ModMED

Modelling Mediterranean Ecosystem Dynamics

FINAL REPORT

EU - DG XII - ENV4 CT97 0680

LIST OF PARTICIPANTS

Contractors

1) Dipartimento di Arboricoltura, Botanica e Patologia Vegetale, Università di Napoli *Federico II*, Italy
Prof. Stefano Mazzoleni (project coordinator) – email: *mazzolen@unina.it*

2) Institute of Ecology and Resource Management, University of Edinburgh, UK
Dr. Colin Legg.

3) Department of Ecology and Systematics,University of Athens, Greece
Prof. Margarita Arianoutsou.

4) Dipartimento di Coltivazione e Difesa delle Specie Legnose, Università di Pisa, Italy
Prof. Riccardo Gucci.

Associate contractors

5) Remote Sensing Department, University of Trier , Germany
Prof. Joachim Hill.

6) Estação Florestal Nacional, Portugal
Prof. Francisco Manuel Cardoso de Castro Rego.

7) Dipartimento di Scienze Animali, Vegetali e dell'Ambiente, Università del Molise, Italy
Prof. Donato Chiatante.

8) Istituto sulla propagazione delle specie legnose, Italy
Dr. Massimiliano Tattini.

Sub-contractors

9) Istituto di Biologia, II Università di Napoli, Italy
Prof. Antonietta Fioretto.

10) GE.PRO.TER. soc.coop. a.r.l., Italy
Dr. Antonio Di Gennaro.

11) Institute of Sub-Tropical Plants and Olive Tree, Greece
Mr. C.D. Economakis.

12) Centre de Recerca Ecologica i Aplicacions Forestals (CREAF), Spain
Prof. Carlos Gracia.

13) World in box Finland OY
Mr. Duncan Heathfield.

External participants

(supported by OMFB Hungarian Foundation - INCO funds)

13) Department of Plant Taxonomy and Ecology, Leotvos University of Budapest, Hungary
Dr. Peter Csontos.

