Are constructed wetlands really working as you have designed them?

an example from a nutrient-removal ponds system used to treat agricultural runoff (Southern-Sweden)

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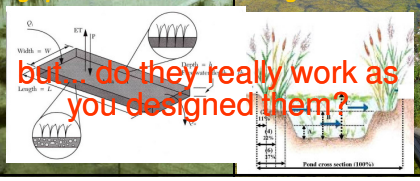
Workshop: *Dye Tracing – Practical Experiences and Application*,
Srinakharinwirot University, Thailand, 20th September 2010

In Sweden, agriculture is the main source of "nutrients" to aquatic ecosystems... since all sewage is treated.

Because they are quite efficient and low cost, constructed wetlands & ponds have been built all over Southern-Sweden

- ✓ *to enhance sedimentation* → *vegetation*
- ✓ *to provide fine filtration* → *sediment*
- ✓ *for nutrient removal (uptake/sink)* → water column

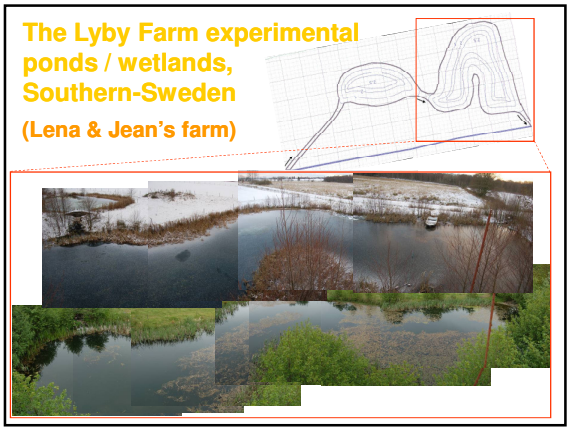
Design parameters from monitoring studies & research...



but... do they really work as you designed them?

The Lyby Farm experimental ponds / wetlands, Southern-Sweden

(Lena & Jean's farm)



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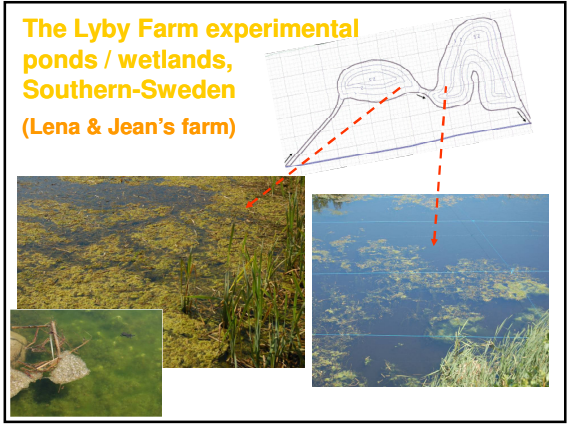

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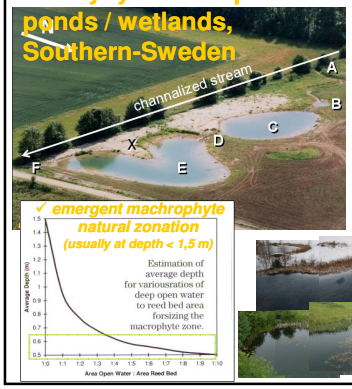


Wetland complex after construction in 2001:
- (A) Inflow stream;
- (B) Sediment trap;
- (C) First wetland;
- (D) Connecting riffle;
- (E) Second wetland;
- (F) System outflow;
- (X) Observation tower

✓ *emergent machrophyte natural zonation (usually at depth < 1,5 m)*

Research Aims

We know that…

Vegetation plays a crucial role in enhancing water quality in ponds and wetlands:

- Nutrient uptake
- Habitat and aesthetic value

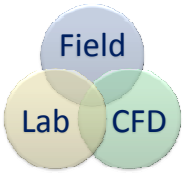
That short circuiting ($t < t_n$ ($t_{nominal}$ = Volume/Flowrate)) is often identified as one of the causal factors of poor performance of constructed wetlands

