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LULUCF-TR
GHG Monitoring and Reporting System

7th training style workshop:

Session 1.1

a) What is modelling? Types of models in LULUCF Sector and their specifications

b) What is a scenario?

c) Why do we need modeling and scenarios? Implementation of climate change policy: connection to mitigation of GHG emissions

AESA CONSORTIUM

What is modelling?

- Model is a logical, simplified mathematical representation of real world's complex relations:
- …. models are less complicated than reality;
- …. quantities simulated by the mathematical model are more readily measured than are model input values,
- …. conceptualization of ecologic processes: *empirical* (based on inventory and measurements of modelled parameters) or *process-based* (biochemical and (eco)physiological processes);
- …function based on black boxes (i.e. input and output are known, not intermediary steps)
- ….. a trade-off among ***precision*** (producing quantitatively precise estimates), ***realism*** (producing qualitative realistic estimates, i.e. accurate) and ***generality*** (representing a broad range of conditions without model modifications)

Sources: https://www.open.edu/openlearn/science-maths-technology

Types of models in LULUCF Sector and their specifications

Models in forestry are numerous, especially for quantification of biomass/volume!

- are used to estimate ***individual tree*** volume or biomass, ***stand production*** (e.g. standing stock volume or biomass in time) and ***stand productivity*** (e.g. annual net growth increment):

  a) yield tables for merchantable trees or entire aboveground volume;

  b) age/DBH/H - dependent equations;

  c) tables or equations to estimate share of other biomass components (e.g. branches, stumps, roots, leaves)

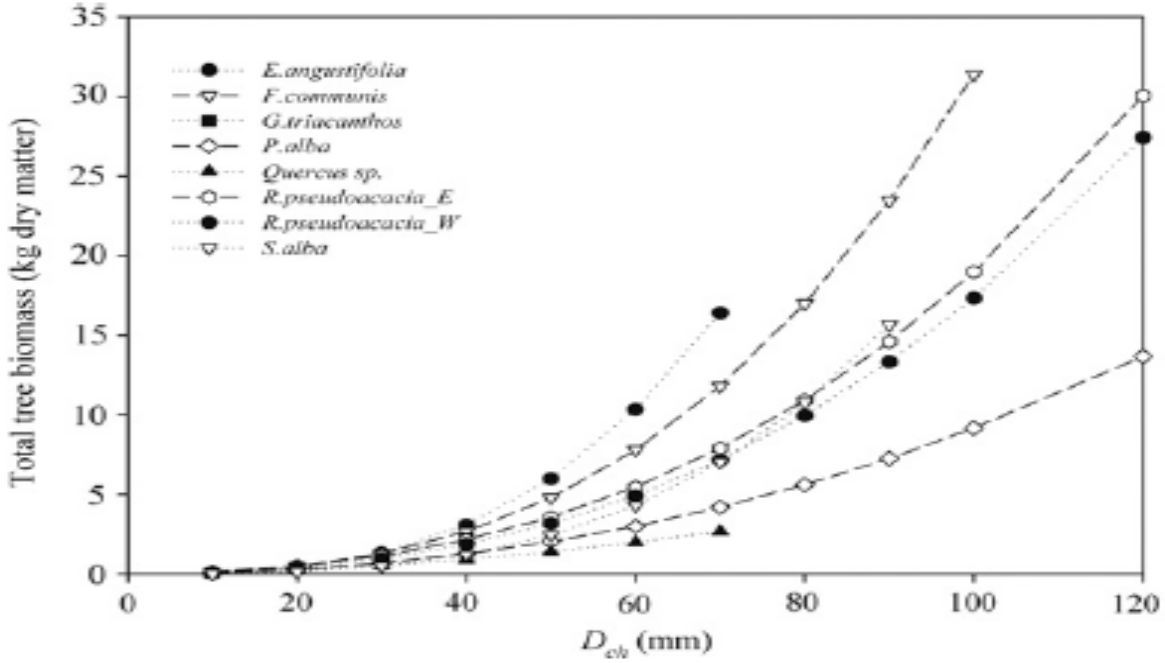
  d) mortality rate (e.g. transfer from living biomass to dead wood);

  e) dead wood fall rate (i.e. transfer from standing dead wood to laying dead wood);

