Correcting parameters

Vincent Bisquay Gracia

27/04/2021

I. Introduction

I.a) Set up

```
wd = "D:/Internship 3A/GitHub/Project-Klamath-2021/Model Parameterization"
files_dir = "E:/FIF/Stage 3A/Results single cell/CC single cell/"

setwd(wd)
library(magrittr)
library(cowplot)
library(ggplot2)
library(raster)
library(knitr)
```

I.b) Presentation

When looking at the results after a first run of the scenario with only the climate change (CC only), it was observed that the ecosystem was starved in nitrogen. The more likely explanation is a too important stock of nitrogen in one (or several) of the soils pools of carbon and nitrogen.

These pools simulates the different soil stocks of nitrogen and carbon that interveine in the biochemical cycles. As decay progresses, carbon and nitrogen are transferred to and among the fast, slow, and passive soil organic matter (SOM) pools, with some loss to the atmosphere and through leaching. The picture below is a schematic diagram of NECN functionning, based on the CENTURY modelling.

The process described concern only the bottom panel, showing the 3 pools *SOM1*, *SOM2* and *SOM3*. NECN allows to parameter a forth pool, simulating the soil litter.

Thus, it was decided to change the decay rate of these pools. To do so and not spend too many time on computing, these tests where done using the single cell landscape. The method used to build this test landscape is detailed on the pdf document "Test_Landscape".

I.c) Scenario

The scenario used to test the parameters correspond to a single cell landscape with only climate change i.e. without disturbancies (insect breakout, fire or harvest). A summary of the settings used in the different subscenarios of the signle cell run are presented on the following table. They correspond to the decay rate of the four soil layers.

