Remote Sensing and Archaeology Instructions

A Citizen Science Project

2019-20



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Llywodraeth Cymru Welsh Government

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Project Description

The potential of LiDAR (Light Detection and Ranging) and digital photographs for identifying archaeological sites is well-known, and occasionally professional archaeologists and others have contacted the Trust with information on sites that they have recognised from these sources, but there has been no systematic programme of identification of these archaeological sites and adding the information to the Historic Environment Record (HER). The systematic identification of sites using LiDAR, aerial photographs and other sources and the creation of new records will be undertaken during this project.

Use will be made of other easily available sources. These include:

- The Historic Environment Record (HER)
- The National Monuments Record (NMR)
- Digitised Historical Maps
- Digitised Tithe Maps
- And many more.....

Aim of Project

The aim of this project is to inform understanding on existing or previously undiscovered archaeological sites in selected areas of South-West Wales, covering Carmarthenshire, Ceredigion and Pembrokeshire. This will be achieved by using remote sensing, in particular LiDAR, and accompanied by other easily available sources such as digital aerial photographs, the Historic Environment Record (HER) and Digitised Historical Maps. HER records will be updated for any existing site, if appropriate, and new HER records will be created for each new site that is identified. Site visits will then be made to a small selection of sites to verify any findings. This information will be collected by a small group of volunteers who will systematically search remote sensing data (and other sources) that are available for Carmarthenshire, Ceredigion and Pembrokeshire. A short report will be produced in order to present the results of the project.

About LiDAR

Airbourne LiDAR (Light Detection and Ranging) is a surveying method which measures the height of the ground surface and other features (such as trees or buildings) in large areas of landscape with a high resolution and accuracy. It does this by sending a pulse from a laser to the ground and back again. LiDAR can provide highly detailed and accurate models of the land surface at metre and sub metre resolution. This provides archaeologists with the capability to recognise and record otherwise hard to detect features. However, LiDAR pulses cannot penetrate the ground, so it will not see buried features; nor can it penetrate water or through trees and dense vegetation. The pulse can also be affected by the weather, i.e. clouds/rain and snow.

LiDAR has several applications: Mapping and Cartography, Flood Mapping, Forestry Applications, Utilities, Transport and Infrastructure, Planning, Coastal Management, Military and of course, Archaeology and more! In December of 2017, The Environment Agency announced that it plans to map England's entire landscape, using LiDAR, by 2020; this data will be primarily used to assess flood risk and inform conservation work, but its applications are numerous.



Using and Understanding LiDAR

We will be getting our datasets from Lle (A Geo-Portal for Wales). It is a Natural Resources Wales (NRW) composite dataset for LiDAR which has derived from surveys over several years and covers approximately 70% of Wales. There are four types of datasets available on Lle, 50cm, 25cm, 2m and 1m Data. Each refers to the resolution that particular dataset. Not all of Wales is covered by each type of resolution dataset, therefore, that may mean that if you find a feature at 2m resolution, you may not be able to find the same feature at 50cm resolution and vice-versa. Not all of Wales is covered by LiDAR at all, as you can see from the image below there are some 'blank' spots. These are areas that have not been surveyed and therefore do not have any data attached to them.



There may also be 'blank' spots as you zoom in closer on the map, this may be due to bodies of water (such as rivers and ponds) as the pulse will reflect back off water and will present you with a blank result. The same can be said for anything which is reflective. An example of this is shown below; it shows the River Towy in Llandeilo. It has captured some of the river, but there are some grey blank spots where it has not recognised the water.



As well as the different types of resolutions, there are different types of models the data can be presented in. The Digital Surface Model (DSM) will show you the detailed surface features of your chosen area, it will show you trees, hedges, buildings etc. Sometimes DSM is also known as 'The First Return' Data, as this is based on the first reflection of the pulse. The Digital Terrain Model (DTM) will show you the terrain of your chosen area, and will show earthworks and mounds etc. This is sometimes known as 'The Last Return' Data (or Bare Earth Data), as this is the data reflected back from the ground surface with trees and other features removed.



It is important to consider both datasets as sometimes archaeology can disappear when you remove the DSM layer. This is shown below with an example of Dinefwr Castle, (PRN 882) in Carmarthenshire.



