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MAPPING BUSHFIRE HAZARD AND IMPACT

Developing spatial information on fire hazard for planners, land managers and emergency services

Prof. Albert Van Dijk, Dr. Geoff Cary and DR. Marta Yebra

Fenner School of Environment and Society, ANU College of Medicine, Biology and Environment, ACT.

An Australian Government Initiative

CRC AUSTRALIA

Australian National University

PROJECT TEAM MEMBERS

Australian National University

Lead End-users

Jeff Kingwell, Geosciences Australia

John Bally, Bureau of Meteorology

Neil Cooper and Adam Leavesley, ACT Parks and Conservation Service

David Taylor, Parks Tasmania

Richard Wald, South Australian Country Fire Service (tbc)

Lawrence McCoy, NSW Rural Fire Service (tbc)

External collaborators

Prof. Emilio Chuvieco (University of Alcalá, Spain)

Dr. Alex Held and Arancha Cabello-Leblic (CSIRO / TERN AusCover)

Jim Gould and Dr. Luigi Renzullo (CSIRO)

Dr. Philip Zylstra (UOW)

MOTIVATION

Australian National University

1) End-users require accurate, timely, spatial information on bushfire hazard (e.g., fuel load and moisture) with reference to conditions experienced in the past.

2) Currently little such information available, but this is situation is rapidly evolving:
   - New generation satellite, airborne and mapping derived products and models useful for estimating hazard are now readily available;
   - Applicability, value and adaptations of these need to be assessed with reference to data required for fire risk calculations and fire modelling;
   - Remote sensing and fire behaviour research/modelling are rapidly changing.


G. Cary, ANU

ACTIVITY 1

FIRE HAZARD MAPPING AND MONITORING

Australian National University

Objective

Develop methods to produce reliable and operationally useful spatial information on critical aspects of bushfire hazard

Approach

Exploration of relationships between measured fuel load, structure and moisture to remote sensing data

Products

Interpretation methods across broad spatial extents, of fuel load, structure and moisture to support fire management activities

2014	• Case study: using LiDAR for fuel structure mapping
2015	• Trials: spatial satellite monitoring of fuel structure and moisture
2016	• Development plan: data products chosen for development into operations
2017	• Algorithm validation and documentation
2018	• Data processing chain development and testing
2019	• Transition to agency as pre-operational product
2020	• Products released in beta

Project roadmap for activity 1.


G. Cary, ANU

ACTIVITY 2

FIRE IMPACTS ON LANDSCAPE VALUES

Australian National University

Objective

Develop methods to determine the impact of unplanned and prescribed burning on fuel accumulation as well as landscape values (habitat, water resources and carbon storage) over time, in support of fire management

Approach

Combine spatial information on water use and carbon uptake with past fire events and severity to analyse the impact on water, carbon and fuel as a function of fire severity and time since burning.

Products

Time series of weekly water use and carbon uptake in study cases in ACT's water catchments recovering from the 2003 bushfires.

- 2014 • Analysis of spatial data and models for fire impact prediction
- 2015 • Model-data assimilation method demonstrated
- 2016 • Case study documented, roll-out planned
- 2017 • Method trialled for two other case studies
- 2018 • Prediction software coded and tested
- 2019 • Prediction method and software documented
- 2020 • Prediction software released in beta

EARLY ACHIEVEMENTS

Australian National University

1) New commencements:

a) *Dr. Marta Yebra*, Research Fellow, Fenner School of Environment & Society (ANU)

b) *Suzanne Marselis* (MSc student form the University of Amsterdam). Project title: "Comparing different types of remote sensing data for forest fuel mapping in the Australian Capital Territory region"

2) Project planning meetings

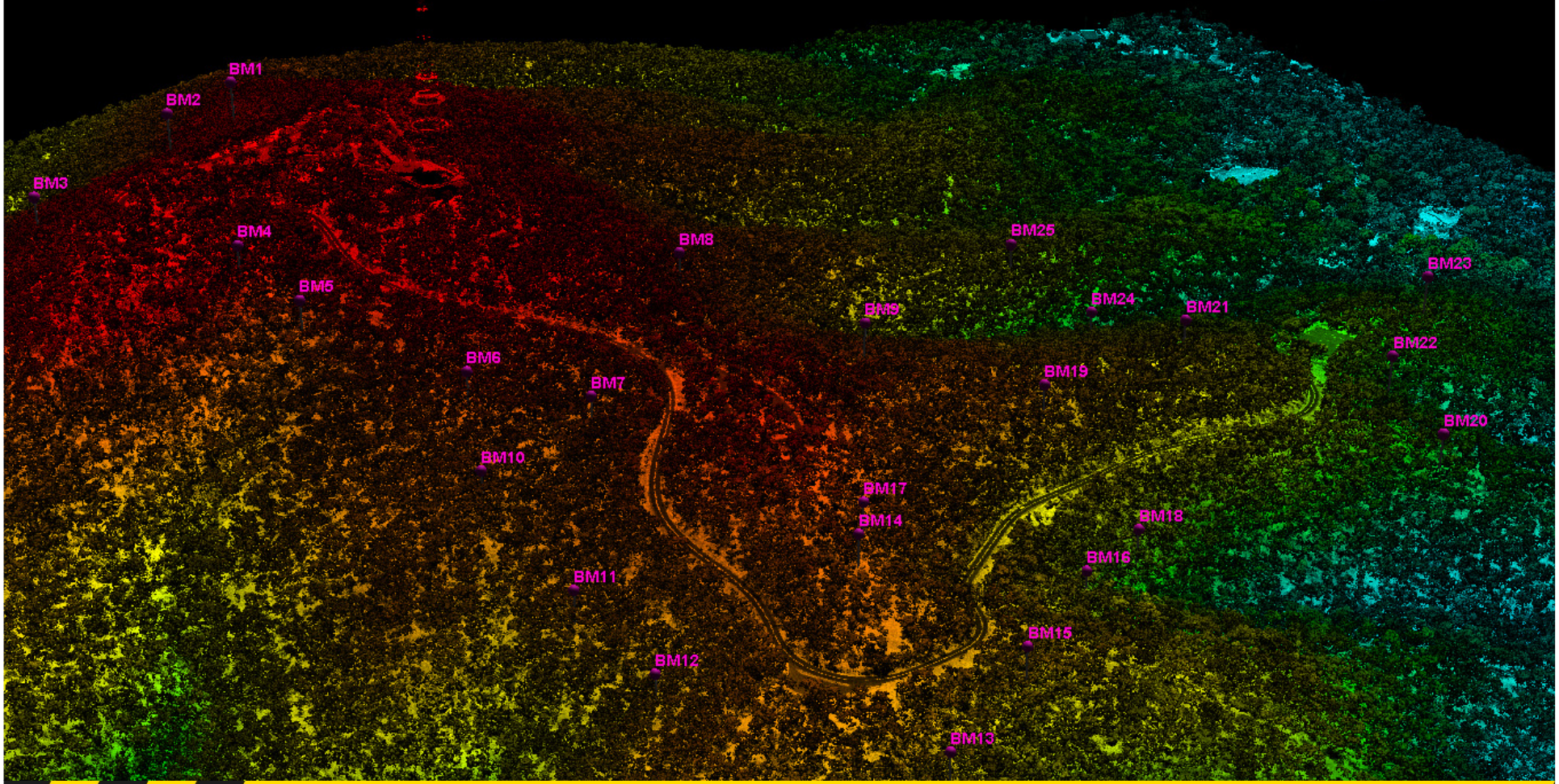
a) with external collaborators, 25 September 2013, Canberra

