rtsetse workflow

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rtsetse is an R package for simulating tsetse fly populations to investigate control options. It follows from Hat-Trick, an Excel Tsetse model.

This document outlines how rtsetse can be used. All text in the grey boxes below can be copied and pasted into the R console (including a simple command to start up a user interface for the model : `rt_UI()`).

Installation and loading in R

```
if(!require(devtools)) install.packages("devtools", dependencies=TRUE)

install_github('AndySouth/rtsetse', build_vignettes=TRUE)
```

```
# Load the package in each new R session.
library(rtsetse)
```

Where to find documentation

```
# This will bring up a brief description of the rtsetse package :
?rtsetse

# Click on 'index' at the bottom of the description page to go to a list of help pages
# for each function in the package.

# This document
vignette('rtsetse-workflow')

# documents about movement and a model test
vignette('vignette-movement.pdf')

vignette('vignette-eg1-sav-grass.pdf')
```

User Interface

```
# to start a graphical user interface
# with options and buttons allowing the model to be run and outputs to be viewed
rt_UI()
```

The user interface starts with an 'About' screen (Fig. 1) followed by 5 others :

1. seek stable mortality

- select population parameters to find adult mortality values that generate stability and will be used in later screens
- can be skipped to accept default inputs

2. aspatial model
   - runs model for a single randomly-mixed population using inputs from 1.
3. load map
   - load a map from the package or elsewhere to be used in 4 & 5.
4. run grid model
   - run a gridded model using inputs from 1, 2 & 3.
5. control
   - add simple control options to inputs from 1,2,3, & 4

UI 1. seek stable mortality

Modify population inputs on the left hand side (Fig. 2), then press the 'Seek Stable Mortality' button at the top. View results on the right hand side, e.g. for mortality by age (Fig. 3).

UI 2. aspatial model

Modify inputs on the left hand side (Fig. 4), press the 'Run Model' button. View results on the right hand side, e.g. 'Males by age' to see the number of males in each age class in each day. The 'Code' tab contains code that can be copied and pasted into the R console to recreate this run.

UI 3. load map

Load a map for use in the grid model. Starts with a very small example map (Fig.5). You can select other internal stored maps (Fig. 6) or external maps that you've created yourself.

There is a link to a helpfile about creating vegetation maps.

UI 4. run grid model

Modify inputs on the left and and press the 'Run Model' button at the top (Fig. 7). The model runs using inputs from this and earlier screens. With the small example map the model should run in seconds, with larger maps for longer time periods it can take minutes or hours. When the model is running the interface will display the message 'Calculation in progress' at the top right. The R console will display progress as 'day [current] of [total]'. After a run, there are 4 ways of looking at the results.

1. view tabs on the right (e.g. 'Maps daily' shown in Fig 8. for one of the internal maps)
2. download a run report using button on left, creates a pdf report of the run
3. save numeric results using button on left, creates a txt file of numeric results (population in time and space)
4. repeat the run in the R console using code copied from the 'Code' tab on the right. Then use `rtsetse` functions to output and display the results in different ways.

UI 5. control

Modify inputs on the left and and press the 'Run Model' button at the top. You can select the proportion of flies killed by your control method and a border area where control does not apply. Fig 9. shows the results of applying control of 0.1 with a border area of 10 grid cells to the previous run.