Dinefwr Castle, Llandeilo in DSM (First Return)



Dinefwr Castle, Llandeilo in DTM (Last Return)

As you can see, the clearly defined castle walls, and all the woodland in the DSM layer has been removed in the DTM layer.

The alternative to the example above is that sometimes Archaeology can appear when you remove the DSM layer. Here is an example of Pembrey Country Park, Carmarthenshire (PRN 31392).



Pembrey Country Park in 1m DSM

Pembrey Country Park in 1m DTM

As you can see, some features have appeared beneath the woodland. These may be remains of Pembrey's Munitions Factory, easily spotted with the help of LiDAR.



Using Lle

This link will take you to Lle

https://lle.gov.wales/catalogue/item/LidarCompositeDataset/?lang=en

While using Lle, it will only allow you to zoom in to a certain point, if you zoom in too far it will revert back to an OS (Ordnance Survey) map. Sometimes this might be useful, as some aspects on this map will be labelled, and it will also show you road and place names, which will be helpful with identification. On this homepage you will find more detailed information of what is available from the Lle LiDAR Dataset, and there is also an Additional Technical Information and Frequently Asked Questions PDF available.

We begin our project by clicking	Lle - Map Browser	BETA
View in Lle Map Browser at the	★ Layers	į
right hand side of the screen; this		
will bring up your LiDAR map.	Background	
To the left of the new screen are	✓ Ordnance Survey Vector (viaEuropa) →	\$
the active layers available for the		_
map (Pictured to the right). By	Active layers (8) Add / Remove Da	ata
selecting all or some of these,	LIDAR Composite Dataset - DSM 25cm	_
will bring up the corresponding		_
LiDAR on the map. You can use	LIDAR Composite Dataset - DTM 25cm	
any dataset you choose, all or	LIDAR Composite Dataset - DSM 50cm	
just one, as long as whichever	LiDAR Composite Dataset - DTM 50cm	
one you choose is made clear in	LiDAR Composite Dataset - DSM 1m	
your Participant Return Form.	LIDAR Composite Dataset - DTM 1m	_
This will allow us to find any		
features you find again.	LiDAR Composite Dataset - DSM 2m	
	LIDAR Composite Dataset - DTM 2m	

Once you have selected all of the datasets you wish to view, you can now search for your area. This can be done by searching in the toolbar at the top of the mapping. Here you can search for a place name or postcode.



During this project, the instructions are based on looking for your chosen area on the Lle website itself, however, if you have access to GIS then please feel free to download your area from Lle here <u>https://lle.gov.wales/</u>

<u>GridProducts#data=LidarCompositeDataset</u> This data is available in 10k square grids. Once you click on your chosen grid square you are able to download all the available LiDAR data for that square. For example if a square only contains data for 1m DSM and DTM then that's all that will be downloaded. Each square may have several datasets included in them. If you can not download the data, then you can search on Lle using an NGR and will still be able to work online. Please bear in mind that Lle is open source software and may not be available all the time, and may be prone to glitches.



For this project we will be searching for areas using NGRs (Instructions on how to do so are given below, or at this point you can download a grid square if you have GIS Software, but these instructions are written for those using the Lle opensource software). You should have been given one or several NGRs to begin your research with your welcome email (If not, please contact Jenna). Search for your given or chosen area within Carmarthenshire, Ceredigion or Pembrokeshire and then search through and interpret the LiDAR data as best you can. There will be no limit to how far you search, so you can do as little or as much as you like as long as you are using your given NGR as a base point. We are hoping that this will allow for some overlap between participants and allow for the same areas to be interpreted by several people in order for us to get as much information from areas as possible.

Lle	e - Map Bro	Q Search				
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Bac	kground					1. N. 6.
✓	Ordnance Surv	vey Vector (viaEuropa		\$	Ċ	
Act	ive layers (8)		Add / Remove D	ata	\uparrow	
\checkmark	LiDAR Compos	site Dataset - DSM 25	icm			
\checkmark	LiDAR Composite Dataset - DTM 25cm					
\checkmark	LiDAR Composite Dataset - DSM 50cm					
\checkmark	✓ LiDAR Composite Dataset - DTM 50cm					
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\checkmark	LiDAR Compos	site Dataset - DSM 2r	n			
\checkmark	LiDAR Compos	site Dataset - DTM 2r	n			

This will open and give you the options to Measure or Navigate. Select the Coordinate Tool.