b) With end-users, 14 March 2014, Canberra

EARLY ACHIEVEMENTS

Australian National University

1) LiDAR and Hyperspectra data acquisition in collaboration with CSIRO/ACT Parks



LiDAR image from Black Mountain in ACT
showing the midpoint of the 25 ground truth plots

EARLY ACHIEVEMENTS

2) Ground truth work

ANU/CSIRO/Wollongong Uni researchers and volunteers collecting information about tree structural parameters at and FMC at Black Mountain

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DISASTER LANDSCAPE ATTRIBUTION: THERMAL ANOMALY SURVEILLANCE AND HAZARD MAPPING, DATA SCALING AND VALIDATION

END-USERS

Country Fire Authority

Dr. Danni Martin – Dr. David Nichols

Department of Environment and Primary Industries

Mr. Adam Damen

Geoscience Australia

Dr. Geoff Kingwell

Bureau of Meteorology

Dr. John Bally

RESEARCH PARTNERS

Professor Simon Jones - Dr. Karin Reinke - Professor Nicholas Chrisman

School of Mathematical & Geospatial Sciences, RMIT University

Dr. Andreas Eckhardt - Frank Lehman

DLR (German Aerospace), Germany

Dr. Alex Held

TERN / CSIRO

Dr. Ian Grant

Bureau of Meteorology

Dr. Andrew Skidmore

ITC, University of Twente, Netherlands

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RMIT UNIVERSITY

DLR

CSIRO

Australian Government Bureau of Meteorology

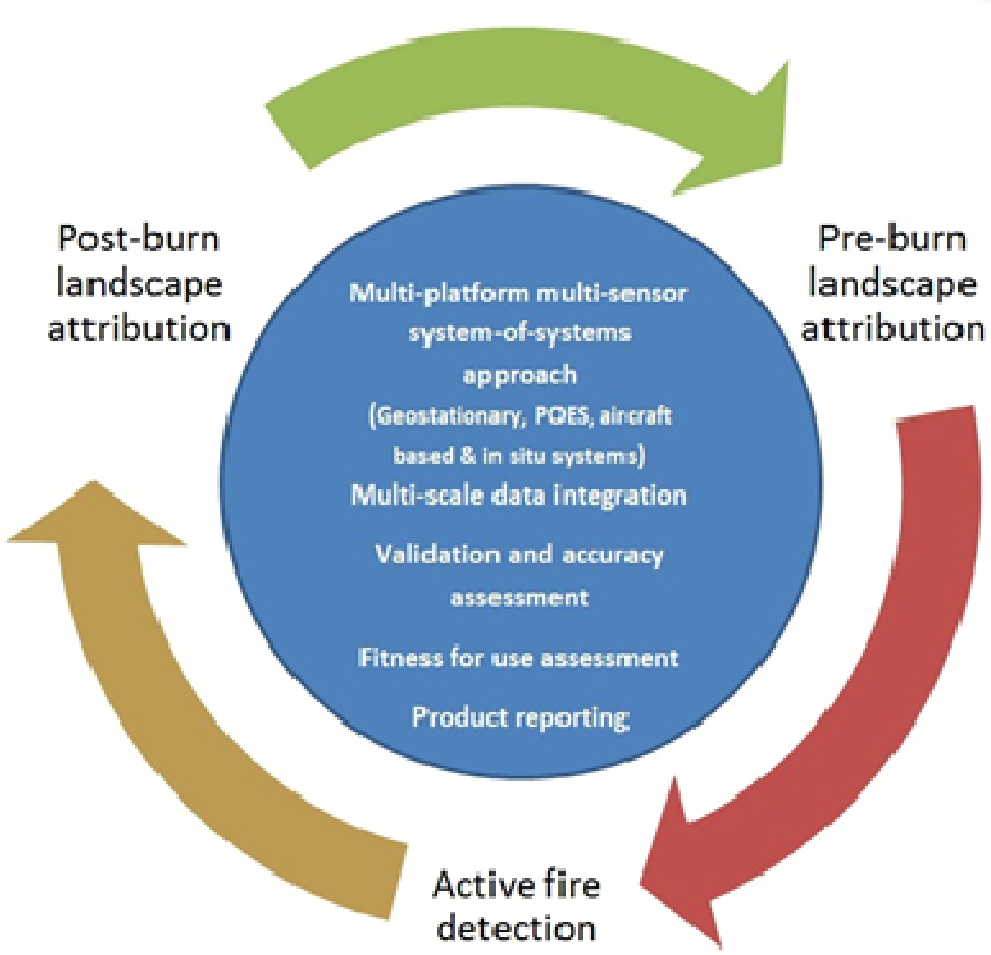
MOTIVATIONS AND OBJECTIVES

Understanding the **fitness-for-purpose** of emerging satellite constellations and **new data products** designed for active fire detection and mapping.