- Pond geometry
- Vegetation (seasonal variations)

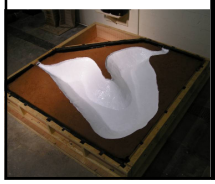
The Research therefore aims at developing a better understanding of the way in which vegetation affects pond flow patterns and retention times

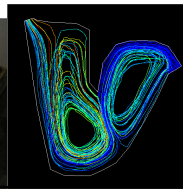
Methodology

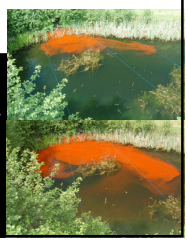
- Field observations – University of Kristianstad, Sweden (J.O. Lacoursière & L.B-M Vought)
- Laboratory experiments – University of Warwick, UK (*Prof. Ian Guymer & grad-students)*
- Computational Fluid Dynamics (CFD) – University of Sheffield, UK (V. Stovin & students)



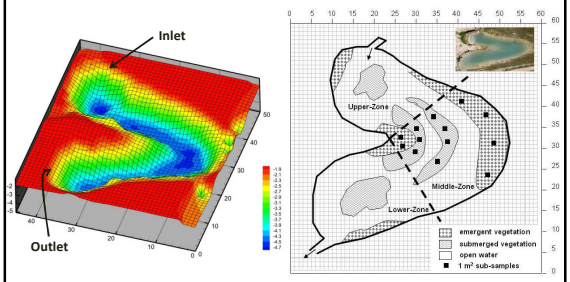
The effects of vegetation on residence times







Survey data



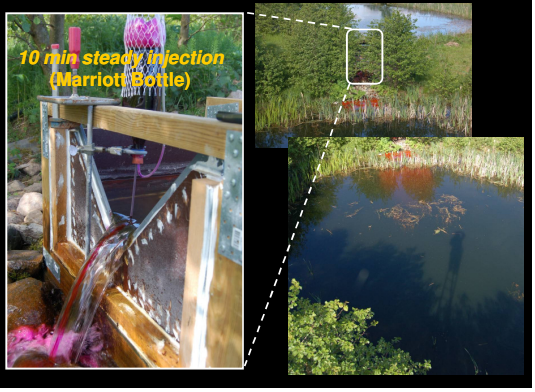
Data Collection

Inflow

Residual concentrations?

