Radiotracers for the environmental management of coasts and water bodies

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Australian Nuclear Science and Technology Organisation

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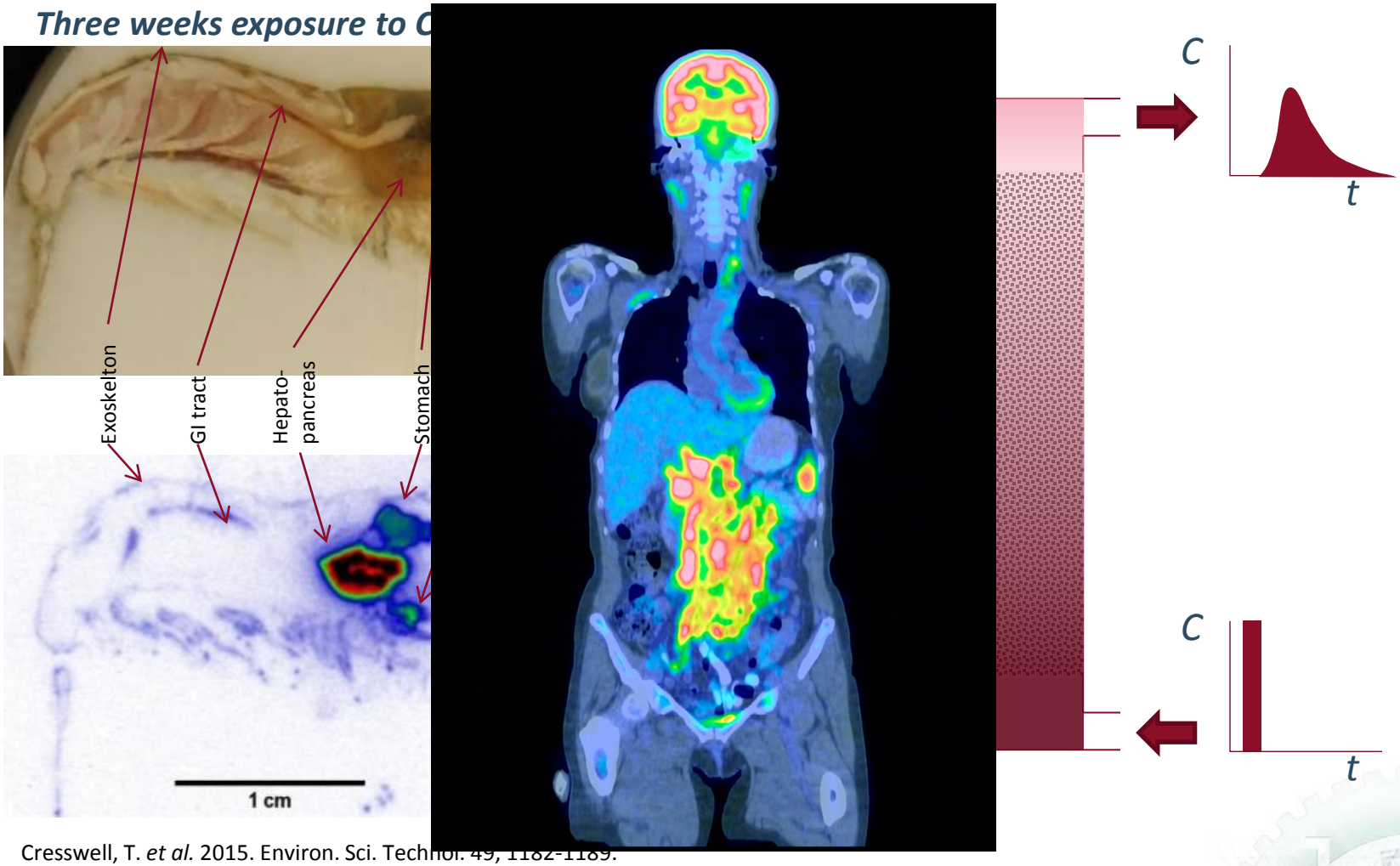
International Atomic Energy Agency Scientific Forum

ATOMS IN INDUSTRY

Radiation Technology for Development

15–16 September 2015, Vienna, Austria

What is radiotracing?



