group is discussed. The comparison of term use has been made by examining the percentage frequencies of occurrence both within a participant – video group and between them. The results are shown in Figure 5 and Figure 6, respectively.

The most important finding is how each group uses variations of major landform terms. There are a number of terms which are commonly used by both groups – namely, *monte*, *serra* and *montanha* – as described in the previous section. In conjunction with these common landforms, participants used many variations with similar meanings. Interestingly the Odemira participants' variations consisted predominantly of terms derived from those three common landforms. For example, they used terms such as *montezinhas*, *pequeno monte* and *monte grande* with a 78% occurrence (over both videos) compared to the 22% use by Lousã participants. Similarly the terms *pequeno serra, serrazinha, serrinha, serra maior and serra alta* were used with 80% occurrence by the Odemira participants, 20% by those from Lousã. Finally, *montanha* variations like *mini-montanha, montanha baixa, montanha suave, montanha pequena* and *montanha alta* had 67% use by Odemira participants compared to the remaining 33% by Lousã participants.

A complimentary trend can be found when looking at the frequencies of occurrence of other terms used to describe topographic eminences or elevations. The group of terms aggregated under the 'Hills' category – *colina, morro, cabeço, penedo, elevações* and *elevaçãozinha* – were used 86% of the time by Lousã participants. The terms aggregated under the 'Slopes' category – *encosta, encostazinha, encosta abruptas, ladeira, inclinado, poco inclinado, inclinação* and *rampa* – were used 67% of the time by Lousã participants.

Together these two results indicate differences in the vocabulary used to describe elevations in the landscape. The Odemira vocabulary is largely limited to variations on *monte*, *serra* and *montanha*, while the Lousã participants demonstrated a much greater variety of words to describe the same set of convex landforms.

There are two other categories in which the Odemira and Lousã participants' responses differ noticeably. Firstly, the category 'Lowlands' which comprises of *várzea, várzea grande, baixio, baixa, terreno chão e alagadiço, lezíria, planalto, pequeno planalto* and *plana*, terms which were used by Odemira participants 62% of the time. Secondly, the category of 'Ridge/peak' – *cumeeira, cume de montanha, cume da serra, cume da encosta, cumeada* and *pico da montanha* – which was more often used by Lousã participants at 78% occurrence. Similarly there are a number of terms which were used solely by the Lousã participants when describing the Lousã video – *arriba, lombo* and *perfil da montanha*. The term *lombo* (meaning 'back', referring to the back of a mountain) is particularly interesting because it was only used by the participants who recognised views 4 and 5 of the Lousã video, but was used many times in their descriptions. It is possibly not a term common to all Serra da Lousã inhabitants, but only to a more localised group. Alternately its use may reflect the participants' knowledge of landform specific names (as opposed to type terms), as all the elevations in the area are called '*Lombo de …*', eg. *Lombo do Mouro*. It was clear however, that participants were using the word as both a term and as a part of place names.

It is important to remember, in using the example of *lombo,* that these results are extracted from the descriptions of both study sites and hence do not, in general, reflect the influences of familiarity or recognition, but rather indicate the extent of each group's landform lexica. That particular term was unique in its very high use amongst a very small group of participants.

These findings reiterate the previously made point that the landform vocabulary of each group reflects the variability of the landscape they inhabit. Most of the Odemira vocabulary lies in words used to describe lowlands, while the terms they used for eminences are largely restricted to variations on three basic terms. The use of terms for describing the ridges and peaks of mountains is rare. The Lousã vocabulary is much more diverse on the other hand and people appear to have multiple terms for both lowlands and elevations. The most distinctive part of their vocabulary seems to lie in the identification of the backs, ridges and peaks of the mountains and hills.

This clearly supports the relationship which Mark and Turk (2003b) state; that 'basic level categories in a language *must* be tuned to the variations in the particular environment in which a speech community lives'. Their statement referred to basic level categories in general, and the results of this dissertation confirm their claim for the case of landform categories specifically.

In his work on geographic category norms Pires (2005) commented on the effect of distinctive geographical differences on participant responses. In his case he was comparing the results of the most common geographic objects identified by American and Portuguese participants. He notes that Portuguese participants specify many more water features than the American participants, who often mentioned canyon, cliff and cave. This led him to suggest that the elements of the landscape which are present in participants' day to day lives have an impact on their impressions of what is a natural earth formation, for example. The results of this dissertation support his comment, and suggest that this effect is evident at much smaller intra-country scales. The potential of the landscape to effect conceptions of geographic categories exists at a very localised level.

6.2 Comparison of DEM landform classification and participant landform categorisation

The macro scale landform classification produced by following Morgan and Lesh's (2005) steps in ArcGIS has been compared with existing topographic maps to provide some visual assessment of its accuracy. Ideally geomorphology maps would have been used to make this assessment, however they could not be obtained for the study areas. Other available landscape classification maps (such as the landscape type map shown in Figure 2) consist of much larger units of analysis and hence are not useful.

The classification appears to well represent the landscape variation across the Odemira study site as it captures the transitions between flat lands with various sized elevations, characteristic to the area. Mountain ranges or more prominent elevations are clearly represented in the classification (for example the area of Moderate hills and High hills near Views 1, 2, 3 and 4 in Figure 8). The classification method appears to be well suited to this type of landscape with gentle undulations and no dramatic changes in elevation or shape.

The landform classification of the Serra da Lousã study site does not represent the landscape as well as the Odemira region. This is not to say that there is an error in the classification, but rather that the resolution of the classification is not sufficient to well capture the features of this landscape. This is largely due to the rapid changes in elevation which characterise the Lousã area. These changes occur at too small a (horizontal) scale for the classification thresholds to detect and hence the variability is not reflected in the resultant landform classes. In order to better represent the range of landform features in this small region, the classification system would need to be recalibrated to use smaller neighbourhood aggregation areas and possibly a higher resolution DEM. Gallant et al. (2005) suggest that the method is highly sensitive to the calculation of areas of gentle slope, which is often not well captured by the standard thresholds. Such refinements to the method were beyond the scope of this dissertation.

Given that the automated classification produced landform classes at a much coarser scale than the participant categorisations, it was necessary to aggregate their results to make a meaningful comparison. The DEM classification generally corresponds well to the common terms used by participants in each video view. For example, in areas classified as '31 - Plains with hills', participants gave the categories *planicie* (plain) and *monte* (hill) (see Table 9).

Participants described the intermediate sized eminences in the Odemira video as *monte*, *serra* or *montanha*, which corresponded to the landform classifications '42 - Open low hills' and '43 - Open moderate hills'. The larger eminences were referred to predominantly as *serra* and *montanha* corresponded to '52 - Low hills', '53 - Moderate hills' and '54 - High hills'. Here the change in participant terminology corresponded to a change in the slope class in the classification algorithm. This indicates that participants' formation of the eminence categories may be sensitive to the slope of the eminence, not just the height. This trend does not hold well at the Lousã site due to the wide range of participant landform terms corresponding to few landform type classes.

The major discrepancy between the participant categorisations and the automated classification lies in the lack of identification of major valleys in the Serra da Lousã area. While participants identified both the topographic eminences (such as *montanha,* *serra* and *monte*) and the valleys between, the automated classification simplifies the landform types to refer to the eminences only. It does not, therefore, represent the variations in valley depth between the eminences.

6.3 Observations regarding categorisation drivers

6.3.1 Evidence of multiple drivers

The positive comparison of the DEM classification with participants' responses suggests that landscape profile and landform shape, both salient features in the landscape, had a noticeable influence on the landform categories participants formed. However, participant responses also suggest that a number of other factors may be driving their categorisation processes. These factors include the perception of vegetation and land-use, a distinction of landforms according to what happens at that location (for example, 'plain subject to flooding' as opposed to just 'plain'), references to additional contextual information (such as clouds), the apparent use of mental maps to help develop landform descriptions, and the delineation of landforms due to knowledge of place name only (rather than landform and place name).

These observations all indicate that participants have considered how parts of the landscape may be used (by themselves or others) or how they have experienced and moved through that landscape before. This shows utilitarian motivations in the formation of landform categories. Observations from this study do not suggest that they are the predominant driving force, but certainly that they provide a significant contribution to category identification. Hence, the proposition that the categorisation of landforms is more dependent on utilitarian motivations than salient environmental features (the third research question) cannot be supported. Neither is the idea conclusively rejected however. Had the interviews with participants been better targeted towards eliciting category formation information the contributions from each driver may have been more prominent, and more conclusive evidence found.

6.3.2 Land cover and land-use

While land cover can be considered a salient feature of the landscape, because it is a visually observable characteristic of the earth's surface, it also appears to have been used to explore what a participant could expect to do, or expect to happen at a particular location. This is a similar finding to that described by Levinson (2008) and Burenhult and Levinson (2008), where they note that 'the proposed driving forces of landscape categorisation are difficult to tease apart. Perceptual salience can be an interactional property'. For example, the vegetation in low lying areas of the study sites indicated to participants that they were not only lowlands (or plains), but specific types of plain. These areas were given many terms such as 'cultivated plain' (*várzea*), 'floodplain' (*lezíria*) and 'flat land that is subject to flooding' (*terreno chão e alagadiço*). In these cases participants used their knowledge of what happens in a particular part of the landscape to describe not only the land cover (for example, 'cultivated land') but that actual landform as well. This is to be expected, considering that both study sites cover rural agricultural areas where the land is viewed in terms of its potential to accommodate crops, animals or other forms of agro-silvio-pastoral land-use.

The participants' desire to describe the vegetation and land-use was the most consistently observed response to the videos. The identification of landforms, even when participants understood what was being requested of them, was always secondary to descriptions of land cover. This indicates that the most natural way of observing and categorising a landscape is not according to landform, but into parts more akin to the 'ecotopes' described by Hunn and Meilleur (2010). Participants more readily identified parts of the landscape according to a combination of geomorphological, biological and affordance factors. Bian's (2007) criteria for spatial region delineation are certainly observed as, when pushed to describe landforms only, participants' categories were clearly influenced by their initial view of the land cover (relating to three of Bian's delineation factors - attributes, processes and mobility).

