XXXVIII
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Modelling of the velocity profile in a channel partly covered by sub-merged vegetation

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- SGGW

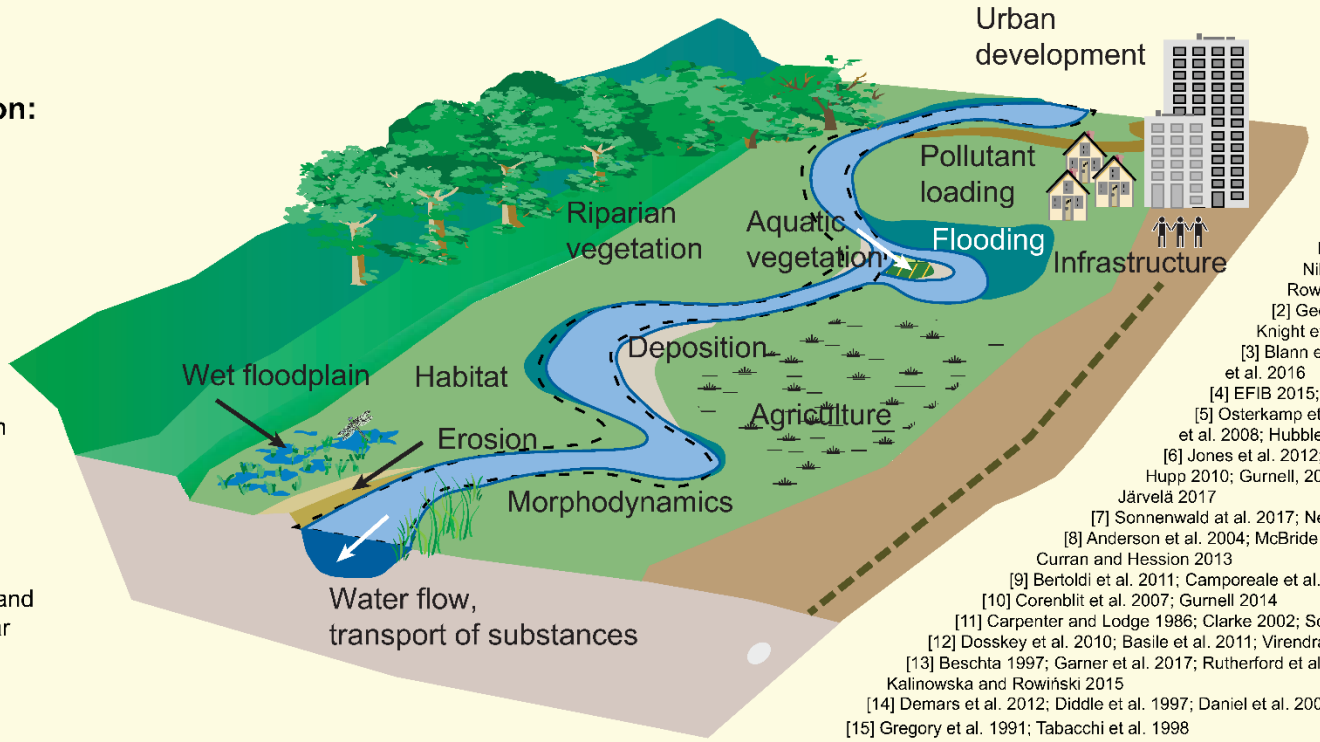
Why?

- **Narew River, photos by A. Bielonko**

Why?

Implications of riverine vegetation on:

- **Water flow:** e.g. hydraulic resistance[1], flood conveyance[2], agricultural drainage[3], erosion control[4]
- **Transport and mixing processes:** e.g. erosion[5], deposition[6], mixing[7]
- **Morphodynamics:** cross-sectional geometry[8], channel planform[9], landform development[10]
- **Water quality:** e.g. nutrients[11], pollutants[12], temperature[13]
- **Ecology:** e.g. physical habitat[14], source of energy and matter[15], moderation of solar energy fluxes[16]



