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Introduction

The Western Stone Forts form some of the most spectacular archaeological monuments in the country and include well known sites such as Dún Aonghasa, Co. Galway and Cahercommaun in Co. Clare. The group comprise a number of heterogeneous forts characterised by their exceptionally thick and high stone walls and other distinctive architectural features such as terraces, steps, guard chambers or *chevaux de frise*. Another defining trait is their strategic landscape setting, commanding coastal and inland views and natural route-ways (Cotter 2012a, 5). They are frequently compared to the drystone walled settlements of Atlantic Europe with particularly strong associations with Scottish brochs (Wileman 2014, 17). As well as sharing many architectural characteristics and landscape setting, these monuments were often located in areas of limited quality farmland. It is clear however, that the Western Stone Forts are a loosely defined group of monuments that have a broad chronological span ranging from the Late Bronze Age to the Early Medieval period. This is highlighted by Cotter's (2012a) recent publication of the Dún Aonghasa excavations, as well as earlier studies at Cahercommaun (Hencken 1938) for example. In this regard, the commonalities shared by the forts make it difficult to ascribe a date without excavation.

Cotter (2012a, 5) has identified approximately 31 forts that may be included under the broad term 'Western Stone Fort', with a sizable group of others that may be considered as part of that grouping. Only eleven of these have been included on the Tentative List of UNISCO World Heritage Sites, these include: Caherconree, Co. Kerry, Faha (Benagh), Co. Kerry, Staige, Co. Kerry, Cahercommaun, Co. Clare, as well as the seven examples found on the Aran Islands, Co. Galway, namely, Dún Aonghasa, Dúchathair, Dún Chonchúir, Dún Eochla, Dún Eoghanachta, Dún Fearbhaí and Dún Formna. Five of these sites have been subject to laser-scanning surveys by The Discovery Programme. While these produced incredibly detailed three dimensional models, only the monuments themselves, and not their immediate environs, were mapped. While this technique allows sub-centimetre accuracy and resolution, it is time consuming, expensive, and in many cases can leave 'data holes' where smaller features obscure data capture. Considering the inaccessible nature of some forts like Caherconree or Faha, it is unpractical to use this technique for survey.

This aim of this project is to create a complete suite of high resolution three dimensional models of the Western Stone Forts on the Tentative List using cost and time effective methods that will complement The Discovery Programmes recent mapping study (Figure 1.1). To achieve this, the project will use drone technology to capture high resolution vertical and oblique aerial photographs that will be used to create a three dimensional model using photogrammetry. As such, only the six forts not targeted by The Discovery Programme were selected for detailed survey, these include Cahercommaun, Caherconree, Faha, Dún Chonchúir, Dún Fearbhaí and Dún Formna. Modern GIS analytical methods will be used to quantitatively analyse the location, function and effectiveness of architectural features like walls, guard chambers, entrance passages etc., of these recorded forts, allowing a more detailed understanding of these iconic sites.

1.1 Chronological Framework

The Western Stone Forts of Ireland form some of the most iconic archaeological sites in the country, and while they do share some morphological characteristics, it is clear that they comprise a loosely defined group of monuments that have a broad chronological span ranging from the Late Bronze

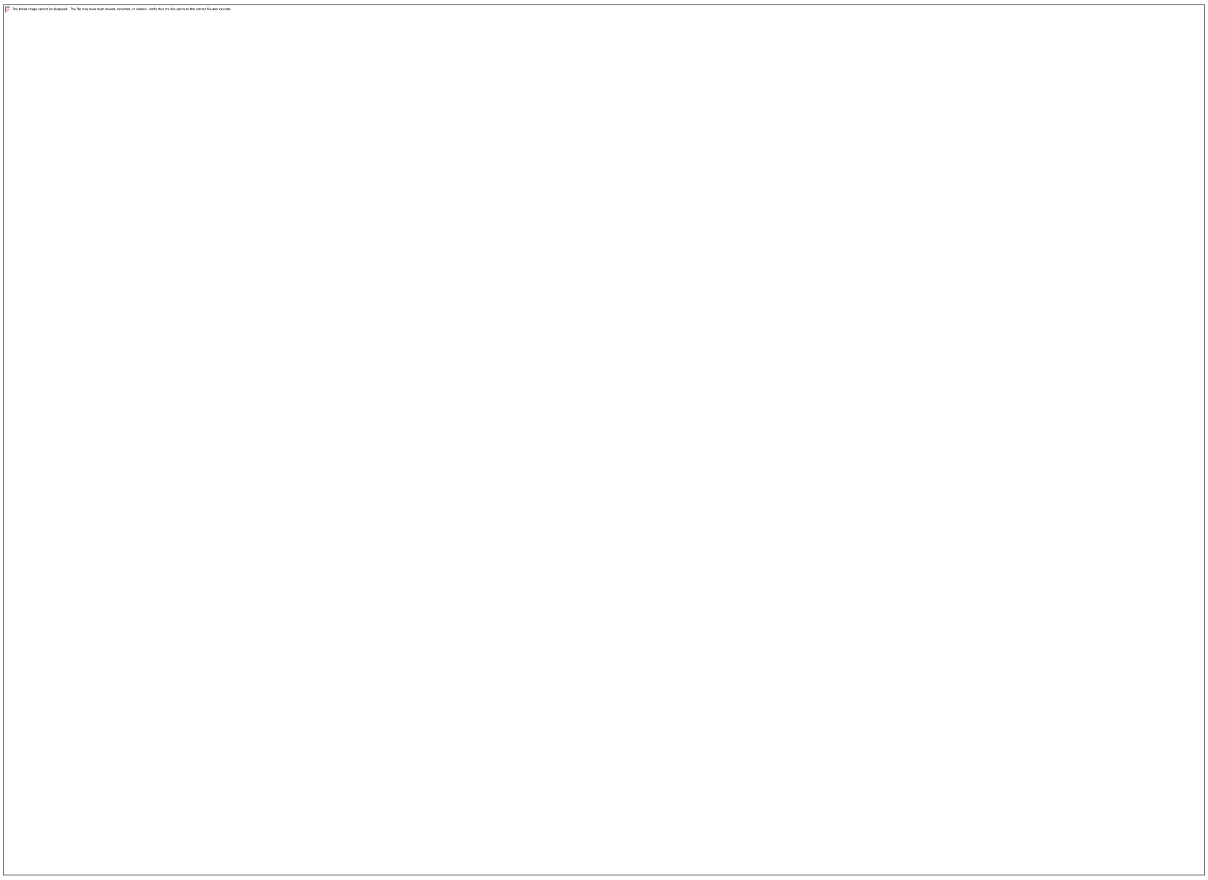

Figure 1.1: Western Stone Forts surveyed as part of this project.

Age to the Early Medieval period. This is highlighted by Cotter's (2012a) recent publication of the Dún Aonghasa excavations, as well as earlier studies at Cahercommaun (Hencken 1938) for example. The former is regarded as an excellent example of a Late Bronze Age hillfort, while the latter has been tentatively dated to the Early Medieval period, interpreted as a ringfort and centre for a regional chiefdom.

There are significant difference between the Early Medieval and Late Bronze Age, and it is important to attempt to place and interpret these monuments within their correct temporal setting. However, without excavation, it is difficult to ascribe a date due to the apparent similar architectural style of these forts. With regards to the forts studied in this project, their distinct landscape settings may help us to ascribe tentative chronologies.

Hillforts of the Western Stone Forts

Faha, Co. Kerry, Caherconree, Co. Kerry (Figure 1.2) and Cahercommaun are positioned in dominant topographical locations reminiscent of hillforts, and have therefore been ascribed a tentative Late Bronze Age date, though the dating of the latter fort is contested. Raftery (1972, 39) proposed the first classification of Irish hillforts, dividing 40 known examples into three groups. Class 1 hillforts comprised univallate sites. Class 2 sites were defined as widely-spaced, multivallate defences on (a) hill-tops and (b) cliff-tops such as Dún Aonghasa, Co. Galway and Cahercommaun, Co. Kerry. Class 3 included inland promontory forts such as Faha, Co. Kerry and Caherconree, Co. Kerry.

Since Raftery's (1972) publication, the number of identified hillforts in Ireland has risen to approximately 108 examples. They form some of the largest archaeological monuments in Europe and are recognised as regional centres of power and authority of the late prehistoric era. They comprise one or more concentric lines of earthworks, stone walls and/or timber palisades, which enclose an area often several hectares in size. In many cases, their placement in the landscape may be linked with natural route-ways and/or natural resources, representing an ever-increasing need to control trade networks and the procurement, exploitation and supply of natural resources (see for example Brown 2009, 201; Bruck 2007, 31; Bruck and Fokkens 2013, 95; Fonte *et al*. 2011; Grogan 2005b; 2014, 68; Hamilton and Manley 2001, 31; Murrieta-Flores 2012, 114).

Although the concept of enclosing hilltop sites is a recurring feature from the Neolithic period onwards, the phenomenon flourished throughout Europe during the Bronze Age. In Ireland,

Figure 1.2: Caherconree fort, Co. Kerry.

hillforts with securely dated enclosing elements indicate a Late Bronze Age construction horizon, beginning at the transition from the Middle to Late Bronze Age (*c.* 1400 BC) and continuing until the latter part of the Late Bronze Age (*c.* 800–600 BC) (O'Driscoll 2016, 60–64). The beginning of this construction horizon corresponds with a sudden and severe intensification of hillfort construction on the continent (Primas 2002, 50). This corresponds with a dramatic increase in the exploitation of natural resources, maximisation of agricultural productivity and competition over trade routes (Earle 2002; Bruck and Fontijn 2013, 202). Central to this was the prestige goods economy which is archaeological visible in the significant numbers of bronze and gold artefacts found throughout the Continent. The limited natural availability of ores led to the development of exchange networks and facilitated the evolution of politicised economies concerned with the production, display and consumption of such artefacts (Van De Noort 2013, 382; Yates 2007, 120). This, in turn, stimulated an increase in agricultural activity to provide enough surplus stock to exploit or trade these items (see Yates 2007, 4), as well as competition between communities to acquire these goods. As Harding (2012, 196) notes, this was a period of warfare and inter-regional competition.

Earle (1977; 2002, 42) and Kristiansen (1993; 1999) have argued that hillfort societies were centralized and stratified, and this has become the enduring image of hillforts. Chiefs or elites are set apart from the agrarian substrate and rule through a retinue of warriors, exploiting the farming communities through tribute and taxation (Kristiansen 1993, 19–20). These 'archaic states' developed in regions where surplus could be generated and controlled, and then, through a formalized system of tribute, converted into large-scale ritual activities such as the building of ceremonial centres, organization of craft production, or centralized trade (Kristiansen 1993). Although such an approach has been strongly opposed in favour of heterarchical models (see Lock 2011 for example), it corresponds well with evidence currently available in Ireland (see O'Driscoll 2016) and integrates with the widely accepted prestige goods economic model. Cunliffe (2008, 234) supports this model, stating that elites and farming communities could have functioned well together, the hillfort and connected farming communities 'providing the stability and resources for the elite who, in turn, by virtue of their prowess attracted other resources through gifts and the spoils of successful raids'.

Although there is general consensus that hillforts had a number of diverse functions which changed throughout time and region, debate has focused on two competing views (Armit 2007; Brown 2009; Harding 2012, 27; James 2007; Lock 2011). The first argues that some functioned as practical, defensive enclosures (see Armit 2007). An alternative view criticizes this position, highlighting the inherent weaknesses in hillfort design, interpreting them as symbols of 'social isolation' built by a dispersed community in order to facilitate social bonding (see Lock 2011). More recent studies stress the importance of monumental display in hillfort architecture and their role in the proclamation of power and status (Sharples 1991; Driver 2013).

Ringforts

Dún Chonchúir, Dún Fearbhaí and Dún Formna have generally been considered Early Medieval, and may be included in the ringfort class of monuments. Circular enclosures termed ringforts, are the most common archaeological site from the Early Medieval period, *c.*400–1200AD (Figure 1.3). These are generally interpreted as dispersed rural settlements, mostly farmsteads, with morphological variability partly associated with social hierarchy. In total, there are thought to have been in the region of 45,000–60,000 examples, with only a small percentage having being excavated.

Ringforts can be defined in their most basic form as 'a space most frequently circular, surrounded by a bank and fosse or simply a rampart of stone' (Ó Ríordáin 1979, 29–30). However,

Figure 1.3: Dún Fearbhaí fort on the Aran Islands, Co. Galway.

applying a definition to this monument type is problematic, as ringforts can vary considerably in their size, shape, and composition. 'Ringforts are…by no means a homogeneous group' (Barrett 1980, 39), though this may be expected considering the number of recorded examples.

It is widely accepted that the majority of ringforts date to the Early Medieval period. Occasionally, arguments are put forward to suggest the construction of these sites in both the late prehistoric and Later Medieval periods. Through Stout's (1997, 24–29) compilation of scientifically dated ringforts, both early and late examples have been highlighted. This seems to confirm that the majority of ringforts were constructed and occupied during a 300 year period between the 7th–9th centuries AD (*ibid* 1997, 24). This suggests that the majority of ringforts were broadly contemporary within the Early Medieval period.

Binchy (1954, 54) has described Early Medieval society 'tribal, rural, hierarchial, and familiar' in nature. This is attested in early Irish law texts dating from the 7th century AD onwards, and correlates reasonably well with contemporary archaeological evidence. Ireland was divided into a number of tribal communities known as *túatha*, meaning 'tribe' or 'petty kingdom', which were further divided by groups of people with a common great grandfather, known as the *derbfine* (Kelly 1988, 3). Byrne suggests that 150 túatha, each comprising some 5000 people existed at any one time (Byrne 2001, 48). Kelly (1988, 4), however, estimates the average population of a *túath* to be around 3000, but accepts Byrne's hypothesis of 150 *túatha*, with MacNeill (1923, 96) estimating the number in existence to be around 80. These differences underline the highly speculative rational used when estimating population levels during this period.

These *túatha* were part of a hierarchial social system that was reflected in the divisions of social status, and attested to in contemporary documentary sources (and possibly ringfort morphology). As such, personal status was measured and ranked with respect to wealth. This status (honour price) was measured in the form of cattle, from which a commoner to a king was valued. Kelly (1988, 9) suggests that there were two social divisions within this society:

1. between those who were *nemed* (privileged), and those who are not (freemen).

2. between those who are free and un-free.

1.2 Methodology

Drone Survey and Photogrammetry

Drone technology in an archaeological context to map both built heritage and landscapes is a cost effective tool when compared to traditional aerial mapping methods or more recent innovations in the areas of Laser-Scanning and LiDAR. This technology can be used to capture overlapping geo-referenced vertical and oblique photographs in order to create accurate and dense three-dimentional models. As well as its minimal cost in comparison to LiDAR or laser scanning surveys, it is a highly portable technology, allowing more inaccessible sites to be surveyed.

For this project, AerialEye Ltd. were commissioned to undertake these surveys. They used a ………….. drone to collect a series of overlapping images for each site, creating both an ortho-rectified vertical photograph and photogrammetric derived three-dimensional models. This was done using the software programme Pix4Dmapper Pro Version 3.1.18.

For each site, a pre-designed flight path was derived prior to the survey (Figure 1.4). After the drone is launched in-field, the drone becomes autonomous and follows this path, taking geo-referenced photographs at set intervals. The absolute position uncertainty of each photograph is derived in order to ascertain if they have sufficient GPS accuracy to be included in the final processing procedure for ortho-rectification and three-dimensional model creation (Figure 1.5).

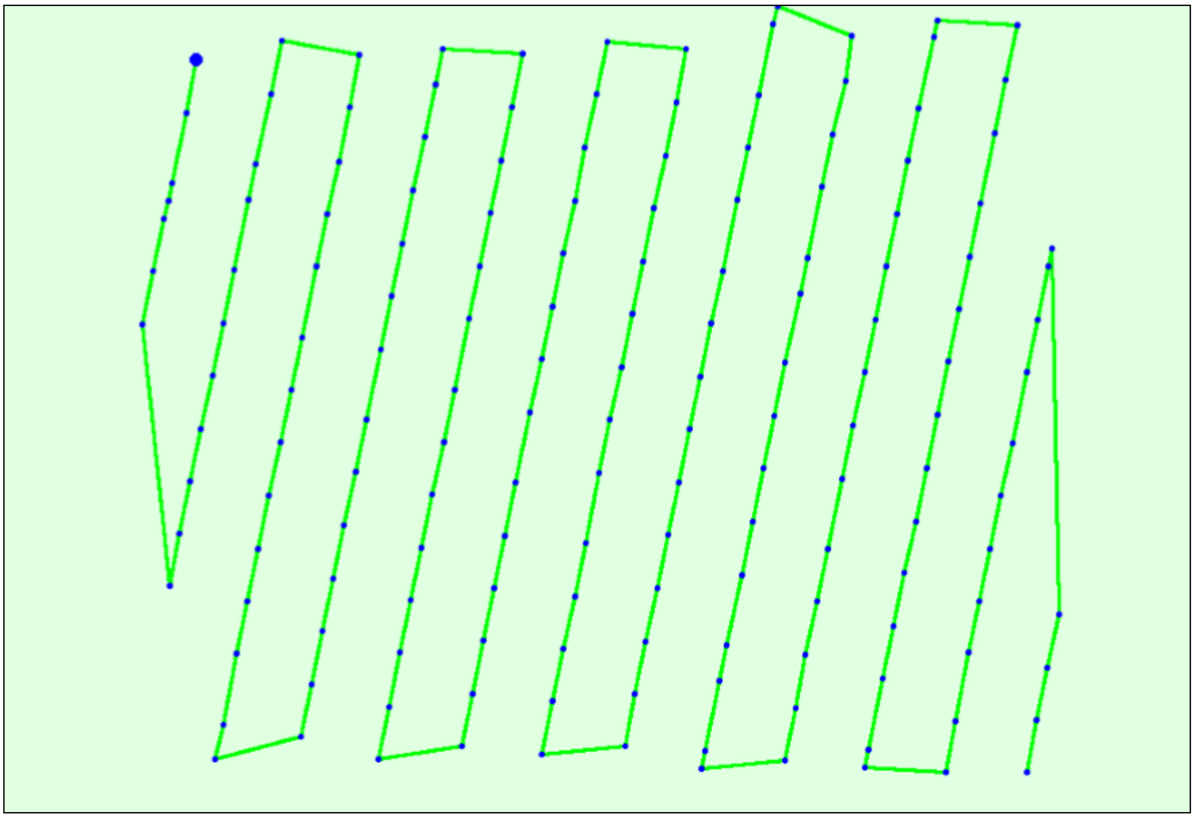
Figure 1.4: An example of a pre-designed flight path with blue dots denoting the capture position of photographs.

The software programme is able to create a three-dimensional model of the select area due to the multiple overlapping images at slightly differing positions, giving each photograph a unique angle of the select area/object while also providing it with keypoints (reference points) visible to multiple photographs. As such, it is important that multiple photographs overlap. Prior to the final processing procedure, the software programme computes the number of overlapping photographs to make sure there are sufficient numbers of overlapping photographs (Figure 1.6).

Each pixel in the orthomosaic is analysed to see how many keypoints can be linked to it, hence deriving the accuracy of the model. In instances where there is sufficient overlap, the number of keypoints per pixel can be well in excess of 10,000 (Figure 1.7). This is more than sufficient to derive an accurate model.

The final model and orthomoasic can be output in a number of different formats. Depending on the variables outlined above, each survey had a varying resolution, though each survey had a minimum resolution of 1600 points per metre squared. For this project, each dataset has been saved in a skypixel model, making them freely available to the public to view, as well as in ASCII Grid format and in basic cloud point format. This will allow data to be used by other software packages.

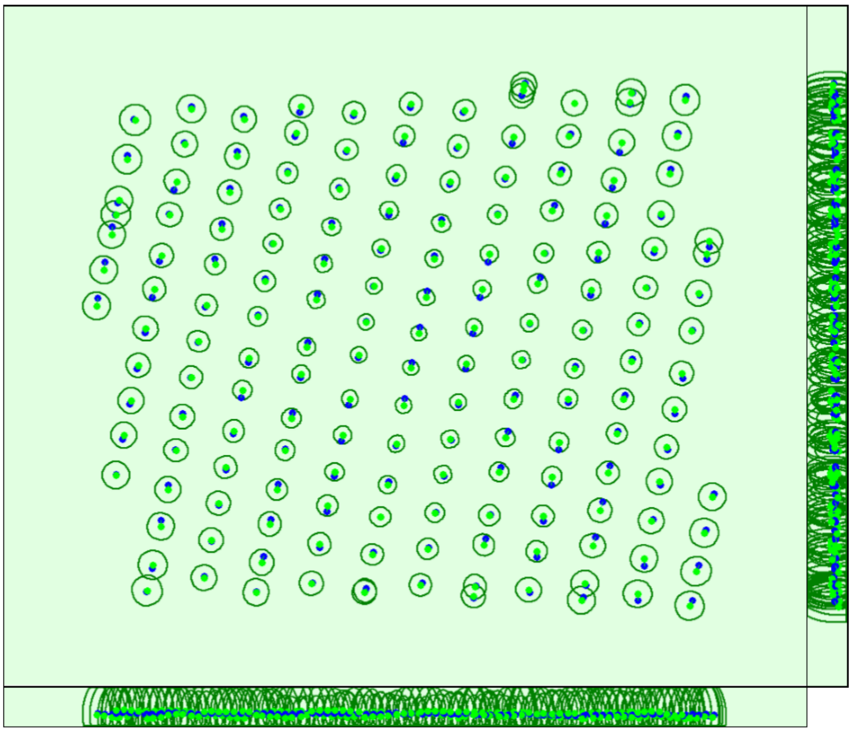

Figure 1.5: Offset between initial (blue dots) and computed (green dots) image positions as well as the offset between the GCPs initial positions (blue crosses) and their computed positions (green crosses) in the top-view (XY plane), front-view (XZ plane), and side-view (YZ plane). Dark green ellipses indicate the absolute position uncertainty of the bundle block adjustment result. (note that uncertainty ellipses are magnified by 10.

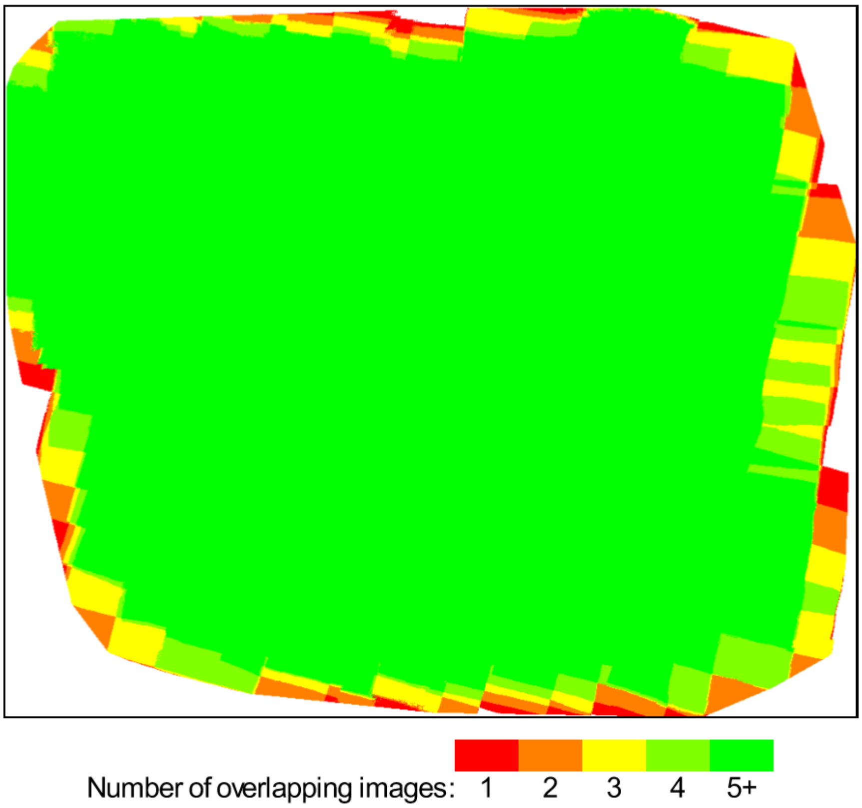

Figure 1.6: Number of overlapping images computed for each pixel of the orthomosaic. Red and yellow areas indicate low overlap for which poor results may be generated. Green areas indicate an overlap of over 5 images for every pixel. Good quality results will be generated as long as the number of keypoint matches is also sufficient for these areas.