6.3.3 Context

On a number of occasions, participants made reference to elements of the videos which were not related to the landforms or land cover, but helped them to develop their categories. The most common of these was the mention of the clouds which could be seen in View 2 of the Serra da Lousã video. Many of the Odemira participants who were not familiar with that landscape said that the clouds showed them that it must be a high mountain they were looking at, not just a low lying hill.

In this way contextual information, not directly derived from the land, was a categorisation driver.

It is unclear whether this contextual information was useful to participants only due to the lack of a sense of scale and perspective when watching a video rather than actually being in the landscape, or if such factors play a role in all situations. The author suggests that although contextual information may be most useful in videos, it is probably always a driver for categorisation. Given that the 'category mountain is not distinguished in a bona fide fashion from neighboring categories such as hill' (Smith and Mark, 2003) the formation of the concept is likely to include the context in which it is viewed. Equally, Smith and Mark (1998) stated that geographic objects are generally 'too large to serve as targets of comparison. Some theory, and much additional contextual knowledge will be required for categorization purposes'.

6.3.4 Familiarity and mental maps

In Section 6.1.1 the relationship between the recognition of video views and the number of landform terms used, was discussed. Place recognition markedly changed the way participants described the landscape and it is suggested that it contributes as a driver for categorisation.

The effect of place recognition appears to be the same as zooming in and viewing the landscape from a closer perspective, and even from multiple different perspectives. By moving through their mental map, participants were able to zoom in to some parts of the landscape, to move through it in three dimensions and evoke the feeling of being in the landscape. In this way their categorisation was very much driven by what each part of the landscape can offer to them, by utilitarian motivations.

Participants in this study showed the desire to recognise views and it appeared to allow them to become involved with the landscape they were looking at. Kaplan (1979) made a similar observation in his work about perceptions of landscapes. He noted that it was surprisingly easy for people to interpret the third dimension from a two dimensional image, and that there was a general preference for scenes where 'it appears as if one could see more if one were to "walk into" the scene a ways'. He calls this desire to be in the scene the '"involvement" component'.

Those who did recognise places seemed to be more aware of the continuity between parts of the landscape. Their mental map allowed them to see behind, see beyond and re-experience how the landforms fit together and what each part offers to them. In this way people identified more landforms like water lines, rivers, deep valleys and various types of slopes which often lay at the boundary points of more general mountain and plain landforms which the majority of participants identified. This approach to the categorisation may reflect a change in the understanding of the topology of the landforms. While 'geographical kinds result from a more-or-less arbitrary drawing of boundaries in a continuum', they can also either be thought of as topologically contiguous or separated (Smith and Mark, 1998). When participants recognised a place they appeared to understand (and describe) the landforms as part of a continuous surface with individually identified boundaries between them. When the view was unfamiliar however, they saw the landforms as separated objects.

6.4 The importance of water

There were no visible rivers, lakes, ocean or water of any kind in the videos used for this study. Despite this, water and water bodies were commonly referred to by participants, as an important part of the landscape. This appears to be a common finding amongst landscape and geographic category research (Burenhult and Levinson, 2008; Mark and Turk, 2003b; Pires, 2005; Smith and Mark, 1998). Smith and Mark (1998) attribute this to the fact that water 'is an especially distinctive substance that is critical to life'. Pires (2005) also notes in a cross-cultural comparison of geographic category norm research, that Portuguese participants mentioned water bodies more frequently than the American participants. This suggests that in Portugal, water is a particularly important part of the landscape and people's lifestyles.

In this study references to water appear to take two forms. Firstly, in conjunction with descriptions of land cover [for example, descriptions of areas as marshy (*lameiro*)] and specification of landform type [for example, 'flooplain' (*lezíria*), 'cultivated plain next to a river' (*várzea*) and 'flat land, subject to flooding' (*terreno chão e alagadiço*)]. And secondly, references to water as a force which shapes the land and divides it. In this case the terms centred around water courses [for example, 'river' (*rio*), 'stream' (*ribeiro*), 'water lines' (*linhas da água*), 'water passage' (*passagem de água*) and 'basin' (*bacia*)]. Here the lines of water flow, and the shapes they form appear to have been used as boundaries between other landform categories. Even if the water was not visible, some understanding of how water is likely to flow in an observed part of a landscape is a useful means of segmenting the otherwise continuous surface into categories. Waterlines provide the observer with one of very few bona fide boundaries in natural landscapes (Burenhult and Levinson, 2008).

6.5 Observations regarding place names

This study did not focus on eliciting toponyms (or place names) from people, however they were usually given freely when the participant recognised a place. The majority of the place names took the binomial form of landform term plus a descriptor. Examples of these are *'Lombo do Mouro'*, *'Lombo do Ventoso'*, *'Vale do Fonte'* and *'Cabeço da Aira'* in the Serra da Lousã, and *'Rio Mira'* and *'Cascada d'pedra d'agua'* in Odemira. Others took a monomorphic form, independent of landform, such as '*Ave Sol'* and *'Caniveta'*.

One particularly interesting place name was given to a place in View 2 of the Lousã video. None of the participants knew a landform term for this part of the landscape but two participants had a place name for this location. Interestingly their place name was *'Penedo do Corgo'* which is made up of two landform terms (a *penedo* is a rocky outcrop and a *corgo* is a water course). In this case they were using landform terms but intending them to be the name of the place, not the type of feature. They both stated they did not know why this place was called by that name.

7 LIMITATIONS

There are a number of limitations to the study presented in this dissertation. It is important to consider the results in the context of these constraints, in order to avoid misinterpretation.

The first, and most important limitation, is that of the different distributions of participant age, sex and occupation between the two study sites. While the Lousã participants ranged in age from 44 to 64, the Odemira participants were much younger with an age range of 25 to 44. Also, the Lousã participants had a range of occupations from farmers to restaurant owners and an architect, while the Odemira participants were predominantly professionals or students of a *Higiene e Segurança no Trabalho* (Health and Safety at Work) course. Although some were also farmers, the course was their primary occupation. The Odemira participants were mainly female, compared to a more even mix of the sexes amongst the Lousã participants. These factors were not controlled during the selection of participants largely due to the short project time frame and the author's limited ability to make connections in communities and source participants. In future studies of this sort, it is recommended that a greater number of participants be interviewed, and the effects of demographic variation assessed.

Similarly the author suggests that one of the questions on the Participant Information sheet be reworded. The current question asks the participant 'How long have you lived at your current address?', however it should read 'How long have you lived in the Serra da Lousã region/Odemira municipality?'. Anecdotally the author learnt that many participants had lived in multiple different places within the region, however this was not formally recorded. Considering this information was not used in the data analysis of this study (beyond the requirement of having lived in the area for more than 5 years) the mistake was not corrected. In the future it would be beneficial to collect this information and compare the results accordingly.

The second consideration is that of the study area sizes. The areas of the two study sites (encompassing the video view locations and participant residences, not the *concelho* boundaries) vary markedly. The participants in the Serra da Lousã live close together and close to the filmed locations, while in Odemira the participants live far apart. The research was designed such that participants all resided in the same broad landscape type, and because this requirement was met, the study site areas were not controlled. Upon analysing the study results, the relationship between recognised places and the number of terms participants used was noted. The rates of recognition were less for Odemira participants than for Lousã participants (possibly due to greater distances between video view locations and participant residences). This could be an alternate explanation for why Odemira participants used relatively few landform terms to describe the Odemira video, rather than the proposed connection between landscape complexity and vocabulary size. This effect could not be accounted for in this study, however it is recommended that the proximity of participant places of residence to the video view sites be controlled (or given greater consideration) in future work.

Conversely, this impact of different study area sizes is possibly partially offset by the different lifestyles of the inhabitants of each region. The Lousã participants generally appeared to move in a small radius around their homes, while the Odemira lifestyle generally involves people commuting bigger distances for work or study. They would therefore be exposed to (and able to recognise) places further from their homes. There is no definitive evidence to support this observation but it would be useful to gather this information from participants in future studies.

The study methods were designed to minimise the impacts of the author's limited Portuguese language skills, however it is likely that the results were effected to some degree. The manner in which the project and interview requirements were presented to participants, changed over the course of the 21 interviews, simply due to improved communication skills. Although not intentional, this may have influenced the responses of the participants. Patton (1990) states that 'The quality of the information obtained during an interview is largely dependent on the interviewer.' and hence there is likely to be some variation in the quality of the participant responses and subsequently extracted data.

The author consulted Portuguese speakers for help with translations and familiarisation with relevant vocabulary. Nevertheless, in future work it may be advisable to find a Portuguese counter-part to help conduct interviews.

The final discrepancy to note is that of the video production. Care was taken to film parts of the landscape at comparable scales in both study sites, to accurately reflect the relative magnitudes of all landforms. This was difficult to achieve however, and the resultant videos did differ in the perspective from which the landscape was viewed. Due to the various accessibility limitations in each region and the very different landscape types, the Lousã video was made predominantly from an elevated perspective, from amongst the mountain ridges looking across, or down valleys. The Odemira video is largely made from the perspective of being in the lowlands and looking up at topographic eminences. There is no evidence to suggest that this difference in perspective impacted on participant responses, however it is recommended for further consideration in future work. In addition, it would be of interest to include zoom shots in the videos, along with pan shots; this may further encourage participants to 'step into' and become more involved with the scenes.

8 FUTURE WORK

The work presented in this dissertation is a step towards expanding the use of GIS in linguistic studies, as called for by Weibel (2009). It is evident that there are differences in landform terms used by people living in different landscape types. The comparison with the Morgan and Lesh (2005) landform categorisation is a start towards determining landscape-language variation correlations. If this study were repeated in similar landscapes across the country, a comparison of the lexica could be made, and the relationships between landscape and landform terms refined. If the patterns detected in this dissertation were repeated then the landscape types could be used as predictors of geographic lexica for the area. However, no language – landscape relationship would be independent of other cultural and individual influences, and research would benefit from the inclusion of data layers showing variations in lifestyle (occupation and commuting distances, for example), age and length of time spent in that landscape type. Census data could be used to give an indication of some of these factors. Certainly GIS is the best tool to use for such multiple source data analysis, as Weibel suggests.

