The (Re)construction of Ancient Indigenous Landscapes through Visibility Analyses. Analysing visibility patterns from multiple viewsheds during the Late Ceramic Age (AD 800-1500) in the coastal zone of the Montecristi Province, Dominican Republic.

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Cover image: View from MC-44 in Montecristi photo taken by Herrera Malatesta.

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Thesis Outline

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Chapter 1. Introduction

In the last decade, the northern region of the Dominican Republic and Haiti have been an important subject in archaeological research (Arranz Márquez 1991; Guerrero and Veloz Maggiolo 1988; Herrera Malatesta forthcoming; Hofman *et al*. forthcoming 2017; Hofman and Hoogland 2015; Ortega 1987; Ulloa Hung 2013; de Ruiter 2012). This area is the first area that was colonised by the Spaniards after Columbus' arrival at Guanahaní, San Salvador (Hofman *et al*. forthcoming 2017). In this area the Spaniards established their first settlements, where, after they experimented with crops and cattle, made plans for the colonisation of the island and the conquest and enslavement of the indigenous peoples. The knowledge that the indigenous peoples gave to the Spaniards about the environment, the location of important resources, and indigenous networks were vital for the conquest of Hispaniola and the rest of the Caribbean. In this period complex indigenous exchange networks existed that connected the Caribbean islands and the main land of South America (Hofman *et al.* forthcoming 2017).

When Columbus sailed along the coast he noticed various smoke columns rising from the hilltops. This could either reflect fire that is used during daily activities, but it could also reflect a signalling network between indigenous sites (Sonnemann *et al*. 2016, 71). In the northern part of the Dominican Republic where the Cordillera Septentrional borders the Atlantic Ocean, the archaeological sites are arranged according to a certain pattern. From earlier research (Ulloa Hung 2013; de Ruiter 2012), it appears that the sites are capable of visually control each other, since they are located in close proximity to each other. Besides, there are extraction sites in the coastal zone that are located close to mangroves for the harvesting of marine resources, while larger sites are located more in the flatter hinterland. The extraction sites seem to be connected with small hilltop sites that (in)directly connect the (large) habitation sites with the extraction sites (Ulloa Hung 2013; de Ruiter 2012; Sonnemann *et al.* 2016). (Inter)visibility can be considered an important factor in the determination of site location. However, the reconstruction of this network was only based upon elaborate fieldwork, and not on formal GIS-based visibility analyses (Hofman *et al.* forthcoming 2017; Sonnemann *et al.* 2016).

Therefore, in this thesis, GIS will be used in carrying out visibility analysis in the coastal area of the Montecristi province, which is located in the north of the Dominican Republic (fig 1). Traditionally, GIS analysis has been tested and integrated as a tool in European archaeology (Conolly and Lake 2006; Wheatley and Gillings 2002). Generally speaking, relatively little GIS related research has been carried out in Caribbean archaeology, however this is rapidly changing (Brughmans *et al*. forthcoming 2017; Herrera Malatesta forthcoming; Sonnemann *et al.* 2016; Reid 2008; de Ruiter 2012). The visibility tools available in GIS software can be important in understanding the distribution of settlements, the way landscape was perceived, the dynamics between settlements, and even islands and the possible ways in which colonisation and transportation between the Caribbean islands occurred. By using visibility studies, it is possible to reconstruct dynamic ancient networks among the different Amerindian peoples in the Caribbean archipelago (Brughmans *et al*. forthcoming 2017; Hofman *et al.* forthcoming 2017; Hofman and Hoogland 2011; Hofman and Bright 2010).

In this thesis, viewshed analyses are combined with characteristics of the landscape and habitation during the Late Ceramic Age (AD 800-1500), such as geomorphological characteristics and settlement distribution, in order to describe visibility patterns in the coastal area of Montecristi. The data and archaeological categories of size, elevation, and cultural identifications that are used for carrying out these analyses were collected during the summers of 2013-2015 survey campaigns in the Montecristi coastal area, as part of the PhD research of Eduardo Herrera Malatesta that is part of the Nexus 1492 research project, funded by the European Research Council (ERC) as part of the European Union's Seventh Framework Programme (FP7/2007-2013) / ERC grant nº 319209, under the supervision of Prof. dr. Corinne L. Hofman. During this survey, around 100 sites were recorded (Ulloa Hung and Herrera Malatesta 2015), of which 44 are located in the case-study area and will be analysed in this thesis.

Figure 1: An overview of the Caribbean and the location of Montecristi (Arcgis Online Basemap).

1.1 Objective and relevance

The traditionally defined social cultural borders in the Caribbean region are changing, according to new insights. In the past, changes in the ceramic sequences were explained by the movements and replacements of indigenous peoples from mainland South America. These changes, however, are now considered as a result of a highly interconnected region where internal processes such as exchange, trade and marriages initiate cultural changes on and between the islands of the Caribbean (Hofman and Bright 2010; Hofman *et al.* 2008; Keegan and Hofman 2017; Keegan 2010). In order to redefine these cultural boundaries, the material culture needs to be reanalysed on a regional scale, to provide new interpretations and models about social interactions (Ulloa Hung 2013). Another parameter that can be used to redefine regional exchange networks is visibility. Within the NEXUS 1492 objective of reconstructing indigenous landscapes, wherein visibility models can be utilised (Brughmans *et al.* forthcoming 2017), a case-study area is taken within an area with clear archaeological context and on going research. By analysing viewsheds, the internal organisation of view between different sites and regions can shine a new light the on social and cultural interactions. By creating viewsheds and by describing the visibility patterns of the case-study area in the coastal zone of Montecristi, the relationships between different sites are explored, and a model developed that can contribute to these greater research objectives.

1.2 Research questions

In order to develop models that can contribute to the reconstruction of ancient indigenous landscapes, the following main research question is asked:

To what extent can visibility patterns of Late Ceramic Age (AD 800-1500) sites within the coastal zone of Montecristi contribute to the (re)construction of indigenous landscapes?

In order to answer this main question, the following sub questions are developed:

- What are the visual prominent environmental features in the defined case-study area of Montecristi province?

- To what extent is it possible to reconstruct the role that visibility played in the determination of site location, based on multiple viewsheds in the case-study area?

- To what extent do multiple viewsheds correlate with site clusters?

- What can be said about the control of marine resources, indigenous communication networks and visibility based on multiple viewsheds analyses?

1.3 Methods and approaches

In this thesis, a methodological approach towards visibility studies is followed. For this approach viewsheds are taken in order to describe and evaluate visibility patters in the case-study area. For the analyses of this thesis, the visibility tool in ArcGIS 10.2 is used in order to create multiple viewsheds. To do this, multiple viewsheds that are taken from multiple sites within the case study area, and sites are categorised by size and elevation. They are further divided into small, medium and large sized sites, and low, middle and high-elevated sites. From each category, which includes multiple sites, a viewshed is then taken that calculates all the visible points that can be observed per category. The coordinates that are used for the visibility analysis were taken by Herrera Malatesta (forthcoming) for his PhD project, and are taken from the centroid of the sites. This is limiting in two ways: 1) the viewsheds, and thus the inter-visibility of sites, can be changed when humans changed their observation point at the sites. This is a major problem in visibility analyses, but so far there is no standardised method to include human mobility into the analyses. 2) Besides, the viewsheds in this thesis only includes the visible points at surface level. The viewsheds can thus also be different when objects with a higher elevation than the surface elevation, such as houses, other humans or smoke columns are incorporated in the parameters. The alterations of viewsheds caused by these factors require more in depth evaluation before they can be applied into visibility analyses, which is a relevant topic for further research.

1.4 Thesis outline

After this introduction, the second chapter of this thesis will give an overview of the most important environmental and cultural information of the northern part of the Dominican Republic. In the environmental section, the exploitation of resources by the indigenous peoples of the northern part of the Dominican Republic will be discussed to stress the human environmental interactions. Secondly, the two most influential environmental parameters on visibility analysis are discussed, i.e., geomorphology and (Palaeo)vegetation. Geomorphology and (Palaeo)vegetation both influence the extent of a viewshed, since places with a higher elevation or places with little vegetation have a better visibility and *vice versa*. The cultural section will comprise information on the most important ceramic series for this part of the Dominican Republic, namely the Ostionoid, Meillacoid, and Chicoid series. The mixed occurrence of these series will also be discussed in order to show the intricacies of the very complex indigenous networks that existed at the time.

Chapter three, the methodological chapter, will provide an overview of the GIS-based research, the different types of visibility analyses that are available, followed by the different types of viewsheds that are available for carrying out visibility analyses and how different parameters have consequences on the methods. Here, I also explain what parameters are used for the multiple viewsheds that are used in this thesis.

Chapter 4 provides an overview of the data. Here the acquisition of the data is discussed, together with the definition of the case-study area and the type of data that are present.

Chapter 5 discusses the results of multiple viewshed analyses that are carried out for the sites in the case-study area. For this viewshed analyses the sites were classified by size and elevation so there are small medium and large sized sites and low, middle and high-elevated sites. In order to create a more specific model, the same was done for only the Meillacoid sites. The general patterns and the Meillacoid visibility patterns can then be compared.

In chapter 6 and last chapter, a discussion and conclusion are provided.

Chapter 2. Environmental and archaeological background

In this chapter the environmental and cultural background information on the region and case-study area are presented. In the environmental section, a brief overview is given about how the indigenous peoples exploited their environment. Afterwards, the most influential environmental parameters on visibility present in the case-study area—geomorphology and vegetation—are evaluated. In the section on culture, an overview is given about the Ostionoid, Meillacoid and Chicoid ceramic series, and how re-evaluating these series, in combination with visibility analyses, can contribute to understanding cultural interactions in the region.

2.1 Exploitation of resources

In the northern part of the Dominican Republic, the most important geomorphological features are the Cordillera Septentrional and the coast. The Cordillera Septentrional is a mountain range that connects the coastal area with the inland Cibao Valley, which stretches out over an area of around 200 kilometres. (Hofman *et al.* 2016, 307).

Under the influence of the Atlantic Ocean and the difference in altitude of the Cordillera Septentrional, the precipitation varies, which creates microclimate regions along the Cordillera Septentrional that ranges from dry semi-arid regions to humid tropical regions. This makes the northern coast of the Dominican Republic one of the most diverse geomorphological areas of the island. The eastern part of the Cordillera Septentrional is predominately humid, with subtropical to tropical rainforest vegetation. The western part of the Cordillera Septentrional is predominantly arid to semi-arid, with more cacti or succulent vegetation (de Ruiter 2012; Sonnemann *et al.* 2016).

These different geomorphological characteristics in the landscape had specific functions in the subsistence strategy of the indigenous peoples. The coastal marshes and mangroves were vital for the extraction of marine resources such as shells, fish, lobsters and crabs. The shells were used for consumption, but also for the fabrication of tools and ornaments (Guzzo Falci 2015). Besides, the sea itself was also used for fishing activities.

The agriculture or horticulture that was practiced by the indigenous peoples relied mostly on slash and burn techniques, in which pieces of forest lands were cut and burned for clearing land to create more open areas suitable for agricultural activities. Some of the crops that were probably consumed are tuberous crops such as manioc, maize, arrowhead, sweet potato, cocoyam and marunguey, but also legumes like the common bean and wild legumes. (Pagan-Jimenez *et al.* 2005). The most important source for the supply of meat was the sea. A wide range of fish was hunted, such as herring, ladyfish, mullet, snook, amberjack, and many more. Besides, other marine fauna was exploited, such as sea turtles, queen conch, manatees and seals. In addition, on land there could hunt crocodiles, iguanas, sloths, and various rodents like rats and guinea pigs (Newsom and Wing 2004; Wilson 2007). The exploitation of these diverse geomorphological zones is also reflected in the determination of site location, in the northern part of the Dominican Republic. In general, the sites are located on the edge of different geomorphological and ecological zones, which makes it possible to extract resources in both zones (Keegan and Hofman 2017; de Ruiter 2012).

2.2 Geomorphology

As discussed above, the northern coastal area of the Dominican Republic is a very diverse geomorphological area. In this section, the geomorphology of the case-study area will be described, and how the geomorphology might influence the visibility analyses carried out in this thesis.

As can be seen on the geomorphological map (fig 2), the case-study area can be divided into four geomorphological areas. Along the coast are located several mangrove areas. The mangroves are flat areas in connection with the sea, and are expected to be visible from the sites in the surrounding area because they are important for the extraction of resources like shells and fish. However, not the entire coastline is a mangrove area. There are other geomorphological areas that border the sea, such as a relatively low-elevated hilly areas and alluvial fans. More inland, the hilly section changes into a mountainous area, where the lower-elevated hills continue. In short, the case-study area can be considered as a flat coastal area, followed by a hilly and mountainous area that borders a relatively flat hilly inland area (Reyna Alcántara *et al.* 2012, 9). From a visual point of view, the high-elevated regions of the Cordillera Septentrional have the best-expected spots to command wide viewsheds that can both visually control the flat inland and coastal areas. However, it might also be possible that hilltop sites are well visible from the surrounding flat areas. In the flat areas itself, it is also possible to observe other sites that are situated in close proximity to the observation point.

The geomorphology will be used in order to categorise the case-study area into geomorphological zones that are used for the description of visibility patterns. These zones are based upon current data, and thus might be different than in the past. Mangroves especially might have been located at other places in the past. Besides, the resolution of the geomorphological map is very large and not that accurate, for instance in regards to the digital elevation model. So, in order to define the geomorphological zones, the geomorphology map and the DEM are combined because the most important geomorphological aspect that influences visibility is elevation. The geomorphological zones can be divided into a coastal zone, which first, consists of areas that borders the sea such as mangroves. Secondly, consists of a coastal lowland area that includes a hilly to flat area and some alluvial fans that are situated in front of the mountains. Thirdly consists of a mountainous area that consists of the Cordillera Septentrional and some alluvial fans. Lastly, there is a flat and hilly inland area that is situated at the southern flanks of the Cordillera Septentrional.

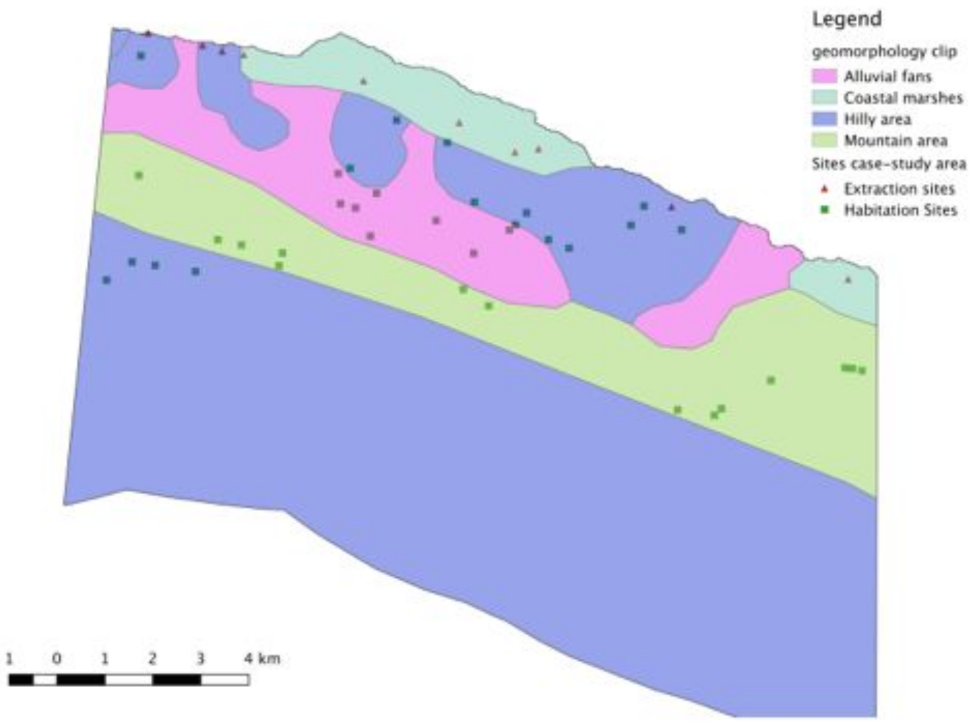

Figure 2: Geomorphology of the case-study area (after Reyna Alcántara êt al. 2012).

