Aurora: Enhancing the capabilities of Landgate's FireWatch with fire spread simulation

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FireWatch – What is it?

- Collection of spatial information that is useful for managing and monitoring bushfires across Australia.
- Multiple delivery methods – website, map services, email.
- Information includes:
    - Satellite imagery
    - Fire hotspot locations (derived from the satellite imagery)
    - Hourly weather observations (from BoM)
    - Lightning strike locations
    - Aerial photography (WA only)
    - Historical record of fire burnt area (from 1989)

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Fire hotspots can be seen over the latest MODIS satellite image.

The fire front can be seen from the hotspots and the area burnt over the previous week.
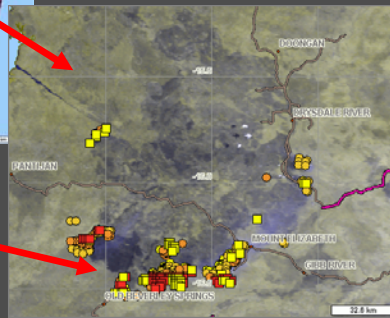
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FireWatch – Where does the satellite imagery come from?

- Primarily from two American satellite constellations:
    - NOAA's Advanced Very High Resolution Radiometer (AVHRR) x 4 satellites
    - NASA's Moderate Imaging Spectroradiometer (MODIS) x 2 satellites
- Two satellite receiving stations at Curtin and Murdoch Universities, Perth, operated by the Western Australian Satellite Technology and Applications Consortium (WASTAC).
- Provides a potential image roughly every two hours, day and night.
- Access to data from other satellite receiving stations around Australia.
- Having direct access to receiving stations means data can be provided in near real time (usually within 45 minutes of an overpass for Perth).

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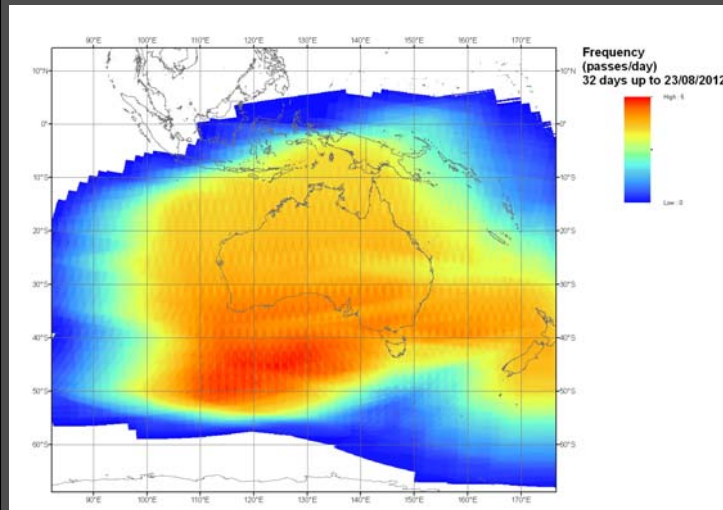
MODIS pass frequency

- All of Australia covered at least 3 times/day.
- Gap in data when satellites are within line-of-sight of NASA DSN station at Canberra.

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Aurora – What is it?

Easy to use desktop GIS and web based system to accurately simulate a bushfire in real-time.

Partnership
- Landgate – developing desktop GIS and web based systems.
- UWA – developing simulator core (Australis).
- FESA – end user.

Funding
- Department of Broadband, Communications and the Digital Economy (DBCDE) under the Digital Regions Initiative
- Some in-kind support from each agency.
- May 2010 to June 2013.

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Systems Developed

Desktop GIS Tool – (Add-On for ArcGIS)
- Enables fire agencies to use Aurora within their corporate mapping environment.
- Uses higher resolution spatial data.
- Agency can use its own spatial data.

Web Application
- View automatically generated fire spread simulations using satellite mapped fire hotspots as ignition points.
- Run custom fire spread simulations, by defining your own ignition points, with forecast or custom weather inputs.
- Uses lower resolution pre-existing spatial data.
- No need to be concerned about the input of spatial data.
- Just requires an internet connection.

