It is obvious, that the forest enterprises are confronted with increased spendings for forest protection on account of forest decline. But also increased planting expenses due to development of competing ground flora, to collapsing forest stands or to missing natural reproduction as well as to additional amelioration costs have surely to be expected on different levels according to site. The recording of those additional expenses is less problematic than to supply the proof that they are caused by an external force.

5. Final Remark

Concerning the development of the forest decline we are in a situation of uncertainty. Lacking any prognosis, strategies have to be worked out based on scenarios to be able to keep the damage in any case as low as possi Measures under discussion in the same context are not the subject of this paper. It is a fact that they cannot depend only on one instrument. Only a broad number of activities and programs can perhaps result in a relief for the forest enterprises and the timber markets. So it might be possible to limit further grave consequences for forestry and timber industry.

Summary

The paper deals with the specific problems to evaluate the economic impacts caused by atmospheric deposition, discusses the purposes of evaluation and the corresponding approaches and methods. Because the impacts cannot be determined by a comparison of current market values, it is necessary to analyse and evaluate individual damage components. The loss in value, resulting from decreased volume increment, for example is composed of the diminished forest harvesting and the drop of stumpage prices caused by a changed log classification.

Zusammenfassung

Der Beitrag zeigt spezifische Probleme der Bewertung der ökonomischen Belastung durch Immissionen auf, befaßt sich mit Zwecken und entsprechenden methodischen Ansätzen der Bewertung. Da die Belastungen nicht durch Vergleich von Verkehrswerten festgestellt werden können, ist es notwendig, einzelne Schadenskomponenten zu analysieren und wertmäßig zu erfassen. Der aus Zuwachsverlusten resultierende Schaden ergibt sich z.B. aus geringeren Nutzungen und niedrigeren erntekostenfreien Erlösen aufgrund veränderter Sortenstruktur.

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APPROACHES AND METHODS TO EVALUATE THE IMPACTS OF THE FOREST DIE-BACK ON THE SOCIAL FUNCTIONS

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1. INTRODUCTION

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The forest die-back phenomenon in Central Europe has developed itself to an environmental policy problem of high priority within the last 3-5 years.

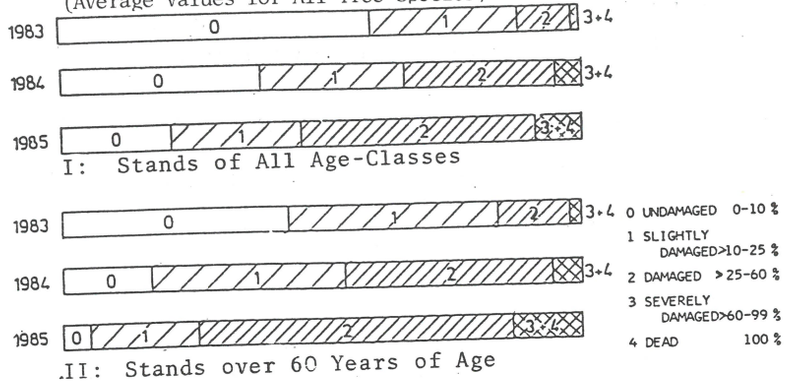
In connection with these die-back symptoms the question arises on how the output of infrastructural services of forests are affected and how these possible impacts can be evaluated.

In the first place, it has to be stated that due to the manifold demands for forest services and different effects of the forest die-back, there is no standard approach to evaluate these impacts. In the following, a solution model is presented using a feedback circle system to evaluate the protective services of mountain forests against avalanches, soil erosion and flooding only. By constructing such a model we consider the high importance of mountainous forests for protection against these mass movements and due to the forest-decline we take into regard the most critical situation in the Bavarian Alps.

1.1 The Forest Die-Back Situation in the Bavarian Alps in 1985

Fig. 1 shows the development of the average damages due to die-back symptoms for stands of all age-classes (I) and for those over 60 years of age (II) in the Bavarian Alps from 1983-85. The outcome is that the state of health of the Bavarian mountain forests has worsened increasingly. This is true especially for stands of more than 60 years of age which represent more than 75 % of the forest area. The development of the damages and distribution of the damage-classes gives cause for alarm.