Command Line running

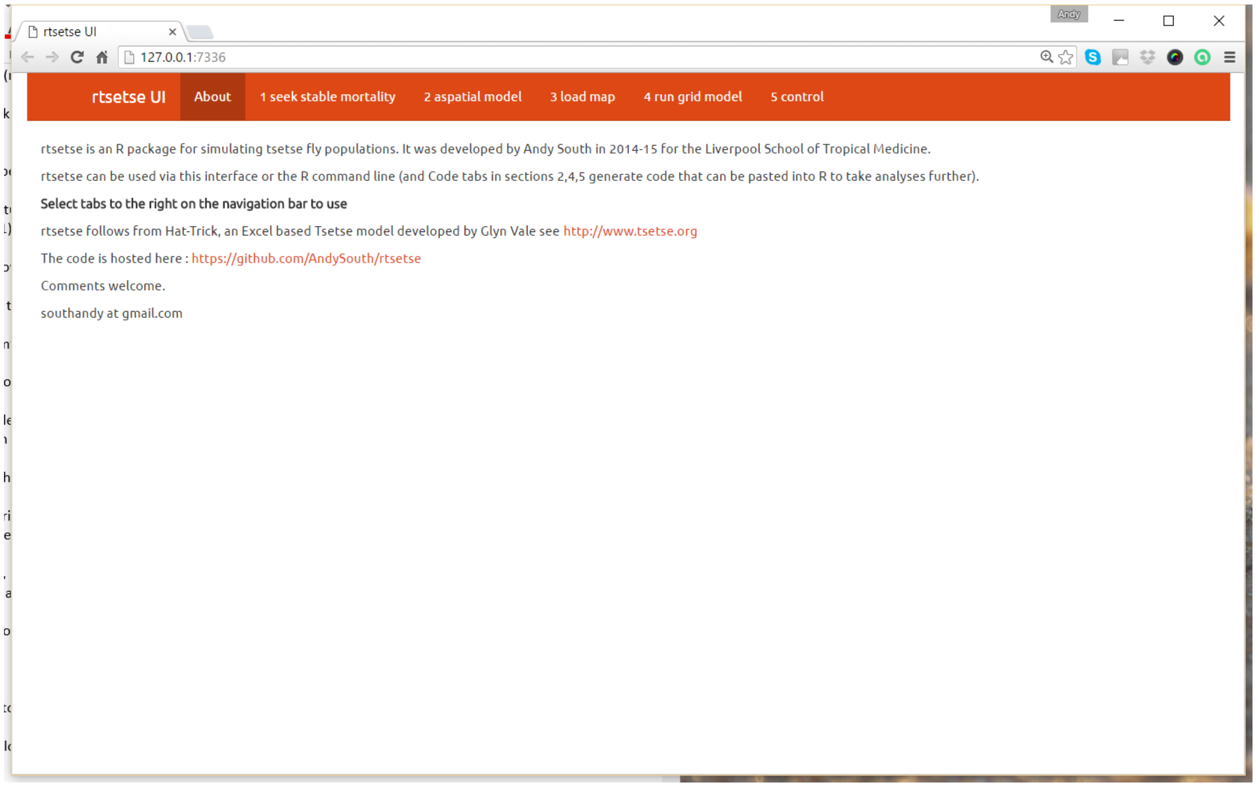
`rtsetse` functions can be run from the R command line giving the user more control.

```r
# To find documentation about this function and the inputs.
?rt_runGrid

# Click on 'index' at the bottom of the description page to go to a list of help pages
# for all other functions in the package.

# Set number of days.
iDays <- 10
# Run the model (results are saved to aRecord or any othr object name you choose to use).
aRecord <-
  rt_runGrid (  pMoveF=0.6,  pMoveM=0.3,   iDays=iDays,  pMortF=0.082,  pMortM=0.139,
                pMortPupa=0.2,  fStartPopPropCC=1,  iCarryCapF=200,  propMortAdultDD=0.25,
                iFirstLarva=16,  iInterLarva=10,  pMortLarva=0.05,  propMortLarvaDD=0.25,
                propMortPupaDD=0.25,
                mVegCats=system.file("extdata","vegHalfSavannahHalfGrass50x50.txt",
                                     package="rtsetse"),
                dfMortByVeg=list(code = c("D", "T", "O", "S", "B", "G", "N"),
                                 name = c("Dense Forest", "Thicket", "Open Forest",
                                          "Savannah", "Bush", "Grass", "No-go area"),
                                 mortality = c(200, 150, 110, 100, 110, 210, 999),
                                 pupmortality = c(120, 110, 105, 100, 120, 170, 999))  )

# Plot some of model results (in this case adult popn across the whole grid).
rtPlotPopGrid(aRecord)
# or plot a map of the population distribution
rtPlotMapPop(aRecord)
# or select particular days, ages and genders
rtPlotMapPop(aRecord, days='final', sex = 'M', age = (20:120))
```

Brief workflow (for Steve!) for creating a new map and running the grid model on it

1. in Excel create a grid with each cell containing one of DTOSBGN
2. save as a tab delimited .txt file
3. optionally create or copy an attributes .csv file as explained here
4. from R : rt_UI()
5. UI screen 4 : load map.
6. Select ‘Local’ from ‘Where to get map from’
7. Press ‘choose files’, select your .txt and optional .csv
8. UI screen 4 : run grid model : press ‘Run Model’

User Interface screenshots



rtsetse is an R package for simulating tsetse fly populations. It was developed by Andy South in 2014-15 for the Liverpool School of Tropical Medicine.

rtsetse can be used via this interface or the R command line (and Code tabs in sections 2,4,5 generate code that can be pasted into R to take analyses further).

