Natural Hazards Research Australia

T8-A3

Remote sensing of grass condition

Estimating grass fuel condition from space

RESEARCH TEAM

Karin Reinke (presenter)
RMIT University

Trung Nguyen, Simon Jones, Johann Tiede
RMIT University

Andrew Edwards
Charles Darwin University

Marta Yebra
Australian National University

© Natural Hazards Research Australia

Natural Hazards Research Australia

We acknowledge the Traditional Custodians of all the lands on which we live and work, and pay our respects to Elders past, present and emerging. We recognise that these lands and waters have always been places of teaching, research and learning.

Rationale

Almost 75% of the Australian continent is made up of natural or modified grassy-fuel systems.

Grassy systems include grass, pasture, crop, gamba, savanna, spinifex and spinifex woodland

Grass fuel condition estimates affect fire spread predictions, emergency warnings, preparedness and resource allocation.

This Photo by Unknown Author is licensed under CC BY-SA

© Natural Hazards Research Australia

What we have today

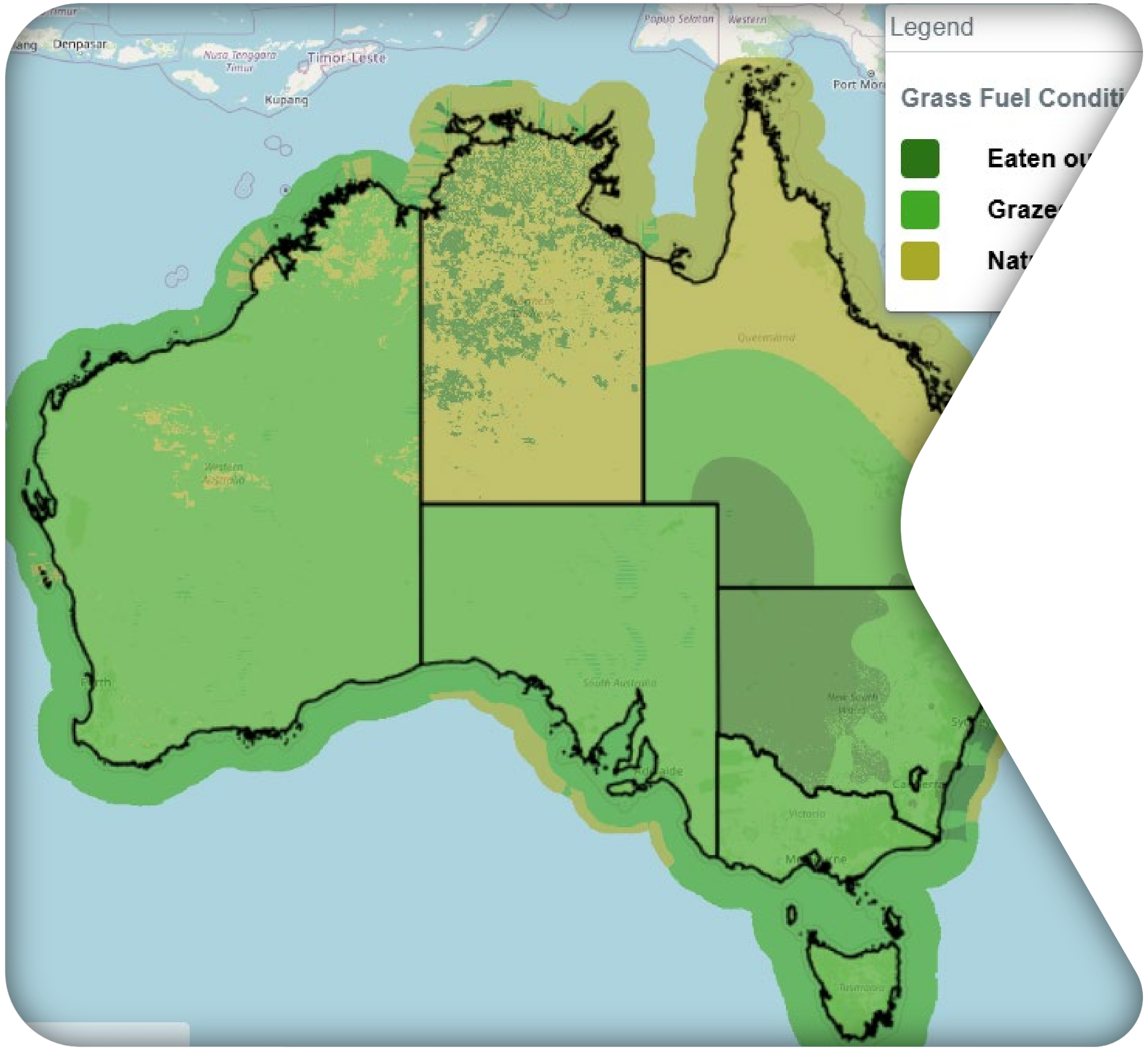
The **amount of fuel** present that is readily available to burn and it is **related to the height of the fuel,** as defined by AFDRS.

