SILVEX, a computer-based simulation environment of forestry practices

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SILVEX is a research project aiming at the development of a computer application for the simulation of the different forest management practices, but also allowing the 3D-landscape visualisation of the results for landscape architecture assessment purposes. The project was carried out between 1993 and 1995 in the School of Forestry of Madrid (Polytechnic University of Madrid) and conducted by Prof. Manuel Balgañón.

Simulating the basic forestry practices, such as cutting, planting and the effect of felling or pruning, using a computer platform is a practical and flexible tool for students and teachers in the schools of forestry. Understanding the basic dynamics of a tree population formed by thousands of individuals of different species, with different growth rate and reaction to external factors, while computing the productivity and the effect on the landscape of the basic operations applied in forestry is a complex task. By means of a visualisation tool linked to a population management and growth engine, the SILVEX project aimed at these demands. This project was developed in two phases.

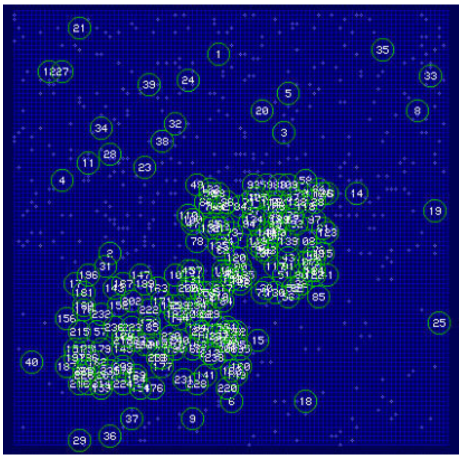


Fig. 1. The basic forestry operations, such as planting and cutting, are edited in the screen.

Phase 1 - SILVEX 2.2

In the first operational version of SILVEX (v2.2) the basic forestry management functions were put in place. Thus, the application allowed to plant a number of trees of a certain age, species and health status over a marked area.

Other functionalities included selection of trees according different criteria (height, diameter, species etc.), volume accounting and tree-cutting processes, differential growth over the years and alteration of the health status due to wind, snow and forest fires.

The visualisation solution adopted was a simplistic pseudo-3D projection in which each tree could be seen located in a different plane according to the distance to the observer, which remains in the same place.

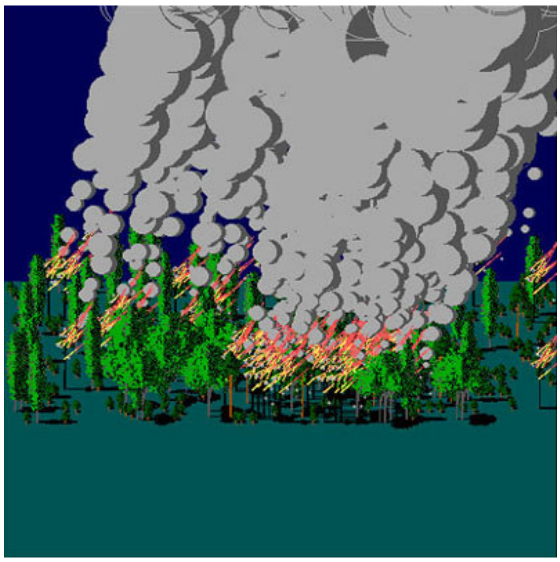
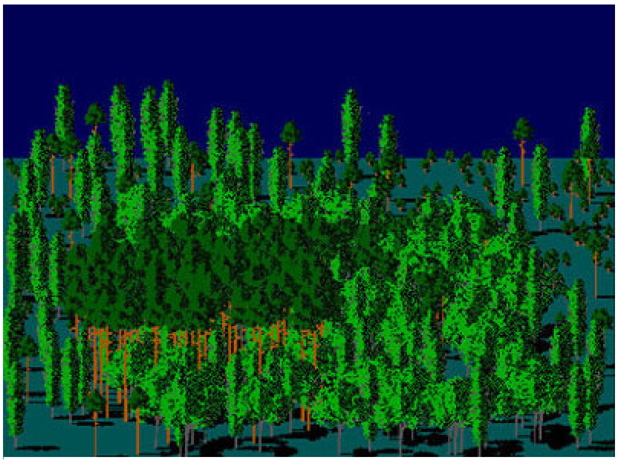
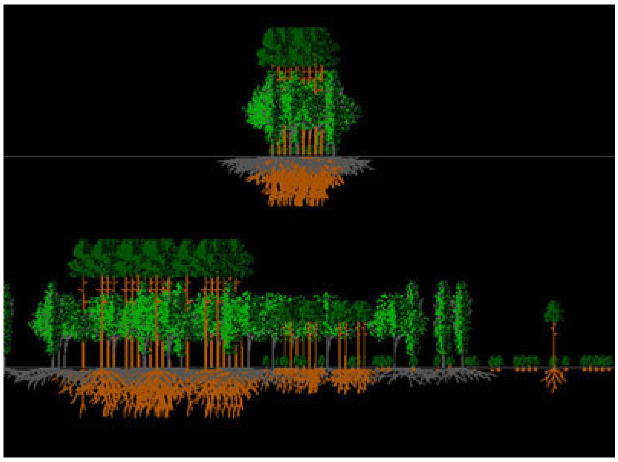


Fig. 2. External natural processes, such as wind, snow and forest fires, are considered in the forest growth.

