Mats Berlin (Skogforsk)

Planter's guide: progress and future challenges

Session C: B4EST Final Meeting, Lisbon 2022-06-21

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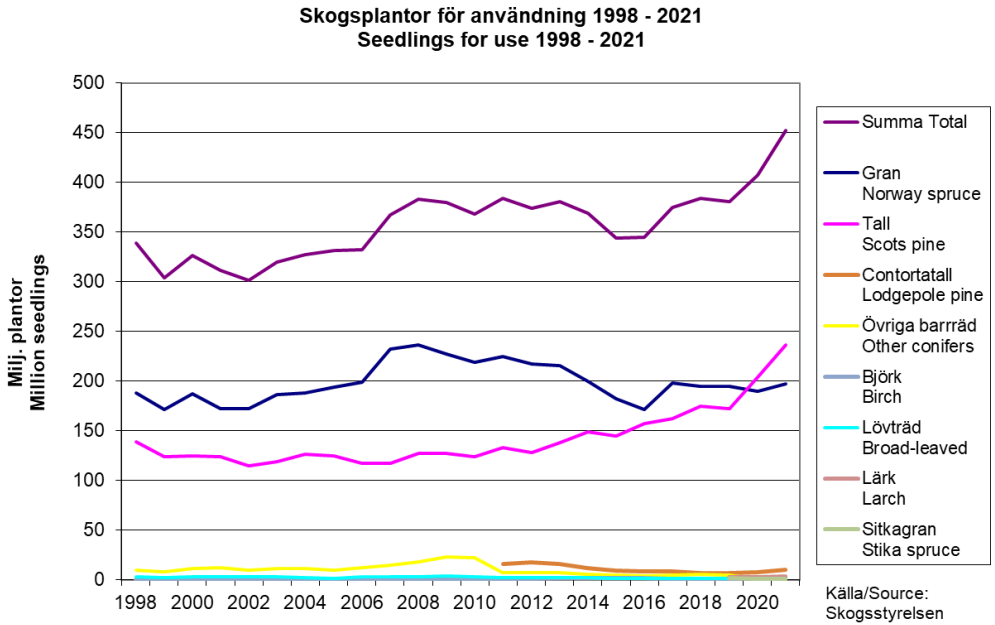
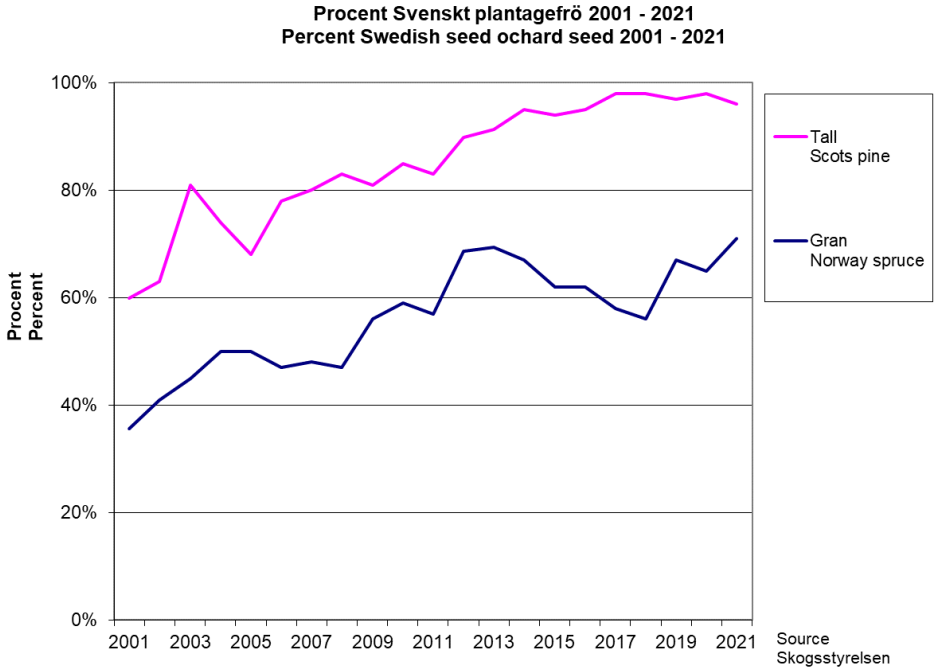
Swedish forestry & commercial tree species

- Gross harvested volume ~ 90 million m^3/year.
- Final felling ~ 200 000 hectares/year
- 85-90% of the regenerations are by planting.
- Norway spruce and Scots pine are by far the two biggest species used.
- 2021, 450 million seedlings were planted.



