POLISH FOREST ECOSYSTEMS: THE INFLUENCE OF CHANGES IN THE ECONOMIC SYSTEM ON THE CARBON BALANCE

WOJCIECH GALINSKI
Research Institute of Forestry, Forest Ecology Section, 00-973 Warsaw, 3, Bitwy Warszawskiej St., Poland

and

MANFRED KÜPpers
Technische Hochschule Darmstadt, Institut für Botanik, Schnittspahnstrasse 10, D–64287 Darmstadt, Germany

Abstract. In order to study the effects of a change in the economic system on carbon balance at a national scale, a balance of the carbon influx and effluxes was prepared for forest ecosystems in Poland for 1988, and was repeated for 1990. The year 1988 was the first year of drastic economic changes (and severe crises) in Poland. Two entirely different approaches were used to estimate the carbon influx into a forest ecosystem. The forest inventory approach was based on data from conventional measurements of merchantable timber in forests, whereas the carbon flux and allocation approach was based on the estimate of net photosynthetic productivity of forest ecosystems to calculate the carbon influx. Results from both approaches were within the range 1.17 to 5.77t C/ha/yr which most likely defined lower and upper limits for the carbon influx into forest ecosystems in Poland. On the national scale, the carbon influx into Polish forest ecosystems was estimated by the forest inventory approach to be about 12.8 Mt C/yr. This result was similar for both years. Efflux of carbon from Polish forest ecosystems resulted almost entirely from the decay of logging residues. The efflux in 1990 (3.82 Mt C/yr) was about 26% lower than that in 1988. Storage of the carbon in Polish forest ecosystems (including an estimate of the carbon pool in forest soils) was 1.8% greater in 1990 (2518 Mt C) than in 1988, when it equalled 2473 Mt C.

1. Introduction

In Eastern Europe the 1990s have differed remarkably from the previous five decades. The decline of communism and the emergence of new political and economic systems have created new options for, and limitations to, environmental management. This provides a unique chance to study the effects of severe economic changes on the environment at a national scale. From among these effects, the carbon budget of Polish forests has been chosen since CO₂ is involved in the “greenhouse effect”. An inventory of sources and sinks of carbon in Polish forest ecosystems was prepared for the initial year 1988, and repeated again for 1990. The year 1988 was, at least for Poland, the last year of the communist era, whereas 1990 was the first complete year with a new economic system. Results of these
inventories may therefore reflect the influence of economic changes on the carbon budget in Polish forest ecosystems.

Poland is a rather small (312,500 km$^2$) country located mainly in the Great Central European Valley. The share of lowland forest sites is as high as 89.1% of the forested area, while highland and mountain forest sites constitute 3.5% and 7.4%, respectively. The prevailing forest site type is “the moderately moist coniferous forest” (30.2% of total forest area). All coniferous forest site types total 63.4% of the forested area. Although the remaining forest area is classified as being of various “woodland forest site types”, part of it is covered with man-made coniferous forest. As a result, only 20.8% of the forested area is actually covered with deciduous forests (Anonymous, 1989b, 1991a).

As State-owned forests constitute about 82% of all forests in Poland, the forest management practices often reflect the state of the national economy. This paper will address the changes in the carbon budget of Polish forests as affected by changes in the forest economy, especially in logging intensity.

2. Theory and Assumptions

Two entirely independent approaches for estimating the carbon input to forest ecosystems were applied. The first was based on forest inventory data (e.g. commercial wood production in Polish forestry) while the second was based on eco-physiological considerations of carbon influx into forest ecosystems. No data were shared between the two approaches. Results from both approaches were used to assess the range of “true” values of the investigated processes.

An assumption of equilibrium is generally adopted to estimate carbon budgets for forest ecosystems (Kolchugina and Vinson, 1993a,b; Swedish Environmental Protection Agency, 1991; Eriksson, 1991; Apps et al., 1991; Isaev et al., 1993). This assumption will be applied here in establishing the carbon balance in Polish forest ecosystems. All processes discussed herein can, therefore, be represented by means of differences in their values at the beginning and at the end of one year (annual budgets). For completely cyclic processes the budgets equal zero. Furthermore, no account was taken of sources of carbon emission generated by human activities related to forests (silviculture, forest transport, etc.), as well as carbon release from forest products.

For the purpose of carbon budget estimation it is sufficiently precise to split Polish forests into only two ecosystem types: deciduous and coniferous forest type (due to the low variability of forest sites within each of the ecosystems). This partitioning was made independent of age structure since at present there is no national forest biomass data sensitive to age structure of the forests. Data (sensitive to age structure) from forests in other countries were not used as these may be so country/forest specific that they could introduce errors far exceeding the expected gain in accuracy.