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Web Application Modules

Automatic Fire Spread Simulations
- Fire spread simulations are created automatically with the satellite mapped fire hotspots from MODIS used as ignition points.
- These simulations are predicted out to 24 hours using gridded forecast weather.
- Results available on the internet within 45 minutes of satellite overpass (for passes received in Perth).

User Defined Fire Spread Simulations
- Ability to run your own custom fire spread simulations.
- Ability to run a series of scenarios quickly to optimise fire suppression outcomes using a variety of weather scenarios, fuel load adjustments and fire break options.

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Input Data

Projection
- Albers Equal Area Conic Projection.
- Australia is a mid-latitude country and extends predominantly east-west so this type of map projection is ideal for equal-area mapping.

Static Datasets
- Landscape defined by a set of tiles, with each tile containing irregularly spaced points.
- Ideally a single tile should be at least big enough to cover the area of a large fire.
- Automatic simulations use 1km point spacing with tile size of 100km x 100km.
- User defined simulations use 250m point spacing with tile sizes of 25km x 25km.

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Input Data

Static Datasets

- 3 intersections with the tiles.

- 1st with resampled version of the 1 second (30m) smoothed digital elevation model (DEM–S).
- Derived from the Shuttle Radar Topographic Mission (SRTM) data.
- Has undergone several processes in order to remove noise.
- Vertical accuracy is approximately 5m.

- 2nd with Major Vegetation Subgroups (MVS) dataset taken from the National Vegetation Information System (NVIS).
- Dataset contains 67 groups that represent the dominant vegetation occurring in each 100m x 100m cell across Australia.

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Input Data

Static Datasets

- 3rd with Time Of Last Burn (TOLB) dataset generated from the NOAA-AVHRR derived fire scar maps.

- Landgate has mapped fire scars every nine days at 1km resolution from the NOAA satellites going back to January 1989.

- At the end of each calendar month the most recent nine day datasets are spatially cleansed and added to the TOLB dataset.

- To keep the two sets of tiles (250m and 1km) current the intersection with the TOLB dataset occurs within one hour of it being updated.

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Input Data

Static Datasets

- A vegetation mapping file is used to map the vegetation codes in the NVIS MVS dataset to a set of fire spread and fuel accumulation models.

- Currently 30 different fire spread models that can be used within the simulator. These include the McArthur forest and grassland meters and models developed as part of Project Vesta.

- Some models used for shrublands and mallee-heath use the TOLB to determine the fuel load.

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Input Data

Dynamic Datasets

- Gridded forecast weather from the Bureau of Meteorology (BoM).

- Created using the Australian Community Climate and Earth-System Simulator (ACCESS) Numerical Weather Prediction (NWP) systems and is supplied with hourly forecasts up to 48 hours into the future.

- Each hourly forecast has a set of weather attributes for each $0.11°$ x $0.11°$ cell across Australia.

- Created four times per day and the last file is usually available within three hours of the base times (00:00, 06:00, 12:00 & 18:00 UTC).

- Simulator uses screen level air temperature, relative humidity and wind vectors at a height of 10m.

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Input Data

Dynamic Datasets

- Drought factor (DF) from BoM.

- Uses the Keetch-Byram Drought Index (KBDI).

- Generated on a daily basis for each $0.25°$ x $0.25°$ cell across Australia.

- Used in the McArthur forest and grass meters to modify the rate of spread based on fuel moisture.

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Website

Technology

- Built on the latest web-mapping technology.
- Uses web services.
- Interoperable. Corporate GIS can 'consume' the web services.
- Integrate external web services from BoM and GA.

Features

- Save your default view and data layers.
- Print and save PDF maps for easy map sharing.
- View a quick-look of all data layers before you turn them on.
- Change the transparency of all data layers.
- Re-order the list of data layers.

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Operation

http://aurora.landgate.wa.gov.au

- To be granted access to use the website a user needs to firstly lodge a web request to create an account
- This request has to be approved by FESA.
- If the user has been approved an email is sent stating that access has been approved.

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Operation

Data

Five expandable folders.
- Backgrounds – Google and MapQuest image layers (one at a time).
- Overlays - PSMA vector layers.
- My Sims – expandable folder containing all simulations the user has run.
- FireWatch - expandable folder containing all of the FireWatch layers.
- Aurora - expandable folder containing layers just pertaining to simulations.

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Operation

Legend

- A legend for each layer that can be classified in some form.
- Includes both vector and raster layers.