Select tabs to the right on the navigation bar to use

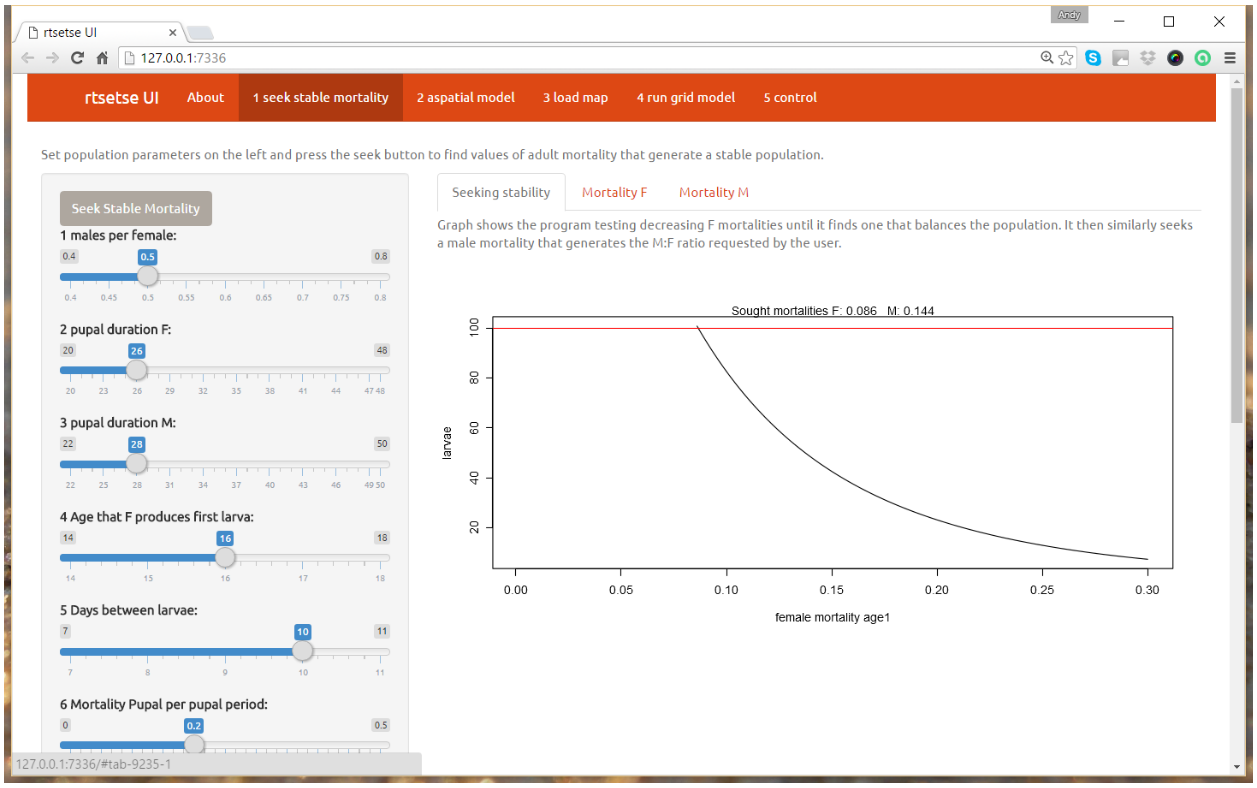
rtsetse follows from Hat-Trick, an Excel based Tsetse model developed by Glyn Vale see http://www.tsetse.org

The code is hosted here : https://github.com/AndySouth/rtsetse

Comments welcome.

southandy at gmail.com

Figure 1: Start page of rtsetse UI reached by `rt_UI()`



Set population parameters on the left and press the seek button to find values of adult mortality that generate a stable population.

Graph shows the program testing decreasing F mortalities until it finds one that balances the population. It then similarly seeks a male mortality that generates the M:F ratio requested by the user.

1 males per female: 0.5 (0.4 – 0.8)

2 pupal duration F: 26 (20 – 48)

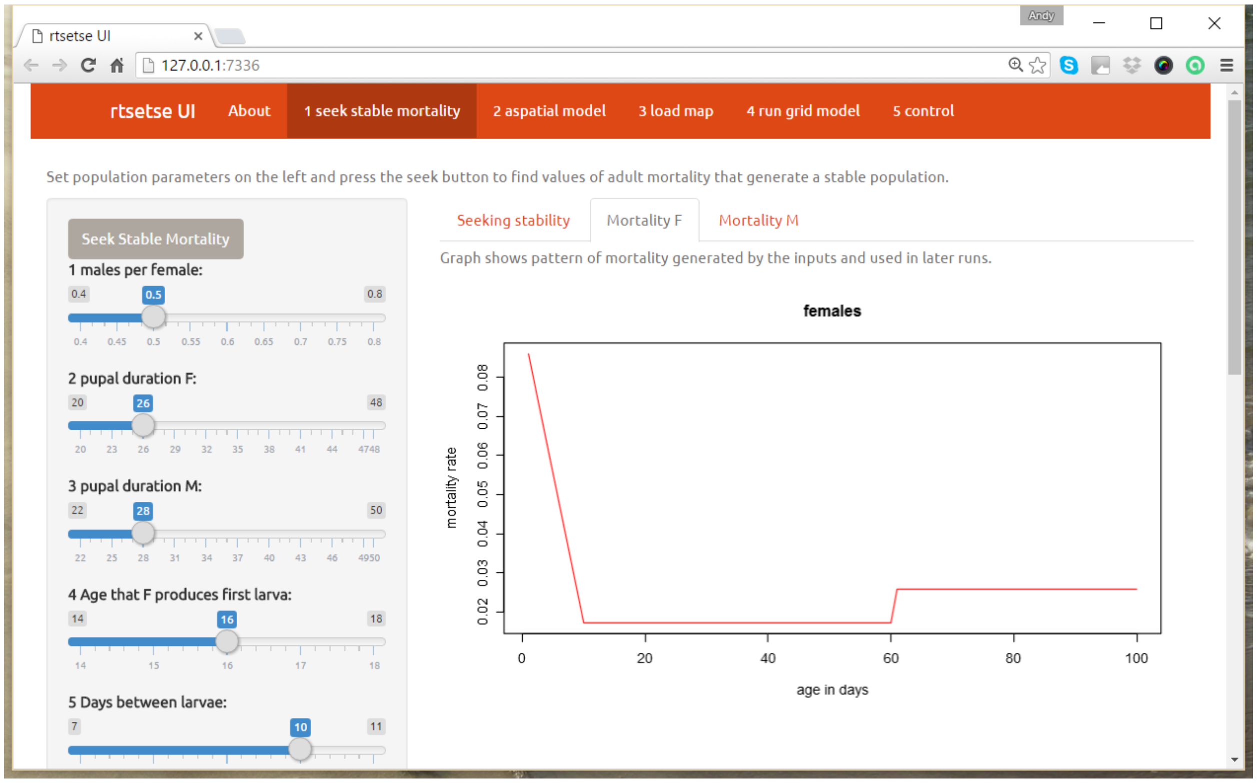
3 pupal duration M: 28 (22 – 50)

