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Abstract	User's guide for AdriaFirePropagator
Keywords	Wildfire simulation, AdriaFirePropagator, user's guide

1 Content

2 Accessing AdriaFirePropagator

After initiating the AdriaFirePropagator directly from the website, the user is first presented with a login screen, as seen in Figure 1.

Figure 1 – Login screen for AdriaFirePropagator

The login screen is only presented if the user is accessing the AdriaFirePropagator directly. However, if the user is accessing the simulator from the AdriaFireGIS, the user is automatically presented with the main application screen, as seen in Figure 4.

3 AdriaFirePropagator overview

3.1 System overview

The overview of the whole AdriaFirePropagator system is given in Figure 2. The system consists of two basic modules:

- Before Fire Module that include fire behavior modelling and fire spread simulation based on archived meteorological data (education and investigation mode suitable for pre-fire and post-fire activities), and
- During Fire Module that includes fire behavior modelling and fire spread simulation based on real time meteorological data.

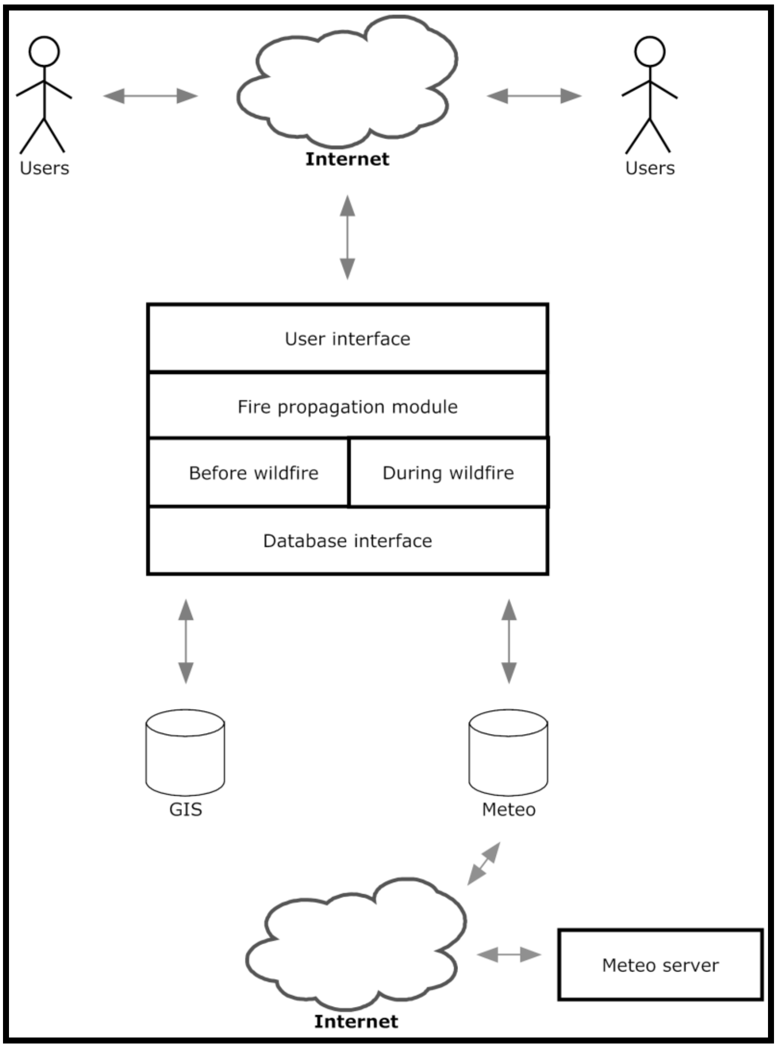

Figure 2 - An overview of the AdriaFirePropagator system

Fire propagation module is a module that is responsible for the actual wildfire simulation. It is a module that requires a set of input data based on which it produces fire simulation results. It runs in the background of the server. After choosing simulation settings, a user initiates a fire simulation from a web-based user interface. If all input data are provided, the fire propagation module produces fire simulation results that are then displayed back to the user using the same web-based user interface.

Fire propagation module is designed for a multi-user environment, meaning that multiple users can start the fire simulation simultaneously and independently. After authenticating with the system, each user is presented with his own user interface, from which he controls all the simulation actions.

Fire propagation module is based on the capabilities of a Geographical Information System (GIS). Another important aspect of this module is the interoperability. Therefore, it requires a clearly defined set of input data. Results are saved in a standard format, allowing any other system with permissions to display the results. The system is conceived as a web based application and that means that the only user interface is a standard web browser. This means that all the data is stored on the server, and all the applications in the fire simulation software are server based programs that run when requested by the users. The users are divided into certain classes of users with different rights and permissions to read, edit or execute certain modules. Users can access the system from any location, using any available wired or wireless ways of accessing the Internet.

There are three main groups of users that use AdriaFirePropagator:

1. System administrator,
2. Firefighting activities planner and
3. Sentry in the firefighting center.

Also, AdriaFirePropagator can be used in two modes:

1. Active mode: that uses real data based on the events happening on the field and current meteorological conditions
2. Simulation mode: used for education and where meteorological data can be either randomly generated or extracted from a meteo database.

In active mode, all the pre-calculations are done automatically and user is only asked to specify certain simulation settings (such as duration of the simulated fire, etc.). In simulation mode, however, the user is asked to specify much more parameters including moisture and wind data. In the latest version of AdriaFirePropagator, it is not necessary to calculate Rate of spread (ROS) each time the user changes wind or moisture parameters thus allowing easier user experience. However, all changes to wind and moisture parameters are automatically taken into account for the following simulations. More about each of these steps will be given in the following of this document.

4 AdriaFirePropagator user interface

Each user is presented with his own user interface (depending on the type of the user and level of access) and his own data, allowing the independent usage of the AdriaFirePropagator system. Therefore, all the simulations initiates or settings the user chooses are his own and independent from the other users. In the main application screen, the user is presented with a geographical map and several additional controls and panels, including:

- Map navigation controls: including zoom and movement controls
- Layer switcher
- Minimap
- Scalebar
- Coordinate display
- Simulation settings information panel
- Menu:
    - Button for terminating any previous calculations
    - “Refresh” button
    - Additional button for layer transparency control
    - “CORINE legend” button
    - Fire barriers controls
    - Fire perimeters controls
    - “Default view” settings controls
    - “Logout” button

The default user view can be set by zooming and panning the camera view to the desired view, and then clicking the “Set as default” button in the lower part of the AdriaFirePropagator user interface. Next time AdriaFirePropagator is web-page is refreshed, the user will be presented with the chosen view. The default view for the first run is shown in Figure 3.

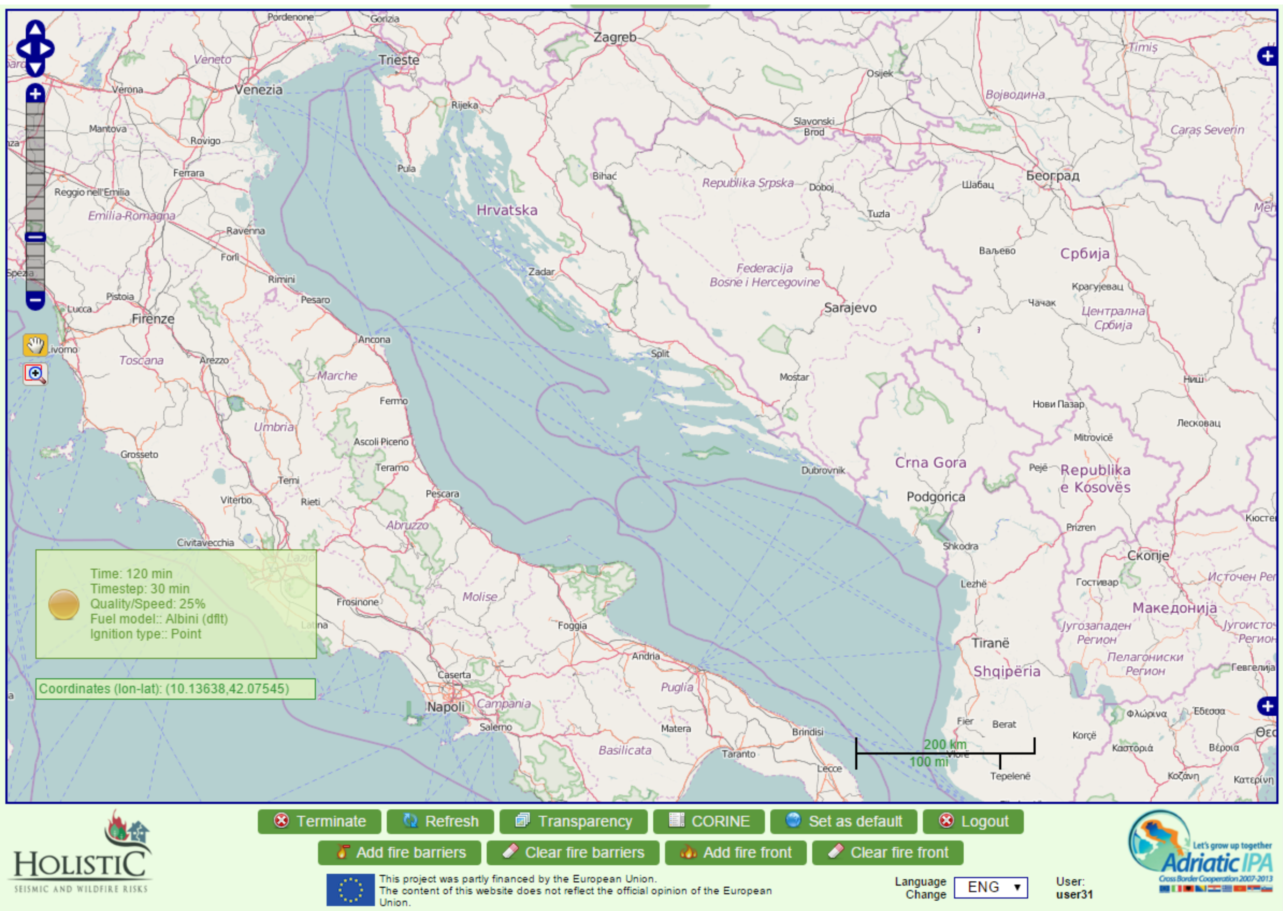

Figure 3 – The default view on AdriaFirePropagator's first run

Figure 4 – The main application screen for AdriaFirePropagator

Figure 5 – Map navigation controls

Map navigation controls are shown in Figure 5. By clicking on "+" sign the user zooms in the map, and similarly, by clicking on the "-" sign the user zooms out. By moving the vertical slidebar the user can also choose the level of zoom he desires.

On top of the vertical slidebar, the user is presented with four arrow buttons that can be used to move the map in the desired direction. The "easier" way to move the map is to click-and-hold anywhere on the map and move the mouse pointer in the direction where the user wants to navigate. Also, the map can be moved by using arrow keys on the keyboard, as well as "+","-","Page Up","Page Down", "Home" and "End" keys. The user can also choose between pan and zoomToExtent controls.

In the lower left corner of the user interface, the user is presented with a coordinate display panel, as seen in Figure 6. The coordinates represent the location of the point on the map underneath the mouse cursor, and as such change automatically as the mouse cursor moves.

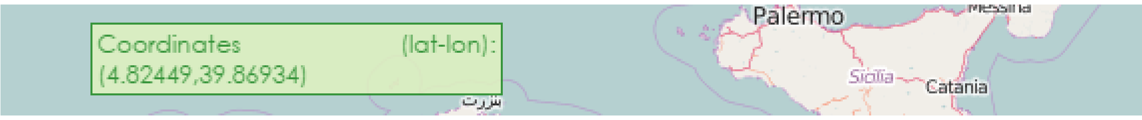

Figure 6 – Coordinate display panel

The scalebar represents distances on the map, in this cases displayed in both kilometers and miles. As the user navigates the map, the scalebar automatically updates. The scalebar is presented in Figure 7.

Figure 7 – The scalebar in AdriaFirePropagator

The layer switcher (shown in Figure 9) allows the user to choose the layers he wishes to see displayed on the map. The layers are divided into two categories:

- Base layers
- Overlays

The user can choose only a single base layer per map, and as such this layer represents the main layer over which other layers are displayed. In our case, the user is given a choice of 5 base layers:

- Google satellite
- Google hybrid
- Google street
- Google physical
- Open street map

Examples of base layers are given in Figure 8.

Figure 8 – Four different base layers

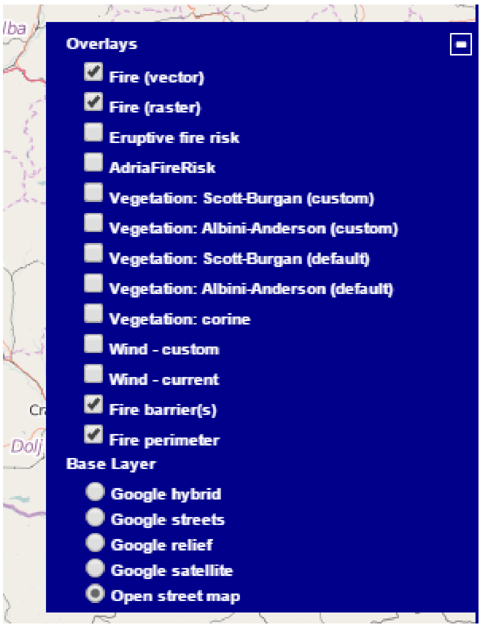

Figure 9 - Layer switcher panel

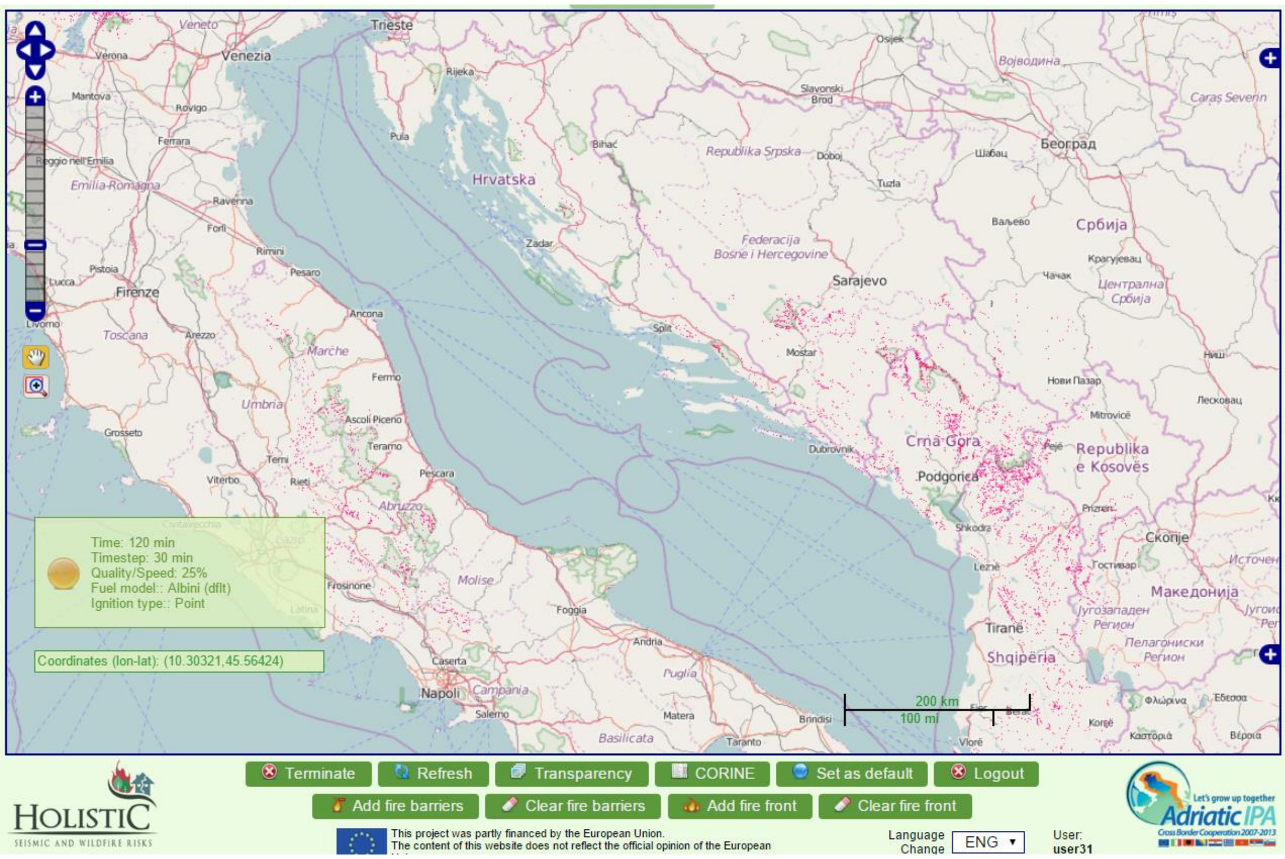

Figure 10 – An example of eruptive fire risk layer

After choosing the base layer for his map, the user can choose the layers he wishes to see overlayed over the base layer. In the contrast to the base layer, as we will see in the following of this document, the user has more control over these overlays.

