



Vulnerability/Impact Modelling at the Broad Landscape Scale.

Justin Leonard¹, Raphaele Blanchi¹,
Anders Siggins², Glenn Newnham²,
Darius Culvenor², Kimberley Opie², Felix
Lipkin¹

¹ CSIRO Ecosystem Sciences, Highett, VIC 3191

² CSIRO Land and Water, Clayton, VIC 3168

Overview

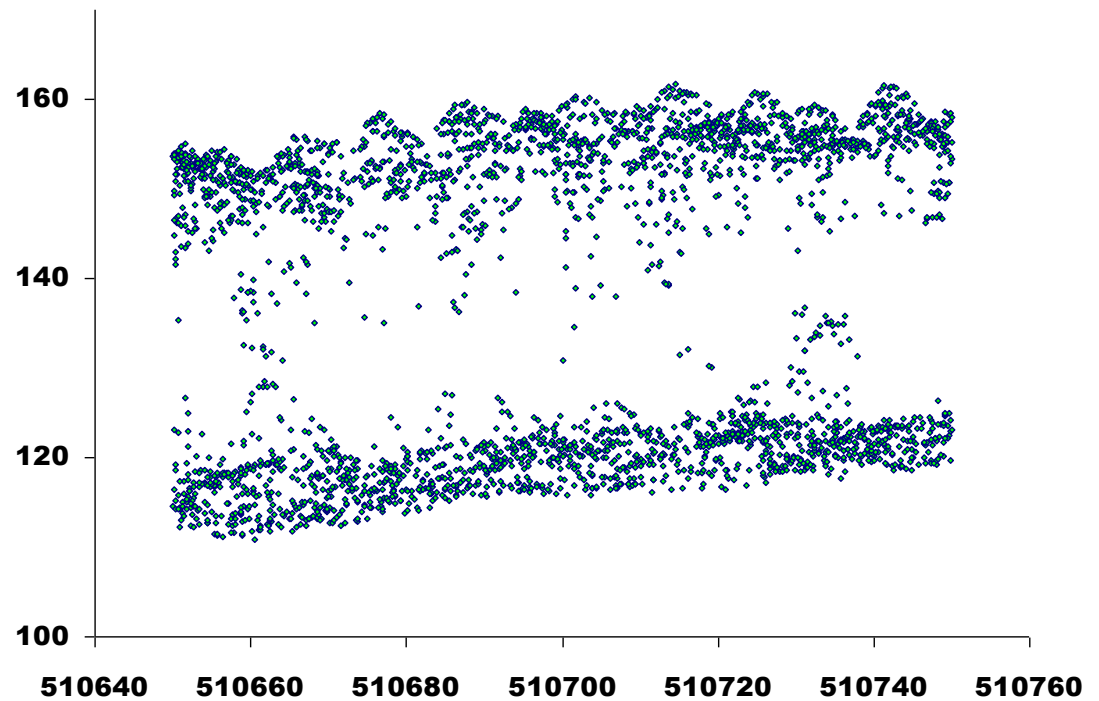
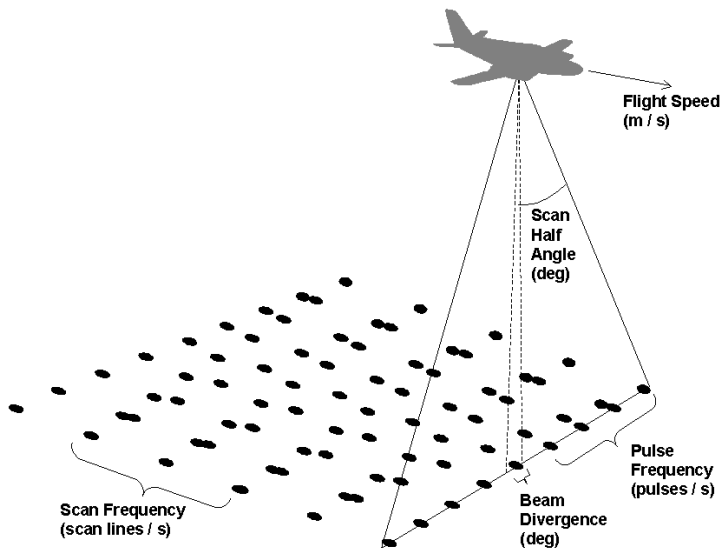
Vulnerability is derived from House Exposure Level and House Response Assumptions. This work focuses on **House Exposure Level** but is based on broad landscape datasets.

- For a given location, how much of the current location ‘sees’ the flame front?
 - Obscuration by vegetation
 - Obscuration by terrain
 - Obscuration by buildings
 - Flame front location, orientation, size
- Resolve the time/radiation profile for an advancing fire front and use this to determine building ignition potential
- Explore the correlation between ember exposure levels and ignition likelihood.

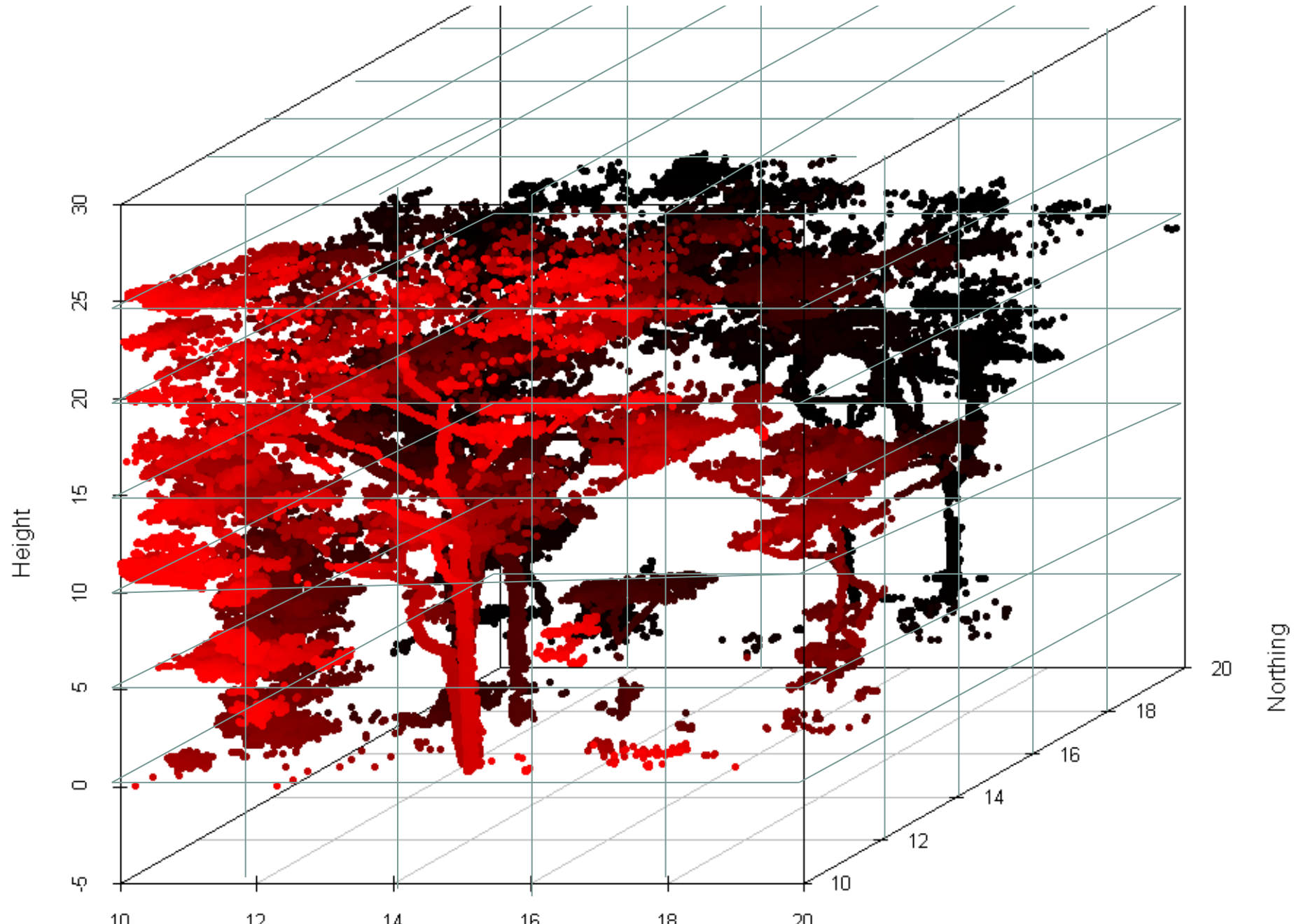
LiDAR Derived Data

- Digital Terrain Model
 - Slope
 - Aspect
 - Local topography
- Vegetation
 - Vegetation Height
 - Vegetation ‘Density’
 - ‘Managed’ vs ‘Unmanaged’ (Newnham et al, 2012)
- Buildings
 - Location
 - Proximity

