Laboratori d'Enginyeria Marítima
UNIVERSITAT POLITÈCNICA DE CATALUNYA

DURCWAVE: experimental modelling for coastal safety in low-lying coastal zones

DURCWAVE

Horizon 2020
European Union Funding
for Research & Innovation

MARIE CURIE ACTIONS

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DURCWAVE

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amending the Design criteria of URban defences in LECZs through Composite-modelling of WAVE overtopping under climate change scenarios

Marie Skłodowska-Curie actions (MSCA) **Individual Fellowship** (IF):

- support the mobility of researchers within and beyond Europe
- promote **bottom-up research** and **training-through-research**

H2020-EU.1.3.2. (Nurturing excellence by means of cross-border and cross-sector mobility)
Grant Agreement No. 792370

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DURCWAVE

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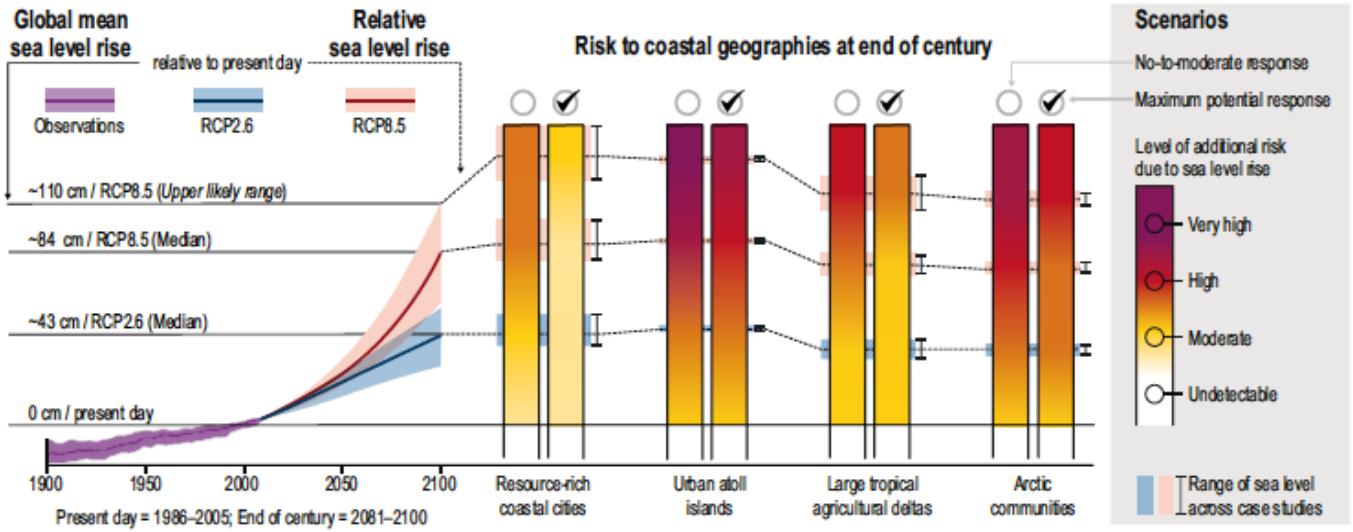
amending the Design criteria of URban defences in LECZs through Composite-modelling of WAVE overtopping under climate change scenarios



IPCC (2019)

Climate action: cross-cutting priority under Horizon 2020

Activity: strengthening coastal defences against storm surges & sea-level rise

MOTIVATION

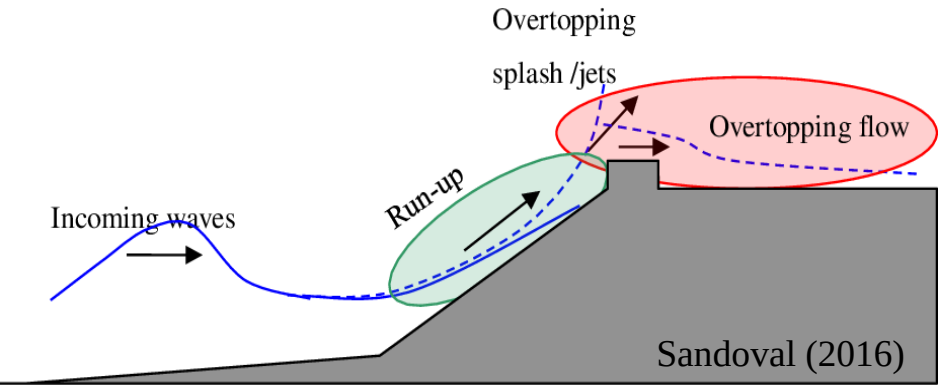
How much the risk for people living in LECZs will increase? How to tackle it?

Need to improve/increase

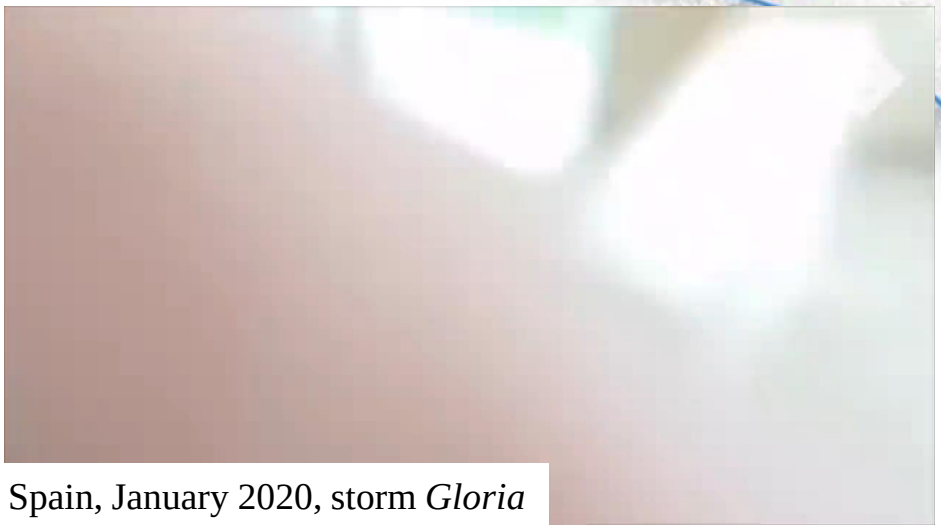
- knowledge on wave overtopping and post-overtopping processes
- the design criteria of coastal defences

