
DEVELOPING A MACHINE LEARNING MODEL FOR THE IDENTIFICATION OF ARCHAEOLOGICAL LANDSCAPE FEATURES

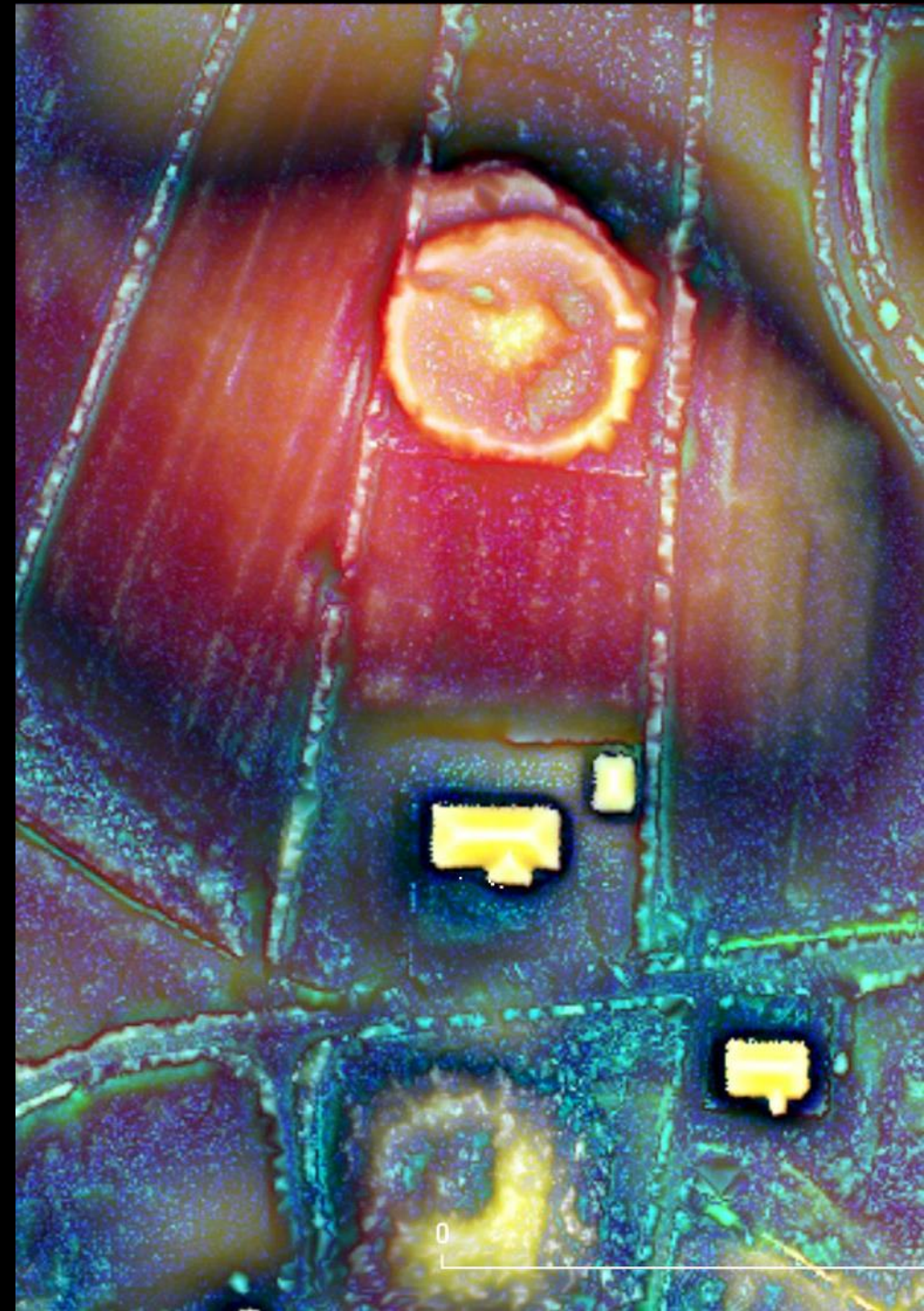
***(OR: APPLIED ARCHAEOLOGICAL RESEARCH IN SUPPORT OF
INFRASTRUCTURAL BUILT DEVELOPMENT)***

Dr John O’Keeffe BA (Hons) PhD MCIOB MIAI MCIFA

Chief Executive Officer, The Discovery Programme

Presentation for TII National Roads and Greenways Conference 2023

29 September 2023





The Discovery
Programme

Centre for Archaeology
and Innovation Ireland



Funded by

An Chomhairle Oidhreachta
The Heritage Council

THE IRISH TIMES, Saturday, May 11, 1991

National archaeological project begins

By Paul O'Neill

A MAJOR archaeological research and excavation programme was inaugurated yesterday by the Taoiseach, Mr Haughey. The project, which has a budget of £250,000 this year and £500,000 per annum in future years, would discover the past from the moment man first set foot in Ireland, he said.

The initiative, which is the fruit of Mr Haughey's personal vision,

Meath. Another being considered is Rath Cruacain in Roscommon, while Mr Haughey emphasised his own interest in the islands off the west coast, which, he said, were very important in relation to the early Christian era.

He also said that the programme, which he first announced at the Fianna Fail Ard-Fheis, would combine a professional archaeological approach with a popular dimension and would involve the "great institutions" around the

schools, information which will be made available to the public in the form of interpretative centres where necessary.

The project is being financed by the National Lottery funds via the Department of the Taoiseach. Mr Haughey said that no limit was being put on the programme — it could go on for five, 10 or 15 years. "The idea is that it will be all embracing and comprehensive, covering the whole country era by era. We want now to chart the whole thing so that from now on, it will be part of this

Mr Haughey said the panel would be able to "sound the alarm" about projects.

Professor Eogan, a member of the National Heritage Council, said the story of Ireland would be covered from the beginning of human settlement down to the end of the early Christian period.

He also predicted spin-offs in terms of job creation and tourism and he said that work on at least one site would begin this year. On Tara, he said that despite the fact that it was well known, it was not at all understood archaeologically.

pean archaeology as a whole because while Ireland was an island, its archaeology was not insular. "It's part and parcel of the great story of the emergence of European society," he added.

An international archaeologist has yet to be added to the advisory panel. But in addition to Professor Eogan, the other members include Professor Peter Woodman of UCC, Professor John Waddell of UCG, Dr Mike Baillie of Queen's University, Professor Michael Herity of UCD, Dr Pat Wallace, director of the National Museum, Mr Pascal Scahill of the National Heritage



ZRC SAZU



The Discovery Programme

Anthony Corns John O’Keeffe

Robert Shaw Susan Curran

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Žiga Kokalj Nejc Čož

Bias Variance Labs

Dragi Kocev Ivica Dimitrovski

Ana Kostovska

University College Dublin

Steve Davis



Funded by the TII Open Research Call 2021

TII

Paul O’Keeffe James Eogan

Rónán Swan

Historic Environment Scotland

Dave Cowley

PROJECT OUTLINE

- Comprehensive review of archaeological studies with ALS and Convolutional Neural Networks (CNN)
- Review of raster visualisation methodology with respect to monument morphology & features
- Review of machine learning (ML) techniques with respect to remote sensing data

- Review of Irish monument detection and suitability
- Shortlisting of selected monument classifications
- Statistical analysis on relevant monuments versus lidar extents

- ALS data preparation
- Creation of training dataset
- Object detection process
- Object segmentation process

- Performance evaluation of the machine learning model (MLM)
- Jupyter Notebook User Interface
- Testing, debugging & validation

- Production of software user guide
- Development of associated training data
- Delivery of training

Castlesize early medieval enclosure,
Co. Kildare (Sallins Bypass)
(Photo: KNRO & IAC Ltd)