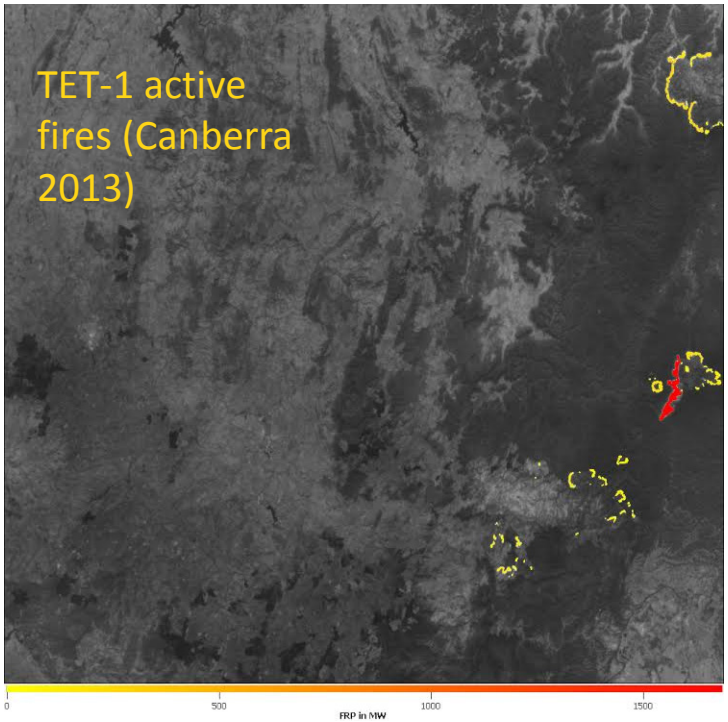
Remote sensing is ubiquitous; how to **effectively** integrate multi-source data to support **accurate fire decision making** for (1) **active fire** detection and mapping, and (2) rapidly quantifying **landscape change** in response to fire.

Effect of scaling from multiple data sources when used as input for fire modelling and management decisions.

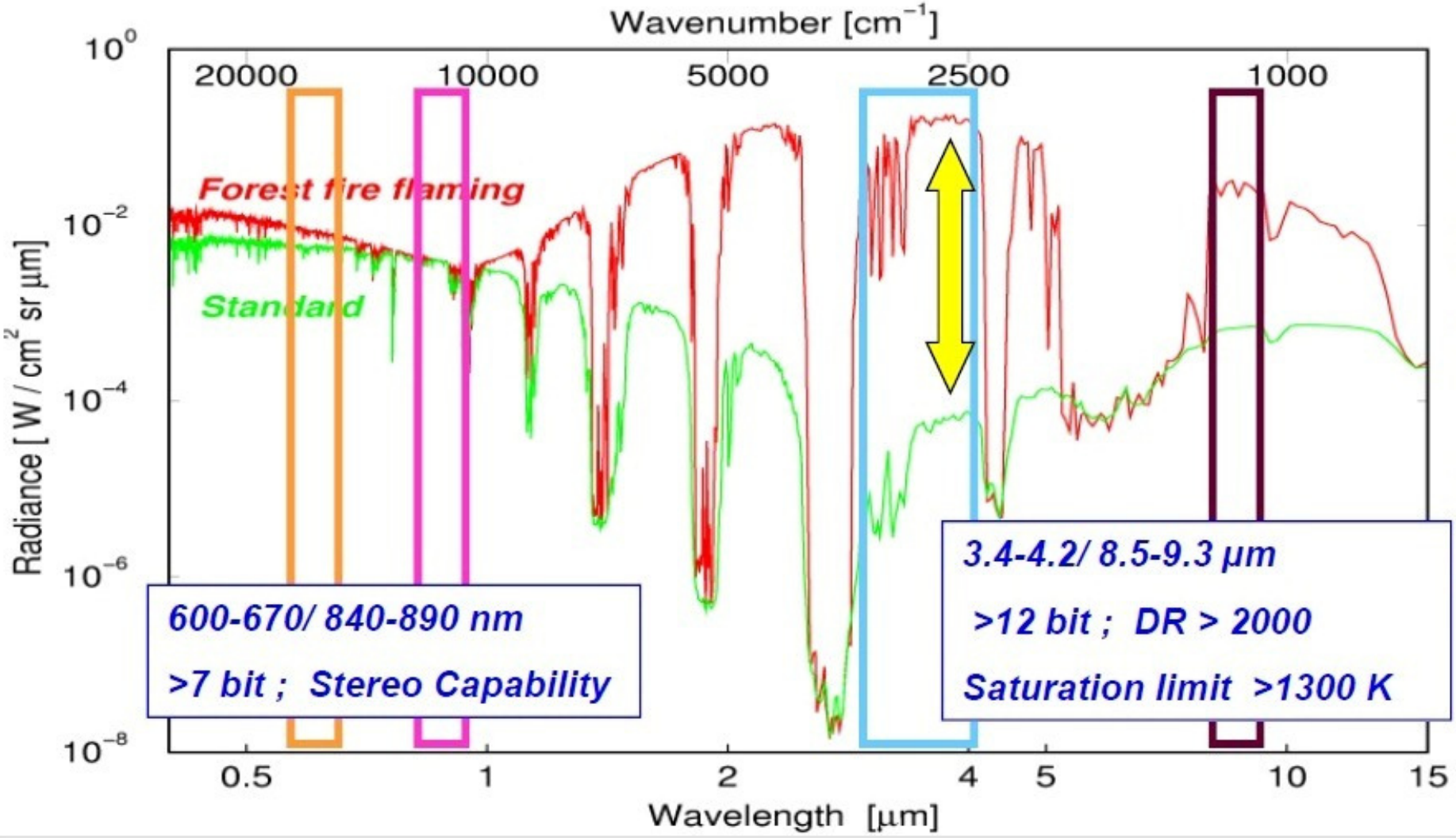
Across **different Australian landscapes**: peri-urban areas – grasslands – closed forest systems.