First two overlays: Fire (vector) and Fire (raster) are the most important overlays in the terms of AdriaFirePropagator, as they represent the result of the fire spread simulation. More information about simulation results will be given in the following of this document.

Eruptive fire risk layer represents the risk map labelling current regions where eruptive fires might occur. An example of such layer is given in Figure 10.

AdriaFireRisk overlay displays the result of the current AdriaFireRisk calculation for the visible area, as seen in Figure 12.

The following five overlays represent vegetation, or in other word, fuel categories. First two overlays (Vegetation – Scott-Burgan (custom), Vegetation – Albini-Anderson (custom)) represent user's custom fuel maps that can be imported from AdriaFireGIS by request. These fuel maps represent 40 Scott-Burgans and 13 Albini-Anderson fuel categories. However, the user can not only import his own fuel maps, but can also change the parameters for all fuel map categories, thus allowing him to fully personalize fuel models for his needs. Any change the user makes to these categories will influence the simulation results. Nevertheless, any change the user makes is independent of the other users and will not influence their simulations. The procedure for both obtaining user's custom fuel maps and setting/changing fuel parameters will be given later in this document.

Layers Vegetation – Scott-Burgan (default), Vegetation – Albini-Anderson (default) represent the same 40 Scott-Burgans and 13 Albini-Anderson fuel categories, however these are the default maps with default parameters common to all the users using the AdriaFirePropagator system. An example of classification of geographical area into 40 Albini-Anderson (default) fuel categories is given in Figure 13.

Last layer in this group is the "Vegetation: corine" layer that shows Corine Land Cover in its original form. It represents land cover land use categorization on geographical area. More information about CORINE land cover, land use can be obtained by clicking on the "CORINE legend" button which is located in the lower part of the AdriaFirePropagator user interface, as seen in Figure 11.

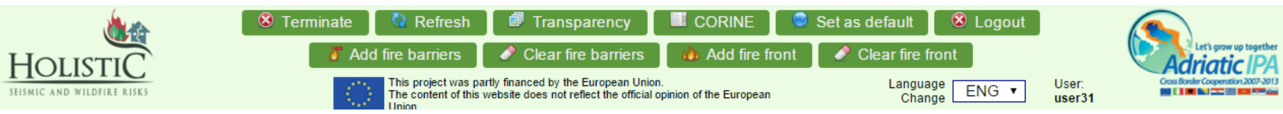

Figure 11 – "Refresh", "Transparency" control, "CORINE", fire barriers control buttons and fire perimeters control buttons, "Terminate previous calculations", "Set as default view", Logout

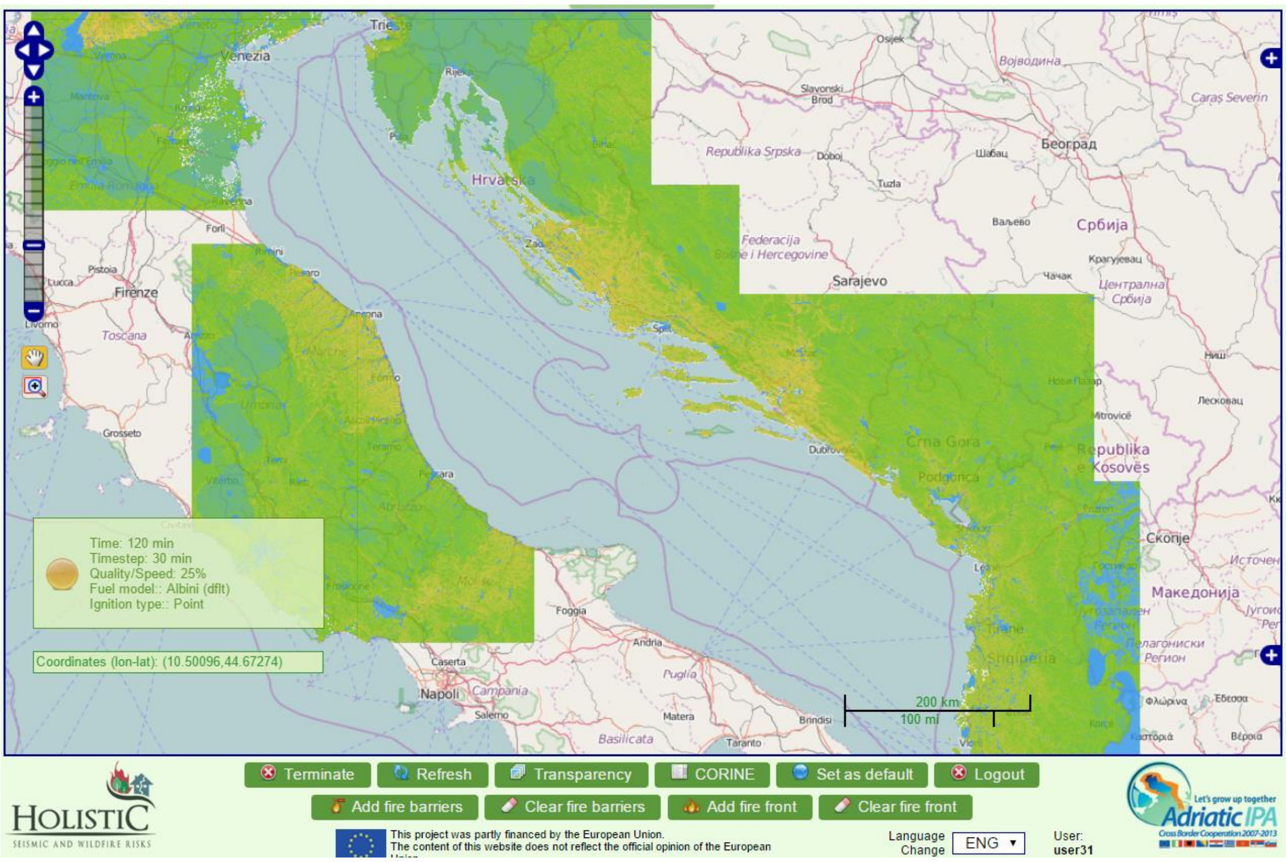

Figure 12 – AdriaFireRisk as an overlay in AdriaFirePropagator

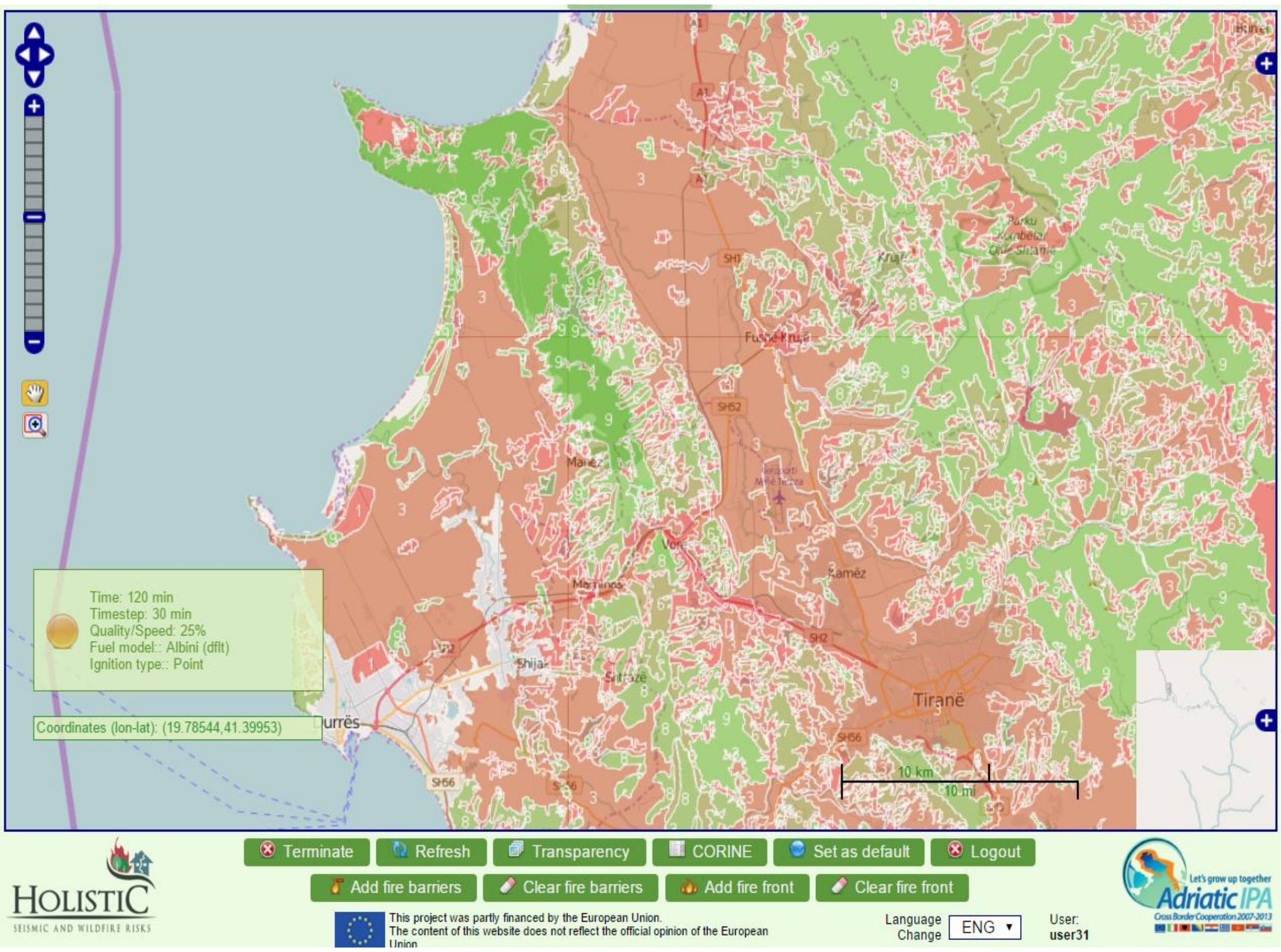

Figure 13 - Overlay – Vegetation – Albini-Anderson (default) fuel categories

After clicking on the “CORINE legend” button, the user is presented with the description of land cover land use categories, as seen in Figure 14.

CORINE classification (CLC 2000)

CORINE class 3rd level

Code	Description
111	Continous urban fabric
112	Discontinous urban fabric
121	Industrial or commercial units
122	Road and rail networks and associated land
123	Port areas
124	Airports
131	Mineral extraction sites
132	Dump sites
133	Construction sites
141	Green urban areas
142	Sport and leisure facilities
211	Non-irrigated arable land
212	Permanently irrigated land
221	Vineyards
222	Fruit trees and berry plantations
223	Olive groves
231	Pastures
242	Complex cultivation patterns
243	Land principally occupied by agriculture
311	Broad-leaved forest
312	Coniferous forest
313	Mixed forest
321	Natural grasslands
322	Moors and heathland
323	Sclerophyllous vegetation
324	Transitional woodland-shrub
331	Beaches, dunes, sands
332	Bare rocks
333	Sparsely vegetated areas
334	Burnt areas
411	Inland marshes
421	Salt marshes
422	Salines
423	Intertidal flats
511	Water courses
512	Water bodies
521	Coastal lagoons
523	Sea and ocean

Source: European Topic Centre on Land Use and Spatial Information - Detailed

CLOSE

Figure 14 - CORINE land cover land use categories

Next two overlays display wind conditions. In the first case, custom wind conditions are displayed, or in other words, the wind conditions the user wants to use for his fire spread simulations based on custom conditions. The procedure how to change those wind parameters will be given in the following of this document. The last overlay represent current wind conditions obtained from Croatian meteorological and hydrological service. Wind is represented by arrows, where type and color of arrows represent wind speed, and arrow angle represents wind direction. Please note that this overlay requires couple of seconds to be displayed.

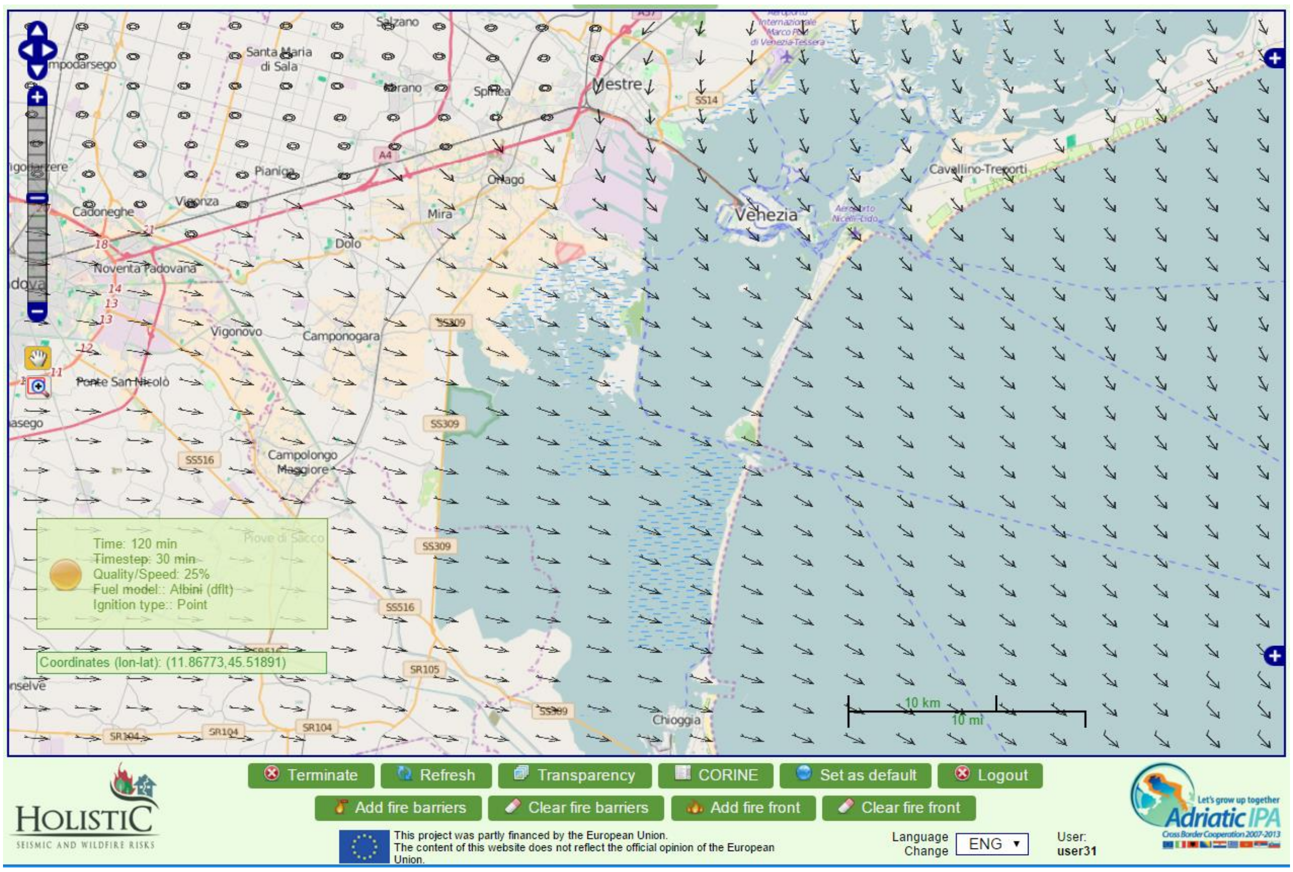

Figure 15 – An example of Wind conditions overlay

Next layer is “Fire barrier(s)” and is used to display polygons that the user wants to use as fire barriers for his custom simulations. More concerning fire barriers is given later in this document.