INTEGRATION BETWEEN LANDSCAPE AND COMMUNITY MODELS

Introduction

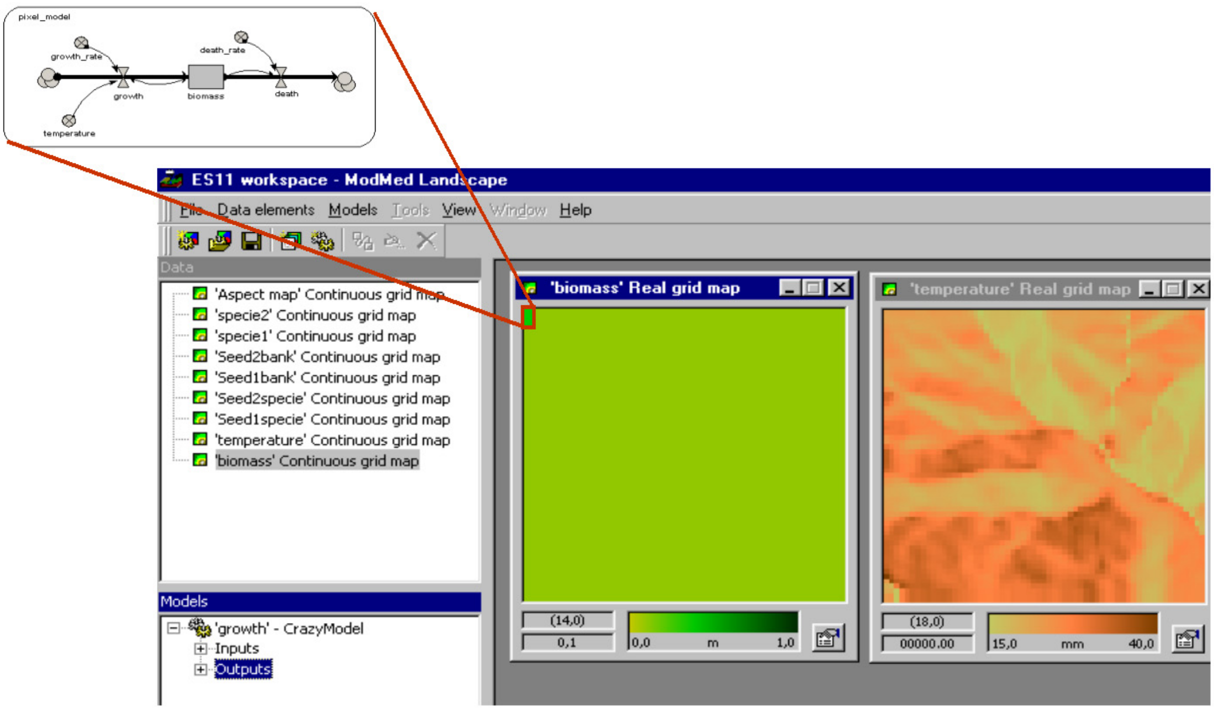
Stefano Mazzoleni

Growth of plants and vegetation is driven by internal factors and processes, but it is also influenced by variables which depend on landscape processes. On the other hand, landscape processes can be strongly dependent on spatial patterns of community level properties.

For example, let's think of a plant (a model of a plant) growing in a valley or on the top of a ridge and being affected by water. Obviously, water run off (landscape level process) will distribute different water amounts to these different locations and consequently the plant (the model of plant) growing on the bottom position will be watered more than the other one.

At the same time water run off can vary according to the distribution of vegetation cover over the landscape.

On this base it is clear how the integration between community and landscape models can open very interesting possibilities of complex modelling scenarios. In order to achieve this aim, in the ModMED project, community models have been interfaced to the single pixels of the raster grid of the landscape modelling environment.



The link of the community level models to the landscape modelling environment produces an upscaling of the community level processes. In fact, beside their own dynamic behaviour, it becomes possible to analyse also their spatial patterns which reflects their response to the distribution of landscape level variables. These latter can dynamically change according to landscape level processes, being also affected by feedback mechanism from behaviour of community models.

Technical solutions

Duncan Heathfield, Brian Mac Intosh, Jasper Taylor, Allan Kelly, Francesco Giannino, and Robert Muetzelfeldt

The technical problems behind the software integration between CLM and LM have not been easy and they are not yet fully solved. However, the interaction between "Simile" and "LandLord" has been demonstrated though it requires some further refinement to become a simple plug in operation.

1. First the easiest, but not efficient, possibility of integration would be by a shuttle file (or files) between Landlord and Simile
2. The mechanism for allowing Simile models to be run as C programs from inside the model editor makes use of a 'stub' dll that is dynamically loaded into the Tcl/Tk interpreter. This defines new Tcl/Tk commands to load, reset, execute and query a model implemented as another dll. Originally only one model could be in use at once, but Landlord requires that it be possible to open several instances of several different types of model via its GCLMI2 interface.To allow this we switched to C++ as the model language. The stub now defines a Simile model class. For each instance of this class that is created, a model dll is loaded to implement a different model. The model dll also defines a class, corresponding to its particular model. It can create many instances of this class, allowing the same model to be run simultaneously with different parameters in different grid squares.The Landlord interface uses yet another dll that provides the GCLMI2 functions. This loads Tcl/Tk, and starts executing a script that loads the stub dll, and translates GCLMI2 requests to actions on the classes and instances of Simile models.
3. A slightly different solution that is currently verified is on automatic compilation of Simile-generated C++ code into a COM-compatible DLL binary with implementation of IRasterModel interface.
4. Alternatively, a last solution, could be a tool program running outside Simile, using C++ code outputted from Simile. This would be based on a automatic extraction of modelling logic from Simile-generated C++/TCL code, followed by automatic generation of source code for COM-capable compiler (VC++, VBasic, Delphi, etc).

Examples of integration

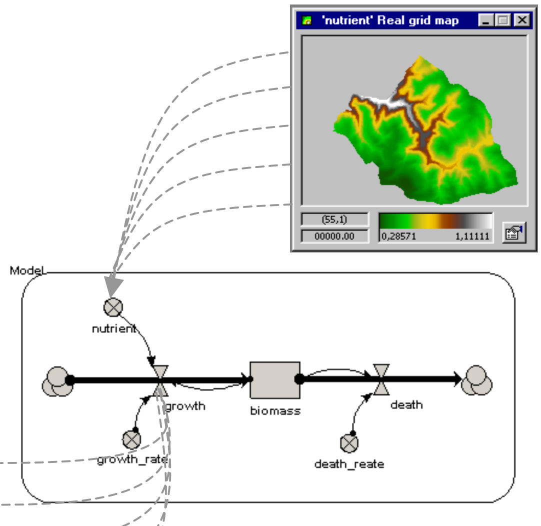
Francesco Giannino and Stefano Mazzoleni

