

A 3D model of a forest landscape with various tree shapes and colors (yellow, green, brown) on a light green ground plane.

Capsis annual workshop

UMR AMAP, Montpellier, 17th June 2008

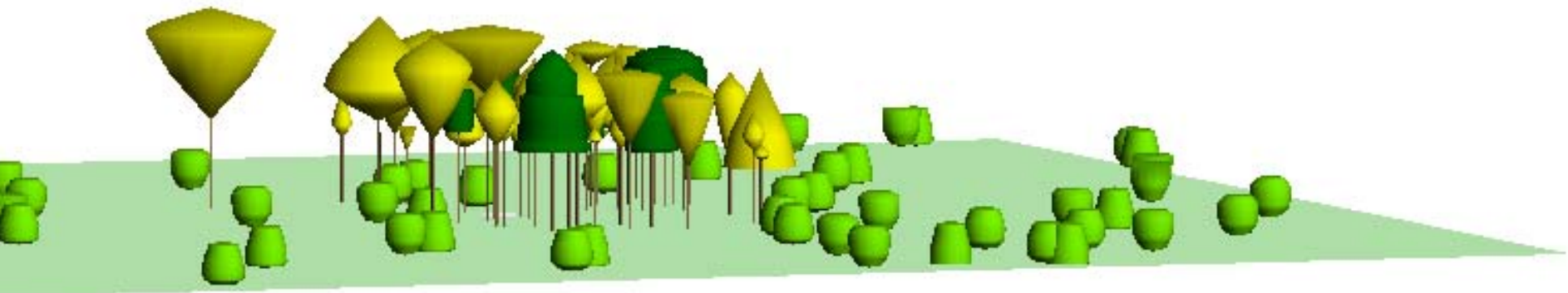
Fire Paradox Fuel Manager

A fuel manager for wildland fire modelling

Isabelle LECOMTE; Éric RIGOLOT; Oana VIGY
UR Ecologie des Forêts Méditerranéennes, Avignon



François de COLIGNY; Sébastien GRIFFON
UMR AMAP, Montpellier

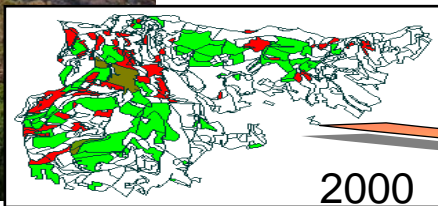


Scientific context

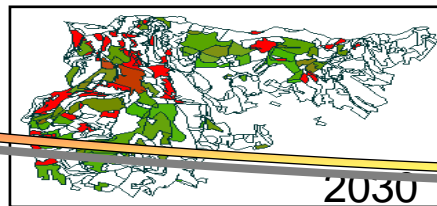
Fire behavior modelling

Post fire ecological effects assessment

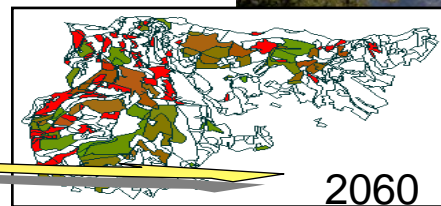
Fire regime integration in forest dynamics



2000



2030



2060



An Innovative Approach of Integrated Wildland Fire Management Regulating the Wildfire Problem by the Wise Use of Fire: Solving the Fire Paradox

- **Type:** 6th Framework Programme for R & D
- **Topic:** Integrated forest fire management
- **Instrument:** integrated project (research, development & dissemination)
- **Partnership:** 36 teams in 16 countries
- **Duration:** 48 mois, March 2006; February 2010

A 3D physically-based model for fire propagation FIRETEC

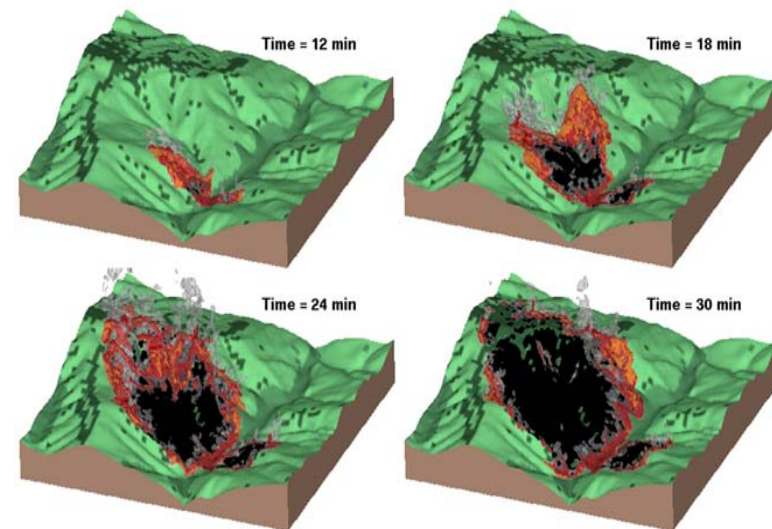
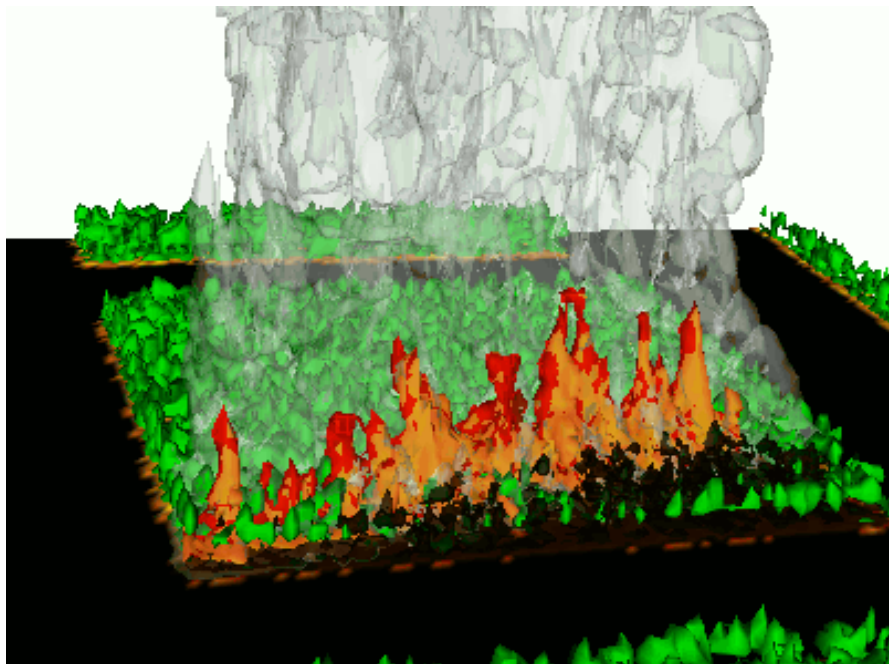
Representation of coupled critical physical processes of a wildfire

Explicit resolution (computation) of some processes (turbulence transport, radiation, ...) and theoretical modeling of others (thermal degradation, combustion, ...)

It is a coupled atmospheric transport/wildfire behavior model (**HIGRAD/FIRETEC**)

Spatial résolution: 2 to 10 m **Domains:** 300 to 3000 m in (x,y), 600 to 1500 m (z)

Predicted **variables:** temperatures, flux, masses consumed, oxygen, ...



