

Mixing in Rivers

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Dye Tracing - Practical Experiences and Applications
20th September 2010
Srinakharinwirot University



Outline

- River Narew Study (Poland)
- Planform curvature - meandering channels
- Environment Agency - time of travel & dispersion database
- An example from China

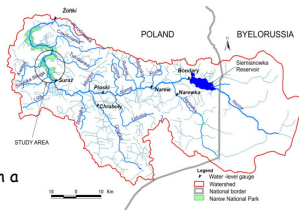


Illustration by E.H. Shepard

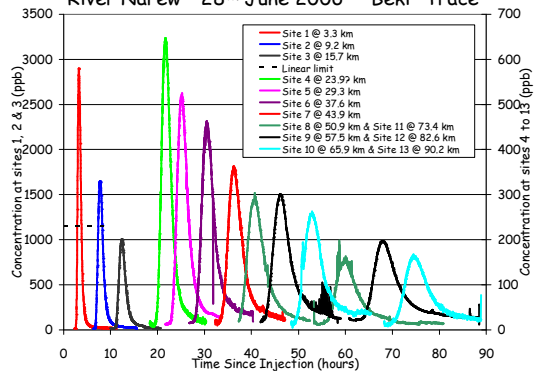


River Narew Study with Professor Pawel Rowinski (& students!) from Institute of Geophysics, Polish Academy of Sciences

Transport of blue/green algae from potential source, 90km downstream. Potential impact in a National Park.