2.3 Palaeovegetation

The reconstruction of palaeovegetation is quite problematic since there is very little research done on this issue for the region. Most of the studies done on palaeovegetation are about the reconstruction of palaeodiet, but there are some studies that include the reconstruction of climate change in the Montecristi region through pollen analyses (Caffrey *et al.* 2015). In addition, the modern-day environmental maps and observations in the field can be helpful in understanding vegetation that might have been present in the case-area. This is, however, extremely problematic since most of the vegetation is heavily influenced by humans. In addition, the vegetation also underwent radical changes when the region was colonised by the Spaniards, who brought a great variety of crops from the Old to the New World (Hofman *et al*. forthcoming 2017). In the past and present, the Montecristi region appears to be an arid environment, with less then 700 mm precipitation per year (Caffrey *et al*. 2015, 10). Nowadays, the region is used for agricultural activities, but there are some human controlled dry forests left. The pollen samples from Laguna Saladilla confirm that an ancient arid environment existed, with vegetation mostly consisting of various grasses, palm trees and pine trees. Besides, there is evidence for mangrove trees and plants that are able to grow in marshy conditions (Caffrey *et al.* 2015, 15). Currently, there is also an open arid environment in Montecristi where the above named species still occur. It is thus difficult to say how the vegetation might have influenced visibility patterns in the past, but an open environment makes it possible to have wide viewsheds. With the current data and methods, it is impossible to use vegetation as a parameter in the visibility analyses.

2.4 Cultural section

The Northern part of Hispaniola, one of the largest islands of the Caribbean archipelago consisting of the Dominican Republic and Haiti, is a very important area in understanding the encounter of the Old and New Worlds. From this area, Christopher Columbus and his men initiated the Spanish conquest of the island, and later on the colonisation of the rest of the continent (Hofman *et al.* forthcoming 2017; Sonnemann *et al*. 2016, 71). Obviously, one of the first contacts between the indigenous communities and the Spanish took place in this area, and in order to understand the dynamics of the conquest and the indigenous networks, it is important to study the social and spatial arrangement of sites and their interrelationship.

2.4.1 Ostionoid, Meillacoid and Chicoid

The ceramic series that are most abundant prior to the contact period in the northern part of Hispaniola are the Meillacoid and Chicoid series. The major characteristics of the styles are discussed in combination with the dispersal of the series.

Before discussing the Meillacoid and Chicoid series, the Ostionoid series will be evaluated shortly first. Ostionoid ceramics emerged around AD 600 in the eastern parts of the Dominican Republic. Ostionoid can be considered as an overarching term since there are many variations in this series that are linked to the emergence of social identities (Keegan and Hofman 2017, 118). The characteristics of the Ostionoid series are simplistic egg formed shapes, with a diameter between 21 and 25 cm. As well, Ostionoid ceramics in general do not have handles, but there are exceptions (Ulloa Hung 2013, 159). Ostionoid vessels do have a reddish brown slip layer, and have fine-lined incisions. Anthropomorphic and Zoomorphic adornos are also present in the Ostionoid series. When the Meillacoid series emerged, many Ostionoid characteristics were also mixed into the Meillacoid series (Ulloa Hung 2013, 160). However, there are no Ostionoid shreds found in the case-study area so far.

Meillacoid pottery is predominantly black, greyish coloured, which means that the fire conditions were mostly reduced, however, there are some reddish vessels. The walls are quite thin, and the surface of the ceramics is smoothened but not burnished. Most of the vessels are rounded or egg shaped bowls, with outward braided rims and an inward turned neck. The decoration consists of applications, such as nubbins, but also of fine lined incisions (Ulloa Hung 2013). The adornos on Meillacoid vessels are either anthropomorphic and zoomorphic, and the facial attributes are formed by appliqué (Keegan and Hofman 2017, 120-121; Sinelli 2013). The Chicoid pottery is mostly grey to brownish in colour, are much thicker, and has highly polished surfaces. Besides, there is a broader range of vessel shapes and jars. The decoration consists exclusively of incisions, which are broader than on Meillacoid pottery, both for the adornos and the rest of the vessel (Keegan and Hofman 2017; Ulloa Hung 2013).

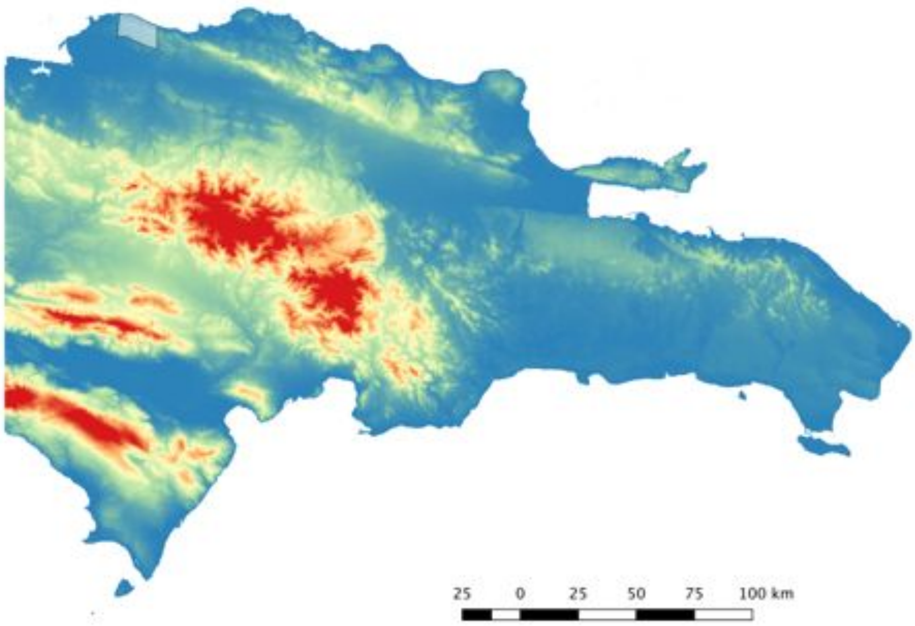

Figure 3: DEM of the Dominican Republic with the Cibao valley located between the Cordillera Central and the Cordillera Septentrional. The polygon highlights the case-study area.

The origin of the Meillacoid series is in the Cibao Valley, situated between the Cordillera Central and the Cordillera Septentrional (fig 3) (Keegan and Hofman 2017; Sinelli 2013; Wilson 2007). The Cibao Valley has some important rivers that originate in the surrounding mountain ranges, making this region one of the most fertile on the island, and a very important agricultural production centre for the Dominicans today (Sinelli 2013, 225). The Meillacoid series spread from the northern part of Hispaniola southwards towards Jamaica, but it is also present in parts of Cuba, the Turks and Caicos Islands, and The Bahamian archipelago (Keegan and Hofman

2017; Sinelli 2013). The possible reasons for this wide dispersal are discussed below.

Around the 9th century AD when the Meillacoid series emerged, the way of subsistence of the indigenous peoples changed. With the introduction of new cultigens, the subsistence strategy became more focussed on agriculture, instead of hunting and fishing. Therefore, the locations of the settlements were expanded from the coastal plains to the hilltops more inland, close to rivers (Keegan and Hofman 2017, 127). Besides, the introduction of new cultigens, possibly also explain the reason why a new type of ceramics dispersed so rapidly over a large area. New types of food need new ways of food processing, and thus another set of material culture. In addition to agriculture, fishing remains an important protein source (Wing and Wing 1995). So, when the sites were moved toward hilltops, visibility could have played an important role in the management of marine resources.

The reason for the wide distribution of the Meillacoid series can be explained by several causes. One explanation is focused on climate changes that occurred in the Cibao Valley around the 10th century AD (Sinelli 2013, 228). The climate changed from predominantly wet to a very dry environment. Around the same period, the Meillacoid style started to spread to the Bahamas, so it is likely that these movements of people were caused by the changing climate conditions. The dryer climate probably forced the people to move to the Bahamas and Cuba in order to exploit other food resources (Sinelli 2013, 228).

The other explanation for the rapid spread of the Meillacoid series has to do with exchange networks. Before the dispersal of the Meillacoid series, there was already a huge mixing of styles taking place. For instance, Ostionoid elements were mixed with Meillacoid elements (Ulloa Hung 2013). Due to interaction on both a local and non-local levels, elements of different ceramic series were combined. These small alterations reflect different communities that express their social identity by incorporating motifs of other styles into their own material culture. The mixing of material cultures reveals indigenous trade networks, and intermarriages between different social groups, but also conflicts and control over certain areas or resources. The emergence of the Meillacoid series can then be considered as combined elements that became the dominant tradition after a process of exchanging material culture, traditions and ideas. Meillacoid groups should therefore not be considered as homogenous, but as heterogeneous groups that share a set of general ideas and concepts, which is reflected in their material culture (Keegan and Hofman 2017; Ulloa Hung 2013, 2014).

The Chicoid style emerged around AD 950 in the eastern parts of the Dominican Republic. This style started to spread out around the 13th century AD, when it begins to appear in the neighbouring areas. The Chicoid series is one of the most refined and decorated styles in the Caribbean area, and was considered as the material culture of the so-called Taíno peoples. The spread of the Chicoid series is traditionally explained with the emergence of hierarchical societies that were ruled by caciques. These are considered as leaders of distinctive chiefdoms, the Cacicazgos. The problem, however, is that Spanish conquistadors first described these political structures, and then archaeological data was framed in order to prove these structures (Keegan and Hofman 2017, Ulloa Hung and Herrera Malatesta 2015). These kinds of schemes do not necessarily provide more information about the life ways, the cultures, and the interactions of the indigenous peoples that inhabited the Caribbean prior to European contact. Because, the establishment of cultural boundaries are based upon Spanish descriptions that contain both misconceptions about the indigenous inhabitants and concepts of the Spanish culture that are influenced by their European perspective. Secondly, a cultural boundaries classification system consist of homological assumptions rather then an approach that is founded on diversity (Keegan 2010). For instance, in the Chicoid era, similar cultural attributes, such as *zemis*, *duhos,* burial practices and ornaments can be found throughout the Caribbean region. This has been interpreted as an expansion of one culture, described as the Taíno culture, that dominated the Greater and Lesser Antilles. However, recently, it has been shown that these cultural attributes can be related to multiple cultures that were present before the arrival of Columbus (Keegan and Hofman 2017; Keegan 2010).

2.4.2 Comments

Besides the widespread Chicoid pottery and motifs of the Chicoid style in the Greater Antilles, there is a clear influence of Chicoid culture on the Lesser Antilles, in both ceramics and other ritual objects (Hofman *et al.* 2008). These objects include many beads and pendants, three pointer stones, shell masks, guanín and wooden seats. Besides objects, various concepts or ideas have also been spread throughout the region, since house plans, burial practices, pictographs, petroglyphs and the organisation of settlements are also similar, which of course may vary on a local level (Keegan and Hofman 2017, 143).

Traditionally, the occurrence of these kinds of artefacts with associated Chicoid pottery was linked to a process of colonisation and the replacement of present local cultures by the “Taíno” culture. However, the archaeological record does not support a one-way model of the replacement of cultures and the colonisation of a dominant power. Instead, it is clear that different cultures shared common values, beliefs, and social practices that were distributed across the Caribbean by a complex network of exchange, marriage, warfare and religious conversion (Hofman *et al*. 2007, 2008, 2010; Keegan and Hofman 2017; Keegan 2010). It is clear, that throughout the

Caribbean, goods and objects were traded between the islands themselves and between the islands and the mainland of South America, which resulted in the many similarities among the different cultures present prior to the conquest by the Europeans. In order to understand this complex network of exchange and to illustrate the social and cultural dynamics on the different islands and eventually in the Caribbean archipelago, it is important to carry out detailed studies on local sites and regional areas to re-evaluate the autonomy of different areas and the interaction between them (Keegan and Hofman 2017; Ulloa Hung and Herrera Malatesta 2015; Ulloa Hung 2013).

Chapter 3. Methods

In this chapter, the methods that are used for carrying out the analysis used to answer the research questions of this thesis are discussed. To test the research questions with the available data is challenging. Since this study is all based on survey data, there are some problems that will occur while analysing and interpreting the data. Firstly, it is unknown if the data that is gathered on the surface is a reliable reflection of the unknown information that is still buried beneath the ground. Secondly, not all of the sites in the case study area are dated, and only a few have thus absolute dates.
It remains unknown if the studied sites were all in use contemporaneously. However, until a detailed chronology is given of the region, it is possible to assume that the sites with the same set of material culture and especially the same pottery tradition are more or less from the same period. In addition, it is possible to say that the sites in the case study area can be dated between AD 1200 and AD 1480 based on C14 dating and stylistic similarities. So, it will be possible to still carry out the analysis, but it is important to be aware of the limitations in both the methods and data.

For the reconstruction of inter-visibility among sites, and for the determination of important visible characteristics in the landscape, there are several approaches that can be taken. There are so-called informal visibility analyses that do not include the use of geographical information systems (GIS) in the analyses, and there are formal visibility analyses that do include the use of geographical information systems in the analyses. In this chapter, the differences between these approaches will be discussed, but for this thesis GIS-based visibility analyses are used. The most important tool that is used for visibility analyses are viewsheds, a process that calculates all the visible cells in a digital elevation model from a defined observation point. The limitations and possibilities that the use of viewsheds offers are discussed in this chapter, as well and how viewsheds are used for this thesis as well.

3.1 Geographical Information Systems

For the analysis that will be carried out in this thesis, Geographical Information Systems (GIS) will be used. The use of GIS in archaeology has become a very powerful tool in academic research since it can be used for a variety of purposes, ranging from creating analytical maps to the calculation of complex spatial analysis. Since the application of GIS is very broad, it is difficult to define an inclusive definition, however, it can be considered as a system in which geographical referenced data can be stored, manipulated and analysed (Wheatley and Gillings 2002, 9). Throughout the years many different types of GIS programs have been developed, such as MapInfo, ArcGIS, AutoCAD, Surfer and Idrisi, with all their own specifications. For instance, AutoCAD is better for digitalising maps, while Idrisi and Surfer are better in creating digital 3D models. Besides, there are also some open source platforms that can be used such as GRASS, Quantum GIS, and MapInfo GIS. In the past, the open source platforms were complicated to use, but they became more user-friendly (de Ruiter 2012, 48). For the analysis that will be done for this thesis, ArcGIS is used, since available open-source software is still in development. In the long term, this can lead to the inaccessibility of data, since updated versions are not always compatible with previous ones.

Geographical Information Systems developed in the 1960s in Canada and the United States in order to address problems such as the mapping and managing of cultural and natural resources, including forestry management or the creation of maps for rural and urban development programmes (Wheatley and Gillings 2002). GIS was thus in the first place developed to create predictive models, in which the relationship between humans and their environment are studied in order to generate reliable predictions about the locations of unknown sites. These techniques are used a lot in the cultural management sector to include archaeology and heritage in development policies (Conolly and Lake 2006; Wheatley and Gillings 2002).

Since archaeological research is rich in spatial data, GIS can be used to organize this data in such a way that better interpretations can be made from that data. GIS makes it possible to create dynamic maps that go beyond static distribution maps of artefacts. In a GIS, several layers of both cultural and natural information can be combined in order to carry out multivariate analysis (Wheatley and Gillings 2002). A few examples of these types of analyses are least cost path analyses, network analysis, visibility analyses, predictive modelling, and the study of territories. As mentioned in this thesis, visibility analyses are applied.

3.2 Visibility Analyses

The application of visibility analyses has become very popular in archaeological research. These studies were mostly focussed on the location of monuments in the landscape. A few examples of this type of research included whether monuments were inter-visible, and whether monuments were deliberately placed at certain positions in a landscape in order to overlook other physical characteristics of the landscape (Conolly and Lake 2006, 225).

