

Modelling Wildfire Impacts on Cities: Quantifying Threats to Buildings, Infrastructure, and Population Evacuation

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Te Whare Wānanga o Waitaha

Summary



1. Problem and aim
2. Integrated Research Streams
3. Modelling Wildfire Impacts on Cities
4. Model Implementation





1. Problem

WUI fires, such as Los Angeles 2025 fires, generally have the following characteristics:

→ **Urban infrastructure** directly and indirectly exposed



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→ Large and multimodal **evacuations**.

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WUI fires, such as Los Angeles 2025 fires, generally have the following characteristics:

- Fire spread between buildings
- Large and multimodal **evacuations**.
- **Urban infrastructure** directly and indirectly exposed



1. Problem

WUI fires, such as Los Angeles 2025 fires, generally have the following characteristics:

→Rapidly changing conditions

→Fire spread **between buildings**

→Large and multimodal **evacuations.**

→**Urban infrastructure** directly and indirectly exposed

1. Aim



High risk fires at the WUI, such as Los Angeles 2025 fires, are characterized by :

1. Develop a model system to assess exposure from WUI fires to infrastructure and people.
2. Implement it in resilience platforms currently used by decision makers for climate change adaptation and urban resilience

Summary



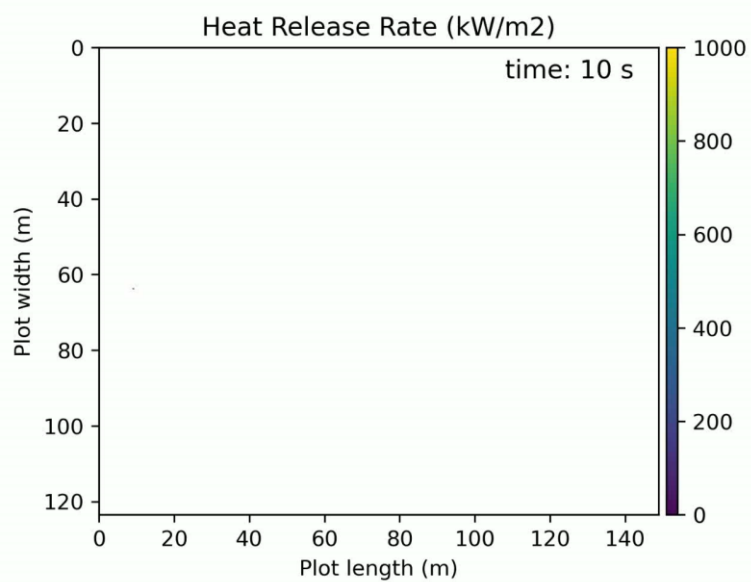
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2. Integrated Research Streams



Large-scale wildland fire observations



Rakaia Fire Experimental campaign, 2020. Led by Scion Scion, FENZ, Dr. Marwan Katurji's team, USFS

