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Modeling Land Use Strategies in the Central River
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Hunter-Gatherers in Dynamic Landscapes: Modeling Land Use Strategies in the Central River Valley of the Netherlands

Mesolithic; hunter-gatherer; landscape modeling; decision modeling; subsistence-settlement strategies.

Interactions between humans and the landscape have now become a standard line of research for many archaeologists, anthropologists, geographers, and palynologists, to name just a few. However, the methods and techniques used to answer questions of human-landscape relationships differ greatly and can thus provide distinctive yet worthwhile perspectives. In the central river valley of the Netherlands, archaeological representation of the Mesolithic period is incomplete and scholarly understandings vague. To counteract these deficiencies, a simulated decision-based model is developed, founded on reconstructions of the dynamic paleo-landscape. In this paper, a brief discussion is provided of the data and methodology employed, followed by implications of the model for the archaeological record.

The Mesolithic period in the Netherlands lasted from c. 10,000–6000 ¹⁴C years B.P., bookended on the earlier side by the melting of the last glacial ice sheets in the Younger Dryas and on the later side by the arrival of agriculture as the primary mode of subsistence. From a geologic point of view, this post-glacial period is considered to have been extremely dynamic: climates ameliorated, glaciers retreated, sea levels rose, and isostasy occurred. The physiography of the lower Rhine river valley transformed from an alluvial plain with meandering channels flanked by higher Pleistocene grounds into a deltaic environment dissected by many small anastomosing channels. The environment shifted from polar desert, to semi-desert, to closed forest over the 4000-year period. However, it is unclear if individual Mesolithic hunter-gatherer-fishers were aware of these external landscape changes and further, to what degree these changes affected human behavior.

To attempt to answer such questions, a multi-criteria decision-based model is described, based on detailed reconstructions of the landscape in three key study areas (see Fig. 1). These study areas were spaced carefully throughout the central river valley of the Netherlands, and were chosen based on their ability to represent unique abiotic and biotic contexts throughout the Early and Mid Holocene. The paleo-landscape reconstructions were generated at 500 and 1000-year time intervals from geologic-geomorphologic data, borehole descriptions, groundwater level interpolations, and soil maps. On top of these physiographic surfaces, associated floral and faunal communities were overlaid with reference made to macrobotanical, palynological and zooarchaeological information.¹ The goal of this phase of the modeling was to produce snapshots of the ‘total landscape’ in different spatio-temporal contexts within the lower Rhine river valley.

Once a physical approximation of the landscape was achieved, the next step was to apply the human element; that is, to explore the decision-making objectives and criteria that may have influenced the way that people mapped themselves onto the landscapes.

1 See Brouwer 2011 for a detailed description of the methodology.

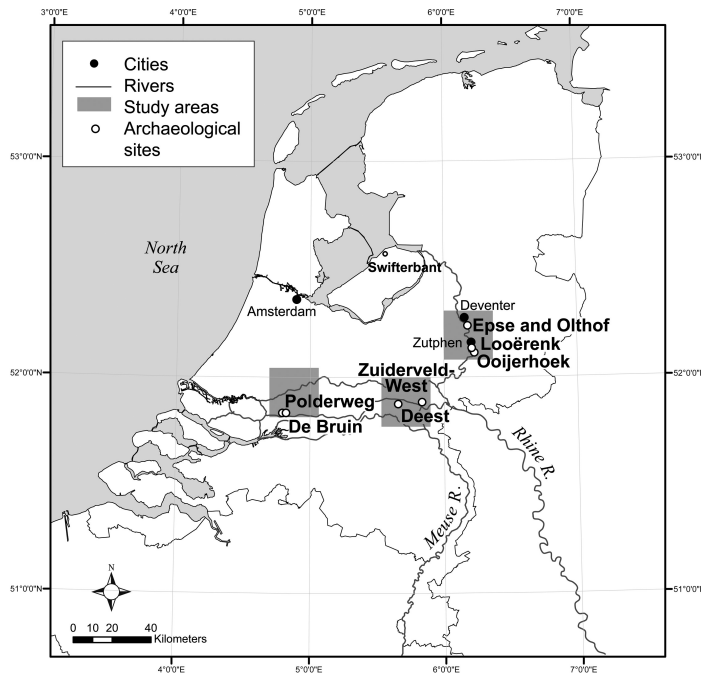


Fig. 1 | The Study Areas, situated in the Netherlands. White dots represent Mesolithic archaeological sites considered in this research.

This mapping would have entailed specific resource acquisition strategies, in which people keyed into specific resources or resource patches, as well as settlement placement practices. It was assumed that the latter practices were linked to a cascading set of associated objectives and opportunities. Further, it was assumed that Mesolithic hunter-gatherer groups thought of themselves as inextricably linked to the landscape, an important component within the larger functioning whole.² Therefore, the landscape as a cultural construction, in which meaning is uniquely embedded and encoded through various landscape markers and toponyms, was also built into the modeling of human land use.³

Reference to the ethnographic literature of boreal and temperate forest hunter-gatherers was made in order to understand some of the overarching ways in which recent foragers think about and make choices concerning landscape use. Some objectives that appear to consistently impact decisions about resource allocation include securing sufficient subsistence and raw material resources, while concurrently minimizing any risk to the individual or group.⁴ The most important criteria for placing a settlement, no matter how ephemeral, appear to have involved finding reasonably dry locations with ample shelter from the elements. In many cases, obtaining a view was also considered, although this was most likely more important in settling longer-term base camps than shorter-term hunting camps or extractive sites.