FWEW – Ignition points
FWEW – 0 to 4 hours
FWEW – 4 to 8 hours
FWEW – 8 to 12 hours
FWEW – 12 to 16 hours
FWEW – 16 to 20 hours
FWEW – 20 to 24 hours

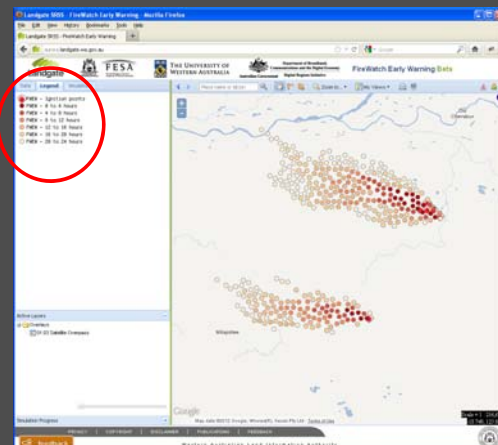# Aurora: Enhancing the capabilities of Landgate's FireWatch with fire spread simulation

Using Automatic Fire Spread Simulations

View the fire simulation legend

Click on the "Legend" tab at the top left to view the legend.

The ignition point is a diamond with a flame in the middle.

The fire spread is coloured from red to cream signifying the time elapsed since the time of the ignition point.
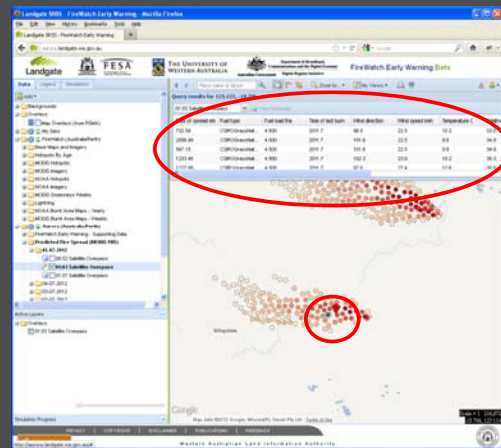
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Using Automatic Fire Spread Simulations

Query the simulated fire spreads

Once zoomed into a current fire
and its predicted spread:
- Click your left mouse button on a fire
  spread point to view the attributes.
- Attribute table should load.
- View the other attribute information.

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Operation

Simulations
- Six panels which allow a customised simulation to be run.
    - Duration
    - Ignition Sources
    - Fuel Load Adjustments & Firebreaks
    - Weather
    - Annotations (Points of interest)
    - Name and Run Simulation

- Uses 25km tiles with each tile having points spaced at 250m.

- Simple simulations can run in less than 10 seconds.

- Complex simulations may run for more than a minute.

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Creating Custom Fire Spread Simulations

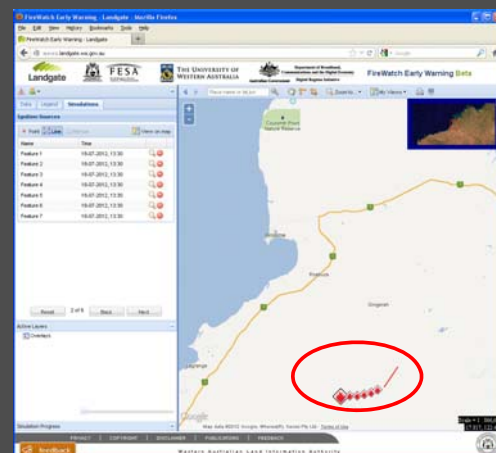To create your own fire spread simulation:
- Select the tab called "Simulations".
- Enter the "Start Date" or use the calendar.
- Enter the "Start Time" or use the pulldown menu.
- Use the arrows to select the "Duration".
- Zoom to your area of interest using "+" or "-" or by holding "Shift" key and drawing a rectangle while holding down the left mouse button.
- Click on "Next".
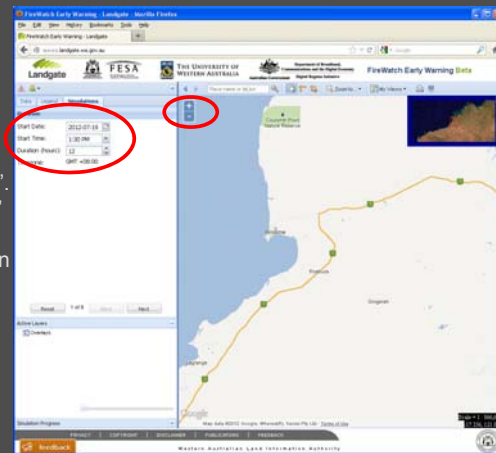
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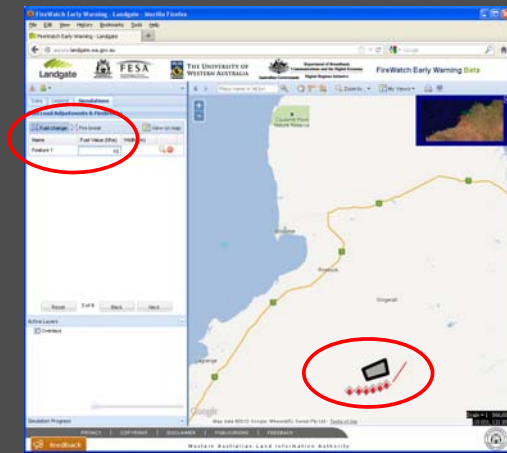## Creating Custom Fire Spread Simulations