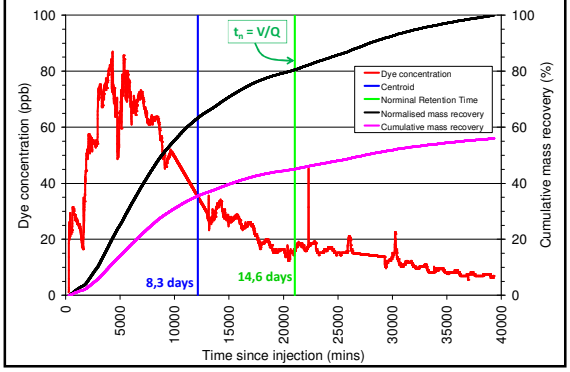
Outflow

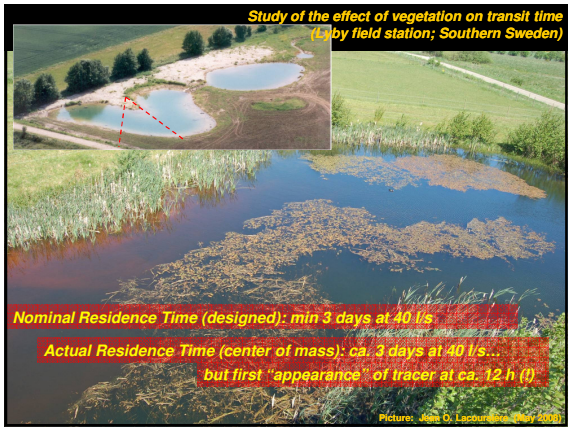
Trace



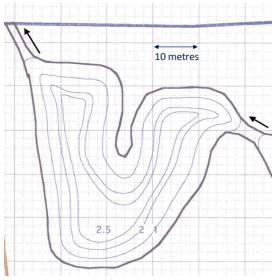
Trace

Field Results – April 2009



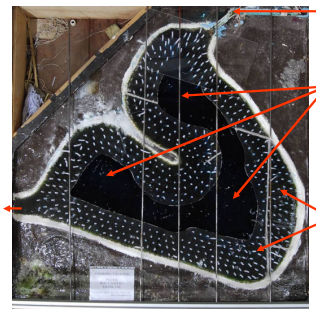


Laboratory scale model



Horizontal scale: 1:30
Vertical scale: 1:15

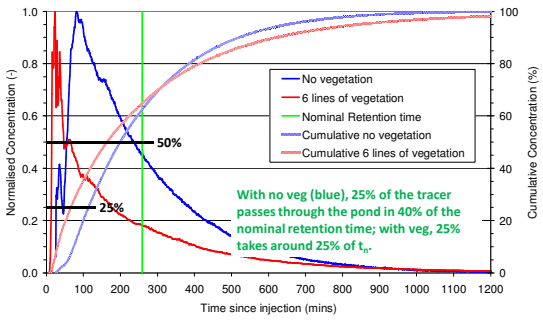
Representing Vegetation



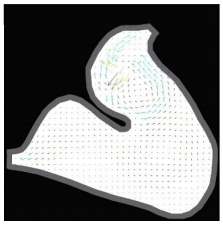
Configurations Tested

- Vegetation:
  - None
  - Emergent only
    - Various strip widths/coverages
  - Emergent + submerged
- Discharges:
  - From 4.4 ml/s [7.5 l/s full scale]
  - Up to 45.9 ml/s [80 l/s full scale]
  - (Typical pond flows ~ 3-15 l/s)

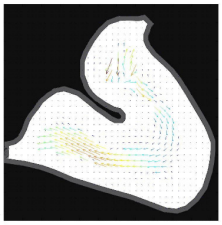
Laboratory results



Surface PIV results



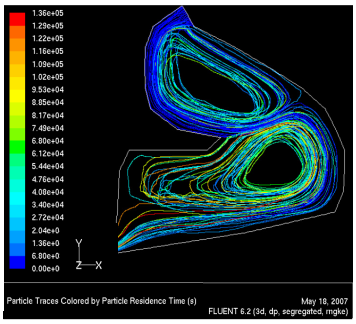
a) Without vegetation



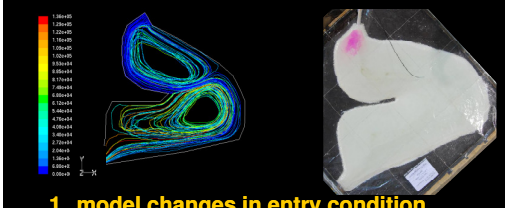
b) With maximum emergent "vegetation"

Q = 11.48 ml/s [20 l/s full scale equivalent]

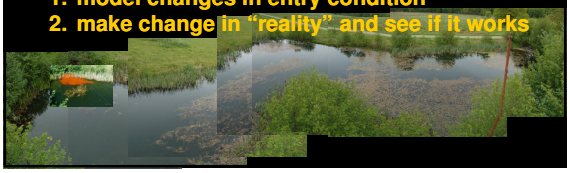
Preliminary CFD results for Lyby pond



So... What Next ?



1. model changes in entry condition
2. make change in "reality" and see if it works



Conclusions and Suggestions for Future Work

- Although vegetation plays an important role in enhancing water quality and amenity value in SUDS ponds, its impacts on flow patterns and retention times are still not well understood
- Understanding of potential effects – and their implications for pond design and operation – is here being obtained through a unique combination of field measurements, laboratory experiments and numerical simulations
- This unique set-up allows to test "adjustments" and assess their effect on both hydraulic and bio-processing efficiency.
- To be continued ...

A story to follow...
Interested in a challenge ?