The last layer is “Fire perimeter” layer, used to define fire ignition point/area. More on this subject will be given later in this document as well.

As stated earlier, the user is presented with more control over overlays then over base layers. After clicking on the “Transparency control” button (as seen in Figure 11), the user is presented with a user interface where he can choose the transparency level of a given overlay, as seen in Figure 16.

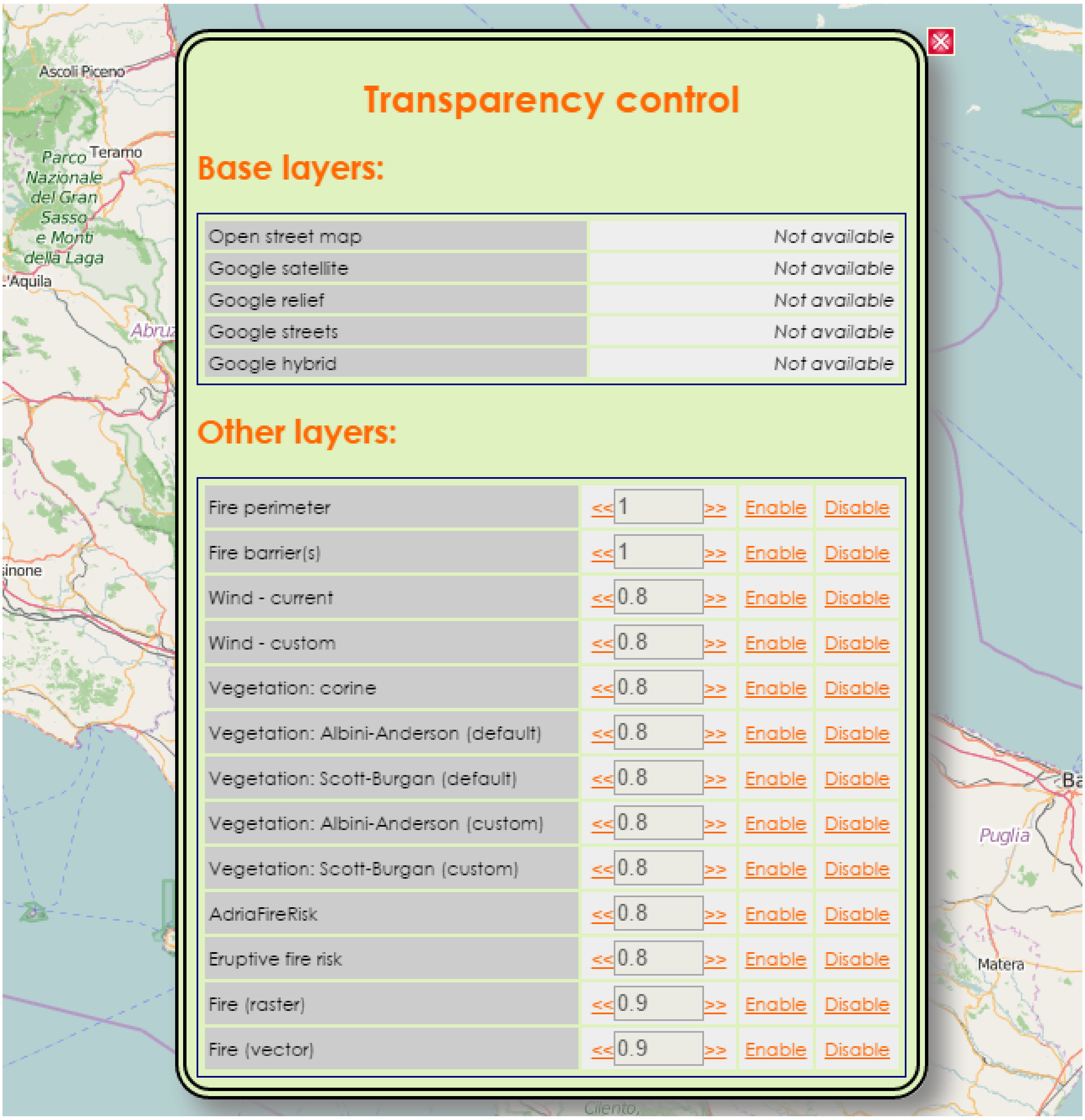

Figure 16 – Transpaerncy control UI

Another map control that has to be mentioned is a minimap. This control can be found in the lower left corner of the AdriaFirePropagator user interface, as seen in Figure 17.

Apart from showing the location of the current view on a smaller map that covers larger geographical area, minimap can also be used to navigate the current view.

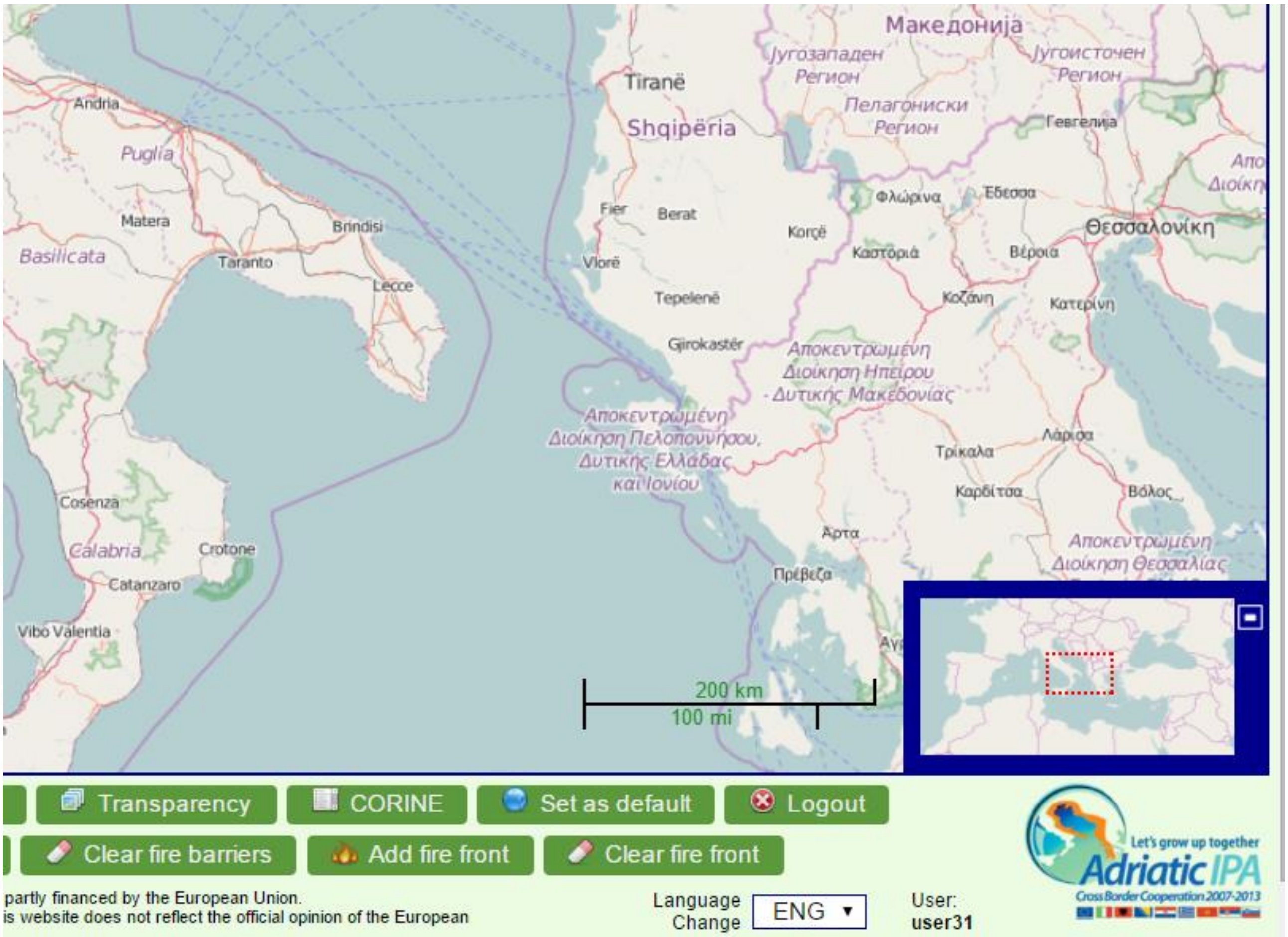

Figure 17 – Minimap in the lower right corner of AdriaFirePropagator

“Simulation settings” panel that can be found in the lower left part of the AdriaFirePropagator user interface, as seen in Figure 18.

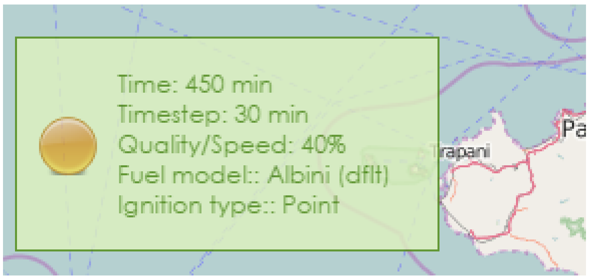

Figure 18 - Simulation settings panel

This panel displays all the relevant information about the simulation, such as duration of the fire that is to be simulated, timestep used to connect the fire-front at given time moment, ratio between the quality and speed of the simulation, a chosen fuel model, and finally chosen ignition type. More about these settings will be given in the following sections of this document.

Another important user interface component is the Contextual menu that is displayed after a right mouse click anywhere on the map, as seen in Figure 19. In the following Section we will explain in detail all the options from this contextual menu and how to actually run simulations based on chosen parameters.

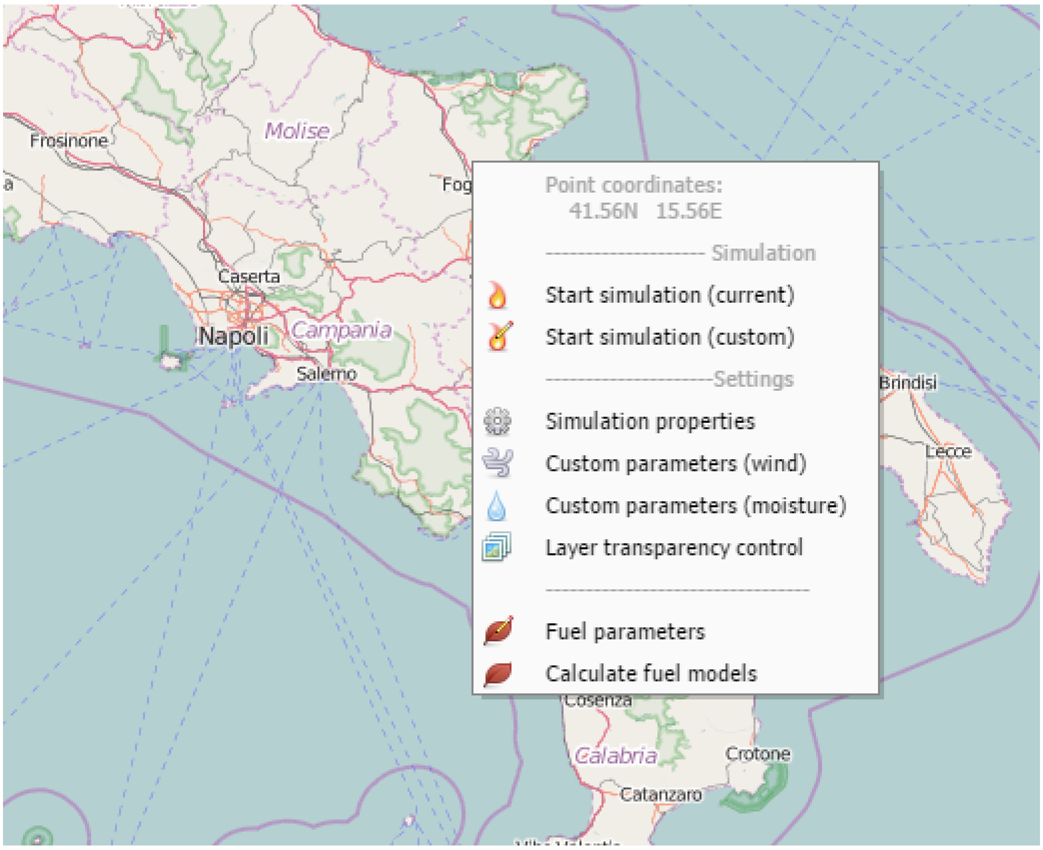

Figure 19 - Contextual menu of AdriaFirePropagator

Each time the user initiates some kind of calculation, “Running icon” appears in the screen, as seen in Figure 20. There are several reasons that can cause “Running icon” to appear:

- Running simulations in any mode
- Obtaining meteorological data from meteorological database
- Calculation of fuel models

This icon will appear when calculations are preformed even if AdriaFirePropagaor web page is reloaded. This is because all the calculations are run in the background.

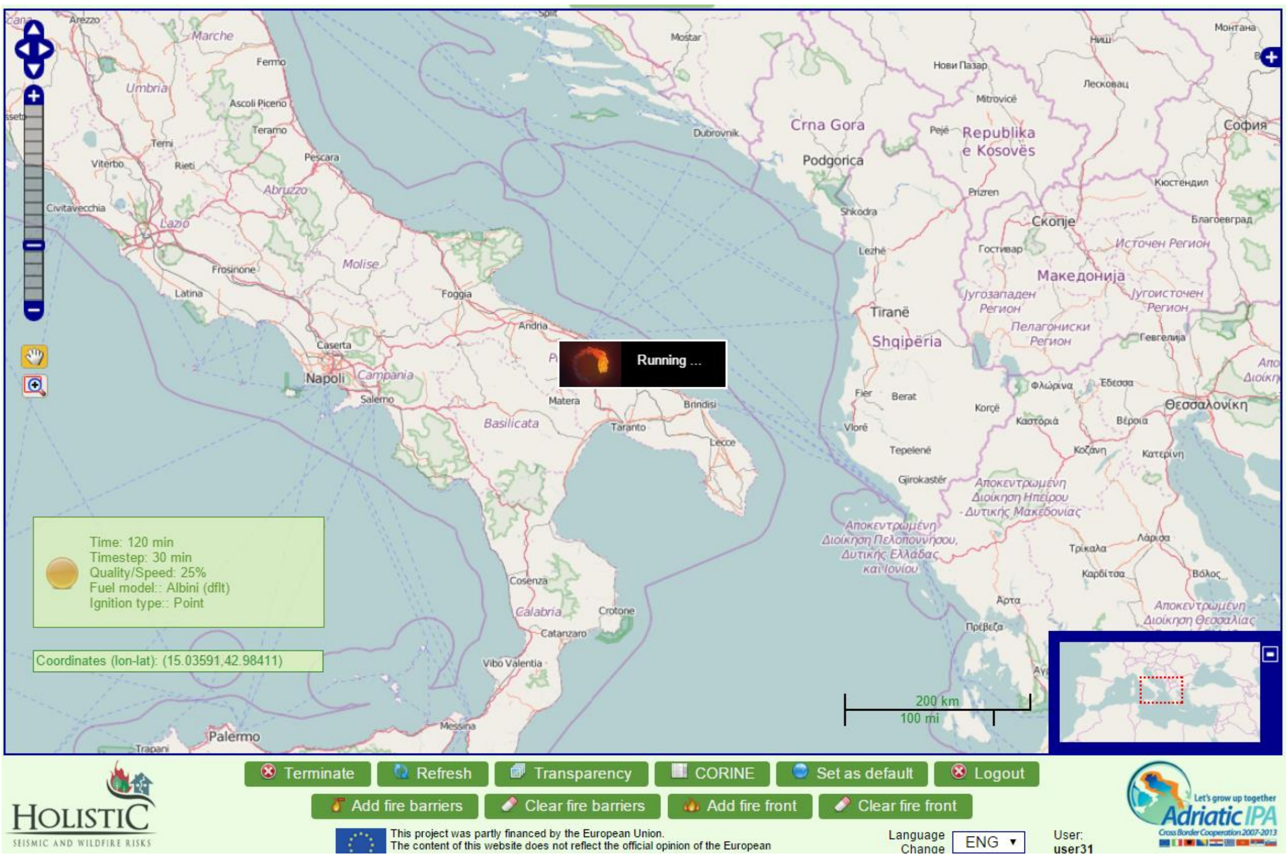

Figure 20 – “Running” icon showing that some kind of calculations is running in the background

5 Preparing the simulations

5.1 Contextual menu

Contextual menu appears after right clicking anywhere on the map. It consists of 9 items, as can be seen from Figure 21.