4 Age that F produces first larva: 16 (14 – 18)

5 Days between larvae: 10 (7 – 11)

6 Mortality Pupal per pupal period: 0.2 (0 – 0.5)

Figure 2: UI screen 1: seek stable mortality



Set population parameters on the left and press the seek button to find values of adult mortality that generate a stable population.

Graph shows pattern of mortality generated by the inputs and used in later runs.

1 males per female: 0.5 (0.4 – 0.8)

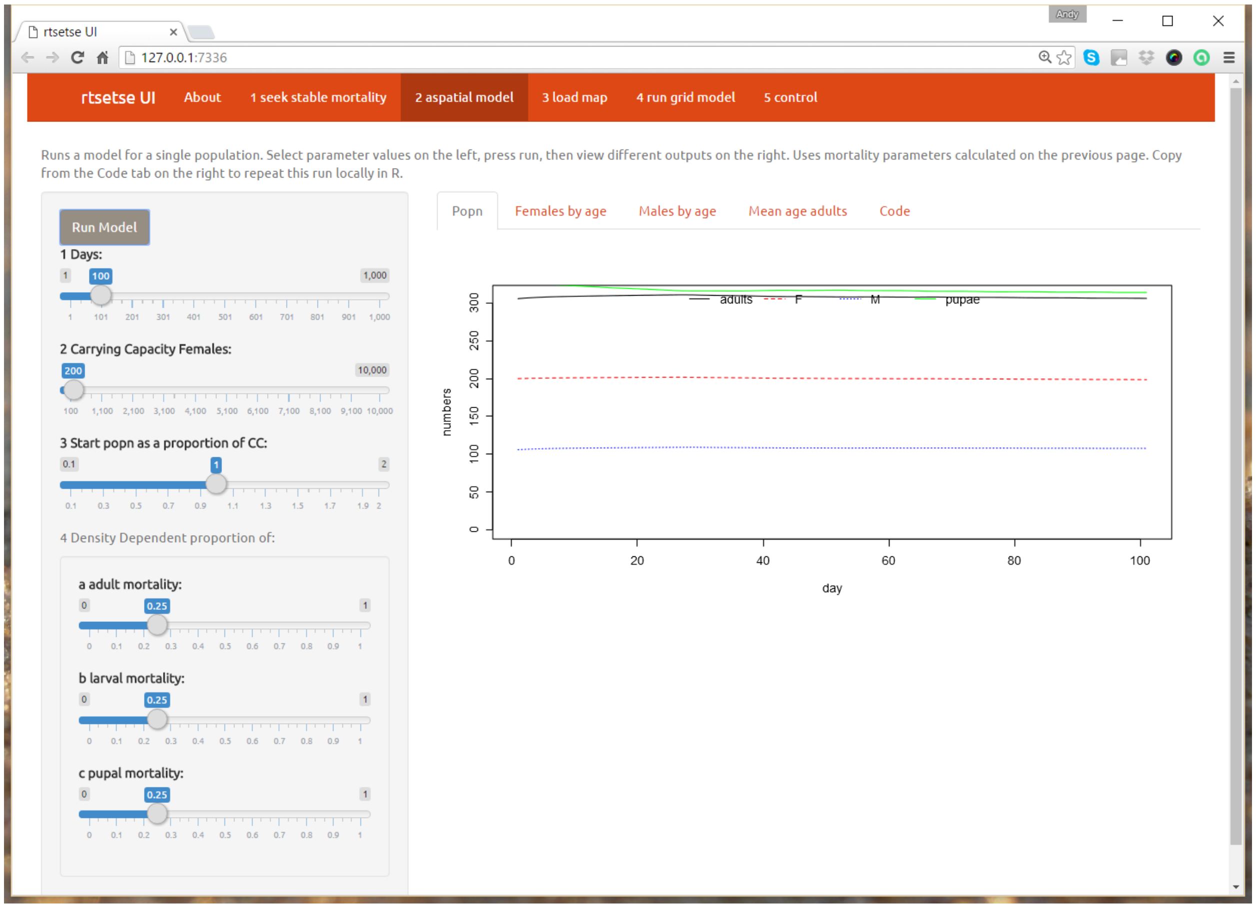
2 pupal duration F: 26 (20 – 48)

3 pupal duration M: 28 (22 – 50)

4 Age that F produces first larva: 16 (14 – 18)

5 Days between larvae: 10 (7 – 11)

Figure 3: UI screen 1: seek stable mortality, output by age



Runs a model for a single population. Select parameter values on the left, press run, then view different outputs on the right. Uses mortality parameters calculated on the previous page. Copy from the Code tab on the right to repeat this run locally in R.

