

Forest

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The cost calculators for sustainable procurement of logging residues, thinning wood and stumps for fuel

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 - The history of the forest chip procurement cost calculators
 - Primary aim of the procurement cost calculators
- The procurement cost calculators
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 - The supply chains of the procurement cost calculators
 - Internet applications of the procurement cost calculators
 - Conclusions

The history of the procurement cost calculators

Volume & cost estimator for young stands and final fellings

2nd cost calculator for stumps

Cost calculator for roundwood

Cost calculator for delimbed longwood

Cost calculator for stumps

Cost calculator for whole-trees

Cost calculator for logging residues

2011, "METKA - Forest energy profitably" project

2007, "Large-scale forest fuel supply solution through a regional terminal network" project

2005, "Harvesting alternatives and cost factors of delimbed energy wood" project

2004, "Harvesting of stumps and processing of forest energy wood" project

2004, "Development of chip production from young forests" project

2001, "Cost factors and large scale procurement of logging residues" project



ClimBus



PUUENERGIA



TEKES

Forest chips calculators – Simple tools for the stand level cost and sensitive analysis*

Cost calculator for the stumpwood chips procurement



Finnish Forest Research Institute, Joensuu Unit
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The primary aim of the Excel-based cost calculators is to familiarize the user with the various ways different factors affect cost of forest chips. The calculator enables the user to investigate how changes in processed material or in the productivity and hourly cost of machines influence the harvesting cost of the whole system.

The cost calculator for logging residue procurement

Finnish Forest Research Institute
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The cost calculator for whole tree chips procurement

Finnish Forest Research Institute
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© Juha Laitila 2004



The cost calculator for roundwood chips procurement

Metla, Joensuu Research Centre
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Characteristics of forest stand

	Set value		
Area, ha	2.0		
Forwarding, m	150		
Transporting, km	40	Feed stand knowledge into the cells beside!	
Accumulation of small sized energywood, m ³ /ha	60		
Pine, % of accumulation	33 %	Attention: The sum must be 100 % Total: 100 %	
Spruce, % of accumulation	2 %		
Birch, % of accumulation	60 %		
Others, % of accumulation	5 %		
Stem volume of whole-tree (with branches), dm ³	25	→	
	Set value	Presumed value	Model uses
Moisture of fresh whole tree, %		55 %	55 %
Moisture of seasoned whole tree, %		35 %	35 %
Loss of seasoning, %		5 %	5 %
Seasoning time at roadside storage, months		8	8
Interest of capital, %		6 %	6 %

Results

Quantities of delimbed energy wood on site

	m ³	MWh	m ³ /ha	MWh/ha
Fresh energy wood	240	490	40	82
At roadside storage seasoned energy wood	238	519	40	86