Fuel description and modeling

Fuel data requirements:

- Fine fuel particles characteristics (leaves, needles, twigs)
- Fuel density or **distribution in space of crown volume fraction**

Methods to assess particles volume fraction in crown

- Specific volume fraction measurements using « cube » method
- Architectural approach
- Terrestrial LIDAR



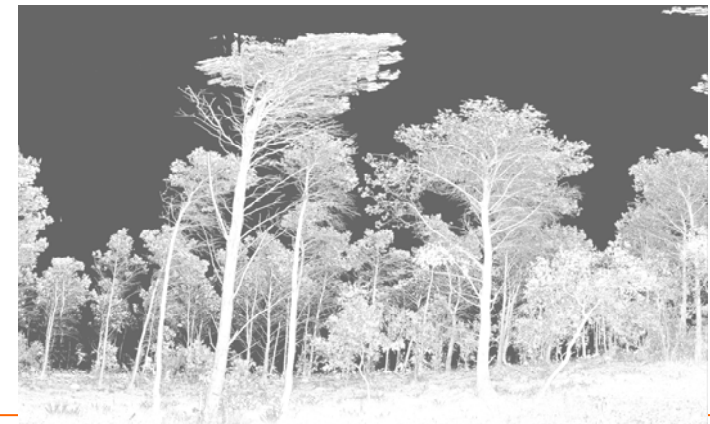
Cube method
(FIRESTAR)



Architectural approach
(INRA/CIRAD AMAP)



Lidar data



Fire behavior modeling process

Field measurements

Destructive sampling

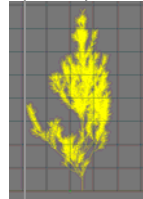
1) Particules



2) Crown

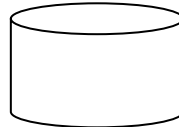


Architectural models

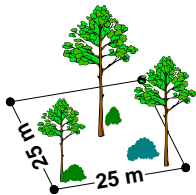


Fuel modeling

Data base
EuroForestFuels
(WLS)

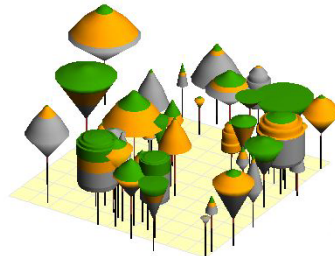


Stand description



Composition
Cover
Structure

Vegetation scene
Fire Paradox Fuel Manager



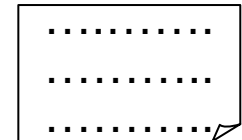
Capsis4

Fire modeling

Fire models
FireTec, FireStar3D



Data files





FIRE PARADOX FUEL MANAGER

A key application in the fire modeling process with the following functionalities:

- **Fuel manager:** user friendly software for input files generation of fuel complexes for fire behavior models
- **Fire effects visualisation** on shrubs and trees
- **Fuel succession visualisation** after fire occurrence

FireParadox Scene Editor

Scene generation

Scene
generation
options

The screenshot shows the 'Scene editor' window with a blue title bar. The main area is titled 'Scene generation' and contains several options: 'Database inventory' with a text field and 'Browse' button; 'Detailed inventory' with a text field and 'Browse' button; radio buttons for 'For viewing only' (selected) and 'For matching with database'; 'From field parameters' with a 'Field parameters' button; and 'From scratch' with 'Length (m):' and 'Width (m):' text fields. Below these is a 'Generate the scene' button and a checkbox 'then go to the scene editor page'. At the bottom, there is a status bar with the message 'The species list was correctly loaded', a progress indicator at '100%', and buttons for 'Login', 'Password', 'Connection', 'Patterns Editor', 'Next', 'OK', 'Cancel', and 'Help'.

EuroforetFuel
database
management

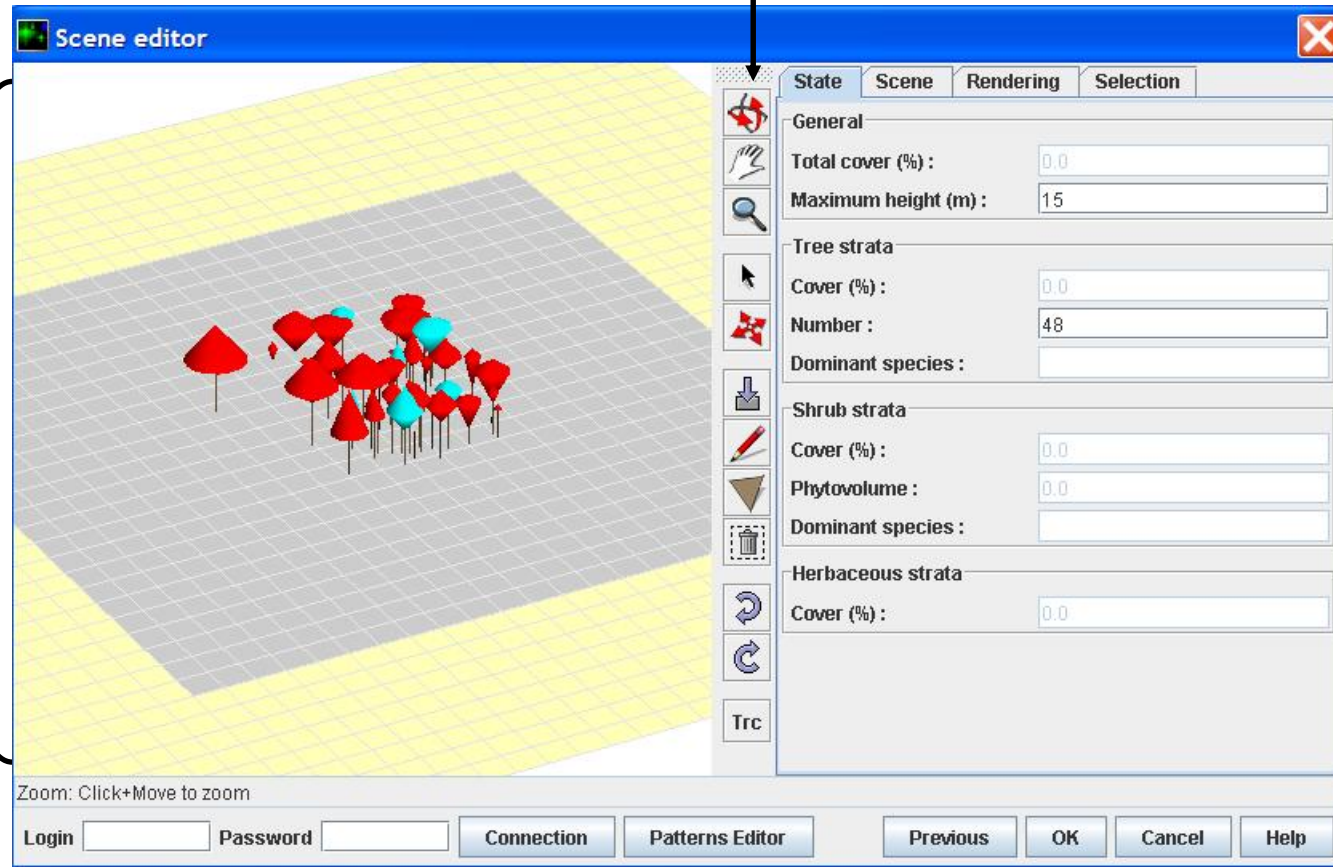
Pattern
editor

FireParadox Scene Editor

Scene edition

Tool bar

3D
editor

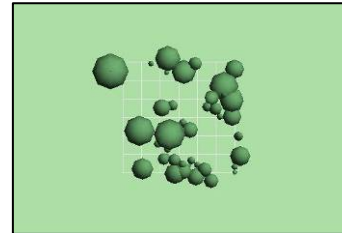
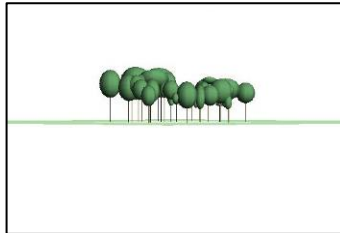
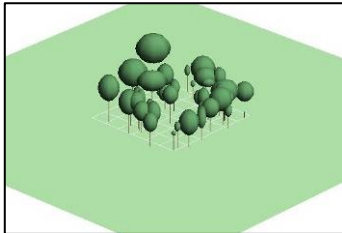


