Sustainable and environmentally friendly wood material production for future industrial needs (SUSWOOD)
2009 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 Aspnäs (1.1-30.6.2009), M.Sc. (Tech) Artur Signell (1.1-31.12.2009, Ph.D. student), Kristoffer Paro (1.4-31.12.2009) (M.Sc. student), Jens Smeds (1.6-31.12.2009 part time) and Mikael Mölsä (1.2-28.2.2009 support), 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 2009

	Planned tasks	Tasks been done in 2009	Expected results
F3.1	Further development of statistical models for the investigation of climate change alternative forest management systems and its impact on socio-economic development in forestry regions.	- developed new model formulation to be implemented in SPATE-HPC. - Statistical modelling of a new set of mapped forest stand data (together with existing data) for simulating uneven-aged forest stand - Tested and calibrated input parameters for even- and uneven-aged forest stand simulation using SPATE-HPC. - Simulated wood raw material production for two alternative forest managements.	- A new model specification implementation for forest simulation. - A test case of even- and uneven-aged forest management simulation. - A set of simulated wood raw material production using uneven-aged forest managements in North Karelia region for socio-economic study.

IT3.1	Further development of HPC software for simulating alternative forest managements with various socio-economic scenarios, e.g., flexible harvesting schedule and assortments to meet market demands.	- Implemented new model formulation in SPATE-HPC - Created a graphical user interface for adjusting parameters for the simulator. - Developed a new method for creating correlated random numbers for a large number of trees. - Implemented the correlated random number algorithm in the simulator. - Reimplemented and improved algorithms for low and selective thinning. - Implemented support for volume calculations per assortment - Added a transformation to give the user more control on the diameter distribution for generated trees - Released the simulator as open source software	A fully functional single-tree level forest dynamics simulator, including a user interface, which can be used to simulate a very large tree population consisting of multiple species located in multiple compartments and use multiple thinning methods. The output consists of compartment level volumes per species and assortment. The simulator is available as open source from the project web site www.it.abo.fi/Suswood. 3 papers and one Master's thesis
G3.1	Evaluating the socio-economic impacts of transformation of forest sector under uneven-aged forest management systems on localities and regions, and investigating the potentials of exercising uneven-aged forest management systems in Finland.	The GEO group completed the work of scenario analysis. The data for the socio-economic impact model was obtained as well as the results of the FOR and IT. The model experiment will be done during the first half of 2010 and reported.	The GEO group have prepared research papers for publishing and publications are to be expected to appear in journals, as well as one Master's thesis and a Ph.D. dissertation.

4. Modifications to the original research plan

Forestry:
The study of climate change resulted with insufficient evidence in tree growth. This might be due to the sample size of the empirical data was small and that the study period (approximately 20 years since 1986) was not long enough to detect climate change effects on tree growth.

Information Technology:

The scale of the area and forest the simulator is capable of simulating is 10 times larger than in the original plan. A 3 million hectare polygon-shaped forest with 8 billion trees has been simulated. A graphical user interface for setting simulation parameters has also been created.

Geography:
None

5. Research outcomes in 2009

Conference and out-reach
Forestry:
Research meeting in METLA, Vantaa, 2-4.2.2009
Metsäpolitiikan tulevaisuuden haasteet, Helsinki University, 30.9.2009.
Uneven-aged silviculture for forest owners seminar, Hammaslahti, 17.10.2009
Innofor Oy Director of Board Marcus Walsh visiting Joensuu to discuss uneven-aged forest management, 26.10.2009

Information Technology:
Publication of open source software SPATE-HPC at www.it.abo.fi/Suswood

Geography:
Annual Meeting of the Association of American Geographers, Las Vegas, 22-27.3.2009.
NGM09, Turku, 8-11.6.2009
XIII European Society for Rural Society Congress. University of Vaasa, Åbo Akademi University and ESRS, Vaasa, 17-21.8.2009
Suomen XLII maantieteen päivät Oulussa - maantieteet muutoksessa, Oulu, 6-7.11.2009.

