Balancing, Optimizing and Sustaining Multiple Forest Functions

- using System Engineering, Big data, AI, and Cloud computing

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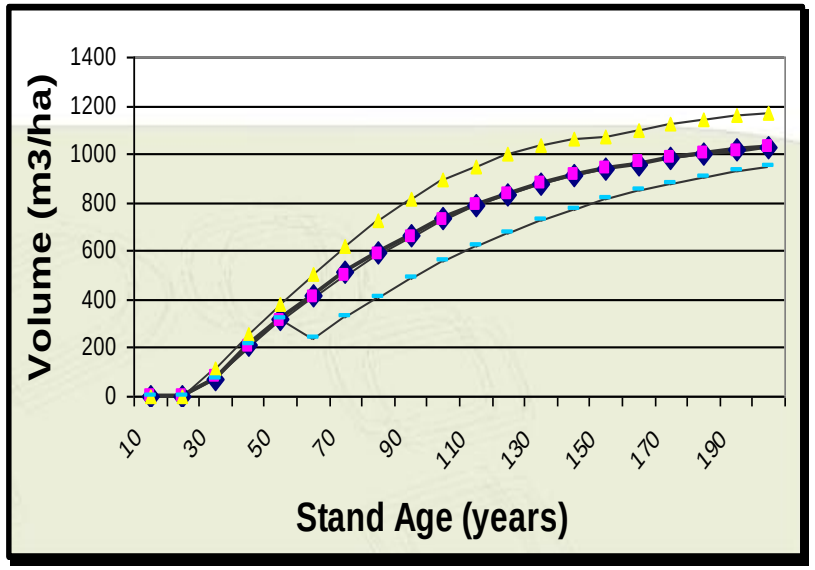
Canada forest cloud： http://forestcloud

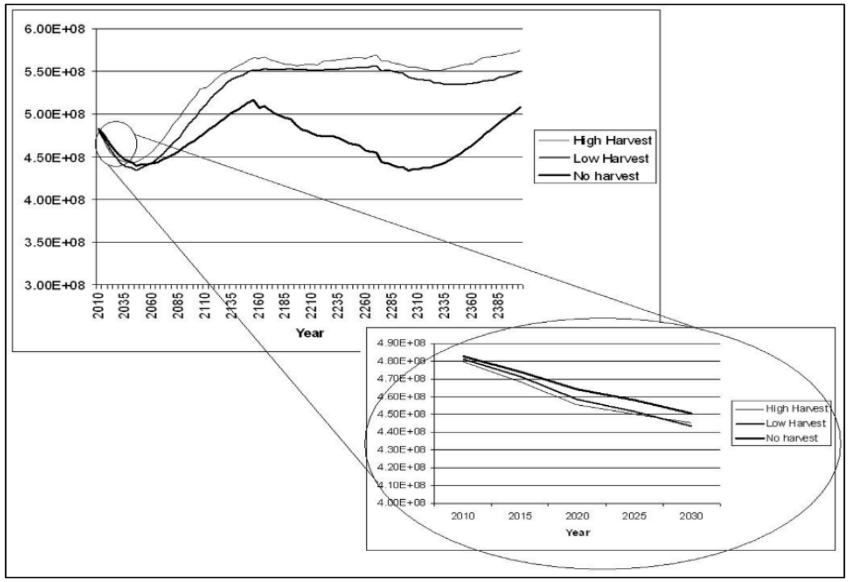
China forest cloud： http://forestcloud.

How can we let people participate?

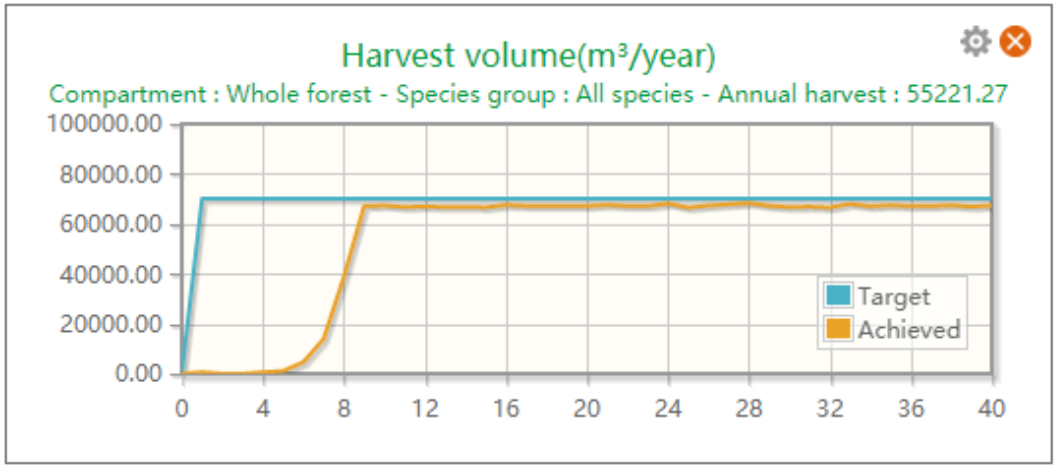
Multiple temporal and spatial scales Make the problems a million times more complicated.