1 Days: 100

2 Carrying Capacity Females: 200

3 Start popn as a proportion of CC: 1

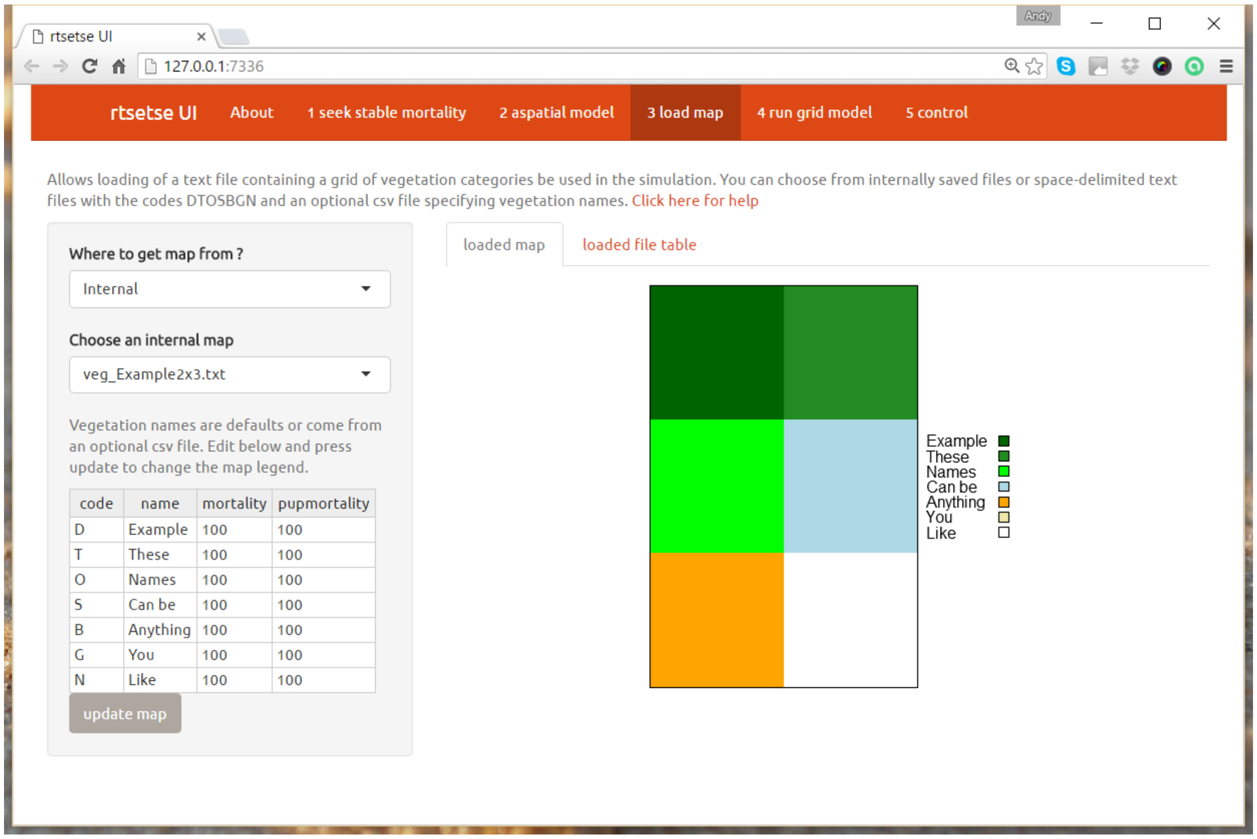
4 Density Dependent proportion of:

a adult mortality: 0.25

b larval mortality: 0.25

c pupal mortality: 0.25

Figure 4: UI screen 2: aspatial model



Allows loading of a text file containing a grid of vegetation categories be used in the simulation. You can choose from internally saved files or space-delimited text files with the codes DTOSBGN and an optional csv file specifying vegetation names. Click here for help

