Visualisation of Spread of Chalara Ash Dieback for Raising Public Awareness and Responsible Woodland Access

Chen Wang[*1], David Miller[†1], Paula Horne[‡1], Yang Jiang[§2]
Gillian Donaldson-Selby[**1] and Jane Morrice[††1]

[1]The James Hutton Institute, Aberdeen, UK, AB15 8QH
[2]School of Computing Science and Digital Media, Robert Gordon University, UK

Summary

A 3D model of ash (*Fraxinus excelsior*) woodland was developed to present information on the symptoms and spread of Chalara ash dieback (*Chalara fraxinea*) as part of a knowledge exchange programme for the Scottish Tree Health Advisory Group. A hypothetical woodland was designed, with characteristics of the vegetation and topography of a site in north-west Scotland. A model of different stages of infection was prepared and represented in a virtual environment. This was presented to audiences in Edinburgh and Aberdeen, and feedback on experiences and understanding of the disease provided to the team monitoring and advising on the disease outbreak.

KEYWORDS: Ash Dieback, Woodland, 3D Visualisation, Public Participation, Knowledge Exchange.

1. Introduction

Chalara fraxinea, a fungal pathogen causing dieback of ash trees (*Fraxinus excelsior*), was first reported in the UK in 2012, having spread across Europe from its identification in the Baltic States in the early 1990s. The disease is particularly destructive on young ash plants, with older trees surviving for many years before succumbing to secondary infections.

Denmark has suffered 60% to 90% loss of ash trees, and similar impact in Scotland would be significant for its 10.7 million ash trees, and associated loss of ecosystem services. The Forestry Commission Scotland Chalara Action Plan (Forestry Commission, 2013) identifies the need to promote and enhance proportionate biosecurity measures amongst the general public as part of a programme of knowledge exchange.

There is increasing use of 3D modelling tools, games engines and virtual reality environments for exploring scenarios of historic change at sites (e.g. Rua and Alvito, 2011; Verhagen, 2008), and scenarios of future change (e.g. Wang et al., 2012; Wang et al., 2013). This paper describes the use of interactive 3D models of an ash wood which is progressively infected by Chalara, as part of the communication programme.

2. Methodology

The framework used for developing a 3D model and simulation of disease spreading through a woodland comprised: design of features (e.g. tree species), compilation into a single site model, representation of stages of infection, and implementation in tools for public engagement (Figure 1).

[*] chen.wang@hutton.ac.uk
[†] david.miller@hutton.ac.uk
[‡] paula.horne@hutton.ac.uk
[§] y.jiang2@rgu.ac.uk
[**] gillian.donaldson-selby@hutton.ac.uk
[††] jane.morrice@hutton.ac.uk

Model inputs comprise spatial data and associated imagery, non-geospecific imagery (e.g. photographs of features), which are designed independently and then compiled in a single package (Autodesk Maya). The model is exported into a viewer (Octaga) in which functionality is coded in JavaScript and VRML. The environment within which the model was used in public engagement was the mobile Virtual Landscape Theatre (VLT; Ball et al., 2008; Donaldson-Selby et al., 2012), at events hosted in the John Hope Gateway Centre, Royal Botanic Garden Edinburgh.