Real
Time
Panel

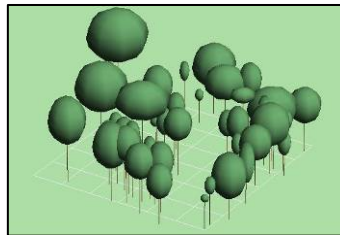
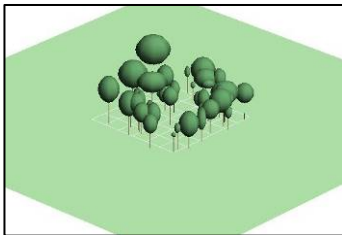
FireParadox Scene Editor

Scene edition : viewpoint motion

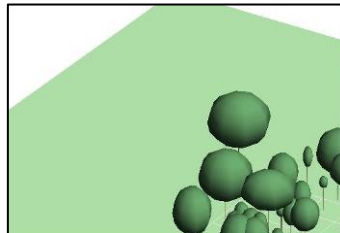
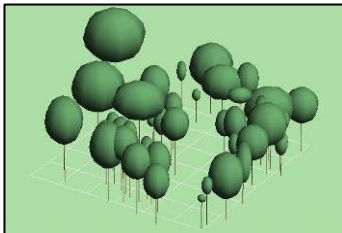
Orbit



Zoom

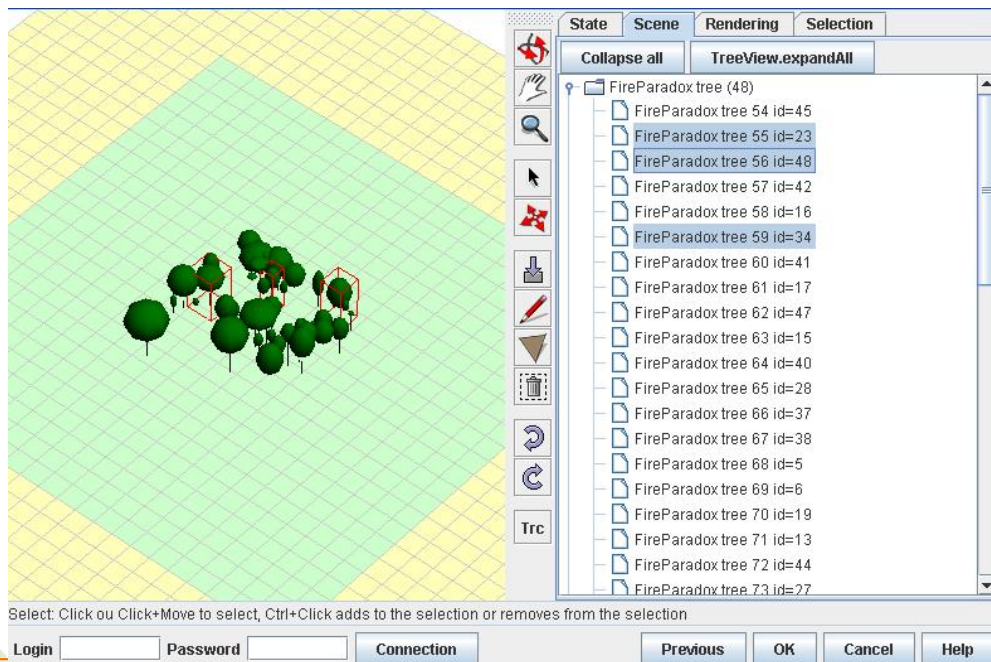
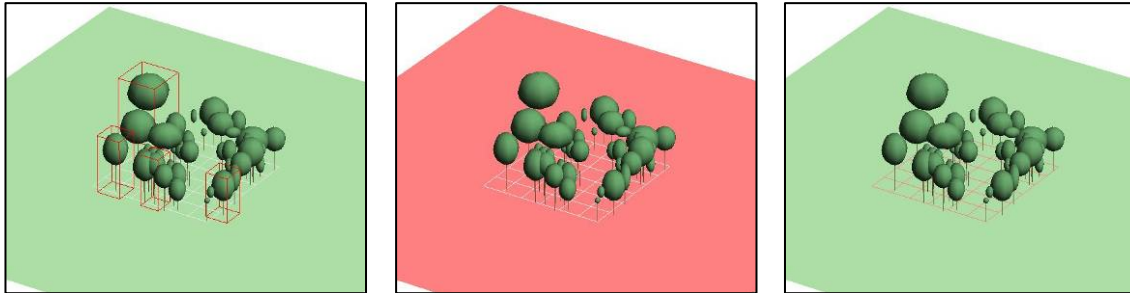


Pan



FireParadox Scene Editor

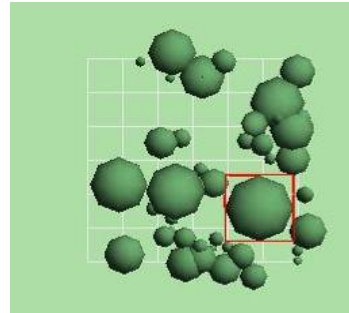
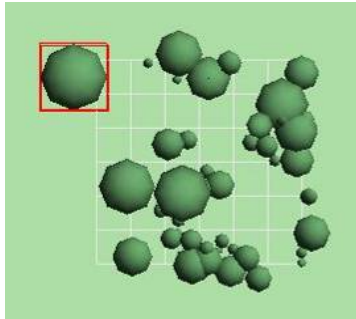
Scene edition : selection 



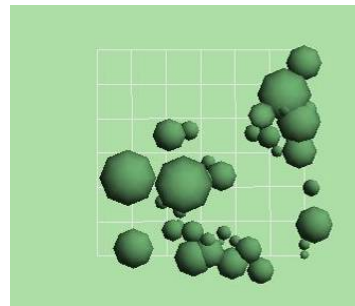
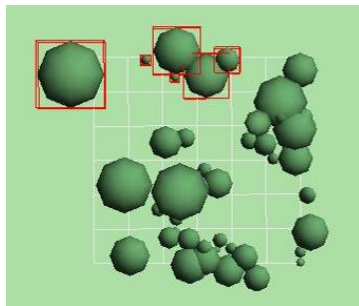
List of
objects
on the
scene

