TECHNISCHE UNIVERSITÄT DRESDEN

Climate Change – Some Considerations of Silvicultural Strategies

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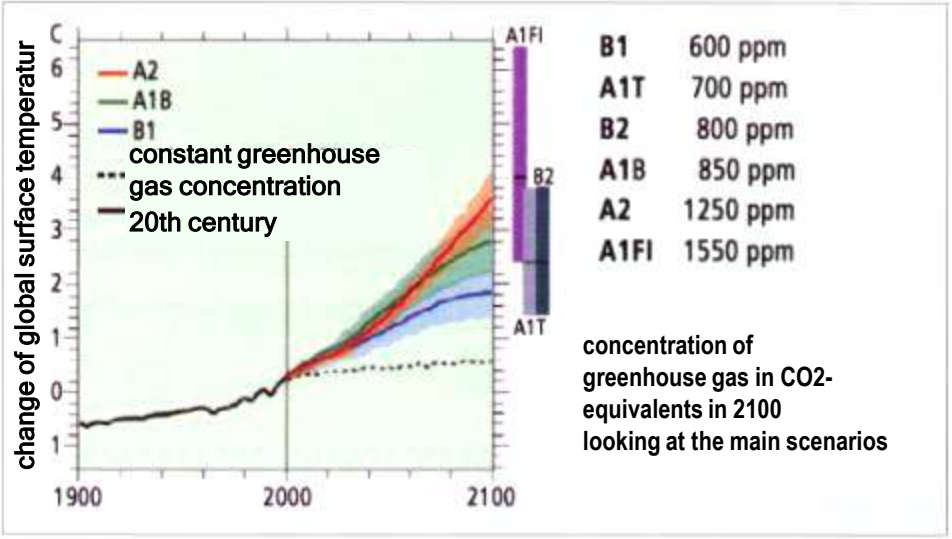
Environmental changes und problems for forests

- the predicted environmental changes (warming, less precipitation) meet established forest ecosystems.
- with respect to management aims: are there unacceptable disturbances?
- what about the ability to regeneration?
- what about the opportunities to cope with risks?
- multiple uncertainty makes it difficult to look and to plan ahead.

Uncertainty in predicting environmental factors (I)

- even if the climate forecast seems to be better and better - intensity and frequency of disaster occurrences are still open and interaction with other dynamical environmental factors are doubtful (such as nitrogen-deposition)



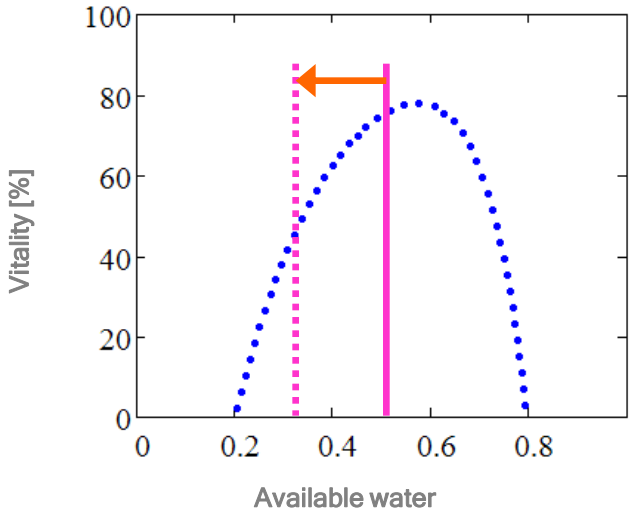
predicted temperature rise by different climate scenarios

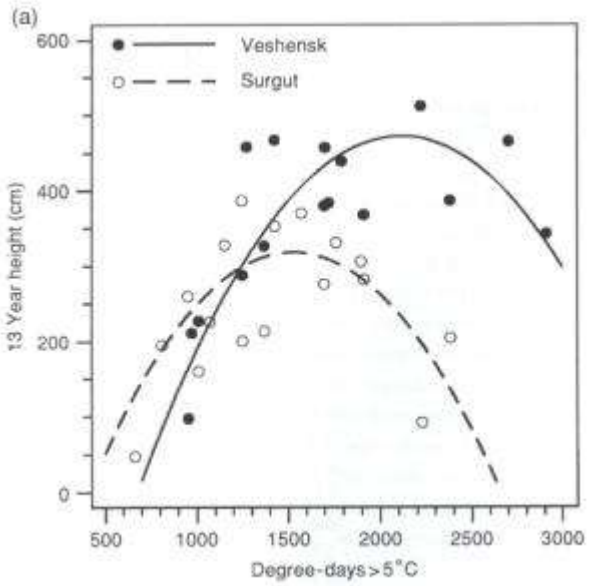
Uncertainty in predicting environmental factors (II)

