Development of Dose Assessment Method for a Conifer

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Abstract

Since conifers are known to be more sensitive than other organisms in the general environment, we planned to establish the radiation dose assessment method for one type of conifer and get its natural background radiation dose rate. After considering that the first commercial spent nuclear fuel reprocessing plant is now under final safety review of its operation by the Nuclear Regulation Authority, we selected a forest of Japanese black pine (*Pinus thunbergii*), about 4 km away from the main stack of the plant, as our target field. In addition, we studied the iodine dynamics in the forest for possible radioiodine release from the plant.

We plan to get data on shape, weight, elemental composition and radionuclide concentration using three black pine trees of midrange size in the target field. The first tree was sampled and various measurements were made in FY 2017. In FY 2018, the second tree was collected on July 31 –August 1, 2018. Wet weights of the above- and below-ground parts were found to be 430 kg and 96 kg, respectively. Litter and soil samples in 0 – 2 m depths around this second tree were also collected and analyzed for apparent density, and stable element and radionuclide concentrations for radiation dose evaluation.

In order to evaluate radiation dose to the tree by the radiation transport code using a Monte Carlo method (EGS5), a pine tree phantom of the above ground part was constructed from results for five sample trees collected in fiscal years of 2016 and 2017. The phantom consisted of a geometrically shaped main structure with voxel phantoms consisting of 1×1×1 mm voxels for a lateral branch at each of three height levels. In our target field, the crown of a pine tree in the midrange size has about 25 nodes at different heights with 3 to 4 lateral branches on average. By using EGS5 and the phantom, we estimated absorbed dose rate in the whole above ground part was 61 nGy h^{-1} including cosmic rays.

To study iodine dynamics in the forest, we measured stable iodine concentrations in plant, atmospheric and hydrological samples collected inside and outside the forest. Mean dry deposition rates of particulate, and organic and inorganic gaseous iodine from the atmosphere to the tree canopy were estimated to be 5.0E-3 m s^{-1}, 5.0E-4 m s^{-1} and 5.0E-2 m s^{-1}, respectively, by using data during the non-precipitation period. The mean removal rate of iodine by stem flow was estimated to be 7.8E-7 g m^{-2} d^{-1} during June 2018 – March 2019.

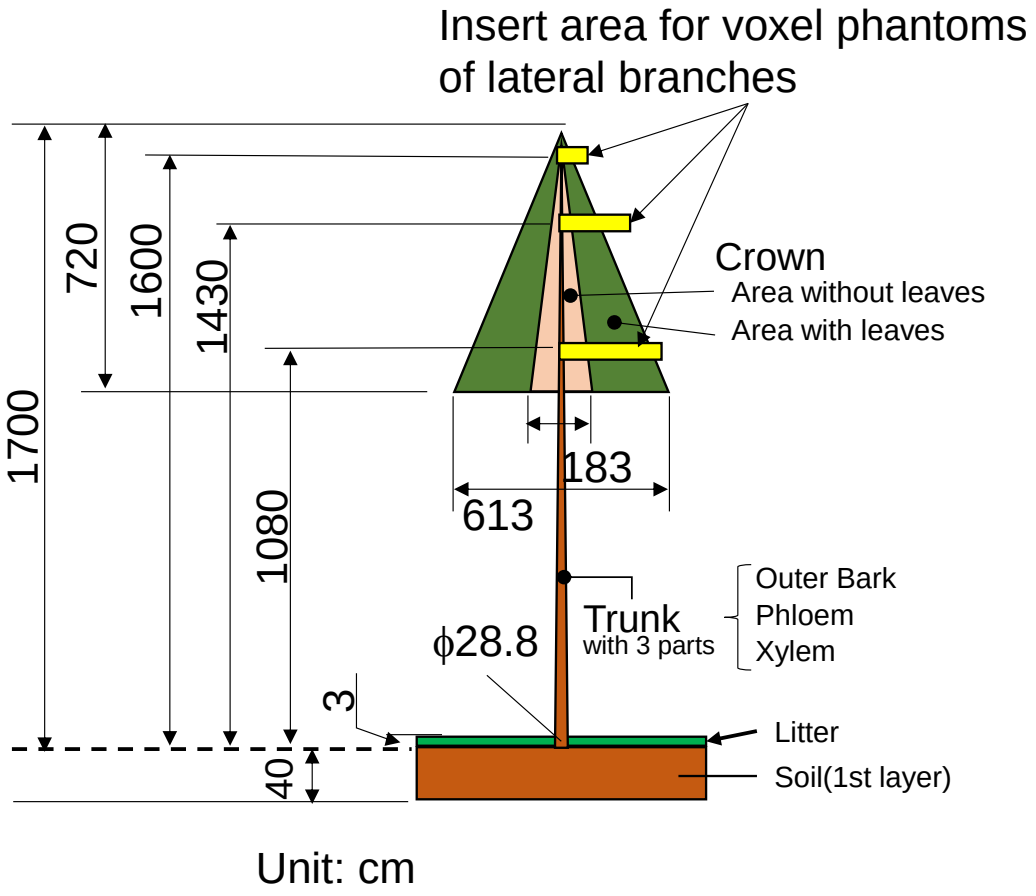

Fig. 1 Dimensions of a primitive pine tree phantom with above ground part.

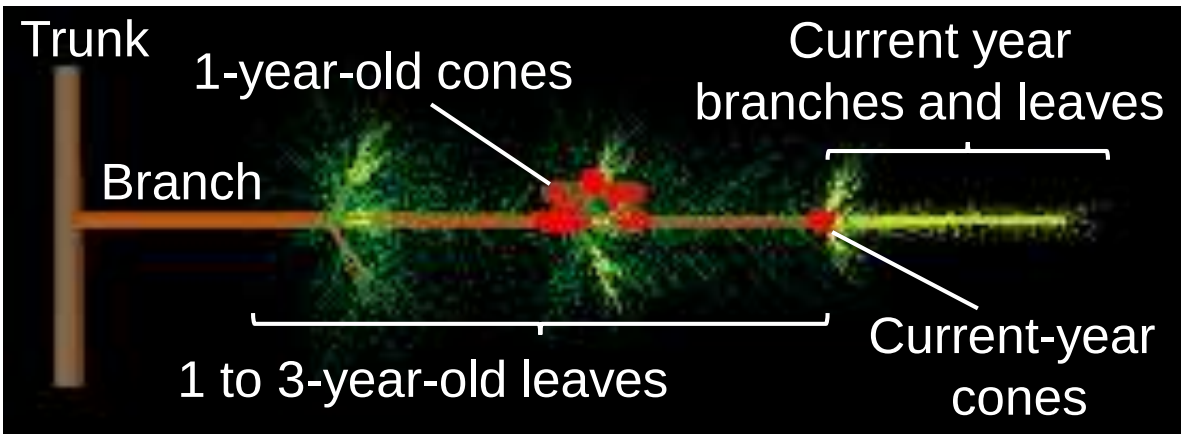

Fig. 2 A 3D image of the voxel phantom of a lateral branch at 16.0 m height above the