Modelling Known Land Routes:
A Philosophical and Methodological Rethinking

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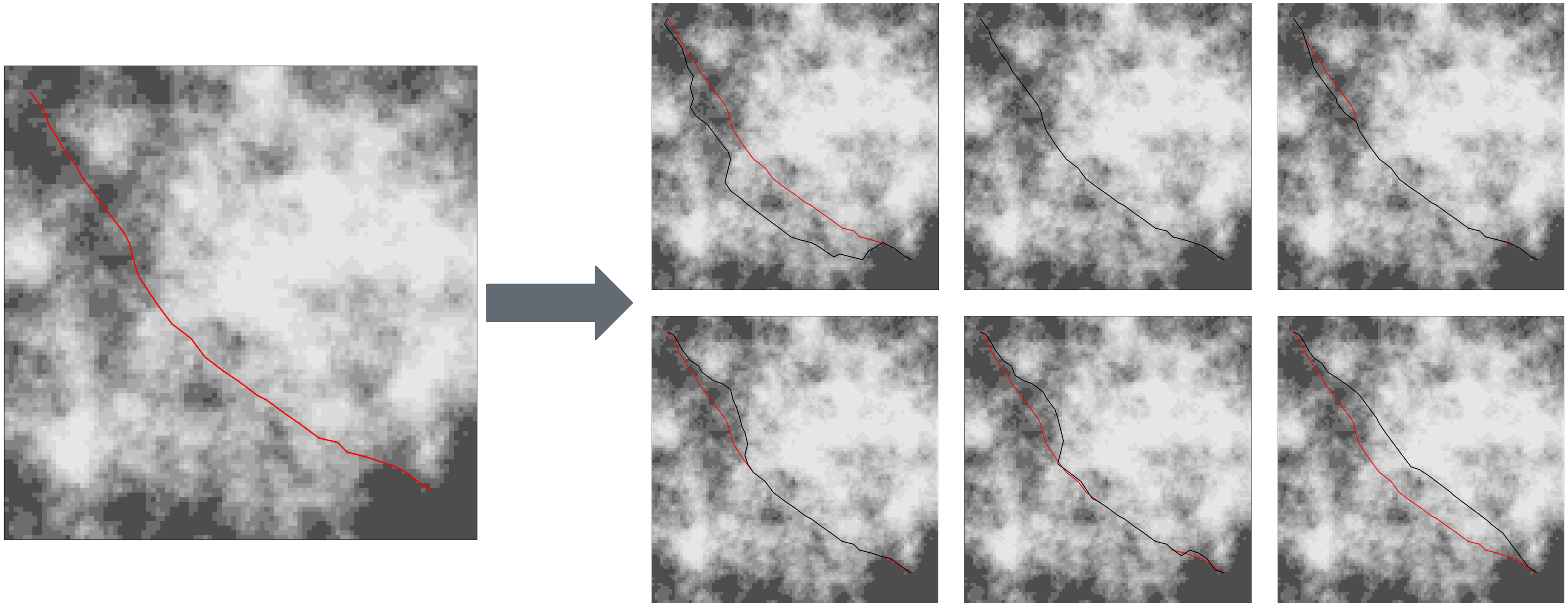
The Status Quo: Generalisable Models



Moving from Essentialism to Materialism...

ESSENTIALISM

- **Types defined according to a set of *essential* characteristics;**
- **Exist naturally in the world;**
- **Uncovered from empirical observations**

FORMAL ROUTES

ROADS

INFORMAL ROUTES

PATHS

TRAILS

Moving from Essentialism to Materialism...

MATERIALISM

- **Types defined as theoretical units always becoming something else;**
- **Constructed from analytically-useful units that measure things;**
- **Share attributes and values deemed analytically important**

Sinuosity	Gradient
Width	‘Lost ascent’

Philosophical Rethinking

PHILOSOPHICAL

(1) When are all things equal? The *Ceteris Paribus* clause;
(2) The problem of inconsistent models;
(3) The need for better hypotheses

METHODOLOGICAL

(5) Choosing the cost function;
(6) The need for a formal framework

When are all things equal? The *Ceteris Paribus* clause

"Other things being equal;

other things being absent;

other things being just right"

HOWEVER a problem arises:

"all other things are rarely equal"

Some reasons for *the principle of least effort** not holding:

- Landcover type;
- Altitude;
- Visibility;
- Rivers;
- Loads;
- Social and Cultural factors

* for simplicity assumed models minimise time/energy only

The Problem of Inconsistent Models

SUBSTANTIAL ASSUMPTIONS

- Causal structure of the model (e.g. time taken or energy expended by slope)