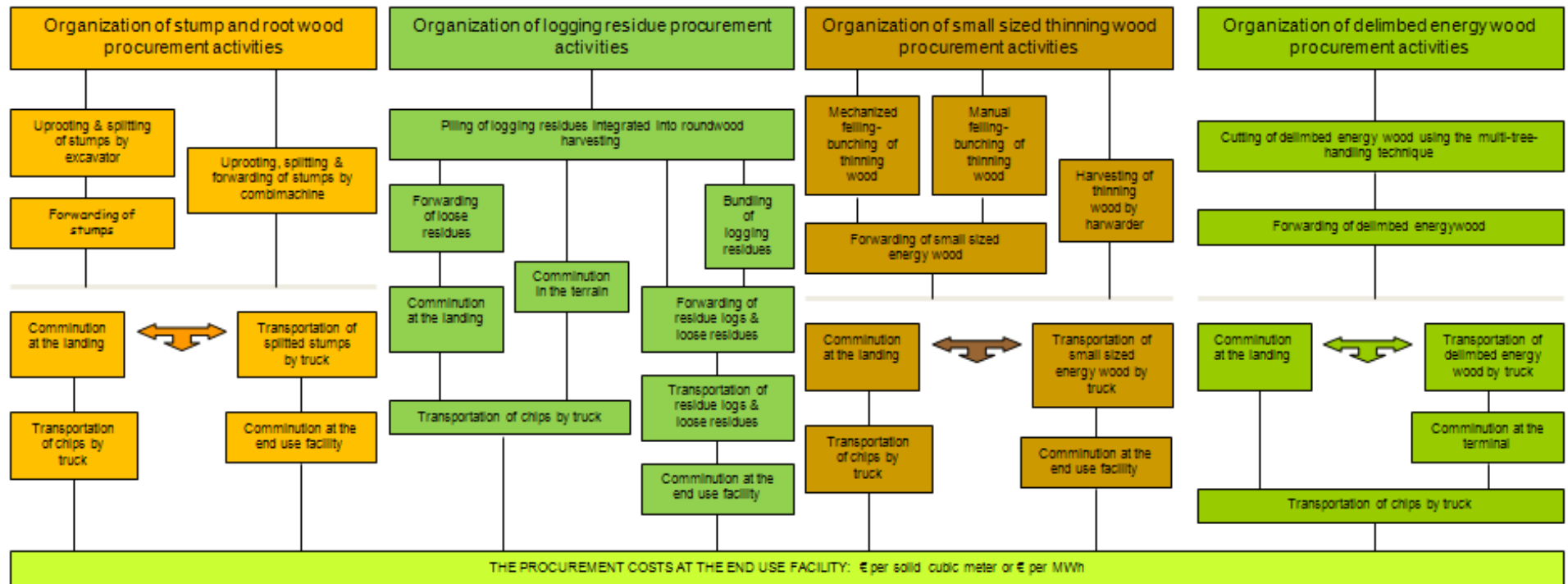
Cost at power plant by different supply chain methods:

RS = roadside storage

	Fresh wood, €/m ³	Fresh wood, €/MWh	Dry wood, €/m ³	Dry wood, €/MWh
Chipping at RS & direct delivery to plant	36,2	17,7	38,3	17,6
Chipping at terminal & delivery from terminal to plant	38,6	18,9	40,6	18,6

*Laitila, J. 2006. Cost and sensitive analysis tools for forest energy procurement chains. Metsandusliikud Uurimused - Forestry Studies 45: 5-10.

The main work stages of the procurement cost calculators



Procurement costs on the basis of the stand data*

	Set value		
Area, ha	2,0		
Forwarding, m	200		
Transporting, km	40		
Feed stand knowledge into the cells beside			
Accumulation of small sized energywood, m ³ /ha	60		
Pine, % of accumulation	33 %	Attention :The sum must be 100 % Total: 100 %	
Spruce, % of accumulation	2 %		
Birch, % of accumulation	60 %		
Others, % of accumulation	5 %		
Stem volume of whole-tree (with branches), dm ³	30		
	Set value	Presumed value	Model uses
Moisture of fresh whole tree, %		55 %	55 %
Moisture of seasoned whole tree, %	30 %	35 %	30 %
Loss of seasoning, %		5 %	5 %
Seasoning time at roadside storage, months		8	8
Interest of capital, %		6 %	6 %

Overview from the stand data sheet in the cost calculator for whole-tree chips procurement

In the stand data sheet, the user can insert specific information about:

- Forwarding (m) & transporting (km) distances
- Moisture content of fresh/dried energy wood (%)
- Seasoning time (months) & loss at the roadside storage (%)
- Area of the stand (ha)
- Tree and stump size (dm³)
- Accumulation and recovery rate of biomass (m³/ha or %)
- Interest of capital (%)

To help the estimation of the volume of the harvested trees there is a separate cell, where the volume of different tree species can be calculated by the DBH and length.

Forest chips energy content is calculated as a function of moisture content and wood fuels heating values

*Hakkila, P. 1976. Stump wood as industrial raw material. Folia Forestalia, 292. 39 pp.

