fireNull

Steve Cumming

04 August 2016

Overview

This module provide a basic representation of spatially variable fire regime. It is designed for use as a null fire model in LandWeb simulation.

The spatially variable fire regime paramater is the `Fire Return Interval`. We expect the parent LandWeb module to provide a shapefile in the sim environment that contains this element. The expected shapefile name is `shapeFileFireRegime` and the expected field name is `fireReturnInterval`.

This shapefile was derived by Cumming's lab from an image on a power point slide, prepared by Dr. David Andison. This image presented Andison and Company's estimates of pre-modern fire return intervals by ecoregion or ecodistrict, within what we take to be the LandWeb study region. An image of this map, and references to any supporting documents, will be addded to this .Rmd file in due course.

The module code is based on Cumming's spatialised implementation of the model of Wagner (1978). This very widely used theoretical model relates forest age distributions to the "fire cycle", defined as the length of time by which accumulated fires will burn an total area equal to the size of a given study area. Under very strong assumptions of stationarity and spatial homogeneity (assumptions which almost nobody now believes to hold anywhere), this is equivalent to the periodic probability of burning at a point. A fire cycle of length `f` can be simulated in SpaDES by burning raster cells with periodic probability `p = 1/f`. This model simulates a fire cycle of length `f` by randomly burning pixels with a probability `p`, that may vary among spatial polygons but is uniform within spatial polygons. The units of time are years.

According to Reed (2006), the equation relating `p` and `f` only applies if the size of fires is constant. For any other size distribution, the expected length of simulated fire cycles is longer than `f`. In this module, where each pixel burns independently, all fires have size one pixel, so Reed's condition applies. However, users should take note that, because of the dependency on the fire size distribution, the application of the original fire cycle concept "causes confusion in simulation studies" (Reed 2006).

Usage

```
library(igraph)
library(rgdal)
library(raster)
library(magrittr)
library(archivist)
library(SpaDES)

SMALL <- FALSE # change this if you want to run on just a small area for testing

rasterOptions(maxmemory = 1e9)
baseDir <- file.path("~", "Dropbox", "SpaDES", "Data")

parentModule <- "fireNull" #which module should hold the cached data for GitHub
                           #this would normally be a parent module, hence the name
inputDir <- file.path(tempdir(), "inputs") %>% checkPath(create = TRUE)
```

```
outputDir <- file.path(tempdir(), "outputs")
moduleDir <- file.path(".")

# For now, we can't share cache directory between people, so use one NOT in git repo
setPaths() # sets default paths, including cachePath
cacheDir <- .paths()$cachePath

LCC05 <-raster(file.path(baseDir, "LandCoverOfCanada2005_V1_4", "LCC2005_V1_4a.tif"))

foo <- path.expand(file.path(baseDir, "LandWeb", "shp")) #somebody does not like ~s
shpStudyRegion <- SpaDES::cache(cacheDir, readOGR, foo,"shpLandWeb")#, notOlderThan = Sys.time())
shpStudyRegion$fireReturnInterval <- shpStudyRegion$LTHRC #because of course it does.
rm(foo)

# small polygon for testing
if (SMALL) {
  smallExt <- new("Extent" , xmin = -983660, xmax = -899973,
                  ymin = 8007529, ymax = 8085986)
  shpStudyRegion2 <- spTransform(shpStudyRegion, crs(LCC05))
  shpStudyRegion <- crop(shpStudyRegion2, smallExt)
}

colrs <- colorRampPalette(colors = c("red", "dark green"))(max(shpStudyRegion$fireReturnInterval))[shpS

spplot(shpStudyRegion["fireReturnInterval"])


times <- list(start = 0, end = 10)
parameters <- list(
  # .progress = list(type = "text", interval = 1), # for a progress bar
  fireNull = list(startTime = 1,
                  returnInterval = 1,
                  .statsInitialTime = 1
  ),
  timsSinceFire = list(startTime = 1,
                  returnInterval = 1,
                  .statsInitialTime = 1
  ),
  initBaseMaps = list(),
  fireDataPrep = list()
)
modules <- list("initBaseMaps", "fireDataPrep", "fireNull", "timeSinceFire")#, #"landWebDataPrep", "LBM
objects <- list(LCC05X = LCC05, shpStudySubRegion = shpStudyRegion)

paths <- list(
  modulePath = moduleDir,
#  cachePath = cacheDir,
  inputPath = inputDir,
  outputPath = outputDir
)
#devtools::load_all("~/GitHub/SpaDES/.")
system.time(mySim <- simInit(times = times, params = parameters,
                             modules = modules, objects = objects,
```

```
                                paths = paths))

#archivist::createLocalRepo(cachePath(mySim))
#set.seed(123);system.time(nxtSim<-spades(SpaDES::copy(mySim), debug = TRUE))
```

Events

Init

This creates an optional cummulative burn record in the form of sim raster object `timeSinceFireMap` that conforms to the study area template raster, here assumed to be sim raster object `studyAreaRaster`. The tsfMap is initialised to `0`.

Burn

This event simply applies the burn probability map to randomly select pixels for burning, and returns a vector of the burned cells as sim vector object `ignitionLoci`.

If the `timeSinceFireMap` exists, it is updated.

Plotting

No plots are generated unless the parameter `doAgeMapping` is `TRUE`, in which case the time since fire map is plotted.

Saving

No files or state are saved.

Stats

Some summary statistics are gathered, inherited from Cumming's `vanWagner` module.

Data dependencies

Input data

`shapeFileFireRegime` is defines the regions and species their fire return intervals; this value is expected in a field/collumn named `fireReturnInterval`.

`rasterStudyArea` is the template raster for the study region.

`LCC05` raster of land cover. Must conform to `rasterStudyArea`.

Output data

Description of the module outputs:

- `rasterFlammable` derived from `LCC05` in the init module;
- `rasterBurnProb` created in the init event from the shapefile and the template raster, but with non flammable cells set to 0;
- `burnLoci` annual is a numeric vector of locations of burned cells relative to the template raster;
- `currentBurnMap` annual is a logical map of the currently burned locations, just a very long-winded representation of `burnLoci` (this map conforms to the template raster).

Links to other modules

As suggested above, this module was developed to be used with several other modules:

1. `initBaseMaps`;
2. `fireDataPrep`;
3. `timeSinceFire`;
4. `landWebDataPrep`;
5. `LBMR`.

References

Reed, William J. 2006. "A Note on Fire Frequency Concepts and Definitions." *Canadian Journal of Forest Research* 36 (7). NRC Research Press: 1884–8.

Wagner, CE Van. 1978. "Age-Class Distribution and the Forest Fire Cycle." *Canadian Journal of Forest Research* 8 (2). NRC Research Press: 220–27.