Models with the same substantial assumptions are compatible with one another

AUXILIARY ASSUMPTIONS

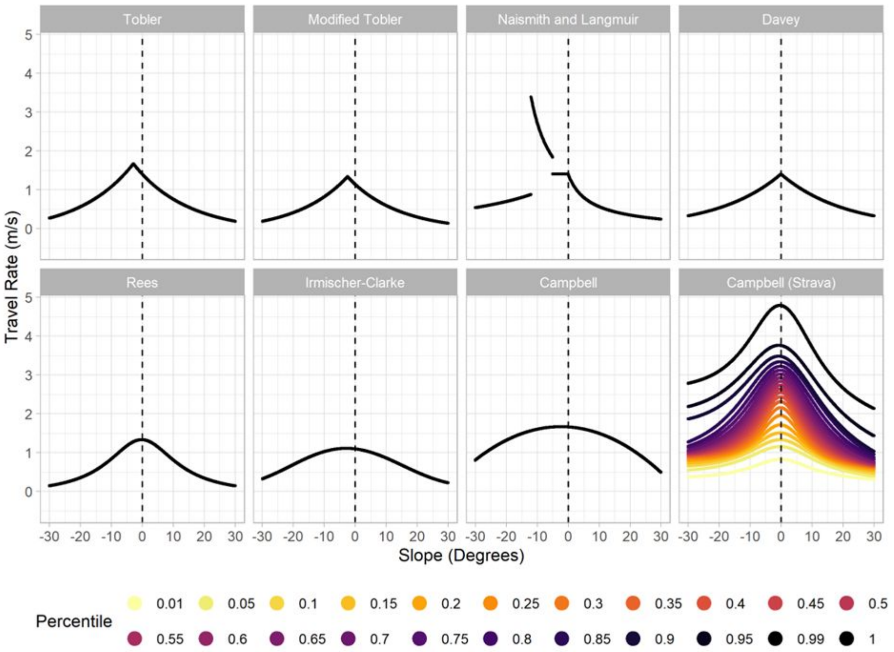
- Components and number of parameters in a model;
- Simplification of the data (e.g. curve fitting)

Models with different auxiliary assumptions are compatible with one another given they share substantial assumptions

The Problem of Inconsistent Models

ASSUMPTIONS

- **Same causal structure (time by slope)**
- **Different components/parameters**



Different auxiliary assumptions but share substantial assumptions

COMPATIBLE

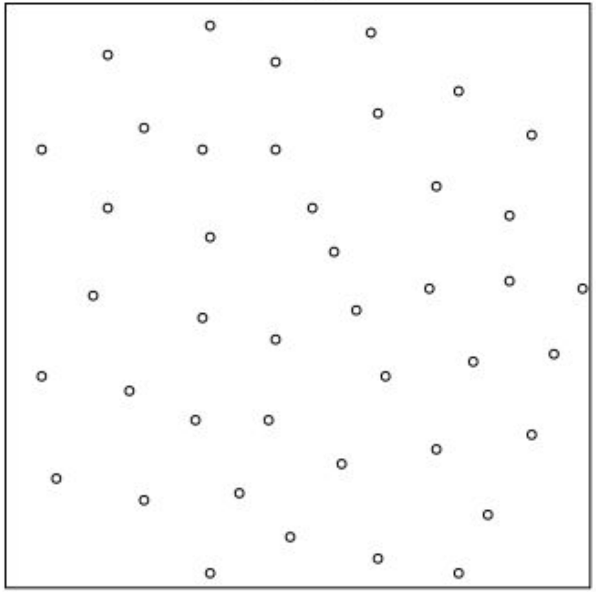
The Need for Better Hypotheses (Models)

NORMATIVE FUNCTION:

- **Representation of how idealised, optimal, and rational people *ought* to act(ed)**

DESCRIPTIVE FUNCTION:

- **Representation of how people *actually* act(ed)**



Complete Spatial Randomness in Point Pattern Analysis

Methodological rethinking

PHILOSOPHICAL

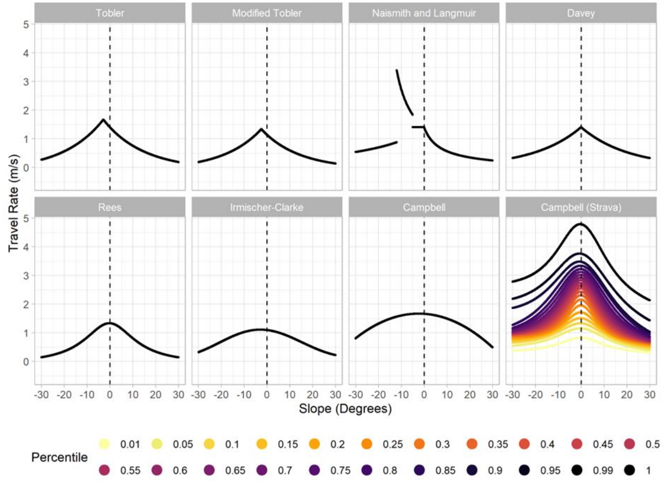
(1) When are all things equal? The *Ceteris Paribus* clause;
(2) The problem of inconsistent models;
(3) The need for better hypotheses

