Simulation modelling of forest ecosystem development under the different forest management scenarios

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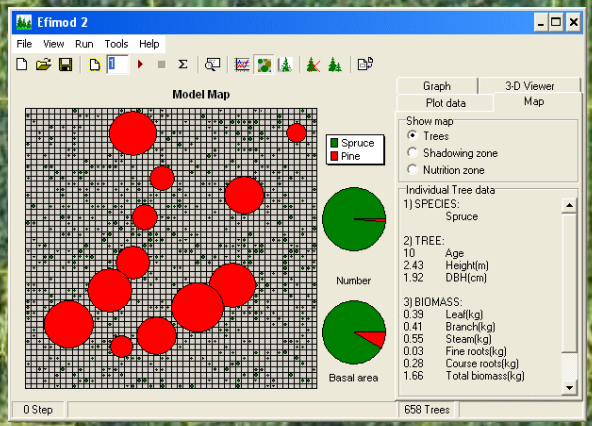
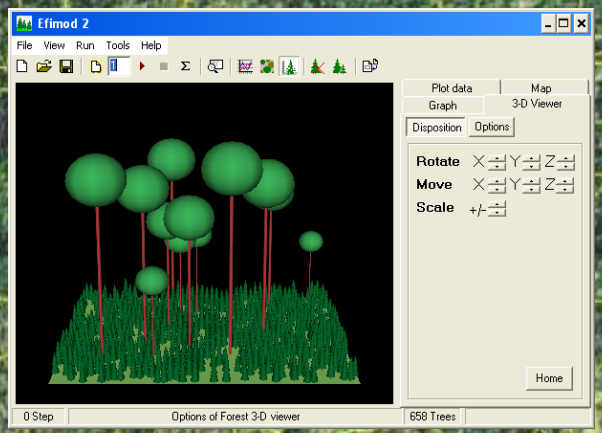
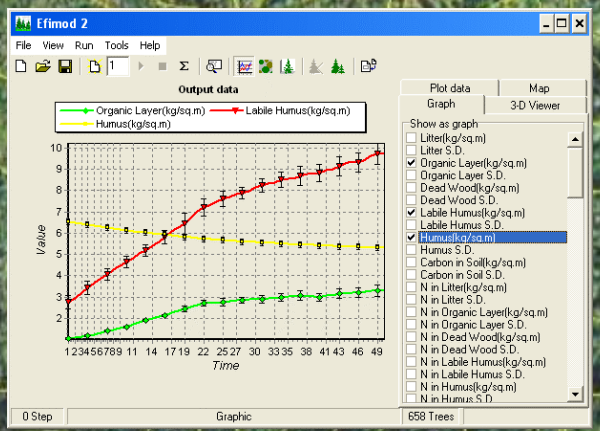
Objectives

- Implementation of the EFIMOD model for local level of forest enterprise at case study in Central European Russia
- Comparison of 4 different silvicultural regimes at long-term simulation
- Analysis of Carbon budget of forest territory
- Analysis of Biodiversity of forest territory
- Analysis of wood production of forest territory

