Coupling Litter and Soil Moisture Dynamics For Dead Fuel Moisture Content Forecasting

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This research aims to evaluate the role of soil moisture in determining dead fuel moisture content by coupling litter and soil moisture dynamics.

1. INTRODUCTION

Dead fuel moisture content (FMC) is critical for fire ignition and is an input to most fire danger and fire behavior predictions. Several models have been developed for dead FMC forecasting. Those models range from empirical regression functions against weather variables to physical-based models which use water and energy conservation equations. However, none of these models explicitly consider the role of soil moisture dynamics in determining FMC. This research aims to evaluate how soil moisture content affects FMC forecasting by coupling litter and soil moisture dynamics.

2. METHOD

A physical-based Koba model (Matthews, 2006) simulates physical processes for litter fuel moisture prediction. It is being coupled with a grid-distributed biophysical model, the Australian Water Resources Assessment system Landscape model (AWRA-L) (Van Dijk, 2010; Frost *et al*., 2016) used by the Bureau of Meteorology to estimate soil moisture, among others.

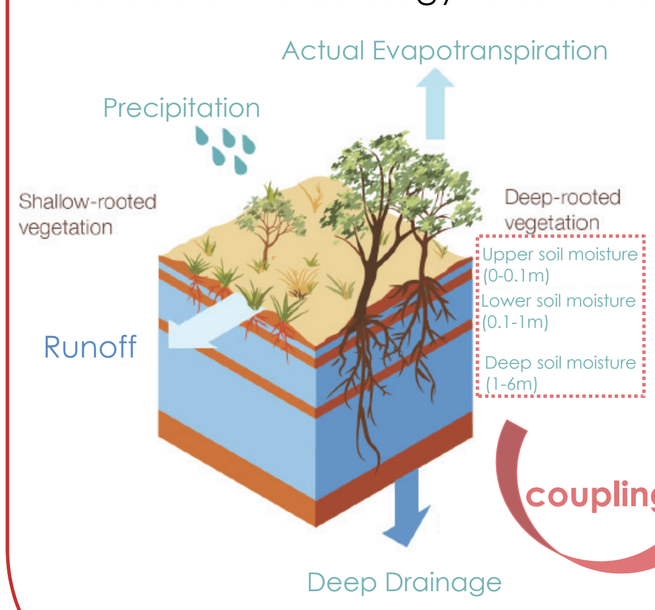

Fig 1. Conceptual AWRA-L grid cell with key water stores and fluxes shown (Frost *et al*., 2016)

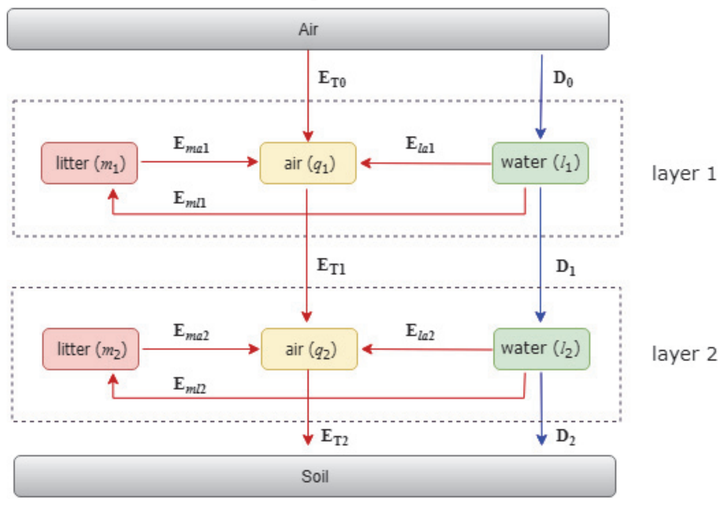

Fig 2. Model structure of water balance in the Koba model: each layer includes litter, water and air and the water content of them are m_1, l_1 and q_1 respectively. Red arrows represent vapor flux between materials (vapor flux between litter and air E_{ma}, vapor flux between water and air E_{ml} and turbulent vapor flux E_T) and blue arrows represent liquid water drainage(D).