Utilising Airborne LiDAR Data

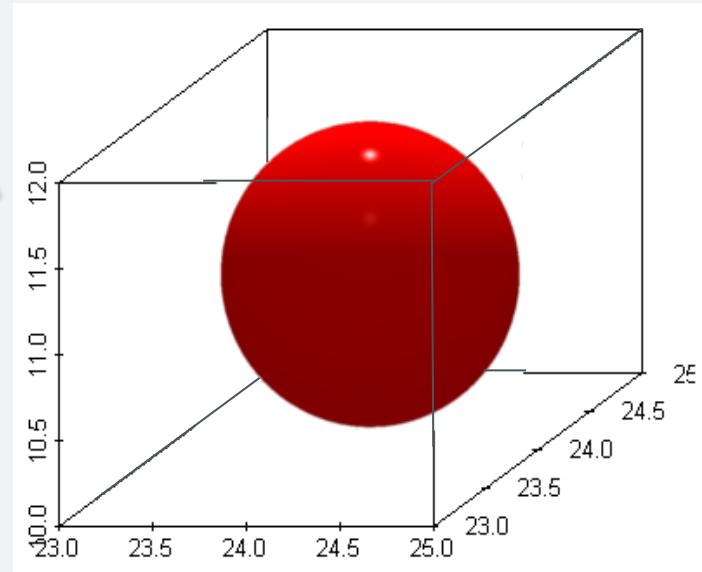
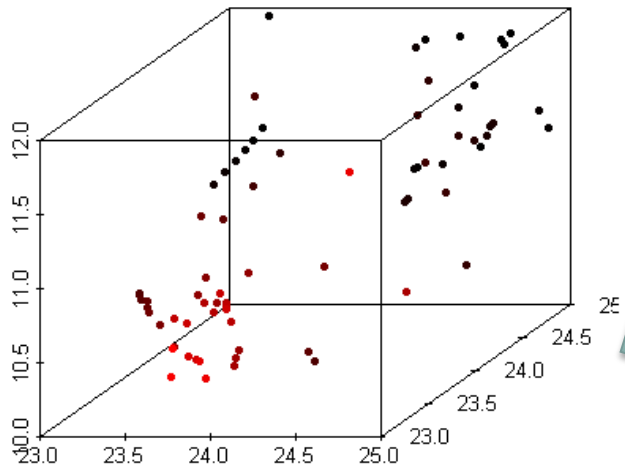


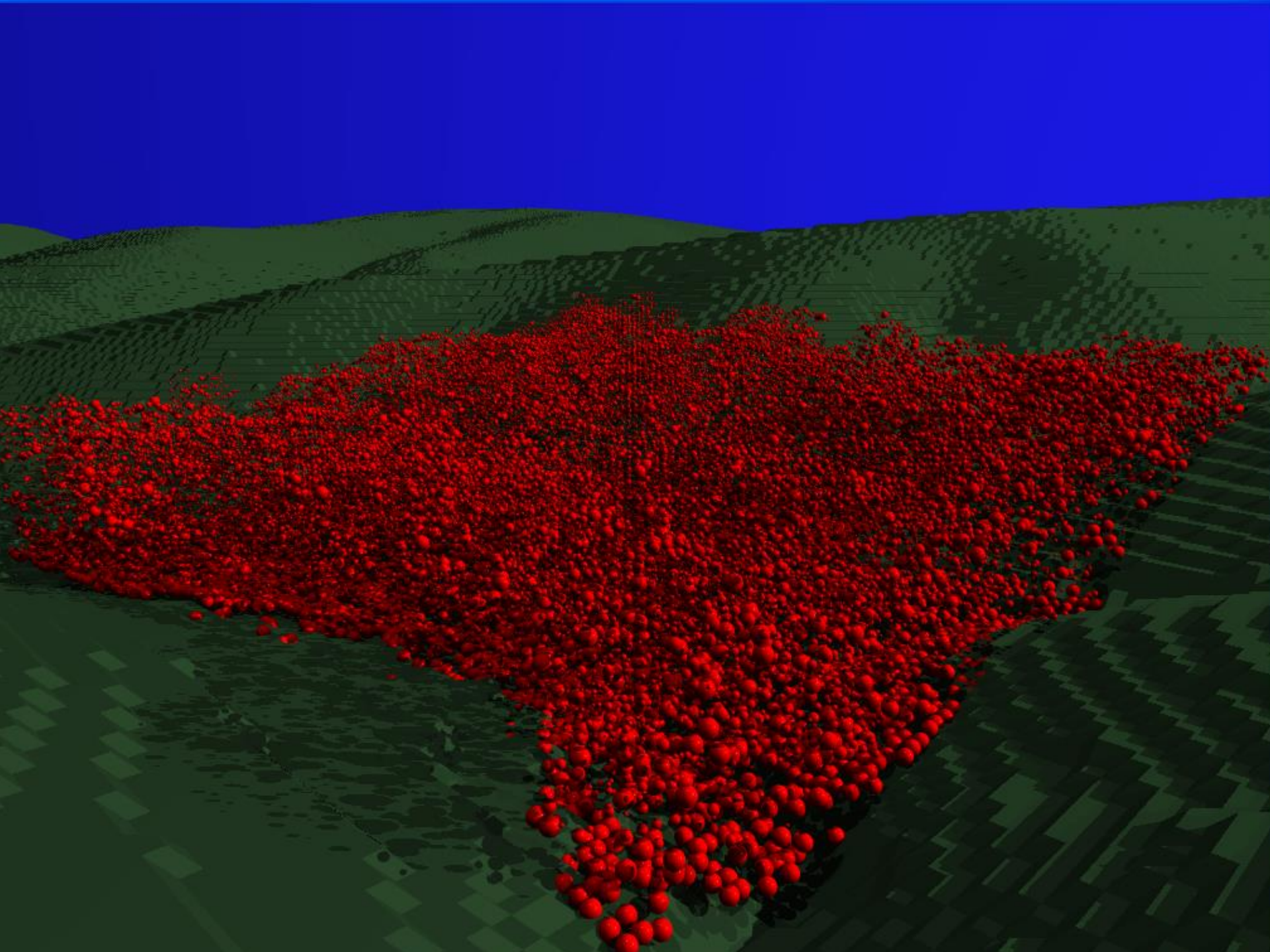
Modelling Forest Density with Voxels



From Voxels to Spheres

Voxel







Pine Ridge Road focus Study

- King Lake West Victoria
- Heavily effected by 2009 fires
- Extensive LiDAR dataset collected in the months prior and following to the 2009 bushfires



- 115 residential buildings
- 272 out-buildings
- 163 water tanks
- 4x4km area centred on the intersection of pine ridge road and national park road

