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Modeling Natural and Human Landscape in Prehistoric and Medieval Southwest Finland from 500 BC to 1500 AD – Computer Based Visualization

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Abstract. The landscape rendering project (duration 2001–2003) presented in this paper focuses on Southwest Finland – more specifically, on its northern part called ‘Vakka-Suomi’. In this study, GIS methods have been utilised in classifying digital elevation data. The data have been saved in DXF or MIF format and imported into the AutoCAD program and then to the modeling program (3D Studio MAX), in which a completely three-dimensional model of the research data has been generated. In landscape rendering, the aim is to present the landscape of the past with all its parts in as much detail and as justifiably as is possible on the basis of our present knowledge. Ten subjects of study have been chosen from a time span of 2000 years (500 BC – 1500 AD), each of which is studied only on one time level. With the help of these different sites, a story emerges of how the region changed from the prehistoric area on the fringes of hunting lands to the field cultivation area of the 16th century.

Keywords. Vakka-Suomi, landscape, map analysis, GIS analysis, 3D modeling, contour lines, topographical aspects, prehistoric sites, historical sites

1 The Landscape of the Past as a Subject of Computer Modeling

Landscape archaeology in Finland has been one of the most strongly developing subdivisions of archaeology during the last years. Partly its emphasis is on the need, which arises from the management of ancient sites, to study the different layers and dimensions of landscape. In this respect, landscape archaeology starts off from the present landscape and maps different parts of it. The landscape rendering project (duration 2001–2003) presented in this paper focuses on Southwest Finland – more specifically, on its northern part called ‘Vakka-Suomi’. The Vakka-Suomi ancient landscape project has the same starting methods as landscape archaeology in general, that is, the data is analysed using GIS software (comp. Bishop et al. 1999). However, after this stage the Vakka-Suomi project differs from the usual. For a landscape researcher, a GIS analysis is, in itself, very informative (Tuovinen 2002), but when the aim is to show a reconstruction of an ancient landscape to a wide audience, GIS methods are not necessarily adequate or may not even have been intended for this kind of use (Gahegan 1999; Maceachren 1999).

Models of ancient landscapes have been made with traditional methods as artists’ drawings for a long time, but ancient landscapes created with a computer are mainly the result of the 1990s when new software came into use with which one can control extensive areas and their various changing surfaces and structures. One very good method that is greatly utilised, is to combine the basic data modeled on a computer to the skills of a professional artist, in which case you achieve excellent individual paintings (Uotila & Sartes 2000).

When modeling an ancient landscape, it has been common to choose important building complexes – such as castles, churches, temples, cities, etc. – as the main subjects. As far as prehistoric sites are concerned, those ancient remains that are clearly discernible have been brought forward. Through this kind of distinction, it has always been those parts of human activity that are considered to be the most important that have been at the centre of investigation. In temporal studies, researches have usually presented the different stages of a site – for example, a castle developing from a wooden fortress into a restored museum of the present.

2 The Vakka-Suomi Project

With regard to both of the basic elements mentioned above, the Vakka-Suomi project now being conducted differs considerably from what we are used to. Firstly, even though churches, manors and villages have been chosen as the subjects of study, the main focus is nevertheless on the whole surrounding environment. (Barford 2000) The viewpoint and zooming have not been chosen merely on the basis of one subject, but we have rather tried to present a wide area of the landscape – as an example one could mention the western coastal area where we study the significance of land uplift with the help of a 20 x 40 km 3D digital model. With regard to low coastal areas and the changes in them, it is of primary importance to perceive wide areas in this manner. On the other hand, modeling for example individual trees as a part of a forest is both impossible and unnecessary.

Secondly, with regard to the temporal element, ten subjects of study have altogether been chosen, from a time span of 2000 years (500 BC – 1500 AD), each of which is studied only on one time level. With the help of these different sites, a story emerges of how the region changed from the prehistoric area on the fringes of hunting lands to the field cultivation area of the 16th century. Through this we also gain an understanding of how the area changed continuously and how people needed to react to it. For example, the permanent coastal settlement of early Iron Age became in contact with difficult environmental factors very quickly and life itself forced people to change and adjust to a new situation constantly.

