# Assessment of Climate Change for the Baltic Sea Basin - The BACC Project - 22-23 May 2006, Göteborg, Sweden

# Climate-related Change in Terrestrial Ecosystems

## 2) Potential Future Changes

Climate scenarios universally point to increasing temperatures in conjunction with rising greenhouse gas concentrations over the coming century. Precipitation patterns may change, with the temperate southern area of the Baltic Sea basin being subject to increasing growing season water deficits. Effects of changes in non-climatic drivers of ecosystem processes, including changes in land use and land management, constitute the greatest source of uncertainty in predicting overall impacts on terrestrial ecosystems.

**Major potential impacts** of climatic and other environmental changes on terrestrial ecosystems in the Baltic Sea basin up to 2100 are listed below. Relevant uncertainties are shown in blue text.

### Extended vegetation period

- Extension of the vegetation growing period by 2-6 weeks, depending on the magnitude of warming. Other factors, such as day length (which will not change), and physiological responses to the increasing risk for frost damage, may restrict phenological changes in plants.

### Changed species distributions and community structure

- Species distributional shifts tracking isotherm migration. Lags associated with population and community processes, dispersal limitations etc. are likely for many species, especially at southern/warm boundaries. Human land use, species choice in forestry etc. may overwhelm direct climate response (Fig. 1).
- Upslope migration of altitudinal treelines. Wholesale shifts in biome distributions, e.g. northward shift of the temperate-boreal forest limit, will likely be slow compared to the rate of isotherm migration.
- Transient changes in community structure and age structure in vegetation, possibly with an increased representation of shade-intolerant species, southerly/warm-climate species and younger tree age-classes.

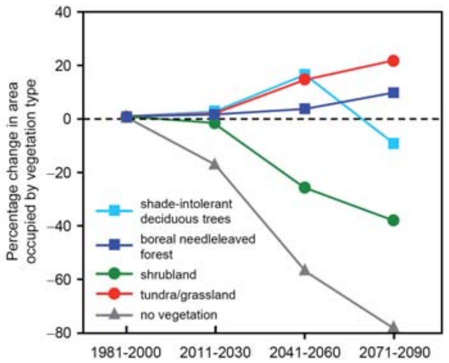


Fig. 1: Simulated changes in the relative cover of different vegetation types in northern Europe under a future climate scenario. Source: Wolf & Callaghan, submitted.

### Changed vegetation growth and ecosystem carbon sequestration

- Increases in ecosystem productivity and forest growth in northern (boreal) parts of the Baltic Sea basin where temperatures limit growth; negative to small positive changes in productivity in southern (temperate) area, depending on the magnitude of changes in water balance (Fig. 2). Climate effects on productivity will interact with multiple abiotic drivers including nitrogen deposition and mineralisation rates, acidification and "$CO_2$ fertilisation". Stress, disturbances, pests and pathogens may limit growth enhancement. Growth enhancement in forests will depend on species choice and management.
- Northern land areas are expected to remain a net sink for carbon, while in southern areas increased soil respiration combined with small or negative production enhancement may lead to ecosystem carbon losses (Fig. 3). Land use scenarios point to increased forest cover, tending to augment carbon sinks. Decreases in permafrost and ground frost at high latitude may liberate previously inactive soil carbon; changed hydrology might promote increased relative methane release, accentuating greenhouse forcing.

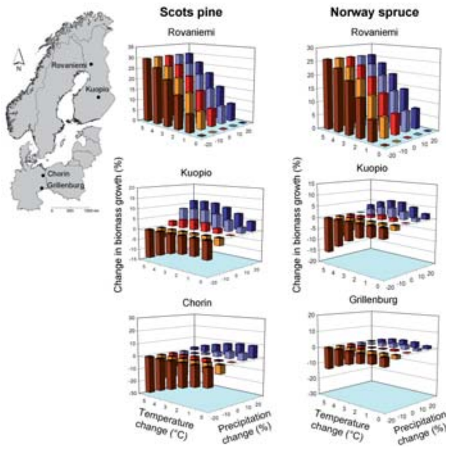


Fig. 2: Potential growth responses of Norway spruce (Picea abies) and Scots pine (Pinus sylvestris) to temperature and precipitation changes along a climatic gradient within the Baltic Sea basin, as simulated by a tree growth model. In northern boreal forests (Rovaniemi) growth is limited by temperature and growing season length and is insensitive to moderate changes in the precipitation regime. Temperate-zone forests (Chorin, Grillenburg) are subject to growing-season water deficits and benefit from increased precipitation, while increased evapotranspiration negates any positive effect of climate warming on growth. In the southern boreal zone (Kuopio), the net effect of plausible climate changes on growth may be positive or negative and depends on species. Source: SilviStrat project, Lindner et al. (2005).

### Enhanced susceptibility to stress and disturbance

- Increasing susceptibility of trees to spring temperature backlashes in some areas under some climate scenarios.
- Increased susceptibility to drought, especially in temperate parts of the Baltic Sea basin.
- Increased susceptibility to fungal pathogens and insect pests seems likely, but system understanding is limited.

Choice of species and provenance, e.g. in forestry, could mitigate risks for stress-related damage and mortality.

### Storm damage

- Increased frequency of wind throw in forests, especially in southern areas, older, recently-thinned and coniferous stands. Susceptibility will depend on combined effects of changing soil temperature, water content and snow depth on tree anchorage. Projected changes in storm strengths and frequencies are uncertain and differ among scenarios.

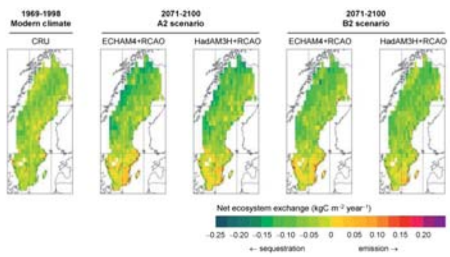


Fig. 3: Mean annual net ecosystem carbon exchange (kgC $m^{-2}$ $year^{-1}$) in Sweden simulated by a process model under the modern climate (1969-1998) and under four alternative scenarios of climate and atmospheric $CO_2$ concentrations in 2071-2100. Milder temperatures leading to an extended growing season, combined with "$CO_2$ fertilisation," increase vegetation growth and carbon storage in boreal central and northern Sweden, while unfavourable water balance combined with increased soil respiration result in net carbon losses in the temperate south. Source: Koca et al., in press.


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