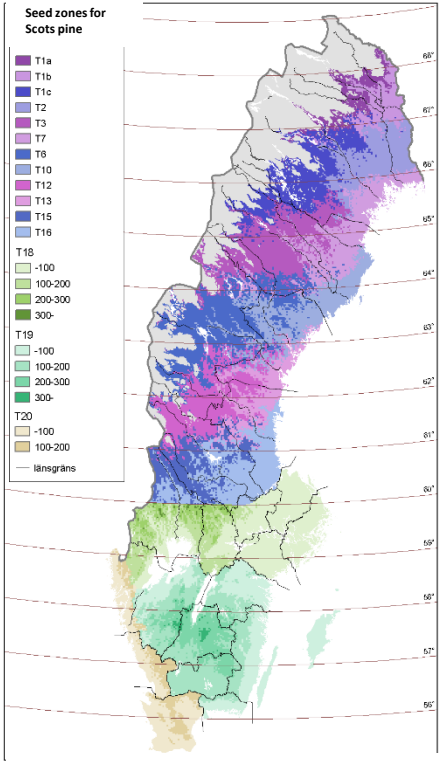
Use of improved FRM in Sweden

- Of all planted seedlings most originate from seed orchards.
- Almost all Scots pine seedlings and > 70% of the Norway spruce seedlings are from SO.
- SP has a reliable seed production – not the case for NS.
- Poor or damaged NS seed crops from 2007-2016. Much better crops the last 5 years!



A wide variety of seed orchards available

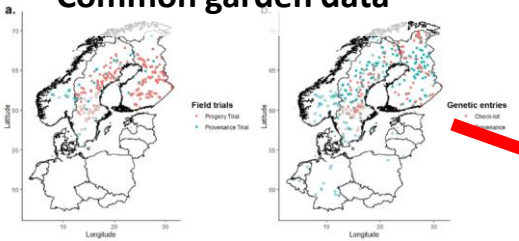
- Seed/seedlings from approximately 40 Norway spruce and over 70 Scots pine Swedish seed orchards are commercially available in Sweden.
- Each with a different adaptation profile (there are over 10 different seed zones for each species formally defined).
- Several different genetic gain levels exist. A span from 1g (10%) to 1.5g (25%).
- Decision support is needed -> Planter's guide.

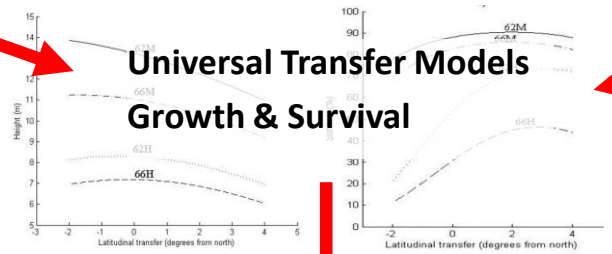


Inst. skogl. Resurshushållning & geomatik. SLU (2011)

The Planter's guide platform

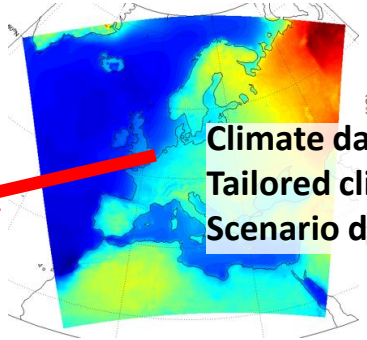
Common garden data



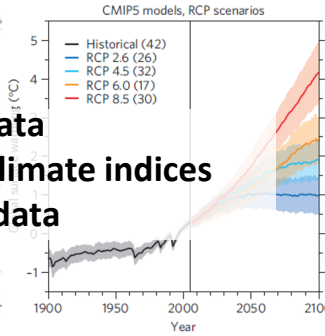


Universal Transfer Models
Growth & Survival

(Berlin et al, 2016)



Climate data
Tailored climate indices
Scenario data



(Knutti & Sedlacek, 2012)

