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The impact of bushfires on water quality

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ABSTRACT

The population growth in urban areas leads to a higher demand in water supply. The quality of water is a very important factor not only from the aesthetic point of view, but also for the health purposes.
This research is designed to develop a spatial approach to support the planning of the water quality in the areas subjected to bushfires, in the State of Victoria. In particular, this research involved the implementation of a hydrological model in order to predict the river water quality, to assist in the decision-making process.
The impact of bushfires on water quality can be highly variable for many of the individual water quality constituents. This variability is caused by a number of landscape influences and climatic factors, most notably rainfall. High magnitude and intensity rainfall events soon after fire generate the largest impacts on water quality and sometimes trigger extreme erosion events.
There are many important water quality parameters that must be taken into account when the water is delivered to the population. For some of the water quality parameters there is very little information available, which makes it difficult to draw conclusions about bushfire impacts.
Existing modelling tools are concerned primarily with predicting event magnitude after a fire has occurred (i.e. the catchment conditions and the fire event are given). The challenge is to understand fire impacts on soil and to be able to model the connectivity between hillslopes and drainage networks for different fire severities.
The outputs of the model showed higher concentrations of suspended sediments and nutrients.
However, because of the limited number of water quality data available, the evaluation of the model is still in progress.

INTRODUCTION

Water quality planning responsibilities involve the management of land use change, the detection of the early signs of soil erosion and the reducing of the nutrients and sediment loads from agricultural, forestry and urban land use in order to make wise decisions to improve the river water quality.
In Australia, the bushfires are natural phenomenon that occurs in particular dry weather conditions.
They are periodical events that damage and change the quality of river water.
The magnitude and intensity of the bushfires in Australia, tragically impacted families and communities and caused significant damage to the environment, community infrastructure and private property.
The impact of bushfires on water quality can be highly variable for many of the individual water quality constituents. This variability is caused by a number of landscape influences and climatic factors, most important being rainfall. Severe follow-up storms have resulted in large quantities of sediment, nutrients, organic matter, ash and metal contaminants entering streams and reservoirs, which mean large impacts on water quality.

The study site

Covering a course of 270 kilometres, the Latrobe River is the longest waterway in West Gippsland Water Catchment. It has 17 tributaries, before reaching its mouth in Lake Wellington east of Sale. Reasons for choosing this study area:
-it is a bushfires prone area and
-for the data availability.

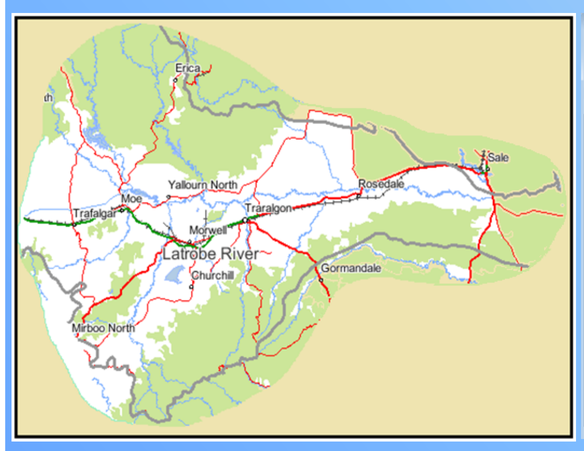

Fig.1 Latrobe catchment – West Gippsland

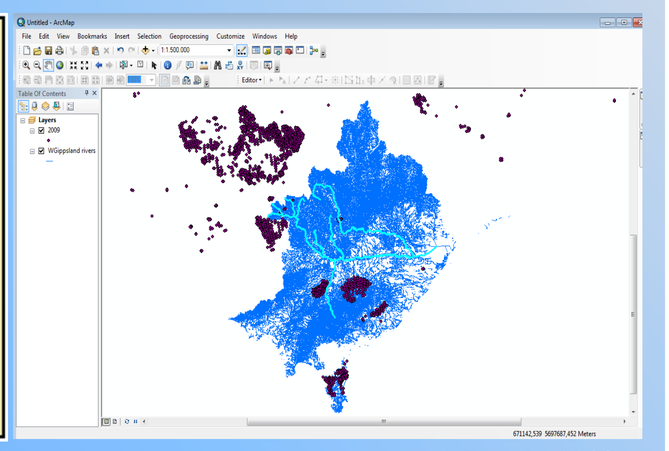

Fig.2 Latrobe Catchment and bushfires in 2009

Water pollutants of interest

Total Suspended Solids (TSS), Total Nitrogen (TN), Total Phosphorus (TP), Electrical conductivity (EC), Dissolved oxygen (DO), Temperature (T)

METHOD

The concentrations of the pollutants in the river water were predicted using eWater, This is a conceptual, semi-distributed model, which applies the flow accumulation principles. eWater Source - Australia's National Hydrological Modelling Platform (NHMP) – is developed by eWater CRC, Australia. It is designed to simulate all aspects of water resource systems to support integrated planning, operations and governance from urban, catchment to river basin scales including human and ecological influences.
The model integrates rainfall runoff models and constituent generation models that can be parameterized in order to predict the pollution levels with good accuracy. Various scenarios can be created.
The catchment is divided in sub-catchments with various functional units – areas with same hydrological response.
The outputs of the eWater model were the pollutants concentrations at the same time-step such as the inputs, generated in the nodes. To calibrate, validate and evaluate the model, the output data must be compared with the measured data in the same location and at the same time.