AFDRS uses **three broad classes**, limiting its usefulness for modern fire risk assessment and decision-making.

Class	Description
Natural / Unharvested	Where fuels have built up over a period of time or where a good season has encouraged the growth of grasses and crops with no/minimal reduction of fuel due to disturbances such as fire or grazing. Above knee height or greater than 50cm in height.
Grazed / Harvested	Where grass growth is considered "grazed" at or below knee height and above ankle height. Average grass height is between 10 - 49cm in height.
Eaten out/harvested and baled	Where previous fire activity or harvesting/grazing has removed the majority of fuel; or where seasonal conditions has kept grass short. Grass height is less than 10cm (ankle height)

© Natural Hazards Research Australia

Known limitations



- No national grass condition product for fire danger calculations
- Subjective classifications
- Lack systematic and frequent updates
- Lack of spatial granularity and completeness
- Inconsistent approaches across jurisdictions

© Natural Hazards Research Australia

The Next Iteration in Grass Fuel Condition

- Continuous condition metric
- Fuel load*
- National consistency and coverage
- Operational compatibility
- Frequent updates
- Transparent and repeatable methods

What is **the biggest improvement** to current grass condition product/s you would like to see?
1. Availability, improved scale and better regionally bespoke modelling of satellite data, regular updates (Monthly or at least quarterly) with predictions based on potential condition
2.Something that can be used now.
3. Remotely sensed continuous condition index. This would complement the curing layers to enable fire predictions and danger ratings to reflect actual conditions
4. Empowering future grass fire research to move away from subjective grass classes
5. Fine fuel load measurement from remote sensing
6. Accurate grass fuel load estimate from remote sensing
7. A consistent national grass condition product to improve national fire danger rating products
8. Towards a product that is better than what is currently used operationally

© Natural Hazards Research Australia

An Incomplete Data Environment

If **the pasture conditions are the same and are continuous, it really doesn't matter if the fuel load in each pasture is heavy or light**. (Cheney & Sullivan, 2008)

Grass systems are typically **low-stature** (< 0.5 m) and **highly dynamic**
→ weak, noisy, and ambiguous active-sensor returns
→ signals easily confounded by soil roughness, surface

Active satellite sensors provide **limited spatial and/or temporal sampling** of grasslands (e.g. sparse GEDI LiDAR footprints)

Defining **grass fuel height** in a consistent, repeatable, and operationally meaningful way **is not practical** at large spatial scales (Cheney & Sullivan 2008)

Grass **structural** properties (height, load, fine-scale continuity) are **difficult to estimate reliably** from satellite observations (*Tiscornia et al. 2019; Wang et al. 2022; Zhang & Ren 2023*)

Satellite studies therefore **focus on proxies** (e.g. biomass, fractional cover, phenology) **rather than direct height** retrieval

A remote sensing-based framework that relies primarily on fuel structural variables is (currently) **not operationally feasible nor transferable at continental scales**

© Natural Hazards Research Australia

Reference Datasets

Dataset	Description	Dominant Fuel Type	Temporal Availability	Role in Project
AFDRS Fuel State Estimator Observations	Ground-observer grass fuel-state records (3 condition + 2 continuity classes)	Crops & Pasture	Since 2023 Variable observation (dense during spring/summer, sparser during autumn/winter)	Model training + testing
Data Farming harvester data	Harvest location, crop type & date	Crops	Cropping regions; per-harvest	Validate predictor products
WA DFES monthly observation photos	Monthly geotagged post-harvest paddock photos	Crops	Since Nov 2025	Validate predictor products
CFA weekly farmer photos	Weekly paddock photos	Pasture	Vic, limited; last summer only	Validate predictor products
CSIRO / CFA field experiments	Detailed structural field measurements (height, cover, biomass, stem count)	Crops	Experiment sites; recent years	Validate predictor products

Future-proofing reference data.

