

# Minutes of the 3<sup>rd</sup> Advanced Workshop JRA1 - Scaling morphodynamics in time -

Deliverable D5-XIII

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## **DOCUMENT INFORMATION**

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## MINUTES OF THE WORKSHOP ON SCALING MORPHODYNAMICS IN TIME

## VENUE AND ATTENDEES

Venue: LEGI – CNRS Grenoble

Date: 24-01-2018

Attendees: All participants

Apologies: Andrea Marzeddu (LIM/UPC)

## TOPICS FOLLOWING AGENDA

Item	Time	Subject	Presenters	Institutes
0	09:30	Opening	Frans Hamer	Deltares
1	09:35	Introduction to the deliverable	Jochen Aberle	NTNU
2	09:40	Scaling morphodynamics in time: experiences from the Metronome and Eurotank facilities	Wout van Dijk	Univ. Utrecht
3	10:05	MOREphometry: simple measurements for complex dynamics in experimental geomorphology	Eli Lazarus	Univ. Southampton
4	10:30	Lightweight plastic granulate as substitute for sand and gravel in morphologic scale models of rivers	Thorsten Hüsener	BAW
5	11:20	Lightweight materials to reproduce coastal sedimentary processes in a small physical models	Andrea Marzeddu Presented by Agustín Sánchez-Arcilla	LIM/UPC
6	11:30	Cohesive sediments for cliff erosion physical models	Dominique Astruc	CNRS / IMF Toulouse
7	11:40	Experimental modelling of morphological evolution over long time scales using distorted models	Rocio Fernandez	Univ. Hull
8	11:50	General discussions & contributions to deliverable	Jochen Aberle + all	NTNU + Hydralab
9	12:30	Closure	Jochen Aberle / Frans Hamer	NTNU / Deltares



### INTRODUCTION AND MOTIVATIONS OF THE WORKSHOP

As part of the fourth HYDRALAB Workshop Event, the third advanced JRA 1 RECIPE workshop was organized around the issues addressed within the task 8.3 - scaling morphodynamics in time (task leader: NTNU). The consequences of climate change on our environment are characterized by effects occurring over rather long time-scales and therefore physical scale modelling is crucial as it allows for the investigation over the time-scales at which the processes occur and interact. However, our understanding of how to compress or extend the relation between the model time and the real time is limited, particularly with regard to morphodynamic processes. In a close link with the other on-going works within the JRA1 RECIPE, the workshop was organized around three invited presentations from external experts and complemented by three shorter presentations, which were delivered by researchers from partners within the Hydralab+ consortium. The workshop was completed by technical discussions in a plenary session, which were focused on elucidating the difficulties associated with scaling morphodynamics in time and to identify the protocols that should be considered when using scaled models to address climate change impacts. The objective of the discussions, which are closely linked to the work carried out for the preparation of deliverable D8.III, were reflected by the following research questions during the introduction to the workshop:

- How to investigate the dynamic scaling or morphodynamic acceleration in distorted models to represent longer time scales in a robust and repeatable manner?
- How to investigate wave and hydrograph sequences to represent longer time series and to test non-linear responses of sediment and accelerated model time (together with Task 8.2)?
- How to investigate and develop surrogate sediments (e.g. composite material, polymers) and potentially alternative fluids (e.g. fluids with lower density than water) to enable morphodynamic time scales to be substantially reduced and to minimise scale effects?
- How to investigate the use of numerical modelling to test different strategies for time scaling morphological responses, to minimise the experimental tests required (links with Task 9.5/10.5)?

#### MINUTES OF THE GUEST PRESENTATIONS

To broaden the expertise developed within the HYDRALAB+ network, guest speakers and speed-talk contributors were invited to present innovative experimental approaches and to share established know-how to address time scales in morphodynamic experiments. A summary of these presentations is given below.