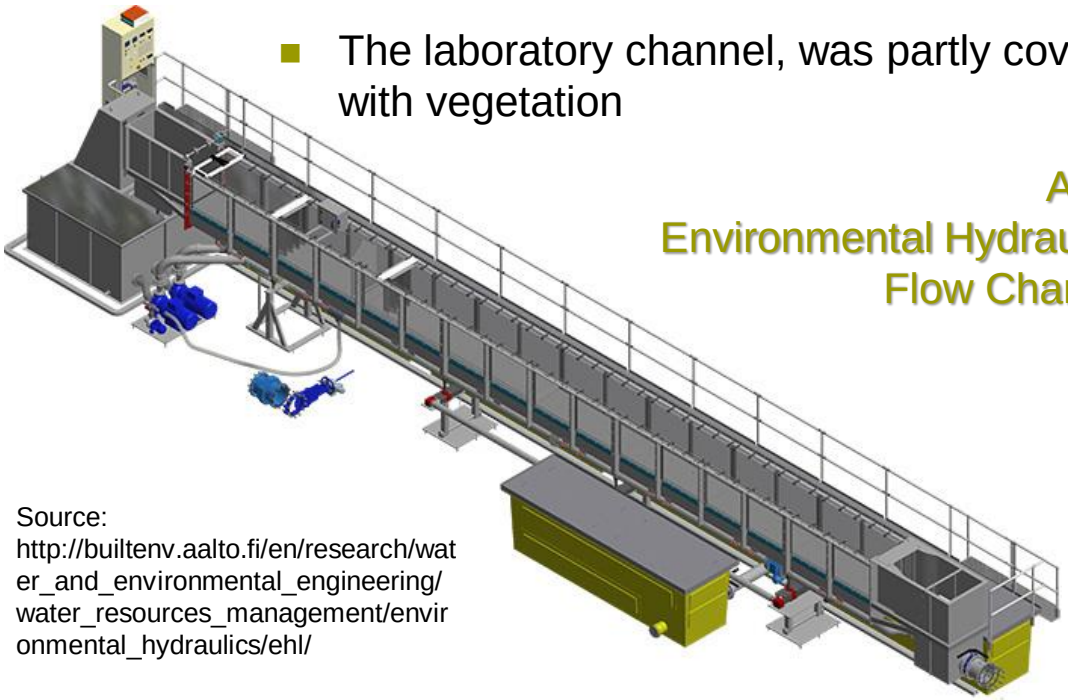
Literature sources:
[1] Järvelä 2002; Knight et al. 2010; Nikora et al. 2008; Rowiński et al. 2005
[2] Geerling et al. 2008; Knight et al. 2010
[3] Blann et al. 2009; Västilä et al. 2016
[4] EFIB 2015; Evette at al. 2009
[5] Osterkamp et al. 2012; Florsheim et al. 2008; Hubble et al. 2010
[6] Jones et al. 2012; Osterkamp and Hupp 2010; Gurnell, 2014; Västilä and Järvelä 2017
[7] Sonnenwald at al. 2017; Nepf 2012
[8] Anderson et al. 2004; McBride et al. 2010; Curran and Hession 2013
[9] Bertoldi et al. 2011; Camporeale et al. 2013
[10] Corenblit et al. 2007; Gurnell 2014
[11] Carpenter and Lodge 1986; Clarke 2002; Schulz et al. 2003
[12] Dosskey et al. 2010; Basile et al. 2011; Virendra et al. 2008
[13] Beschta 1997; Garner et al. 2017; Rutherford et al. 2004; Kalinowska and Rowiński 2015
[14] Demars et al. 2012; Diddle et al. 1997; Daniel et al. 2006
[15] Gregory et al. 1991; Tabacchi et al. 1998
[16] Dugdale et al. 2018

- All scientific research related to flow and transport processes become very complicated in the channels with vegetation.