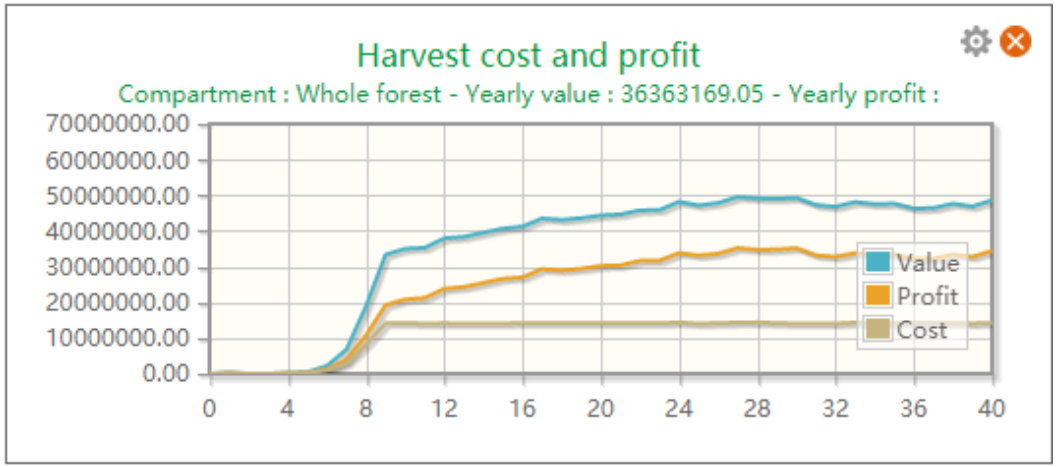
Trees, Stands, Forests, Temporal, Spatial

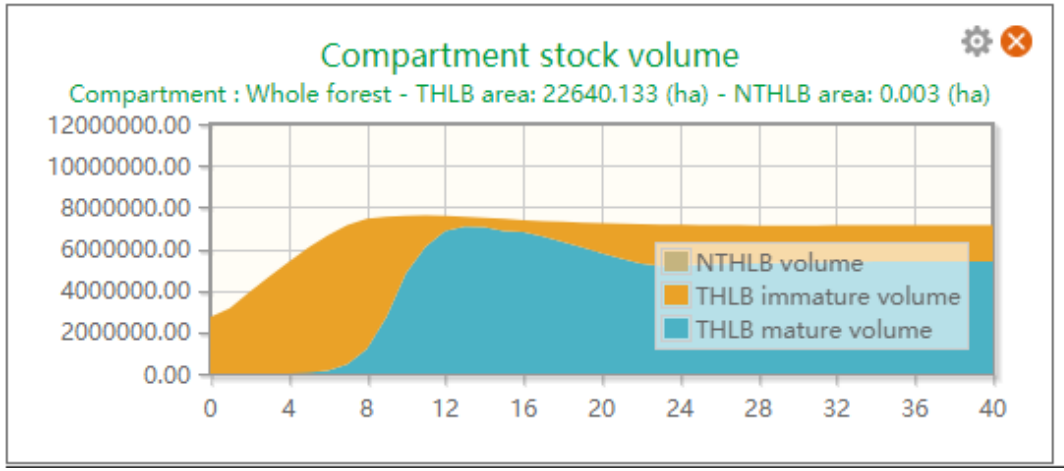


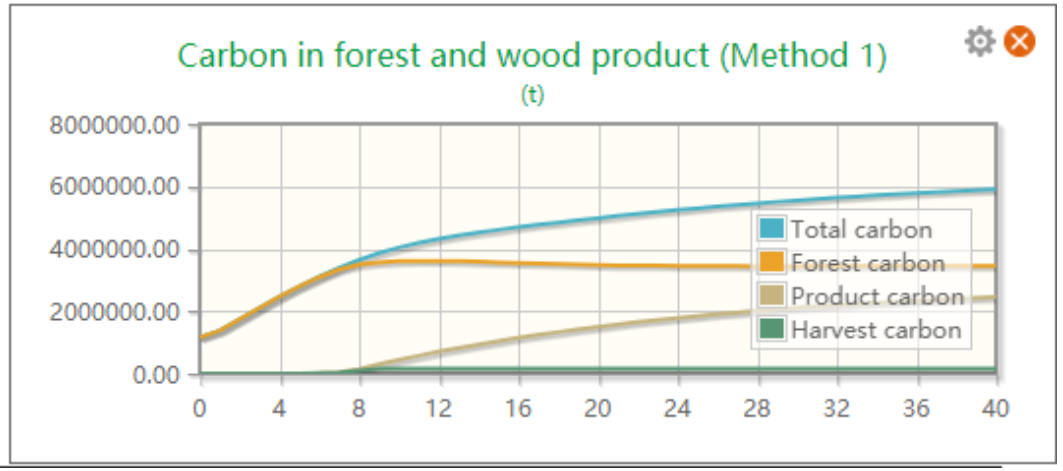


Balance and Optimize using Artificial Intelligence
from multiple temporal and spatial scales









We need models

- Strategic and Tactical
- Simulation and optimization
- Regulation-based and target-oriented
- Spatial and non-spatial
- Trees, stands and forests

FSOS

FSOS is a Forest Simulation Optimization System model.

FSOS uses artificial intelligence (Simulated Annealing) to generate forest management plans to transform forests to their desired states, maintain the desired states, balance and sustain profit and product flows.