The drawing of the trees made use of *graftals*, that is, algorithms which use successive branching angles and lengths according to rules defined for each species, age, health status and season. Leaves type and coverage were programmed as well, and a rudimentary effect of shading was also included.

According to experts, the visualisation of the root systems should be also interesting, so we included a functionality to select a strap in the area and showing the profile with trees and roots. This is specially useful when analysing differential growth of species over time





Figs. 3 and 4. Trees are represented using graftal algorithms, with branching rules for each species. Drawing of root systems makes also use of this technique.

The effect of wind, snow and forest fire was included in the growth calculation engine by affecting the growth rate with a factor as result of real world observations. These effects were also included in the visualisation, showing downed trees by wind and snow and burned or scorched trees by fire. A very basic visualisation of the burning areas were included.

Phase 2. SILVEX 3.0

In the second phase a wealth of new functionalities were developed and a completely new graphical interface was designed, although the main algorithms regarding forest management remaining the same (volume accounting, growth engine etc.). First main contribution to the program was the inclusion of maps coming from GIS platforms. These should include Digital Elevation Model (DEM) correspondent to the geographical area of study.

The second major advance was the development environment which was ported from the old DOS to the Windows, thus improving usability noticeably. Although the basic functionalities of setting trees population, marking and accounting, cutting processes, volume accounting remained the same, the way the required inputs were introduced changed into a much more user-friendly fashion.

The number of individuals in the population was increased to 10,000, allowing differential growth according to species, age, health status and treatment. The tables feeding the system were obtained from statistical analysis of real data about the selected species. These were described in a catalogue embedded in the system.

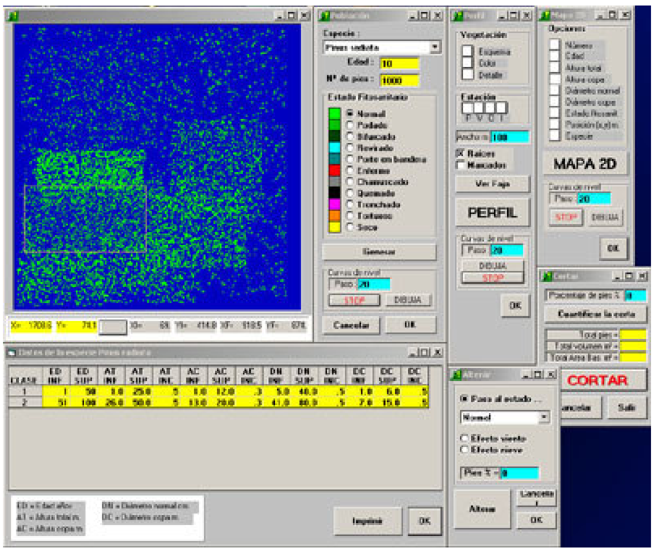


Fig.5. Graphical User Interface of SILVEX 3.0, developed under Windows. The basic edition map, the population accounting functions and the basic forestry operations are integrated in a user-friendly environment.

Visualisation improved noticeably, allowing the user to select any observer and target position in space. Other options were included, such as terrain shadowing and degree of detail of the represented trees. The system positioned the trees in the terrain according to the DEM automatically. The system provided a real 3D rendering of the landscape and profile views including root systems, which could be saved as BMP images into the disk.

Further developments of SILVEX will include an improvement of the forest management by implementing territorial organisation into plots, cost and benefit analysis and better growth models.

Besides, a forest fuel accounting system should be develop according to mortality and vegetal debris production, thus automatically generating forest fire potential and forest risk according to the values threatened.

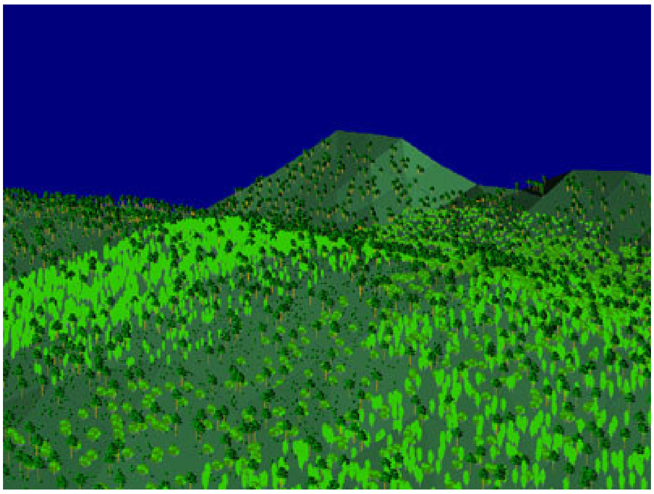


Fig. 6. A 3D projection and visualisation tool was integrated to obtain landscape renderings with the tree population and the terrain elevation, providing basic shadowing of such elements.