Cyclone Xaver (2013)

GOALS



Skecth of run-up and overtopping



Spain, January 2020, storm *Gloria*

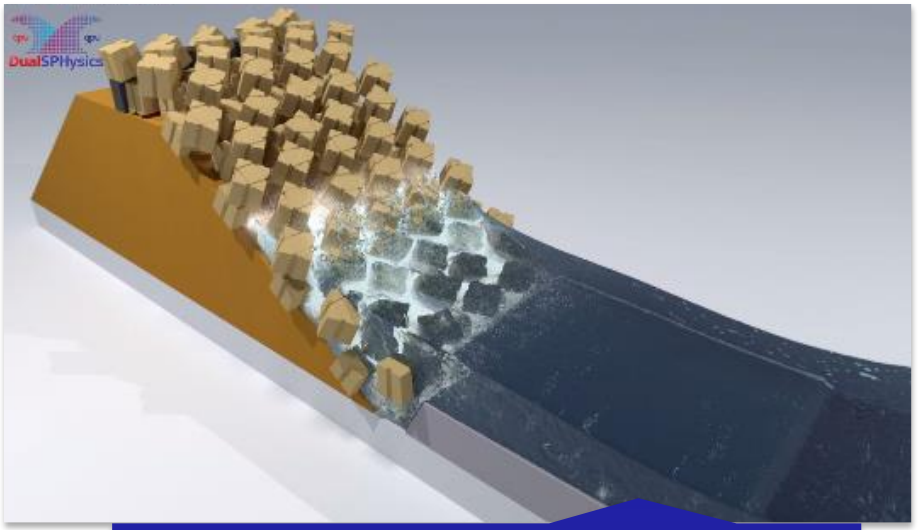
Spain, January 2020, storm *Gloria*

Amalfi (Italy), October 2018

METHODS

COMPOSITE-MODELLING: physical modelling (PM) + numerical modelling (NM)

Small and large scale model tests



Meshless DualSPHysics model

METHODS

- ✓ **Cheap**
- ✓ **Versatile**
- ✓ **No scale effects**
- ✓ **All metrics provided**
- ✓ **Validation**
- ✓ **Physics**

Project information

DURCWAVE

Grant agreement ID: 792370

Status
Ongoing project

Start date
1 March 2019

End date
4 April 2021

Funded under:
H2020-EU.1.3.2.

Overall budget:
€ 170 121,60

EU contribution
€ 170 121,60

Coordinated by:
UNIVERSITAT POLITECNICA DE CATALUNYA
Spain

Overview of the present research carried out at UPC

5 Work Packages:

- **Physical modelling**
- **Numerical model development**
- **Integration PM and NM data**
- **Dissemination and public engagement**
- **Project Management**

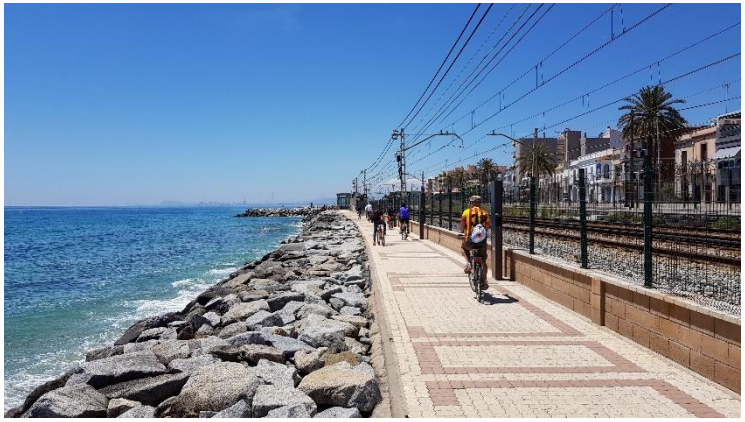
GOALS OF PM

- **to characterize individual overtopping flows (V, u, λ, q)**
- **to verify coastal safety limits and overtopping**
- **to provide data for NM validation**

CASE STUDY: PREMIÀ de MAR (Maresme coastline)

Wave condition (Barcelona buoy)

- Tr=1,2,5,10,20 years
- Hm0,o=3.6m-5.41m
- Tp,o=11.96s-12.96s
- do=68m
- dtoe=1m-2m
- Rc=3.5m-4m