Short description of the EFIMOD model



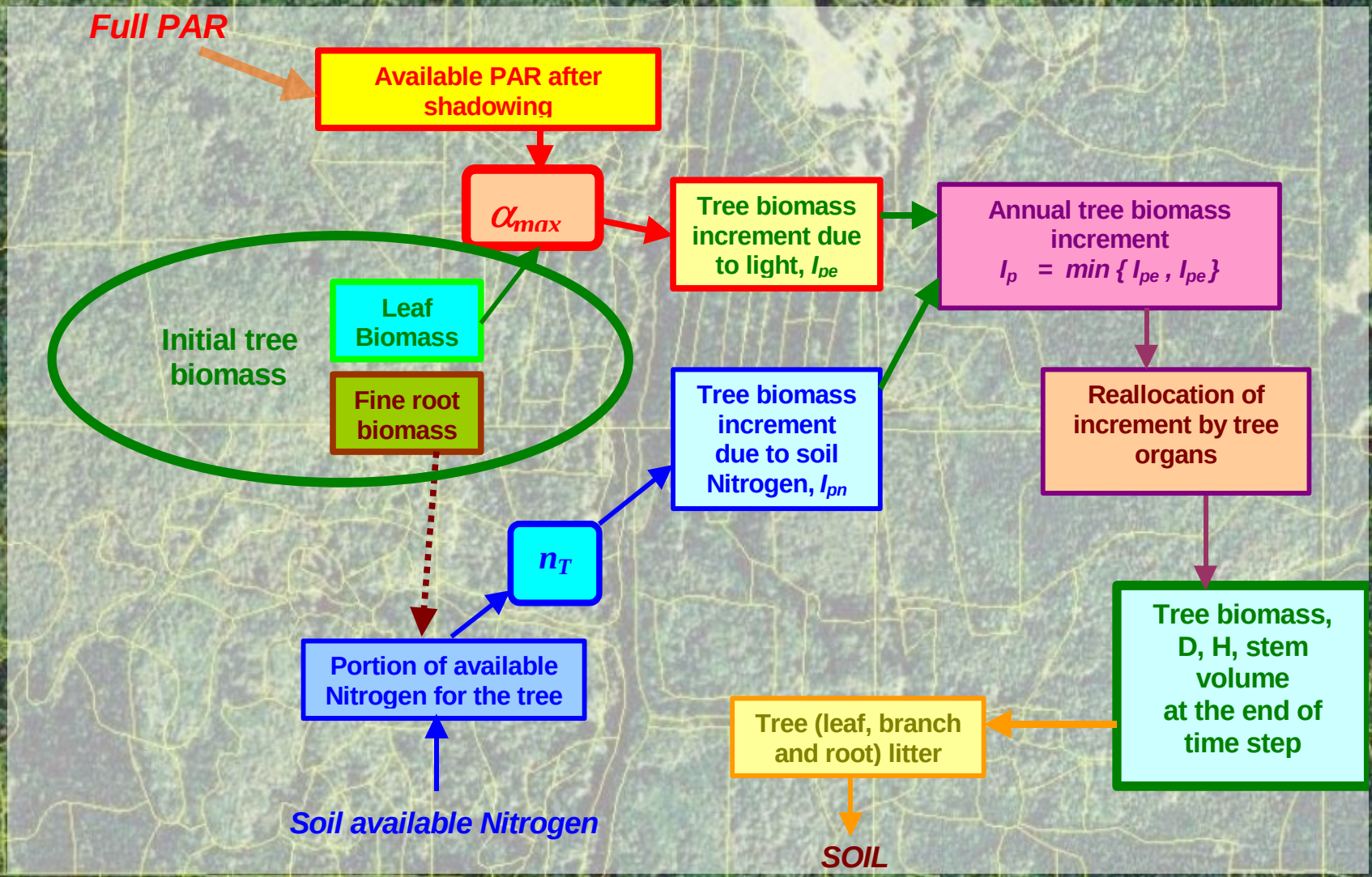




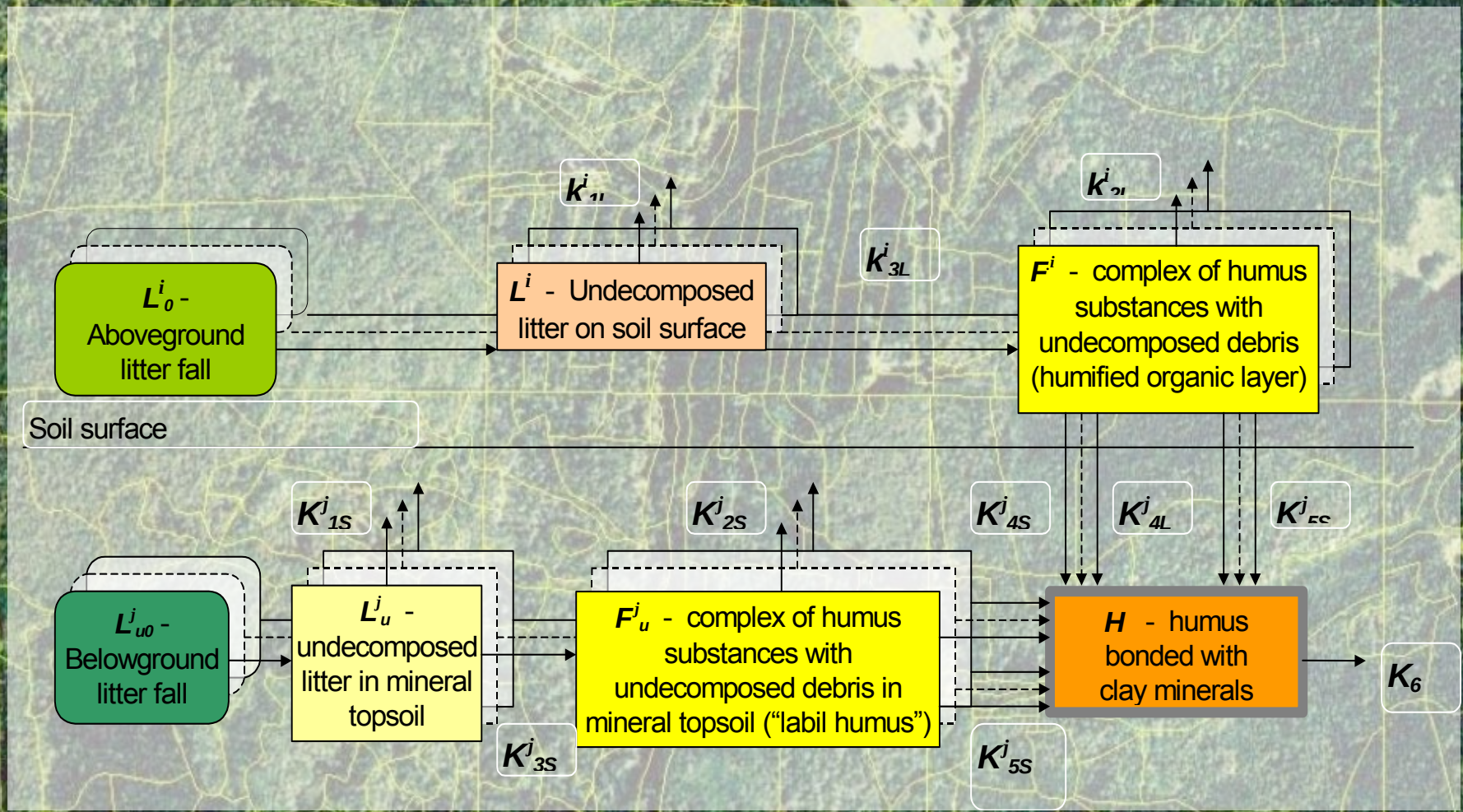
- EFIMOD is spatially explicit individual based model of forest ecosystem
- The system consists of 3 main parts: tree sub model, soil sub model (ROMUL) and statistical climate generator (SCLISS)
- Tree sub model is an individual growth simulator in dependence on light and soil nitrogen
- ROMUL is the model of forest soil organic matter dynamics
- SCLISS allows for estimation of soil temperature and moisture using measured standard long-term meteorological data

	Input	Output
Climate data	Air & soil temperature, Precipitation (Recalculated into forest floor & soil moisture)	Soil temperature and moisture with monthly step
Soil data	Pools of Soil Organic Matter and Nitrogen in forest floor and mineral soil	Pools of Soil Organic Matter and Nitrogen in organic and mineral soil horizons
Tree Species data	Potential growth, specific nitrogen consumption, allocation of biomass between tree organs	
Forest data	Tree species composition, number of trees, height, diameter with standard deviation	Tree species composition, number of trees, height, diameter, Growing stock, BA, biomass
Silvicultural data	Cutting regimes, type of cutting, rotation length	Harvested wood, removal of carbon and nitrogen from the ecosystem