Cresswell, T. *et al.* 2015. Environ. Sci. Technol. 49, 1182-1189.

Why are radiotracers useful?

- Unique – no/low natural background
- Direct analogue for chemical under study
- V small mass so no toxicity/concentration effects
- Easily detected in situ or in samples
- Short half life = no memory effect

Hydrodynamics & effluent dispersion		
^{99m}Tc	^{82}Br	^{198}Au
^{131}I	^{3}H	

Sediment transport		
^{192}Ir	^{198}Au	^{46}Sc
^{181}Hf	^{51}Cr	^{110m}Ag

Biological and chemical uptake						
^{65}Zn	^{59}Fe	^{203}Hg	^{109}Cd	^{75}Se	^{54}Mn	^{35}S
^{134}Cs	^{60}Co	^{133}Ba	^{48}V	^{32}P	^{3}H	^{14}C

Radiotracers are sometimes isotopes not found in nature or produced in the nuclear industry

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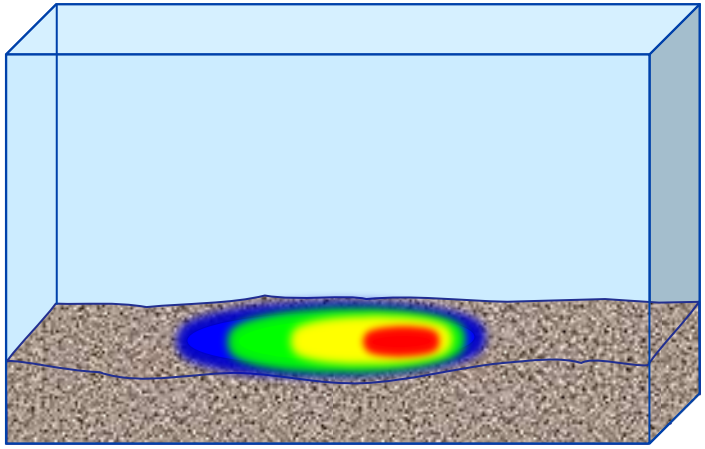
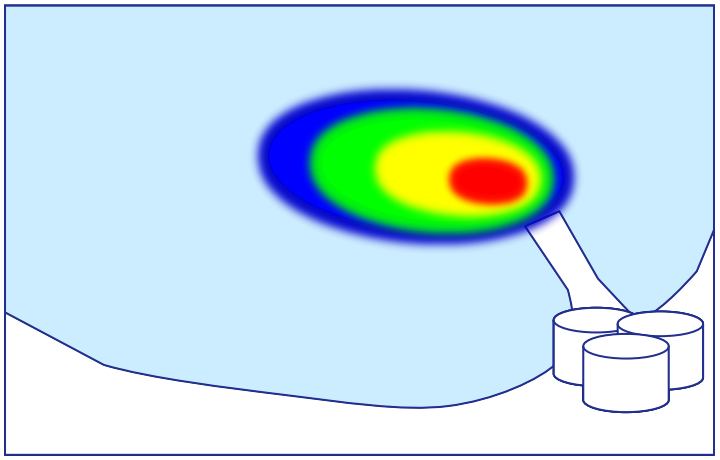
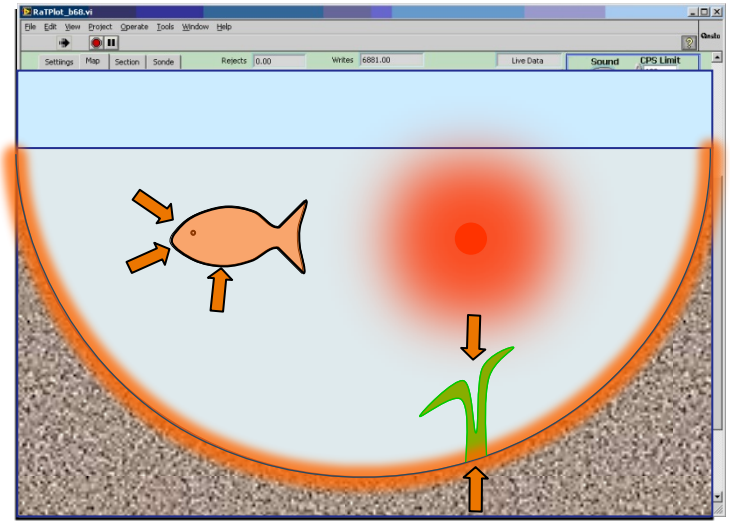
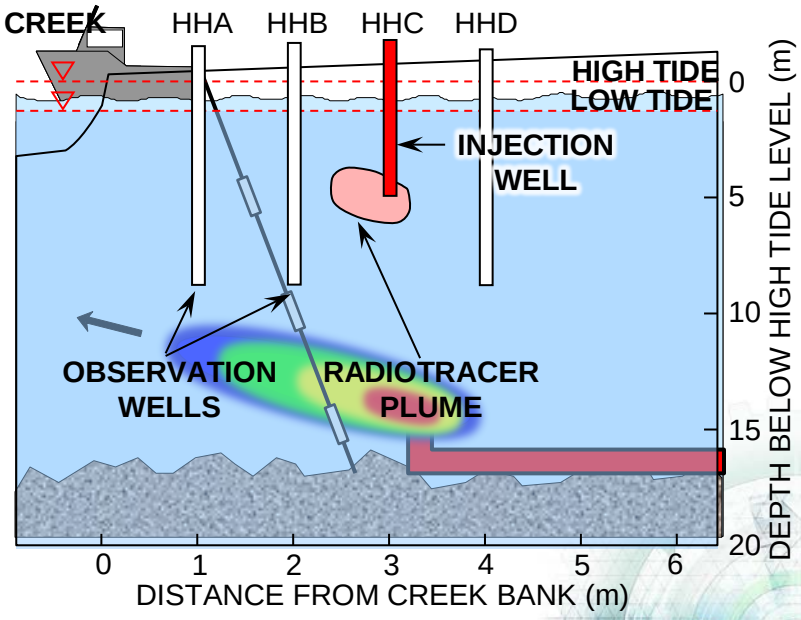
Radiotracing *outside* the lab