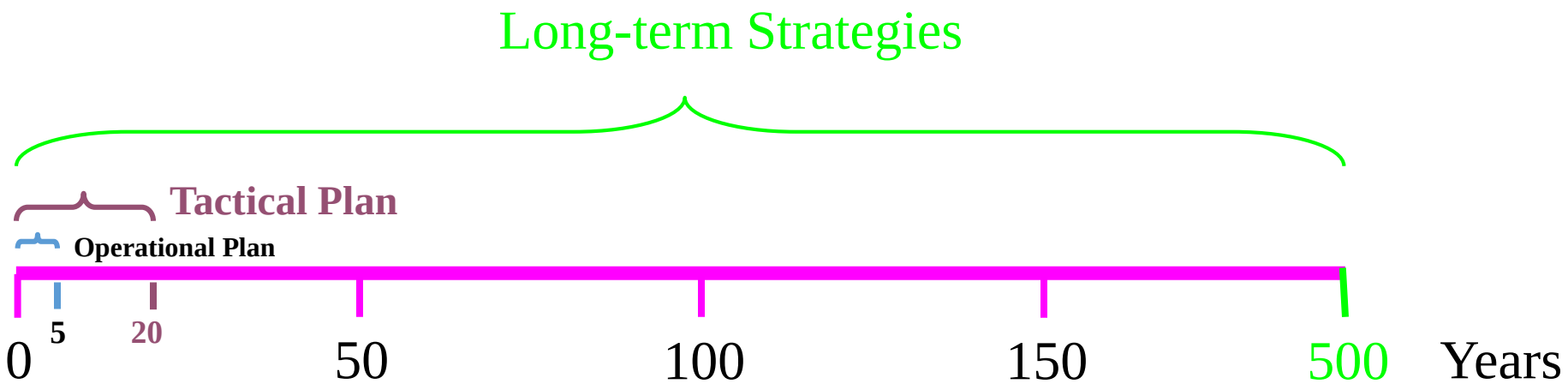
Desired states are defined from the perspectives of watershed condition, carbon storage, wildlife habitat, biodiversity, recreation, visual quality objective etc. Timber flows can be outputs of FSOS。

FSOS uses cloud computing, you can use any internet browser to run FSOS at any time and any places and do not need to install any particular software. Using FSOS is like playing a game. It is a good tool for forest planners, researchers and students to learn forest modelling, artificial intelligence algorithms, and parallel cloud computing.

FSOS key features

1. FSOS focuses on both “what we can take from the forest” and “what we can create in the forest”.
2. FSOS uses our own cloud computing technology “EasyCloud” that can allocate a number of computers in the private network or the cloud to find good solutions in shorter time.
3. FSOS uses an artificial intelligence algorithm simulated annealing to optimize, balance and sustain forest ecosystem services.
4. Trade-offs can be made between temporal scales because all periods are considered simultaneously.
5. Trade-offs can be made between ecosystem objectives, areas and layers because all layers and zones are considered simultaneously.
6. Layout road and blocks, and schedule simultaneously.
7. FSOS can integrate stand levels in landscape levels modeling.
8. FSOS combines spatial and non-spatial in one model.