- Click on "Point".
- Using the left mouse button click on where you want the ignition points.
- Repeat for each point.
- Click on "Line".
- Using the left mouse button click on where you want the line to start and any subsequent points. Double click to finish.
- In future coordinates can be entered.
- Click on "Next".

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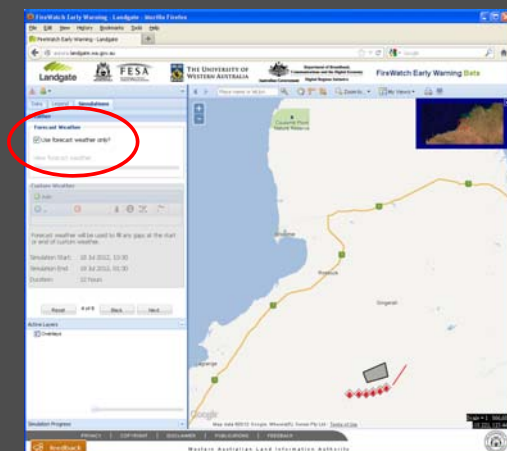**Creating Custom Fire Spread Simulations**

- Click on "Fuel Change".
- Using the left mouse button click on where you want the polygon to start and any subsequent points. Double click to finish.
- Click below "Fuel Value (t/ha)" and enter "0" and press "Enter".
- Click on "Next".

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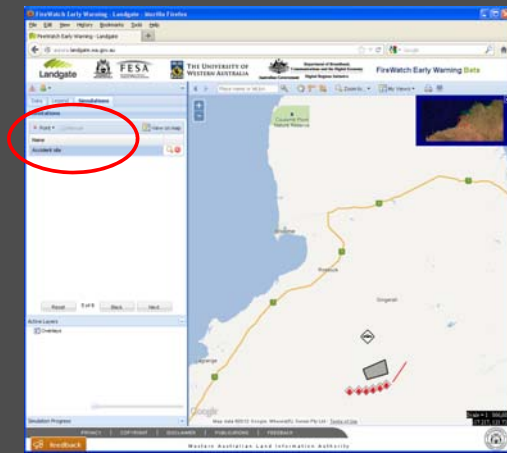**Creating Custom Fire Spread Simulations**

- Leave "Forecast Weather" checked.
- Click on "Next".

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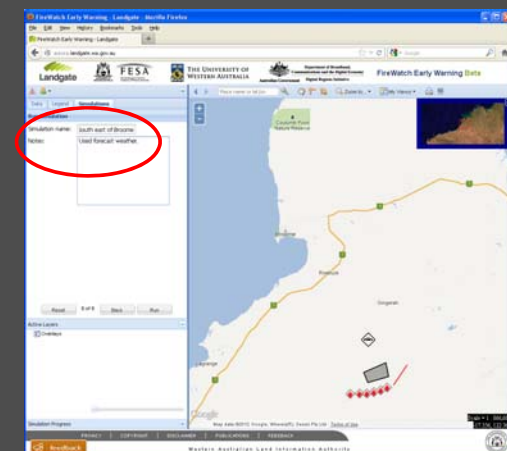
Creating Custom Fire Spread Simulations

- Click on "Point".
- Choose a type of annotation.
- Using the left mouse button click on where you want the annotation.
- Click below "Name" and enter the name of the annotation" and press "Enter".
- Click on "Next".