Early medieval complex, Dowdstown,
Co. Meath (M3 Clonee to North of Kells)
(Photo: StudioLab)

MANAGING PROJECT RISKS

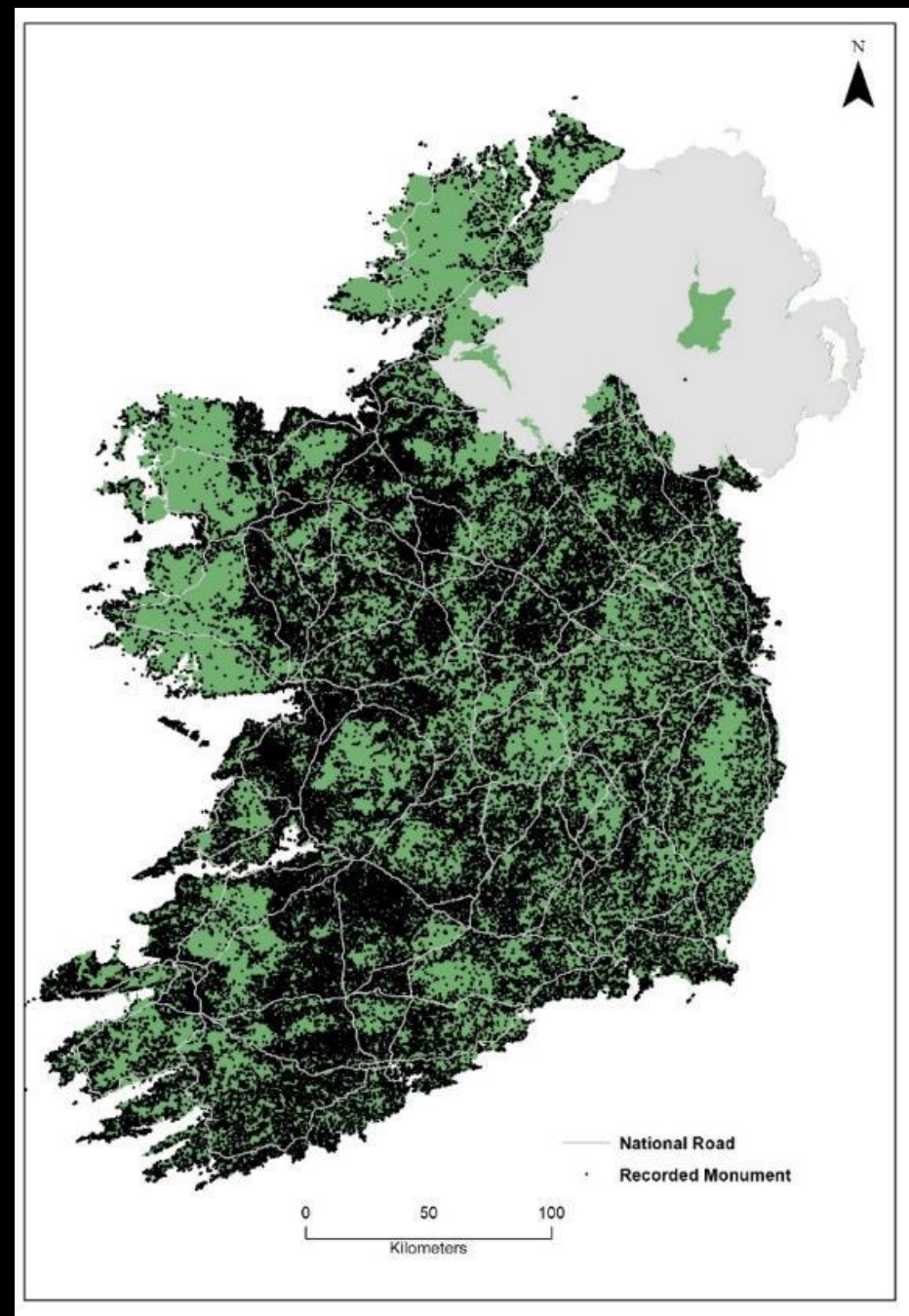




Stone row, Ardamore, Co. Kerry



Rock art, Áth an Charbail,
Co. Kerry



Distribution of recorded monuments in the Rep. of Ireland

SO MANY
PROBLEMS?

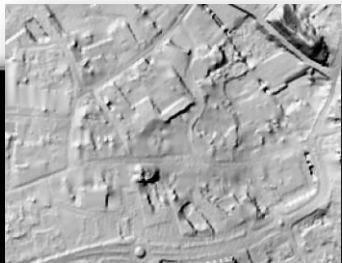
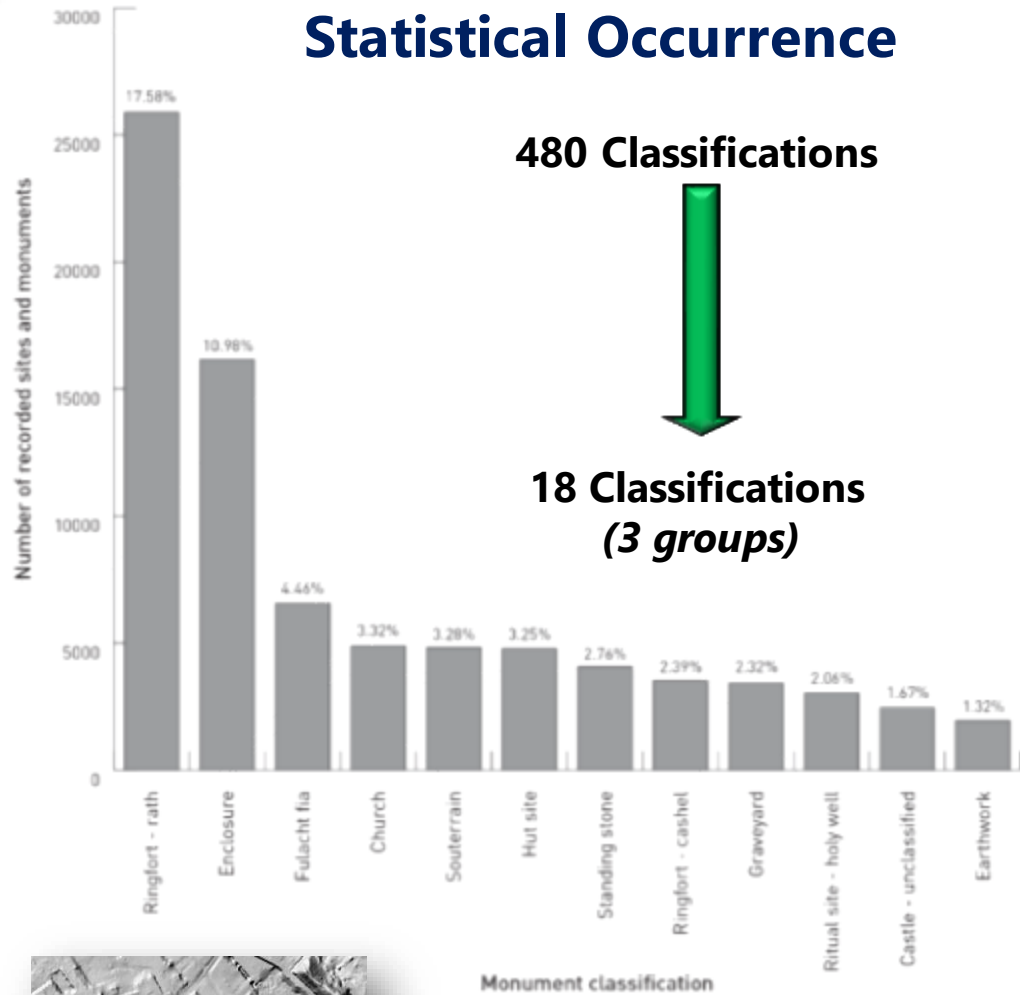