METHODOLOGICAL

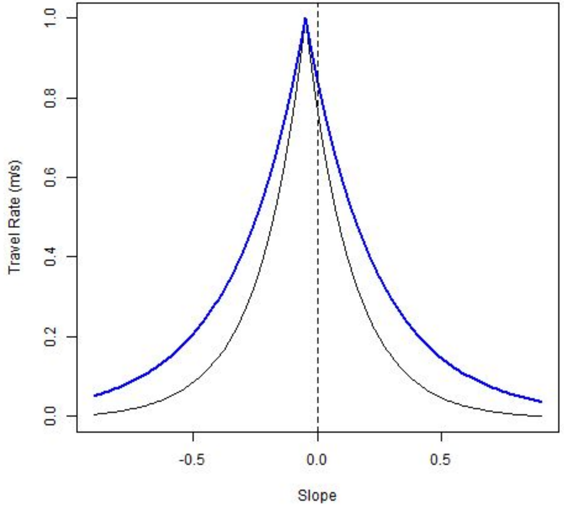
(5) Choosing the cost function;
(6) The need for a formal framework;
(7) Generative models

Choosing the Cost Function

- **Substantial assumption chosen (time by slope)**
- **Auxiliary assumptions are flexible**



Tobler's Hiking Function (Double Exponential)