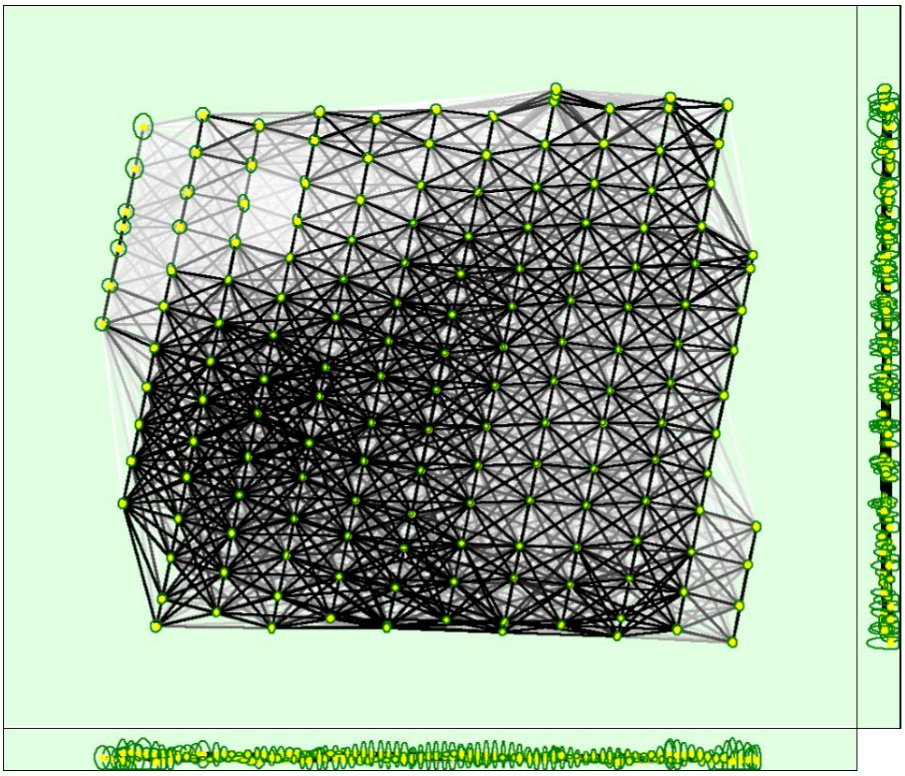

Figure 1.7: Computed image positions with links between matched images. The darkness of the links indicates the number of matched 2D keypoints between the images. Bright links indicate weak links and require manual tie points or more images. Dark green ellipses indicate the relative camera position uncertainty of the bundle block adjustment result.

GIS Analysis

Following the capture of this information and the creation of orthomosaics and three-dimensional models, GIS analysis will be used to assess and analyse the data. GIS (Geographical Information Systems) is a computer software system that is designed to capture, store, manipulate, analyse, manage and present data that has a spatial or geographical component. The software is used by a wide range of industries and is being increasingly adopted for archaeological projects. GIS has largely been used in a data management capacity and for the creation of cartographic maps like monument distribution plots. Recently, spatial analytical techniques have been gaining popularity among archaeologists with particular interest in viewshed, cumulative viewshed, Least-Cost-Path (LCP), aspect and slope analysis. These types of analysis can produce new quantifiable information based on different environmental variables.

Spatial Analytical Techniques: Viewshed Analysis

Viewshed analysis is a technique that aims to 'identify those areas that can or cannot be seen from a single (or a set of) viewpoint(s) within a digital model of a terrain, either by calculating line-of-sights between pairs of point locations or via viewshed generation' (Paliou 2013, 2). Wheatley and Gillings (2001, 1) suggest that viewshed analysis is the most unique and valuable GIS application for archaeologists. It is argued that this type of analysis, being at its core 'a model of the field of vision of human actors', can help build and expand quantified generalizations and methodologies for archaeological research (Wheatley 2004, 11). Tschan *et al.* (2000, 33) describe viewshed analysis as a tool closely associated with the human capacity of sight as it attempts to explore past cognitive acts such as the movement of people and their perception of the contemporary landscape. While having obvious functionalist advantages, viewshed analysis has the potential to contribute to wider theoretical approaches, such as cognitive perception, culture/nature dichotomy, visualism and sensory primacy, temporality and directionality (Wheatley 2004, 11).

Others, such as Thomas (1993, 23), reject the 'functionalist' approach which GIS has often been associated with, primarily due to the seeming inability of such systems to accurately model past landscapes, or correctly incorporate human agency. The effect of vegetation in the past is a particular problem, as the height of tree canopies and the extent of forestry cannot be modelled with certainty. Ogburn (2006) discusses other problematic factors that influence visibility, such as the limits of human visual acuity, past environmental effects and the physical properties of objects and their surroundings, all important factors which are often not considered. In many cases, these problems can be compensated for. For example, he suggests that the limits of human recognition acuity for a 1m wide object is 6880m. Significant methodological issues such as visual reciprocity (Loots 1997), the quality of data (particularly the digital elevation model), and the modelling of 'fuzzy viewsheds' (Fisher 1996), need to be considered in order to create more robust visibility models, even if this is not always possible.

An excellent description of the methodological approach has been outlined by Wheatley (1995, 5). Two data-sets are needed to create a viewshed map, namely, point data and a raster terrain model (Figure 1.8). In each cell in the raster, a straight line is generated between the point data and every individual cell within the raster terrain model. The height of all the cells that occur on the straight line between the point data and largest cells is then obtained in order to ascertain whether or not the cell exceeds the height of the three dimensional line at that point. The result of each of these calculations is then transformed into either a positive (1: representing visible areas) or negative (0: representing not visible areas) cell, creating a binary image of visibility (Figure 1.8). A

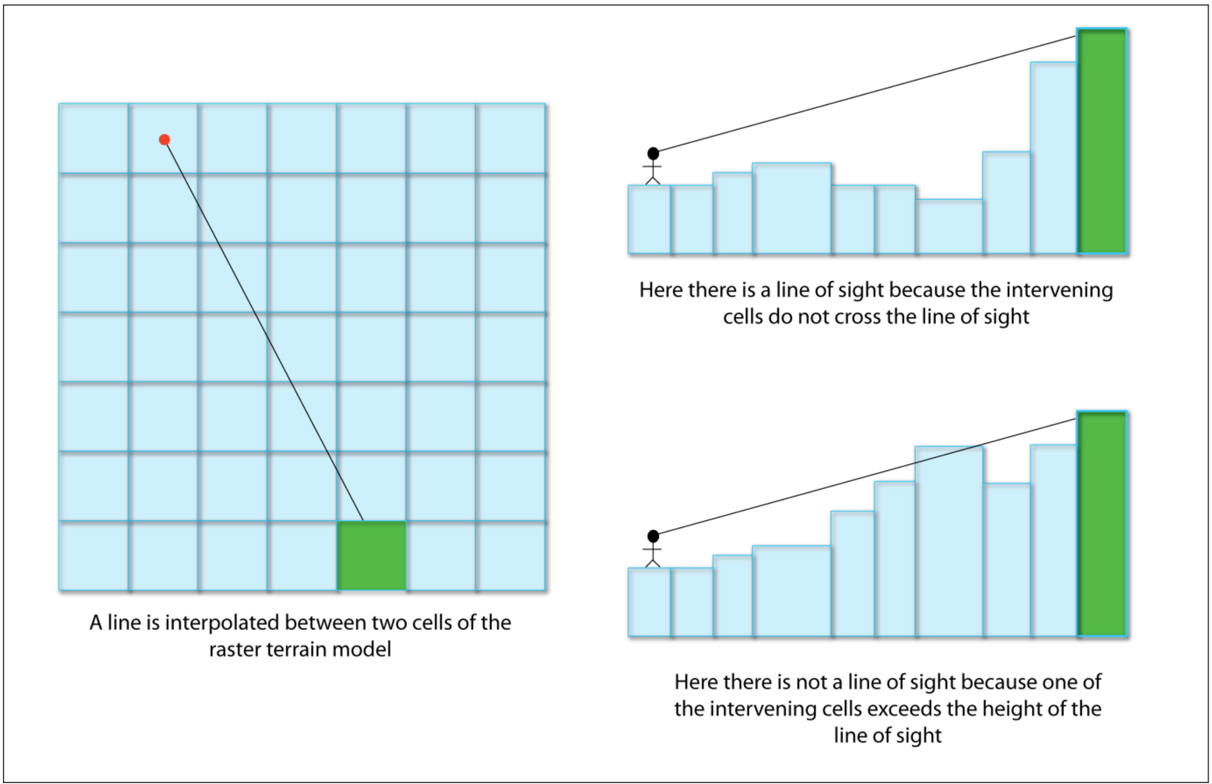

Figure 1.8: The application of viewshed analysis in GIS systems.

cumulative viewshed is the repetitive process of applying the former technique on the same raster terrain multiple times with different point data (i.e. different positions on the terrain). The multiple binary maps are then overlaid with cells visible from two different points combining and having a value of two, cells visible from three different points having a value of three and so forth. The resultant image is the sum of all the viewsheds, with the value of each cell corresponding with the number of points that can be seen from the cell. Wheatley (1995, 171) suggests that cumulative visibility can be used to make inferences about the relationships of intervisibility between related sites within a landscape.

Spatial Analytical Techniques: Least-Cost Path (LCP)

LCP analysis can be described as the generation of the optimum path of travel between two chosen points. To pass between these points involves traversing terrain as well as natural and cultural features that impede movement (Howey 2007, 3–4). These impediments are classified and given a cost in the model (these are called 'cost surfaces'), which then choses the path that accumulates the least 'cost' connecting each point (Figure 1.9). Terrain is probably the most commonly used variable

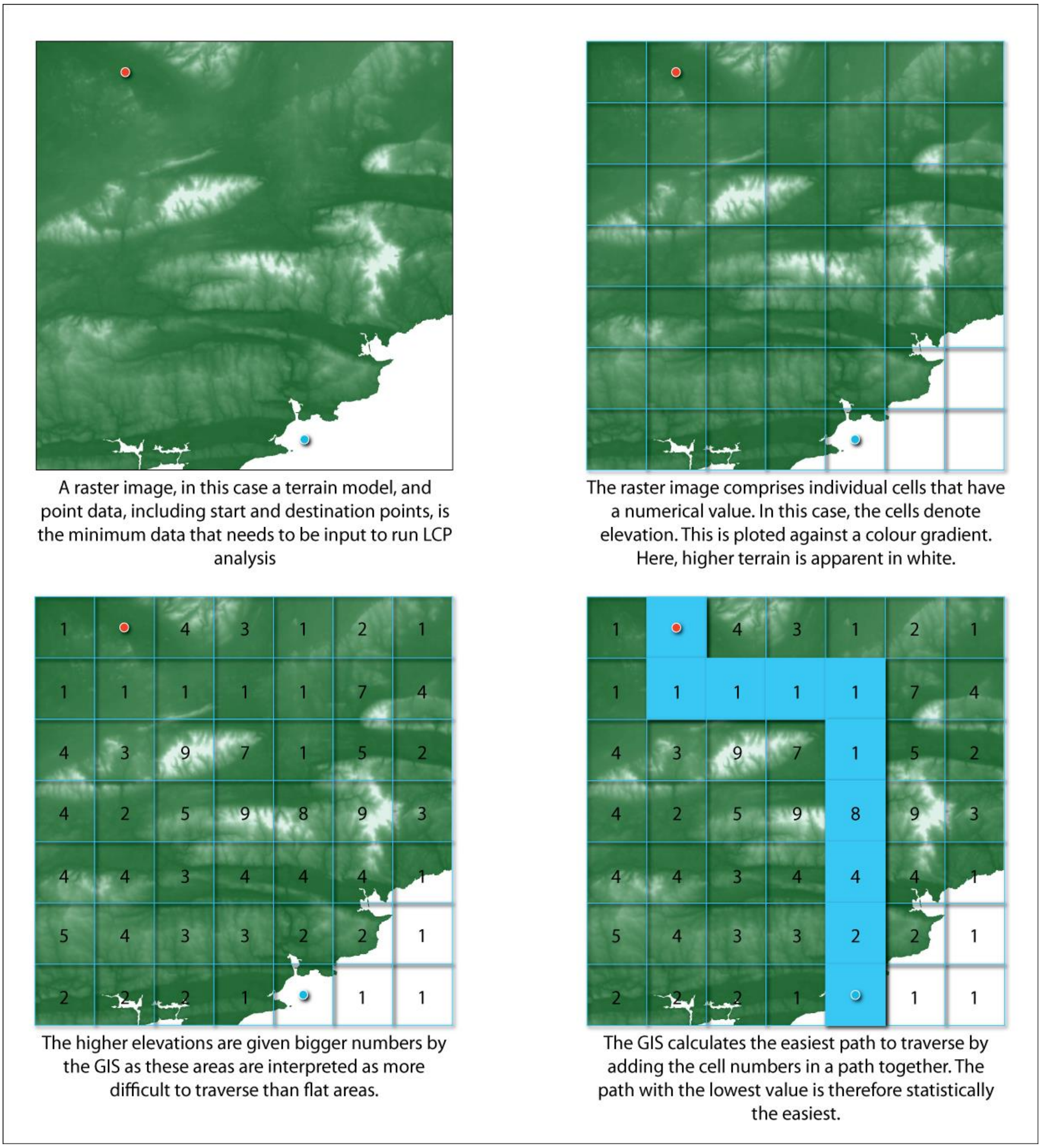

Figure 1.9: The application of Least Cosy Path (LCP) analysis in GIS systems.

in LCP models because of the energy expenditure to traverse irregular terrain can be easily modelled (Bell and Lock 2000; Surface-Evans 2012, 137; Murrieta- Flores 2010, 254). Bell and Lock (2000) have contributed to the classification of elevation data by recognising that the cost of climbing a slope may not be directly proportional to the degree of slope, i.e. a 45 degree slope is not 45 times more difficult than moving through level terrain. The relationship between slope and effort is therefore not linear (Bell and Lock 2000, 88) and neither is it uniform in direction. Slope is anisotropic, meaning the cost of traversing a downhill slope is not equivalent to travelling uphill. Furthermore, travelling downhill is not necessarily an easier task due to the effects of gravity (Llobera 2000;

Murrieta-Flores 2010). When interpreting routes through a landscape with an element of directionality, further calibration is required. In these cases an anisotropic cost algorithm may be used (see Bell and Lock 2000, De Silva and Pizziolo 2001). This algorithm incorporates the direction of force (i.e. downslope) in conjunction with its magnitude (slope). Effectively, an anisotropic algorithm will imply force against someone moving uphill and force with someone moving downhill. Whilst this is appropriate for most applications, there is no consideration of the implications of this over very rough terrain. Beyond certain thresholds in slope, effort moving downhill will ultimately become increased as the slope no longer assists movement. This type of cost analysis is also closely linked with catchment models, where the same 'cost surfaces' can be used to create catchment zones and model travel time.

Despite the advances in understanding slope, Llobera (2000) has emphasised the importance of additional 'cost' factors, suggesting a methodology based entirely on slope- dependant costs negates the importance of cultural factors that might strongly influence movement. Movement can be influenced by social, political or cultural factors, and also by religious beliefs and territoriality in the prehistoric period (Murrieta-Flores 2010, 258). These influences are often difficult to model, hence a reliance on physical factors such as slope. Modelling the physical environment, however, is also problematic. Palaeo-environmental information is often unavailable or too coarse to be able to effectively model woodland, wetland, vegetation cover, etc. Although it is best practice to include multi-criteria surface analysis for large spatial scales (Howey 2007, 1831), this is not always practical, particularly at a micro-landscape level.

Spatial Analytical Techniques: Aspect and Slope

Aspect analysis is used to assess the direction in a raster image, usually a terrain model. The technique identifies the downslope direction of the maximum rate of change in value from each cell to its neighbour. It essentially creates a pseudo TIN (Triangular Irregular Network) surface by connecting the edges of individual cells in a raster image to create a sloped surface. The angle of slope can then be measured and plotted against a colour gradient (Figure 1.10). Aspect is essentially the direction of slope and the values of the resultant analysis will be the compass direction of aspect. It is expressed in positive degrees from zero to 359.9 and flat areas are assigned a value of -1. As such, slope analysis works in a similar way. Slope information is extracted from an input TIN or raster terrain model. The resultant analysis produces a vector image of the severity of slope plotted

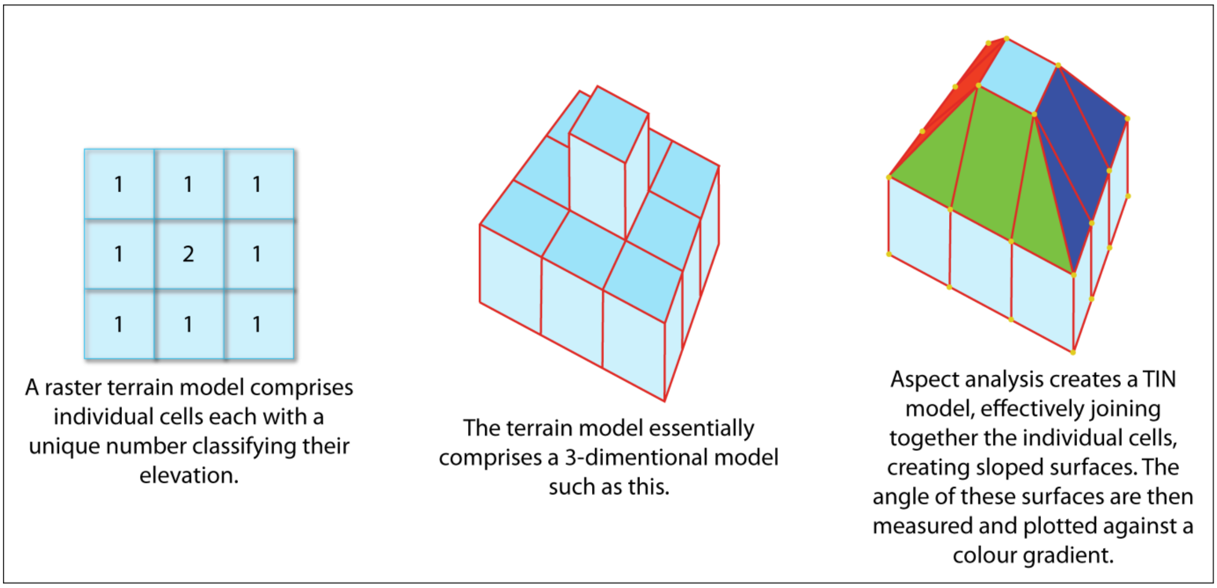

Figure 1.10: The application of aspect analysis in GIS systems.

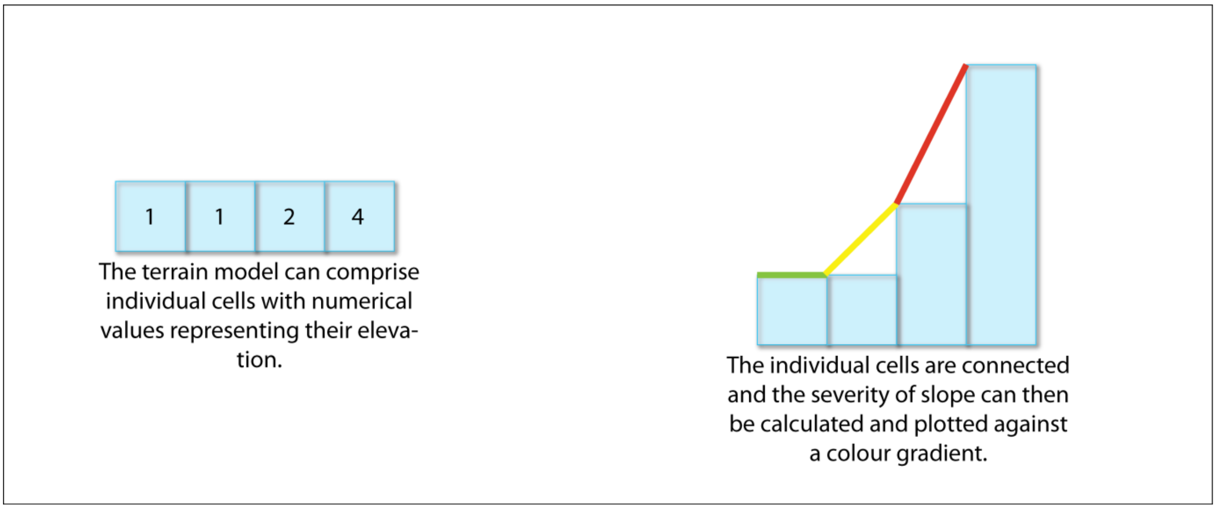

Figure 1.11: The application of slope analysis in GIS systems.

against a colour gradient. For example, a minor slope of 4 degrees will have a lesser value than a slope of 25 degrees (Figure 1.11). For both analytical techniques, the quality and resolution of the original raster image or TIN is important.

1.3 Research Aims

In addition to creating a comprehensive collection of high resolution three-dimensional data that is freely available to other researchers and the public, this study aims to assess the form, function and strategic positioning of these monuments using the data collected for the project, as well as other freely available datasets such as NASA's SRTM topographical data. The project has a number of specific aims:

- To record in detail the archaeology of each individual landscape, using the collected data to identify unrecorded settlement features, field-systems and other extra-mural features.
- The assess the topographical setting of these forts
- To use the data to visualise each fort in their surroundings
- To examine and record the design and form of the different types of architectural features identified at each site and compare these results.
- To inform potential construction techniques
- Use the data and information retrieved from GIS analysis to re-access the potential chronologies of each site, their potential function and significance in contemporary society.

The results of this study should enhance the already extensive amount of information available for these important sites and future study.

2

Western Stone Forts in Kerry

Raftery (1972, 39) includes Caherconree and Faha in his list of Irish hillforts, listing them in the Class 3 sub-category of inland promontory forts. This sub-division comprises five sites: Caherconree, Co. Kerry, Faha, Co. Kerry, Castle Gale, Co. Limerick, Lurigethan, Co. Antrim and Knockdhu, Co. Antrim. Though there are approximately 63 other inland promontory forts recorded in Ireland, Driscoll (2016, 39) notes that those included in Raftery's list are uniquely positioned in high-altitude locations in a dominant topographical setting.

The inland promontory fort of Knockdhu is the only example that has been excavated to date (Macdonald 2008; 2012). The monument uses cliff edges to the north, east and south as a natural barrier. The western approach is protected using a series of three banks and two ditches. Macdonald (2008) notes that although the enclosing elements are visually impressive, the three banks are relatively slight features that have been carefully positioned to exploit the promontory's natural topography and maximise the impact of their appearance. Their composition also contrasts with those found at Faha and Caherconree, which comprise drystone walling, though this may be explained by the readily available stone collected through field clearance in the latter examples.

Excavation at Knockdhu revealed two main phases of phases of construction. Macdonald (2008) has argued that the inner and middle banks were probably contemporary, stating that the latest dates derived from a sample obtained from buried soil beneath the inner bank (1409–1221 BC) is superseded by the latest date derived from a sample taken from buried soil underneath the middle bank (1008–858 BC).