In general, there are two types of visibility analyses; GIS-based visibility analysis and non-GIS based visibility analyses, which can be subdivided into several categories (Lake and Woodman 2003). It is relevant to discuss the differences and similarities among these categories in order to stress the potential of different types of visibility studies in general, and to be aware of the possibilities and the limitations of the data set that will be used in this thesis.

3.2.1 Non-GIS based visibility analyses

Starting with the non-GIS based visibility analyses, there are three types of non-GIS based visibility studies—informal studies, statistical studies and humanistic studies. Informal visibility studies are characterised by a lack of methodology and "common sense reasoning". So, visibility analyses are done from (subjective) observations in the field, and could be part of general descriptions, for instance, the location of sites in a landscape (Lake and Woodman 2003, 690). To show an example, Ulloa Hung (2013) tried to deduct visibility patterns form field observations. From these field notes, he stated that there is a relationship between visibility and the location of sites, geomorphology, and the extraction of resources. During the survey, it was also possible to observe a large number of the surrounding sites, which suggests that the inter-visibility of sites played an important role in the determination of site location (Ulloa Hung 2013). However, these observations were not tested with a systematic method, so it can only be considered as subjective observation.

Statistical visibility studies are based on quantitative data that is analysed by statistical methods, such as Chi-squared tests, in which two types of hypothesis can be tested. This makes it possible to analyse whether the position or alignment of certain monuments in a landscape that provides a better view is due to change, or whether these monuments were deliberately located upon places with a better viewshed. To name an example of statistical visibility analysis in the region, de Ruiter (2012) used statistical analyses in order to evaluate the inter-visibility of sites, by calculating the percentage of sites that is visible from other sites, and the percentage of the studied area that is visible from the sites. She stated that in general, the Chicoid sites have a more restricted view than Meillacoid sites, and that visibility could have played a role in communication networks (de Ruiter 2012, 87-90).

The last type of non GIS-based visibility analysis is humanistic studies. Humanistic studies are focussed on the relationship between human agents and how they perceive their surrounding environment. Elements of phemenology are used in such an approach (Johnston 1988; Llobera 2003; Llobera 1996). One topic that has been studied is how visibility changes when a human agent moves through a monumental landscape. For instance, the change of view and the perception of Neolithic earthen mounds were tested, by walking over them, taking photographs and descriptions of the alterations in view, and how other monuments or environmental characteristics come in and out of the viewshed. However, it is extremely difficult to reconstruct the perception of ancient people, since it's almost impossible to reconstruct experiences of past peoples from visibility because the experience of the landscape is not just caused by view, but also by sound, smell and other senses (Lake and Woodman 2003, 692). Another problem in the reconstruction of perception is the difference between perception and observation as discussed in the theoretical chapter of this thesis, and the limited abilities that humanistic studies or GIS-based studies have in approaching the perception of past peoples.

3.2.2 GIS-based visibility studies

In GIS based visibility studies, the same kind of categories can be found as in the non-GIS based visibility studies. However, since these studies are carried out with GIS software, there are different types of challenges, problems, criticisms, and possibilities involved that will be discussed by using some examples. The first types of GIS-based visibility analysis were also lacking well-developed methods, as it was the case with the informal non-GIS based visibility analyses. For instance, Krist and Brown (1994) studied the view on caribou migration routes from Paleo-Amerindian sites, in order to study whether these sites were deliberately situated on locations with good views on migration routes of animals that were hunted. However, in this study, the views from the Paleo-Amerindian sites were not compared with views form non-site locations on the caribou migration routes, so it does not show whether the sites were placed there to control these migration routes (Lake and Woodman 2013).

Statistical GIS based visibility studies are mostly carried out to test hypotheses. The viewsheds from sites and from off-sites points are statistically compared in order to test whether sites were deliberately located on places in the landscape, with a specific visual advantage over locations that do not have such an advantage. However, there are some problems in visibility analysis on theoretical, pragmatic and methodological levels that are criticised. One of the major criticisms is that GIS studies can be environmentally deterministic, since it is a tool that is used for the analysis of spatial data, which is mostly focussed on environmental characteristics. Another criticism on GIS based visibility analyses is connected to the previous one, and states that GIS based visibility analyses and GIS studies in general, lack a humanistic centred approach (Frieman and Gillings 2007; Johnston 1998; Lake and Woodman 2013; Llobera 1996). Besides the already discussed theoretical limitations of visibility analyses, there are pragmatic limitations, such as the reconstruction of palaeovegatation or contrast between the studied objects and their background (Lake and Woodman 2003; Llobera 2007; Llobera 2007; Llobera 2003).

The nature of this thesis itself will be descriptive GIS-based visibility studies because the sample size is in some cases too small to carry out statistical analyses. So, viewsheds are used as the most important tool in order to deduce visibility patterns in the case-study area.

3.3 Viewsheds

The predominant method that is used to answer the research questions is the principle of viewsheds. A viewshed is a visibility tool that is commonly used in visibility analyses and which is mostly implemented using GIS software. For calculating viewsheds, the use of raster data is necessary as the calculated values changes over a continuous spectrum of cells, as opposed to vector data that mostly uses data like lines and polygons that represent homogenous values (Conolly and Lake 2006; Wheatley and Gillings 2002). The most crucial element that is needed for calculating viewsheds is a Digital Elevation Model (DEM). In short, this model illustrates the elevation of all the cells in the case-study area in a raster.

There are three types of viewsheds: the single viewshed, the total viewshed, and the cumulative viewshed (Conolly and Lake 2006; Wheatley and Gillings 2002). The differences between these three types of viewsheds will be explained later on, but before an appropriate definition of what a viewshed actually needs to be given. For this thesis, only multiple viewsheds are used, but the differences between the above named viewsheds are discussed first.

A definition given by Conolly and Lake (2006, 300) of a viewshed is a set of locations that are intervisible from a given viewpoint. In other words, it is a set of target points that are visible from an observation point (Brugmans *et al.* forthcoming 2017). The GIS calculates sightlines from the observation point in a DEM, and then it provides an overview of all the cells that are visible from a particular location in the landscape. The output is a binary map that shows all the visible and non-visible in the chosen area.

3.3.1 Different types of viewsheds

As mentioned above, there are three types of viewsheds—a single viewshed, the total viewshed, and the cumulative viewshed. The differences between these types of viewshed are evaluated in order to discuss their possibilities and limitations.

As already discussed above, the single viewshed calculates all visible target points from an observation point within a specific or non-specific range. The cumulative viewshed is a method that was first mentioned by Wheatley (1995) and uses map algebra in order to combine viewsheds from multiple sites or observation points in a landscape. The binary viewsheds maps from multiple observation points are summed up and then converted into a map that shows what cells are visible from a certain number of observation points. For instance, if there are 4 sites in an area, the values of the cumulative viewshed can range from 0 to 4, since raster cells can be visible from a maximum 4 sites in this case (Conolly and Lake 2006; Wheatley and Gillings 2002).

A total viewshed, a concept that was developed by Llobera (2003), on the other hand, is a tool in which each cell in a DEM is considered as an observation point. The tool thus provides an overview of all the visible cells in a landscape and the values of the cells range from zero to a maximum of the total amount of cells in an area. However, it is unlikely that this maximum number of visible cells will be reached, since there are always invisible places in a natural landscape (Brughmans *et al.* forthcoming 2017; Conolly and Lake 2006).

Considering the relatively small size of the case-study area and the relatively high amount of sites, multiple viewsheds will be used in this study. By carrying out viewsheds from the sites (n=44) in the case-study area, it is already possible to reconstruct the places in the case-study area with a higher visibility, without the use of a total viewshed. Even more since the geomorphology of the landscape that might influence visibility is relatively easy to understand in the case-study area, namely their area consists of a coastal zone, followed by a lowland plain with some hills, followed by the Cordillera Septentrional mountain range with another valley behind. Obviously, the mountain range provides places that allow a better view than places that are located in the lowland valleys.

3.3.2 Limitations in visibility analyses

However, there are more problematic issues in visibility analyses, including the reconstruction of palaeovegetation. Visibility calculated by a viewshed can either be different from real life view, due to challenges on a computational, experimental, substantive, and theoretical level that all manipulate and affect the outcome of a viewshed in their own way (Conolly and Lake 2006, 228-33).

To give an example on a computational level, the viewsheds outcome might be slightly different, when the algorithm that calculates the viewshed varies per different software.

On an experimental level there are more issues that need attention. One is the edge effect. Viewsheds are mostly taken with a specific radius. When viewsheds are taken from viewpoints that are situated in proximity to the edge of the DEM of the case-study area, it is possible that the viewsheds from viewpoints close to edge are artificially truncated because the chosen range is wider then the distance to the edge. This makes it harder to compare with viewsheds from viewpoints that are not located close to the edge. Therefore, it is useful to create a buffer around the edge of the DEM that has the same range as the maximum visibility range used during the analyses (Conolly and Lake 2006, 229). However, in the case of the case-study area, it is useless to create a buffer around the edge of the DEM, since the DEM is adjacent to the sea and thus lacks reliable elevation data from one side. This leads to another problem, namely the DEM's resolution.

Visibility tools are strongly interdependent on elevation, such as peaks and crests, and an inaccurate DEM can create problems. It is important to note the resolution of the DEM, and to keep in mind that a model is not always a perfect reflection of reality (Conolly and Lake 2006, 230).

Maybe, one of the most important problems in visibility analyses are the substantive issues. In short, all the parameters those are included during the analyses. An important example deals with palaeoenvironment and palaeovegetation. The data that is used for identifying viewsheds is current data and might not be an accurate representation of the past environment. However, it is unlikely that many major modifications occurred throughout the last millennium regarding to elevation in the landscape, but it is important to be aware off.

A larger and more relevant problem in visibility analyses is including palaeovegetation as a parameter in visibility analyses. Vegetation is even more manipulative to view than elevation. It is obvious that high trees and shrubs can block views, but it is difficult to compensate for vegetation in a model because of two factors. Vegetation has the ability to change quickly over the years, especially in a human manipulated environment, and the consequences of vegetation on visibility are also season dependent. There are certain ways to compensate for vegetation in the analyses, by either putting in a "tree-factor", which is a constant variable that combine the effect of vegetation on view, or by adding the average height of the vegetation onto the digital elevation model (Conolly and Lake 2006, 231). However, both solutions are still based on the assumption that vegetation is a constant, unchanging phenomenon, where in reality it does not have to be a restriction on view.

Llobera (2007) discussed another possibility to calculate visibility through vegetation. By combining the already existing Dean's Visual Permeability Method, in short, an algorithm that calculates the change that a line of sight has to survive when it interferes with vegetation, and physical laws, such as the Beer-Lambert's Attenuation Law that calculates the probable amount of photons that is able to pass trough materials, in order to calculate the possibility of seeing through vegetation. Homogenous vegetation can then be plotted on areas in a DEM where it is likely to have vegetation and then the visual depth can be calculated (Llobera 2007, 799-810). However, at the moment, it is only possible to calculate visibility through a single type of plant or tree with the same dimensions and densities, so this method needs more development before it can be used to model a realistic reflection of vegetation in visibility analyses. And even then, it is challenging to reconstruct the type of vegetation and its arrangement in a human influenced palaeoenvironment.

In this study, palaeovegetation will therefore not be taken into account because accurate methods are still lacking. Besides, the study area is currently not densely vegetated because the majority of the case-study area is arid to semi-arid. A more open landscape has a higher visibility rate, but the current environmental data might be misleading, since it can be changed over time, especially during the colonisation process when many new crops were introduced to this region. Therefore, the most accurate option is to base the viewshed on the digital elevation model, at the moment.

Lastly, there are some other factors that also influence the outcome of visibility analyses, such as contrast and the position and stature of the observer.

Contrast can be defined as how well distinctive objects are from their background. This of course depends on the colours of the objects, light conditions and atmospheric conditions. Objects or places with a high contrast are more visible over long distances and might thus represent public important places, while objects or places with a low contrast could be of a more intimate nature since they are only visible from a short distance.

The sunlight and weather conditions are also able to change contrast, and thus visibility. It is possible to calculate the maximum viewing distance under several conditions that change contrast and thus visibility, and predict the cells are always visible, and the cells that are only visible under specific conditions and how this changes throughout a certain period of time (Conolly and Lake 2006, 231-32). The concept of contrast will not be taken into detailed account in this study, since a detailed description of how the maximum view distance changes as a result of changing weather or light is absent. Based on other visibility research, the maximum view distance will be set on 10 kilometres, and the minimum view distance on 3 kilometres (Brughmans *et al.* forthcoming 2017; van Leusen 1998).

The final parameters that can be problematic in visibility analyses are the stature and position of the observer. Stature varies per person and therefore changes the offset from the ground, which can alter the view. In this study, an average height of 1,60 m is used as well, based on earlier research (Brughmans *et al.* forthcoming 2017). Humans as mobile agents have the ability to change their location from where they make visual observations. As they move through a landscape, they catch different viewsheds. During the survey, which was carried out by Herrera Malatesta (forthcoming) for his PhD research, the centroid coordinates are taken from the registered sites. The viewsheds in this thesis are thus only taken from a single point at the sites, namely the centroid points, and thus do not take the mobility of human agents into account.

The identified limitations are of course problematic, however, these cannot be used as an argument to not use visibility analyses in archaeology at all. As long as the consequences of used parameters and the limitations of the methods are discussed, it is possible to use viewsheds as a reliable method. In the future, more standardised methods need to be developed in order to create a standardised approach on visibility analyses, which makes it easier to compare visibility studies as well.

Chapter 4. Data

4.1 Data acquisition

The archaeological data were gathered during the summer 2014 and 2015 survey campaigns in the coastal area of Montecristi, Dominican Republic by Herrera Malatesta (forthcoming). Environmental data used in this thesis originated from the Atlas de la Biodiversidad y Recursos Naturales de la Republica Dominicana (Reyna Alcántara *et al.* 2012). A digital format of these data was provided to the Nexus 1492 group by the Ministerio de Medio Ambiente y de los Recursos Naturales. The raster digital elevation model used in this thesis, was distributed under an open source license and developed by the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) on behalf of NASA and the Japanese Ministery of Economy, Trade and Industry that developed a Global Digital Elevation Model (GDEM). The second version of the model (GDEM2) was used (released in 2011). The resolution of GDEM2 is 15 m with an accuracy ranging from 7 to 15 m (http://www.jspacesystems.or.jp/ersdac/GDEM/ver2Validation/Summary_GDEM2_validation_report_final.pdf). The DEM coordinates and other analysed spatial data are derived from the UTM 19 North projection and WGS84 world geodetic system. ESRI's ArcGIS version 10.4.1 was used in the analysis of all spatial data.

More then 300 archaeological sites were identified in regional surveys of Montecristi, Puerto Plata, and northern Haiti (Hofman *et al.* forthcoming 2017). Goals of Herrera Malatesta's survey in the coastal zone of Montecristi were to assess archaeological data and early map and written accounts for northern Hispaniola regarding post-AD 1492 landscape transformations (Herrera Malatesta, forthcoming).

4.2 The definition of the case-study area

The case-study area was selected on the basis of four criteria:

1. Site density. In total, 102 sites were recorded in the Montecristi survey (Herrera Malatesta forthcoming). Of these, 44 sites (43%) were selected for analysis based on the remaining study-area criteria (fig. 4).
2. Chronology. Three of the sites were radiocarbon dated to the proto-historic/Contact period, the time frame of interest for the current study. Excavated shells from Sites MC-32, MC-44, and MC-47 produced date ranges of AD 1270–1335, AD 1245–1440, and AD 1420–1485, respectively (fig 5). Many of the other sites within the case-study area may also date to this time frame.
3. Topography. The coastal area with its beaches and mangroves border the hills and mountains of the Cordillera Septentrional. These diverse habitats represent a wide range of marine, coastal, and interior resources available to the inhabitants. Further, the higher elevations of the hills and mountains allow for visual control over the various landforms and associated resources.
4. Site size. There are four sites located in the case-study area that are each larger than 3 ha. These sites are assumed to have a greater regional impact and thus are interesting to include them in the visibility analyses.