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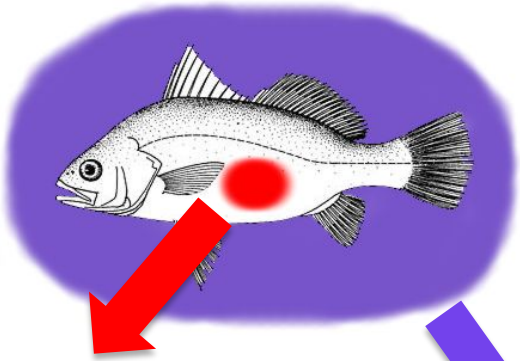
Is it safe for the environment?



DETERMINE EXPOSURE

- Radionuclide conc. (Bq/L,kg)
- Organism geometry
- Habitat factors (surface, benthic, water column)
- Occupancy factor (%)

INGESTION

- Concentration factor (Bq/kg per Bq/L)
- Dose conversion coeff (µGy/h per Bq/kg)

IMMERSION

- Dose conversion coeff (µGy/h per Bq/L)

IS IT A RISK?

- Dose:response data
- Dose guidelines

INTERNAL DOSE + EXTERNAL DOSE = TOTAL DOSE

We now have the tools to ensure that doses for all organisms will ensure no adverse effects

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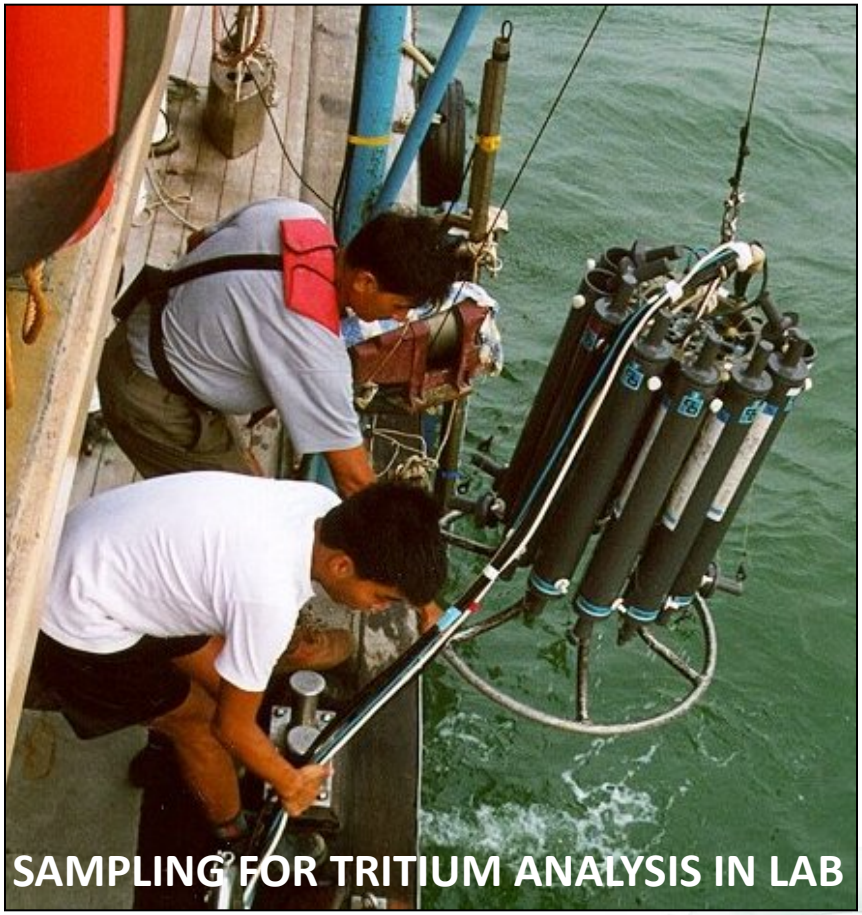
Tracing sewage effluent

DETECTION OF ^{198}Au IN REAL TIME



SAMPLING FOR TRITIUM ANALYSIS IN LAB

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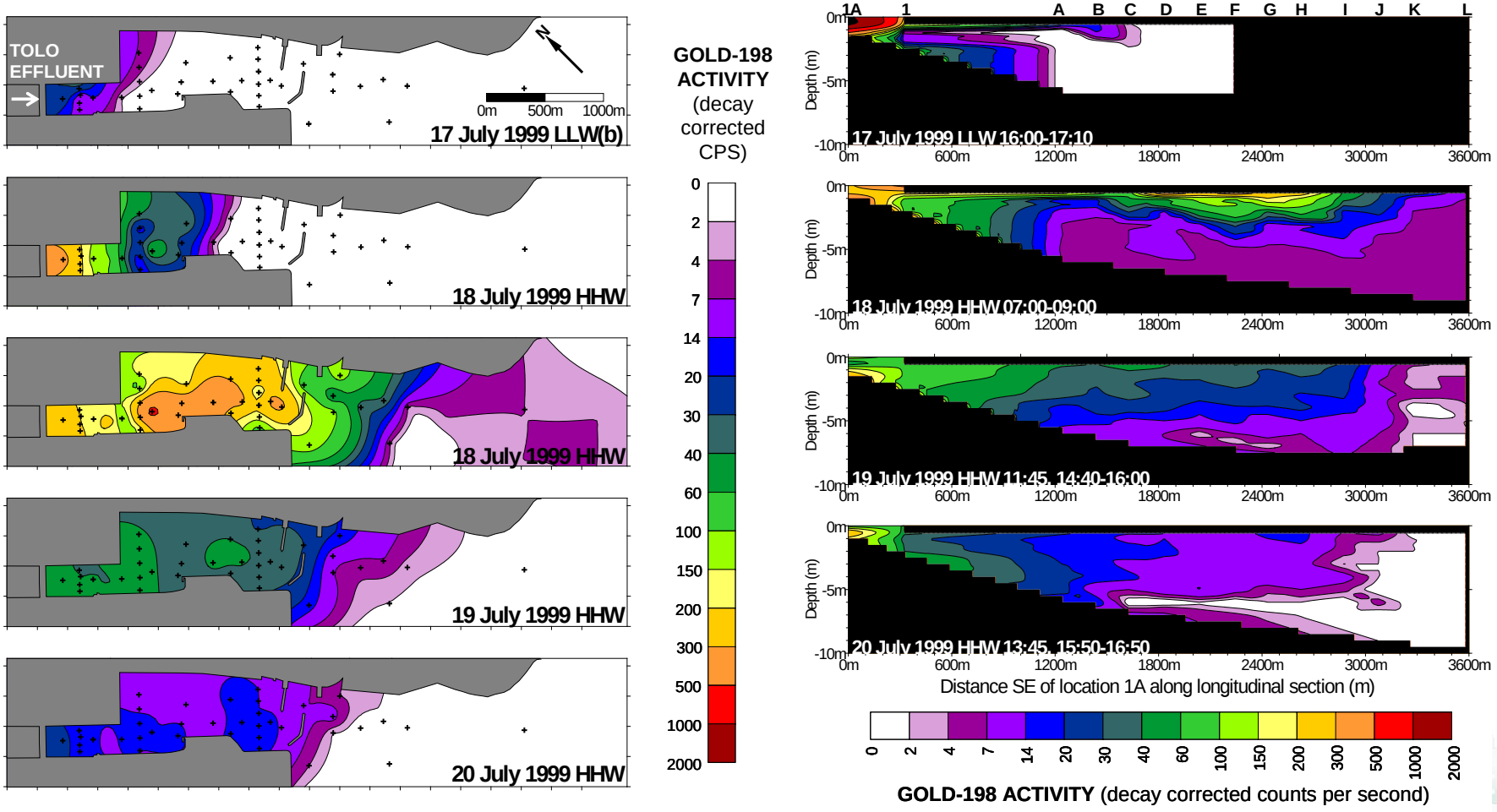
Gold-198 and tritium used to trace sewage in Hong Kong