Well-designed reference datasets continue to support innovation as sensors, algorithms and monitoring requirements evolve.

C – Comprehensive
- Covers the full range of fuel types and conditions
- Captures variation in height, gaps and condition

A – Adequate
- Sufficient samples across space
- Sufficient samples across time

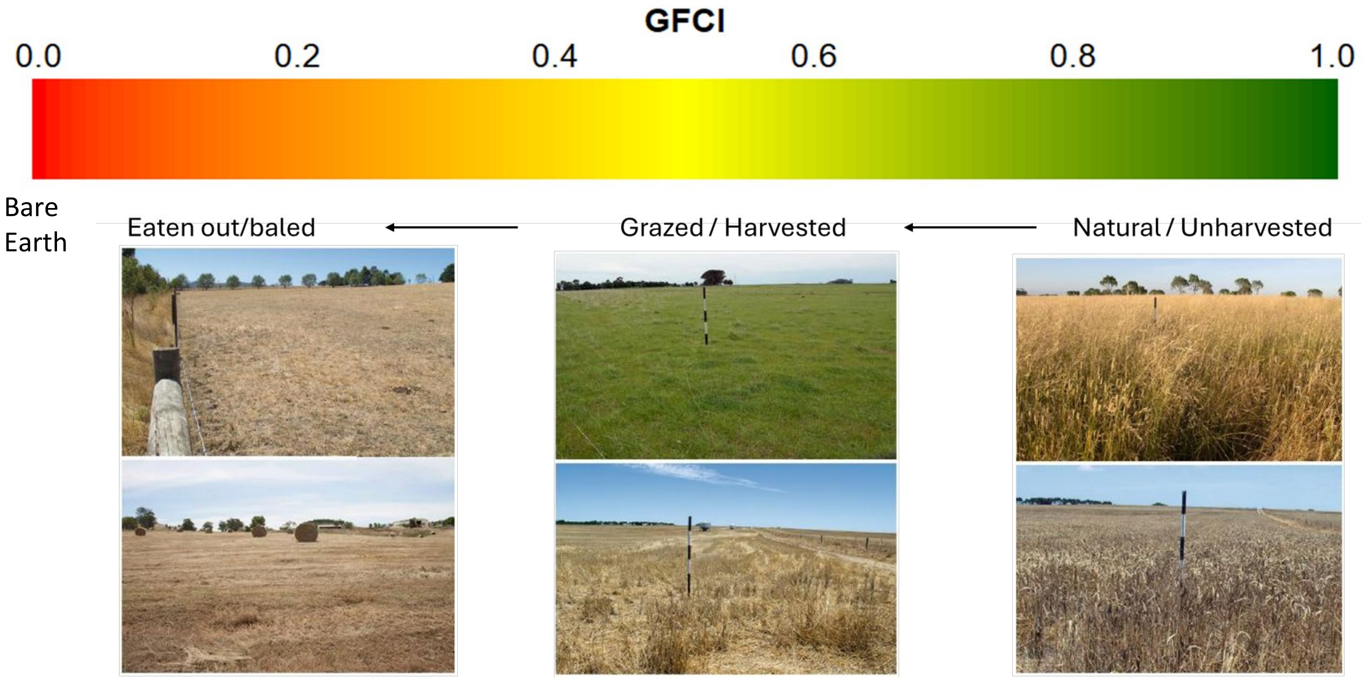
R – Representative
- Reflects real-world fuel and environmental variability
- Supports model development across different landscapes

