Assessing the critical factors that determine the availability of forest fuel in Switzerland with an agent based model

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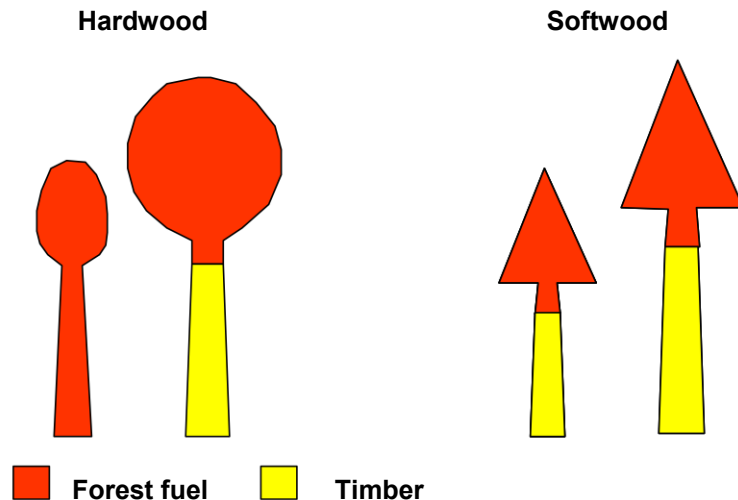
CCSS Conference, Zurich

June 12th, 2009

1) What exactly are forest fuels?

- Harvest residues
  - Treetops
  - Branches
  - Bark
  - Etc.
- Wood from forest thinnings

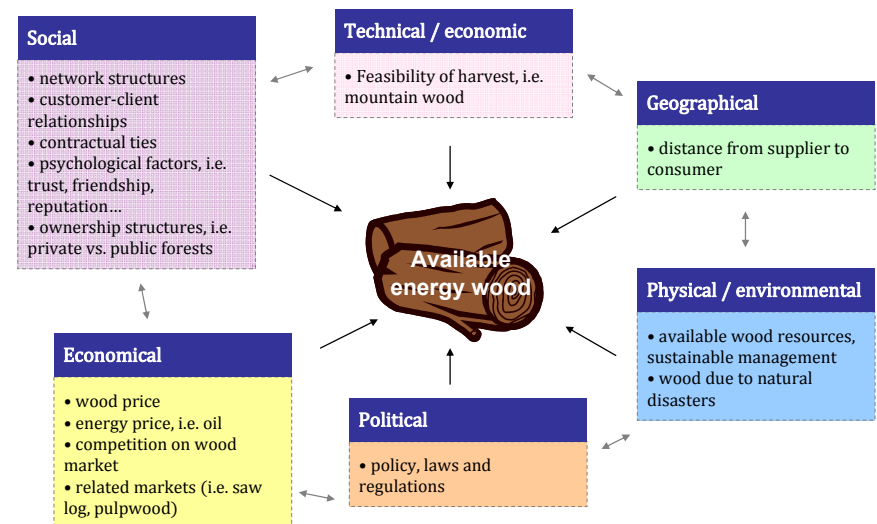**Hardwood** **Softwood**

■ Forest fuel   ■ Timber

But: definition is loose…

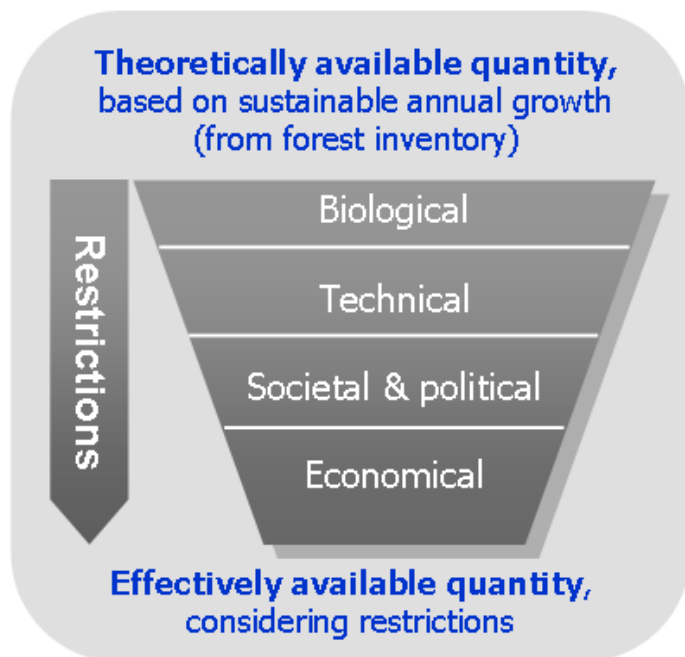## 2) Why are we concerned with forest fuels?