FireParadox Scene Editor

Scene edition : Moving



Deleting

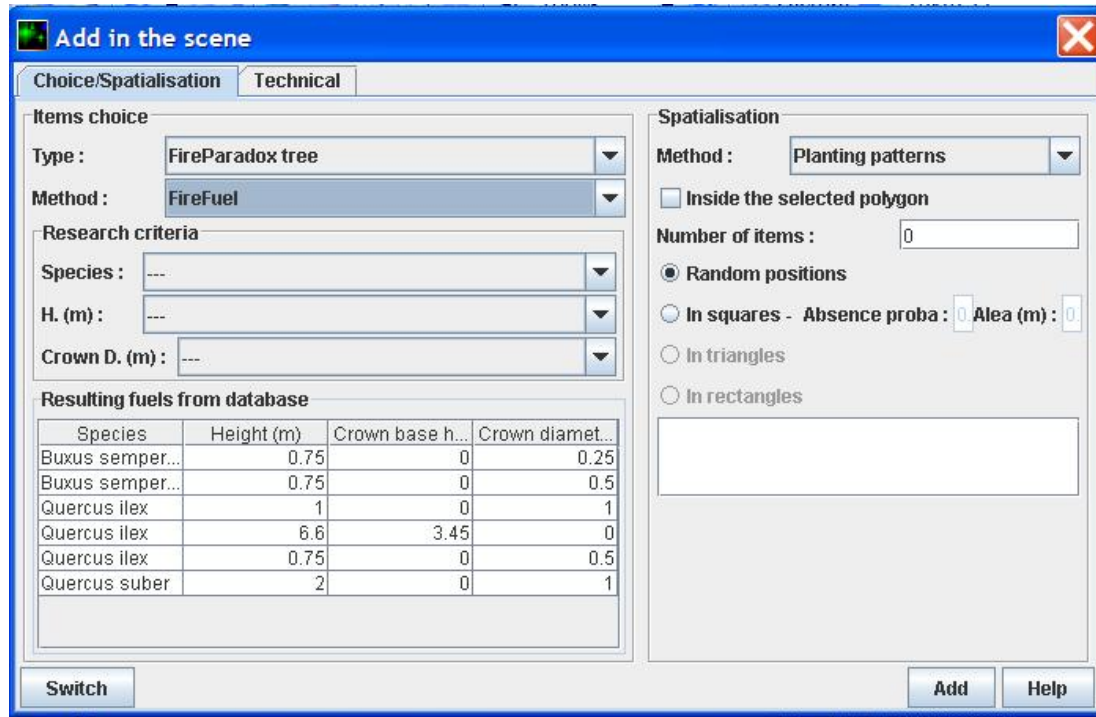


Undo/Redo



FireParadox Scene Editor

Scene edition : adding 



Add in the scene

Choice/Spatialisation | Technical

Items choice

Type : FireParadox tree

Method : FireFuel

Research criteria

Species : ---

H. (m) : ---

Crown D. (m) : ---

Resulting fuels from database

Species	Height (m)	Crown base h...	Crown diamet...
Buxus semper...	0.75	0	0.25
Buxus semper...	0.75	0	0.5
Quercus ilex	1	0	1
Quercus ilex	6.6	3.45	0
Quercus ilex	0.75	0	0.5
Quercus suber	2	0	1

Spatialisation

Method : Planting patterns

☐ Inside the selected polygon

Number of items : 0

☒ Random positions

☐ In squares - Absence proba : 0, Alea (m) : 0

☐ In triangles

☐ In rectangles

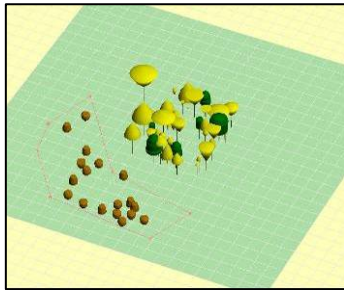
Switch Add Help

Planting options

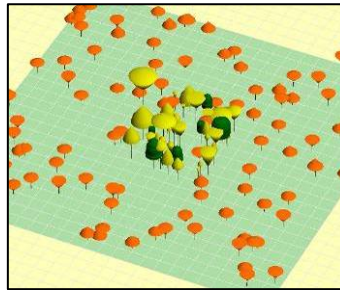
Fuels choice from EuroForestFuel Database

FireParadox Scene Editor

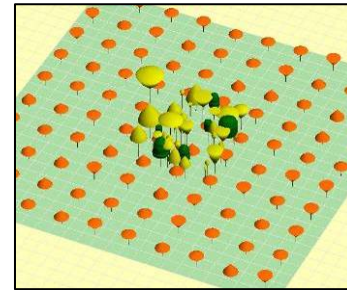
Scene edition : adding



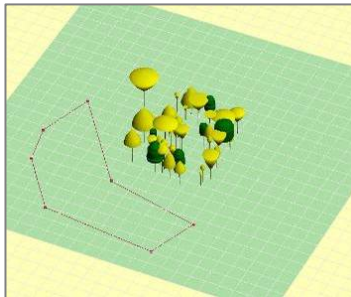
Within a polygon,
random



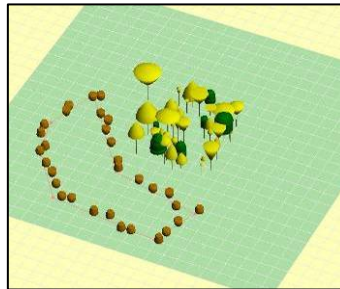
Within the scene,
random



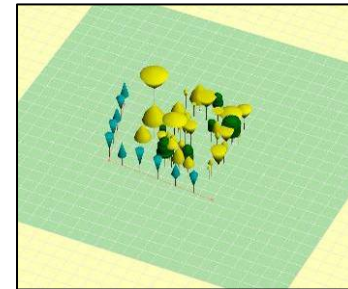
Within the scene,
with a square
pattern



Drawing a polygon



Along a polygon

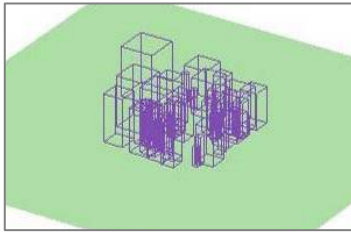


Along a line

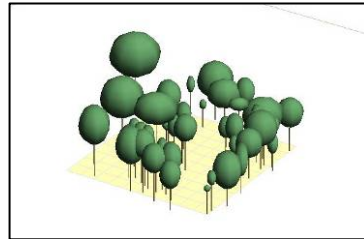
Interactive planting

FireParadox Scene Editor

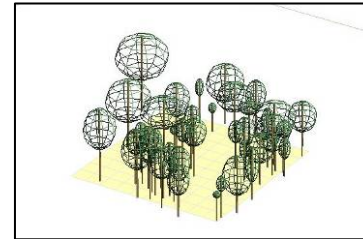
Scene edition : renderers



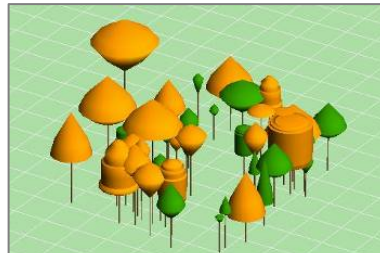
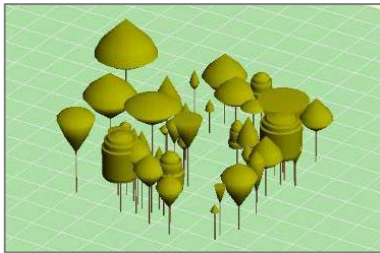
Boxes



Lollipops



Outlines



Patterns

FireParadox Scene Editor

Scene analysis

State Rendering Selection

General

Total cover (%) : 0.0

Maximum height (m) : 15

Tree strata

Cover (%) : 0.0

Number : 48

Dominant species :

Shrub strata

Cover (%) : 0.0

Phytovolume : 0.0

Dominant species :