MONUMENT SELECTION

Statistical Occurrence

480 Classifications

18 Classifications
(3 groups)



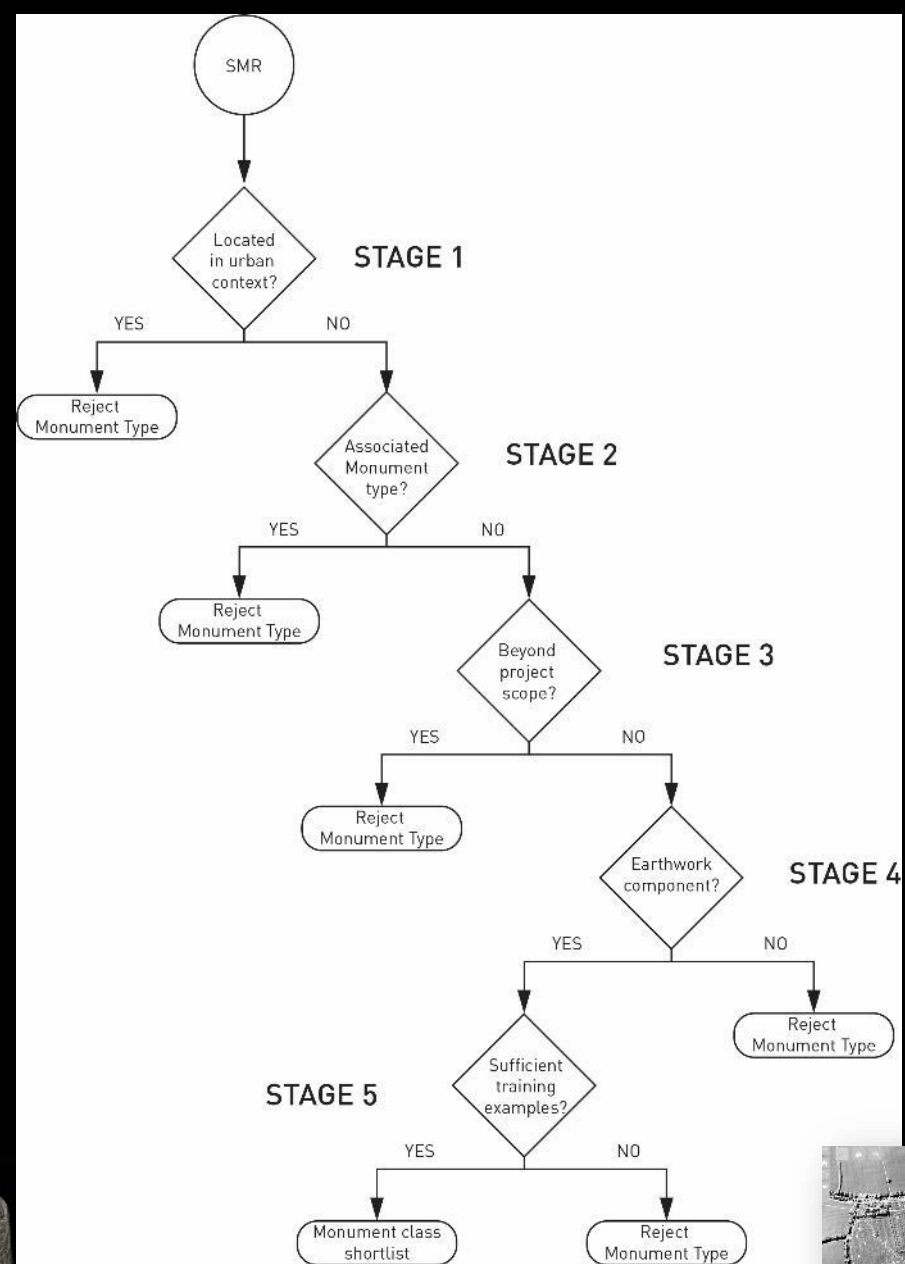
Town
Defences,
Portlaoise,
Co. Laois



Fahan Cross
Slab, Co.
Donegal

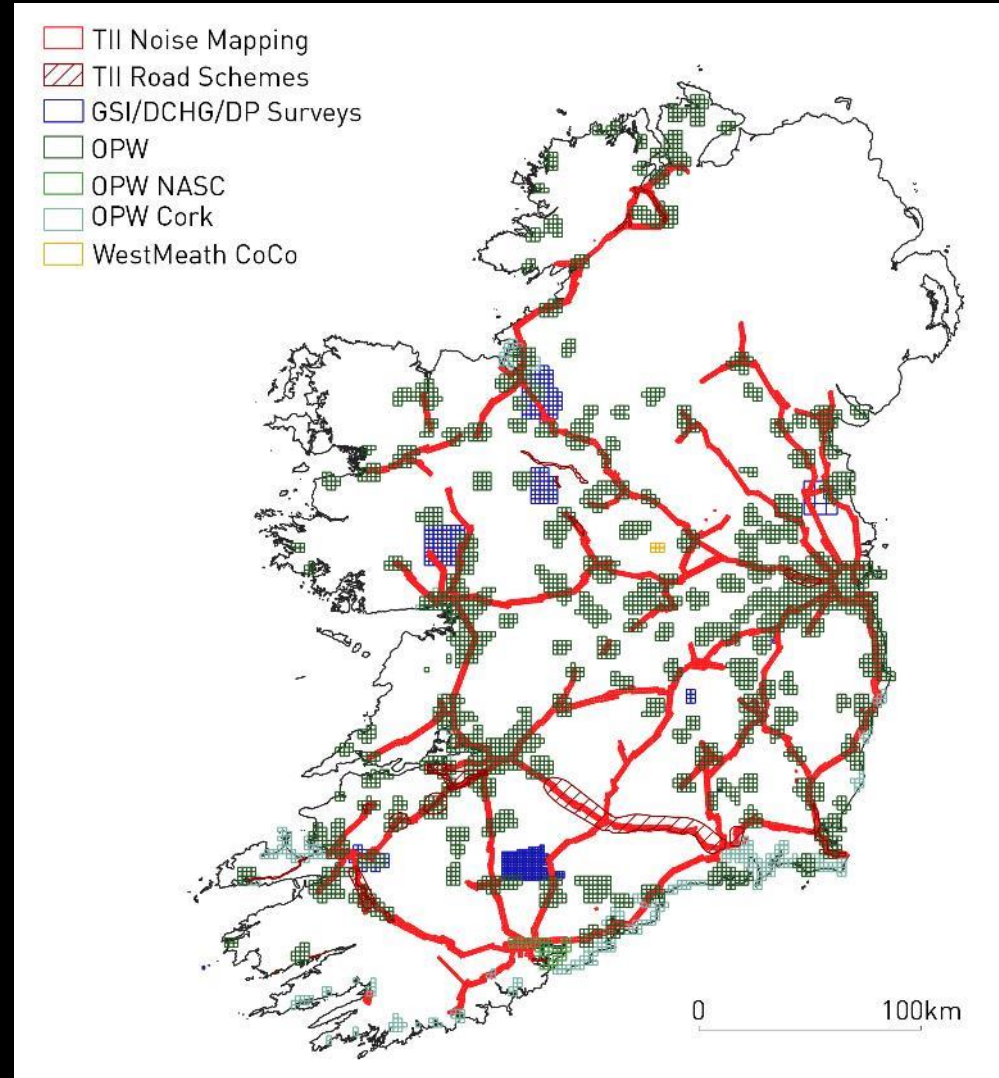
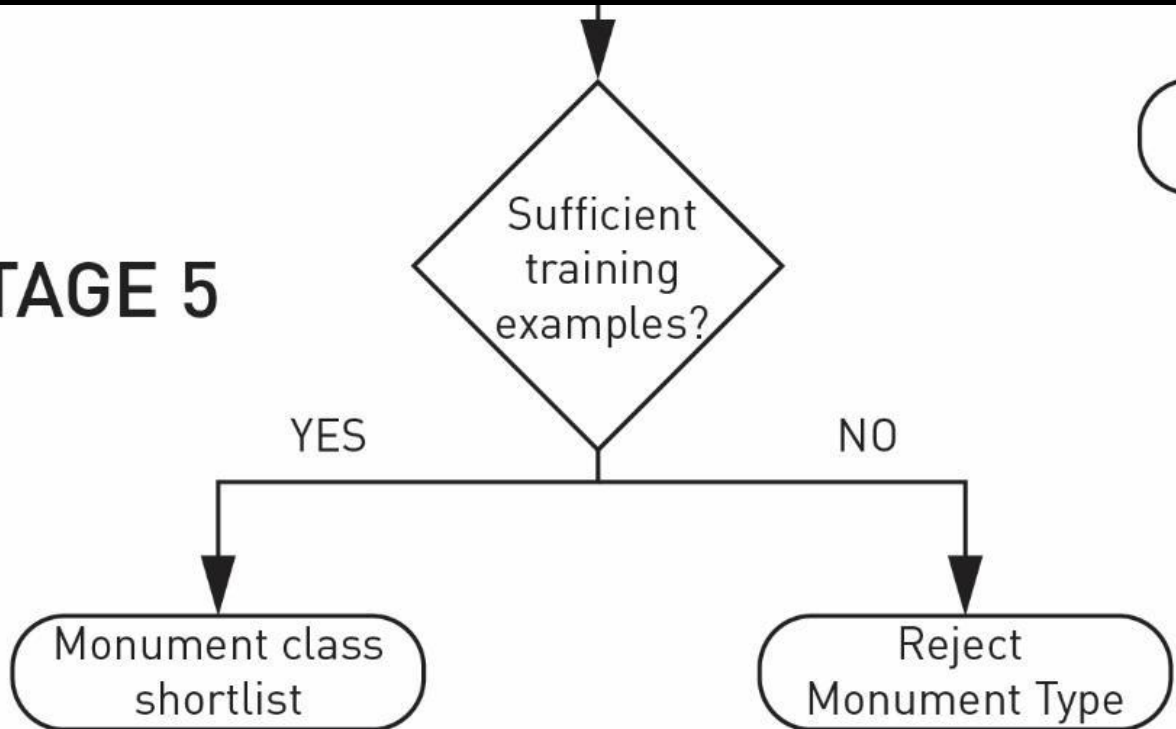