- even though there is uncertainty there are already changes. These changes have to be considered!
- the adaptation of climate planning data in forestry, i.e. climate zones, to already existing changes is necessary (= update).

Uncertainty in predicting vitality of tree species (I)

- there is just one paper (Rehfeldt et al., ty of sing special p

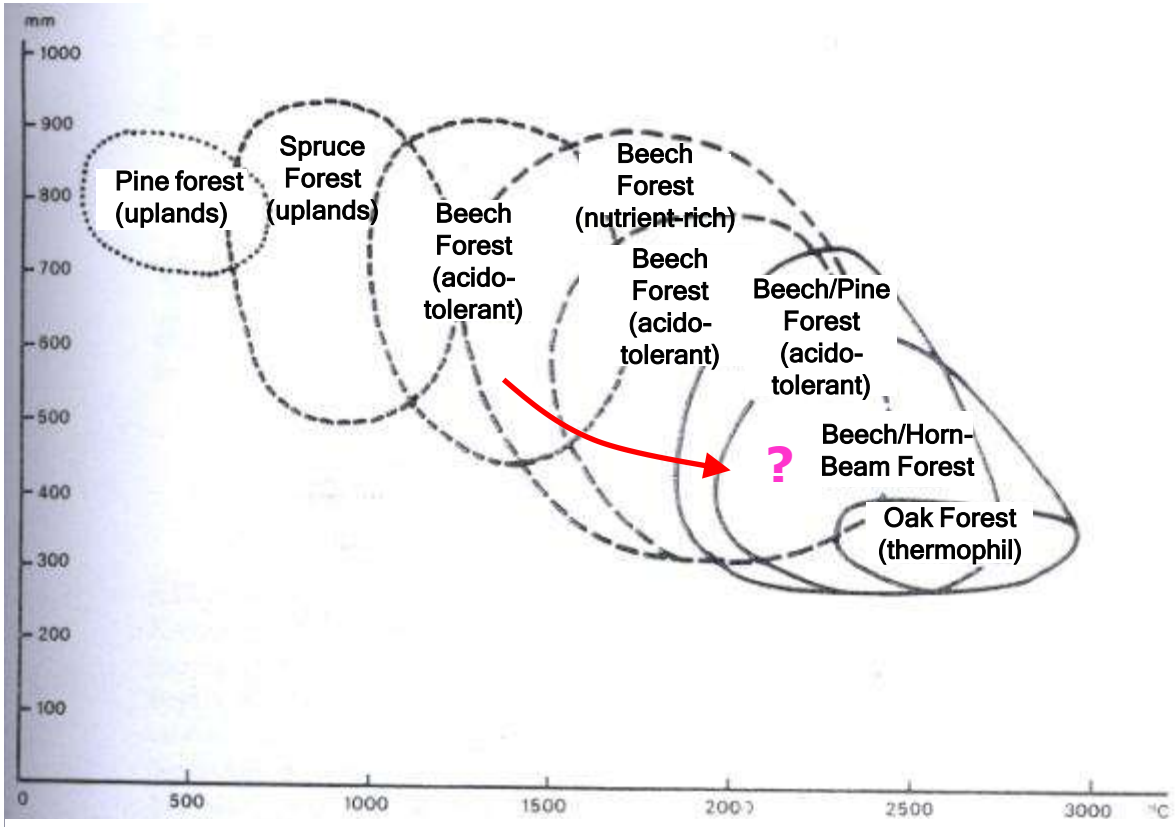




Height of 13 years old Pine stands stocking on different sites and climate situations (duration of vegetation period).