River Narew - 28th June 2006 - "Beki" Trace



Outline

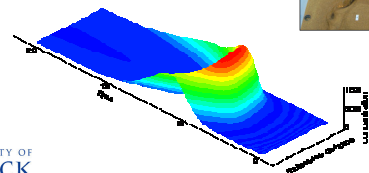
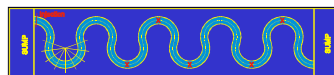
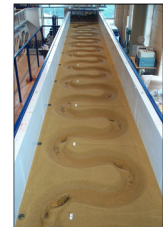
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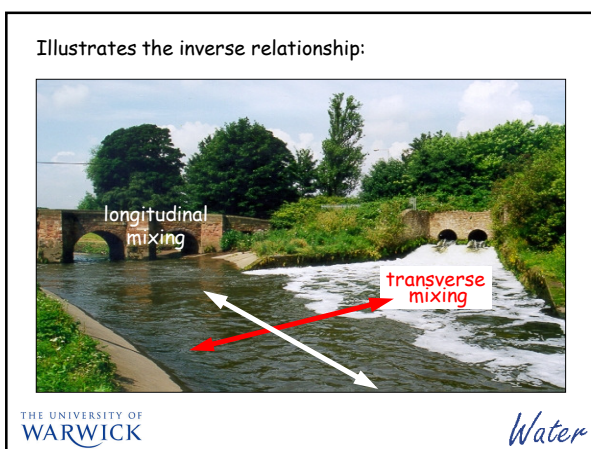
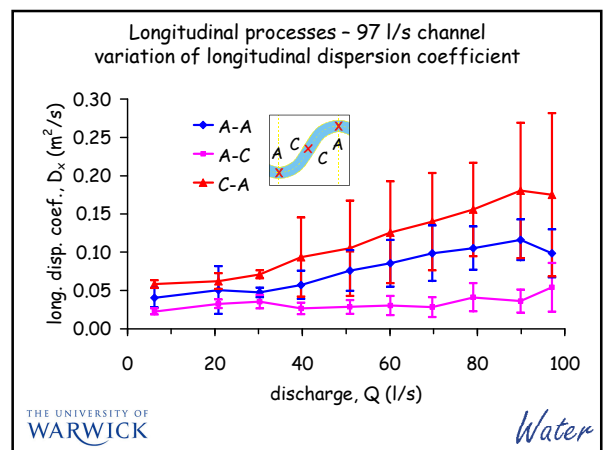
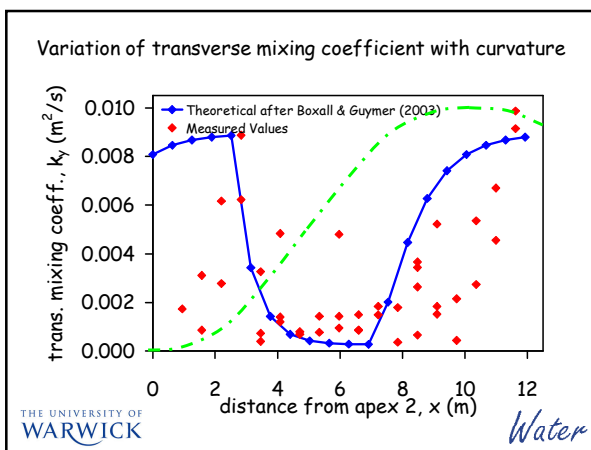
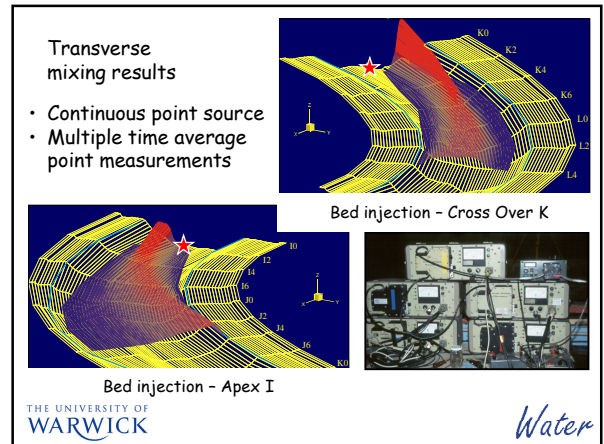
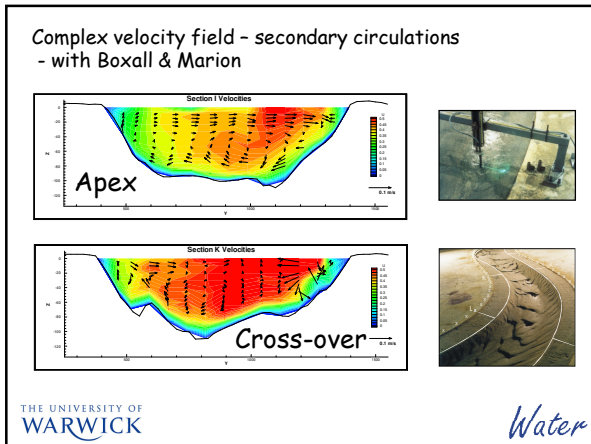


Illustration by E.H. Shepard



Some Meandering Channel Studies





Outline

- River Narew Study (Poland)
- Planform curvature - meandering channels
- Environment Agency - time of travel & dispersion database
- An example from China

"Playing Pool Sticks"

Illustration by E.H. Shepard

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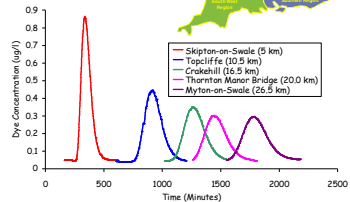
UK Environment Agency EA Time of Travel Database

- 196 data sets, 27 different rivers
- Physical data recorded
 - reach slope, catchment areas, flow rates
 - (instantaneous, annual mean, daily mean, Q95)



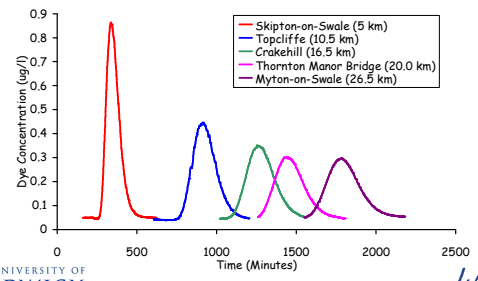
A National Database of Travel Time, Dispersion and Methodologies for the Protection of River Abstractions