This will bring up the pop up box shown below.

Coordinate Tool	- ×
Lon/Lat	•
Lon	
Lon	
Lat	

This box will automatically be set to Latitude and Longitude, but this can be changed to Eastings and Northings by selecting the drop down arrow (shown above) and changing to Eastings and Northings.

N.B. If you need assistance with Eastings and Northings and NGRs, please let me know and I can send you a brief tutorial. Also please see in the bibliography, there is a Free Map Tools website which allows you to convert NGRs to Postcodes and vice versa. This may be useful if you have any areas of interest you want to look at. Once you have selected Easting and Northing you can then enter them (X =

Eastings and Y = Northings). By then pressing the coordinate button you should be taken to your chosen location, or in the vicinity of, this will depend on how accurate your NGR co-ordinates are. By having this tool open it will always track where you are on the map. Therefore if you find a feature that you think is worth recording, you can easily acquire the grid reference. Click on

the feature you would like and NGR for and then click the copy button you can then paste the Eastings and Northings in your Participant Return Form.

If you would like to, you can also use the measure tool.



This may be useful to measure the extent of a feature, which can be used in your description, or it could be used to say how far away your feature is from something recognisable such as a building or road. To do this, select the measure tool. This will bring up a new pop up 'Measure' box.



Distance will be automatically selected (as shown above). You will be able to measure distance which can be done in several types of unit; the preferred unit is Metres or Kilometres (N.B. Please make the unit clear in your Participant Return Form). You then click to start drawing. You will see the total of miles as you click and draw your line, and this will also be shown in your pop up box, you are also able to remove all measurements and start again if you wish. The image to the right is an example of the approximate distance in kilometres from Dinefwr Castle to the **River Towy.**





By selecting Area, you are able to measure the area of a chosen site. Again, you can obtain your results in different units, but the preferred is square metres or square kilometres (N.B. Please make your unit clear in your Participant Return Form). You use the draw tool in exactly the same way as measuring, by dragging and drawing, and the results will be shown in the same way. To the left is an example of the approximate area in square metres of inside Dinefwr Castle's walls.

Other Sources

Primarily, we are looking to identify possible new sites using LiDAR data, so this means that it would be good practice to look at other sources to confirm whether what has been found is indeed a new site.

Firstly, check the Historic Environment Record. The public platform for the Welsh Historic Environment Record is Archwilio. Found here, <u>https://</u><u>www.archwilio.org.uk/arch/</u> on Archwilio you can search specific areas to coordinate with your findings. Here there are map layers which you can toggle on and off depending on what you are searching for (image below). For this project's purpose some of these boxes may not be appropriate to use, such as the Listed Buildings. If you come across a potential site on LiDAR, and search for and find it on Archwilio, we have already identified that site, and there will already be a description for it. However, if you find that this description is now out of date, please let us know as we can then update that description with your findings. It may be that you find that the NGR for a particular site is slightly (or completely) wrong, and you have a more accurate NGR. Please make a note of the PRN (Primary Record Number) and get in contact with any information you have gathered that will help us update the HER. This can be done by filling out and returning your Participant Return Form.



You are not able to search Archwilio using an NGR, you will either have to search by area on the Map , or you are able to search by Community. This function is available on the left hand side of the screen next to the map layers. The example below shows a site on Archwilio: Dinefwr Castle, Llandeilo (PRN 882). The Red Circles denote Core Records on the HER, Dinefwr Castle is PRN 882. The Green Squares denote Archaeological Events that have happened in that area i.e. Excavations or Watching Briefs. These will have an Event Record Number (ERN), for example a Watching Brief carried out by Dyfed Archaeological Trust at Dinefwr Castle in 1997, has the ERN 54472.



When searching on Archwilio, Events are shown as a Red E next to the name of the Event. When you click on any of the results (Core or Event) a new window will open with all the relevant information of that record. There may be a description, a report, NGR, images and more if applicable.

