GIS and landscape archaeology: the South Cadbury Environs Project

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Introduction

- South Cadbury (exc. 1960s)
  Iron Age hillfort – 7 ha. interior
  5th/6th Century AD – King Arthur
  Increasing importance of landscape archaeology
  Classic excavation reinterpreted in its landscape context

- Analytical GIS
  Functionality beyond data management and display
  1) Network Analysis – dating of geophysical anomalies using test pitting data
  2) Modelling colluviation – implications for visibility of archaeological remains
South Cadbury Environs Project

- Fieldwalking
- Geophysics
- Excavation
  - Shovel Testing (Topsoil only)
  - Test Pitting (Full excavation)
  - Trial Trenching
Dating Geophysics

- The Sigwells (West) dataset
  Good results from geophysics
  Focus for test-pitting/excavation
  Preliminary phasing (6 systems)
  Two main trends:
  1) WNW/ESE (System 1: AD200-400)
  2) NE/SW (System 2: 100BC-AD200)

- Ceramic phasing
  8 phases based on excavation
  1) Neolithic
  2) Early Bronze Age ≈ System 4
  3) Middle Bronze Age ≈ System 4
  4) Middle Iron Age 1 ≈ System 2
  5) Middle Iron Age 2 ≈ System 2
  6) Late Iron Age ≈ System 3
  7) Early Romano-British
  8) Middle Romano-British ≈ System 1
Network Dataset

- **Network dataset:**
  - Arcs (edges) and nodes (junctions)
  - Turn features

- **Heads-up digitising:**
  1) Edges linking start/end points of anomalies and intersections with other anomalies
  2) Nodes created at start/end points and all intersections regardless of connectivity

- **Cleaning:**
  - Checked against excavation plans
  - Remove gaps (e.g. entrances)
  - Link interrupted anomalies
Adding Complexity

- **Impedances**
  Initial travel ‘costs’ based on length of edge

- **Connectivity**
  Z-values used to establish connectivity
  Offsets apples to z-values to model stratigraphic relationships

- **Turn features**
  Contemporary features parallel or perpendicular to one another
  Impedances assigned to turns to model physical relationships

- **Building**
  Network dataset built in ArcGIS
Closest Facility Analysis

- **Network locations**
  Facilities – start/end points of network
  Incidents – contemporary spot date(s)
  Barriers – later spot date(s)

- **Network solution**
  Shortest route to every facility from each incident
  Individual solutions for each phase of activity
  Number of barriers decreases with time

- **Iterative process**
  ‘Logic’ matching
  Initial solutions – unconstrained
  Later solutions – constrained
Combining Solutions

- **Overlay**
  Overlay individual solutions starting with most recent phase

- **Aggregation**
  Anomalies dated on basis of either:
  1) number of arcs per phase
  2) total length of arcs per phase

- **Raw count**
  Number of times an arc is used in the solution for each phase
  Counts for individual arcs aggregated for each anomaly

- **Weighted count**
  Raw counts standardised and converted into percentages
Comparison of Results

Provisional phasing (left) and network-based phasing (right)
Testing the Methodology

- Assessment of robustness
  5 random datasets (Samples 1-5)
  Network locations created for spot dates using arc centroids
  Number of spot dates per phase kept constant
  Solutions compared against initial network-based solution

- Comparison of solutions
  Direct hits = solution identifies latest phase
  Indirect hits = spot dates one of possibilities
  Sample 2 (Phase 1) – systemic error no possible solution
  Multiple direct and indirect hits - high confidence in methodology

![Diagram showing network locations and solution hits]
Colluviation

- Long recognition of the importance of geomorphological processes and their impact on the archaeological record (e.g. Butzer’s Human Ecology, 1982)
  Linked to past land-use practices
  Often recognised and discussed within the context of surface survey
  Computer-based attempts to model and visualise, interpolating surfaces