Fundamental Research

<https://doi.org/10.1071/WF22108>

<https://doi.org/10.1016/j.firesaf.2023.103862>

Applied Research

2. Integrated Research Streams



Fundamental Research

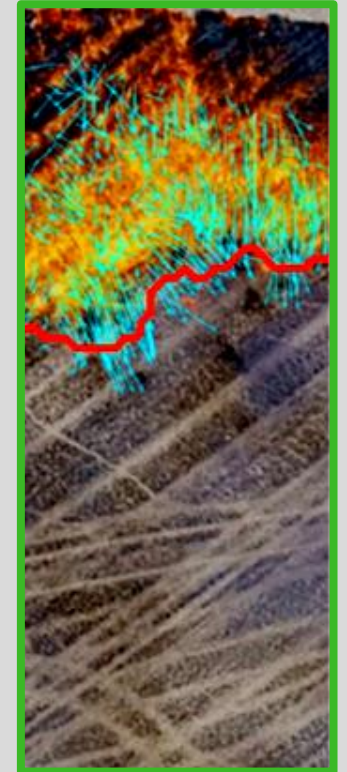
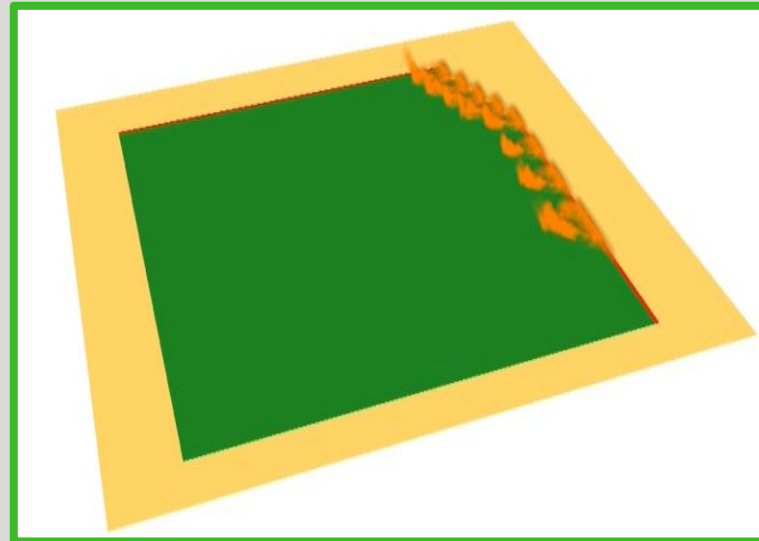
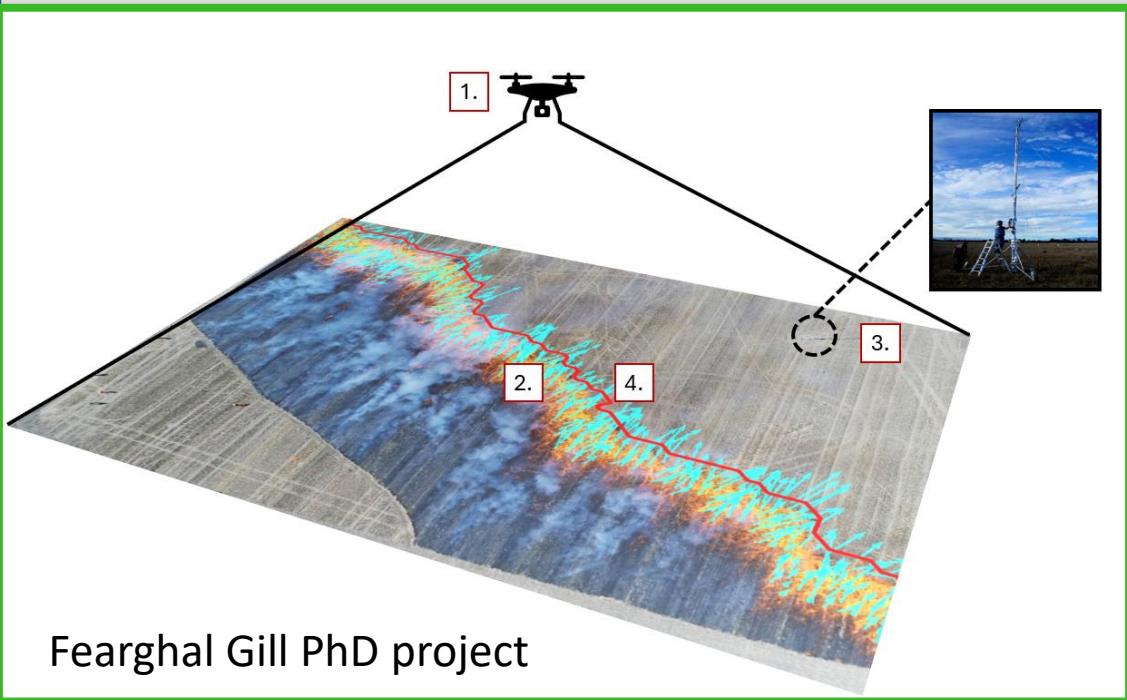
WF23167 <https://doi.org/10.1071/WF23167>

Applied Research

2. Integrated Research Streams



Reduced physics-based wildfire modelling



Fundamental Research

DOI 10.1088/1742-6596/2885/1/012071

Applied Research

2. Integrated Research Streams



Building materials exposed to wild conditions



2. Integrated Research Streams



Forecasting wildfires using machine learning

MACHINE LEARNING

Led by Dr. Alberto Abid

Image hosted by: WittySparks.com | Image source: Pixabay.com

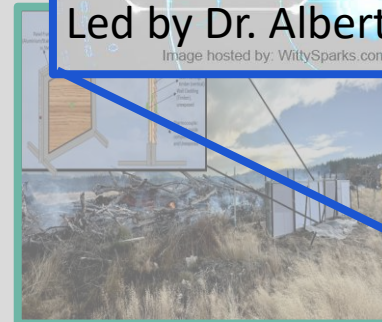
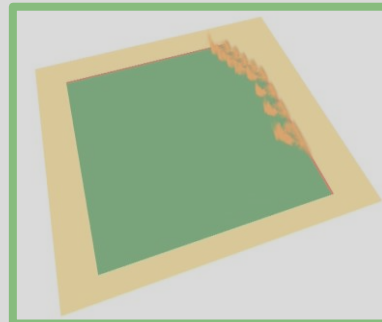
Large-scale wildland fire observations