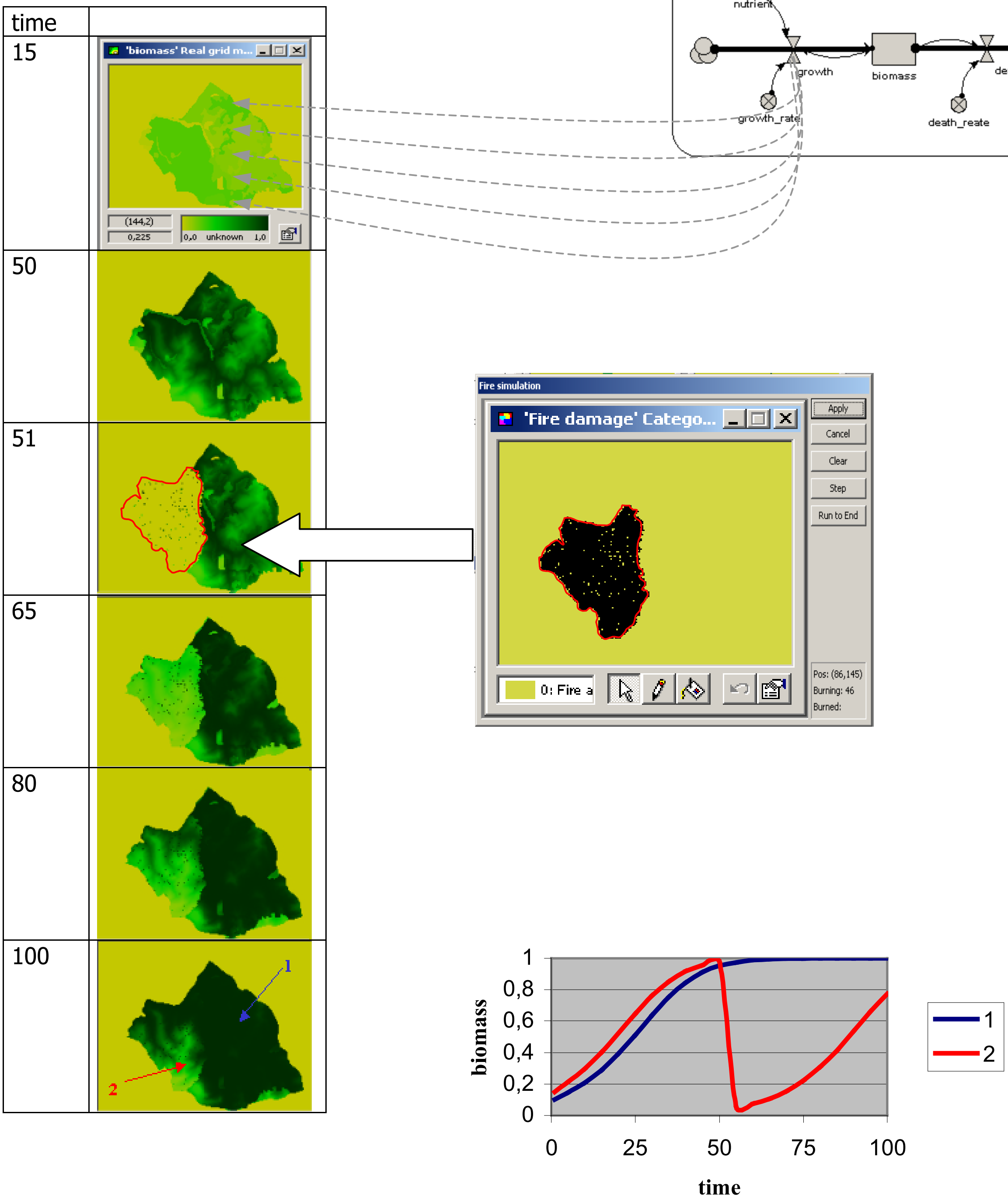
Rule based model of vegetation dynamics have been interfaced to run inside a Landlord 1 environment by Brian Mac Intosh and Duncan Heathfield, but this exercise is not reported here.

In the following pages two examples of integration between *Simile*-like models and *Landlord* environment and models are illustrated to clarify the concept and potential of the integration.