#### Metronome/Eurotank - Presenter: Wout van Dijk

Selected recent investigations from the Eurotank and the Metronome facilities were presented after recalling the basic principles of scaling as well as the different physical model classifications based on the degree of similitude with the prototype situation (e.g., Peakall et al., 1996). The main idea of the Eurotank and Metronome facilities is to develop modelling protocols that allow for the development of scaled experiments between the distorted and the analogue model types (see deliverable D 8.1). For these types of models, similarity in the hydraulic and sediment transport basic processes must be considered together with the similarity/analogy in the large scale morphological processes and stratigraphy observed in the prototype situation (Kleinhans et al., 2014, 2015, 2017). Distorted and analogue models are small-scale representations of the prototype and in such modelling approaches, not all morphodynamic features of the prototype are of interest. Since experiments are typically limited in space, the boundary conditions for the experiment may be processes in themselves. For example, bend migration is a boundary condition for the formation of scroll bars, whereas small-scale processes such as ripples might be considered as noise when the desired outcome is to produce an equilibrium bed profile. Thus, it can be suggested that larger scale features should be considered as the boundary condition for the process/ feature of interest.

This hypothesis was investigated by van Dijk et al. (2012) in relation to meander stability in rivers. It was found from a series of experiments that meander migration could only be reproduced when the upstream water inflow was moved back and forth enabling meander growth and migration leading to the development of scroll bars, and chute cut-offs analogous to the bend instability process observed in Nature. However, the time scales involved in such experiments remain unclear since there are various approaches that can be used to define them, e.g. considering the hydraulic time scale (Froude similarity), the time scales associated with the sediment transport rates, or a morphological time scale defined by comparing the bend migration speed between the model and the field (Kleinhans et al. 2015).

Estuaries are influenced by tides at their downstream boundary as well as by the river inflow upstream. Processes such as bank failure of the outer banks and liquefaction or breaching of bars inside the estuary are important for reproducing natural system dynamics, but the most important boundary conditions are the bi-directional flow associated with the ebb and flood conditions of the tide. For river experiments, sediment mobility can be achieved by increasing the slope to compensate for shallow flow conditions. In estuaries this is more difficult, since there is a reduced sediment mobility when the downstream water level associated to ebb and flood conditions is varied. One way of addressing this issue is to tilt the flume periodically, so that sediment is mobile during both the flood and ebb conditions (see Figure 1 and Kleinhans et al., 2017). However, the time scale definition is in this case is difficult to resolve as the basic hydraulic process driving the morphodynamic changes is distorted. For example, some tests were carried out with 15,000 tidal cycles, equivalent to 40 yrs of natural hydrodynamics with two tides per day. The widening of the estuary could however be compared to widening of the Western Scheldt Estuary (in the Netherlands) that occurred over centuries to millennium, suggesting a significant acceleration of the morphological process of interest compared to the hydraulic input in the experiments.



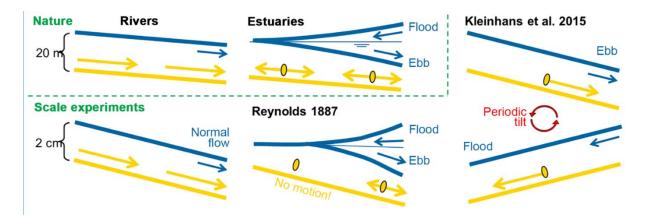


Figure 1 – Metronome operating principle as published in Kleinhans et al. (2017): considering the use of the same sediments in scaled experiments and in the real scale natural system, the shear stress in experiments must be the same as in nature to achieve a similar sediment mobility. With much smaller water depths, this requires much larger gradients of the water surface, which is easily achievable for river experiments. In tidal experiments, however, these increased water surface gradients are difficult to obtain in fixed flumes when reproducing a scaled tidal prism (see Reynolds, 1887). This may be overcome by using a tilting flume, as described by Kleinhans et al. (2015).

The rapid development of a morphological features of interest in a scaled experiment, such as the formation of meanders or estuaries, may be partly due to the absence of cohesion in the sediment, which prevents the correct modelling of bank erosion processes. van Dijk et al. (2013) and Kleinhans et al. (2015) further investigated the effect of adding cohesive materials such as clay and silt, on bank erosion. For the cases with silica flour (van Dijk et al. 2013), bank migration rates reduced by a tenth compared to the tests by van Dijk et al. 2012, which would suggest the duration of the experiment would present the morphological development over 50 years instead of 500 years.

Although these approaches enable the investigation of physical processes at time scales that are relevant to study climate change effects, strict time scaling is difficult and further investigations are needed to understand what are the optimum sets of parameters to be used (content of cohesive material, tilting angle and frequency, use of lightweight material,...).