Seed orchard database
Definitions

Deployment recommendations

Rules and legislation

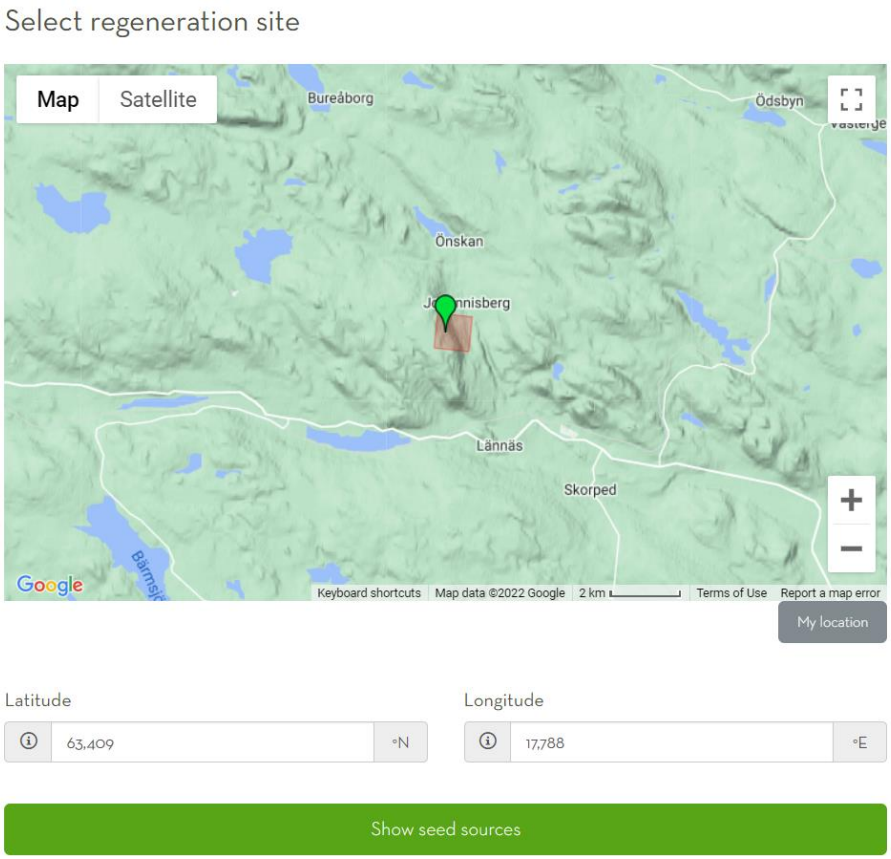
Planter's guide

Planter's guide - optimization

Planter's guide

- A web-based decision support tool hosted by Skogforsk.
- Openly available.
- Platform independent (works on computers, Ipads, smartphones)
- Simple interface using Google maps.
- Select a regeneration site by clicking in the map or entering the coordinates.

(Norway spruce beta version as an example)



Planter's guide

- Seed orchards are ranked according to their predicted performance at the selected regeneration site
- Local stand seed is given as a reference (100). 120 means 20% better than local.
- Climate scenario can be changed (all four RCP-scenarios available). Ranking will change dynamically.
- Key climatic drivers at the regeneration site are given.

Conditions for ranking

Altitude (m.a.s.l.)	204 m
Temperature sum	Establishment phase: 946, Growth phase: 1265 degree days
Precipitation	Establishment phase: 421, Growth phase: 450 mm

Climate scenario	RCP4.5 2050
Adjustment for local conditions	Average
Seed orchard origin	All countries

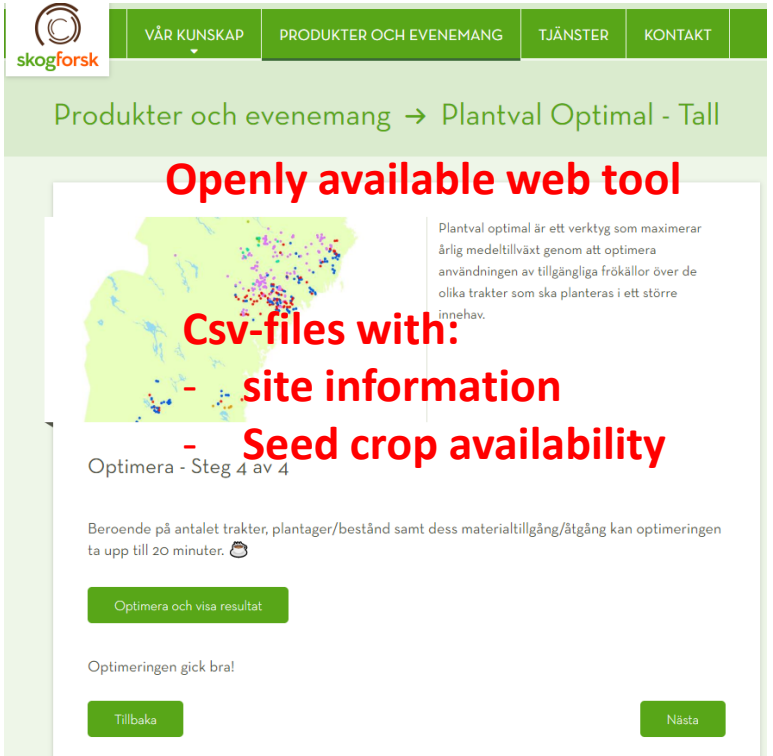
Seed orchards

No	Name	Country	Ind	PC	Lat	
	Local origin		100		63.4	
N1221	Kaupanger FH	Norway	124	40	61.1	☐
N1221b	Kaupanger FH-EPI	Norway	124	40	61.1	☐
FP-601	TreO G4 Ed	Sweden	124	49	60.6	☐
Sv428	Taavetti	Finland	124	49	60.7	☐
Sv447	Mikkolanniemi	Finland	123	49	61.3	☐
Sv412	Puula	Finland	123	49	61.6	☐
FP-604	TreO G5 Gärdskär	Sweden	123	49	58.4	☐

Planter's guide - optimization

The Planter's guide tool is not well suited for actors with large forest holdings (and often nurseries) as they have:

- Many regeneration sites every year.
- Access to many different seed orchard crops – each with a limited amount of seed available.
- New interface that could handle many sites and seed orchards simultaneously
- Optimize the use of the seed available by maximizing (total) mean annual growth.