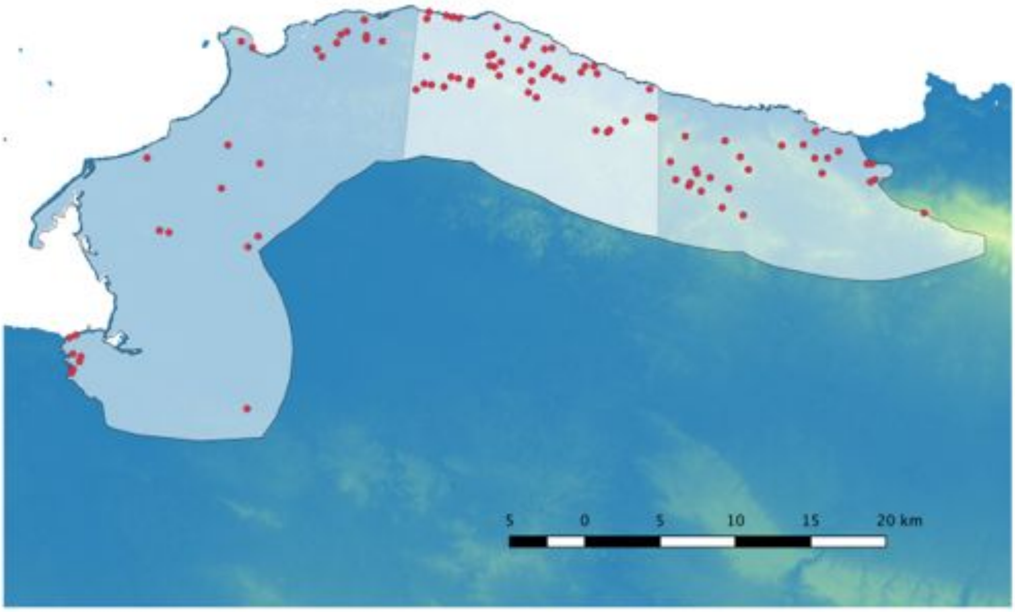

Figure 4: Overview of the case-study area (after Herrera Malatesta forthcoming).

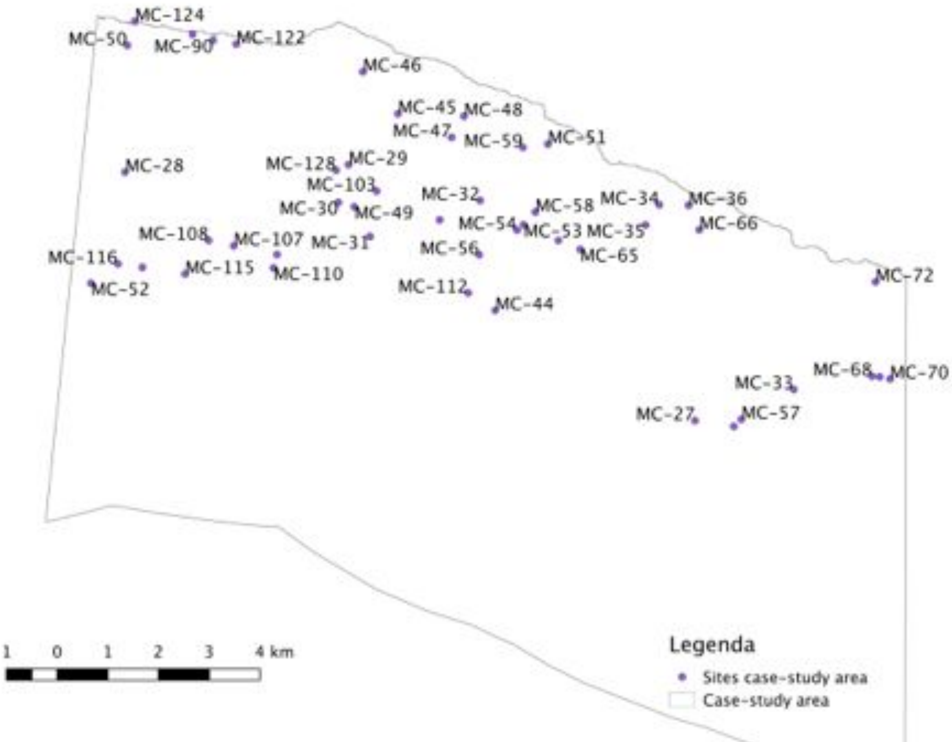

Figure 5: Overview of the sites with site names (courtesy of Herrera Malatesta forthcoming).

4.3 Site classification by size and material culture

Herrera Malatesta (forthcoming) assessed the Montecristi sites in terms of human use of space and human-environment relations. In addition, he proposed a distinction between marine-resource exploitation and habitation sites (fig 6). The small sites in the region, especially those located near the sea, were primarily used for marine-resource extraction. The surfaces of these sites produced numerous marine shells, occasional stone tools, and little to no ceramics. At the larger sites, larger then three hectares, also many marine shell remains were found, but then a greater variety of species, together with a large quantity of ceramics, lithic artefacts and bone and shell ornaments.

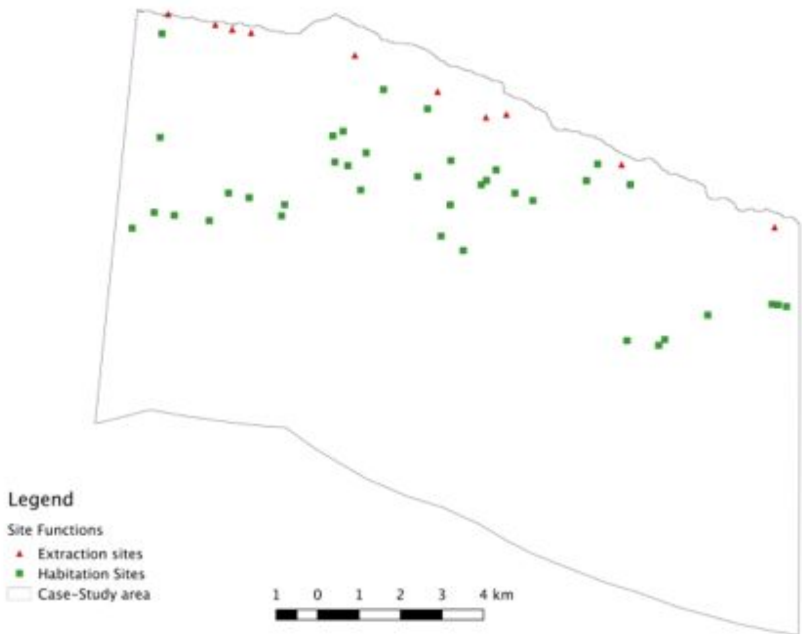

Figure 6: Function of sites (courtesy of Herrera Malatesta forthcoming).

The ceramics that was found mostly resembles the Meillacoid series, but at some sites also Chicoid ceramics were found (Ulloa Hung and Herrera Malatesta 2015, 95).

Since only a few sites underwent absolute dating, it is important to look at the ceramic sequence in order to date the sites relatively. To create a better understanding of the spatial distribution of the different types of ceramics, the different ceramic types are plotted as a pie chart together with the sites in a map (fig 7). As can be seen in the map, for 34 % of the sites (n=15), it is unknown what kind of ceramics is present, since they are not encountered during the survey. Another remarkable and important aspect is that at 14 % of the sites (n=6) there were no ceramics registered. This coincides with the sites that are only used for the extraction of marine resources. The distribution map also shows that the Meillacoid series are the predominant ceramic series in the case study area, with 52 % (n=23) of the total amount of sites. There are some other sites with the presence of ceramic groups such as mixed Meillacoid and Chicoid, but these series only occur in combination with the Meillacoid ceramics, so until a more detailed chronology of the sites is available, the sites will be considered as Meillacoid in the analyses.

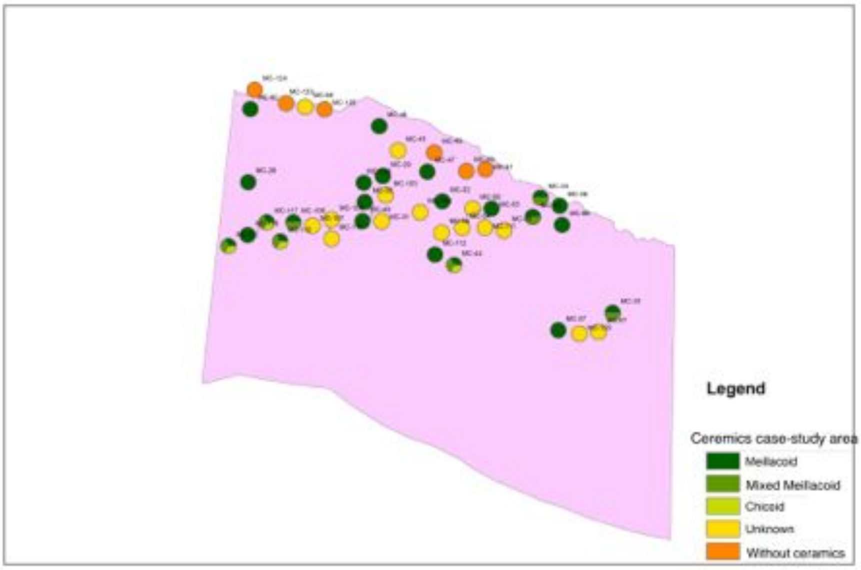

Figure 7: Distribution of the ceramics series in the case-study area (courtesy of Herrera Malatesta forthcoming).

Chapter 5. Results

By carrying out a viewshed from all the sites in the case-study area, it became clear that a very large part of the case-study area was visible from each site. Many sites are located in areas with a wide viewshed that provides with a high possible inter-visibility. However, in order to better understand this visual prominence and the relationship between the viewsheds of the different sites in the case-study area, it is relevant to divide the sites into different categories that might change their visibility.

Based on the available survey data, two factors can be extracted that influence view, namely elevation and size. Elevation is an obvious factor as visibility generally improves by an ascending altitude. Another important parameter that can be used is the size of a site in square meters, since it is plausible that larger sites have a higher regional impact than smaller sites, which can alter visibility patterns.

Size and elevation are also interdependent on each other; because the size of a site is expected to decrease by an increasing elevation, since the potential suitable amount of territory available for land use decreases moving higher up a mountain.

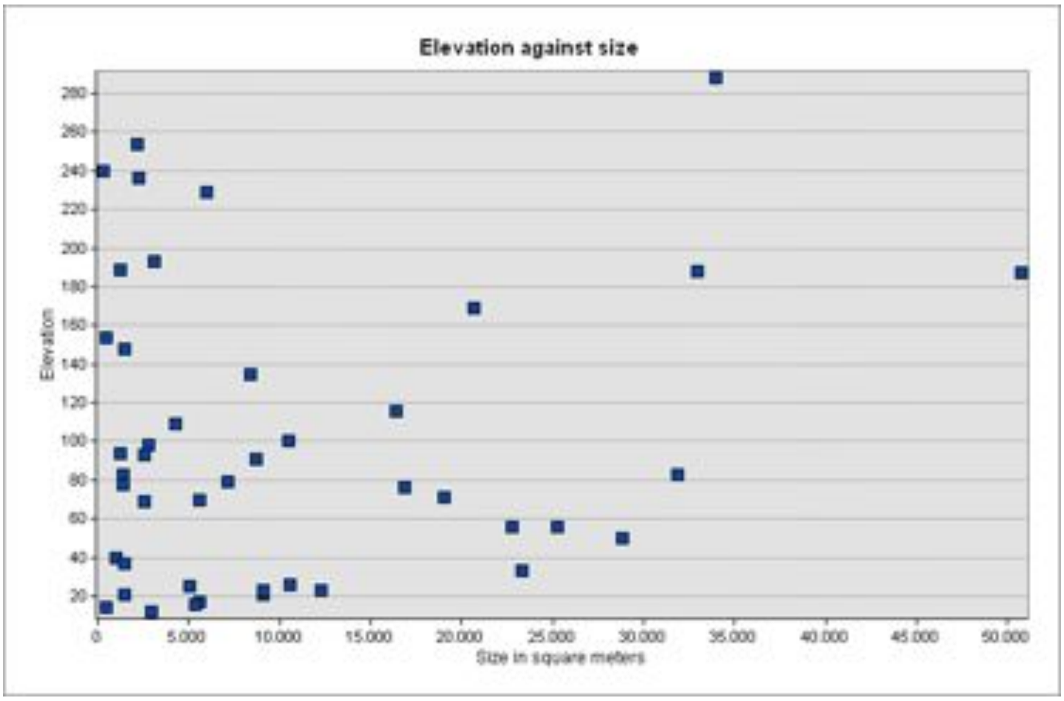

Figure 8: Scatterplot elevation against size.

Code	East	North	Elevation	Area (square meters)
MC-27	246.325.096.673	219.493.172.148	188	32.976.785.964
MC-57	247.239.375.676	219.494.457.682	189	1.217.319.093
MC-125	247.089.728.704	219.480.063.441	193	308.773.299
MC-33	248.282.444.329	219.555.404.989	288	33.955.741.075
MC-72	249.925.624.195	219.777.070.832	22	7.945.086.874
MC-67	249.983.963.336	219.579.095.701	235	5.542.554.558
MC-68	249.833.081.004	219.580.805.493	222	4.343.719.485
MC-70	2.501.841.647	219.574.431.105	217	3.031.772.697
MC-66	246.464.080.358	219.890.563.602	26	10.554.692.858
MC-36	24.626.127.082	219.942.078.932	12	2.949.145.893
MC-34	245.684.624.677	219.943.994.837	33	23.301.037.865
MC-35	245.406.442.813	219.902.258.914	50	28.827.683.873
MC-65	244.109.653.552	219.853.265.649	69	2.600.124.733
MC-111	24.368.176.146	219.872.603.741	70	5.628.861.504
MC-44	242.412.027.762	219.728.465.832	187	50.740.713.881
MC-112	241.884.033.722	219.765.903.819	169	20.708.994.291
MC-56	242.115.245.267	219.845.076.136	236	2.242.500.005
MC-54	242.869.414.744	219.895.307.914	83	1.387.062.796
MC-53	243.000.081.684	219.906.297.318	78	1.425.028.052
MC-58	243.233.804.675	21.993.236.591	56	22.766.596.343
MC-32	242.148.731.066	219.957.998.523	56	25.290.153.522
MC-104	241.345.649.659	219.918.665.569	154	489.778.575
MC-31	239.964.524.393	219.886.106.151	135	8.414.520.357
MC-47	241.605.192.766	220.090.467.313	40	100.091.731
MC-48	241.855.469.339	220.134.282.851	17	5.609.505.227
MC-45	240.552.282.573	220.141.113.344	98	2.811.006.126
MC-46	23.987.403.124	220.229.743.565	23	12.258.640.319
MC-103	240.107.576.352	219.980.699.743	79	7.141.289.012

MC-49	239.664.316.752	219.948.489.476	94	1.217.196.585
MC-30	239.350.191.622	219.958.220.357	109	4.299.158.744
MC-109	238124.03	2.198.514.938	240	31.256.672
MC-110	238.049.051.425	219.823.515.061	148	1.506.467.227
MC-107	237.271.814.273	219.870.566.095	254	2.158.557.465
MC-108	236.777.950.635	219.882.863.883	229	5.957.785.213
MC-115	236.302.977.585	219.813.408.546	116	16.404.543.635
MC-117	235.462.658.615	219.828.439.893	100	10.474.756.333
MC-116	234.980.996.488	219.836.428.544	93	2.567.036.612
MC-52	234.441.484.349	219.797.016.686	76	16.889.817.851
MC-28	235.149.903.962	220.027.462.271	91	8.717.955.384
MC-122	237.384.043.857	220.291.066.578	21	1.446.798.614
MC-90	236.928.748.605	220.299.776.569	25	5.085.562.209
MC-123	236.524.333.945	220.312.896.282	21	9.064.469.504
MC-124	235.392.197.055	220.341.216.768	14	504.008.064
MC-50	23.523.412.827	220.291.599.114	37	1.506.757.046
MC-51	24.350.362.445	220.073.781.135	16	5.332.029.313
MC-59	243.010.037.892	220.067.421.866	23	9.081.174.356
MC-29	239.563.741.628	220.036.520.079	83	31.879.229.025
MC-128	239.313.944.638	22.002.515.218	71	19.048.257.183

Table 1: Data on which the scatterplot is based on (courtesy of Herrera Malatesta forthcoming).

