A modelling perspective for framing thoughts on vegetation dynamics

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The presentation has three main aims. The first is to give a brief overview of Dynamic Global Vegetation Models (DGVM's), and to provide some insight into how DGVM's are structured and how they work. The LPJ (Lund-Potsdam-Jena) and ED (Ecosystem Demography) models will be used as examples. The second aim is to present and assess results from the LPJ model for the Australian continent. The final aim is to provide a summary, based partly on our insights from DGVM models and their implementation, of key issues and questions for consideration when developing models of dynamic vegetation for Australian ecosystems.

Dynamic Global Vegetation Models (DGVM's)

Early attempts at modelling global vegetation distribution were based on concepts of vegetation 'equilibrium', and were closely tied to the biome concept. However, climate change, human land-use, and natural and anthropogenic disturbances are all non-equilibrium processes that affect vegetation structure and function at a range of scales. At the global scale the requirement to assess the impacts of non-equilibrium vegetation dynamics and their interaction with the global climate system has led to the development of a new class of model – the DGVM. DGVM's seek to predict (rather than prescribe) global vegetation distribution based on dynamic climate, disturbance dynamics, and soil constraints. A simplified diagram of a typical DGVM is shown in Figure 1.

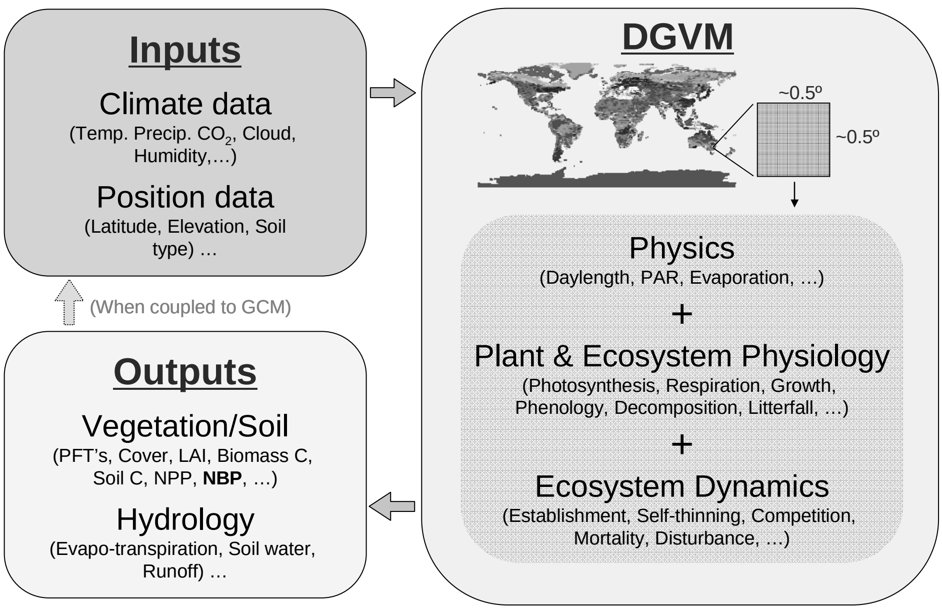

Figure 1. Overview of the structure of a generalised DGVM, adapted from http://seib-dgvm.com/oview.html.

The fundamental vegetation unit within a DGVM is the Plant Functional Type (PFT). PFT's are non-phylogenetic collections of species based on functional similarity. The model generates combinations of coexisting PFT's at a given location based on physiological tolerances, disturbance responses, and competition. This collection of coexisting PFT's is therefore an emergent property of the model, and the identity and relative abundances of the different PFT's specifies the overall vegetation structure and function at that location.

The LPJ v1.3 DGVM defines 10 global PFT's, of which 7 are predicted to occur in Australia. The predicted percentage cover of the four most abundant PFT's for Australia are shown in Figure 2. These and other results from our LPJ simulations will be discussed during the presentation

C3 Perennial Grass C4 Perennial grass Temp. Broad. Evergrn. Temp. Needle. Evergrn.