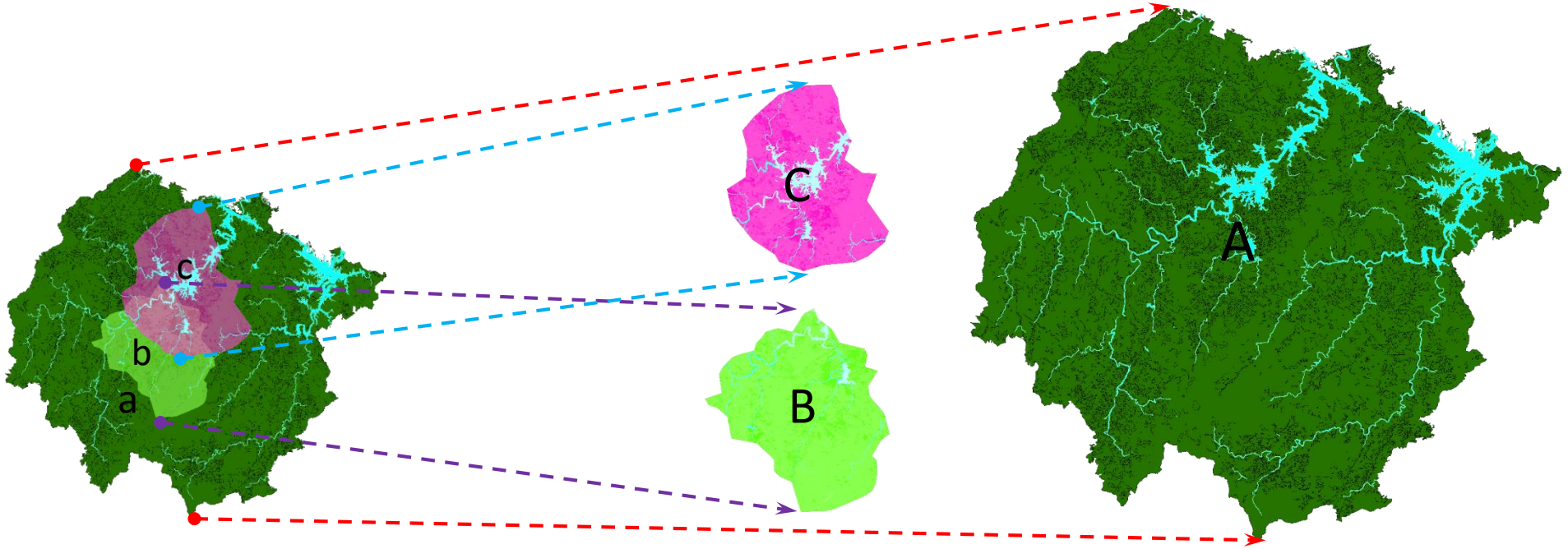
FSOS Integrates Strategic and Tactical



FSOS integrates block, road locations and scheduling

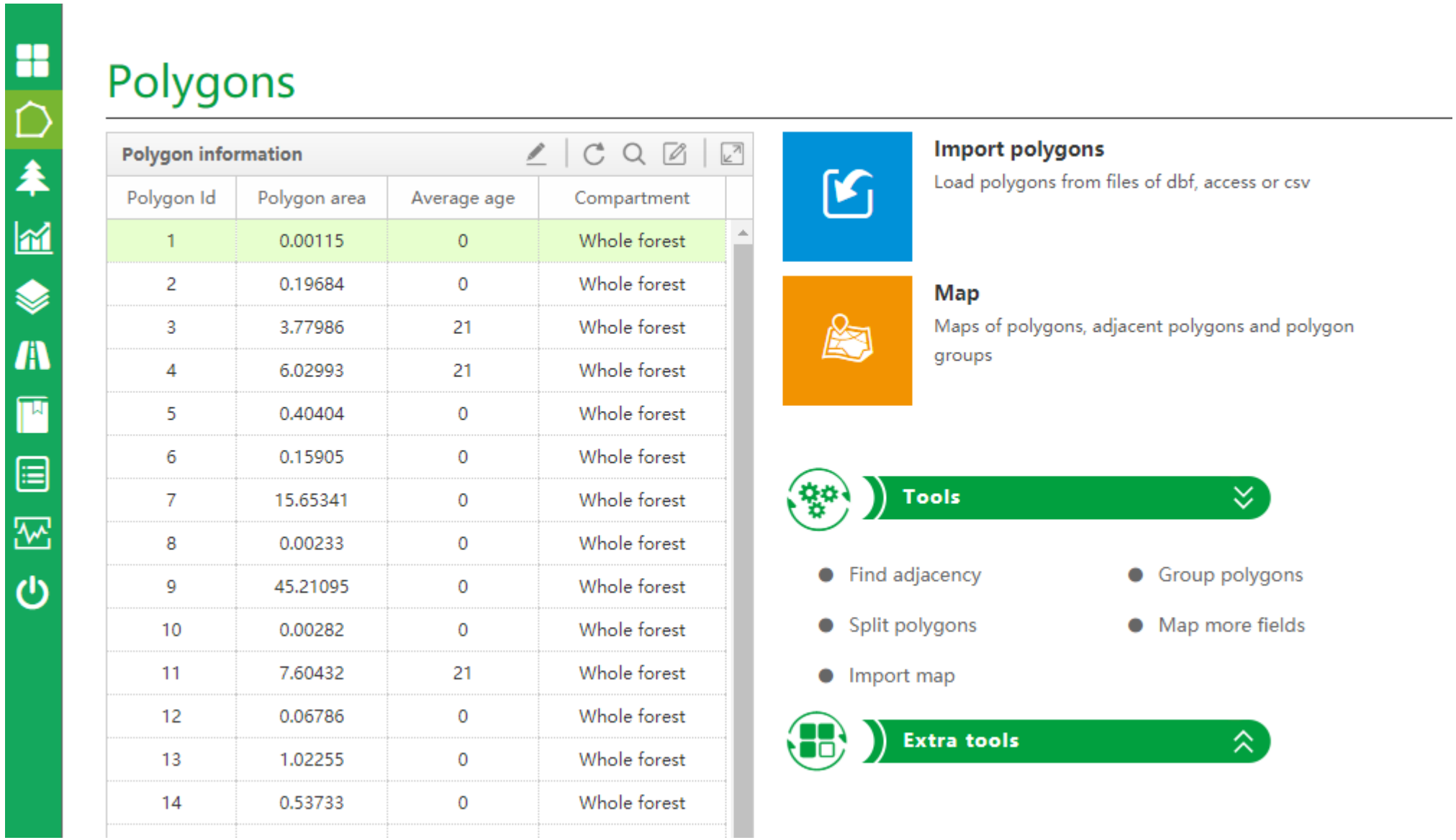