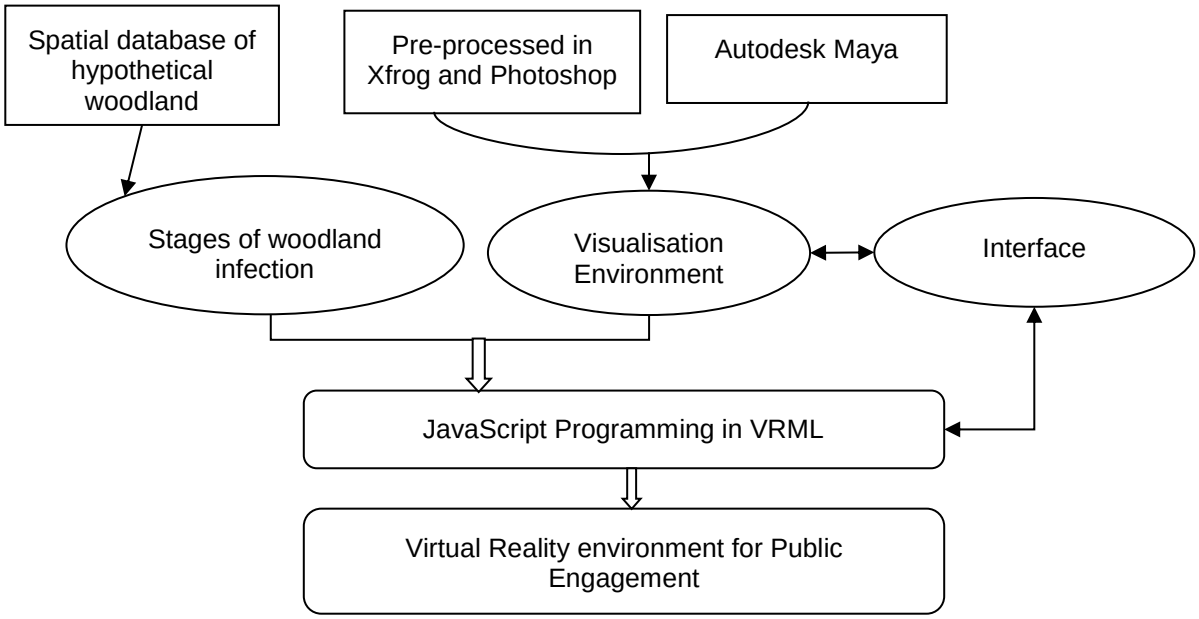


Figure 1. Framework for development of 3D model and simulation of woodland affected by ash dieback.

2.1 Model creation

The content of a hypothetical woodland was prepared based upon the spatial patterns and rocky terrain of Rassal Ashwood, north-west Scotland, using information on the soils, topography, and vegetation. This was developed in ArcGIS to produce a spatial plan which could then be populated with features such as bare rock, ground and tree vegetation. This provided freedom to represent stages of infection and removed the potential for audience misunderstanding of infection at an actual woodland.

2.2 3D Model Creation

A 3D model was created as follows:

(i) compilation of GIS database representing characteristics of the current woodland;
(ii) creation of a terrain model, modified to create physical features to support views of combinations of trees, and enable communication of the narrative of disease spread;
(iii) preparation of textures of landscape backdrops using high-resolution aerial imagery.

Elements added to the model were:

(i) 3D models of features associated with woodland environments including trees species such as ash, rowan, yew, willow and birch; and a range of colours of the lichens found locally. The individual features were developed in Xfrog, modified in Photoshop, and compiled in Autodesk Maya;
(ii) photographs of the symptoms of Chalara on tree branches and leaves;
(iii) photographs of woodland signs used by the Forestry Commission to inform woodland visitors of the status of infection at a site (www.forestry.gov.uk/chalara) and QR codes for the relevant WWW site.

Other features added to the model included wildlife such as red squirrels, sheep and deer. Figure 2 shows an extract from the model with a view across the woodland, including the healthy ash trees, red deer and rocky terrain.

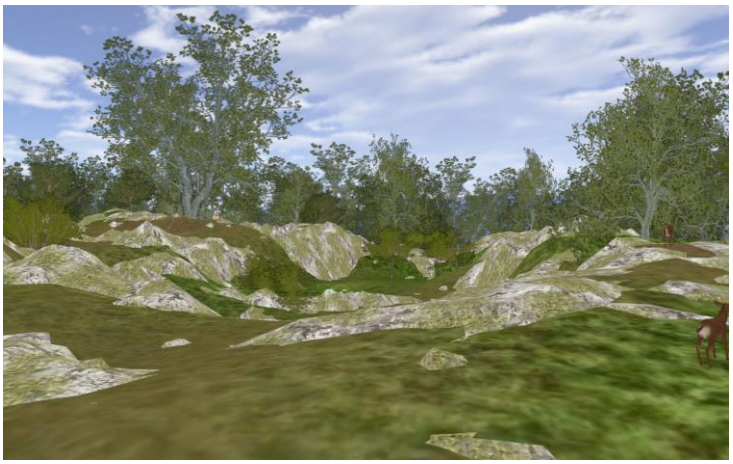


Figure 2. A view of a 3D model of a hypothetical ash woodland in Scotland.