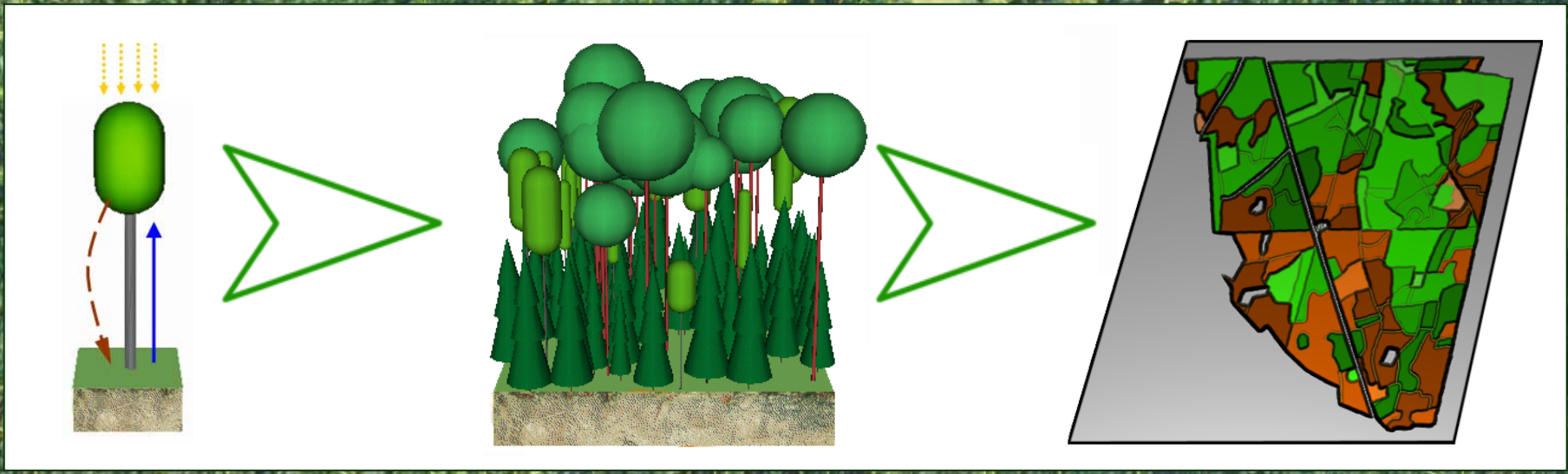
EFIMOD 2: Tree sub model



EFIMOD 2: Soil sub model ROMUL

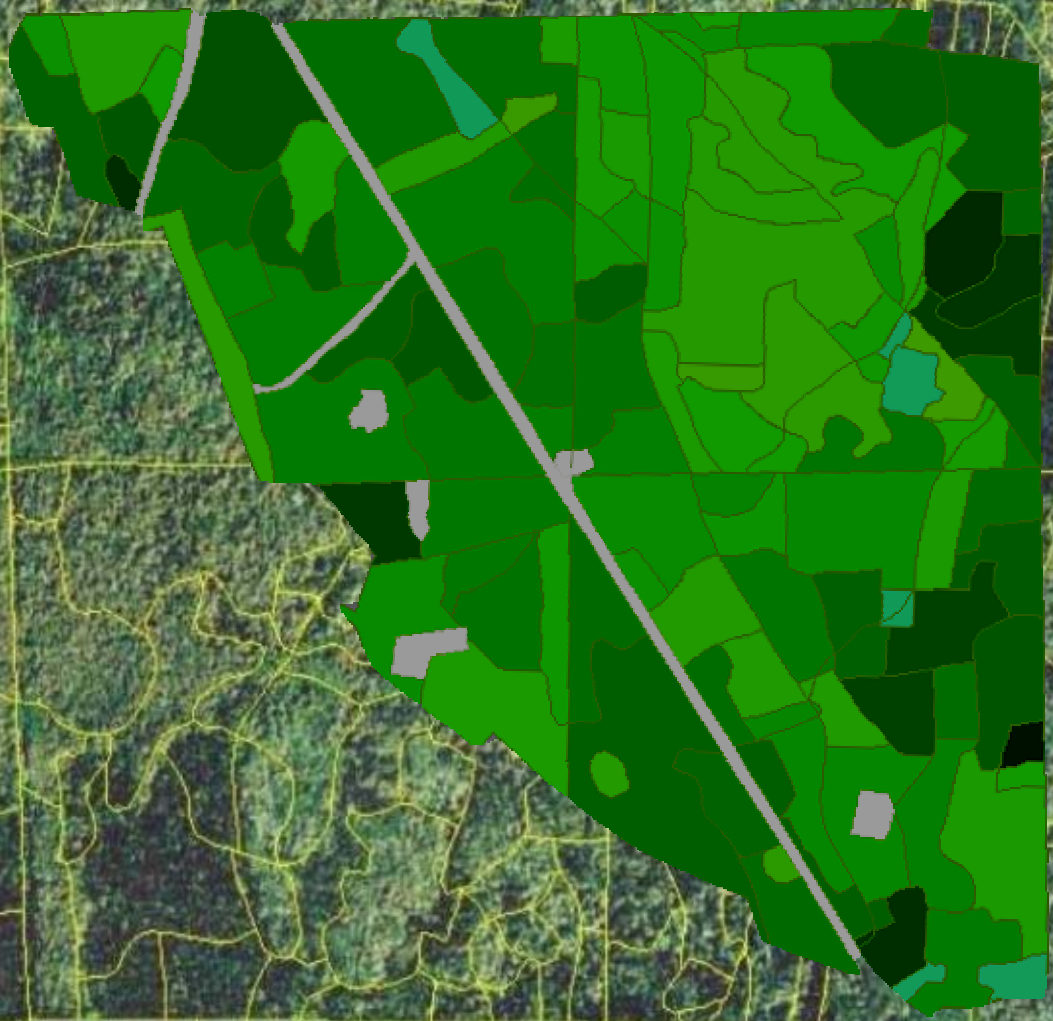


Model levels



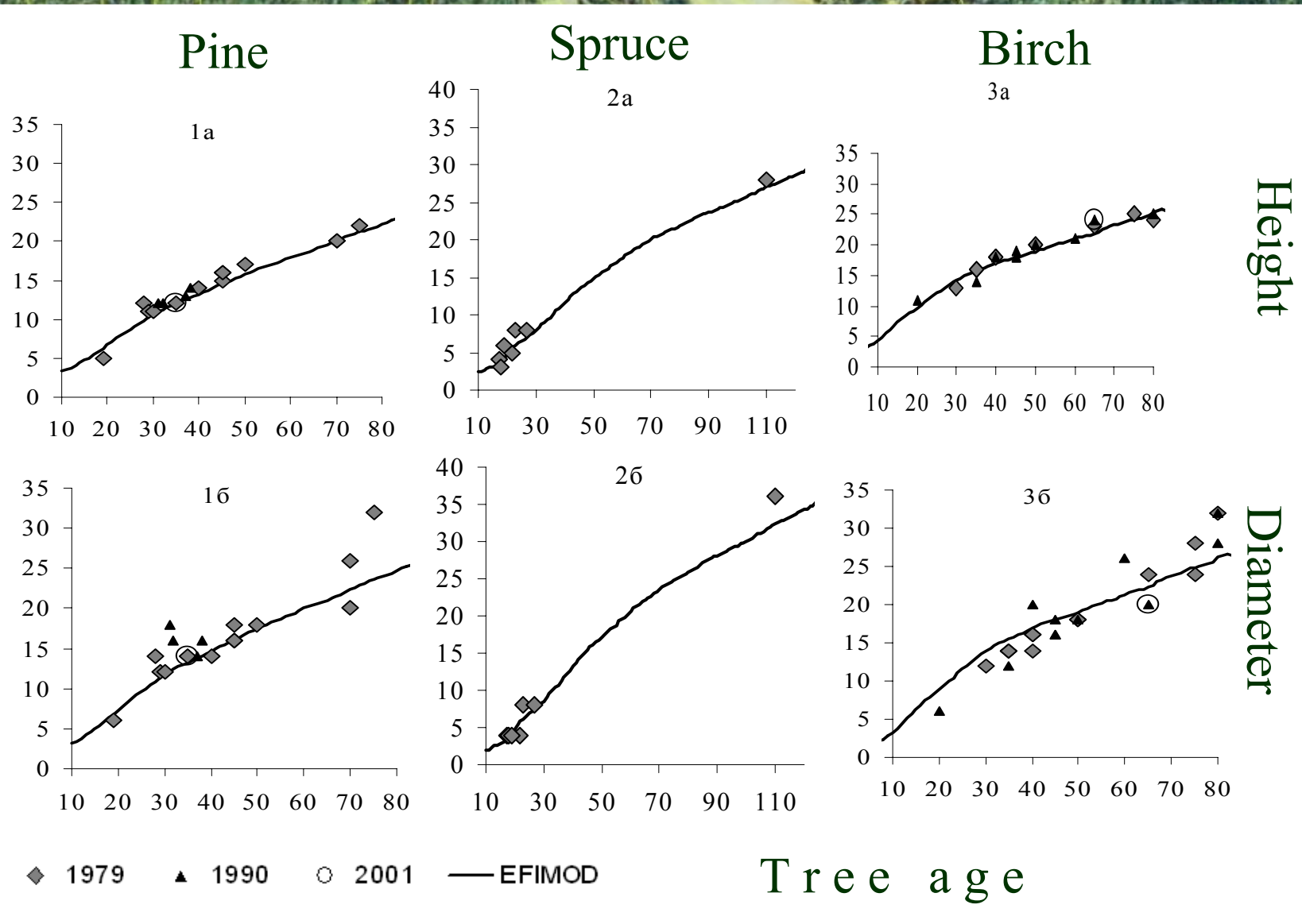
Modelling of single tree growth → Modelling of stand development → Modelling at local scale

