Computational modelling of vegetated flows: past, present, future
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Past and present: RANS vs LES

Let me start with a few case studies:

Case study #1: RANS validation

The approach:

\[ F_{\text{eq}} = \frac{\rho L_{f}}{2} C_{f} \]

Some results:


Past and present: RANS vs LES

Let me start with a few case studies:

Case study #2: RANS application

River Rhine, Southwest Germany

Out in the field

Vegetation on Floodplain
Typical Bed Material in Main Channel

Counting trees and bushes

Vegetation on a Typical Groyne Field

No risk, no fun

Tracer Tests in the Groyne Field during 1999 Flood

Got some data

Mean Observed Flow Velocity $v$ [m/s]

<table>
<thead>
<tr>
<th>Measurement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<tbody>
<tr>
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<td>0.92</td>
<td>1.11</td>
<td></td>
</tr>
</tbody>
</table>
Finally, validation

Past and present: RANS vs LES

Let me start with a few case studies:

Case study #3: Some LES work

The approach:

Some results:

Flow Resistance

- Drag Coefficient $C_D$
- Reynolds Number $Re_D$
- $C_D = 0.27$
- $C_D = 0.15$
- $C_D = 0.091$
- Isolated cylinder

Analyzed time-averaged flow

Secondary currents

Turbulence Structures
Past and present: RANS vs LES

What have we learned so far:

- RANS is cheap but relies on empirical coefficients
- LES is accurate and provides a full picture of the flow but is expensive and is limited to simple geometries
- So what’s next?

Some work in progress

How to deal with real vegetation

Real plants are “reacting” to the flow
Some work in progress
Some preliminary results

Future challenges

1) Every plant is different – every river is different
   How do we quantify plant properties?

2) Every flow is different
   How do we account for flow non-uniformity and viscous effects?

Summary
Several powerful simulation strategies for modelling flow through vegetation exist
   These either rely on empirical input or are expensive and unpractical
   Improvements are needed in several areas
   Funding, funding, funding

Many thanks