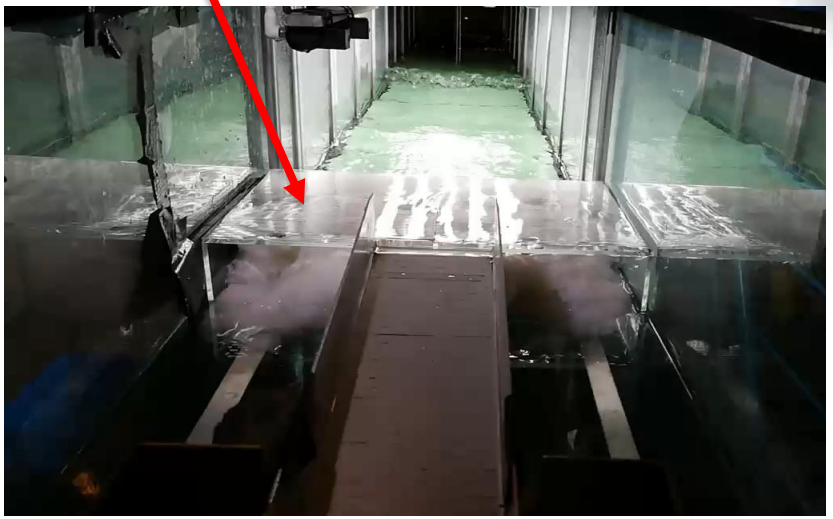
EXPERIMENTAL SETUP

Small scale flume "CIEMito" at LIM/UPC

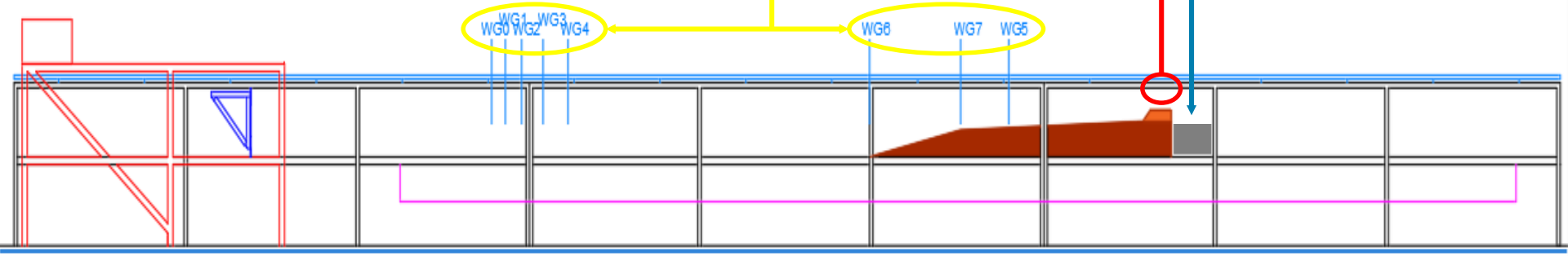
Measurement setup:

- 8 resistive sensors (WG) along the flume;
- 2 acustic sensors (AWG) on the promenade;
- 2 load cells;
- 2 high - speed cameras.

Promenade (0m, 6m and 12m)



2°case_slope 1:30



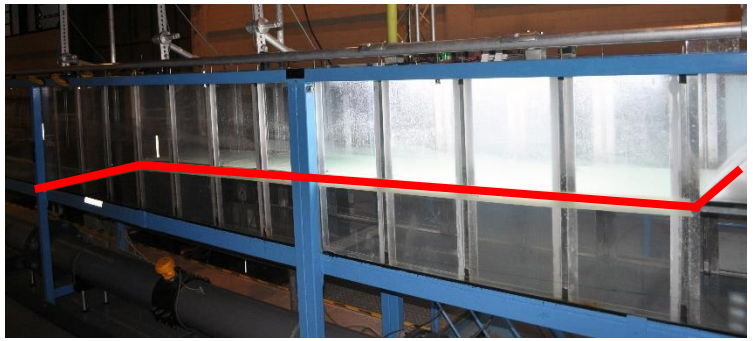
TEST MATRIX (420 tests)

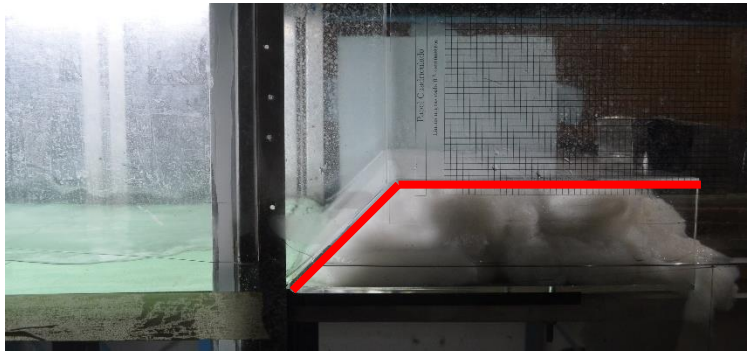
Prototype scale:

Slope	T_R [y]	H_{m0} [m]	T_p [s]	SEED	Depth [m]	Prom. [m]
1:15	1	3.60	11.96	1;5	14.5-15-15.5	6-12
1:15	2	4.01	12.28	1;5	14.5-15-15.5	6-12
1:15	5	4.59	12.67	1;5	14.5-15-15.5	6-12
1:15	>10	5.55	9.9	1;5	14.5-15-15.5	6-12
1:15	>10	4.59	10.6-11.3	1;5	14.5-15-15.5	6-12
1:15	>10	4.50	9.9-10.6-11.3-12	1;5	14.5-15-15.5	6-12

Slope	T_R [y]	H_{m0} [m]	T_p [s]	SEED	Depth [m]	Prom. [m]
1:30	1	3.60	11.96	1;5	15.25-15.5	6-12
1:30	2	4.01	12.28	1;5	15.25-15.5	6-12
1:30	5	4.59	12.67	1;5	15-15.25-15.5	6-12
1:30	>10	5.55	9.9	1;5	15.25-15.5	6-12
1:30	>10	4.59	9.9-10.6-11.3	1;5	15-15.25-15.5	6-12
1:30	>10	4.50	9.9-10.6-11.3-12	1;5	15.25-15.5	6-12