Case study

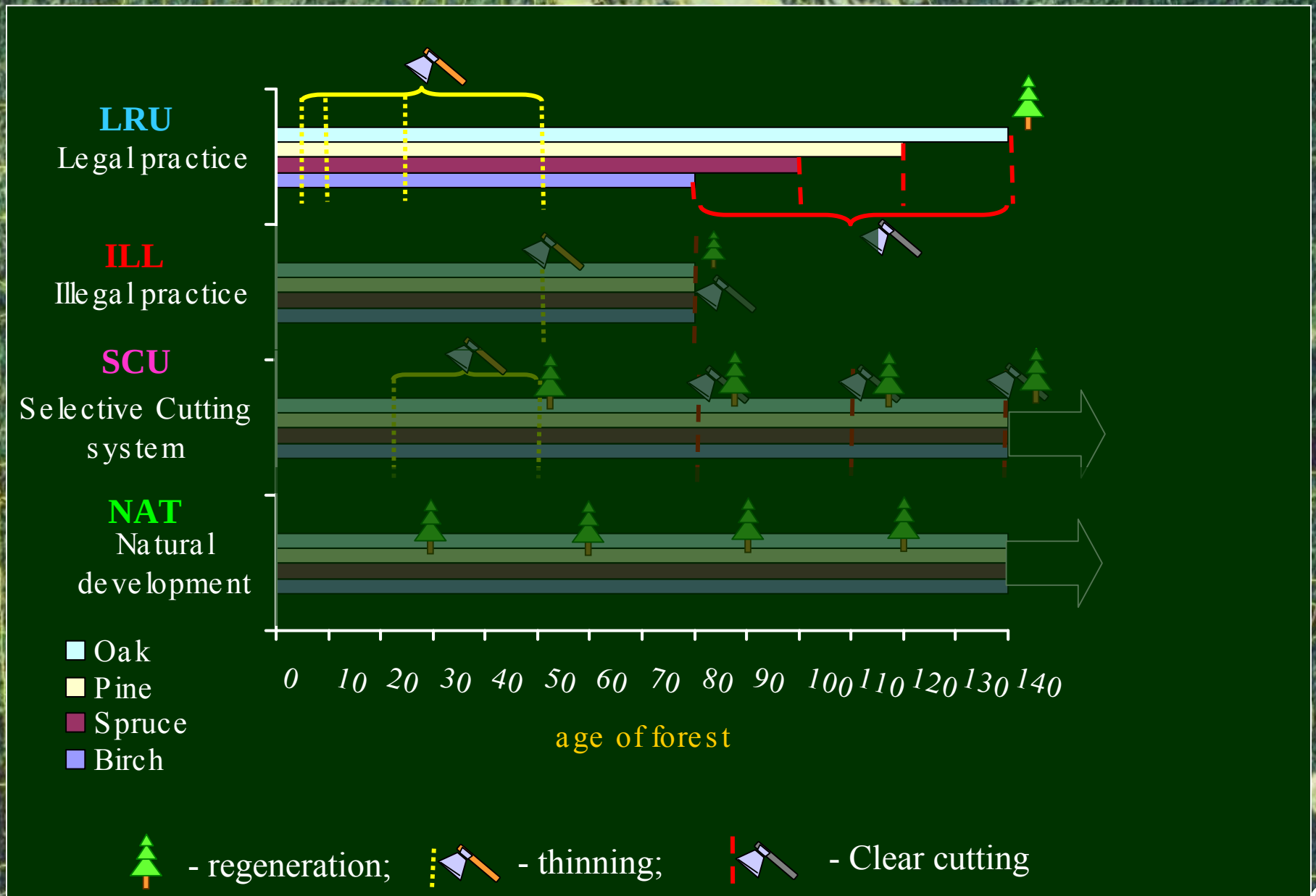


The State Forest "Russky Les" is situated 100 km South of Moscow (Russia) on Central East European Plain with continental climate of the border between coniferous and broad-leaved forest zones
It was selected 104 stands (Total area is 273.4 ha)