Tower House,
Carrig, Co.
Cork



STAGE 5: ALS CHECK

STAGE 5



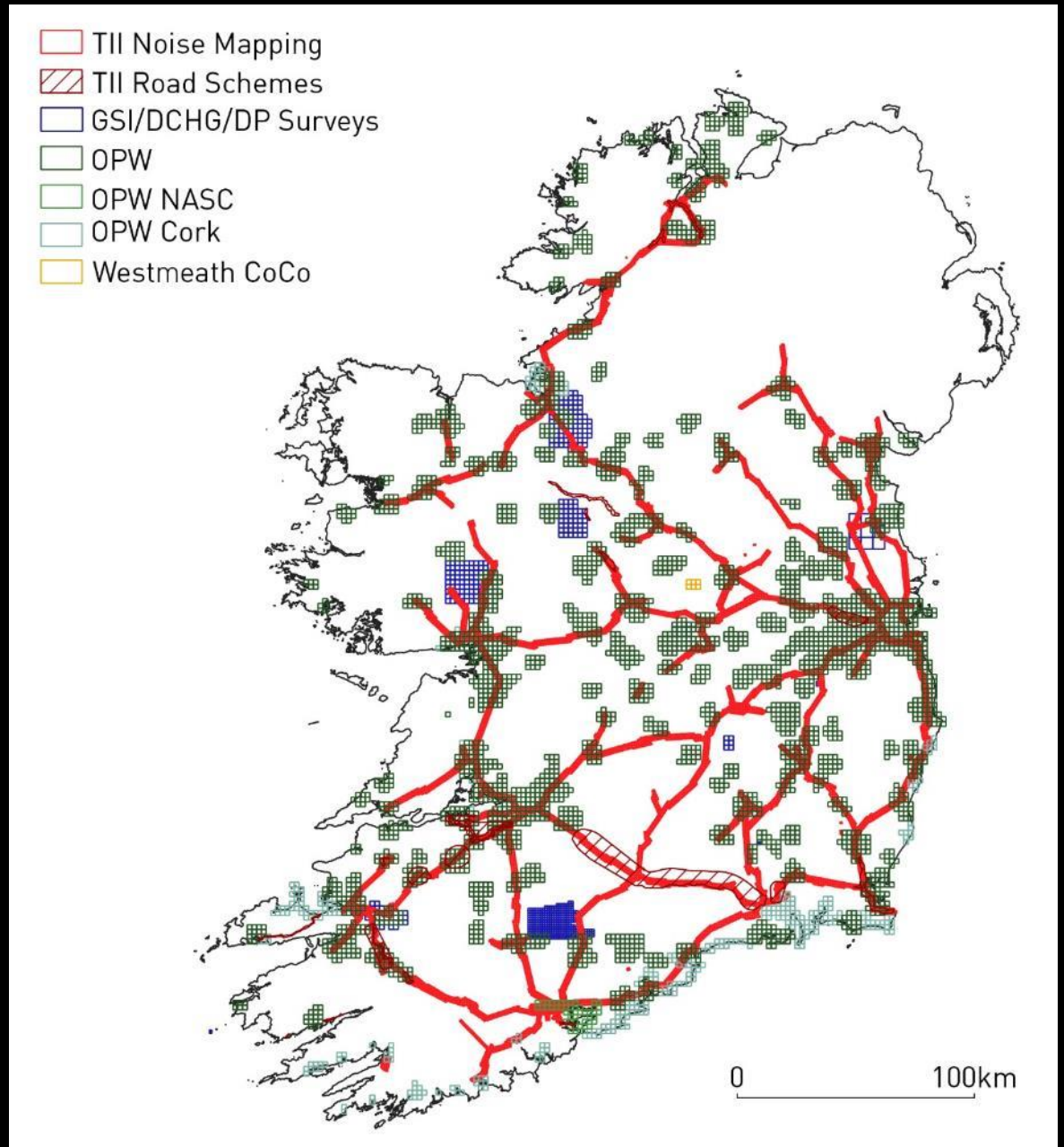
ALS DATA IRELAND

Variable

- Resolution
- Accuracy
- Capture dates
- Quality
- Format
- .las Classification

Standardisation

Past hinder the future



Ringforts

- Ringfort - rath
- Ringfort - cashel
- Ringfort - unclassified
- Ring-ditch



R0035-012



R0027-001



CL010-064003

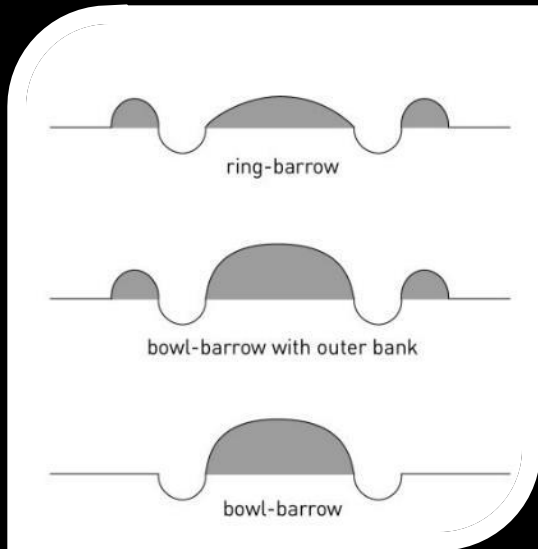


LA018-072

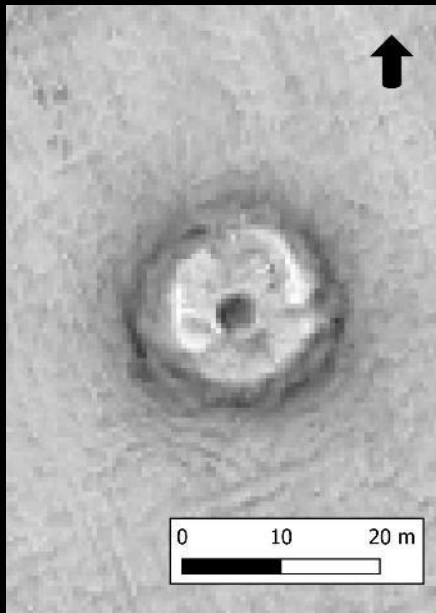
Images: www.archaeology.ie

Barrows

- Bowl-barrow
- Ditch barrow
- Embanked barrow
- Mound barrow
- Pond barrow
- Ring-barrow
- Stepped barrow
- Unclassified



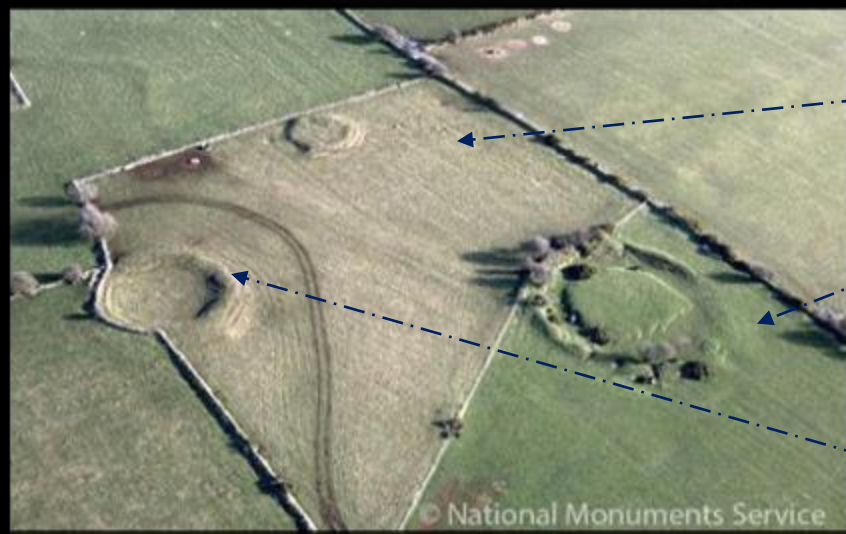
CL056-002 Ring-barrow



GA083-042 Bowl-barrow



www.archaeology.ie



RO035-078 Embanked Barrow

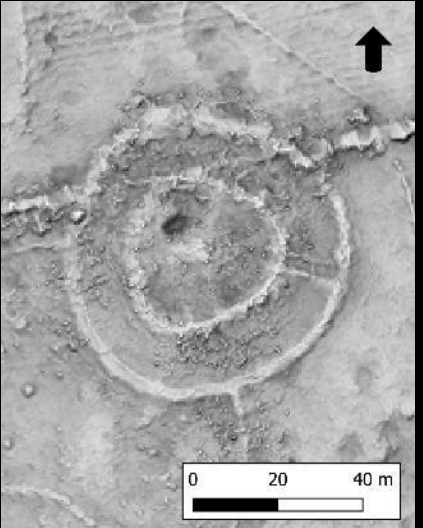
RO035-076 Ring-barrow

RO035-077 Pond Barrow

www.archaeology.ie

Enclosures