The research sites of the Vakka-Suomi project are shown in Figure 1. The primary subjects of study are the gradual development of cultivation in the area, the development of settlements from single houses into villages and the chief families in the villages becoming differentiated as the leaders as well as their development into noble families. The arrival of Christianity in the area proceeded in stages from the 11th century onwards and culminated in the building of the stone churches in the 15th century (Alifrosti 2000; Hiekkanen 2002; Purhonen 1997).

One reason for the continuous change in the landscape of the area is already included in the main theme – the sea withdraws from the landscape. In the fragmentary landscape of Vakka-Suomi, land uplift and shore displacement have been factors that cause continuous change, and they may have been part of the reason why one single long-term centre never had a chance to develop in the area. (Alifrosti 2000; Hatakka & Glückert 2000; Tuovinen 2002)

Fig. 1. *Location of the research area.*

3 The Research Process

We always began the production of content by gathering maps and archival material. The map analyses also included analyses made of raster data in order to illustrate topographical phenomena. The archive data was collected from the reports in different archives and then entered into tables, where the location of a site was usually indicated as a point in the same coordinate system as all the other material. There were differences in processing the data depending on whether the subject depicted in a model was prehistoric or historic. The younger the landscape to be modeled, the more important it became to process maps, and with prehistoric sites, ancient remains and topographical aspects were emphasized.

We began the manipulation of the maps by importing them into the MapInfo program. In MapInfo they were all registered in the same coordinate system, so that they could be studied on top of each other (overlay analysis). Coastal stage, slopes and gradient directions as well as soil types were retrieved from the raster data. The software used for the retrieval was Idrisi. The map layer that resulted from this analysis was imported into MapInfo. (Tuovinen 2002)

Due to the low resolution of the raster data, the result was rather simplified. However, when the examination was taken closer to the subject, the coastal stage was studied with the help of contour lines of other maps, and then it was possible to discern, for example, the small-scale changes. When studying the ancient remains, we firstly tried to date them. If the remains had not previously been studied, the coastal stage was used to help the dating. Secondly, we identified the nature of each ancient remain – whether it was a cemetery, dwelling site or some other feature.

In analysing the research data, we mostly used the exclusive method, in which the surroundings of the site to be modeled are approached by looking for elements that are younger than the chosen time of presentation. Our starting point was always the present-day situation, from which elements that were too young were first searched for with the help of maps, topographical conditions and ancient remains of different times. When these were found, the remaining elements were digitised from the screen in MapInfo and saved as importable files. Secondly, on the basis of, for example, aerial photos and soil type we tried to estimate what the vegetation could have been like. Thirdly, we tried to determine where settlements had been located by searching for the most likely places, for example (Maaranen 2002).

The data has been processed from the following sources (1-7 archaeological-geographical study; 8 topographical classification; 9 data pre-processing; 10 visualisation):

1. Maps: There is a comprehensive collection of maps from the research area, beginning already from the end of the 18th century, and the oldest used map dates as far back as the end of the 17th century. When comparing maps, one must take into consideration the fact that older maps often concentrate on depicting elements that are essential from a financial point of view. (Aliforsti 2000)
2. Coastal stages: Because the research area is located on the seacoast or in its immediate vicinity, post-glacial land uplift is an environmental factor that has significantly affected the landscape. The speed of the uplift is known, so it is possible to count the time when the sea level was level with a certain contour line. This reconstructed coastal stage was used, for example, in estimating the vegetation of the site to be depicted. (Hatakka & Glückert 2000; Uotila 2000)
3. Other topographical aspects: The raster maps of the research site were used to find for example slopes and certain orientations with the help of GIS methods, and with the help of these we deliberated on, among other things, the possible locations of settlement in cases where there so far is no archaeological evidence.
4. Soil type: Soil types have significance in for example estimating locations of settlement, arable lands and vegetation. The problem is that soil maps usually only indicate the most common soil type and even this at a certain depth from the ground level, in which case the thin layer of topsoil, for example, is not revealed.
5. Present knowledge: Information about for example surface rocks and forest types was taken from basic maps

and aerial photos. Present-day lakes and rivers were also digitised from them.

