

**Sustainable and environmentally friendly wood material production for future industrial needs
 (SUSWOOD)
 2008 Consortium annual report for
 KETJU programme, Academy of Finland**

1. Objectives

SUSWOOD project examines the potentials of alternative forest management systems to meet the needs for sustainable production of wood raw material as well as maintaining forest ecosystem functions. A stochastic forest dynamics simulation system using high performance computing will be designed and implemented in order to analyze and quantify the effects of alternative forest management systems, climate conditions, etc. on wood raw material production and its socio-economic implications. This fundamental research will provide scientific knowledge on sustainability of wood raw material production, and their impacts on socio-economics.

2. Consortium

Forestry: Drs. Taneli Kolström (Project leader) and Julian Lin, Mekrijärvi Research station, University of Joensuu.

Information Technology: Drs. Jan Westerholm and Mats Aspнас, M.Sc. (Tech) Artur Signell and Evren Yurtesen (1.11.2008-31.12.2008) (Ph.D. students), and Magnus Södergård (1.1-30.6.2007), and Johan Schöring (1.9.2007-30.11.2008) (M.Sc. students), Department of Information Technologies, Åbo Akademi University.

Geography: Dr. Markku Tykkylainen, M.Sc. Olli Lehtonen (Ph.D. student), Lauri Korhonen (M.Sc. student), Department of Geography, University of Joensuu.

3. Progress in 2008

	Planned tasks	Tasks been done in 2008	Expected results
F2.1	Developing statistical methods, e.g., sampling techniques, to scale-up single-tree information for assessing stand and regional level statistics, such as basal area per hectare, under alternative forest types, i.e., even- and uneven-sized forests.	Since the magnitude of the simulation has achieved 3 million hectare with more than 8 billion trees, the sampling technique does not need to be developed. The regional level statistics will be computed for the whole region from single-tree data.	The method developed for F2.1 and F2.2 will be integrated into the simulation software. Restructure simulation framework to accommodate the simulation of polygonal forests. Simulating irregular polygons as compartments

F2.2	Developing statistical criteria for sustainable and environmentally friendly forest management systems.	Statistics on demand and supply of wood raw material and environmental protection are needed for developing the criteria. The statistics are collected from Finnish forestry statistical yearbook and summarized for the analysis purposes.	A set of statistical criteria to be included in the simulation software reporting functionalities.
IT2.1	Large-scale simulations of alternative forest management systems: calibration of model parameters, software adjustments and further developments to include topological features in the modelling.	<ul style="list-style-type: none"> - Implemented a completely parallelized (based on data decomposition) version of the tree population simulator created last year. Billions of trees can now be simulated concurrently on thousands of processors. - Implemented load balancing algorithms to ensure CPU time is not wasted. - The simulator has been extended to handle multiple marks and multiple tree species. - Different management methods have been implemented. - Implemented a more flexible parameter model to make program input simpler. - Created a separate program for generating realistic simulation areas for large scale simulations. 	A fully functional, single tree level forest population simulator which can be used to simulate very large tree population.
G2.1	Study of the supply potential of wood under different wood demand conditions (i.e. wood for various industrial and energy use) in uneven-aged forest management systems.	The GEO group scrutinizes and models the future development of forest-based production and its regional and spatial socio-economic impacts. It applies the developed modelling for studying potential use of wood under different wood demand conditions (i.e. wood for various industrial and energy use) and under different forest management objectives.	Analyses and scenarios of potential use of wood and its socio-economic impacts under different wood demand conditions and different forest management objectives. The results are of use in planning, development of methods and theorizing of regional development.
G2.2	Evaluating the socio-economic impacts of the transformation of the forest sector under uneven-aged silvicultural management systems on localities and regions		

4. Modifications to the original research plan

Forestry:

Statistical sampling study is replaced by the simulation of complete forest landscape. Sustainability of wood raw material demand and supply will be studied more extensively focusing on wood-energy issues.