- Archaeological Use of Flow Models
  Verhagen (1995) – most detailed consideration of methodology:
  Concluding emphases:
  Importance of DEM resolution and quality (interpolation artefacts can affect ‘flow’)
  Importance of small-scale local effects, problems with
  Large-scale generalised modelling
Test-Pitting Data

- **Study Area**
  12km by 9km centred on hillfort
  Localities 1 to 5

- **Regular Test Pits**
  241 test pits (139 with colluvial deposits)
  1m by 1m test pits on 100m grid

- **Targeted Test Pits**
  71 test pits (31 with colluvial deposits)
  Assessment of geophysical anomalies

- **Colluviation**
  Episodes of colluviation –
  Min = 1 Max = 7
  Cumulative depth ≤ 1.68m
Topographic Analysis

- Morphometric classification
  Six feature types (Wood 1996):
    1. Plane
    2. Channel
    3. Ridge
    4. Pass
    5. Peak
    6. Pit
  Scale dependent classification

- Fuzzy classification
  Individual datasets created for window sizes from 3 to 99
  6 new datasets created, one for each feature class
  Cell with values between 1 and 0 - confidence in classification
Colluvial Zones

- **Key topographic zones**
  - Transition between topographic highs and topographic lows (i.e. planes)
  - Net deposition at margins of topographic highs (‘depositional’ exceeds ‘erosional’ potential)
  - Net deposition at margins of topographic lows
  - No deposition or net erosion along centreline of topographic lows
Modelling Colluviation

- **Planar surfaces**
  - Isolate planes
  - Weight points on planes where ‘depositional’ potential is greatest

- **Slope**
  - Identify range of slope values for test pits with colluvial deposits

- **Curvature**
  - Weight upslope and downslope areas

- **Weighted surfaces**
  - Weighted colluvial zones based on interpolated depths of colluvium from test-pitting

<table>
<thead>
<tr>
<th>Surface parameters for test-pits with colluvial deposits</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>S.D.</th>
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<tbody>
<tr>
<td>Elevation</td>
<td>34.00m</td>
<td>189.00m</td>
<td>48.73m</td>
<td>36.37m</td>
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<tr>
<td>Slope</td>
<td>0.43°</td>
<td>12.88 °</td>
<td>3.81 °</td>
<td>2.49 °</td>
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<td>Aspect</td>
<td>012 °</td>
<td>356 °</td>
<td>193 °</td>
<td>95.86 °</td>
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<tr>
<td>Curvature</td>
<td>-0.68</td>
<td>0.39</td>
<td>-0.06</td>
<td>0.13</td>
</tr>
</tbody>
</table>
Colluvial Deposits

- Phases of Colluviation
  Modern – 43 test pits
  Medieval – 7 test pits
  Romano-British – 8 test pits
  Late Prehistoric – 8 test pits
  Early Prehistoric – 6 test pits
  Post Glacial – 9 test pits

- Depth of Colluvium
  Interpolate continuous surface for each phase of colluviation
  Include test pits with no evidence of colluvium (Depth = 0cm)
  Exclude undated colluvial deposits from all test pits
  Modify interpolated surface using weighted colluvial zones
Evaluating the Model

- **Modern colluviation**
  Locality 5 - cluster of test pits with modern colluvial deposits
  Weighted interpolated surface respects local topography
  Interpolated values correlate with measured depths
  Assumptions for model independent of data from test pits

- **Archaeological visibility**
  Relationships to areas of geophysical survey
  Correlation with known archaeological sites
Conclusions

- **Network Analysis**
  A robust methodology which can be applied to larger datasets
  Iterative process which highlights potential dating errors

- **Potential limitations**
  Methodology best suited to large-scale datasets with
  1) A widespread spatial distribution of spot dates
  2) Multiple spot dates for each phase of activity

- **Modelling Colluviation**
  Implications for archaeological visibility and landscape change
  No assumptions made about colluvial zones
  Independent validation of model using test-pitting data

- **A work in progress**
  Future work to include:
  1) Hydrological modelling
  2) Reconstruction of past land surfaces