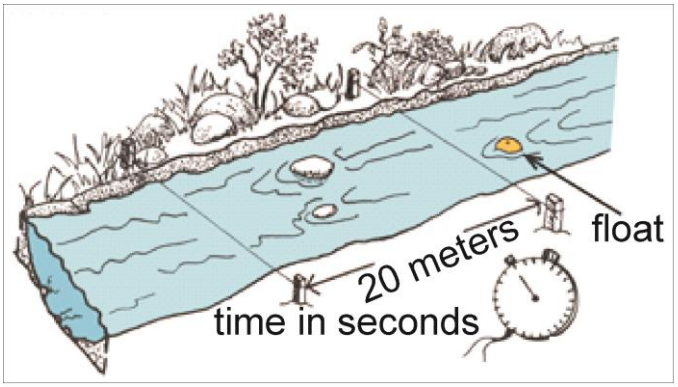
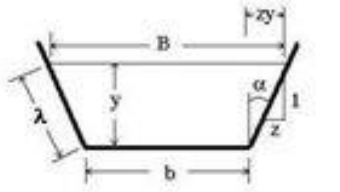
Module (3rd February, 2015)
NATURAL HAZARDS IN MOUNTAIN AREAS

FLOOD ANALYSIS EXERCISES

1. Measuring and estimating discharge

We will analyse a reach of the Aare River close to Bern (Switzerland). The reach is 30 m long and approx.10 m wide; and the slope is 0.02.





Trapezoidal Cross Section

$A = y(b + B)/2$

QUESTIONS:

1. Estimate the cross-sectional area of the channel (assuming a trapezoidal shaped channel), knowing that it is 1.5 m high and the width is 11 m and 10 m up and down respectively.
2. We place a float upstream and we measure the time it needs to travel 20 m. Calculate the discharge using the cross-sectional area above: (a) if the float takes 30 seconds; (b) and 10 seconds.
3. If the river bed channel is formed by gravel (Manning roughness ranging from 0.03 to 0.05), calculate the discharge for a wetted perimeter of 11.6 m.

2. Learning 1D-models (Hec-Ras)

We will analyse a flood-prone reach of Aare River crossing Bern.

These are the main characteristics of the studied reach and the profile:

Reach length: 50 m

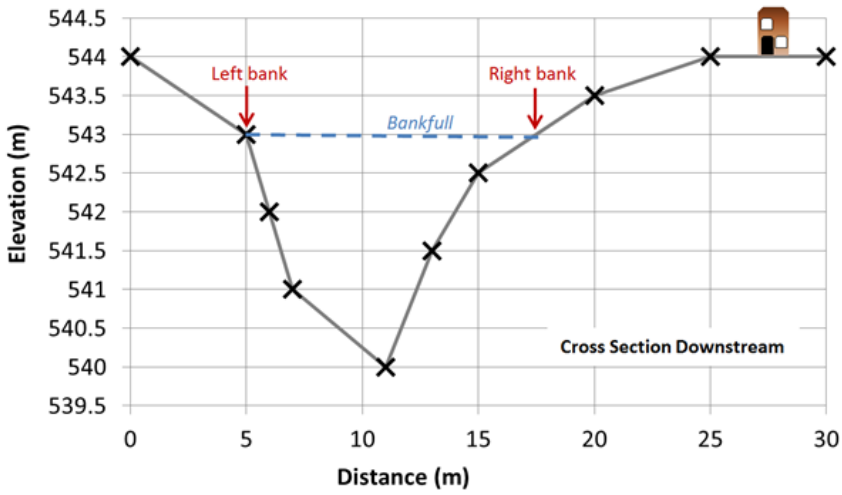
Elevation ranges from 540.4 to 540 m a.s.l.

Reach slope: 0.008 $m \cdot m^{-1}$

Main channel width: 12 m

River bed: gravel

Flood plains: light brush and trees



QUESTIONS:

1. What is the water elevation for a discharge of 20 $m^3 \cdot s^{-1}$?
2. What is the bankfull discharge?
3. What is the minimum discharge value that would affect the house?
4. What is the minimum discharge value that would affect the second floor of the house, if this is 3 meters high?

Continuity Equation (Manning): $Q = VA$

Manning's Equation

$$V = \frac{R^{2/3} S^{1/2}}{n}$$

V is average velocity (m/s)
R = hydraulic radius (m)
S = energy slope (m/m)
n = Manning's roughness coefficient

Discharge Equation

$$Q = \frac{A R^{2/3} S^{1/2}}{n}$$

Q is discharge (cms)
A = channel cross-sectional area (m^2)

Type of Channel and Description	Minimum	Normal	Maximum
A. *Natural Streams*			
1. **Main Channels**			
a. Clean, straight, full, no rifts or deep pools	0.025	0.030	0.033
b. Same as above, but more stones and weeds	0.030	0.035	0.040
c. Clean, winding, some pools and shoals	0.033	0.040	0.045
d. Same as above, but some weeds and stones	0.035	0.045	0.050
e. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
f. Same as "d" but more stones	0.045	0.050	0.060
g. Sluggish reaches, weedy. deep pools	0.050	0.070	0.080
h. Very weedy reaches, deep pools, or floodways with heavy stands of timber and brush	0.070	0.100	0.150
2. **Flood Plains**			
a. Pasture no brush			
1. Short grass	0.025	0.030	0.035
2. High grass	0.030	0.035	0.050
b. Cultivated areas			
1. No crop	0.020	0.030	0.040
2. Mature row crops	0.025	0.035	0.045
3. Mature field crops	0.030	0.040	0.050
c. Brush			
1. Scattered brush, heavy weeds	0.035	0.050	0.070
2. Light brush and trees, in winter	0.035	0.050	0.060
3. Light brush and trees, in summer	0.040	0.060	0.080
4. Medium to dense brush, in winter	0.045	0.070	0.110
5. Medium to dense brush, in summer	0.070	0.100	0.160
d. Trees			
1. Cleared land with tree stumps, no sprouts	0.030	0.040	0.050
2. Same as above, but heavy sprouts	0.050	0.060	0.080
3. Heavy stand of timber, few down trees, little undergrowth, flow below branches	0.080	0.100	0.120
4. Same as above, but with flow into branches	0.100	0.120	0.160
5. Dense willows, summer, straight	0.110	0.150	0.200
3. **Mountain Streams, no vegetation in channel, banks usually steep, with trees and brush on banks submerged**			
a. Bottom: gravels, cobbles, and few boulders	0.030	0.040	0.050
b. Bottom: cobbles with large boulders	0.040	0.050	0.070