Herbaceous strata

Cover (%) : 0.0

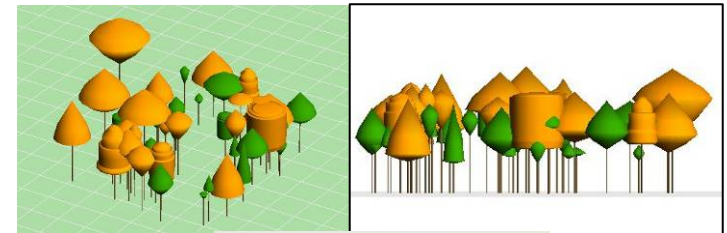
State Rendering Selection

Selection: Trees inspector

3 41

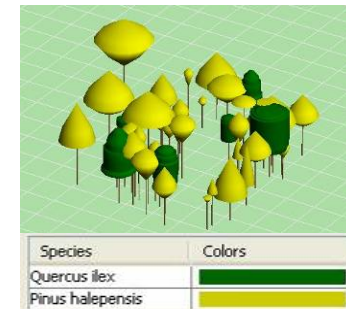
FireTree

Field	Value
AbsoluteMax	(1.67, -0.42, 1...
AbsoluteMin	(-6.68, -8.77, 0)
Age	0
CONIC	1
Cell	SquareCell_12...
ClosedEnviron...	<input checked="" type="checkbox"/>
CrownBaseHeight	9.0
CrownColor	java.awt.Color...
CrownDiameter	8.35
CrownDiamete...	9.7976440948...
CrownKilledHei...	2.1137088485...
CrownRadius	4.175
CrownScorch...	4.2825351904...
CrownType	2
DBFuelId	PH_FuelId
Dbh	10.0
ExternalRef	null
FileId	3
HCMMax	8.0374240282...
HCMMin	5.6705145281...
Height	14.199999809...
Id	3
ItemId	37
Key	FireTrees
Marked	<input type="checkbox"/>
Max	(4.18, 4.18, 14...
Min	(-4.18, -4.18, 0)
Name	FireParadox tre...
PatternName	ex-14 - 33 - s8...
PlotRegistered	<input checked="" type="checkbox"/>
SPHERIC	2



Stratum	Colors
< 11.0	
>= 11.0	

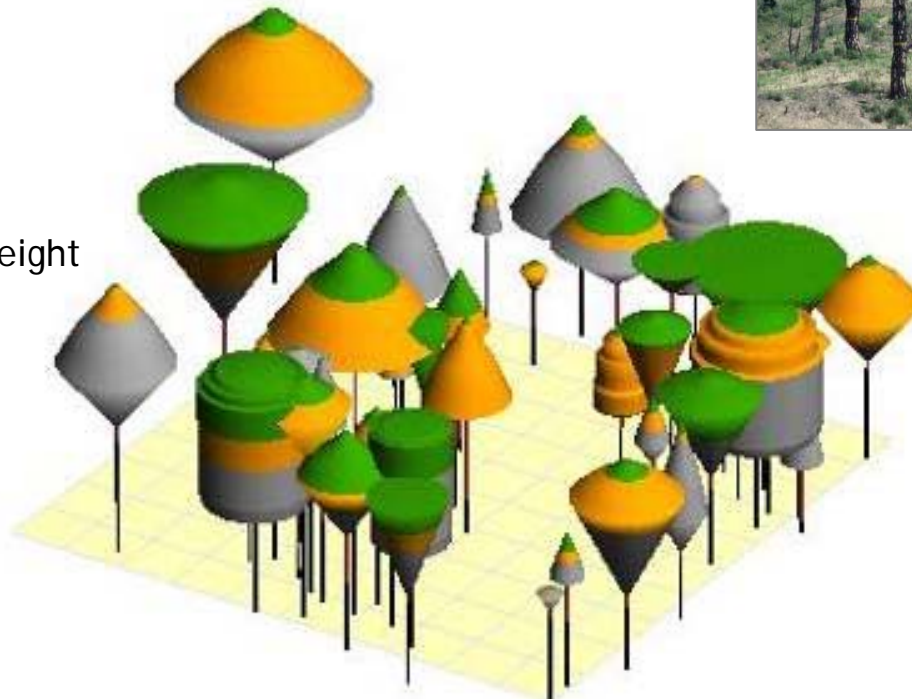
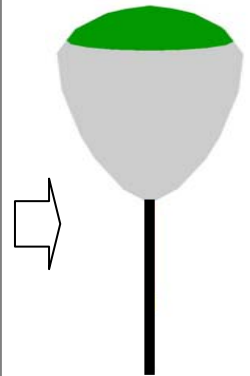
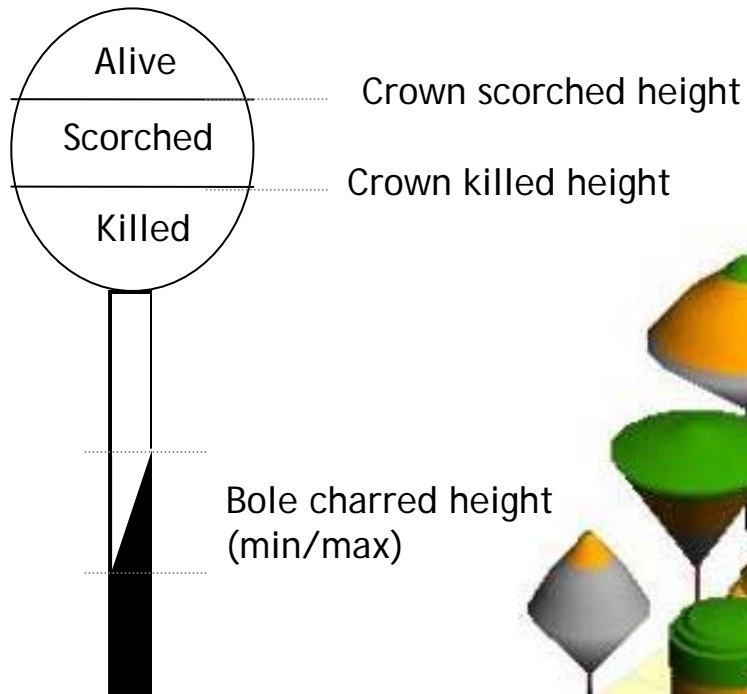
By height



By species

FireParadox Scene Editor

Fire damage visualisation



EuroForestFuels Database Management

Searching data

Searching
fuels in the
EuroforetFuel
database

Add in the scene

Choice/Spatialisation **Technical**

Items choice

Type : FireParadox tree

Method : FireFuel

Research criteria

Species : ---

H. (m) : ---

Crown D. (m) : ---

Resulting fuels from database

Species	Height (m)	Crown base h...	Crown diamet...
Buxus semper...	0.75	0	0.25
Buxus semper...	0.75	0	0.5
Quercus ilex	1	0	1
Quercus ilex	6.6	3.45	0
Quercus ilex	0.75	0	0.5
Quercus suber	2	0	1