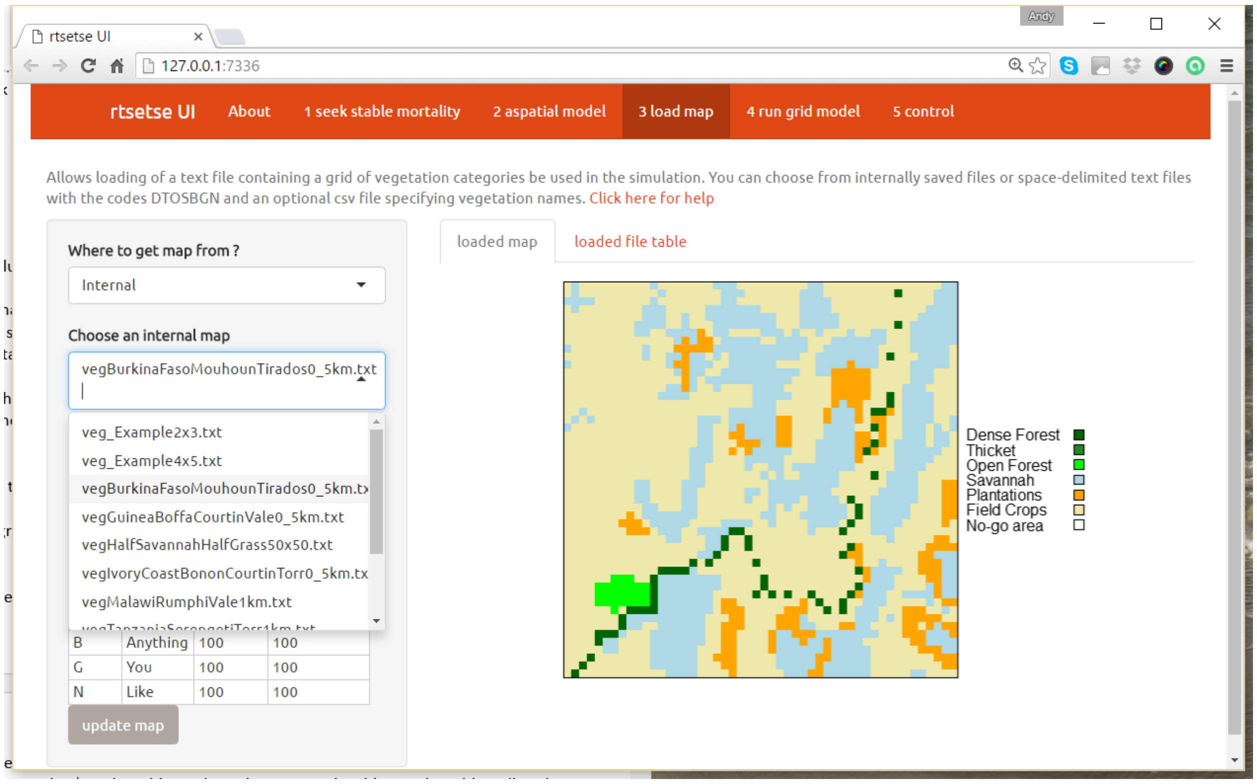
Where to get map from ? Internal

Choose an internal map veg_Example2x3.txt

Vegetation names are defaults or come from an optional csv file. Edit below and press update to change the map legend.

code	name	mortality	pupmortality
D	Example	100	100
T	These	100	100
O	Names	100	100
S	Can be	100	100
B	Anything	100	100
G	You	100	100
N	Like	100	100

Figure 5: UI screen 3: load map starting example



Allows loading of a text file containing a grid of vegetation categories be used in the simulation. You can choose from internally saved files or space-delimited text files with the codes DTOSBGN and an optional csv file specifying vegetation names. Click here for help