NZ vegetation flammability



Physics-based wildfire simulations



Fundamental Research

<https://doi.org/10.1071/WF24113>

Applied Research

2. Integrated Research Streams



Implementation into urban resilience platforms

Partner : **Urban Intelligence**

Platform : **Resilience Explorer**



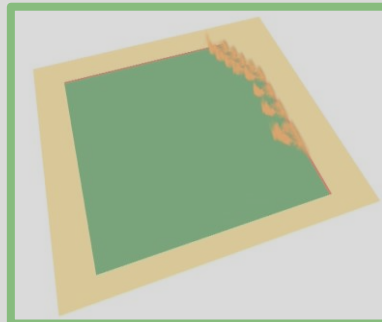
Large-scale wildland fire observations



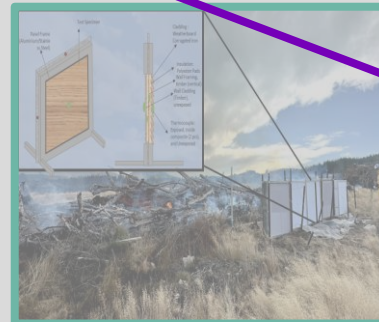
NZ vegetation flammability



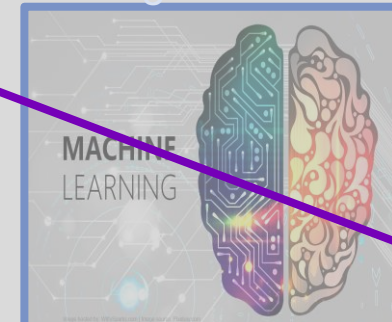
Physics-based wildfire simulations



Buildings exposure conditions



Machine learning



Fundamental Research

<https://resilience-explorer.org/>

Applied Research

2. Integrated Research Streams



Multiple research streams integrated into a platform to assess exposure from wildfire to built environment