To stress the relationship between elevation and size, a scatterplot was made with on the y-axis the elevation and on the x-axis the area in square meters (fig 8; tab 1). The expected curve representing the association between these values would start in the upper right corner corresponding to high elevation values and a small settlement size, and curves downwards towards the lower left corner where it reach a low elevation value with a large size. The majority of the sites fit in this pattern, however there are two remarkable exceptions. In the case-study area there are sites present at a low elevation with a small size, but this can be explained by the presence of extraction sites along the coast. These sites are only used for a specific purpose, namely the extraction of marine resources. On the other hand there are large sites situated on hilltops. This is remarkable since the largest sites in the case-study area are located on the highest elevation. Considering the potential limited space on hilltops, there could be other reasons involved for choosing this specific settlement location, such as a wider viewshed.

The sites were thus reclassified into six categories considering size and elevation. For size the sites were classified into small (less then 1 hectares, medium (between 1 and 3 hectares) and large (more then 3 hectares) and for elevation the sites were classified into low (less then 56 meters), medium (between 56 and 154 meters) and large (more than 154 meters). The sites are classified by using the same size classification as Herrera Malatesta (forthcoming) in his PhD thesis and for elevation the classes were calculated in ArcGIS through natural breaks.

In total 20 viewsheds were taken from various sites. To create a general impression of the visibility patterns in the case-study area, viewsheds are taken for every category. So viewsheds are taken for low, middle and high elevation and small, medium and large sites. In these analyses sites with no ceramics and sites with unknown ceramic series are included. To see whether the visibility patterns will be different within sites with little additional data the analyses are repeated for the Meillacoid and extraction sites. The general visibility patterns can then be compared with visibility patterns from Meillacoid and extraction sites to see whether there are significant differences in the visibility patterns. All the viewsheds are calculated with the visibility tool in ArcGIS, which calculates viewsheds from multiple points. For instance, the viewshed that is taken for the high elevation sites is taken from all the sites with a high elevation. This thus does not mean that the visible areas can be seen from all the high elevation sites, since multiple viewsheds consist of visible areas from multiple points. To make a more structured description of the visibility patterns, the case-study area can be divided into four zones. Starting from the coast the case-study area can be divided into the coastal zone, which is the border between land and sea, the coastal lowland, the mountains of the Cordillera Septentrional and the hinterland.

5.1.1 Visibility from the high elevation sites

Obviously the high elevation sites have a very wide viewshed that provides a view over a specific area of the centre of the coastal line within the case-study area, and also the coastal lowland located further inland (fig 9). Many mountain peaks of the Cordillera Septentrional are also visible. However, this may be biased since this viewshed was taken from these peaks as well. The hinterland is also very visible from these viewpoints but there are so far no sites recorded in this area. From the high sites it is possible to view other high sites of various sizes, but also middle and low elevation sites of various sizes in the coastal lowland and coastal zone alongside some extraction sites.

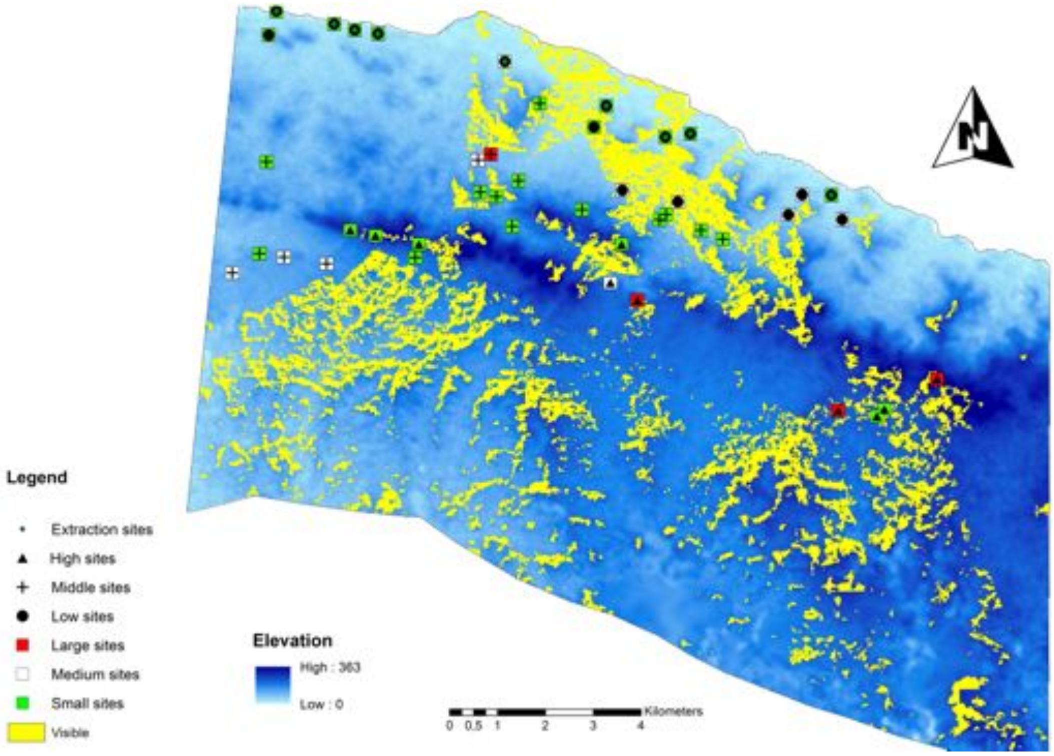

Figure 9: Visibility high elevation sites.

5.1.2 Visibility from the middle elevation sites

The middle elevation sites (fig 10) have a predominant view over the coastal lowland area. Similar to the high elevations sites a very specific area of the coastal zone is visible. In general the middle elevation sites have a better view of the mountain peaks of the Cordillera Septentrional and little to no view of the hinterland. Since the middle elevation sites are more situated in the coastal lowland zone, it is possible to view other middle and low elevation sites as well as extraction sites in the area of various sizes, but they also have to possibility to view small hilltop sites in the Cordillera and one large hilltop site in the area.

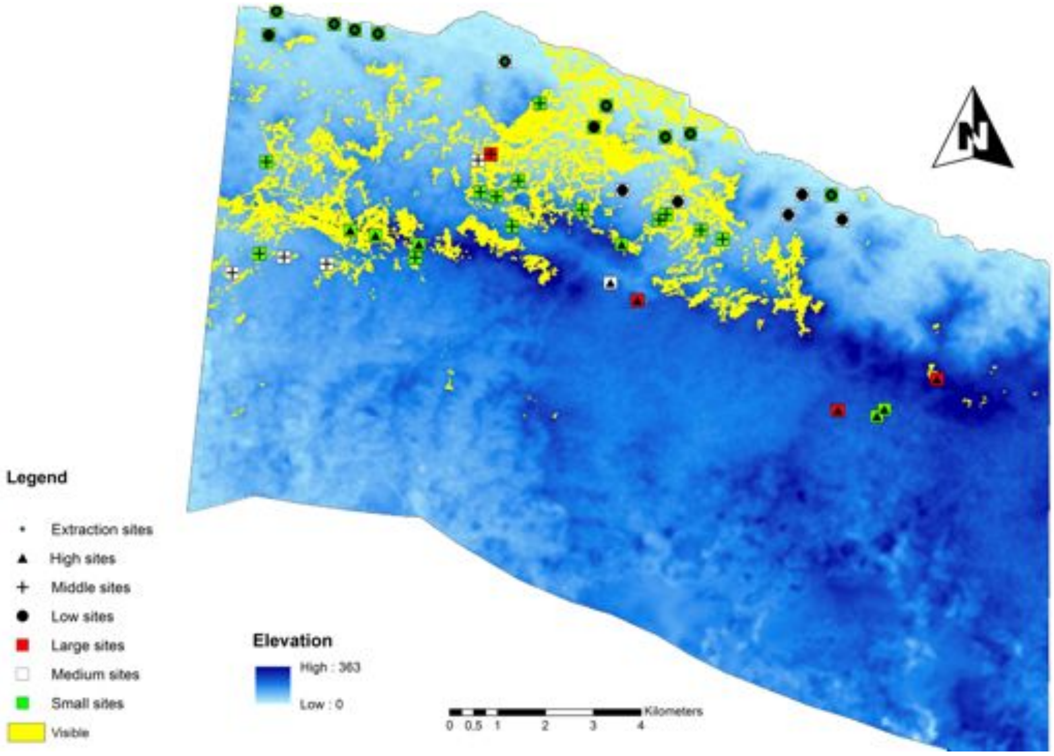

Figure 10: Visibility middle elevation sites.

5.1.3 Visibility from the low elevation sites

The low elevation sites (fig 11) provide views over the coastal zone but with a different focus then the middle and high elevation sites. Predominantly the view of the low elevation sites is clustered in the central area of the coastal lowland area and a few hilltops of the Cordillera are also visible. The low elevation sites provide a good view over middle and low elevation sites of various sizes in the coastal lowland area and to some small, medium and one high elevation site in the Cordillera Septentrional.

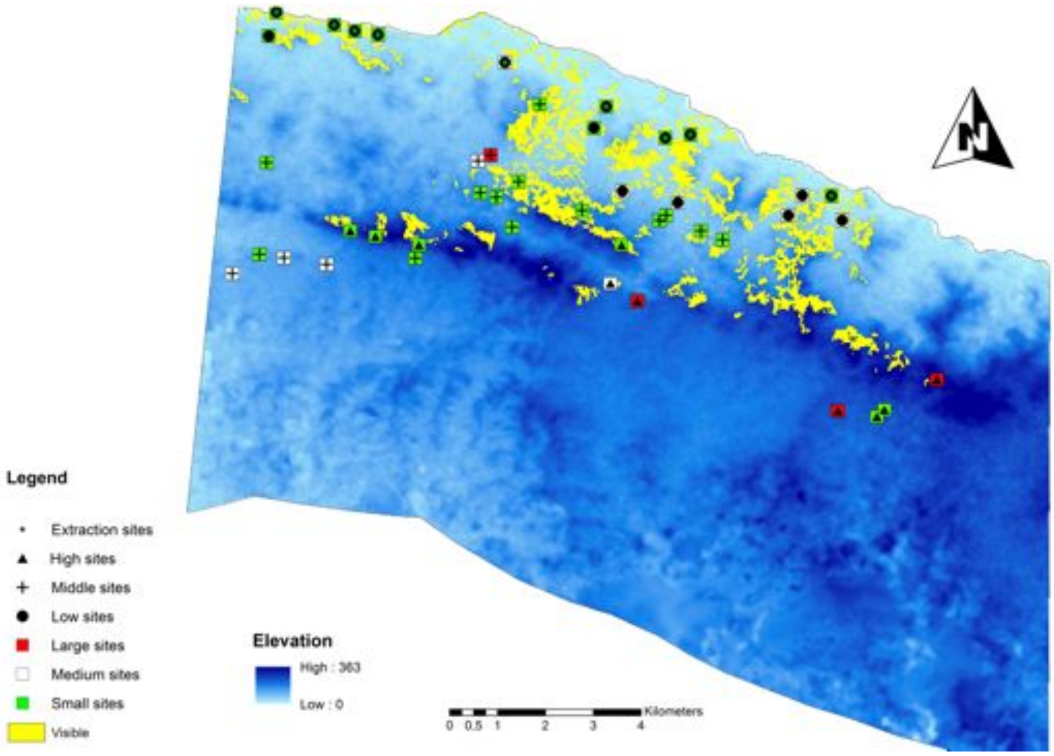

Figure 11: Visibility low elevation sites.

5.1.4 Visibility from the large size sites

Since the large sites (fig 12) are expected in the low areas the viewshed has some similarities with the viewshed of the low elevation sites. However as aforementioned the large sites, which are located on hilltops, have many differences as well. The large sites do not have any view of the coastal zone. There is one large site that is situated in the coastal lowland area, which provides a view over several spots, and small and medium sites of various altitudes in the lowland area, while the large sites on the hilltops of the Cordillera provide view over the hinterland and other hilltop sites of the Cordillera.

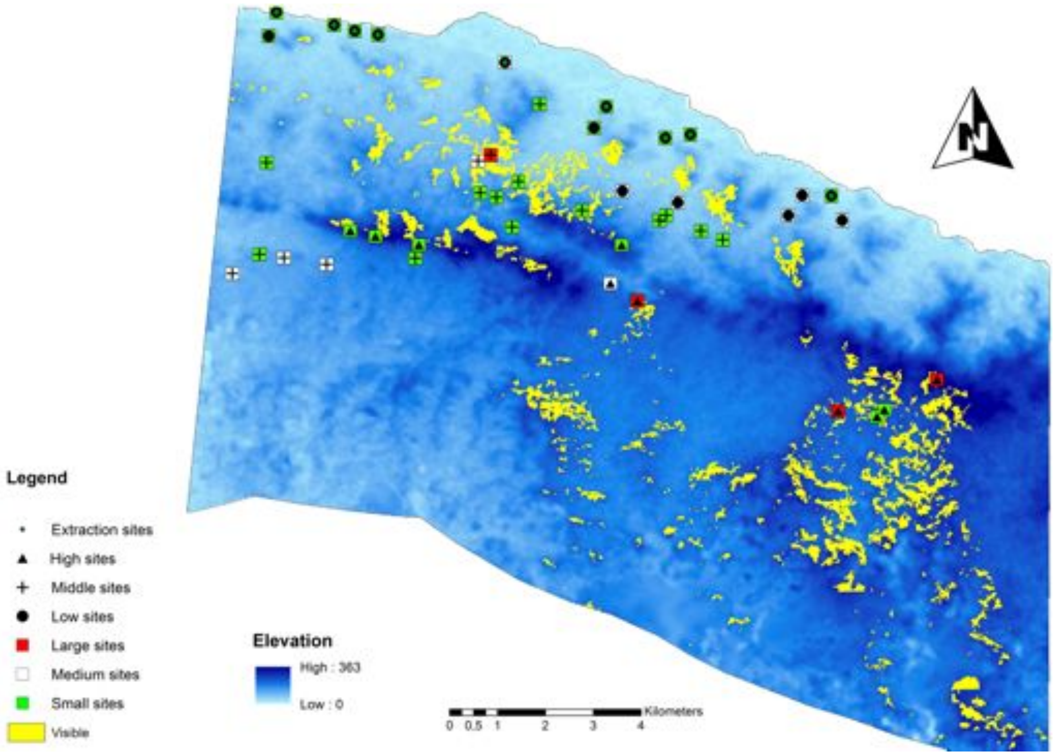

Figure 12: Visibility large sites

5.1.5 Visibility from medium size sites

The medium size sites (fig 13) have a rather restricted view that is focussed on small, medium and large sites in the coastal lowland area and their surrounding valleys. From these sites the small hilltop sites in the western part of the Cordillera are also visible.