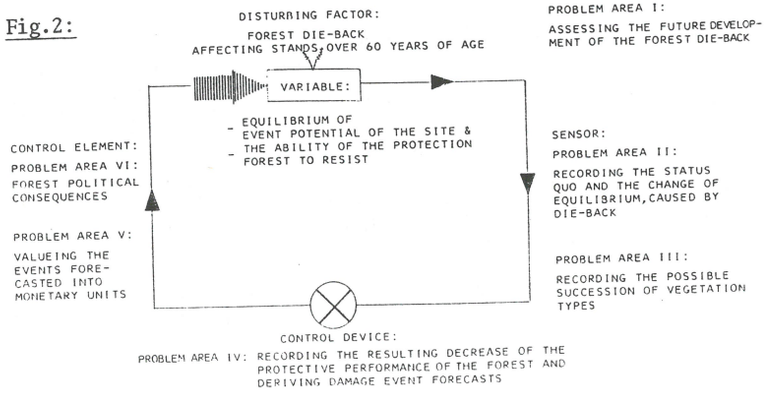
Fig.1: Development of Forest Damages in the Bavarian Alps 1983-85
(Average Values for All Tree Species)



2. THEORETICAL FRAMEWORK

In designing a model to cope with the problem of the dying forests we want to rely on the findings of systems-theory as derived for open systems (see REIMANN et al 1985). In this context the following possible reactions of forests on the environmental impact can be identified and shall be considered in the model (Fig. 2).

Fig.2:



1.) The forest is able to buffer these impacts and to preserve its structure for instance by increasing its regeneration rate.

2.) The forest changes its structure for instance by changing the species composition.

3.) The forest decomposes partly or completely and will be replaced by another vegetational type or by technical constructions.

The listing shows that developing a solution model means to consider all the influence factors besides the forest die-back factor that have disturbing impacts on the systems behaviour.

3. APPLICATION OF THE FEED-BACK PRINCIPLE ON THE MOUNTAIN FOREST DIE-BACK PROBLEM

The overall problem shall be seperated into 6 problem areas, being defined at corresponding positions of the respective feed-back circle. Each forest site in the mountains has its own event potential as far as mass movements are concerned. This potential depends, with regard to the respective event, upon a series of site factors for instance, geology, slope, exposition and so forth. A protection forest can offer an effective resistance to this potential. The ability of the protection forest to resist and the event potential of the site results in a more or less instable equilibrium. This state of balance is defined in the feed-back circle as the variable to be controlled which is influenced by the disturbing factor 'forest die-back'.

3.1 Problem Area I: Assessing the Future Development of the Forest Die-Back

Since the intensity and the future development of the disturbing factor 'forest die-back' is of high importance for the possible effects, the assessment of these parameters plays an essential role in this context. Fig.3 represents different approaches to forecast possible developments of the die-back process. These methods have been subjectively judged here by their usefulness. A survey of these die-back forecasts to date has shown a large disagreement as far as the development and the distribution of the forest-decline is concerned. This is due to the various assumptions on the ability of the forest ecosystem to regenerate, the effectiveness of the administrative measures undertaken, as well as the selection of the research area considered. Obviously when designing such forecasts one has to take into account several variants of a prognosis.

Fig.3: Problem Area I: Assessing the Future Development of the Forest Die-Back

METHODS:	APPLI-CATION	SUBJECTIVE ASSESSMENT OF THE USEFULNESS OF THESE METHODS						
		NOT USEFUL	0	1	2	3	4	VERY USEFUL
SUPPOSITIONS	X					X		
TREND ANALYSIS	X				X			
TREND EXTRAPOLATIONS	-			X				
EXPERT POLLS	X					X		
DELPHI-TECHNIQUE	-					X		
SIMULATION MODELS	X				X			
CATASTROPHE THEORY	X					X		
BRAINSTORMING	-			X				
BRAINWRITING	-			X				

Fig.4: Problem Area II: Recording the Status Quo

METHODS:
TERRESTRAL INVENTORIES
PHOTOGRAMMETRIC MEASURES
INTERPRETATION OF MAPS
- TOPOGRAPHIC MAPS
- SLOPE STABILITY MAPS
- YIELD MAPS
- PROTECTION FOREST MAPS
- HYDROGRAPHIC-MORPHOLOGICAL MAPS

3.2 Problem Area II: Recording the Status Quo and the Change of Equilibrium Caused by the Die-Back Syndrome

To quantify the influence of the disturbing factor 'forest-decline' on the equilibrium state it is necessary to analyze the parameters of the site event potential as well as those of the resisting protection forest. Fig. 4 gives a set of methods that can be applied for data collection for this purpose. Here the selection of methods depends on the level of precision demanded. Next, the data has to be aggregated so that the ability of the protection forest to resist and the site event potential can be characterized by them. The amalgamation of data can be done by intuitive, empirical as well as mathematical-logical procedures. Often, the theory of fuzzy sets helps in the formal representation of vague scientific knowledge prevailing here. In doing so, the question of validity of data and their amalgamation rises basically.