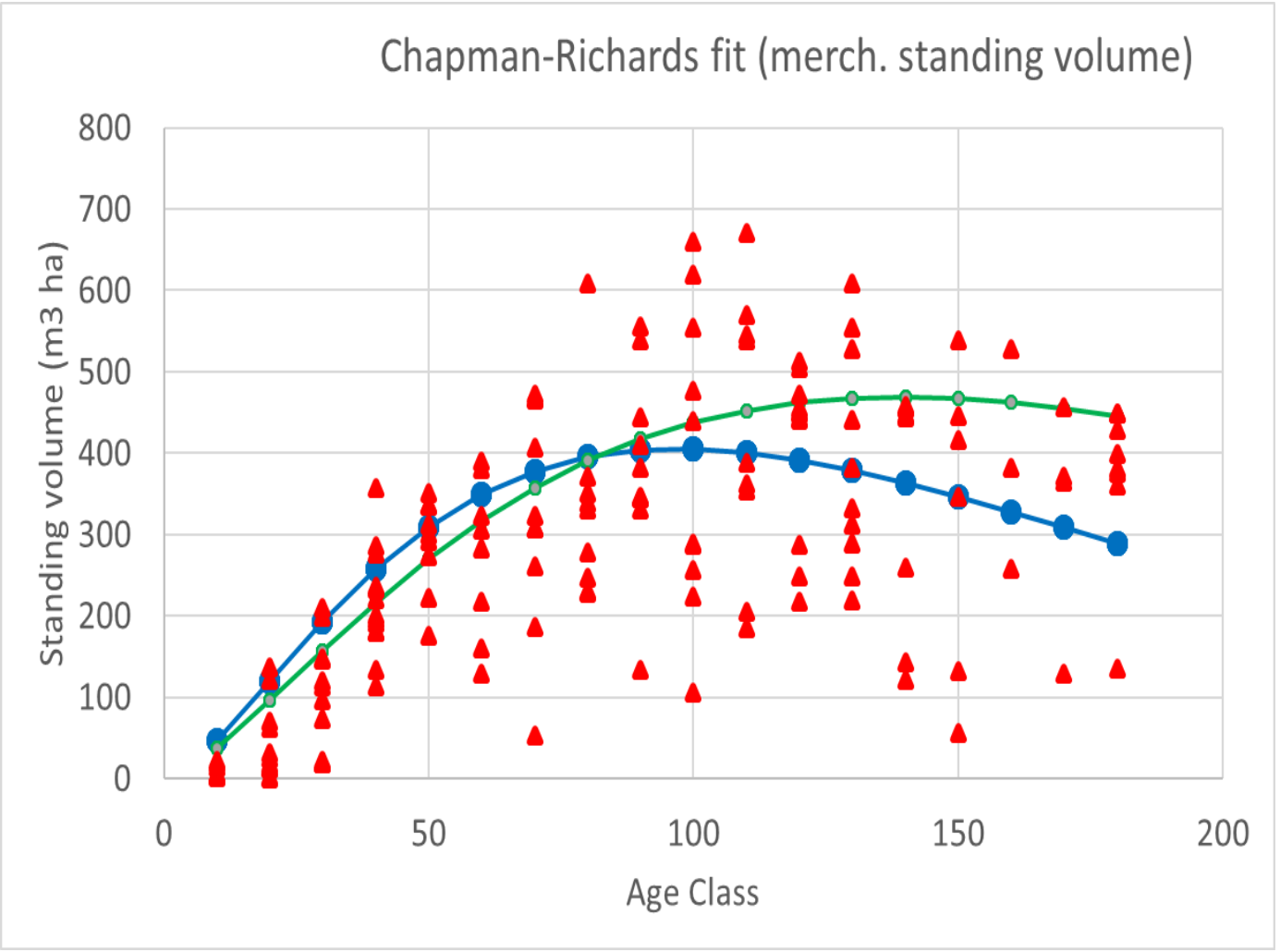
  f) decomposition of dead wood and litter;

