1.1 Development of high-resolution land cover datasets and rainfall-runoff models to inform other projects

Summary

This project aims, in the first year, to develop a high-resolution land cover dataset for the Melbourne Water region, linked to spatially explicit hydrologic models. In subsequent years, a library of historic and predicted future maps will be developed. These data are critical pre-cursors to other partnership projects that aim to predict ecological and hydrologic responses to management actions, and to develop prioritization frameworks. The project will work closely with Melbourne Water spatial analysts to ensure integration into management activities: these data will be of direct use to diverse parts of the business, and will underpin the addressing of strategic priorities in the Healthy Waterways Stormwater Strategies.

Research Theme

Models of ecological response

Timing

2013-2014 (and ongoing)

Project Team

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in collaboration with
Grace Detailed-GIS Services (GraceGIS)

Deliverables

- Development of high resolution LULC dataset
- Development of methods for spatial weighting, runoff and flood modelling, and drainage line classification using Little Stringybark Creek data and trial catchments as they are completed by Grace-GIS
- Development of rainfall-runoff models and classification of drainage lines
- Development of library of historic & future datasets

Background

Recent studies in the Melbourne region have demonstrated the strength of spatially weighting land-cover in the prediction of the degree of degradation in stream ecosystems (Walsh & Kunapo 2009; Walsh & Webb 2013). In weighting impervious surfaces by distance to the nearest downslope stormwater drain, and forest cover by distance to the nearest stream, models that permit prediction of stream response to potential management actions provide a powerful tool for informing strategies for land planning, and protection and restoration strategies.

The measure of spatially-weighted impervious cover that best explained macroinvertebrate assemblage composition (Walsh & Kunapo 2009) has been adopted by MW as a measure of 'directly connected imperviousness' (DCI: Urrutiaguer et al. 2012). Recent uses of these data have demonstrated their potential usefulness in aiding decision-making, but have also identified shortcomings that limit their usefulness. Similarly, the more recent work identifying spatially weighted forest cover as a strong predictor (Walsh & Webb 2013) has uncovered a number of limitations in the existing land use and stream network data, which limit the reliability of these models:

- The iterative development of the existing data has resulted in topological inconsistencies between the impervious coverage layer and the digital elevation model on which attenuated imperviousness was calculated.
- Ground truthing in focus catchments has revealed substantial error in the impervious polygon layer at small scales. The proponents spent substantial effort manually correcting forest coverage in the existing land use dataset, but errors remain, particularly away from drainage lines, which were the focus of our corrections.
- The weighting approach taken to date distinguishes overland and in-stream flow paths, which rely on a consistent, defensible delineation of the stream network. In reality, upland

drainage lines and small streams form a continuum. Modeling of attenuation effects over land and along drainage lines requires a classification of drainage line/stream types that currently does not exist for the region.
• Different variants on this indicator are likely to be more applicable to other biota or other aspects of stream management such as geomorphic management or flood mitigation. Calculation of such variants is not simple with the current data.

Modelling of hydrologic and ecological processes at multiple scales, which are central to the partnership research agenda and MW's management needs, requires high-quality spatial data. High-resolution maps of land cover, and its relationship to the natural and constructed drainage network, including stormwater retention infrastructure are required. A primary need is for accurate maps of current conditions, but a library of historic, and predicted future maps should also be developed. We propose to address these needs using Melbourne Water's newly acquired LiDAR, aerial orthophoto and updated council stormwater drainage data to build a new set of land-cover data linked to digital elevation models.

This proposal combines a research project aiming to develop new approaches to spatial weighting for hydrologic and ecologic modeling with a consulting project to produce the large-scale spatial data. Both aspects of the project will be conducted in collaboration with Melbourne Water's GIS analysts and potential users of the data to ensure maximal compatibility and use of the resulting products. The data provided by the project will be of immediate use to modeling projects being undertaken by the partnership (as well as other research Partners of Melbourne Water), but will also have immediate applications across the Melbourne Water business. We will construct the project so that products of the project can be easily incorporated into Melbourne Water systems and activities.

Methods

The project is divided into two integrated components

1. Development of high-resolution land cover dataset: This will form the base data for many of the partnership projects, and will be conducted as a consultancy project by GraceGIS, in collaboration with the broader research team. A new set of impervious data and land use/land cover will be developed using LiDAR non-ground data coupled with 4-band aerial photography that will not only be more accurate than the existing dataset, but provide substantially greater and detailed information on land use/land cover for model development and management prioritization. We also propose to invest substantial time during and after the data development to work with the potential users of the data in Melbourne Water to ensure that the products produced by the project not only contribute to important scientific advancement, but also provide tools that can easily be incorporated into Melbourne Water's management activities. (See Appendix A for details).

2. Development of rainfall-runoff models: We propose deployment of distributed hydrological modeling tools to make use of high-resolution input datasets such as the land-cover dataset to be developed by GraceGIS (above), LiDAR based digital elevation model (DEM), and parcel-level effective imperviousness data. Two types of DEMs will be used for modeling: an 'engineered' DEM, forced through the stormwater drainage network, and a 'natural' DEM modeling only overland flow. Rainfall-runoff models will be developed for the region to permit an objective classification of drainage lines, both for asset management, but also for assessment of the ecological importance of small drainage lines on stream health. (Note Project 16—Refining hydrologic prediction in ungauged subcatchments—is aiming to provide accurate predictions of flow regime, not just runoff volume).

A sub-catchment dataset will be extracted from the engineered DEM, in consultation with MW stakeholders to allow reach-based predictions. Two rainfall-runoff models will be developed—'natural' and 'current'— the first using the natural DEM, pre-European vegetation cover and rainfall surfaces, and the second using the engineered DEM, current land cover data (derived in Methods 1) and rainfall surfaces. The 'natural' model will permit a more objective determination of stream origins than is currently possible (projects 2, 5) and a weighting variable that is more appropriate than flow accumulation across a region of widely ranging climate (project 2). The 'current' model will be useful for a range of other modelling applications, such as the identification of areas of nuisance flooding (project 15).