Getting a grip on climate effects

Description

We want more of everything from the forests. At the same time, climate change will give us faster growing forests â?? but also greater risks. The Swedish Forest Agency is now introducing the process-based 3PG model to get a better grip on the future forest resources.

Swedish forests are expected to meet more demands than they can supply today â?? and even more pressure will be put on the forest resources in the future. In addition, risks associated to climate change will demand new types of forest management. Challenges related to climate change, biodiversity, policy development and market mechanisms all imply higher demands, although in different ways. Few are satisfied with todayâ??s situation. Business as usual is not an option; there is strong demand for change.

Even if climate change is halted in line with the Paris Agreement, this will lead to new conditions for our forests and the forest management. A warmer and longer vegetation period, with drier summers together with more rainfall during the winter, will likely lead to changed water balances and less ground frost. The effects will differ regionally within Sweden. Higher temperatures and longer vegetation periods increase growth, but the risk of drought and reduced growth increases if the water balance changes.

This also increases the risk of various forest damages. The longer vegetation period increases the risk of spring frost and root rot. Drought affects the risk of spruce bark beetle infestations and fires. Wetter winters with less ground frost mean increased risks of snow breakage and storm damage. These risks can be met with through a more resilient, climate-adapted forest management aiming to prevent damages and/or through measures to deal with damages.

To deal with these factors, the Swedish Forest Agency has decided to use 3PG. Narayanan Subramanian, PhD in Forest Management at the Southern Swedish Forest Research Centre (Swedish University of Agricultural Sciences), is the leading Swedish expert on the model when introducing it in the new SKA22.

â?? In the previous analysis 2015 (SKA15) climate change was still under consideration, but was indirectly implemented using an approximation model based on another process-based mode: BIOMASS. With that approach, a 30-year growth was simulated using BIOMASS model with changing climate, Narayanan Subramanian explains.

â?•
The major strength of 3PG is to highlight the adverse effects of climate chang
•

Narayanan Subramanian, Swedish University of Agricultural Sciences.

â?? Later, the change in growth was calculated due to climate change. This was implemented in the Swedish forest growth and management model Heureka. By doing this, the climate impacts are averaged for 30-year period, thus underestimating the adverse effects of climate change, in example drought. Drought episodes happen for several weeks to a month, but can have a large effect for a long period. So when you consider the average growth effects for longer periods, the impact of these droughts will likely be underestimated. While in SKA22 with 3PG model, monthly climate data is feeded to the model and if there is a drought episode, it will better represented in tree growth. Thus, the major strength of 3PG is to highlight the adverse effects of climate change.

What are the biggest challenges when using 3PG?

â?? Well, 3PG is developed in Australia for predicting growth for fast growing eucalyptus plantations. It is designed to work under soil water-limited conditions. The biggest challenge is to adapt the model for Swedish conditions. We had to redesign the model and avoid not-so-useful parts of the model for it to work for Swedish forests.

Narayanan Subramanian continues:

â?? In my simplistic personal view, forest growth models have three important modules: the growth and physiology module, a management and mortality module and the regeneration module.

â?? In SKA22, we use only the growth and physiology module from 3PG. For the rest we use the established empirical functions in the Heureka model, which is already widely used in Sweden and updated regularly using recent data from 2015-2019 (the National Forest Inventory, NFI). By doing this we could minimize the data needed to run the 3PG model, which is important. Process based models need to be tuned before implementation. With a lot of data, the tuning process â?? what we call the parameterization process â?? will be more difficult.

â?? By this approach we could reduce the number of tuning variables needed down to five, such as the maximum age the trees grow (without final felling), minimum, optimum and maximum temperatures for growth and the site fertility factor.

The first four ones are easy to obtain, while the site fertility factor is the most important input variable. In a stand level study site fertility can be a factor from 0 to 1 where 0 means nothing growth there and 1 means a very good utopian site where no limitations to tree growth occurs.

â?? The site fertility factor is determined during the tuning process. SKA 22 is done for whole of Sweden which is a landscape level study, so we couldnâ??t use the usual 0 â?? 1 factor approach, as the study include thousands of stands.

â?? So we have another approach where site fertility is determined by the type of ground vegetation present in the forest floor. We are formulating a linear regression function for site fertility and the type of ground vegetation present. This is one of the biggest challenges, since this has to be done separately for each county. We have divided the bigger counties into smaller parts and do separate functions for each part.

Are there any stand types or regions that are particularly challenging?

â?? It depends on what data we have. We have less data from mountain forests region in the north, so this landscape will be poorly represented in the model. In the NFI data, most of the production forests sites have bilberry type as ground vegetation, while other ground vegetation like poor shrubs and rich herbs are not as common. They will be poorly represented in the model due to lack of data.

Can you describe the difference between working with 3PG in natural forests co

â?? The 3PG includes how much the trees grow every month. As temperature gets warmer, trees will grow faster during summer â?? unless there is a drought so growth gets affected. We also consider the factor that with climate change the trees flush earlier and shed their leaves later, thus increasing the growing season. So â?¦ there is really no difference in working with 3-PG in production forests and nature conservation stands. 3PG just calculates how much the tree grows, and when physiology occurs based on the forest already present there.

On the other hand â?? the management, mortality and regeneration functions from the Heureka model are fed with empirical data. There is a clear differentiation in how the management activities are conducted in a production and nature conservation forests.

â?? By using already established widely used empirical functions â?? which are already implemented in Heureka â?? we could simplify our approach and also reduce a lot of uncertainties. It is difficult to formulate forest management functions using process-based models. We picked the strong points of each model: growth and physiology part from the 3PG model and management and mortality functions from the empirical Heureka model.

SFA FACTS/ Swedish scenario analysis and forest impact assessment â??SKA22â?•

The Swedish government has ordered the Swedish Forest Agency to deliver a long-term scenario analysis and forest impact assessment in 2022, called SKA 22. To support well-informed decision-making, these analyses should build onto scenarios reflecting an emphasis on different forest values. The alternative scenarios that the Swedish Forest Agency intends to simulate are:

- Forest management combining increased growth and more biodiversity â?? This scenario simulates higher ambitions and better quality of forest management, promoting both biodiversity and wood supply.
- Forest management promoting biodiversity â?? This scenario aims toward a more diverse forest, benefitting biodiversity and social values.
- Forest management promoting increased growth â?? This scenario aims to increase the annual growth and the harvest potential.
- Forest management promoting climate adaptation â?? This scenario aims to reduce the risk of climate related damages.