Institute of Hydraulic and Water Resources Engineering, Vienna University of Technology

River Engineering

Tutorial Sheet 4 – A flood event

In January 2011 the lecturer stayed with his mother for a month on the riverine plains of inland Australia, normally very dry, with an annual rainfall of only 350 mm. There were heavy rains and a major flood (in the middle of the Australian summer). Mother and son had to evacuate from a farm 25 km away into the village as she was a possible medical emergency case and the only bridge was about to be blocked by floodwater. Two days later at 5:30 in our emergency accommodation, sirens rang, and we were compulsorily evacuated to Melbourne on the only other road remaining open, as the levee banks surrounding the village were in danger of bursting.

(a) General view of flood approaching lecturer's home village

(b) Water level has reached the bridge in the village. If only someone knew how to calculate its resistance ...

(c) GPS measuring water level and anxiously numerically differentiating with respect to time and extrapolating. The most important calculation!

(d) Village surrounded, levees in danger of bursting, people (inc lecturer and mother) do not yet know they will be compulsorily evacuated at 5:30 tomorrow

(e) Eucalyptus tree exerting resistance

(f) The electricity supply for hundreds of thousands

The flood wave shown in Figure (a) was several kilometres wide and many kilometres long. The peak took about 5 days to travel $120\ \mathrm{km}$. Estimate the mean water velocity. The land falls by about $40\ \mathrm{m}$ in $75\ \mathrm{km}$. Estimate $n|k_{\mathrm{St}}$ for the floodplain if the mean depth were estimated to be $1\ \mathrm{m}$.

Solution

$$\begin{aligned}
S &= \frac{40}{75 \times 1000} \approx 5 \times 10^{-4} \\
c &= \frac{120 \times 1000}{5 \times 24 \times 3600} = 0.28\ \mathrm{m\,s^{-1}} \\
U &= \frac{3}{5} \times 0.28 \approx 0.17\ \mathrm{m\,s^{-1}} \\
0.17 &= \frac{1}{n} \times 1^{5/3}\sqrt{0.0005} \\
n &\approx 0.13,\ k_{\mathrm{St}} \approx 7.5
\end{aligned}$$

Yes, this is very high resistance, but the water is flowing over grassland, fields, bushes, trees, *etc.*, with many obstructions. Let us see what Λ is:

$$\begin{aligned}
U &= \sqrt{\frac{g}{\Lambda}\frac{A}{P}S} \\
0.17 &= \sqrt{\frac{10}{\Lambda} \times 1 \times 5 \times 10^{-4}}, \\
\Lambda &= 0.17,
\end{aligned}$$

which is nearly the greatest value on the diagram of river values on p31 of the lecture notes.

The river runs beside the village. The photograph (e) is of a eucalyptus tree ("River Red Gum") about $90\ \mathrm{cm}$ in diameter, near the main stream, where, of course, the local fluid velocity is expected to be rather larger. Estimate the height of the stagnation mound on the upstream face – the lecturer thinks it is about $5\ \mathrm{cm}$. Use Bernoulli's law to estimate the velocity of the water at the surface.

$$U = \sqrt{2g\Delta z} = \sqrt{2 \times 10 \times 5/100} = 1.0\ \mathrm{m\,s^{-1}},$$

which agrees with the lecturer's visual estimate at the time.Any calculation of the force on the tree would probably not be important ...In any case, the tree is a good example of the iconic tree of the huge river network of inland south-eastern Australia, `https://en.wikipedia.org/wiki/Eucalyptus_camaldulensis`.