MAPPING AND MONITORING ACTIVE FIRE EXTENT, INTENSITY AND CONFIGURATION

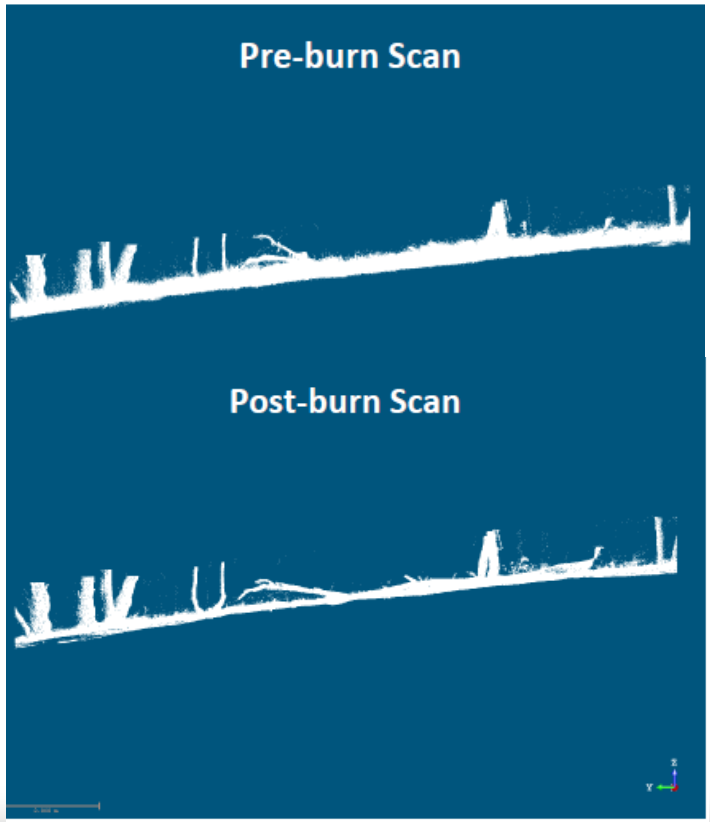


FIREBIRD CONSTELLATION (TET-1 –operational, BIROS -2015) SPECTRAL SENSITIVITY

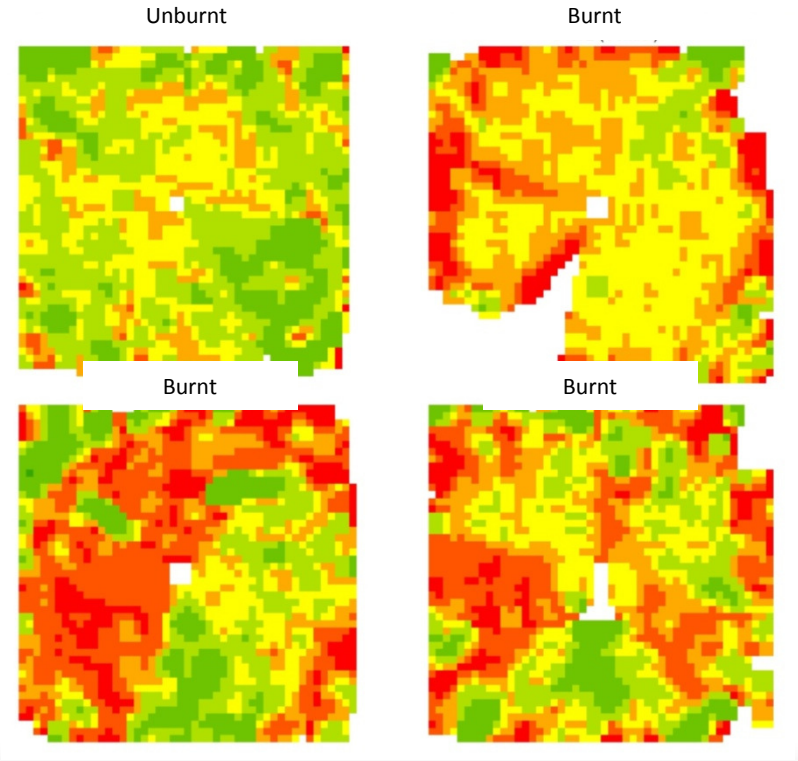


RAPID LANDSCAPE ATTRIBUTION AND INFORMATION FOR FIRE MANAGEMENT

Changes in vegetation structure and fuel following a burn in a dry sclerophll forest using a Terrestrial Laser Scanner

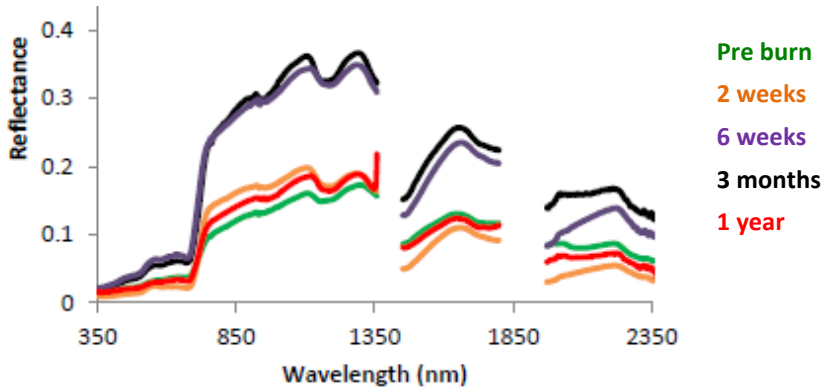


Spatial distribution of change in vegetation structure and fuel as an indicator of burn intensity (where green/yellow = little to no change, orange = small change and red = large change)

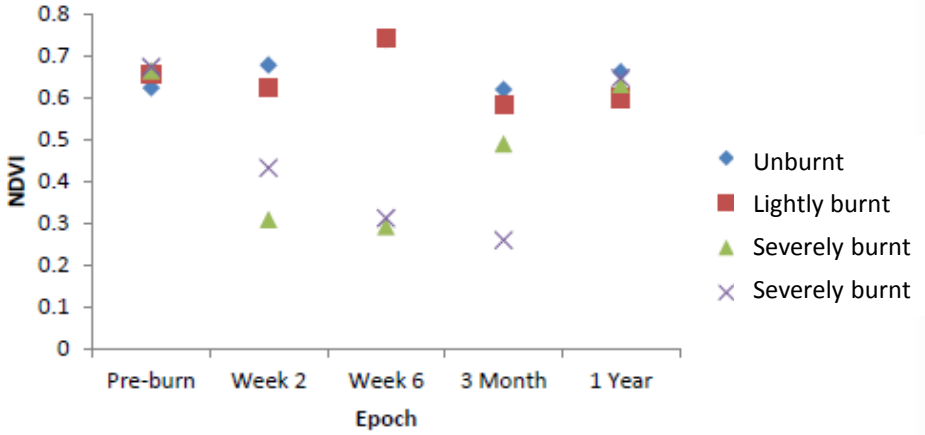


Gupta, V, Reinke, K, Jones, S and Holden, L 2012, 'Detecting change in burnt landscapes using a terrestrial LiDAR system', in Arrowsmith, C. A., Bellman, C. J., Cartwright, W. E., Jones, S. and Shortis, M. R. (ed.) *Proceedings of Geospatial Science Research_2 Symposium (GSR_2)*, Melbourne Australia, 10-12 December, 2012, pp. 1-10.

