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Adaptive forest management for drinking water protection under climate change

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Drinking water resources drawn from forested catchment areas are prominent for providing water supply on our planet. Despite the fact that source waters stemming from forested watersheds have generally lower water quality problems than those stemming from agriculturally used watersheds, it has to be guaranteed that the forest stands meet high standards regarding their water protection functionality. For fulfilling these, forest management concepts have to be applied, which are adaptive regarding the specific forest site conditions and also regarding climate change scenarios. In the past century forest management in the alpine area of Austria was mainly based on the cultivation of Norway spruce, by the way neglecting specific forest site conditions, what caused in many cases highly vulnerable mono-species forest stands. The GIS based forest hydrotope model (FoHyM) provides a framework for forest management, which defines the most crucial parameters in a spatial explicit form. FoHyM stratifies the spacious drinking water protection catchments into forest hydrotopes, being operational units for forest management. The primary information layer of FoHyM is the potential natural forest community, which reflects the specific forest site conditions regarding geology, soil types, elevation above sea level, exposition and inclination adequately and hence defines the specific forest hydrotopes. For each forest hydrotope, the adequate tree species composition and forest stand structure for drinking water protection functionality was deduced, based on the plant-sociological information base provided by FoHyM. The most important overall purpose for the related elaboration of adaptive forest management concepts and measures was the improvement of forest stand stability, which can be seen as the crucial parameter for drinking water protection. Only stable forest stands can protect the fragile soil and humus layers and hence prevent erosion process which could endanger the water resources. Forest stands which are formed by a tree species set which conforms to the potential natural forest community are more stable than the currently wide-spread mono-species Norway spruce plantations, especially in times of climate change, where e.g. bark beetle infestations threat spruce with increased intensity. FoHyM also provides the relevant ecological boundary conditions for any estimation of climate change adaptations. The adaptation of the tree species distribution within each forest hydrotope to climate change conditions was fulfilled by the integration of climate change scenarios and the estimation of the eco-physiological characteristics of related tree species. Hence it was possible to define the tree species distribution related to a specific climate change scenario for each forest hydrotope. The silvicultural concepts and measures to accomplish the defined tree species distribution and forest stand structure for each forest hydrotope were defined and elaborated by taking the specific requirements of drinking water protection areas into account, what e.g. comprised the prohibition of the clear cut technique and the application of continuous cover forest management concepts. The overall purpose of these adaptive silvicultural concepts and techniques which were based on the application of FoHyM was the improvement of the water protection functionality of forest stands within drinking water protection zones.