The effects of the scale at which the landscape is viewed have not been explored in this dissertation, aside from the identification of an apparent 'zoom into' the landscape when participants recognised a place. It would therefore be interesting to repeat the study, using a range of videos, with landscape views at different scales. The results of this work would likely make an important contribution towards understanding the types of relationships which exist between geographic categories used at different scales.

The findings of this study are a useful contribution towards understanding the drivers of landform categorisation and the impacts of different influences on the individual, and they provide a good basis for locally representative landform ontologies to be developed. Future work should include a greater focus on the formalisation and comparison of the landform concepts identified by participants in this study. This could be done by developing representative conceptual spaces for different term types according to a set of defining qualities (parameters/space axes). This method of representation and formalisation has been used to consider the concepts of building facades by Raubal (2004).

In working towards the formalisation of landform concepts, it will then be possible to apply semantic similarity measures and better define, or assess, the ways to achieve interoperability between differing landform lexica and their corresponding ontologies. Kavouras et al. (2005) present a thorough methodology towards assessing the quality of concept definitions, and relationships between them for the purpose of improving the semantic mapping between ontologies.

The formalisation of concepts and the computational reasoning which can follow could be used in developing the study of landscapes in linguistics (Kuhn, 2011). It would be interesting to extend this current study to include an analysis of formalised concepts, for the purpose of understanding landform lexica variations across Portugal.

9 CONCLUSIONS

The study presented in this dissertation has yielded insights into the effects of landscape familiarity and place recognition on the detail of landform categorisations, the variations in categories used due to the type of landscape in which people live and the drivers of categorisation. The results also comprise of useful datasets for comparing human and automated landform categorisations.

The effects of familiarity on landform categorisation were found at two different levels, or scales of landscape recognition. At the broad-scale landscape level it was found that participants used more terms to describe familiar landscapes than the less familiar. At a place recognition scale it was similarly shown that when people recognised a place (that they could name) in the landscape videos, they described more landforms. These relationships were found for participants from both study sites.

Interestingly, there appears to be a link between the complexity of the landscape and the range of landform terms used by each participant group. The participants from the Serra da Lousã region live in a more varied landscape with rapid changes in shape and elevation over short distances. Their landform vocabulary includes a wide range of terms for topographic eminences (or hills) and slopes. The Odemira landscape varies more gently and is largely flat with gentle elevations and some distinct ranges of hills. The participants from this region had the more varied vocabulary for plains and lowlands, however their terms for eminences were largely limited to variations on three base terms (*monte, serra* and *montanha*). These trends were observed in descriptions of both study sites and hence are independent of landscape familiarity.

The participant landform categorisations were found to compare well with the automated DEM-based landform classification, when observed at a macro scale. The classification algorithm appeared to yield a more accurate classification for the Odemira region as corresponding changes in the slope parameter thresholds and participant terms were found. The major landform changes were certainly represented. In the Lousã region however, the classification was performed at too large a scale to successfully capture the dramatic variability of that landscape. The result was a generalised version of the categorisation produced by participants. Most noticeable was the omission of lowlands and valleys which were smoothed out of the classification, but noted by participants.

The initial suggestion regarding the dominance of utilitarian motivations over salient features, in driving human landform categorisations can neither be supported nor rejected with certainty. The generally good correspondence of the DEM-derived classification with participants' categories suggests that elevation, slope and landscape profile (or shape), which are salient features in the landscape, do play a significant role in the formation of landform concepts. Similarly the common reference to land cover suggests that the salient changes in vegetation are also driving factors. Lines of water flowing through the landscape provided some, of few, bona fide boundaries between categories. A number of other observations do, however, support the importance of landscape affordance as an influence in categorisation. They include the references to land-use (not only land cover), referring to experiential contextual information (such as cloud cover), and the effect of 'stepping into' and 'walking through' the landscape while describing it, which was evident when participants recognised places. Knowledge of place names also appeared to create categories for some participants in locations where others did not delineate any.

The findings of this study provide an important contribution towards understanding the variability and motivations for landform categorisation. The results support previous suggestions of geographic category norm candidates (landform terms commonly used by all participants) while highlighting the variations of the landform lexica at more detailed levels.

This work could be used towards developing localised landform (and geographic domain) ontologies for Portugal. Repeated research and the formalisation of the landform concepts would allow for semantic similarity measures to be defined and ontology interoperability achieved. This is useful not only for geography and the meaningful application of GIS, but for linguistic research as well.

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APPENDIX 1: VOCABULARY LISTS

Paisagem – Landscape
Formas do relevo – Landforms

The following table contains the definitions of landform terms used by participants. The terms are grouped according to the order presented in Table 4, Chapter 5.

Portuguese term	Portuguese definition*	English term	English definition
Várzea	Planície cultivada nas margens de rio	Cultivated plain	Cultivated plain next to a river
Várzea grande		Big cultivated plain	Big cultivated plain next to a river
Baixio	Banco de areia	Sand bar	Sandbar
Baixa	Depressão do terreno, lugar baixo ou fundo de um vale	Low land	Land depression, low place or bottom of a valley
Terreno chão e alagadiço	Terreno liso e sujeito a alagar-se	Flat land	Flat land and subject to flooding
Lezíria	Terreno alagado pelas enchentes, nas margens de um rio	Floodplain	Flood plain on banks of rivers
Planalto	Terreno extenso, quase plano	Plateau	Extensive, almost flat land
Pequeno planalto		Small plateau	Small extensive, almost flat land
Plana	Que não apresenta desigualdades de nível nem ondulações; liso; raso; chão	Plain	Without changes in level or undulations; flat; shallow; ground
Planície	Extensa área da superfície terrestre lisa ou levemente ondulada, sem relevos, a baixa altitude	Plain	Large area with smooth or slightly undulating surface, without relief, low altitude
Vale	Depressão alongada entre duas montanhas ou colinas	Valley	Elongated depression between two mountains or hills
Vale fundo		Deep valley	Deep elongated depression between two mountains or hills
Arriba	Rochedo que a forma, riba, ribanceira	Cliff	Rocky form, river bank, ravine or bluff
Monte	Elevação de terreno acima do solo circunjacente, menos extensa e menos alta do que a montanha Sede de herdade formada por vários edifícios em torno de um patio (Alentejo)	Hill	Land raised above surrounding earth, less extensive and lower than a mountain Headquarters of a farm consisting of several buildings around a courtyard
Montezinhas		Small hill	
Pequeno monte		Small hill	
Monte grande		Big hill	
Colina	Pequena elevação de terreno	Hill	Small elevation in the land
Morro	Monte de pouca altura	Low hill	Low hill

(Continues on next page…)

Portuguese term	Portuguese definition*	English term	English definition
(Continued from previous page…)			
Cabeço	Pequeno monte arrendondado	Knoll	Small rounded hill
Penedo	Rochedo	Rocky outcrop	Rocks
Elevações	Lugar cuja altura se destaca em relação ao plano em que se situa	Elevation	Place where the height stands out in relation to the plain in which it lies
Elevaçãozinha		Small elevation	
Encosta	Declive de um monte	Slope	Gradient/incline of a hill
Encostazinha		Small slope	
Encosta abruptas		Steep slope	
Ladeira	Inclinação de terreno	Slope	Inclination in the land
Inclinado	Que não está em posição vertical nem horizontal; desviado da posição perpendicular	Incline	Not in a vertical or horizontal position; deviated from the perpendicular position
Poco inclinado		Small incline	
Inclinação	Posição ou estado daquilo que está inclinado	Inclination	An inclined position
Rampa	plano inclinado	Incline, slope	Inclined plain
Serra	Montanha; grande extensão de montanhas ligadas umas às outras	Mountain or mountain range	Mountain; large expanse of mountains connected to each other
Pequena serra		Small mountain	
Serrazinhas		Small mountain	
Serrinha		Small mountain	
Serra maior		Higher mountain	
Serra alta		High mountain	
Montanha	Relevo da crusta terrestre de altitude considerável, de vertentes muito declivosas, que ocupa uma grande extensão	Mountain	Relief in the earth's crust of considerable altitude with steep slope and occupying a large extent
Mini-montanha		Small mountain	
Montanha baixa		Low mountain	
Montanhas suave		Gentle mountain	
Montanha pequena		Small mountain	
Montanha alta		High mountain	
Cumeeira	Parte mais elevada da montanha	Ridge	Highest part of a mountain
Cume da montanha	Cimo de uma elevação de terreno	Mountain peak	Top of an elevation of land

(Continues on next page…)

Portuguese term	Portuguese definition*	English term	English definition
(Continued from previous page…)			
Cume da serra		Mountain peak	
Cume da encosta		Slope peak	
Cumeada	Linha formada por uma série de cumes	Ridge	Line formed by a series of peaks
Pico da montanha	Monte alto que termina em bico, cume aguçado	Mountain peak	End of a high mountain peak, sharp ridge
Lombo	Dorso, elevação	Back	Back, elevation
Cordilheira	Cadeia de montanhas contíguas	Mountain range	Continuous chain of mountains
Perfil da montanha	Visto de lado, aspect	Mountain profile	Viewed from the side, aspect
Rio	curso natural de água que nasce, em geral, nas montanhas e vai desaguar ao mar	River	Natural course of water born, in general, in the mountains and flowing to the sea
Ribeiro	Rio pequeno	Stream	Small river
Margens do rio	Terreno que ladeia um rio ou corrente de água	River margins	Land that runs alongside a river or stream of water
Passagem de água	Lugar por onde se passa (água)	Water flow path	Place where water passes
Linhas da água	Percurso seguido por (água)	Water lines	Route followed by water
Bacia	Depressão de terreno cercada de montes ou Colinas; conjunto de terras cujas águas são drenadas por um rio e os seus afluentes	Basin/ watershed	Depression in the land surrounded by mountains or hills; part of the land whose water us drained by a river and its tributaries

* Sourced from online dictionary and encyclopedia, Infopédia (www.infopedia.pt)

Table A 1. List of landform term definitions

The following table contains the additional common words participants used in their descriptions, but which are not landforms. They include terms used to describe land cover and land-use.