Uncertainty in predicting the outcome of interspecific competition (I)

- great difficulty in forecasting competition outcome, because the analysis is retrospective



Dependency between the presence of forest community in the CSFR and sum of temperature as well as precipitation (in: Matejka, 1976)

in: Thomasius, 1991

Uncertainty in predicting the outcome of interspecific competition (II)

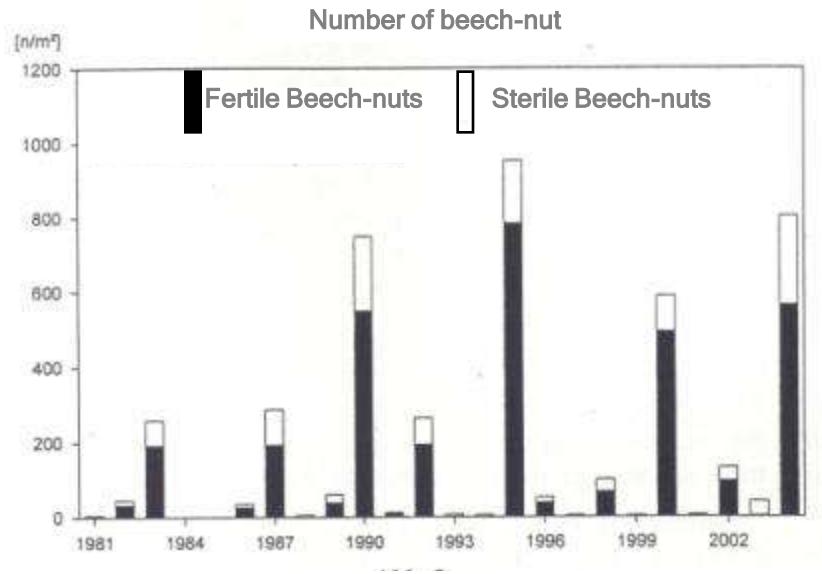
- the combination of environment factors will probably change in future. We do not have experiences for these situation.

  ➡ the diagram shows an example:

  the increasing frequency of masting during the last 20 years in beech.

  reason for this observation?

  climate change or nitrogen-input?



Masting of beech (nuts/m²) at the Göttinger Wald site from 1981 to 2004 (1984: no data available).

In: Schmidt, 2006

Interim result

- beyond every uncertainty the experts feel confident
  - that most of the regions will get more warm and more dry,
  - that we will get more of extreme occurrences (dry spell, storms)

  → Intensity and serious consequences depend on the site.

  - that the pace of these changes could overcharge trees and stands in their adaptability.

  - that tree species are affected in a specific way,

    in particular
    - Spruce will turn out to be a problematical tree species (depend on the site!)
    - tree species with a high climate amplitude probably will be more robust (such as common oak, birch trees or Douglas fir)

Strategies to cope with uncertainty

- One may differentiate between three strategies:
  - (1) management strategies in order to assure specific services in the next century
  - (2) management strategies in order to absorb uncertainty
  - (3) management strategies to cope with the trend of dynamics

(1)management strategies in order to assure specific services in the next century

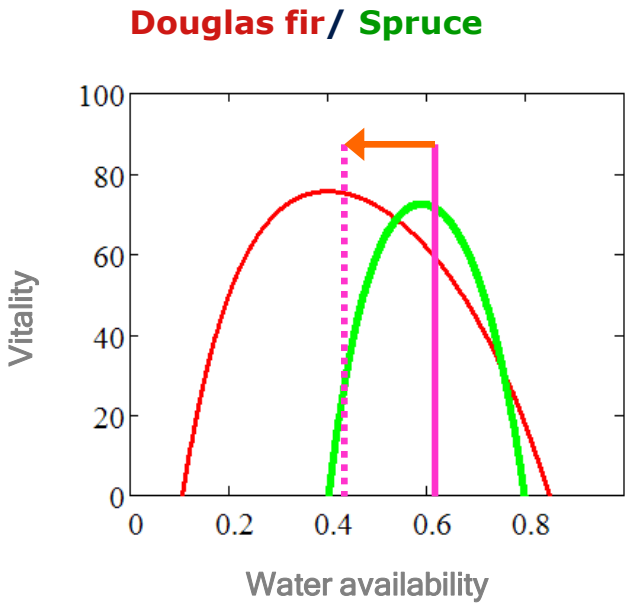
- in case of site change (~ climate change) with constant consideration of current forest services (e.g. harvest profit) forest conversion is needed

  ➡ forest conversion with the objective of forest services.