#### MOREphometry – Presenter: Eli Lazarus

This presentation described the motivation, protocols and assumptions used in the experimental investigation of coastal overwash morphology (Lazarus, 2016). More precisely, this work showed how scaling laws describing a morphological process could be derived by unifying quantitative descriptions of analogue physical experiments and field observation. The original idea was to reproduce morphological patterns typical from an overwash process (lobes, throats, head scarps and sediment plugs) by simulating overwashes over a sand barrier in a sand pit of about 3m by 4m (Figure 2). The sand used being given; a trial and error approach was used to define the design of the low flat barrier as well as the speed of the water rise in the reservoir on one side of the barrier. Topographic scans of final barrier topographies were realized allowing for a quantification of the morphological features, such as the width, length, area volume and spacing of lobes and throats. Preliminary results from the analogue experiment and comparisons with field data suggested that



for all these situations, different parameters of the features scale with the length of the lobe/throat. The presentation then considered the process development in terms of model time by characterizing the time evolution of the correlation between the length and area of the lobes/throats and the evolution of the mean spacing ratio between the lobes. After the variation induced by the initial conditions, these parameters were shown to be approximately constant in time, showing that these experiments characterized an equilibrium state.

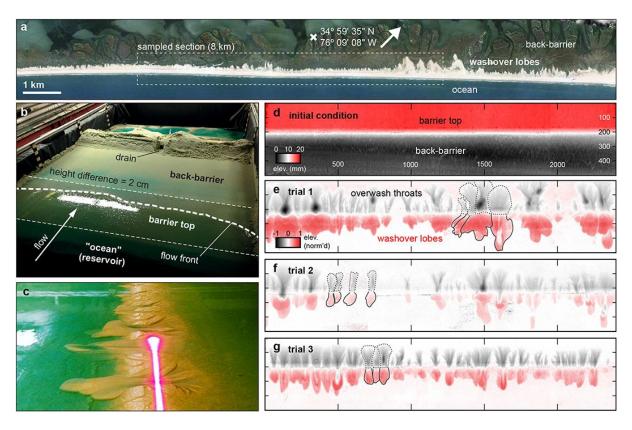


Figure 2 – Investigation of barrier overwash morphology in the field and laboratory as published by Lazarus (2016): (a) Washover lobes along an undeveloped barrier island (Core Banks, North Carolina, USA; image from 2005, via Google Earth; white arrow indicates north). (b) Experimental apparatus and design used to generate overwash morphology in spatially extended series. (c) Scanning back-barrier features with a topographic laser. (d–g) Uniform initial condition of experimental barrier and resulting patterns of overwash morphology (three trials). Units are in millimeters; in Figures 1e–1g, topographic change is normalized relative to maximum deposition across all three trials. Representative throats (dotted) and lobes (solid) are outlined to illustrate how features were delineated for measurement.

As an outlook, the approach to model morphodynamic physical processes was discussed. Based on the work of Paola et al. (2009), it was identified that experiments should not necessarily be considered as "models or miniatures of the real world, but simply as small systems in their own right", where the same physical processes may occur. Thus, terms such as "analogue model" and "physical model" may have to be abandoned in terms of describing morphodynamic experiments. In essence, "a model is an idealization or theory about how nature works. An experiment is part of nature, however simplified or reduced in scale it may be." These points were completed by a reminder of the hierarchy of experimental design as established by Paola et al. (2009):



- "Full-scale experiments: a phenomenon is isolated and studied in full details (e.g. sediment transport, small bedforms).
- Complete (or nearly) dynamical scaling: all the relevant dimensionless numbers are the same as in the field prototype, or in the same regime (e.g. any Froude-scaled model and its variations of river processes).
- Strong scale independence: mechanics known to be independent of scale (e.g. gravity waves)
- *Inferred scale independence:* Natural similarity implies scale independent processes but the mechanistic understanding is incomplete (e.g. erosional landscapes, braided rivers).
- *Exploratory experiments:* harder to extrapolate, but interesting" (e.g. Paola, 2009, and Kleinhans et al., 2014).

In such classification, the uncertainty in extrapolating the results to the field/prototype situation is increasing from the first to the last category. These points were further discussed in the general discussion after the presentations.

