Four abstracts with Peter Lohmander and coauthors

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ABSTRACT

Keynote.
Peter Lohmander
(Professor, Swed.Univ.Agr.Sci., Sweden)

Title: **Economic optimization of sustainable energy systems based on forest resources with consideration of the global warming problem: International perspectives**

Economics, optimization of industrial processes, infrastructure, logistics, sustainable energy systems, forest resources, global warming, and international trade are mostly studied as more or less independent topics. It is however obvious that these things have very strong links. This lecture focuses on the big picture, painted this way: Our planet has a common atmosphere. If, and to what extent, we have global warming problem, partly caused by an increasing CO2 level in the atmosphere, is and has been intensively debated in connection to international negotiations during the latest period. In any case, some countries and regions of the world, have already defined targets with consideration of the CO2 issue. For instance, European Union has the target to have at least 20% renewable energy in the year 2020.

The global distribution of forest resources such as standing timber and forest land with different properties can be studied via official statistics published by United Nations and different national and regional organizations. The rationality of existing and potential forest activities, such as harvesting and forest investments in different parts of the world, can be studied and analysed via cost and revenue data obtainable from a large number of sources, including published reports from forest reserach organizations. Statistics of relevance to infrastructure and logistics, such as capacities and costs in different countries, are available from the World Bank.

It has been found that the "forest production capacity utilization" levels are very different in different countries. In large regions, such as Russian Federation and Canada, the harvest levels are several times lower than what is possible if the production potential of the land is fully utilized. This partly depends on limited infrastructure availablility in these regions.

The present lecture contains a general analysis of some of the central decision problems of relevance to "Economic optimization of sustainable energy systems based on forest resources with consideration of the global warming problem, with international perspectives".

An operations research approach to the total optimization problem is suggested, that maximizes the expected present value and takes the CO2 considerations into account in different forms. In order to generate optimal total results, infrastructure investments have to be coordinated with forest utilization expansion. Furthermore, all other related decisions have to be handled in an optimal way. Some examples are given that show that it is possible to generate considerable economic results and simultaneously reach the CO2 targets. In order to obtain the best possible total economic and environmental results, it is important to update existing national forest laws and regulations and to investigate the problems without considering national boundaries as strict constraints. Economics and environmental issues are global topics and have to be treated as such, in the interest of general economic development and the sustainability of life on our planet.

ABSTRACT

Peter Lohmander:
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Title: **Spatial dynamic optimization of district heating and/or cooling systems based on forest resources.**

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In Sweden and several other countries, the utilization of forest raw materials such as branches tops and roundwood, for energy production, is rapidly increasing. With CHP, combined heat and power, a large proportion of the energy potential of the forest resources can be utilized, primarily for electricity (power) in combination with hot water for district heating. In other countries, the potential market for hot water for district heating is more limited. There, similar solutions can be developed for district cooling. The present analysis concerns spatial dynamic optimization of the district heating and/or cooling systems based on forest resources.

When a district heating system should be developed for a community, some of the important questions are these: What capacity, or perhaps capacity development, of the hot water (and power) plant is optimal? What is the optimal location of the plant (or plants)? We may divide the residential (and sometimes industrial) areas into neighbourhoods. What neighbourhoods (or areas) should be connected to the heating systems and in what order? The problem is defined as a present value maximization problem. The dynamic development of the district heating system is defined and optimized via dynamic programming. This part of the problem can be solved, provided that the location and capacity of the heat (and often power) plant are already known, or exogenous.

The total optimization problem, where the location and capacity of the heat (and often power) plant should be determined in a way that is optimal in combination with the development of the district heating system within the community, can be solved this way: We maximixe the total economic present value of all activities that can be influenced. In the main program, we optimize the location and capacity of the heat (and power) plant. This can be done via grid search or gradient methods. The most suitable selection of this method depends on the properties of the physical environment in the area and the possible presence of "physical and/or legal constraints". For each alternative of the location and capacity of the heat (and power) plant, there is an optimal development of the district heating system. This can be considered as a sub problem, which is solved via dynamic programming. This sub problem has already been described.

The analysis includes a complete software illustration. A software for one version of the dynamic programming sub problem has been developed and is available via Internet. This software has been used to study the rational development of the district heating system in a town in a forest region of Sweden, provided that the capacity and location of the heat (and power) plant is exogenous.