*Hakkila, P. 1978. Harvesting small-sized wood. Folia Forestalia, 342. 38 pp.

*Hakkila, P. 1991. Crown mass of trees at the harvesting phase. Folia Forestalia, 773. 24 pp.

*Nurmi, J. 2000. Characteristics and storage of whole-tree biomass for energy. Metsäntutkimuslaitoksen tiedonantoja 758. 42 pp.

*Repola, J., Ojansuu, R. & Kukkola, M. 2007. Biomass functions for Scots pine, Norway spruce and birch in Finland. Metlan työraportteja 53. 28 pp.

The supply chain information sheets

The supply chain information sheets are included default values, for example for the:

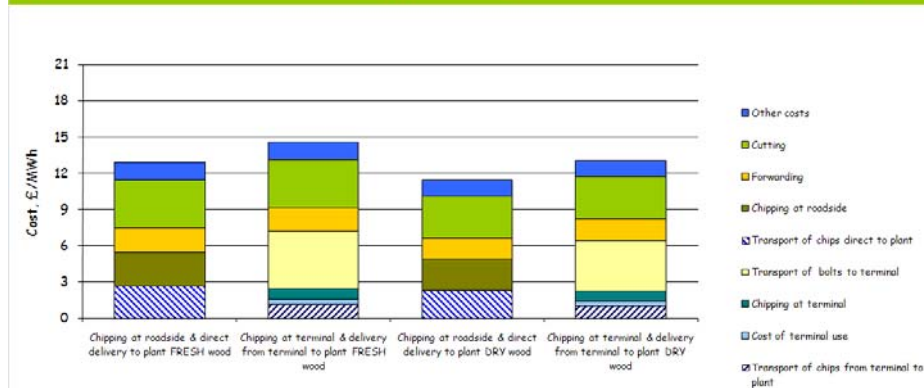
- Overhead costs for each supply system (€/m³)
- Covering costs of energy wood at the roadside storage (€/m³)
- Stumpage price of the energy wood (€/m³)
- Hourly cost of machines and trucks (€/h)
- Load capacity for forwarding and transporting (m³)
- Transferring cost of machines (€/turn)
- Loading and unloading time for transporting (h)
- Chippers productivity and chipping costs (m³/h & €/m³)

In the supply chain information sheet the user can, if needed, change the default values. This is because in reality the machines and procurement systems calculation basics and situations can vary significantly