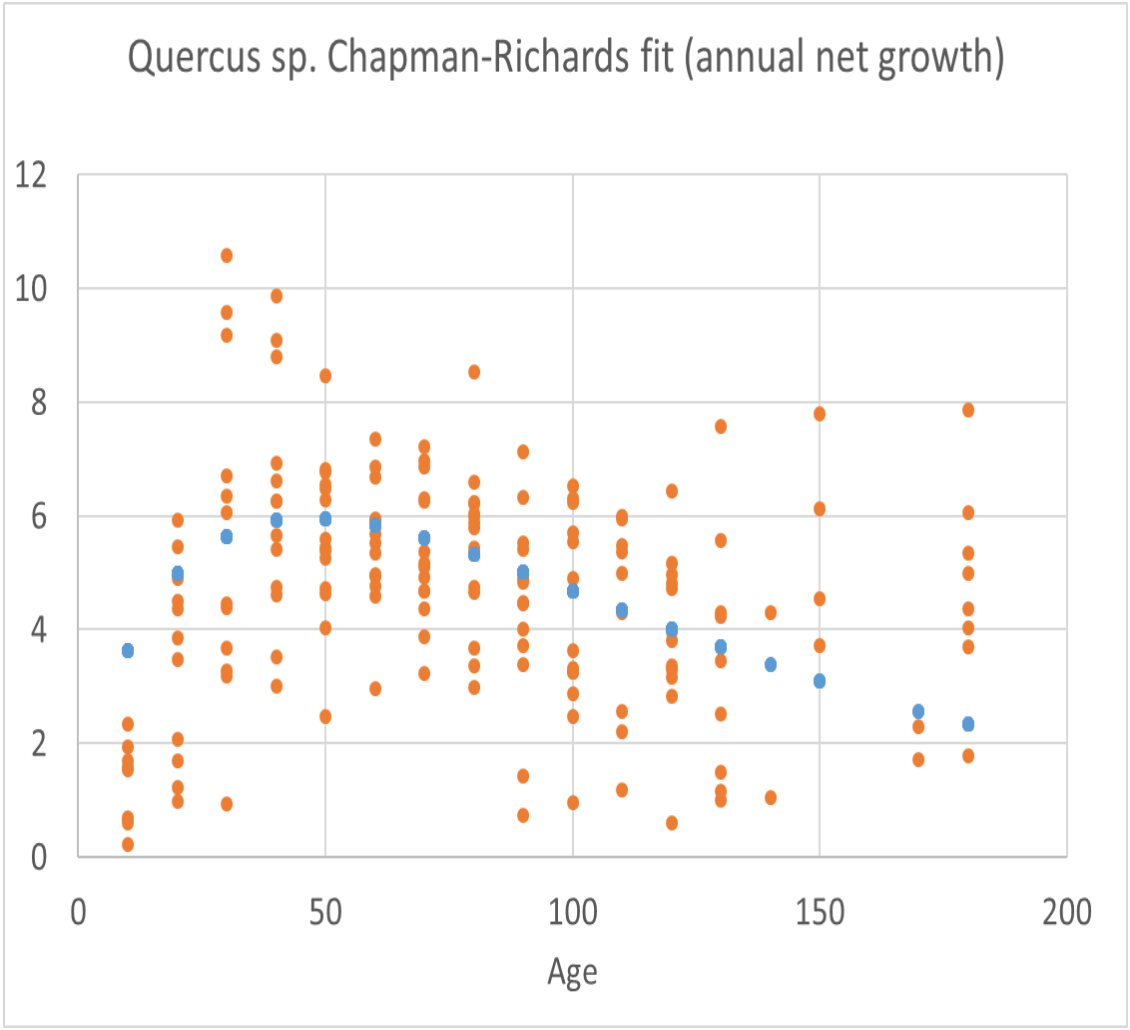
  g) …..

