Numerical Model for Leaching & Transporting Behavior of Radiocesium in MSW Landfill

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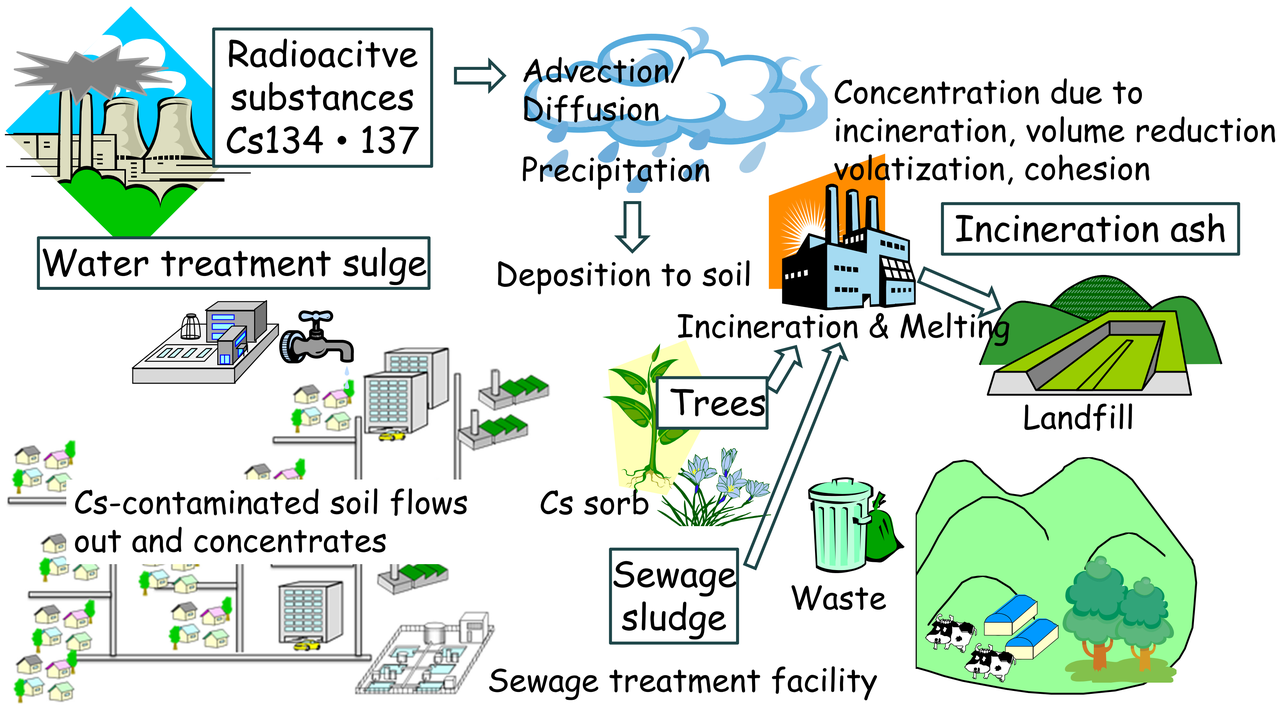
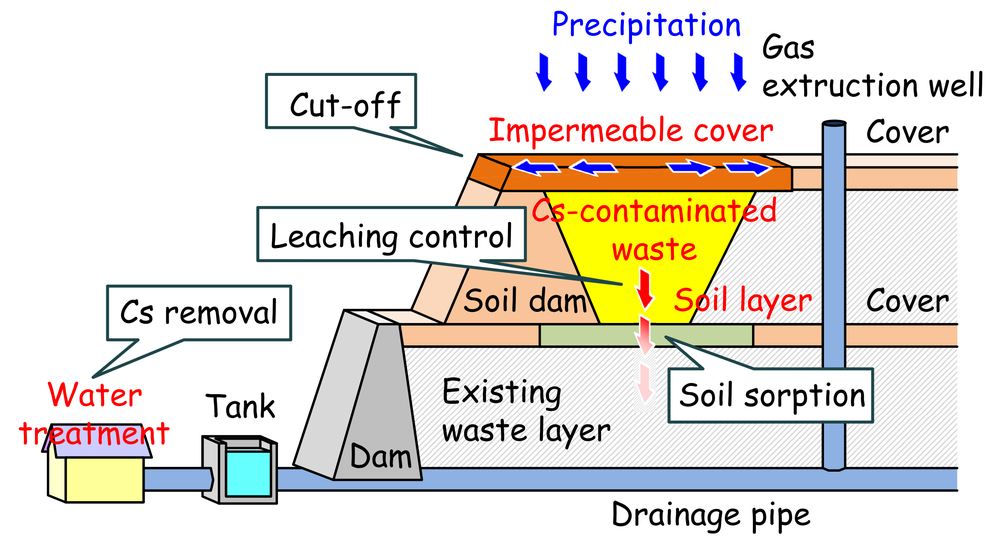
Radiocesium-Contaminated Wastes and Final Disposal ~Fukushima Daiichi nuclear disaster~