- 1. adaptation of current horizontal stand structure in medium-term
  - Diminishment of water availability ➡ readapting stocking grades, adjusting thinning regime.

(1)management strategies in order to assure specific services in the next century

- 2. adaptation of stands by long-term regeneration management
  - vectored climate change ➡ increasing tree species proportions which are better adaptable.
  - in case of decreasing vitality the alternative tree species might compensate growth deficit.
  - establishment of these tree species in pure or mixed stands.



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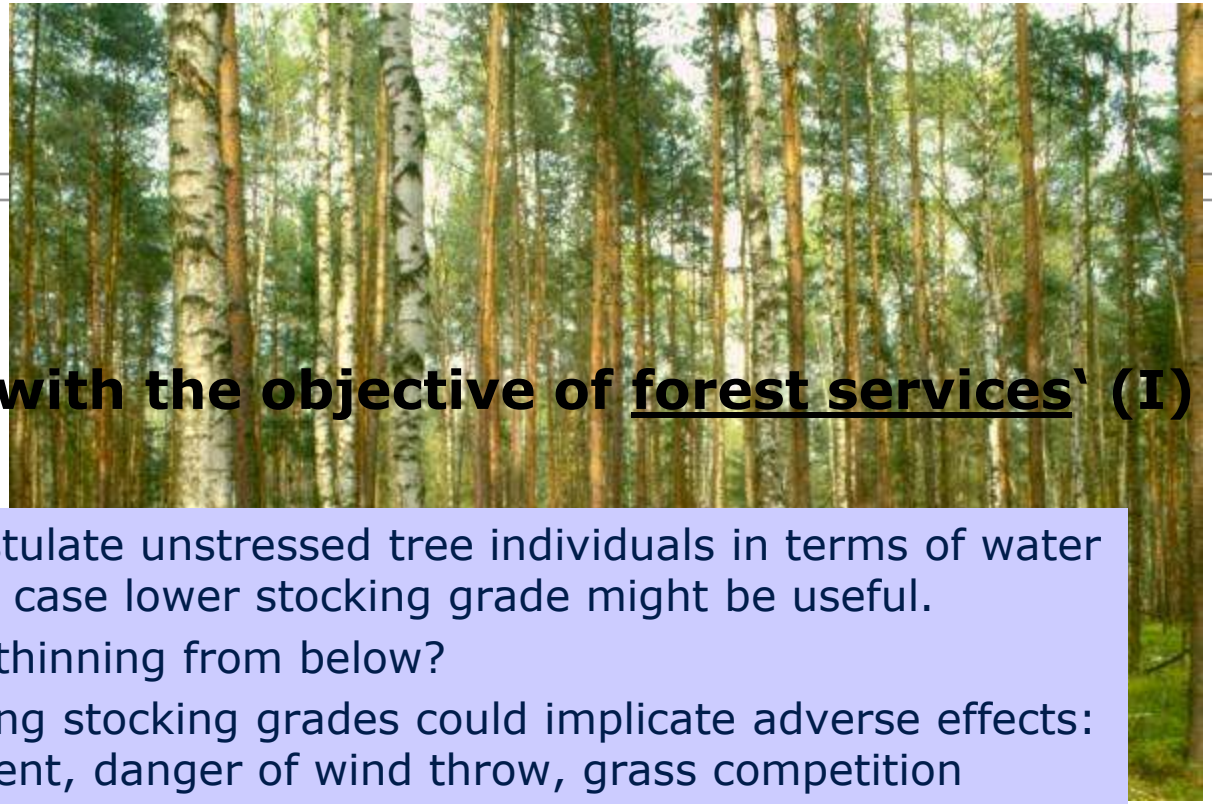


Interim result
‚forest conversion with the objective of forest services' (I)

- forest services postulate unstressed tree individuals in terms of water availability. In this case lower stocking grade might be useful.
  crown thinning or thinning from below?
- but then: decreasing stocking grades could implicate adverse effects: decreasing increment, danger of wind throw, grass competition

- tree mixtures might compensate decreasing volume increment.
- but then: the management of mixtures is delicate, are there problems in marketing?