- Ceremonial enclosure
- Concentric enclosure
- Ecclesiastical enclosure
- Embanked enclosure
- Enclosure
- Enclosure – large enclosure



GA03-079 Concentric Enclosure



GA095-016002 Ecclesiastical Enclosure



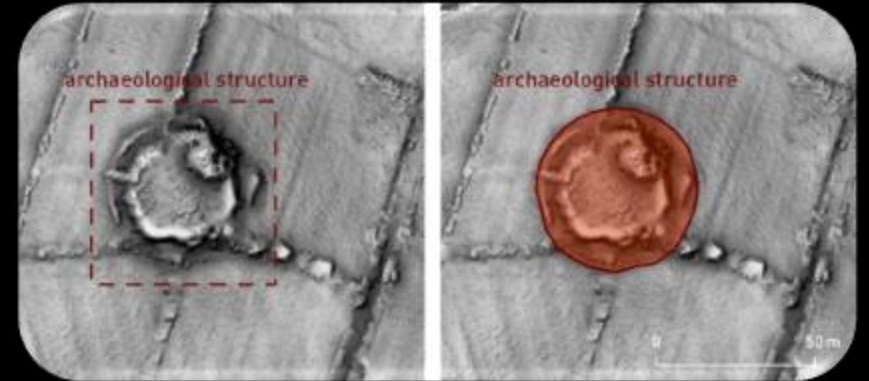
SL025-093 Enclosure



RO027-012001 Ceremonial Enclosure

Images: www.archaeology.ie

- ❖ Quality of available ALS datasets
- ❖ Suitability of archaeological monuments
 - Physical attributes
 - Consistency in morphology
 - Monument survival
 - Location & landscape
 - Sufficient number of examples
- ❖ Creation of the training dataset
 - Sites and Monuments Record (SMR)
- ❖ Training strategy



Monument Extent Creation

Object Detection (*labelled bounding box*)

Object Segmentation (*labelled footprint*)

Ringforts: 5,933

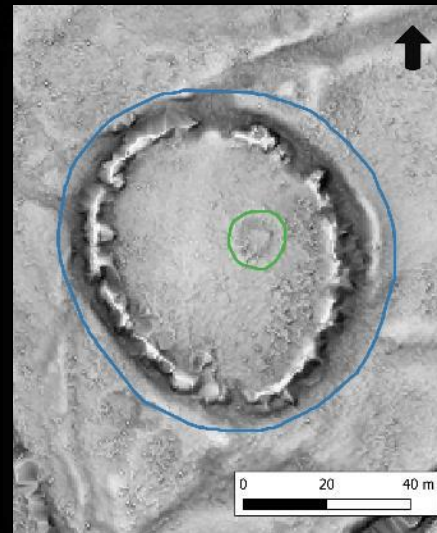
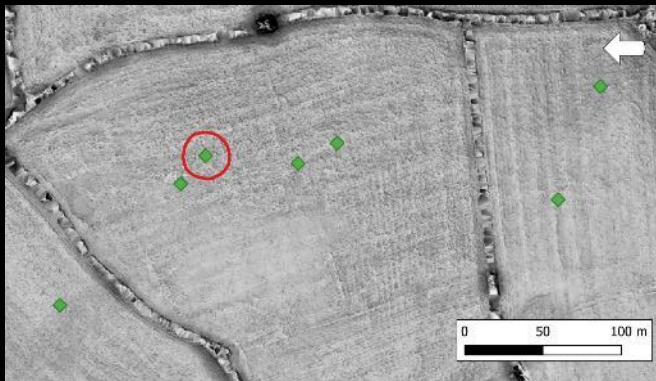
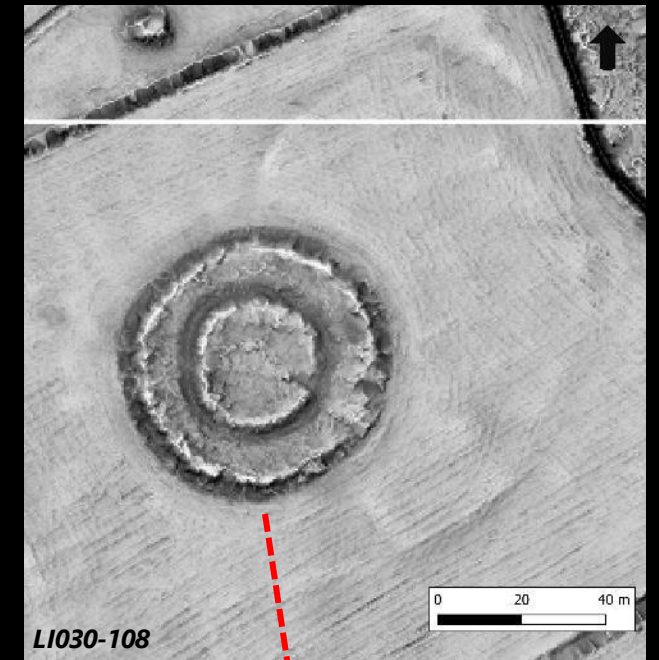
Enclosures: 2,324