RESULTS

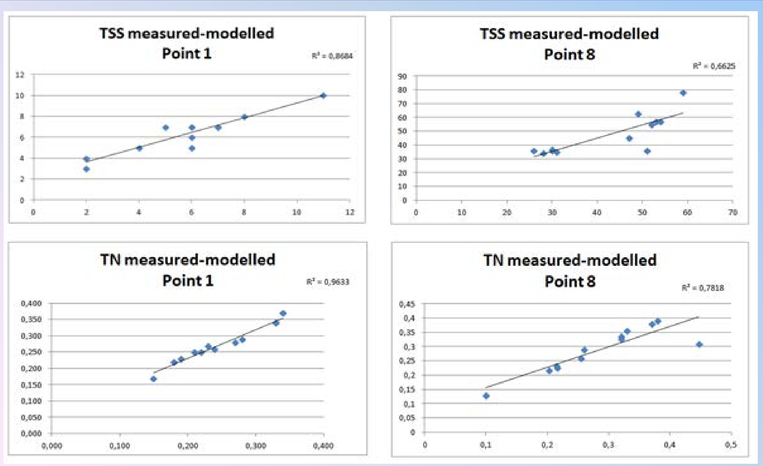

Fig.3 The correlations between the modelled and the measured data in two points within Latrobe catchment

The correlations between modelled and measured data for TSS and TN in two points were chosen. The results showed good correlations, which means that the model is able to predict the TSS and TN levels in Latrobe catchment. The results could be improved by creating various scenarios, with different values for the empirical parameters.

CONCLUSION

The focus of this research is to investigate the impacts of bushfires on river water quality.
The model used in this research was eWater. The modeled concentrations for TSS and TN are well correlated with the measured data in the same points. This means that the model is able to predict the levels of TSS and TN in the Latrobe catchment.
The outputs of this research could be used by the authorities for the catchment management plan, for the remediation initiatives as well as in the design of monitoring programmes aimed to identify the status and trends of water quality in that catchment.
This study could be important in order to prioritize the pollutants in a catchment, which is essential with regard to future catchment management.
This research is still in progress.

LIMITATIONS

The data will be based on measurements made at specific points, within the Latrobe catchment. The interpretation of the data should consider:
- How representative both the sampling period and sample location are;
- The measurement uncertainties.

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REFERENCES

Bell, T., Nyman, P., Posell, M., Sheridan, G., Turnbull, T., Volkova, L., Weston, C., Bushfire Cooperative research Centre, (2014), Fire in the Landscape – Final Project Report
Dawdy, D.R. and O'Donnell, T., (1965), Mathematical models of catchment behavior, Journal of Hydraulics, Division A.S.C.E., vol 91, no. HY4, pp 123-139
Lane, P.N.J., Sheridan, G.J. and Noske, P.J., (2006), Changes in sediment loads and discharge from small mountain-catchments following wildfire in south eastern Australia, Journal of Hydrology, 331(3-4): 495-510
Nyman P, Sheridan GJ, Smith HG, Lane PNJ (2011) Evidence of debris flow occurrence after wildfire in upland catchments of south-east Australia. *Geomorphology* 125(3), 383-401.
Sheridan, G., Lane, P., Noske, P., Feikema, P., Sherwin, C. and Grayson, R., (2007), Impact of the 2003 Alpine bushfires on Streamflow: Estimated changes in stream exports of sediment, phosphorus and nitrogen following the 2003 bushfires in Eastern Victoria, Murray-Darling Basin Commission, Canberra
Smith, H., Cawson, J., Sheridan, G., and Lane, P.,(2011), Desktop review – Impact of bushfires on water quality, for the Australian Government Department of Sustainability, Environment, Water, Population and Communities
Smith HG, Sheridan GJ, Lane PNJ, Nyman P, Haydon S (2011) Wildfire effects on water quality in forest catchments: A review with implications for water supply. *Journal of Hydrology* 396(1-2), 170-192
Smith, H.G., Sheridan, G.J., Lane, P.N.J. and Bren, L.J., (2011), Wildfire and salvage harvesting effects on runoff generation and sediment exports from radiata pine and eucalypt forest catchments, south-eastern Australia. Forest Ecology and Management, 261: 570-581.
Sood, A. and Smakhtin, V., (2015) Global hydrological models: a review, Hydrological Sciences Journal 60 (4), http://dx.doi.org/10.1080/02626667.2014.950580
White, I., Wade, A., Worthy, M., Mueller, N., Daniell, T. and Wasson, R. (2006), The vulnerability of water supply catchments to bushfires: Impacts of the January 2003 bushfires on the Australian Capital Territory. Australian Journal of Water Resources, 10(2): 1-16.
Environmental Protection Authority, http://www.epa.vic.gov.au
Minister for Environment, Climate Change and Water, http://www.vic.gov.au
The Victorian Catchment Management Council, http://www.vcmc.vic.gov.au/
Victorian Environmental Water holder, http://www.vewh.vic.gov.au
http://ewater.com.au/casestudies/victoria/