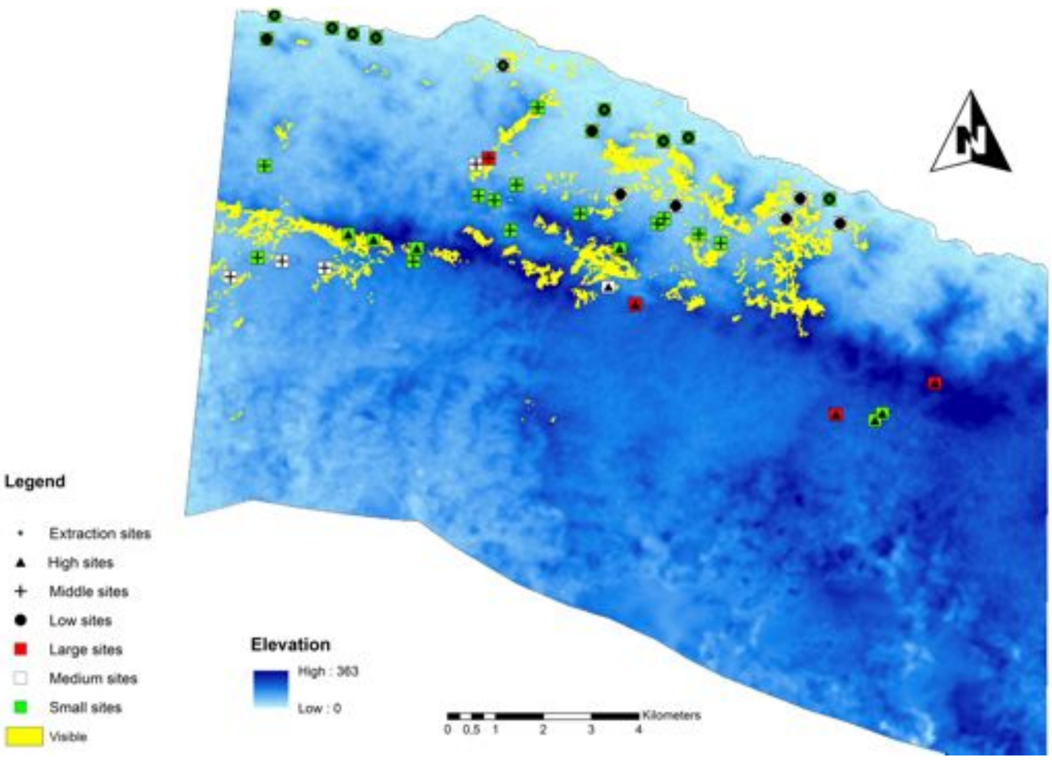

Figure 13: Visibility medium sites.

5.1.6 Visibility from the small size sites

Since the small sites (fig 14) are both located in the coastal zone, the coastal lowland area and the Cordillera, the small sites have the most extensive visibility of all processed viewsheds. They have view of the coastal zone, the coastal lowlands, the hilltops of the Cordillera and the hinterland. From small sites it is possible to view other small, medium and large sites that are situated in close proximity of the small sites.

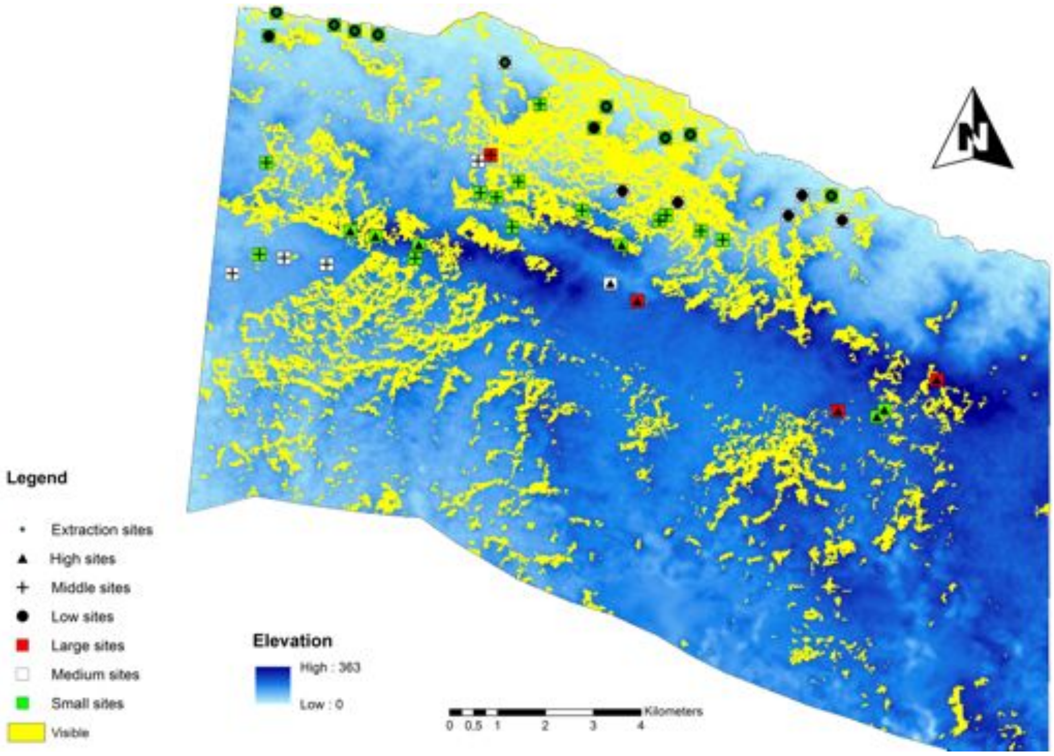

Figure 14: Visibility from the small sites.

5.1.7 Visibility from the high-elevated Meillacoid sites

Having discussed the general patterns of visibility for all the sites in the case-study area, the viewsheds will be refined to only the Meillacoid sites in the area. The major differences between the general visibility patters and the Meillacoid visibility patterns will be discussed in the discussion part of this thesis.

The high-elevated Meillacoid sites (fig 15) provide view over a very few hilltops in the Cordillera, but the view is predominantly focussed on the hinterland. It is remarkable that the coastal zone and the coastal lowlands are not visible from the high-elevated Meillacoid sites. There is also very little view over other sites, but there are only some hilltop sites visible.

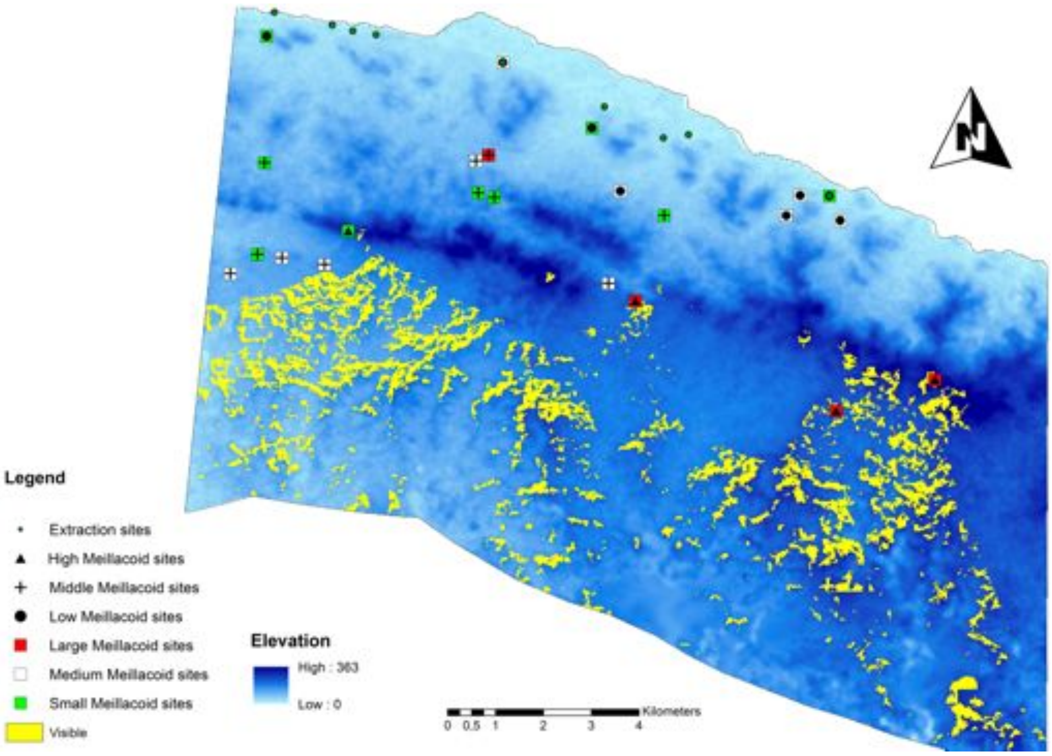

Figure 15: Visibility from the high Meillacoid sites.

5.1.8 Visibility from the middle-elevated Meillacoid sites

The middle-elevated Meillacoid (fig 16) sites have a restricted view on the coastal zone but the coastal lowland area is visible together with some hilltops in the western and central part of the Cordillera in the case-study area. From the middle-elevated Meillacoid sites, other middle and low elevated Meillacoid sites are visible of various sizes in the coastal lowlands and the Cordillera.

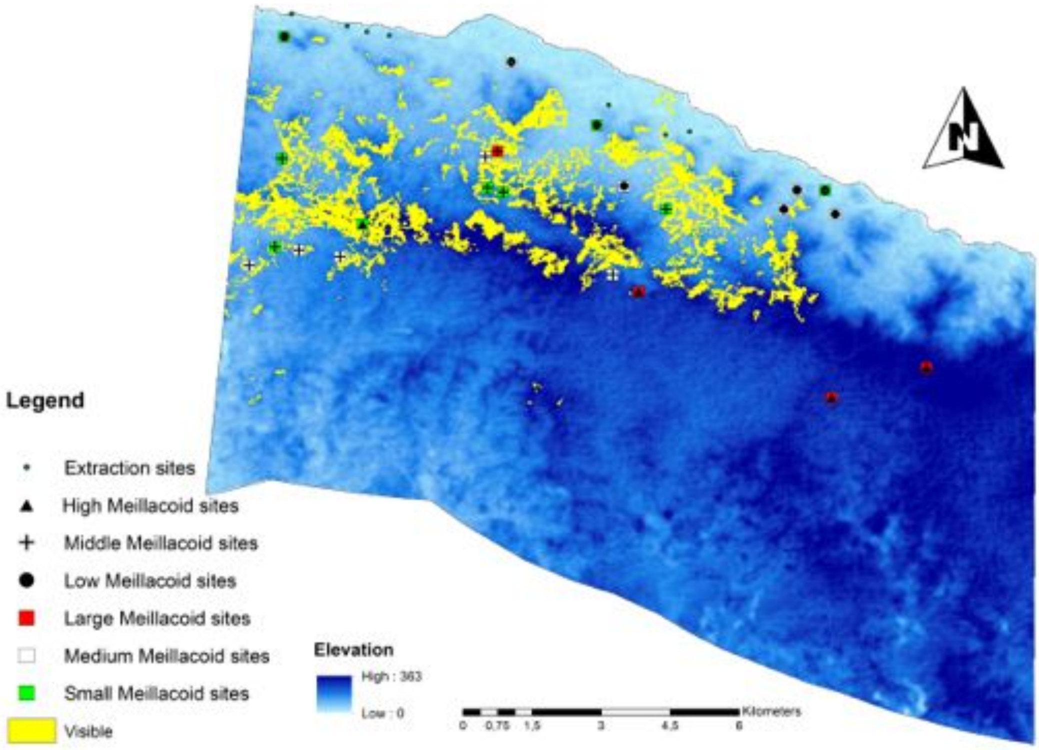

Figure 16: Visibility middle Meillacoid sites.

5.1.9 Visibility from the low-elevated Meillacoid sites

The visibility patterns of the low-elevated Meillacoid (fig 17) sites are very similar to the visibility patterns of all the low elevation sites in the case-study area. The predominant view is centred on the central part of the coastal lowland zone combined with a view on some specific hilltops of the Cordillera. From the low-elevated Meillacoid sites it is possible to see surrounding extraction sites in the coastal lowland zone, other Meillacoid sites in the coastal lowland zone of various sizes, elevations, and to see some hilltops sites in the Cordillera.

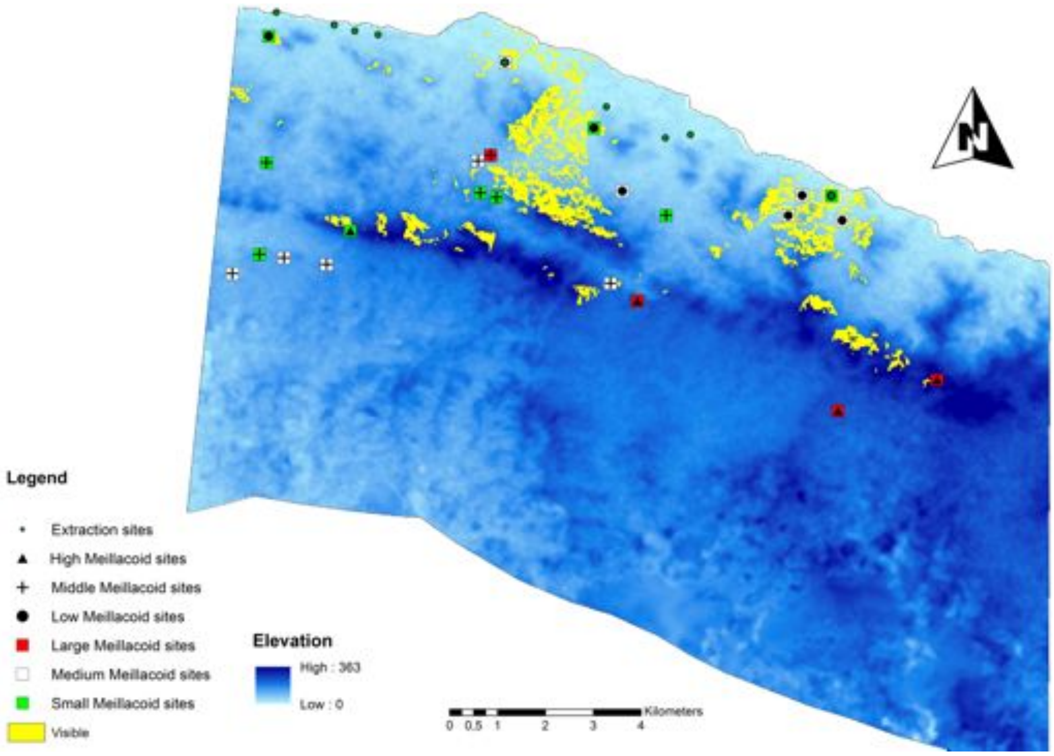

Figure 17: Visibility low Meillacoid sites.

5.1.10 Visibility from the large sized Meillacoid sites

The visibility patterns of the large sized Meillacoid sites are exactly the same as the visibility patterns of the large sites in the entire area, since all the large sites in the case-study area are Meillacoid sites (fig 12).

5.1.11 Visibility from the medium sized Meillacoid sites

The visibility patterns of the medium sized Meillacoid sites (fig 18) are very similar to the general visibility patterns of the medium sized sites. However there are very small differences. The medium sized Meillacoid sites do have a more restricted view on some hilltops of the Cordillera.