2.3 Woodland infection sequence

Four stages of infection of woodland were created (Figure 3, a to d), planned using data of the spatial distribution of vegetation for the current state of the hypothetical site. A narrative was developed using expert knowledge of the disease with respect to age of trees and the potential for exposure, which was based on segmenting the woodland into three areas diagonally across the site. The stages of infection were then considered for each area in turn.

Attributes of spatial data features were allocated values for species, age, height, which informed interpretation of timescales for infection and stages of dieback on individual trees. Additional polygons were added to represent where other vegetation species could succeed ash trees. The 3D model of the stages of infection and change was developed with ash trees distributed across the three areas. In summary these are:

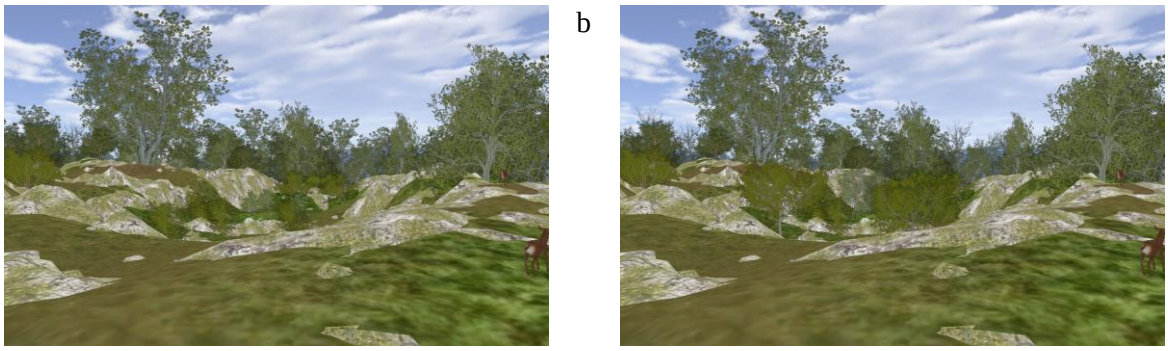
Stage 1: 1/3 ash trees in Area A experience die-back, and ash trees in Area B; Area C remains healthy.

Stage 2: ash trees dieback by 2/3 in Area A; other tree species begin to succeed (e.g. rowan) in Area A; ash trees dieback by 1/3 in Area B; ash trees in Area C remain healthy.

Stage 3: all ash trees in Area A are almost dead; succession trees grow in Area A; all ash trees dieback 2/3 in Area B; other tree species regenerate in Area B; all ash trees dieback by 1/3 in Area C.

Stage 4: worsening of level of dieback across the woodland; all ash trees dead in Area A, and succession trees continuing to grow; all ash trees almost dead in Area B, and succession trees are taller; all ash trees dieback by 2/3 in Area C, and other tree species start growing (rowan and birch).

a b



c d

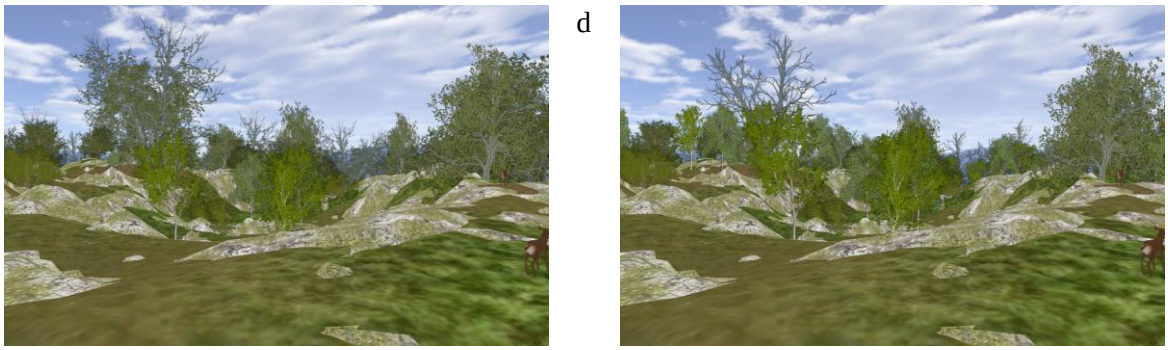


Figure 3 (a to d). Visualisation of four stages of woodland infection ((a) none, to (d) trees dead).