Tracing sewage effluent



Gold-198 and tritium used to trace sewage in Hong Kong

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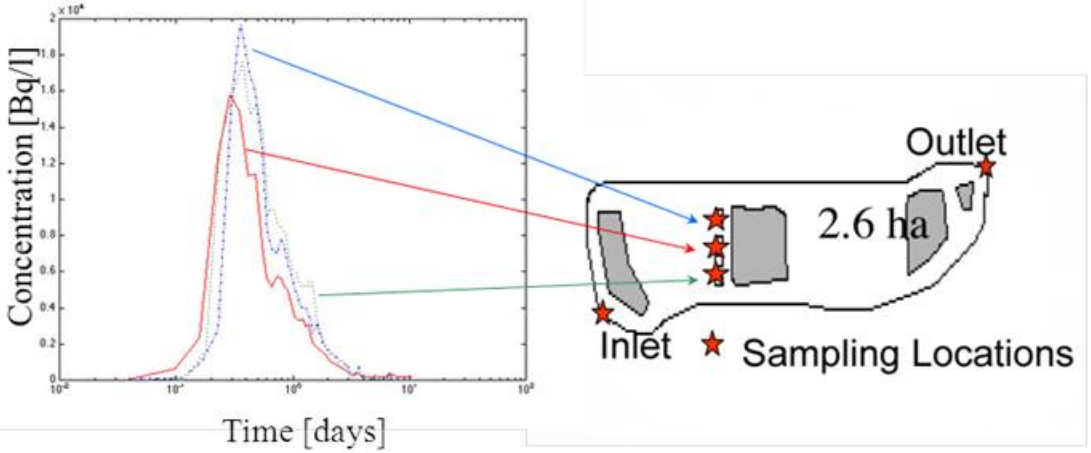
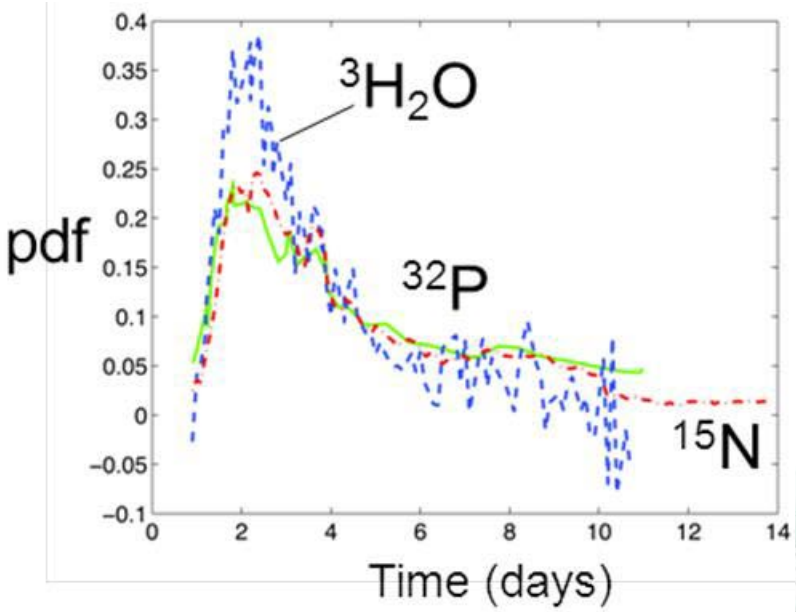
Wetland flow and nutrients