Changes in spectral signature of burnt plot over one year (canopy layer)



Changes in NDVI over one year (near surface layer) across all plots



Gupta V., Reinke K., Jones S. (2013) Changes in the spectral features of fuel layers of an Australian dry sclerophyll forest in response to prescribed burning. *International Journal of Wildland Fire* **22**, 862–868.

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Mitigating the effects of severe fires, floods and heatwaves through the improvements of land dryness measures and forecasts.

Lead Researcher: Dr Imtiaz Dharssi

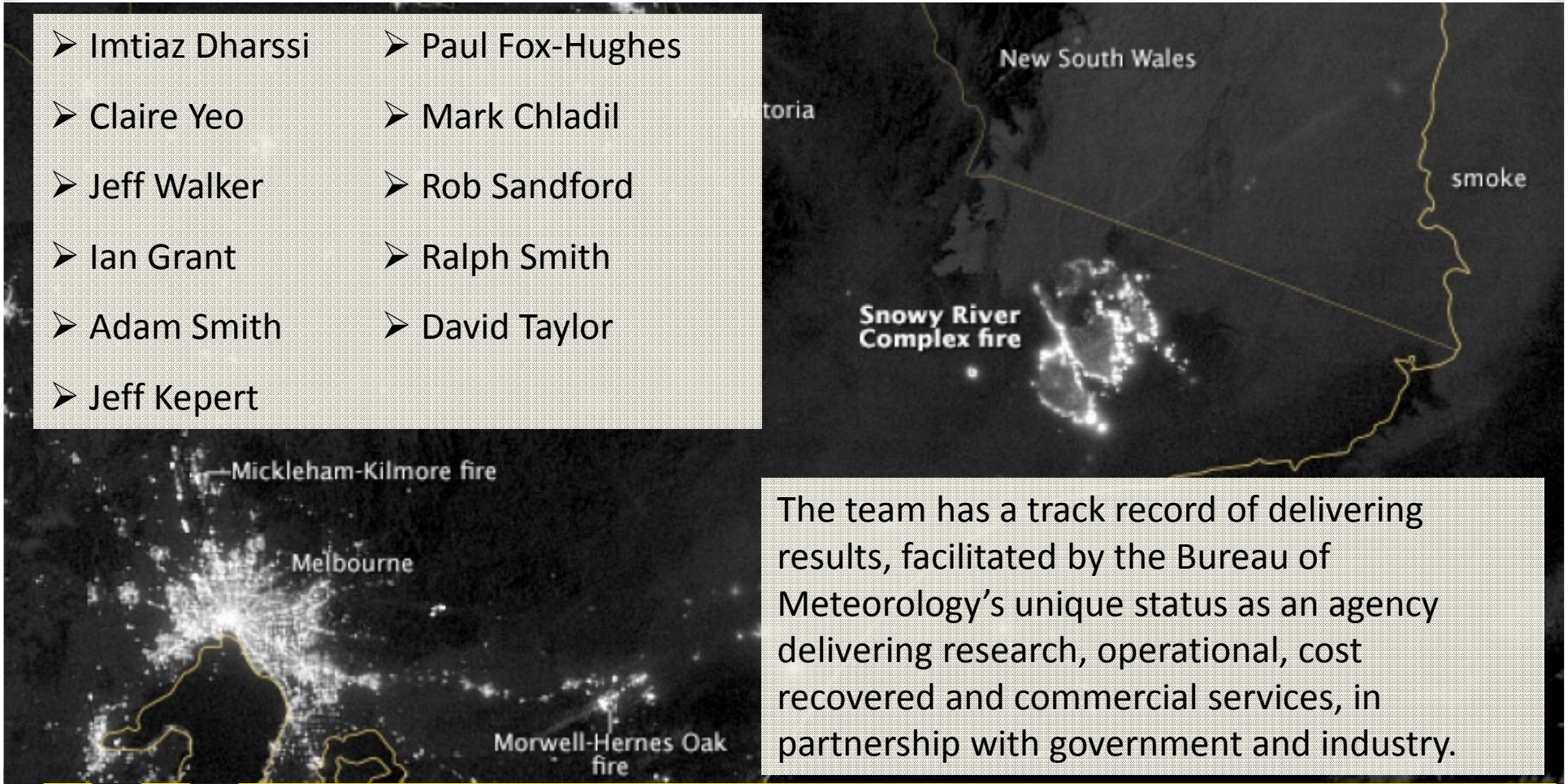
Land Surface Data Assimilation Scientist, CAWCR, Bureau of Meteorology

An Australian Government Initiative

Project Team Members

Tasmania Fire Service, South Australian Country Fire Service, Fire and Emergency Services Authority of Western Australia, Parks and Wildlife Service Tasmania, Monash University, BoM, CAWCR, CSIRO