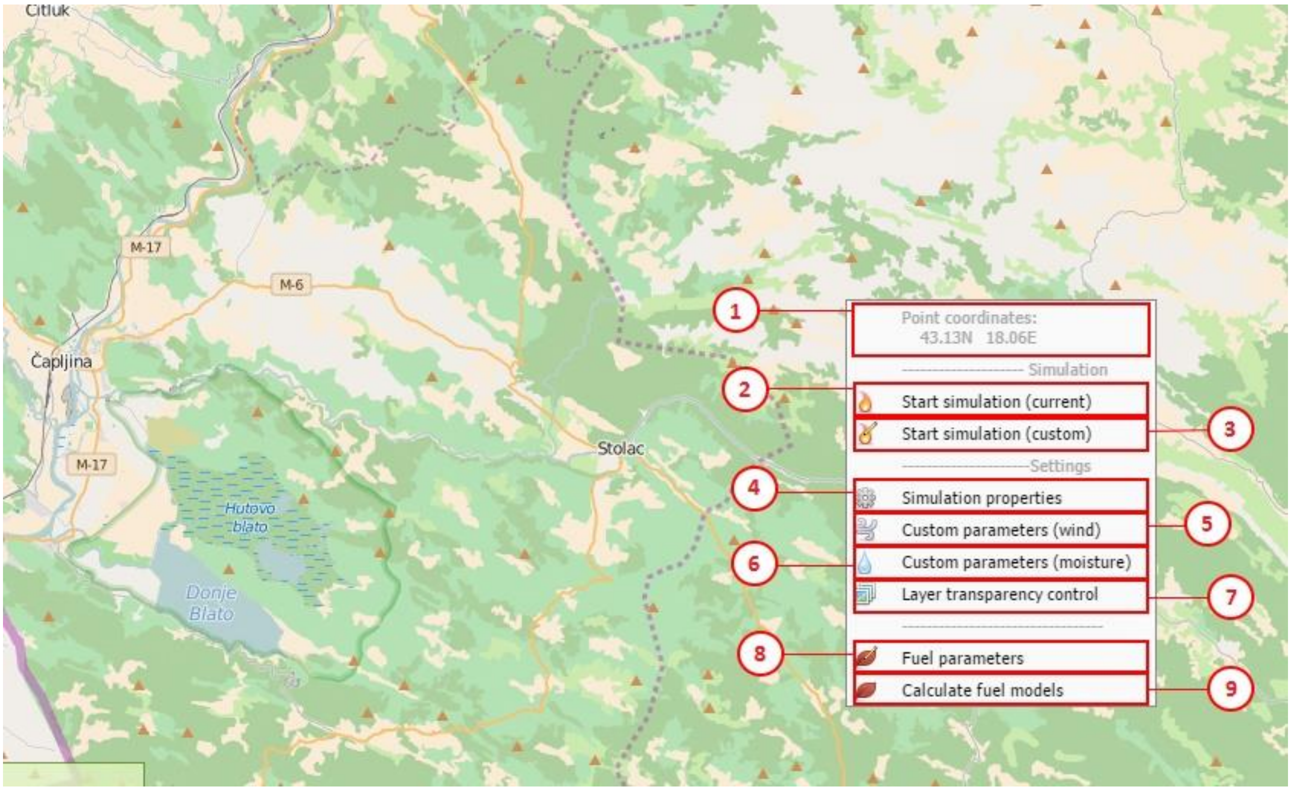

Figure 21 - Items of the contextual menu

5.1.1 Item 1 – Point coordinates

The first item represents latitude/longitude coordinates of the point clicked on the map. Also, it represents the coordinates that will be chosen as the source of the fire to be simulated if simulation is to be started.

The following group of items is used to start the actual simulation, either in active or simulation mode:

3. Active mode: that uses real data based on the events happening on the field and current meteorological conditions

4. Simulation mode: used for education and where meteorological data can be either randomly generated or extracted from a meteo database.

5.1.2 Item 2 – Start simulation (current)

This item is used to star the simulation based on current conditions prevailing in the scene, or in other words in active mode. All the required data is obtained automatically, however, the user is still required to specify simulation properties.

5.1.3 Item 3 – Start simulation (custom)

This item is used to start the simulation based on custom conditions prevailing in the scene, or in other words in simulation mode. Not only that the user must specify simulation properties, but must also provide data to be used for the simulation, such as wind speed and direction, as well as moisture data.

The following group of items deals with specifying simulation settings.

5.1.4 Item 4 – Simulation properties

Simulation properties – after clicking on this item, the user is presented with a new UI control by which he can choose several simulation options, as seen in Figure 22. This includes setting the expected duration and time of the wildfire, timesteps that will be used to mark the fire front at certain time instant, etc. Also, the user here selects the quality of the simulation, what is important since higher quality of the simulation comes at a non-negligible cost of time required to run the simulation. The user can also choose the fuel model for the simulation. Four different fuel models are to be chosen from:

- Default Albini-Andersons' – original 13 categories
- Default Scott-Burgan's – original 40 categories
- Modified 13 categories (Albini-Andersons' custom) – based on fuel parameters modification that will be described later in this document
- Modified 40 categories (Scott-Burgan's custom) – based on fuel parameters modification

Finally, the user can choose ignition type: either a point or fire perimeter. If point is chosen, fire ignition will be the point on the map where user has clicked before starting the simulation. If perimeter is chosen, the ignition area will be polygons the user has drawn on the map.

5.1.5 Item 5 – Custom parameters (wind)

The following item "Custom parameters (wind)" is strongly connected with item 3 - "Start Simulation (custom)". By clicking on this item, the user is presented with the possibility to specify wind conditions (wind speed and wind direction) that will be used for simulation mode of AdriaFirePropagator. The user is presented with the UI control shown in Figure 23. Please note that all geographical data provided to the system concerning wind must be in projection EPSG:900913.

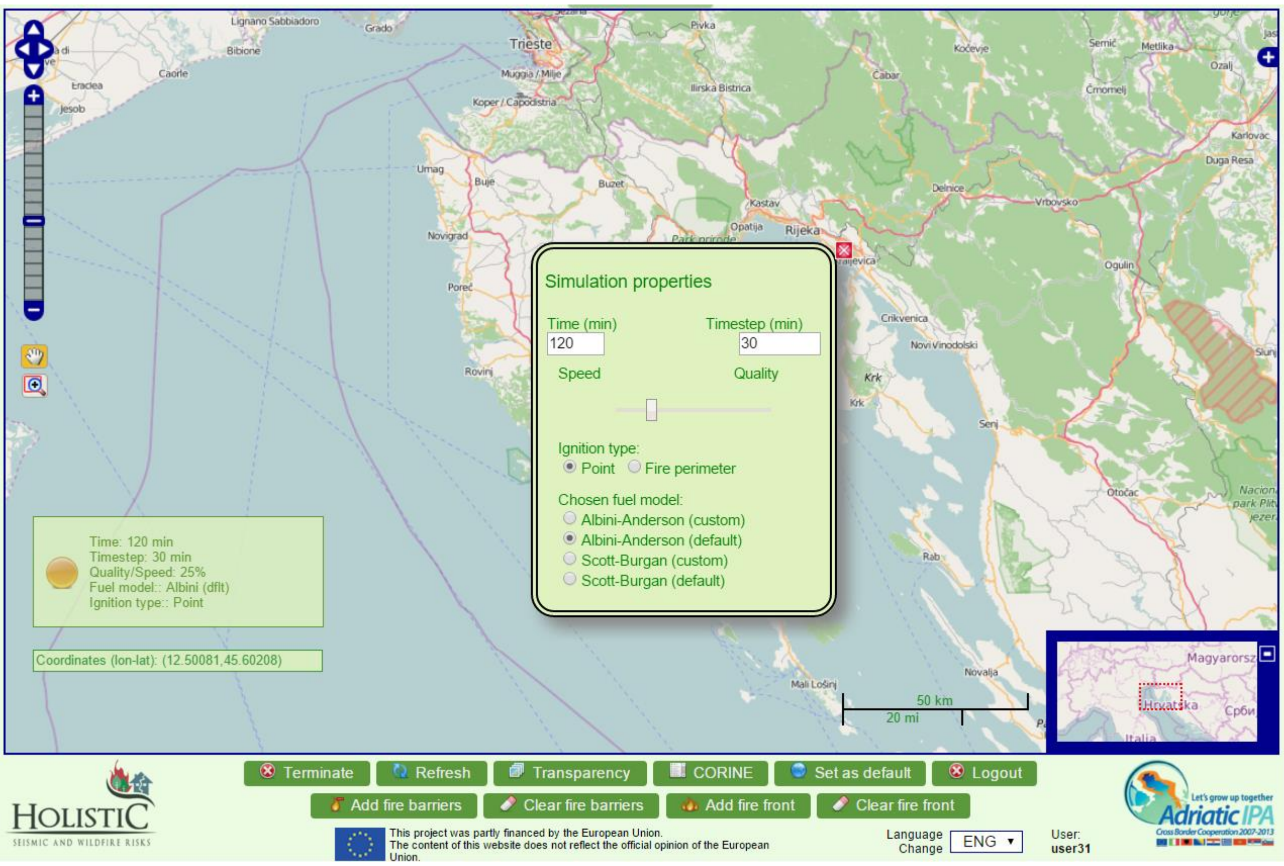

Figure 22 - Simulation properties

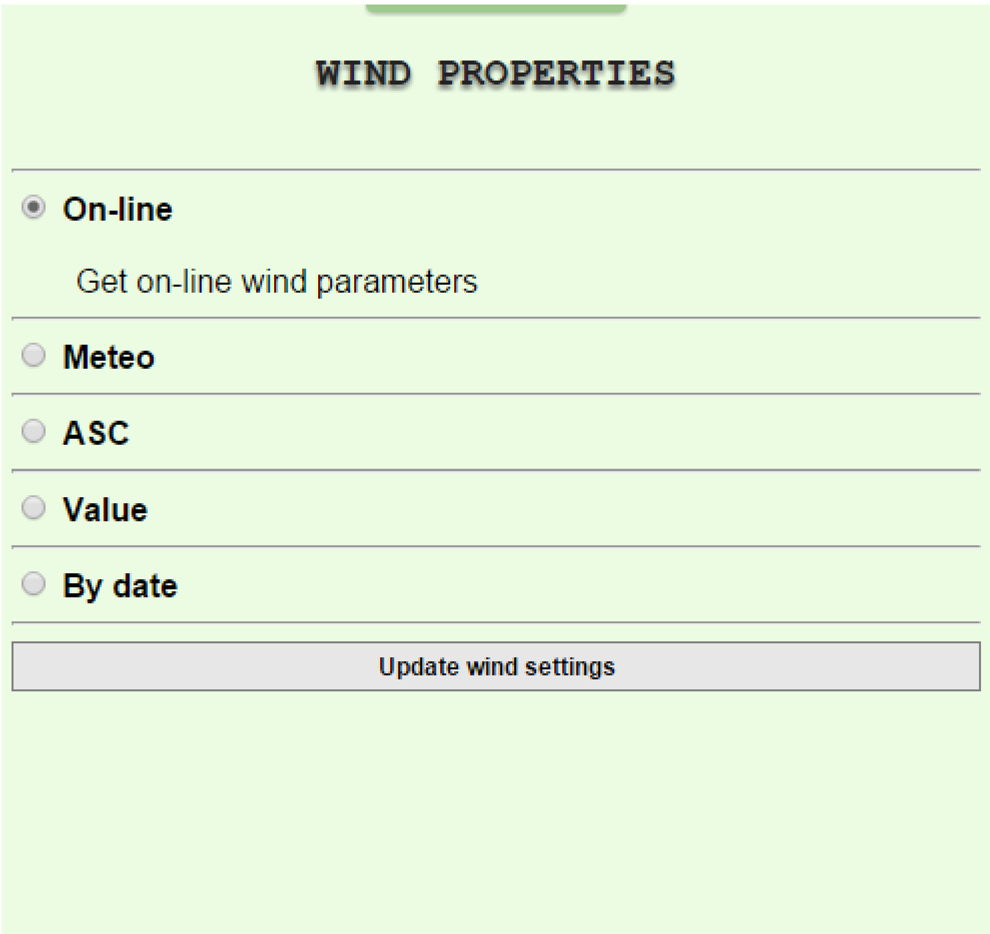

Figure 23 - Custom parameters (wind) settings

The user can choose wind parameters in 5 different ways:

- **The first option** is to choose current (on-line) wind conditions prevailing in the scene.
- **The second option** is to choose a meteo file that holds the information about wind parameters. An example of meteo file is given by the following figure:

```
BROJ_TOCAKA_X_:    72
BROJ_TOCAKA_Y_:   110
_START_MODELA_:  2008091100
_BROJ_TERMINA_:    25
LO.LONG LA.LATI K   U+00   V+00   U+03   V+03   U+06   V+06   U+09   V+09   U+12   V+12
16.0000 42.5073 0   2.09  -1.96   3.00  -2.19   2.33  -1.48   3.76  -2.79   0.65  -0.61
16.0244 42.5073 0   2.11  -1.98   2.99  -2.20   2.34  -1.48   3.82  -2.84   0.56  -0.60
16.0488 42.5073 0   2.13  -2.01   2.95  -2.20   2.34  -1.50   3.86  -2.87   0.51  -0.58
16.0732 42.5073 0   2.15  -2.01   2.93  -2.18   2.35  -1.51   3.90  -2.90   0.55  -0.60
16.0976 42.5073 0   2.17  -1.98   2.93  -2.15   2.38  -1.50   3.92  -2.93   0.61  -0.62
16.1219 42.5073 0   2.17  -1.98   2.90  -2.11   2.38  -1.49   3.93  -2.94   0.69  -0.62
16.1463 42.5073 0   2.20  -2.00   2.88  -2.09   2.39  -1.50   3.97  -2.95   0.84  -0.63
16.1707 42.5072 0   2.25  -2.03   2.90  -2.09   2.42  -1.53   4.03  -2.99   0.97  -0.66
16.1951 42.5072 0   2.30  -2.05   2.93  -2.09   2.43  -1.56   4.06  -3.00   1.07  -0.67
16.2195 42.5071 0   2.36  -2.06   2.97  -2.07   2.43  -1.57   4.08  -3.00   1.23  -0.68
16.2439 42.5071 0   2.43  -2.05   3.03  -2.04   2.47  -1.58   4.11  -3.01   1.38  -0.69
16.2683 42.5070 0   2.47  -2.02   3.10  -2.03   2.50  -1.59   4.13  -3.00   1.47  -0.68
16.2927 42.5070 0   2.50  -1.99   3.17  -2.02   2.54  -1.59   4.15  -2.99   1.57  -0.69
16.3171 42.5069 0   2.56  -1.99   3.25  -2.03   2.60  -1.61   4.17  -2.98   1.69  -0.70
16.3415 42.5068 0   2.59  -1.99   3.29  -2.03   2.65  -1.62   4.16  -2.95   1.74  -0.71
16.3658 42.5067 0   2.58  -1.99   3.30  -2.04   2.68  -1.62   4.12  -2.89   1.77  -0.70
```

Figure 24 - An example of a meteo file holding the information about wind

Meteo file shown in Figure 24 is calculated and provided by Croatian Meteorological and Hydrological service, and is retrieved twice a day for a next 12 hours in 3 hours resolution (U+00, U+03 ...) as geo referenced data with spatial resolution of 2 km. In this case, U and V are wind vector components, while +XX represents the forecast for next couple of hours. This forecast can also be used in AdriaFirePropagator. To successfully choose wind parameters, the user must also select the forecast (+hour), as seen in Figure 25.