Q – Quantitative
- Accurate and defensible measurements
- Consistent and repeatable collection methods
- Suitable for robust model development, calibration and validation

© Natural Hazards Research Australia

A New Idea: GFCI

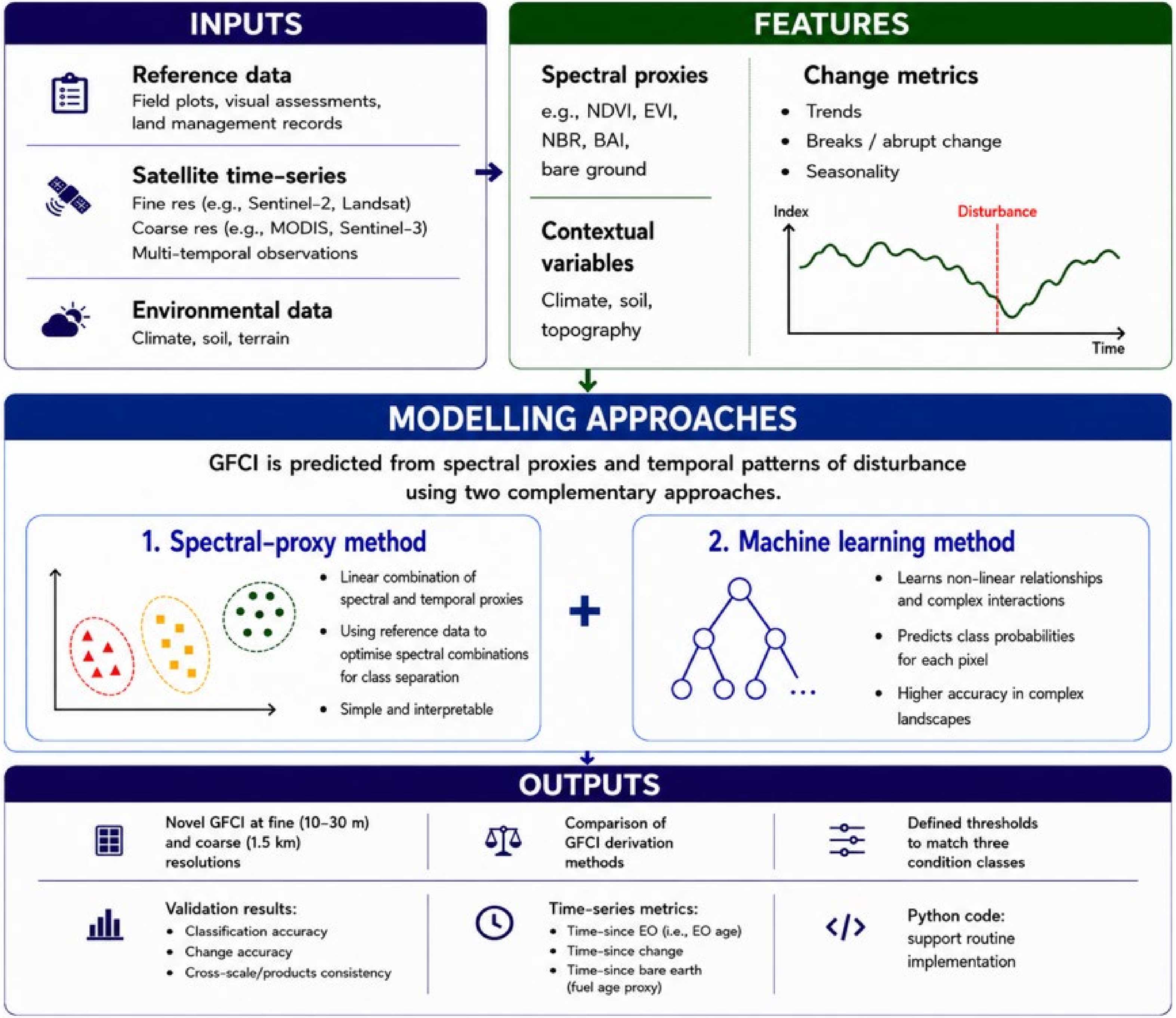
- **A satellite-derived continuous index** representing grass fuel condition
- **Transferable** across spatial and temporal (weekly, monthly) scales
- **Transformable** into three conventional condition classes using calibrated thresholds
- Expected to **correlate with grass fuel load, height, and continuity**
- Designed to **distinguish disturbance-driven changes from phenology**