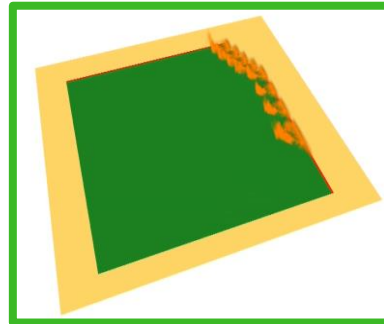
Large-scale wildland fire observations



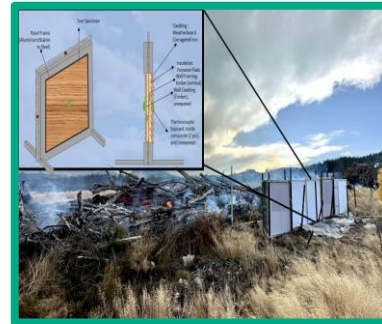
NZ vegetation flammability



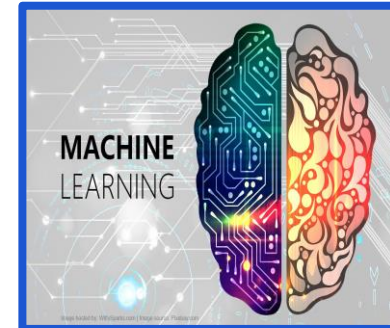
Physics-based wildfire simulations



Building materials exposed to wildfire conditions



Forecasting wildfires using machine learning



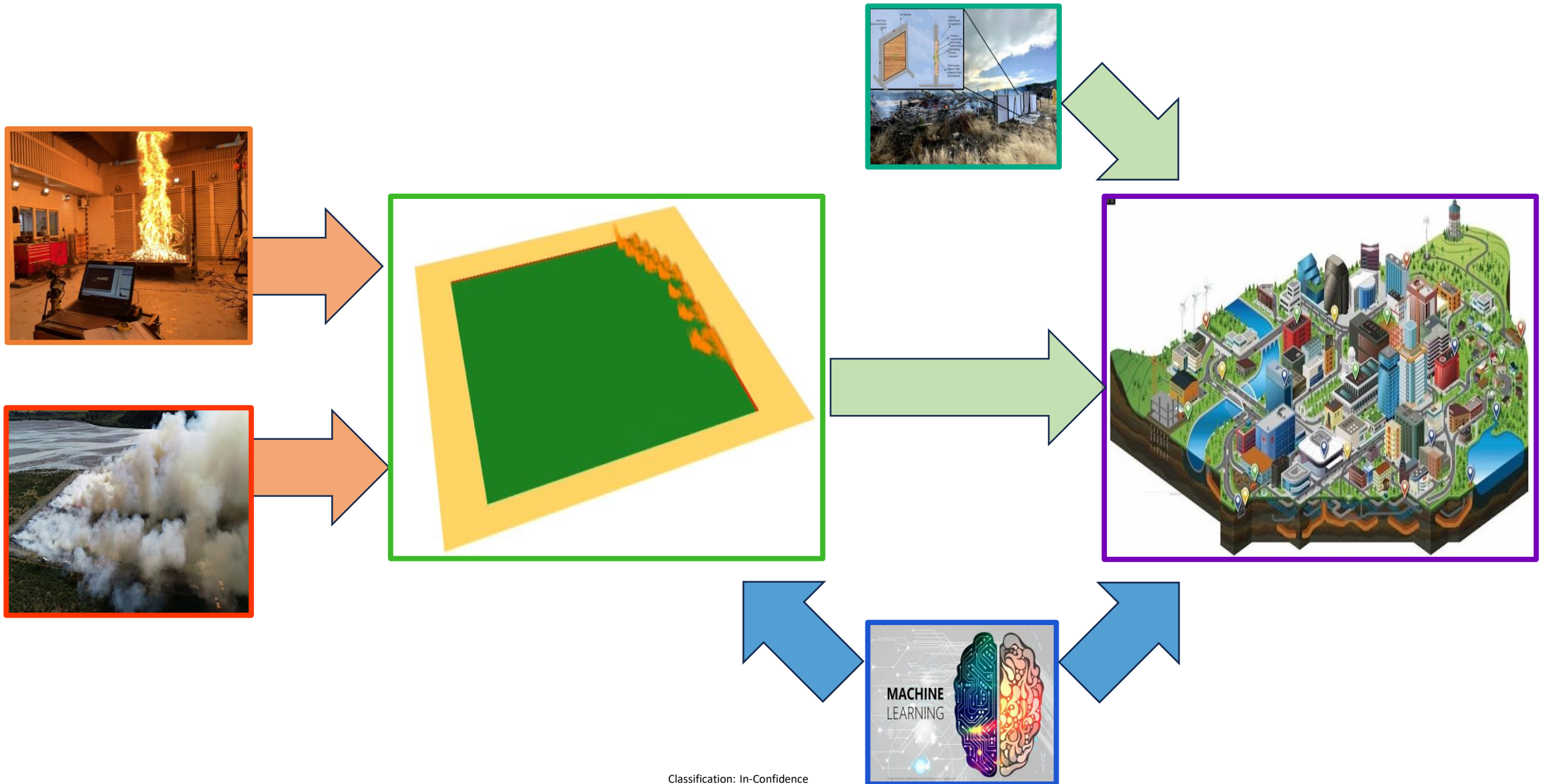
Implementation into urban resilience platforms



Fundamental Research

Applied Research

2. Integrated Research Streams



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3. Modelling Wildfire Impacts on Cities

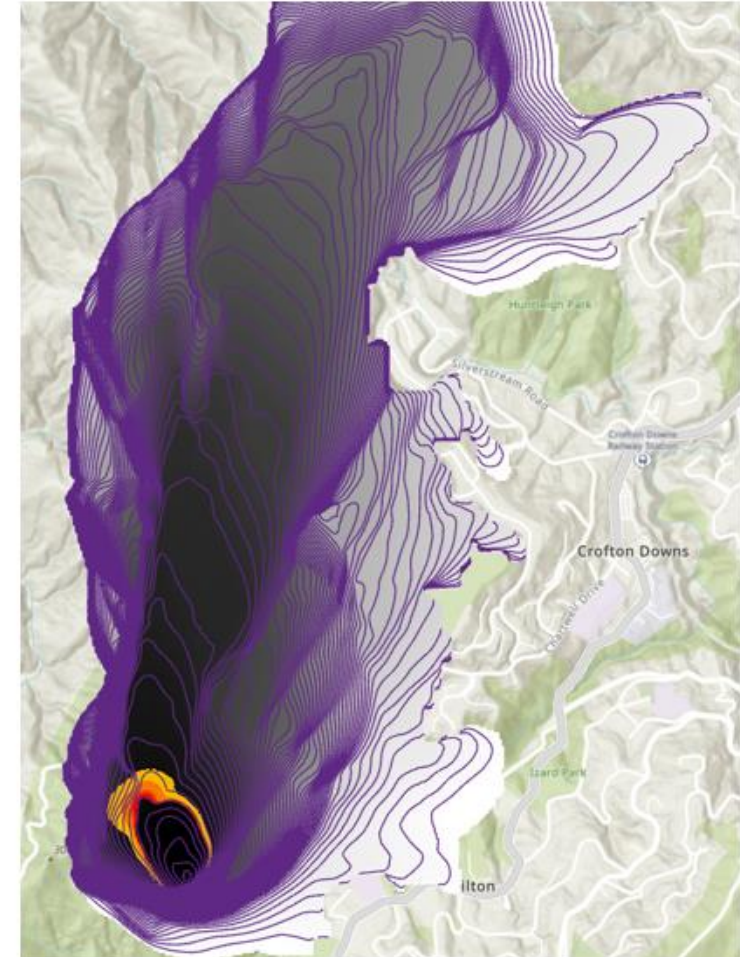


WUI Fires exposure : Model System

1) Wildfire spread calculation

- *Fire spread model agnostic.*
- *Currently using empirical fire spread model.*
- *Transition to reduced physics model in near future*