The latest date from the outer bank was obtained from a sample taken from buried soil underneath the bank and dates to (1426–1293 BC). Although all three banks could be contemporary, there was no stratigraphic evidence to validate this assumption. The second phase of activity is represented by an extension of the inner bank and the re-cutting of its associated ditch after it had accumulated a substantial amount silt. The latest radiocarbon date obtained near the base of this re-cut provides a terminus post quem of 740–389 BC.

The entrance of the fort comprises a simple corresponding gap in the enclosing elements at the southern end. Excavation of the break in the inner bank revealed a roughly cobbled surface overlaying polished bedrock that was 1.9m wide. A large post-hole 0.4m wide, was revealed underneath 0.55m from the edge of the entrance. This feature is likely to be associated with the original entrance. A radiocarbon date from twigs recovered from the fill of the post-hole dates the dismantling of the structural wood to 1118–930 BC. Sealing the post-hole, a series of heat-modified clay deposits contained charcoal were revealed. This surface had been subject to intense burning (Macdonald 2008). This feature may be associated with the burning of the wooden palisade. Although no obvious post-holes were associated with this feature, the narrow trench may not have been large enough to reveal possible palisade features. No date was retrieved from this surface.

Five circular structures or platforms were excavated within the interior of the hillfort. There have been approximately 70 possible hut structures identified within the interior, the majority recently being revealed by high-resolution LiDAR commissioned by the Northern Ireland Environmental Agency (McNeary 2012). The majority of excavated structures appear to date to the Late Bronze Age and may be broadly contemporary with the construction and occupation of the hillfort (Macdonald 2008). One structure dates to the Late Neolithic/Early Bronze Age (dates from a hearth produced ranges of 2425–2201 and 2459–2206 BC and a charred hazelnut from a wall-slot returned a date of 2459–2206 BC), indicating that the promontory was periodically exploited prior to the construction of the enclosing elements.

The dating of Knockdhu, therefore, corresponds with the chronology of other Irish hillforts, with a concentrated construction horizon around the end of the Middle Bronze Age and Late Bronze Age periods (O'Driscoll 2016, 64). Though without excavation evidence for Caherconree or Faha, we cannot securely establish a chronology for the sites, a Late Bronze Age date would seem more appropriate at present. This supposition is tentatively supported by the landscape setting of the both sites.

2.1: Faha

Positioned on a ridge near Brandon Mountain, on the western edge of the Slieve Mish Mountain range at 777m OD (Figure 2.1) (ITM: 447882, 612002). The high altitude inland promontory fort of Faha (RMP: KE037-048) is the highest recorded hillfort in Ireland or Britain. The Slieve Mish Mountains are a narrow range extending in an east–west direction for approximately 19km. They

Figure 2.1: Aerial photograph of Faha hillfort, taken from the east.

comprise a high ridge of sandstone with numerous U-shaped valleys and corrie lakes created during the last ice age.

The fort is positioned within the townland of Faha/Benagh and occupies a total foot print of approximately 13.46ha. This almost inaccessible monument comprises two widely spaced drystone walls that defend the southeastern edge of a ridge. The remainder of the promontory is surrounded by steep cliffs that narrow to the north forming a sub-triangular shape. The construction methods used at Faha are strikingly similar to those found at the nearby inland promontory fort of Caherconree.

Faha: enclosing elements

Due to the inaccessible nature of this high altitude inland promontory fort, there are few published descriptions of the site. The inner wall of the promontory fort was first recorded in the second edition 25 inch Ordnance Survey maps. It comprises a drystone wall approximately 1.3m high and about 2.2m wide. It runs in an arc roughly north–south for a length of about 45m, both terminals abutting the edge of steep cliff face. There are no obvious entrance features to this enclosure. Although poorly preserved, there are tentative suggestions of possible internal terracing. The wall was constructed using blocks of sandstone (probably field clearance) stacked horizontally length-ways, with the external face set in a roughly flush arrangement. There is a possible entrance comprising a 9m gap between the faced terminal of the stone bank and the northern cliff face.

The outer enclosing element is positioned 125m–140m from the inner example and is in a much better state of preservation. It curves in an approximate north–south direction for a length of 155m and is constructed in a similar manner to the inner example. Both terminals abut the edge of steep cliff face. A 28m long central section is preserved particularly well. In this section, the drystone wall stands to a height of about 1.95m and is 2.5m thick. There is also definitive evidence for at least one terrace, with the likelihood of a lower terrace also noted. There is a simple entrance gap, approximately 1.3m wide, in this central section. This entrance was flanked on its northern side by a flagstone sitting on edge, while the southern side comprises stones of the enclosing wall set in a roughly flush arrangement. There is also the possibility that this entrance was paved.

There are no recorded internal features or evidence for internal occupation apparent on the surface or in aerial photography.

Faha: photogrammetry survey and results

A total of 505 geo-tagged aerial images were captured surrounding Faha hillfort, resulting in the generation of a DSM (Digital Surface Model) and orthomosaic 125.4ha in size (Figure 2.2 and Figure 2.3). The DSM consists of approximately 2301455 three-dimensional data points with an average density of 12.73 points per metre. Considering the severity of topographical variation within the surveyed area, more points per metre were obtained from features at a higher elevation (such as the fort itself), as there was increased pixel resolution in these areas (the areas being closer to the camera than features further downslope). As part of the project, a 3D model was created and is available for the public to view: https://sketchfab.com/models/b393d7754de64494ab233aae6b607be0. Similarly, a 360 degree aerial image can be viewed at: https://www.skypixel.com/photos/d7e58a6c-1366-4717-a87e-027a9e0d61cd.

Figure 2.2: Faha DSM generated from photogrammetry survey.

The orthomosaic was useful in identifying a number of possible archaeological features (Figure 2.3). **A1** represents a possible hut structure abutting the outer face of a denuded section of the external wall. It comprises a circular area of cleared stones measuring 2.93m in diameter, surrounded by a footing of large stones (Figure 2.4 and Figure 2.5). Approximately 3.5m to the north, another possible hut site is apparent (**A2**). It abuts the outer face of a denuded section of the outer wall and measures 3.62m in diameter. It is less defined than the latter example, though its interior is cleared of loose surface stone. There are no obvious structural features visible on the surface or in the photogrammetry results within the hillfort, though it is notable that the interior has been cleared of scree and loose stones, in contrast with the surrounding landscape.

The inner wall ranges from 1.83m to 2.56m in width and is a maximum of 1.6m high (Figure 2.4). The inner face has a single terrace approximately 0.85m wide. The outer face is vertical and is preserved well for the majority of its length. The southern section of the wall is more denuded and

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Figure 2.3: Faha DSM generated from photogrammetry survey.

curves westward towards the steep incline which forms the defensive barrier at the south-west,west and north. There is a 1.63m wide entrance break at the near the centre of the wall (**A3**). The southern terminal of this is faced. The wall runs for a total length of 33.5m. At the northern side of the mountain, the orthomosaic reveals a possible extension to the inner defences (**A4;** Figure 2.6). This low grass covered mound of stones measures approximately 3.9m wide and 0.3m high, and runs for 214m. Without excavation, it is difficult to interpret if this feature is archaeological. However, if it can be considered as part of the enclosing elements of the hillfort, it would increase the visibility of the monument from low-lying areas to the north in Tralee Bay. Considering the possible function of Irish hillforts (see O'Driscoll 2017), it could be argued that visibility of the monument from settled landscapes was a primary concern.

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Figure 2.4: Plan and profiles of Caherconree hillfort.

Figure 2.5: Location of hut sites A1 and A2.

Figure 2.6: Three-dimensional view of possible extension of inner wall at the northern side of the hillfort.

The outer enclosing wall is between 107–142m from the inner example. There is a slight curve at its centre and this increases substantially to the south, where the wall begins to follow the contours of the hill. The wall continues for a length of approximately 191m, varying from an impressive 2.1m high, 2.65m wide barrier with internal terrace and vertical external face, to a low heap of stones with the footing of its inner face being partially preserved. Similar to the inner wall, the terrace, where preserved, is approximately 0.92m wide. It also has a simple 1.47m wide entrance near the centre of the wall (**A5**). The southern terminal is well preserved and is faced. The entrance also appears to be paved with stone slabs.

There is a curious break in the wall (both the preserved wall and the remains of the heap of stones that probably represents the wall) at the northern section of the enclosure (**A6**). This measures approximately 7m wide. The northern 'terminal' of this break also seems to have been faced. This, therefore, may be another possible original entrance. It is not uncommon for hillforts to have multiple entrances along the same enclosing elements, the best example being Mooghaun in Co. Clare (Grogan 2005).

Visibility analysis suggests that there is not any advantage, from a line-of-sight perspective, to building the internal terraces, considering the slopes of the interior are so severe that one can see beyond the wall from only a few metres inside the enclosure. The terraces, therefore, may have been added for practical reasons, to allow the occupants of the fort access to the top of the wall, or to allow them to gain a height advantage while also having defensive cover from attackers. Visibility from inside the inner wall is substantially restricted, again due to the severe slopes of the mountain (Figure 2.7). Although this could be considered a defensive disadvantage, the slopes surrounding the summit, as well as the boulders and stones, would have added significantly protection to the occupants. The lower slopes of the mountain and the low-lying terrain beyond this are highly visible from the summit. Outside the fort, the topography restricts visibility of the interior (Figure 2.8). This could have been a defensive design, though it could also have been used as a way of restricting certain peoples access and visibility to the activity within the interior, and therefore this arrangement may also have had a ritual function.

Wider viewshed analysis (Figure 2.9) highlights that Faha hillfort may have been positioned to afford maximum views of Tralee Bay. However, the hillfort is located in a mountainous region which would have diminished its visibility when viewed from Tralee Bay. The addition of the possible enclosing elements on the northern slopes of the mountain would have significantly augmented visibility in this area.

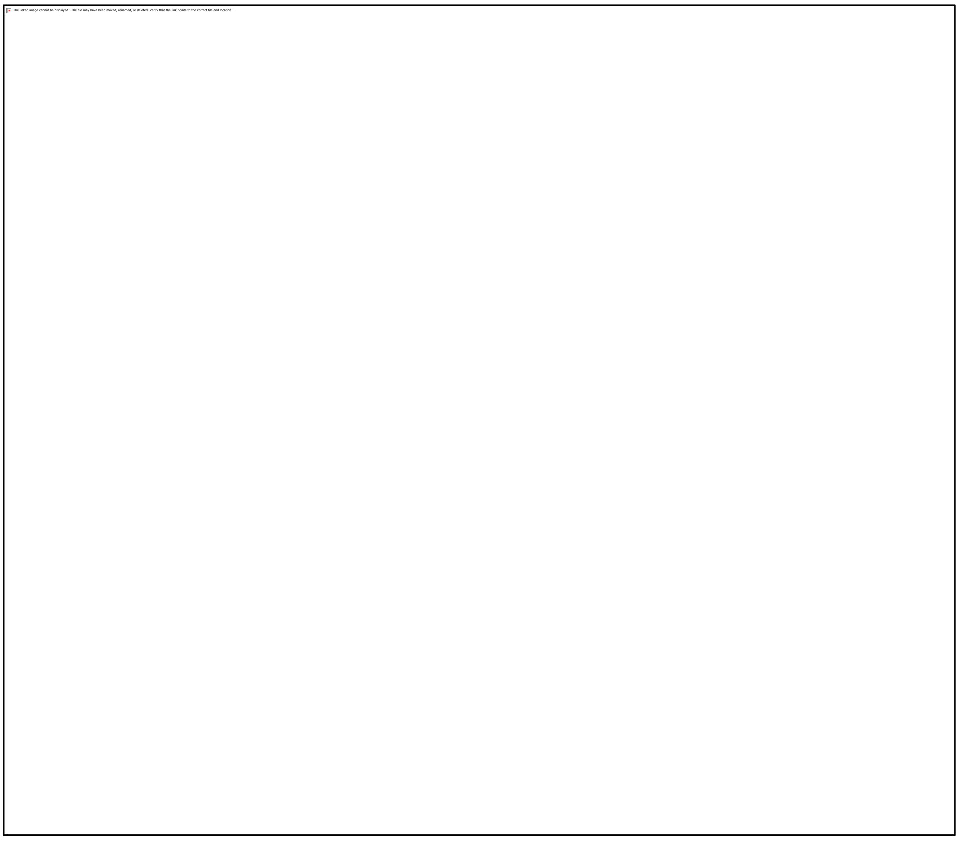

Figure 2.7: Viewshed analysis of Faha hillfort, with areas visible from the interior visible in blue.

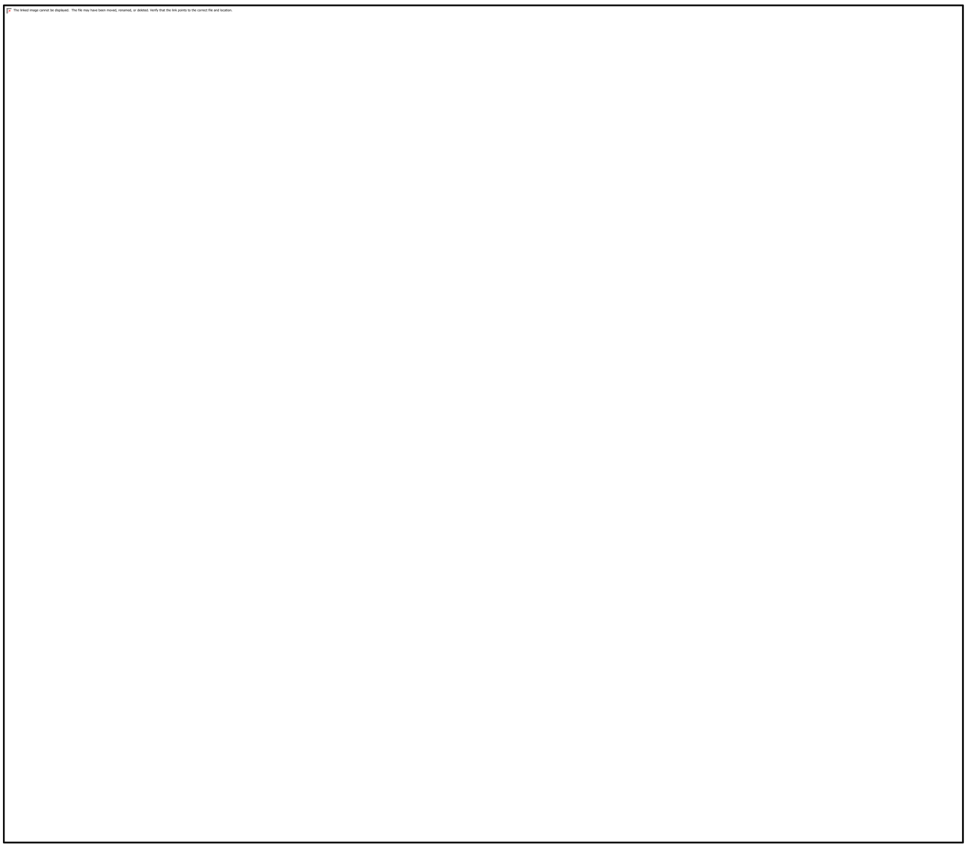

Figure 2.8: Viewshed analysis of Faha hillfort, with areas visible from outside the eastern approach to fort visible in red.

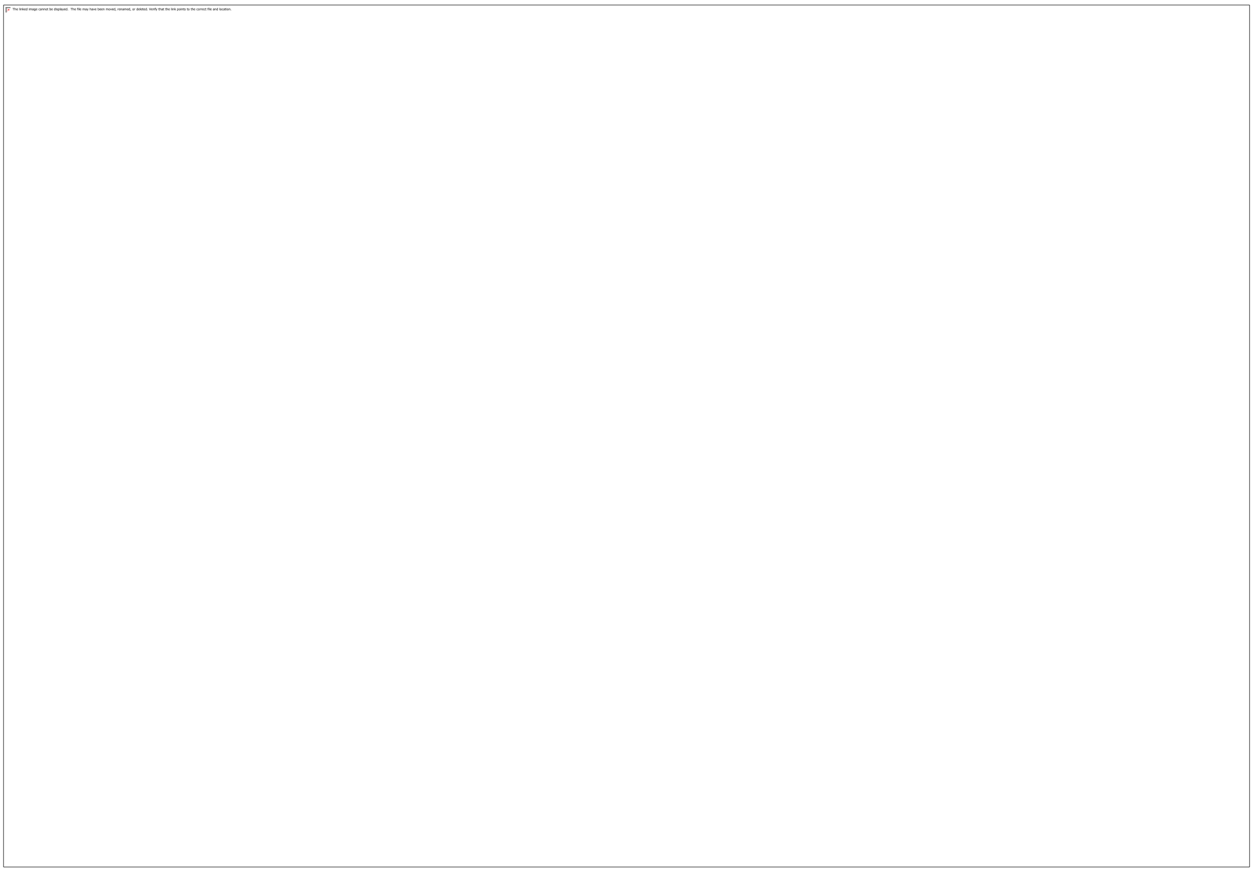

Figure 2.9: Viewshed analysis of Faha hillfort landscape, with areas visible from the hillfort highlighted in green.

Summary

The photogrammetry survey of Faha hillfort was successful in recording the current state of the important hilltop fort, providing both high-resolution ortho-rectified aerial images, as well as a DSM. A number of entrances were identified and recorded in detail, as well as the condition of the enclosing elements. Significantly, a possible extension to the inner wall at the north was identified, which would have greatly added to the visibility of the monument from the low-lying landscapes in Tralee Bay. Unfortunately, there are no obvious features of archaeological potential visible in the slope or hillshade models, though the orthomosaic was helpful in identifying some possible hut sites. The dramatic slopes and landscape that surrounds the hillfort would have made settlement in the environs difficult, though this adds to the peculiar location of the monument, which is both inaccessible and inhospitable.

2.2 Caherconree

Approximately 25km to the east of Faha, another high altitude inland promontory fort at Caherconree (RMP: KE-046-003) is positioned in the heart of the Slieve Mish Mountains (ITM: 472643, 606700). The fort is situated on the edge of a west facing mountain ridge at 659m OD, in the townland of Ballyarkane Oughter (Figure 2.10). This ridge is a distinct topographic feature that is highly visible from low-lying areas. The fort comprises a single drystone wall which curves in an east-west direction for approximately 110m, cutting off the eastern approach to a triangular promontory. The site has a total foot print of about 1.22ha. There is tentative envidence for a second, outer enclosing elements. The remainder of the fort is protected by steep natural cliff edge at the north, west and south.

Viewshed analysis confirms the extensive views from the site, with dominant views of Dingle Bay, as well as a large portion of Tralee Bay being visible. The visibility of the monument is enhanced by the distinctive promontory the site is built on, which contrasts sharply with the natural landscape, creating what Smith (1756, 156) described as 'a beacon' in the landscape. This locational setting was probably a contributing factor in the placement of the fort, particular considering the monument is immediately overlooked to the north-east by the mountaintop also known as Caherconree. This setting leaves the site vulnerable, although one could consider the inaccessible location of the fort itself highly defensive. The location of Caherconree may be related to a need to be highly visible in the natural landscape, to have extensive views of both northern and southern sea-routes, and to appear monumentally defensive.

Figure 2.10: Caherconree hillfort looking south towards Dingle Bay.

There are a number of references to hillforts in the ancient narratives, the best example being Caherconree; 'the fort of Cú Roí'. Cú Roí seems to have been a non-historical figure with strong mythological associations, who played an important role as ruler over Munster (Cotter 2012a, 18). His fort is described as being near Sliabh Mis in the tale of Cú Roí's death. At 659m OD, Caherconree in the Sliabh Mis mountain range of the Dingle peninsula is the second highest hillfort in Ireland. Curiously, the literature explains that at night, Cú Roí casts a spell on the fort so that the stronghold revolves or is covered in mist, hiding the entrance. This may be an indication of the extreme height of the fort which is often covered in mist and cloud.

There is an interesting connection between mountains and warrior heroes, who are often depicted visiting or fighting on these summits. In cases where hillforts have been mentioned in these texts, they seem to be mentioned as pagan or prehistoric centres. In *Silva Gadelica*, Finn mac Cumhaill's hunting mound is positioned 'on top of high Keshcorran'. Keshcorran mountain in Sligo, is notable for the large cairn at its summit, which is surrounded by a hillfort (No: 72). Kelly and Condit (1998) have suggested that the two closely positioned hillforts on the two summits of Friarstown Hill (No: 46 and 47) can be associated with Tara Luachra. This ancient stronghold is described as the Luachair of many hill's in *The Intoxication of the Ulstermen* and is often divided into the eastern and western Luachair, possibly reflecting the topographical setting of the two hillforts at Friarstown.

Caherconree: enclosing elements

Similar to Faha, the inaccessible location of Caherconree means there has been limit study of this inland promontory. The site itself comprises a single drystone wall, constructed by stacking blocks of sandstone horizontally length-ways with the external face set in a roughly flush arrangement. The wall is roughly straight, extending in a north–west/south–east direction for a length of 110m. The wall survives best at the centre, where it measures 3m in maximum height and approximately 4.5m wide. Internal terracing is apparent throughout most of its length and consists of three steps surviving in good condition. Two possible original entrances are visible in the inner enclosing element at the north-east. No evidence for any internal features on the surface, although deep peat deposits may obscure possible activity. A possible stone trough was found in the interior (Lynch 1910).

There is tentative evidence for a second enclosing elements approximately 10m outside the inner example. This comprises a low bank and outer ditch visible for a length of about 25m at the northwestern edge of the site. Lynch (1899, 12–17) noted that the bank originally extended the full width of the promontory.

Five D-shaped structures are apparent abutting both the internal and external face of the inner wall. It is not apparent if these are contemporary with the initial construction of the fort or are latter features. No other features are visible within the interior, although deep blanket bog, up to 80cm in depth, may be overlying more extensive settlement evidence.