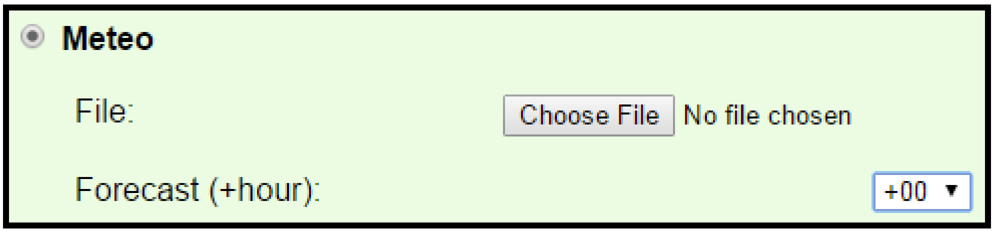

Figure 25 - Meteo file as the option for setting of wind parameters

- **The third option** is to choose ASC files, as shown in Figure 26. In this case, the user must provide two ASC files, one that holds information about wind speed, and one that holds information about wind direction. Wind speed is expressed in km/h, while wind direction in degrees.

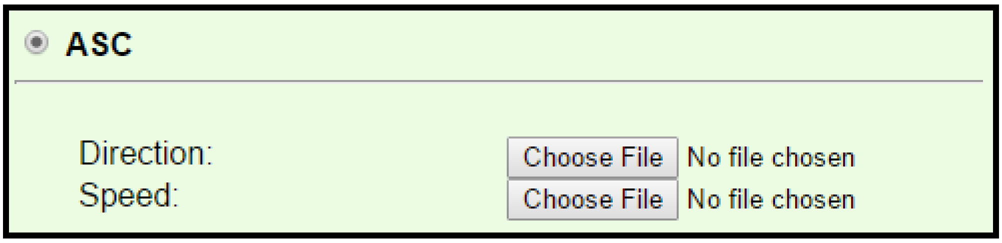

Figure 26 - ASC files as option for setting of wind parameters

An example of ASC file holding information about wind direction is given in Figure 27.

```
ncols 25
nrows 17
xllcorner 5514444.38886601
yllcorner 4849754.56117183
cellsize 608.416155
NODATA_value -9999
0 0 0 0 0 0 0 0 0 6 27 168 82 249 249 249 249 249 249 249 0 0 0 0 0
0 0 0 0 0 0 0 135 24 6 27 27 27 45 249 249 249 249 249 249 0 0 0 0 0
0 0 0 0 0 0 0 90 65 165 165 182 45 45 27 249 249 249 249 249 0 0 0 0 0
0 27 6 6 223 0 27 166 154 28 174 27 76 27 27 27 249 249 249 249 249 249 249 249 249
27 6 27 6 27 0 169 45 200 155 29 27 27 6 27 27 27 249 249 249 249 249 249 249 249
27 6 27 0 0 0 27 45 52 195 186 31 6 27 27 27 6 45 249 249 249 249 249 249 249
6 6 6 27 27 6 27 165 57 223 154 223 169 27 27 27 27 27 27 6 249 249 249 249 249
249 27 6 0 6 6 27 6 80 186 124 60 230 162 37 27 27 6 27 27 45 249 249 249 249
249 249 27 6 27 45 27 27 6 27 234 222 227 200 162 26 27 27 27 6 6 6 249 249 249
249 249 249 27 45 27 27 69 6 31 45 34 222 175 246 154 31 27 27 6 27 6 6 249 249
249 249 249 249 45 45 27 27 244 27 0 45 45 223 179 247 37 31 6 27 27 6 27 27 249
249 249 249 249 249 249 27 27 27 223 45 27 27 80 195 227 165 237 154 84 6 6 45 27 45
249 249 249 249 249 249 249 45 45 61 45 27 45 45 31 81 234 195 223 196 27 27 6 27 27
249 249 249 249 249 249 249 249 45 26 27 27 27 27 27 27 161 172 63 201 162 168 24 6 27
249 249 249 249 249 249 249 249 249 45 197 187 76 45 45 45 51 179 175 61 237 162 24 6 27
0 0 249 249 249 249 249 249 249 249 45 27 27 45 27 45 27 27 161 128 61 131 175 0 0
0 0 0 249 249 249 0 249 249 249 249 27 27 27 24 27 27 27 27 174 236 230 154 0 0
```

Figure 27 - An example of ASC file holding the information about wind direction

- **The fourth option** is to set uniform values for wind speed and wind direction for the whole region, as seen in Figure 28. Wind speed is expressed in km/h, while wind direction in degrees. Please note that the system will not allow values outside expected range.

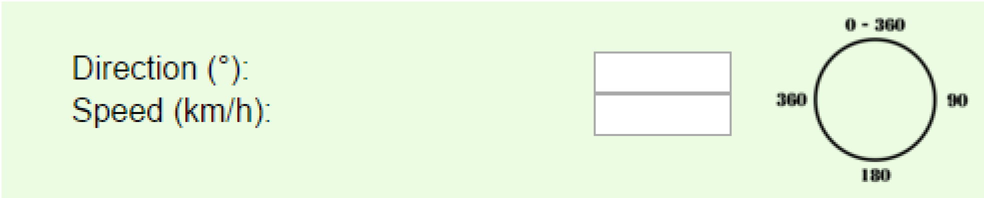

Figure 28 - Wind direction and speed as uniform values for the whole region

- **The fifth option** is to obtain wind data from meteorological database. The user is expected to select the date and hour, as seen in Figure 29.

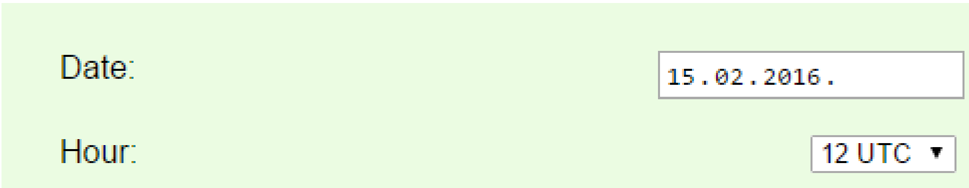

Figure 29 – Wind data obtained from meteorological server (by date and hour)

5.1.6 Item 6 – Custom parameters (moisture)

Similarly to wind, the user can select several choices how to set custom moisture parameters. After choosing this item from the contextual menu, the user is presented with the following UI control:

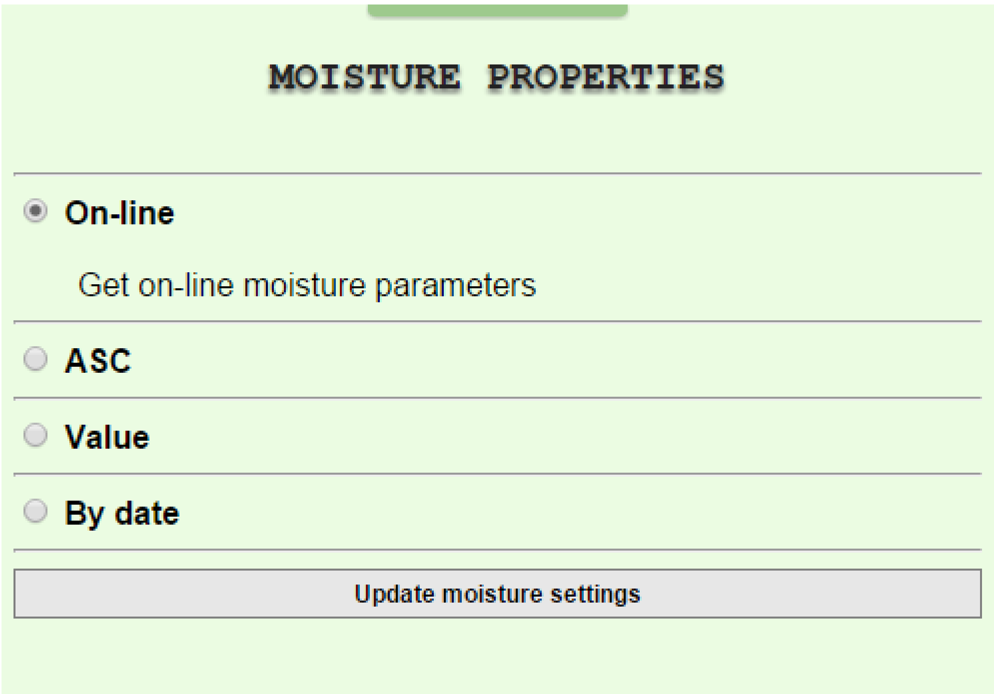

Figure 30 - Custom parameters (moisture) settings

- **The first option** – similarly to wind options, the user can obtain current (on-line) moisture parameters for his custom ones.
- **The second option** – The user can choose ASC files to represent moisture values, as seen in Figure 31. The user is asked to specify at least two out of four ASC files. The files that user does not specify are calculated automatically.

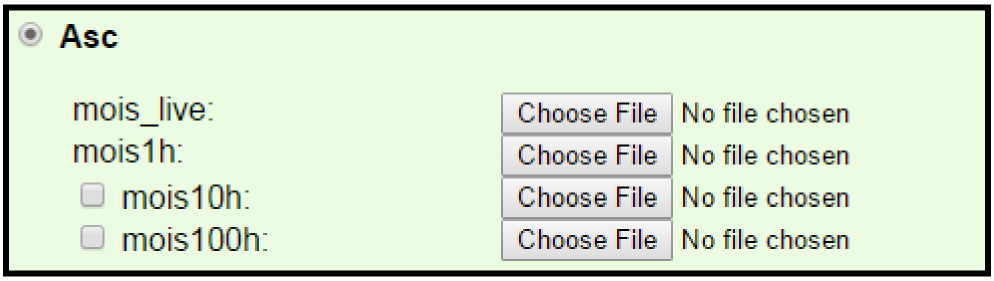

Figure 31 - Setting the moisture parameters by using ASC files

Required moisture data are the following: live (herbaceous) fuel fuel moisture (percentage content multiplied by 100), 1-hour (<.25") fuel moisture (percentage content multiplied by 100), 10-hour (.25-1") fuel moisture (percentage content multiplied by 100), 100-hour (1-

3") fuel moisture (percentage content multiplied by 100).

- **The third option** – The last option is to provide single values for live (herbaceous) fuel fuel moisture, 1-hour (<.25") fuel moisture, 10-hour (.25-1") fuel moisture, 100-hour (1-3") fuel moisture. Please note that the system will not allow values outside expected range.

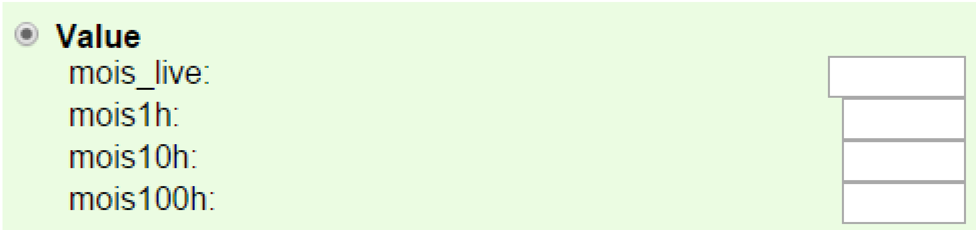

Figure 32 - Setting the moisture parameters as a single value for the whole geographical area

- **The fourth option** – obtain moisture data from meteorological database. The user is expected to select the date and hour, as seen in

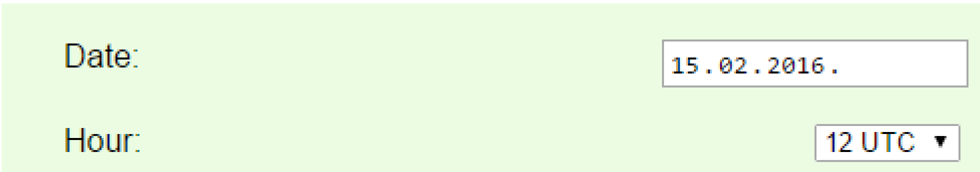

Figure 33 – Setting the moisture parameters by obtaining data from the meteorological server

5.1.7 Item 7 – Layer transparency control

Layer transparency control opens the same UI control as seen in Figure 16.

5.1.8 Item 8 – Fuel parameters

By selecting the “Fuel parameters” control, the user is presented with a new UI control where he can modify the fuel parameters for his simulations. Please note that AdriaFirePropagator is a multi-user system, however, and any change to these parameters do NOT influence other users, but only the one user who made the changes. Any changes to fuel parameters will influence only “Vegetation: Scott-Burgan (custom)” and “Vegetation: Albini-Anderson (custom)” layers. Please note that this will not modify “Vegetation: Scott-Burgan (default)” and “Vegetation: Albini-Anderson (default)” in any way, since those layers are default fuel models common to all the users of AdriaFirePropagator.

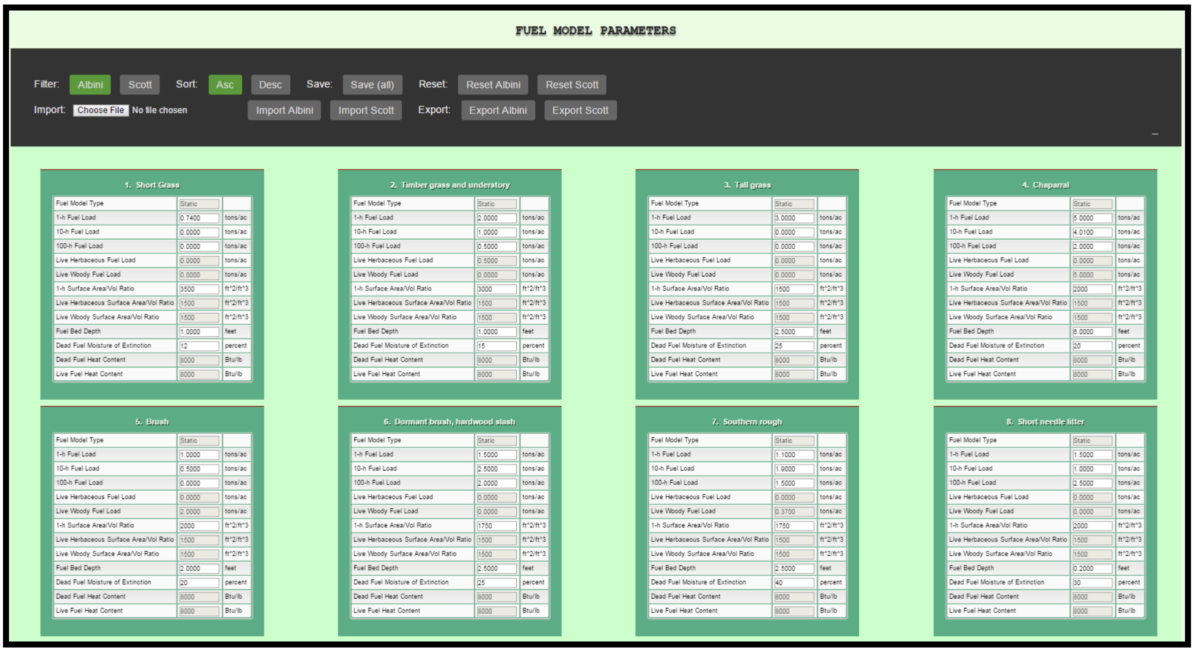

Figure 34 - Fuel parameters UI control

Figure 34 shows the user interface that gives the user the control over fuel parameters. As seen in Figure 35, the menu consists of 8 components.