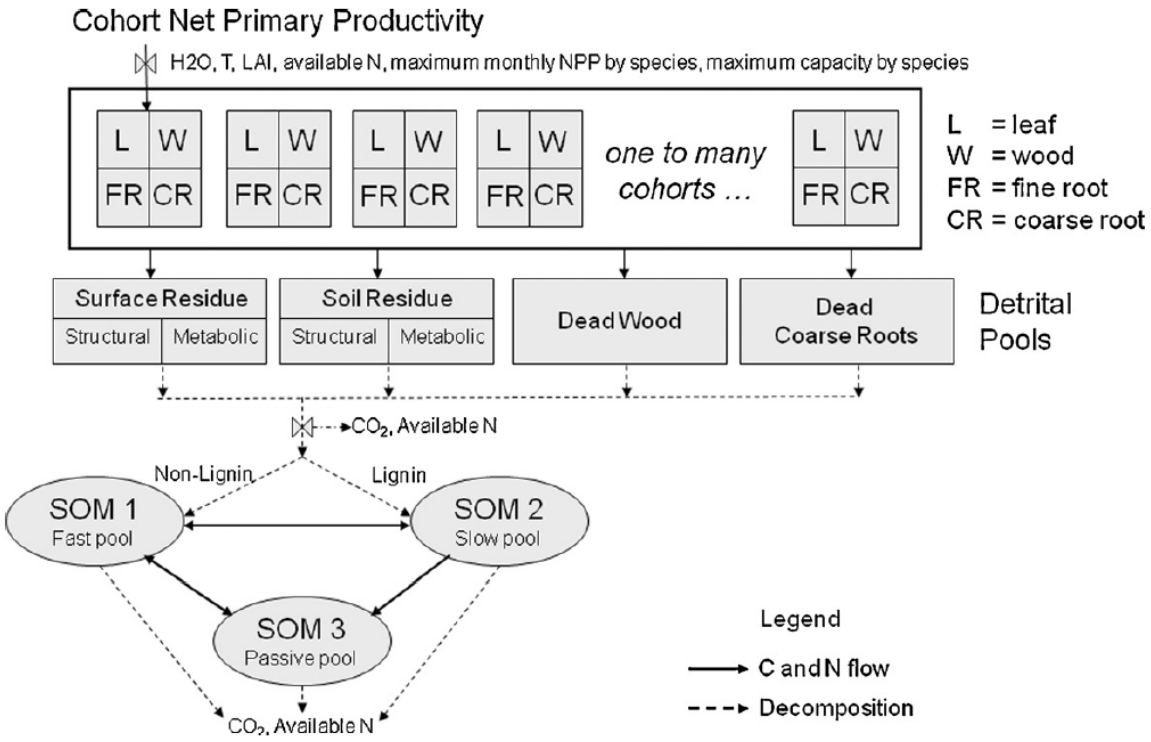


Figure 1: Capture of figure NECN publication

```
kable(data.frame("V1" = c(0.82, 0.53, 0.02, 0.0003),
                 "V2" = c(0.99, 0.76, 0.04, 0.0003),
                 "V3" = c(0.99, 0.90, 0.05, 0.0003),
                 "V4" = c(0.99, 0.99, 0.99, 0.0003),
                 "V5" = c(0.99, 0.99, 0.04, 0.0003),
           row.names = c("DecayRateSurf","DecayRateSOM1",
                         "DecayRateSOM2", "DecayRateSOM3")),
      caption = "Decay rates used in the sub-scenarios")
```

Table 1: Decay rates used in the sub-scenarios

	V1	V2	V3	V4	V5
DecayRateSurf	0.8200	0.9900	0.9900	0.9900	0.9900
DecayRateSOM1	0.5300	0.7600	0.9000	0.9900	0.9900
DecayRateSOM2	0.0200	0.0400	0.0500	0.9900	0.0400
DecayRateSOM3	0.0003	0.0003	0.0003	0.0003	0.0003

II. Carbon and nitrogen dynamics

The succetion log files of the NECN extention are imported for all the sub-scenarios. Only the variables of interest are selected.

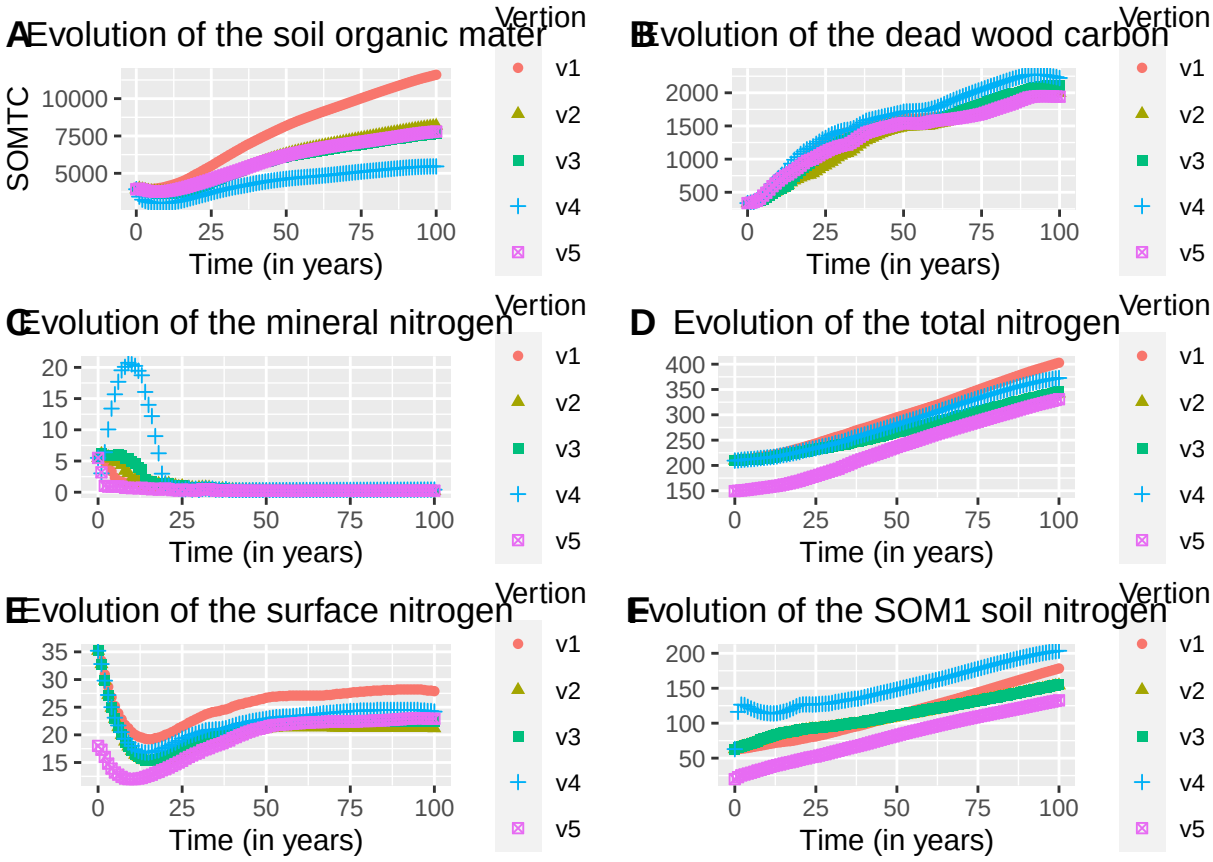
```
NECN_V1_long = paste0(files_dir,"NECN_V1.csv") %>% read.csv()

NECN_V1 = aggregate(data=NECN_V1_long, cbind(SOMTC, MineralN, TotalN, C_DeadWood,
                                             N_SOM1surf, N_SOM1soil, N_SOM2) ~ Time, mean)
NECN_V1$Vertion = "v1"


NECN_V2_long = paste0(files_dir,"NECN_V2.csv") %>% read.csv()

NECN_V2 = aggregate(data=NECN_V2_long, cbind(SOMTC, MineralN, TotalN, C_DeadWood,
                                             N_SOM1surf, N_SOM1soil, N_SOM2) ~ Time, mean)
NECN_V2$Vertion = "v2"


NECN_V3_long = paste0(files_dir,"NECN_V3.csv") %>% read.csv()

NECN_V3 = aggregate(data=NECN_V3_long, cbind(SOMTC, MineralN, TotalN, C_DeadWood,
                                             N_SOM1surf, N_SOM1soil, N_SOM2) ~ Time, mean)
NECN_V3$Vertion = "v3"


NECN_V4_long = paste0(files_dir,"NECN_V4.csv") %>% read.csv()

NECN_V4 = aggregate(data=NECN_V4_long, cbind(SOMTC, MineralN, TotalN, C_DeadWood,
                                             N_SOM1surf, N_SOM1soil, N_SOM2) ~ Time, mean)
NECN_V4$Vertion = "v4"
```

```
NECN_V5_long = paste0(files_dir,"NECN_V5.csv") %>% read.csv()

NECN_V5 = aggregate(data=NECN_V5_long, cbind(SOMTC, MineralN, TotalN, C_DeadWood,
                                             N_SOM1surf, N_SOM1soil, N_SOM2) ~ Time, mean)
NECN_V5$Vertion = "v5"


NECN = rbind(NECN_V1, NECN_V2, NECN_V3, NECN_V4, NECN_V5)
```