Logging based on energywood harwarder <small>(results are based on Maigu AGGE combi-grip's productivity)</small>				
Other costs				
		Set value	Presumed value	Model uses
Stumpage of energywood, €/m ³			5	5
Overhead costs, €/m ³		3	4	3
Covering costs, €/m ²			0.9	0.9
	Fresh whole-tree, €/m ³	Fresh whole-tree, €/MWh	Stored whole-tree, €/m ³	Stored whole-tree, €/MWh
Other costs	8.9	4.5	9.4	4.3
Logging of whole-trees by harwarder				
		Set value	Presumed value	Model uses
Hourly cost of harwarder, €/h		75	73	75
Load capacity of harwarder, m ³			6.2	6.2
Gross effective / effective time ratio			1.25	1.25
Transferring cost of harwarder, €/turn		70	100	70
	Fresh whole-tree, €/m ³	Fresh whole-tree, €/MWh	Stored whole-tree, €/m ³	Stored whole-tree, €/MWh
Logging	26.2	13.2	27.6	12.6
Chipping at roadside storage or at power plant				
		Set value	Presumed value	Model uses
Chipper's productivity on operational hour, loose-m ³			85	85
Lowering of chippers's productivity, stored/dried whole-tree			15 %	15 %
Chipping cost at roadside storage, €/m ³ (solid)			5.3	5.3
Transferring cost of chipper, €/turn			45	45
	Fresh whole-tree, €/m ³	Fresh whole-tree, €/MWh	Stored whole-tree, €/m ³	Stored whole-tree, €/MWh
Chipping at roadside storage	5.7	2.9	6.1	2.8
Crushing at the power plant	1.8	0.9	1.8	0.8
		Set value	Presumed value	Model uses
Crushing cost at power plant, €/m ³ (solid)			1.8	1.8
Transportation of chips				
		Set value	Presumed value	Model uses
Load size, loose-m ³			110	110
Loading- and unloading cost, €/h			53	53
Hourly driving cost, €/h			76	76
Unloading time, h			0.5	0.5
Auxiliary time, h			0.3	0.3
Transportation of whole trees				
		Set value	Presumed value	Model uses
Load size, m ³ (solid)			25	25
Loading- and unloading cost, €/h			52	52
Hourly driving cost, €/h			75	75
Loading time, h			1.0	1.0
Unloading time, h			0.5	0.5
Auxiliary time, h			0.3	0.3
	Fresh whole-tree, €/m ³	Fresh whole-tree, €/MWh	Stored whole-tree, €/m ³	Stored whole-tree, €/MWh
Transportation of chips	5.2	2.6	5.4	2.5
Transportation of whole trees	8.3	4.2	8.3	3.8
Cost at the power plant				
	Fresh whole-tree, €/m ³	Fresh whole-tree, €/MWh	Stored whole-tree, €/m ³	Stored whole-tree, €/MWh
Chipped at roadside storage	46.0	23.1	49.9	22.7
Chipped at power plant	45.3	22.7	48.5	22.1

The sheet of the results

Proportional cost of the different supply chain stages from the total cost of chips at plant:



- The cost of each step of the procurement chain and the total cost at end use facility are expressed as either €/m³ (solid cubic meter) or €/MWh

Overview from the result sheet in the cost calculator for roundwood chips procurement

Results

	Stumps, m ³	Stumps, MWh	m ³ /ha	MWh/ha
Quantities of harvested stump wood on site	120	260	60	130

Cost of the chips at the plant:

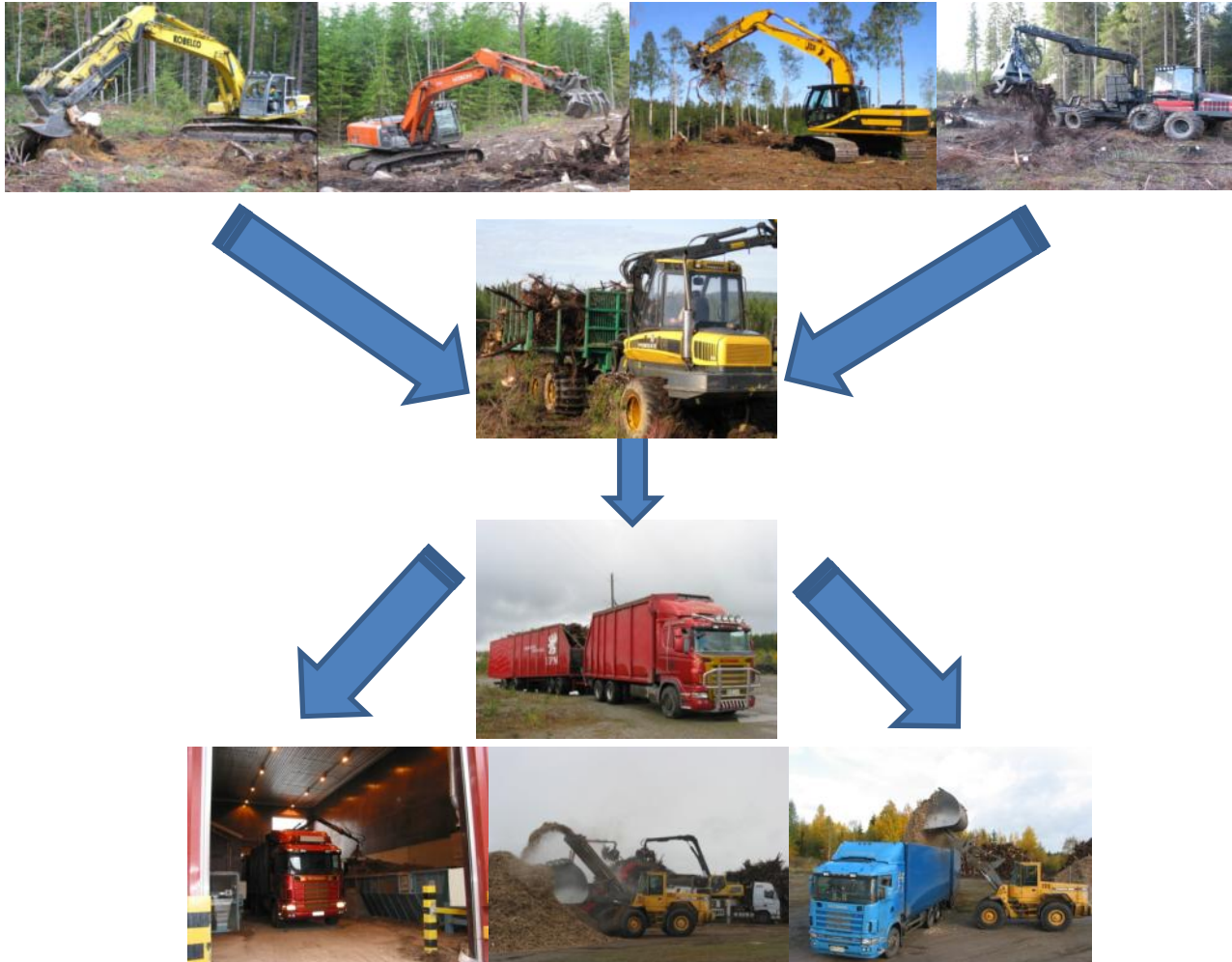
	Chips, €/m ³	Chips, €/MWh
Supply chain based on comminution at the terminal	36,9	17,0
Supply chain based on comminution at the plant	30,0	13,8

Harvesting time consumption per hectare:

	h/ha	€/ha
Stump extraction	14,4	823,1
Stump forwarding	8,6	517,1

Overview from the result sheet in the cost calculator for stumpwood chips procurement

The supply chains of the cost calculators: Stumps*



* Laitila, J., Ranta, T. & Asikainen, A. 2008. Productivity of stump harvesting for fuel. *International Journal of Forest Engineering* 19(2): 37-46

* Laitila, J. 2010. Kantojen korjuun tuottavuus. *Working Papers of the Finnish Forest Research Institute* 150. 29 p.

* Laitila, J., Ala-Fossi, A., Vartiamaäki, T., Ranta, T. & Asikainen, A. 2007. Kantojen noston ja metsäkuljetuksen tuottavuus. *Working Papers of the Finnish Forest Research Institute* 46. 27 p.

The supply chains of the calculators: Logging residues*



* Asikainen, A., Ranta, T., Laitila, J. & Hämäläinen, J. 2001. Hakuutähdehakkeen kustannustekijät ja suurimittakaavaisen hankinnan logistiikka. University of Joensuu, Faculty of Forestry. Research Notes 131. 107 p.

The supply chains of the calculators: Whole-trees*



* Laitila, J. 2008. Harvesting technology and the cost of fuel chips from early thinnings. *Silva Fennica* 42(2):267-283

* Laitila, J., Asikainen, A. & Nuutinen, Y. 2007. Forwarding of whole trees after manual and mechanized felling bunching in pre-commercial thinnings. *International Journal of Forest Engineering* 18(2): 29-39.

* Laitila, J. & Asikainen, A. 2006. Energy wood logging from early thinnings by harwarder method. *Baltic Forestry* 12(1): 94-102.

