INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

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MOUNTAIN SILVICULTURE AFTER THE HEAVY AIR POLLUTION STOPPED

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DECISION MAKER HAS TO KNOW WHAT WAS THE HISTORY OF THE FOREST LIKE

- **Long human influence started with the colonisation of the mountains and lasted to the late middle ages: or mining, glassworks → pasture**
- **regular forest management (since the end of 18th century and then developed**
- **the latest history = impact of air pollution (immissions) (1950) 1975 – 1995 (2000)**

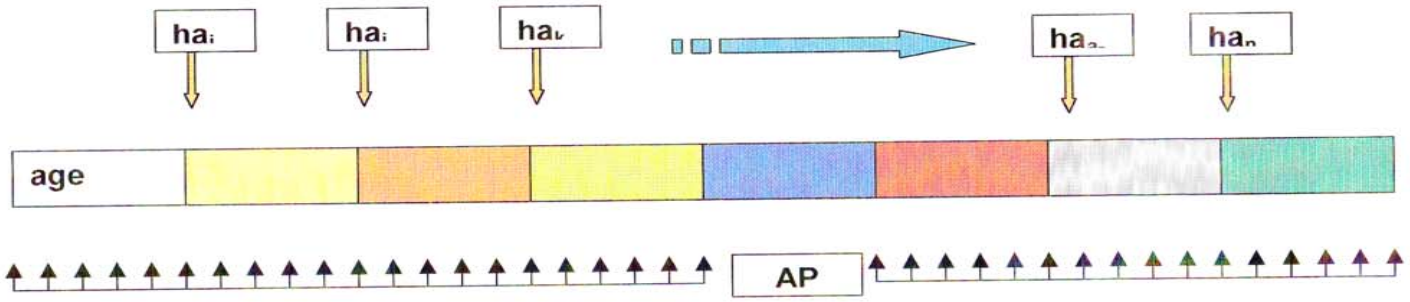
Main features of the mountain forest

Delimitation of the mountain forest in the gradient of ecological conditions

Characteristique of the ecotope and natural species composition

Czech mountains

Mountain range	thousands of ha	AVZ (%)				
		5	6	7	8	9
1 Krušné hory	99,6 (63,8)	31	26	28	8	
11 Český les	63,0 (21,6)	62	31	4	0,1	
13 Šumava	140,4 (134,2)	4	57	29	9	1
14 Novohradské hory	11,1 (10,4)	7	81	12	-	-
21 Jizerské hory a Ještěd	32.9 (24,0)	22	40	8	13	
22 Krkonoše	34.0 (31,8)	6	42	19	21	11
23 Orlické hory	22,0 (16,8)	23	57	18	1	
27 Jeseník a Králický Sněžník	555,1 (41.0)	25	39	22	9	2
40 Moravskoslezské Beskydy	51,7 (36,1)	74	9	1	0,03	



synergism

FUNDAMENTAL KNOWLEDGE OF THE BEHAVIOUR OF FORESTS UNDER THE AFFECT OF AIR POLLUTION

1 The effect of air pollutants on the forest stand **amplifies the natural process of the decline of low-vitality trees whose growth has been suppressed**.

Trees in the main level are affected only **upon a sudden exposition** to heavy air pollution load or **with the proceeding time** of the pollution impact. The natural process of the decline of low-vitality trees is accelerated

2 The physiological effect of air pollution **speeds up the ageing of assimilatory organs**, old needles fall, young needles are incapable of photosynthetic performance and consequently the production performance of tree crown would decrease. Susceptibility to air pollution impact increases with the increasing

FUNDAMENTAL KNOWLEDGE OF THE BEHAVIOUR OF FORESTS UNDER THE AFFECT OF AIR POLLUTION

3 **Harmfull physiological agent, which determines the size and dynamics of damage to stands, is not only the mere concentration of the noxious substance but rather**

its *multiple with the velocity of airflow* as a so-called *immission flux*. It acts specifically according to macro-, meso-, and microscale:

a) on a landscape scale, the damage increases with the increasing altitude and hence with the increasing airflow velocity, which has a greater share in the resulting injury than other factors.

b) Stands affected most in a forest complex are those in the terrain relief exposed to the increased airflow.

c) The air flow affects physiological and growth processes inside the forest stand; the more airflow penetrates into the crown layer, the greater is the tree exposure to pollutants. The stand disintegration is more dynamic if the crown canopy is open or gappy.

The effects of immission flux may be controlled at all scales by silvicultural measures.

Common differentiation frameworks for the management

Management complexes (MC)

(given by the environment conditions)

51, 53, 55, 57, 59,

71, 73, 77, 79, 01, 02, (03)

Forest categories (FC)

according to forest functions (given by the social requirements and prescribed by forest policy decisions)

One of the difficulties of the mountain silviculture: more forest functions required on the same management units → multipurpose management systems under difficult nature conditions

Target management units (TMU)

as intersection of MC with FC

Air pollution (AP) load as a crucial differentiation framework for decision making

There are two basic differentiation frameworks concerning the AP for the application of partial silvicultural measures or silvicultural or forest management systems as a whole.