Term	English description
Zona interior pinhal	Interior pine zone
Tipicamente Alentejano	Typical Alentejo
Terra semeada	Seeded land
Terreno cultivado	Cultivated land
Pastagem	Pasture
Passagem de gado	Path for cattle
Mata	Small dense forest
Floresta	Forest
Eucalyptus	Eucalypts
Sobreiros	Cork trees
Castanheiros	Chestnut trees
Oliveiras	Olive trees
Montado	Open landscape with agro-silvo-pastoral land-use (including predominantly cork trees) in the Alentejo
Souto	Chestnut grove
Lameiro	Marsh, swamp
Quinta	Farm
Campo	Field

Table A 2. Common non-landform terms used by participants

APPENDIX 2: SUMMARIES OF TERM USE PER PARTICIPANT

	Odemira participants											
	A	B	C	E	F	G	H	I	J	K	L	Term tally
Várzea	x											1
Várzea grande												
Terreno chão e alagadiço												
Lezíria												
Planalto	x			x	x	x						4
Planicie						x		x			x	3
Vale	x	x	x	x	x	x	x	x	x	x	x	11
Vale fundo												
Arriba												
Plana						x			x			2
Monte		x	x	x	x	x	x	x			x	8
Montezinhas								x				1
Pequeno monte										x		1
Morro												
cabeço												
Serra			x	x			x	x	x	x		6
Serra alta										x		1
Elevações												
Encosta												
Encosta abruptas												
Ladeira				x								1
Rampa												
Inclinado												
Inclinação												
Lombo												
Montanha	x	x		x	x		x		x		x	7
Montanha pequena							x					1
Montanha alta		x										1
Cordilheira			x									1
Cumeeira												
Cume de montanha	x											1
Cume da serra												
Cume da encosta												
Cumeada												
Perfil de montanha												
Pico da montanha		x										1
Rio												
Ribeiro												
Bacia												
Linhas da agua									x			1
Number of views recognised	0	0	0	0	0	0	0	0	0	0	0	
Total number of landform terms used:	5	5	4	6	4	5	5	5	5	4	4	

Table A 3. Summary of terms used by Odemira participants to describe the Lousã video

	Lousã participants										
	A	B	C	E	F	G	H	I	J	K	Term tally
Várzea											
Várzea grande								x			1
Terreno chão e alagadiço							x				1
Lezíria						x					1
Planalto							x		x		2
Planicie		x						x			2
Vale		x	x	x	x		x	x	x	x	8
Vale fundo						x					1
Arriba								x			1
Plana									x		1
Monte		x	x	x	x		x				5
Montezinhas											
Pequeno monte											
Morro						x					1
cabeço		x				x	x			x	4
Serra	x	x	x			x	x	x	x	x	8
Serra alta											
Elevações									x		1
Encosta						x	x				2
Encosta abruptas							x				1
Ladeira											
Rampa						x					1
Inclinado							x				1
Inclinação							x				1
Lombo						x	x	x		x	4
Montanha			x	x	x	x	x	x		x	7
Montanha pequena											
Montanha alta											
Cordilheira											
Cumeeira	x										1
Cume de montanha					x						1
Cume da serra						x			x		2
Cume da encosta							x				1
Cumeada		x	x								2
Perfil de montanha	x										1
Pico da montanha											
Rio											
Ribeiro						x	x			x	3
Bacia	x										1
Linhas da agua		x									1
Number of views recognised	3	3	2	1	2	2	4	2	1	3	
Total number of landform terms used:	4	7	5	3	4	11	14	7	6	6	

Table A 4. Summary of terms used by Lousã participants to describe the Lousã video

	Odemira participants											
	A	B	C	E	F	G	H	I	J	K	L	Term tally
Várzea	x			x			x	x	x			5
Baixio												1
Baixa									x			
Lezíria												
Planalto	x				x	x	x			x		5
Pequeno planalto							x					1
Planicie	x		x	x		x	x	x	x	x	x	9
Vale	x	x	x	x	x	x	x	x	x	x	x	11
Plana		x				x		x	x			4
Monte		x	x	x	x	x		x		x	x	8
Montezinhas		x				x						2
Pequeno monte				x						x		2
Monte grande					x							1
Colina												
cabeço					x							1
Penedo												
Serra	x		x	x		x	x	x	x	x		8
Pequeno serra	x		x			x	x			x		5
Serrazinhas												
Serrinho							x					1
Serra maior			x									1
Elevações				x								1
Elevaçãozinha												
Encosta												
Encostazinha						x						1
Inclinado								x				1
Poco inclinado									x			1
Montanha	x	x			x		x		x		x	6
Mini-montanha	x											1
Montanha baixa									x			1
Montanhas suave												
Montanha pequena												
Cordilheira												
Rio	x						x		x	x		4
Ribeiro			x									1
Passagem de agua												
Margens do rio										x		1
Linhas da agua												
Number of views recognised	2	0	0	0	0	0	2	0	4	2	0	
Total number of landform terms used:	9	5	7	7	6	9	10	7	10	9	4	

Table A 5. Summary of terms used by Odemira participants to describe the Odemira video

	Lousã participants A	 B	 C	 E	 F	 G	 H	 I	 J	 K	Term tally
Várzea	x						x				2
Baixio							x				1
Baixa											1
Lezíria						x	x	x			2
Planalto									x		1
Pequeno planalto											
Planicie		x	x		x	x	x	x	x		7
Vale	x	x	x	x	x			x	x		7
Plana					x						1
Monte	x	x	x	x	x	x	x	x	x		9
Montezinhas		x									1
Pequeno monte				x							1
Monte grande											
Colina							x				1
cabeço										x	1
Penedo								x			1
Serra	x					x	x		x	x	5
Pequeno serra			x								1
Serrazinhas			x								1
Serrinho											
Serra maior											
Elevações						x			x		2
Elevaçãozinha			x								1
Encosta							x				1
Encostazinha											
Inclinado						x					1
Poco inclinado											
Montanha					x		x	x		x	4
Mini-montanha											
Montanha baixa											
Montanhas suave	x										1
Montanha pequena					x						1
Cordilheira									x		1
Rio				x						x	2
Ribeiro											
Passagem de agua						x					1
Margens do rio											
Linhas da agua	x			x					x		3
Number of views recognised	0	0	0	0	0	0	0	0	0	0	
Total number of landform terms used:	6	4	6	5	6	7	9	6	8	4	

Table A 6. Summary of terms used by Lousã participants to describe the Odemira video

APPENDIX 3: ASTER DIGITAL ELEVATION MODEL MAPS

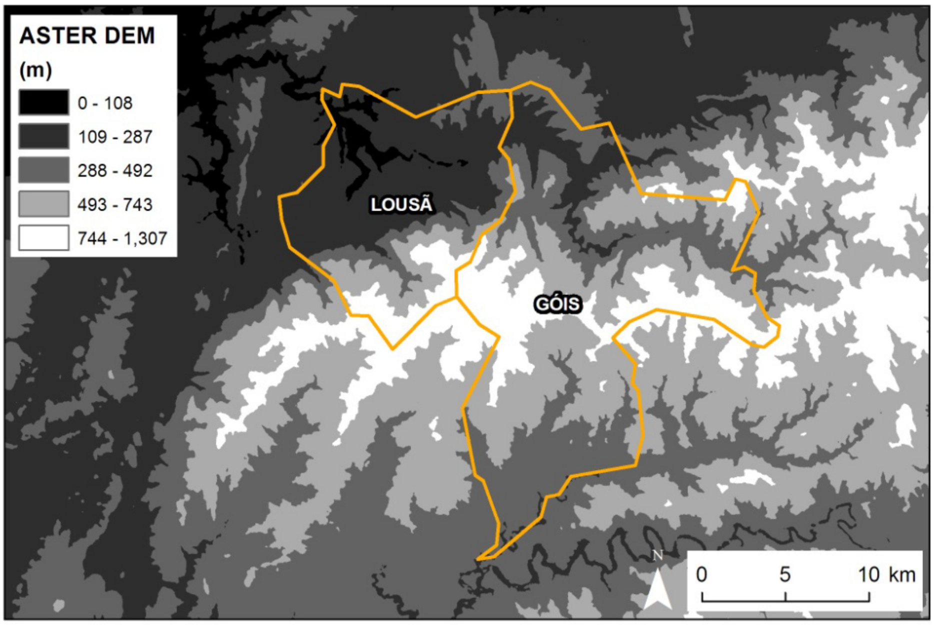

Figure A 1. Lousã site DEM

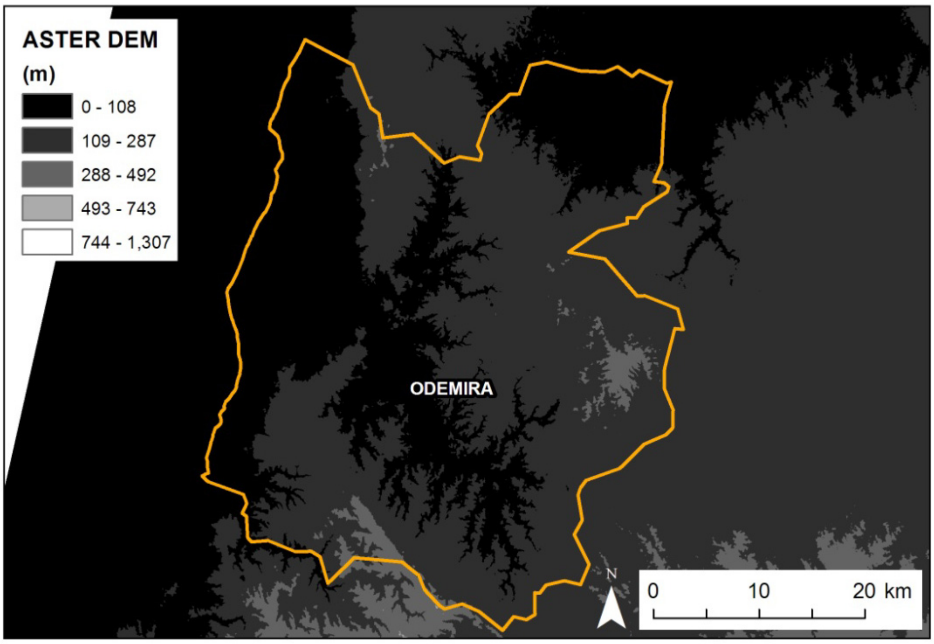

Figure A 2. Odemira site DEM

APPENDIX 4: MORGAN AND LESH LANDFORM CLASSIFICATION

The following four Model Builder models were used to perform the landform classifications according to the steps outlined in Morgan and Lesh (2005).