Planter's guide - optimization

Resultat från optimering

(Debug) beräkningstid: 1 sekund

Gain in volume production

Produktionsvinst - Volym	6271 m^3sk/år
Produktionsvinst - Procent	19,90 %

Trakter	
Antal	1028 av 1028
Nyttjandegrad	100 %

Ladda ner trakter med optimerad rekommendation

Plantager/bestånd	
Antal	8 av 17
Nyttjandegrad	31,6 %

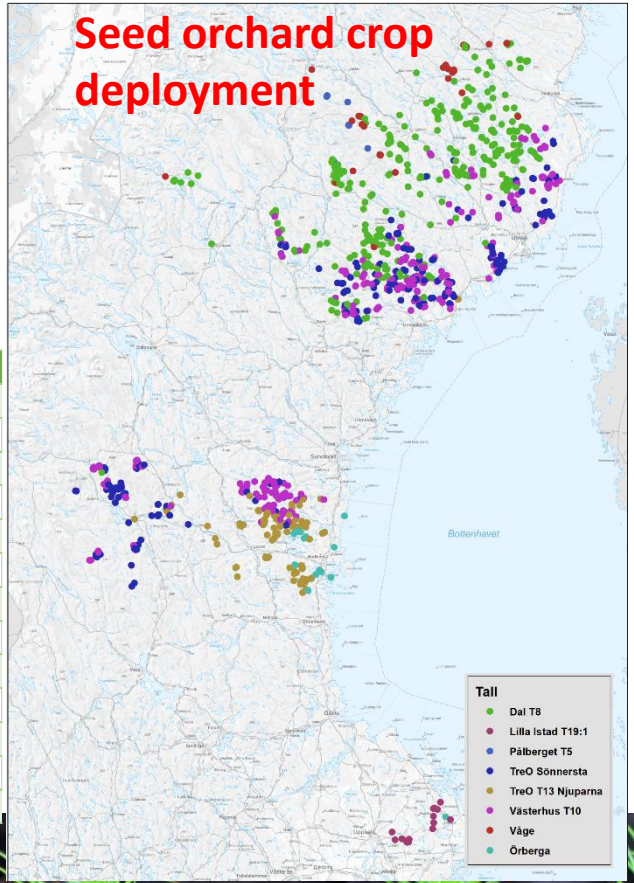
Ladda ner nyttjandegrad för plantager/bestånd

Tillbaka

Seed orchard crop utilization

Seed orchard	Name	Utilization rate (%)
FP-125A	Våge	40,3
FP-412B	Domsjöänget	0,0
FP-604A	Lilla Istad T19	99,8
FP-612	Örberga	27,0
FP-606B	Gotthardsberg T19	0,0
FP-620A	Gnarp T12	0,0
FP-616	Sollerön	0,0
FP-621	Västerhus T10	99,8
FP-622	Pålberget T5	4,9
FP-623	Pålberget T6	0,0
FP-625	Dal T8	100,0
FP-631	TreO Sönnersta	66,0
FP-633	TreO T13 Njuparna	99,5

Seed orchard crop deployment



Operational status and beta version

	Operational tools	Beta version tools
Scots pine	Planter's guide Planter's guide - optimization	Planter's guide
Norway spruce	Planter's guide Planter's guide - optimization	Planter's guide
	1 scenario SRES-A1B National climate data	4 scenarios RCP2.6-8.5 European scale climate data "uncertainty maps"

Challenges ahead for beta versions to become operational

Seed orchard definitions

- Several characteristics (genetic gain, calculated “origin”, pollen contamination, …) have to be homogenized for all countries on a common scale.
- A lot of work done in B4EST towards a common system for SO definitions!

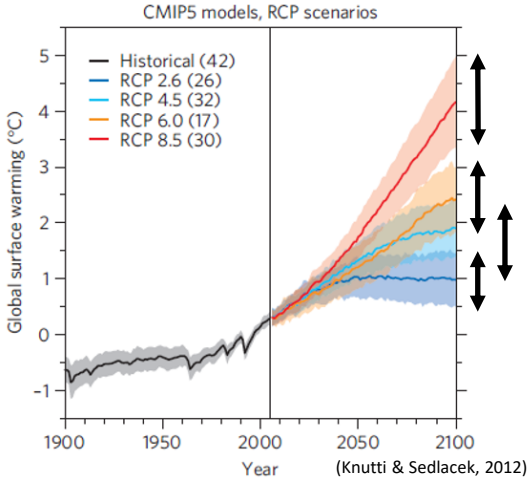
National rules and regulations

- Each country has its own set of rules/regulations for transfer of FRM. These can be quite different.
- Positive contacts with formal authorities in Sweden/Finland for common use of Scots pine FRM!