(Images: AFDRS Grass Fuel State Fact Sheet)

© Natural Hazards Research Australia

Building the Index: Two Different Methods

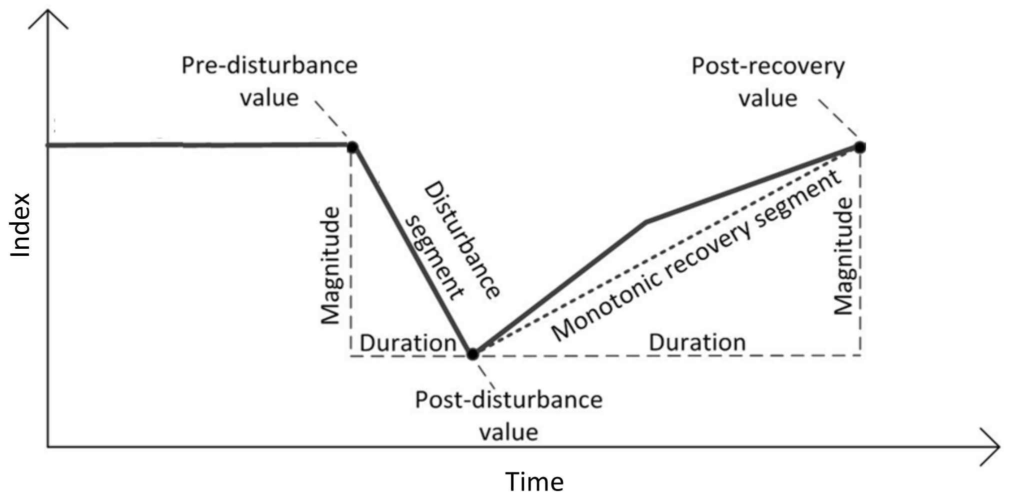


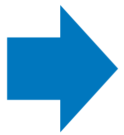
© Natural Hazards Research Australia

Derivation of Change Metrics

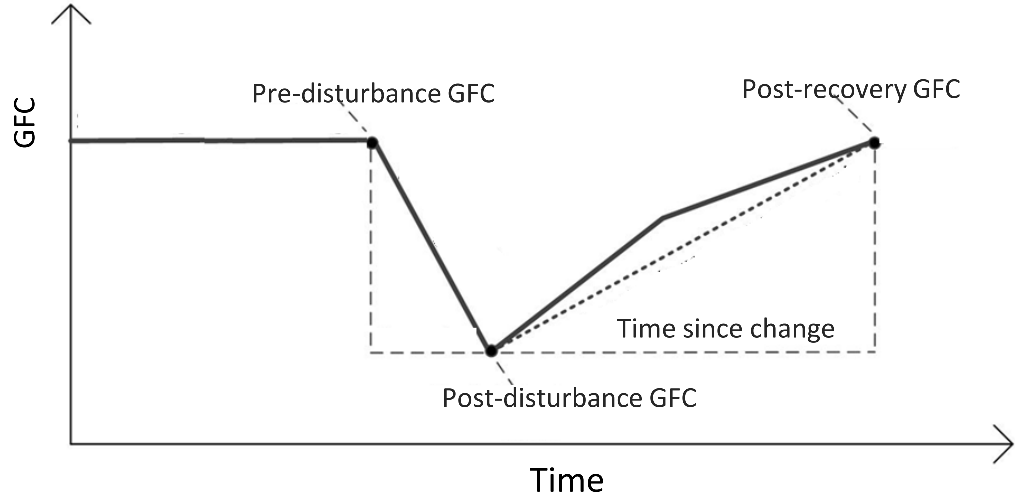
From spectral change detection to GFC change attribution