2.4 Model functionality

Interactive functions were added to the model which allowed the presentation of a narrative about the Chalara Ash Dieback threat to woodlands, including the stages of spread of infection, symptoms of infection, the death of trees, and succession of woodland. The functions support the delivery of the narrative of the spread of infection and dieback, and the evolution of the woodland. These include:

(i) switching between stages of spread in the infection of a woodland by Chalara;
(ii) switching on and off visibility of photographs of visual evidence of dieback of leaves of ash trees, and lesions on young branches;
(iii) switching on and off of icons to represent woodland signs, using representations of the official signs for infection as provided by FC on the Chalara www site;
(iv) QR code imagery in the 3D model to enable audience members use mobile devices to access relevant www sites;
(v) switching between presence and absence of some wildlife;
(vi) preset viewpoints for key parts of the narrative, in particular views to specific trees for viewing embedded images of symptoms of Chalara;
(vii) a 'cartoon' of take-home message ('Boots, Bikes and Buggies'), visible from specific viewpoints.

3. Medium and public engagement

The 3D model and simulation of impacts of ash dieback were used in a public engagement campaign "Moving Forward from Ash Dieback" at Royal Botanic Garden Edinburgh, and in the national tour the wider knowledge exchange programme. The event used the James Hutton Institute's mobile Virtual Landscape Theatre (VLT) as an interactive immersive environment, for audiences up to 20, for exploring landscapes, changing their content and discussing land management options.

The model was navigable, with interactivity to appeal across the range of prospective audiences. The drop-in sessions of 20 minutes were run throughout each day, with hand-held consoles used for providing feedback on selected options on the topic of ash dieback. Younger participants were able to respond to questions on wildlife and their habitats. Participants included families from across Europe,

United States, Canada, as well as the UK, in all of which there are trees affected by Chalara.

Figure 4. A view of a woodland with mature ash trees and a mix of other species such as birch, hazel, yew and willow, presented to the RBGE arboriculture team and apprentice gardeners.

Figure 5. A woodland infected by Chalara ash dieback with some dead ash trees and evidence of regeneration of other woodland species.

A high proportion of adults, across nationalities, recognised the term 'ash dieback', and the nature of risks posed to ash woodlands. There was awareness of the symptom of 'die back' of leaves, but low awareness of the symptom of lesions on branches. The geographic origins of the disease, and its distribution across Europe were not well known, or that north and west Scotland were not yet affected. There was also low awareness of the mechanisms of spread of the disease (i.e. by spores blow between sites, or transferred in soil and tree litter via vehicles or footwear).

Of those who owned or managed woodlands with ash almost all were familiar with the risk. However, for those without direct responsibility for ash trees there was a low appreciation of the potential rate of spread of disease once present in a woodland, and the likely death of young trees within a year compared to several years for more mature trees.

4. Discussion and Conclusions

The knowledge exchange programme appeared to contribute to raising public awareness of Chalara ash dieback, and risks of its spread. The use of spatial models of disease spread and visualisation of stages of infection of woodlands in a virtual reality environment have had several benefits, including:

(i) accessibility of information on symptoms and impacts of the disease, without taking people to infected sites,
(ii) explanation, of background to the disease and means of spread,
(iii) communication, of impacts of disease spread through time, bringing together different stages of infection which may take several years, into a period of a few minutes,
(iv) representation, of stages of vegetation succession in a woodland, with the loss of one species and the species which can take its place,
(v) testing, audience understanding of key messages conveyed during the sessions.

A lesson learnt from the Foot and Mouth outbreak was that the 'countryside remains open for business', and not closed to access. The knowledge exchange programme forms one part of the strategy to restrict disease spread, and limit damage done. To date, the strategy for restricting spread of the disease appears to be working, with significant areas of north and west Scotland still clear.

5. Acknowledgements

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6. Biography

Chen Wang is a Landscape and Visualisation Scientist at the James Hutton Institute. He received his BEng at Soochow University, China, and a PhD at the University of Bradford. His research interests include 3D modelling of landscapes; urban environment modelling and reconstruction; character and traffic animation; 3D real time flood simulation.

David Miller is the Knowledge Exchange Coordinator at the James Hutton Institute. His background is in GIS and modelling landscapes and land use. He is Coordinator of the Scottish Government's Strategic Research Programme Theme on Land Use.

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