Links to the preliminary sub problem optimization software:
http://www.lohmander.com/DHINV/DHINV_example.pdf
http://www.lohmander.com/DHINV/Complete_ex2.pdf
http://www.lohmander.com/DHINV/DHINV22.EXE
http://www.lohmander.com/DHINV/DHINV22.zip

Application:
http://www.lohmander.com/Lacruz_sept_2010.pdf

ABSTRACT

Peter Lohmander and Liubov Zazykina:
(Peter Lohmander, Professor, Swed.Univ.Agr.Sci., Sweden and Liubov Zazykina, PhD Student, Moscow State Forest University, Russia)
Title: **Dynamic economical optimization of sustainable forest harvesting in Russia with consideration of energy, other forest products and recreation.**
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Forests are used for many different purposes. It is important to consider these simultaneously. A new methodological approach to optimization of forest management with consideration of recreation and the forest and energy industries has been developed. It maximizes the total present value of continuous cover forest management and takes all relevant costs and revenues into account, including set up costs. In several regions, in particular close to large cities, such as Paris and Moscow, the economic importance of recreation forestry is very high in relation to the economic results obtained from traditional "production oriented" forest management. This does however not automatically imply that production of timber, pulpwood and energy assortments can not be combined with rational recreation forestry. On the contrary: It is sometimes necessary to harvest and to produce some raw materials taht can be utilized by the forest products industry and/or the energy industry, in order to avoid that the forest density increases to a level where most kinds of forest recreation becomes impossible, at least for large groups of recreation interested individuals.

The optimization model includes one section where the utility of recreation, which may be transformed to the present value of net revenues from recreation, is added to the traditional objective function of the present value of the production of timber, pulpwood and energy assortments. In several situations, individuals interested in recreation prefer forests with low density. This means that forest management that is optimal when all objectives are considered, typically is characterized by larger thinning harvests than forest management that only focuses on the production of timber, pulpwood and energy assortments.

The results also show that large set up costs have the same type of effect on optimal forest management as an increasing importance of typical forms of recreation, close to large cities. Both of these factors imply that the harvest volumes per occation increase and that the time interval between harvests increases. Even rather small set up costs imply that the continuous cover forest management schedule gives a rather large variation in the optimal stock level over time. The general analysis of the optimization problems analysed within this study is based on differential equations describing forest growth, in combination with two dimensional optimization of the decisions "harvest interval" and "stock level directly after harvest". All of the other variables are explicit functions of these decisions.

ABSTRACT

Liubov Zazykina and Peter Lohmander:
(Liubov Zazykina, PhD Student, Moscow State Forest University, Russia and Peter Lohmander, Professor, Swed.Univ.Agr.Sci., Sweden)
Title: **Lost profits caused by forest laws and rules that are not optimal.**
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The forest management methods that maximize the relevant objectives, often implicitly assumed to be the total present value, are functions of a large number of conditions, or parameters. Some of these parameters, such as prices of different assortments and costs of different activitites, are usually not the same in different regions of the world. Furthermore, within each country, there is usually considerable variation with respect to forest production parameters. The site productivities, soil types, slopes, species proportions, existing stock levels, and many other things of importance to rational forest management decisions, have to be taken into account if we want to optimize our decisions and obtain the best possible results.

Forestry laws and regulations can differ very much, also between countries with very similar conditions with respect to prices, costs and physical properties. In some countries, such as Switzerland, continuous cover forestry is the only legal method. In other countries, such as Sweden, several forest act rules and recommendations, direct the forest owner towards forestry with final fellings. Some forest acts, such as in Wales, UK, say that forests close to streams have to be harvested. In Sweden, the situation is quite different and the trees close to the streams should not be harvested. In Sweden, the size of an harvest area is not “directly constrained”. It is indirectly constrained in the sence that the total area of a forest property that simultaneously has trees below a specific age is limited. In several other countries, the maximum size of a harvest area is strictly constrained. There are many more examples of this kind. FSC is sometimes considered to be the best way to make sure that forestry is performed in an “acceptable” way from different points of relevance. It is important to be aware of the fact that FSC requieres that forestry is performed according to the forest act rules in the different countries! This means that, if you want to follow the FSC rules, many forest management activities that are necessary in one country are strictly forbidden many another countries, even if every economical and physical detail of the forestry problems are identical.

This inconsistency is an important problem from a principal point of view. It is obvious that, if one solution is optimal in one place, it is also optimal in another place, if every condition of relevance is identical. Therefore, we can instantly conclude that these differences in rules have to imply that the total objective function value is negatively affected by these differences in rules. The analysis of this study includes a number of cases with numerically specified situations where the costs of rule imperfections are determined. These cases are specified with production functions and economical parameters from Sweden and Russia. Furthermore, forestry laws, harvest limitations, recent forest fires and costs in the Moscow region are discussed.