Model Verification



Silvicultural regimes selected for 200-year simulation

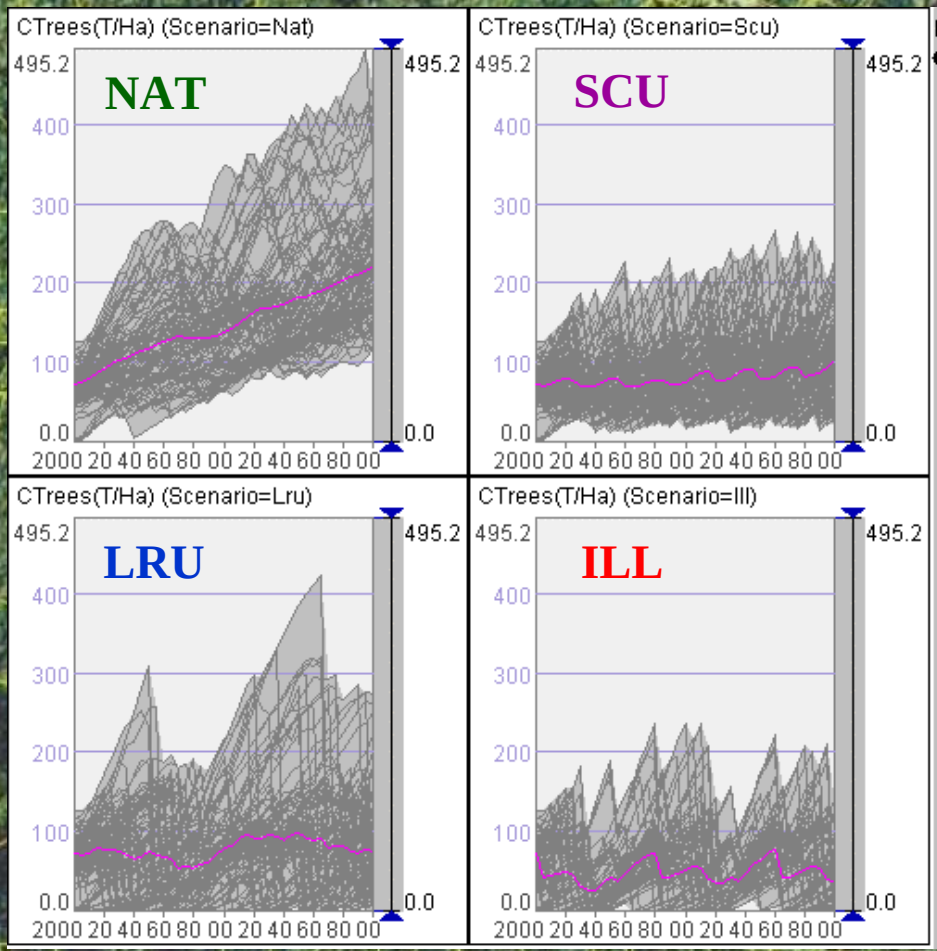


Silvicultural regimes selected for 200-year simulation

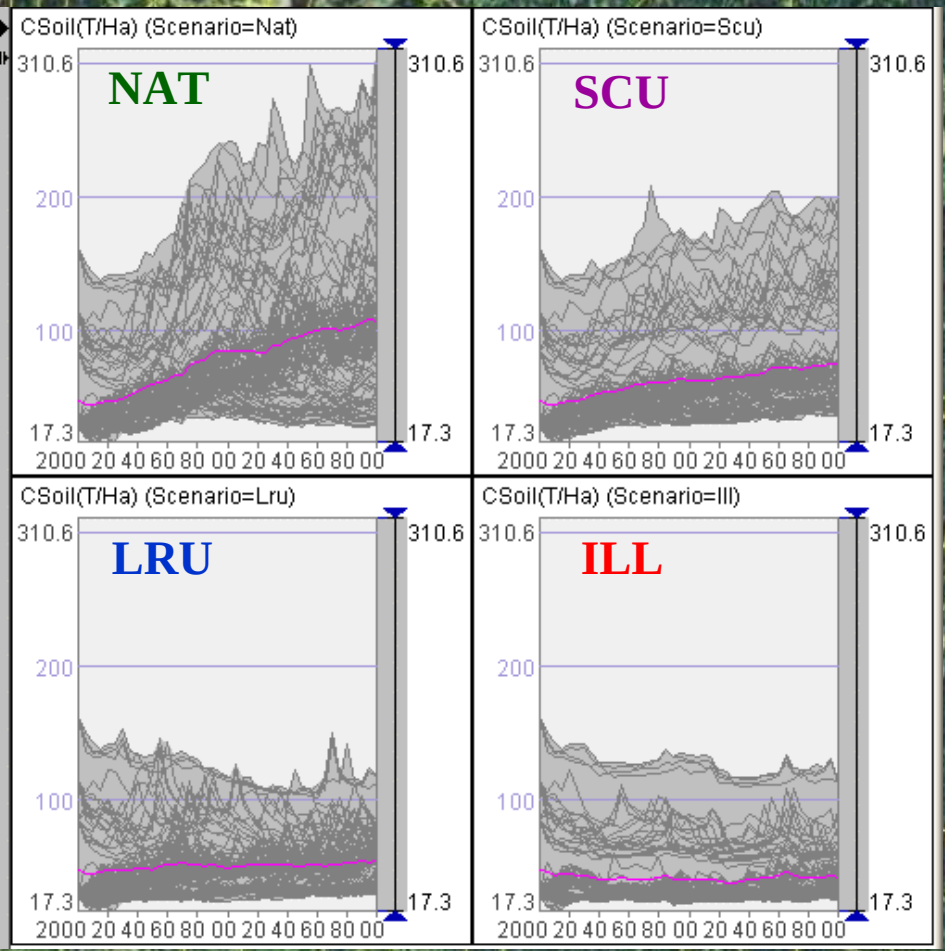
- *Natural development (**Nat**)*. This scenario is a full protection of the forest in all forest compartments without cutting
- *Russian legal practice (**LRU**).* The scenario describes managed forest with 4 thinnings (at 5, 10, 25 and 50 years), the final clear cutting (90 year age for coniferous and oak, 60 year age for birch and lime), with successful natural regeneration
- *Selective cutting system (**SCU**).* Managed forest with 2 thinnings and then selective cuttings each 30 years (30% of basal area from above)
- *Illegal practice (**ILL**).* It is a heavy upper thinning and removing of the best trees, clear cutting without conservation of natural regeneration