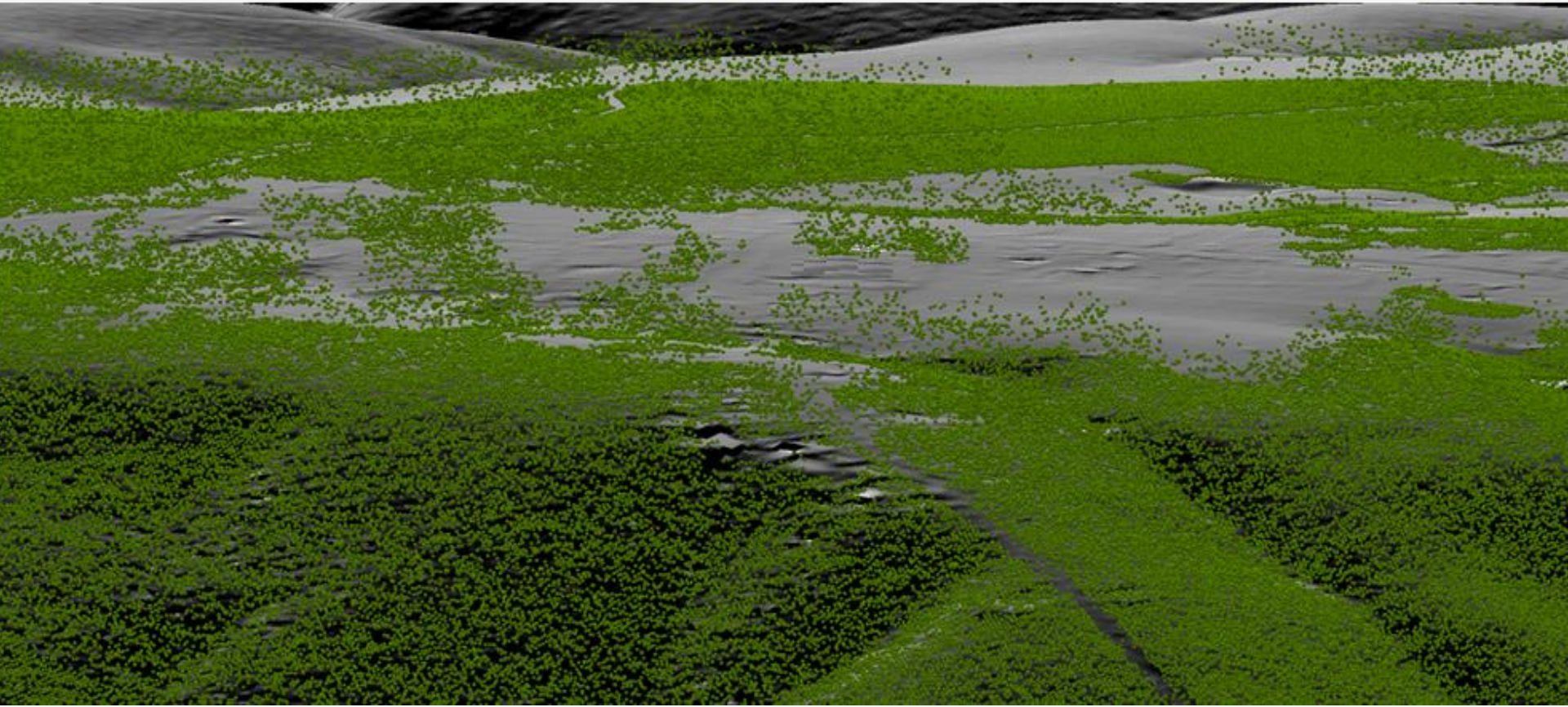
 Unburnt

 Burnt

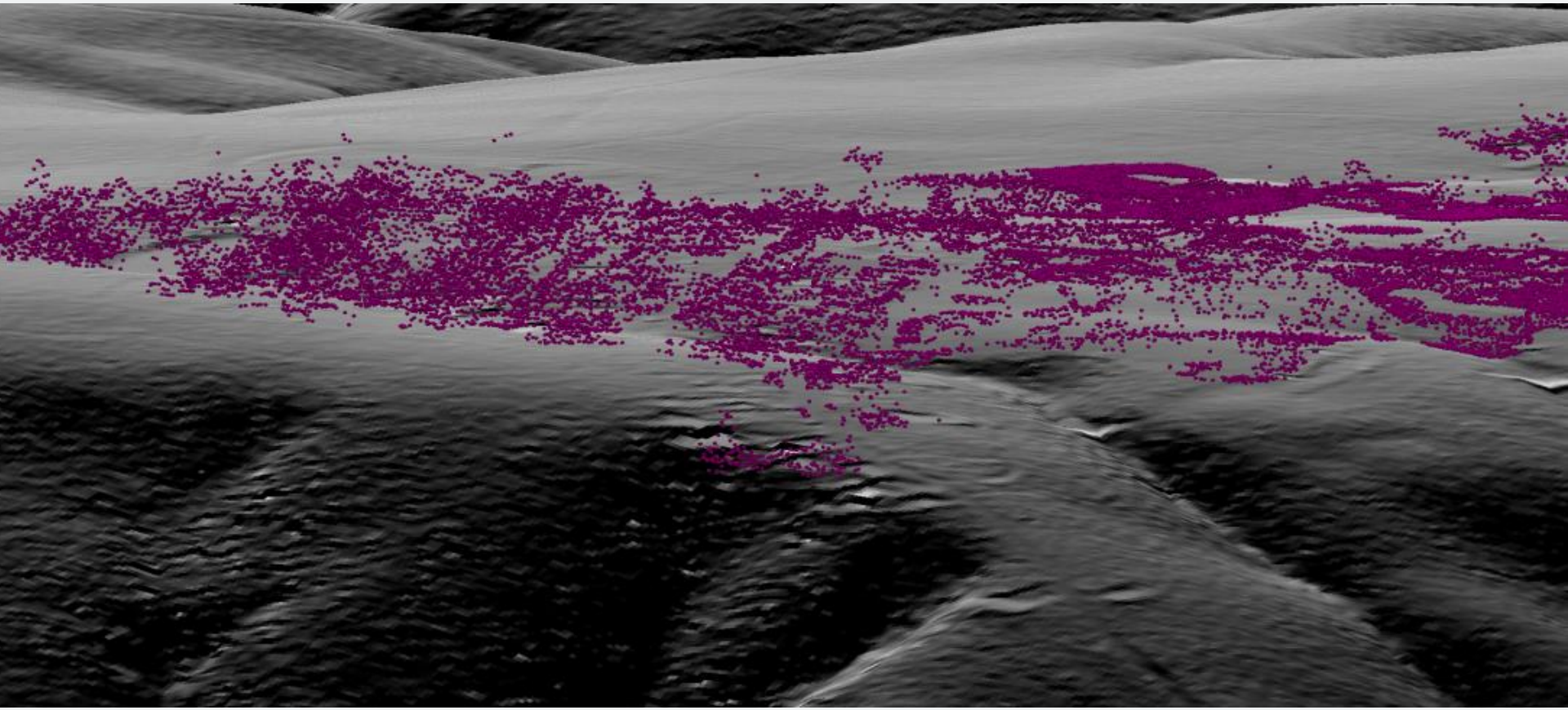




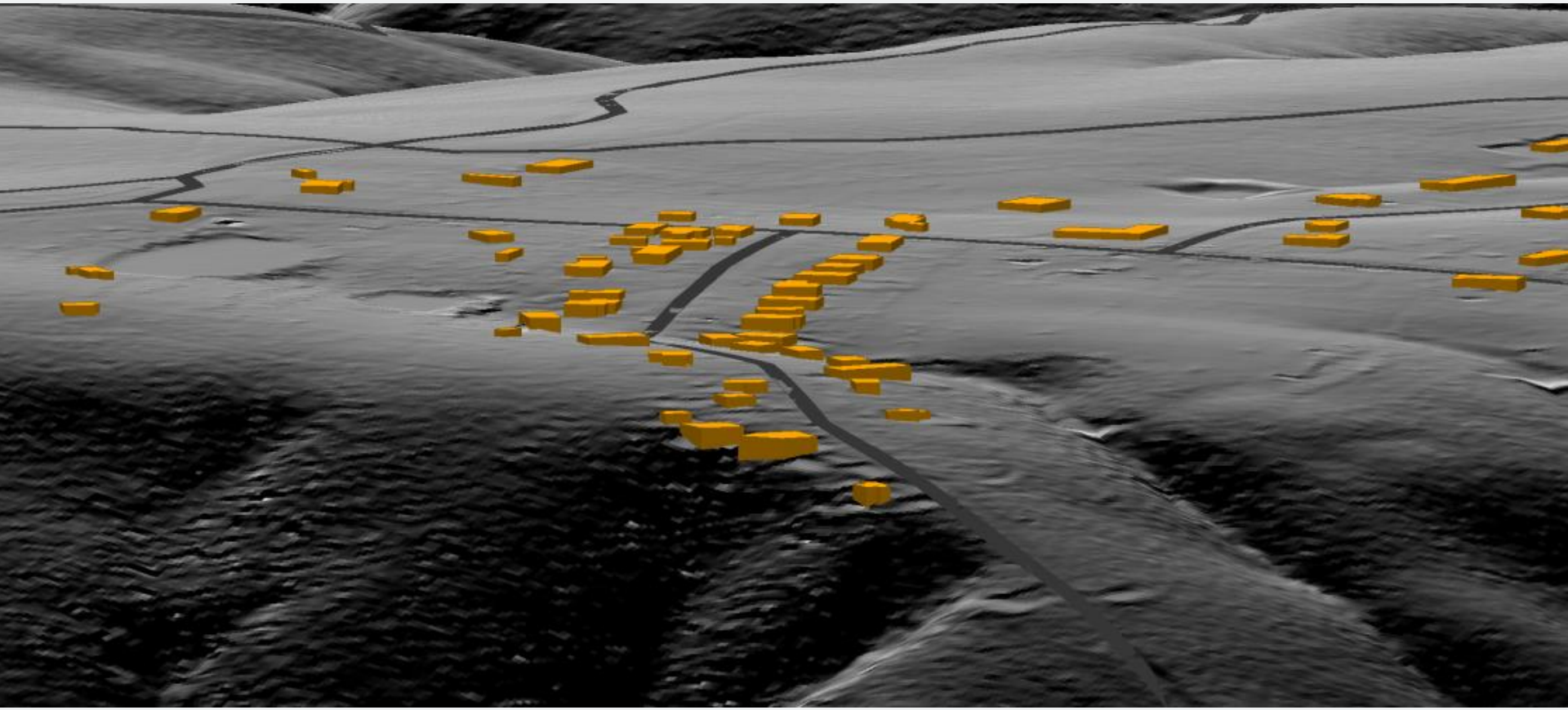
Unmanaged Vegetation



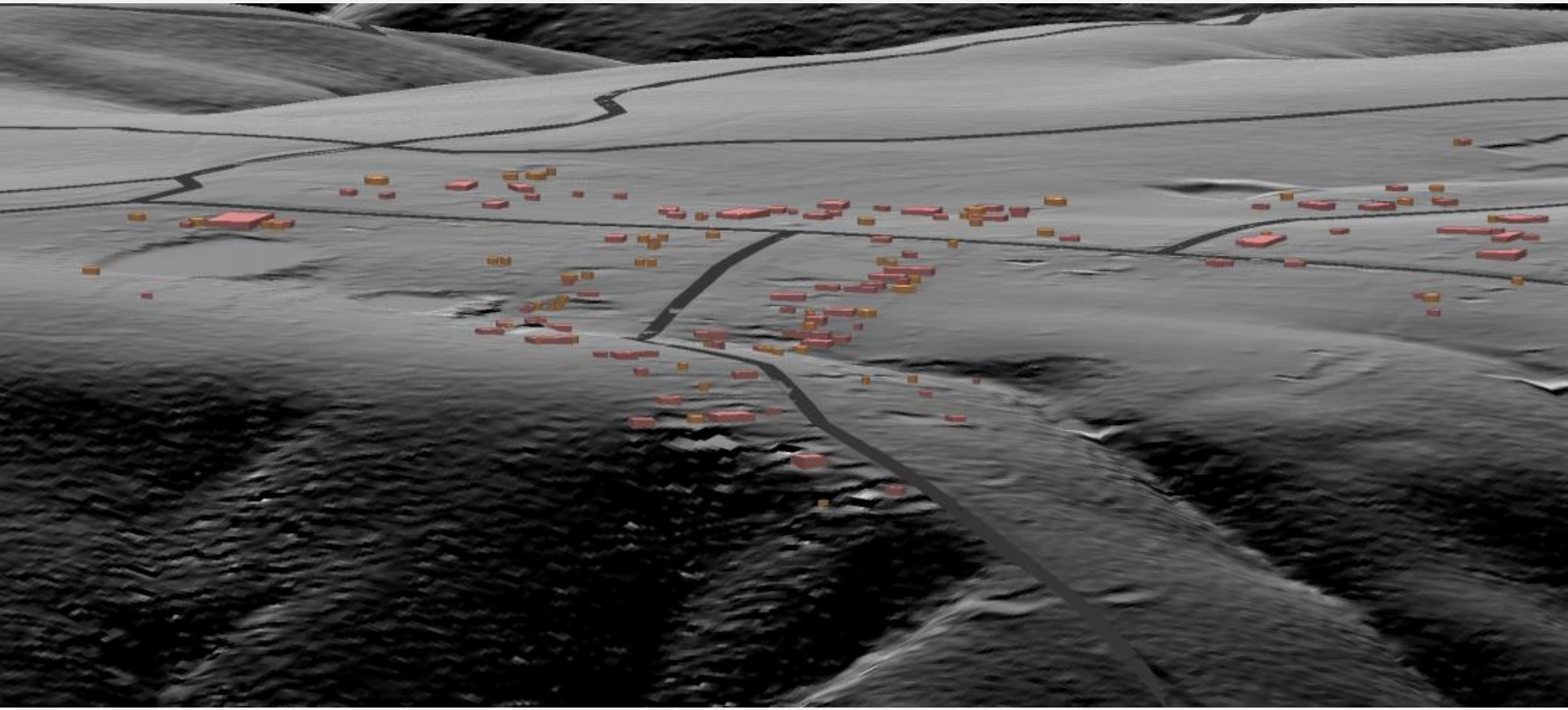
Managed Vegetation