Radiocesium Leaching and Transporting Model

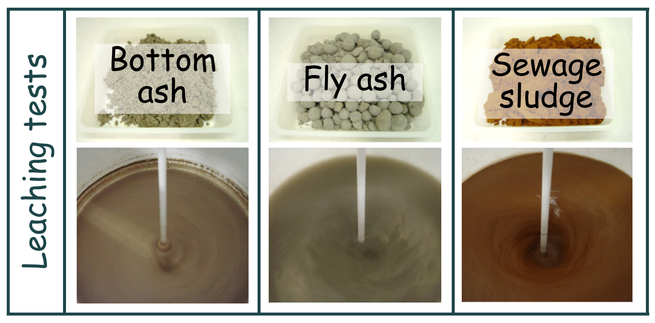


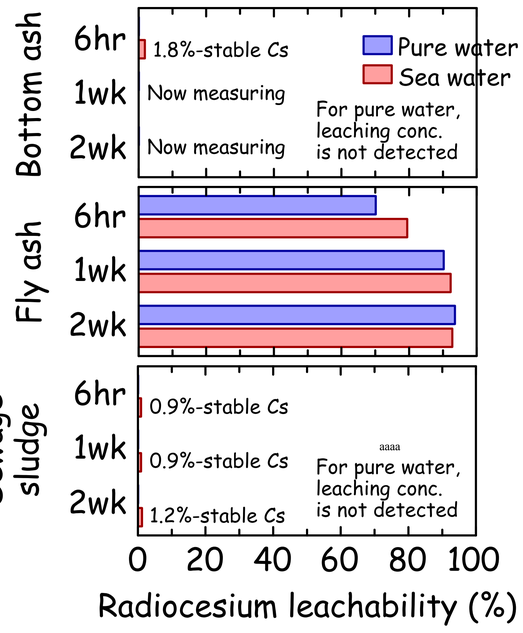
Design concept ~Multibarrier system~

Radiocesium naturally attenuates with time. Many defense technologies are combined in multiples, and the radiocesium can be maintain in landfill. Therefore, it can be decreased to a harmless concentration level.