Carbon dynamics

Carbon in trees

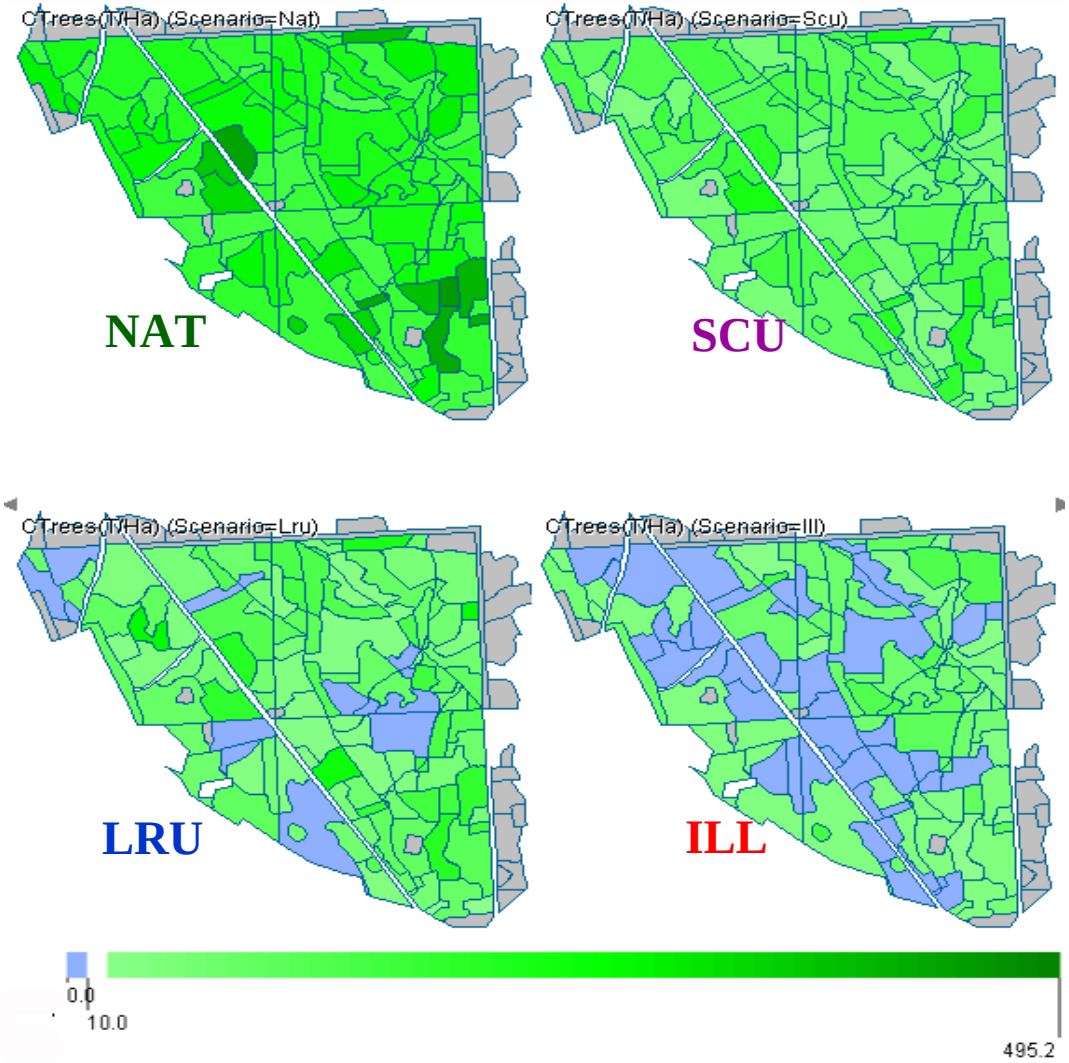


Carbon in Soil

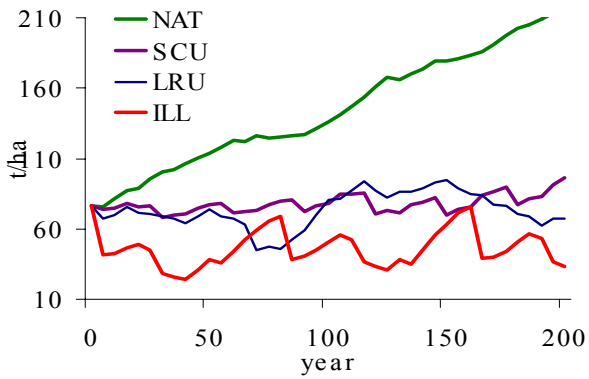


Carbon dynamics in stands

Difference of tree carbon between last and first time step of simulation



Mean value of Carbon in Trees



NAT – natural development

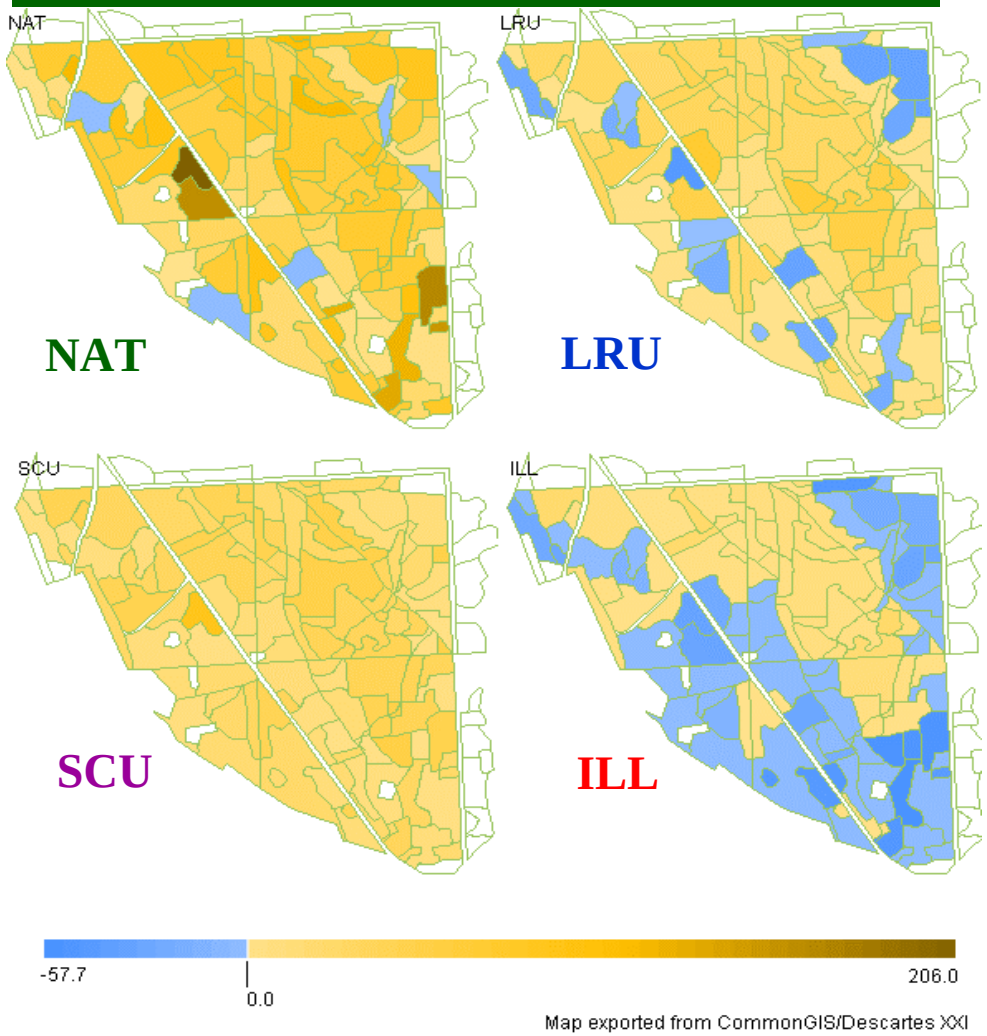
SCU – selective cutting

LRU – legal practice

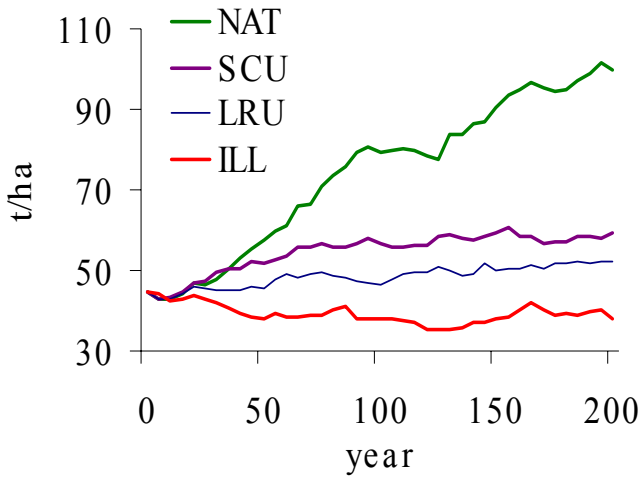
ILL – illegal practice

Dynamics of soil carbon

Difference of soil carbon between last and first time step of simulation



Mean carbon value in soil



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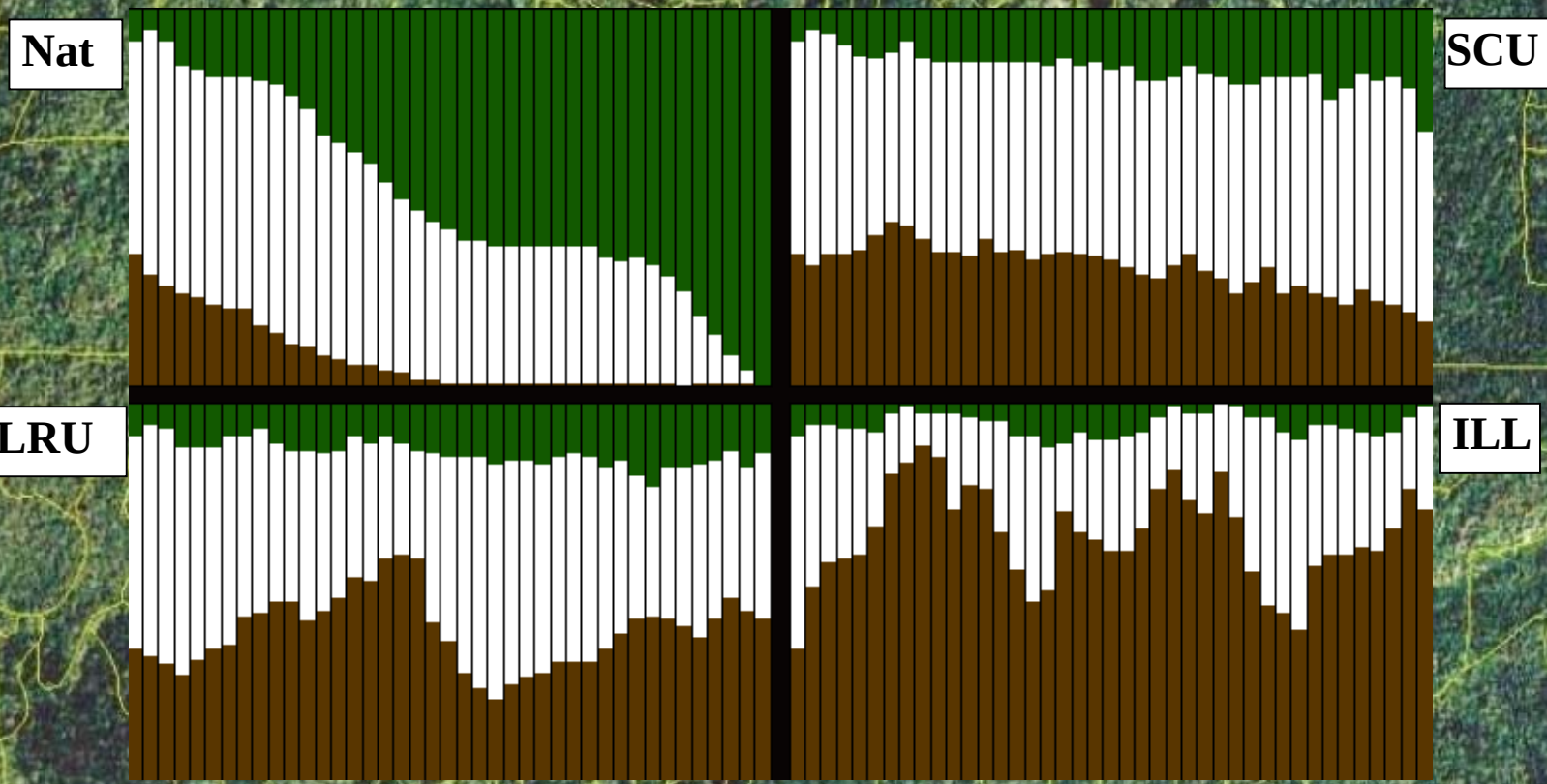
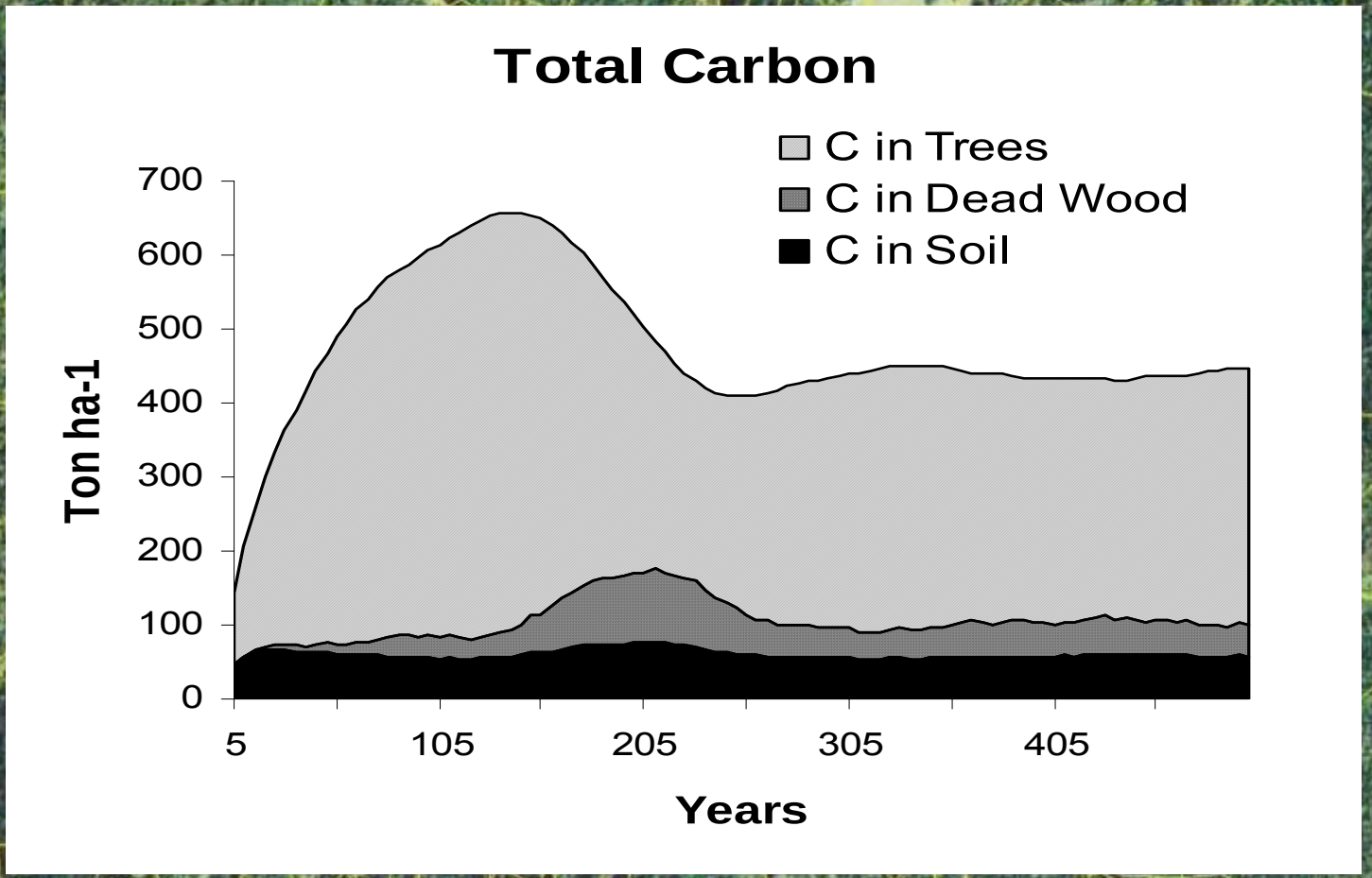
Frequency distribution dynamic of stands with different Carbon stocks



