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

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Introduction and research question

1) What exactly are forest fuels?
- Harvest residues
- Treetops
- Branches
- Bark
- Etc.
- Wood from forest thinnings

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?

But: definition is loose…

- Timber
- Forest fuel

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

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
General methodology

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

Biological

Technical

Societal & political

Economical

Restrictions

Effectively available quantity, considering restrictions

Application to the Swiss case

“Onion skin model” by Hofer et. al 2008

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
How do we get a model of forest owner behaviour?

- 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”!

Result of interviews and literature
Current state of the model

Definition of a trade / interaction protocol

Consumer
- Start
- Evaluation of demand
- Requests wood

Supplier
- Start
- Generates offer
- Transmits offer
- Evaluates offer
- Accepts / declines offer
- Adjusts wood quantities
- End

Different buyers and sellers trading with each other

Materials Science & Technology

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
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
Conclusions

- 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.
Outlook

- Empirical data collection (currently ongoing):
  - Behavioural data from survey & interviews
    - Forest owners’ preferences & behavioural types
    - Consumers’ preferences & 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?