

A Landscape-level Dose Assessment of a French NPP Using the SYMBIOSE Platform

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Context & objective

SYMBIOSE is a simulation platform for assessing the fate and transport of pollutants in environmental systems, and their dosimetric impact on humans (see Poster 713, Gonze & al.). Its latest version has been put to the test through a dose assessment of a French Nuclear Power Plant (NPP). This exercise, performed in 2009 and 2010 by IRSN and EDF, aimed at: testing the feasibility of a wide scale case study with SYMBIOSE and sketching a methodology for performing landscape-level assessments, notably in terms of data gathering & pre-processing, formulating physical & calculational hypotheses.

Scenario

Releases: atmospheric and liquid routine releases by the NPP from 2004 to 2008 ; 22 radionuclides considered.

Area of interest: 5 km around NPP, 150 km downstream the river.

End points: time and space evolution of activities and activity fluxes in the environment, effective doses and dose rates received by a rural adult population.

Transfer and exposure pathways: the modelled domain covers the atmosphere, river, agricultural and anthropogenic systems. Major transfer process at their interface are accounted for: deposition, irrigation, watering, food uptake, internal and external exposures. Radioactive decay and growth in compartments and during transfers are modeled.

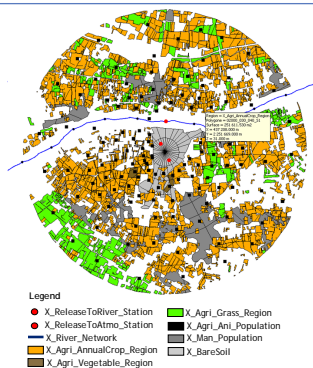
Spatial modeling

Landscape model: a set of geographic frames dedicated to various biosphere components. Inputs and calculation results are expressed on the relevant frames, increasing realism.

The landscape is built using site-specific geo-referenced information, by a fit for purpose pre-processor.

Spatial interactions: interactions between biosphere components with spatial transfers.

The connections between the involved geographic frames must be specified: deterministic values or proximity rules based on geographical & geometrical attributes can be used.



Site specific data

Landscape: geo-referenced land cover and digital terrain model databases produced by European or national organizations, and a 2008 parcel-level survey of agricultural land cover in the 5km around the NPP (SENSIB project).

Releases: EDF measures of liquid releases and atmospheric releases from two chimneys, at a fine available time sampling.

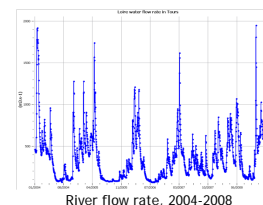
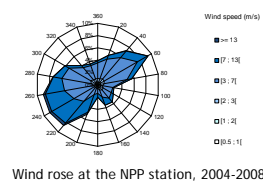
Meteorology: hourly to daily measures of wind speed and direction, rainfall height, cloud cover, from NPP station or nearest Météo France station.

River data: daily measures and mean monthly data of flow rate, suspended matter load, temperature, for the main river and/or tributaries.

Agricultural data: agricultural calendars (e.g. sowing and harvesting dates) reported by a local agricultural bureau.

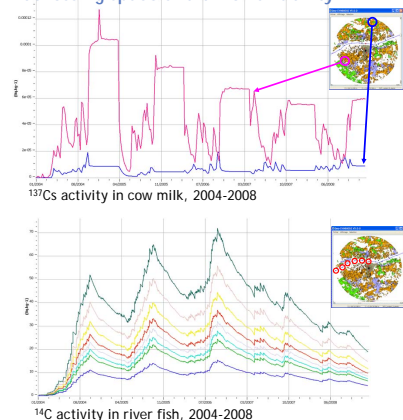
Occupancy: occupancy rates for 8 activities (indoors, in the terrestrial or river environments), derived from regional-level data.

Food intake: adult consumption rates of foodstuffs and locally produced foodstuffs, derived from a 2008 survey carried out in the 5km around the NPP (SENSIB project).

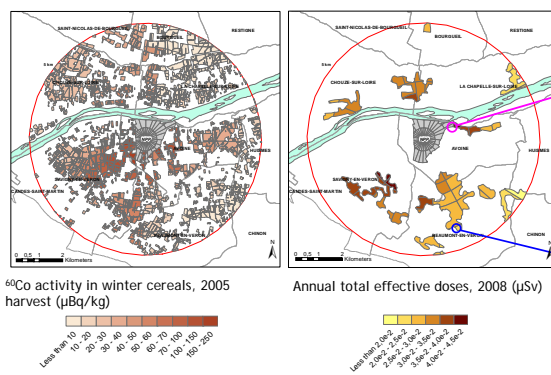


Results

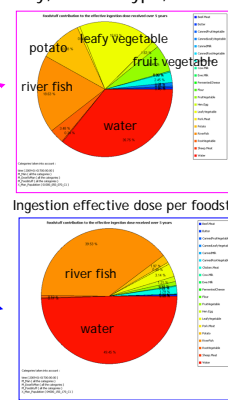
Addressing space and time variability...



...on dedicated spatial frames.



Analyzing dose contributions: per radionuclide, exposure pathway, release type, foodstuff ...



Conclusion & perspectives

This first landscape-level dose assessment with SYMBIOSE has been successful with respect to computational and methodology aspects.

Integrated approach deals with multiple release points and release types, in a multimedia environment.

Space and time modeling approach highlights:

- complex time kinetics and seasonal variability, even in a routine release context,
- significant spatial heterogeneity.

Future work will focus on:

Sensitivity analyses regarding:

- time and space sampling levels of input data,
- spatial modeling assumptions.