- Global warming, environmental concerns → urgent need to reduce the use of fossil fuels

- Forest fuel currently contributes with 3-5% to Swiss primary energy needs

- Future potential? → can we double that? (that is a lot…)

- Crucial question:

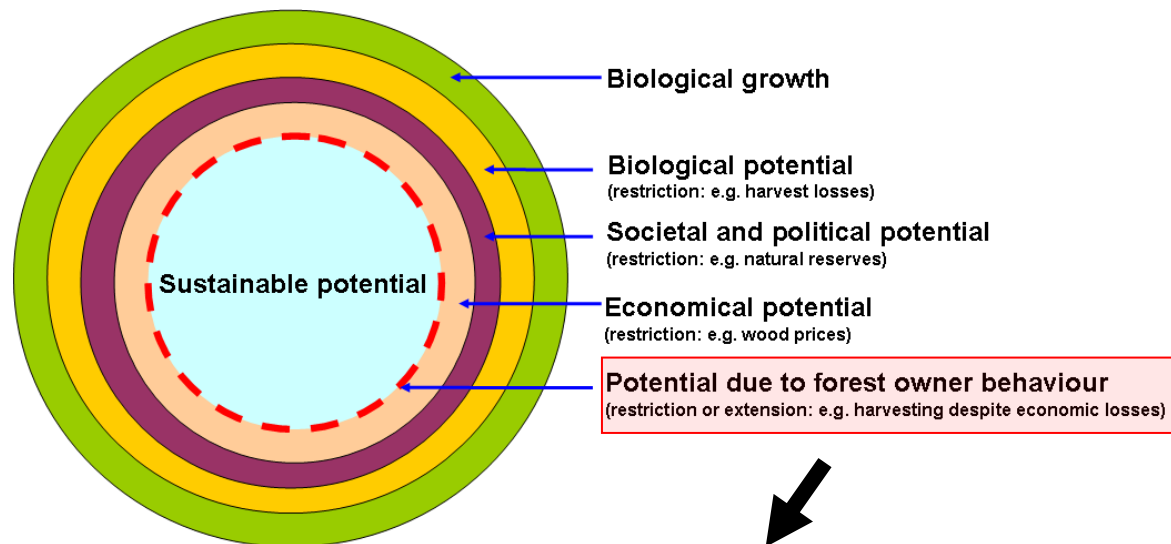**What are the factors that determine the availability of forest fuels ?**

Social
- network structures
- customer-client relationships
- contractual ties
- psychological factors, i.e. trust, friendship, reputation…
- ownership structures, i.e. private vs. public forests

Technical / economic
- Feasibility of harvest, i.e. mountain wood

Geographical
- distance from supplier to consumer

Available energy wood

Physical / environmental
- available wood resources, sustainable management
- wood due to natural disasters

Economical
- wood price
- energy price, i.e. oil
- competition on wood market
- related markets (i.e. saw log, pulpwood)

Political
- policy, laws and regulations

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General methodology

Theoretically available quantity, based on sustainable annual growth (from forest inventory)

Restrictions

- Biological
- Technical
- Societal & political
- Economical

Effectively available quantity, considering restrictions

Application to the Swiss case

"Onion skin model" by Hofer et. al 2008

Sustainable potential

Biological growth

Biological potential
(restriction: e.g. harvest losses)

Societal and political potential
(restriction: e.g. natural reserves)

Economical potential
(restriction: e.g. wood prices)