Rowiński PM, Västilä K, Aberle J, Järvelä J, Kalinowska MB (2018). How vegetation can aid in coping with river management challenges: A brief review, Ecohydrology and Hydrobiology, 18(4): 345-354

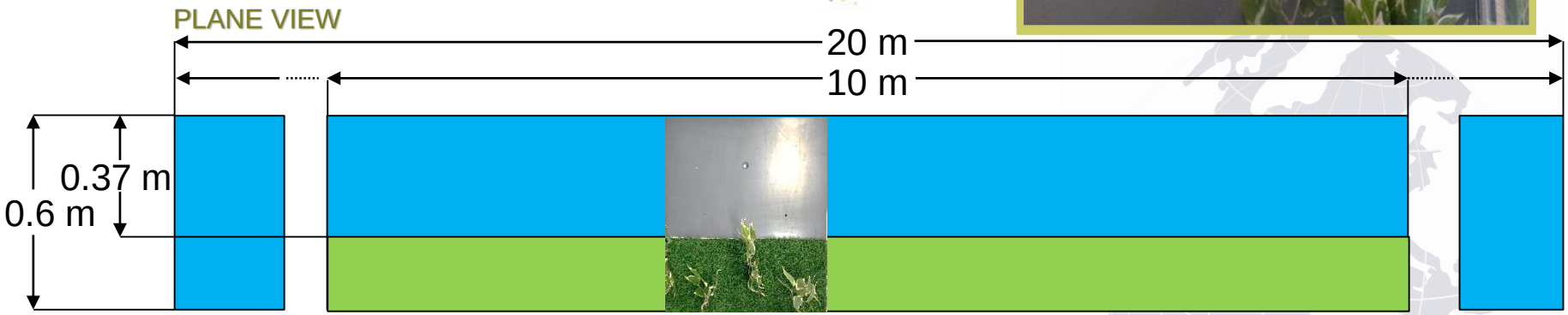
Laboratory experiment

- The laboratory channel, was partly covered with vegetation



Aalto
Environmental Hydraulics
Flow Channel

Source:
http://builtenv.aalto.fi/en/research/water_and_environmental_engineering/water_resources_management/environmental_hydraulics/ehl/



Caroppi G, Västilä K, Järvelä J, Rowiński PM, Giugni M (2019). Turbulence at water-vegetation interface in open channel flow: experiments with natural-like plants. Adv Water Res 127:180-191

Measurements and calculations variants

	Variant	Discharge Q [m³/h]	Slope I [-]
Bare-grass	**B1**	80	0.0005
	B2	180	0.0015
	B3	300	0.0029
Leafless	**L1**	80	0.0007
	L2	180	0.0017
	L3	300	0.0041
Foliated	**F1**	80	0.00017
	F2	180	0.0034
	F3	300	0.007

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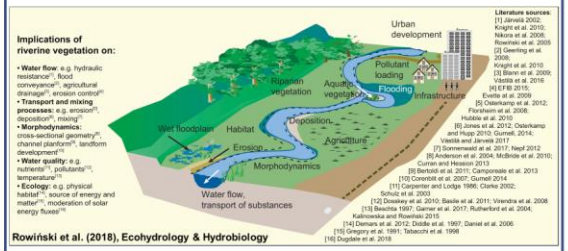
MODELLING OF THE VELOCITY PROFILE IN A CHANNEL PARTLY COVERED BY SUBMERGED VEGETATION

MONIKA B. KALINOWSKA, KAISA VÄSTILÄ, ADAM KOZIOŁ, PAWEŁ M. ROWIŃSKI, ADAM KICZKO AND JANUSZ KUBRAK

OBJECTIVE

THE VEGETATION IS COMMONLY PRESENT IN RIVERS AND CHANNELS

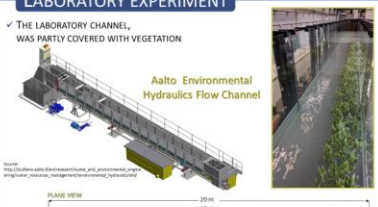
- ✓ ALL SCIENTIFIC INVESTIGATIONS RELATED TO THE FLOW AND TRANSPORT PROCESSES BECOME MUCH MORE COMPLICATED IN THE CHANNELS WITH VEGETATION