Caherconree: photogrammetry survey and results

A total of 183 geo-tagged aerial images were captured surrounding Caherconree hillfort, resulting in the generation of a DSM (Digital Surface Model) and orthomosaic 31.732ha in size (Figure 2.11). The DSM consists of approximately 8430430 three-dimensional data points with an average density of 18.16 points per metre. Considering the severity of topographical variation within the surveyed area, more points per metre were obtained from features at a higher elevation (such as the fort itself), as there was increased pixel resolution in these areas (the areas being closer to the camera than features further downslope). As part of the project, a 3D model was created and is available for the public to view: https://sketchfab.com/models/f0f728712d014953984e8acee4a51f96. Similarly, a 360 degree aerial image can be viewed at: https://www.skypixel.com/photos/cddb507c-e158-4edc-95c5-2fa39225d9fd?utm_source=url&utm_medium=copied&utm_campaign=share.

The orthomosaic was useful in identifying a number of possible archaeological features (Figure 2.12 and Figure 2.13). A slight vegetation mark running roughly north–south and extending from the southern terminal of the stone wall of Caherconree, on the southern facing slopes, is likely the remains of a field-boundary that was used to mark the townland boundary between Beheenagh and Ballyarkane Oughter (**A1**). Though this boundary seems to have been levelled prior to the completion of the first edition Ordnance Survey mapping programme, a 48m section that is partially extant is visible in the orthomosaic. It consists of a stone rubble wall approximately 1.5m thick and is located within an area of scree.

Interestingly, within this area of scree, there seems to be a number of circular platforms visible in the orthomosaic that have been partially cleared of scree, some of which are surrounded by a band of stone stacked on edge. These could be interpreted as possible unrecorded structures. **A2** and **A3**, for example, are located on the eastern side of the scree deposit and measures

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Figure 2.11: Caherconree DSM generated from photogrammetry survey.

approximately 4m just over 3m diameter respectively (Figure 2.14). These features correspond with slope analysis, which shows that they are placed on circular terraces cut into the natural slope of the hill. The hillshade model shows similar results, as well as highlighting a third smaller circular terrace abutting **A3** at the north. This measures approximately 2.3m in diameter and might be regarded as an appendage to the larger structure to the south, forming a figure-of-eight type structure. At the centre of the scree deposit, **A4** represents a circular area of clearance approximately 2.6m in diameter that corresponds with the slope and hillshade models which indicate the clearance is located on a circular platform cut into the natural slope of the hill. There are a number of other possible features that might represent structures in this area (**A5**, **A6** and **A7**), though these are more tentative than the examples listed above. Approximately 30m outside the defences at the east are two possible hut structures visible in the orthomosaic (**A8** and **A9;** Figure2.15). **A8** measures 3.6m in diameter and is defined by a circular area surrounded by a band of stones. **A9** comprises an

Figure 2.12: Caherconree Orthomosaic generated from photogrammetry survey.

oval area of 4m by 2.2m, again defined by a setting of stones. About 128m to the south-east is another circular area of partially cleared scree defined by a broad setting of stones (**A10**). This corresponds with both slope and hillshade models which suggest this circular feature is located on a terrace cut into the natural slope of the hill. All of the potential hut structures identified in this survey are close to the hillfort, and it is notable that there is a lack of potential structures in other areas.

The northern face of the scree deposit has a defined edge, following the more subtle break of slope in this area (Figure 2.13). Some sections of this face consist of boulders and there is a possibility that there may have been a stone wall protecting the southern edge of the promontory. The northern edge of the promontory is defined by a much more imposing cliff-face. One could question the defensive capabilities of the fort if the southern slopes were not defended by some form of barrier, however, it is also possible that the scree deposits could have acted as a natural

Figure 2.13: Plan and profiles of Caherconree hillfort.

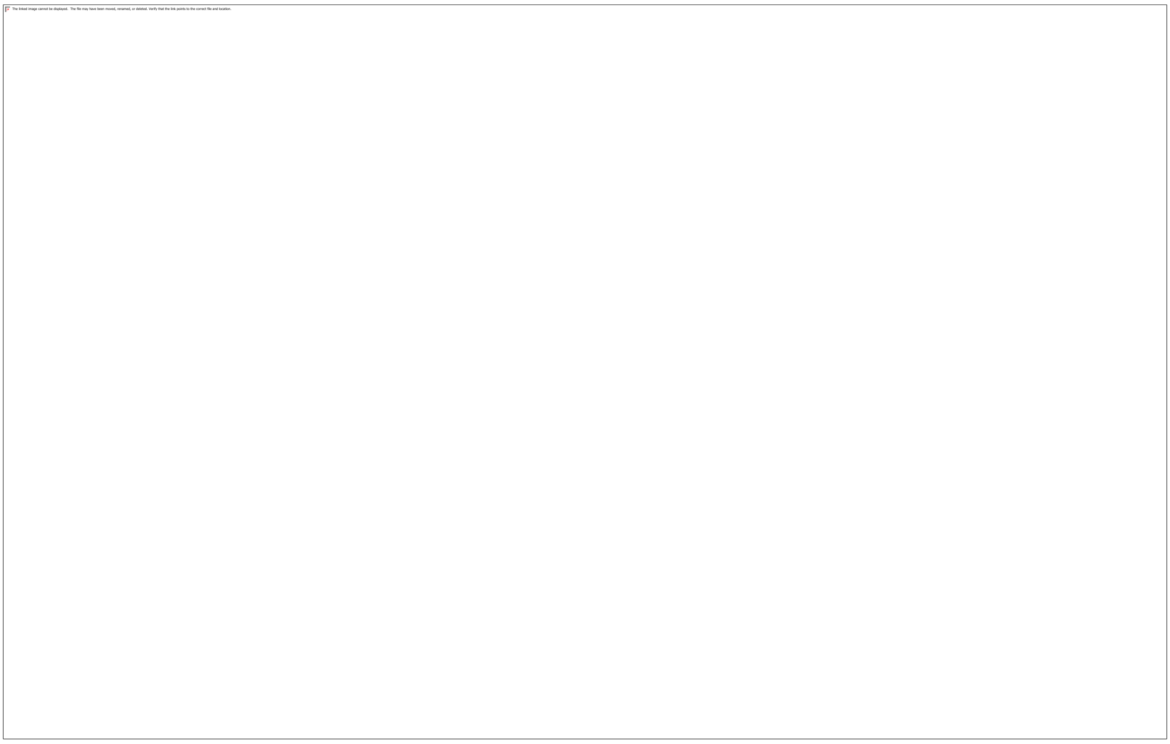

Figure 2.14: Orthomosaic and Slope model highlighting possible hut structures **A2** and **A3**.

chevaux-de-frise type defensive feature, augmenting the defences in this area. LCP (Least-Cost-Path) analysis suggests that the scree, or indeed the slopes on the southern side of Caherconree, did not provide much in the way of defence, with all of the start points (4) in this area traversing through the scree to access the interior (Figure 2.16). This may lend further weight to the interpretation that this side of the fort may have originally been defended by a stone wall. Why spend time and effort making an imposing stone wall on the eastern approach to the fort if the interior could easily be accessed from the south?

The slope model was useful in helping to define the possible outer enclosing elements (**S1;** Figure 2.13 and Figure 2.17). The northern section of this feature is still visible on the ground and consists of a 3m wide low-rise bank running in-line with the extant inner wall for a length of 32m. The feature terminates in-line with the corresponding entrance to the inner bank. However, the feature is faintly visible in the slope model further to the south, where it stays on average 14m from the inner wall (**S2**). There is also a 4m wide break in this feature (**S3**) which corresponds with break in the inner wall. Considering the antiquarian evidence corresponds with the information gained from the current survey, we can now consider Caherconree as a multivallate hillfort, with two widely spaced enclosing elements. Although this is a significant finding, it fits well with other high altitude inland

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Figure 2.15: Examples of possible hut structures found at Caherconree hillfort.

Figure 2.16: Least-cost-path analysis of the area surrounding Caherconree hillfort.

Figure 2.17: Slope analysis highlighting the line of the outer enclosing elements at Caherconree.

promontory forts in Ireland, as prior to this survey, Caherconree was considered the only example of its type to be univallate. Now, we could suggest that multivallation is a defining characteristic of this site type.

Slope analysis highlights the uneven topography of the interior of the fort, though considering the depth of peat deposit, this may not reflect the actual level of the old ground surface upon which it accumulated (Figure 2.18). Of particular interest, however, are two curious breaks in the steep-sided cliff-face at the west and north-western side of the fort. The western break (**S3**) is approximately 4.2m wide. Although it is still steep, it can be used to access the interior of the fort. The overhanging rock-face on either side as one traverses the gap are an impressive, presumably natural, feature, that would have added a sense of spectacle if used as a formal entrance. LCP analysis highlights that this could have functioned as an entrance, with all of the start points (5) in this area traversing this gap. The second possible break at the north-west (**S4**) is approximately 6m wide. The northern terminal is in-line with the inner wall of the fort, and it is possible that the terminal represents the partially robbed-out remains of the edge of the inner wall, which could have extended beyond the break of slope. This would explain what seems to be a gap between the edge of the inner wall and the natural break of slope, which would have allowed access to the interior of the fort. If this interpretation is correct, than **S4** could be considered a deliberately constructed entrance feature. If the builders of the fort did not want an entrance in this area, could have connected the north-western edge of the inner wall with the natural cliff-face rather than leaving

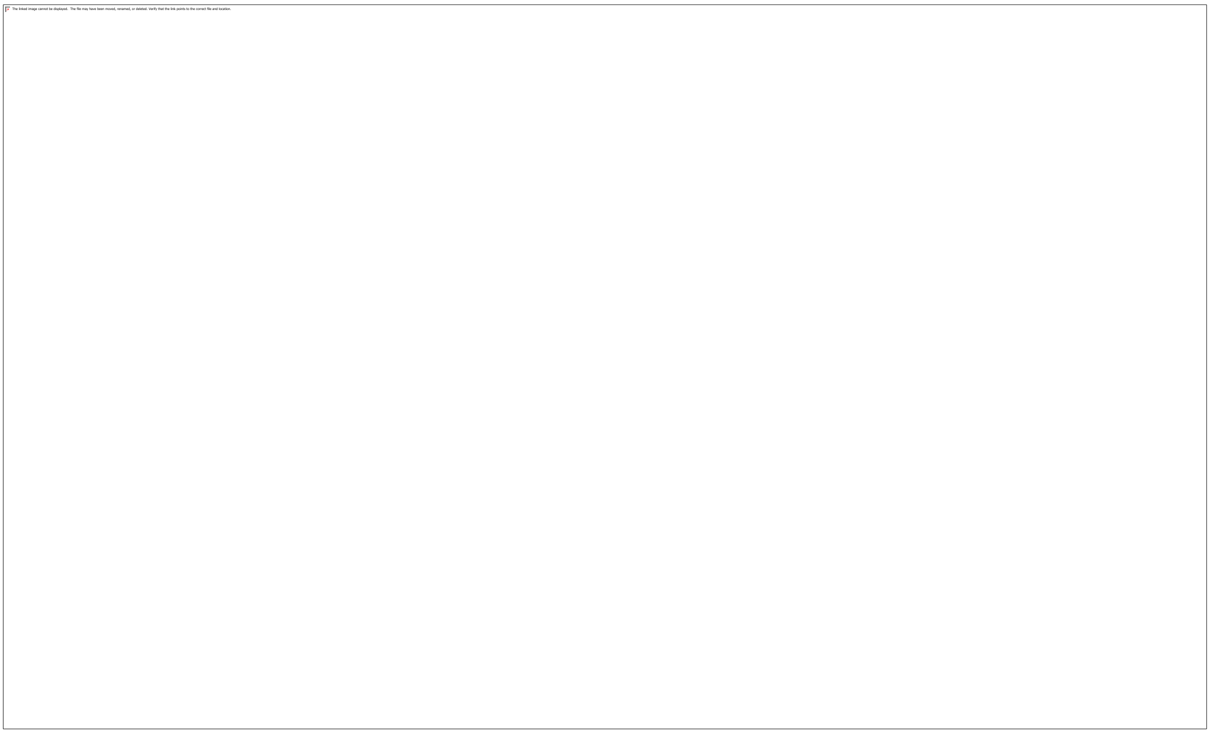

Figure 2.18: Slope analysis of Caherconree hillfort highlighting the uneven nature of the interior.

this break. The break helps to funnel three start points, indicating it could have been used as an entrance.

Using the slope and hillshade models to more accurately measure the inner enclosing elements highlights that the inner wall is a maximum of 5.6m wide and 3.2m high and the promontory fort is 1.34ha, making the defences and area enclosed substantially larger than what has been recorded by the archaeological survey. Interestingly, the slope model highlights the presence of a flat terrace abutting the inside of the inner wall, as well as a similar feature abutting the inner and outer edge of the possible outer enclosing element. These platforms may have been utilised during the construction of the hillfort, providing a level area to begin construction and could also have been used to mark the intended circuit of the defences. Similar evidence has been found at Mooghaun hillfort in Co. Clare (Grogan 2005, 226), as well as at a number of the Baltinglass hillforts in Co. Wicklow (O'Driscoll 2016).

Such level areas where also ideal places for settlement, and this is supported by the number of recorded structures that abut the inner wall. Five recorded hut sites abut the internal face of the wall and two are placed against the outer face. However, none of these structures have been given relevant geographical coordinates, meaning it is impossible to distinguish there location. Considering there are additional structures that have been recorded by this survey, the author will describe all of the possible structures present, working from north to south and describing those abutting the inner face of the bank first.

S5 is positioned on the northern side of the inner wall. It comprises a circular sunken depression measuring 1.86m in diameter abutting the inner face of the inner wall. There is no clear evidence for a circular band of stones that might represent the foundations of a wall. **S6** is located 1m to the south. It measures 2.27m in diameter and is defined as a slightly sunken features with an outer band of stones. Though this structure abuts the inner face of the inner wall, it is not built using or on top of wall collapse. This, therefore, could be a contemporary with the hillfort, though dating would be needed to clarify this. Approximately 1.7m to the south, an oval depression abutting the inner face of the inner wall measures 2.38m by 1.43m (**S7**). This feature is visible on the surface as a depression, however, there are no associated stone features that might represent the footings for a wall. About 6.3m to the south, and immediately south of a possible original entrance to the fort, a circular band of stones measuring 2.29 in diameter corresponds with a slight depression visible in the slope model (**S8**). **S9** represents a well preserved oval structure measuring 3.9m by 2.13m. It surrounds a deep sunken area and is defined by a band of stones. Although the archaeology survey has suggested that this was constructed using collapsed stone from the inner wall, considering the wall is well preserved in this area and the structure is not built upon wall collapse, it is possible that the hut site could be contemporary with the hillfort. Near the southern edge of the inner wall, there is a circular depression measuring 1.93m in diameter that underlies some wall collapse (**S10**).

Outside the inner wall to the north, a C-shaped band of stones measuring approximately 3.83m in diameter is probably a relatively modern construction (**S11**). Immediately to the north of a possible original entrance, a circular platform cut into the natural hillslope measures approximately 3.09m in diameter (**S12**). The southern edge of this platform is defined by a band of stones, though this does not form a complete circle. Abutting the outer face of the inner enclosure is a circular band of stones measuring 4.34m in diameter which corresponds with a flat terrace feature apparent in the slope model (**S13**). This setting is partially covered by wall collapse. **S14** abuts the outer edge of the inner wall immediately to the north of another possible original entrance. This feature consists of a circular platform approximately 3.13m in diameter and is visible on the surface a circular band of stone that is partially covered by wall collapse. Built within and on top of wall collapse is a circular setting of stones that measures approximately 2.71m (**S15**).

Using aspect analysis, we can see that there are subtle and evenly spaced depressions in the northern section of the inner wall (Figure 2.19). There are approximately 4.6–6.1m apart, and could represent evidence that the hillfort was constructed by groups or 'gangs' of people, with each gang (or every season) constructing a section of the defences that would later be joined together. Evidence for gang working is apparent at a number of hillforts in Britain. At Perborough Castle, in

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Figure 2.19: Aspect analysis of the northern section of the inner wall at Caherconree. Note the red dots highlight areas the analysis has highlighted a change in aspect (direction of slope) which could indicate gang-working.

Wessex, the hillfort banks appear to have been created from a series of straight sections with angular changes in alignment, which has been interpreted as evidence for gang-working (Corney *et al.* 2006, 41). Similar evidence is found at Cherbury Camp, Oxfordshire (Bradford 1940), Chiselbury in Wiltshire (Pugh and Crittall 1957) and Mere Hill, Herefordshire (Ray and Hoverd 2000). There are often well-defined angles where the individual sections join, an excellent example being the hillfort of Castell Bwa-drain Camp in Wales (Murphy *et al*. 2006). These sections of bank would have been worked by a group or gang of people. These gangs may have been further divided into smaller groups who extracted material from a series of closely set pits. Yarnbury Castle in Wiltshire is an excellent example, where hollows at the bottom of the ditch are likely to represent individual pits which have subsequently been joined together (Cunnington 1933). Interestingly, at Cahercommaun, Hencken (1938) identified a number of vertical joints in the three enclosing walls which he argues is evidence for gang working. No comparative evidence was identified at Caherconree.

Grogan's study of Mooghaun hillfort in Co. Clare has revealed features that could be related to gang working. Topographical survey identified a series of slight angular joints in all three of the enclosing elements and led Grogan to conclude that the hillfort is polygonal (Grogan 2005a, 129). He observed that the enclosing elements are made up of 35–90m long straight sections in the inner and middle banks and 60–135m in the outer example. Differences in structural detail was noted in adjoining bank sections, which Grogan has interpreted as evidence for gang working. He suggests that each gang worked from a 'general structural blueprint', but provided individual solutions to problems encountered.

Smaller gang working sections been identified at other sites, such as at Breiddin hillfort in Powys, Wales (Musson 1991, 176). Musson suggests that the 'meandering' line of the bank could be divided into 8m sections that could reflect different gangs. Even smaller sections were identified by Mytum (2013, 220) at Castell Henlly in Pembrokeshire, Wales. Section of up to 2.2 and 2.4m were revealed by variations in the rear facing, suggesting small gang groups.

Viewshed analysis of Caherconree shows that the inner wall of the fort partially obscures visibility of the interior from up to 60m away (Figure 2.20). At a distance of about 100m from the inner wall, the majority of the interior is visible due to the elevated terrain in this area (Figure 2.21). Though this could be considered counter-defensive, Robertson (2016) and Armit (2007) have argued that 60m is the approximate distance for effective use of sling stones or other projectile weapons used during the Late Bronze Age or Iron Age. We could consider the height of the wall, which in places is over 3m, to have been built to deter attackers as well as obscure visibility of the interior

Figure 2.20: Viewshed analysis of Caherconree and its eastern approach highlighting the limited visibility of the interior from up to 60m from the inner wall.

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Figure 2.21: Viewshed analysis of the lower slopes of Caherconree highlighting the complete lack of visibility of the interior from these positions.

within a buffer zone of approximately 60m. On the lower slopes surrounding Caherconree, visibility of the interior is almost completely blocked by the natural terrain (Figure 2.21).

Examining the wider landscape setting of Caherconree, we can see there are extensive views from the fort (Figure 2.22), which overlooks both Tralee Bay to the north and Dingle Bay to the south. From a distance, the visibility of the fort is enhanced by the distinctive promontory the site is built on, which contrasts sharply with the natural landscape, creating what Smith (1756, 156) described as ‘a beacon’ in the landscape. This locational setting was likely a contributing factor in the placement of the hillfort, particular considering the monument is immediately overlooked to the north-east by the mountaintop also known as Caherconree. The location of Caherconree in the wider landscape may be related to a need to be highly visible in the natural landscape, to have extensive views of both northern and southern sea-routes, and to appear monumentally defensive.

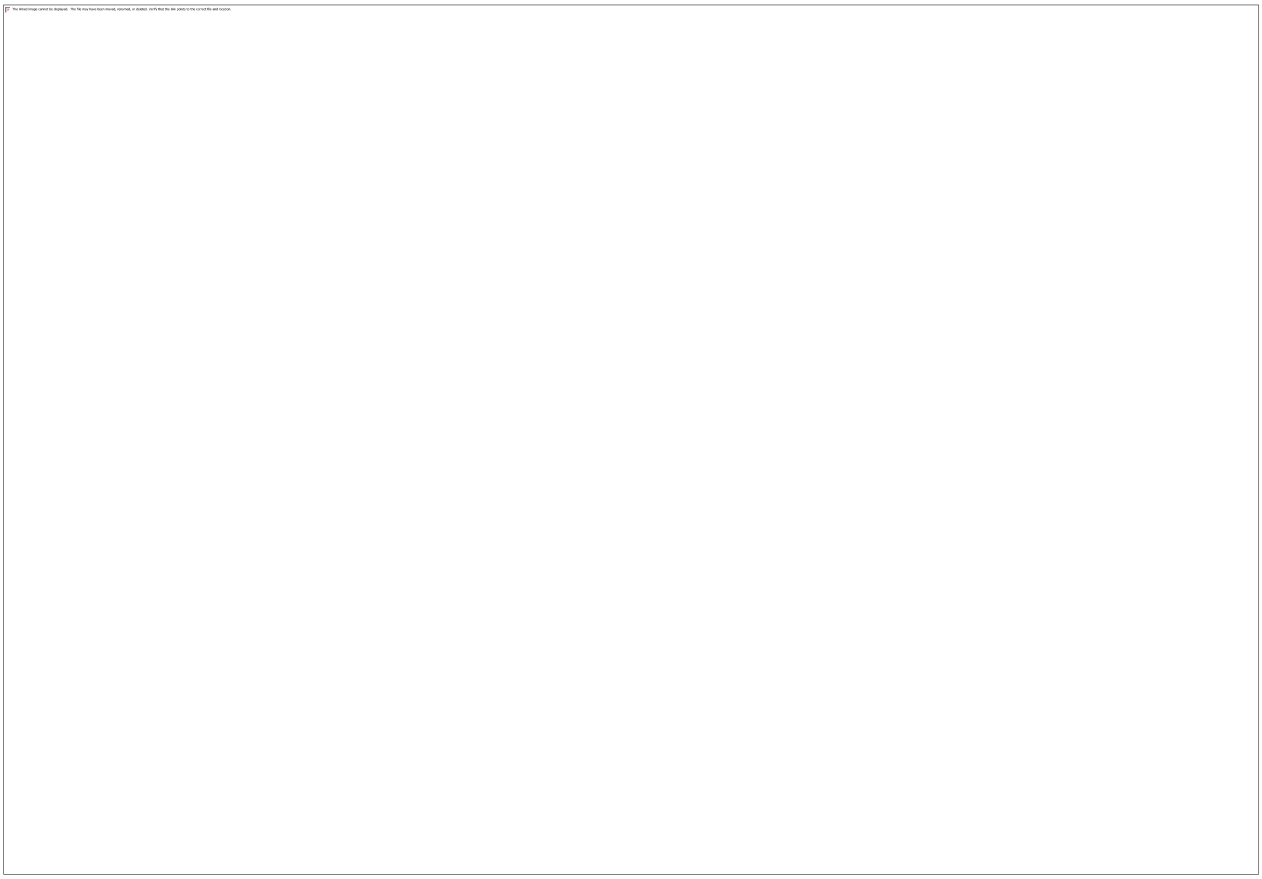

Figure 12: Wider viewshed analysis of Caherconree hillfort, revealing extensive visibility of Tralee Bay to the north and Dingle Bay to the south.

Summary

The photogrammetry survey of Caherconree hillfort was successful in recording the current state of the important hilltop fort, providing both high-resolution ortho-rectified aerial images, as well as a

DSM. This allowed for a detailed analysis of the site using GIS techniques, which helped to reveal a number of unrecorded features and potential monuments. For example, two possible entrances were identified using LCP and slope analysis, while a significant number of possible unrecorded hut structures near the fort were identified. The latter is particularly interesting, as only 9 other hillforts in Ireland that have evidence for 10 or more hut structures within their interiors. Significantly, three of these, including Caherconree, Lurigethan and Knockdhu, are high altitude inland promontory forts. Considering that Caherconree is the third highest hillfort in Ireland and Britain, it is curious to find significant evidence for possible habitation. The confirmation of a second enclosing element approximately 14m outside the inner wall is also an important conclusion, as all other high altitude inland promontory forts are multivallate.