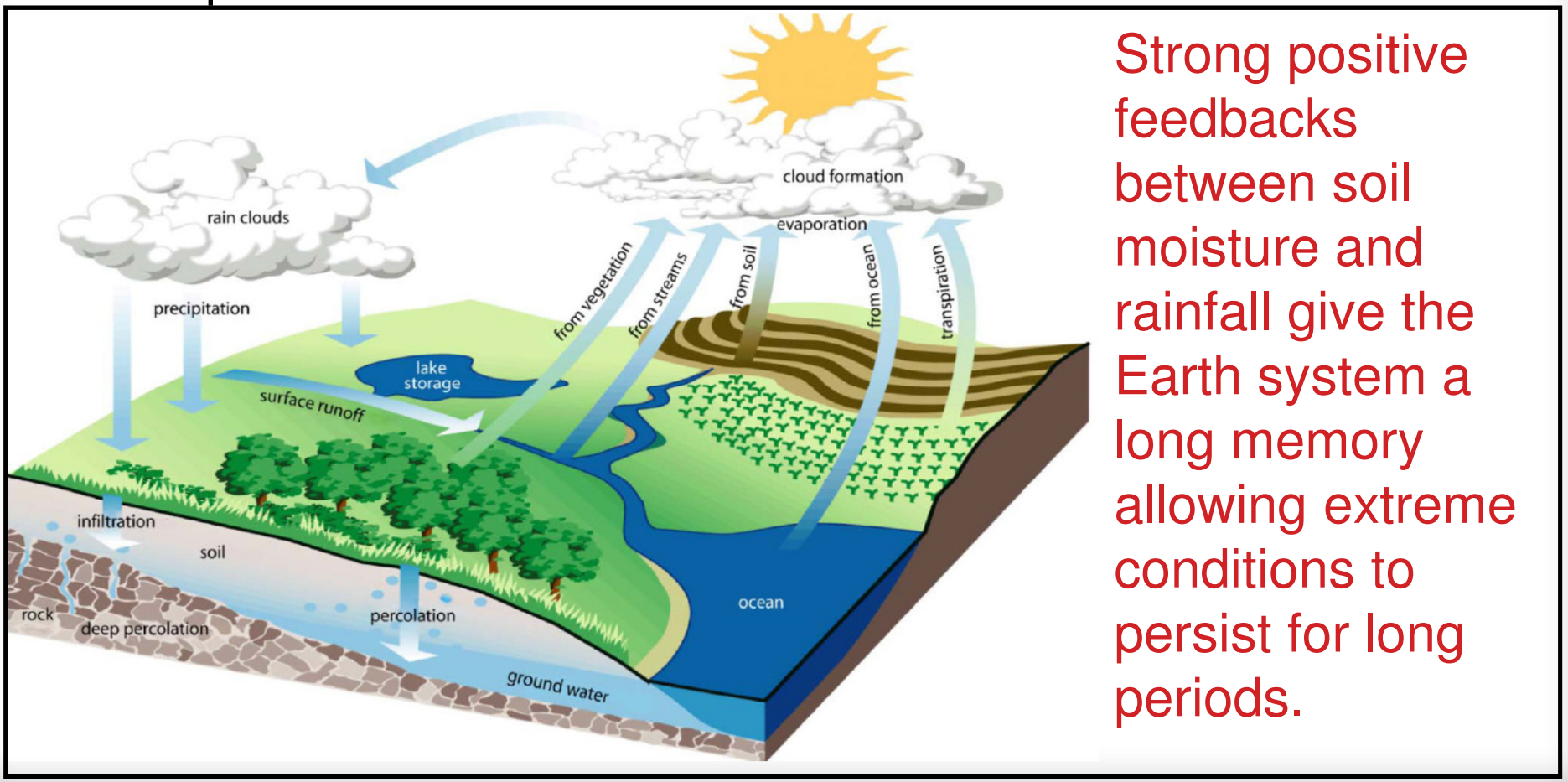
- Imtiaz Dharssi
- Claire Yeo
- Jeff Walker
- Ian Grant
- Adam Smith
- Jeff Kepert
- Paul Fox-Hughes
- Mark Chladil
- Rob Sandford
- Ralph Smith
- David Taylor



The team has a track record of delivering results, facilitated by the Bureau of Meteorology's unique status as an agency delivering research, operational, cost recovered and commercial services, in partnership with government and industry.

Motivation

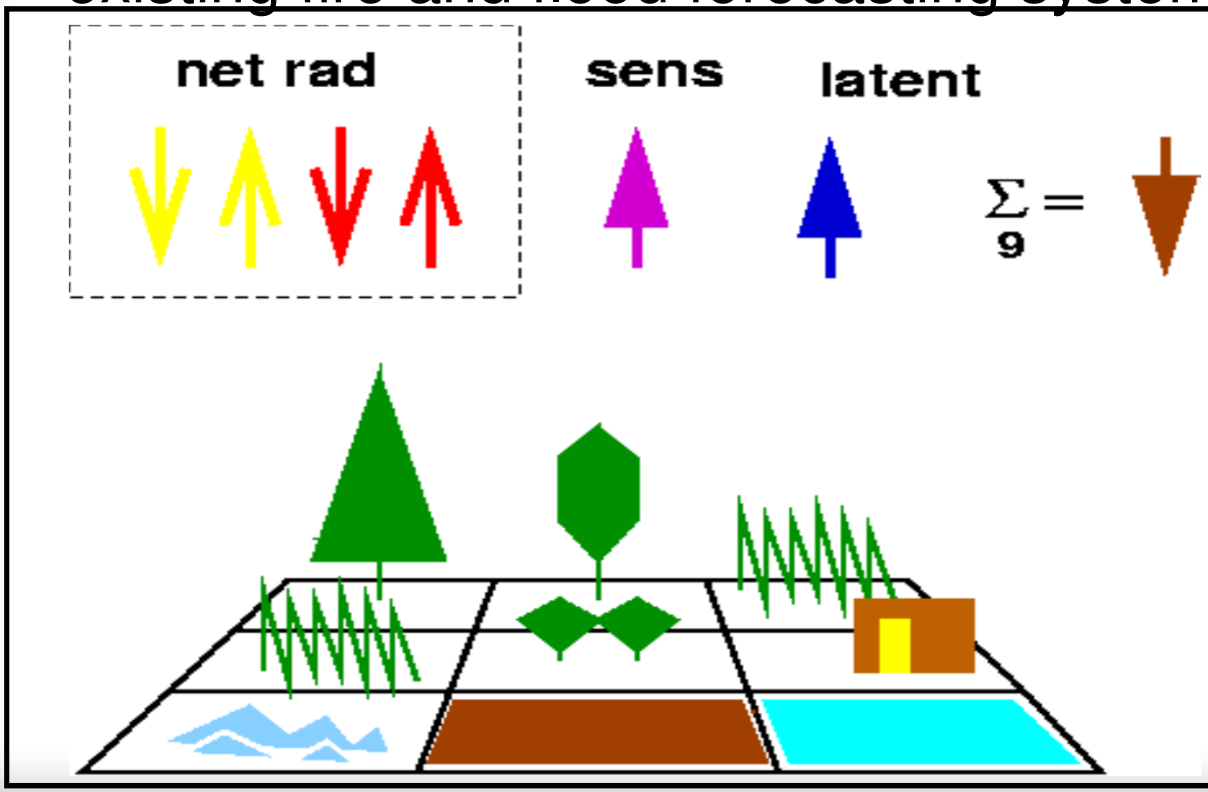
Knowledge of landscape dryness is critical for the management and warning of fires, floods, heatwaves and landslips.