The carbon and nitrogen dynamics are then plotted against time for all the sub-scenario.

```
SOMTp = ggplot(NECN, aes(x=Time, y=SOMTC, col=Vertion, shape = Vertion)) +
  geom_point() +
  scale_x_continuous(name= "Time (in years)") +
  scale_y_continuous(name = "SOMTC") +
  ggtitle("Evolution of the soil organic mater") +
  theme(plot.title = element_text(hjust = 0.5))

CDWp = ggplot(NECN, aes(x=Time, y=C_DeadWood, col=Vertion, shape = Vertion)) +
  geom_point() +
  scale_x_continuous(name= "Time (in years)") +
  scale_y_continuous(name = "") +
  ggtitle("Evolution of the dead wood carbon") +
  theme(plot.title = element_text(hjust = 0.5))

MNp = ggplot(NECN, aes(x=Time, y=MineralN, col=Vertion, shape = Vertion)) +
  geom_point() +
  scale_x_continuous(name= "Time (in years)") +
  scale_y_continuous(name = "") +
  ggtitle("Evolution of the mineral nitrogen") +
  theme(plot.title = element_text(hjust = 0.5))

TNp =  ggplot(NECN, aes(x=Time, y=TotalN, col=Vertion, shape = Vertion)) +
  geom_point() +
  scale_x_continuous(name= "Time (in years)") +
  scale_y_continuous(name = "") +
  ggtitle("Evolution of the total nitrogen") +
  theme(plot.title = element_text(hjust = 0.5))

SNp =  ggplot(NECN, aes(x=Time, y=N_SOM1surf, col=Vertion, shape = Vertion)) +
  geom_point() +
  scale_x_continuous(name= "Time (in years)") +
  scale_y_continuous(name = "") +
  ggtitle("Evolution of the surface nitrogen") +
  theme(plot.title = element_text(hjust = 0.5))

N1p =  ggplot(NECN, aes(x=Time, y=N_SOM1soil, col=Vertion, shape = Vertion)) +
  geom_point() +
  scale_x_continuous(name= "Time (in years)") +
  scale_y_continuous(name = "") +
  ggtitle("Evolution of the SOM1 soil nitrogen") +
  theme(plot.title = element_text(hjust = 0.5))
```

```
N2p =  ggplot(NECN, aes(x=Time, y=N_SOM2, col=Vertion, shape = Vertion)) +
  geom_point() +
  scale_x_continuous(name= "Time (in years)") +
  scale_y_continuous(name = "") +
  ggtitle("Evolution of the SOM2 nitrogen") +
  theme(plot.title = element_text(hjust = 0.5))

plot_grid(SOMTp, CDWp, MNp, TNp, SNp, N1p, N2p, labels="AUTO", ncol = 2, nrow = 3)
```