3

Western Stone Forts in Clare

Cahercommaun fort (RMP: CL010-064003) is position at the southwestern edge of Tullycommon townland (ITM 528161, 696525) in Co. Clare (Fig. 2.1). The site is *c.* 145m above Ordnance Datum and overlooks a deep north–east/south–west ravine, approximately 30m in height. The fort itself is approximately 0.68ha in total area, and comprises three widely spaced enclosing elements that abut the edge of the ravine to the north. These defend the east, south and west approaches to the fort, while the north is protected by the steep natural cliff face. The monument was partially excavated by Hugh O'Neill Hencken (1938) in 1934 as part of the Harvard archaeological Expedition to Ireland.

Fig. 3.1: Cahercommaun fort, Co. Clare, looking south.

Cahercommaun is situated within the extensive karst landscape of the Burren. This landscape was formed in the last glacial maximum, when ice sheets mover across the Burren, eroding the overlying soil and exposing the underlying limestone surface. These surfaces where further altered by exposure to rainwater, which dissolved the limestone bedrock by falling on and flowing through the fractured limestone. The lack of soil cover is less suitable for intensive farming, therefore, the ancient landscape of the area has not been subject to the destruction associated with modern farming practices as other parts of the country. Ancient features such as occupation sites, field systems and burial monuments ranging from the Neolithic to the modern era are more frequently recorded in a good state of preservation. Hull and Comber (2007) note that the most visible and plentiful settlements in this region date to the second half of the first millennium AD, the Early Historic or Early Medieval period. Most of these consist of stone cashels, a sub-category of the ringfort class of monuments, and are frequently associated with extant field systems. The density of these sites infers relatively dense settlement of the Burren despite the poor soil conditions (Hull and Comber 2007).

Gibson (1995, 118–121) argues that Cahercommaun was the centre of a regional Early Medieval chiefdom which he terms *Tulach Commain*, and has tentatively reconstructed their possible territory, the fort being positioned at the geographical centre. He also connected the nearby monastic settlement of *Tempal Chronain*, and a probable prehistoric burial mound, *Tulach Commain*, with Cahercommaun, the former acting as the principal ecclesiastical settlement of the chiefdom and the latter a possible inauguration mound.

3.1 Cahercommaun Fort: Enclosing Elements

Cahercommaun fort consists of three widely spaced enclosing elements build of limestone blocks. These were probably gathered through field clearance are there is no visible indication of quarrying in the area. The inner and middle example were identified in the first edition of the 6 inch Ordnance Survey, with the outer example being recorded as an associated field system. A more extensive recording was provided in the second edition 25 inch Ordnance Survey maps, with all three enclosing elements being recorded.

The inner enclosing element is the most substantial, surviving as a grass covered stone bank to a height of nearly 4m It is 7.5m in average thickness (maximum 8m, minimum 2.5m). It encloses approximately 0.07ha and occupies a total area of 0.14ha. The central enclosure is the only example that forms a complete circuit, though on the northern side, where it abuts the edge of the ravine face, it is reduced to a slighter wall. Excavation by Hencken (1938) reveals that this enclosing element consists of a rubble core faced on both sides with coursed limestone blocks. A single entrance is apparent at the east and comprises a paved pathway flanked by side walls. There is terracing on the inner face of the wall at the south-west consisting of two steps (measurements). Hencken (1938) recorded five niches on the inner wall face in this section of the wall, indicating this is the best preserved part of the inner enclosure.

The middle enclosing element is located 10–13.5m from the inner example. It encloses an area of approximately 0.3ha and occupies a total area of 0.32ha. It has been extensively robbed-out, particularly at the south and west, though a section to the south-east survives to a height of *c.* 1.7m. There are a number of linear walls, now much dilapidated, connecting the inner and middle enclosures, effectively sub-dividing the area between the two enclosures. There are no obvious breaks in the wall that could represent an entrance.

The outer enclosure surrounds an area of 0.62ha and has a total site foot-print of approximately 0.68ha. The wall is more extant than the middle example, although the eastern and western terminals where the enclosure approaches the ravine have been largely robbed-out. The southeastern section survies to a maximum height of approximately 2m and thickness of about 8.3m. Its thickness varies considerably over the course of its perimeter and Hencken (1938) has concluded this may have been a consequence of gang-working. He also noted nine vertical joints along the perimeter of the wall which may represent sections where two gangs of workers met. Up to three radial bank are visible, connecting the middle and outer enclosures. There are no obvious breaks in the wall that could represent an entrance.

3.2 Cahercommaun Fort: Internal Features

The excavation of the inner enclosure at Cahercommaun produced an extensive amount of material culture and structural remains. A number of structures were recorded (CL010-064076, CL010-064089, CL010-064090, CL010-064091 and CL010-064092) as well as two souterrains (CL010-064077 and CL010-064078).

Up to six possible structures were excavated by Hencken (1938) all of which have been given a single record number (CL010-064076). These were interpreted as 'lean-to' structures positioned at the south-east and north-east of the interior wall face.

Two coinjoined structures are positioned at the northern edge of the inner enclosure (CL010-064089 and CL010-064090) Hencken (1938, 2) interprets these structures as the residencies of the chief of the fort and the people secondary to the chief. Structure CL010-064089 is a sub-circular hut measuring 7m in diameter with a central hearth. A large hearth was recorded between the wall of this structure and the inner face of the inner enclosure, possibly inferring occupation of the fort prior to the construction of this structure.

Structure CL010-064090 is joined to the latter at the west. It is sub-circular and measures 6m in diameter with a central hearth. Inside this structure, a stepped passage leads into a souterrain (CL010-064077) measuring approximately 7m in length and up to 1.1m in width. This passage led under the northern section of the inner wall where Hencken argues a vertical crevice in the face of the cliff offered a means of escape in an emergency. A second souterrain was discovered near the latter and measured approximately 6m long and up to 1m high. To the south of the recorded entrance to the inner enclosure, Hencken excavated a structure he interpreted as a guard-house (CL010-064091).

The record number CL010-064092 represents a series of small rectangular structures which Hencken interprets as the quarters of the serving people and the kitchen. This interpretation was prompted by the concentration of quern stones within these structures as well as the presence of two ash layers. Conversely, Cotter (1999, 67) suggests that these rectangular buildings became the principal dwellings of people inhabitation the fort after the latter went out of use because they are centrally located and were better constructed.

Five hut structure have been identified between the inner and outer enclosing elements, though none of these have been excavated. Between the inner and middle enclosing elements, a small circular structure measuring 1.5m in diameter survives to a height of 1.5m (CL010-064003). Attached to the outer face of the middle enclosing element is a rectangular structure measuring approximately 5m by 2m (CL010-064095). Abutting the inner face of the outer enclosure is a rectangular structure measuring approximately 1.7m by 2.6m is visible at the south/south-east (CL010-064094). At the southern side of the outer enclosure, a rectangular hut site measures *c.*3m by 2.5m (CL010-064096). Finally, attached to the inner face of the outer enclosure at the south/south-west is a sub-circular structure measuring approximately 3m in diameter (CL010-064097). About 20m outside the outer enclosure at the south/south-east is a circular structure measuring up to 7m in diameter with a small souterrain within the interior.

3.3 Cahercommaun Fort: Material Culture and Dating

Cotter (1999, 44) argues that, although the date of the construction of Cahercommaun and early activity at the site is still a matter of debate, she concludes that Hencken's original date for the site, around the beginning of the ninth century AD, is correct, primarily because the prehistoric artefacts found on site were not stratigraphically linked with the walls of the fort. She proposes that these items pre-date the construction and occupation of Cahercommaun. Conversely, there is little to link the Early Medieval assemblage with the fort, as the stratigraphy of the site was difficult to record. In fact, Gibson (2012, 94) notes that a silver brooch of Early Medieval origin was one of the few items found in a secure stratigraphy, and even this may have been a secondary feature of the site. Contextual information is therefore absent in significant amounts to definitively conclude a date for the construction and original occupation of the fort. As such, there have been a number of contrasting interpretations.

Hencken (1938, 27–30) has argued that the construction and occupation of Cahercommaun probably dated to the early part of the ninth century AD. This date was proposed on the basis that the decoration of a silver brooch found within souterrain B, as well as an unprovenanced fragment of an enamelled ornament and a zoomorphic brooch, compare favourably with those manufactured around the ninth and tenth century AD (Hencken 1938, 27–30; Gibson 2012, 92–93). Raftery (1972, 51) challenges the relevance of the unprovenanced artefacts and their typological dating, and argues that the silver brooch, although found in a recorded stratigraphy, was found in a souterrain and could therefore not be securely linked with the initial construction of the fort. There are many prehistoric enclosures that have extensive evidence for Early Medieval occupation, a primary example being Mooghaun hillfort in Co. Clare (Grogan 2005a) or Rathgall hillfort, Co. Wicklow (Raftery 1972). Furthermore, Raftery (1972, 51–53) identified several artefacts that clearly pre-date Hencken's proposed dating, such as blue glass beads, iron and bone pins, stone axes, bone spearheads, a bronze brooch with zoomorphic terminals, flint end scrapers, as well as saddle querns and rubbing stones (although Hencken acknowledged the presence of the saddle querns and rubbers, as well as the stone axes, had possible prehistoric origins, he suggested they dated to the early ninth century due to their stratigraphic location). Of particular importance in this respect, were the blue glass braclets, which have been found in Iron Age Britain (Gibson 2012, 92–93). Ó Floinn (1999, 74–75) has also recognised an iron penannular brooch and iron pins with looped heads as pre-dating Hencken's proposed chronology.

More recently, Gibson (2012, 95) has obtained radiocarbon dates from bone found at the site. Five bone samples processed for dating. Unfortunately, one sample was discarded due to faulty processing equiptment and a further two did not have enough collagen to produce a date. Two samples were successful and produced dates of 681–886 AD and 670–970 AD from unprovenanced contexts. While this does support occupation of the interior during the second half of the first millennium AD, without further contextual information, an earlier date for the construction of the fort cannot be discounted.

A number of authors have proposed prehistoric dates for the construction of Cahercommaun. Rynne (1982), for example, argues from an Early Iron Age date, suggesting that an iron hook found directly underneath a skull was evidence for Iron Age head-cult activity. Caulfield (1981, 210–211) suggests the fort was built before the turn of the millennium BC, due to the presence of some of the aforementioned objects. Interestingly, both Caulfield (1981) and Harding (2012, 174) suggest that saddle querns were essentially a Late Bronze Age type that continued in use in the earlier Iron Age. While Cotter (1999) acknowledges the prehistoric chronology of these items, she concludes that these predate the construction of the fort, despite the fact that they were contained within the limits of the inner enclosure and cannot be stratigraphically linked with any of the enclosing elements (Harding 2012, 174). Harding, on the other hand, comments that bulk of evidence from Cahercommaun suggests occupation in the first millennium AD or earlier. This contrasts with Gibson's (2012, 94) conclusions that The body of material assemblage corresponds with Hencken's estimations of an early ninth century date.

Henderson (2007, 184–186) has identified what he believes are a number of features within Cahercommaun that indicate the occupation of the interior was a secondary feature. He argues that the thirteen cellular structures excavated by Hencken are comparable to drystone roundhouses found at a number of sites in Atlantic Soctland dating to the first millennium AD. Henderson states that it is possible 'to envisage the small-scale irregular buildings as a secondary, cellular re-use of the central cashel at Cahercommaun, lasting-perhaps intermittently-over a number of centuries in the first millennium AD'. Henderson (2007) concludes that a broad date range comparable with Dún Aonghasa may be an appropriate chronology for Cahercommaun, arguing that at both sites, evidence for the Late Bronze Age and Iron Age would have been almost completely removed prior to periods of secondary occupation.

Gibson's (2012; 2016) investigations of the Cahercommaun environs suggests that the area surrounding Cahercommaun was densely occupied during the prehistoric period. Cahercommaun seems to have been established in proximity to a number of Early Bronze Age settlements (Gibson 2004), as well as the Late Bronze Age enclosure in the Carron depression 2.3km north of Cahercommaun (Gibson 2007) and a 'multicomponent' settlement near Cahercommaun with cultural layers dating to the Neolithic, Cahlcolithch, Early Bronze Age and Late Bronze Age (Gibson 2016).

Raftery (1972, 51–53) included Cahercommaun in his list of Irish hillforts on the basis of its size and landscape setting. Though it is small in comparison with the average hillfort, which about 5ha in average size (O'Driscoll 2016), it is large in comparison to Early Medieval ringforts. Its dominant landscape position, however, is typical of Late Bronze Age hillforts. Cahercommaun overlooks one of the primary access routes through the Burren from the south and is in a defensibly advantageous position.

In many ways, Cahercommaun has a number of analogous features found at the Late Bronze Age fort of Dún Aonghasa, Co. Galway and other possible prehistoric sites included under the broad term of the 'Western Stone Forts', such as Faha, Co. Kerry and Caherconree, Co. Kerry. All four of these sites feature two internal terraces in the inner enclosures. More notably, all of these sites have widely spaced multivallation, the occurrence of which is primarily a prehistoric feature. When found in an Early Medieval context, is usually associated with burial monuments. Dowling (2011) sees the act of multiplication as an intentional device used to intensify the liminal properties of the boundary zone and to further amplify the significance of the site itself. He states that the power of central places can be radically enhanced by making them more clearly demarcated from other places (*ibid.*, 224). Similarly, authors such as Cunliffe (2012, 261–262), Bowden and McOmish (1987; 1989) and Sharples (2010, 116–117) have argued that multiple lines of enclosure could be interpreted as a mark of status, although in most cases they are discussing closely spaced multivallation. This feature can therefore be linked with a need to project status, but may also have had a practical function. Armit (2007), James (2007) and Finney (2006) argue the spaced enclosing elements keeping defenders out of range of effective sling fire and helping to prevent any possible rush attack. In this respect, the internal terracing may have provided a platform for defenders to supress an attack force, though it must be noted that none of these sites have produced evidence for an attack or sling stones. There are also dissimilarities between Cahercommaun and these sites, such a lack of wall chambers and the presence of niches, though this does not confirm their lack of contemporaneity.

3.4 Cahercommaun Fort: Photogrammetry survey and results

A total of 166 geo-tagged aerial images were captured surrounding Cahercommaun hillfort, resulting in the generation of a DSM and orthomosaic 11.69ha in size (Figure 3.2 and Figure 3.3). The DSM consists of approximately 13519874 three-dimensional data points with an average density of 186.84 points per metre. As part of the project, a 3D model was created and is available for the

Figure 3.2: Cahercommaun DSM generated from photogrammetry survey.

public to view: https://sketchfab.com/models/1c8c4b56544a472099d6556f6cd521aa. Similarly, a 360 degree aerial image can be viewed at: https://www.skypixel.com/photos/2a13cd60-855b-48d5-9c35-b826b2ef26db?utm_source=url&utm_medium=copied&utm_campaign=share.

There are a number of relict field patterns apparent in both the orthomosaic and slope model (Figure 3.3, Figure 3.4 and Figure 3.5). **A1**, for example, is a series of levelled field boundaries visible in the slope and orthomosaic images as a low-rise vegetation mark dividing the area to the south-West of Cahercommaun fort into field sizes more comparable to those further to the south. The boundaries are approximately 3m wide and 0.1–0.3m in height. To the east of Cahercommaun fort, an unrecorded n-shaped boundary joins the northern end of a visible field-system, creating a 0.26ha parcel of land (**A2**). The low-rise feature is approximately 2m wide and up to 0.2m high. Immediately to the south of this, two unrecorded rectangular boundaries, 1.4m wide and up to 0.3m high, create small enclosures 0.05ha and 0.02ha in size. They are attached to an oval depression

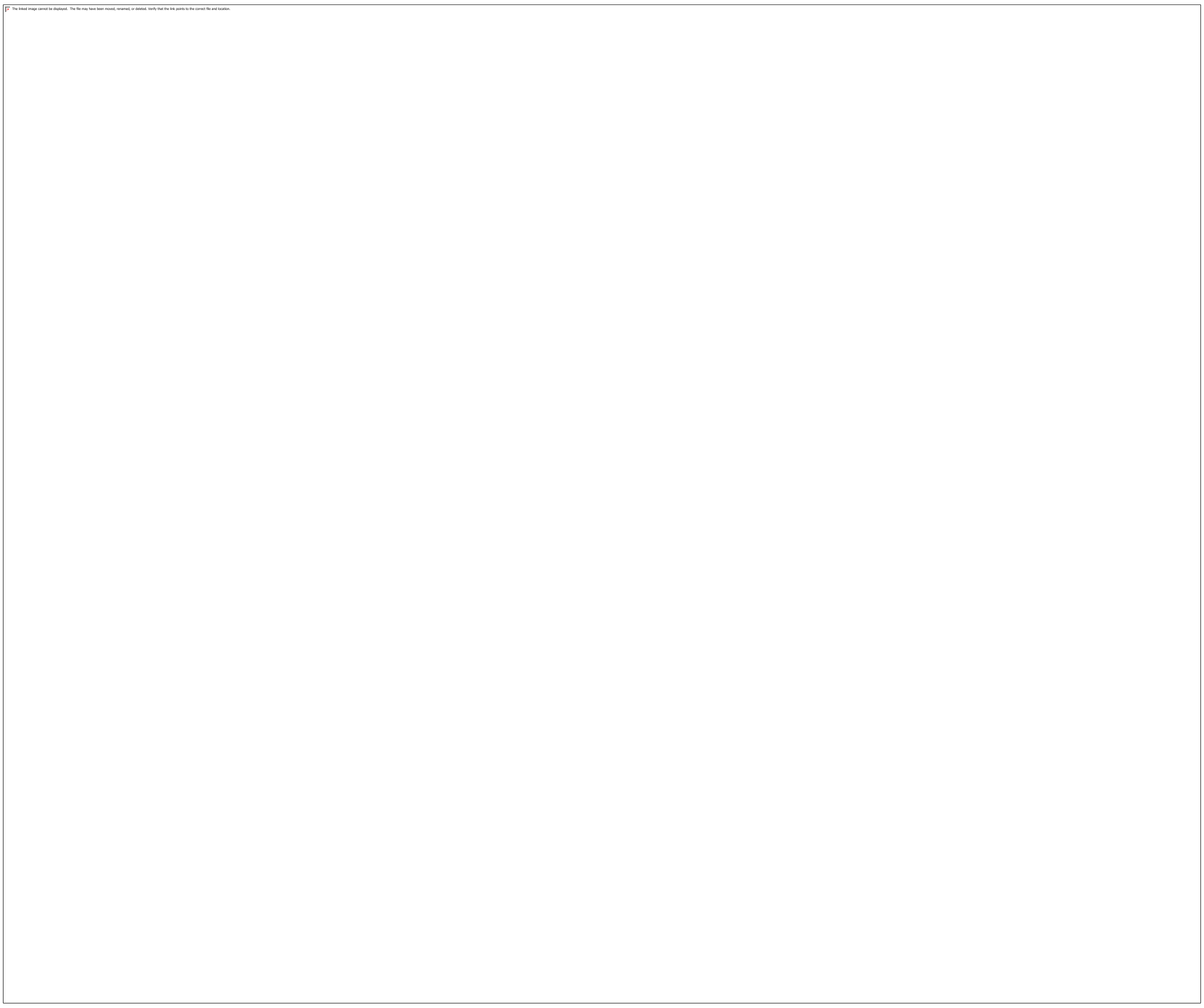

Figure 3.3: Cahercommaun orthomosaic generated from photogrammetry survey.

immediately to the south that measures 38m east–west by 18m north–south (**S1**). To the southeast of Cahercommaun fort there are extensive numbers of unrecorded field boundaries (**A3**). The increased survival rate in this area may be associated with the different farming practices of landowners over the centuries, the southeastern section being divided by an extant boundary that separates Cahercommaun fort from actively farmed land in private ownership. Interestingly, there are a series of narrow, elongated field plots in this area, with the boundaries being separated as little as 7m apart.

Distributed within these field systems, and possibly associated with them, are up to 11 possible hut structures, two of which have previously been recorded. **S2** is positioned with a small parcel of land defined by a partially extant field system (Figure 3.6). The possible hut structures is more visible in the slope model as a circular depression measuring approximately 9.13m in diameter. There is a slight indication in the orthomosaic that the depression is further defined by a low-rise band of stone on its outer edge. To the west, **S3** comprises a circular feature faintly apparent in the

Figure 3.4: Cahercommaun slope generated from photogrammetry survey.

slope model that measures approximately 7.74m in diameter, placed within a slight depression 12m by 15m in size. Further to the west, **S4** consists of a circular depression 7.76m in diameter, located at the north edge of a concentration of field systems. **S5** is a recorded hut structure positioned with a natural depression defined by field boundaries. It measures approximately 9.26m in diameter. To the west of **S5**, a circular platform approximately 6.58m in diameter may also represent a possible unrecorded hut structure (**S6**). This is also positioned within a small, sub-circular field system. About 20m to the north, another circular depression, 9.63m in diameter (**S7**), is apparent in the slope model. **S8** is located at the centre of a small D-shaped field system and measures 6.64m by 5.11m. Further to the north, S9 represents a circular platform approximately 4.53m in diameter. Positioned just 23m south of Cahercommaun fort, the rectangular depression **S10** measures 5m north–south by 8.11m east–west. **S11** consists of a recorded hut structure with associated souterrain. It measures 7.62m in diameter and is visible in the orthomosaic as a circular setting of stones surrounding a slightly sunken area which is visible on the slope model. Finally, **S12** is located off the escarpment

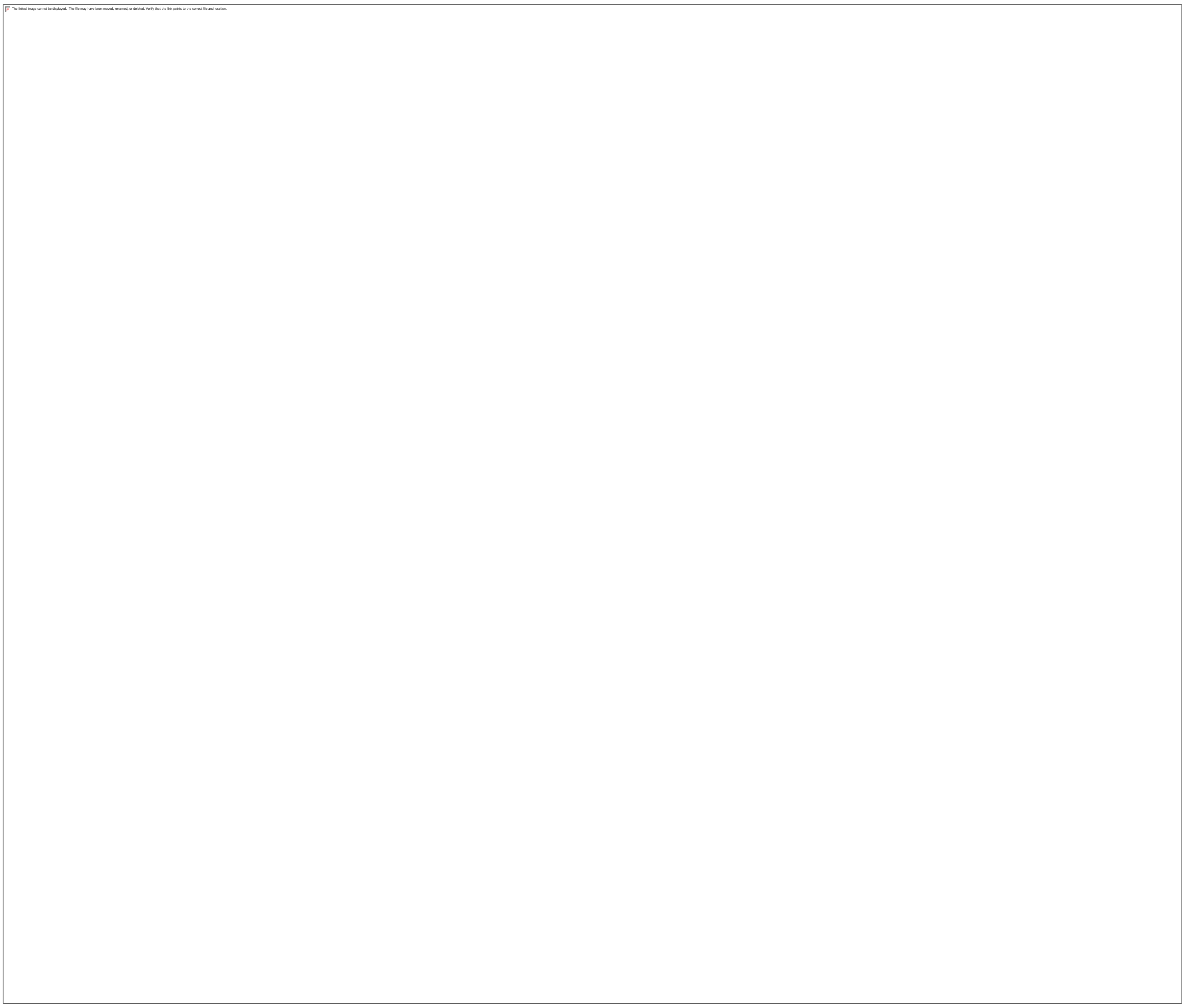

Figure 3.5: Cahercommaun DSM generated from photogrammetry survey.

and is overlooked by Cahercommaun fort to the north. It is positioned with a sub-rectangular field system, abutting a steep, cliff-face to the east. It measures approximately 8.28m in diameter and is visible in both the orthomosaic and slope model.