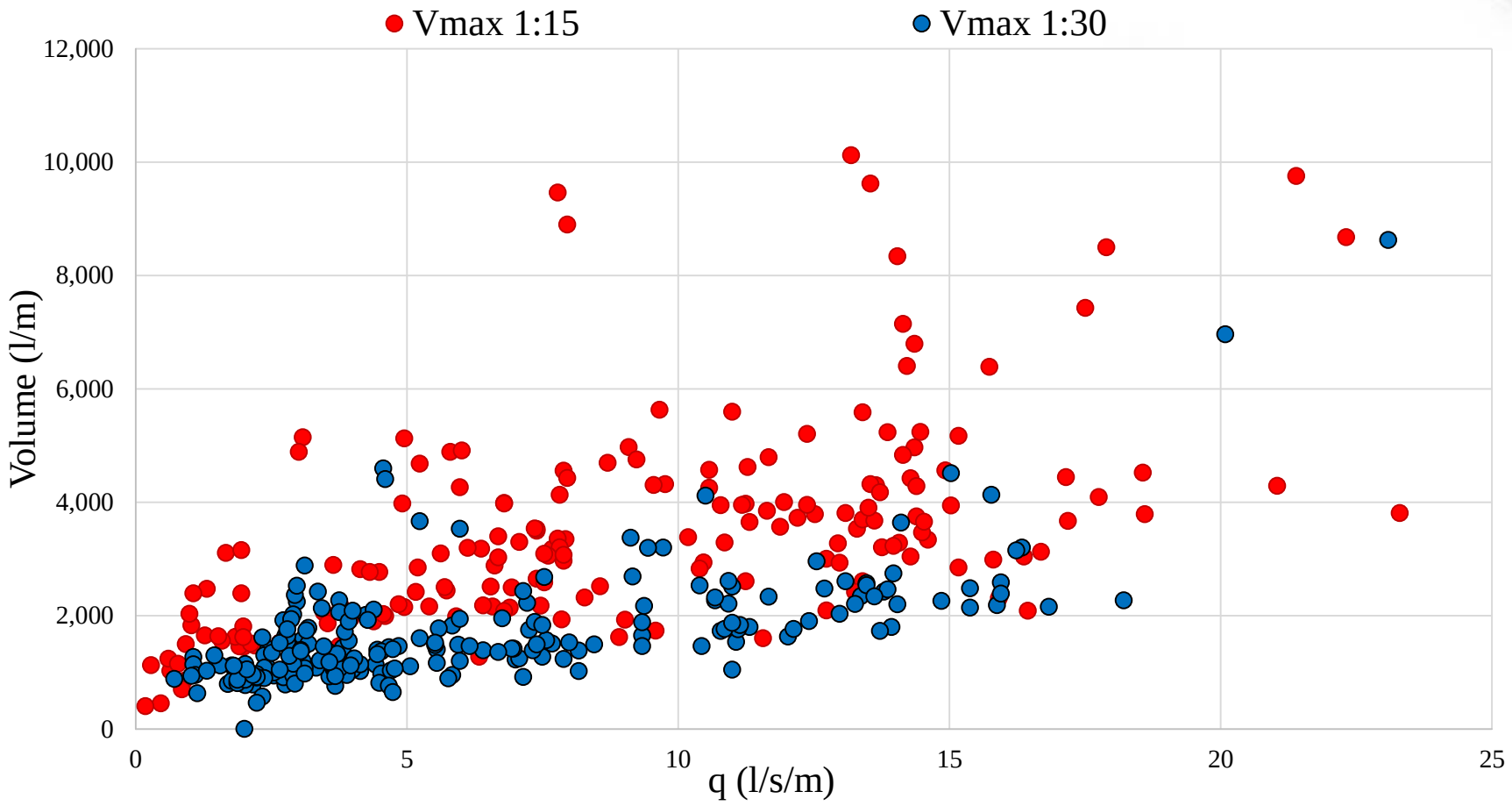
Scale 1:50





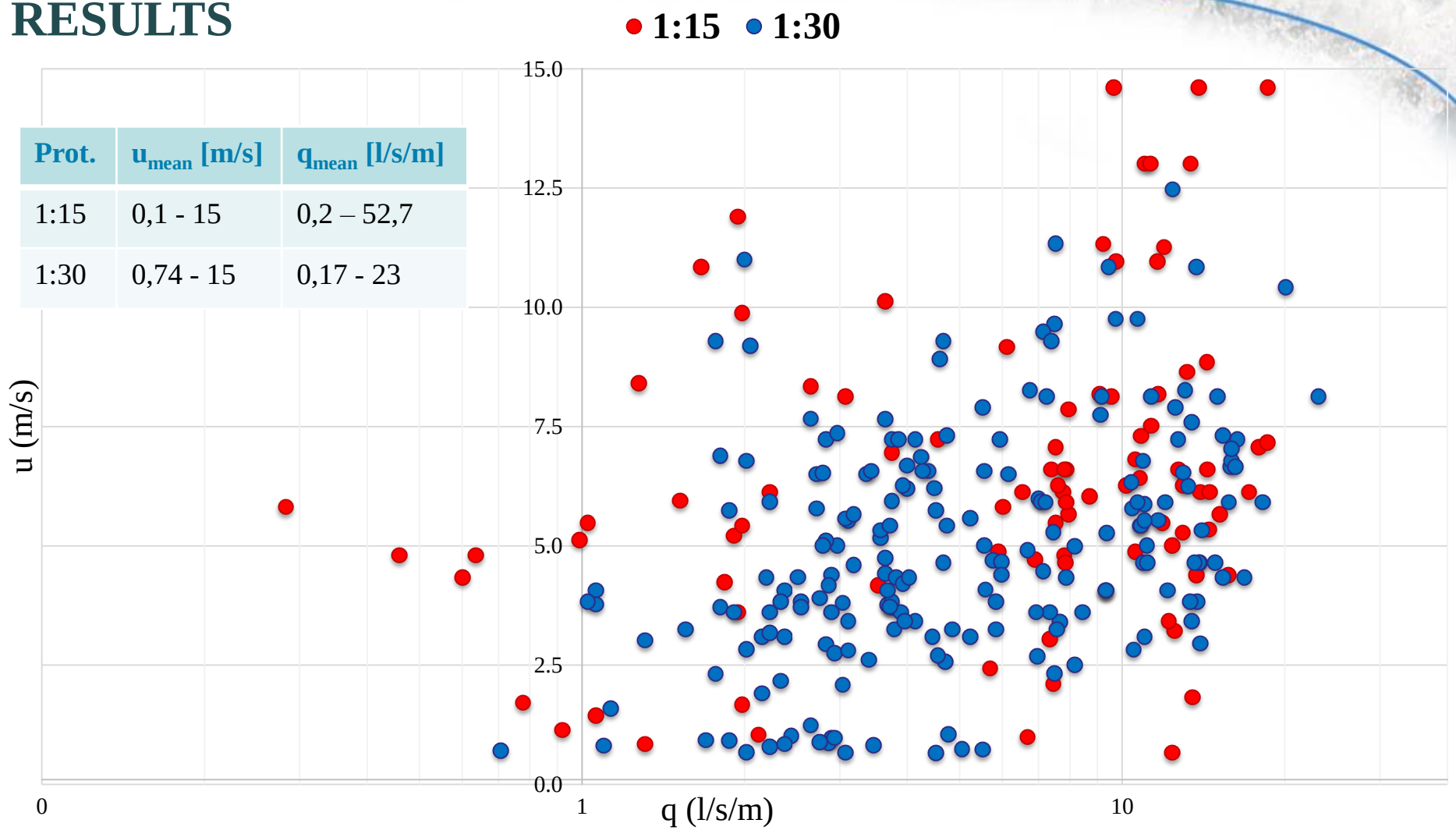
Dike slope= 1:1

RESULTS


Vmax 1:15
Vmax 1:30
12,000
10,000
8,000
6,000
4,000
2,000