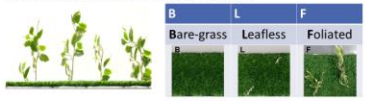
- ✓ ALTHOUGH MANY EXPERIMENTAL AND NUMERICAL STUDIES HAVE ALREADY BEEN CARRIED OUT TO DETERMINE THE EFFECT OF VEGETATION ON FLOW HYDRODYNAMICS, THERE ARE STILL MANY QUESTIONS AND PROBLEMS THAT REQUIRE FURTHER INVESTIGATIONS
- ✓ FOLLOWING THE DEFINITIONS OF NEPF (2012), THE PRESENT STUDY INVESTIGATES DEEPLY SUBMERGED GRASSY VEGETATION CORRESPONDING TO CONDITIONS ON FLOOD-PLAINS WITH MAINTAINED VEGETATION DURING HIGH FLOWS

LABORATORY EXPERIMENT

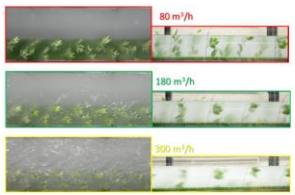
- ✓ THE LABORATORY CHANNEL, WAS PARTLY COVERED WITH VEGETATION



- ✓ VELOCITY MEASUREMENTS IN THE LABORATORY CHANNEL HAVE BEEN CARRIED OUT FOR VARIOUS VEGETATION VARIANTS (CAROPPI ET AL., 2019)



MEASUREMENTS AND CALCULATIONS VARIANTS



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Foliated	F1	80	0.00017
	F2	180	0.0034
	F3	300	0.007

- ✓ FOR EACH LABORATORY MEASUREMENTS VARIANT, MANY NUMERICAL SIMULATIONS WERE PERFORMED TO OBTAIN THE RIGHT MODEL PARAMETERS TO REPLICATE THE RESULTS OF LABORATORY TESTS BEST

MODELS

TWO DIFFERENT MODELS HAVE BEEN USED

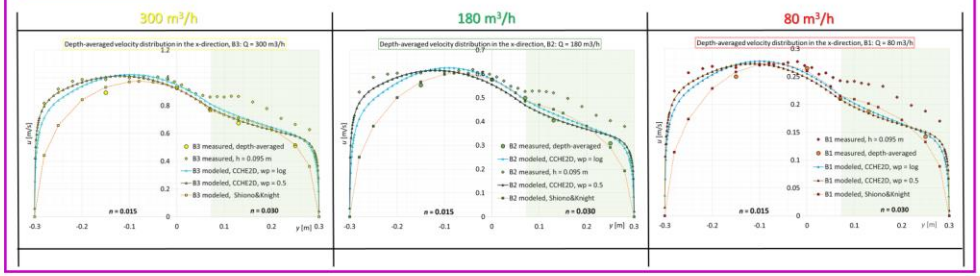
THE CCHE2D MODEL

A TWO-DIMENSIONAL DEPTH-AVERAGED HYDRODYNAMIC MODEL FOR UNSTEADY TURBU-LENT FREE SURFACE FLOWS (JIA & WANG, 2001; YE & MCCORQUODALE, 1997)

SHIONO AND KNIGHT MODEL

A QUASI-TWO-DIMENSIONAL MATHEMATICAL MODEL TO CALCULATE THE LATERAL DISTRIBUTION OF THE DEPTH-AVERAGED VELOCITIES, WATER FLOW AND BOUNDARY SHEAR STRESS IN LABORATORY CHANNELS AND NATURAL RIVERS (SHIONO & KNIGHT, 1990 & 1991).

SELECTED RESULTS



REFERENCES

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- ✓ Jia Y, Wang SSY (2001). CCHE2D: Two-dimensional Hydrodynamic and Sediment Transport Model for Unsteady Open Channel Flows over Loose Bed, Technical Report No. NCCHE-TR-2001-1, NCCHE, The University of Mississippi, USA
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- ✓ Rowiński PM, Västilä K, Aberle J, Järvelä J, Kalinowska MB (2018). How vegetation can aid in coping with river management challenges: A brief review, Ecohydrology and Hydrobiology, 18(4): 345-354
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Thank you!

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