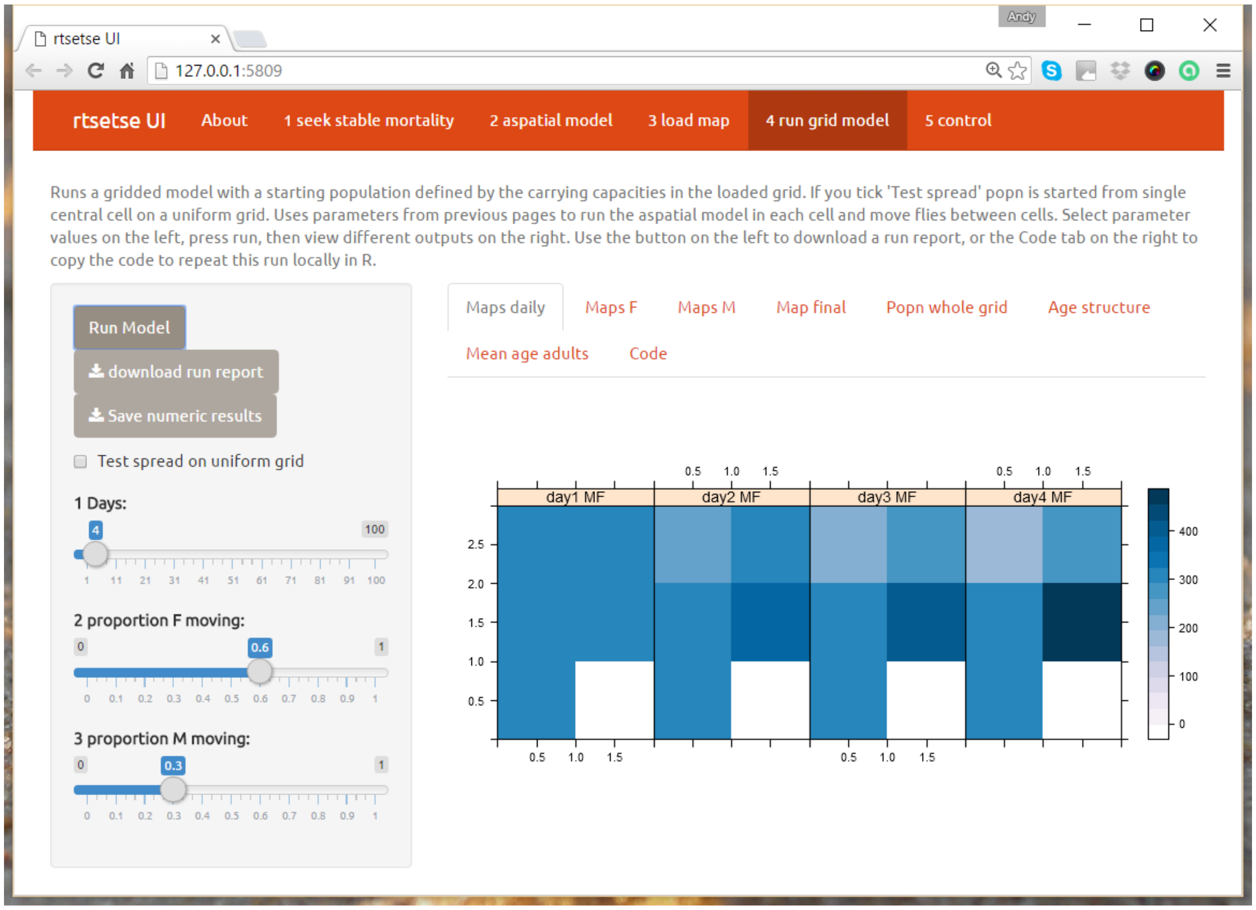
Where to get map from ? Internal

Choose an internal map: vegBurkinaFasoMouhounTirados0_5km.txt

- veg_Example2x3.txt
- veg_Example4x5.txt
- vegBurkinaFasoMouhounTirados0_5km.tx
- vegGuineaBoffaCourtinVale0_5km.txt
- vegHalfSavannahHalfGrass50x50.txt
- vegIvoryCoastBononCourtinTorr0_5km.tx
- vegMalawiRumphiVale1km.txt

B	Anything	100	100
G	You	100	100
N	Like	100	100

Figure 6: UI screen 3: load map : one of the stored maps


Runs a gridded model with a starting population defined by the carrying capacities in the loaded grid. If you tick 'Test spread' popn is started from single central cell on a uniform grid. Uses parameters from previous pages to run the aspatial model in each cell and move flies between cells. Select parameter values on the left, press run, then view different outputs on the right. Use the button on the left to download a run report, or the Code tab on the right to copy the code to repeat this run locally in R.

