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Optimisation of a GIS process for grid interconnection of renewable energy projects

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Motivation

The turnaround in energy politics affects the power grid. Renewable energy power stations (e.g. wind farms) have to be built at locations where the resource (wind) is sufficiently available. Many suitable places are far away from existing transmission lines, therefore, new lines are required for the interconnection. The planning process for transmission lines is time consuming and many aspects have to be taken into account. This is where GIS software could be brought into play. Manual analysis of different maps can be replaced by a much faster automated processing of geodata. A prototype, which takes the most important regulations and technical limits into account and generates a least cost path, was developed at ETH Zurich during the spring semester 2012 by Patricia Moll.

Objectives

Although, the visibility is very important for the social acceptance, it has no influence on the existing path finding process. Hence, the new process should allow a minimisation of the visual impact.

The resulting paths of the former tool are curvy and longer than necessary. As a consequence, the paths should be straightened.

The exact effect of the inclusion of the visibility and straightening is unknown. Hence, the influence of the two modifications should be analysed.

The former tool calculates corridors of well suited areas too. However, even though, they are beneficial for detailed manual analysis, their information cannot be used for alternative route calculations with the former tool. The new process should offer more influence possibilities in order to generate alternative routes.

The final goal of the planning process is the designation of one path. For this purpose the alternatives have to be evaluated. The new tool should allow such an evaluation.

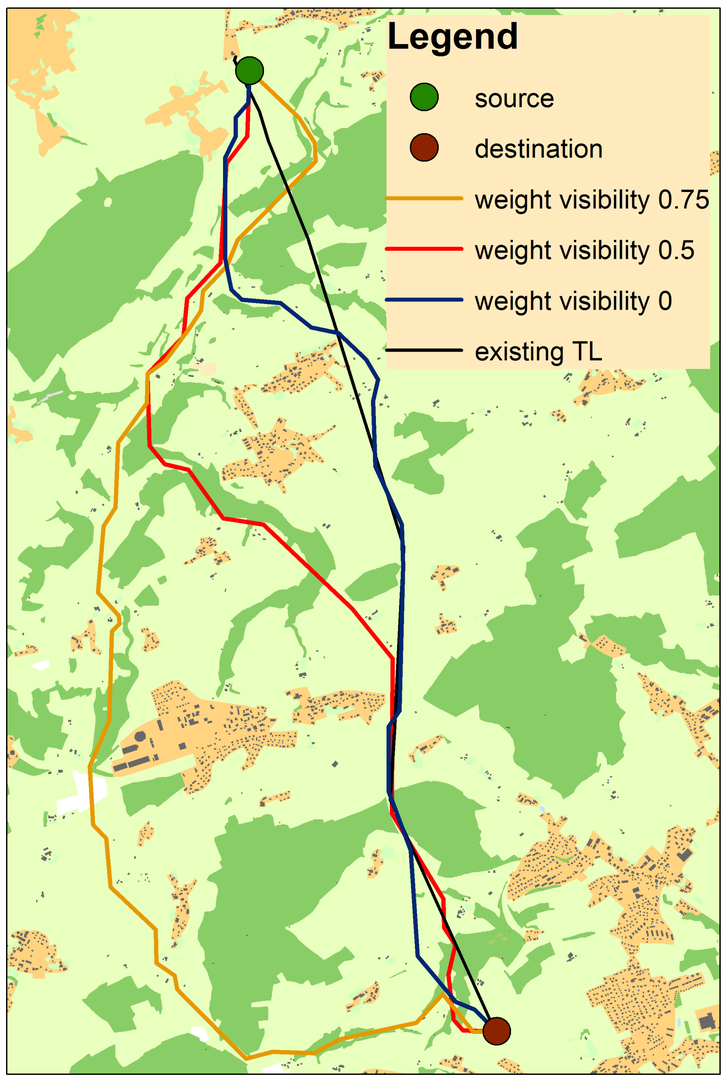
Implementation

The tool for the transmission line siting is implemented in ArcGIS 10 and uses the Python site-package Arcpy.

In order to consider the visibility a cost surface “visibility” is included into the process. Since the visual impact of a transmission line depends on the distance to the observer (here centers of the buildings), several differently weighted cumulative viewshed analyses are required for the creation of the cost surface “visibility”.

The paths can be straightened with a specific modification of the cost surface. This has the advantage that the resulting paths still avoid unsuitable areas. Simple polyline straightening tools would not regard the cost surface.

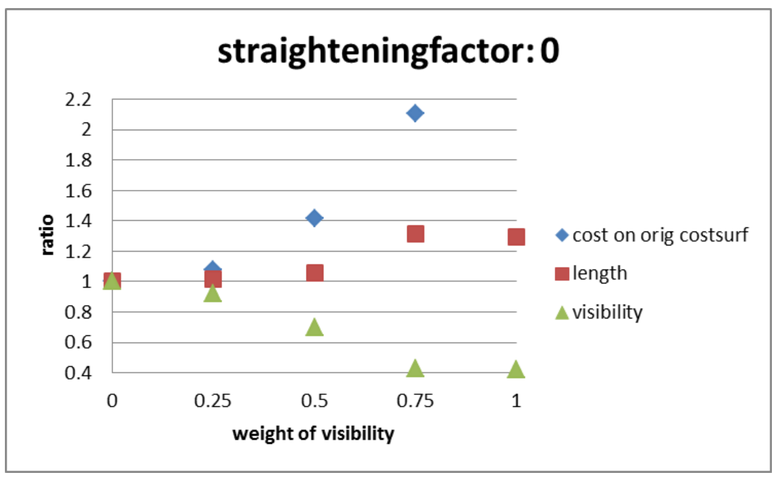
A factor for the straightening as well as a weight for the visibility must be defined. As it is not possible to determine a suitable factor or weight prior to a path calculation, a sensitivity analysis regarding this two values is implemented. Hereto, the tool calculates paths for different combinations of the two parameters.



Paths with different weights of the visibility
Source of geodata: Bundesamt für Landestopografie swisstopo (Art. 30 GeoIV): 5704 000 000

The user can force the tool to cross defined points, areas or polylines. Thus, it is possible to calculate alternative routes. The ideas of such alternative routes may derive from already calculated well-suited corridors. In addition, the user can easily modify the calculated cost surface. Thereby, it is possible to benefit from information that is not implemented in the process.

The quality of the calculated paths can be analysed by a comparison of three calculated costs (length, visibility and a cost on a reference cost surface).



Costs for different weights of the visibility

Results and Conclusion

The figure above shows ratios of the three costs for different weights of the visibility. In this case no straightening is conducted. On the figure in the center, selected paths are shown.

The straightening as well as the integration of the visibility improve the paths in terms of the respective costs (length or visibility).

For one test site the tool provides a path which is very similar to an existing transmission line and other paths can reduce the visibility clearly.

At another test site a manual influence enables a transition of an area which automatically gets rated unsuitable, even though, the existing transmission line crosses it.

The optimised application does not decide which of the calculated paths is most suitable. However, it suggests several paths and facilitates a comparison based on the calculated costs.

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