A validity test can be conducted here by different field studies only, taking the parameters and their aggregates and deciding whether the situation in question can be represented by them virtually.

Altogether by this type of analysis it seems possible to identify the influence of the disturbing factor of 'forest-decline' on the quantified state of equilibrium, without taking into account the question of dynamic processes of the vegetational development so far.

3.3 Problem Area III: Recording the Possible Succession of the Vegetation

Deriving the resulting vegetation state is essential because of the possible consequences of the decline process (JOBST & KARL 1984) Fig. 5 represents the techniques to conduct such an analysis. Extensive field studies in the Bavarian Alps by BURSCHEL, LÖW, METTIN in 1977, as well as SCHREYER and RAUSCH in 1978, have proven, the high natural regeneration potential of the forests here. It can be started from the fact that this potential has been affected only slightly by the forest die-back. But the ability to regenerate actually is influenced by steering factors, which lead, depending on their intensity and combination, to various degradations of the vegetational cover.

Fig. 5 considers the following main influence factors i.e. game stock, forest pasture, snow creeping and possible damages due to die-back at the regeneration. Five different vegetation units have been identified here.

Fig. 6 gives a listing of methods to assess the vegetational successions here. By combining the different variants of damage progresses and the vegetational successions to be expected, a forecast of the probable actual state of the system seems possible.

Fig.5:

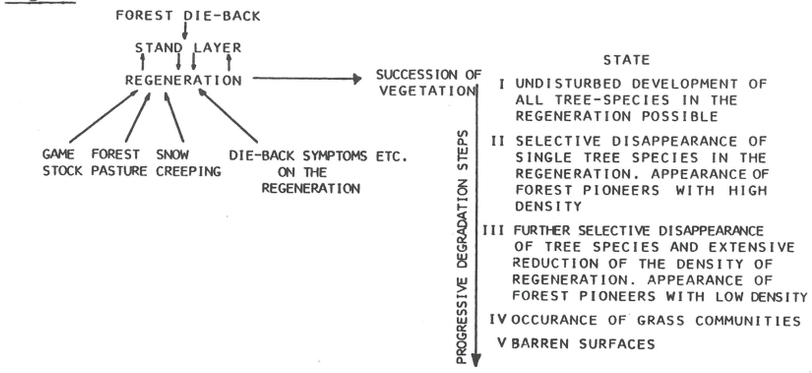


Fig.6: Problem Area III: Assessing the Possible Successions of the Vegetational Cover

METHODS:	SUBJECTIVE ASSESSMENT OF THE USEFULNESS OF THESE METHODS						
	NOT USEFUL	0	1	2	3	4	VERY USEFUL
HISTORICAL ANALOGIES			X				
SUPPOSITIONS				X			
RISK ANALYSIS					X		
SIMULATION MODELS				X			
EXPERT POLLS				X			
DELPHI TECHNIQUE					X		

3.4 Problem Area IV: Recording the Resulting Decrease of the Protective Performance of the Forest and Deriving Damage-Event Forecasts

The main function of the control device consists in a comparison of the nominal and actual value of the variable. The nominal value represents in our case the value of the status quo of the system. With an increasing deviation from the actual and the nominal value it can be assumed that certain damage-events will occur more frequently and/or more intensively. The maximum extent of such events will be steered by the site potential for the occurance of damages. Fig. 7 shows the methods to record the resulting deviation and effects.

The main problem here is the definition of threshold values for certain damage events. Since many of the mass movements including avalanches are events that happen abruptly we will try to apply the

findings of catastrophe theory on these phenomena. The events forecasted serve as input parameters for the evaluation process. On the other hand they form the basis for an early warning system. By establishing such a system one can identify areas with a high risk event, due to the progress of the forest decline. Thus, specific and early counter measures can be taken against the possible extensive damages.

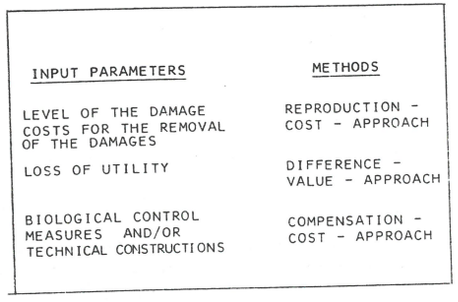
Fig.7: Problem Area IV: Recording the Resulting Decrease of the Protective Performance of the Forests

METHODS:	SUBJECTIVE ASSESSMENT OF THE USEFULNESS OF THESE METHODS						
	NOT USEFUL	0	1	2	3	4	VERY USEFUL
HISTORICAL ANALOGIES			X				
SUPPOSITIONS				X			
RISK ANALYSES					X		
SCENARIO WRITINGS				X			
DELPHI-TECHNIQUE					X		
ALTERNATIVE DANGER-ZONE-PLANNING						X	

3.5 Problem Area V: Valueing the Events Forecasted into Monetary Units

Fig. 8 shows three different approaches to evaluate the events forecasted.