Agency R&D Technical Report P346
Dr I. Guymer

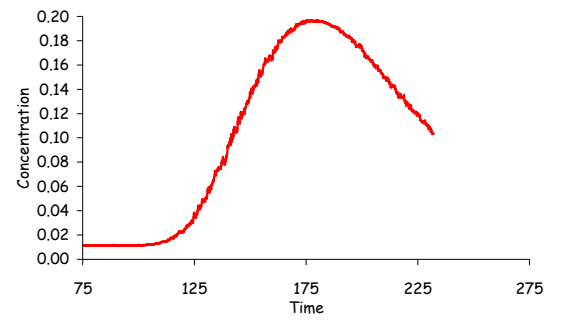


Overall Project Objective

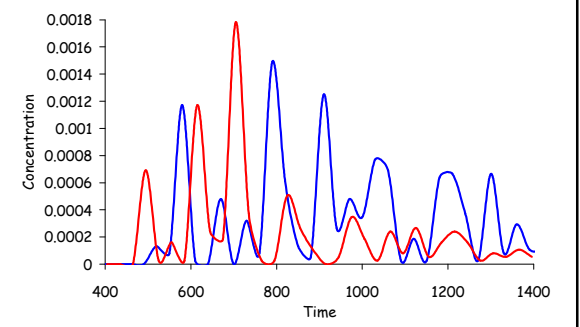
- To provide each region with a national time of travel and dispersion database, coupled with simple empirical equations for predicting the travel time and spread of pollutant in a river catchment.



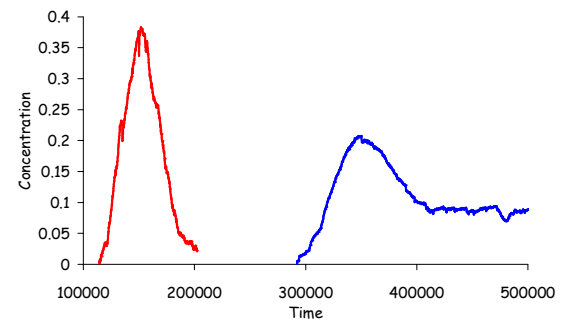
Incomplete trace (recording ceased early)



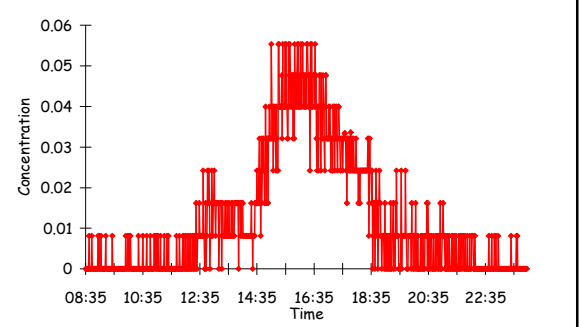
Noisy ill-defined distributions - type of tracer