6. Ancient remains: If an ancient remain dates from a younger period than the time presented by the model, it is left out. The importance of ancient remains becomes more marked the further back in time you go, because the amount of other sources telling about human behaviour correspondingly decreases. On the basis of the location of ancient remains, deductions have also been made about phenomena for which there is no archaeological evidence so far. For example, a cemetery tells that a nearby settlement also existed during its time of use, so we have tried to include a dwelling site on a suitable place near the cemetery. (Purhonen 1997)
7. Historical sources: These include, among others, the tax system of villages, with which one can roughly estimate their age, as well as information about the lowering of the water level of lakes, field cultivation and slash-and-burn cultivation in the historical times and buildings. (Alifrosti 2000)
8. Digital elevation data: The digital elevation data in vector format was obtained from the Topographic Database of the National Land Survey of Finland (NLS) by using the MapInfo 5.0 software. Additional features from the Topographic Database have been utilised as reference material, such as lakes and fields. The contour lines are based on the contour lines of the basic maps of the NLS, in which the contour interval is 5 metres and, when needed, the auxiliary contour lines supplement the data every 2.5 metres. The data have been retrieved from the Topographic Database with the help of SQL query into their own layers according to the altitude value.
9. Combining and importing: The data (archaeological and topographical as well as additional features) have been saved in DXF or MIF format and imported into AutoCAD 2002 Map.
10. Modeling and rendering: CAD-format files have been imported to the modeling program (3D Studio MAX 4), in which a completely three-dimensional model of the research data has been generated (Uotila & Tulkki 2002, 428).

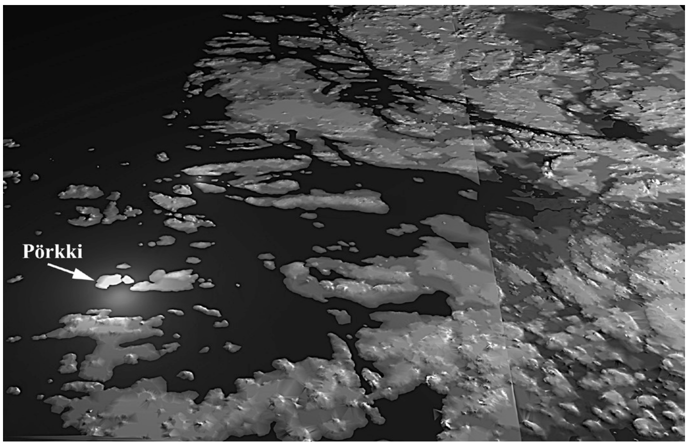

Fig 2. *The visualised sailing routes and location of the Pörkki site (under water) in 800-900 AD. The Pörkki site has been seen as a trade centre in 800-1000 AD (Hinneri & Santamala 1997). However, our modeling showed that during that time period the site was under water and the nearby areas were unsuitable for trade centre activities.*

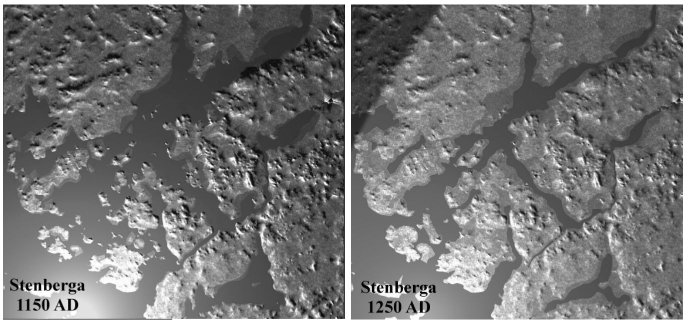

Fig. 3. *Land uplift and locations of flooded areas were visualised in the area of the Stenberga castle, located in the southern part of Vakka-Suomi. There were changes in sailing routes in the area in the 12th and 13th centuries, and intensive shore displacement during the 13th and 14th centuries had a remarkable impact on the contemporary landscape (Uotila 2000).*

3 Modeling Archaeological Fact, Deduction and Interpretation

During the last years, the development of computer technology has offered opportunities to render more and more realistic-looking people, buildings and whole landscapes of the past and the present. It is obvious that in all archaeological research one of the central questions of the discipline is how to connect the hard fact produced by excavations and the consequent deductions to a wider context and interpretation of the past.

In landscape rendering, the aim is to present the landscape of the past with all its parts in as much detail and as justifiably as is possible on the basis of our present knowledge. In this respect, it is assembling research, in which the research results, deductions and interpretations of many disciplines – both the natural sciences and the humanities – are combined.