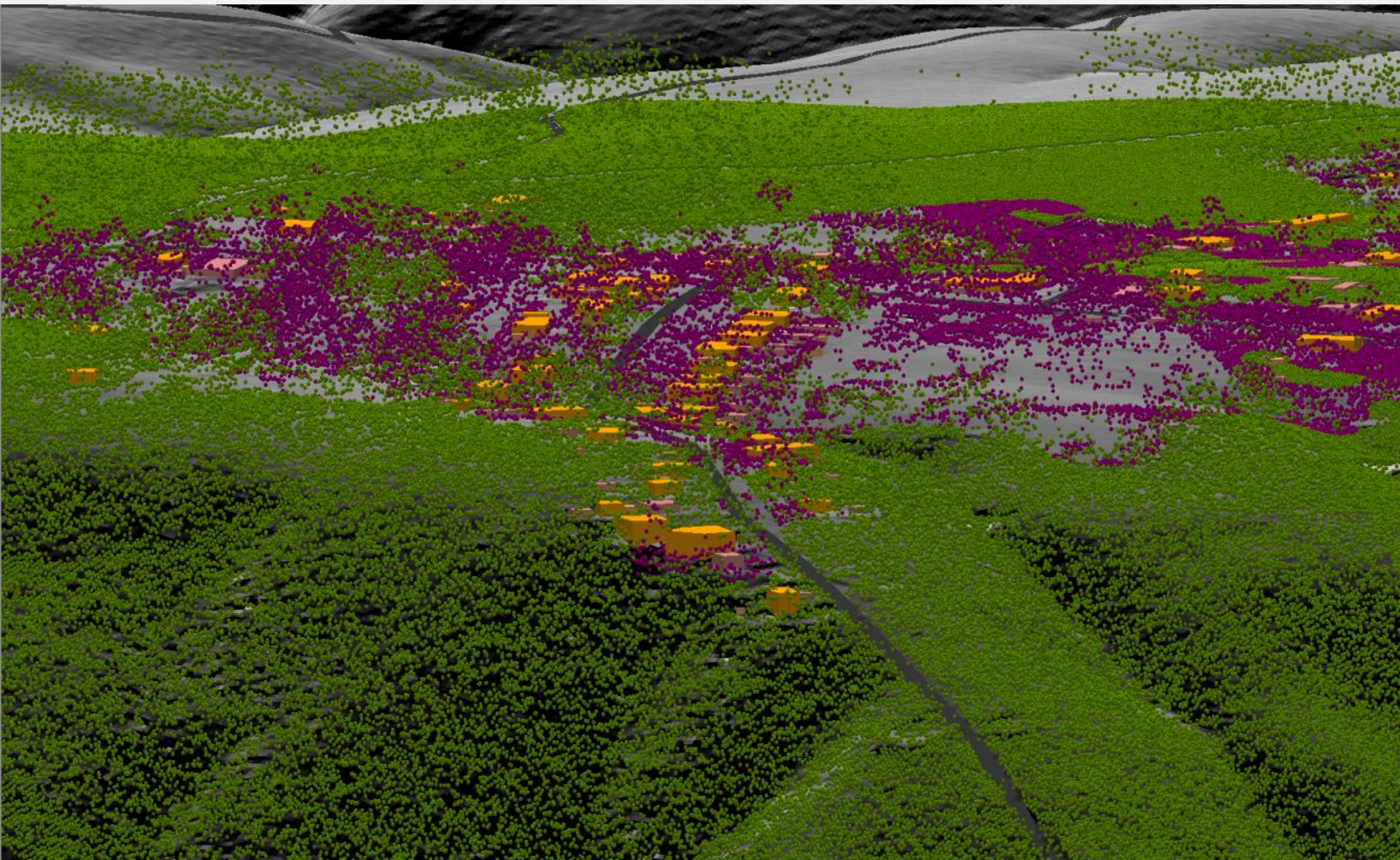
Residential



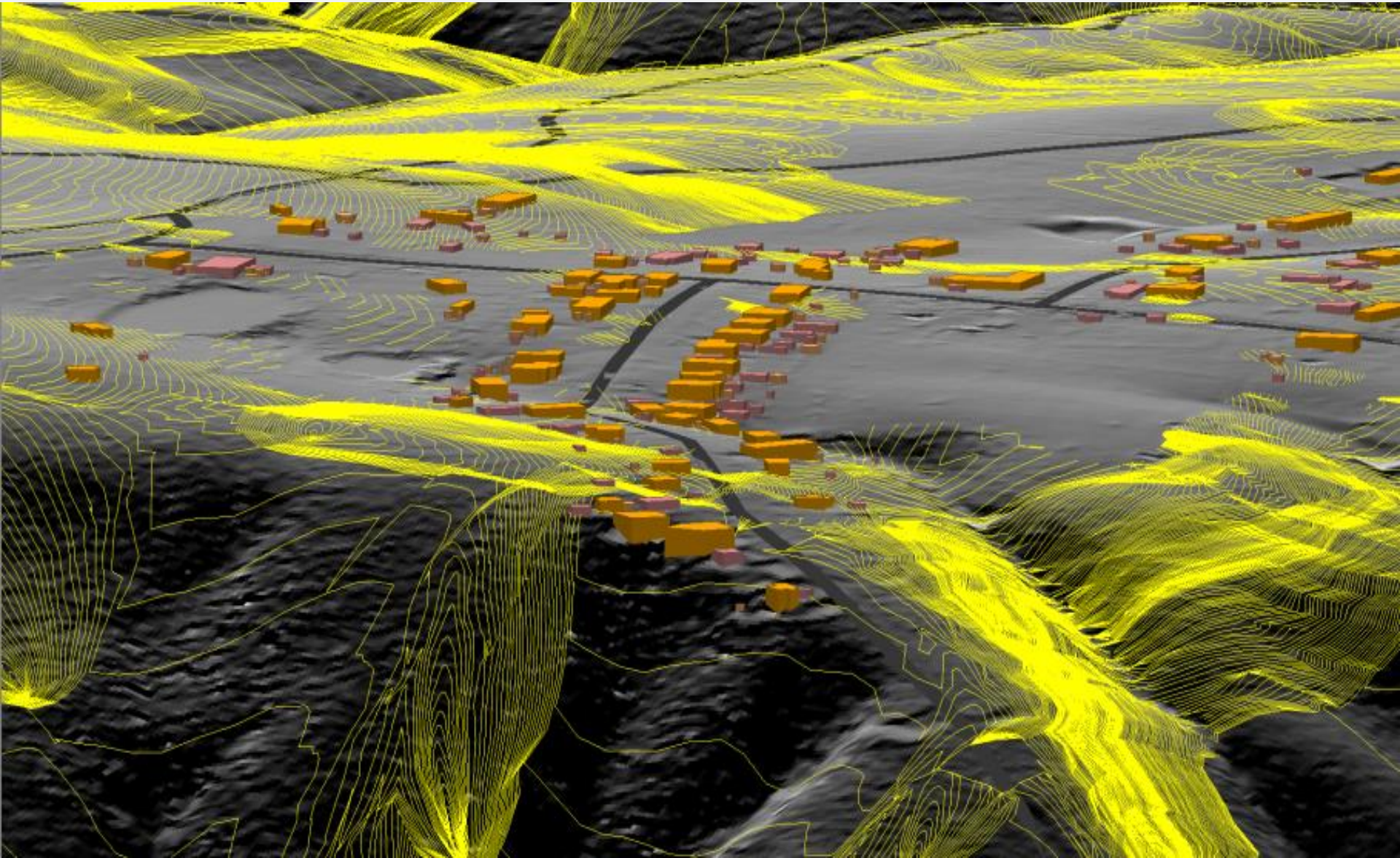
Out-buildings and water tanks



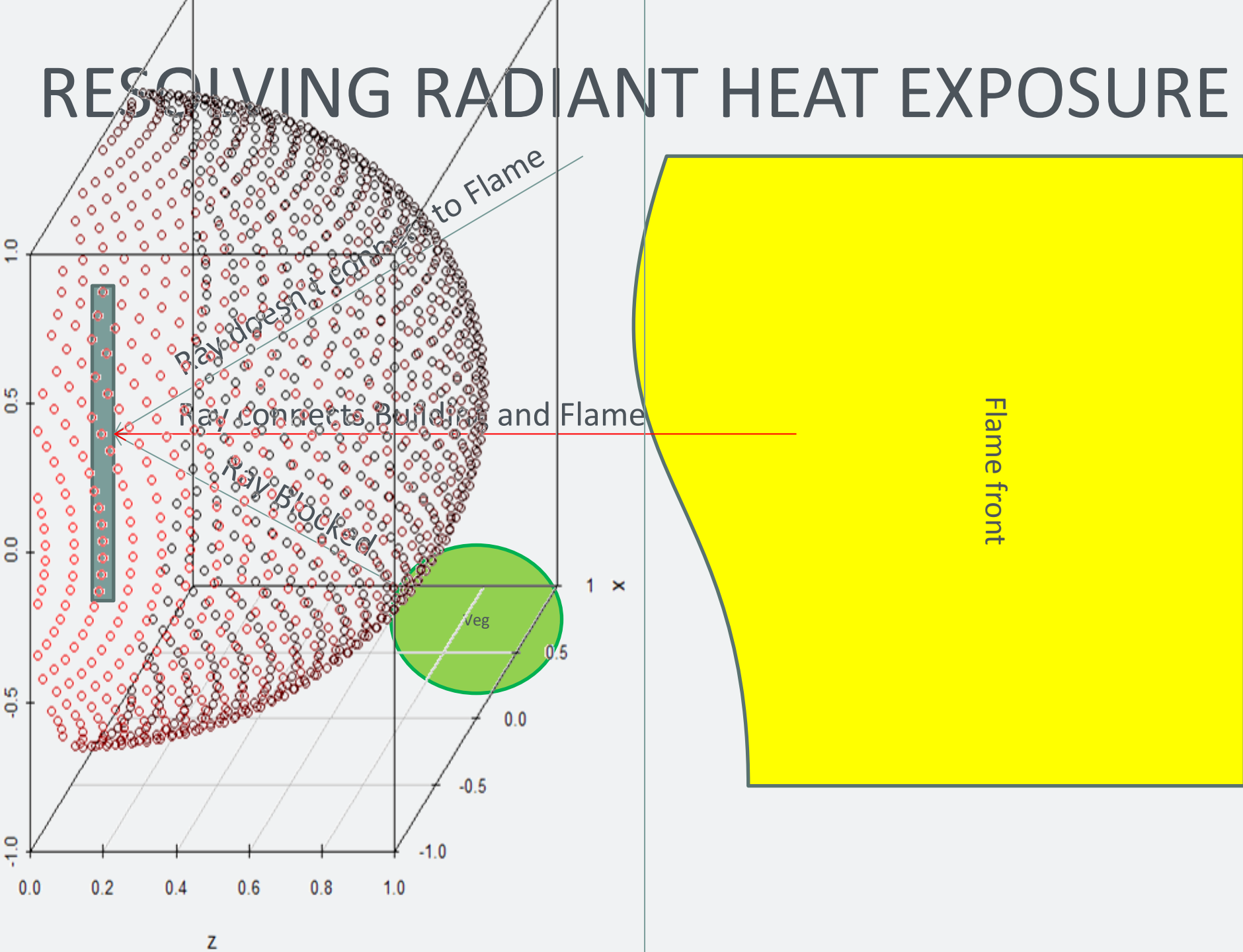
AGGREGATED SCENE

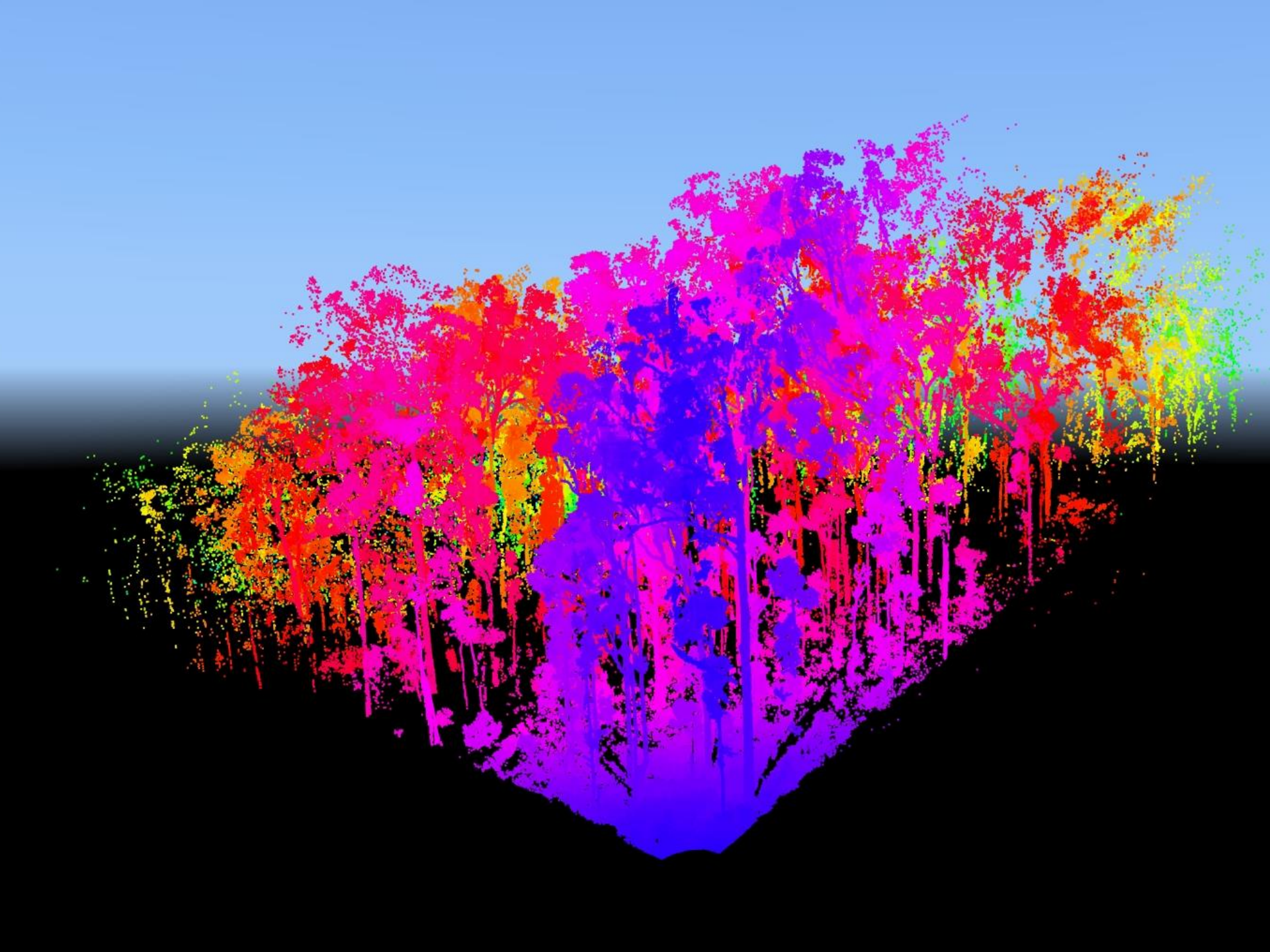