The vertion 4 is the one selected.

III. Initial quantity of soil nitrogen

III.a) Modification of initial nitrogen cocentration for a single cell raster

Because the surface nitrogen quantity seems higher than the landscape can equilibrate with, it was decided to change it. This modification was first done for the sigle cell simulation.

```
Nsoil1 = paste(files_dir,"som1nsoil2.tif",sep="") %>% raster()

Nsurf1 = paste(files_dir,"som1nsurf4.tif",sep="") %>% raster()

a = freq(Nsoil1, merge=T) %>% as.data.frame()
b = freq(Nsurf1, merge=T) %>% as.data.frame()
```

```
Nsoil1[1] <- 20
Nsurf1[1] <- 18

c = freq(Nsoil1, merge=T) %>% as.data.frame()
d = freq(Nsurf1, merge=T) %>% as.data.frame()

rbind(a,b,c,d) %>% data.frame(row.names = c("Initial N on SOM1 soil layer","Initial N on SOM1 surface la
                                  "New N on SOM1 soil layer", "New N on SOM1 surface layer")) %>%
  kable(caption = "Initial and modified concentration of nitrogen on the SOM1 layers")
```

Table 2: Initial and modified concentration of nitrogen on the SOM1 layers

	value	count
Initial N on SOM1 soil layer	63	1
Initial N on SOM1 surface layer	35	1
New N on SOM1 soil layer	20	1
New N on SOM1 surface layer	18	1

```
writeRaster(Nsoil1, file=paste(files_dir,"som1nsoil_V1", sep=""),
                format = "GTiff", datatype='FLT4S',overwrite=T)
```

```
## Warning in .gd_SetProject(object, ...): NOT UPDATED FOR PROJ >= 6
```

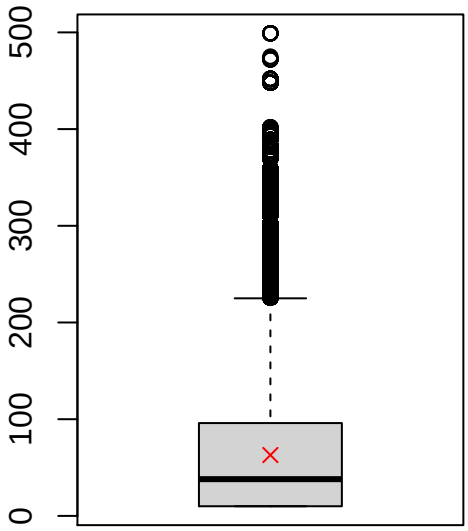
```
writeRaster(Nsurf1, file=paste(files_dir,"som1nsurf_V1", sep=""),
                format = "GTiff", datatype='FLT4S',overwrite=T)
```

```
## Warning in .gd_SetProject(object, ...): NOT UPDATED FOR PROJ >= 6
```

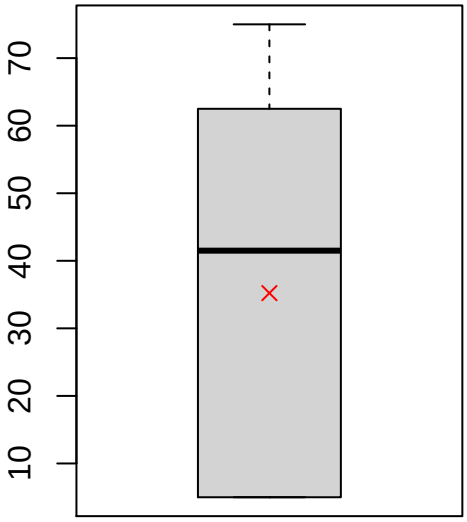
III.b) Modification of initial nitrogen cocentration for the initial raster