#### Morphologic scale models at BAW – Presenter: T. Hüsener

This presentation was aimed at detailing the successful application of lightweight plastic granulate as a substitute for sand and gravel in morphologic scale models of rivers. After a brief introduction of the German Federal Waterways Engineering and Research Institute (BAW), the first part of the presentation reintroduced the basics concepts relating to the scaling of sediment material in scaled hydraulic models. In order to obtain the similarity between prototype and model, the forces need to be scaled appropriately, leading to the definition of specific scaling criteria by, for example, Froude and Reynolds numbers. By obtaining similarity in sedimentological and morphological experiments, additional parameters must be scaled properly such as the Particle Froude number (Shields number), the Particle Reynolds number, and further functions must be considered like specific density, friction velocity and sediment grain size. A fictional example of the use of these scaling rules was given considering three flood situations. Based on the scaling approach chosen, the position of these three scaled events would change in the Shields diagram compared to the prototype situation. The presenter then emphasized that a necessary condition (but not sufficient) for similarity is that each of these single events needs to be located in the same transport regime as the prototype situation.

An example of such a modelling approach was given with the description of a mobile-bed model of the Oder river (Henning et al. 2008), study carried out by BAW (Figure 3). Several plastic materials were tested in order to identify a material that allowed the development of dunes with the correct shape (using a trial and error approach). Following a model design approach similar to the one mentioned above, the model reached a dynamic equilibrium condition in good similarity to prototype situation. There were several deterministic ways for calculating time scales leading to time scaling factors between 2000 and 4000, then averaged to a factor of about 2500. However, the comparison of the development of the morphodynamic process of interest, dune migration speed and sediment transport rates, led to an evaluation of the time scale at which the model operates would rather be between 5000:1 and 6000:1.



In addition to the tests carried under a constant discharge, T. Hüsener also presented some features of the model behaviour under varying hydrographs. A hydrologic time scale could be derived empirically based on the maximum water slope increase in the model (flood wave propagation). For this specific example, the resulting hydrologic scale factor is 1: 800. However the dune development corresponded to a time scaling factor of 5000 under steady conditions, which was reduced to 2000 under unsteady conditions. This demonstrates the potential range of time scales that may be reproduced as a consequence of the morphodynamic time scale being flow dependent.



Figure 3 – Illustration of the morphological features developed in the model of the Oder Hohenwutzen conducted at BAW (unpublished work). The model is built with a horizontal length scale of 1:100 and a vertical length scale of 1:40, thus with a distortion of 2.5. Thus, the full length of the model is 80 m, or 8 km in nature. The model bed is made of solid banks with groins and dams and a the movable lightweight sediments are a polystyrene plastic granulate.

To follow up on the use of lightweight sediments from the previous example, the case of the River Rhine model was also presented. In contrast to the other models, this model had to deal with a bimodal grain size distribution in the gravel bank at Jungferngrund, with sand and coarse gravel. To represent this sediment diversity, three significant grain sizes were characterized from an assessment of the dominant transport modes in the Shields diagram, and these grain sizes were represented by three plastic materials with different sizes and, in particular, different densities. Such lightweight materials are easily available as the plastic industry provides a wide range of materials with different grain sizes, densities, shapes and colours. The use of tracers and dye for simulating suspended material and wash load was also described in the presentation of the Elbe river model.



In conclusion, it is clear from the BAW perspective that there are several major challenges to be tackled when it comes to scaling morphological processes in a deterministic way, namely:

- The non-existence of "simple" or "exact" criterion for sediment scaling.
- The fact that all morphologic processes and phenomena are unsteady, but unsteady simulations in scale models with sediment transport are very tricky to represent and often long lasting.
- Morphologic simulation can yield a wide range of results. It is thus necessary to repeat the same test several times in order to converge statistically.
- Time scales are difficult to calculate, and hydraulic, sedimentological and hydrologic time scales are mostly unequal.
- Morphodynamic time scales are often flow dependent, so in the same model different time scales exist.

The common time scales used in BAW's scale models implied that time scales between 0.5 and 4 years could be simulated in 1 or 2 working days. This is sufficient for most practical/engineering applications, but the use of such approaches for longer time scales still needs to be investigated. Finally, the scaling of wide or bimodal grain size distribution with mixing of plastic granulate with different grain size and density is not widely tested, but BAW first experiences are promising, validating the use of lightweight sediments for the investigation of more complex sedimentary processes.