Spectral change metrics



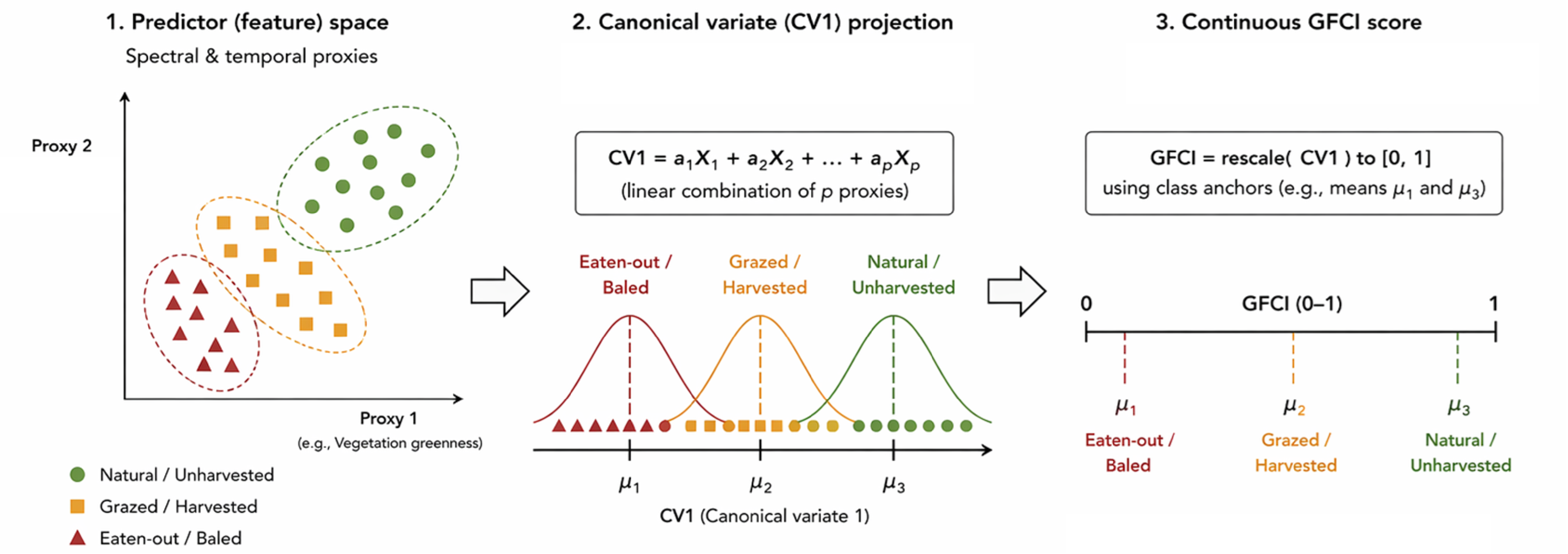


Change attribution

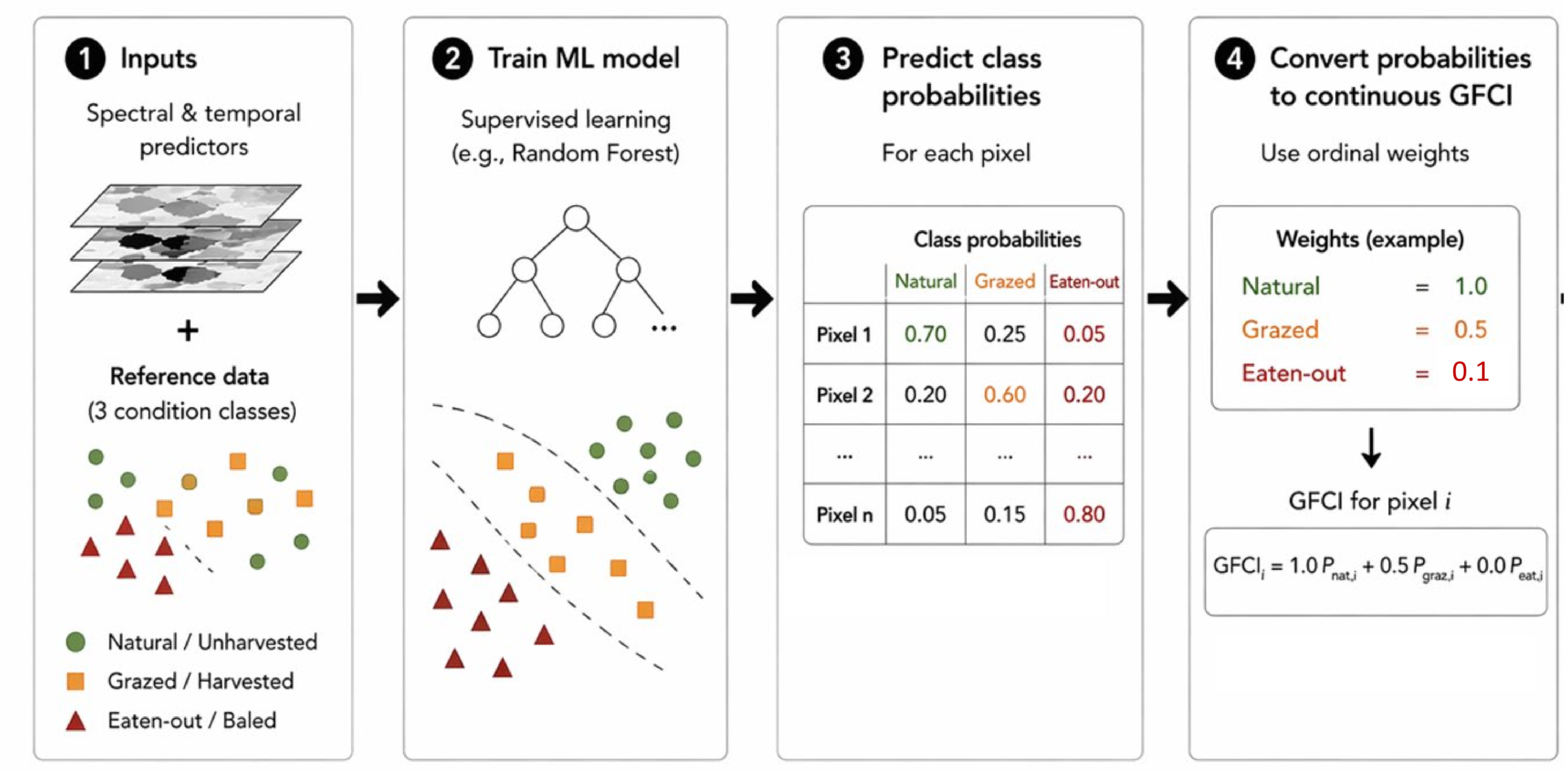


- Time since disturbance (management and fire)
- Time since bare earth as proxy for age
- Disturbance event change