Interim result
‚forest conversion with the objective of forest services' (II)

- forest conversion with the objective of forest services can be a radical solution – especially in case that tree species composition is changed spaciously.
- taking uncertainty for granted, a spacious change in tree species is most of all problematical.
- However, all recent information of site investigation are essential when arranging tree species regeneration.

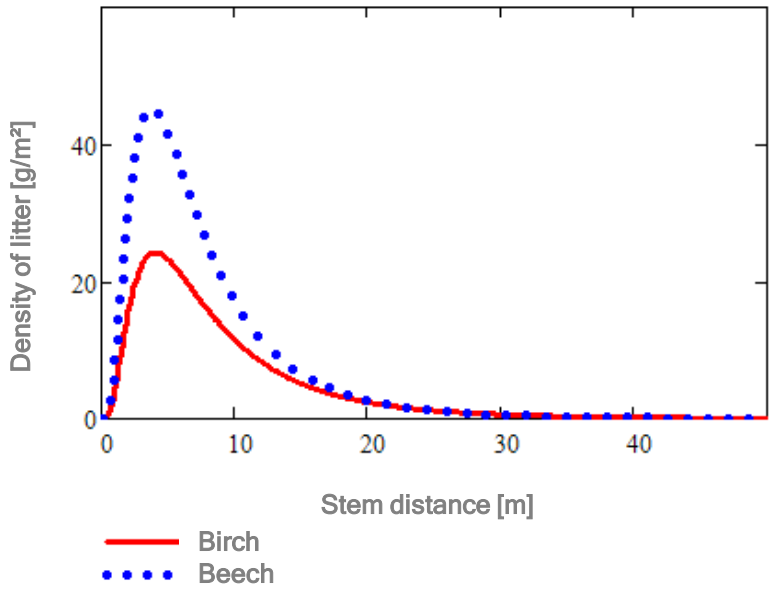
(2) management strategies to assure sustainability

- all mentioned uncertainties (e.g. climate change, reaction of tree species, increasing frequency of disturbances, marketing situation) could be mitigated by a management strategy focussing on sustainability issues!

- This means: conservation or regeneration of
  - site productivity
  - biological diversity (in particular of key-species)
  - the ability to (natural) regeneration of stands
  - vitality of single trees and stands

Site productivity

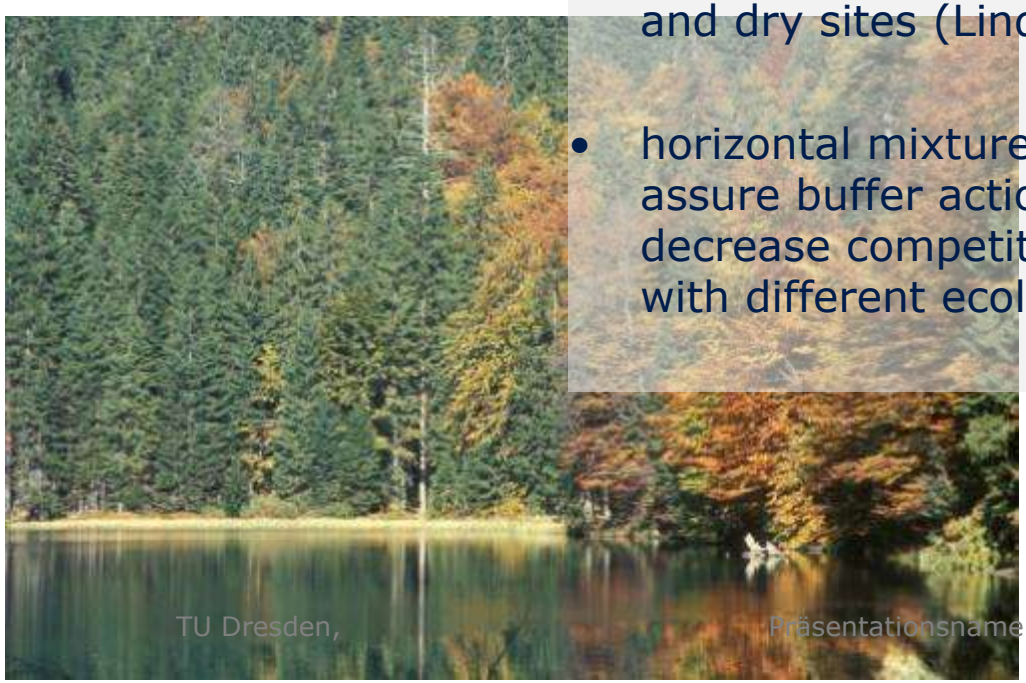
- site adapted tree species – in particular with intensive root system and mixed stands
- spacious presence of litter material easy to mineralize – by managing with main tree species or convenient mixture
- herbaceous ground vegetation – no dark stand situations