The modification is then done for the raster used on the final simulations.

```
Nsoil1_Tot = paste(files_dir,"Tot/som1nsoil2.tif",sep="") %>% raster()
Nsurf1_Tot = paste(files_dir,"Tot/som1nsurf4.tif",sep="") %>% raster()

SoilMean = cellStats(Nsoil1_Tot, stat='mean', na.rm=TRUE, asSample=TRUE)
SurfMean = cellStats(Nsurf1_Tot, stat='mean', na.rm=TRUE, asSample=TRUE)

par(mfrow=c(1,2))
boxplot(Nsoil1_Tot, maxpixels=1000000, xlab = "SOM1 Soil N")
cellStats(Nsoil1_Tot, stat='mean', na.rm=TRUE, asSample=TRUE) %>% points(pch=4,col="red")

boxplot(Nsurf1_Tot, maxpixels=1000000, xlab = "SOM1 surface N")
cellStats(Nsurf1_Tot, stat='mean', na.rm=TRUE, asSample=TRUE) %>% points(pch=4,col="red")
```



SOM1 Soil N



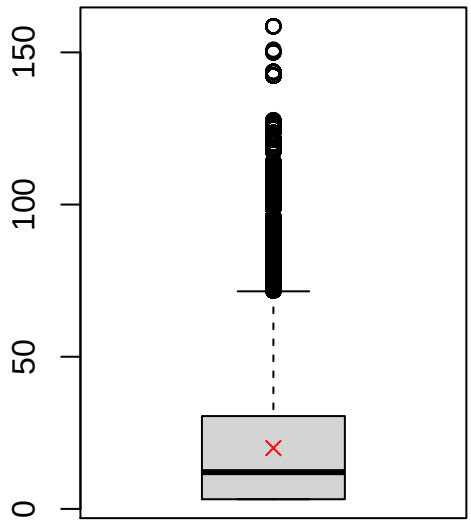
SOM1 surface N

```
print(paste("Mean of SOM1 soil raster:", SoilMean, "Mean of SOM1 surface raster:", SurfMean, sep=" "))
```

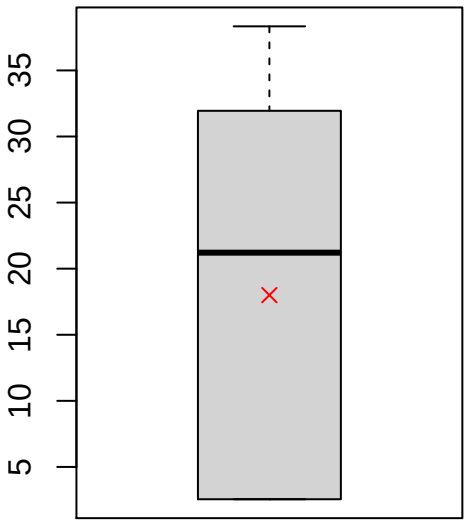
```
## [1] "Mean of SOM1 soil raster: 62.9439680398293 Mean of SOM1 surface raster: 35.2173852118269"
```

The information above concern the nitrogen concentration before changing it.

```
Nsoil1_New = Nsoil1_Tot*(20/SoilMean)

Nsurf1_New = Nsurf1_Tot*(18/SurfMean)

par(mfrow=c(1,2))
boxplot(Nsoil1_New, maxpixels=1000000, xlab = "SOM1 Soil N")
cellStats(Nsoil1_New, stat='mean', na.rm=TRUE, asSample=TRUE) %>% points(,pch=4,col="red")

boxplot(Nsurf1_New, maxpixels=1000000, xlab = "SOM1 surface N")
cellStats(Nsurf1_New, stat='mean', na.rm=TRUE, asSample=TRUE) %>% points(,pch=4,col="red")
```



SOM1 Soil N



SOM1 surface N

```
writeRaster(Nsoil1_New, file=paste(files_dir,"Tot/som1nsoil_V1_Tot", sep=""),
                format = "GTiff", datatype='FLT4S',overwrite=T)

writeRaster(Nsoil1_New, file=paste(files_dir,"Tot/som1nsurf_V1_Tot", sep=""),
                format = "GTiff", datatype='FLT4S',overwrite=T)
```

The information above concern the nitrogen concentration after changing it. As wanted, the distribution seems unchanged.