By classes of damage is *actual status* of the forest stand classified. A scale from 0 to 4 was and still is used. The damage classification is important particularly for immediate silvicultural and logging operations.

Long-term planning was based on the so-called zones of exposure to danger. The four zones - A, B, C, D are defined according to the *survival time* of forest stands from the beginning of air pollution impacts to the moment of the entire destruction of the stands. The zone A vitality is up to 20, the zone B up to 40 years whilst the zone D had the vitality of up to 80 years.

Until lately almost all forest were affected, primarily, this in a high degree and in all area of the mountains.

Ecological conditions on the deforested areas in exposed zones

Deep disturbances of the bio-climate caused by:

- **high mean speed of the wind**
- **extreme temperature regime**

consequences:

- **strong air pollution flux**
- **damage by late frost**
- **the snow cover blowen away → frost desiccation of the organs → flag forms**
- **failure of the soil water regime (waterlog, freeze into the depth)**
- **harmful phytocoenoses and zoocoenoses conditions**

More extreme are the ecological conditions of the deforested area more important is the sheltering effect of submicrostation (broken trunk, concave terrain, stump, other barriers).

The consequences of prior AP effects for the present

According to the plant physiology principles it is deduced that the influence of AP lasts for a long time after the AP load subsides at a physiological (invisible) level

and can become a starting factor for another types of damage. (examples).

The Norway spruce management problems are still serious most of all.

The air pollution era is considered as a great ecological „experiment“ to learn. It has showed the ability of forest trees and stand structures to cope with an harmful external factor.

The question follows: which features of the climatic changes are similar to air pollution influence?

Principle of preliminary caution

TWO STRATEGIES OF FOREST MANAGEMENT UNDER AIR POLLUTION LOAD 1(2)

Reconstructive strategy **= total species reconstruction of the stands in case of rapid disintegration dynamics**

Stand and ecotope conditions.- Large areas for reconstruction → extreme ecological conditions → large input of energy and material necessary for overcoming the situation → functionally (economic) "incomplete" stands - equivalent of pioneer forest/substitute tree stands as particular case.

Main goal: to maintain the elemental ecological functions, afterwards to enlarge the functional potential if possible

Principles of reforestation

to use tree species capable to sustain the given ecological conditions

and find the optimal place in the (sub)microscale

Silvicultural measures for R – strategy

Fundamental resolutiom: what about the remnants of destroyed stands?

Regarding ecological risks it is mostly profitable (also from the economic point of view) to keep the damaged groups of trees in order to help the protection of the new generation of the stand. These protective stands must be orientated against the *critical air pollution* flux so that they protect of forest *laterally.* This kind of reforestation under the protective influence of the original stand should be applied particularly in sites where the forest has unreplaceable soil and climate protective roles.

These units protect laterally the young generation against overstraining complex of ecological factors

RAPID FOREST DISINTEGRATION STARTS NATURAL SUCCESSION

Course of succession: preparatory → transition → terminal (?) forest

How to deal with the succession processes? Differentiated resolution:

- **To leave them for spontaneous development only**
- **To interfere intentionally in them**

Substitute trees stands as one of the results of the R – strategy.
Maintain or transform them? -
Ecology versus economy = a matter extremely pronounced

TWO STRATEGIES OF FOREST MANAGEMENT UNDER AIR POLLUTION LOAD 2(2)

Consolidation (stabilisation) strategy = set of measures to (1) retard the disintegration of forest and (2) to promote the resistance capacity of individual stands if possible

Measures.- Limitation of the size of clear cuts

+ regeneration under lateral shield effect of neighbouring stand

+ intensive tending regime.

Main goal: maximal possible multifunctional forest management

Where are the strategies applicable

R: high mountain elevations in the A, B threat zone at and/or close to the alpine timberline - target management unit (TMU) 71, 73, 77, 01, 02, (03)

C: everywhere in the C threat zone - (TMU) 51, 53, 55, 57, 59, (71, 73, 77)

Reclamation and fertilization goals

Reclamation goals:

- **the screening of proton deposition → limitation of their unfavourable effects on the soil (not to difficult)**
- **the improvement of conditions for the development of root system (long-time process with regard to slow shift of amelioration material into the depth)**

Fertilization goals:

- **improving the overall nutrition status**
- **increasing the tolerance of particular species to the particular complex of stress factors**
- **The fertilization not separate from liming**

Principles of sustainable mountain forest management and approach to fulfil them

P r i n c i p l e s

- **Management of the forest as an ecosystem (the holistic approach)**
- **Optimum structure of the forests differentiated according to site condition and management targets**
- **Support and creation of flexible multipurpose management to achieve the balanced functional potential**
- **To build the forestry infrastructure (logging and transport technologies, transportation network) friendly to environment**
- **Applicable commonly, but in mountains with stressed importance**

