Remote sensing aided national forest inventories past, present, future

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The techniques of using aerial photographs for purposes of forest inventory have been developed since 1930's. Aerial photographs were first used to aid stratification during the 1940s and 1950s by the Forest Inventory and Analysis (FIA) programme of the U.S and by Spain and Switzerland in the 1960s and late 1970s, respectively. Later, aerial photographs were used also to reduce the standard errors of the forest resource estimates. An example is a grouping method, a variation of a double sampling for stratification used, e.g., in the 1960's and 1970's in North Finland. The use of space-borne remote sensing data for forest inventory purposes were tested in Finland in late 1960s and early 1970 with the data from a NASA weather satellite. A method utilising ground observations, digital map data and satellite images and called multi-source inventory was developed in the turn of 1980s and 1990s in Finland. The k-nearest neighbour method and its variants have become quite popular and widely studied among the forest inventory teams since then.

While airborne laser scanner data has been successfully used in management inventories over ten years, the use in national forest inventories is limited, mainly due to costs. To date, a wide range of techniques have been used in the analysis of remotely sensed data in combination with NFI field inventory data to improve the estimates of forest parameters and variables through pre and post-stratification approaches.

Other Earth Observation systems, such as synthetic aperture radar (SAR) both air-borne and space-borne have been used in forest applications for some special cases, such as forest cover, biomass and damage mapping but to our knowledge, not yet in the connection of national forest inventories. Examples of relevant data sources are C-band Sentinel-1 (ESA), X-band Tandem-X (DLR) and L-band ALOS-2 PALSAR-2 (JAXA) and C-band RADARSAT-2 (CSA). New SAR satellites and satellite constellations are under development, e.g., NASA NISAR and ESA Biomass. One reason for the limited use of SAR in national forest inventories could have been, in addition to the price and the relatively new applicable data sources, the processing tools needed. However, Copernicus data are now free. ESA provides also tools for data handling. Examples of techniques include backscatter analysis, interferometric coherence analysis, interferometry phase analysis, polarimetry, polarimetric interferometry and SAR polarimetric tomography. Overall, the use of SAR data has a big potential in forestry application.

We discuss briefly the history of the use of remote sensing data in forest inventories and focus on the future possibilities, particularly on the possibilities and limitations of active microwave data.