Information Technology:

Successfully made the previously implemented simulator into a fully parallel program capable of simulating billions of trees. So far a 3 million hectare polygon-shaped forest with 6 billion trees has been simulated.

Geography:

No major amendments.

5. Research outcomes in 2008

Conference and out-reach

Forestry:

Oral presentation, Energy Säästävyys ja kestävyys, AKA, 17-18.6.2008

News paper interview, Karjalainen 14.7.2008.

Meeting at Metsäteollisuus ry (Andres Portin) on alternative forest management issues, Helsinki, 8.9.2008

Metsäteollisuus ry press conference (Puutuoteklusterin tutkimusstrategia), Helsinki, 20.8.2008

METLA research meetings, Helsinki and Parkano

Information Technology:

Cray Users Group 2008, May 5-8 2008, Helsinki, Finland;

International Supercomputing Conference '08, 17-20.6.2008, Dresden, Germany;

Alumni day at Åbo Akademi University, September 25th, 2008.

Geography:

Researchers have participated in the annual conferences of geographers (Finland and the USA) and the intensive course of the Geography Graduate School in Finland. One radio interview and one tv-interview.

Publications

Forestry:

- Regeneration and recovering of understory after uneven-sized management in a *Picea abies* (L. Karsten)-dominated forest (full article, revising, FOR-METLA)
- Silvicultural alternatives in a *Picea abies* dominated uneven-sized forest (full article, submitted, FOR-METLA)
- Simulation of single-tree dynamics on polygonal area with high performance computing (full article), FOR-IT joint paper, final draft)
- Model Switch for simulation of single-tree characteristics (full article, FOR, draft)

- Empirical cumulative density function transformation (short communication, FOR, draft)

Information Technology:

- Artur Signell, Johan Schöring, Mats Aspнас, Jan Westerholm. An individual tree simulator for assessment of forest management methods. Proceedings of Cray User Group Annual Technical Conference, May 5-8 2008, Helsinki, Finland.
- Johan Schöring, Optimization and Parallelization of a Single Tree Level Forest Simulator. M.Sc. (tech.) Thesis, Åbo Akademi University, Department of Information Technologies, 2008.
- Artur Signell, Johan Schöring, Mats Aspнас, Jan Westerholm. Parallelization of a Single Tree Level Forest Simulator. Submitted to the International Journal of High Performance Computing Applications.

Geography:

- Tykkyläinen, M. & Lehtonen, O. (2008). Russian Roundwood Exports: The Effects of Tariffs on the Finnish Border Economy. *Eurasian Geography and Economics* 49(6): 731-754
- Lehtonen, O. & Tykkyläinen, M. (2008). Labor Shortage in Forestry and its Impacts on the Regional Economy in the Remotest Areas in North Karelia, Finland. 2008 Annual Meeting of the Association of American Geographers, Abstract Volume.
- Tykkyläinen M. & Korhonen L. (2008), Metsäsektorin rakennemuutoksen skenaariot Pohjois-Karjalassa. Maantieteen päivät 2008. Abstraktit.
- Lehtonen, O. (2008). Alueellisen hyvinvoinnin kehitys Pohjois-Karjalassa 1993–2003. Maantieteen päivät 2008. Abstraktit.

6. Plans for 2009

Forestry: New model structure has been implemented in the simulator (SPATE-HPC) and modelling work will continue. The main goal for forestry is to complete the large scale simulation with alternative silviculture systems. A secondary goal is to publish the research results in international refereed journals.

Information Technology: An updated version of the input editor. Summary output of simulation results. Public domain readiness. Further development of the program according to forestry needs. Assisting forestry in model calibration.

Geography: Based on background scenarios the geography group applies the developed model for analysing potential use of wood and its socio-economic impacts under different wood demand conditions (i.e. wood for various industrial and energy use) and under different forest management objectives. The group pays attention to complete the dissertations started and continues to present and publish the research results internationally.