Barrows: 522

UK Barrows: 1,939

Total: 10,718

- Location (*SMR Coordinates*)
- Monument survival / visibility
- Disturbance
- Destruction / removal
- Overlapping monuments
- Monuments within monuments

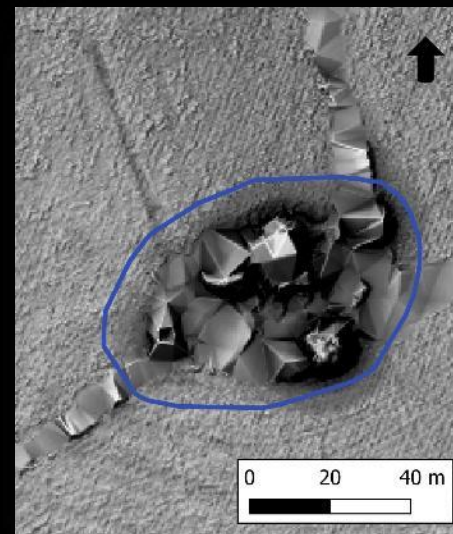
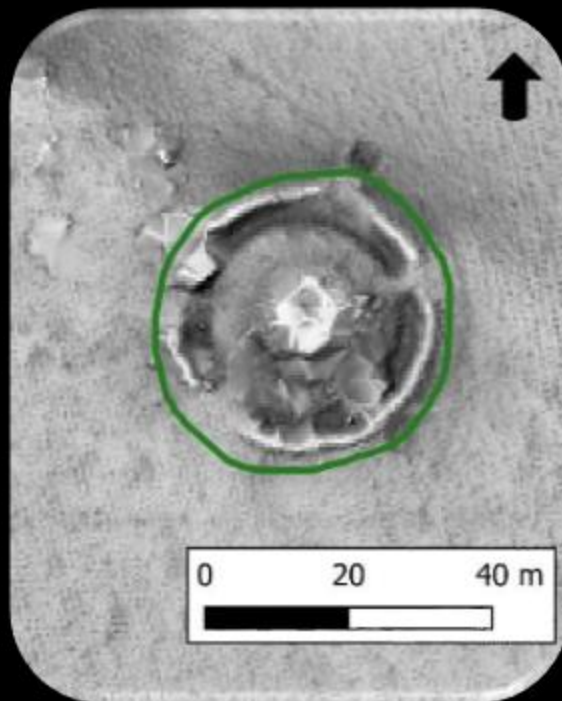


