

ABSTRACT

Material flow analysis is a systematic assessment of the flows and stocks of materials in a well-defined system. It is based on the law of the conservation of mass and this characteristic makes the material flow analysis method attractive as a decision-support tool in resource management as it delivers complete and consistent information about all flows and stocks of materials in the system.

This study is one of five studies on carbon flow analysis in the forest, paper and pulp industry and the results obtained will be compiled with results from the other studies and integrated into static and dynamic models for a complete analysis of the entire forest product sector value chain. The ultimate objectives of all five studies are:

- To understand how carbon fluxes both in and out of the forest affects the total forest carbon stock
- Estimate the total quantity of wood to be harvested in order to make the forest region carbon positive or neutral
- Determine the most beneficial use of wood in terms of paper making, furniture making or wood pulping.

This study is limited to the carbon fluxes in and out of the South African plantation forests, and estimates the threshold harvest which will make the forest carbon neutral.

The commercial forests in South Africa have a total area of 1.27 million ha, with 83 % under private sector ownership and 17 % under public ownership. The predominant species grown in the plantations are *Pinus patula* (Pine), *Eucalyptus grandis* and *Acacia mearnsii* commonly known as black wattle. The wood harvested is grouped into two categories: softwood and hardwood. Softwood is wood produced by coniferous trees for example *Pinus patula*, and hardwood is wood produced by broad leaved trees such as *Eucalyptus* and *Acacia*.

The overall aim of this study was to analyse carbon stocks and flows in the South African plantation forests by applying the Material Flow Analysis Tool. The scope of this study is limited to the carbon flows through the commercial forest plantations, as such, timber import flows, and flows from indigenous forests and woodland forests are not considered. In the model, the input flow corresponds to tree growth (carbon sequestered in the forest) whereas the output flow is the removal of carbon from harvesting wood and also from carbon released to the atmosphere via damage such as fires or insect infestation.

It was hypothesised that the total plantation forest carbon stock decreases annually as a result of forest management activities and continuous usage of forest products. The total area under commercial forests was divided into 12 forest regions consistent with the report on commercial timber resources and primary roundwood processing in South Africa (2011). It was shown the entire region is, as a whole carbon positive. Six out of the twelve forest regions were carbon positive with respect to forest management activities in the year 2011. In these regions, more trees were being grown than were being harvested, hence the forest stock gradually increased. Also it was found that these regions are not sensitive to changes in input nor output flows.

The hypothesis was proven for the other six forest regions namely Mpumalanga Central Districts, Mpumalanga South, KwaZulu-Natal Maputaland, KwaZulu-Natal Midlands, KwaZulu-Natal South and the Eastern Cape forest regions. In these regions, fewer trees were being grown and there was less carbon input into the forest than was being removed from harvesting or damages. It was found that these regions with the exception of the Eastern Cape forest region, are extremely sensitive to carbon flow changes with the carbon stock change being positive or negative with slight changes in the input or output flows. It was suggested that more trees be grown, trees with greater mean annual increments or hybrid trees be planted in these regions. Further, the quantity of wood harvested should be substantially reduced or else the forest carbon stock will be depleted year after year.

The total tree growth in the forests in 2011 was 5.328 million ton carbon (dry mass) and this offset the total carbon emission from all industries and processes in South Africa by 6.1 %. It was concluded that, when the forest absorptions together with the pulp and paper making process emissions are combined, the net result was carbon dioxide absorption and a tax offset mechanism could be implemented to recognise the sequestration effects of private company owned plantations in South Africa.