FLOW STRUCTURE AND RESISTANCE IN FLEXIBLE VEGETATED CHANNELS.

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The present paper helps to understand the behaviour of the flow through plants, as a first approximation to the environmental interactions happening in natural rivers. The main was to obtain the friction factor of flexible vegetated channels, in different density and flow conditions, and describe the influence of turbulence in it. The experimental set up was a 20 m long, 1 m wide flume with a mild slope and gravel bed. Plastic strips were used to model riverine vegetation (*Common Reed*). A bidimensional electromagnetic sensor and a Sontek Doppler sensor (25 Hz) was used to measure flow velocities. The Darcy Weisbach friction factor (f) shows good agreements with the approach by Kouwen (Kouwen 1992). We show the behaviour of the friction factor versus the density of the plants for increasing flows. Also, the vertical distribution of longitudinal velocity was measured and compared in dimensionless form and discussed. We present some results showing a relationship between shear velocity (v*) and "slip velocity" (v_k) measured just on the top of deflected canopy. We studied the Integral scale, the Reynolds stresses profile (like Naot (1993), Nepf (2000)) and the turbulent intensity distribution with and without plants.

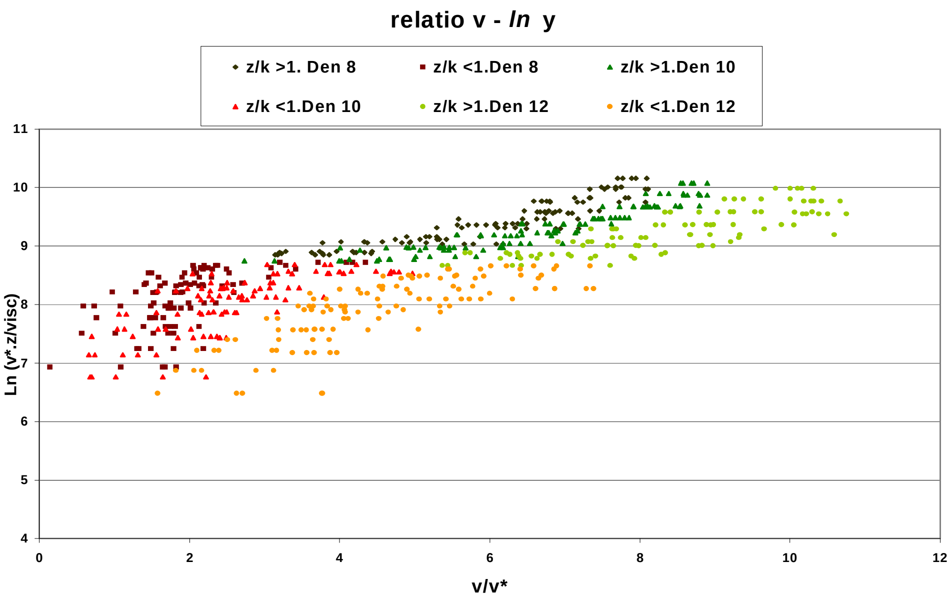


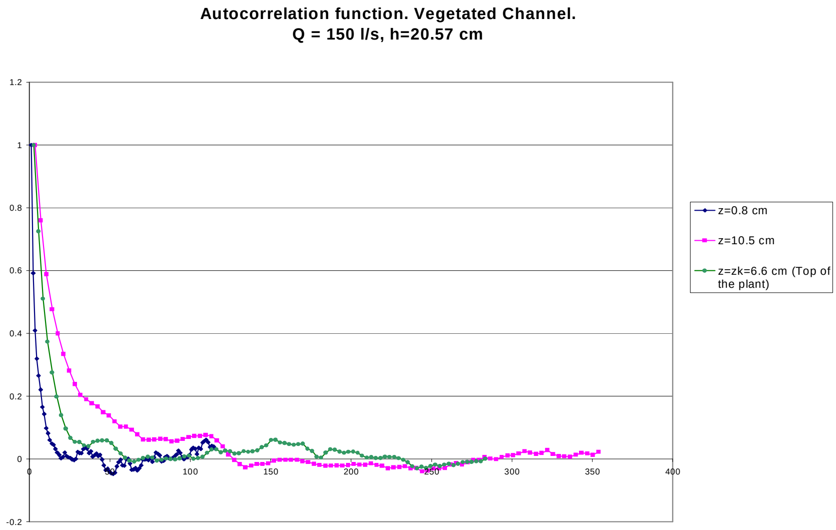
Figure 1. Velocity distributions profiles.

Previous figure shows velocity vertical distribution over and inside canopies. Velocity has been dimensioneless with shear velocity v* .

A good agreement from the hypothesis of Kouwen (1992) shows that the velocity profile of the flow over the top of the plant is really a logarithmic distribution and the flow through the plants is linear, nevertheless wide spread data are obtained in this zone.

