Design of Decision Suport Systems for Industrial Forest Management

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Summary

- Traditional approaches of DSSs for managing industrial forests
  - Components
  - Factors
- A different look
  - Simulation
  - Optimization
- The importance of the Decision Maker in the Decision process

Management of Industrial Forest

- Simple objective: **profit maximization within a specific time frame**
  - Environmental and sustainability issues are seen as constraints to reach the desired goals
  - Most problems are NOT multi-objective as most everything reduces itself to money
- The actual decision making problem is: **what to do with the time and resources available so that profit is maximized**

  How can a Decision Maker justify her decision?

Typical Industrial Forest Decision Making

- DSS Components
  - A database with inventory data
  - Simulator and prescription writer
  - Optimization tool - scenario generator

- Types of planning
  - Strategic – long term actions
  - Tactic – medium term actions
  - Operational – short term actions

Objectives:
an Action Plan or Insight?

- A solution (scenario) provided by a DSS more than an action plan is supposed to give **Insight**
- Managers require information to make decisions
- If the Action Plan cannot be accomplished, the system should provide the adequate analysis to propose an "optimized alternative" and provide the justification for a new decision

So…

- We have the growth models
- We have the optimization tools
- is the problem solved?
  - Are Decision Makers in a higher ground?
  - Are their decision better?
  - Do they have adequate information to base their decisions upon?
    - Are the simulation models adequate?
    - Are the optimization models adequate?

What are DSS builders actually giving to Decision Makers

- Complex models
  - Different planning levels with little to no integration
  - Difficult to validate in some cases
- Difficult tools or black boxes
- Difficult data requirements
- A caveat: "*do not execute what our tools suggest, try to get insight*"
  - So, no answers!

Simulation

- Simulation is fundamental for decision making
  - Good Models are necessary!
    - Economic models
    - Biometric models
    - Risk models
    - Climatic models(?)
  - But what is a "good model"?
    - Models should be simple
    - Models should be robust
    - Models should be usable

Model usability

- A good scientific model is not necessarily a good model for a DSS
- A good model for decision making is a model any user can use despite the data limitations that will **always** exist
  - E.g. how will a plantation grow in a new region?
- A bad model is better than no model at all?
  - No! Users can live with uncertainty, but not with bad data.
- Models must be simple. Simplicity is the key to usability
  - It is much more than an implementation issue
    - Few parameters
    - Few factors
    - Avoid "models within models"

Model Insight

- Insight is inversely proportional to the complexity of the model.
  - Complex models offer less opportunities for insight than simple models
  - E.g.
    - Climatic variables impact on productivity
    - Enforcing locational specificity - Integer models vs linear programming)

Optimization

- An optimization scenario (A) is considered better than another (B) if by following a set of practices it produces a better objective function
  - Is "better" just the result from the objective function?
  - What are we sacrificing by choosing A instead of B?
  - What is the robustness of a scenario?
    - What is the impact of a change in the implementation? Can a decision maker using a specific DSS actually evaluate the enforced change?

Incorporating risk into scenario modeling

- How to deal with risk?
  - Difficult in optimization unless probabilistic models are used
    - Increase the model complexity- reduce the capability for insight
- How to deal with the climate?
  - It is a very complex issue
    - The effects of an abnormal year can be unforseeable in an optimization model
  - Should managers deal with it?
  - **Is it really relevant?**

Putting scenarios into practice

- **Can scenarios be put into practice?**
  - Can different planning levels be properly integrated?
  - Are the models complete?
    - Can they EVER be complete?
- Is the information provided by current models and scenarios sufficient and relevant for adequate action?

- **Do users trust the models?**
  - Can they actually derive insight from them and understand the nature of the solutions?

Evaluating the industrial forest

- Is the result of the objective function in an optimization model a good metric?
  - For comparing scenarios?
  - For comparing models or methodologies?
    - Are models statistically different from each other?

- How can we **validate** the "reality" of the result of an optimization function?
  - Can we at least **compare** scenarios?
  - Is it possible to explain to users why two very similar scenarios as for objective function values can have totally different expressed decisions?

What do Forest Decision Makers Want?

- **What to do with the time and resources available so that profit is maximized**

  How can a Decision Maker justify her decision?

- **With so many questions still extant, are we actually answering decision makers needs?**
  - **or instead, finding solutions to problems researchers find relevant?**

Designing Forest Management DSSs

How can a Decision Maker justify her decision?

- If this is what is desired, design must follow suit
- A DSS must be defined according to the user (the Decision Maker) needs
  - So far users were never considered!
- There are no situations alike
  - Even for simple Industrial Forest problems no two situations are the same!
  - There are NO Recipes

- Users do not like oracles:
  - "We harvest here because the system said so"

Power to the User!

- It is necessary to understand what an user values and how she, in the absence of any system, bases her decisions
  - Growth models should not be used blindly
    - Very accurate models vs. robust models
    - Is climate a factor?
  - Optimization or just simulation?
  - Detailed (localized) scenarios or not?
  - One planning level or scale integration?
  - Is risk an important factor to consider?
    - Does it conditions decisions?

Power to the User! - Part 2

- The decision maker must be aware of the limitations of each possible solution
  - Generally, simpler models allow for better understanding of the results and increased insight
  - More complex models may produce "better" answers but difficult to understand, evaluate, compare or justify
- It is fundamental to understand what are the factors behind the decision process
  - How decision is made within the organization
  - It is not the DSS builder that will change it!

- **Misunderstanding user requirements is the road for certain failure!**