Tracers & Tracing Techniques

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Dye Tracing - Practical Experiences and Applications
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Srinakharinwirot University

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warwick Water
Water & Environmental Resources

Tracers & Tracing Techniques

- transport, fate and effect of soluble pollutants and contaminated fine sediments
- laboratory or field based
- quantify the dominant transport and mixing processes in: river, coastal and urban drainage systems

Where
do contaminated flows go ?
When
will they arrive at any location downstream ?
How much
what concentration will occur
physical, chemical, biological changes ?

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Properties of the ideal tracer

- conservative
- no effect on flow properties
- moves at same speed as water
- resist adsorptive loss onto particulate materials
- stable not subject to decomposition

Advantages of fluorescent dyes

- accurately detected with a Fluorometer to less than 1.0 ppb.
- soluble and stable in normal water environments
- low toxicity ratings
- cost effective and easily measured on-site
- inexpensive
- used successfully for tracing over a long time

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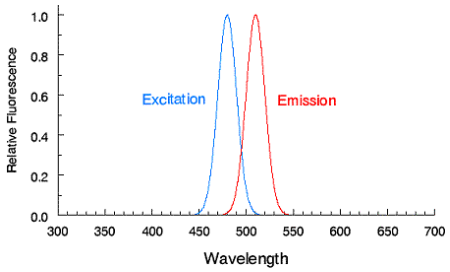
Water

Fluorescence is the molecular absorption of light energy at one wavelength and the instantaneous re-emission at another, usually longer, wavelength.



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Principle of Fluorescence

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Advantages of Fluorescence

- Specific
  - no two molecules excite and emit at the same wavelength
- Simple
  - no treatment required for many applications
- Sensitive
  - detect 0.02 ppb
- Fast
  - readings taken on-site

Comparative injection volumes of salt and fluorescein for a ground water test

Peter Smart, Univ. of Bristol

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Water

Tracing may be used to provide information on:

- Discharge or flow rates
- Travel time, mean velocity or velocity pdf
- Mixing processes
  - diffusion, dispersion
  - vertical, transverse and longitudinal

Using either constant or instant injection techniques

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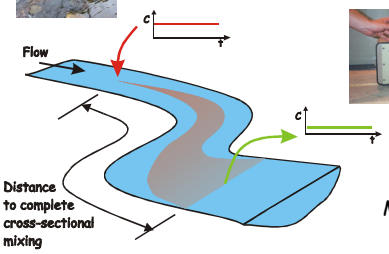
Water

Constant injection



Mass balance

$q_i c_i = Q_o c_o$

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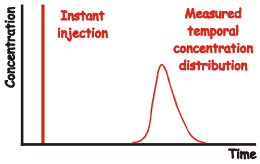
Instant injection

Total mass input
= concentration
x time
x flow rate

Same assumptions as for constant injection:

- Distance sufficient for full cross-sectional mixing
- No tracer lost between injection and measurement section
- Employ mass balance



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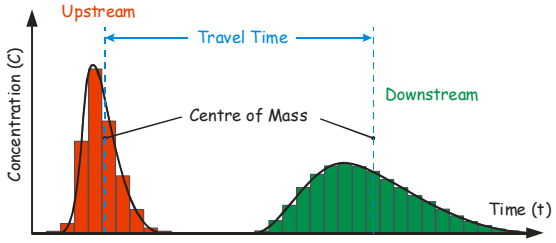
Travel time, mean velocity

- difference in time of centroids



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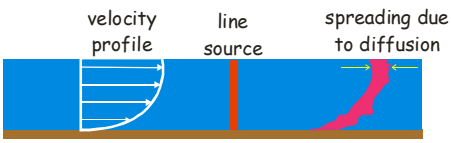
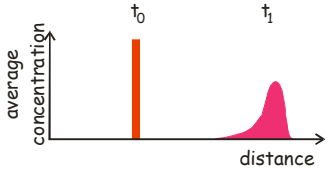
Shear dispersion





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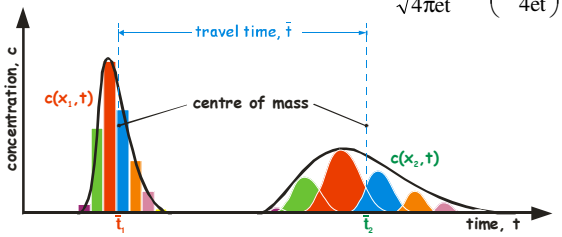
Dispersion coefficients

$$c(x,t) = \frac{m}{\sqrt{4\pi et}} \exp\left(-\frac{x^2}{4et}\right)$$



Assuming Fickian type diffusion, analyse using change in variance with time or distance.

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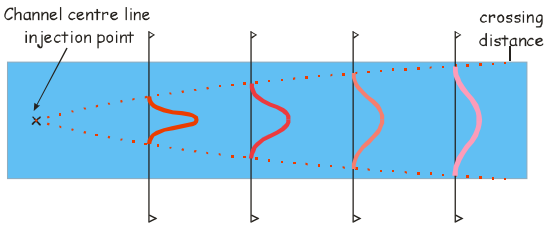
Transverse and Vertical Mixing



From a continuous point source injection
Analyse using change in variance with distance

team working

Fieldwork Studies
for AIT MSc
students

learning new field
measurement techniques

Monitoring
fluorescence
using SCUFA