0
Volume (l/m)
0
5
10
15
20
25
q (l/s/m)

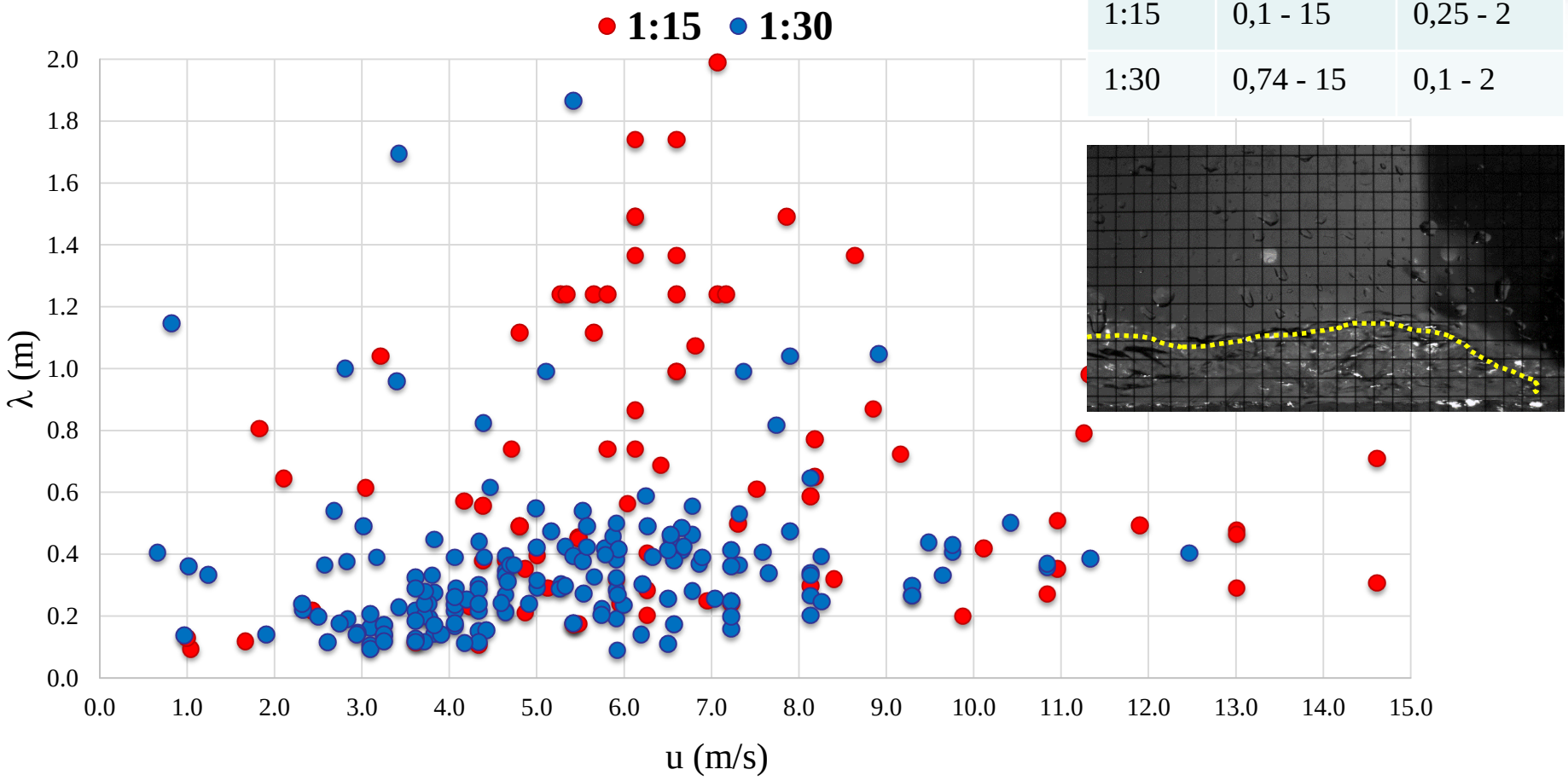
RESULTS

Prot.	u_{mean} [m/s]	q_{mean} [l/s/m]
1:15	0,1 - 15	0,2 – 52,7
1:30	0,74 - 15	0,17 - 23