Ringfort

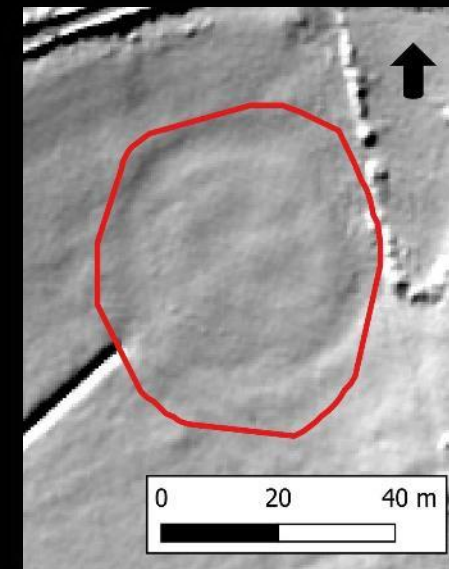


'DFM' Ratings

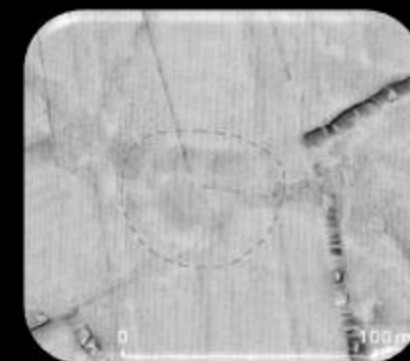
Barrow



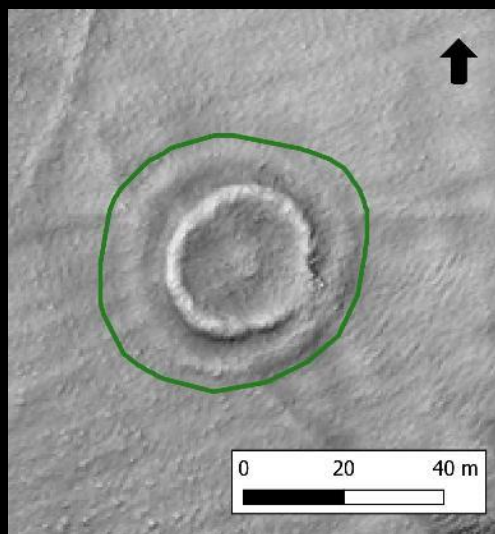
Enclosure



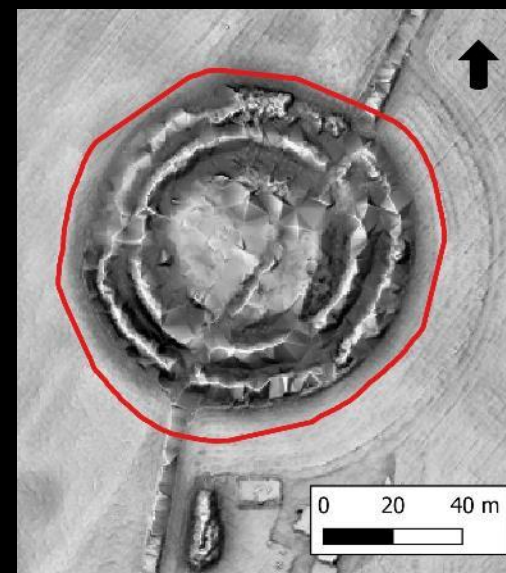
Ringfort

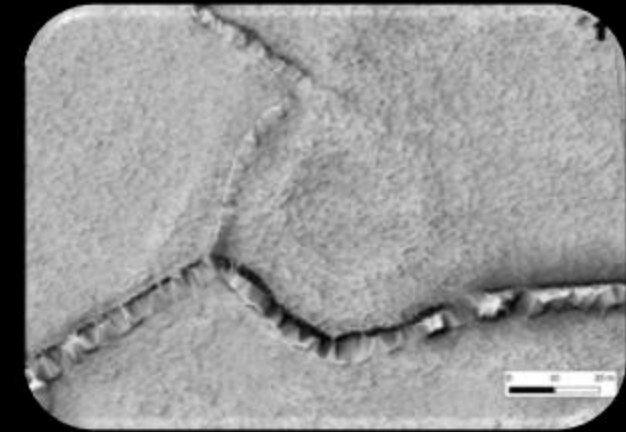
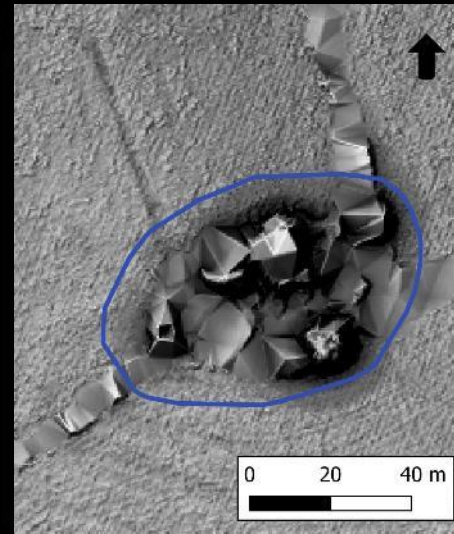
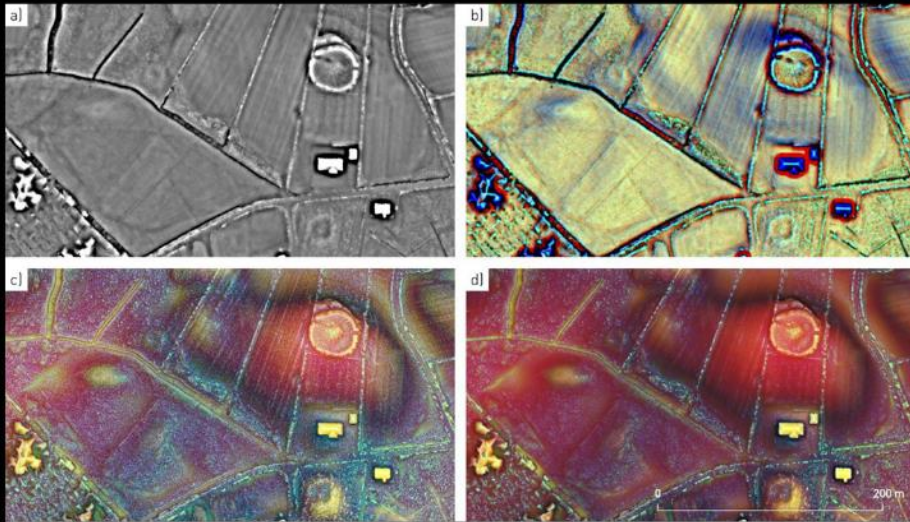


