Proposition de Travail de fin d'études

Titre	**Understanding complex symmetric and asymmetric flows in shallow rectangular reservoirs**
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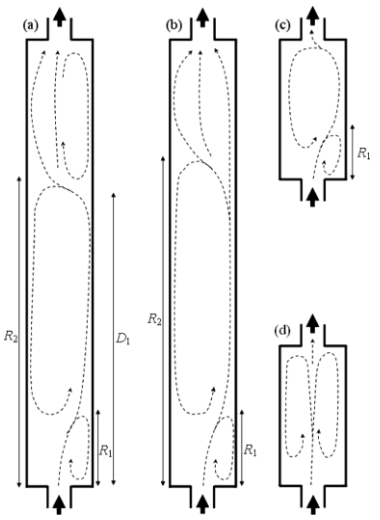
Collaborateur(s)	**Eric Delhez (ULg), Jonathan Lambrechts (UCL)**

Description du sujet



As was pointed out by Cammasio (2014), "shallow rectangular reservoirs are common structures in urban hydraulics and river engineering. Despite their simple geometries, complex symmetric and asymmetric flow fields develop in such reservoirs, depending on their expansion ratio and length to width ratio." Such (stable) flow patterns are depicted in the figure opposite (Dufresne et al. 2010). In some cases, particulate matter must also be taken into account.

Due to their pervasiveness, the above-mentioned phenomena have been studied extensively in the field, in the laboratory and by means of numerical simulations. However, thus far, simple and quantitative diagnostic quantities of them have remained elusive. The aim of the present project is to make an attempt to develop such diagnoses, by having recourse to the tools provided the Constituent-oriented Age and Residence time Theory (CART, www.climate. be/cart, this website is in the process of becoming obsolete and is to be revamped within a few months).

The age of a particle of a constituent (in dissolved or particulate phase) of a fluid mixture, is defined as the time elapsed since it left the region where its age is prescribed to be zero: age is a measured of an elapsed time. The residence time is the time needed to reach the region where the residence is prescribed to be zero. These timescales and some of their variants may be computed at any time and location by solving partial differential equations that take into account all the transport processes (i.e. advection, diffusion, settling and resuspension) and reactive phenomena as well.

The aforementioned diagnostic equations will be solved using the two-dimensional, depth-integrated flow and diffusivity fields provided by the *Hydraulics and in environmental and civil engineering* (HECE) group of the University of Liège (ULg) for a range of shallow, rectangular reservoirs. Time permitting, particulate matter will also be considered. Hopefully, CART's diagnoses will offer a different, holistic and quantitative view of the abovementioned phenomena that will be conducive to new interpretations.

By the end of this master thesis, the student will have gained insight into transport processes in fluid flows occurring in man-made reservoirs as well as methods to simulate them numerically.

Cammasio E. et al., 2014, Prediction of mean and turbulent kinetic energy in rectangular shallow water reservoirs, *Engineering Applications of Computational Fluid Mechanics*, 8, 586-597

Dufresne M. et al., 2010, Classification of flow patterns in rectangular shallow reservoirs, *Journal of Hydraulic Research*, 48, 197-204