WILDFIRE MANAGEMENT TOOL
WEB EDITION

Using NASA Web World Wind to Predict Wildfire Behavior

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Frascati, Italy
The Wildfire Management Tool (WMT)

Mobile and desktop compatible web app

http://wmt.emxsys.com/

#WMTweb
The Wildfire Management Tool (WMT)

http://eurochallenge.como.polimi.it/

1st place in the NASA World Wind Europa Challenge 2015
FOSS4G Europe, Como, Italy
Bruce Schubert
T.J. Walton
Shawn Patterson
Built on NASA’s Web World Wind SDK

https://nasaworldwind.github.io

- Web WorldWind JavaScript API
  - Well crafted; extensible, easy to use
- Custom shapes
  - Analytic surfaces, rigid shapes, terrain conforming surface shapes, volumes, place marks, geographic text, ….
- 3D globe and continuous 2D map mode with extensible projections
- KML and Collada support
- Flexible and extensible viewing and navigation system
- Shapefile support
- WCS and WMS support
Embodies the Campbell Prediction System (CPS)

Learn from the Past—Predict the Future
What does the fire tell you?

- Alignment of Forces Concept
  - In-alignment tracks
- Trigger Points
  - Geographic/Temporal
- Fuel Flammability Curves
- Replications

Doug Campbell
Includes Rothermel’s Fire Spread Model

\[ R_{\text{surface}} = \frac{I_R \xi (1 + \phi_w + \phi_s)}{\rho_b \varepsilon Q_{\text{ig}}} \]

Richard C. Rothermel
Fire Lookouts – *Dynamic Spatiotemporal Markers*

*Fire behavior is the manner in which a fire reacts to the influences of: fuel, weather, topography.*

- Simply drag-n-drop *Fire Lookouts* where you want to know the potential fire behavior.
- *Fire Lookouts* show fuel model, flame lengths for head, flanks & heal, and direction of max spread.
- Fire Lookouts react to changes in weather and temporal solar conditions.

*Developer Note: Fire Lookouts are custom composite renderables made from Placemark and GeographicText objects*
New Symbol – The Wildfire Diamond

- Fire behavior depicted for all quadrants
- Arrow shows direction of head fire

<table>
<thead>
<tr>
<th>Intensity</th>
<th>Flame</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>0-1’</td>
<td>Very little resistance to control and direct attack with firefighters is possible.</td>
</tr>
<tr>
<td>Moderate</td>
<td>1’-3’</td>
<td>Moderate resistance to control but can be countered with direct attack by firefighters.</td>
</tr>
<tr>
<td>Active</td>
<td>3’-7’</td>
<td>Substantial resistance to control. Direct attack with firefighters must be supplemented with equipment and/or air support.</td>
</tr>
<tr>
<td>Very Active</td>
<td>7’15’</td>
<td>Extreme resistance to control. Indirect attack may be effective. Safety of firefighters in the area is a concern.</td>
</tr>
<tr>
<td>Extreme</td>
<td>&gt; 15’</td>
<td>Extreme resistance to control. Any form of attack will probably not be effective. Safety of firefighters in the area is of critical concern.</td>
</tr>
</tbody>
</table>
Weather Scouts

National Weather Service point weather forecasts are rendered using standard weather station symbols.

- Simply drag-n-drop *Weather Scouts* to where you want to know the wx.
- *Weather Scouts* show:
  - Sky cover
  - Wind speed and direction
  - Air temperature (F)
  - Relative humidity (%)
- *Weather Scouts* are spatiotemporal markers.

Developer Note: *Weather Scouts* are custom composite renderables made from *Placemark* and *GeographicText* objects.
NWS Point Forecasts

National Digital Forecast Database (NDFD) REST Web Service

- Documentation: http://graphical.weather.gov/xml/rest.php
- REST: http://graphical.weather.gov/xml/sample_products/browser_interface/ndfdXML.htm
- Results in Dynamic Weather Markup Language (DWML), i.e., XML
  - Processed by WMT-REST server and sent to WMT client via JSON
Spatiotemporal Data at Reticule

**Temporal Widget**
- Application date and time
- Sunrise and sunset times
- Local solar hour angle (sun icon)
- Sunrise and sunset hour angles (tick marks)

**Location Widget**
- View orientation (compass)
- Solar azimuth (sun icon)
- Slope (% and inclinometer)
- Aspect (tick mark)
- Ground elevation (m)

*Developer Note: Widgets are custom composite renderables made from ScreenImage and ScreenText objects; slope and aspect are computed from Globe and ElevationModel objects.*
GeoMAC Wildfire Incidents

http://www.geomac.gov/
- REST: http://wildfire.cr.usgs.gov/arCGis/rest/services/geomac_fires/MapServer
  - Active fires
- WMS: http://wildfire.cr.usgs.gov/ArcGIS/services/geomac_dyn/MapServer/WMSServer
  - Perimeters: current, previous and historic
  - Recent fire activity: MODIS and HMS satellite imagery analysis

Developer Note: Active Fire icon is a standard Placemark object.
NASA World Wind’s Earth Elevation Model

- WMS: [http://worldwind26.arc.nasa.gov/elev/](http://worldwind26.arc.nasa.gov/elev/)
- Layers:
  - USGS NED 10m (USGS-NED)
  - ASTER GDEM Version 2 30m (aster_v2)
  - General Bathymetric Chart of the Oceans (GEBCO)
LANDFIRE Fuel Models

http://www.landfire.gov/

- REST: http://landfire.cr.usgs.gov/arcgis/rest/services/Landfire
- WMS: http://landfire.cr.usgs.gov/arcgis/services/Landfire/US_130/MapServer/WMSServer
Wind Affects Fire Behavior

- Flames are inclined towards the fuel
- Fuels are heated by radiation and convection
- Direction of max spread is inline with wind direction

Direction of max spread same as wind direction
Slope Affects Fire Behavior

- Upslope fuels are closer to the flames.
- The results are very similar to the effect of wind.
- In the absence of wind, the direction of max spread follows the upslope vector.

*Direction of max spread is aligned with upslope vectors*

*The inclinometer shows slope at the reticle*
Solar Radiation Affects Fire Behavior

- Changes the fuel flammability
  - Solar Radiation *preheats* the fuel
  - *Drives off moisture, making the fuel more flammable*
- Changes with time and aspect
  - Creates an unstable fuel bed

*Fire behavior is exacerbated on the east aspect in the AM*

*Solar azimuth is aligned with terrain’s east aspect*
CPS Alignment of Forces Concept

- **Variations** in Wind, Slope and Preheating explain changes in fire behavior
- **Wind, Slope and Preheat** are the primary forces
  - Fire Behavior is affected by variations in:
    - Strength
    - Dominance
    - Alignment
- **In-Alignment Forces** Exacerbate Fire Behavior
- **Out-of-Alignment Forces** Reduce Fire Behavior
Software Architecture
In Closing

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  • Project: github.com/emxsys/WorldWindWildfire