TerraME: MayaSim

Modelling the growth and decline of Mayan culture

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Abstract
The following model is based on the work by Scott Heckbert [1] and shows a possibility to calculate the surrounding factors during the growth and decline of the Mayan civilization. Except for some small changes the model uses the algorithms, functions and data like in the native approach by Heckbert. The outcome is a map that shows the distribution of the Mayan villages and the impact on surrounding conditions like soil degradation or forest succession.

Methods
At the beginning it was necessary to parse the base data from the files, which contain finegrained information about soil, temperature, precipitation and elevation. As so much information was hard to handle, it was decided to only use every tenth value to make a fast processing possible. Based on this the slope was calculated for every cell using ArcGIS to spare some processing time. An order was generated starting from the highest cell (elevation) to use it later to calculate the water flow. The result was a cellular space containing 89 x 97 cells.

After loading the data into tables the related cells in the grid were changed according to the information in the table. In addition to these values table fields for the net primary productivity, agricultural productivity and ecosystem services were initialized. In the next three time steps the changing functions for the environment were called without any agents to ensure fully developed spatial conditions.

During the third time step 50 initial Mayan villages with 100 people each are created to get a first stable population for the landscape. The placing of each village contains a test if general conditions like ecosystem services, water level and soil productivity are suitable for living. After that in each time step cropped cells are added if it is necessary to increase the income per capita for living. If the population reaches a certain level the village splits and a new village is created at a new suitable location in the environment.

As the usage of soil and forest decreases the ecosystem services and therefor the income per capita the environment will not have enough resources for the population at a certain level. At this point the population density will decrease and the Mayans will start to become extinct. After that the environment will start to recover slowly until everything is like before the Mayan civilisation.

Results
Figure 1 shows the connection between the underlying data and the processing functions. It is slightly different to the original model but has in general the same outcome. For the first 80 steps the civilization gets bigger and reaches a climax. After

that the environment is not able to provide enough resources and the civilization starts getting smaller. After another 100 steps the Mayans are basically extinct.

Problems during the development

There were several different problems during the development. These were mainly caused by the undocumented function given in the paper by Heckbert. Also it was not possible to use the data in its full extent, as the processing time would have been too long to create a reasonable result.

Conclusion

This model seems to be a reasonable approach to get an insight into the development phases of an ancient culture. It takes multiple natural factors into account as well as anthropological inputs like trade, travel costs and income. As the author of the original paper also mentions some functions and algorithms must be adjusted and improved like the fixed birth rate or soil degradation.

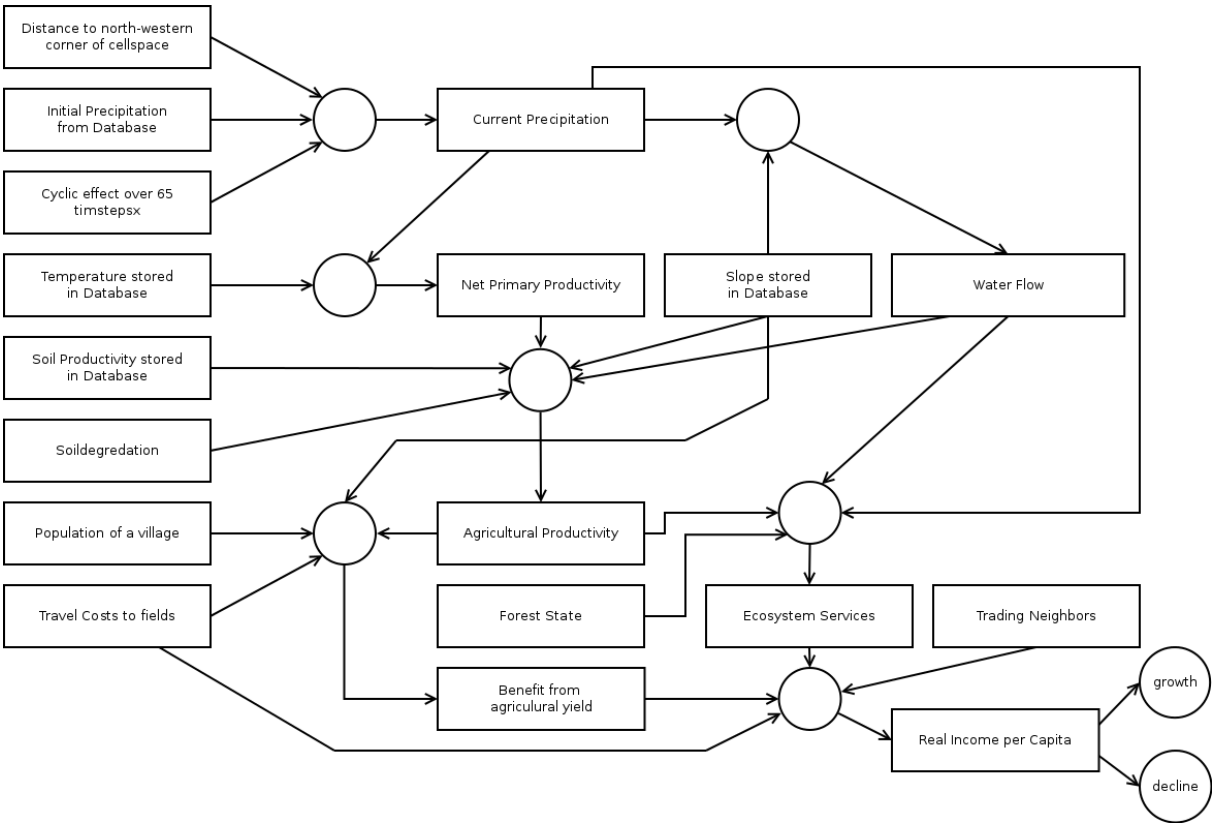

Figure 1: Schematic flow and connection of functions and parameter

References

[1] Heckbert, Scott. "MayaSim: an agent-based model of the ancient maya social-ecological system." Journal of Artificial Societies and Social Simulation 16.4 (2013): 11.