Vegetation growth and fire disturbance

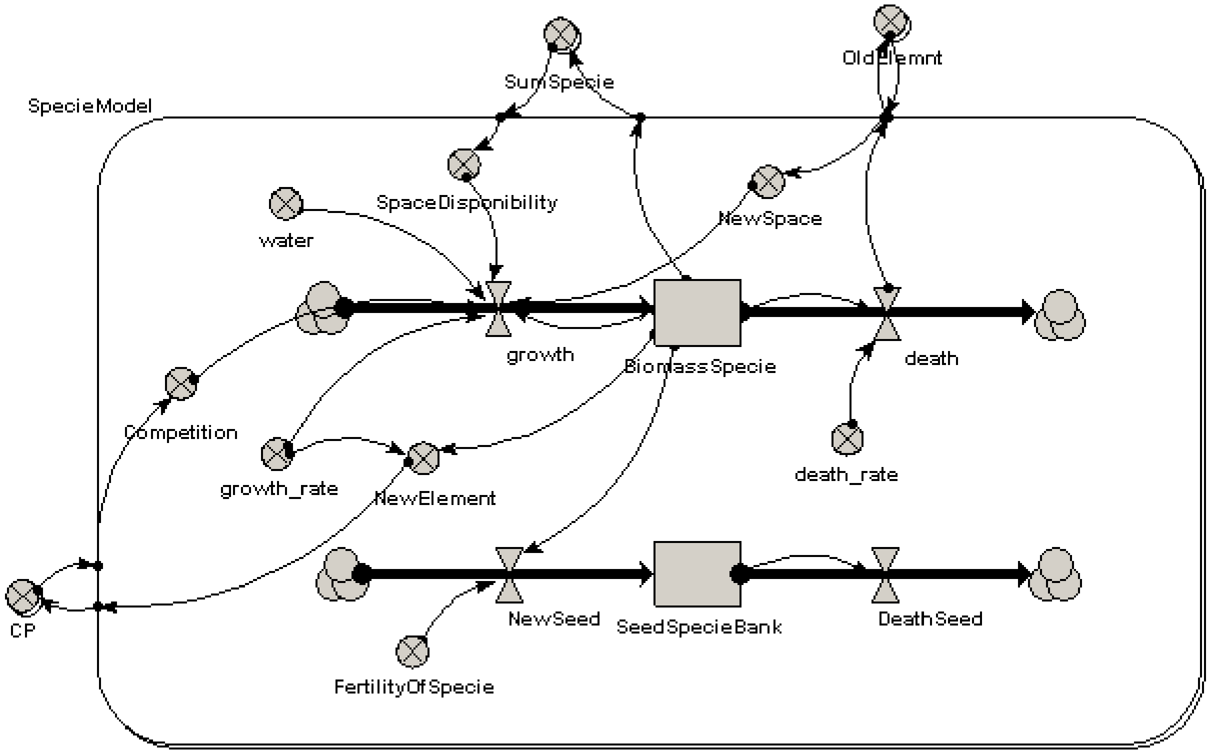
A community level model is distributed into a landscape scenario. It uses as input a Nutrient map (static grid map) and runs for 100 days. On day 51 a fire occurs and a landscape level model of fire propagation is applied over the vegetation landscape. The burning reduces the biomass and is followed by regrowth of vegetation





Species competition and seed dispersal

This simulation demonstrates the integration of a vegetation model (biomass and seed production of two competing species) and a seed dispersion model (landscape process).



In the vegetation model, two species differs in their growth rates and competition capacity (Competition and biodiversity in spatially structure habitas, Tilman, Ecology 75(1), 1994, pp.2-16). The first species has a lower growth rate (0.2 % $time^{-1}$) and is affected only by its own biomass accumulation. The second species presents a greater growth rate (0.8 % $time^{-1}$), but its growth is reduced by all biomasses, i.e. its own and the other species amounts.