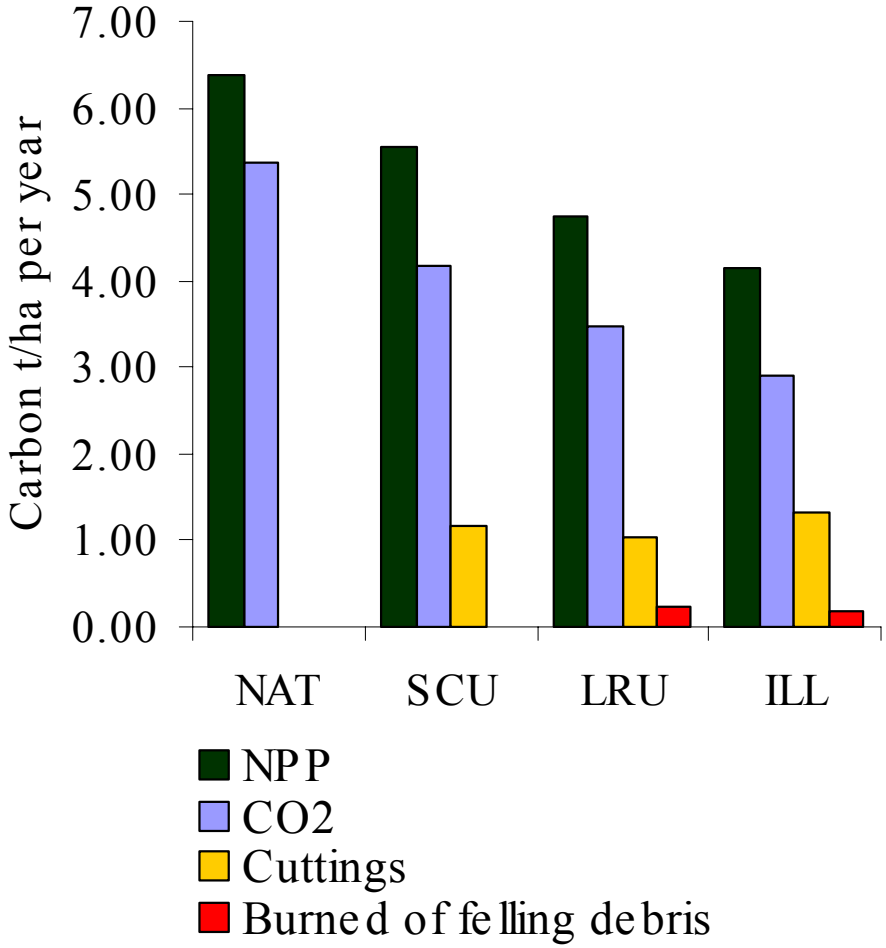
Brown: from 0 to 100 t/ha; **White** from 101 to 200 t/ha; **Green** from 201

