



## **Integrating Green and Blue Water Management Tools for Land and Water Resources Planning**

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The role of land use and land use change on the hydrological cycle is well known. However, the impacts of large scale land use change are poorly considered in water resources planning, unless they require direct abstraction of water resources and associated development of infrastructure e.g. Irrigation Schemes. However, large scale deforestation for the supply of raw materials, expansion of the areas of plantation forestry, increasing areas under food production and major plans for cultivation of biofuels in many developing countries are likely to result in extensive land use change. Given the spatial extent and temporal longevity of these proposed developments, major impacts on water resources are inevitable. It is imperative that managers and planners consider the consequences for downstream ecosystems and users in such developments. However, many popular tools, such as the virtual water approach, provide only coarse scale “order of magnitude” type estimates with poor consideration of, and limited usefulness, for land use planning.

In this paper, a framework for the consideration of the impacts of large scale land use change on water resources at a range of temporal and spatial scales is presented. Drawing on experiences from South Africa, where the establishment of exotic commercial forest plantations is only permitted once a water use license has been granted, the framework adopts the “green water concept” for the identification of potential high impact areas of land use change and provides for integration with traditional “blue water” water resources planning tools for more detailed planning. Appropriate tools, ranging from simple spreadsheet solutions to more sophisticated remote sensing and hydrological models are described, and the application of the framework for consideration of water resources impacts associated with the establishment of large scale tectona grandis, sugar cane and jatropha curcas plantations is illustrated through examples in Mozambique and South Africa.

Keywords: Land use change, water resources, green water, blue water, biofuels, developing countries