Handling the effects of **climate change** is major challenge …

Climate change variability

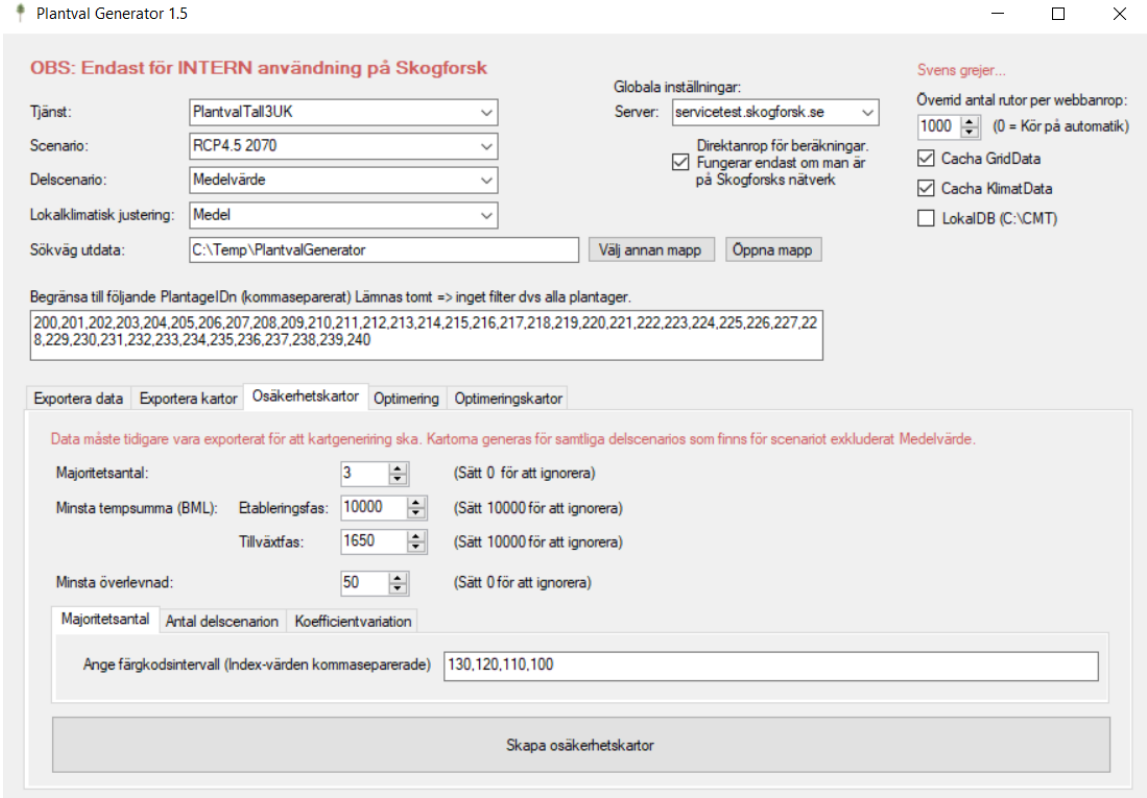
- Four RCP-scenarios are available representing different amount of GHG emissions. They result in different levels of global warming.
- For each RCP-scenario there are several GCM/RCM parameterized to correspond to the scenario (we have 5 GCMs per scenario).
- There is a variability in the level of predicted global warming also within an RCP.
- This in turn creates a variability in the predicted FRM performance and optimal deployment areas.
- Methods to address this variability are under development.



(Knutti & Sedlacek, 2012)

Automated tool to generate uncertainty maps

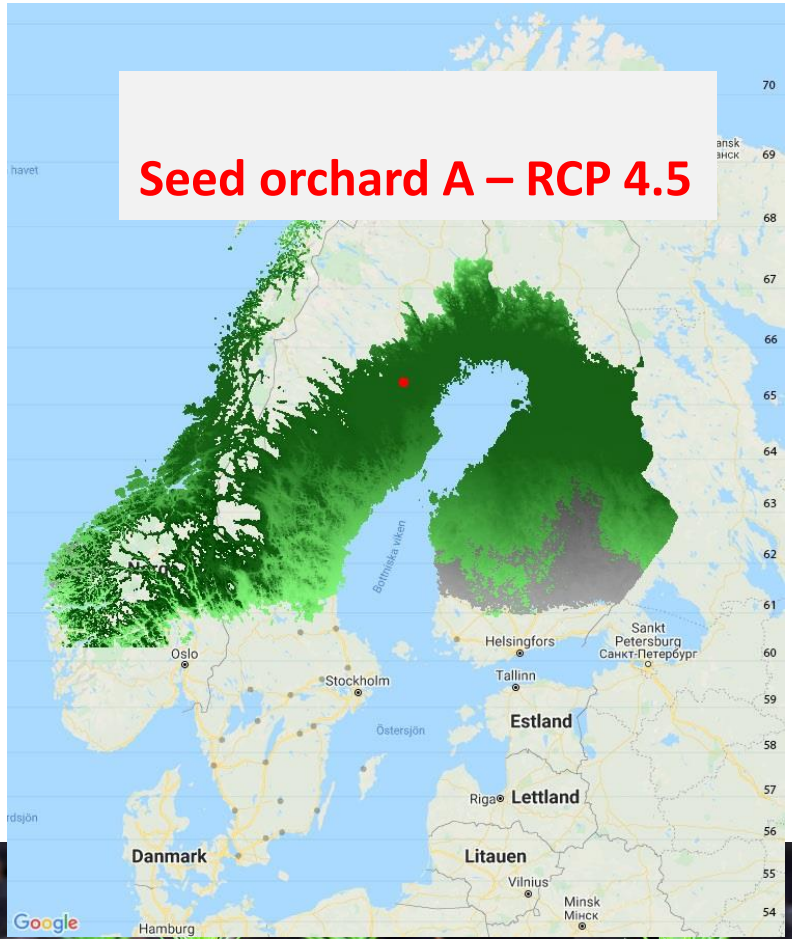
A tool has been developed on the Planter's guide platform to generate different types of "uncertainty maps" in an automated way.