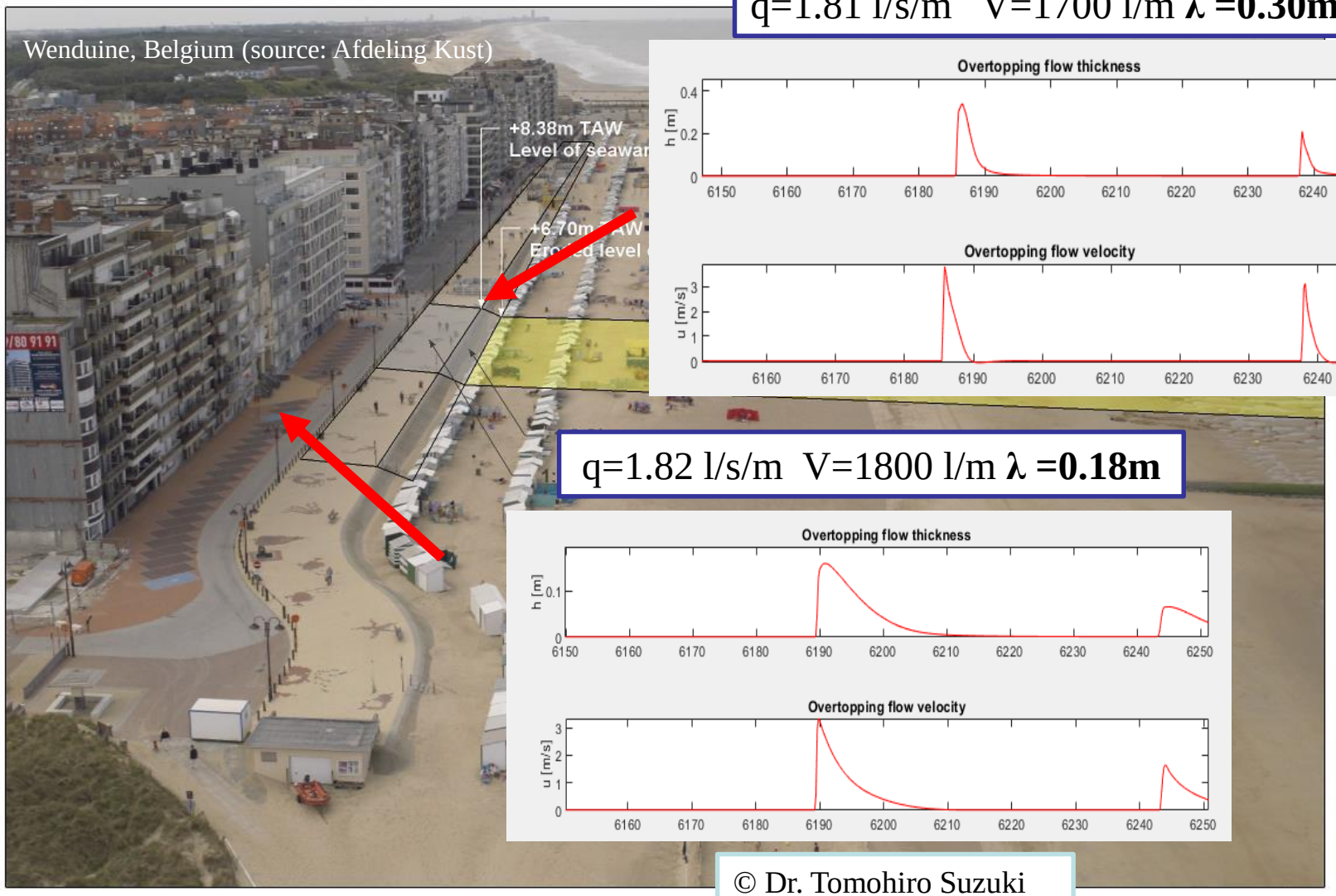


RESULTS

Prot.	u_{mean} [m/s]	λ_{mean} [m]
1:15	0,1 - 15	0,25 - 2
1:30	0,74 - 15	0,1 - 2



q=1.81 l/s/m V=1700 l/m **λ =0.30m**



q=1.82 l/s/m V=1800 l/m **λ =0.18m**

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OVERTOPPING DESIGN CRITERIA (EurOtop, 2018)

Hazard type and reason	Mean discharge q (l/s per m)	Max volume V_{max} (l per m)
People at structures with possible violent overtopping, mostly vertical structures	No access for any predicted overtopping	No access for any predicted overtopping
People at seawall / dike crest. Clear view of the sea.		
H_{m0} = 3 m	0.3	600
H_{m0} = 2 m	1	600
H_{m0} = 1 m	10-20	600
H_{m0} < 0.5 m	No limit	No limit
Cars on seawall / dike crest, or railway close behind crest		
H_{m0} = 3 m	<5	2000
H_{m0} = 2 m	10-20	2000
H_{m0} = 1 m	<75	2000
Highways and roads, fast traffic	Close before debris in spray becomes dangerous	Close before debris in spray becomes dangerous