Potential due to forest owner behaviour
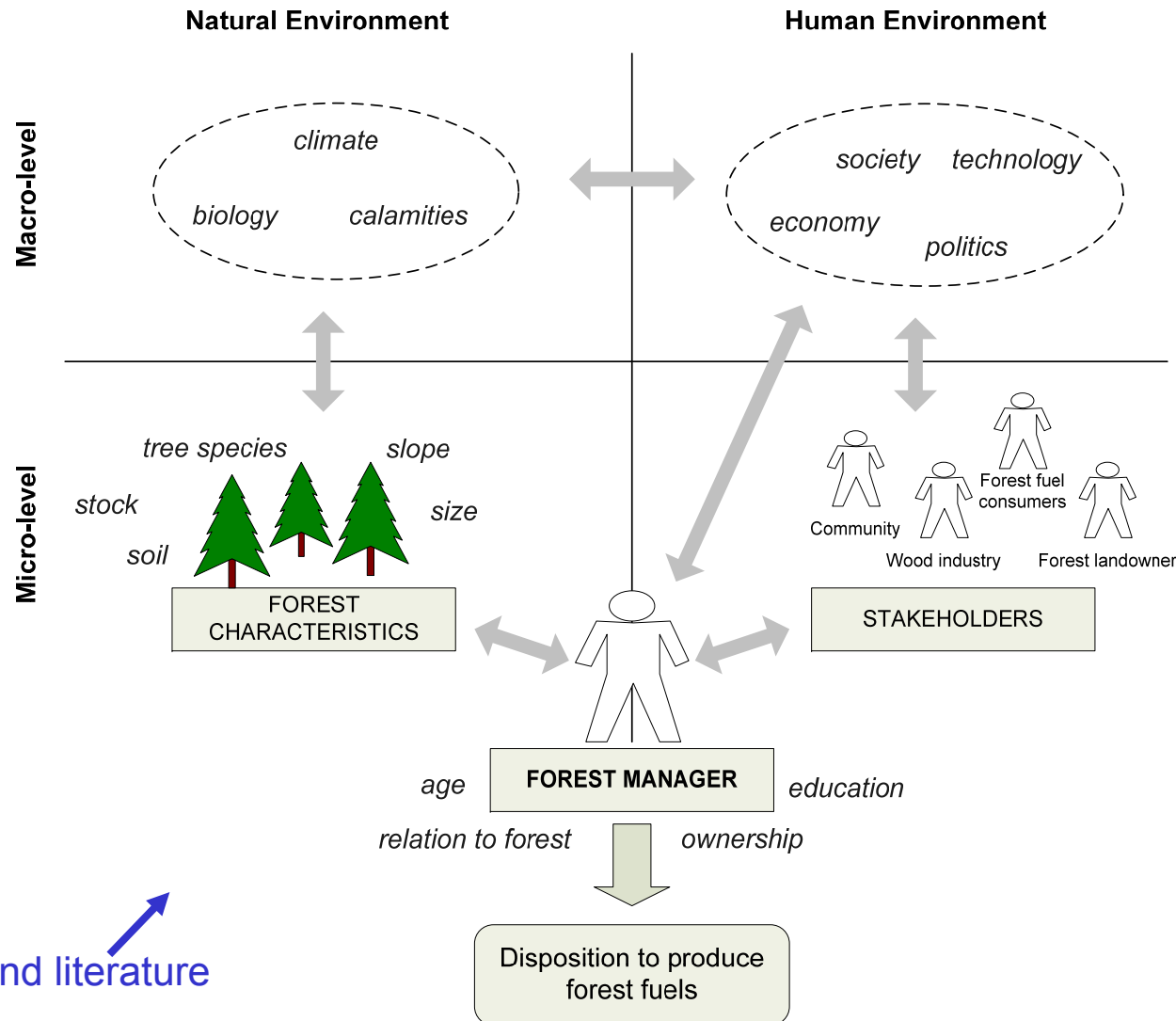(restriction or extension: e.g. harvesting despite economic losses)

Examples of forest owner behaviour:

■ Supply of forest fuels despite losses

■ No supply even if profitable (no interest in producing forest fuels)

■ But also price driven actors

■ Supply to certain actors only (preferences)

■ Differences between public and private forest owners and within these groups

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Materials Science & Technology

- Large literature on "timber harvesting behaviour of NIPF landowners (non-industrial private forest owners)"

- However, hardly any literature on:

  - public (and industrial) forest owners (75% in CH)

  - harvesting / supply behaviour for *forest fuels*

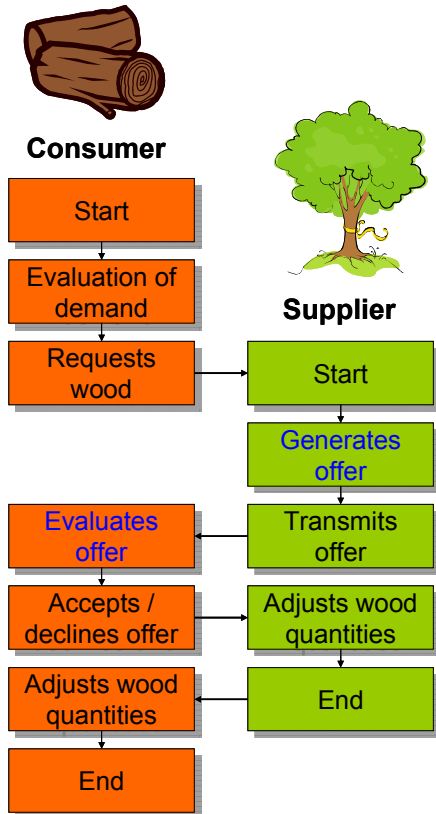➔ Need to generate that data ourselves:

  - Interviews
  - Survey

*The forest manager is the central actor deciding "how much forest fuels will go where" !*

Natural Environment

Human Environment

Macro-level

climate

biology *calamities*

society *technology*

economy

politics

Micro-level

tree species *slope*

stock *size*

soil

FOREST CHARACTERISTICS

Community

Forest fuel consumers

Wood industry

Forest landowner

STAKEHOLDERS

age **FOREST MANAGER** *education*

relation to forest *ownership*

Disposition to produce forest fuels

Result of interviews and literature

Definition of a trade / interaction protocol

## Different buyers and sellers trading with each other
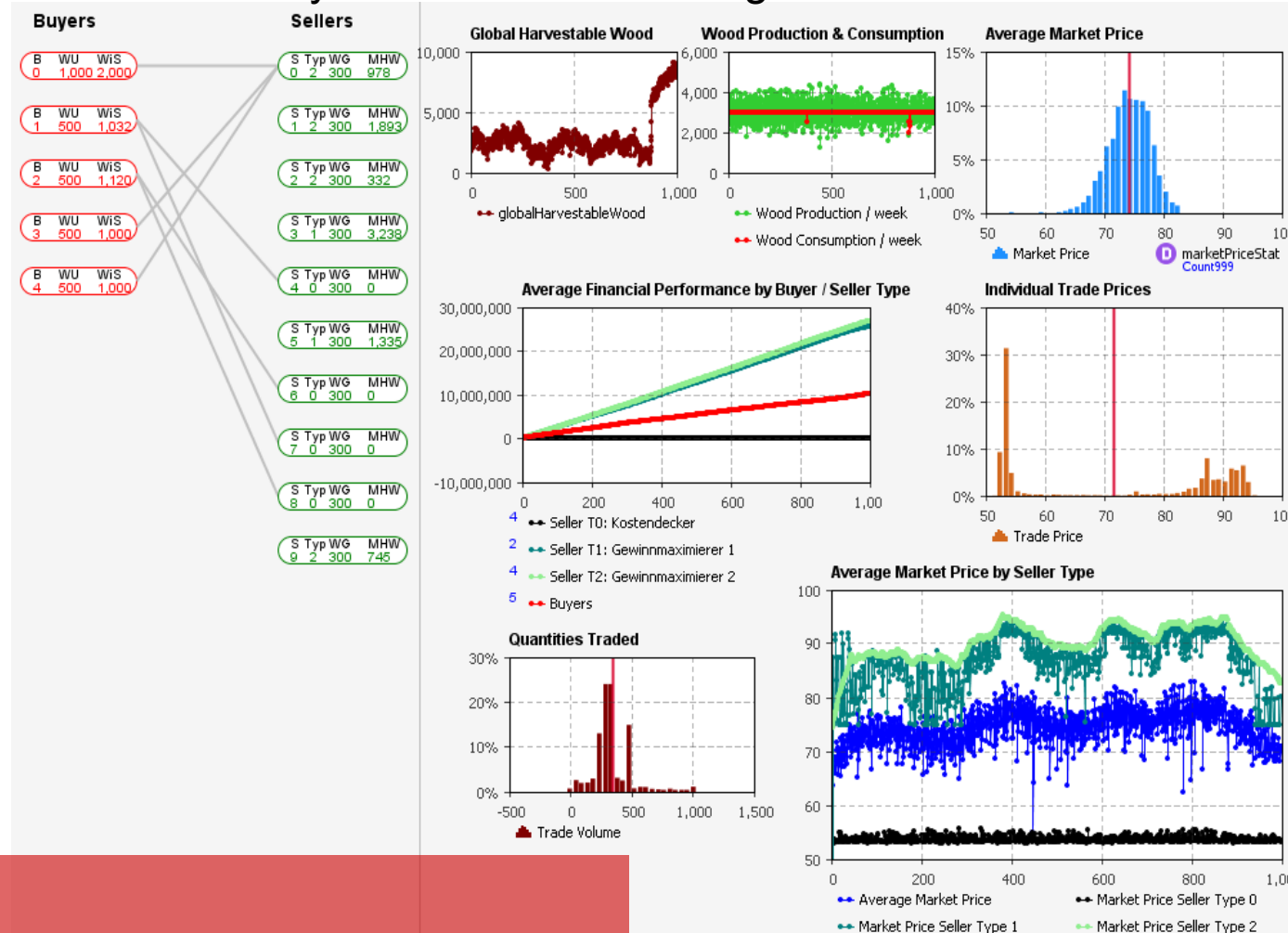
Current model features

- Forest fuel trade according to standard economic theory
- Different demand and supply actors (types and sizes)
- transaction costs
- Simulate wood cooperative foundation

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- **Question:** What are the effects of different supplier constellations on the demand actors?

- Experiment
  - Agents:
    - Public forest owners, "cost-coverers"
    - Public or private forest owners, "outsourcers" and profit maximizers
    - Consumers of different sizes, same reasoning
  - Variations:
    - Supplier constellation
    - Transaction costs
    - Suppliers join cooperation
  - Measured variables:
    - Consumer profit
    - Market price

- Results