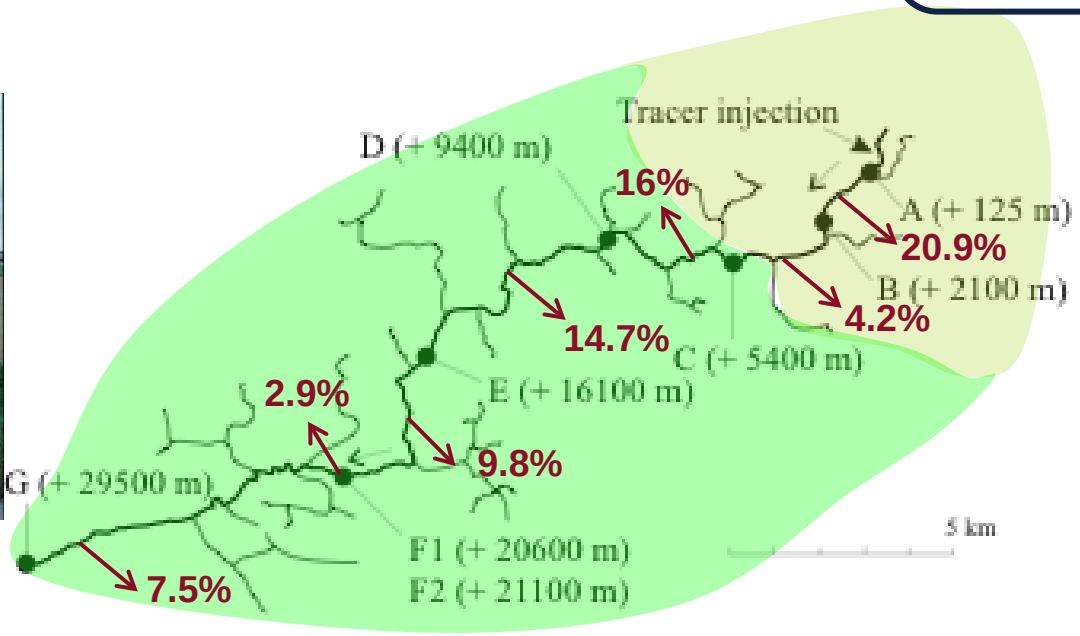




Kjellin et al 2007 Controlling factors for water residence time and flow patterns in Ekeby treatment wetlands .*Adv Water Research,* 30: 838-850