OVERTOPPING DESIGN CRITERIA (EurOtop, 2018)

Hazard type and reason	Mean discharge q (l/s per m)	Max volume V_{max} (l per m)
People at structures with possible violent overtopping, mostly vertical structures	No access for any predicted overtopping	No access for any predicted overtopping
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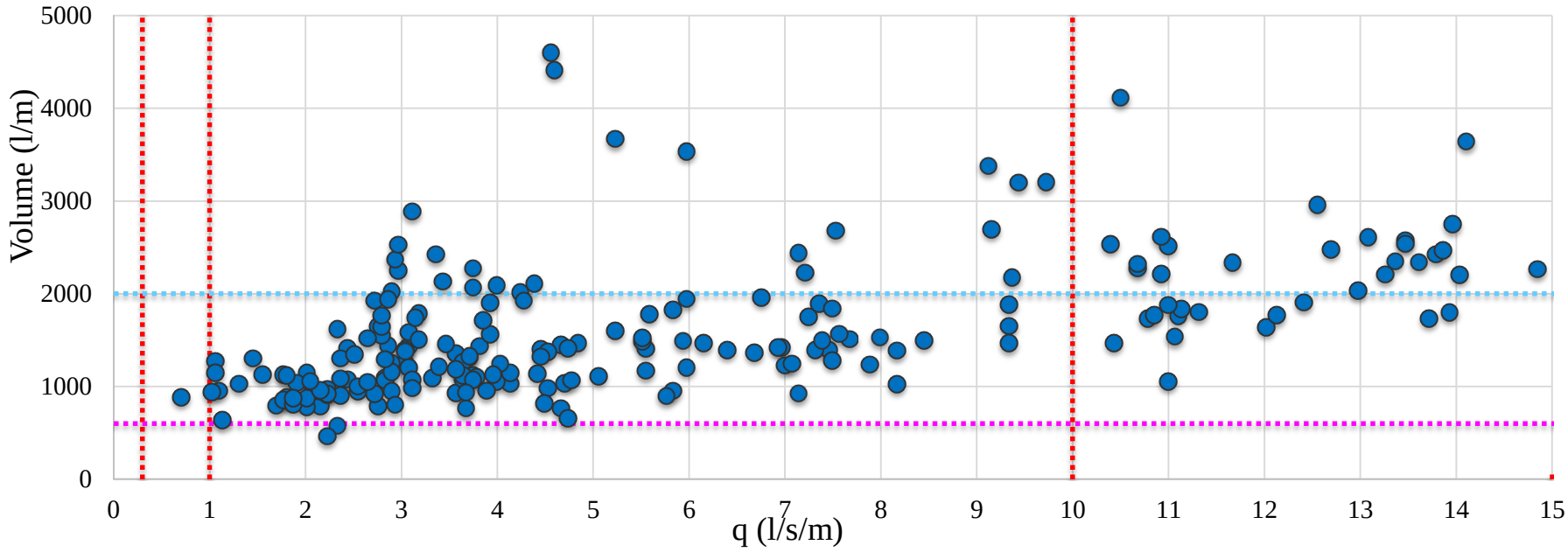
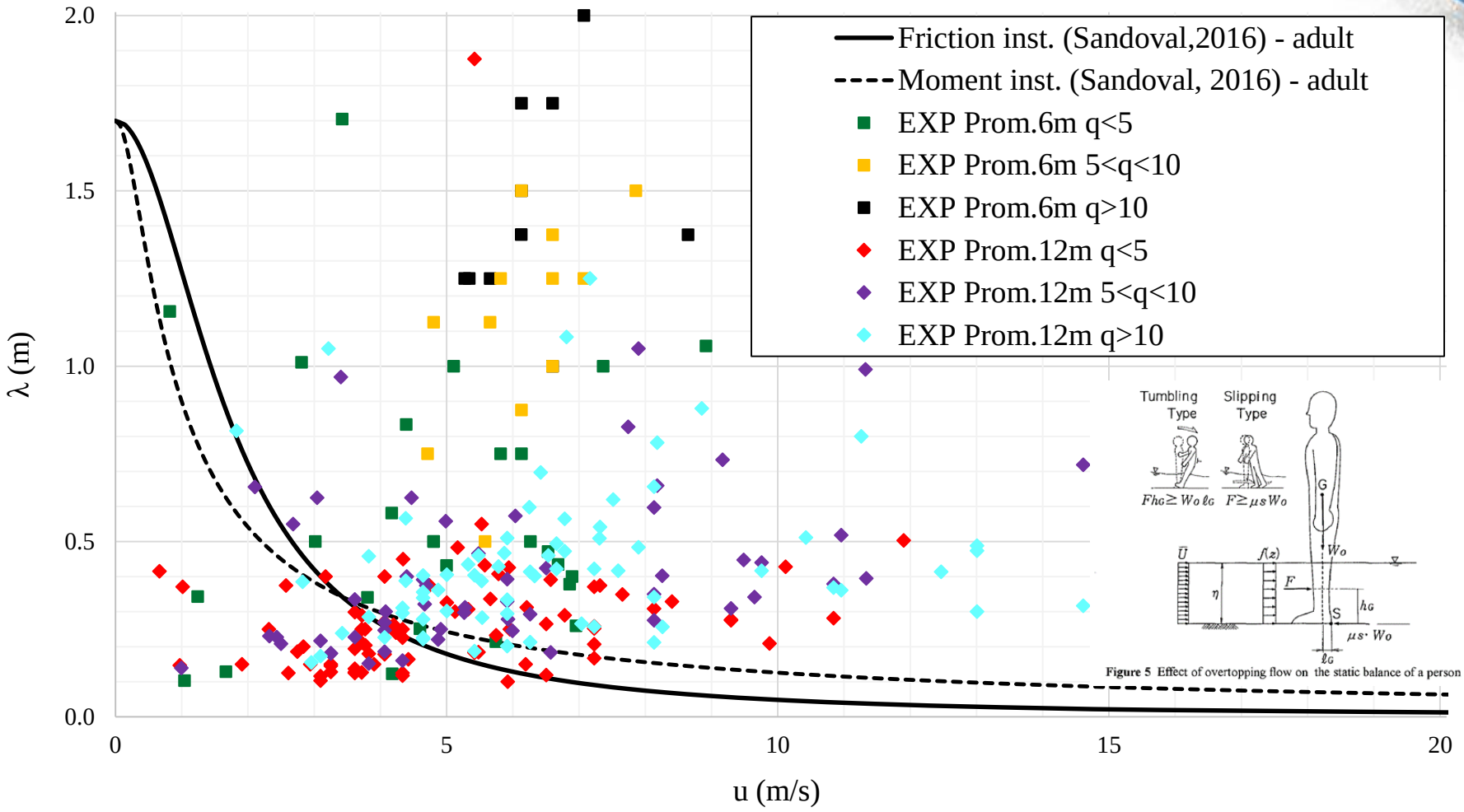