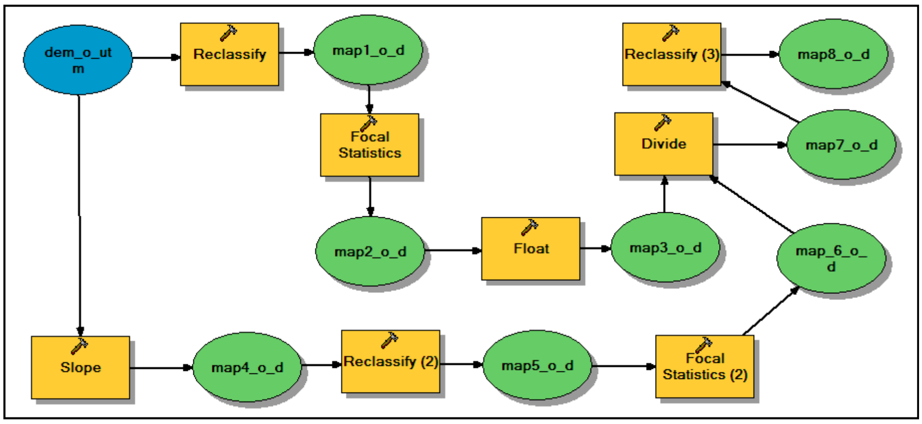

Figure A 3. Slope sub-model

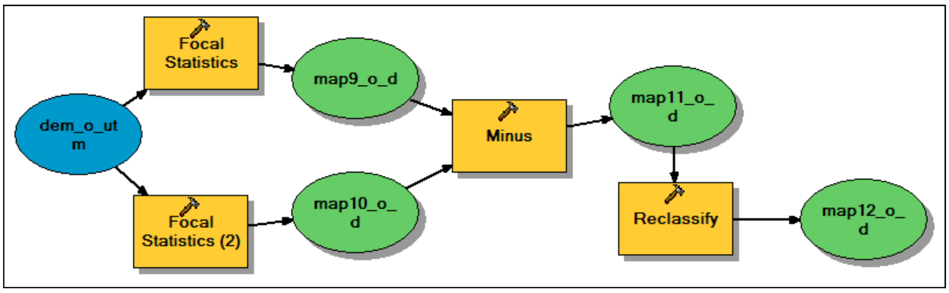

Figure A 4. Relief sub-model

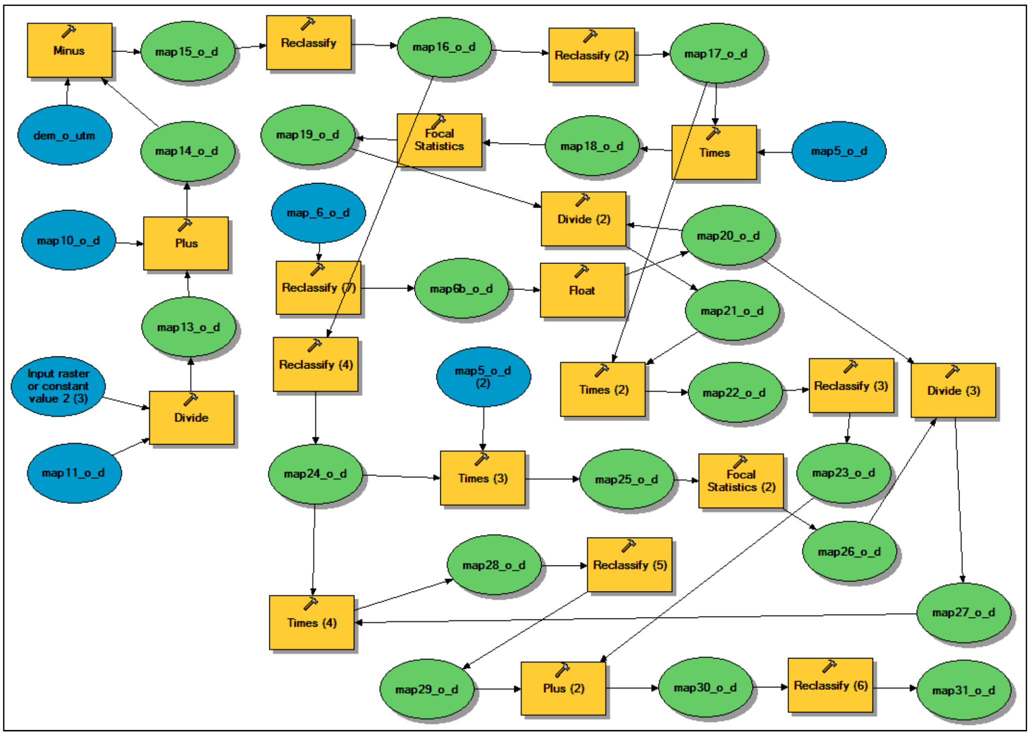

Figure A 5. Profile sub-model

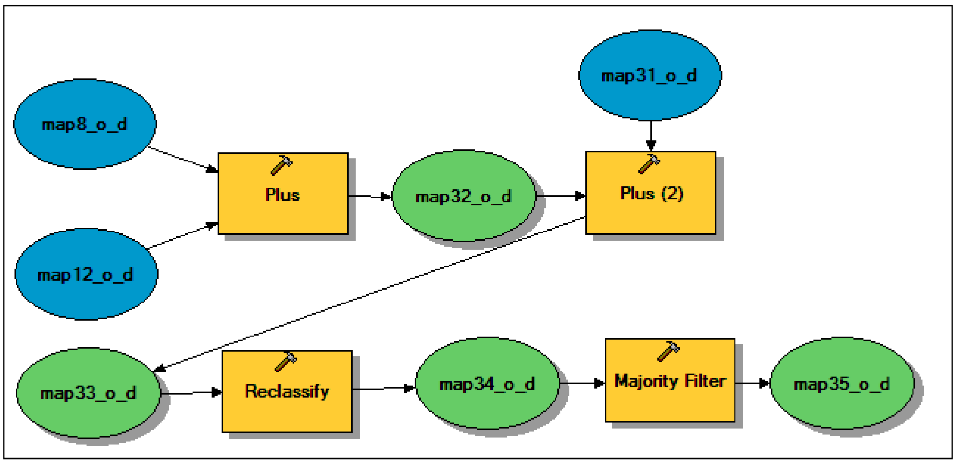

Figure A 6. Final classification

APPENDIX 5: AGGREGATED LANDFORM CLASSES

Morgan and Lesh landform classes	Dikau/Morgan and Lesh super-class	Description (Morgan and Lesh, 2005)
Plains		
411 – 414 421 – 424 311 – 314 321 – 324	11 12 13 14	Flat or nearly flat plains Smooth plains with some local relief Irregular plains with some local relief Irregular plains with moderate relief
Plains with hills or mountains		
431, 432, 331, 332 441, 442, 341, 342 451, 452, 351, 352 461, 462, 361, 362	31 32 33 34	Plains with hills Plains with high hills Plains with low mountains Plains with high mountains
Tablelands		
433, 434, 333, 334 443, 444, 343, 344 453, 454, 353, 354 463, 464, 363, 364	21 22 23 24	Tablelands with moderate relief Tablelands with considerable relief Tablelands with high relief Tablelands with very high relief
Open hills and mountains		
221 - 224 231 - 234 241 - 244 251 - 254 261 - 264	42 43 44 45 46	Open low hills Open moderate hills Open high hills Open low mountains Open high mountains
Hills and mountains		
131 - 134 141 – 144 151 – 154 161 – 164	53 54 55 56	Moderate hills High hills Low mountains High mountains

Table A 7. Aggregation of classes into Morgan and Lesh landform classes, and definitions