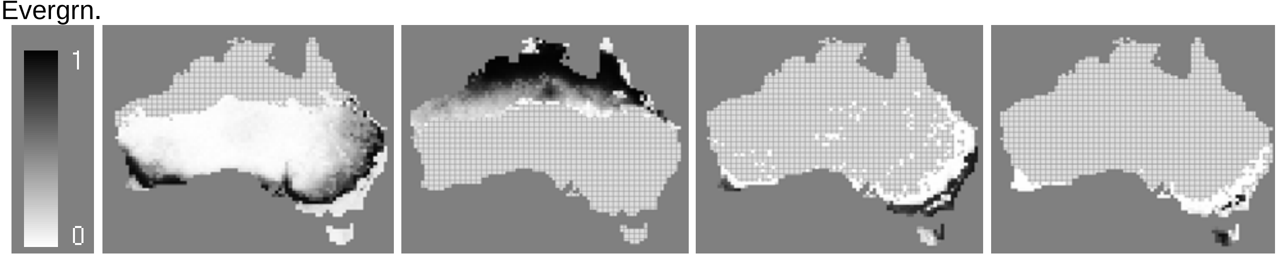

Figure 2. Continental distribution of the four most abundant PFT's as predicted by the LPJ DGVM v1.3. Values are average gridcell cover of each PFT over the period 1900-2000. The model predicts dominance by C3 grasses in the south, and C4 grasses in the north. Forested ecosystem are predicted to occur only on the coastal margins, and in Tasmania. The predictions are for natural vegetation, excluding land management.

10 key issues/questions for modelling vegetation dynamics in Australian ecosystems

There are many aspects of ecological systems to consider when developing a capacity for dynamic vegetation modelling. Some of these are already included in existing DGVM schemes either through explicit processes or implicitly through model interactions; others are more specific to Australian ecosystems. The list below is intended to be a starting point for discussion. Some of points will only be briefly considered, as they form major themes in other parts of the workshop. The list is ordered more-or-less thematically, starting with over-arching questions, and ending with a consideration of specific driving processes that are of particular importance in Australian landscapes. Amendments, additions and subtractions welcome!

- Why develop a dynamic vegetation modelling capacity?
  What are the models to be used for? At what spatial and temporal resolutions?
- Scale of application and data requirements.
  DGVM's operate at large spatial scales, often 0.5 degrees x 0.5 degrees. How can they help with local/landscape/regional problems? What data do we have/need for model calibration & validation.
- Capturing variability / scaling
  Scaling through space and time is a critical issue. The mathematical tools exist to scale vegetation dynamics correctly, but do we have the right sorts of data to use them effectively?
- Level of process description required?
  Empirical relationships may not remain valid under a changed climate. Predictive modelling requires a certain level of process description. What processes? How detailed?
- Simplifying the Australian biota
  How do we simplify the Australian biota for modelling purposes? Are PFT's the way to go?
- Spatially contagious processes
  Many important landscape process are spatially connected, such as fire spread, water flow, and species dispersal and invasion dynamics. How do we incorporate these dynamics into broad-scale modelling activities?
- Fire
  Fire, vegetation distribution, and vegetation dynamics are closely linked. Accurate representation of fire and its impacts in Australian landscapes is a key priority.
- Water / Nutrient cycling

Vegetation requires three basic resources: light, water, nutrients. Australian ecosystems are generally nutrient-deficient and water limited, and climate change will impact on the availability of these key resources.

- Herbivory

  Herbivores consume vegetation! 10%-20%(?) of global NPP is consumed by native, domestic, feral and insect herbivores. How do we include these and other trophic relationships?

- Land management

  Most DGVM's start with the assumption of 'natural' or 'potential' vegetation. For real-life applications the influence of land management must also be included