$$W = 1 * exp - 3.5 \, |x + 0.05|$$

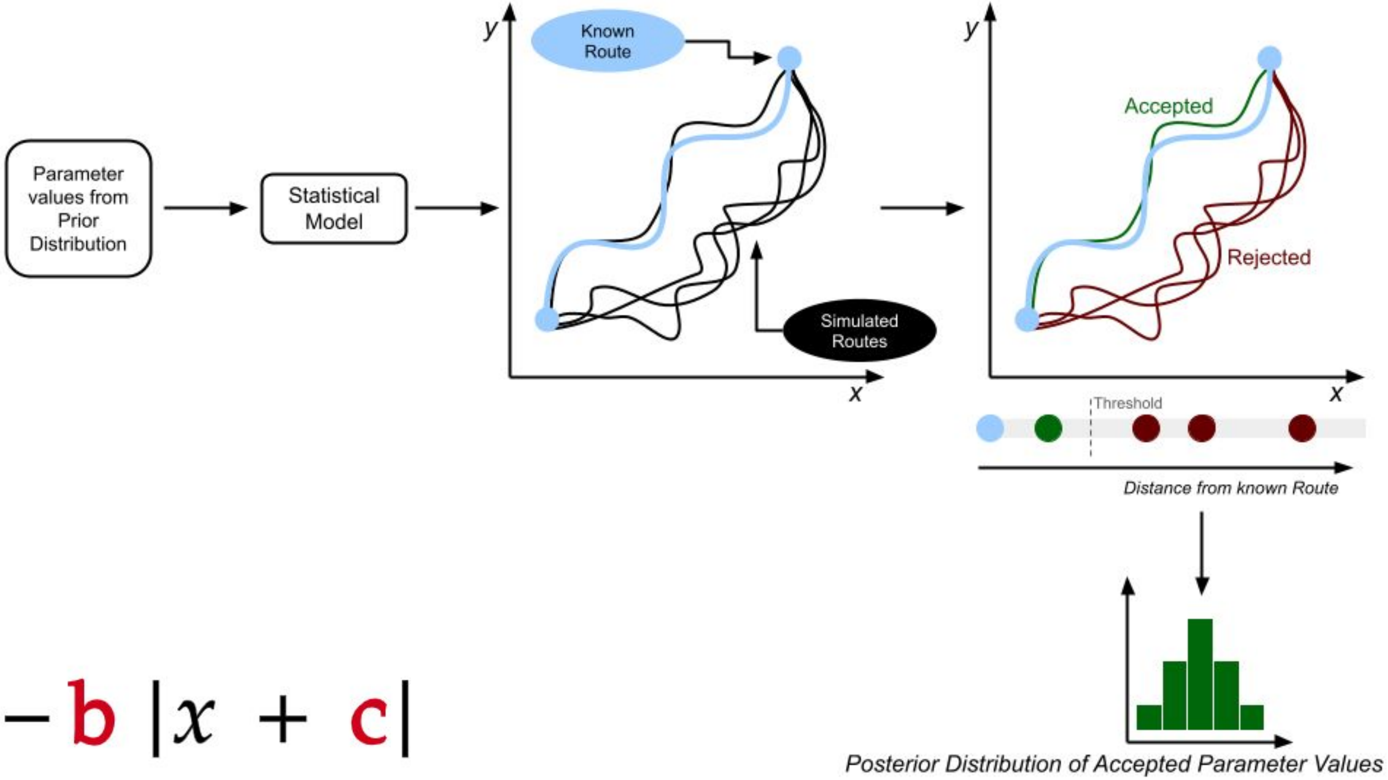
$$W = a * exp - b \, |x + c|$$

The Need for a Formal Framework

APPROXIMATE

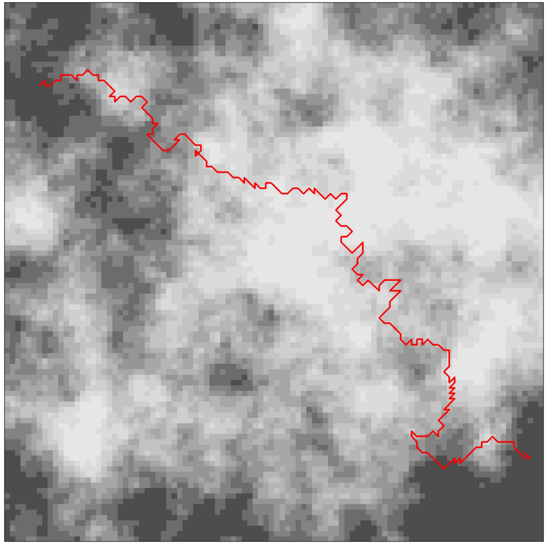
BAYESIAN

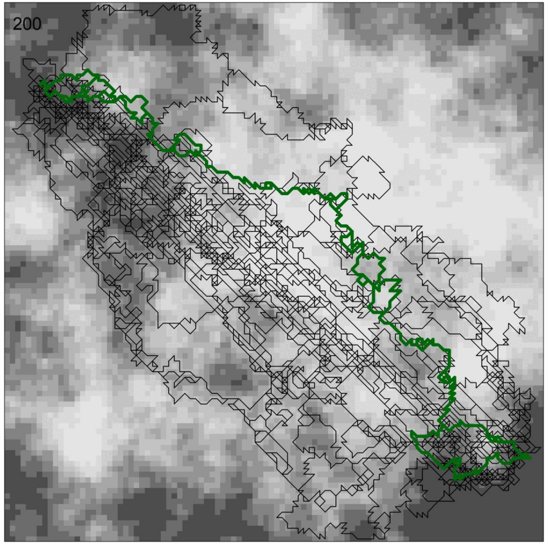
COMPUTATION

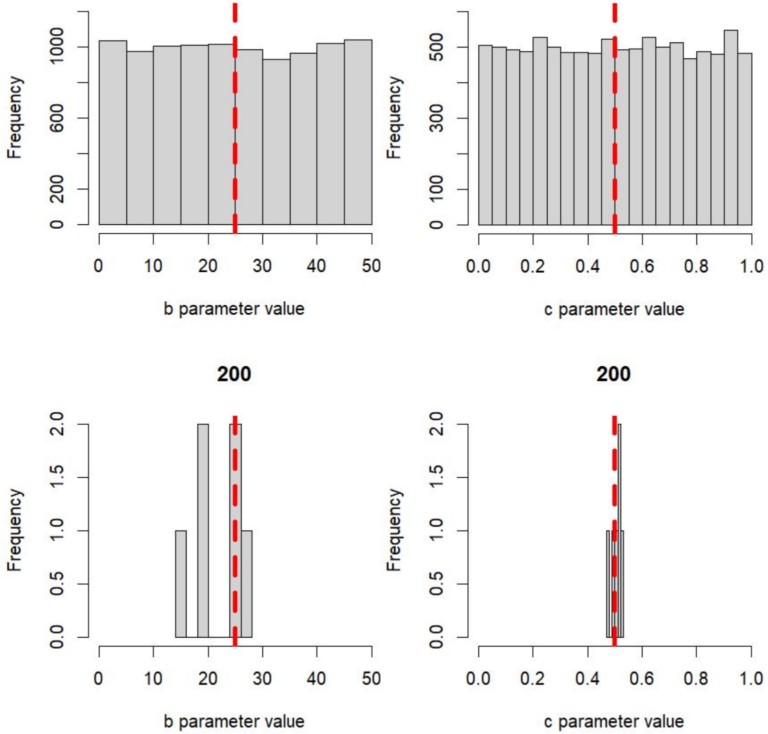


$$W = \mathbf{a} * exp - \mathbf{b} \, |x + \mathbf{c}|$$

A Simulated Example





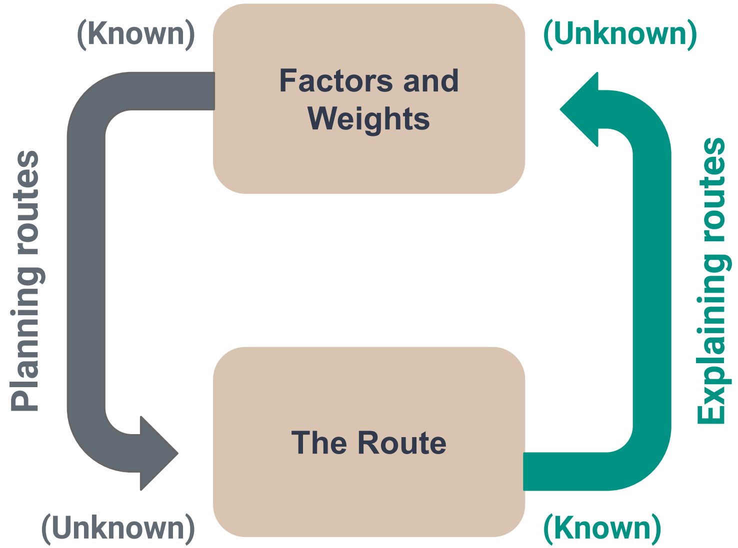


$$W = \mathbf{a} * exp - \mathbf{b}\,|x + \mathbf{c}|$$

Proposed Approach: Generative Models

- How the route might have been generated (the story behind the data)