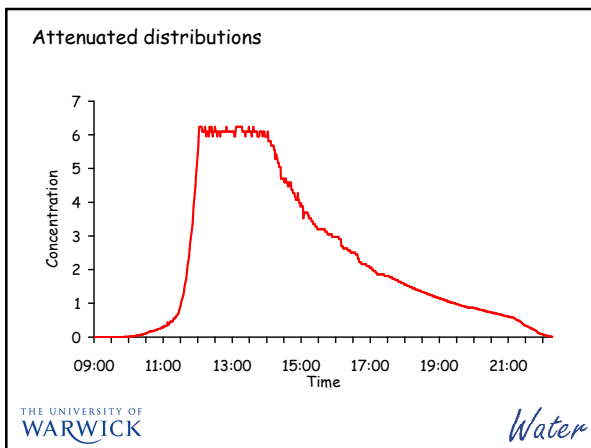
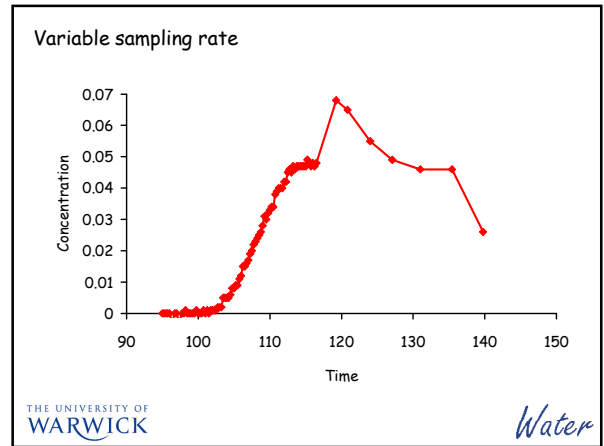
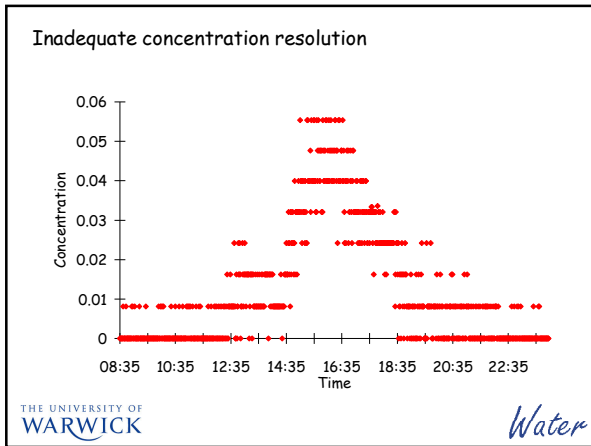


Variable Background Values



Inadequate concentration resolution



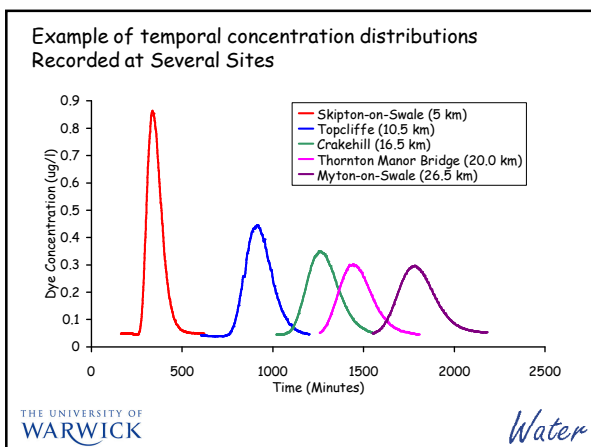


EA Definition of Acceptable Data

- The minimum concentration resolution should be 1/40th of the measured peak concentration (after background removal). Much greater resolutions are, however, preferred.
- Tracer arrival and peak should be clearly defined.
- The tail should recede at least to 5% of the peak and ideally to background.
- The temporal resolution of the data should provide a minimum of 40 points to define the distribution.

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Aim: to provide simple empirical equations for predicting the travel time and spread of pollutant in a river

ADE Dispersion - routing

$$c(x_2, t) = \int_{x_1 - \tau}^{x_1 + \tau} \frac{c(x_1, \tau) u}{\sqrt{4\pi D\tau}} \exp\left[-\frac{u^2(\bar{t} - t + \tau)^2}{4D\tau}\right] dy$$