  - Consumers make more profit in a supplier constellation with outsourcers.
  - Market entry (of new actors) appears more successful in a setting with more outsourcers.

- Explaining remark
  - These results depend of course heavily on the assumed cost functions…!

- Link to availability?
  - Outsourcers produce forest fuels cheaper → the (economically) available quantity of forest fuels is higher than if only cost-coverers are present

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1. Consumer profit increases with number of outsourcing suppliers

Legend: Public cost-coverers — Public and private outsourcers — Profit of the consumer — Market price
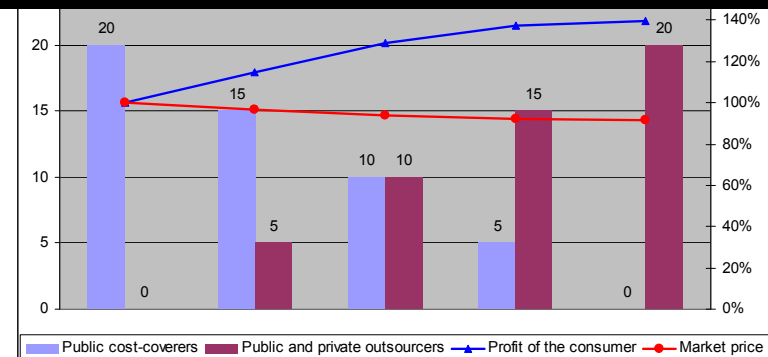
2. With increasing transaction costs, consumers make more profit in the presence of outsourcers

Legend: Consumer profit, cost coverers — Consumer profit, outsourcers
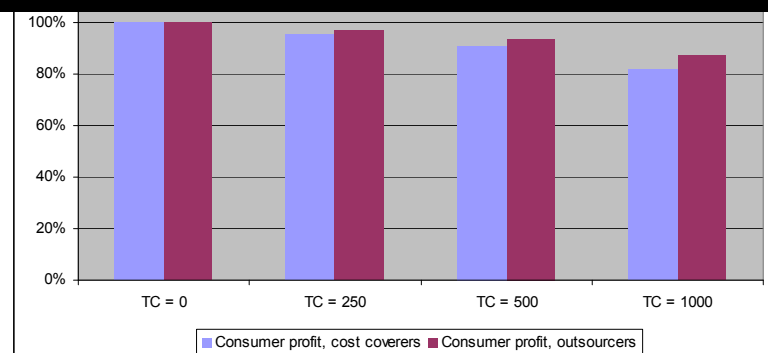
3. Bilateral monopoly is favorable for consumers when transaction costs involved. (and it may also give security for suppliers)

Legend: Profit consumers, when suppliers = cost coverers — Profit consumers, when suppliers = outsourcers

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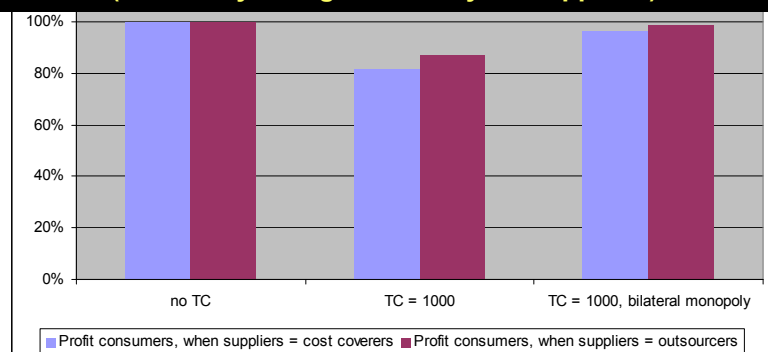
- As forest fuels are becoming scarcer, it is important to have knowledge of the associated markets and other context specific factors to predict their availability

