



Accounting for Environmental and Anthropogenic Factors: Approaches to enhancing horizontal resolution and interpretability in geophysical surveys

Ashely Green* and Rachael Holmes

*agreen@bournemouth.ac.uk | Department of Archaeology, Anthropology and Forensic Science | Bournemouth University

Introduction

Ground-penetrating radar (GPR) survey, whether small-scale or landscape, can be hindered by environmental and anthropogenic factors which reduce maximum vertical and horizontal resolution, and data interpretability compared with ideal survey conditions.

Pilot surveys aimed to mitigate these factors by increasing horizontal resolution, and so refining published protocols (David et al. 2008) for single channel ground-penetrating radar surveys of areas <1ha.

The pilot dataset suggested that for single channel GPR surveys utilising a 250MHz–800MHz central frequency antenna:

- In general, a 0.10m traverse interval maximises the potential to delineate targets smaller than 2.5m² where the orientation is unknown and the antenna's central frequency is ≥ 500MHz.
- A traverse interval ≤25% the size of the minimum dimensions of a discrete target (where the target is at least 1.5m²) is adequate to delineate significant anomalies but may overlook smaller anomalies.

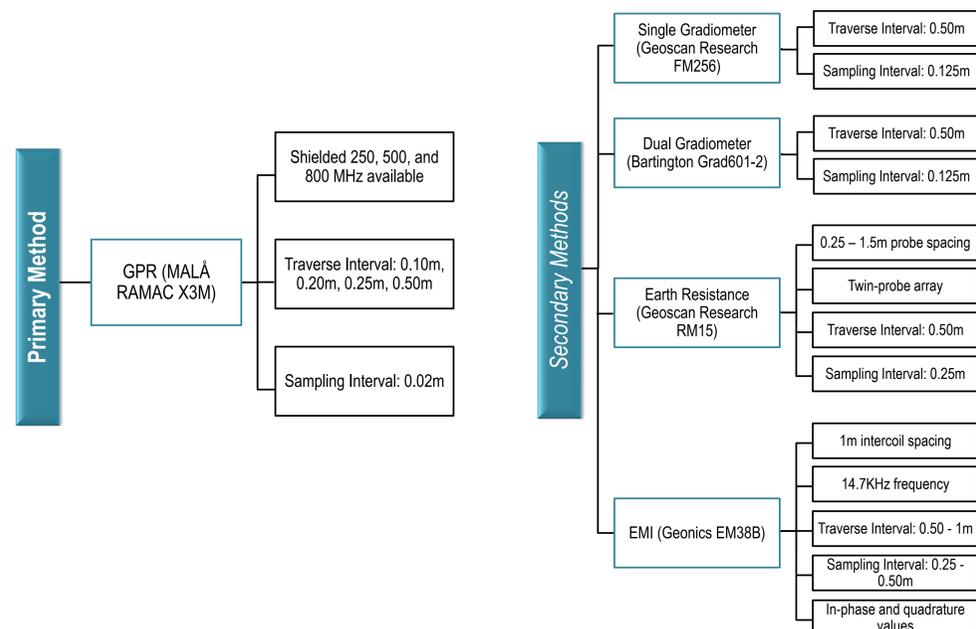
High Resolution Parameters	Coarse Resolution Parameters
Traverse Interval: 0.10m	Traverse Interval: 0.25m – 0.50m
Sampling Interval: 0.02m	Sampling Interval: 0.02m – 0.05m
Minimum Potential Target Hits: 10/metre	Minimum Potential Target Hits: 2 – 4/metre
c. 3 hours to survey 100m ²	c. 1 hour to survey 100m ²

Figure 1: Comparison of coarse resolution parameters (those with logistical survey constraints) and the recommended high-resolution parameters

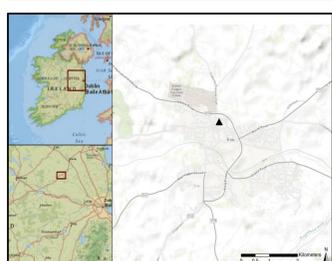
These survey parameters were further tested at several sites having impeding factors. The sites are still undergoing ground-truthing.

Methods

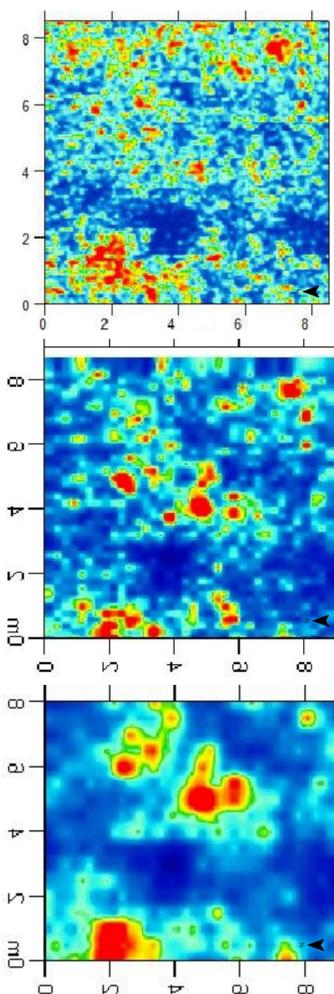
High resolution GPR survey was accompanied by magnetic, resistance, and/or electromagnetic induction (EMI) survey, and archived data where available.