APPENDIX 6: LANDFORM CLASSIFICATION AT VIDEO VIEWPOINTS IN 2 ½ D

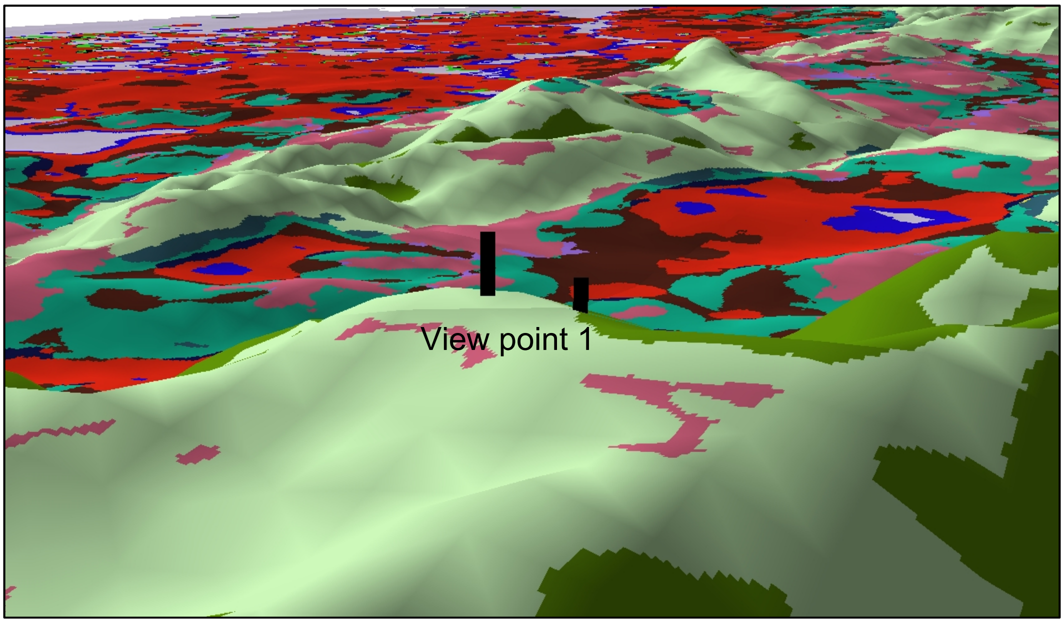

Figure A 7. View 1 Morgan and Lesh landforms, Lousã

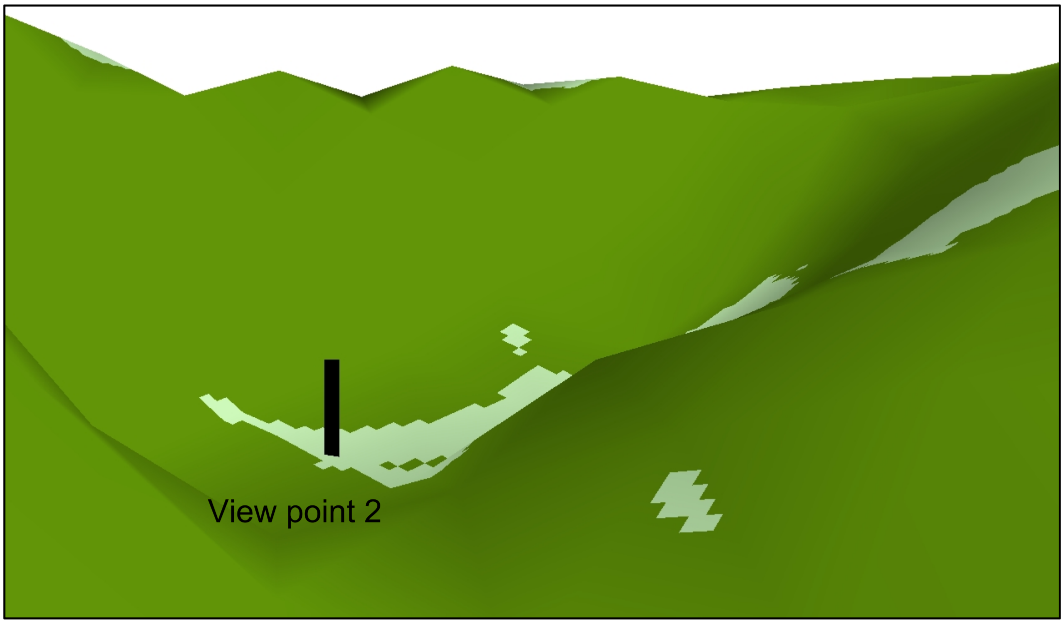

Figure A 8. View 2 Morgan and Lesh landforms, Lousã

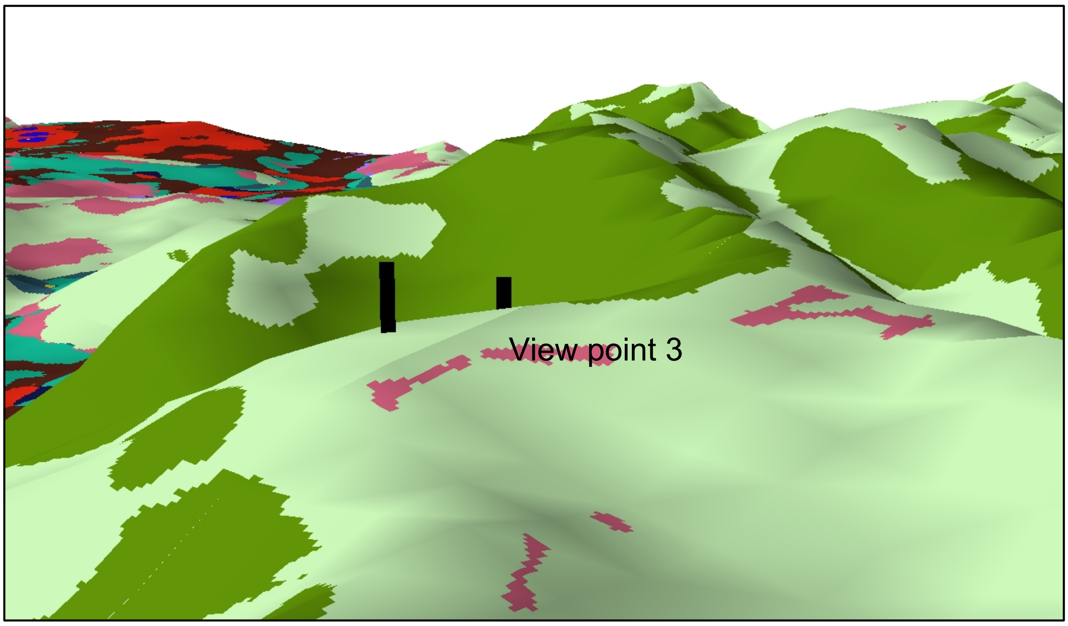

Figure A 9. View 3 Morgan and Lesh landforms, Lousã

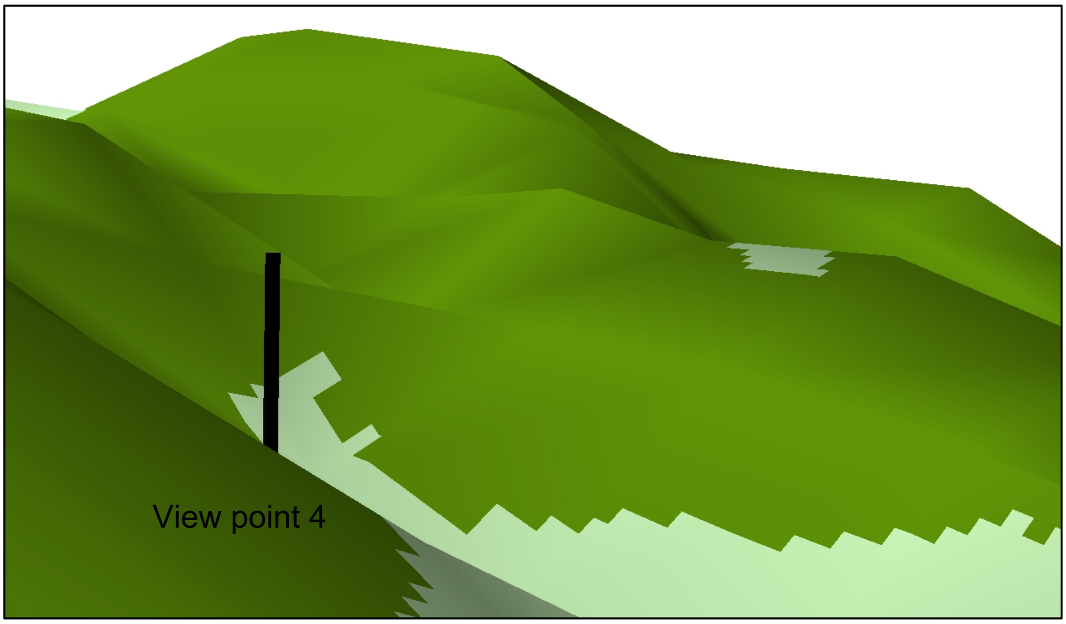

Figure A 10. View 4 Morgan and Lesh landforms, Lousã

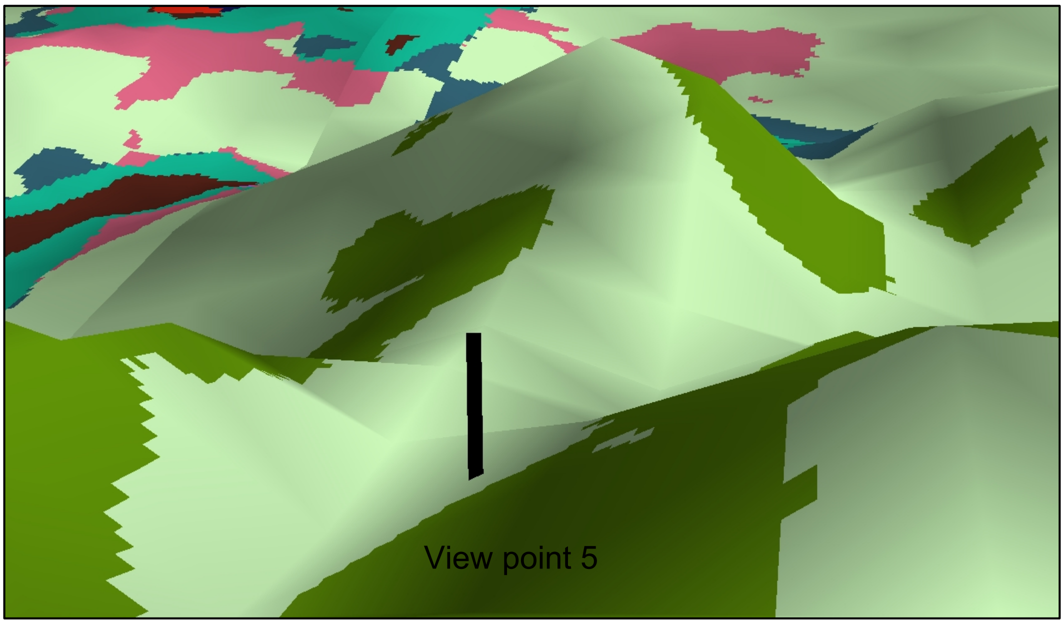

Figure A 11. View 5 Morgan and Lesh landforms, Lousã

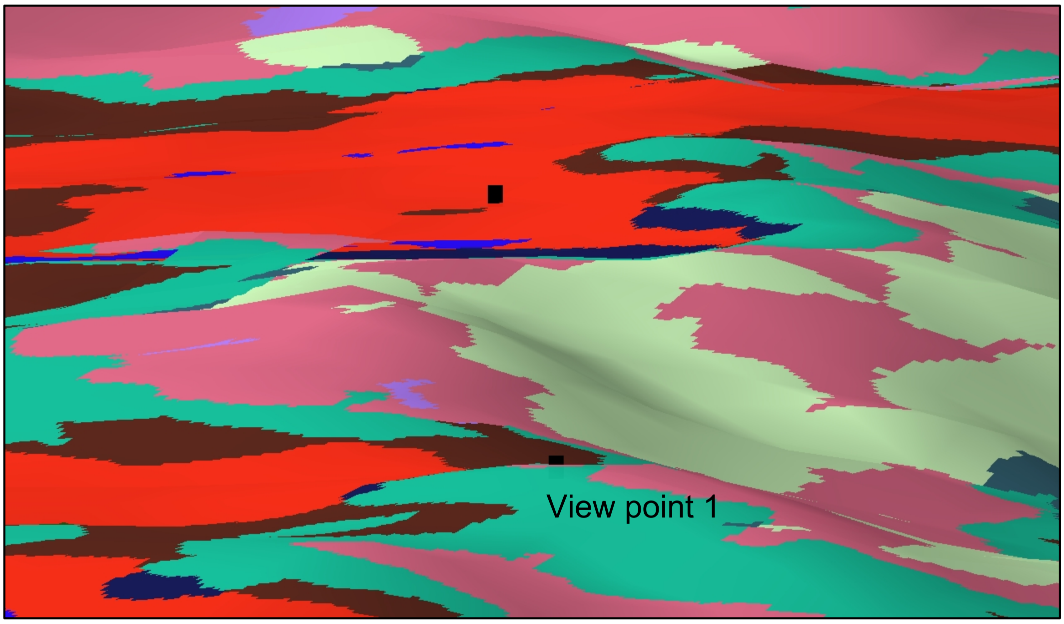

Figure A 12. View 1 Morgan and Lesh landforms, Odemira

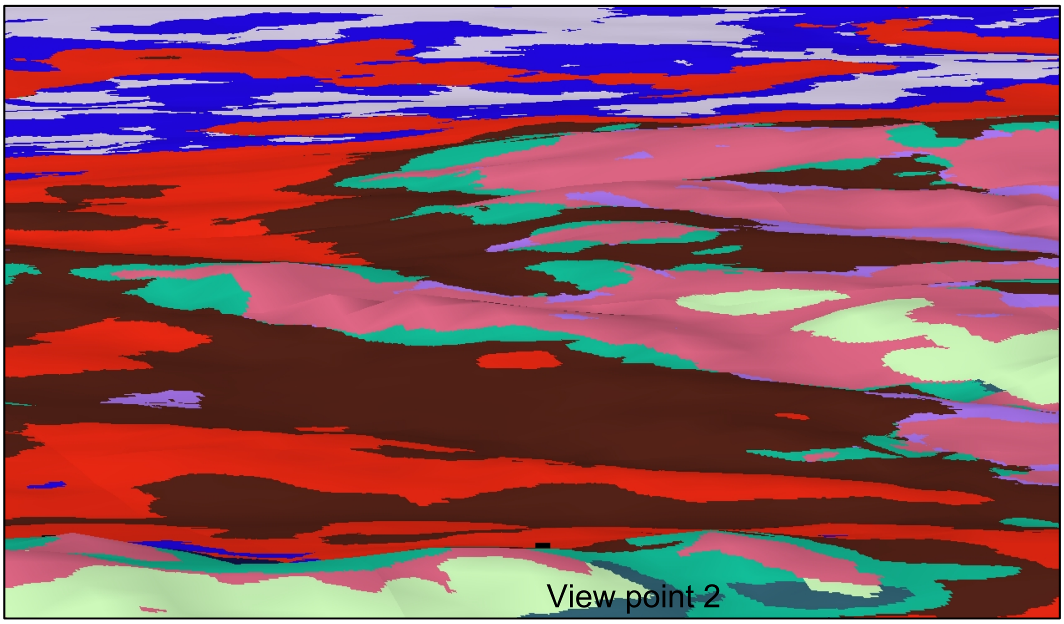

Figure A 13. View 2 Morgan and Lesh landforms, Odemira

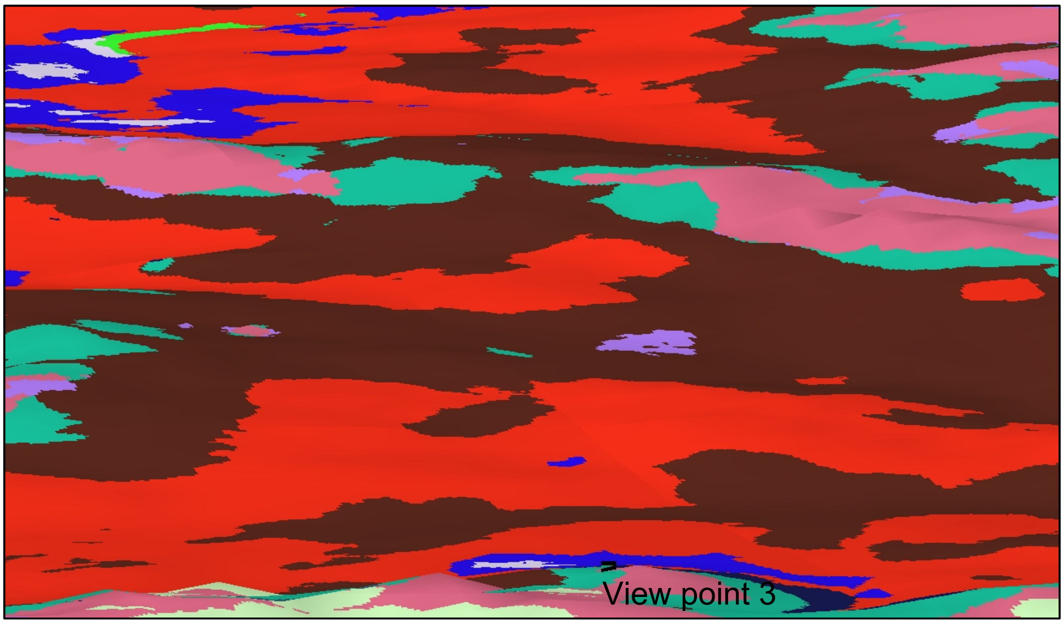

Figure A 14. View 3 Morgan and Lesh landforms, Odemira

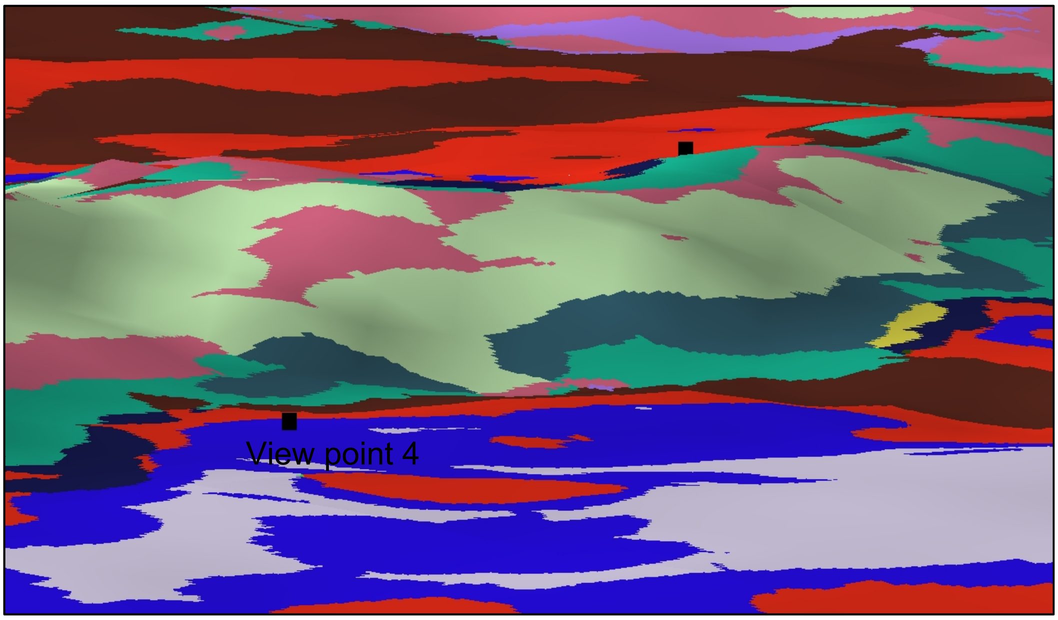

Figure A 15. View 4 Morgan and Lesh landforms, Odemira

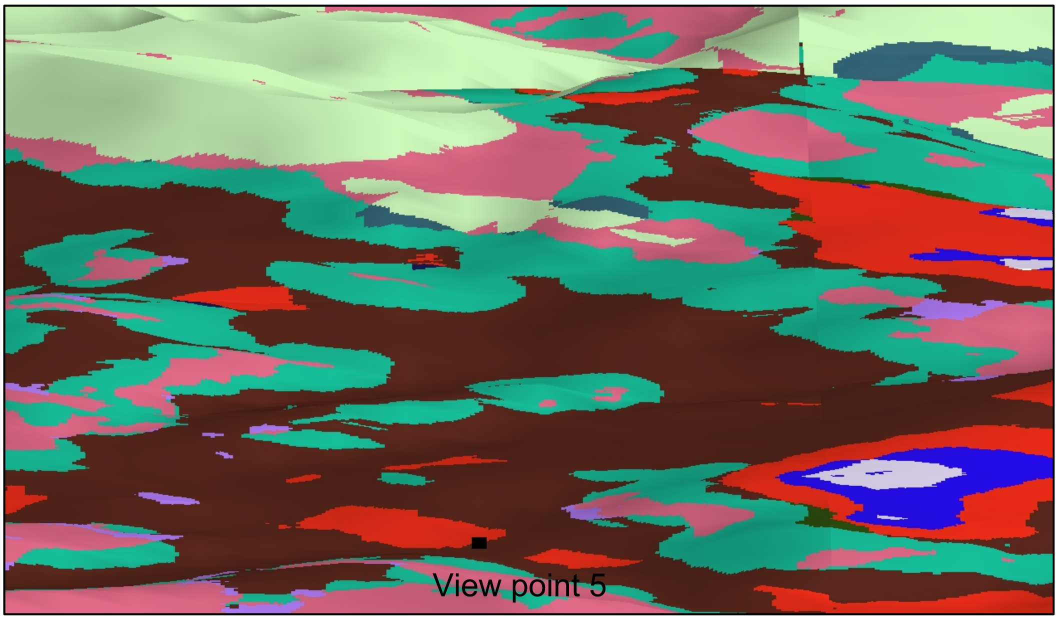

Figure A 16. View 5 Morgan and Lesh landforms, Odemira

APPENDIX 7: LANDFORM CLASSES AND PARTICIPANT TERMS

Landform number	Most common terms	Morgan and Lesh class
1	Montanha, Serra	54 - High hills, 55 - Low mountains
2	Vale, Montanha, Monte	14 - Irregular plains with moderate relief, 43 - Open moderate hills, 53 - Moderate hills
3	Vale	54 - High hills
4	Serra, Montanha	55 - Low mountains
5	Ladeira, Cume, Encostas abruptas	55 - Low mountains
6	Cume/cumeada, Serra, Montanha	55 - Low mountains
7	Vale	55 - Low mountains
8	Montanha, Serra, Montes	55 - Low mountains
9	Montanha	55 - Low mountains
10	Montanha	55 - Low mountains
11	Vale	54 - High hills
12	Monte	55 - Low mountains
13	Serra, Montanha	55 - Low mountains
14	Montanha, Serra	54 - High hills
15	Montanha, Serra, Monte	55 - Low mountains
16	Vale	54 - High hills
17	Vale	54 - High hills

Table A 8. Comparison of Morgan and Lesh landform classes with participant terms, per landform - Lousã video

Landform number	Most common term	Morgan and Lesh class
1	Várzea, Planicie	14 - Irregular plains with moderate relief (Elev. 200 m)
2	Monte, Serra	43 - Open moderate hills (Elev. 260 m)
3	Planicie	14 - Irregular plains with moderate relief (Elev. 150 m)
4	Monte	14 - Irregular plains with moderate relief (Monte elev. 190 m)
5	Monte	14 - Irregular plains with moderate relief
6	Serra, Montanha	43 - Open moderate hills, 53 - Moderate hills, 42 - Open low hills
7	Monte, Serra	14 - Irregular plains with moderate relief (Monte elev. 170 m)
8	Planicie	31 - Plains with hills, 14 - Irregular plains with moderate relief, 12 - Smooth plains with some local relief (Elev. 150 m)
