Ecography

E7608
Engler, R., Hordijk, W. and Guisan, A. 2012. The MIGCLIM R package – seamless intergration of dispersal constraints into projections of species distribution models. – Ecography 35: xxx–xxx.

Supplementary material

Appendix 1. Illustration and details of the barrier to dispersal parameters.

In MIGCLIM, the optional [`barrier`] and [`barrierType`] parameters can be used to indicate cells across which dispersal cannot occur. These are called "barrier cells". Barrier cells are considered as permanently unsuitable (i.e. they cannot become colonized), but unlike regular unsuitable cells, the also impede dispersal across them (see Fig. S1). In example, for a frog species, both a parking lot and a highway are unsuitable habitats. However, while the frog can disperse through a parking lot, it might not be able to cross a highway. The [`barrier`] parameter must be given as a layer of integer, binary, values: 1 (cell is a barrier) or 0 (cell is not a barrier).

Fig. A1 below illustrates the difference between barriers cells and unsuitable cell. This example assumes that the only cell occupied by our species is the central cell (in black) and that it can disperse propagules to a distance up to 10 cells (which means that all cells of the small landscape in Fig. A1 are within reach and thus that dispersal distance is not a limiting factor). The landscape also contains unsuitable cells (white colored) and barrier cells (striped).
The cells indicated as "c_1" and "c_2" are examples of cells that cannot be colonized due to the presence of barrier cells (a straight line between the black source cell and these cells crosses a barrier cell, as illustrated by the red arrows). To the contrary, the "c_3" cell can be colonized, because the unsuitable cells (in white) that are located between "c_3" and the source cell (in black) do not impede dispersal across them (illustrated by the green arrow).

To summarize, unsuitable cells might not be able to host the species (and therefore cannot be colonized), but dispersal across them is possible. Barrier cells are also unsuitable for the species (and thus cannot be colonized), but on top of that they also impede dispersal across them.

Note that propagule dispersal can only occur in a straight line, and that barrier cells cannot be circumvented in a single dispersal step. For instance, the "c_2" cell in Fig. A1 will eventually become colonized (orange dashed arrow), but this will involve several dispersal steps. In other words, a source cell cannot disperse directly to "c_2" by circumventing a barrier cell, even if the actual distance (including the detour involved in the circumvention) is within dispersal distance.

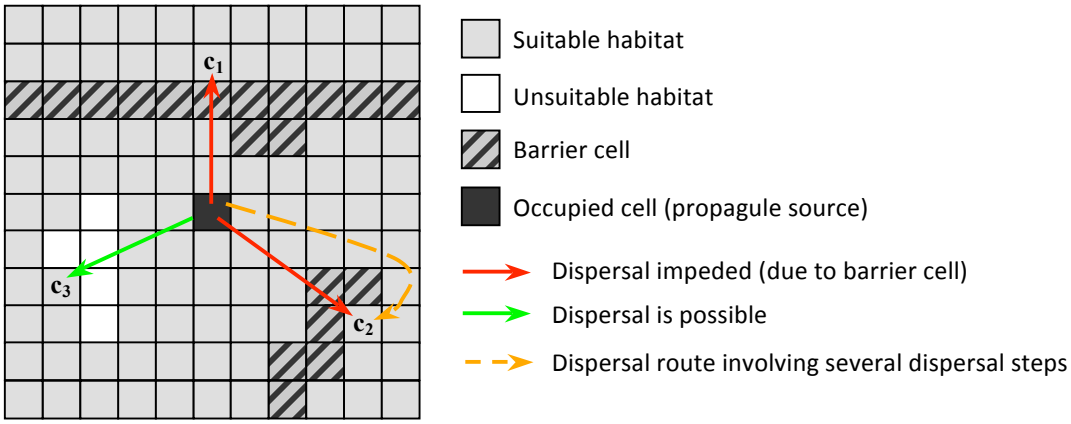

Figure A1. Illustration of the difference between barrier cells and regular unsuitable cells.

Two kinds of barriers can be implemented in MIGCLIM: "strong" barriers and "weak" barriers. This is entered in the `MigClim.migrate()` function via the [`barrierType`] parameter (`barrierType="strong"` or `barrierType="weak"`). Essentially, the difference is that strong barriers are more restrictive than weak barriers. Note that a barrier layer is either entirely "strong" or entirely "weak", a mix of both is not possible.

To determine whether there is a barrier between a source cell (black cell in Fig. A2) and a sink cell (orange cell in Fig. A2), the algorithm looks whether 5 different straight line paths (represented by arrows in the Fig. A2) intersect a barrier cell or not. As illustrated in Fig. A2, the 5 paths connect each corner as well as the center of the source and sink cells.

When setting [`barrierType="strong"`], dispersal is impeded between the two cells when more than 1 of these paths intersects with a barrier cell.

When setting [`barrierType="weak"`], then dispersal is only impeded when all of the 5 paths intersect with a barrier cell.

Fig. A2 shows two examples where using the "strong" barrier setting would impede dispersal between the two cells, while using the "weak" setting would not.

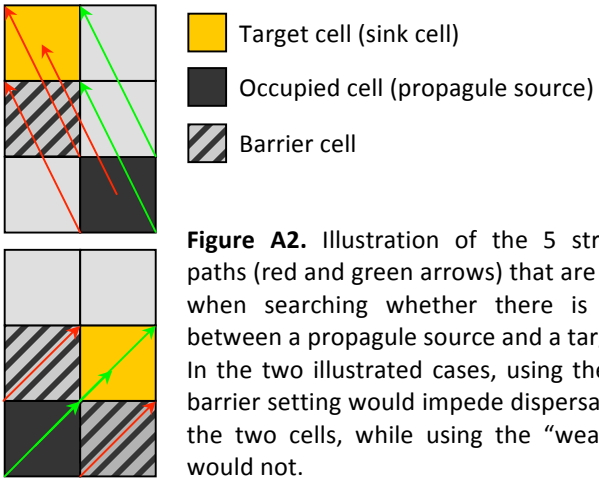

Figure A2. Illustration of the 5 straight line paths (red and green arrows) that are evaluated when searching whether there is a barrier between a propagule source and a target cell. In the two illustrated cases, using the "strong" barrier setting would impede dispersal between the two cells, while using the "weak" setting would not.

Reminder: long distance dispersal events are not affected by barrier features. Barriers only affect regular (non-LDD) dispersal.