Distributed throughout the southern edge of the survey area are a number of irregular depressions (**S13** and **S14** for example). These are sometimes associated with possible hut structures identified above, and in instances where they are not, may have been utilised or incorporated with field systems in antiquity.

Distributed throughout the southern edge of the survey area are a number of irregular depressions (**S13** and **S14** for example). These are sometimes associated with possible hut structures identified above, and in instances where they are not, may have been utilised or incorporated with field systems in antiquity.

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Figure 3.6: Examples of possible hut structures found outside of Cahercommaun fort.

The photogrammetry survey was useful in that it accurately mapped the fort itself (Figure 3.7). The slope model highlights that the inner enclosure of Cahercommaun sits on a natural platform that raises the fort, making the enclosing elements seems larger and more impressive from the exterior. In some instances, this can add an additional 0.7m to the height of the enclosing wall. This platform is apparent in Westropp's plan of the site, though it could also be interpreted as grass

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Figure 3.7: Plan and sections of Cahercommaun fort derived from photogrammetry survey.

covered wall collapse (Westropp 1897). It is most apparent at the western side, where the wall stands up to 3.3m high and 11m wide. Further to the east, the height of the wall is lower, on average being approximately 2.7m high and 9m wide. It impact of restoration works must also be considered when assessing the enclosing works, though it seems from Westropp's plan that the most impressive section of the inner enclosure in the west was largely extant at the time. Cotter (1999, 49) suggests that an estimated 16500m³ was needed to build the inner wall, which would have necessitated extensive quarrying. It could be argued that the area surrounding the inner enclosure was used as a quarry. This would have provided the material for the wall while reducing labour efforts as the quarry was in close proximity. It may also be responsible for the raised platform upon which the enclosure sits, creating an artificial raised area to make the enclosing elements seem larger from the exterior.

Though Hencken (1938) has blocked many of the niches and terraces of the inner enclosure at Cahercommaun, some of these features, particularly the terracing, are visible in places. The terracing is most visible to the west where it is apparent as two slight steps on the inner face of the inner enclosure. The eastern entrance to the fort was also blocked by Hencken, though it is apparent as a depression in the survey results. The entrance passage leading to the inner wall was not blocked and is apparent in the survey as a 32m long, 1.5m wide passage enclosed by two stone walls up to 0.7m high in places. The slight break in the inner enclosure at the north, which facilitated the exit of a souterrain, is also visible in the survey. The inner defences enclose an area of 0.076ha.

The middle enclosing element is on average 10m from the inner wall and has been extensively robbed out. It survives best at the south-west, where it 2.1m wide and up to 1.75m high. A sub-circular feature visible in both the orthomosaic and slope model measures approximately 7.6m by 6.9m (**H**2) and may represent another unrecorded hut structure. It is positioned between the inner and middle enclosures and is one of only two possible hut sites in this area. A number of possible unrecorded radial walls connecting the inner and middle enclosure were also identified by the photogrammetry survey. The middle defences enclose and area of approximately 0.302ha.

The outer enclosure is approximately 19m outside the middle example and measures 2.6m in maximum height and 2.1m maximum thickness. It encloses an area of approximately 0.664ha. Surprisingly, this is substantially less that other estimates of the total size of Cahercommaun, with Cotter (1999) for example, estimating the size of the fort at 0.81ha. The current work comprises the most accurate survey of the monument to date, and as such, the revised, smaller area is a more accurate measurement. Westropp (1897) recorded four structure abutting the inner face of the outer wall, though only three of these have been identified since his survey. The fourth example is almost certainly the feature **H1** visible in the slope model as a rectangular feature measuring 5.14m by 2.91m, located immediately north of a metal container abutting the inner face of the wall. No obvious evidence for terracing survives in either the middle of outer enclosure.

Aspect analysis did not reveal any specific evidence regarding the construction of the enclosing elements. Similarly, the ability for LCP analysis to identify potential approach ways to the site is limited by the number of extant field boundaries, which greatly effect generated paths.

Viewshed analysis highlights that views from the interior of the inner enclosure are restricted by the substantial defences (Figure 3.8). Even at the north, where the wall is less substantial, there is restricted visibility of the east–west running valley floor. These restricted views may have necessitated access to the upper levels of the defensive wall and terraces. Hencken (1938) recorded steps that allowed access to these features. Visibility from the terraces and top of the wall are significantly increased, with the southern, eastern and western approaches to the fort being highly visible, as well as visibility of the valley to the north (Figure 3.9). A large east–west running field boundary obstructs visibility further to the south, though considering the natural break of slope to the south of the boundary, visibility of this area would probably not have been much more extensive. The heightened visibly from the top of the inner enclosure may explain why there is no evidence for terracing in the middle and outer enclosing elements, as such features may have been practical elements incorporated into the defences of the inner wall to augment the visibility of the immediate landscape to those inside the interior. As such, it was not necessary to incorporate such features, allowing the walls to be thinner which, in turn, resulted in reduced costs in labour and resources. In fact, the practicalities of the walls themselves come into question when we consider the viewshed analysis from between the inner and outer enclosure (Figure 3.10). Views from this position are restricted by the outer wall, which in antiquity would have probably been taller that what is visible today. This could indicate that the outer two enclosing elements may have been constructed primarily to convey the status and power of the occupants to those approaching the fort, though they could have also had a number of subsidiary functions, such as cattle management and defence.

Taking a larger landscape approach, from Cahercommaun, there is extensive visibility of the northern valley, in contrast to the limited views of the eastern, southern and western approach (Figure 3.11). It could be argued that the fort was located to command and oversee this valley, which could have been used as an overland natural routeway. In this regard, Cahercommaun was strategically situated in the landscape, and is comparable to many Late Bronze Age hillforts located overlooking such routes. However, we must also consider that the visibility of the enclosing

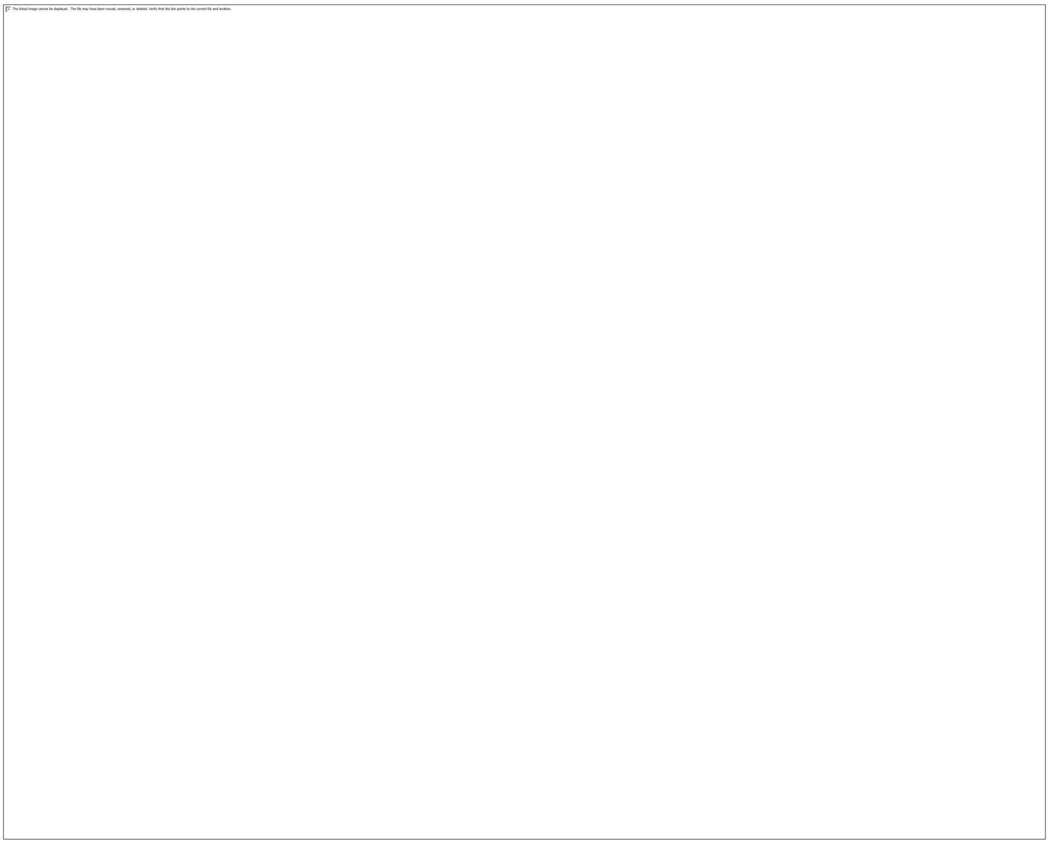

Figure 3.8: Viewshed analysis from the interior of Cahercommaun fort.

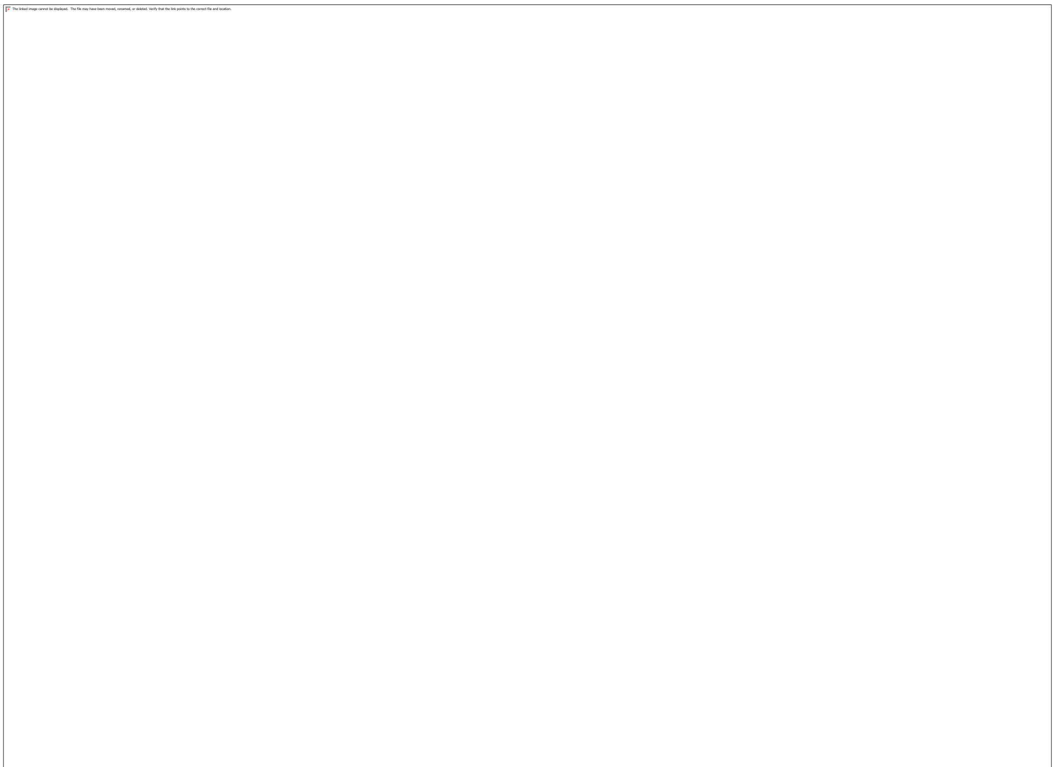

Figure 3.9: Viewshed analysis from the top of the inner defences at Cahercommaun fort.

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Figure 3.10: Viewshed analysis from between the inner and middle enclosing elements of Cahercommaun.

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Figure 3.11: Viewshed analysis of the Cahercommaun landscape.

elements from the northern valley floor would have been limited. As such, the builders of Cahercommaun must have given some importance to the approaches to the site, considering they invested significant time, effort and resources into the construction of the enclosing elements. While the enclosing elements could be regarded as defensive in nature, the photogrammetry survey and viewshed analysis highlights that the height of the outer wall would have restricted the visibility of people located between the inner and outer defences. It may be more plausible to regard the middle and outer defences principally as status symbols that could have had a secondary defensive function.

Summary

The photogrammetry survey at Cahercommaun fort was successful in recording the current state of the fort and its immediate environs, providing both high-resolution ortho-rectified aerial images, as well as a DSM. This allowed for a detailed analysis of the site using GIS techniques. This helped to reveal a number of possible unrecorded archaeological features. The survey was particularly useful with regard to discoveries within the immediate environs of Cahercommaun fort. A number of possible unrecorded hut structures and field systems were identified, however, without excavation and dating evidence, it is difficult to relate these new features to Cahercommaun. Visibility analysis has highlighted that access to the top of the inner defences, which was facilitated by internal terraces and steps, was critical for the occupants. The substantial size of all three enclosing walls restrict visibility of approaches from the east, south and west, as well as the valley to the north. Visibility from the top of the inner wall is more expansive. The inner enclosure could have functioned as an impressive defensive enclosure, though the middle and outer wall may have been more symbolic than practical, being used to convey the status and power of the occupants of the inner enclosure to those approaching the fort. Broader visibility analysis suggests Cahercommaun was located to overlook a natural routeway immediately to the north and may therefore be comparable to the strategic siting of many Bronze Age hillforts in Ireland. Considering this, in conjunction with the question of dating with regard to the fort itself, a prehistoric date for Cahercommaun is conceivable, though without further dating evidence, is highly speculative. The morphological characteristics and setting of Cahercommaun correspond well with the Late Bronze Age hillfort of Dún Aonghasa, Co. Galway, though that site is substantially larger in size. Further excavation at Cahercommaun is needed to clarify its dating.

4

Western Stone Forts on the Aran Islands

Dún Fearbhaí and Dún Chonchúir form two of the seven Western Stone Forts on the Aran Islands. Both are located on the central island known as Inis Meáin. Cotter (2012) has argued that both forts are contemporary and were built by the same community, with Dún Fearbhaí acting as a subsidiary fort to the larger and more elaborate Dún Chonchúir. Neither site has been excavated, though there were extensive renovations of Dún Chonchúir during the nineteenth century which has greatly affected the archaeological remains.

The karstic limestone that comprises the geology of the island has largely restricted dense vegetation or forestry growth and prevented cereal cultivation. This has resulted in a much higher degree of preservation of archaeological remains.

4.1: Dún Chonchúir

Placed centrally and on one of the highest points of the island on a natural outcrop, Dún Chonchúir (GA119–054) (ITM: 493150, 704837) is approximately 65m OD occupying a total area of 0.62ha (Figure 4.1). The fort comprises two widely spaced stone rubble walls faced vertically on either side. As already noted, the walls have been extensively restored. Similarly, evidence for occupation within the interior is visible on the surface, though Westropp (1895) notes that many of the structures had been destroyed prior to restoration works. This calls into question the authenticity of these features.

Dún Chonchúir: enclosing elements

The inner wall of the fort is recorded in both editions of the Ordnance Survey maps. It measures approximately 6m wide and over 3m high, with up to three levels of internal terracing. There is also external terraces, though this could be a result of extensive restoration works. The entrance is


Figure 4.1: Dún Chonchúir fort, Co. Galway, looking south-west.

located at the east, at the centre of the eastern façade. Cotter (2012) estimates that there was about 14000 tonnes of stone used in the construction of the inner wall.

A second enclosing elements is positioned approximately 20m outside the inner example on the eastern, southern and northern side. The western approach does not have a second enclosure, though the inner wall is positioned at the edge of rock outcrop that significantly increases the height of the inner wall. The outer enclosure is marked as a thick wall on the first edition maps, however, it is identified as part of a field system by the second edition survey. Today, the wall survives intermittently, being around 3.8m wide at its thickest point and over 2m high. Abutting it to the north-east is a rectangular annex which Cotter (2012) argues is later in date.

Dún Chonchúir: photogrammetry survey and results

A total of 57 geo-tagged aerial images were captured surrounding Dún Chonchúir fort, resulting in the generation of a DSM (Digital Surface Model) and orthomosaic 6.781ha in size (Figure 4.2 and Figure 4.3). The DSM consists of approximately 5535522 three-dimensional data points with an

Figure 4.2: Dún Chonchúir DSM generated from photogrammetry survey.

average density of 130.86 points per metre. A more extensive area was originally targeted for survey, however, the number of people visiting the site and the legal restrictions with regard to flying over or near them, required a more restricted survey. As part of the project, a 3D model was created and is available for the public to view: https://sketchfab.com/models/9b53379982fb4060b595a7e4c72bf8b0. Similarly, a 360 degree aerial image can be viewed at: https://www.skypixel.com/photos/d01e8cf4-cf6d-4abf-a2ec-9ad9323b953c.

It is important to note the extensive restoration of the fort. This has been noted by Westropp (1895, 268) who describes that 'This fort has been restored as a national monument. Unfortunately, as at Dun Oghil and elsewhere, the works have been carried out with such rash zeal as to greatly diminish the antiquarian value of one of our noblest prehistoric remains; new ramparts, terraces, and steps appearing everywhere. This restoration obviously affects the results of GIS

Figure 4.3: Dún Chonchúir orthomosaic generated from photogrammetry survey.

analysis. For example visibility or LCP models could be affected by features created through this repair work, or conversely, original features that have not been restored or destroyed prior to these works may also affect the final results.

Dún Chonchúir is an excellent case study for the application of photogrammetry techniques on landscapes, as the environment has limited tree or vegetation growth other than grasses. This provides the optimum conditions to record levelled or largely destroyed archaeological features and extant monuments.

There seems to be little in the way of unrecorded archaeological features in the immediate environs of Dún Chonchúir. Neither the orthomosaic, slope (Figure 4.4) of hillshade models have identified any possible settlement sites.

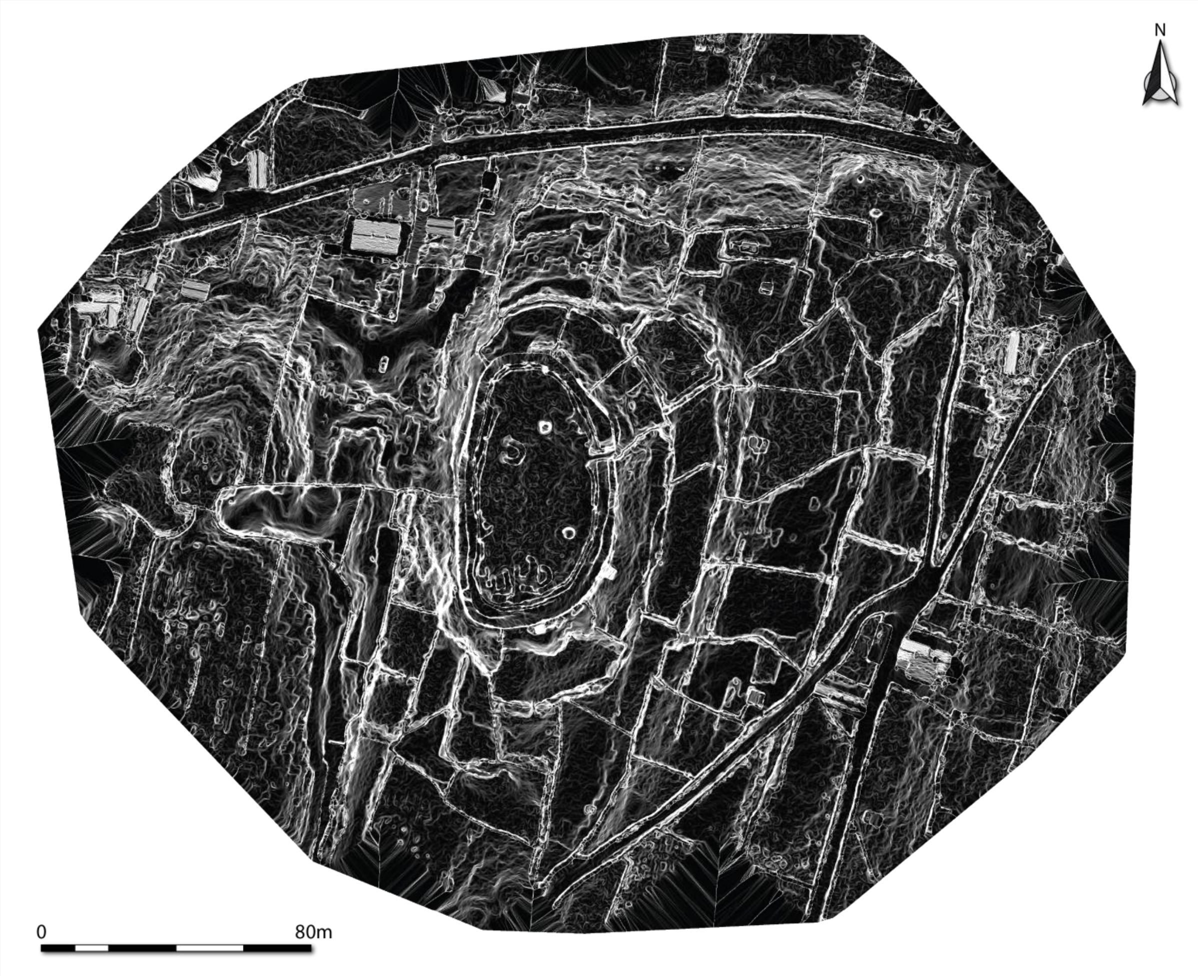

Figure 4.4: Dún Chonchúir slope model generated from photogrammetry survey.

The fort itself comprises two enclosures separated approximately 15m apart (Figure 4.5). The inner example is more extensive (although this was more extensively repaired), measuring up to 6.6m in height and 11.2m wide. The inner enclosure is also built upon a natural outcrop, adding further height to the defences when viewed from outside. For example, at the south-east, the wall has an internal height of 2.8m and an external height of 5.9m. The location of the fort could therefore be viewed as defensive, though it could also be argued that the size of the enclosing elements were meant to impress outsiders and project the occupants status.

The size of the inner wall restricts visibility to and from the interior. This made access to the top of the wall vital, allowing the occupants excellent visibility of the surrounding landscape, though views of the immediate environs are partially limited by the outer enclosing wall (Figure 4.6 and Figure 4.7).