Fig.8: Problem Area V: Valueing the Events Forecasted into Monetary Units



Reproduction - Cost Approach

The prognosticated events can lead to damages on the slope of the mountains or at the bottom of the valleys. These damages will be removed, and the situation before the damage event, will be re-established as far as possible. The costs for these measures and the respective damages occured are taken as indicators for the consequences due to the forest die-back.

The Difference-Value-Approach

The difference-value of a good or service can be defined as the one with and without an unpairment. The utility value of an object, which is secured by a protection forest gives the basis for this method. A damage event due to the forest-decline can reduce this utility value. The resulting difference of the utility value represents the loss of utility of the respective object.

The Compensation Cost Approach

The assumption is, that due to the forest-decline the ability for the protection of forests is diminished in as such that it cannot be restored. The costs for biological and for technical constructions are considered as indicators for the effects of the forest die-back. The measures undertaken form in terms of systems theory the control device within the feed-back circle for compensating the adverse effects of the disturbing factor ' forest die-back '. These control devices establish a new systems equilibrium, since the original one has been lost. The objective is here to promote the regeneration of the protection forest by minimizing the factors limiting this regeneration i.e. game stock, forest pasture and so forth. Due to the possibility, that damage events will occur during the process, the outcome might be that the site potential for damage events will decrease and finally a new equilibrium will be established with less demands on the resisting new protection forest.

3.6 Problem Area VI: Forest-Political Consequences

The model presented will make it possible to develop a set of different approaches to evaluate the possible effects of the forest die-back on various areas and objects in the Bavarian Alps.
This model will give a sound understanding on the possible severe consequences of the forest-decline and form the basis for a rational forest political strategy. Two points of departure can be identified from the model. On the one hand, is to minimize the disturbing factor forest die-back i.e. to reduce drastically the air pollution which seems to be crucially responsible for the forest-decline, and on the other is, to support rigorously all measures for regenerating the damaged protection forests i.e. to remove all factors that impede this process like game stock, forest pasture and so on. In terms of systems theory these forest political consequences have the character of a control element. But forest policy will succeed in its efforts only, if it manages to mobilize the population in our country for that basic forest question. Only by doing so, does forestry seem to have a chance that its voice will be heard in the realm of politics.

4. SUMMARY

In connection with the forest die-back phenomenon in Central Europe the question arises on how the output of infrastructural services of forests will be affected and how these possible impacts can be evaluated.

This paper describes a solution model based on a feed-back circle system to evaluate the protective services of mountain forests against mass movements.

Five problem areas were indentified:
- Assessing the future development of forest die-back
- Recording the status quo and the change of equilibrium caused by the die-back syndrome
- Recording the possible succession of the vegetational cover
- Recording the resulting decrease of the protective performance of the forest and deriving of damage event forecasts
- Evaluating the events forecasted into monetary units

For each problem area, possible methods are shown. Finally some possible forest-political consequences are pointed out.

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THE IMPACTS OF ATMOSPHERIC DEPOSITIONS ON FORESTS FROM POLICY ASPECTS

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Research results in natural science agree to large extent that air pollution figures among the generators of the worldwide appeared forest damage. Independent of the importance attributed to air pollution in connection with several generator-elements, activities to protect the forest are concentrated on the reduction of air pollution, because only within this range combat measures are possible. Hence it follows that measures to protect the forest are involved with questions of knowledge far beyond the traditional scientific field relating to forestry. With that the field study in forest policy is expanding accordingly (1). Herein shall be reported on test results and experiences gained during the treatment of problems in this connection. They are summarized in five theses.

Preliminary remark: On purpose I put deciding structures and deciding behaviour in the limelight, because practical policy is being shaped up from there and because solving or not solving the problems described here depends exclusively on how the political decisions turn out. Through the most extensive analyzation of the substantial influencing factors in the political field of objects will not only be achieved understanding for what practical policy constitutes; at the same time starting points for an encroachment, for a purposive political action become clear. It must also be mentioned that the methods and developments here described only hold expressiveness within the policy model of western democracies.

Thesis n. 1: Forest protection cannot be conceived as an absolute political principle. The significance of the forest and the importance of his protection must be seen in relation to other socio-political requirements.

In the Federal Republic of Germany the forest and with that also forest conservation policy is very high in value.