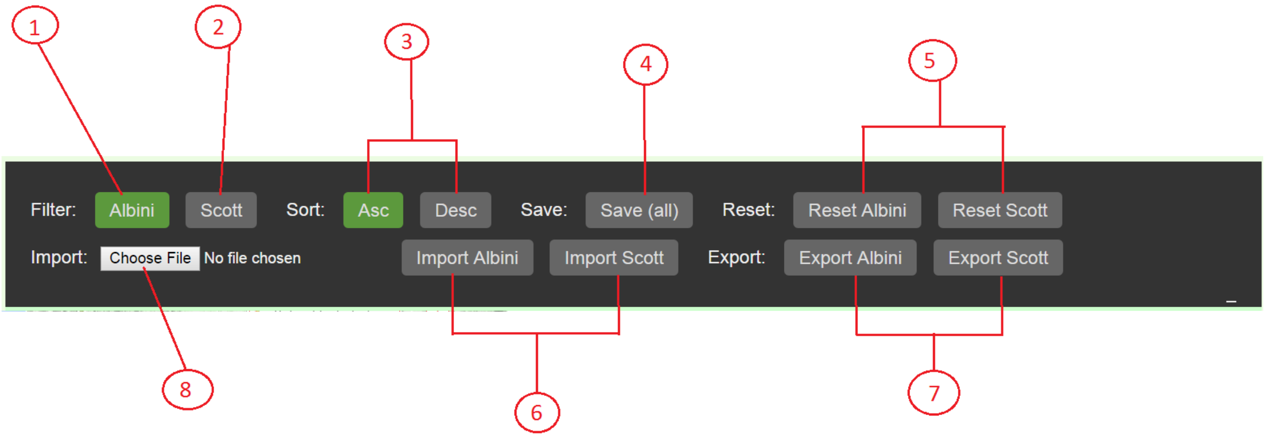

Figure 35 - Menu of the fuel parameters UI control

First, the user can choose either Albini-Anderson (13 categories) or Scott-Burgan (40 categories) fuel model he wants to modify (components 1 and 2). Next, the user chooses type of sorting of the elements (as seen in Figure 34) – component 3. Component 4 "Save (all)" is used to save all the changes made to fuel parameters, while component 5 is used to reset the values to default. Importing and exporting of the fuel parameters is enabled by using components 6,7 and 8.

Each category is defined by several parameters (also seen in Figure 36):

- 1-h Fuel Load (tons/ac)
- 10-h Fuel Load (tons/ac)
- 100-h Fuel Load (tons/ac)
- Live Herbaceous Fuel Load (tons/ac)
- Live Woody Fuel Load (tons/ac)
- 1-h Surface Area/Volume Ratio (ft^2/ft^2/ft^3)
- Live Herbaceous Surface Area/Vol Ratio (ft^2/ft^3)
- Live Woody Surface Area/Vol Ratio (ft^2/ft^3)
- Fuel Bed Depth (feet)
- Dead Fuel Moisture of Extinction (percent)
- Dead Fuel Heat Content (Btu/lb)
- Live Fuel Heat Content (Btu/lb)

1. Short Grass

Fuel Model Type	Static	
1-h Fuel Load	0.7400	tons/ac
10-h Fuel Load	0.0000	tons/ac
100-h Fuel Load	0.0000	tons/ac
Live Herbaceous Fuel Load	0.0000	tons/ac
Live Woody Fuel Load	0.0000	tons/ac
1-h Surface Area/Vol Ratio	3500	ft^2/ft^3
Live Herbaceous Surface Area/Vol Ratio	1500	ft^2/ft^3
Live Woody Surface Area/Vol Ratio	1500	ft^2/ft^3
Fuel Bed Depth	1.0000	feet
Dead Fuel Moisture of Extinction	12	percent
Dead Fuel Heat Content	8000	Btu/lb
Live Fuel Heat Content	8000	Btu/lb

Figure 36 - An example of (default) fuel parameters for a single category

Any change to fuel parameters is highlighted for an easier use, as seen in Figure 37.

1. Short Grass

Fuel Model Type	Static	
1-h Fuel Load	0.8400	tons/ac
10-h Fuel Load	0.0000	tons/ac
100-h Fuel Load	0.0000	tons/ac
Live Herbaceous Fuel Load	0.0000	tons/ac
Live Woody Fuel Load	0.0000	tons/ac
1-h Surface Area/Vol Ratio	3500	ft^2/ft^3
Live Herbaceous Surface Area/Vol Ratio	1500	ft^2/ft^3
Live Woody Surface Area/Vol Ratio	1500	ft^2/ft^3
Fuel Bed Depth	1.0000	feet
Dead Fuel Moisture of Extinction	12	percent
Dead Fuel Heat Content	8000	Btu/lb
Live Fuel Heat Content	8000	Btu/lb

Figure 37 - Any change to fuel parameters is automatically highlighted

5.1.9 Item 9 – Calculate fuel models

Each user has the option to upload his own fuel maps from within AdriaFireGIS interface. Therefore, AdriaFirePropagator must communicate with AdriaFireGIS in order to obtain and prepare these data for successful simulations. This communication can be initiated from contextual menu by clicking “Calculate fuel models”. This will produce two layers “Vegetation: Scott-Burgan (custom)” and “Vegetation: Albini-Anderson (custom)” that can be used for simulations. Please note that those are the layers affected by the “Fuel parameters” action from the contextual menu.

The fuel maps should be calculated the first time the user logins to the system. If not, this may cause unexpected behavior of AdriaFirePropagator. Therefore, in this case of user’s first login, she/he is presented with a dialog box as seen in Figure 38.

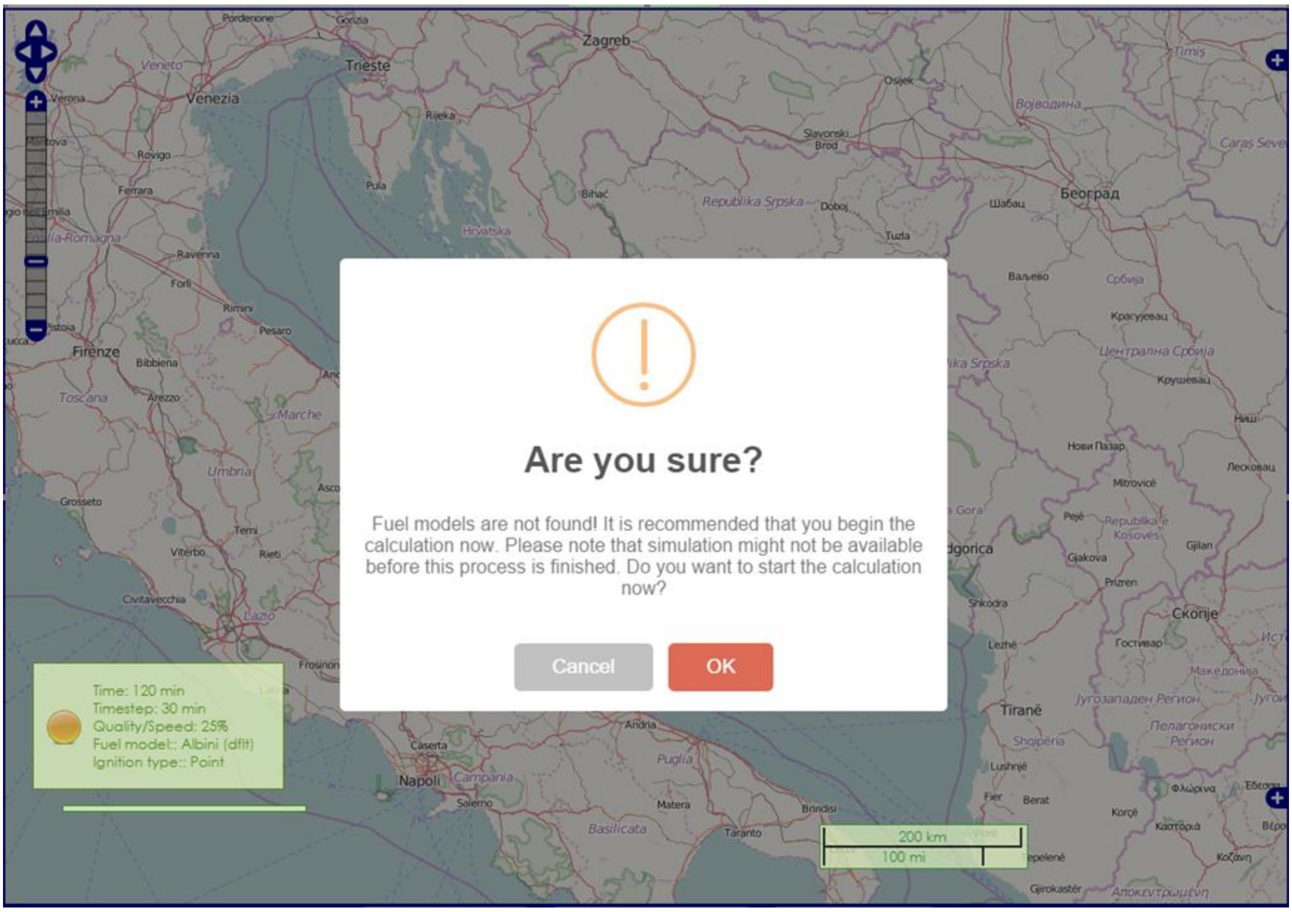

Figure 38 – At first login, the user is presented with information that fuel maps are not prepared

The preparation of custom fuel maps can last some time, depending on the complexity and size of the user’s data. However, the user will not be able to initiate simulations and new fuel model calculations if previous have not finished, as shown in Figure 39.

Also, if the user does not provide his own fuel models through AdriaFireGIS interface, he will still be able to use this feature. In this case, custom fuel models will be copy of the default ones, still allowing the user to change fuel parameters for them.

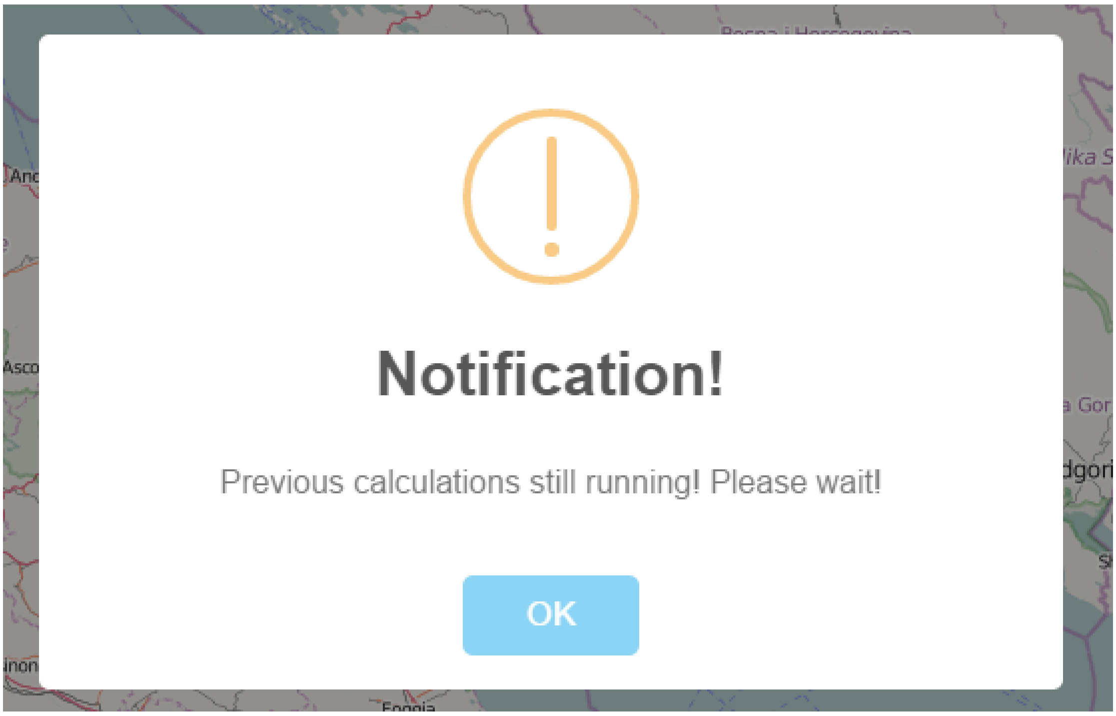

Figure 39 – The user is not allowed to start simulations and new fuel model calculations if previous haven't finished

6 Running simulations

In this section, the procedure how to run active and simulation mode of AdriaFirePropagator will be demonstrated.

6.1 Active mode

To successfully run AdriaFirePropagator in active mode, the user must:

1. Specify simulation properties (Item 4 in the contextual menu)
    a. Specify duration of the simulated wildfire – time (min)
    b. Specify timestep - that will be used to mark the fire front at certain time instants
    c. Specify ratio between speed/quality of the simulation
    d. Choose fuel model to be used for the simulation. Please note that the user is not allowed to use custom fuel models for active simulation mode.
    e. Choose ignition type
2. The user must choose a point on the map by right clicking on it, or draw fire perimeters
3. The users initiates the simulation in active mode by choosing Item 2 “Start simulation (current)” from the contextual menu.

6.2 Simulation mode

To successfully run AdriaFirePropagator in simulation mode, the user must:

1. Specify simulation properties (Item 4 in the contextual menu)
    a. Specify duration of the simulated wildfire – time (min)
    b. Specify timestep - that will be used to mark the fire front at certain time instants
    c. Specify ratio between speed/quality of the simulation
    d. Choose fuel model to be used for the simulation.
2. Specify wind parameters – as explained in Section 5.1.5
3. Specify moisture parameters – as explained in Section 5.1.6
4. Specify fuel parameters (optional) – as explained in Section 5.1.8
5. Specify fire barriers (optional) – as explained in Section 7
6. Specify fire perimeters (optional) – as explained in Section 8
7. The user must choose a point on the map by right clicking on it or draw fire perimeters
8. The users initiates the simulation mode of AdriaFirePropagator by choosing Item 3 "Start simulation (custom)" from the contextual menu.

Finally, Figure 1 shows one example of a simulation result from AdriaFirePropagator.

Figure 40 - An example of a simulation calculated by AdriaFirePropagator

6.3 Empty results (no fire)

In some cases, the simulations may return “no fire” as the result. In such cases, the user is informed, as seen in Figure 41.

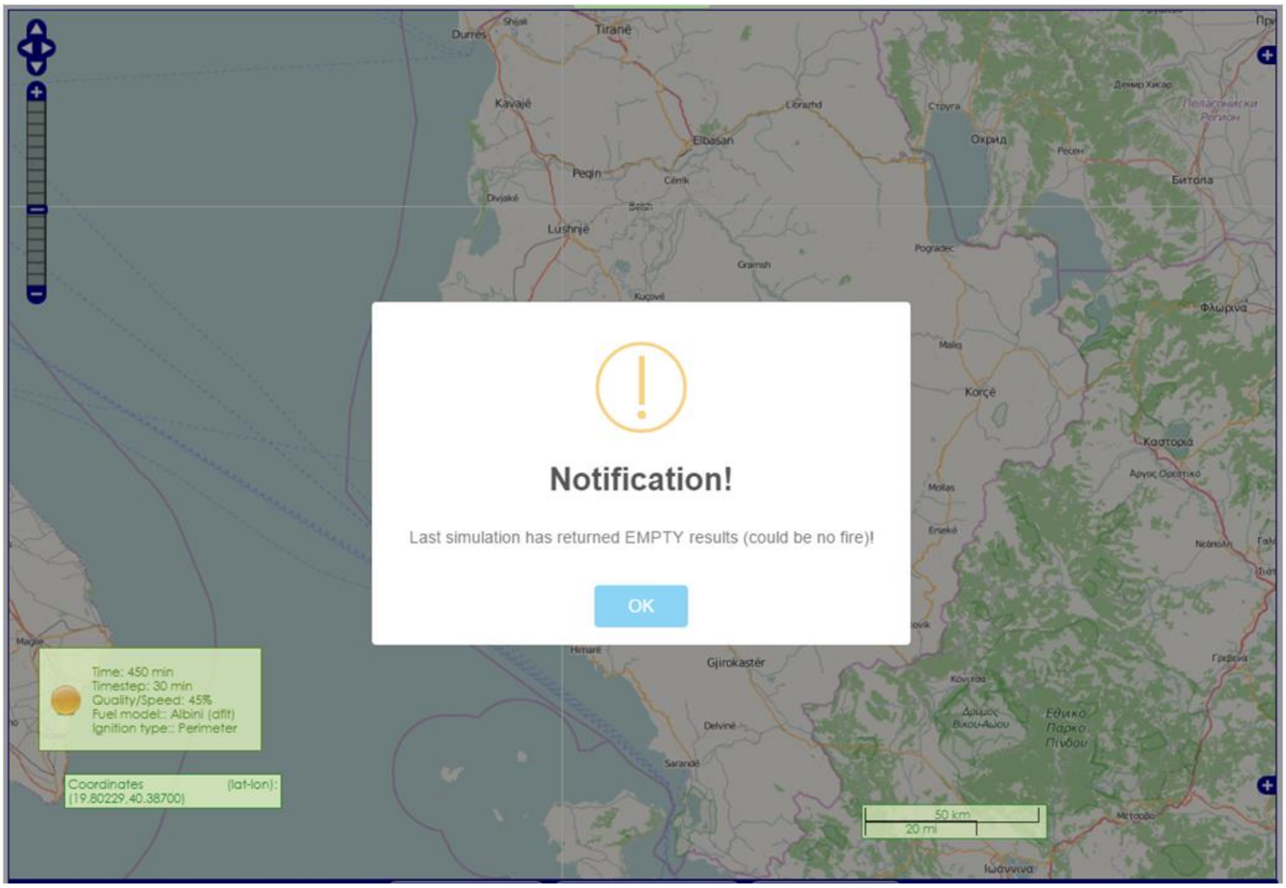

Figure 41 – Empty results (no fire) returned by AdriaFirePropagator

This can occur for several reasons:

- Simulation cannot be started at areas such as water, concrete,...
- Meteorological conditions are such that they don’t allow fire to spread
- An unexpected error has occurred (the user should try with different settings)

6.4 Terminating previous calculations

If previous calculations are not finished, the user will not be able to start a new one, as seen in Figure 42.

