

A web-based application to simulate alternatives for sustainable forest management: SIMANFOR

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Abstract

Growth and yield models at different scales are useful tools for forest stakeholders. Adequate simulation of forest stand conditions after different silvicultural scenarios allows stakeholders to adopt appropriate actions to maintain forest integrity while forest products and services are obtained to benefit society as a whole. SIMANFOR is a platform to simulate sustainable forest management alternatives, integrating different modules to manage forest inventories, simulate and project stand conditions and maintain systems security and integrity. SIMANFOR output is compatible with an Office environment (Microsoft or Open), allowing users to exchange data and files between SIMANFOR and their own software. New developments are being planned under a web 2.0 environment to take advantage of user input to improve SIMANFOR in the future.

Key words: simulation; forestry; models; growth; yield.

Resumen

SIMANFOR: Una aplicación web para simular alternativas de gestión forestal sostenible

Los modelos forestales de crecimiento y producción a diferentes escalas son herramientas útiles para los responsables de la toma de decisiones. La simulación adecuada de las condiciones de los rodales forestales tras diferentes escenarios selvícolas permite a estos responsables adoptar decisiones apropiadas para mantener la integridad de los ecosistemas forestales al tiempo que se obtienen bienes y servicios para el beneficio de la sociedad en su conjunto. SIMANFOR es una plataforma para simular alternativas de gestión forestal sostenible que integra diferentes módulos para gestionar inventarios forestales, simular y proyectar las características de los rodales y mantener la integridad de los ecosistemas. Las salidas de SIMANFOR son compatibles tanto con Microsoft como con Open Office, lo que permite a los usuarios intercambiar datos y documentos entre SIMANFOR y su propio software. Nuevos desarrollos están siendo implementados bajo la filosofía web 2.0 para aprovechar la información de los usuarios y así mejorar SIMANFOR en el futuro.

Palabras clave: simulación; selvicultura; modelos; crecimiento; producción.

Introduction

During the last decade, different forest growth and yield models have been developed. Models currently abound for diverse forest ecosystem types around the world. These models are usually implemented on software that allows end-users to simulate different management alternatives. Among the most used, PROGNOSIS (Wykoff *et al.*, 1982), ORGANON (Hester *et al.*, 1989;

Hann *et al.*, 1995), FVS (Dixon, 2002), CAPSIS (Coligny *et al.*, 2004), TREEGROSS (Nagel, 2005) and SEXI-FS (Harja *et al.*, 2006) should be stressed because of their relevance at the international level. However, there are no systems based on the use of the web and the web 2.0 concept. Using this concept will help to create a user community to cooperate in using and developing simulations models. Models implemented on a software platform can be used for different objectives such as (1)

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simulating sustainable forest management scenarios, (2) estimating and setting values for forest goods (timber and non-wood products) and services (biodiversity, carbon sequestration, etc.), (3) evaluating clean development mechanisms or projects to reduce emissions by avoiding deforestation and forest degradation, (4) developing and testing growth and yield models, (5) improving forestry training by allowing students to simulate the effects of their decisions, (6) increasing public participation because the stakeholders can observe the effect of different management alternatives and (7) implementing adaptive forest management process.

The objective of this paper is to present a web-based application to simulate alternatives for sustainable forest management (SIMANFOR), freely available at www.simanfor.org.

System description

SIMANFOR is a forest growth and yield simulation system having the following characteristics:

— Dynamic management of forest inventories. The system defines a data standard model that serves to store data from different forest inventories. Incorporating new data sets and generating new data subsets are system features, so the user can both import new data and modify (by selecting a subset) the database before using the growth and yield model. Users can recover previous data consults or generate new ones.

— The system includes the following administration functions: (1) user administration, (2) forest inventory administration and (3) model administration.

Functional modules (Fig. 1) are the following: (1) login y access control, (2) administration functions (3) calculation and simulation.

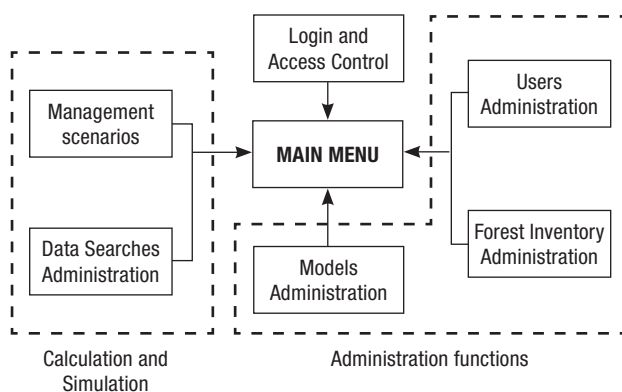


Figure 1. SIMANFOR Platform structure.

SIMANFOR access

SIMANFOR can be used world-wide from any computer with an Internet connection by visiting the web page www.simanfor.org, where the user (Fig. 2) can log into the simulator. The system is hosted in a server located at the “Escuela Técnica Superior de Ingenierías Agrarias”, University of Valladolid (Palencia, Spain). A valid user name and password is required to log into SIMANFOR. The access page provides information on conditions of use and how to request user permission.