The supply chains of the calculators: Delimbed longwood*



Photos: E.Salo, J.Heikkilä & J.Laitila

* Heikkilä, J., Laitila, J., Tantu, V., Lindblad, J., Sirén, M. & Asikainen, A. 2006. Harvesting alternatives and cost factors of delimbed energy wood. *Forestry Studies* 45: 49-56.

* Laitila, J., Heikkilä, J. & Anttila, A. 2010. Harvesting alternatives, accumulation and procurement cost of small-diameter thinning wood for fuel in Central Finland. *Silva Fennica* 44(3): 465-480.



Internet applications of the cost calculators:

<http://www.afo.eu.com/>



Cost calculator for wood chip procurement from thinnings Copyright: Juha Laitila, Finnish Forest Research Institute

This calculator enables you to examine and demonstrate, how the quality of the woodfuel or productivity and hourly costs of machines influence the total costs of the whole supply chain.

With the calculator, you are able to compare the procurement costs of wood chips produced by four different harvesting chains:

- whole tree harvesting with harwarder
- whole tree harvesting with feller-buncher
- manual whole-tree harvesting with chain saw
- delimbed energy wood harvesting with feller-buncher

Instructions:

Set values into the boxes with light green background. The calculator applies the values in boxes with dark green background. As you insert digits in light green boxes, the dark green boxes will be updated upon your action.

Choose country (This affects the default values of costs and productivity):

- English, users guide (pdf)
- Deutsch
- Francais
- Latvija
- Slovensko
- Suomi, käyttöohje (pdf)

Cost calculator for wood chip procurement from regeneration felling sites Copyright: Juha Laitila, Finnish Forest Research Institute

This calculator enables you to investigate how the changes in processed material or in the productivity and hourly costs of machines influence the procurement cost of the whole chain.

You are able to compare the procurement costs of wood chips produced by three different harvesting chains:

1. loose logging residue harvesting with forwarder
2. loose logging residue harvesting with farm tractor
3. logging residue bundling and forwarding with forwarder

For each chain there are three versions for the organisation of harvesting:

1. Forwarding and delivery of fresh, green logging residues straight to combustion
2. Drying of logging residues at the stand before (bundling) forwarding and combustion
3. Seasoning of green residues at the road side storage prior to combustion

Set values into the boxes with light green background. The calculator applies the values in boxes with dark green background. In case you insert digits in light green boxes, the dark green boxes will be updated upon your action.

Internet applications of the cost calculators:

<http://www.pellettime.fi>

Designing of Fuel Supply-Chains

FINNISH FOREST RESEARCH INSTITUTE

- Cost calculations to demonstrate the costs for fuel supply chains.
- Depending on the raw material used, costs of fuel supply to the end using facility can be estimated and calculated according to the input data
- Small and medium scale wood fuel supply chains can be designed according to the needs of the user
- Advice for the production of high quality raw material

“One of the major benefits is that some of the uncertainty of forest based raw material costs delivered to the plant can be minimized. Furthermore this service gives information about the availability of raw material in a given area and the most economic suitable technical solution to bring the raw material from the forest to the plant“.



Conclusions

- The productivity functions of different harvesting methods, gained from the several work & field studies, are revised into an easy-to-use form in the cost calculators
- The cost calculators are very useful tool to transfer valuable research and development knowledge in to practice
- The cost calculators were originally developed to serve research needs, but they are also suitable for companies, contractors and teaching purposes. The feedback from the users has been positive

Conclusions

- In the calculators the analysis is made at the stand level, which thus limits the amounts of cost factors and variables
- Matching the right type of supply chain to the right site requires careful GIS-based availability studies and cost analysis
- The cost calculators are available for free in Finnish, French & English



**Thank you
for your
attention !!!**

The cost calculators are available for free in Finnish, French & English at by contacting e-mail: juha.laitila@metla.fi