- Inverse of multicriteria decision analysis when planning modern-day trails, power lines, and roads



Multicriteria Decision Analysis Framework

THREE FUNDAMENTAL CONCEPTS:

- How factors are scaled
- How factors are combined
- How factors are weighted*

- All factors scaled to between 0 and 1
- Factors combined through summation
- Factors weighted based on preference

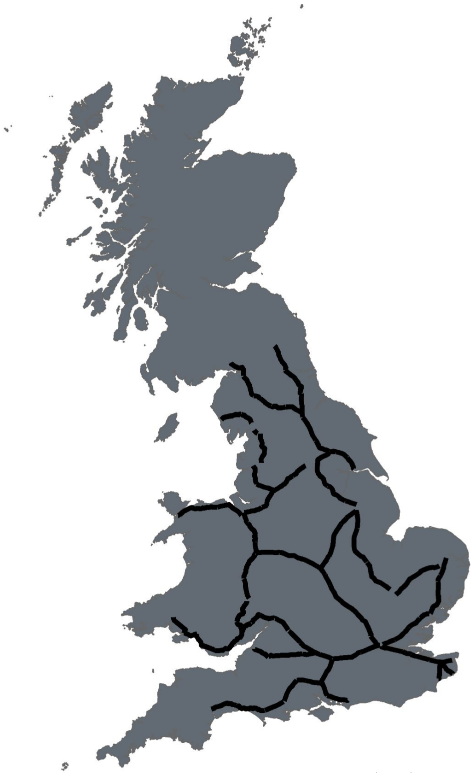
* (1) factors weights between 0 and 1, with sum of all factors equal to 1; (2) greater the weight, more important the factor; (3) factor weights are ratio-scaled