EXPLORING FIRE ARRIVAL – PHOENIX RAPIDFIRE

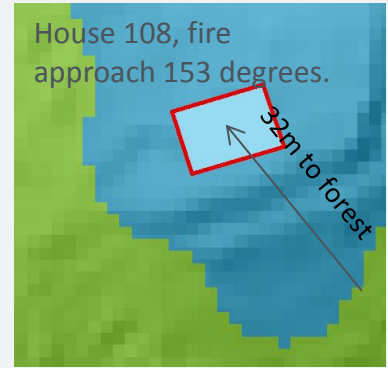
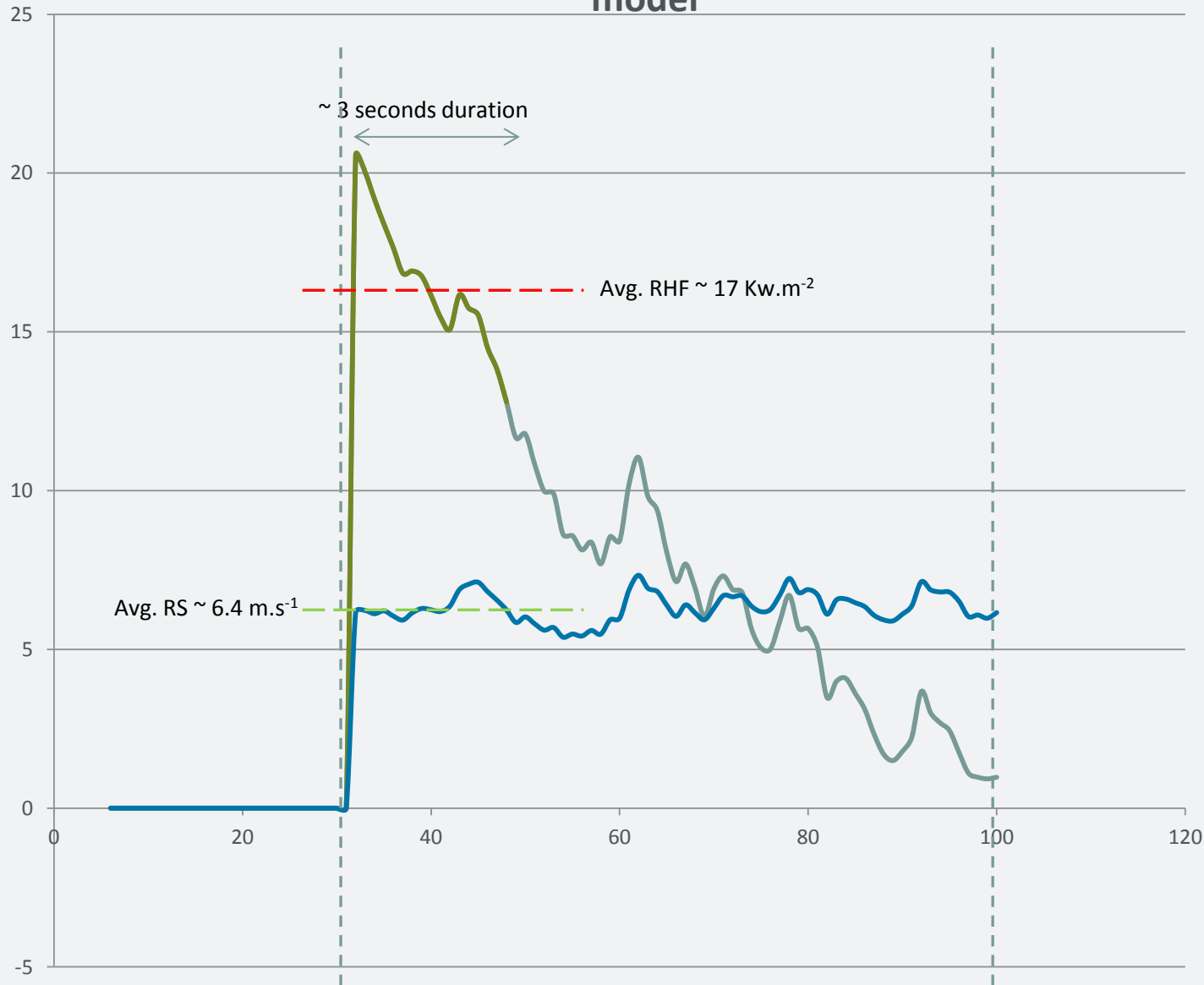


RESOLVING RADIANT HEAT EXPOSURE





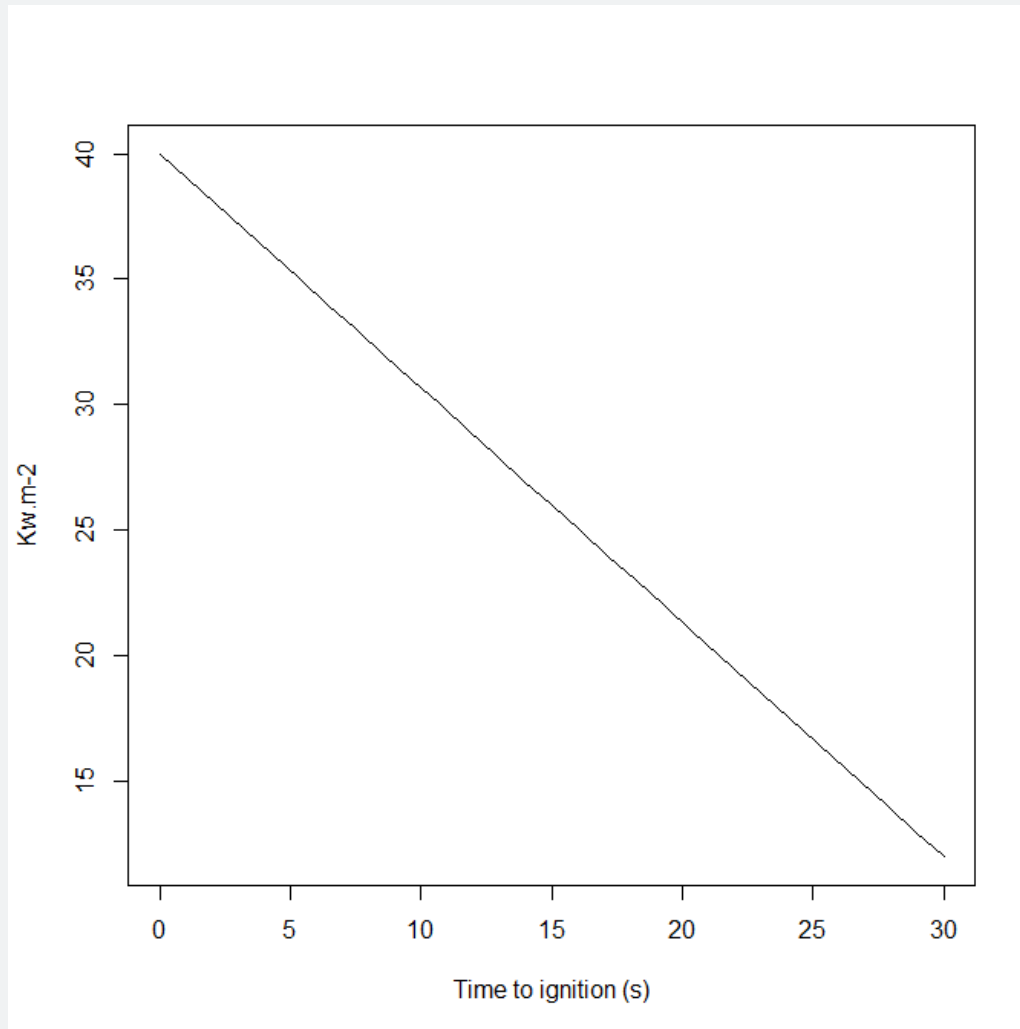
Example of high RHF Exposure insufficient to achieve ignition using 3D model



- RHF
- RHF Above Threshold
- Rate of Spread m/s

The total exposure of the house to incident RHF amounted to approximately half that required to achieve ignition without direct flame contact.