Distribution of litter material surrounding single trees

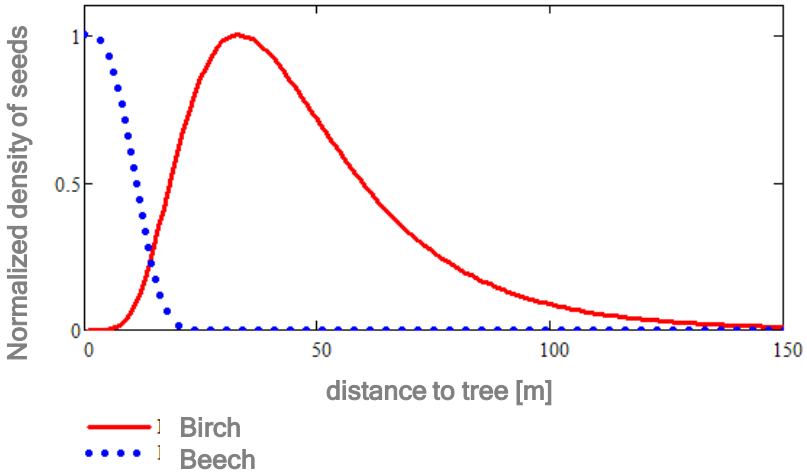
Biological Diversity (in particular of key species)

- consideration of differences in site potential, establishment of different tree species, variety of harvesting and thinning techniques, leaving dead wood.
- pioneer tree species (Birch, Aspen, Pine), Oaks and Douglas fir, as well as tree species adapted to warm and dry sites (Linden, Black Locust).
- horizontal mixtures (different small aggregations) assure buffer action with respect to increment and decrease competition problems between tree species with different ecological requirements.



ability to (naturally) regenerate stands

- extensive participation of pioneer tree species (e.g. Birch). promotion of trees with limited dispersal potential (e.g. linden).
- preservation of genetic transfer between individuals (paying attention to maximum distances!)
- application of species-appropriate harvesting techniques → diversity!



Density of seeds in dependency to distance of mother tree

(standardized to maximum density value:

Linden = 50/m², Birch = 1500/m²)

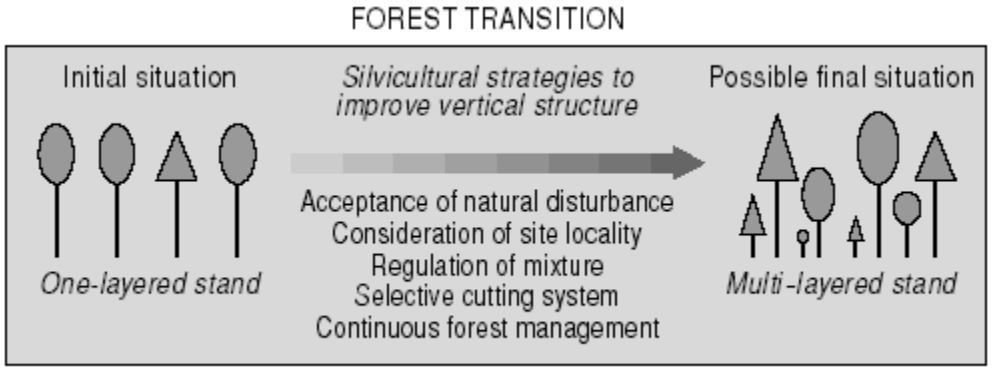
Vitality of single trees and stands

- utilization of site adapted provenances (urgent need of research)
- restricted utilization of tree species with oceanic distribution (such as Spruce).
- forest management in favour of crown vitality (life crown ratio, crown volume) → early and intensive crown thinning)