A p p r o a c h

an optimisation of the even-aged (age classes) management taking the ecological conditionns into account

General objective of spruce forest management system

Main objective

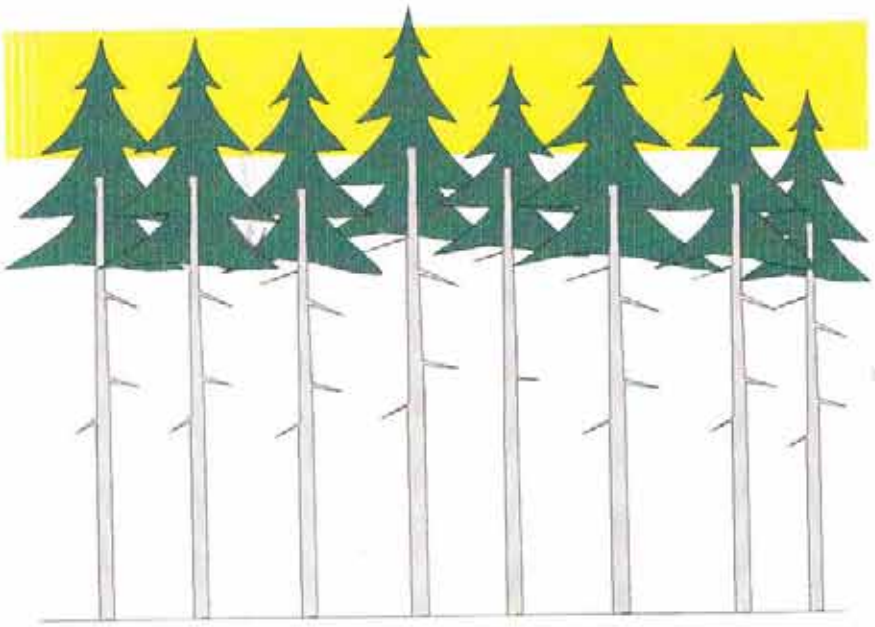
to grow stable stands by the support of trees capable to resist a stress (air pollution and other factors) → to bring the stand near the age of the optimum economic maturity.

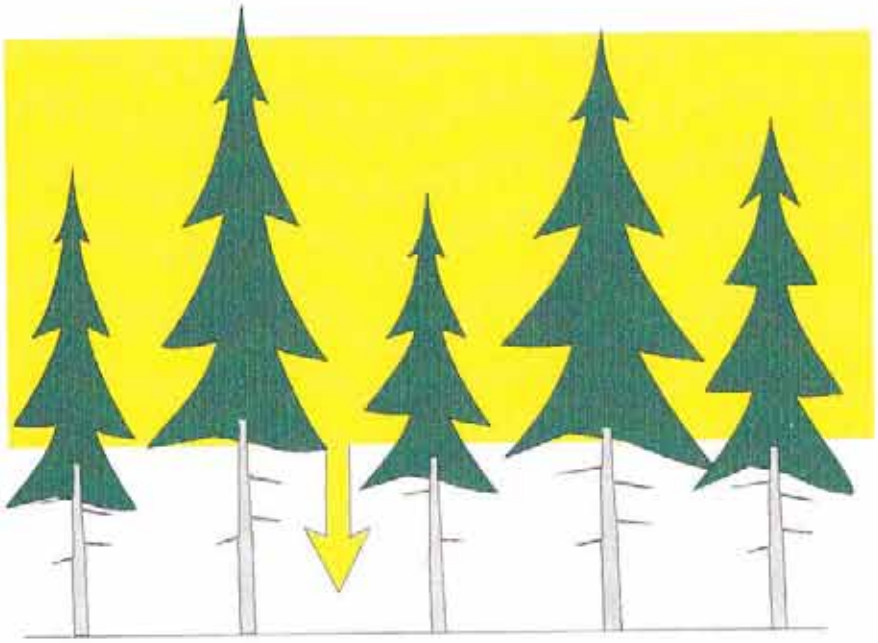
Approach

to built up the adult stands with trees of high vitality and growth vigour and maintain them in condition allowing trouble-free regeneration (transformation) of the ecosystem.

Young and middle-aged stands are most suitable to grow the trees with the emphasis on optimal developed crown in the way to reach the mechanical stability, vitality and longevity.

Tle opening of crown canopy is possible in young stands, in which trees have enough strength to cope with the intense immission flux.





Near-natural silviculture (forest management)

axioms

- **optimum utilization of the growth potential of an ecotope by purposefully mixed stands**
- **continual (long-term) forest regeneration (continuous cover silviculture / forestry)**
- **utilization of the growth potential of each valuable tree**