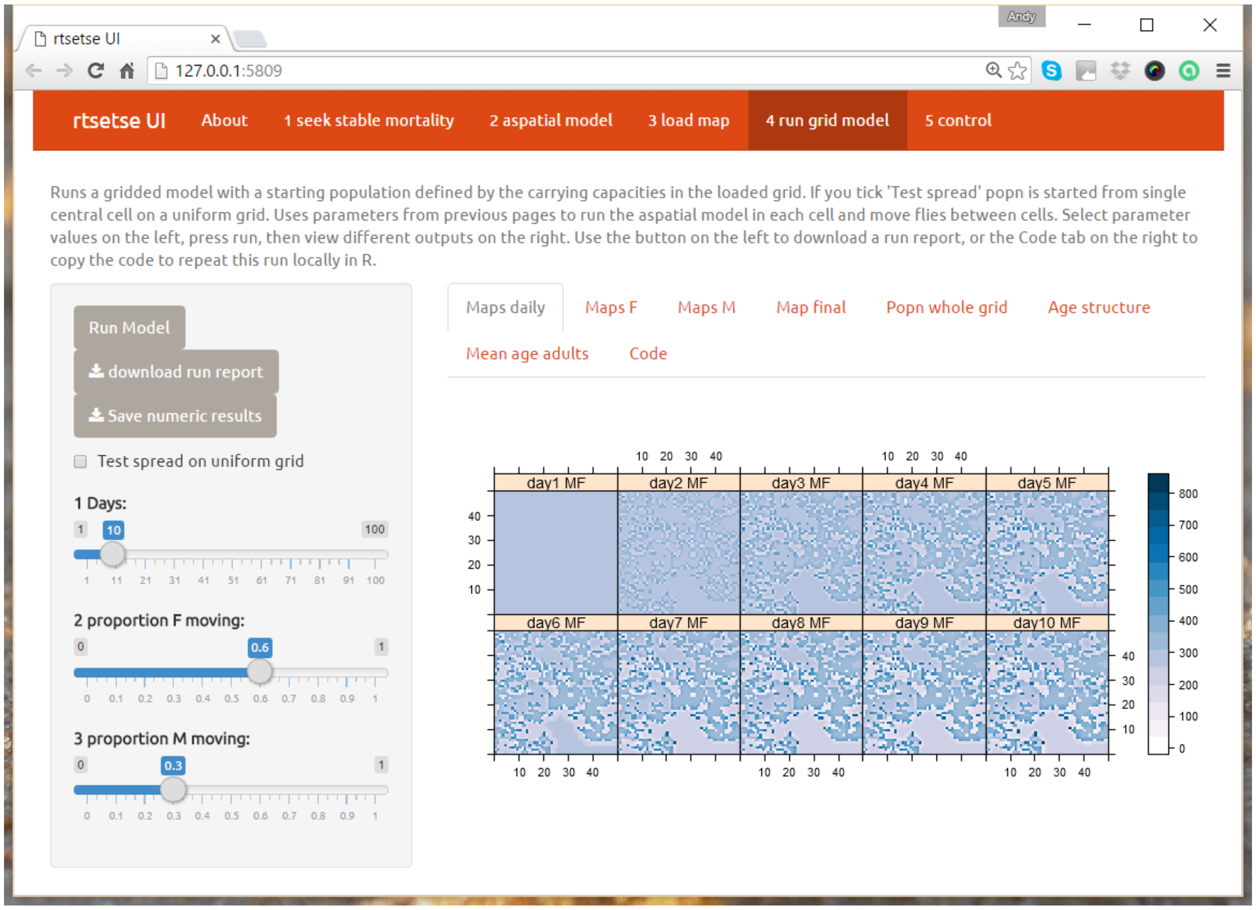
Test spread on uniform grid

1 Days: 4

2 proportion F moving: 0.6

3 proportion M moving: 0.3

Figure 7: UI screen 4: run grid model on small example


Runs a gridded model with a starting population defined by the carrying capacities in the loaded grid. If you tick 'Test spread' popn is started from single central cell on a uniform grid. Uses parameters from previous pages to run the aspatial model in each cell and move flies between cells. Select parameter values on the left, press run, then view different outputs on the right. Use the button on the left to download a run report, or the Code tab on the right to copy the code to repeat this run locally in R.

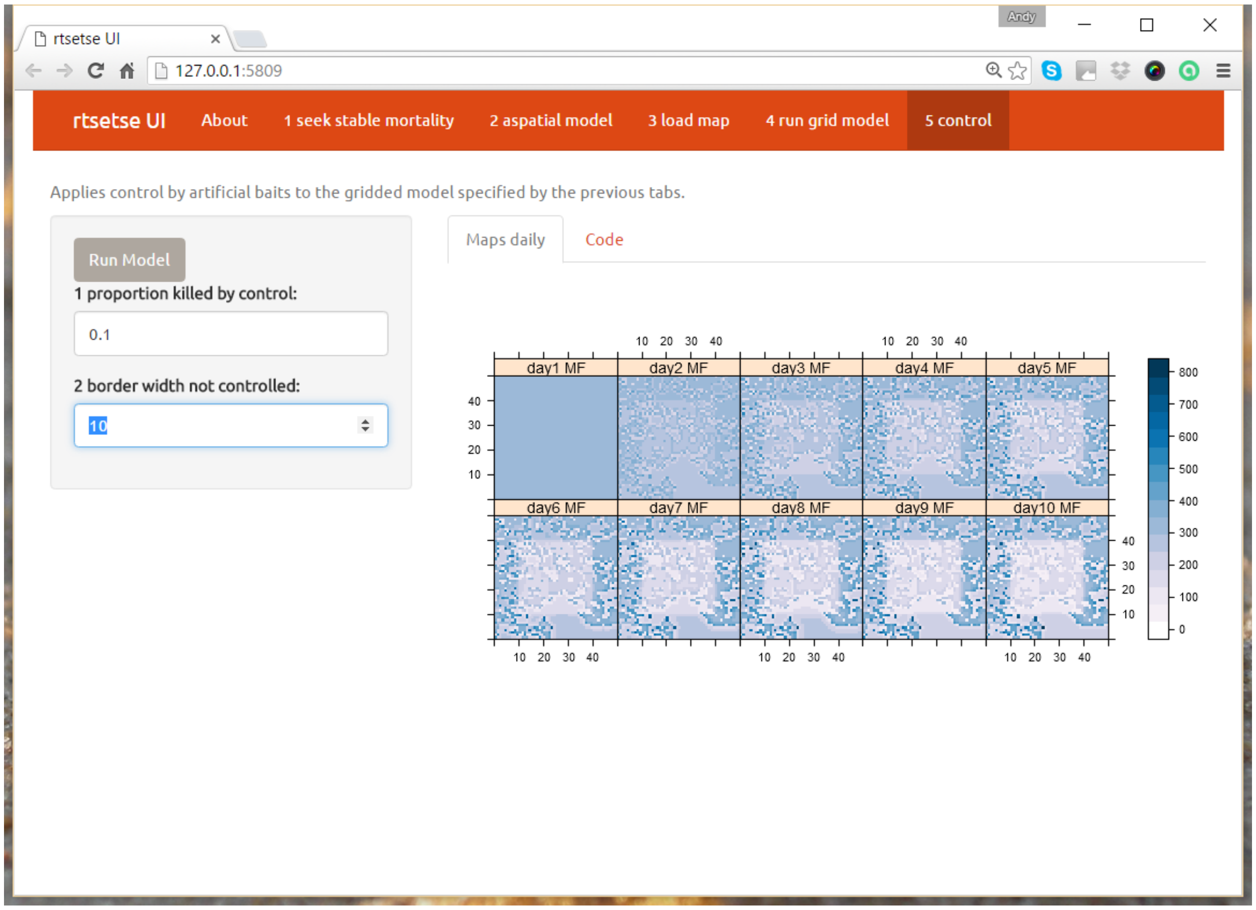
Test spread on uniform grid

1 Days: 10

2 proportion F moving: 0.6

3 proportion M moving: 0.3

Figure 8: UI screen 4: run grid model on larger map



rtsetse UI

127.0.0.1:5809

rtsetse UI | About | 1 seek stable mortality | 2 aspatial model | 3 load map | 4 run grid model | 5 control

Applies control by artificial baits to the gridded model specified by the previous tabs.

Run Model

1 proportion killed by control:

0.1

2 border width not controlled:

10

Figure 9: UI screen 5: control flies. Add control to central area of previous run.