Understanding Desired forest-driven

- Water
- Carbon
- VQO
- Wildlife
- Biodiversity
- Timber
- Economy
- Others

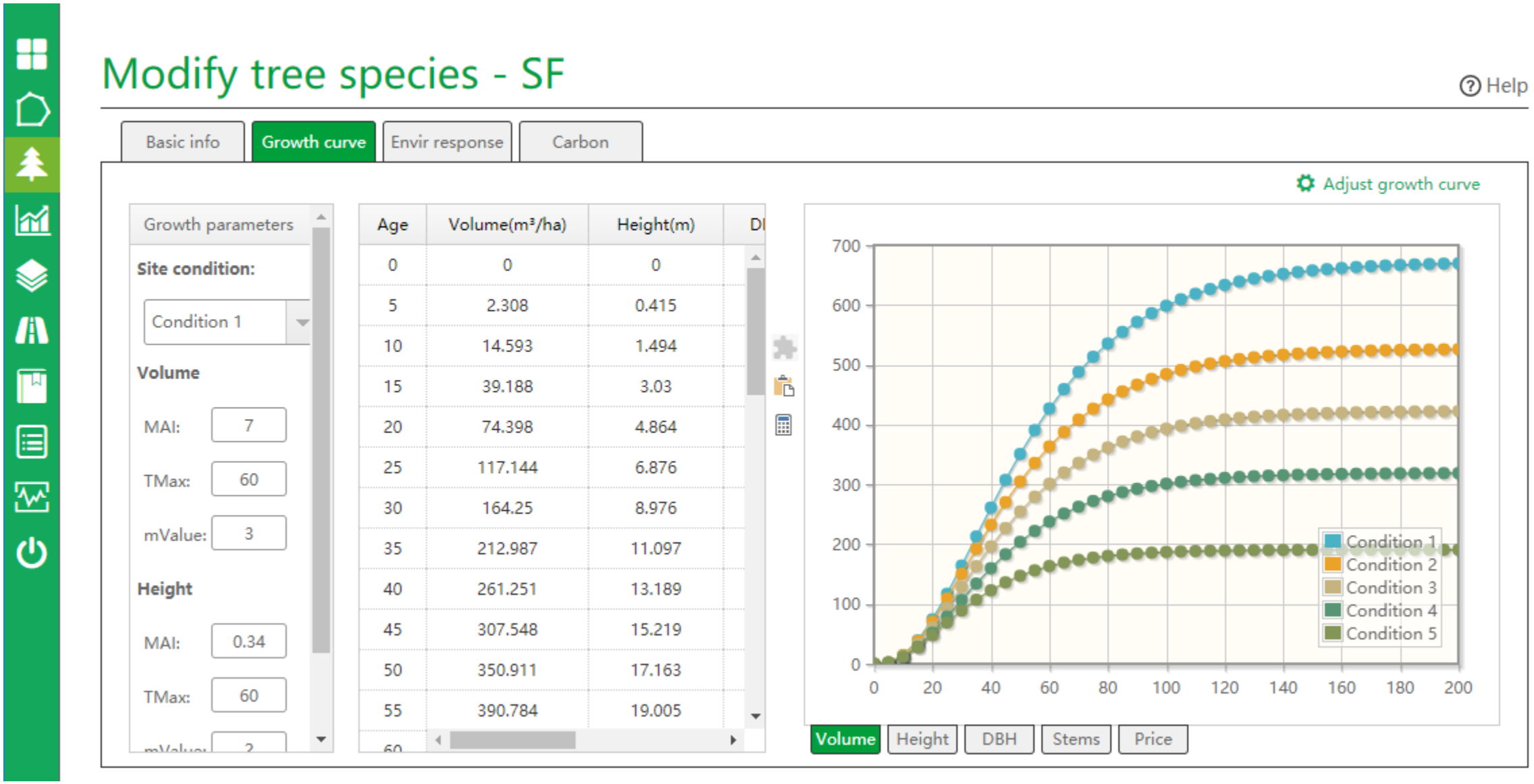


Simple and powerful