Leaching tests
~Radiocesium leachability to water~

Evaluate the leaching rate of radiocesium in incineration ashes

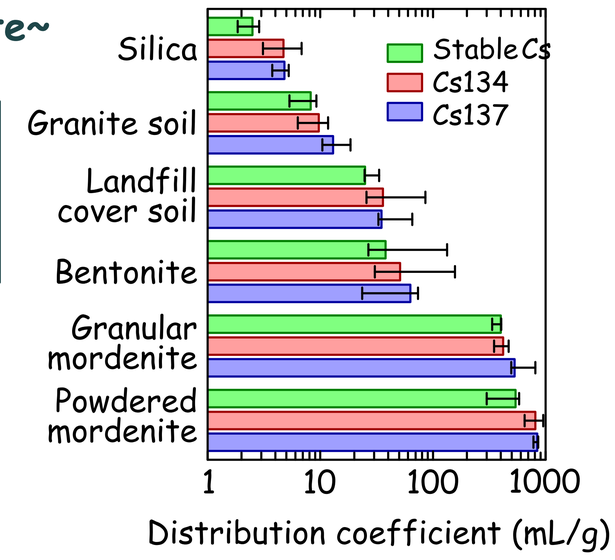




Take care about the landfill of fly ash because of the large leachability

Soil sorption tests
~Distribution coefficent in leachate~

Measure the concentration in the solid phase using waste leachate



Note the handling of these values, because the distribution coefficients are significantly dependent on the chemical compositions of leachte

Numerical simulation model
~Radiocesium leaching and transporting behavior~

Flow Equation (Richard's model)

$$\frac{\partial(\rho_w\theta_w)}{\partial t} = \nabla\left[-\rho_w\frac{k_{rw}K}{\eta_w}(\nabla p_w + \rho_w g\nabla z)\right]$$

Transport Equation (Advection-disperion model)

$$\frac{\partial(c_w\theta_w)}{\partial t} + \nabla(-\theta_w D\nabla c_w + u_w c_w) = -\theta_w\lambda c_w + R$$

Cs Leaching & Soil Sorption (Based on experimental results)

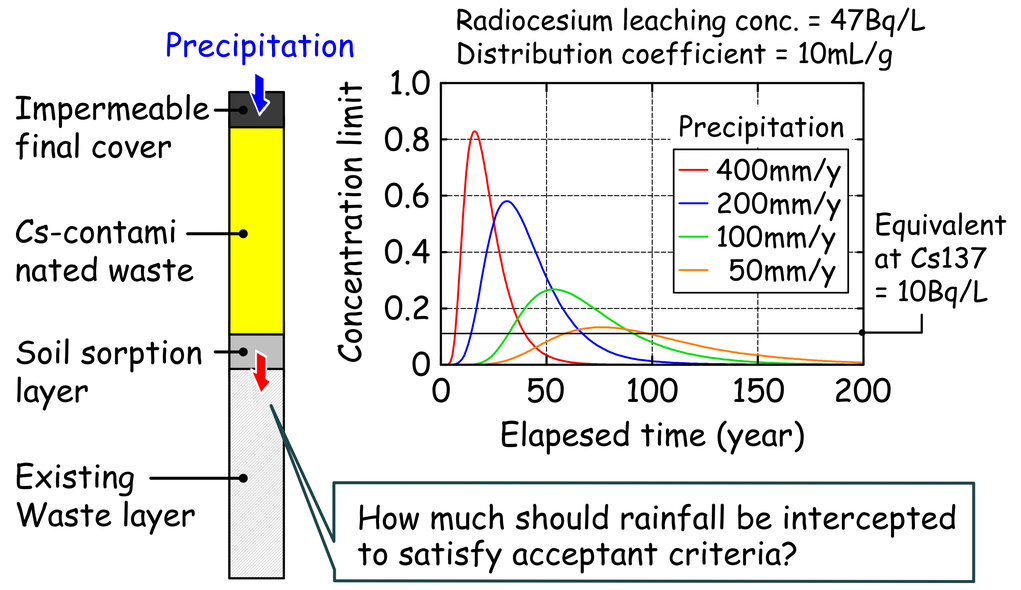
$$R = \rho_d K t^{\alpha} - \rho_d\frac{\partial S}{\partial t}$$

Mass balance in solid phase (Including sorption and decay)