Strong positive feedbacks between soil moisture and rainfall give the Earth system a long memory allowing extreme conditions to persist for long periods.

Objectives

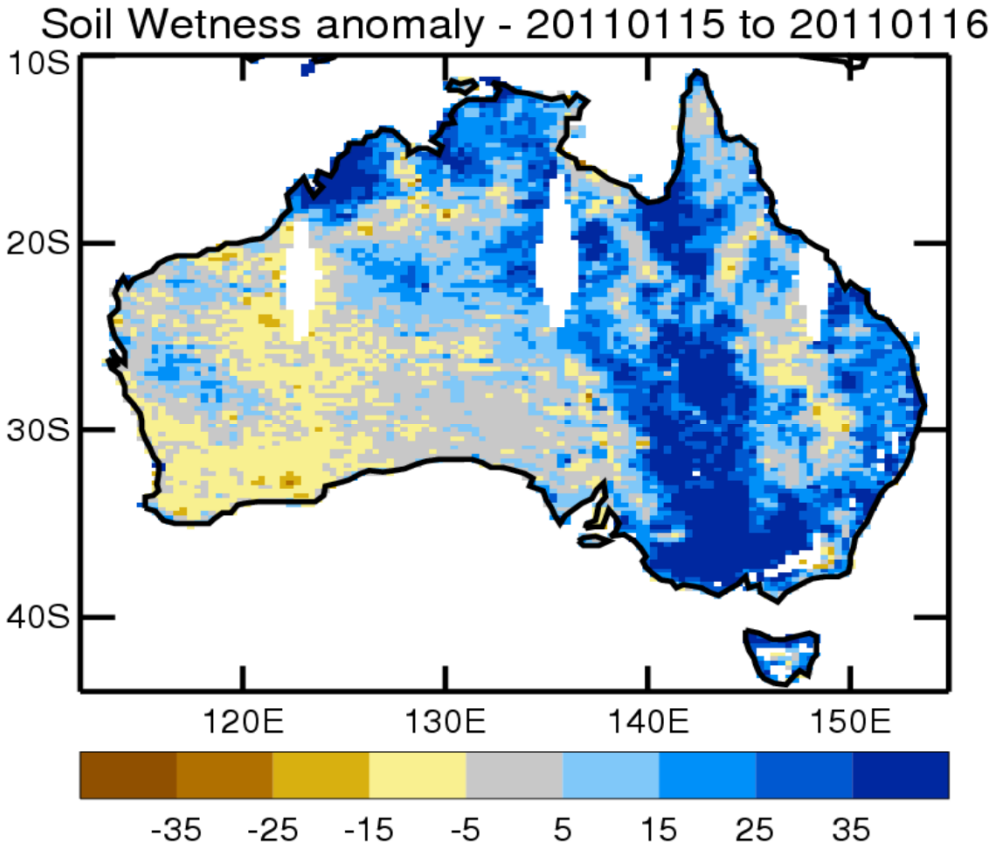
This research will examine the use of detailed land surface models, satellite measurements and ground based observations for the monitoring and prediction of landscape dryness. The new information will be calibrated for use within existing fire and flood forecasting systems.



Modern models calculate landscape dryness with greater sophistication and account for details such as soil texture, solar insolation, root depth, vegetation type and stomatal resistance.

Objectives

There are few ground based observations of soil moisture, temperature and vegetation. Satellite systems provide measurements with national coverage on a daily timescale.



New satellite systems provide information about soil moisture, temperature and vegetation properties. Advanced data analysis methods can extract the maximum amount of useful information from the raw measurements.

Expected Outcomes

✓The benefits will be **far improved versions of the operational systems** that emergency planners are already familiar with

✓The outputs will improve Australia's ability to **manage multiple hazard types and create a more resilient community, by developing a state of the art, world's best practice in soil moisture analysis** that underpins flood, fire and heatwave forecasting.

✓Longer term work will use **multiple-models and optimal data analysis to forecast soil dryness indices for operational fire, flood and heat wave applications.** The vegetation and soil parameterisations in models will be developed to match Australian conditions.

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IMPROVING FLOOD FORECAST SKILL USING REMOTE SENSING DATA

Valentijn Pauwels, Jeffrey Walker
Department of Civil Engineering, Monash University, Clayton, Victoria

An Australian Government Initiative

CRC AUSTRALIA

MONASH University

PROJECT TEAM MEMBERS

1) Researchers:

Dr. Valentijn Pauwels

Prof. Jeffrey Walker

- Two Research Fellows (NN)

2) End Users:

- Bureau of Meteorology
- Geoscience Australia
- Parks and Wildlife Service

MOTIVATION

1) Floods are among the most important natural disasters in Australia.

2) Average annual cost of floods for the last 40 years: $377M/yr.