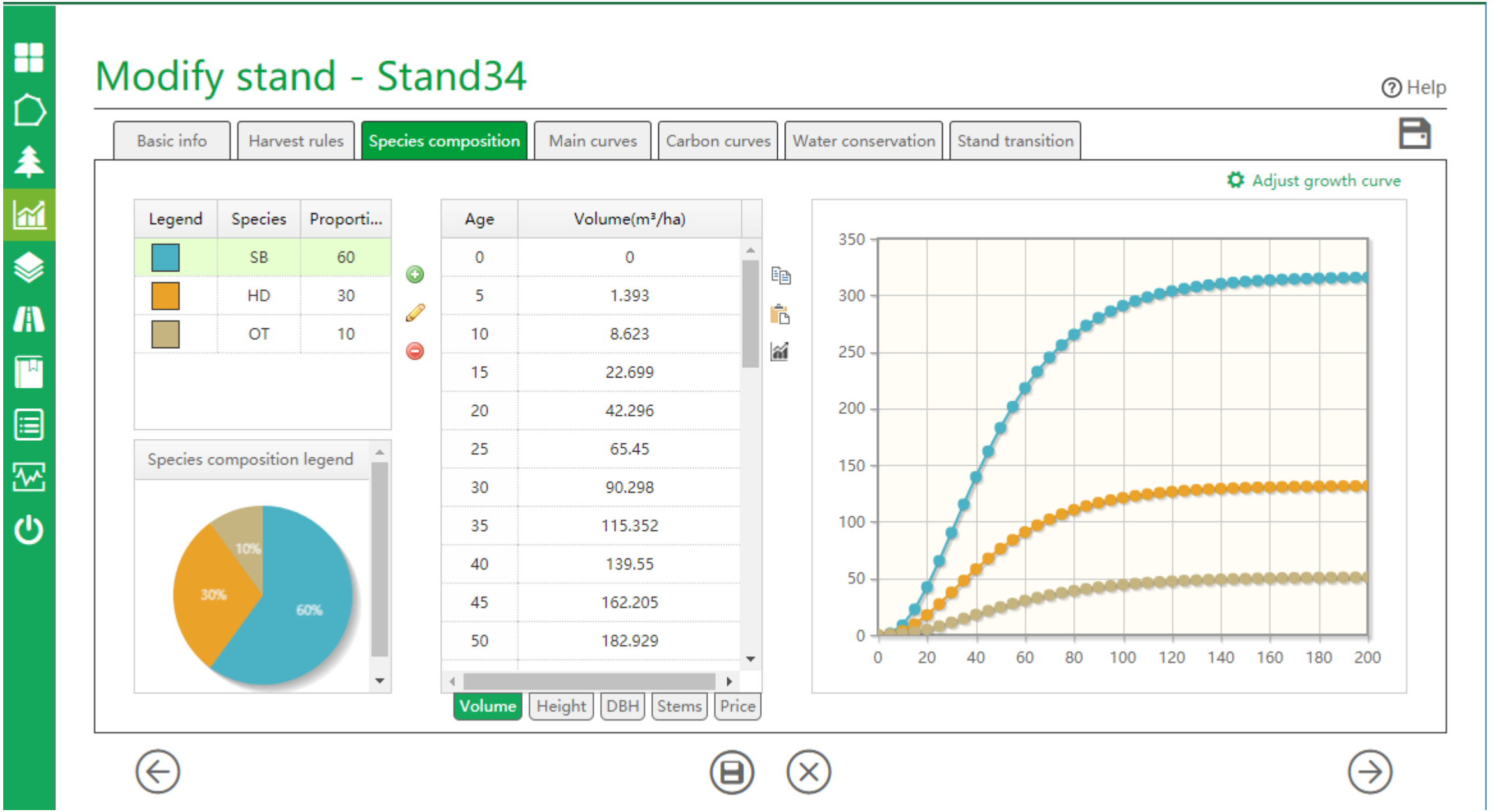
1, Polygon query, edit and tools



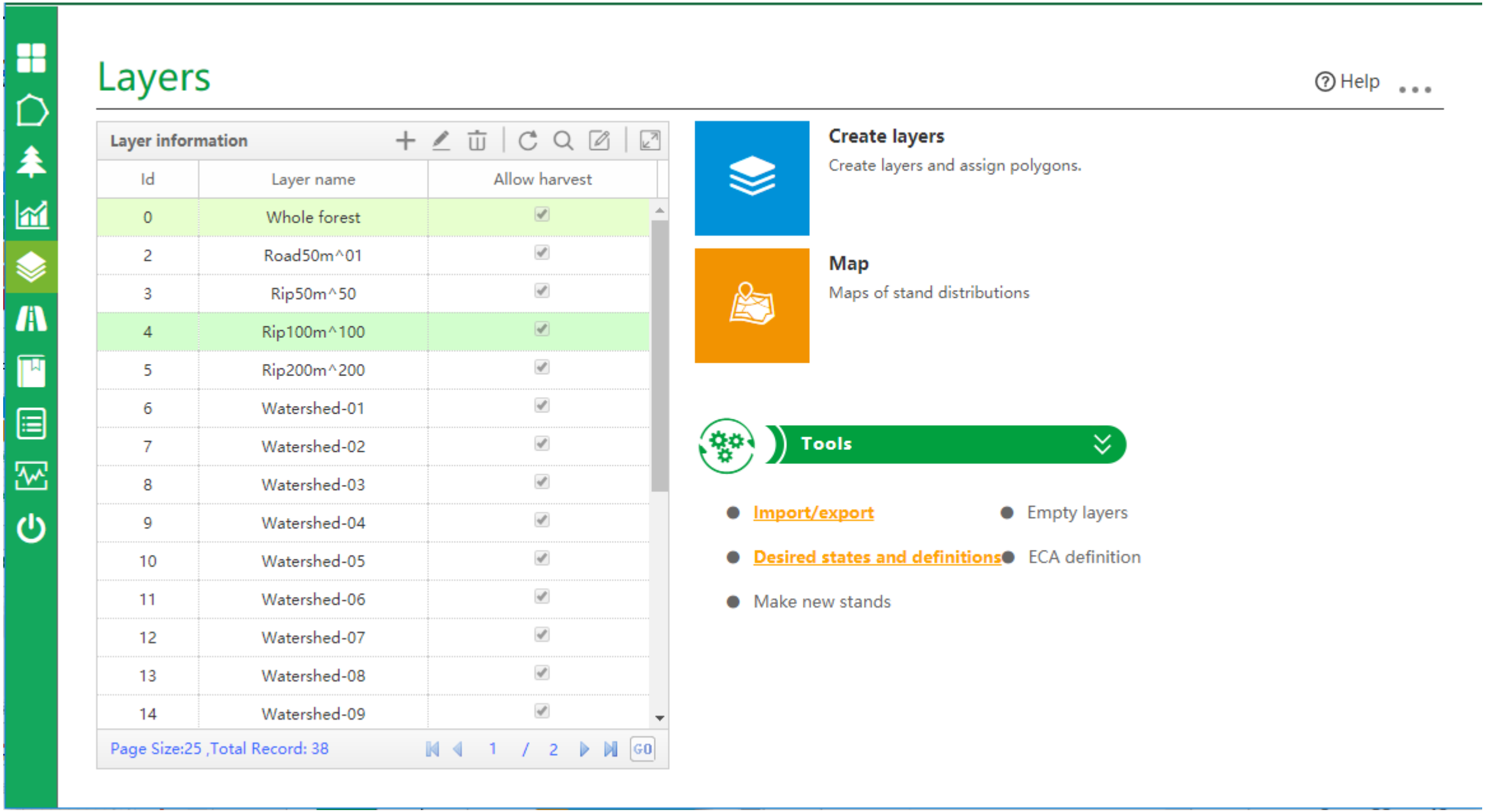
2, List all tree species and generate dynamics using knowledge database