The Black Friary - Pilot Study

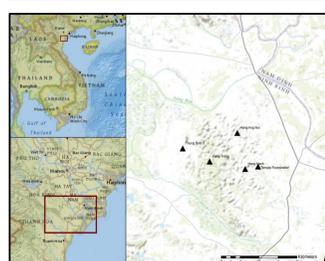


Site Description	13 th Century Dominican Friary (O'Carroll 2014)
Impeding Factors	High attenuation soil Ferrous contamination Modern disturbance
Targets	Inhumations Cemetery boundary Historic town wall

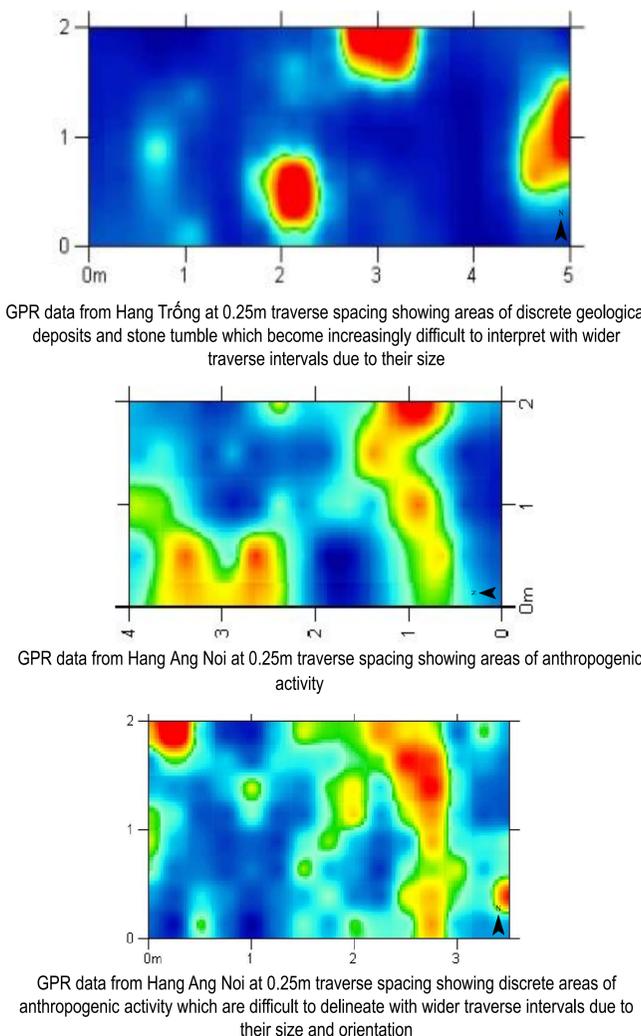


Pilot study data demonstrating a decline in resolution and interpretability as the traverse interval increases from 0.10m to 0.20m and 0.50m (top to bottom)

Tràng An Complex - Mitigating Survey Constraints

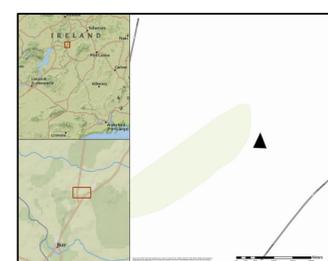


Site Description	5 caves/rockshelters (Rabett 2013)
Impeding Factors	High attenuation soil Ground disturbance Logistical constraints
Targets	Stratigraphic changes Discrete areas of anthropogenic activity



GPR data from Hang Trồng at 0.25m traverse spacing showing areas of discrete geological deposits and stone tumbles which become increasingly difficult to interpret with wider traverse intervals due to their size and orientation

Fort Maigh Leana – Data Fusion



Site Description	Iron Age/Early medieval bivallate ringfort
Impeding Factors	High attenuation soil Ground disturbance Logistical constraints
Targets	Anthropogenic activity Structural remains



GPR data utilising a 0.50m traverse spacing suitable for delineating a possible archaeological structure

Greyscale and XY traceplot of EMI conductivity data surveyed at a 0.50m traverse spacing and 0.25m sampling interval (Location of GPR survey outlined in blue)

Combined interpretation from the secondary survey techniques

Conclusion

The surveys proved successful within these environments as GPR data showed significant responses in poor site conditions, which were corroborated by ground-truthing and secondary survey. Ultimately, these case studies demonstrate the desirability for focused small area, higher resolution surveys on impacted sites in order to improve data interpretability.

Further analysis of the success rate of these parameters is being conducted in England and Ireland in order to mitigate for the trade-off between ground coverage and data quality.

References

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- Rabett, R.J., 2013. The Early Human Occupation of Tràng An, Vietnam: Archaeological and palaeo-environmental evidence. Journal of Geology, Series B 336:1-7.

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