Lightweight materials in coastal physical models – Presenter: Agustín Sánchez-Arcilla

This presentation summarised the use of lightweight materials in small-scale mobile bed physical models in the Marine Engineering Laboratories at UPC (LIM - UPC). The presentation outlined the criterion defining the suitability of lightweight particles to perform efficient movable-bed models which has been described by Hughes and Fowler (1990) and Ranieri (1994), and then showed a short review of studies that have used low density materials with geometrical scale ratios larger than 1:10. Further tests were undertaken at LIM/UPC in the CIEMito small scale wave flume, which aimed at reproducing scaled experiments (1:15 to 1:50) of the full-scale investigations of Dette and Uliczka (1987). This work investigated the dune recession and the development of the beach equilibrium profile under irregular wave conditions, at the GWK (Hannover, Germany).

In these experiments, the hydrodynamic conditions and geometries were scaled according to the undistorted Froude's law, and different lightweight materials (silica sand, anthracite 2 and duroplast) were all tested in 1:15, 1:30 and 1:50 scaled tests. The comparison of the beach profiles obtained showed different morphodynamic responses depending on the beach profile region and the material, due to the occurrence of different modes of transport (see Figure 4). The main outcome of these investigations in terms of morphological scale effects were:



- The results of sandy models were in good agreement with those obtained by Hughes and Fowler (1990) and Ranieri (1994) for sand models.
- The Anthracite granules showed a poor response, both in terms of shoreline displacement and mobility rates.
- In terms of mobility, the use of Duroplast at very small scales provided a better agreement with the prototype situation compared to sands, although berm erosion processes were enhanced.

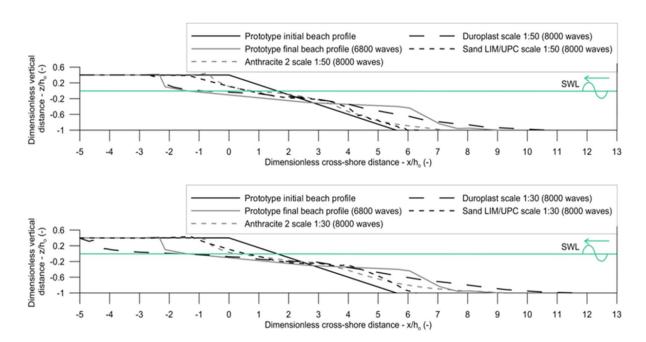


Figure 4 – Typical outcome of beach profile comparison between the CIEMito tests and the tests from Dette and Uliczka (1987). Unpublished work.

Despite being only an initial assessment, these investigations showed the difficulty to identify a lightweight material better suited to improve the morphological response of sand in small-scale models. In addition, not only is particle settling velocity of paramount importance to assess the reliability of a low-density material for physical modelling, but also other intrinsic characteristics such as the material shape, grain size, friction angle, repose angle, capillary rise, porosity, friability and the electrostatic properties of the lightweight material.

#### Physical models of cliff erosion – Presenter: Dominique Astruc

This presentation explored the use of cohesive sediments in small scale experimental investigations of cliff erosion processes. The motivation behind the use of cohesive sediments in such scaled models is that the sediments used needs to have a "solid-like" behaviour prior to erosion, but the material needs to be "eroded" by the type of hydraulic conditions that can be produced in the available experimental facilities within a time scales of hours to days. The definition of the experimental protocols is thus based on a trial and error approach to find an appropriate material that allows for the reproduction of a given erosion process in the experiment which is similar to the processes observed in the natural environment (e.g. notch creation followed by cliff collapse).



The presentation reviewed previous investigations that reproduced scaled cliff erosion processes with various combinations of sand, cement or clay plus water. The main problem that these studies faced was to simultaneously reproduce/scale down the flow regime (according to Froude criterion with incident non-breaking waves and a microtidal regime), the transport processes of the eroded material (according to the surf, Dean and Shields parameters), and the cliff cohesion properties (assessed by the notch aspect ratio). For example, Caplain et al. (2011) could validate the qualitative phenomenology of the cliff erosion, but not the sand beach evolution as the cohesion was lost once the cliff collapsed (mixture sand-water).