There are a number of points (**S1**, **S2**, **S3**) along the base of the inner wall that appear to be the remains of the of the original wall. Though this certainly appears to be the case near the entrance at the east (**S2**), the section at the northwestern face of the wall could also be interpreted

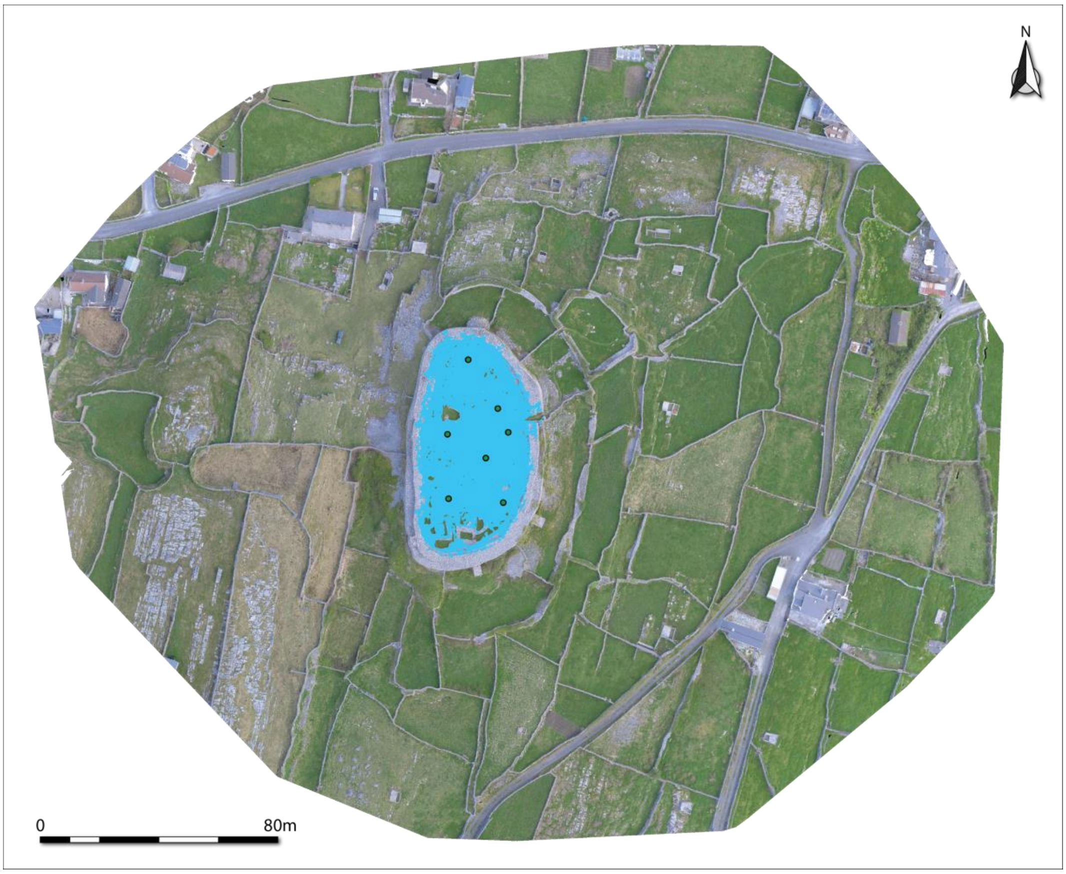

Figure 4.5: Dún Chonchúir viewshed analysis highlighting areas visible from inside the fort.

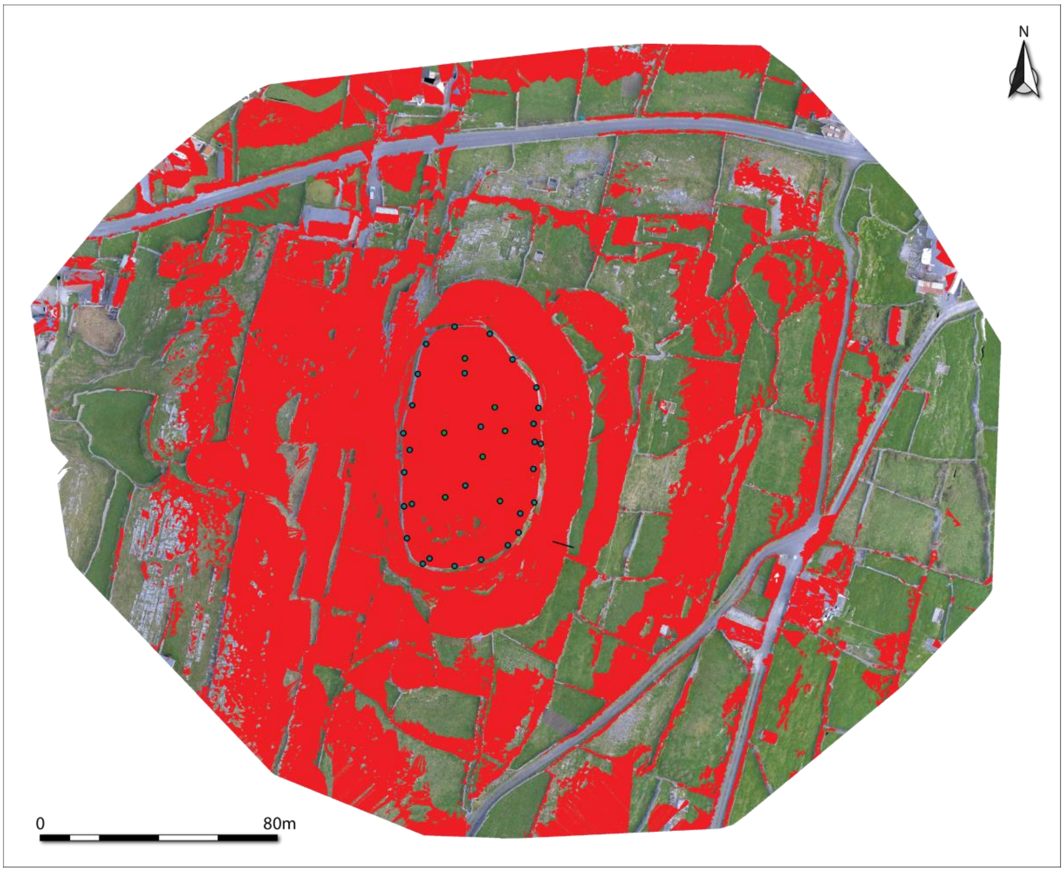

Figure 6: Dún Chonchúir viewshed analysis highlighting areas visible from the summit of the inner wall.

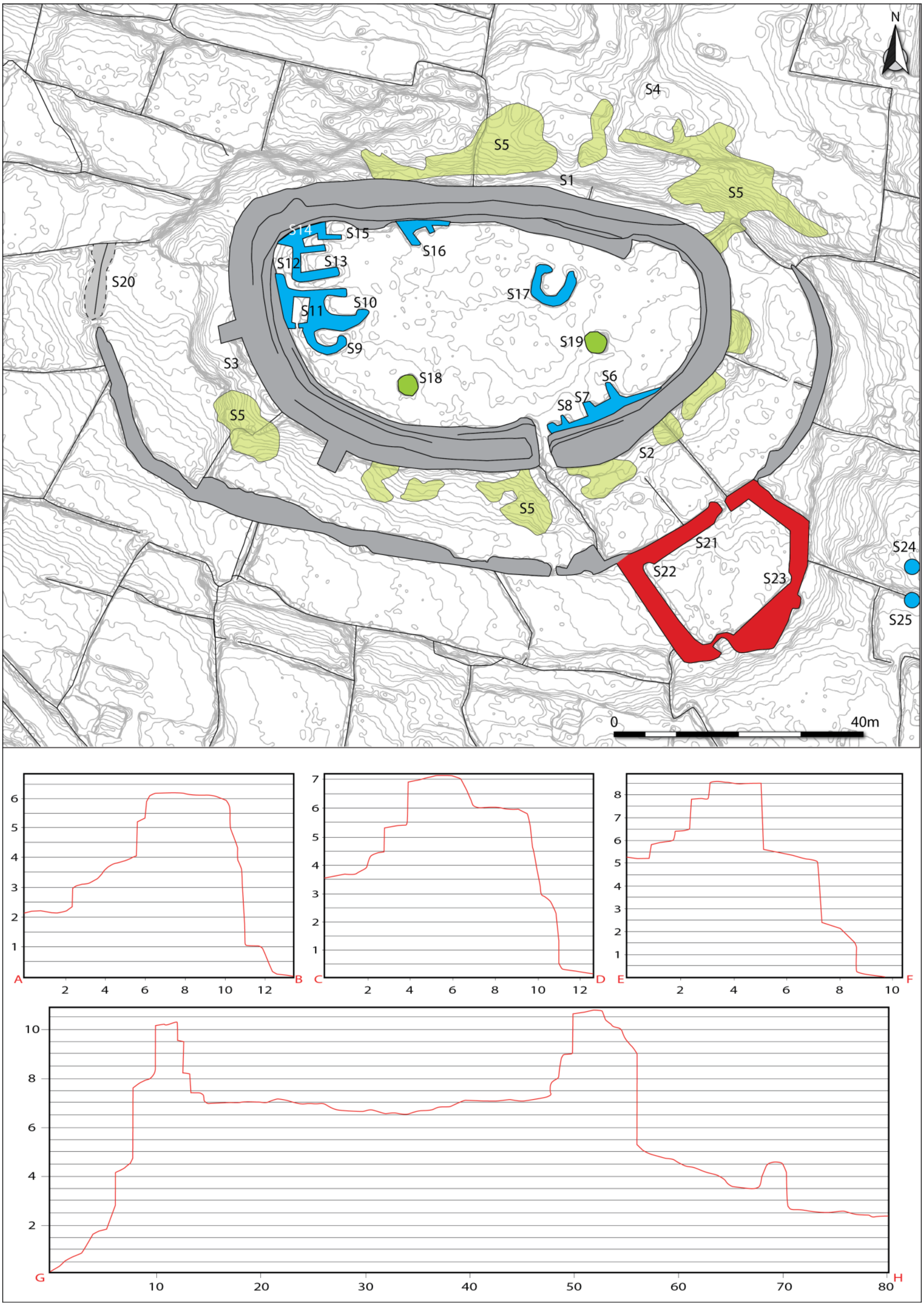

Figure 4.7: Plan and profiles of Dún Chonchúir fort.

as a quarry feature. Although a portion of the enclosing elements likely consisted of gathered field stone, the size of the inner example probably necessitated quarrying. It would have been more practical to extract stones from the immediate area. This would have reduced labour costs, as well as augmenting the natural outcrop upon which the inner defences are built by lowering the surrounding area. The slope model reveals that the area to the north-west of the fort (**S4**) may have been quarried, supporting Cotter's (2012) suggestion of possible quarrying in this area.

There are between two and three terraces built into the inner face of the inner wall. The southern half of the fort also has an external terrace, though this may be a feature built during restoration works to reduce the risk of collapse. This is further suggested by the construction of two buttresses at the southern side of the fort. These external terraces would not have provided any practical advantage both in defensive or competitive display terms, and are therefore considered modern features.

The only entrance to the interior of the fort is positioned on the eastern side. This is approximately 1.86m wide and 7.48m long, with a possible rectangular structure at the eastern side of the passage measuring 2.79m by 1.71m. The entrance, however, was probably largely restored in recent times. Westropp (1895, 268) described the gateway in the late nineteenth century as being 'nearly destroyed', measuring '2 feet and 5 inches wide outside, and 3 feet 6 inches inside'. This suggests that the original entrance had a slight funnel shape and was considerably more narrow than the present day passage.

Surrounding the inner wall are numerous deposits of loose stone (**S5**). This is uncharacteristic of the area, as most surface stones have been cleared and are used to form field boundaries. It is therefore possible that this material is wall collapse that was not incorporated into the restoration of the fort. We could, therefore, argue that the size of the enclosure could have been larger than the modern rebuild.

Inside the fort, there are ten recorded hut structures, though Cotter (2012) suggests there are 12 examples (**S6**–**S17**; Figure 4.8). Westropp (1895, 269) states that these cloghauns were mostly destroyed by the mid nineteenth century and were 'cleared out' at the time of his survey. The restored footings of the structures visible today, therefore, may not reflect the actual size or shape of original features. There are three structures immediately to the north of the entrance and comprise the partial remains of the eastern section of these structures (**S6**–**S8**). There are a group of six possible structures abutting the inner face of the wall at the south. **S9** and **S10** are sub-rectangular structures measuring 2.94m by 3.81m (**S9**) and 3.1m by 4.94m (**S10**). A rectangular

Figure 4.8: Three dimensional model showing inner wall and location of hut structures.

structure (**S11**) measuring 4.14m by 2.01m abuts **S9** and **S10** to the south. Immediately to the west are four rectangular structures (**S12**–**S14**). S12 abuts the inner face of the wall and measures 4.64m by 2.97m. Abutting **S12** to the north are structures **S13** and **S14**. **S13** measures 2.66m by 5.24m and **S14** measures 1.64m by 2.51m. Abutting **S13** to the west, and leaning against the inner face of the fort wall, **S15** measures 2.32m by 4.92m. To the north of this group of structures is the partial remains of structure **S16** which abuts the western face of the inner fort wall. Another sub-rectangular structure is positioned opposite the eastern entrance (**S17**) and measures 3.55m by 3.97m. Other notable features within the interior are two mounds of stones (**S18** and **S19**).

The outer wall varies from 11.45m to 22.47m beyond the inner example. There are up to five radial walls sub-dividing the area between the enclosing elements. These may be a more recent addition, used for livestock management. Parts of this outer wall were also probably restored. The wall varies greatly in composition, ranging from an impressive barrier measuring 5.6m wide and 2.3m in height to an insubstantial field boundary. The latter may have been a recent addition to bridge a gap in the robbed-out or destroyed enclosure. The outer wall probably extended further at the south and this is supported by slope analysis. A grass covered band of raised ground (**S20**) probably represents the continuation of the enclosure in this area.

A possible original entrance survives in the eastern section of the wall (Figure 4.9). This comprises a 0.97m wide, 2.16m long break that is in-line with the entrance of the inner enclosure. The size of this possible entrance corresponds with Westropp's (1895, 268) description of the inner

Figure 4.9: Three dimensional model showing possible entrances.

example, suggesting that this possible entrance may not have been damaged during restoration works.

Approximately 15m to the north of this entrance is a substantial sub-rectangular enclosure with what Cotter (2012) and Westropp (1895, 289) describe as a possible bastion at the northeastern side. The enclosures appears to have been substantially restored, sharing similar features with the inner wall of the fort. The enclosure wall ranges from 3.1m wide and 1.25m high to 3.62m high and 3.6m wide. There is also a single terrace, however, this is not set at the outer edge of the wall, instead built at the centre, and could therefore be considered a more recent feature created during restoration works to avert the threat of collapse. There are two entrances to the enclosures. One is located at the eastern corner and measures 2.47m wide and 2.8m long, though it has been blocked by a low field boundary. The second entrance is positioned at the western side of the enclosure and measures 0.87m wide and 2.31m long. At the northern and southern corners of the fort, the enclosure wall is rounded (**S22** and **S23**), and this may have been used for settlement. When projected, **S22** would measure 2.1m in diameter which **S23** would measure 1.8 in diameter.

Outside the fort, to the north, Westropp (1895, 268) recorded a large cloghaun (**S24**; Figure 4.10). that has been nearly destroyed. This is not been recorded elsewhere. It is rectangular, though only the southern and eastern side of the structure remain. It measures 10.01m by 4.56m. The northern side also incorporates a stone trough. Approximately 17m to the east, a circular footing of stones measuring 2.57m in diameter (**S25**) may represent an unrecorded structure.

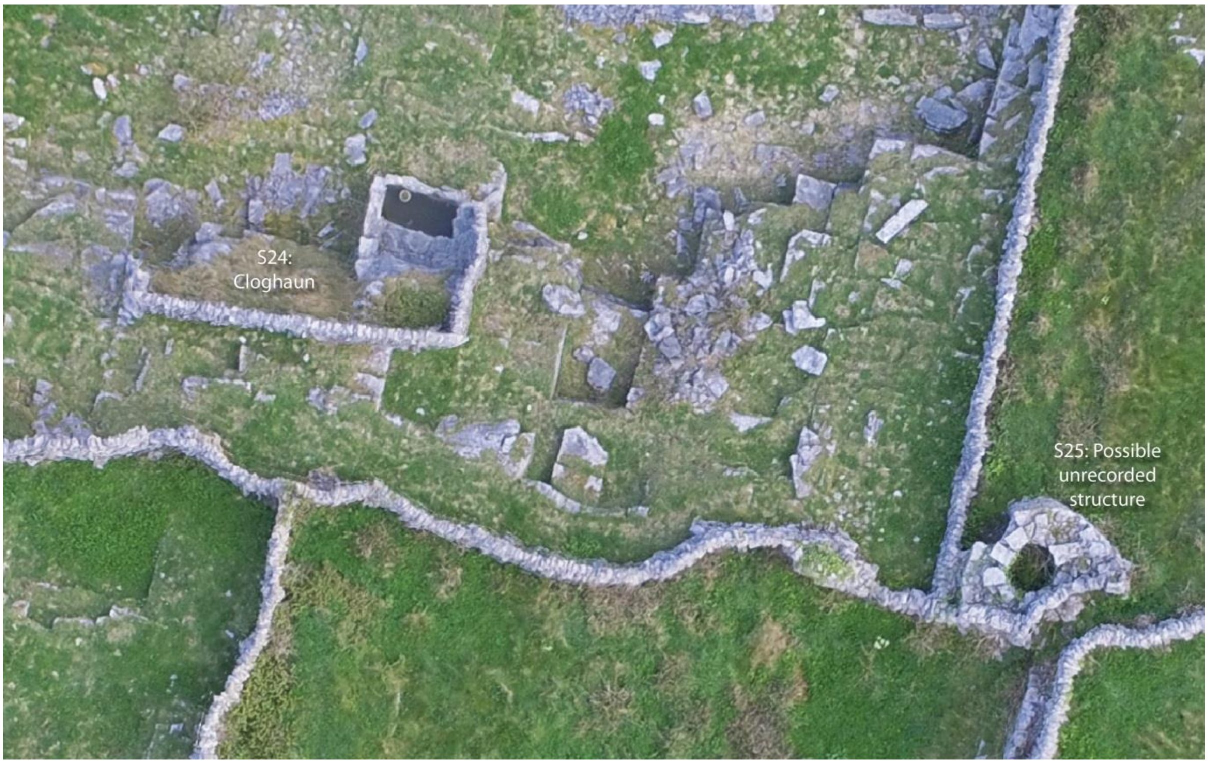

Figure 4.10: Orthomosaic showing Cloghaun (**S24**) and possible unrecorded structure (**S25**).

Dún Chonchúir is highly visible in the local and wider landscape. Westropp (1895, 276) notes that the fort is visible from the 'farther extremities of the cliffs of Moher'. This is highlighted in viewshed analysis. More significant are the extensive views of Galway Bay to the north-east (Figure 4.11).

Summary

The photogrammetry survey of Dún Chonchúir was successful in recording the current state of the fort, even though there has been considerable alteration to the monument in recent centuries. The survey produced both high-resolution ortho-rectified aerial images and a DSM which allowed for further examination using GIS techniques. A number of unrecorded features were identified, including a possible hut structure and quarry area, as well as the continuation of the outer enclosing element west. Viewshed analysis confirmed the wall of the fort restricted views of the interior of the fort. Unfortunately, LCP analysis could not be successfully undertaken, as various attempts were heavily affected by the more recent field patterns surrounding the fort, negating the results.

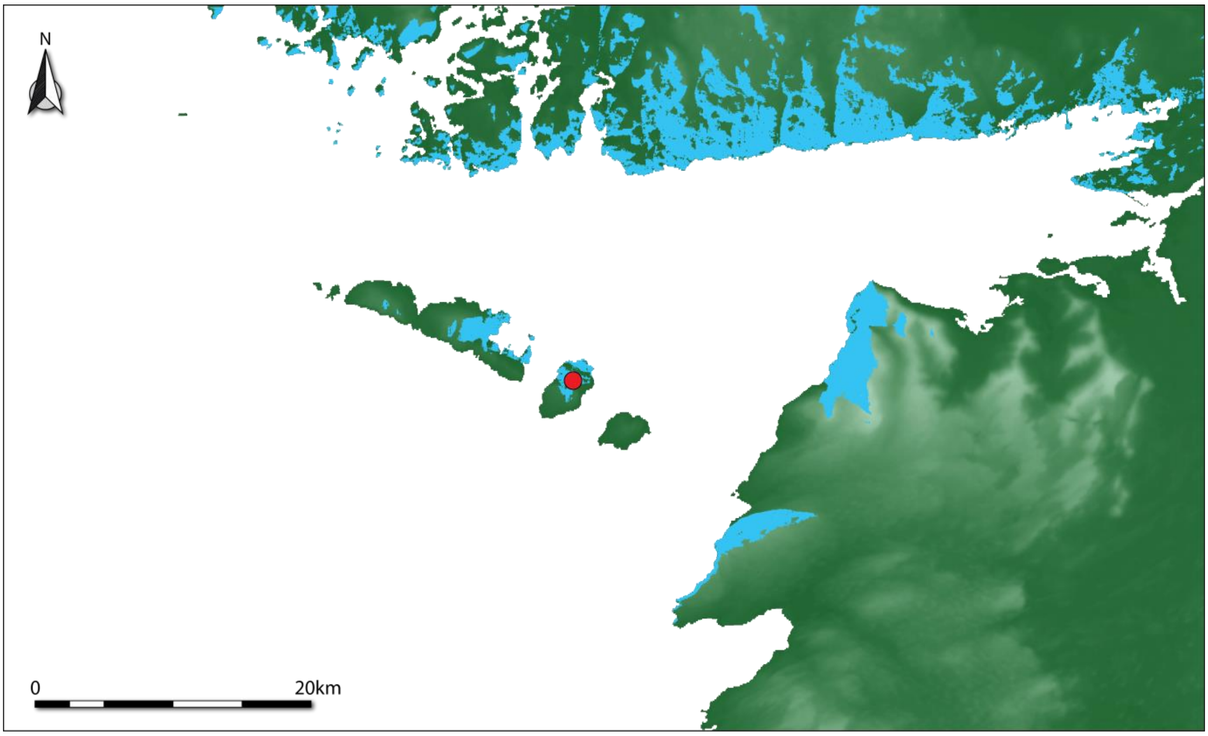

Figure 4.11: Viewshed analysis of the wider landscape of Dún Chonchúir.

4.2: Dún Fearbhaí

Dún Fearbhaí fort is positioned approximately 1km to the east of the larger Dún Chonchúir, overlooking the eastern seaways approaching the island and much of Galway Bay (Figure 4.12). The fort is positioned in-between two ridges on east–west sloping ground with extensive slopes within the interior of the fort. It is approximately 58m OD and occupies an area of 0.1ha. Cotter (2012) has argued that Dún Fearbhaí was a subsidiary to the larger Dún Chonchúir, acting as a look-out point to command the eastern shoreline of Inis Meáin, an area notably obstructed from view at Dún Chonchúir.

Dún Fearbhaí: enclosing elements

The fort consists of a single wall of stones approximately 3m thick and over 2m high, faced on either side. There is a single internal terrace with numerous steps incorporated into the inner wall face to allow access. There is a single entrance at the centre of the eastern façade. The fort was recorded in both editions of the Ordnance Survey where it was named Doonfarbagh, an anglicised version of its Irish name.


Figure 4.12: Dún Fearbhaí fort looking north-east.

Dún Fearbhaí: photogrammetry survey and results

A total of 78 geo-tagged aerial images were captured surrounding Dún Fearbhaí, resulting in the generation of a DSM (Digital Surface Model) and orthomosaic 6.105ha in size (Figure 4.13 and Figure 4.14). The DSM consists of approximately 4913952 three-dimensional data points with an average density of 120.33 points per metre. As part of the project, a 3D model was created and is available for the public to view: https://sketchfab.com/models/90cf320b14f7490e8560651dfdefd5cd. Similarly, a 360 degree aerial image can be viewed at: https://www.skypixel.com/photos/18f12add-7fc9-457a-9fa8-48c493e2cfdb.

