Quantifying Historical Evidence in Agent-based Models: The Islamic Green Revolution in Egypt

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We present the parameterisation strategy developed for an agent-based model of rural households in first-millennium CE Egypt (Nikulina et al., 2026; Nikulina et al., in progress), as part of the ERC-funded project SSE1K: Science, Society and Environmental Change in the First Millennium CE (Grant Agreement: 101044437). The model explores competing explanations for agricultural change, including crop diffusion, market integration, and institutional transformation, across three environmentally distinct regions: the Nile Delta, Middle Egypt, and the Fayum. To achieve this, it integrates evidence from primary documentary sources, archaeological research, palaeoenvironmental reconstructions, and modern agronomic datasets. Structured information extracted from multilingual textual corpora using large language model serves as an additional source of historically grounded behavioural data.

The presentation illustrates this workflow through two case studies: reconstructing annual Nile flood conditions from multiple incomplete datasets, and selecting and weighting the model's productive resources using documentary and agronomic evidence. We discuss the statistical methods used to infer missing parameter values, the explicit assumptions required where evidence is incomplete or unavailable, and the protocol developed to assign different levels of confidence to individual parameters.

Rather than treating uncertainty as a limitation to be minimised, our approach seeks to document and formalise it. We argue that making the translation from historical evidence to computational parameters transparent is essential for reproducible historical simulation. Our workflow provides a transferable framework for integrating heterogeneous evidence into computational models in other historical contexts.

Keywords: Agent-based modelling, parametrisation, historical evidence, uncertainty, first-millennium Egypt

References

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