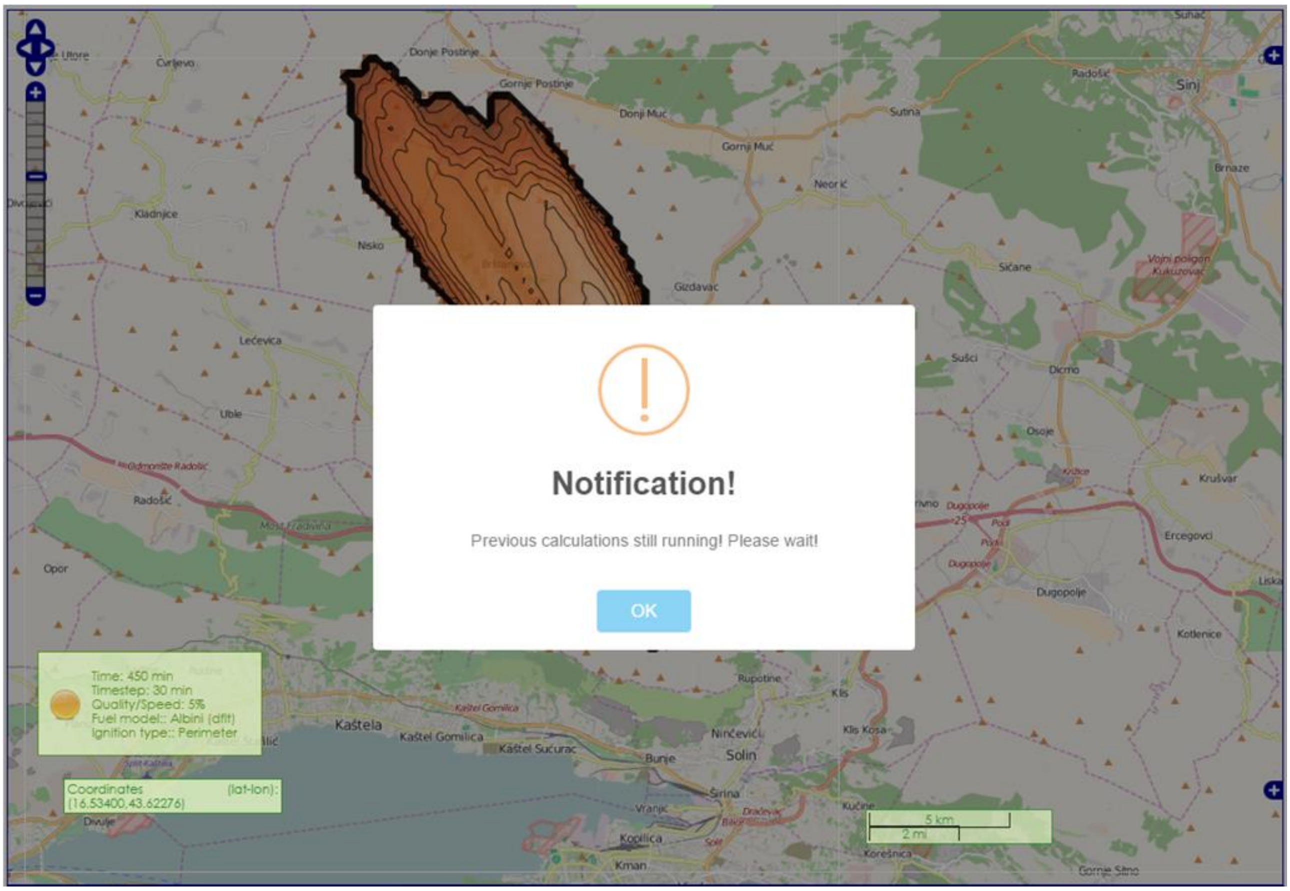

Figure 42 – Previous simulations still running

The user may try to terminate previous calculations if AdriaFirePropagator has become unresponsive for a longer period of time. This can be due to simulations that are to complex and require a very long period of time to calculate. “Terminate previous calculations” button can be found in the lower part of the AdriaFirePropagator interface, as seen in Figure 11. After clicking this button, the user is asked for a confirmation, after which the web page will become unresponsive for several seconds (Figure 43). Please note that this action may not always be successful and in some cases the user might still be forced to wait for the calculations to end.

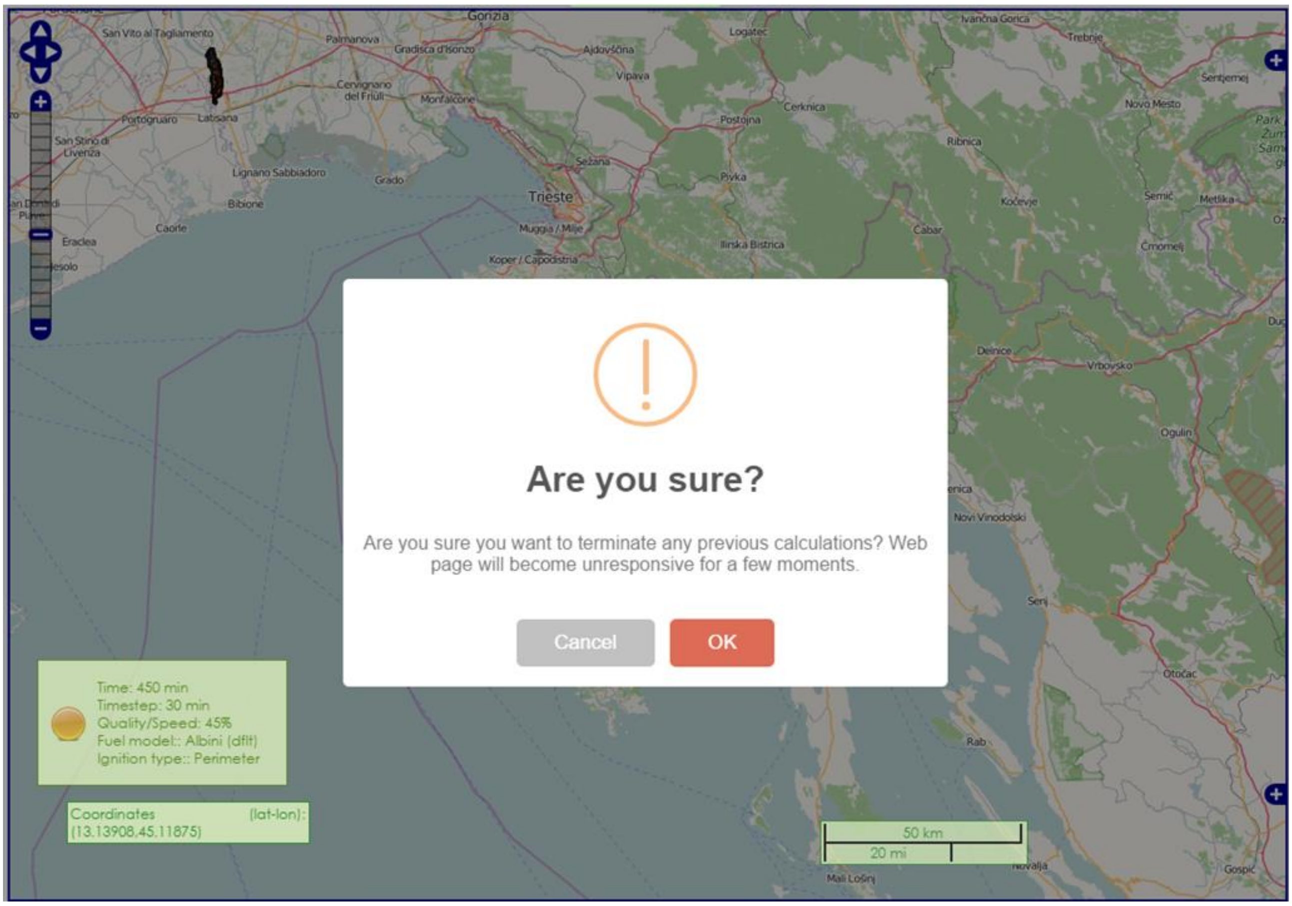

Figure 43 – Terminating previous calculations

7 Fire barriers

Fire barriers could be used to simulate unburnable area. Fire barriers can be used for both active and simulation mode of AdriaFirePropagator. Fire barriers are added by clicking on "Add fire barrier(s)" button in the lower part of the AdriaFirePropagator user interface, as seen in Figure 11.

The first point of the fire barrier polygon is added by clicking on the map. The polygon is closed and the last point is added by double-clicking on the map. Any additional polygon is added by clicking on "Add fire barrier(s)" button again. "Clear fire barrier(s)" is used to remove all the current fire barriers.

After adding or removing the fire barriers, they are automatically taken into account for next simulations. One example of fire barriers is given in Figure 44.

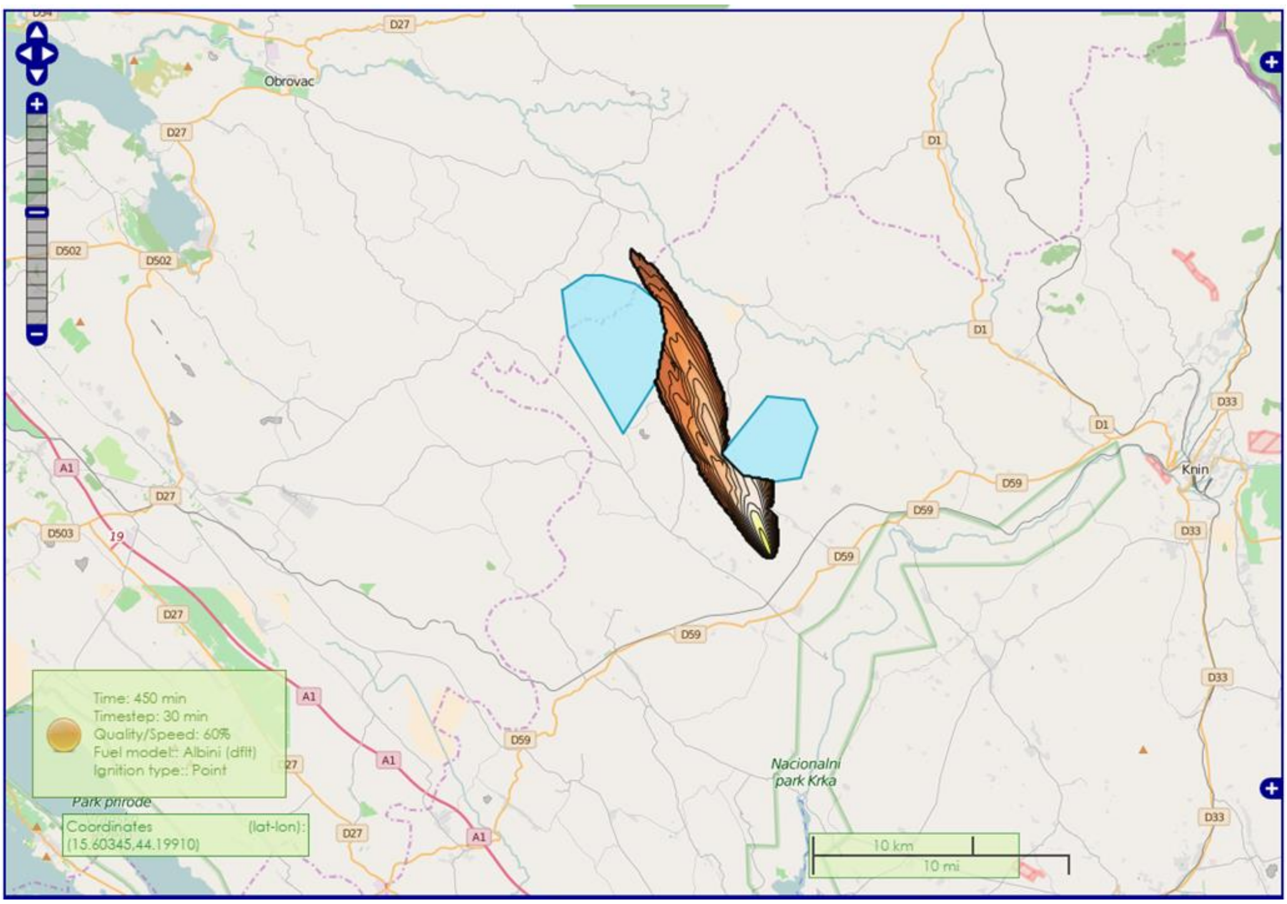

Figure 44 – AdriaFirePropagator in simulation mode with fire barriers

8 Fire perimeters

Fire perimeters is used to allow the user to specify one or several polygons as the ignition area. In this case, the fire spread does not begin from a single point, but rather from a whole set of points, as specified by the user. Fire perimeters are added by clicking on “Add fire perimeter” button in the lower part of the AdriaFirePropagator user interface, what can also be seen in Figure 11.

Similar to fire barriers, the first point of the fire perimeter polygon is added by clicking on the map. The polygon is closed and the last point is added by double-clicking on the map. Any additional polygon is added by clicking on “Add fire perimeter” button again. “Clear fire perimeter” is used to remove all the current fire perimeters. It is important to select “Fire perimeter” as “ignition type” in Simulation properties if one wants to start simulation that takes into account fire perimeters.

Fire perimeters can also be used to run in any simulation mode. One example of fire simulation with fire perimeters included is given in the Figure 46.