Wildfire isochrone



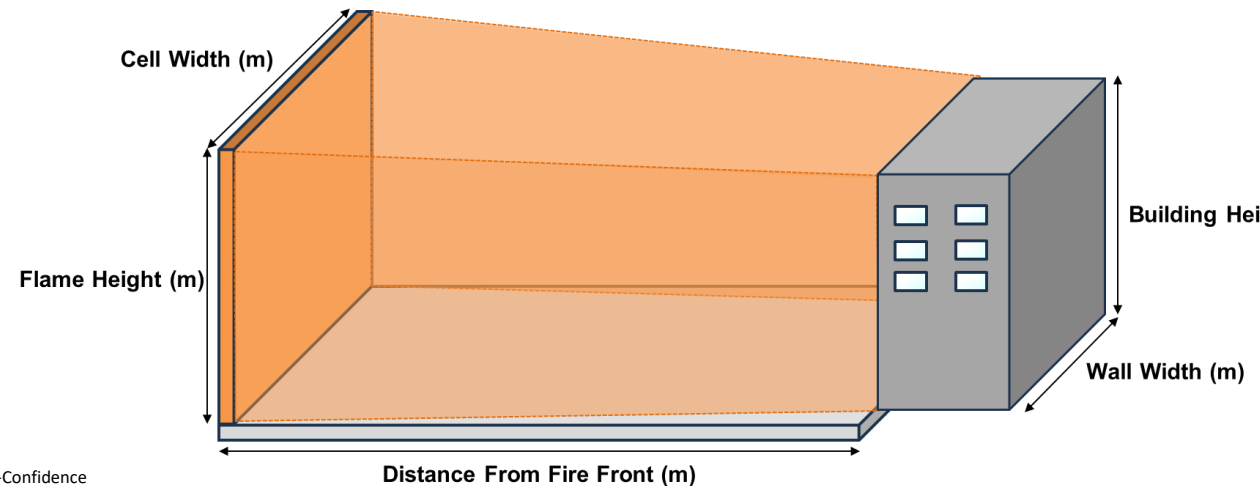
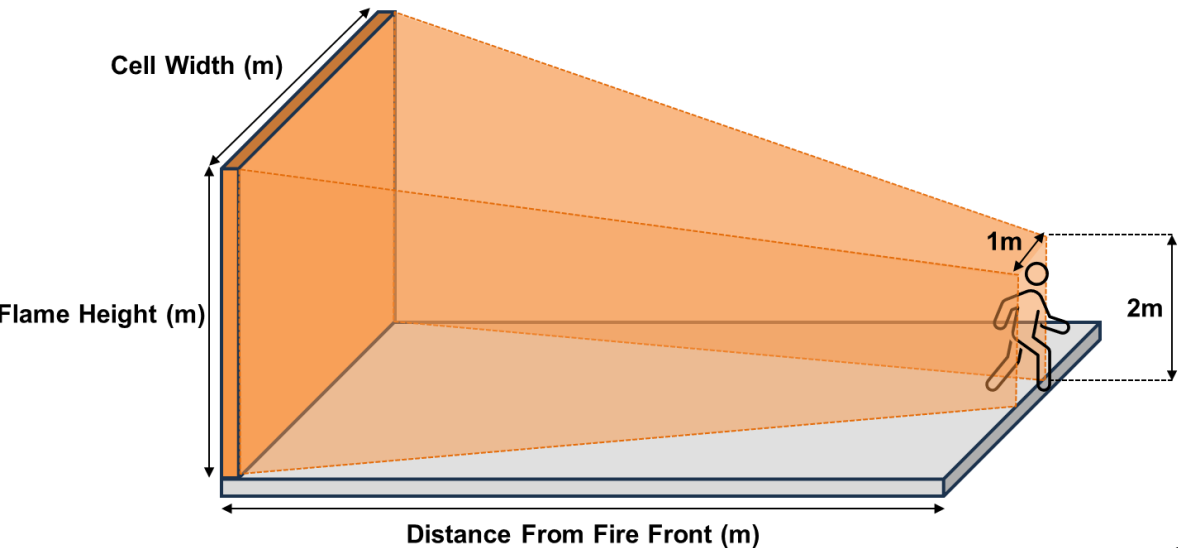
3. Modelling Wildfire Impacts on Cities