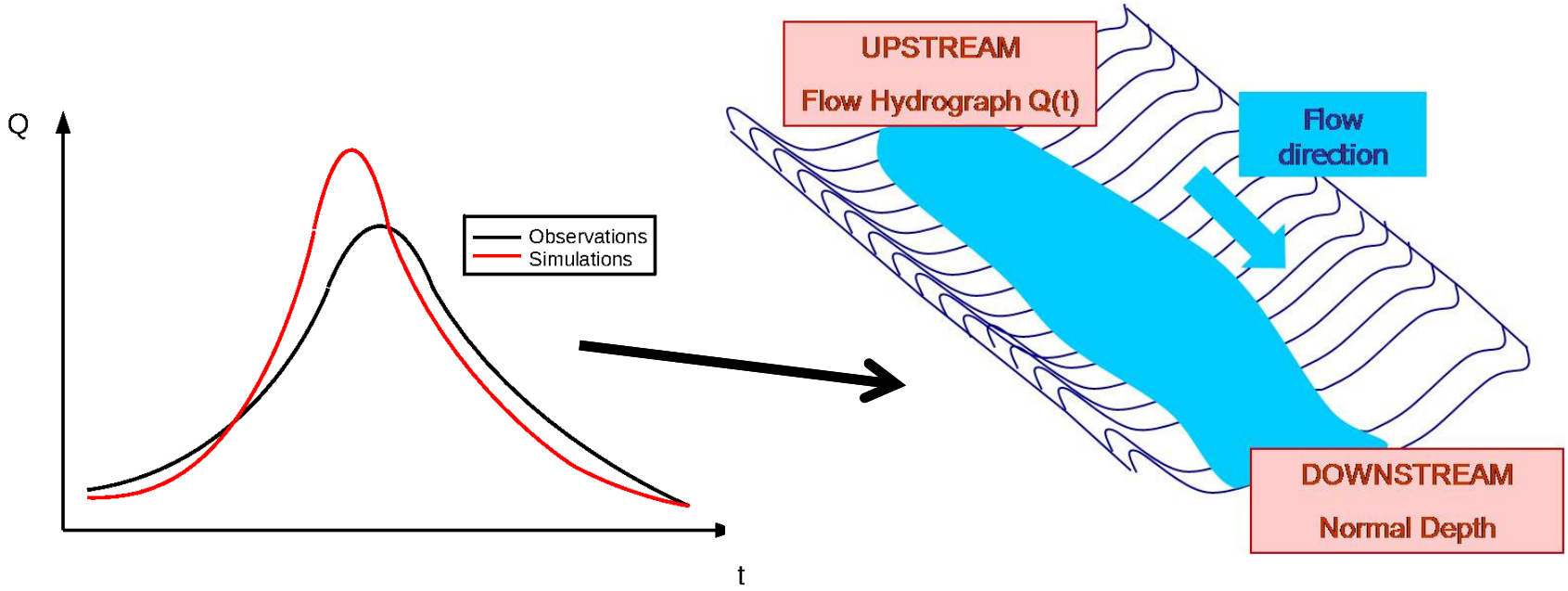
3) 2010-2011 floods in Brisbane and South-East Queensland:
   - 35 confirmed deaths
   - $2.38 billion damage

Examples of airborne radar and visible data

Wagga Wagga Flood 2010

FLOOD FORECAST SYSTEMS

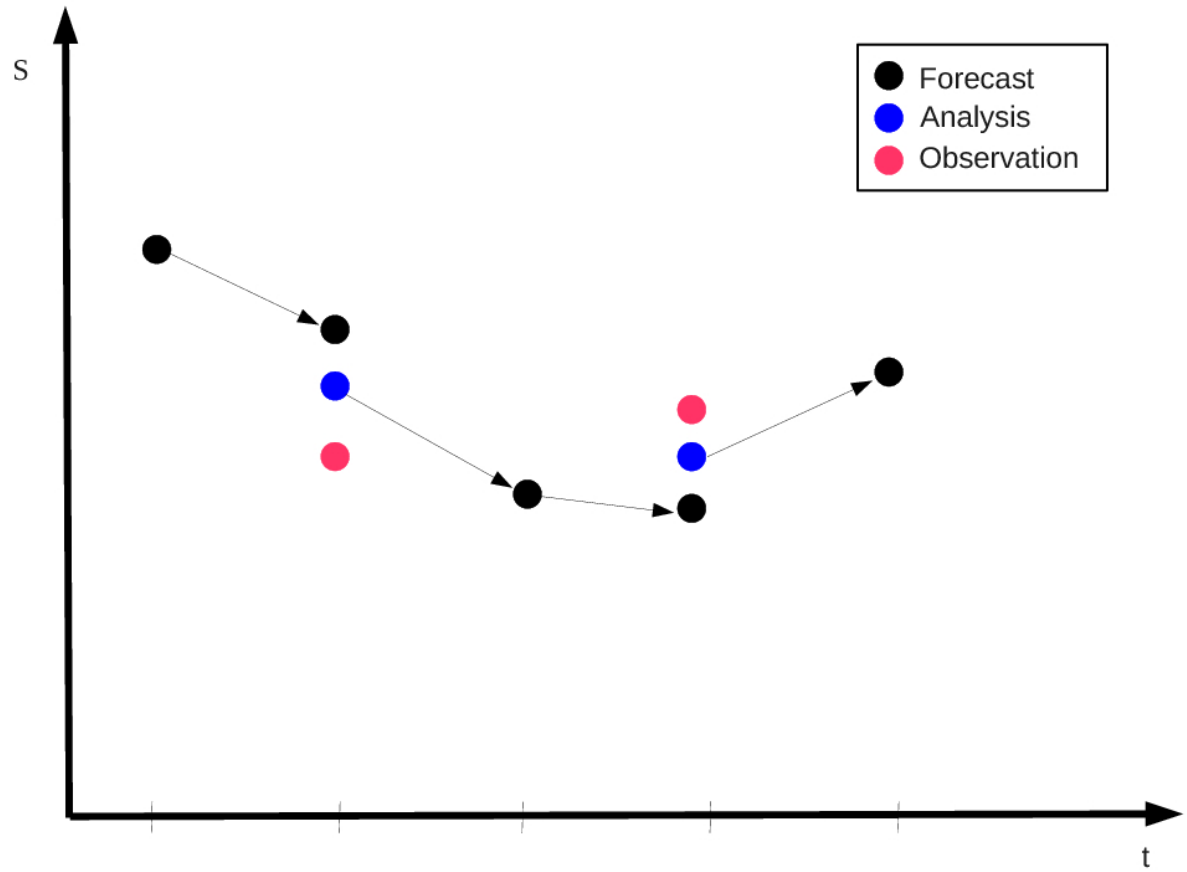
Flood **volume** and **extent** are prediction by a sequence of models:



Remote sensing data should improve the predictive skill of flood forecast systems.

DATA ASSIMILATION

Data assimilation is a **merging** of model results with external observations:



OBJECTIVES

1) Identify two test sites that will form the focus of the study
   - Frequent flooding must have occurred since 2010
   - All data needed to apply the models must be available
2) Calibrate a flood forecasting system using remote sensing data
3) Develop data assimilation methods that work optimally for the hydrologic/hydraulic model sequence and types of data that will be used.
4) Perform a scenario analysis to assess the optimal spatial and temporal resolution of the remote sensing data and hydrologic/hydraulic models.

OUTCOMES

1) A fully coupled hydrologic/hydraulic model, optimally configured for merging with remote sensing data in near-real-time;
2) A method to merge these model results with remote sensing data;
3) Recommendation on how to best use this system in an operational context.