

Catchment scale nutrient balance as a tool in precision forestry

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Catchment scale management of forest nutrient cycles is an important part of modern forestry. A leap towards holistic management of ecosystem services through customised forest management strategies has become possible when high resolution forest, terrain, and soil data can be combined with detailed process-based ecosystem models. We have developed catchment level, spatially distributed nutrient balance and hydrology models, which calculate location-specific nutrient dynamics and the nutrient export from the terrestrial part of the catchment to water courses. Model applications have shown that the nutrient export is very unevenly distributed throughout catchments: 5 % of the catchment area can produce 25% of the nitrogen export. This identification of nutrient export hotspots facilitates knowledge-based planning and cost-efficient locating of water protection. We have found that catchments may contain a wide range of different nutrient balances. Simulations also reveal locations where the forest stand growth is nutrient-limited, and thus opens the possibility for precision fertilization. In precision fertilization the quality, dose and timing of the fertilization can be adjusted so that the site-specific nutrient supply meets the nutrient demand and thus the harmful environmental impacts, such as increased nutrient exports, can be diminished. Furthermore, these models can be used to compare different harvesting methods and forest management strategies with respect to multiple ecosystem services. Process-based ecosystem models including nutrient balance and geospatial high-resolution data are particularly useful in forecasting the effects of climate change allowing development of proactive adaptation schemes in a specific catchment.