WUI Fires exposure : Model System

2) Heat Flux Calculation to infrastructure and people

1) Wildfire spread calculation

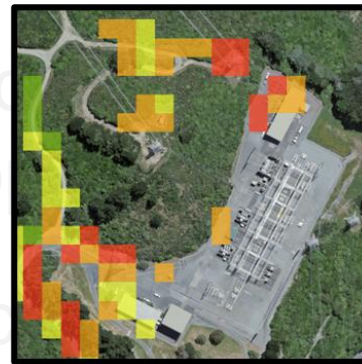
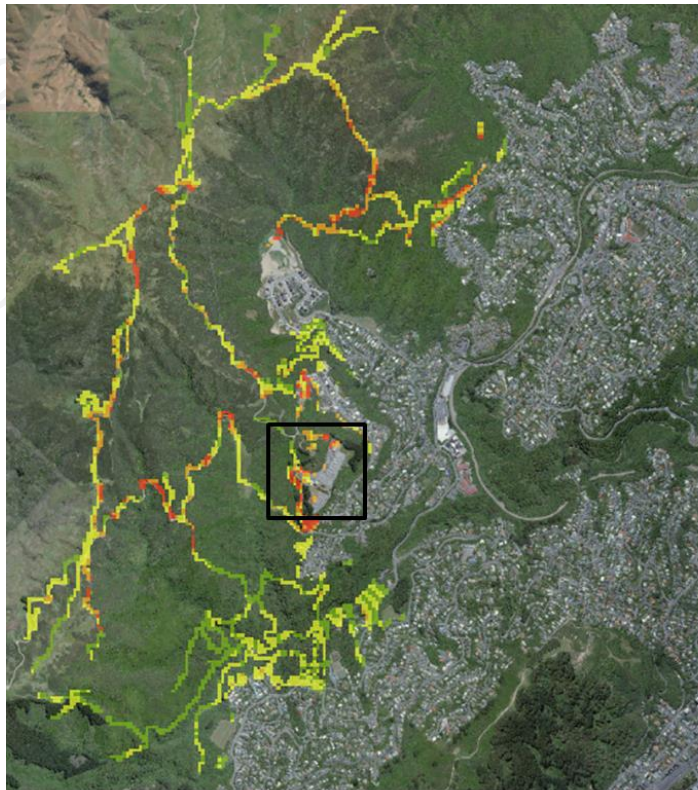


3. Modelling Wildfire Impacts on Cities

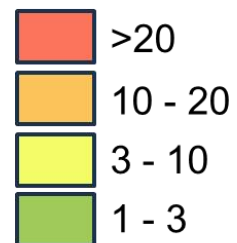


WUI Fires exposure : Model System

3) Exposure Mapping



Max RHF
(kWm⁻²)