Modelling Roman Roads: A Generative Model

Digital Elevation Model

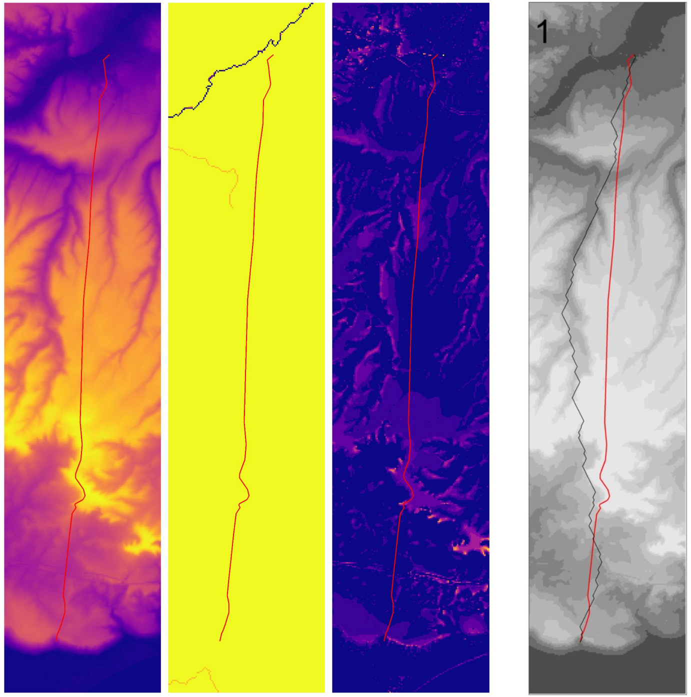
Flood Accumulation

Topographic Position Index

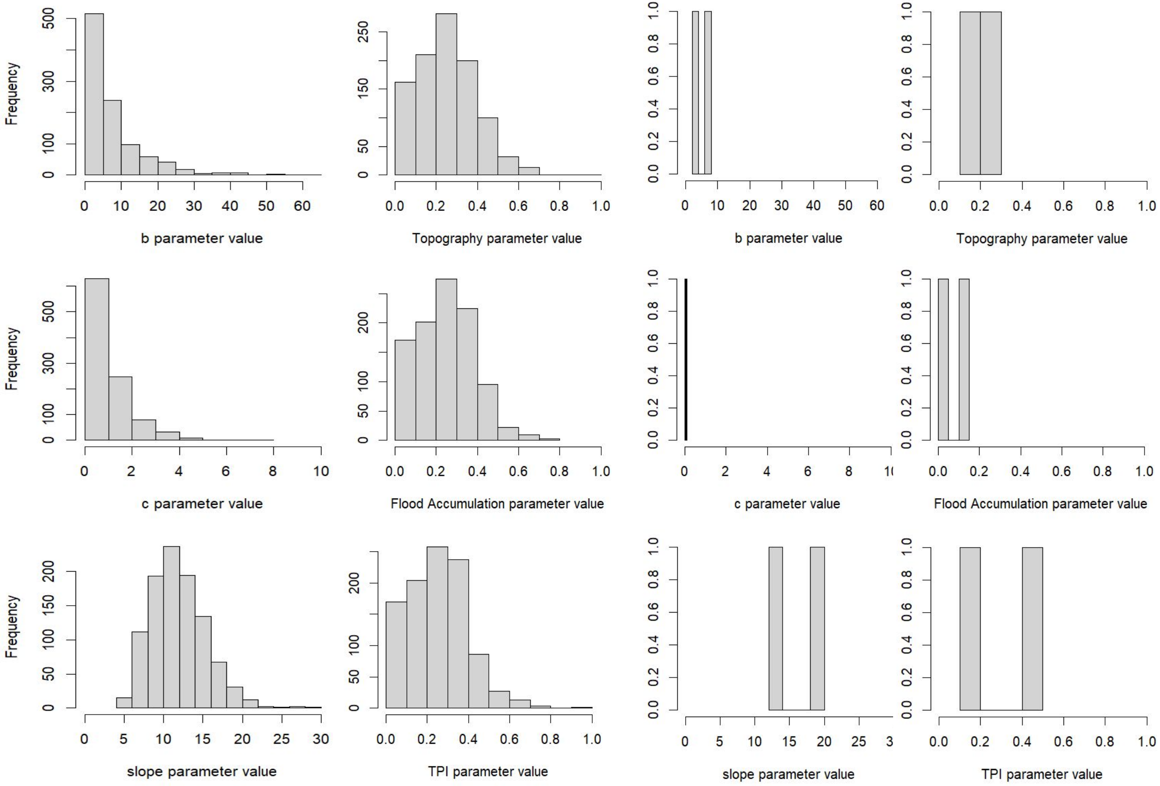


Roman Road System (AI)

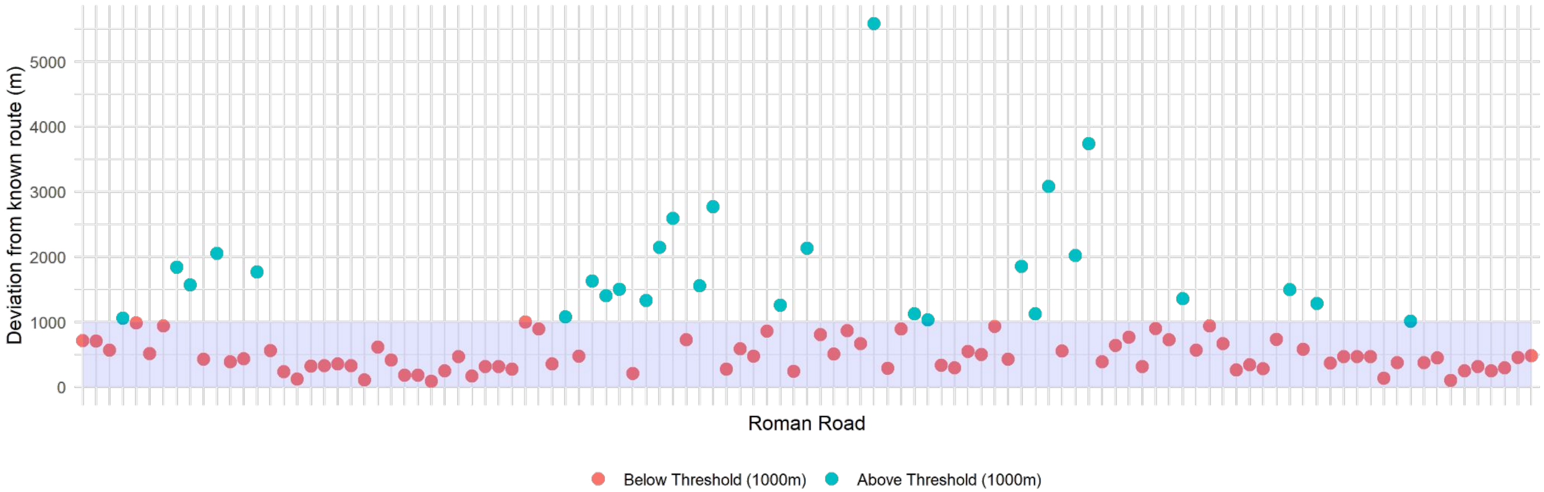
Modelling Roman Roads: Canterbury to Lympne