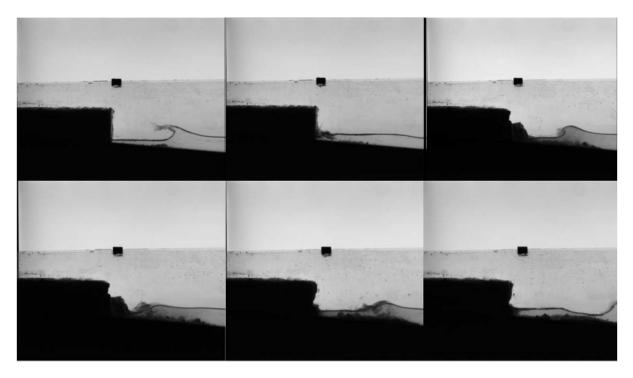


Figure 5 – Illustration of scaled cliff erosion tests under wave action on a sand+water+Xanthane mixture (unpublished work). The successive beach profiles shows no notch before the wave action and a plateau-like shape of the submerged bottom after erosion, thus describing qualitatively the erosion processes observed on cliffs in real scale.

However, recent preliminary tests including a cohesive additive (Xanthane) allowed for a better reproduction of the plateau-like shape of the eroded material at the bottom of the cliff (see Figure 5). This has introduced the possibility to develop protocols to scale the cliff erosion process in time and space. Thus, a natural process occurring over decades could be simulated over a couple of hours or days.

Long-term morphological evolutions – Presenter: Rocio Luz Fernandez

This presentation investigates the possibilities to model morphological evolution over long time scales. For doing so, two cases are presented, namely the reproduction of a delta progradation in a distorted model of Lake Wabush (Labrador, Canada), and the analogue modelling of the evolution and stratigraphy of submarine channel-lobes. For the first case, the lake being modelled was elongated, therefore a concept model of the prototype situation was created in a two-stage flume (with a deep side and a shallow side), the vertical dimension of the scaled basin was distorted by a factor 5 compared to the field situation. The discharge in the model was estimated from the Froude scaling criterion, and distorted with a scaling factor of 30. Thus, a reservoir filling process, typically



occurring over decades could be qualitatively reproduced over a week of experimental time. Results from the physical model were used to calibrate and validate a numerical model to be applied first, at laboratory scale, and then, adapted to the prototype scale (Fernandez et al., 2011)..

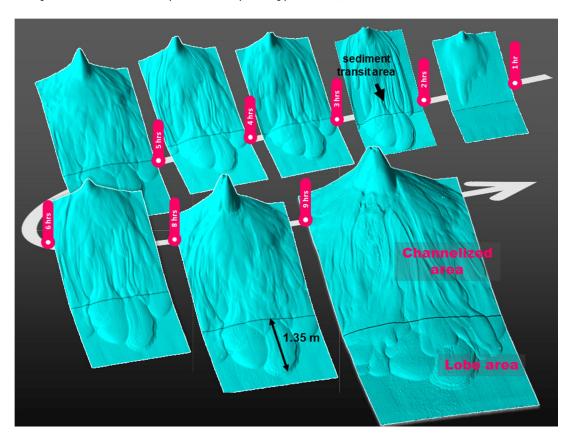


Figure 6 – Measured depositional history of a laboratory representation of a fan deposits. Investigations presented in Fernandez et al. (2014).

Laboratory investigations of the depositional history of submarine fan deposits were then presented (Figure 6). The experiment used a sloping basin to represent a continental shelf with a break in slope (I.e., two distinct slope angles), sediments (kaolin and silica) were mixed with water and introduced from an outlet pipe (point discharge). The effect of different slope angles and sediment concentrations on the deposition patterns were investigated, following an analogue modelling approach. The sediment transit area, channelized areas and lobe area were monitored, and deposition patterns similar to features found in the natural environment could be observed after about 10 hours of experimental time.

#### **GROUP DISCUSSION**

The outline of the work planned within the task 8.3 and the different presentations were very well received. Several discussions relating to the technical content of each presentation occurred after each presentation and this document summarizes the most important points. The first question raised was, how a sequence of hydrographs should be scaled and represented in a model. It was suggested that several studies have investigated the effect of different hydrograph shapes. For example, stair-shaped hydrographs with successive equilibrium flow rates do not necessarily trigger the same morphological response as triangular or gradually varying hydrograph shapes, and



numerical simulations suggests a significant impact from the way flood events succeed each other, which will be investigated further as part of experiments being conducted by UHULL for Task 8.3. However, whilst it is possible to investigate the impact of event sequences, it remains uncertain how to successfully discretise unsteady flow regimes into sequences of events. In general, changes of hydrodynamic conditions (i.e. different magnitude flood events) in a laboratory experiment are often modelled by a succession of equilibrium states, which do not take into account the transient effect and do not reproduces unsteady processes. These questions remain difficult to answer in terms of generic solutions. Obviously, the most important issue when handling morphological processes in a scaled experiment is the definition and the quantification of potential time scale impacts, as pointed out by T. Hüsener.