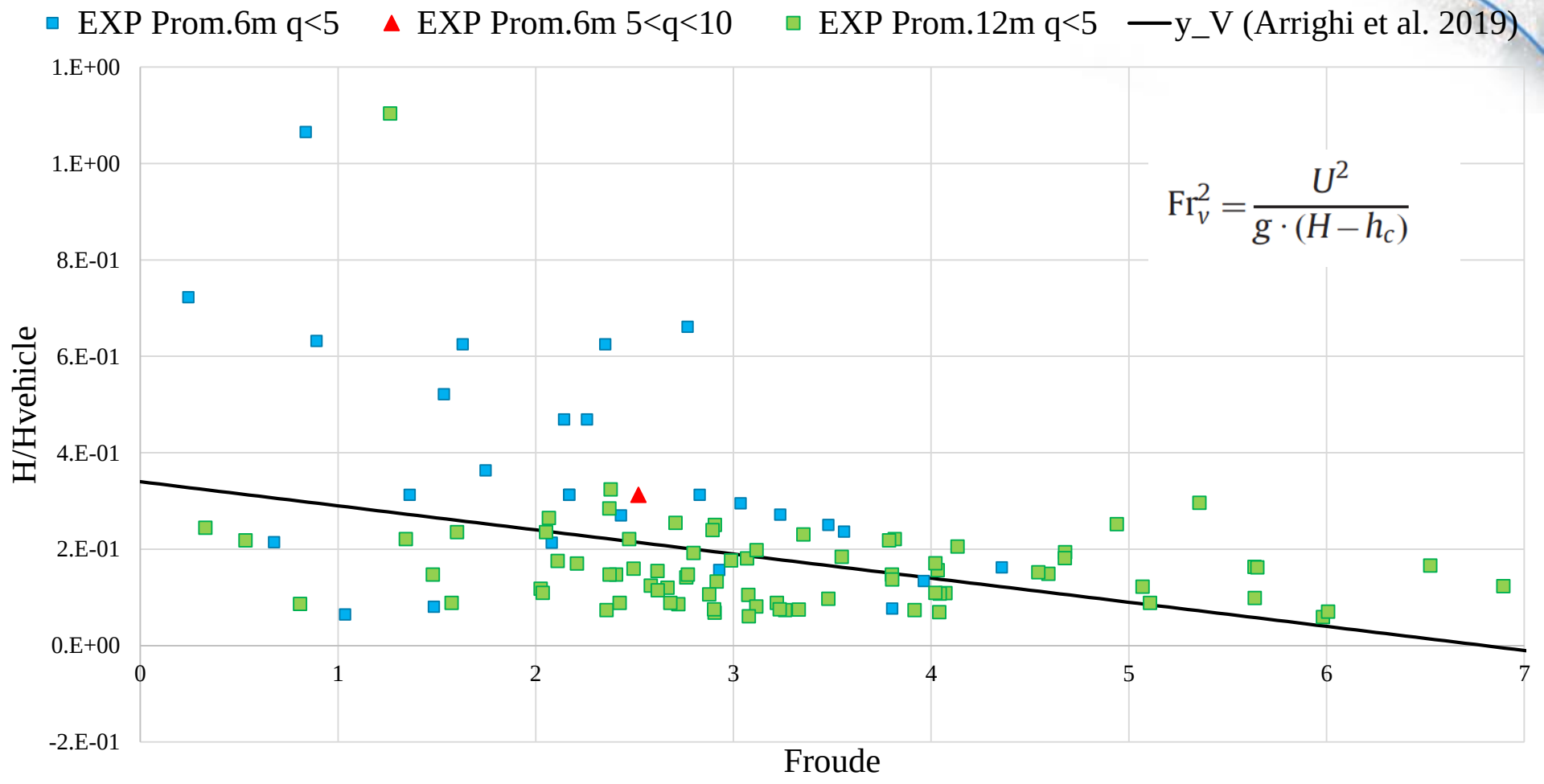
H_{m0} = 3 m	0.3	600
H_{m0} = 2 m	1	600
H_{m0} = 1 m	10-20	600



STABILITY (Sandoval, 2016)



STABILITY (Arrighi et al., 2019)



TAKE HOME MESSAGES

Experimental modelling is fundamental to deepen our understanding of the governing physics

Overtopping metrics, other than discharge and volume, are necessary for coastal safety assessment

THANKS FOR YOUR ATTENTION!

Lloret de Mar (Spain), January 2020, storm *Gloria*