Evaluating wildfire simulators using historical fire data

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Abstract
High-performance wildfire simulators allow the future location of a wildfire to be rapidly predicted. The accuracy of such simulators needs to be evaluated; this can be achieved by comparing simulated and observed spread for documented historical fires. A key issue relates to the accuracy of data obtained from historical fires, such as the time-varying fire location, fire-ground weather and accuracy of fuel type, load and structure data. A methodology used to evaluate the accuracy of wildfire simulators using historical fire data is presented and applied to the AUSTRALIS wildfire simulator using the four distinct phases of a large-scale wildfire occurring in Western Australian sandplain heathlands and a fire reconstruction report on this fire produced by a wildfire expert. Challenges encountered in performing this validation exercise are highlighted.

Keywords: wildfire simulation, GIS, fire behaviour models, simulator testing

1. Introduction

A methodology used to evaluate the accuracy of wildfire simulators using historical fire data is presented. Application of the methodology was examined using the four phases of a large-scale wildfire occurring in Western Australian sandplain heathlands and a fire reconstruction report on this fire produced by a wildfire expert. The spatio-temporal dynamics estimated from the reconstruction report was compared with simulated fire behaviour, as produced by the AUSTRALIS wildfire simulator. The availability of rapid automated fire prediction permits the many variables which influence fire spread to be quickly examined by changing simulator input parameters, such as forecast wind speed and direction, to determine how such changes may impact on the spread characteristics of the fire. While simulators such as the AUSTRALIS wildfire simulator allow the future location of a wildfire to be rapidly predicted, and geographical information systems (GIS) maps with forecast fire-lines overlaid on them to be quickly made available to fire managers, the accuracy of such simulators needs to be examined by application to high-quality datasets from prior fires. A key issue relates to the accuracy of data obtained from historical fires, such as time-varying fire location, fire-ground weather and accuracy of fuel type, load and structure data, which are necessary if meaningful comparisons are to be made.

2. Methods

Simulating the spread of wildfire across a real landscape may, like simulation of other complex natural phenomena, be impacted by multiple sources of inaccuracy. First, the input data used for simulation will be subject to inaccuracy. For example, spatial boundaries in vegetation maps have limited precision and may have changed since the map was generated; initial fire perimeters are generally approximate; the closest meteorological observations may have been taken tens of kilometres from the fire-site. Second, predictive models relevant to fire behaviour, such as fire behaviour models for predicting rate of spread, slope correction, two-dimensional fire shape models, and fuel accumulation models, are all idealised models that approximate real phenomena. Third, the simulation methodology itself can introduce inaccuracy. For example, the discrete event simulation approach of AUSTRALIS (Johnston et al. 2008) relies on spatial discretisation, where the landscape is partitioned into cells that are assumed to have homogeneous attributes, such as vegetation, slope and aspect. When the spatial