Barrow



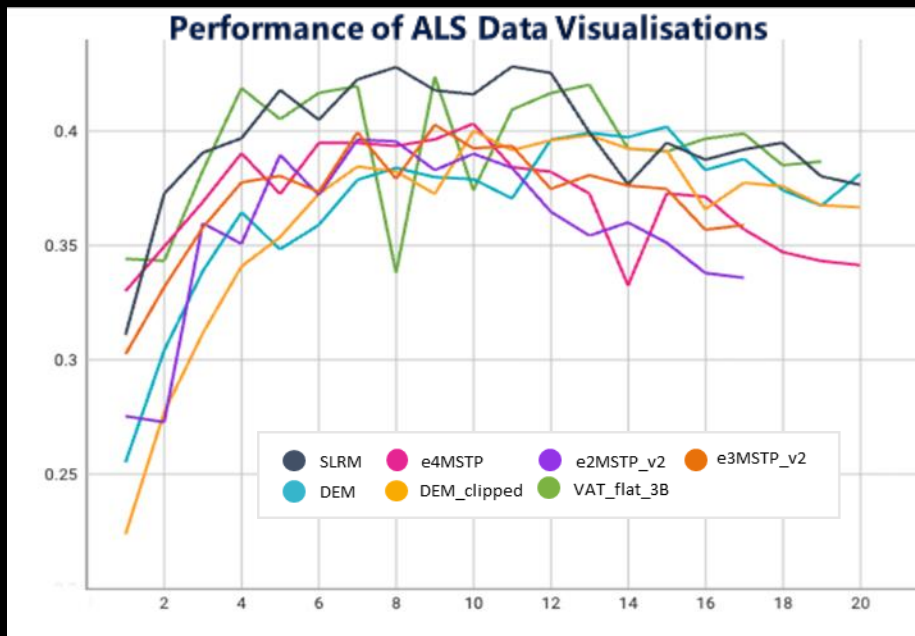
Multivallate Ringfort





Ringfort: DFM 3

Ringfort: DFM 3

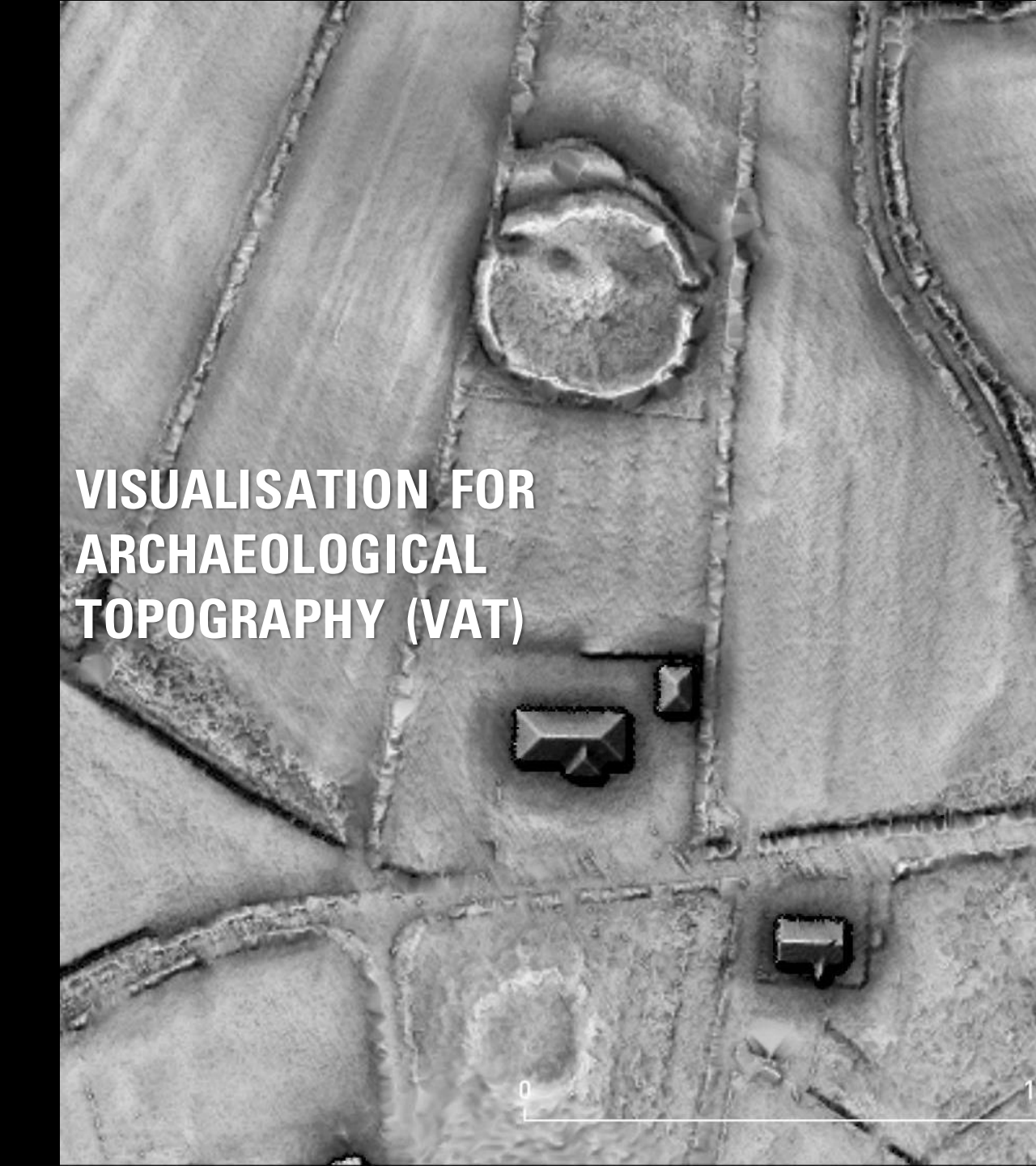


Experiments with removing 'lower quality' monuments from the training process

➤ *DFM 3 and/or DFM 4 –rated monuments*

➤ *May be contributing noise to the data*

➤ *Boost in performance following removal of DFM 4-rated monuments*

An aerial photograph of an archaeological site. The terrain is divided into several rectangular plots by earthen walls. In the upper center, there is a large circular structure with a raised rim. Below it, in the middle-left plot, is a rectangular structure with a gabled roof. To its right, in the middle-right plot, is a smaller rectangular structure. In the lower-right plot, there is another rectangular structure. The ground surface shows subtle variations in elevation and texture, indicating different types of construction or natural terrain features.

**VISUALISATION FOR
ARCHAEOLOGICAL
TOPOGRAPHY (VAT)**

0 10

The same aerial photograph as the left image, but with a Simple Local Relief Model (SLRM) overlaid. The SLRM is represented by white shapes on a dark background, highlighting the topographic features of the site. The circular structure in the upper center is shown as a white ring. The rectangular structures in the middle-left, middle-right, and lower-right plots are shown as white blocks. The SLRM effectively isolates the geometric forms of the buildings from the surrounding terrain and walls.

**SIMPLE LOCAL RELIEF
MODEL**

0 10

IT'S WORKING

Testing of the model is well progressed. We are finding that:

- It is identifying new sites
- Some of that identification is now starting to propose what type of site
- It is providing more accurate locational data for some of the previously-recorded sites
- There are some monuments that remain hard to detect
- We are working on the 'false positives'

Validation – MLM Ringforts

Correctly identified 76% known sites

Missing Sites
83% DFM 3 or DFM 4

Prediction - Orange
Observed Extent - Green



Missed Ringfort DFM 3



Missed Ringfort DFM 4

Validation – MLM Ringforts – New Sites

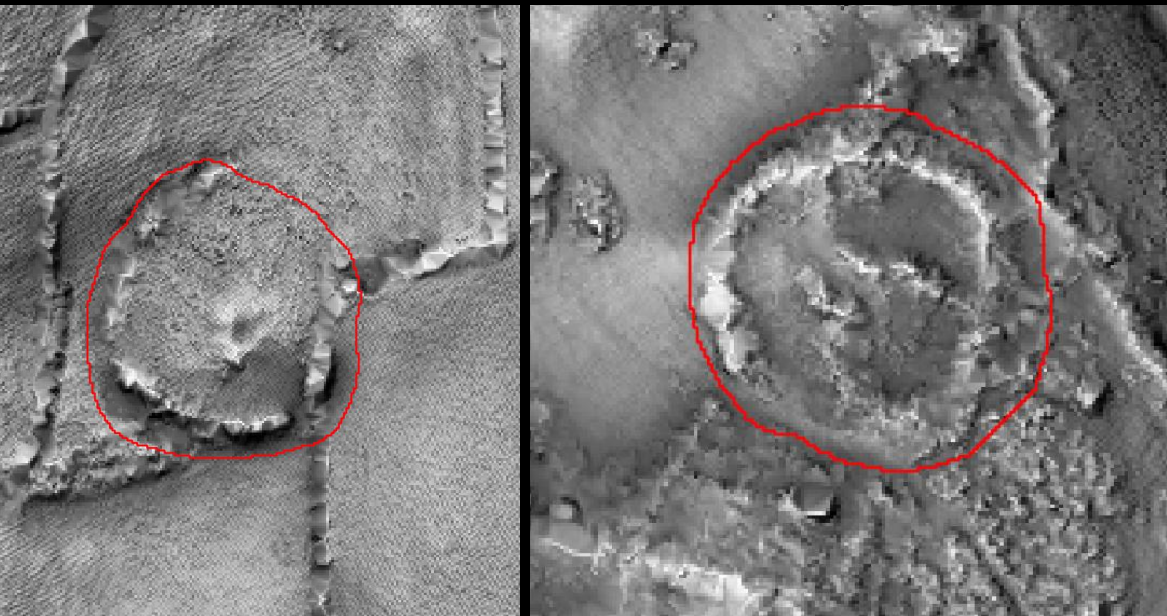
180 Identified

106 – No (modern feature or vegetation)

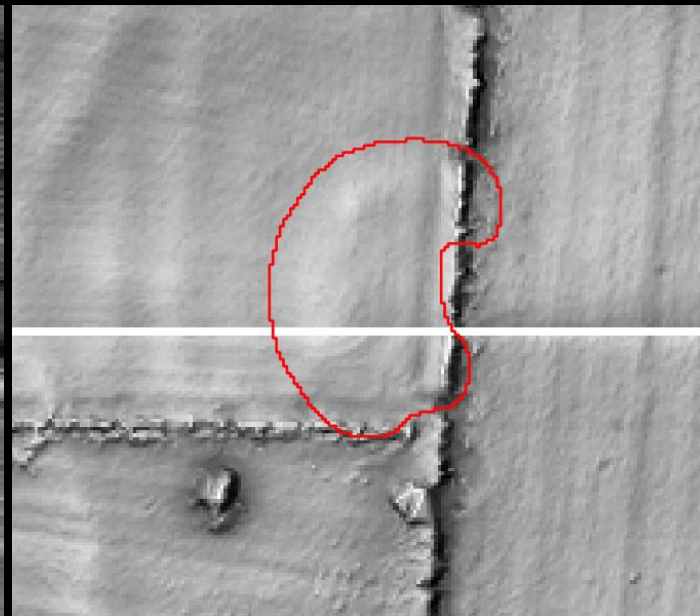
31 – Probable (strong evidence)

43 – Potential (moderate evidence)

Probable New Sites



Potential New Sites



Incorrect Site



ENDURING PROJECT VALUE

Use of the Project Outputs – Application of the Machine Learning Tools and Visualisations:

- Future Highway Development in Ireland
- Wider contribution to infrastructural development in Ireland
- Wider contribution to infrastructural development outside of Ireland
- Enhancing industry standards

ENDURING RESEARCH VALUE

Use of the Project Outputs – Application of the Machine Learning Tools and Visualisations

- Major development in archaeological prospection
- Cross-cutting applications beyond archaeology
- Embedding *FAIR* principles in the use of data and applications
- Continued development and re-use, with future refinement

ENDURING PUBLIC VALUE

Significant societal benefit within professional and
Use of the Project Outputs – Application of the
Machine Learning Tools and Visualisations

- Open access to the methodology
- Open access to data
- Multiple re-use of datasets to inform strategies and policies from addressing climate change to community participation

ENDURING PUBLIC VALUE

Application of this technology will enable:

- More fully-informed decision-making on route selection and associated infrastructure
- Enhanced due-diligence on risks associated with archaeology
- Supports project planning and delivery
- More efficient use of financial and material resources in delivery of major projects

ENDURING PUBLIC VALUE

Some key considerations:

- What data do you need?
- What data has already been gathered?
- When should new data be acquired in the project?
- What else might it be used for?
- What about the weather?

Tús maith leath na hoibre

“a good start is half the work”

Thank You!

Email: ceo@discoveryprogramme.ie

Web: discoveryprogramme.ie

SketchFab: sketchfab.com/discoveryprogramme

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