9	Monte	31 - Plains with hills (Monte elev. 170 m)
10	Serra	43 - Open moderate hills, 53 - Moderate hills, 42 - Open low hills
11	Planicie, Planalto	12 - Smooth plains with some local relief, 14 - Irregular plains with moderate relief
12	Vale	42 - Open low hills
13	Montanha, Serra	53 - Moderate hills, 54 - High hills
14	Monte	42 - Open low hills
15	Vale	42 - Open low hills
16	Planicie	14 - Irregular plains with moderate relief
17	Rio	14 - Irregular plains with moderate relief
18	Serra, Montanha	43 - Open moderate hills, 52 - Low hills, 53 - Moderate hills

Table A 9. Comparison of Morgan and Lesh landform classes with participant terms, per landform - Odemira video

APPENDIX 8: PARTICIPANT INFORMATION SHEETS

Lousã participants

A
11:00 13/11/10

Informações sobre o participante

Nome:

Idade: 51 ANOS

Cidade/Vila de residência CANDAL

Quanto tempo reside nessa morada: 5 ANOS

Ocupação: ARQUITECTO

B
12:00
13/11/10

Informações sobre o participante

Nome:

Idade: 44

Cidade/Vila de residência Lousã

Quanto tempo reside nessa morada: 30 anos

Ocupação: Reformada, ocupo o meu tempo como telefonista na A.R.C.I.L

C
12:30
13/11/10

Informações sobre o participante

Nome:

Idade: 47

Cidade/Vila de residência Lousã

Quanto tempo reside nessa morada: 30 anos

Ocupação: Ajudante de cozinheiro

E
15:00
13/11/10

Informações sobre o participante

Nome: c ... o

Idade: 50

Cidade/Vila de residência — R/C DTO

Quanto tempo reside nessa morada: 1 ANO PRT — 3200-200 LOUSÃ

Ocupação: EMPRESÁRIA — RESTAURANTE — BAR TI' LORNA

Importa-se se eu o contactar par

Quer saber os resultados deste e

Como quer ser contactado?

[Had the restaurant for 7 years]
in Talasnal

F
16:00
13/11/10

Informações sobre o participante

Nome:

Idade: 48

Cidade/Vila de residência LOUSÃ

Quanto tempo reside nessa morada: 13 ANOS

Ocupação: COMERCIAL

Importa-se se eu o contactar para escl

Quer saber os resultados deste estudo com

Como quer ser contactado? 91

[Had the bar since 2000]
in Talasnal

G
11:00
14/11/10

Informações sobre o participante

Nome:

Idade: 64

Cidade/Vila de residência Aigra Nova (f

Quanto tempo reside nessa morada: Araganil

Ocupação: Agricultora.

H
15:00
14/11

Informações sobre o participante

Nome:

Idade: 49

Cidade/Vila de residência Aigra Velha

Quanto tempo reside nessa morada: Sempre

Ocupação: Agricultora

I
14/11/10
16:00.

Informações sobre o participante

Nome:

Idade: 49

Cidade/Vila de residência Aigra Velha.

Quanto tempo reside nessa morada: 26

Ocupação: Agricultora