User types

Different user types can log into SIMANFOR (foresters, researchers, students, etc.) with the following roles: administrator, modeler and user. Administrators manage the system and provide privileges to the other user types. Modelers can upload and develop models, while users can simulate forest management scenarios by projecting growth and yield models previously implemented in the system. Model use, as well as the system itself, is freely available to the whole community. Modelers are responsible for model accuracy and proper performance and must provide adequate documentation to understand and use the models.

Users can upload, modify and download data sets and develop forest management scenarios, which can be stored and retrieved to improve future system performance by repeating past searches or scenarios already tested. Users are responsible for the adequacy and accuracy of their management scenarios.

Starting with SIMANFOR

Once the user has logged into SIMANFOR, a welcome page appears (Fig. 3). This page allows users, depending on their privileges, to access the different system functionalities: inventory management, model uploads, scenario generation and user management.

Help system

SIMANFOR includes a help system (Fig. 3) with a user manual and a manual designed specifically for modelers that insert a template to facilitate model programming. Additionally, support can be re-



Figure 2. SIMANFOR access.

quested by e-mail (simanfor@pvs.uva.es) while a blog (www.simanfor.es/blog) provides solutions to the users' main problems.

Forest Inventories in SIMANFOR

Forest inventories can be uploaded for personal use, but public data (such as National Forest Inventories) can be uploaded as well. When these inventories are uploaded by an administrator, they become accessible

to all users. A data template is included in SIMANFOR to facilitate data exchange and system use. Once the inventory is uploaded to SIMANFOR, users can select a data subset by choosing data according to different criteria (species, location, stand conditions, etc.).

Implementing models in SIMANFOR

A specific module to program growth and yield models is included in SIMANFOR. To facilitate model

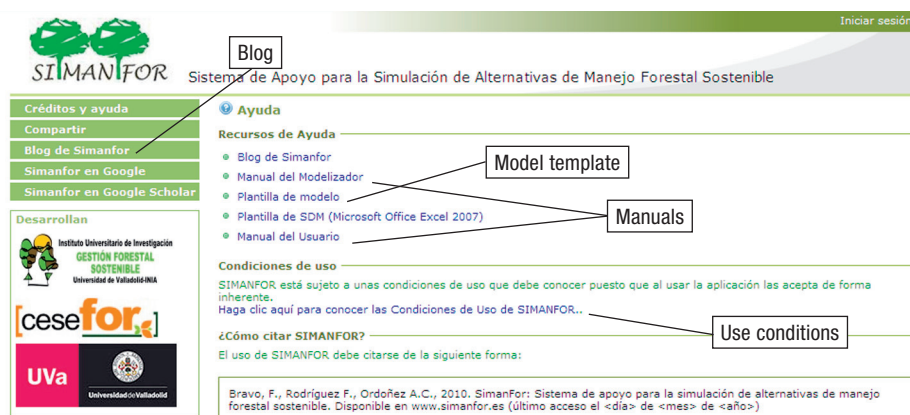


Figure 3. SIMANFOR Help system.

programming by users, a program template is included. The programming language for including models in the system is C#. Currently, two individual tree distance-independent model for *Pinus pinaster* Ait. (Lizarralde *et al.*, 2010a) and for *Pinus sylvestris* L. (Lizarralde *et al.*, 2010b) are included in the system. Each model in SIMANFOR must be adequately documented by the modelers, including information on (1) model name, (2) model description including species and target area, (3) model type including target stand type, data range, model validation and model structure, (4) recommended application, (5) credits (authorship and citation) and (6) contact details.

Scenario simulation in SIMANFOR

By using the models included in the system and the inventories uploaded to SIMANFOR, users can simulate different silvicultural scenarios. Each model projection or silvicultural prescription (including no intervention) generates a node. For each node, SIMANFOR provides information on stand conditions at the appropriate level (tree, size class or stand). Users can redesign their silvicultural prescriptions by starting a new simulation from a specific node obtained in a previously-simulated scenario.

SIMANFOR conditions of use

SIMANFOR use is free, but users must accept some conditions established by the system administrators. The main conditions are: (1) SIMANFOR developers reserve for themselves the right to actualize the system and to translate to other languages; (2) SIMANFOR use is open to the forestry community (foresters, scientists, students, etc.) and can be used for research, teaching and developing new silvicultural scenarios; (3) SIMANFOR use must be acknowledged by the proper citation (a credit link is included in the system to facilitate this) and (4) users must guarantee the reliability of the results provided by SIMANFOR.

Conditions of use are developed to maintain system functionality and SIMANFOR use as a service to the forestry community. Feedback is welcomed to develop a web 2.0 environment.

Conclusions and further development

This paper presents SIMANFOR, which is freely available from www.simanfor.org. SIMANFOR is under permanent development and three new features will be included in the near future: (1) new models programmed, (2) improvement of the user-friendly interface and (3) translation to other languages, starting with English and followed by Portuguese and French. SIMANFOR is open to incorporating models from different ecosystems around the world and is supported by a server that can be scaled up to respond to future demands.

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