Ensemble average

- Taking the average climate of the 5 GCMs to represent the RCP-scenario and calculate performance based on that.
- The current default predictions and maps in the operational Planter's guide.
- No possibility to analyze/value the variability in predicted performance (risk management).

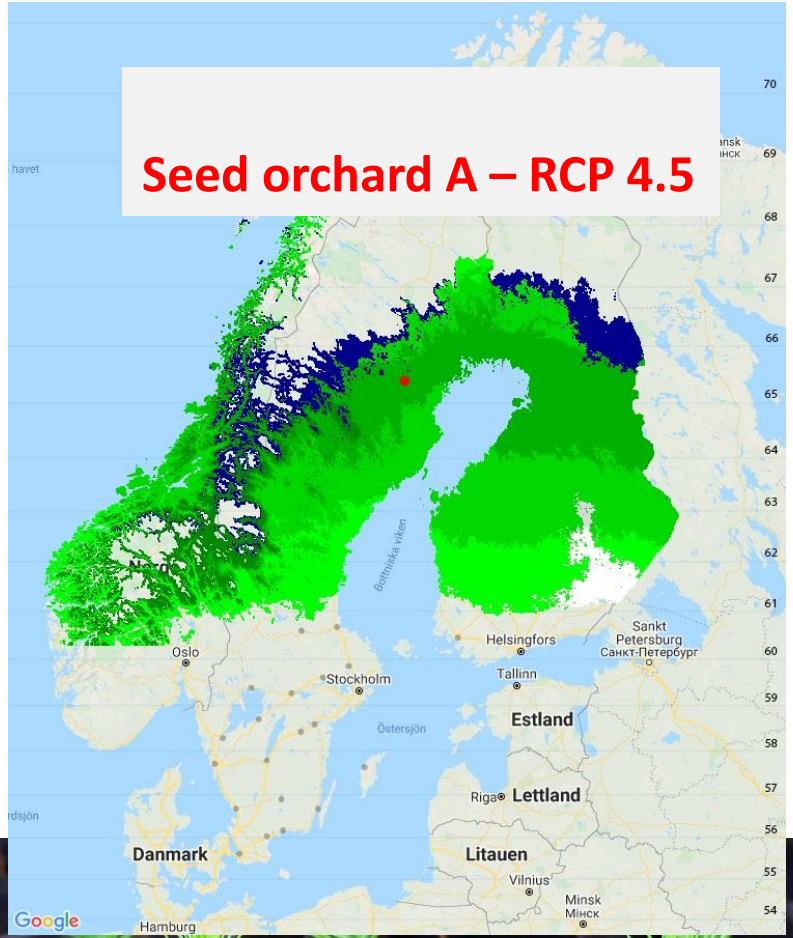
Map on a continuous color scale where:
Light green = low performance
Dark green = high performance
[Grey is a restriction color]



Majority vote

- The predicted performance is calculated for each GCM
- A number of threshold performance classes are given (here >20%, 10-20%, 0-10%).
- If a majority (user decides between 3-5) of GCMs predict a performance above the class threshold it is assigned that class