- Preliminary results indicate that the availability of biomass resources is strongly dependent on the local context, *e.g. from the type of market actors present*

- Agent based modelling may provide a suitable toolkit to investigate a complex dynamic system such as a wood market

- **Empirical data collection (currently ongoing):**
  - Behavioural data from survey & interviews
    - Forest owners' preferences & behavioural types
    - Consumers' perferences & behavioural types
  - GIS data
    - Forest fuel potentials & current demand
    - Forest owner types & consumer types
    - Transport distances & costs

- **Some future model features:**
  - Contracts
  - More elaborate actor's behaviour
    - E.g. different interaction protocols
    - Learning and strategy changes

- **Future scenarios:**
  - Different sets of actors (e.g. actor types, consumer sizes
  - Change in preferences
  - Impact of brokers and cooperatives
  - Policy variables
  - Natural disasters
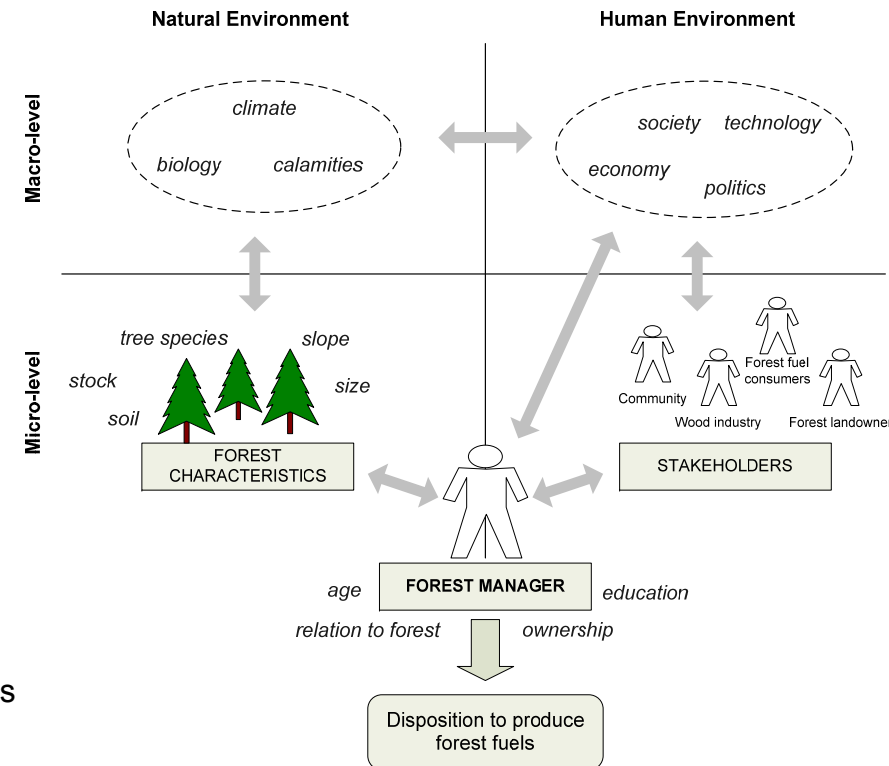
→ Generate knowledge on the critical factors that influence the availability of forest fuel

→ Generate *what-if-scenarios* useful for policy makers and involved market actors
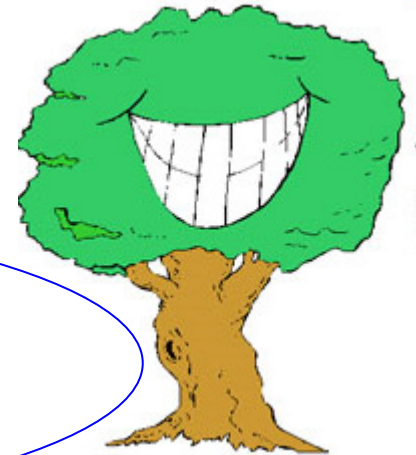
Thank you for your attention!

Questions?