Streamflows & reactive transport

Säva Brook



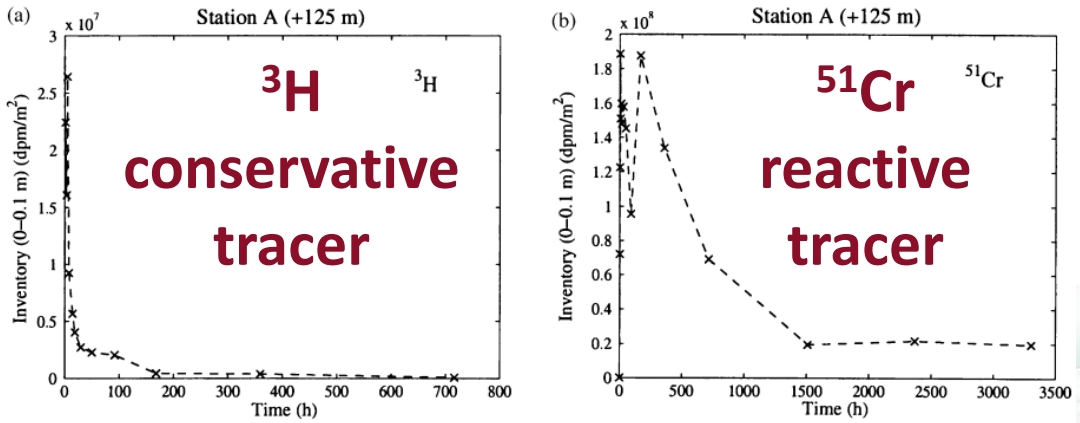
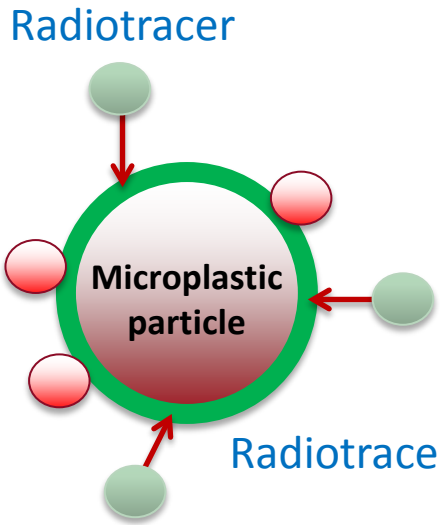
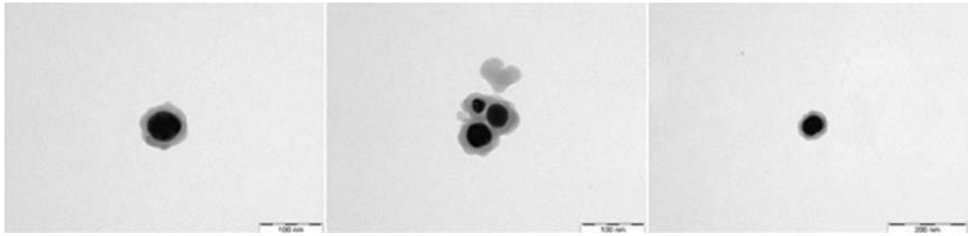


Fig. 5. Breakthrough curve of the mass inventory in the bed sediment (0–10 cm) at station A (a) tritium (b) chromium.

Jonsson, et al 2003. Hyporheic Exchange of Reactive and Conservative Solutes in Streams – Tracer Methodology and Model Interpretation, *J Hydrology* 278:153-171.

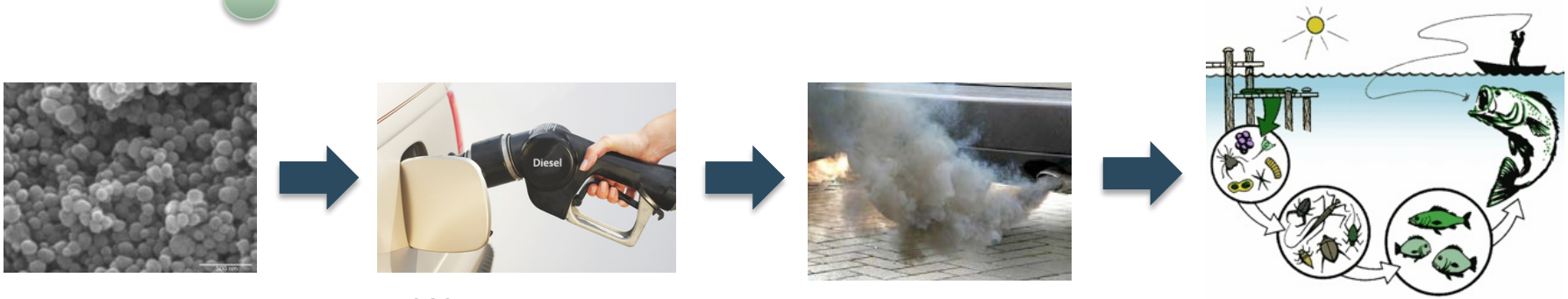
Future development in tracers





^{198}Au nano particles coated with SiO_2

120nm dia – suspended sediment tracer



Bulk, ionic and nano ^{141}Ce to study contaminant pathways in aquatic ecosystems

Study with Dr. Lisa Golding from CSIRO Land and Water Flagship

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CSIRO

Thank you!

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