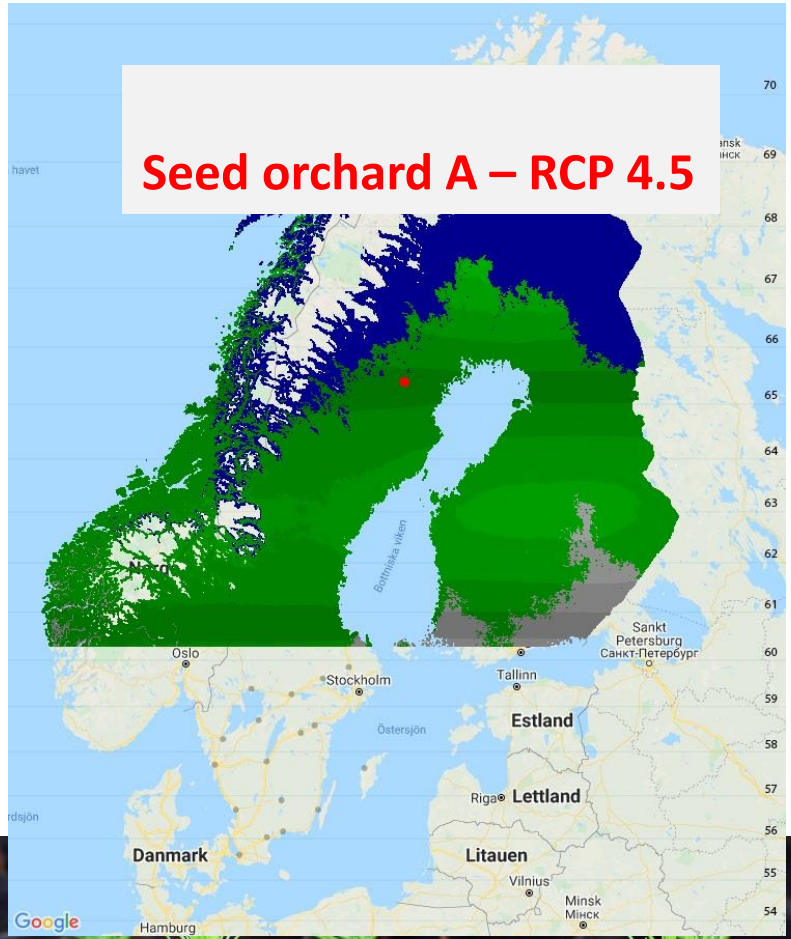
Map on a color scale where:
Light green = low performance (0-10%)
Green = average performance (10-20%)
Dark green = high performance (>20%)
[Blue and grey are restriction colors]



Coefficient of variation

- The predicted performance is calculated for each GCM
- The performance coefficient of variation between the GCMs is calculated.

Map on a color scale where:
Light green = high coefficient of variation
Green = average coefficient of variation
Dark green = low coefficient of variation
[Blue and grey are restriction colors]



Path forward – uncertainty maps

- The methods/maps shown represent alternative ways of illustrating performance variability due to climate change uncertainty.
- This allows for decision makers to manage (perceived) risk in various ways.
- Stakeholder and end-user interaction and feedback is necessary to decide which method(s) to make operational.
- A first meeting with all big forest companies and forest owner associations in Sweden as well as the Forestry Board (formal authority) has been held. More meetings are planned as methods/results are becoming available.

Contact: mats.berlin@skogforsk.se

References:

Knutti R, Sedláček J (2012) Robustness and uncertainties in the new CMIP5 climate model projections Nature Climate Change 3:369-373 doi:10.1038/nclimate1716

Berlin M, Persson T, Jansson G, Haapanen M, Ruotsalainen S, Bärring L, Andersson Gull B (2016) Scots pine transfer effect models for growth and survival in Sweden and Finland Silva Fennica 50 doi:10.14214/sf.1562

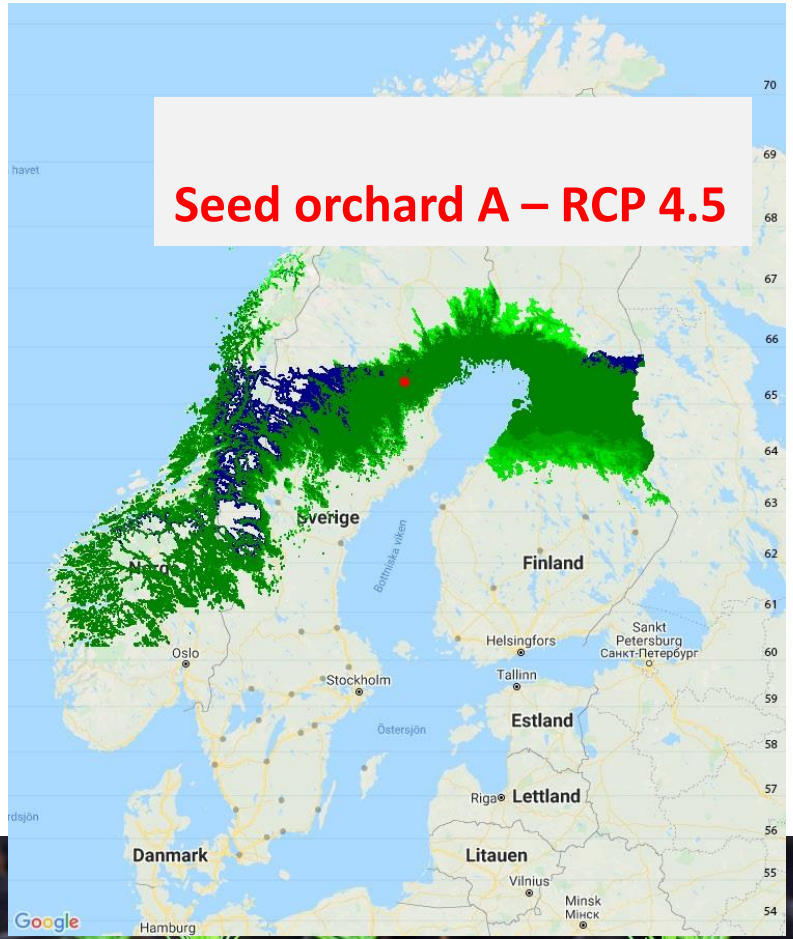
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 773383

