Quantifying Mixing in Low Velocity Emergent Vegetated Ponds

The research aims are to develop a method for quantifying the dispersion of contamination in complex vegetated aquatic environments. Laboratory modelling is combined with field studies to provide extensive results. The effects of local mixing on residence time in regions of vegetated patches, borders and open flow need to be quantified. The influence of growth, density and discharge also need to be investigated.

**Research Aims**

- Artificial Vegetation, controlled flow.
- Three flow regions modelled: free flow, vegetated flow and mixing layer.
- Fluorescent dye evolution recorded spatially and temporally to characterise pollution mixing.
- Variable density and discharge

**Field Study**

- Fully vegetated constructed wetlands
- Tracer studies are conducted to measured residence time distributions
- Auto-sampling records water quality i.e. turbidity.
- Full field and vegetation survey conducted
- Travel times compared.

**Laser Induced Fluorometry**

- Spatially heterogeneous flow field requires multiple point measurements.
- Trace "meandering" and poor mixing demand more precise measurement technique.
- Laser Induced Fluorometry (LIF) increases spatial resolution and provides a non-intrusive detection method (Fig. 1).
- Two-dimensional concentration distribution recorded with single laser beam and camera (Fig. 2).

**Physical Model**

- Initial LIF images appear promising (Fig. 3).
- LIF system permits high frequency, high resolution data acquisition
- Point source instantaneous injection potential allows longitudinal and transverse properties to be characterised
- High spatial resolution describes mixing across heterogeneous vegetated flows

**Results**

- Vegetation alters mean residence time.
- Short circuiting an apparent problem (Fig. 4)

**Moving Forward**

- Real vegetation (Preferential species, optimum configuration, Fig. 5).
- Range of flow conditions
- Detailed Velocity Profiles (Ultrasound vs. Laser Induced Fluorometry (LIF))
- Variations with the growing seasons
- Concentration Modelling at interface

**Applications**

- Motorway and urban drainage
- Diffuse agricultural pollution (Pesticides, Nitrates, Phosphates)
- Sustainable drainage systems (SuDS)
- Wetland and Environmental regeneration
- Industrial point source discharges

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