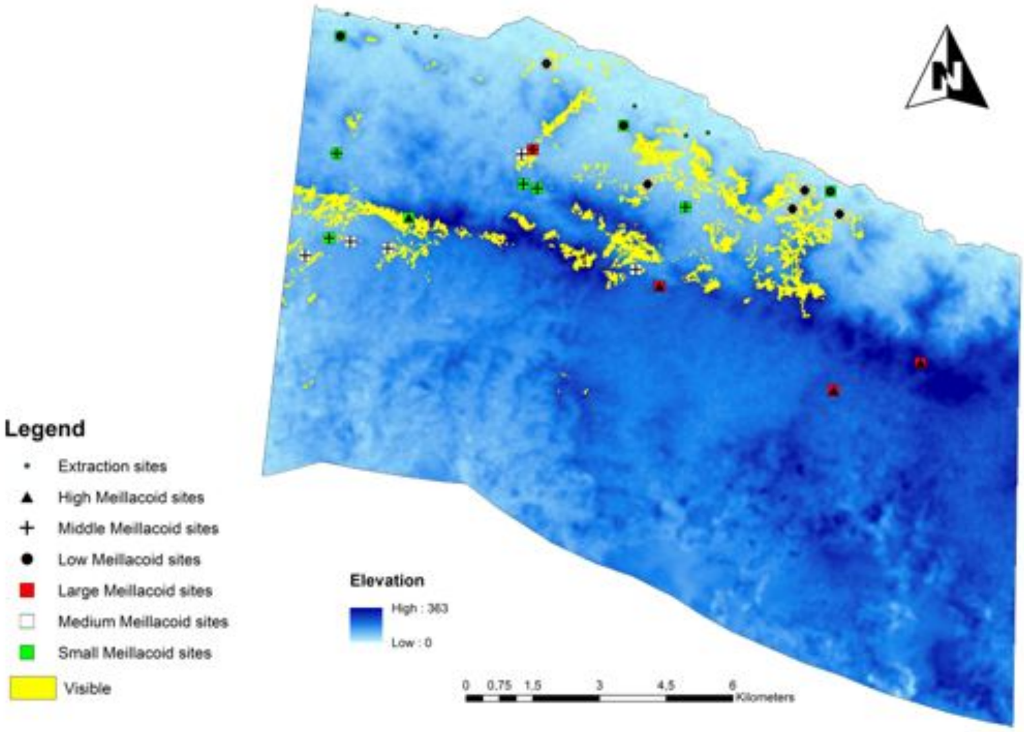

Figure 18: Visibility medium Meillacoid sites.

5.1.12 Visibility from the small sized Meillacoid sites

The small sized Meillacoid sites (fig 19) have a more restricted view on the coastal zone then the general pattern of small sites, because extraction sites are now excluded from the viewshed. The small sized Meillacoid sites have either an extent view on the coastal lowlands and the hinterland. The view on the coastal lowland area is however more restricted on the valleys in the case-study area and the view is more clustered and divided over areas as compared to the general pattern of small sites. The hilltops of the Cordillera are also well visible. From the small sized Meillacoid sites it is possible to view other small and medium sized Meillacoid sites, but also extraction sites in the coastal lowland area, but the large sites on the hilltops of the Cordillera are more hidden.

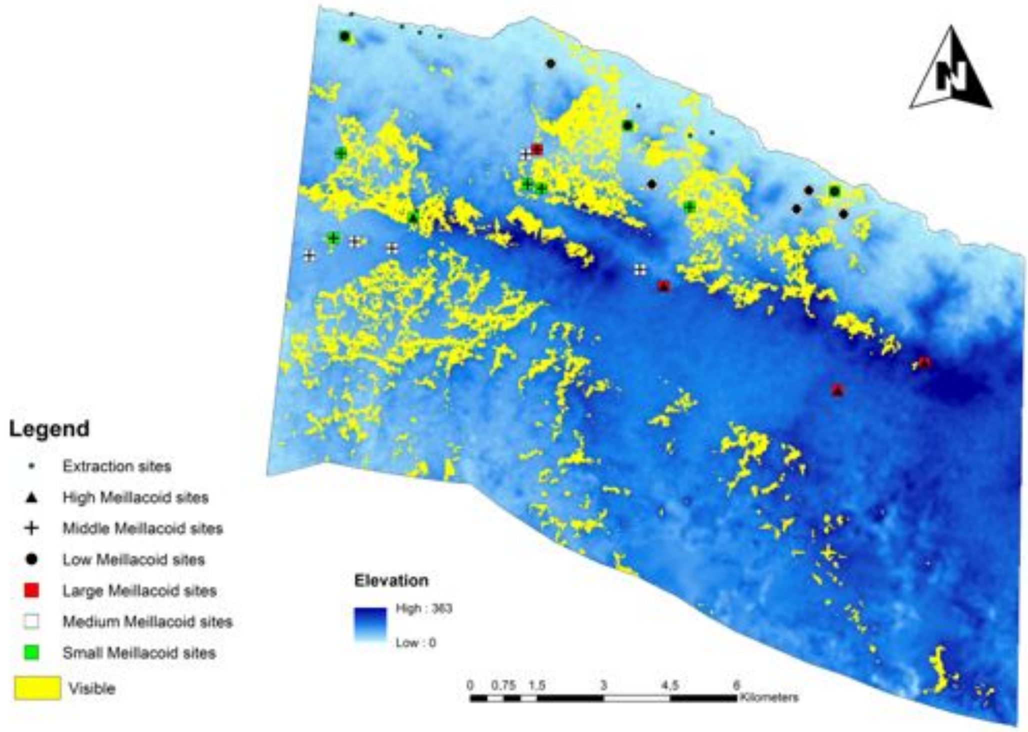

Figure 19: Visibility small Meillacoid sites.

5.2.1 Minimum view range from the Meillacoid sites

The previous viewsheds were all carried out with a view range of 10 kilometres. However, these perfect view conditions are not always achieved so, for the Meillacoid sites there were also some viewsheds carried out with a minimum view range of 3 kilometres in order to see whether there are important changes in the visibility patterns. Only the relevant changes are discussed and these affect only the viewsheds that were taken from the middle and low elevation Meillacoid sites.

5.2.2 Minimum visibility from middle-elevated Meillacoid sites

The major changes in view from the middle-elevated Meillacoid (fig 20) sites are that the view on the coastal lowland areas are more restricted. Only the hilltops and hilltop sites in the western part of the Cordillera remain well visible, together with some small areas in the coastal lowland area together with a few middle and low-elevation Meillacoid sites that are situated over there.

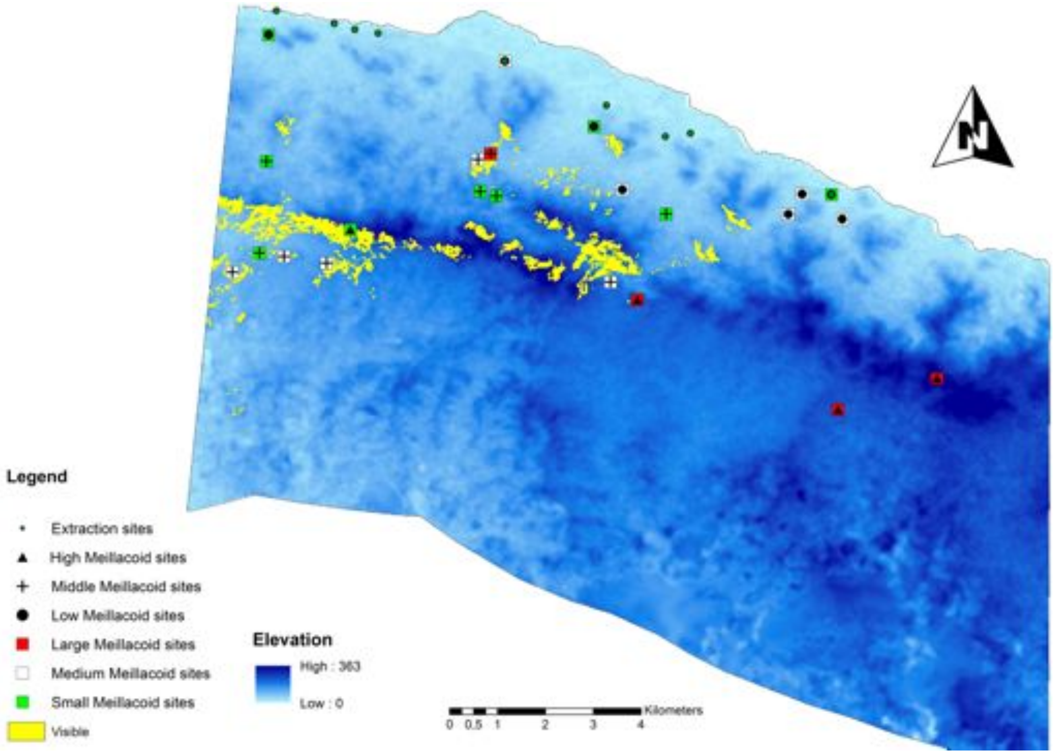

Figure 20: Minimum visibility middle Meillacoid elevation.

5.2.3 Minimum visibility form low-elevated Meillacoid sites

The major changes in view from the low-elevation Meillacoid sites (fig 21) are that the view on the hilltops and hilltop sites disappears. Also a smaller area in the coastal lowland remained visible and is mostly clustered around the low-elevation Meillacoid sites of different sizes. It is thus only possible to view other low-elevation Meillacoid sites together with some extraction sites. Another major change it that the large sites in the area are not visible from the low-elevation Meillacoid sites with this limited view range.

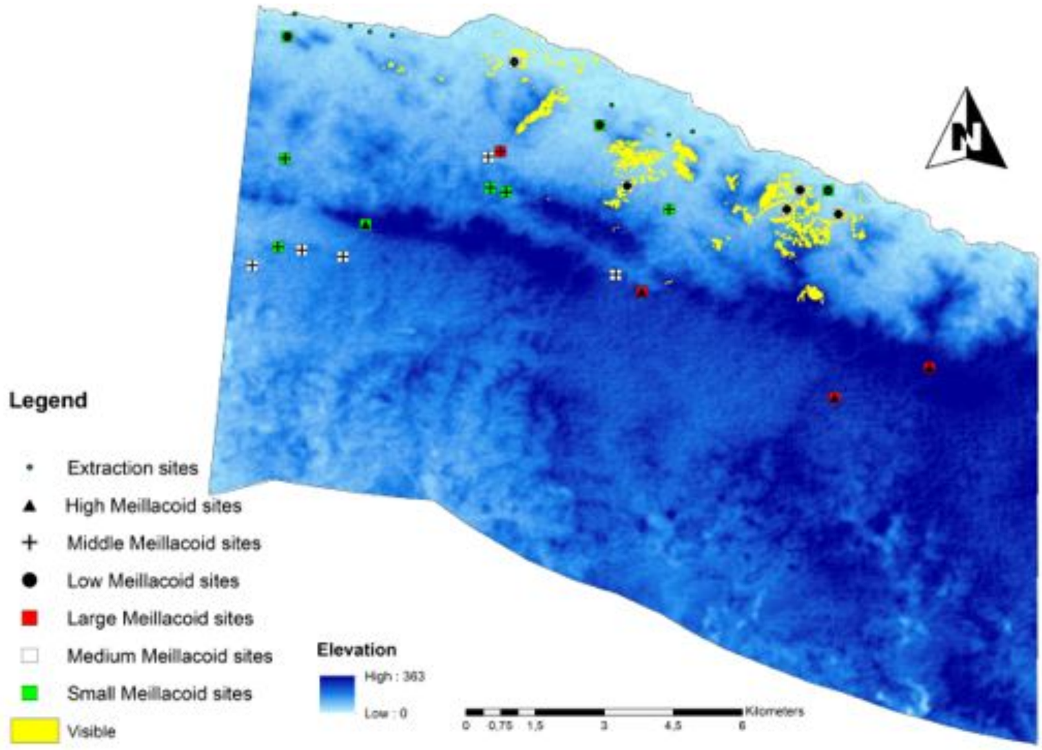

Figure 21: Minimum visibility low Meillacoid elevation.

5.3.1 Visibility from the extraction sites

Lastly there were two viewsheds taken from the extraction sites, one with the maximum view range of 10 kilometres (fig 22) and one with the minimum view range of 3 kilometres (fig 23). The viewshed with the maximum view range shows that the extraction sites have views of the coastal zone, some areas in the coastal lowlands and on the flanks of some of the hilltops of the Cordillera. From the extraction sites it is possible to view other extraction sites and some of the low-elevated Meillacoid sites, and even to see the large and high-elevation Meillacoid site on the east side of the case-study area. However the view on the minimum circumstances drastically reduce the visibility condition and only an area around a medium-sized-low-elevated Meillacoid site remains visible.

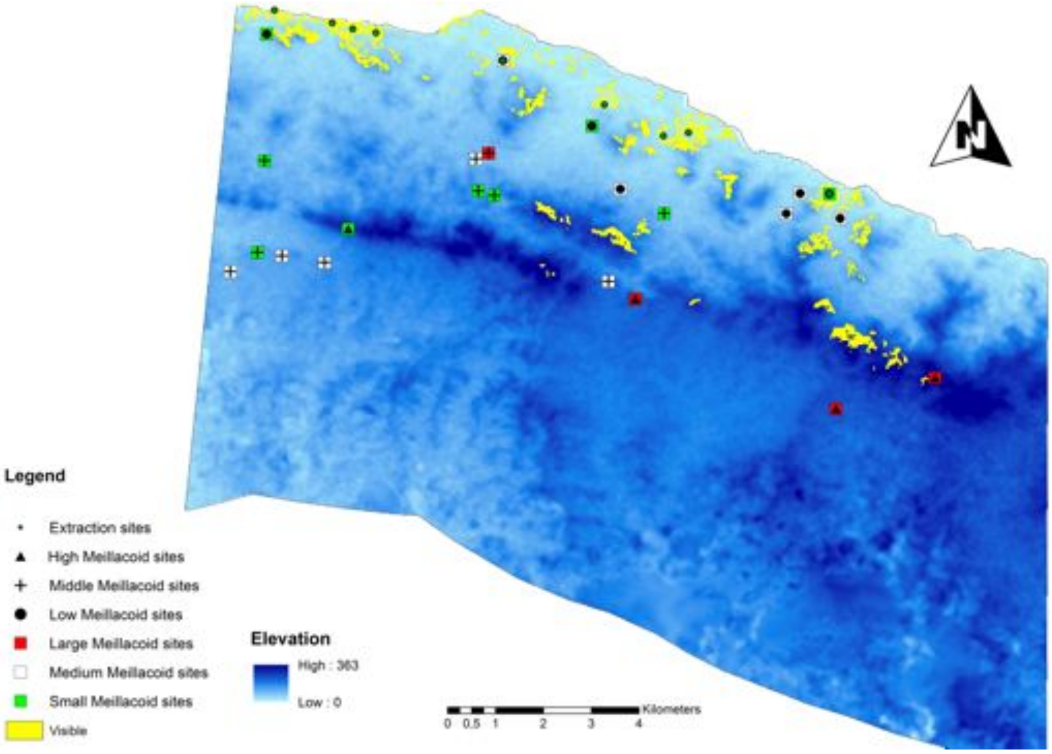

Figure 22: Visibility extraction sites.

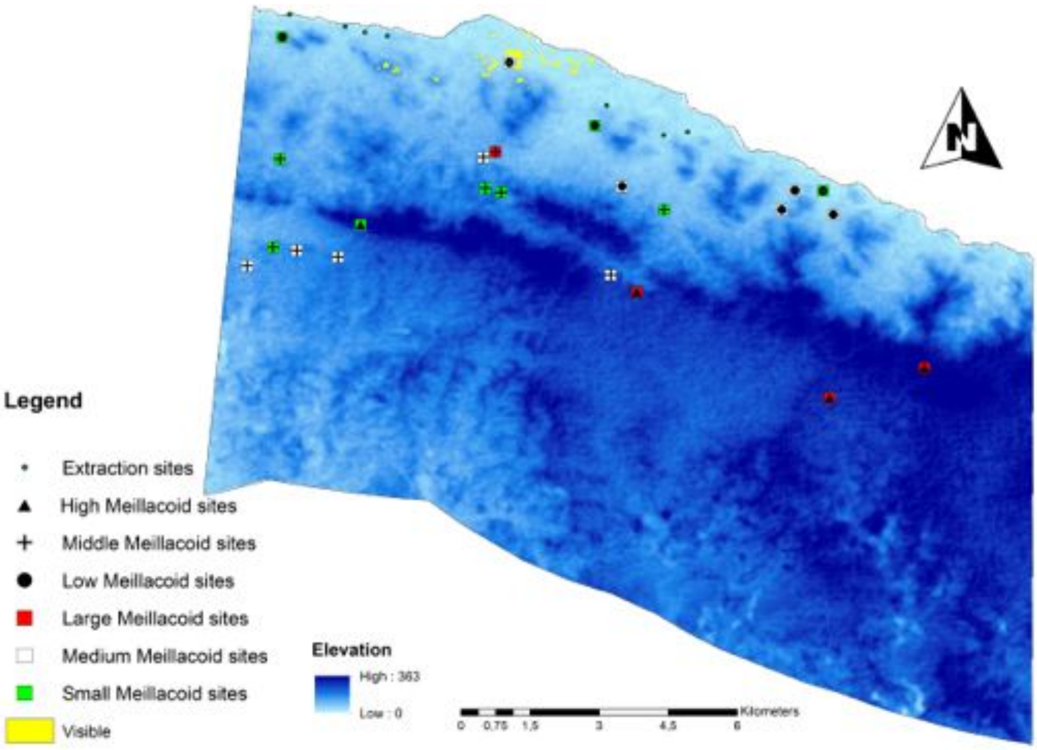

Figure 23: Minimum visibility extraction sites.