Another area of discussion during the workshop was the potential for misunderstanding around some common terminology such as analogue models or scaled models. It was suggested that this misunderstanding might arise from the variety of scientific backgrounds in the community addressing morphological processes. As developed by Paola et al. (2009) and stressed in the presentation of E. Lazarus, the different types of model are different tools that the experimentalists have to investigate morphological processes, and that given a well-defined research question, each model type has its advantages and disadvantages, therefore model choice will always represent some type of compromise. It is thus important to develop a common terminology and understanding of the full spectrum of modelling approaches that are available to physical modellers when experimenting with climate change impacts. A broader classification is presented here and may be discussed in future work within the JRA RECIPE:

- Process models (1:1 scale): use to reproduce and isolate a physical process to improve its basic understanding, as well as calibrate and support other model development (e.g. numerical simulations)
- Scaled models: models that are scaled down rigorously according to scaling criterions (no degree of freedom) to reproduce the force ratios of a prototype situation as accurately as possible (with undistorted/distorted models). This is a predictive approach were physical processes can be quantified.
- Analogue models: these are models were force ratios are not strictly quantified (larger degree of freedom), and where the focus is on a couple of well-defined features of interests which appear to be scale-independent. This is rather a conceptual approach were processes can be qualified.

Like for experimental investigations, numerical simulations also offer the possibility to focus on various times scales depending on the scope of the investigations, with different approaches such as reduced complexity models, cellular automata, physic-based models, or computational fluid dynamics. In addition, some of these models offer the possibility to incorporate external factors such as biology and societal inputs. The use of numerical approaches in combination with some experimental investigations (e.g. hybrid modelling) should be reviewed in the context of the correct representation of various time scales in morphodynamic processes.



### SUGGESTED OUTLINE OF PROTOCOLS TO SCALE MORPHODYNAMICS IN TIME

The discussions in this workshop, have been used to develop a general framework for the deliverable D8.3:

- Introduction
- Scaling laws and scale effects
  - Scaling principle
  - o Time scales
  - o Approaches for scaling morphodynamics in time
- Protocols for compressing time in morphodynamic experiments
  - Fluvial environment (bed load, suspended load, reservoir sedimentation, catchment scale).
  - Tidal environment (Tidal rivers and estuaries)
  - o Coastal environment (Bed load, suspended load, beaches scouring)
  - o Offshore environment (Submarine landslide, density currents)
- Hybrid modelling

During the discussions, it has been suggested that the protocols will start by defining the environment and the problems to be addressed, considering laboratory space/restrictions and other technical aspects. These protocols may be classified into different types, either focusing on the choice of a scale or model distortion (this will define the sediment characteristics), or deliberately choosing a given/available sediment to be used (thus the scale and distortion will be defined). Based on the approach chosen, the protocols should emphasize the assessment of the scale effects based on scaling laws and different time scales (hydrodynamic forcing and morphodynamic response). Some practical considerations may be introduced on how to carry out experiments and this would be done through examples of various studies. More specifically, the following experiments carried on under the umbrella of Hydralab + may be considered:

- Cohesive sediment and cliff erosion (CNRS IMF-Toulouse)
- Catchment simulation (HY+-HULL-01-TES at Univ. Hull)
- Lightweight sediment tests (UPC)
- Distorted beach scale model (LNEC)
- Erosion threshold and chemical surrogates (LU Hanover)
- Lightweight sediments and reservoir sedimentation (NTNU)

All the participants attending this workshop will be asked to further contribute to the content of the deliverable, based on the discussion of the workshop. The time plan for these contributions is detailed below.

#### **ACTION SUMMARY**

No.	Name	Task	Deadline
1	Detailed outline D8.3	Compile and send to the contributors	End March
2	Feedback 1	Collect the contributions	1 <sup>st</sup> June
3	Complete first draft	Send draft for approval to contributors	Mid-August
4	Feedback 2	Discussion / approval and set next actions	Sept. (Catania)



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