Repository - Readme file

1 INTRODUCTION

This readme file describes the analysis steps taken within the Excel files attached to the article “Quantifying the risk mitigation efficiency of changing silvicultural systems under storm risk throughout history”. The Excel models attached contain the quantitative basis which was used to determine the land expectation values (LEVs) resulting from timber production ($\widehat{LEV}_{timber}$) and carbon sequestration ($\widehat{LEV}_{carbon}$) under storm risk.

As described in Fig. 1, various analysis steps were necessary to quantify $\widehat{LEV}_{timber}$ and $\widehat{LEV}_{carbon}$ for three silvicultural systems under different historical assumptions. Within the article, we already describe in detail how we proceeded on the storm risk simulation. Therefore, in this readme file we set the focus on the analyses conducted to derive LEVs from timber production as well as carbon sequestration for silvicultural systems 1-3 under different historical assumptions.

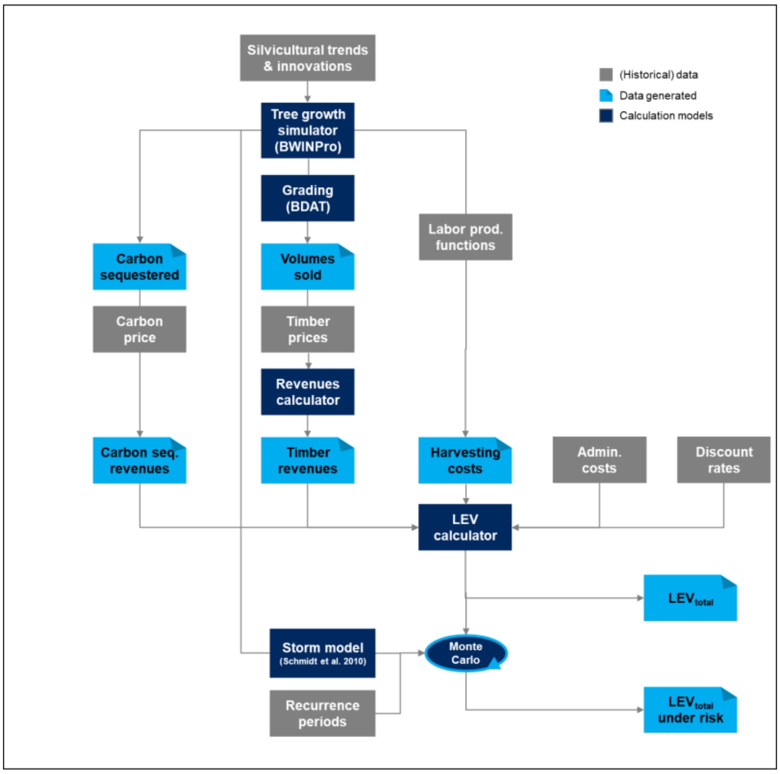

Figure 1: Analysis steps

2 ANALYSIS STEPS

2.1 BWinPro simulation

This article was based on three different stand growth simulations conducted with BWinPro (Nagel et al. 2017). Outcome of these simulations were:

- Stand growth specific data including standing volumes per simulation period and volumes harvested.
- Single tree specific data containing information about the time and properties of the trees harvested throughout one rotation period
- A carbon balance sheet giving insights into the carbon stock change per simulation period

2.2 Revenues and costs simulation

Based on the single tree specific data, as a second analysis step, we calculated the volumes of timber assortments sellable using BDAT algorithms (Kublin and Bösch 2007). Output of this analysis was finally matched with the different assortment specific timber prices representing the different timer periods in focus resulting in revenues from timber sales for system 1 and system 2.

To calculate harvesting costs related to system 1 and system 2, we adopted harvesting productivity functions as introduced in Müller and Hanewinkel (2018). The respective functions are combined with single tree specific data of the scenarios. Labor and machine costs for the respective timer periods are adopted from Müller and Hanewinkel (2018) as well.

For system 3, further analysis steps were necessary. After a recommended thinning period of 90 years, this stand was converted into an uneven aged stand via group cutting starting at age 95 following the silvicultural recommendations of (ForstBW 2014). The simulation data derived from this silvicultural system (system 3a) was downscaled on group size level. The size of the groups resulted from the stand conversion period of the initial BWinPro simulation. The size of the groups as downscaling factor was applied to the single tree and stand specific data from the initial BWinPro simulation until age 90 resulting in group specific revenues and costs. Finally, both cost and revenues were consolidated to derive simulated revenues and corresponding harvesting costs of an uneven aged stand as described in system 3.

2.3 LEV calculation

By combining harvesting costs and revenues from timber sales, we deduct the cashflows induced from timber harvesting throughout one rotation period for systems 1-3. To derive cashflows induced by carbon sequestration we calculated the net carbon stock change excluding roots for the different systems and for each simulation period of five years. Based on this net value we calculated the cashflows from carbon sequestration applying the deflated average CO_2 European Emission Allowances Price 2009 - 2018 P_c of 9.27 EUR/t CO_2 (Insider Inc. and finanzen.net GmbH 2018).

All cashflows calculated are used to finally calculate the LEV of the simulated stands as the sum of k NPVs and a final LEV for rotation kT being k the number of rotations and T the rotation time.

3 EXCEL FILES AVAILABLE IN REPOSITORY

The Excel files available in this repository are containing all analysis steps as described in section 2. The Excel files include the following models:

- R3_Cost and revenues from timber_S1, R4_Cost and revenues from timber_S2, R5_Cost and revenues from timber_S3:
    - These models calculate revenues from timber sales for the respective silvicultural systems based on different historical price levels. Input data is based on price levels as identified in Müller and Hanewinkel (2018) and timber assortments from BDAT grading of the different BWinPro simulations. The models also calculate the harvesting costs related to the different systems under different productivity and price levels. For system 3, the model also scales the initially simulated even aged stand (S3a) and its related costs and revenues down on group level and finally extend it on uneven aged stand level.
- R6_Supplement LEV calc_S1, R7_ Supplement LEV calc_S2, R8_ Supplement LEV calc_S3:
    - These models calculate the harvesting costs related to the different systems under different productivity and price levels and the cashflows induced by carbon sequestration for the different systems. Furthermore, the models contain additional input data such as administration costs and discount rates applied.

The models consolidate all cashflows and input data to calculate $\widehat{LEV}_{timber}$ and $\widehat{LEV}_{carbon}$ for the respective systems under different cost and price levels.

4 REFERENCES

Kublin E, Bösch B (2007) BDAT - das Sorten- und Volumenprogramm. Forestry Research Institute (FVA) of Baden-Württemberg. http://www.fva-bw.de/indexjs.html?http://www.fva-bw.de/forschung/bui/bdat.html

Müller F, Hanewinkel M (2018) Challenging the assumptions of a standard model: How historical triggers in terms of technical innovations, labor costs and timber price change the land expectation value. Forest Policy and Economics 95:46–56. doi: 10.1016/j.forpol.2018.07.009

Nagel J, Duda H, Hansen J (2017) Forest Simulator BWINPro 7. https://www.nw-fva.de/?id=194