Dún Fearbhaí occupies a total area of 0.09ha and is positioned between two natural north–south running terraces that are a defining feature of the local environs. These terraces are so pronounced that field systems in the area incorporate the steep slopes as part of their boundary (Figure 4.15). There are six obvious terraces measuring approximately 24–32m wide that continue from the upper slopes of the hill towards the shoreline. It is likely that these terraces were augmented by the addition of seaweed and other natural fertilisers over the centuries.

The fort is located on severely sloping ground, with the topography rising approximately 6m over the 22m width of the interior (Figure 4.16 and Figure 4.17). This obviously made any permanent

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Figure 4.13: Dún Fearbhaí DSM generated from photogrammetry survey.

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Figure 4.14: Dún Fearbhaí orthomosaic generated from photogrammetry survey.

Figure 4.15: Dún Fearbhaí slope model generated from photogrammetry survey.

settlement of the interior difficult and there are no potential platforms or other features visible in the photogrammetry results that might indicate internal habitation in the form of hut sites.

Despite the absence of any obvious occupation features within the interior, the fort itself is impressive, the walls being vertically faced both internally and externally. There is little variation in the thickness throughout the perimeter, which varies between 3.5–4.1m in thickness. Due to the considerable slope in topography, however, the height can vary dramatically. The eastern façade, for example, has a maximum internal height of 4.3m and a maximum internal height of 2.6m, the slope in this area allowing the builders to make the enclosing elements larger with less labour cost. The northern and southern facades do not vary greatly in height from this, measuring up to 4m externally and 3.4m high internally. The western wall section, however, is positioned on a notable north–south ridge of rising ground which impacts the size of the defences. Here, the maximum

Figure 4.16: Plan of Dún Fearbhaí fort.

height of the external face of the wall measures 2.8m, while the inner face is up to 3.4m high. This still forms a formidable barrier and would have required an equal amount of resources and labour to construct in comparison to other wall sections.

There is a single entrance which is located at the centre of the eastern wall section. Both terminals are faced, though the gap has been blocked by a much thinner, and probably more recent, wall. This may have been used in recent livestock management. The entrance measure approximately 2.03m wide. There is a notable depression in the enclosing elements directly opposite the entrance at the western wall section. This, however, is unlikely to be a blocked entrance, as there is a significant portion of the wall extant and this displays similar construction features as the remainder of the fort. There is also a low mound of stones abutting the external face of the wall in this area, possibly indicating that this depression was formed by wall collapse.

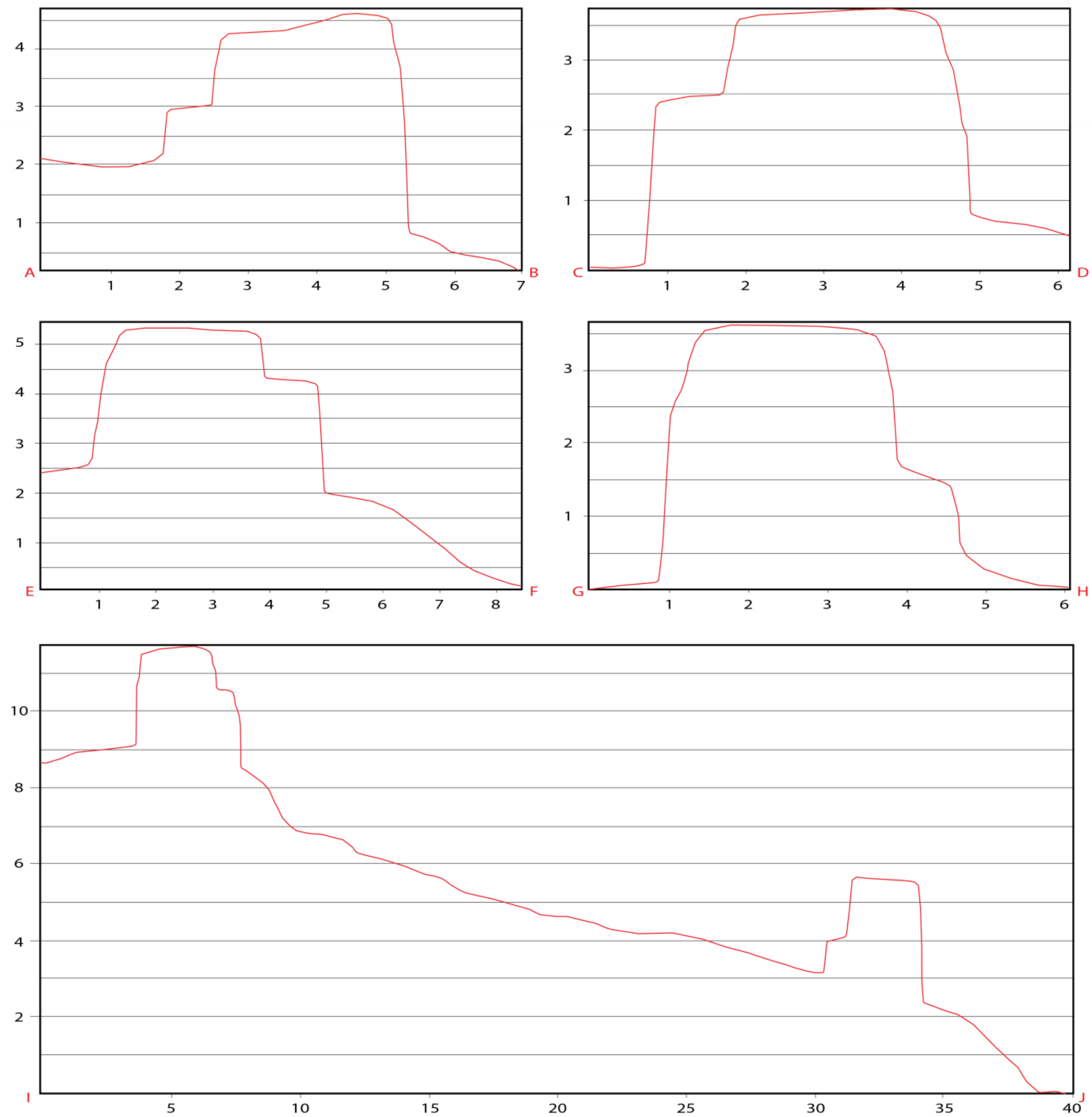

Figure 4.17: Sections of Dún Fearbhaí fort.

There are four sets of steps that allow access to the terrace. These are located at the north, south and two on either side of the entrance at the east (**S1** and **S**2). The concentration around the entrance may hint at a desire to provide access to strategic positions around the access point to the fort for protection. Four outer sets of steps are apparent in the terrace (**S3**). These do not provide access to the top of the wall. Rather, they are used to offset the significant increase in height that rises from east to west. There is only one set of steps (**S4**) that provides access to the top of the wall and this is located to the south of the entrance in the eastern wall façade. However, the terrace is low enough to the north of the entrance in the eastern wall section, that the top of the wall can be accessed by climbing over the terrace.

The amount of stone needed to create the fort probably necessitated the addition of quarried material (**S5**). A notable depression immediately to the south of the fort may indicate possible quarrying in this area, although this is difficult to confirm.

There is little in the way of possible unrecorded (or indeed recorded) archaeological features in the immediate environs of the fort. Approximately 80m to the north-west of Dún Fearbhaí, there is a possible unrecorded cloghaun (Figure 4.18). This comprises the northern and eastern walls of the structure, which measure 7.46m by 4.56m.

Visibility analysis of the interior confirms that, despite the significant slope, the walls of the fort restrict visibility of the interior from the outside and visibility of the immediate environs of the fort from those inside (Figure 4.19). However, considering access to the top of the wall from the interior, and particularly access to the top of the eastern wall section, was a design feature of the defences, visibility of the immediate surrounding would have been significantly increased. This is confirmed by the viewshed analysis which highlights the immediate surroundings of the fort were visible to those on top of the wall (Figure 4.20). Modern field boundaries obviously affect the GIS analysis, notably to the east, and it is likely that visibility of this areas would be increased if these features were removed, though the natural terracing of the landscape would still have obstructed

Figure 4.18: Possible unrecorded cloghaun to the north of Dún Fearbhaí fort.

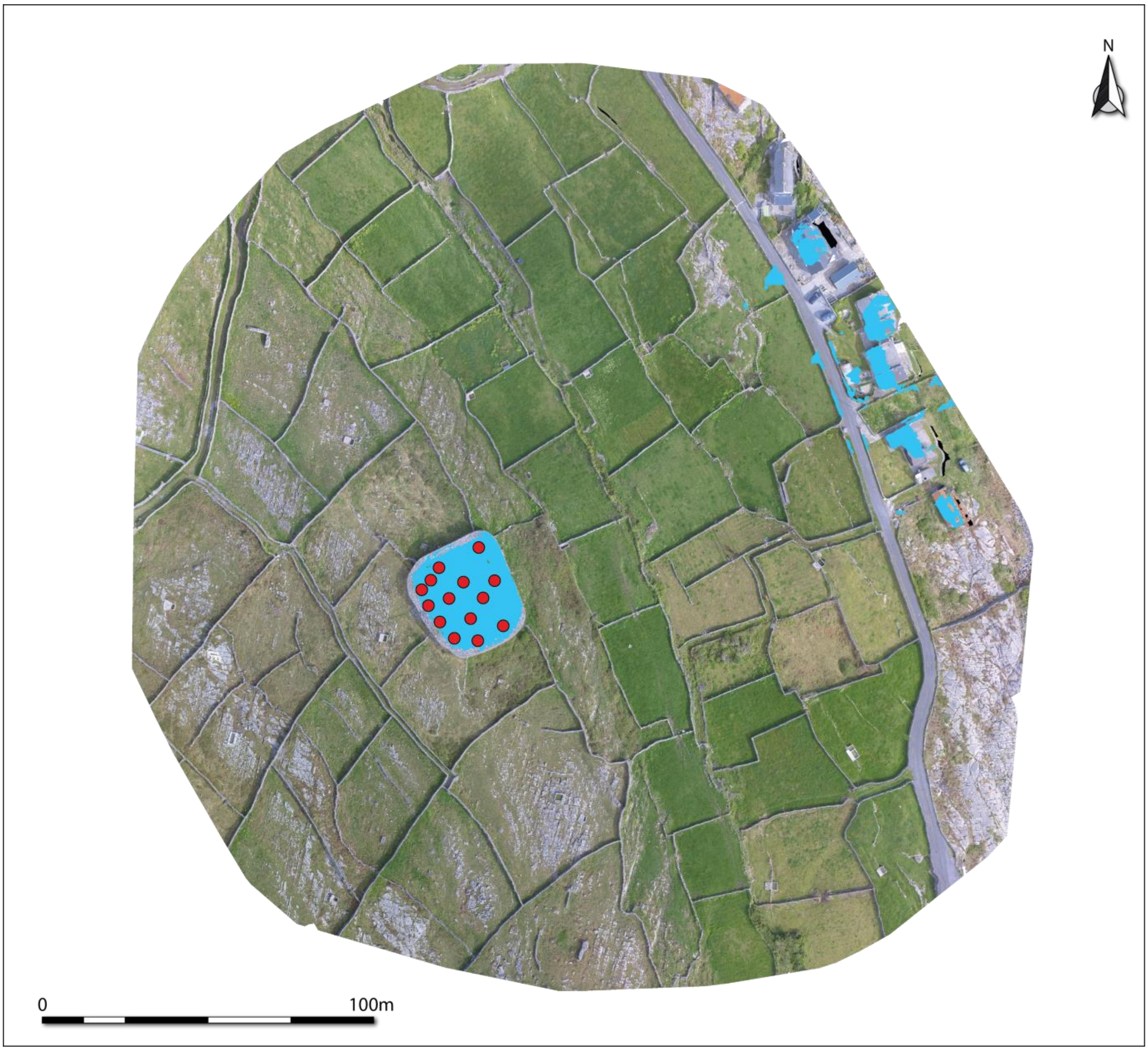

Figure 4.19: Dún Fearbhaí viewshed analysis highlighting areas visible from inside the fort.

visibility to an extent. Although GIS analysis suggests that Cotter's (2012) suggestion that the 'raked interior of this fort allowed the occupants a clear view of any maritime traffic in the harbour below' is now under question, the ability of the occupants to access the top of the fort wall would have greatly increased their visibility, particularity in this area. It would also have restricted visibility of the interior of the fort to outsiders, increasing the defensiveness of the fort.

Visibility of the wider landscape is similar to Dún Chonchúir, where there are excellent views of the Galway Bay to the north (Figure 4.21). Interestingly, Dún Fearbhaí is positioned in overlook the shoreline to the immediate north and east, with excellent views of the seaways between Inis Meáin and Inish Oirr, augmenting Dún Chonchúir's poor visibility of this area.

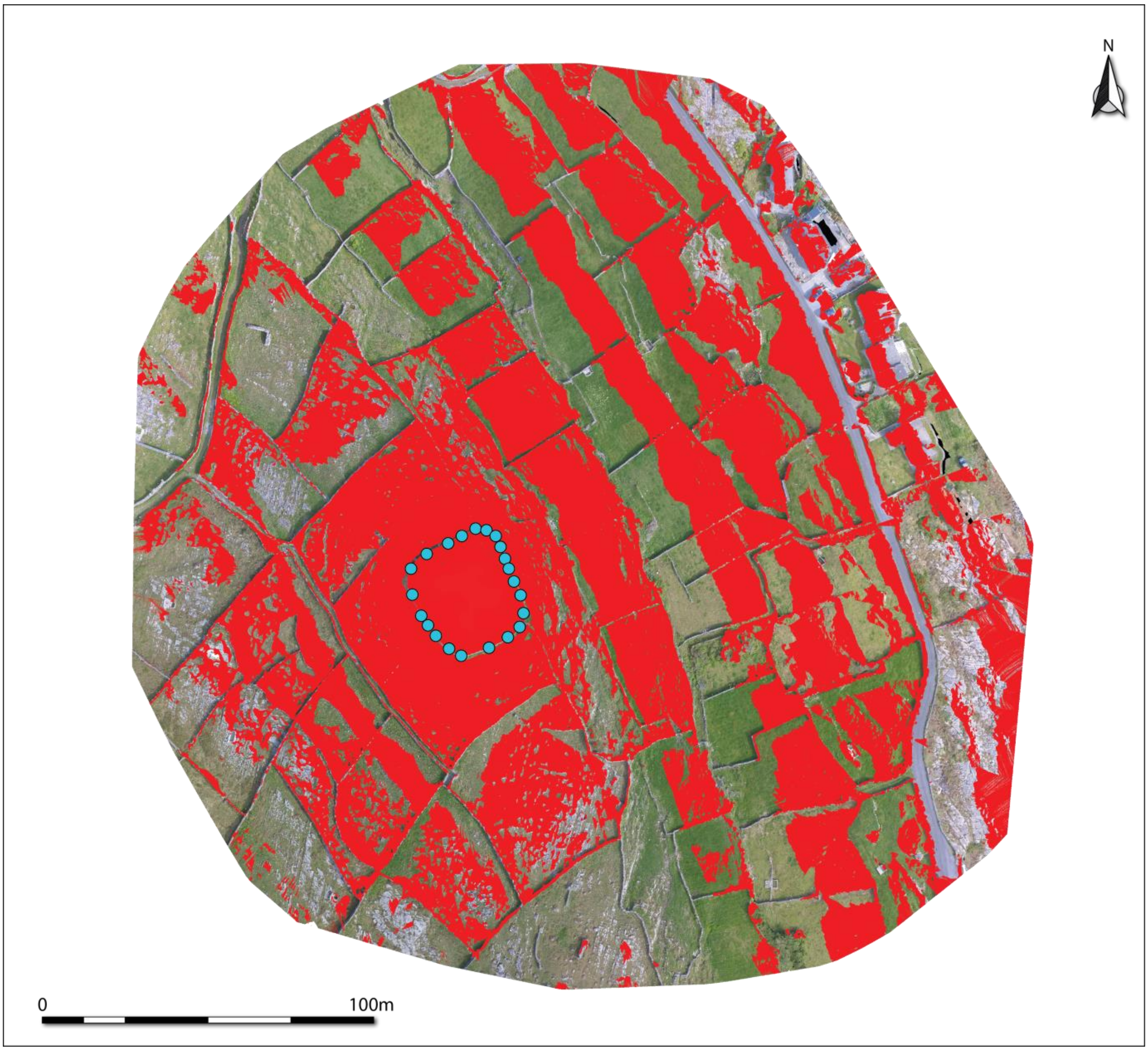

Figure 4.20: Dún Fearbhaí viewshed analysis highlighting areas visible from the top of the wall of the fort.

Summary

The photogrammetry survey of Dún Fearbhaí was successful in recording the current state of the fort, providing both high-resolution ortho-rectified aerial images, as well as a DSM. This allowed for analysis of the site using GIS techniques. Unfortunately, LCP analysis could not be successfully undertaken, as various attempts were heavily affected by the more recent field patterns surrounding the fort, negating the results. Though there is little in the way of unrecorded archaeology, the results of the survey lend further weight to Cotter's (2012) interpretation Dún Fearbhaí as an auxiliary fort to the larger Dún Chonchúir which is positioned just under 1km to the west. The lack of obvious internal occupation, the severe sloping topography within the fort and the numerous access points to the wall terrace and summit could infer that Dún Fearbhaí may have been built as a lookout post for the more prestigious settlement of Dún Chonchúir (Cotter 2012).

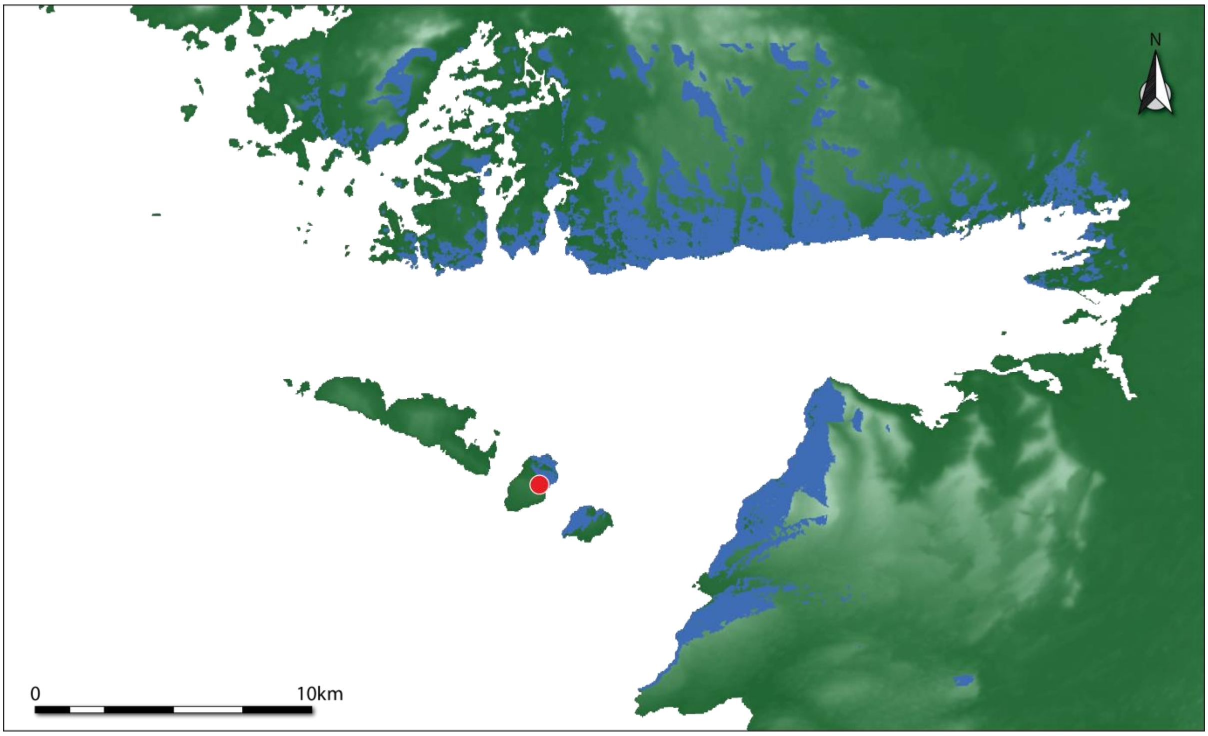

Figure 4.21: Wider viewshed analysis of Dún Fearbhaí highlighting areas visible from the site.

5

Conclusion

The Western Stone Forts form some of the most spectacular archaeological monuments in the country and are of such national significance to be included in the Tentative List of UNESCO World Heritage Sites. This project has added to The Discovery Programmes surveys at other sites on the list, helping to create an extensive collection of highly detailed three dimensional models to both academic and public use. The models created for this project are freely available to view online and have been shared using social media platforms such as Facebook.

This project has also incorporated GIS analysis to help further understand the significance of the individual sites and their shared architectural features. Although the sites are clearly a consort of fortifications from various different periods ranging the Late Bronze Age to Early Medieval period, they retain a number of common architectural features, such as thick stone walls and internal terracing. It is unlikely that these common features represent a continuity of fortification. Rather, the incorporation of thick stone walls could be seen as a practical use of materials available to various communities in the western region of Ireland, where excess surface stone, near surface rock and/or thin soil cover forced peoples to develop construction techniques and fortifications incorporating stone. In many other regions of Ireland, Late Bronze Age hillforts and Early Medieval ringforts were most built of a mixture of earth and stone, reflecting localized ground and geological conditions.

A thick wall would have been necessary for larger, higher walls, resulting in excessive labour and resource costs. This was partly alleviated by terracing the walls, reducing the amount of material used. Terracing of the inner face and incorporation of steps allowed access to the top of the wall, permitting occupants expansive visibility of the immediate environs as well as a strategic advantage over approaching attackers. The vertical walls that met attackers or visitors would have been an impressive barrier that provided practical defence for the occupants, as well status.

GIS analysis highlighted the practical used of internal terracing at these sites, as well as the ability of the large stone walls to block viability of the interior from the outside. In most cases, without access to the upper levels of the wall, the large walls would have blocked the occupants' visibility of the outside. Terracing and steps were, therefore, integral and practical elements of such large walls.

Many of the common architectural features of the Western Stone Forts, therefore, may reflect localised, practical use of materials rather than any specific continuity of fort building. Instead, the shared characteristics could be viewed as simple, practical features employed in the construction of large fortifications of many different time periods. In this regard, it is difficult to distinguish the chronology of individual sites using only these architectural features.

One characteristic trait that every Western Stone Fort shares is a strategic landscape setting. Considering the large nature of the walls and fortifications, it is highly likely that these were important, high status sites. As such, landscape prominence would have been an integral element of choosing a sites location. In many cases, it could be argued that these sites were located to control the movement of people and goods; Cahercommaun overlooking a prominent overland natural routeway, Faha and Caherconree overlooking Dingle and Tralee Bay, Dún Fearbhaí and Dún Chonchúir commanding the seaways surrounding Inis Meáin and Galway Bay. This 'characteristic', however, is not just shared with the Western Stone Fort, but with may high status sites of many periods.

This project was particularly useful in accessing the ability of photogrammetry techniques in archaeological landscape studies. The resolution obtained for this project were far in excess of more costly techniques such as GPS or LiDAR survey, while being far quicker in terms of time in field. The landscapes encountered during this project were ideally suited to this technique, being largely devoid of tree or excessive vegetation cover. The inability to penetrate such vegetation is photogrammetry's biggest drawback, though in many instances, without the correct sensors, the application of LiDAR in such environments is severely limited. The successful use of photogrammetry on landscapes in this project, rather than artefacts, is an excellent pilot study for its wider application in archaeology.

6

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