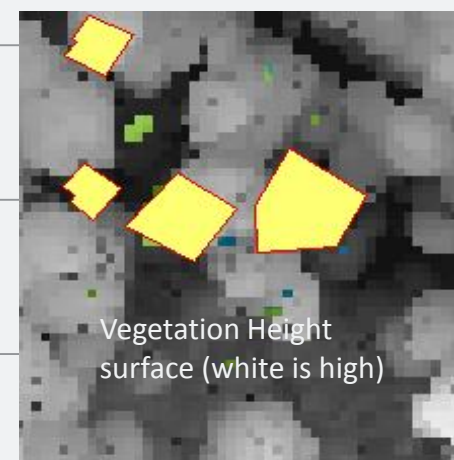
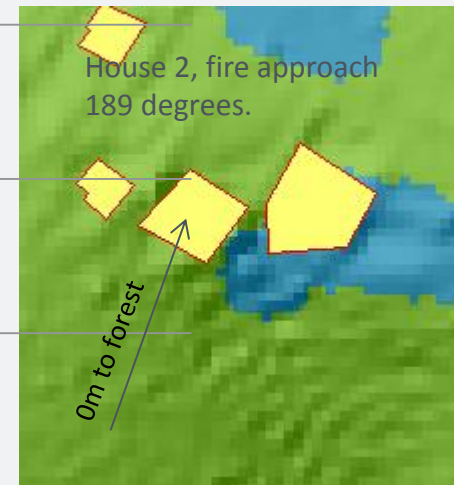
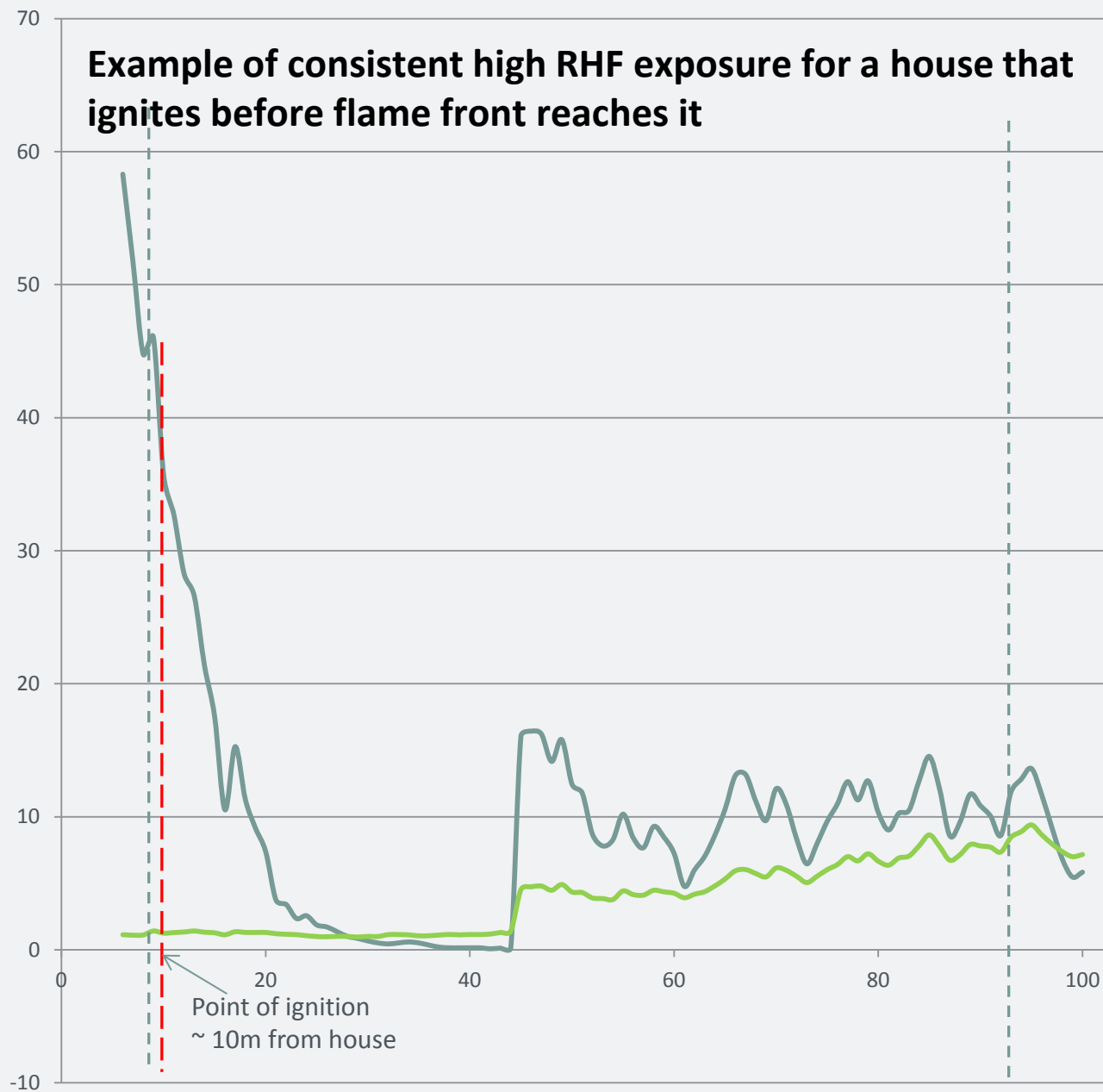
Ignition through time based RHF

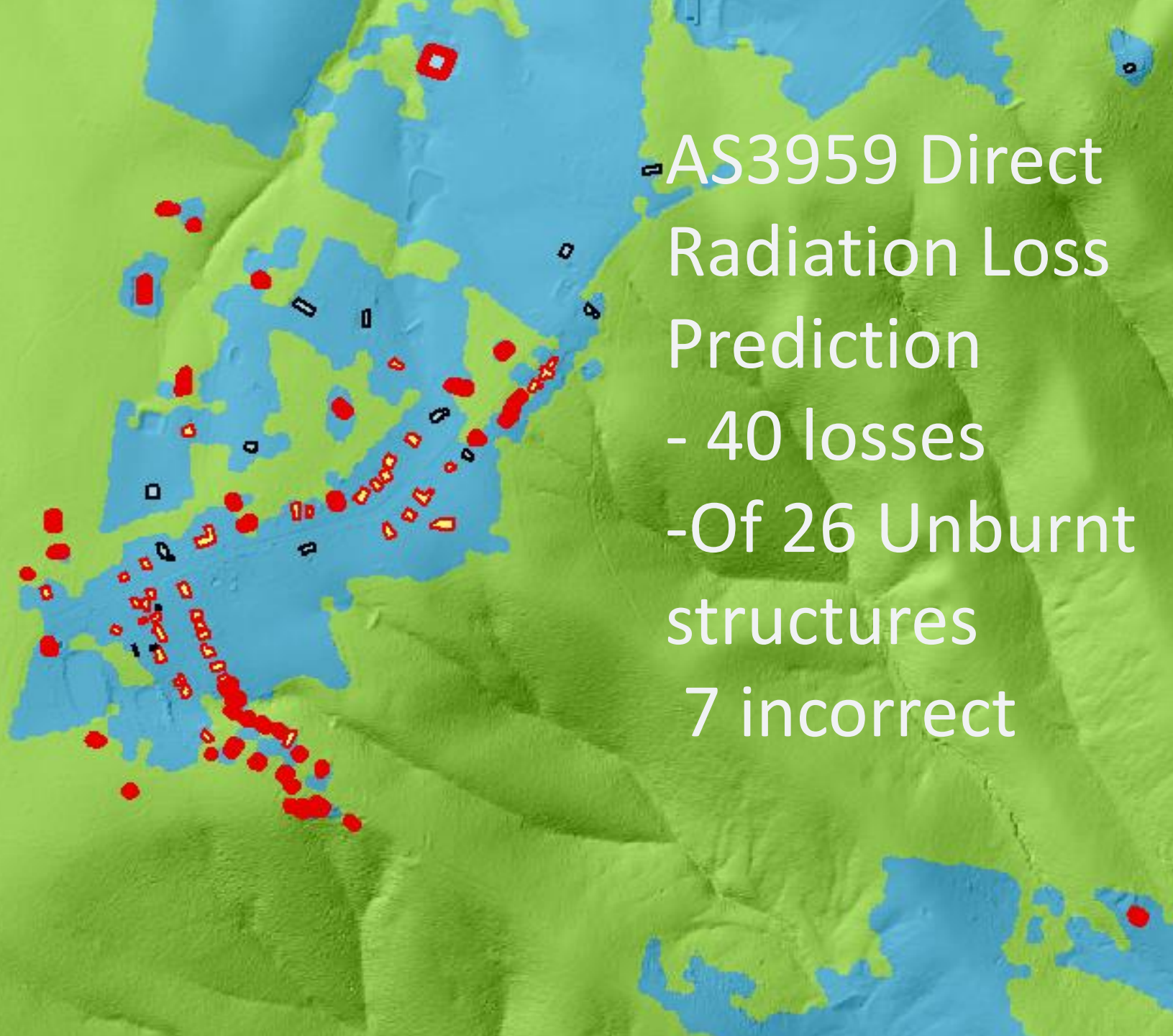


Model based on:

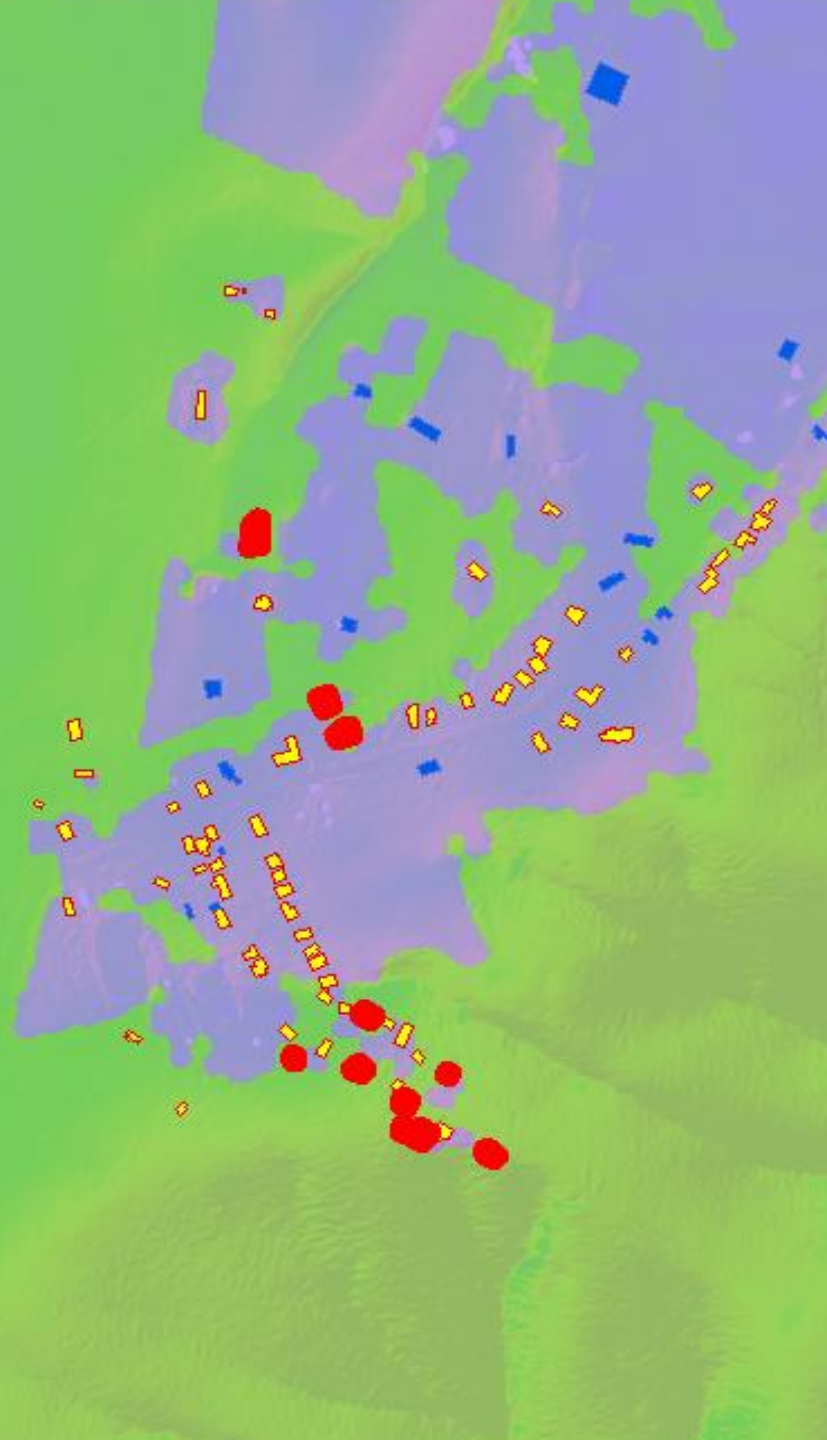
Tran, H. C.; Cohen, J., Jack D.; Chase, R. A., (1992). "Modelling ignition of structures in wildland/urban interface fires," In: *Proceedings of the 1st international fire and materials conference*; 1992 September 24-25; Arlington, VA. London, UK: Inter Science Communications Limited; 253-262.

Example of consistent high RHF exposure for a house that ignites before flame front reaches it



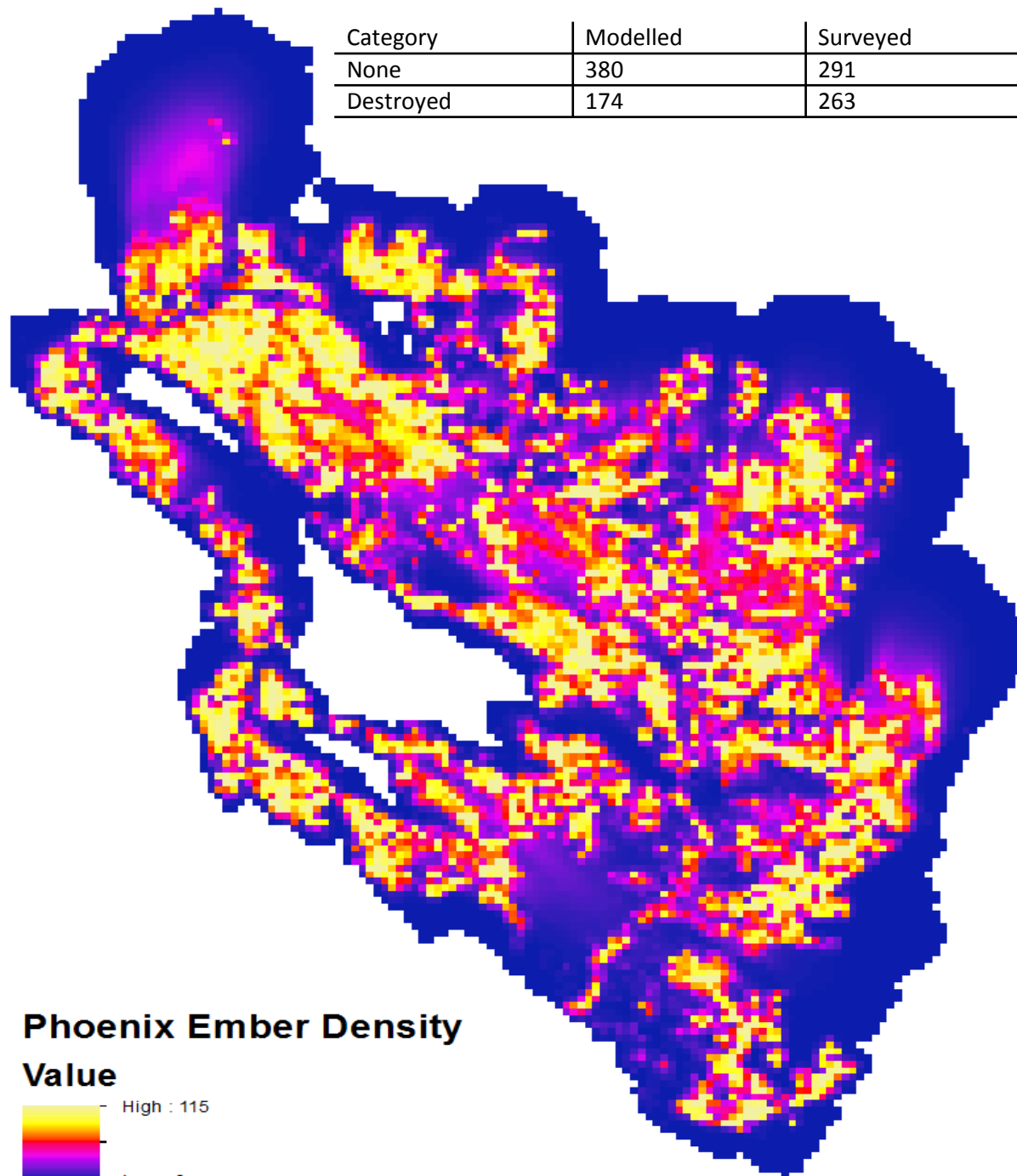


AS3959 Direct
Radiation Loss
Prediction
- 40 losses
- Of 26 Unburnt
structures
7 incorrect



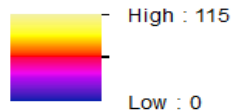
3D Model Direct
Radiation Loss
Prediction
-11 Houses lost
- Of 26 Unburnt
house none were
incorrectly
predicted

Category	Modelled	Surveyed	Correct	Accuracy %
None	380	291	217	57
Destroyed	174	263	100	57



Phoenix Ember Density

Value



Thank you

Reference list

- Newnham, G.J., Siggins., A., Blanchi, R.M., Culvenor, D.S., Leonard, J.E., Mashford, J.S. (2012).
“Exploiting three dimensional vegetation structure to map wildland extent”. *Remote Sensing of Environment*. Vol. 123. pp 155-162
- Blanchi, R., Leonard, J., Culvenor, D., Newnham, G., Opie, K. and Siggins, A. (2011). Vulnerability Model Parameters: Literature Review. Melbourne, CSIRO Ecosystems Sciences - Land and Water - Bushfire CRC report: 26p
- Leonard, J., Blanchi, R., Newnham, G., Culvenor, D., Siggins, A. and Opie, K. (2011). Characterisation of Interface Fuels - Literature Review. Melbourne, CSIRO Ecosystems Sciences - Land and Water - Bushfire CRC report: 36p.