3, Define stands, generate dynamics, link polygons



4, Define layers, set regulations and desired states



5, Integrate demand and supply

Supplies | Possible roads | Demands

Id	X Coordinate	Y Coordinate
1	22393730.542616	5013654.138319
2	22393065.384806	5013988.945203
3	22393197.965528	5014246.923548
4	22392775.126494	5014072.293988
5	22392550.652914	5014320.116808
6	22392463.921377	5014219.770912
7	22392321.989233	5013961.314828
8	22392081.220742	5014282.823115
9	22392045.270614	5013655.75117
10	22383703.919117	5016835.384142
11	22383637.867911	5017018.375484
12	22382438.083357	5018272.461145
13	22382351.627107	5018156.057242
14	22399541.978437	5032751.689008
15	22399333.318935	5034218.256608
16	22399252.794468	5034687.188943
17	22399289.96359	5032897.315264

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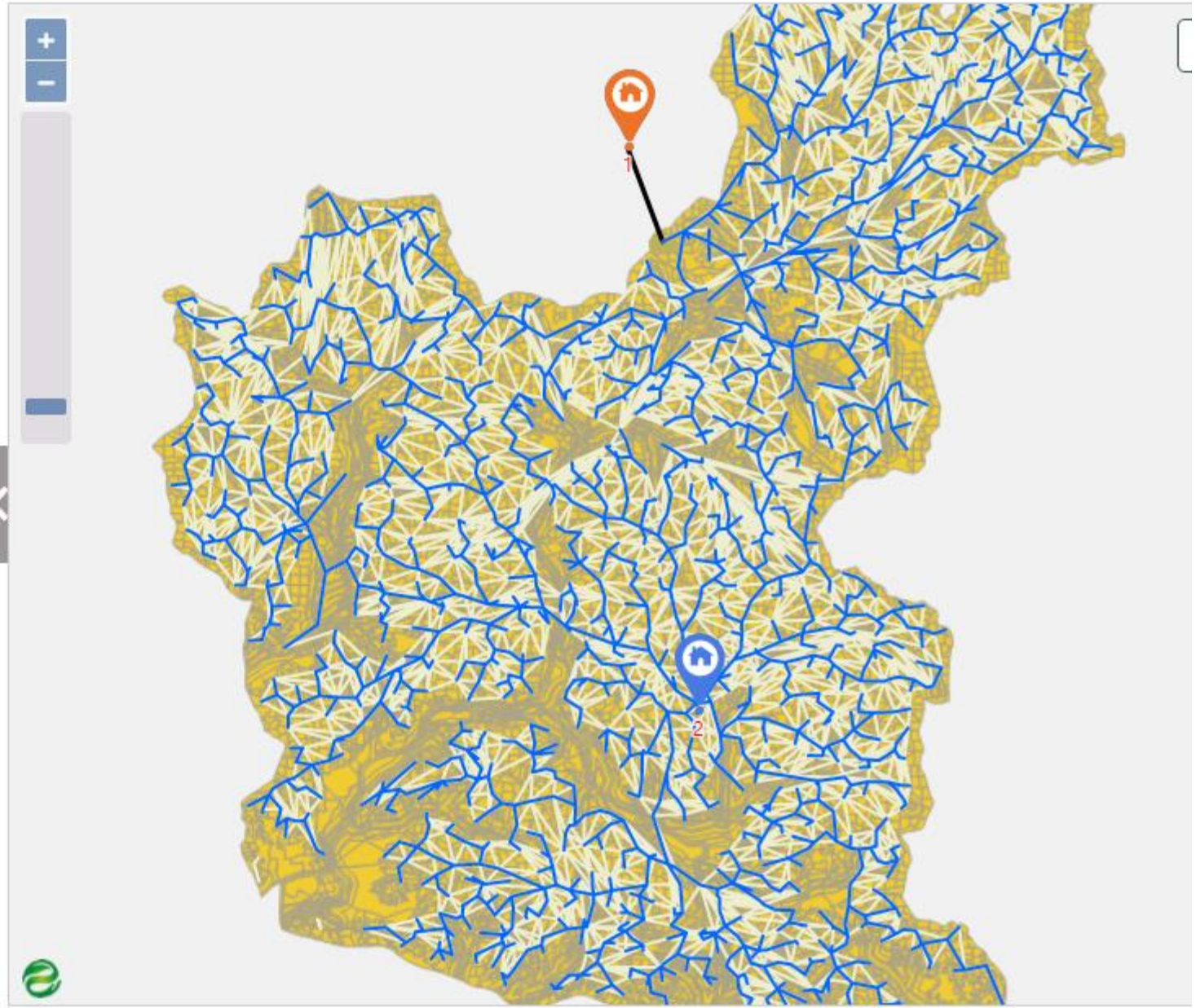
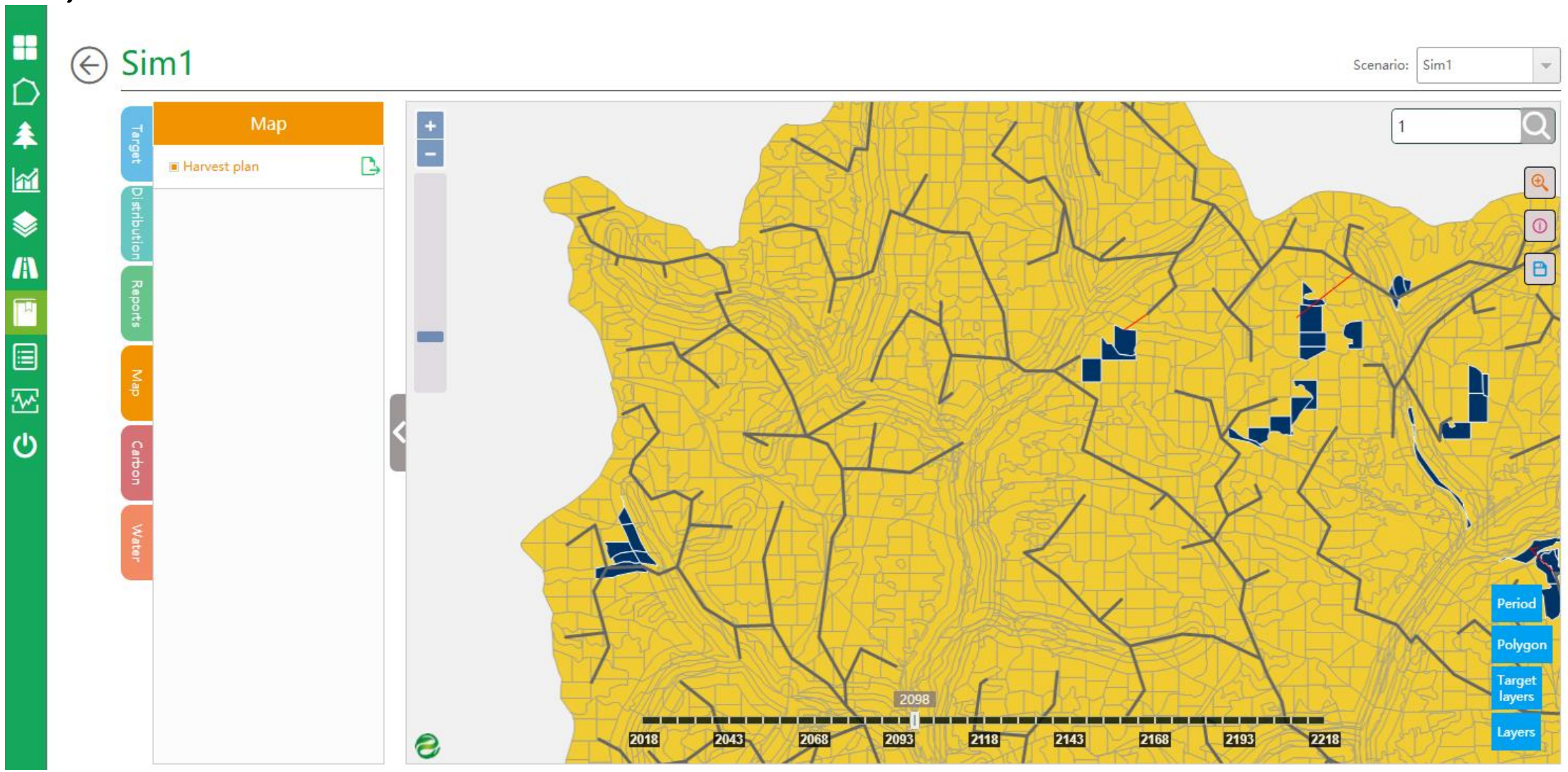