The Autocorrelation function of fluctuations can be expressed as :

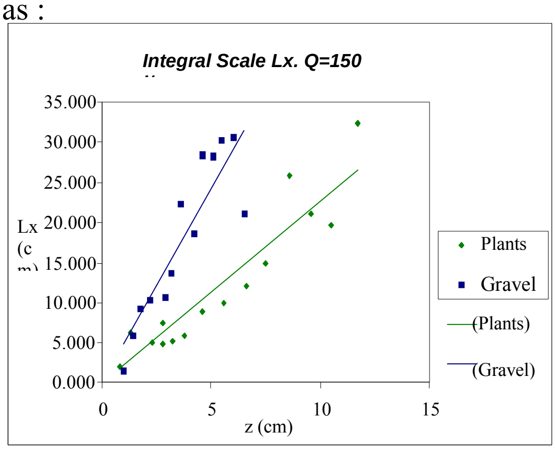
$$\mathrm{Re}(\tau) = \frac{\overline{u'(t).u'(t+\tau)}}{\overline{u'^2}}$$



Using the Taylor hypothesis (freeze turbulence) we can transform these time scales into length scales, L= V. τ. The macroscale of turbulence or Integral scale can be calculated

$$L_x = \int_0^\infty \mathrm{Re}(L).dL$$

as :



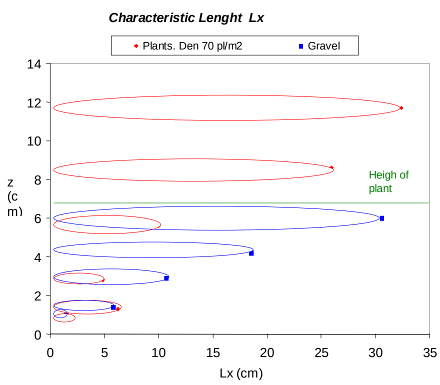


Fig. 3. Length Scales through the height of the flow.

Fig. 4. Comparative of the length of the whirls with and without plants.

In figure 3 we can observe how Integral scale (Lx) decreases when plants are present. In figure 4 we show how the magnitude of the macro-whirl inside plants is smaller than ones in the upper zone and also they are smaller than no-plants integral scales measured near the bed.

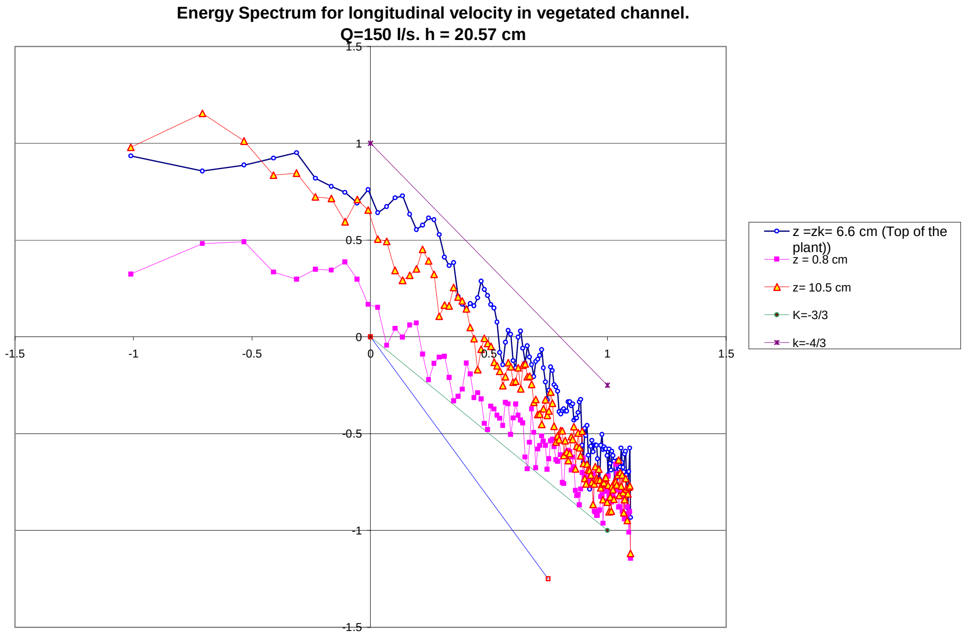


Fig. 5. Energy Spectrums measured in different depths in vegetated channel.

The energy spectrum of the gravel bed shows that energy decays with a –4/3 slope similar to the slope of the zone over the top of the plants in the vegetated canal. But in the zone of flow through the plant the energy decays slower, that is –3/3. Also it can be seen that the energy spectrum just near the top of the plants is higher then other zones.

The stress profile of the gravel bed flow shows a maximum near the bottom of the canal. Plants induces to the flow a elevation of the maximum shear stress value, this value is observed over the canopies of the plants.