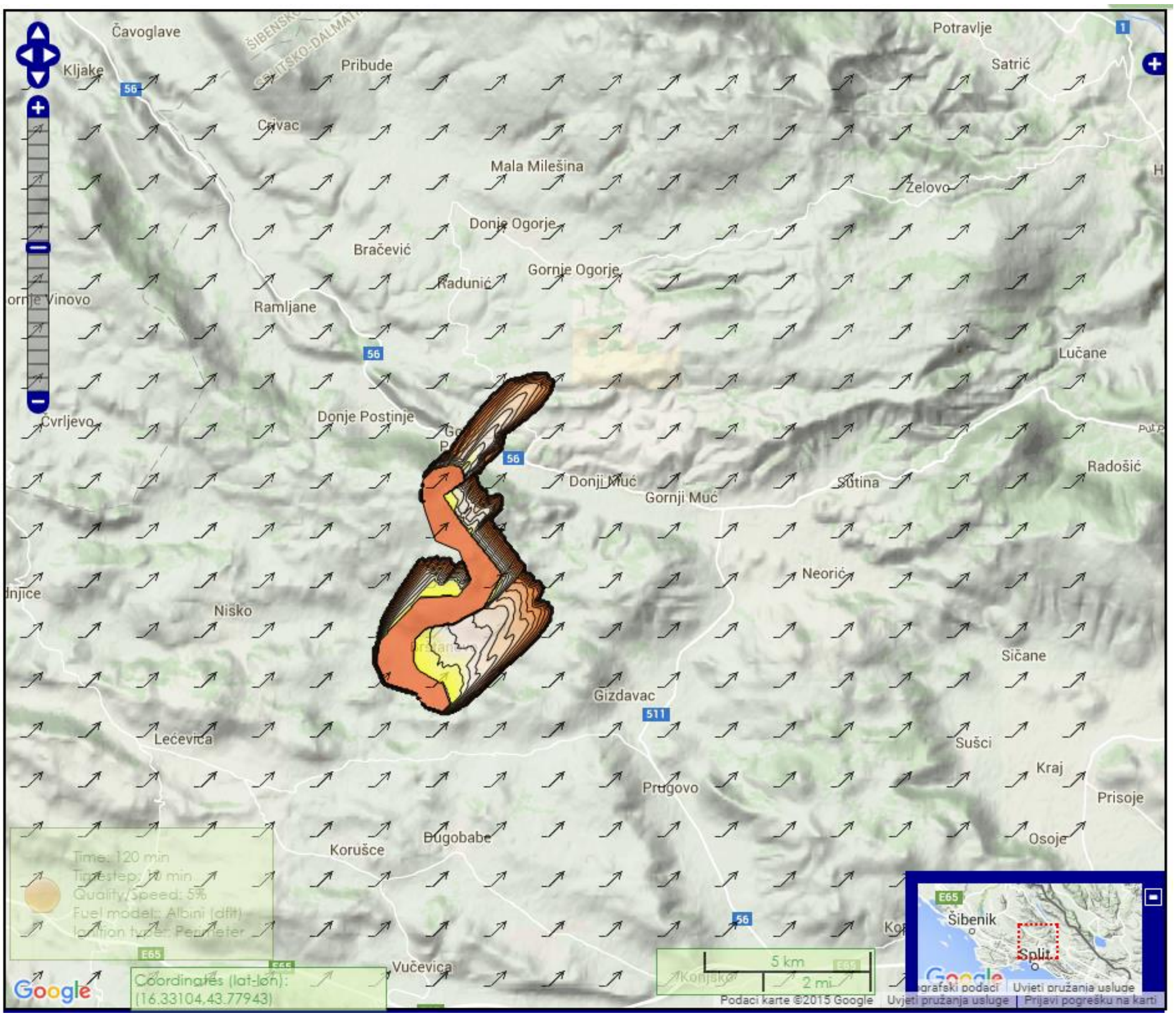

Figure 45 – AdriaFirePropagator simulation with fire perimeters

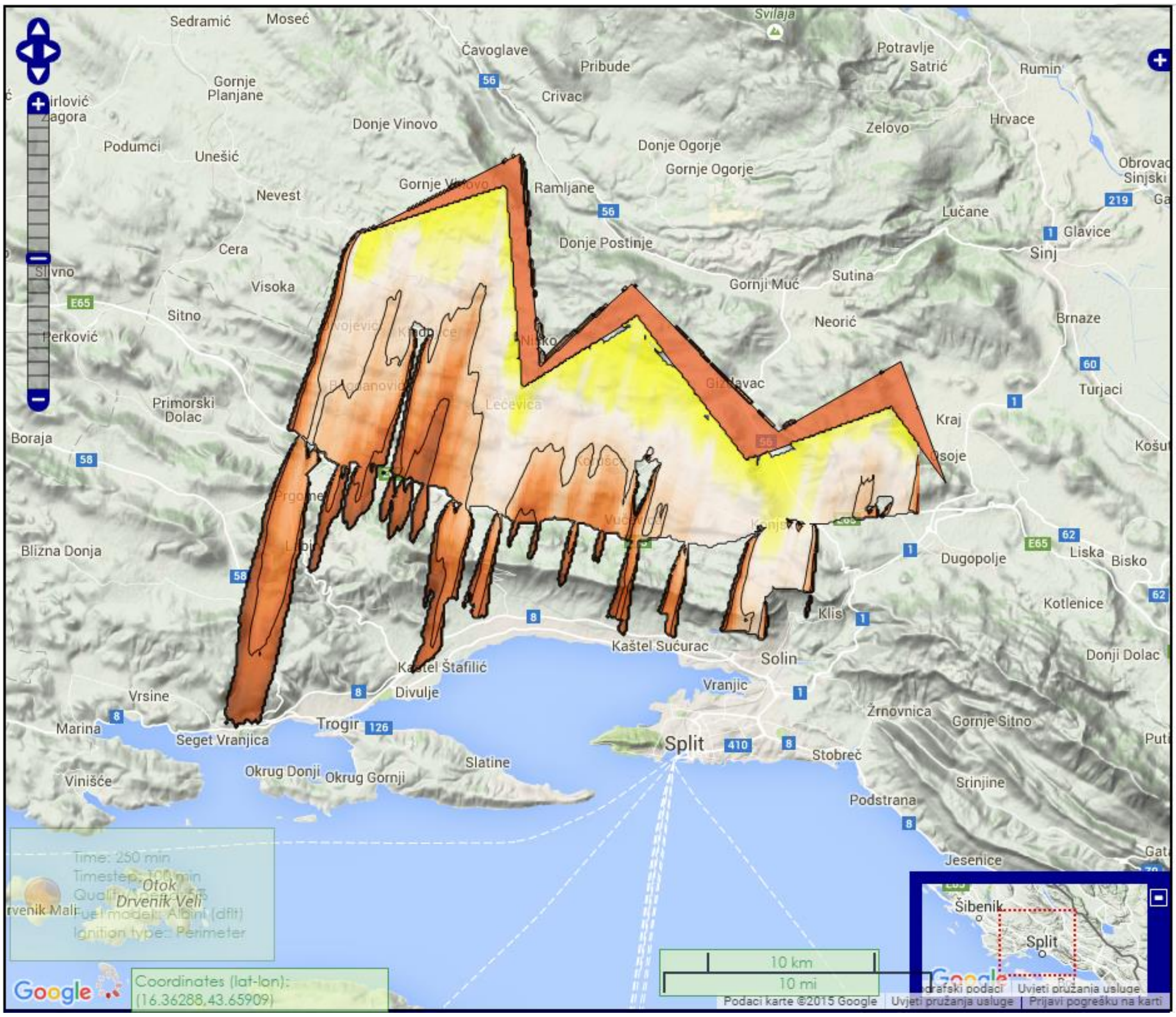

Figure 46 – AdriaFirePropagator simulation with fire perimeters (example 2)

Fire perimeters and fire barriers can be used simultaneously. One example of such combination is given in Figure 48.

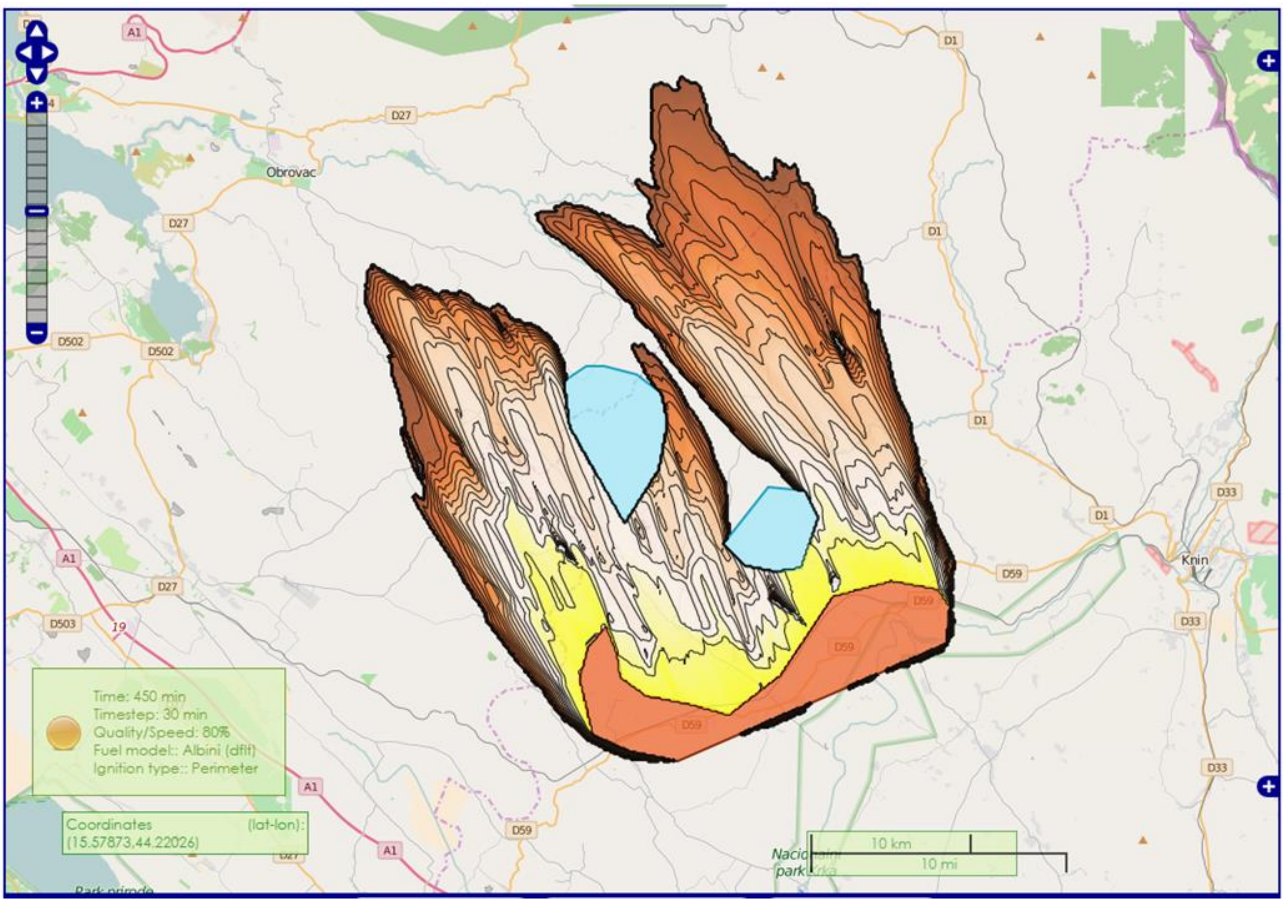

Figure 47 – A simulation result with both fire barriers and fire perimeters included

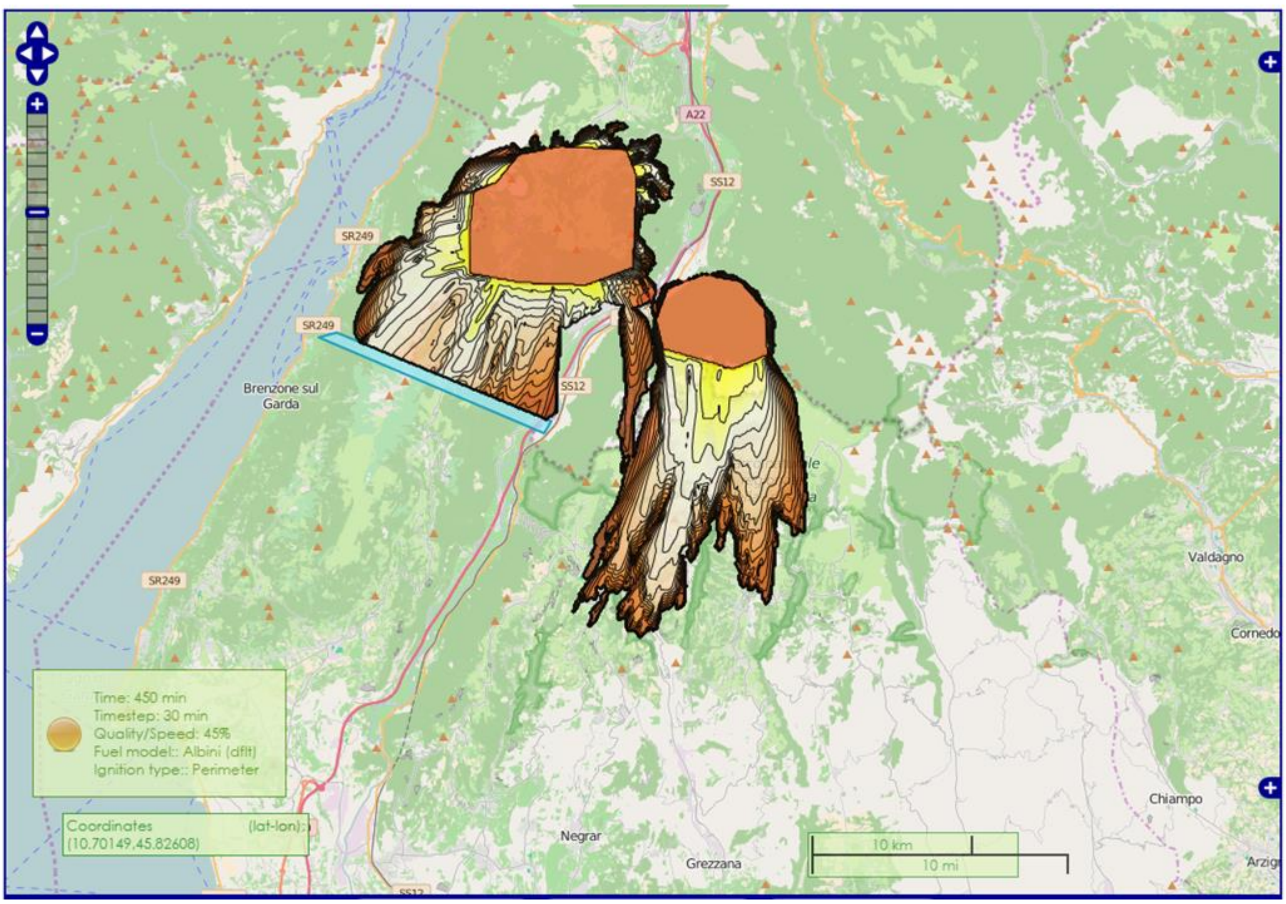

Figure 48 – A simulation result with both fire barriers and fire perimeters included (example 2)

9 Conclusion

In this document we present a user guide of AdriaFirePropagator, a simulation Web based software for wildfire behavior modelling and wildfire spread simulation. AdriaFirePropagator consists of two basic modules that include two firefighting activities:

- Activities before and after a wildfire (simulation mode), and
- Activities during the fire (active mode).

Active mode is the simulation based on current meteorological conditions; while in simulation mode the simulation is run based on user-defined conditions.

AdriaFirePropagator is a multi-user environment, where each user independently initiates its own simulation and stores its own simulation data. No special software is required on the user's side, apart from a standard web browser, because AdriaFirePropagator is a Web based system. The system is installed on server, therefore all simulations are run on the server, and the results are presented to the user through a standard Web browser.

The fire propagation module of AdriaFirePropagator is based on wildfire spread module of Open Source GRASS GIS platform, modified to include more fuel models and to add few additional functionalities.

It is published under MIT license, so it is completely free for use and modification. The source code of modified wildfire GRASS spread module could be freely downloaded from our Web server (CiPOP, 2015). This version of AdriaFirePropagator has to be considered as a starting version that has to first well tuned using data of past well recorded historical fires, but that could be also further improved. In future, particularly through HOLISTIC AdriaFire Virtual Research Center, we plan further improvements of AdriaFirePropagator, for example with:

- More accurate fire spread models,
- Fire spread calculation with more precise data (in this version AdriaFirePropagator is based on meteorological data by 2 km resolution)

Software simulation systems like AdriaFirePropagator are systems that could be quite helpful in various firefighting activities, and we hope that through HOLISTIC project we will initiate its wider use in Adriatic region.

10 References

(HOLISTIC WP5.4-Del.2, 2014) Technical report concerning proposition of uniform methodology for fire behavior modeling and fire spread simulation for Adriatic region, HOLISTIC-WP5-Del.2-Propagation-Model.pdf, http://www.adriaholistic.eu (Reserved Area)

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(GRASS GIS ROS, 2015) GRASS GIS SOFTWARE - http://grass.osgeo.org

(CiPOP, 2015), Center for Wildfire Research, http://cipop.fesb.hr