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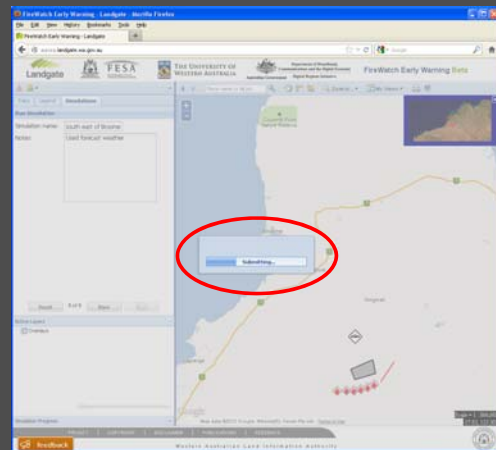
Creating Custom Fire Spread Simulations

- Click on the field next to "Simulation name:".
- Enter the name of the simulation.
- Click on the field next to "Notes:"
- Click on "Run".

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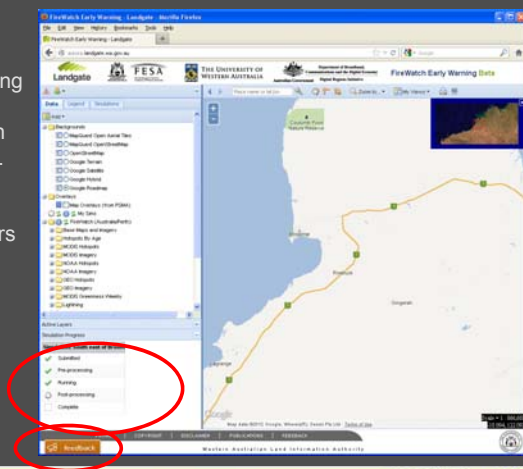
Creating Custom Fire Spread Simulations

- A blue rectangular window will appear and it should say "Submitting…"
- This should disappear with 3 seconds.

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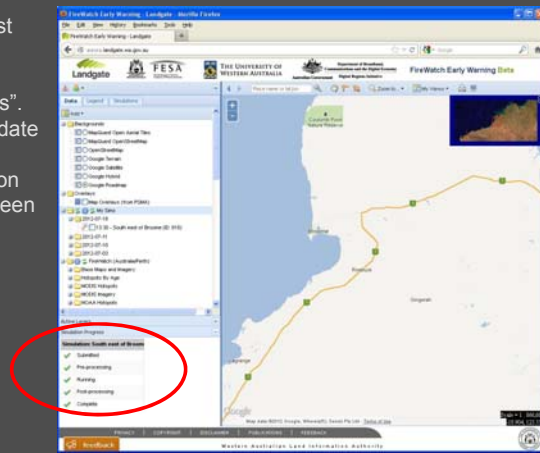### Creating Custom Fire Spread Simulations

- A table should appear in the bottom left hand corner with five rows representing the stages of the running of the simulation.
- A green tick will appear next to each stage when that stage is completed.
- A red cross indicates an error has occurred. A message box should appear detailing the error. Any errors can be reported using the feedback button at the bottom of the screen.

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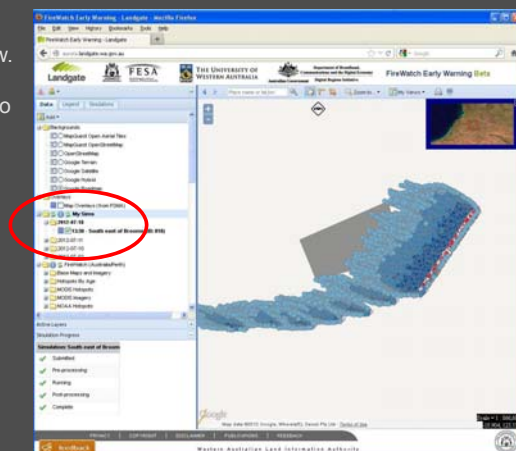
Displaying Custom Fire Spread Simulations

- When a green tick appears against "Complete" the "Data" tab should become active.
- Click on the folder called "My Sims".
- Click on the folder with the same date as the simulation just run.
- Using the left mouse button click on the checkbox to the right of the green dot.