J
15/11/10
11:00

Informações sobre o participante

Nome:

Idade: 44

Cidade/Vila de residência TALASNAL - LOUSÃ

Quanto tempo reside nessa morada: 10 ANOS

Ocupação: FOTOGRAFO

K
15/11/10
13:00

Informações sobre o participante

Nome: [illegible]

Idade: 47

Cidade/Vila de residência Aigra Nova

Quanto tempo reside nessa morada: Sempre.

Ocupação: Lousitanea.

Odemira participants

A
11:30
18/11/10.

Informações sobre o participante

Nome: [illegible]

Idade: 31

Cidade/Vila de residência Odemira

Quanto tempo reside nessa morada: 15 anos

Ocupação:
Tecnica de desenvolvimento local

B
12:00
18/11/10

Informações sobre o participante

Nome: [illegible]

Idade: 27

Cidade/Vila de residência Zambujeira do Mar

Quanto tempo reside nessa morada: 20 anos

Ocupação: Agente de desenvolvimento Local
– área financeira –

C
12:30
18/11/10

Informações sobre o participante

Nome:

Idade: 33

Cidade/Vila de residência S. Teotónio

Quanto tempo reside nessa morada: 33

Ocupação: Administrativa

E
10:30
19/11/10

Informações sobre o participante

Nome:

Idade: 44 ANOS

Cidade/Vila de residência Moitinhas - SABÓIA

Quanto tempo reside nessa morada: 8 ANOS

Ocupação: ESTOU A FAZER UM CURSO NIVEL 3 iquavalência 12º ANO CURSO SEGURANÇA e HIGIENE NO TRABALHO

F
10:45
19/11/10

Informações sobre o participante

Nome:

Idade: 41

Cidade/Vila de residência Boavista dos Pinheiros

Quanto tempo reside nessa morada: 30 anos

Ocupação: estudante

G
11:00
19/11/10

Informações sobre o participante

Nome:

Idade: 30 anos

Cidade/Vila de residência Reliquias - Odemira

Quanto tempo reside nessa morada: 30 anos

Ocupação: estudante

H
11:15
19/11/10

Informações sobre o participante

Nome:

Idade: 41

Cidade/Vila de residência ODEMIRA

Quanto tempo reside nessa morada: 41 anos

Ocupação: Estudante

I
11:30
19/11/10

Informações sobre o participante

Nome:

Idade: 25

Cidade/Vila de residência AZENHA DO MAR

Quanto tempo reside nessa morada: 25

Ocupação:
ESTUDANTE
VENDEDOR
DISTRIBUIDOR

J
12:00
19/11/10

Informações sobre o participante

Nome:

Idade: 27

Cidade/Vila de residência Cavaleiro Cabo Sardão

Quanto tempo reside nessa morada: 27 anos

Ocupação: Estudante

K
12:15
19/11/10

Informações sobre o participante

Nome:

Idade: 34

Cidade/Vila de residência S. Luis

Quanto tempo reside nessa morada: 34

Ocupação: Estudante

L
12:30
19/11/10

Informações sobre o participante

Nome:

Idade: 30

Cidade/Vila de residência - odemira

Quanto tempo reside nessa morada: 30 Anos

Ocupação: curso de S.H.T.

Masters
Program
in **Geospatial**
Technologies