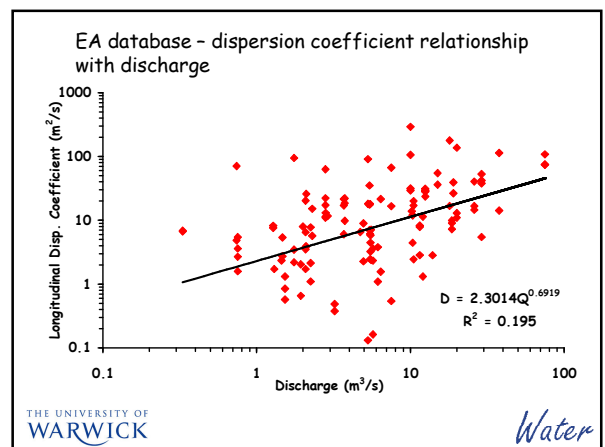
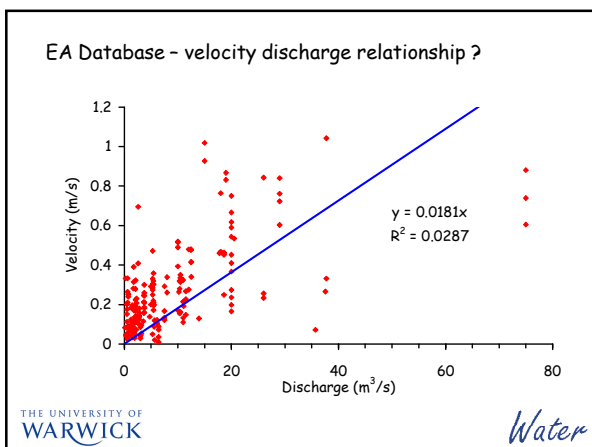
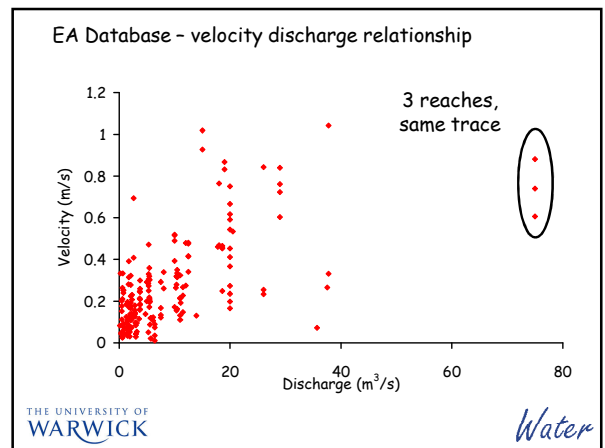
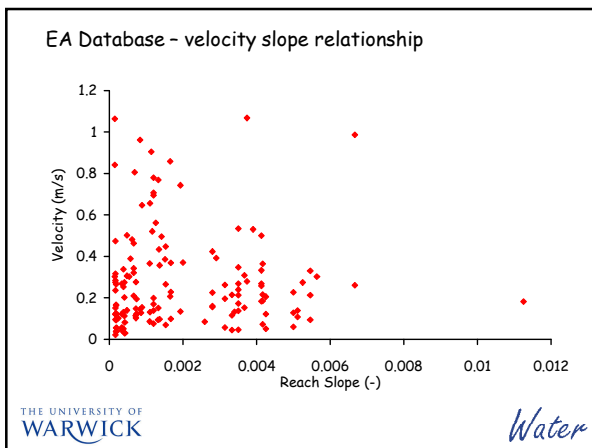
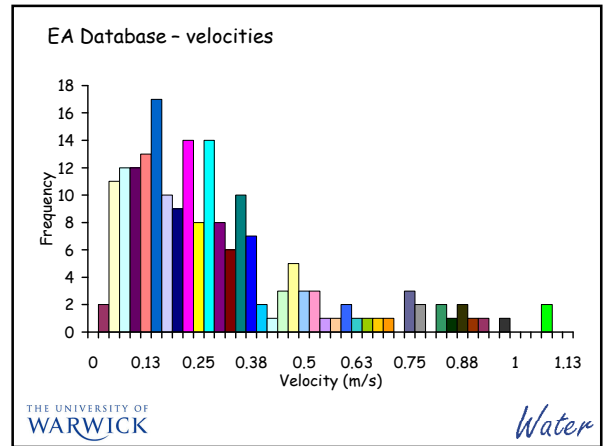
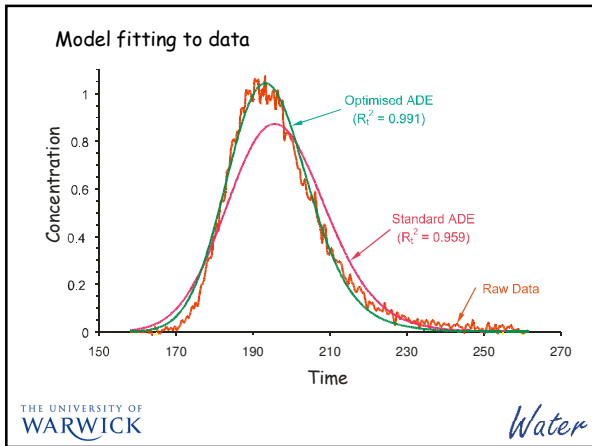
ADZ model - systems approach