AICIWILIO Records of Wales				
Search the Historic Environment Record				
Unitar	у [Any 🔻		
Comm	nunity	Any 🔻		
Period	1	Any 🔻		
Searc	Search term Dinefwr			
<u> </u>	Search only in the map view Search			
Matchi Ref	Matching Records : 148 Ref Period Name			
94418	Modern	E DINEFWR HOME FARM: RECORDII		
880	Not Applicable	DINEFWR : DAT		
97135	Modern	E EXCAVATION AND SURVEY AT DINEFWR PARK : DAT		
97134	Modern	E EXCAVATION AND SURVEY AT DINEFWR PARK, LLANDEILO : DAT		
56262	Modern	E NEWTON HOUSE, DINEFWR BILLIARD ROOM : DAT		
94533	Modern	E TEST PIT EXCAVATIONS AROUND DINEFWR CASTLE : DAT		
97136	Modern	E EXCAVATION AND SURVEY AT DINEFWR PARK, LLANDEILO, CARMARTHENSHIRE : DAT		
50261	Medieval	DINEFWR : DAT		
50260	Medieval	DINEFWR : DAT		
50259	Medieval	DINEFWR : DAT		

You can also use other aerial resources such as Google Maps <u>https://</u> <u>www.google.co.uk/maps?hl=en&tab=rl</u> this will help to confirm what you are seeing on LiDAR, and will help to discover whether the site is something that has already been discovered and recorded. Google Maps can also be very useful to determine the surroundings of the area you have chosen, and will help us create and input accurate description for the Historic Environment Record (HER). If you would like to, you can also download Google Earth <u>https://www.google.co.uk/intl/en_uk/earth/</u> this may be more useful than just Google maps as here you are able to search through the aerial photographs by year.



By selecting the 'Show Historical Imagery' button (highlighted above in the top row) you are then able to drag the map through different time periods using the timeslider (highlighted above). The date to which the map refers is shown in the timeslider, in this example it is 2005. Again, not all of Wales will be covered with every year, some go as far back as the 1940s, but some are only early 2000s, again this may be a useful tool in helping to decipher potential and current sites. Another useful website is The Side by Side Map managed by the National Library of Scotland <u>https://maps.nls.uk/geo/explore/side-by-side/</u> <u>#zoom=14&lat=51.6794&lon=-4.1460&layers=1&right=BingHyb</u> here you can view current mapping alongside historic mapping, which will be beneficial for identifying historical and archaeological sites. As you use this map, your cursor will denote an NGR to ensure you are searching the correct area (Shown in the image below in the bottom right corner). By clicking 'Find by Place' at the top of this screen, you are able to search for areas by place name, NGR or County. And you are able to select what map you would like to view.

Another useful website to consider looking at is the Welsh Tithe Maps held by the National Library of Wales; these can be found here <u>https://places.library.wales/</u>. Here you can search through over 300,000 entries and their accompanying metadata using original and present day maps. You can search in two different ways. Firstly, you can search the Tithe Apportionments, this can be done through parish, farm name, field name etc. This may be useful as you will be able to search the tithe maps for your potential site and this may give you a clue to how old it is, and if it has been previously mentioned on maps. Secondly, you can search by modern place, village, town or city etc., and browse the mapping from there. Below is an example of the area around Dinefwr Castle which shows pins in a map from which you can find out who owned the land, the field number and field name etc.

In the small box highlighted in the image above, you are able to toggle different types of map, i.e. modern, satellite (shown above) and tithe maps. The pins are still shown throughout all the mapping, such as in the image below. Again, looking at tithe maps may be useful to discover what may have previously been on that land, or if a site has previously been discovered and labelled.

Another useful Tithe Map website is <u>https://www.old-maps.co.uk/#/</u>. Here you are able to search for town name, postcode and using Eastings and Northings. Once you have selected your site, your chosen area will appear on the mapping.

There is a column on the left hand side which allows you to choose what year tithe map you would like to view, in the example above the Carmarthenshire 1891 map is selected. Looking at historic tithe maps is useful as it allows us to see any progression of sites over time, or to see if any sites have disappeared over time. You can also use The Royal Commission on the Ancient and Historical Monuments of Wales' Dataset at <u>https://www.coflein.gov.uk/</u> here you can also search for sites. This can be done by searching by place name or NPRN (National Primary Reference Number). On the map, you will only see information for sites that you have searched for, nearby sites will not show on the map automatically, but there is an Associated Sites option to the left of the mapping which will show you any sites that are associated with your chosen site.