3. CASE STUDY: VICTORIA

- Study area and sampling (Dec. 2011~ Apr. 2013) locations (Fig 3)

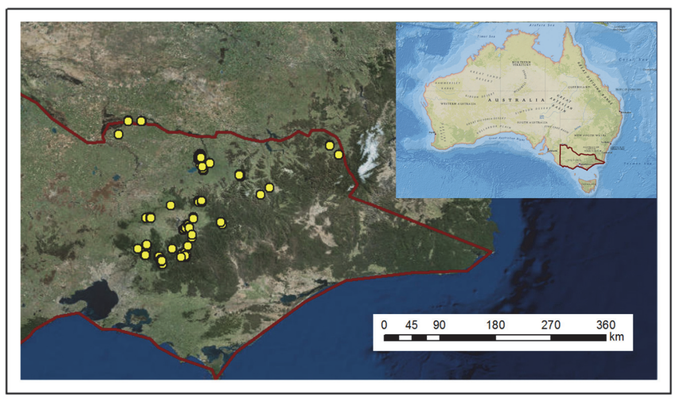

Fig 3. Locations of samples

- Input Data
  - ✓ Daily max and min temperature (BOM 5km)
  - ✓ Daily 3pm vapour pressure (BOM 5km)
  - ✓ Daily rainfall (BOM 5km)
  - ✓ Daily radiation (BOM 5km)
  - ✓ Daily mean wind speed (McVicar *et al*. (2008), 5km)
  - ✓ Daily soil water storage(OzWALD)

4. PRELIMINARY RESULTS

- Coupling reduced mean error (ME) but had little influence on other performance metrics (Table 1).
- The FMC was underestimated (Fig 4).

Table 1. Statistical analysis before and after coupling soil-litter vapor flux exchange compared to FMC measured in surface litter layer (Surface FMC) and bottom litter layer (Profile FMC).

Note: ME, mean error; MAE, mean absolute error; RMSE: root mean square error.

Soil-litter flux	FMC	Contingency Table				Statistics for Hit Only		
		Hit	Correct Rejection	Miss	False Alarm	ME	MAE	RMSE
No	Surface	92%	2%	2%	4%	-2.6	3.2	4.1
	Profile	66%	7%	6%	21%	-3.1	4.7	5.7
Yes	Surface	92%	2%	2%	4%	-1.6	3.2	4.1
	Profile	69%	7%	3%	21%	-1.1	4.2	5.3

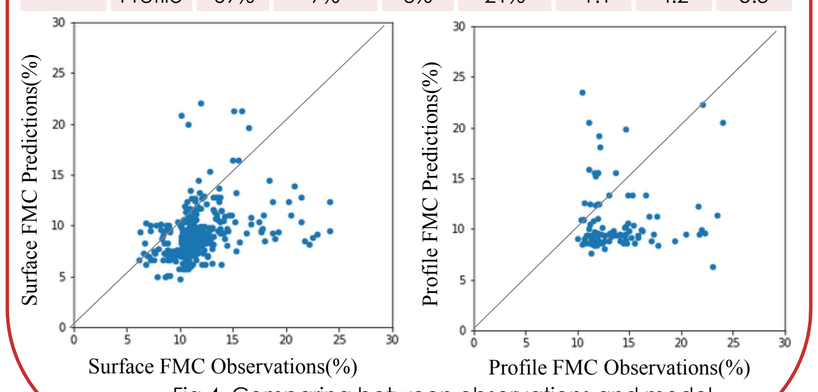

Fig 4. Comparing between observations and model predictions for FMC values <30%

5. CONCLUSIONS AND FUTURE WORK

- Soil water content can influence FMC predictions, especially the profile FMC.
- The coupling model did not show strong impacts on FMC predictions maybe was caused by the underestimation of soil-litter vapor flux exchange or lack of capillary flow.
- The comparison with field FMC was a preliminary test and only considered coupling of vapour fluxes. Future research will consider coupling through capillary flow.

END USER STATEMENT: "Predictions of fuel moisture are vital for many aspects of fire management. This important project will help improve predictions as well as aiding adoption of new soil moisture models." **Stuart Matthews, NSW Rural Fire Service**

REFERENCES

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