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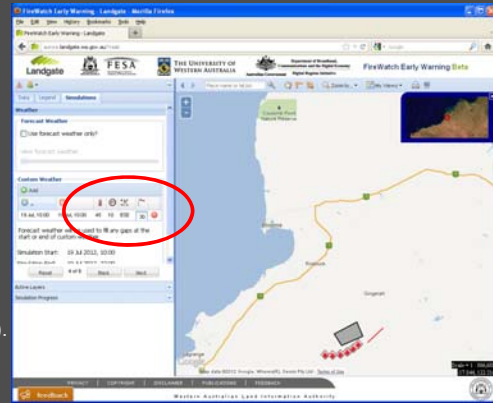
Displaying Custom Fire Spread Simulations

- The simulation may take a few seconds to load into the map window.
- Using the left mouse button click on the spanner icon and select "Zoom to Layer".
- Click on the "-" on the "Simulation Progress" shutter
- Click on a point near the end of the fire spread.

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Creating Custom Fire Spread Simulations

- - This time uncheck the "Forecast Weather".
- - Click on "Next".
- - Click on the little green circle with a cross in it.
- – Click on the date underneath the red clock.
- – Use the calendar and pulldown menu to set the end time and date.
- – Under the thermometer enter a temperature.
- – Under the barometer enter a relative humidity.
- – Under the wind vane use the pulldown menu to select a wind direction (origin).
- – Under the wind sock enter the wind speed.

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Displaying Custom Fire Spread Simulations

- - Click on some points to look at the attributes.
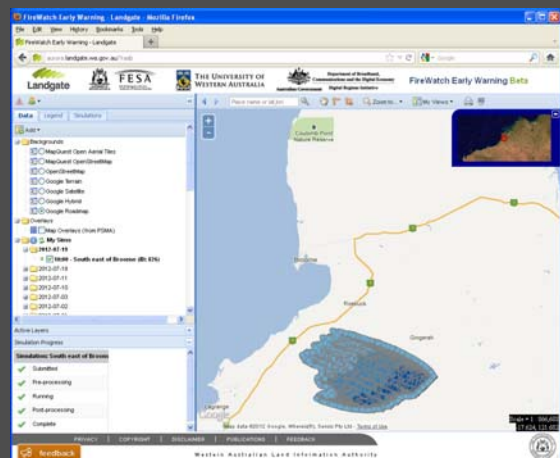
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Improvements

- The simulator does not incorporate any form of road network.
- This means that roads do not act as barriers to the spread of the fire.
- However, for the user defined simulations, firebreaks can be added that mimic the barrier that a road provides for the fire spread.

- 30 fire spread models within the Australis simulator but less than a quarter of these are actually used.
- Expert knowledge has been used to map the various vegetation codes for Western Australia, used in NVIS, to the most appropriate fire spread and accumulation models.
- This same level of expert knowledge needs to be applied to the other states of Australia.

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Improvements

- Point spacing of 250m used for the user defined simulations.
- DEM and NVIS datasets have cell resolutions of 100m so this resolution could be used.
- Trade off is that the Australis simulator would have to calculate the fire spread across more than 6 times as many points which may increase the time taken to process a large fire spread simulation.
- Likewise the map server has to read 6 times the number of points from the database which may increase the time taken to display large fire spread simulations.

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Improvements

- TOLB dataset currently only uses NOAA-AVHRR data. The burnt area that the TOLB is derived from is manually digitised, and only burnt areas larger $4km^2$ are mapped.
- Burnt area mapped from higher resolution satellite data, such as Landsat, could be easily incorporated.
- Fire agencies may have their own burnt area mapping taken from aerial photography.
- Combining these types of datasets would produce a more accurate picture of the burnt area and thus produce more accurate fire spread simulations.

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- Come to booth 65 to see a live demonstration of Aurora.
- Questions?