$$c(x_2, t) = (1 - \alpha)c(x_1, t - \delta) + \alpha c(x_2, t - 1)$$

ADZ Dispersive fraction $D_f = \frac{\bar{t} - \tau}{\bar{t}}$

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China city waits for toxic deluge

Residents of a Chinese city threatened by a chemical spill have been given a few hours to stock up on water before contamination reaches the city.

Authorities had shut off water to Harbin after confirmation that an industrial accident 10 days ago had polluted the city's river.

"Benzene levels were 100 times above national safety levels," said China's Environment Protection Administration.

Water has been switched back on for a few hours to allow people to stock up.



SEE ALSO:

- Toxic leak threat to Chinese city 23 Nov 05 | Asia-Pacific
- China's murky waters 23 Nov 05 | Asia-Pacific
- China warns of water pollution 23 Mar 05 | Asia-Pacific
- In pictures: Harbin ice festival 07 Jan 05 | In Pictures
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Toxic leak reaches Chinese city

A huge swathe of toxic water has reached the north-eastern Chinese city of Harbin after drifting down the river which is the city's main water source.

Massive amounts of the chemical benzene were released by a blast 21 days ago at a plant in Jilin, about 350km (230 miles) further up the Songhua river.

Authorities shut off water supplies to Harbin's 3.8m residents two days ago.

There is plenty of bottled water, wells are being dug and supplies are being driven in, says a BBC correspondent.



SEE ALSO:

- In pictures: Harbin toxic leak 24 Nov 05 | In Pictures
- Toxic spill to hit Russian city 24 Nov 05 | Europe
- Chinese papers condemn Harbin 'lies' 24 Nov 05 | Asia-Pacific
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China apologises for river spill

China has apologised to Russia for a toxic leak 80km (50 miles) long, which is expected to enter Russia from the Songhua river within two weeks.

Foreign Minister Li Zhaoxing's move came after China began an inquiry into how the spill, which caused a major alert in Harbin, was allowed to happen.

Russia's Amur river, which feeds water to more than 500,000 residents of Khabarovsk, is likely to be affected.

Taps in Harbin are due to go back on shortly after a four-day stoppage.



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- Beijing orders Harbin leak probe 26 Nov 05 | Asia-Pacific
- Chinese media expose pollution row 26 Nov 05 | Asia-Pacific
- Evacuations follow China spillage 26 Nov 05 | Asia-Pacific
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spread of the spill

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Russians prepare for toxic leak

Russia is airlifting 50 tonnes of chemicals to try to tackle a toxic spill expected to flow into its rivers from China, Russian media say.

The activated charcoal is needed to treat benzene that spilled into the water after an explosion at a chemical plant in Jilin on 13 November.

The contamination of the Songhua river affected 3.8m people in Harbin city.

Mains water supplies in Harbin have now resumed after they were cut off as a result of the toxic spill.

The Songhua eventually flows into the River Amur in Russia.



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Chinese city water supply 'safe'

Water in the north-eastern Chinese city of Harbin has been declared safe to drink after a toxic chemical leak.

Running water was switched off to the city's 3.8m people for five days after 100 tonnes of benzene spilled into the Songhua river.

Despite reassurances by city officials, some residents said they were still too nervous to drink the water.

Communities further along the river are having to cut off their water supplies as the polluted slick moves downstream.

Russia has warned the spill is heading towards its Amur river, which feeds water to more than 500,000 residents of the...



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"Camellias in a Whirl" by Hiromu Hirayama

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