Alexander Coster & Katya Baranova
GEOB 479: Research in GIS
Landscape Ecology

What Shapes Giant Hogweed Invasion? A Report by Sylvia Moenickes & Jan Thiele

In this paper, the authors chronicle an experiment which was created to model and predict invasive expansion patterns of giant hogweed (*Heracleum mantegazzianum)* in a central European geographic context. It used a life-cycle matrix model combined with mechanistic local and corridor dispersal and a stochastic long-distance dispersal in a cellular automation across eight 1km² study areas set up with real-world landscape configurations of suitable habitats and corridors. These simulations were then compared with monitoring data collected from 2002 to 2009 to determine the simulation modelling efficiency. Giant hogweed is a dangerous invasive species: it can outcompete native plants, turning a diverse ecosystem into a monoculture. The plant's sap contains highly phototoxic furanocumarins which can cause severe skin burns on people and animals. With an accurate model, researchers can quantify the relative importance of different processes for large scale spread and final impacts of the invader, aiding in effective pest management strategies.

The spatio-temporal model consisted of a basic model comprised of quantified spread factors which included habitat suitability, landscape structure, environmental factors (native competitors), dispersal (local, corridor, and long-distance) and survivability rates. Nine hypotheses through modifications of the basic model related to demographic aspects (recruitment limitation and decreasing habitat suitability with succession) and dispersal (long-distance, corridor, and wind direction) were included in the experiment to test the relative importance of each factor. The dispersion model was presented as a 200 x 200 tessellation, each cell 5m in length, representing several categories: the plant, vegetative and generative stages of the plant, and cells colonized through dispersal (corridor, local, and long-distance).. Each of the ten models was run for each of the eight areas to compare their relative modelling efficiencies, examining one process at a time.

The model was a substantial undertaking: it required land cover and linear landscape element spatial data (rivers, streets, railway lines), information on pest management, land cover type identification (suitable and unsuitable for *H. mantegazzianum*), seed survivability and dispersal rates, and environmental factors in order to create a realistic dispersion model. It incorporated high resolution satellite imagery to track the invader's expansion to evaluate the model's accuracy, included a sensitivity analysis for arbitrarily quantified factors, and conducted interviews with local official management project personnel. It is a good example of a research project which incorporates input from a variety of sources, combining spatial and non-spatial information. It is well organized; data allocation is followed by experiment structure, results, and discussion. The statistics behind the formulae are a little abstract for a general audience, though they do not retract from the central message of the report.

However, the experiment did have some shortcomings. Information on pest management and their influence on changes to *H. mantegazzianum's* expanse were not included in the experiment. The satellite surveillance cameras were unable to accurately identify non-flowering plants, greatly reducing accuracy of generative cell counts in the models. Water and nutrient factors were omitted, corridor factor dispersal rates were arbitrarily decided, and long-distance dispersion was random, resulting in low model efficiency in long-distance colonizing rates. Furthermore, an argument could be made against adding the modifications to the model one at a time; it is possible each modification would have feedbacks influencing the effectiveness of one another.

Despite its shortcomings, the logic behind the authors' logic is sound: the basic model produced a high modelling efficiency for all cells occupied (.94), vegetative stage cells, and colonized cells (.89) compared with the monitoring data. Generative stage cell efficiency was much lower (.32). Limitation of recruitment after dispersal, decreasing habitat suitability with succession, and inclusion of long-distance dispersal improved the model, while corridor dispersal, local dispersal and wind direction did not have any significant effects. By isolating the different mechanisms for plant expansion, the authors were able to assess the relative importance of each factor in a clear, if somewhat simple, manner. Their approach was appropriate as well: the authors took many spatial and non-spatial factors in account: differential dispersion methods, seed survivability, suitable habitat information, and local plant expertise.

The authors finish by stating that although generative plant cell predictions and long-distance dispersal patterns were inaccurate, they were able to conclude that demography, long-distance dispersal and invasibility (seed success) are important drivers for invasive expansion, while corridor dispersal is less significant. This report deserves a nine out of ten.

Bibliography

Moenickes, Sylvia & Thiele, Jan (2012). What shapes giant hogweed invasion? Answers from a spatio-temporal model integrating multiscale monitoring data. *Biol Invasions,* 15, 62-73. DOI 10.1007/s10530-012-0268-z