Chapter 6. Discussion

The discussed results of the previous chapter will be compared and discussed and their significance will be put into the context of previous research, of which certain themes are already discussed during chapter two, three and four of this research. Afterwards the results will be related to the research questions and to previous research in order to create a comprehensive view of the situations that are going on in the case-study area.

6.1 The visual prominent geomorphological features from the sites in the case-study area

Starting off by saying that the view from the sites and thus the visual prominent geomorphological features vary per elevation and size category and among the sites itself. Overall there are some general patterns deduced from the multiple viewsheds about well visible geomorphological elements in the case-study area. Where de Ruiter (2012, 98) stated that elevation and visibility already have a linear relationship in their nature, by an increasing elevation the potential extension of view also increases, the viewsheds in this thesis shows exactly the opposite. Both the high-elevated Meillacoid sites and the high-elevated sites in general do not have the widest viewshed over the most diverse geomorphological areas. The small sites that are situated predominantly in the lower-elevated areas, with some exceptions on hilltops do have a wider viewshed. This shows that size categories should be weighed more in the interpretation process, since the size of the sites is also a human component, while having the viewsheds from the elevation categories as a reference to explain major differences.

The view on a restricted area of coastal zone, which can be linked to activities that are connected with the extraction of marine resources, is mostly visible from both all the small sites in the case-study area and from the small Meillacoid sites. This makes sense since many small sites are located in the coastal zone and coastal lowland area, as well as on the hilltops of the Cordillera Septentrional. Small and medium Meillacoid sized as well have a predominant view on the coastal lowland zone and on some of the hilltops of the Cordillera Septentrional. This is more or less similar with the large Meillacoid sites that have both have view on the hilltops and the coastal lowland zone, with the exception of the high-elevated Meillacoid sites that only have view over some of the Cordillera hilltops and the hinterland. A geomorphological aspect that is visual in almost all the taken viewsheds are the hilltops in the western part of the Cordillera Septentrional in the case-study area and can thus be considered as the most visual prominent feature in the landscape that is visible from the sites.

This aspect of the study also shows that it is possible in a relatively small research to determine visually prominent places in the landscape, by using multiple viewsheds, instead of using rather more complex methods such as the total viewshed described by Llobera (2003). However, for a more in depth investigation the outcomes of the multiple viewshed can be compared with the outcomes of a total viewshed.

6.2 The role of visibility in the determination of site location

From the results of the multiple viewsheds, it is possible to conclude that visibility did play a role in the determination of site location, since each category of sites and each individual site have a specific visible area in the landscape and it is possible to see other sites from the indeterminate and Meillacoid sites. In most of the viewshed it is possible to see at least three other sites of the same or a different category that is located in close proximity to the site that is used as a viewpoint. This matches with the statistical analyses that were carried out by de Ruiter (2012, 87), in which is stated that within a radius of 2,5 kilometres from a Meillacoid site, 2 other

Meillacoid sites are situated. By looking at viewsheds with a minimum view range of 3 kilometres, this expected pattern could be observed. Within the 10 kilometres visibility range a similar patterns can be seen. Visibility was possibly used for the visual control of other sites. From multiple viewsheds it is possible to deduct a pattern about the determination of site locations, however this pattern should be more statistically analysed in order to make bolder statements about these patterns, which can also be combined with network analyses. Another important aspect to keep in mind is that it is theoretically possible that the sites are not contemporary and that the close location to other Meillacoid sites was not deliberately chosen.

6.3 The relationship between multiple viewsheds and site clusters

As already discussed in the previous paragraph, the viewshed shows that within a radius of 3 kilometres another site is located and that they are inter-visible. To be more specific about the relation of site clusters and visibility patterns, it seems that site clusters that are located in a similar geomorphological zone, such as the coastal zone, the coastal lowland area and the hilltops of the Cordillera Septentrional or a similar elevation, and are more likely to be inter-visible than sites that do not share such common aspect. However multiple viewsheds are not the best method to study this relationship and it would be interesting to combine more advanced visibility analyses, with network analyses (see Brugmans *et al.* forthcoming 2017) and with least cost path analyses, so that inter-visibility, accessibility and the inter-connectivity among sites can be compared and described.

6.5 The link between multiple viewsheds, the control of resources and indigenous communication networks

The predominant area that can be used for the extraction of resources in the case-study area is the Atlantic Ocean. Along the coast extraction sites are situated that are used for fishing activities. From previous research that was carried out by de Ruiter (2012) and Ulloa Hung (2013), it becomes clear that Meillacoid sites were mostly situated in close proximity to the coast, since marine resources are an important component in their subsistence strategy and thus are likely to be controlled visually. Even the further inland-located Meillacoid hilltop sites have the same abilities to overlook the sea. Based on the viewsheds, the Meillacoid sites that are located in the coastal lowland in general provide view over multiple extraction sites and coastal zones. The most notable point about the viewsheds of the Meillacoid sites is that the high-elevated large sites do not have view over the coastal area at all, but only over some hilltops located on the western side of the Cordillera Septentrional within the case-study area and over the interior hinterland. Based on the viewsheds, the Meillacoid hilltop sites in the case-study area do not have the expected direct visual coastal control. However, both the Meillacoid sites in the coastal lowland area and the Meillacoid sites on the hilltops do have a shared visibility on the western hilltops of the Cordillera Septentrional in the case-study area, on which also small Meillacoid hilltop sites are located. It is thus possible that the large Meillacoid hilltop sites are indirectly linked to extraction and Meillacoid sites in the coastal lowlands by an indigenous network system. Another important issue to keep in mind is that the viewsheds are taken from the centre points of the sites during the survey and that these points are not a valid representation of the visual capacities of the sites and that there are thus better viewpoints present at the sites, while displacing the observation points at the sites during movement. From photographs that were taking during the survey it is clear that the sea can be seen from some of the Meillacoid hilltop sites in the area (fig 24).

Figure 24: View from El Manatial (MC-44) (Courtesy of Herrera Malatesta).

The presence of a plausible indigenous communication network between the lowland sites, small hilltop sites and large hilltop sites, which provides an indirect visual control from the hilltop sites over the coastal zone, can be further advocated by the fact that one of the large Meillacoid sites is also situated in the coastal lowland area. This large site has a wide view on the coastal zone and the coastal lowland area and shares the same view on the western hilltops. It is thus plausible that messages were exchanged among the largest sites of the area and with the option of sending signals through smoke columns more sites are able to be part of this network. In order to explore this theory, a more in depth visibility with the combination of network techniques should be carried out. As of particular interest in regards to the use of possible communication methods is a study by Brughmans *et al.* (forthcoming 2017) on visibility networks by smoke columns for coastal sites in Guadeloupe. Multiple viewsheds are not detailed enough for an in depth study of these kind of networks.

Chapter 7. Conclusion

The main aim of this thesis was to investigate the possibility to reconstruct patterns in ancient indigenous landscapes by using multiple viewshed analyses in a part of the coastal area of the Montecristi province in the Dominican Republic. This was done based on survey data that was gathered by Eduardo Herrera Malatesta for his PhD research. In total 44 sites were classified into several size and elevation categories, namely high middle and low elevation and large medium and small size, from where multiple viewsheds were taken. The same was done for the Meillacoid sites with a view range of 3-10 kilometres, in order to get a more specified overview of the patterns that are deducted from the viewsheds.

The four patterns that were analysed with multiple viewsheds in this thesis were the visually prominent geomorphological features, the role of visibility in the determination of site locations, the relationship between visibility and site clusters and the relationship between visibilities, the control of resources and indigenous communication networks.

The reconstruction of visual prominent geomorphological features is possible in a small case-study area without the use of total viewsheds. Generally speaking the most prominent geomorphological features are the coastal zone and the coastal lowland area, visible from Meillacoid sites that were located in this lowland area. From the large Meillacoid hilltop sites the interior hinterland was visible together with some hilltops located in the western part of the case-study area that were also visible from the coastal lowland located sites.

Given the fact that certain site categories are overviewing different geomorphological areas and that from most of the Meillacoid sites it is possible to see other Meillacoid sites in the area, it is highly possible that visibility played a role in the determination of site location. However, it is important to remind that the analyses are based upon survey data, which means that is unsure whether the sites are contemporary in use. Sites can thus also be placed in close proximity to other sites of earlier periods without the awareness of the existence of these sites. The multiple viewshed is a coarse method to establish an in depth analyses of this phenomenon, for future research it is important to carry out statistical analyses that either accept or reject this pattern.

Speaking about the relationship between the view from multiple viewsheds and site clusters, it seems that sites that are located in a similar geomorphological zone or at a similar altitude are more likely to be inter-visible than sites that do not share such a common aspect. However, a more in depth analyses needs to confirm such a pattern. By combining visibility, network and least cost path analyses, the relationship between visibility, accessibility, interconnectivity and site clusters can be further analysed.

Lastly, the relationship between the views from multiple viewsheds, the control of marine resources and indigenous communication networks was described. Since Meillacoid sites are in general located in close proximity to the sea, and that marine resources are important to the Meillacoid subsistence strategy, it was assumed that the Meillacoid sites in the coastal zone and the Meillacoid hilltop sites do have visual control over sea and the extraction sites in the area. However, the large Meillacoid hill top sites do not have a direct view over the coastal area from the given viewpoints. Since both the lowland sites and the hilltop sites are able to see small Meillacoid hilltop sites in the western part of the case-study area, an indirect visual network between large hilltop sites and the low-elevated extraction sites is suggested. From both the large Meillacoid hilltop sites and small extraction and Meillacoid sites in the coastal lowlands, it is possible to view specific hilltops in the western part of the case-study area. On these hilltops small Meillacoid hilltop sites are located, which probably play an important role in visually connecting the sites in the coastal lowlands with the hilltop sites. In future research the possibility of visual networks through signalling systems such as smoke columns should be analysed by combining visibility analyses with network analyses.

7.1 Limitations and future research

In conclusion, it is possible to observe and deduct patterns in ancient indigenous landscapes with the use of non-complex visibility analyses. The general visibility can be deducted with multiple viewsheds. The visibility patterns in the case-study area already show that there is regional variation in visibility patterns in the northern part of the Dominican Republic. Where Ulloa Hung (2013) and de Ruiter (2012) found out that in the Puerto Plata area, the high-elevated Meillacoid sites have the widest viewshed; the patterns in the case-study area show the opposite. However, the observations in Puerto Plata cannot be compared with the visibility analysis in the case-study area, since the ones in Puerto Plata are not GIS-based. Secondly, the viewsheds are from the sites in this thesis are all taken from the centroid point, so it is possible that the viewsheds are different when they are taken from different points at the sites. For future research it is important to take multiple points at a site for visibility analyses and to study the differences that do occur. When moving along the sites visibility can be totally different. Obversely, there are many subjective parameters that can influence sight, as discussed in method chapter of this thesis, such as the position and height of the observer and vegetation. For future research it is important to combine visibility and network analyses to study the visual networks that are present between sites. By carrying out such analyses on regional scales, it will be possible to redefine socio-cultural areas and the interconnectivity between them within the Caribbean. Besides, it is important to improve the visibility methodologies by understanding the effect of the involved parameters and to come up with new ways to composite for them. For instance, to better understand the consequences of vegetation, alongside the observer height and position, and weather and light conditions that change contrast and the view range, it would be helpful to compare viewsheds with geo-referenced photographs taken by either regular or 360-degree cameras that are taken from different positions at sites, or with different heights under the influence of different atmosphere conditions. For more in depth visibility analyses, multiple viewsheds are not appropriate and adequate enough to come up with an inclusive and comprehensive understanding of the studied patterns. Visibility analyses have much potential in order to redefine the socio-cultural boundaries and interactions in Hispaniola and the rest of the Caribbean archipelago, Therefore it is important to study the visibility patterns per region and to analyse the visual interactions among the various parts of the northern part of the Dominican Republic and the rest of the island.

SUMMARY

In this thesis an attempt was made in order to (re)construct ancient indigenous landscapes through visibility analyses, during the Late Ceramic Age (AD 800-1500) in the coastal zone of the Montecristi, the Dominican Republic. The northern part of the Dominican Republic has been very important in understanding the Spanish conquest of the island, since is one of the first areas where indigenous communities encountered the Europeans. At the time the Europeans arrived in the New World, complex indigenous exchange networks connected the Caribbean islands with the mainland of South America. The information that the indigenous peoples gave to the Spaniards about these networks was crucial for the conquest of the Caribbean. Visibility is considered to be an important parameter to (re)construct the indigenous socio-political dynamics in the Caribbean.

In the defined case-study area, 44 sites were categorized by altitude and size and used to carry out multiple viewshed analyses in order to analyze the relationship between the sites and the visual prominent geomorphological areas in the case-study area, the reconstruction of role of visibility in the determination of site location, the relationship between multiple viewsheds and site clusters and the possible role of visibility in the control of marine resources and indigenous communication networks. The multiple viewshed analyses revealed that it is possible that the low-elevated (Meillacoid) sites in the coastal lowlands are able to visually control the coastal and coastal lowland area, the (Meillacoid) hilltop sites overview the hinterland, that most of the (Meillacoid) sites can see at least three other surrounding sites, that sites within a similar geomorphological area are more likely to overview each other then sites without such a shared aspect and that there could have been an indigenous visibility network, in which the large (Meillacoid) hilltop sites had indirect control over the coastal zone.

Samenvatting

In deze scriptie is een poging gedaan om oude inheemse landschappen te reconstrueren door middel van *visibility analyses* voor de *Late Ceramic Age* (AD 800-1500) in the kust gebied van Montecristi, Dominicaanse Republiek. Het noordelijke deel van de Dominicaanse Republiek is belangrijk voor het begrijpen van de Spaanse verovering van het eiland, omdat het een van de eerste gebieden was waar inheemse groepen in contact kwamen met Europeanen. Toen de Europeanen arriveerden in de Nieuwe Wereld verbonden complexe inheemse uitwisselingsnetwerken de Caribische eilanden met het vaste land van Zuid-Amerika. De informatie die de Spanjaarden kregen van inheemse groepen over deze netwerken was cruciaal voor de verovering van de Cariben. Visibiliteit wordt beschouwd als een belangrijke factor voor de (re)constructie van de sociaal-politieke inheemse verhoudingen in de Cariben.

In het gekozen *case-study* gebied zijn 44 sites gecategoriseerd naar grootte en hoogte en gebruikt voor het uitvoeren van *multiple viewsheds* om: de relatie tussen de sites en de prominent zichtbare geomorfologische gebieden van het *case-study* gebied, de rol van visibiliteit in de locatiekeuze van sites, de relatie tussen *multiple viewsheds* en site clusters en de mogelijke rol van visibiliteit in het controleren van marine grondstoffen en inheemse communicatie netwerken, te analyseren. De *multiple viewsheds* tonen aan dat: de (Meillacoid) sites in het laaggelegen kustgebied het kustgebied visueel te controleren, de (Meillacoid) heuveltop sites het achterland kunnen overzien, het merendeel van de (Meillacoid) sites ten minste drie nabijgelegen sites kunnen zien, sites in hetzelfde geomorfologische gebied een hogere kans hebben elkaar te zien dan sites zonder zo'n gemeenschappelijke factor en er mogelijk een inheems visibiliteitsnetwerk aanwezig is, waarin de grote (Meillacoid) heuveltop sites indirecte visuele controle hadden op het kustgebied.

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