Forest Condition and Forest Damages - Contribution of Remote Sensing to Different Inventory Approaches

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ABSTRACT: The development of inventory activities in the field of forest damage assessment and monitoring during the last decade in Germany and the present state are recorded as far as remote sensing has been involved. Any forest inventory is influenced by external factors, and the resulting difficulties for an introduction of new technologies are described. The following tasks and/or methods are discussed:
- global approaches to deforestation monitoring
- working experience from local and regional case studies
- vegetation and vegetation-damage monitoring in "urban forestry"
- sampling approaches for large areas
- the contribution of spectral signatures and satellite remote sensing to damage assessment

Changing Goals of Inventory

Forests are endangered – world-wide. Both extensive exploitation and forest destruction in the tropics and subtropics, as well as the results of ever growing human activities in general, such as demands on the industry, the economy, the traffic, and the general living- and leisure-time sphere, are leading not only to disquieting prognoses but to factual catastrophes for the natural basis of mankind.

In comparison to other land-use types, forests are even then still relatively “natural”, sensitive eco-systems if they are intensively managed or partly destroyed, and they are therefore no longer regarded and treated only as a production place for regrowing raw products but increasingly recognized as a refuge for threatened plant and wildlife species as well as a sensitive indicator system for environmental quality and – changes.

Appeals to boycott tropical wood in Europe, and intensified attacks of dedicated environmentalists and their associations on the supposedly only “profit-oriented” forest management are typical of the changing awareness and the growing interest of the general public in actual or supposed forest damages. This implies a shift of emphasis in the field of forest inventory, too: Today it is no longer just a branch of forestry essentially concerned with dendrometry, but a field of activity of interdisciplinary interest, and this particularly applies to forest damages. Forests have not only remained difficult objects to be measured and monitored, but, influenced as they are by additional changes and interests, they have become even more complex: vast areas, heterogeneity, changeability due to the seasons and to ecological factors, and, in some cases, inaccessibility, interferences and damages – all these factors have to be taken into account in different ways and combinations.

The Significance of Remote Sensing for Practical Inventory

Hildebrandt, who has concerned himself with remote sensing throughout his active professional life, did this first and foremost as a forester, who very early on recognized the importance of the manifold functions of the forest and who wanted to pay regard to them, but who was also interested in technical innovation (Hildebrandt 1987). He knows very well that the one and only task of inventory
methods is to clarify problems in the user-discipline and to facilitate their solution, since it is just that user-discipline, which determines goals, definition of standards, methods, reference date, rotation period (if repeated) and intensity of the inventory. Looked at from this point of view, remote sensing is nothing more than a competing methodological alternative of “forest inventory” and only has a very modest status within the system of forest sciences and forest management. Hildebrandt anticipated the technical and revolutionizing potential of remote sensing, and he inspired a lot of his students to work on the intricate scientific problems turning up within the field of tension between the technology of remote sensing and the rather anti – than pro – innovating discipline “Forest Management”. This tension between an abundant supply of technologies and a rather hesitant demand of the users is still – at least in Germany – characteristic for the inventory problem “forest-damage assessment”, although it has undergone phases of modification and amplification by now:

- In the first phase there is the conception and there are concepts; however, the developmental stage of a technology does not permit – and this often for quite some time – any operational transfer except perhaps in very special cases. “Only the distance offers a clear view!” This statement, ascribed to Laotse (unverified), could not be transferred to technology for a long time.

- In the second, later phase, impulses for technical innovation are external ones, i.e. they do not come from the user himself. “We have the solution, what is the problem?” With such suggestive and aggressive advertising strategies the advantages of new earth-observing satellites were propagated in the early seventies by the NASA to a (not even existing) “user-community” (Albertz 1974). One (admittedly very drastic) case of air pollution-damages to forest was one of the first published positive reports (Murtha 1973). It is the highly political public rank of environmental problems, which turns remote sensing into an extremely effective tool for convincing decision-makers and the limited circle of experts for the forest and forest inventory. The promise of immediate solutions for environmental problems (frequently “tropical forest monitoring” and “forest damage mapping” are mentioned in this context) therefore belongs to the standard repertoire of PR-campaigns for new remote-sensing technology systems, even if their applicability is (still) doubtful, yet doubtlessly not to be put into practice some time hence. These bragging and over-optimistic propagating methods in favour of remote-sensing technology are leading to long-term irritations both for experts and for decision-makers. As soon as professional experts refuse to apply the suggested new tools, only non-forest authorities dare to carry out forest-damage inventories, the results of which cannot solve the real problems.

- In a third phase, when the applicability and competitiveness of remote sensing is basically established, practical details will have to be discussed. Even in this state of transferring scientifically sophisticated procedures there still are commercial pressures which can discredit the whole technology. The slogan “Our solution – your problem” probably best characterizes the numerous misunderstandings between potential users and commercial firms: Confusing – and confused – definitions of terms, the lack of standards and precise, detailed and generally accepted terms, inadequate descriptions of methods and their implementation here, competition-, costs- and rationalization pressure there. This gap can only be bridged by interdisciplinary applied research, but in Germany financial support for this is extremely hard to get. So in the field of forest damage inventory it must be accepted that results are presented in a “remote-sensing adapted” system of measurements and definitions such as “spectral vitality” or “biological activity” which the users have no equivalents for. Members of the “Arbeitsgemeinschaft Förstlicher Luftbildinterpret” (AFL) can appreciate the time-consuming and labour-intensive task of standardizing definitions and procedures for harmonizing field work and remote sensing.

Inventory Approaches for the Assessment of Forest Condition and Forest Damages

The choice of method-components for definite inventory projects depends not only on inventory goals and the rather intricate framework partly described above, but, to a strong degree, also on technical and economic constraints often leading to solutions which lag behind the latest technological developments. To give an example: Federal and state governments are urgently demanding an annual forest damage inventory which, if carried out on the basis of remote-sensing data, is doomed to failure right from the start, since data collection with optical sensors during the suitable months (July/August) cannot be guaranteed each year because of weather factors. A nationwide, but only spot-checking aerial-photography flight with CIR-film for the relatively small federal state of Schleswig-Holstein, for instance, could only be completed after 5 years. With the present flight frequency of the LANDSAT-satellites over Germany it would still take several years on average, so the calculations by the DLR Oberpfaffenhofen, before a complete set of new LANDSAT-TM-scenes of sufficiently high quality could be obtained.

The most important factors influencing the inventory design of forest condition and forest damage assessment, and thus the application of remote-sensing methods, have to be based on answers for the following questions:

1. What level (global, continental, nation-wide, regional or local) is to be worked on, and what are the smallest reporting units for which results are still expected?
2. What are the criteria and the definitions for the inventory? Is it only canopy destructions that are to be