Spatialisation

Method : Planting patterns

☐ Inside the selected polygon

Number of items : 0

☒ Random positions

☐ In squares - Absence proba : 0 Alea (m) : 0

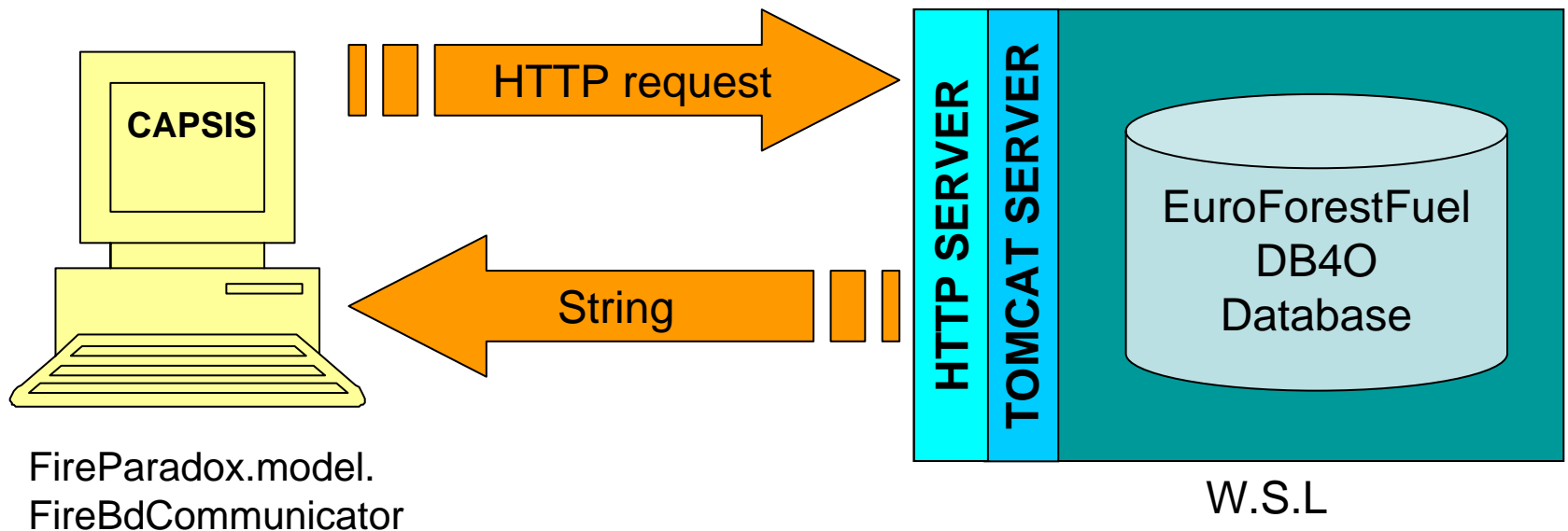
☐ In triangles

☐ In rectangles

Switch Add Help

EuroForestFuels Database Management

`http://http://www.wsl.ch/WebFuel/par?numRequest=30`



```
Shape:1153336;Plant:1156777;Buxus sempervirens;Virtual;0.75;null;0.25;null;null;0;1229055;  
Shape:1187063;Plant:1145567;Buxus sempervirens;Virtual;0.75;null;0.5;null;null;0;1229055;  
Shape:1191895;Plant:1166711;Quercus ilex;Measure;1.0;null;1.0;null;null;535535;0;  
Shape:1194851;Plant:1166981;Quercus ilex;Measure;6.0;3.45;2.0;2.0;null;535535;0;
```

EuroForestFuels Database Management

CAPSIS

fireparadox.model.fireBdCommunicator.class

<http://www.wsl.ch/WebFuel/par?numRequest=30&taxon=Quercus>

HTTP SERVER

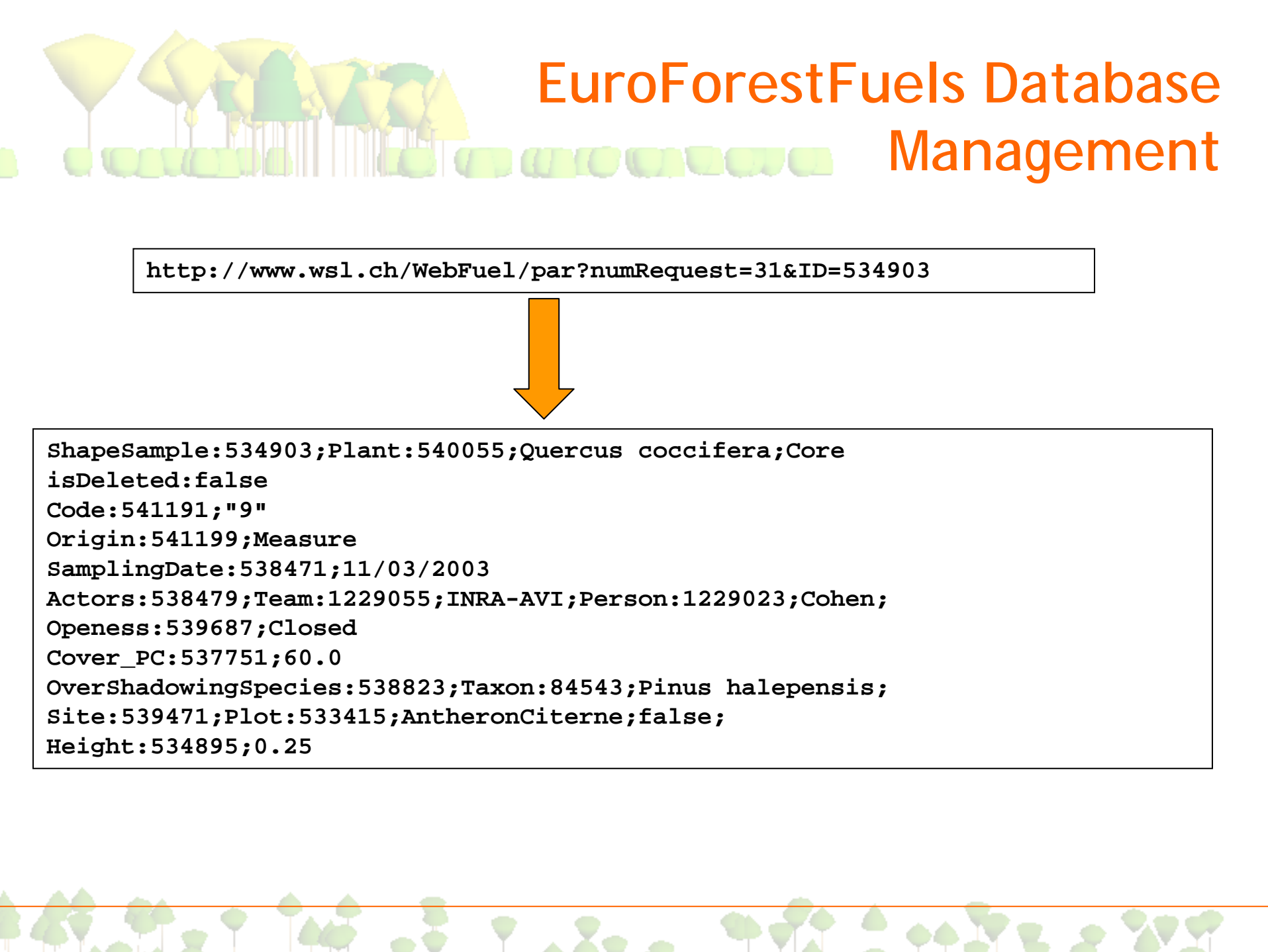
*fireparadox.dbfuel.web.adapters.
FuelManagerSelector.class*

TOMCAT SERVER

EuroForestFuel
DB4O
Database

```
Int nb = Integer.valueOf(request.getParameter("numRequest"));
String dbTaxon = request.getParameter("taxon");
public List<String> requestdb() {
    List<String> myResult = new ArrayList<String>();
    switch (nb) {
        . . .
        case 30: //retrieve fuel list
            myResult = queryShapes(dbTaxon);
            break;
        . . .
    }
}
private List<String> queryShapes(String taxon) {
    . . .
}
```

Shape:1191895;Plant:1166711;Quercus ilex;Measure;1.0;null;1.0;null;null;535535;0;
Shape:1194851;Plant:1166981;Quercus ilex;Measure;6.0;3.45;2.0;2.0;null;535535;0;