- Simple models in forestry (i.e. volume, biomass, biometric parameters)
  - **Individual tree** model/equations (DBH – diameter of breast height 130 cm from the ground, H - tree height):
    - Biomass = a * **DBH** ^{b} (one predictor)
    - Biomass = a * **H** ^{b} (one predictor)
    - Biomass = a * DBH ^{2} * H (two predictors)



- Simple models in forestry (i.e. volume, biomass, biometric parameters)
  - ***Stand*** model: Biomass = a * e^{-b*Age} * $(1 - e^{(-b*Age)*(c-1)})$





More and more prevalence of **models based on parameters having bio/eco-logical significance vs. purely mathematical models**

Fraction of maximum biomass still available to grow

Error term

$$\text{Biomass stock} = a * e^{-b*Age} * (1 - e^{(-b*Age)*(c-1)}) + \varepsilon$$

Maximum biomass possible to accumulate

Standing amount available affected by mortality

Other models in LULUCF sector

- Soil models are less numerous, some applicable to both forest and agriculture: CENTURY, RothC, YASSO, Q, …

Model	Data requirements for model application
CBM-CFS (ecosystem model)	- mean *annual* temperature (+) - *annual* C inputs from simulated living biomass development (+)
CoupModel (ecosystem model)	- mean *daily* temperature (-) - *daily* precipitation sums (-) - mean daily radiation (-) - mean *daily* air humidity (–) - mean *daily* wind speed (–) - *daily* N deposition† (o) - C inputs from simulated living biomass development (+) - day, silt, sand fraction (default available for Sweden)† (o) - soil C content† (o) - soil N content† (o)
Q	- mean *annual* temperature (+) - *annual* C inputs (+) - fractions of chemical compounds of fresh litter† (+)
ROMUL	- mean *daily* temperature (-) - *daily* precipitation sums (-) - *daily* C inputs (-) - N and ash content of fresh dead wood and litter (+) - soil water holding capacity (o) - saturated water content (o) - soil temperature (-) - soil N content† (o)
RothC	- mean *monthly* temperature (+) - *monthly* precipitation sums (+) - *monthly* evaporation (o) - *monthly* C inputs (o) - fraction of decomposable and resistant material in fresh dead wood and litter† (+) - day content † (o)
Yasso07	- mean *annual* temperature (+) - *annual* precipitation sums (+) - *annual* temperature amplitude (+) - *annual* C inputs (+) - fractions of chemical compounds of fresh litter† (+) - mean diameter of dead wood (+)

Other models in LULUCF sector

- HWP products consumption and trade (import and exports) or life cycle (of wood products);
- chains of models linked to economy, energy consumption or population dynamics;

What is a scenario?

- scenario is a predicted sequence of events;
- **….. descriptions of plausible futures**, e.g. although with various expected likeliness to happen;
- “Business-as-usual” or “reference”, or “baseline” scenario is the one which is expected to most likely happen under current circumstances;
- scenarios are implemented through changing inputs into the models *nota bene*: full comparison of multiple scenarios requires using the same model and model parametrization;
- Variables and parameters for future are chosen by the user;

Why do we need modelling and scenarios?

- Modelling and scenarios help to understand complex environments and interlinked factors and complicated processes;
- Needed to report under higher tiers;
- Making decision in LULUCF, e.g.:
  - plan regular forest management actions;
  - understanding GHG risks linked to natural disturbances;
  - define cost effective GHG mitigation strategy;
  - integrate forest management and wood products use;
- Implementation of climate change policy: parties to UNFCCC are required to "formulate programmes containing measures to mitigate climate change by addressing anthropogenic emissions and removals of all greenhouse gases"
  - support in ex-ante analysis of mitigation of GHG emissions;