Publications
Forestry:
Lähde, E., Laiho, O., Lin C.J., 2009. Silvicultural alternatives in an uneven-sized forest dominated by *Picea abies.* Journal of Forest Research, DOI 10.1007/s10310-009-0154-4, 15, 14-20.
Lin, C.J., Laiho, O., Lähde,E., 2009. Regeneration and recovering of understory after uneven-sized management in a *Picea abies* dominated forest (submitted to Scandinavian Journal of Forest Research, revising).
Julian Lin and Kristoffer Paro. Thinning strategy for even- and uneven-aged silvicultural systems using the Weibull distribution. (in progress)
Julian Lin and Taneli Kolström. Spatio-temporal scale in even- and uneven-aged silviculture. (in progress)
Julian Lin. Implementation of a second order hierarchy model structure in simulation. (in progress)

Information Technology:
Artur Signell, Johan Schöring, Mats Aspnäs and Jan Westerholm., "Parallelization, Spatial Decomposition and Load Balancing of a Single Tree Level Forest Dynamics Simulator", accepted for publication in Mathematical and Computational Forestry & Natural Resource Sciences (MCFNS)

Journal
Julian Lin, Artur Signell, Johan Schöring, Taneli Kolström, Mats Aspnäs and Jan Westerholm. Simulating very large-scale tree population dynamics with spatially explicit stochastic models: SPATE-HPC (submitted to Computers and Electronics in Agriculture).
Artur Signell, Jan Westerholm and Julian Lin. An efficient approximative method for generating correlated normally distributed random numbers with sparse correlation matrices in parallel (in progress)
Kristoffer Paro. Implementing computational statistical methods in a scalable individual-tree s. (Master thesis, completed)

Geography:
Lehtonen, Olli & Tykkyläinen, Markku (2009), Potentials and employment impacts of advanced energy production from forest residues in sparsely populated areas, in Brunn, Stanley (ed.). Engineering Earth, Kluwer, Dordrecht (in print).

Lehtonen, Olli & Tykkyläinen, Markku (2009), The Emerging Shortage of Labour in Forestry in a Remote Coniferous Region: A Brake on the Massive Use of Biofuels, Andersson, Kjell, Eklund, Erland, Lehtola, Minna & Salmi, Pekka (eds.), Beyond the Rural-Urban Divide, Cross-continental perspectives on the differentiated countryside and its regulation, 25-55, Research in Rural Sociology and Development 14, Emerald Group Publishing, Bingley.

Korhonen, Lauri, Lehtonen, Olli & Tykkyläinen Markku (2009). Sosiaalinen verkostoanalyysi delfoi-paneelien valintamenetelmänä. Suomen XLII maantieteen päivät Oulussa - maantieteet muutoksessa. Abstraktijulkaisu. Maantieteen laitos, Oulun yliopisto.

Tykkyläinen, Markku, Korhonen, Lauri & Lehtonen, Olli (2009). Impact of restructuring of the forest sector on rural areas in a sparsely-populated area. Re-inventing the Rural: Between the Social and the Natural. Book of Abstract. XIII ESRS Congress. Tampere: University of Vaasa, Åbo Akademi University and ERSR, 27.

Korhonen, Lauri, Lehtonen, Olli & Tykkyläinen, Markku (2009). How to develop the forest sector in a Finnish remote and sparsely-populated region. NGM09, Organising Committee (ed.): Change. Society, Environment and Science in Transition, 168, Turku University, Department of Geography Publications B Nr. 14.

Tykkyläinen, Markku & Lehtonen, Olli (2009). Impacts of Russian Roundwood Export Tariffs: How Can a Finnish Border Economy React? Annual Meeting. Abstract Volume. Washington DC: Association of American Geographers, 2009.

Lehtonen, Olli & Tykkyläinen, Markku (2009). The future of the forest sector and its employment possibilities in a Finnish remote and sparsely-populated region. Annual Meeting. Abstract Volume. Washington DC: Association of American Geographers, 2009.

Web abstracts:

Korhonen, Lauri, Lehtonen Olli & Tykkyläinen Markku (2009). Sosiaalinen verkostoanalyysi delfoi-paneelien valintamenetelmänä – tiivistelmä artikkeliluonnoksesta. Metsäalan ennakointiyksikkö/Hyviä käytäntöjä,