You may have to search for a nearby recorded monument to your area, in order to search for your feature. You are unable to search by NGRs. Therefore to find Dinefwr Castle for example, you could search for Dinefwr, or Llandeilo. You can also zoom in using the map function to find your feature.

DINEFWR CASTLE, LLANDEILO

Here is another example of Dinefwr Castle, Llandeilo (NPRN 425). On Coflein, you will be able to see a NPRN (National Primary Record Number), map references, grid references and more metadata. You may also see a description and possibly photographs. All this can aid you in the identification of sites, and the updating of records.

Beginning Analysis

In your welcome email, you will have been sent a Participant Return Form. This will be what you fill in, and return with all your information. Please fill this form in to the best of your ability with as much information and detail as you can. Then return it to Jenna Smith at <u>j.smith@dyfedarchaeology.org.uk</u>

Firstly, find your given/chosen area and begin to search the terrain as best you can. You may have to use different resolutions and terrain models and go over the same area several times to find features. Once you have a suspected feature then using other sources and Archwilio, check to see if the site already exists. If it does then please check to see if it can be updated in anyway. i.e. the NGR is out of place, or the description is now out of date. If you find that the feature you have found does not exist on Archwilio, then please capture as much data as you can ,particularly an NGR, as all this will help us to identify and verify the records that we will make. Please be aware that some sites may not show on Archwilio even though we have already identified them. This may be because they are protected and are of important nature. However, please still record any information that you think may be useful in updating the records as this will help to keep the records as up to date as possible.

We will be focusing on Carmarthenshire, Ceredigion and Pembrokeshire for this pilot project and will primarily be using Lle. There may be another LiDAR source that you wish to use instead or to accompany Lle, this is fine but for the purpose of these instructions we have used Lle as an example database. If you do use another database, please make sure to reference the site/s in your Participant Return Form, as this will allow us to verify the results.

We are aware that there may be many other sources that could be used to aid this analysis, if you do have any sources that you believe would help then please feel free to send them to me and then I will be able to send them to other participants if appropriate. Any sources that you use, please make reference to them in the Participant Return Form. Another useful open source LiDAR website is <u>https://houseprices.io/lab/</u> <u>lidar/map</u>.This free LiDAR site is only in 1m DSM resolution; because of this not all of Wales is covered with this dataset. This site is also different to Lle as the data is shown in black and white rather than colour. This may be useful to compare with Lle data for any potential site that you find, as it may show a different aspect of the site that is not shown on Lle. Below is an example of Dinefwr Castle in 1m DSM.

There are several useful websites listed in the Bibliography that include different websites for LiDAR, Aerial Photography and Academic Resources.

Types of Features to look for

Here are some examples of the types of sites you may come across, and the features associated with them that you can look for.

Hen Gaer Iron Age Hillfort (PRN 2015), in Ceredigion in 1m DTM

Castell Pen-y-Coed Iron Age Promontory Fort (PRN 3887), in Carmarthen -shire in 1m DTM

Penrhyn Coch Iorn Age Defended Enclosure (PRN2022) in Ceredigion in 1m DSM

Wiston Roman Fort (PRN 5683) in Pembrokeshire in 2m DTM

Example of World War One practice Trenches at Penally (PRN 33458) in Pembrokeshire in 1m DSM

There is a section in this Pdf (Page 11) <u>http://</u>

www.bronzeagecaithness.aocarchaeology.com/wp-content/uploads/PDF/ <u>An%20Introduction%20to%20LiDAR.pdf</u> which shows more examples of different types of archaeology, what to look for, and how to identify it.

Reporting Information and Contact Details

Once you have identified a potential new site or have information regarding a current site, please try to gather as much information as you can about it. Hopefully, most of this will be covered in the Participant Return Form, but there will be an option for you to input as much information as you like. You can send me information on more than one site in your Participant Return Form if it is appropriate, as there are several copies of the form in one document. Or you can just send me one site at a time as you find them. If possible please try to only send information regarding a potential or current site in this format (Participant Return Form), as this will make it simpler to assimilate the information.