Interim result „ forest conversion to assure sustainability‘ “ (I)

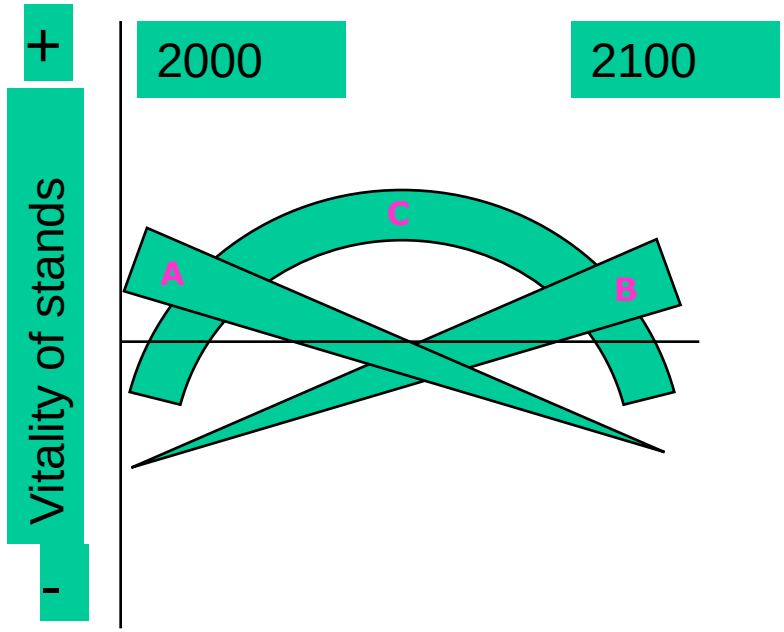
- in contrast to radical forest conversion (as before) forest transition with the objective of sustainability definitely makes sense. There is not much of economical risk.

- forest transition with the objective of sustainability is practiced in many forest districts in Germany (since approx. 15 years). A continuation and extrapolation with special attention to climate change might be a solution of different problems



(3) techniques to cope with the trend in dynamics

- The dynamics of environmental factors is contradictory to management strategies which are statically determined; but nevertheless, the forester have to decide on the planning period.
- Three time horizons for planning may be distinguished; focussing on
  - A. the beginning of the period (classic idea of constant conditions)
  - B. the end of the period ("panic scenario")
  - C. the middle of the period



Adapted from Profft &. Frischbier, 2008

- promising strategies:
  - pioneer crop (Birch above Oak, Alder above Beech and Fir)
  - advanced planting (Oak under Pine, Beech under Spruce)
  - natural regeneration under old stands (Oak, Rowan berry under Pine)
  - temporarily mixtures (Spruce in Beech)

IV. Conclusions (I)

- Importance of disturbances and the ability of stands to proper regenerate have to be discussed against the background of the forest services in demand.

- forest conversion with the objective of forest services implies the knowledge to adapt the tree species to climate change. In particular Spruce will not meet the future demands of timber production on each site (decreasing growing potential, lower mean life span of stands). We have to initiate management with productive tree species resilient against climate change (Douglas fir, Oaks).

- stand management – regulation of mixture, regulation of stock density, promotion of individuals with high growth capacity – is in high demand. We have to modify conventional strategies or we have to develop new management strategies by objective-orientation.

IV. Conclusions (II)

- forest transition with the objective of sustainability is a long-needed and practised strategy in many forest districts. Climate change should provoke renunciation of ‚euphoria of forest-conversion'. It demands a great deal of new ecological knowledge.

- chemical cycles have to be closed and they should be efficient in order to assure biodiversity, the potential of natural regeneration, or vitality of tree species. These are elements of management strategies in case of uncertainty (both, ecological and economical).

- we have to safeguard a variety of tree species with different ecological demands. ➡ mixed stands with pioneers and tree species resilient against climate change and disaster occurrence.

- we can manage in a comparably extensive way when organizing our stands with the objective of sustainability. In contrast, forest conversion with the objective of optimisation for single forest services is an intensive interference in the ecosystem. Situation is much easier when looking at forest transition with focussing on sustainability.