Modelling approaches – Spectral-proxy



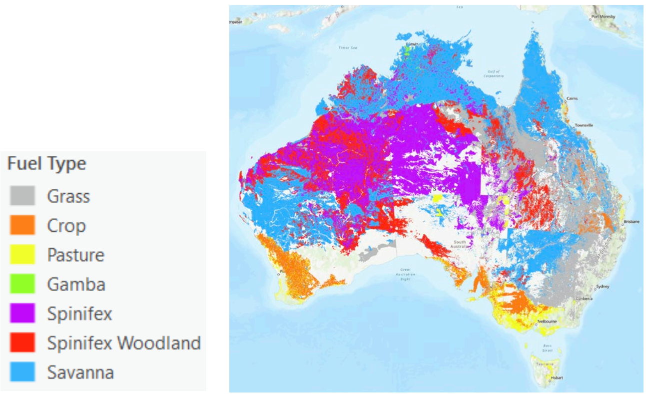
Modelling approaches – Machine learning

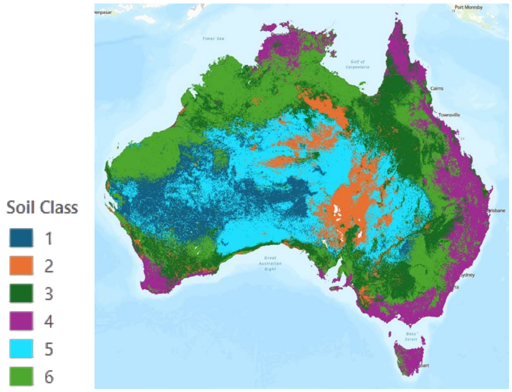


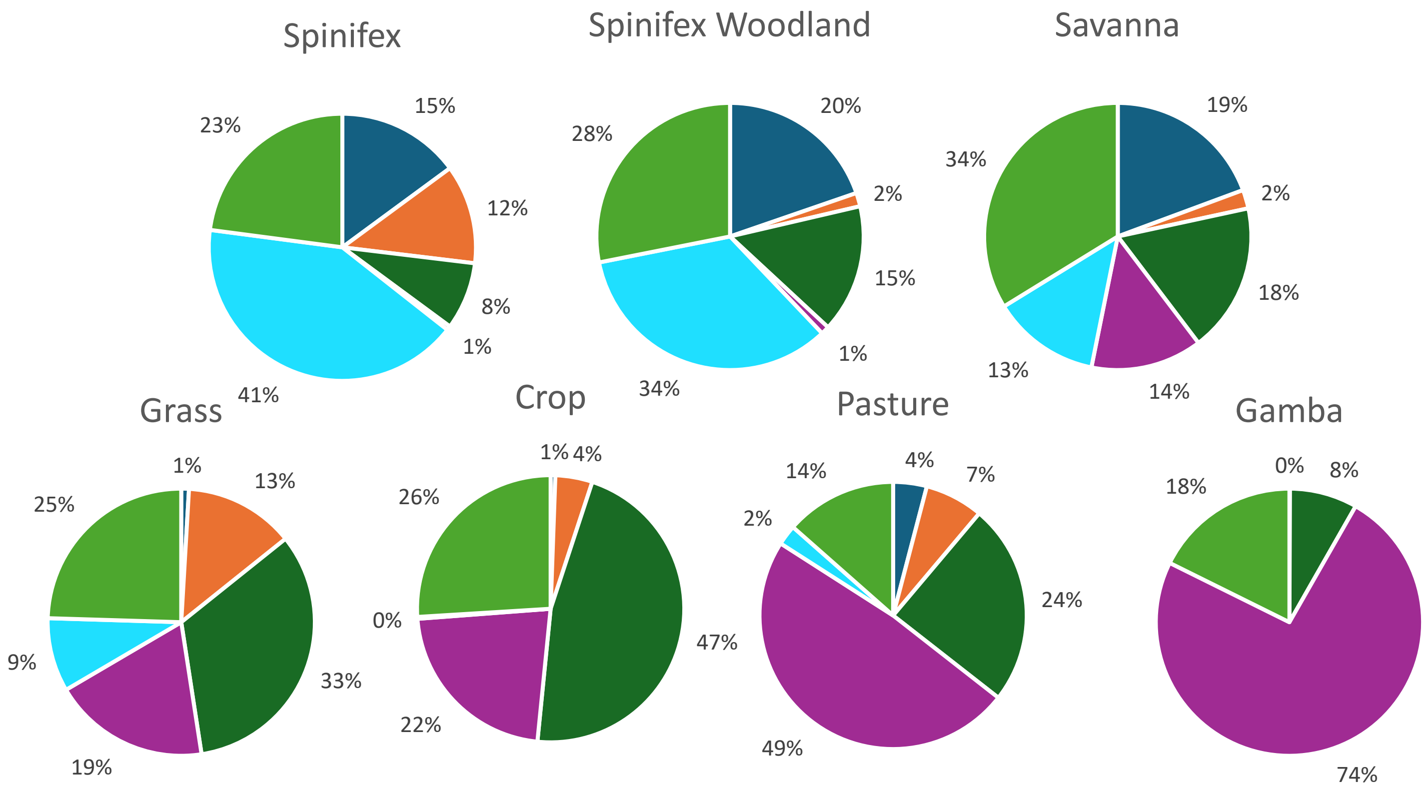
Next steps

- Reference data curation
- Stratification (fuel type + soil color)
- Case study selection (stratification + reference data)

- Identification of relevant indices and predictors
- Data specifications and identification of suitable data sources
- Processing of satellite data for derivation of indices and predictors







© Natural Hazards Research Australia