6, Scenarios


Sim1
Scenario:
Sim1
Target
Distribution
Reports
Map
Carbon
Water
Map
Harvest plan
1
2098
2018
2043
2068
2093
2118
2143
2168
2193
2218
Period
Polygon
Target layers
Layers

Conclusions

FSOS can do simulation and optimization with the same data and parameters. Both simulation and optimization have advantages and disadvantages.

FSOS can produce strategies to transform forest layers from different initial states to the desired states.

Combining blocking and scheduling is an effective way to achieve and maintain patch size distribution targets over the planning horizon while maximizing timber flows.

Conclusions

FSOS can identify treatment strategies under different natural disturbance regimes to transform forest layers to desired states.

FSOS integrates tactical and strategic planning processes. It produces a long-term treatment schedule according to current states, desired states, projected dynamics and the sustainability of resources. The short-term schedule (1 – 20 years) is a subset of the long-term schedule, which guides current forest operations.

Conclusions

FSOS is an efficient tool for adaptive forest management. Forest blocks are dynamic and treatment schedules can be modified when forest engineers reshape the blocks, update the database or when natural disturbance occurs.

FSOS uses simultaneous planning for multiple layers and multiple rotations. Tradeoffs can be made between resources and between rotations. This differs from time-step simulation, which requires explicit intervention of the analysts to examine tradeoffs between resources and between rotations (or periods).

Conclusions

FSOS demonstrates that there are numerous high quality solutions to the problems, and each solution has a different spatial pattern. From operations research perspectives, it is frustrating that there is no global “optimal” solution. However, from a forest management perspective, this is good news because it indicates robustness in the forest management.

Thanks !

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