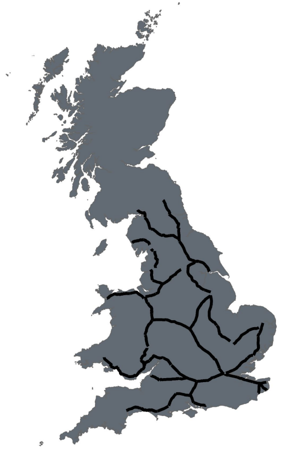


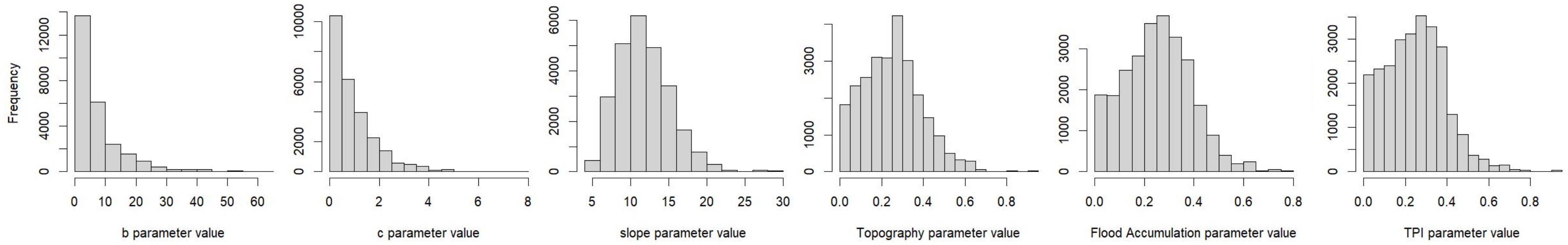
DEM Flood TPI Simulations



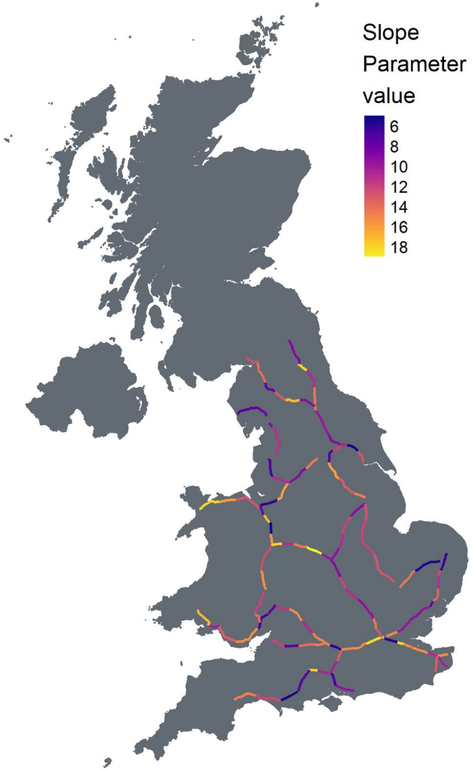
Modelling Roman Roads: Overall Results



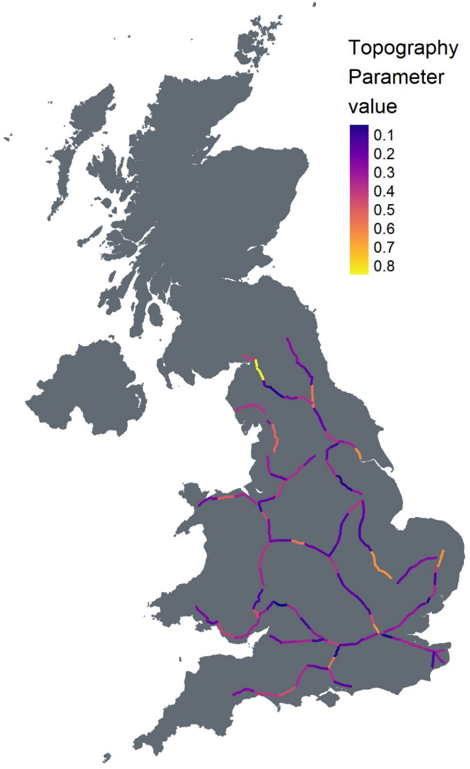




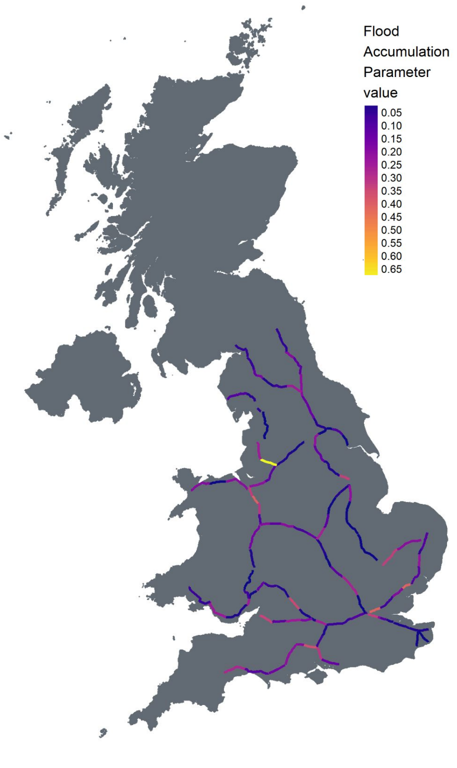
Modelling Roman Roads: ‘Best’ Simulated Routes



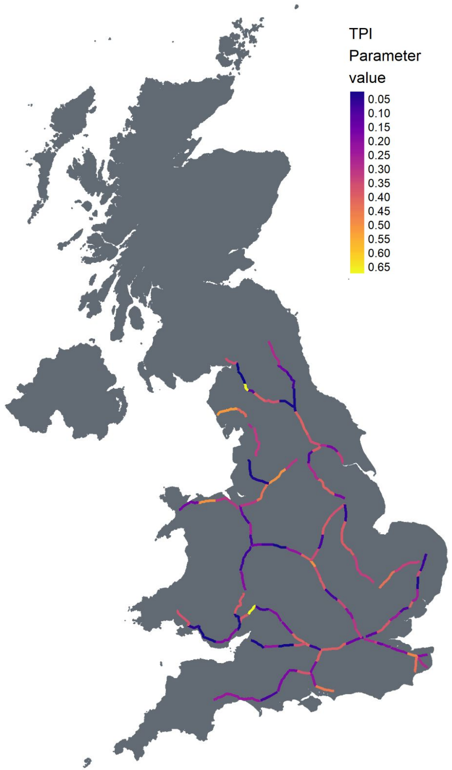
Slope Parameter Values



Topography Parameter Values



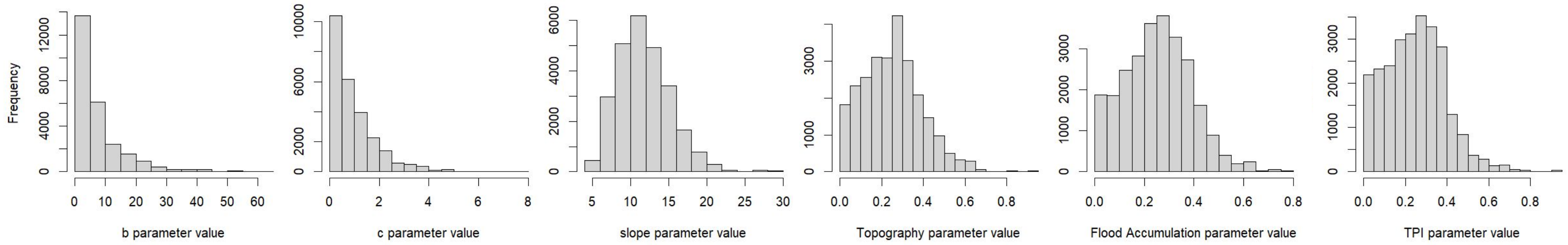
Flood Parameter Values



TPI Parameter Values

Modelling Roman Roads: Next Steps

- **Re-assess generative model**
- **Examine how multiple factors and their parameter values are related**
- **Investigate parameter values' spatial (and temporal) patterns**
- **Assess whether generative model and parameter values are transferable to Roman roads in other provinces**



Thank you
Any questions?

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