EuroForest Fuels Database Management

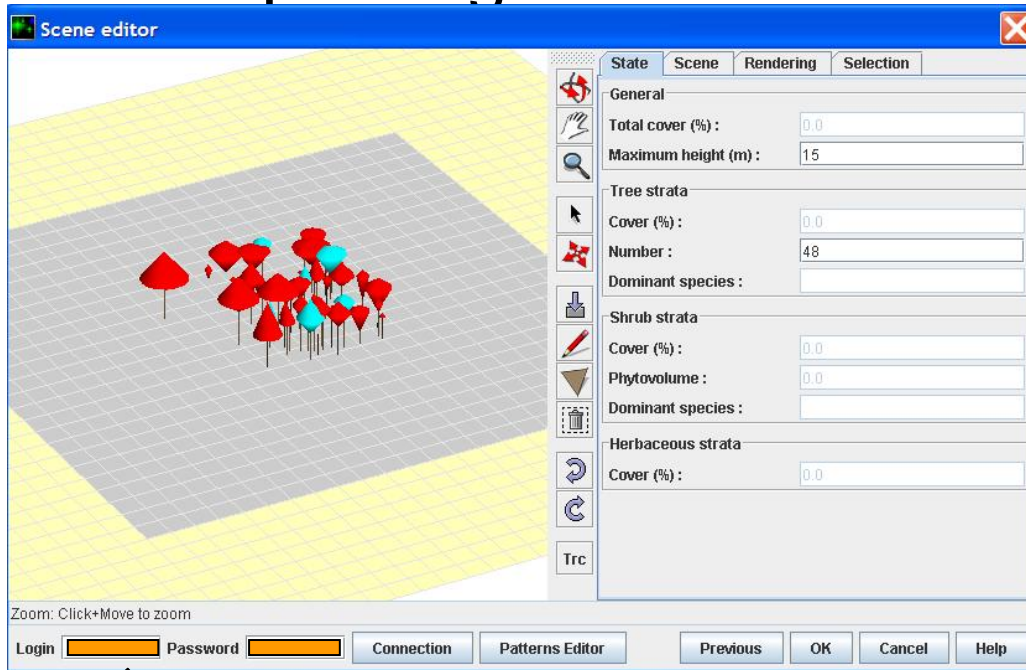
<http://www.wsl.ch/WebFuel/par?numRequest=31&ID=534903>



ShapeSample:534903;Plant:540055;Quercus coccifera;Core
isDeleted:false
Code:541191;"9"
Origin:541199;Measure
SamplingDate:538471;11/03/2003
Actors:538479;Team:1229055;INRA-AVI;Person:1229023;Cohen;
Openess:539687;Closed
Cover_PC:537751;60.0
OverShadowingSpecies:538823;Taxon:84543;Pinus halepensis;
Site:539471;Plot:533415;AntheronCiterne>false;
Height:534895;0.25

EuroForestFuels Database Management

Updating data



1. Super administrator
2. Administrator
3. User



EuroForest Fuels Database Management

Updating data

Particle parameters

Fuel
ID = 916936
Species = Quercus suber
Type = Layer
Height = 10.0

Legend
■ Top
■ Center
■ Bottom
■ Other
□ Not set

Particle parameters
Particle : Twigs_6_25_INRA
Parameter : VF
Alive : 179.36430317848408
Dead : 0.0

600
300
150
100
50
25
0





Add a particle Add a parameter Save in the database Cancel Help

Fuel edition (id=1118831 Quercus suber)

Team 1 - Site description 2 - Simple individual 3 - General comments

Species : Quercus suber
ID : "938"
Latitude (degree) : 0.0 Longitude (degree) : 0.0
Elevation (m) : 0.0
☒ Virtual plant ☐ Measured plant

Shrub thickets
Fuel height (cm) : 600 Crown base height (cm) : 150
Shrub min width (cm) : 550 Max width (cm) : 650

Plant status
 ☒ Isolated
 ☐ Dominant
 ☐ Subordinate
 ☐ Under tree

Openess : Tree cover by dominant species (%) : 0.0
Dominant species 1 :
Dominant species 2 :

Save in database Cancel Help

EuroForestFuels Database Management

CAPSIS

fireparadox.model.fireBdUpdater.class

```
http://www.wsl.ch/WebFuel/update?  
action=update&ID=123233&method=setName&value=INRA&  
valueType=java.lang.String
```

HTTP SERVER

*fireparadox.dbfuel.web.adapters.
FuelManagerUpdater.class*

TOMCAT SERVER

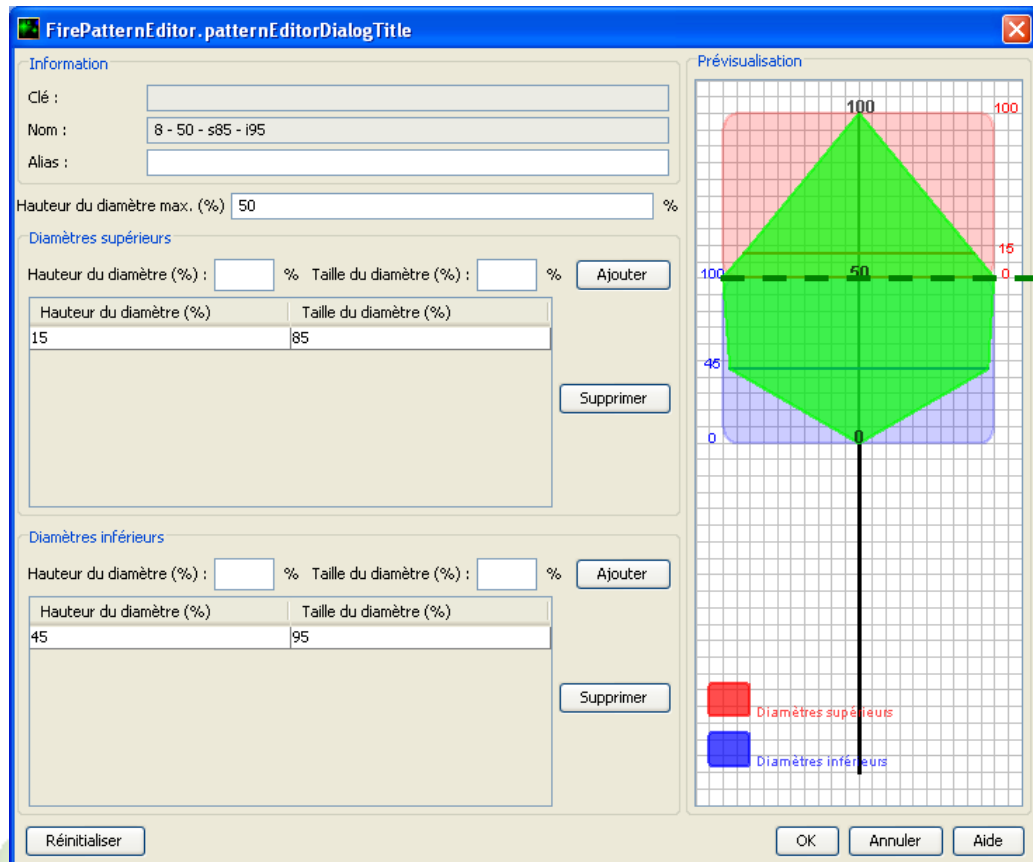
EuroForestFuel
DB4O
Database

```
String dbaction = request.getParameter("action");  
String dbmethod = request.getParameter("method");  
String dbvalue = request.getParameter("value");  
String dbtype = request.getParameter("valueType");  
Long dbID = Long.valueOf(request.getParameter("ID"));  
Object obj = getDbItem(dbID);  
Class objType = obj.getClass();  
if (dbaction.compareTo("update") == 0) result = updateInDb();  
.  
.  
.  
public List<String> updateInDb () {  
    .  
    .  
    .  
    if (dbtype.compareTo("java.lang.String") == 0) {  
        objType.getMethod(dbmethod, String.class).  
            invoke(obj, dbvalue);  
    }  
}
```


FireParadox Pattern Editor

What is a Pattern ?