Long-term simulation of natural development

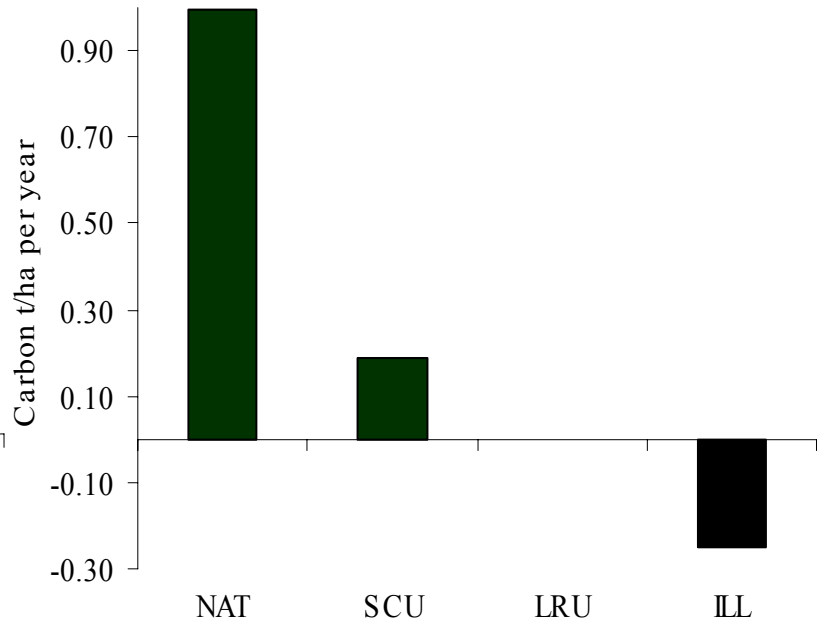


Carbon balance

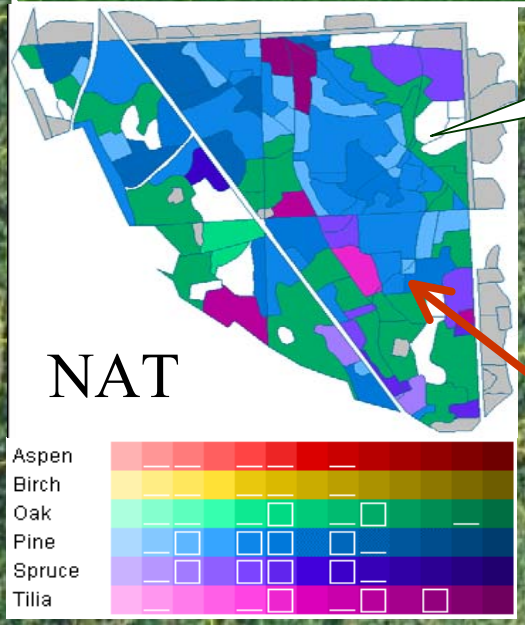
Carbon balance



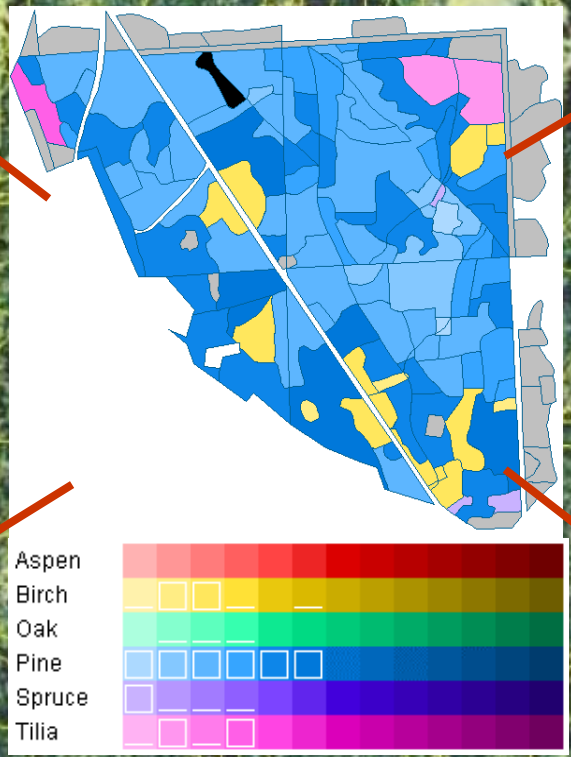
Carbon sourses and sinks

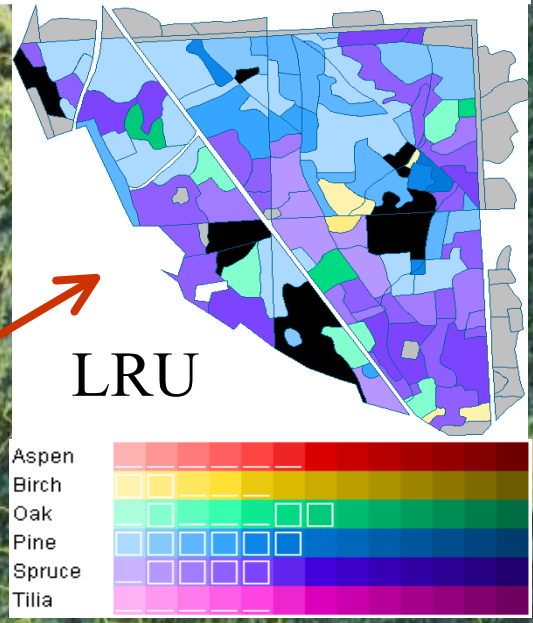


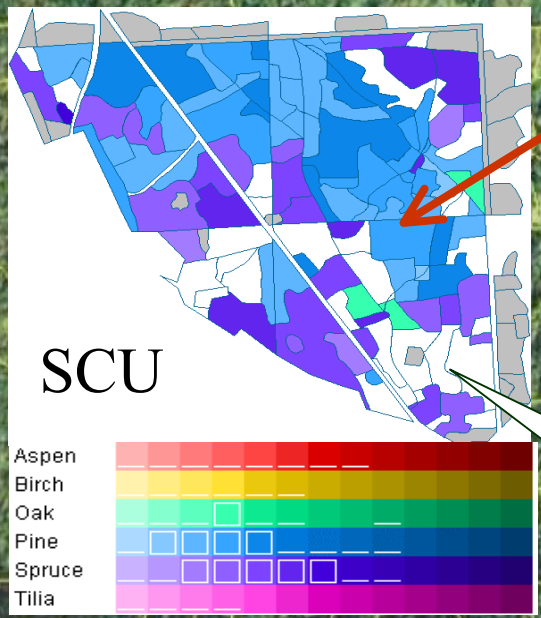
Stand composition



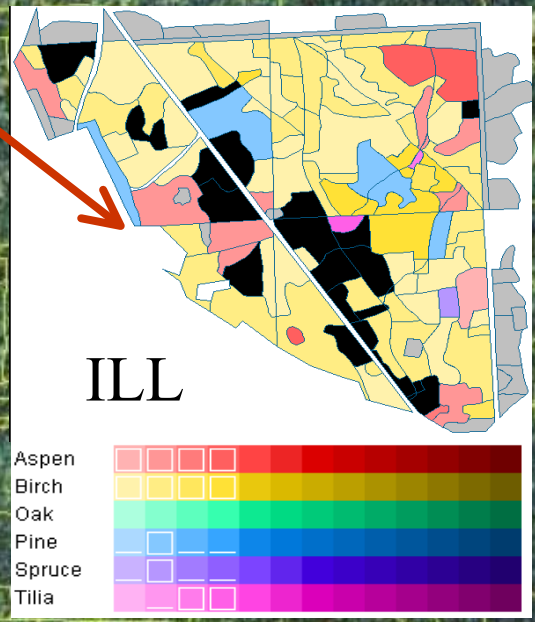
12.5 % mixed







23.1 % mixed



Conclusions

- Simulated forestry regimes show the different ecological and silvicultural effects
- Carbon sequestration: a clear advantage of selective cutting and natural development over clear-cut systems both in relation to stand biomass and SOM
- Biodiversity: selective cutting and natural development have higher proportion of mixed stands and deadwood. Russian legal forestry has also complicated spatial mosaics of stands of different age and composition
- Illegal practice leads to absolute domination of deciduous stands of low commercial value
- The silvicultural effectiveness of selective and Russian legal regimes is approximately the same. Illegal regime demonstrates lager volume of harvested wood due to heavy thinning

Acknowledgements

This work was supported by

- R&D Russian Federal Program “Global climate changes and its possible consequences”, contract № 43-016.11.1625
- Russian Academy of Science Program “Environmental and climatic changes: natural disasters”
- EU-INTAS grants 2001-0633 and 2001-0512

Thank you for your attention!