On the basis of our study, landscape rendering has the following advantages:

1. Visualisation of land uplift involving large areas is an effective tool for reconstructions of the prehistoric and medieval shore displacement that had a socio-economic impact.
2. Visualisation of landscape is helpful in studying sailing routes and navigation both in the large and small scale.
3. It is possible to carry out visibility analysis (point to point) from a chosen location in a more sophisticated manner.
4. The intangible features of the landscape such as prehistoric graves or medieval chapels and manor houses can be experienced.

As all reconstructions, also a landscape model is a combination of hard scientific fact and looser scientific deductions. On the other hand, the reason for using modeling software has been the intention to use the finished research material later in, for example, multimedia programs and movies.

As for virtual archaeology, problems may arise from the fact that it is difficult to join the traditional evaluation of sources and defence of one's own interpretations to an individual rendered image, multimedia program or video presentation. In various parts of the international research community that concentrates on virtual archaeology, people are deliberating on this problem of using source material, to which future technical development may bring new solutions. It is plausible that a databank or a database can already soon be added to at least those models that have been made into digital format. From such a database, other researchers could get the necessary information to evaluate the research, that is, the sources and methods of the visualisation. It is, however, obvious that virtual archaeology specifically is an approach in which the share of deductions and interpretation is always large.

References

ALIFROSTI, K., 2001. Environmental background of early historical settlement process in Finland Proper. *Sites and Settlement*. Edited by Aino Nissinaho. Publications of the project Changing Environment – Changing Society. University of Turku.

BARFORD, P.M., 2000. Seen and unseen: sites in a landscape. *Sites and Settlement*. Edited by Aino Nissinaho. Publications of the project Changing Environment – Changing Society. University of Turku. BISHOP, I. D., et al. 1999. Visualisation of 8000 years geological history in Southern India. *International Journal of Geographical Information Science*, 13, 417-427.

GAHEGAN, M., 1999. Four barriers to development of effective exploratory visualisation tools for the geosciences. *International Journal of Geographical Information Science*, 13:4, 289-309.

HATAKKA, L. & GLÜCKERT, G., 2000. Calibration curves representing shore displacement of the Baltic based on radiocarbon ages in the Karjaa, Perniö, Turku, Mynämäki, and Laitila areas, SW Finland. *Sites and Settlement*. Edited by Aino Nissinaho. Publications of the project Changing Environment – Changing Society. University of Turku.

HIEKKANEN, M., 2002. The Christianisation of Finland – a Case of Want of Power in a Peripheral Area. Centre Region Periphery. *Medieval Europe Basel 2002*. Preprinted Papers. Volume 1, Sections 1-3. Ed. by Helmig G., Scholkmann B., Untermann M.

HINNERI, S. & SANTAMALA, E.,1997. *Viikinkien Kalantiväylä. Vikingarnas Kalandfarled.* Rauma.

MAARANEN, P. 2002. Maiseman monet kasvot: ihmisen muinaisen toimintaympäristön tarkastelua maisematutkimuksen näkökulmasta. *Muinaistutkija* 2 / 2002.

MACEACHREN, A. M., 1999. Constructing knowledge from multivariate spatiotemporal data: integrating geographical visualization with knowledge discovery in dataset methods. *International Journal of Geographical Information Science*, 13:4, 311-334.

PURHONEN, P., 1996. *Vainionmäki – A Merovingian Period Cemetery in Laitila, Finland.* Helsinki 1996.

TUOVINEN, T., 2002. The Burial Cairns and the Landscape in the Archipelago of Åboland, SW Finland, in the Bronze Age and Iron Age. *Acta Universitatis Ouluensis B Humaniora* 46. Oulu.

UOTILA, K & SARTES, M., 2000. Medieval Turku - the Lost City. A project trying to reconstruct a medieval town in Finland. *Virtual Reality in Archaeology, CAA2000*, Barcelona, April 1998, Oxford Archaeopress (BAR International Series 843).

UOTILA, K., 2000. The collapse of defence in Finnish castles around 1500. *Chateau Gaillard* XIX (Graz 1998).

UOTILA, K. & TULKKI, C., 2002. Three-dimensional excavation plans and 3D Studio Max. Experiences from the excavations of the medieval town of Naantali, Finland. *Archaeological Informatics: Pushing the Envelope, CAA2001, Proceedings of the 29th Conference*, Gotland, April 2001, Oxford Archaeopress (BAR International Series 1016).