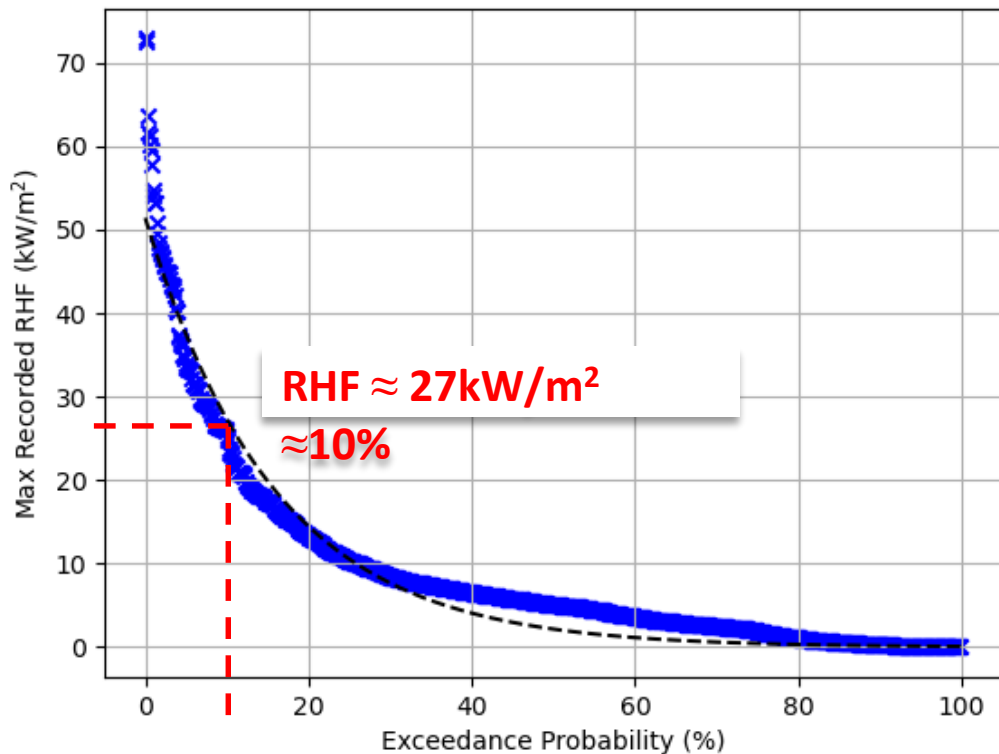
3. Modelling Wildfire Impacts on Cities



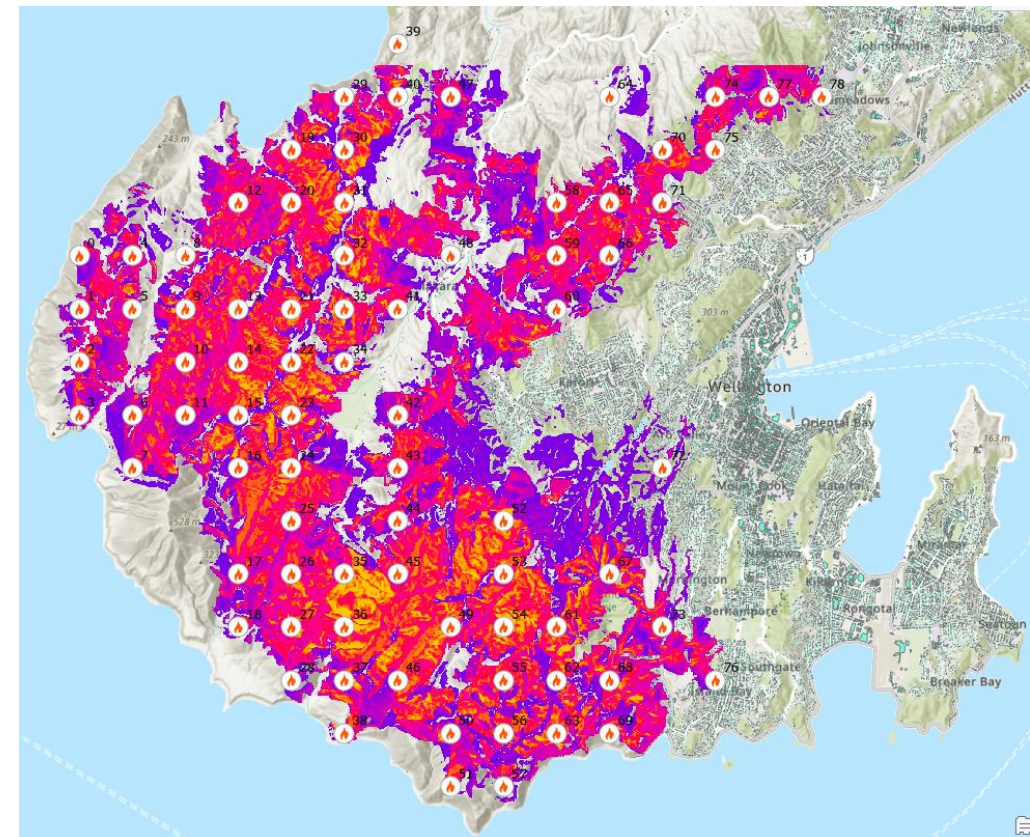
WUI Fires exposure : Model System

4) Ensemble simulation

EP of Points Receiving Heat Within Target Area



Combined – Exemplary Simulation



Maximum Flame Height (m)



3. Modelling Wildfire Impacts on Cities



WUI Fires exposure : Model System

5) Building to building fire spread

4) Ensemble simulation

3) Exposure Mapping

2) Heat Flux Calculation to infrastructure and people

1) Wildfire spread calculation

- *Collaboration with Dr. Keisuke Himoto.*
- *Implementation of his model in the NZ context*