With these basic resource extraction and settlement placement rules established, simulation models were run within an environmental modeling software known as PC Raster-TM. This software allowed for the building of an iterative decision model that considered a cascading set of objectives and criteria within a larger decision rule, or operative framework within which decisions are made. Six such decision rules were utilized, each representing a hypothetical hunter-gatherer adaptive strategy:

1. Large game-focused foraging
2. Large game-focused collecting

2 e.g., Ingold 2000; Jordan 2003.

3 Lovis and Donahue 2011.

4 i.e., Jochim 1976.

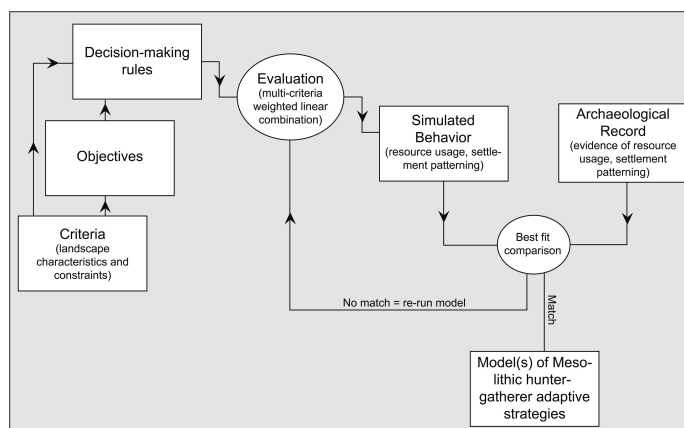


Fig. 2 | Flowchart of Decision-Making Model. (Adapted from Krist 2001.)

3. Non-specific resource foraging
4. Non-specific resource collecting
5. Wetland resource-focused foraging
6. Wetland resource-focused collecting

These hypothetical adaptive strategies were intentionally chosen to represent generalized types of subsistence-settlement patterns that act as non-mutually exclusive ends of an economic-mobility spectrum,⁵ with the overall goal of heuristically exploring the impact and relative intensity of different constraints on decision making.

For each 25×25km surface developed in the paleo-landscape modeling (with a unit grid cell resolution of 100×100m), sets of nested decision-making objectives, criteria, and decision rules were run (see Fig. 2). The results of this modeling were spatial surfaces depicting the suitability of each study area quadrat for specific subsistence-settlement strategies. The output of the hypothetical adaptive strategies was compared with the available archaeological evidence. It is assumed that correspondence between the modeling outputs and the archaeological record signifies that an adaptive strategy may have been a viable way to exploit the area in question. Correspondence was determined by averaging the overall suitability of a location for a given subsistence-settlement strategy, and then comparing with the dominant behavioral markers of such activities in the archaeological record.

The model reveals a number of intriguing implications. First, water-logged marshy or wetland habitats are expected to be best exploited by hunter-gatherers using collector strategies, in which people fan out into the landscape to collect available resources and then bring them back to a dry-ground central base camp or staging area. This accords well with the archaeological evidence from the Hardinxveld-Giessendam late Mesolithic dune sites, where seasonal camps were repeatedly occupied.⁶ Here, a variety of wetland and dryland resources were processed and consumed or used, as evidenced by diverse faunal and macrobotanical remains. The model output further implies that many smaller, short-term extractive/procurement sites should be found radiating outwards from the central, high-and-dry dune sites; future ground-truthing is required to test this hypothesis.

The model also demonstrates that an inverse relationship exists between the patchiness of an area and the degree of organizational flexibility allowed hunter-gatherers in terms of related procurement and mobility strategies, and with important ramifications for site patterning and group size. Highly patchy and heterogeneous habitats allowed only a small amount of organizational flexibility, indicating that edge zones were best exploited

5 e.g., Binford 1980; Binford 1982.

6 e.g., Louwe Kooijmans 2001a, Louwe Kooijmans 2001b.

via collector strategies, decreased residential mobility, and increased storage. In such environments, satellite-type configurations of camps are expected, with an expanded, multi-family base anchoring the settlement system. Conversely, areas with low patchiness and homogeneously distributed resources allowed hunter-gatherers far more leeway in terms of their organizational flexibility. Having the ability to switch back and forth between collecting or foraging strategies would have been highly beneficial for hunter-gatherers who pursued resources in a less systematic manner. Group membership was likely fluid, with aggregation and fission occurring on an ad hoc basis. In such environments (such as the eastern portion of the lower Rhine river valley), settlement patterns are expected to be less “neat” than in wetland contexts, entailing residential and logistical encampments of various sizes. Such patterning appears to be demonstrated by settlement data from sites with many occupational phases of varying size and scope (e.g., the Ooijerhoek and Epse site complexes).

The above discussion investigates only one line of predictions and implications for hunter-gatherer behavior; a number of other suggestions are generated by the model described here.⁷ In summary, the model has shown that although the central river valley of the Netherlands was a dynamic area during most of the Early and Mid Holocene, Mesolithic hunter-gatherers likely did not detect these changes to the landscape at the individual scale. Rather, the results of this modeling exercise indicate that changes to the physical and biotic landscape would have been recognized at a generational scale, as memories of the landscape were compared over generations through the conduit of cosmology and oral histories concerning specific markers in the landscape. Furthermore, the model discussed here helps to elucidate some of the underlying patterning of hunter-gatherer land use, and can provide new ways of explaining the distribution of archaeological sites, as well as making more informed predictions about the uses of locations lacking in archaeological data.

7 See Brouwer 2011 for further discussion.

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