Once you have searched your given area/s then please feel free to ask for another area, or pick an area that interests you. For the project we are concentrating on Carmarthenshire, Ceredigion and Pembrokeshire. If you happen to find information about an area that is not in the Dyfed Archaeological Trust Area, then please feel free to contact the relevant Trust with your information. Details of which are provided on Page 30.

This project will be ending in February 2020. However, if you have an interest in The Historic Environment Record and come across information about sites in the future then please feel free to contact us with any relevant information; this will help to update the HER and possibly create new archaeological sites. This can be through LiDAR or fieldwalking etc.

Throughout this project please feel free to contact me anytime. My email is <u>j.smith@dyfedarchaeology.org.uk</u> and my direct line is 01558 825995. Our opening hours are between 10-4 Monday to Friday and I will endeavour to reply to you as soon as possible during these times.

<u>Bibliography</u>

AOC Archaeology Group 2015, An Introduction to LiDAR for Archaeology. <u>http://www.bronzeagecaithness.aocarchaeology.com/wp-content/uploads/</u> PDF/An%20Introduction%20to%20LiDAR.pdf

<u>Free Map Tools (Use this to convert NGRs to Postcodes) https://</u> <u>www.freemaptools.com/convert-ngr-to-postcode.htm</u> Free Map Tools (Use this to convert Postcodes to NGRs) <u>https://</u> <u>www.freemaptools.com/convert-postcode-to-ngr.htm</u>

Google Maps https://www.google.com/maps

Google Earth Download <u>https://www.google.co.uk/intl/en_uk/earth/</u>

Gov.uk : Environment Agency uncovers landscape with laser mapping <u>https://www.gov.uk/government/news/environment-agency-uncovers-landscape-with-laser-mapping</u>

Historic England 2018, Using Airborne Lidar in Archaeological Survey: The Light Fantastic. Swindon. Historic England. <u>https://historicengland.org.uk/images-books/publications/using-airborne-lidar-in-archaeological-survey/</u>

Historic Aerial Photographs http://lle.gov.wales/services/tiles/apu/#

House Prices IO Lab: 1m DSM dataset. <u>https://houseprices.io/lab/lidar/map</u>

LiDAR Composite Dataset: Natural Resources Wales. <u>https://lle.gov.wales/</u> catalogue/item/LidarCompositeDataset/?lang=en

MAGIC : Natural England https://magic.defra.gov.uk/

Old-Maps : Britain's Most Comprehensive Historical Map Archive <u>https://</u> www.old-maps.co.uk/#/

UK Grid Reference Finder (On this website you can right click on a map and it will provide an NGR, East and Northing, Latitude and Longitude and a nearby address) <u>https://gridreferencefinder.com/</u>

Welsh Tithe Maps: The National Library of Wales https://places.library.wales/

<u>Glossary</u>

Archwilio – [Ar-ch-wil-ee-o] – The public access to the Historic Environment Record (means to explore or examine)

- DAT—Dyfed Archaeological Trust
- DSM Digital Surface Model
- DTM Digital Terrain Model
- ERN-Event Record Number
- GIS—Geographical Information System—designed to create, view, store, and analyse digital mapping and spatial information.
- HER Historic Environment Record
- LiDAR Light Detection and Ranging
- Lle- A Geo-Portal for Wales
- NGR National Grid Reference (Eastings and Northings)
- NMR National Monuments Record
- NPRN National Primary Record Number
- NRW—Natural Resources Wales
- OS Ordnance Survey
- PRN Primary Record Number

RCAHMW– Royal Commission on the Ancient and Historical Monuments in Wales

Welsh Archaeological Trust Contact Details

Clwyd-Powys Archaeological Trust—<u>her@cpat.org.uk</u> or 01938 553670

Dyfed Archaeological Trust—<u>info@dyfedarchaeology.org.uk</u> or 01558 823131

Glamorgan-Gwent Archaeological Trust—<u>her@ggat.org.uk</u> or 01792 634225

Gwynedd Archaeological Trust—<u>her@heneb.co.uk</u> or 01248 352535