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4. Model Implementation



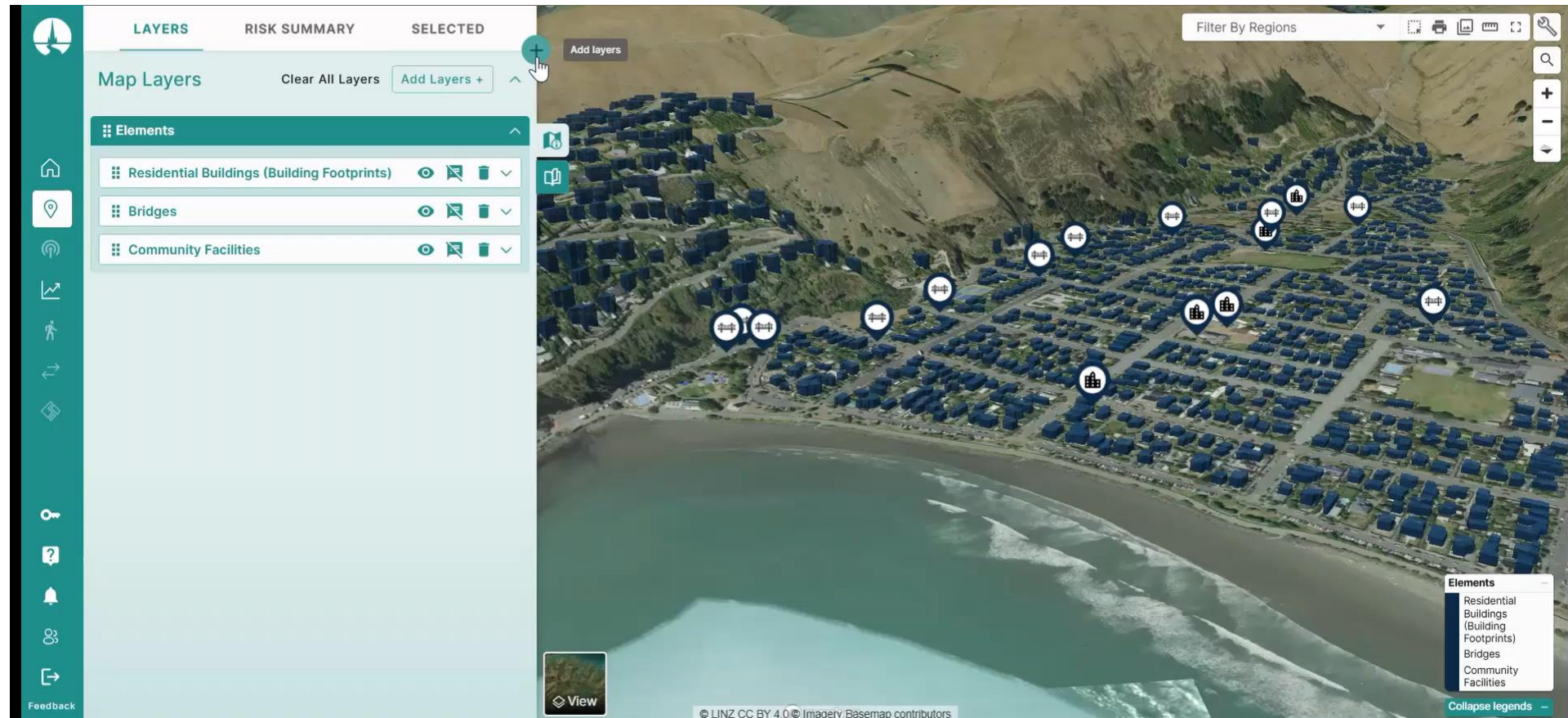
Implementation into Resilience Explorer from Urban Intelligence



4. Model Implementation

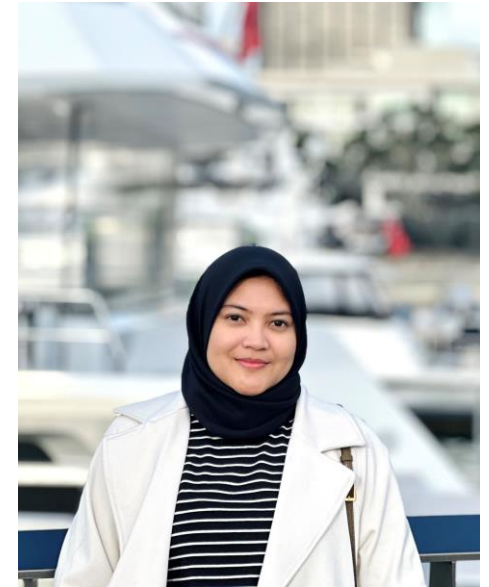


Implementation into Resilience Explorer from Urban Intelligence



Team, Goal and Vision

My team aims for developing new engineering principles capable of reducing the wildfire risk and of building resilient communities



Acknowledgments



- PhD students and postdocs:
 - Barry Evans
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 - Fearghal Gill
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 - Minister of Business and Innovation
 - Fire Research Group / Halliwell Research
 - University of Canterbury
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 - US Forest service
 - Covey
 - IES

Thank you very much!

Any questions??

Any comment/feedback will be welcomed
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