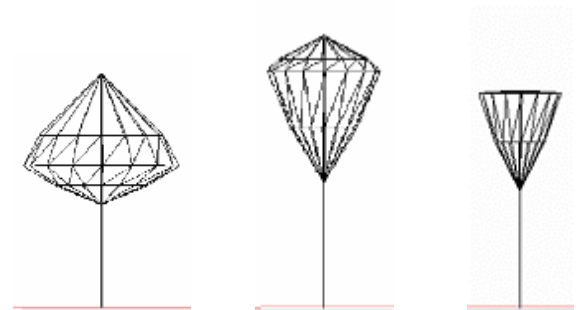
A crown shape defined by upper and lower diameters
capable to be adapted according the height/width of the “central” maximum diameter



Upper diameters

Maximum diameter

Lower diameters



3 shapes of a single pattern
with different max. diameter
values

FireParadox Pattern Editor

Mapping Criteria with Pattern.

Table des patrons

Filtres

☐ Taxons Resineous ☐ Strict ☐ Intervalle [, [☐ Milieu Fermé

Relations Critères/Patrons

+ Taxons	Intervalle	Milieu	Patrons	
Resineous	[, [Fermé	14 - 50 - s0 - s100 - ...	Ajouter
Resineous	[0.0 , 12.0[Fermé	1 - 50 - s60 - s50 - i...	Supprimer
Resineous	[14.0 , 30.0[Fermé	8 - 50 - s85 - i95	Modifier

Prévisualisation

Diamètres supérieurs
Diamètres inférieurs

Client Réinitialiser

Liste des patrons OK Annuler Aide

Criteria based on :

- Taxons (mandatory)**
- Intervals of heights
- Environment (opened/closed)

Liste des patrons

Liste des patrons

1 - 50 - s60 - s50 - i25 - i80 - i65
14 - 50 - s0 - s100 - s0 - i100
cocc-15 - 50 - s60
3 - 40 - s30 - i75
10 - 50
11 - 50
13 - 50
5 - 50 - s50
6 - 50
8 - 50 - s85 - i95
9 - 50

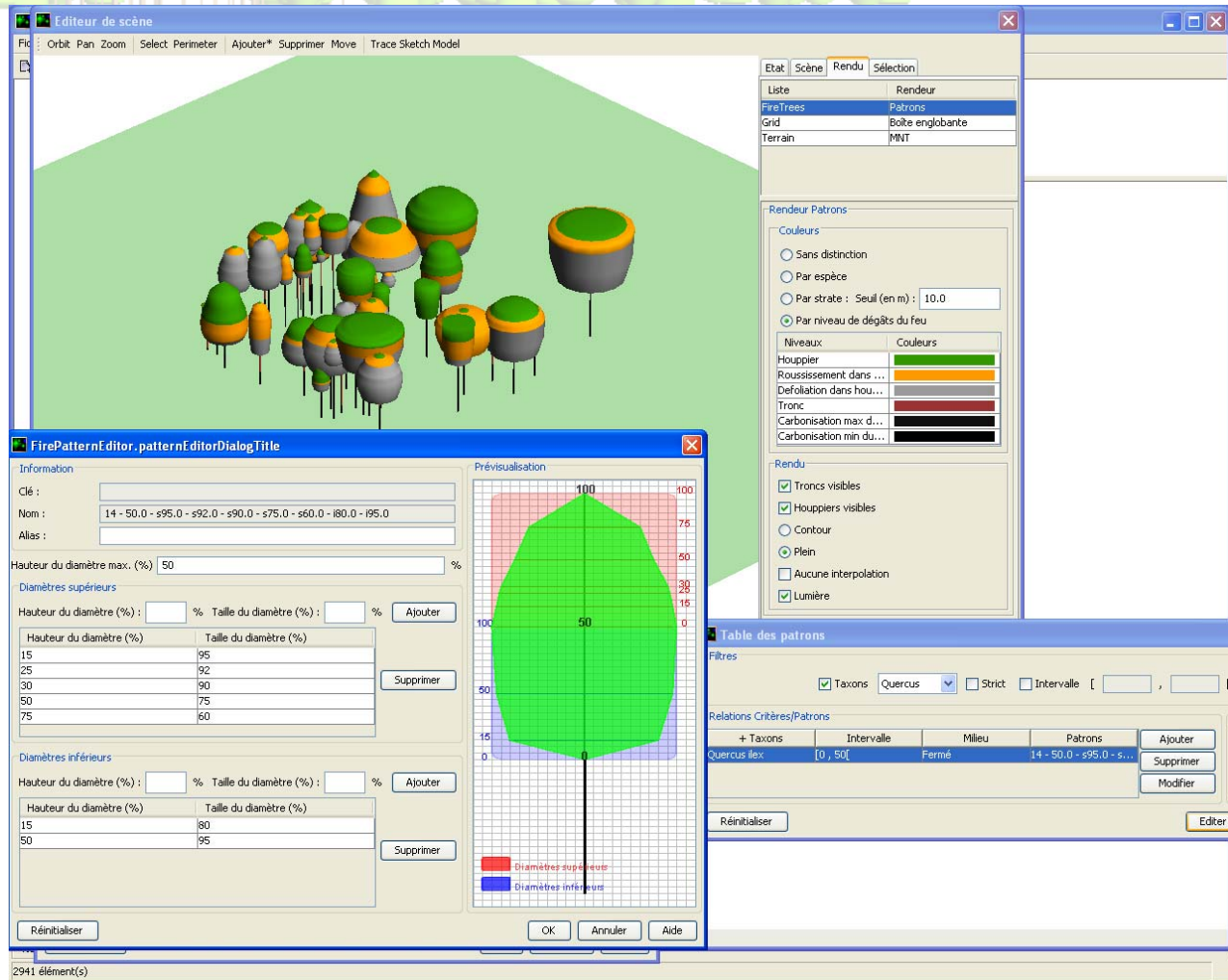
Supprimer Patron
Editer Patron

Prévisualisation

Diamètres supérieurs
Diamètres inférieurs

Réinitialiser OK Annuler Aide

FireParadox Pattern Editor



The renderer finds the most representative pattern for a given tree and computes a revolution surface from the defined 2D profile

Export towards Fire model

- One of the main objectives of the FPFM is to automatically generate input files for 3D fire behaviour models from current vegetation scene.

Export Firetec Monofuel

Firetec Mesh

X axe scene size (m) : 120.0
Y axe scene size (m) : 60.0
X size for Firetec voxel (m) : 2.0
Y size for Firetec voxel (m) : 2.0
Z number of voxel : 10

1. Mesh calculation

X number of voxels : 60
Y number of voxels : 30
Z Total (m) : 23.030933967876265
Z size of voxels (m) :
1.5080309339678764
1.5562165377751336
1.6525877453896491
1.7971445568114222
1.989886972040452
2.2308149910767394
2.5199286139202854

Vegetation insertion

☐ Including twigs

MVR by default (kg/m3) : 700
SVR by default (1/m) : 6000
Height threshold for tree layer/shrub layer (m) : 2
MC by default (tree layer) : 1
MC by default (shrub layer) : 0.7

2. Execute

Output files

treesrhof.dat : treesrhof.dat
tresss.dat : sizescale.dat
treesmoist.dat : moisture.dat
treesfueldepth.dat : actualfueldepth.dat

Done

☒ Control including on Ok **3. File generation** Cancel Help

Perspectives: forest dynamics

Management and climate change