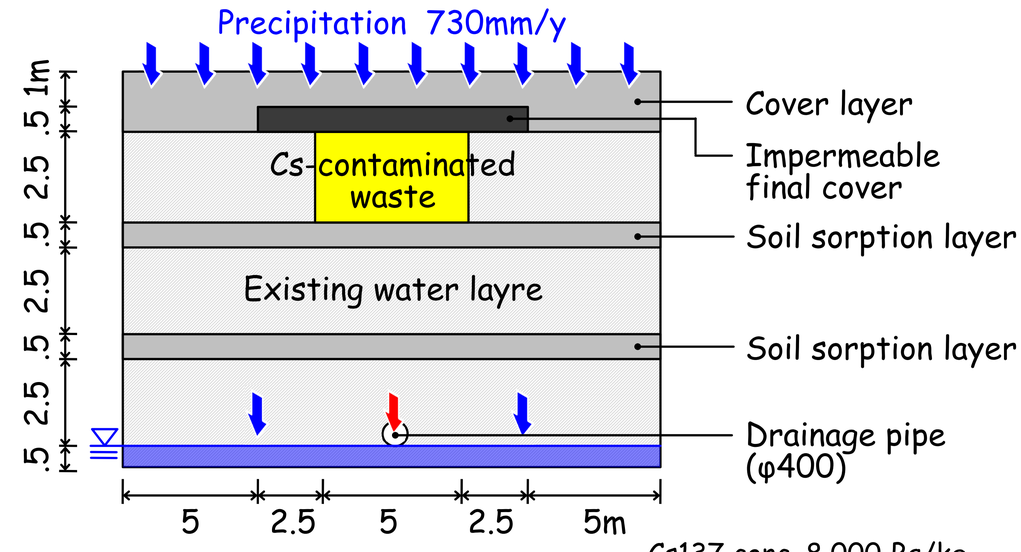
$$\frac{\partial S}{\partial t} = \beta(K_d c - S) - \lambda S$$

COMSOL can easily solve these equation systems.

Case studies
~Predict radiocesium behavior & design landfill~

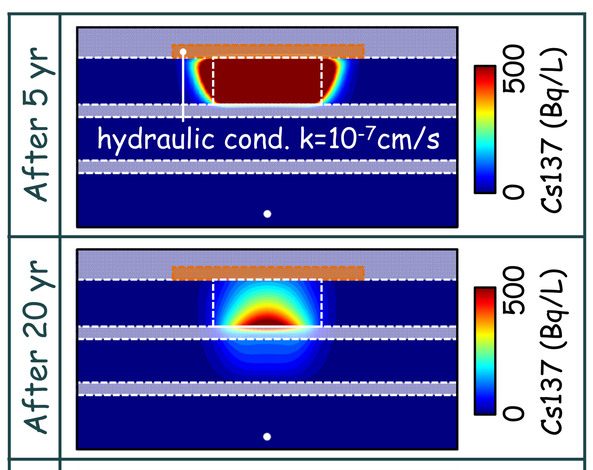


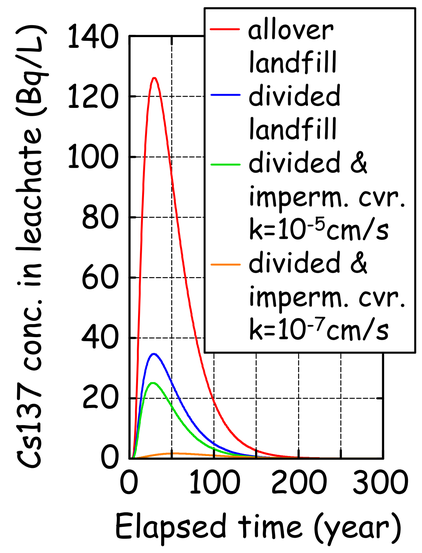
How much should rainfall be intercepted to satisfy acceptant criteria?



Hydraulic conductivity of impermeable final cover is $k=10^{-7}$cm/s

Cs137 conc. 8,000 Bq/kg
Leaching rate 0.5%/hr
Distribution coeff. 30mL/g





A proper leachate treatment is necessary in preparation for the case where radiocesium is detected in the leachte.

Excerpt from the Proceedings of the 2013 COMSOL Conference in Boston