Supplemental slides

Number of predictions where GCMs agree

- The predicted performance is calculated for each GCM
- A performance threshold is given by the user (20% better than local here).
- The number of GCMs predicting performance above the threshold is calculated

Map on a color scale where:
Light green = few GCMs above threshold
Dark green = many GCMs above threshold
[Blue and grey are restriction colors]



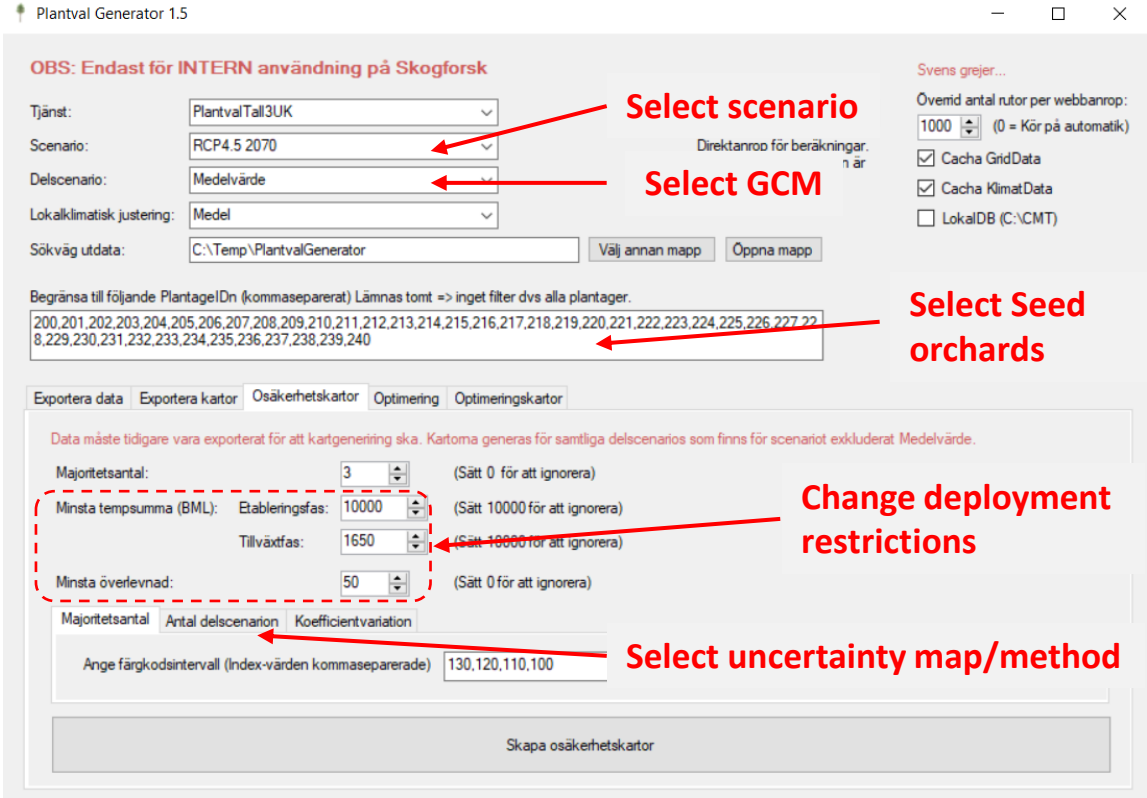
Number of changed optimal SO's

A similar system exists for the Planter's guide optimization model/tool.

- The optimal seed orchard deployment is calculated for each GCM.
- The number of deployment recommendations that agree is calculated for each regeneration site.
- Example using the upcoming regeneration sites for a major Swedish forest company.

Map on a color scale where:
Light green = few recommendations agree
Dark green = many recommendations agree

Automated tool to generate uncertainty maps

A tool has been developed on the Planter's guide platform to generate different types of "uncertainty maps"

- Generates performance data for all selected seed orchards for all GCMs within a scenario.
- Combines the performances into maps depending on uncertainty method selected.
- Handles various different deployment restrictions (e.g. beyond model limits)