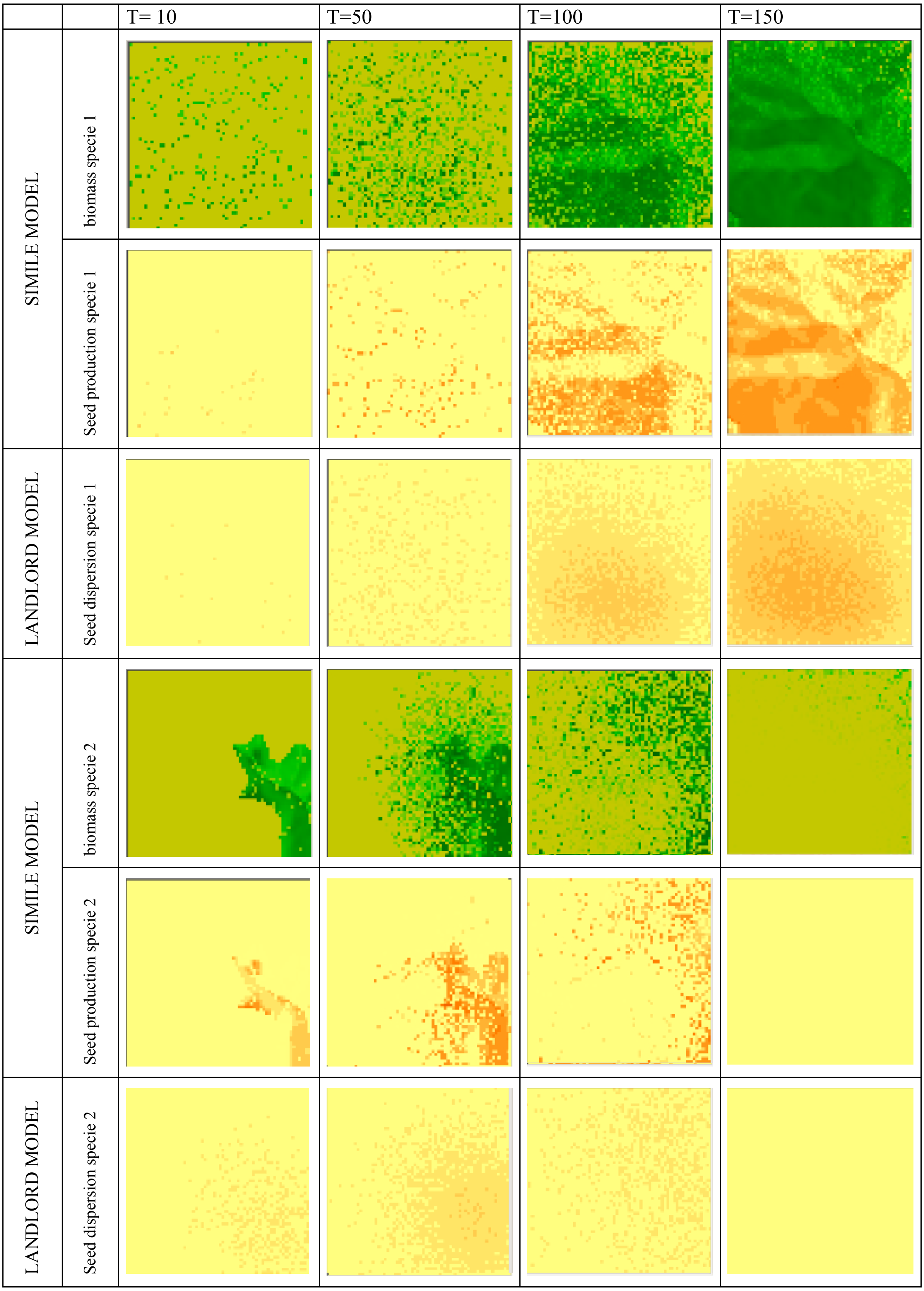
Seed production starts in both species when a critical threshold value of biomass is reached (biomass=70). Seed dispersion is handled by distributing seeds from any pixel when production has been activated to surrounding pixels in a circular area of fixed radius (500 meters). The distribution is handled probabilistically according to a diffuses model which assign equation

$$1-\text{distance}/500$$

The model is initialized on two different spatial patterns, the first species randomly distributed, the second aggregated into a large area.

The simulation shows an initial dominance of species 2 which reflects its higher growth rate, in a later phase specie 1 takes the dominance by its greater competition capacity and this causes a progressive reduction of the second species.

In this exercise, the two models act at different scales (within each pixel and among all pixels respectively), but interact dynamically at run time by exchanging information as input/output connections and feedbacks. The same logic can be applied to more complex models with dynamic scenarios of changing inputs.


T= 10
T=50
T=100
T=150
SIMILE MODEL
biomass specie 1
Seed production specie 1
LANDLORD MODEL
Seed dispersion specie 1
SIMILE MODEL
biomass specie 2
Seed production specie 2
LANDLORD MODEL
Seed dispersion specie 2