Eagre/Aegir: High-seas wave-impact modelling
(EU Marie Curie European Industry Doctorate 2020-2023)

1. Early Stage Researchers: Wajiha Rehman and Yang (George) Lu (ESR1 & ESR2)

2. Maritime Research Institute Netherlands (MARIN): drs Tim Bunnik, Sanne van Essen; Bulent Duz, Arjen Koop

3. School of Mathematics, Leeds: Onno Bokhove (Mark Kelmanson)

- Eagre/Aegir: a high tidal wave or bore (tidal Aegir on the nearby River Trent)

- Start date: 01-01-2020 (**month 1**); original kick-off at MARIN 01-10-2020.

EID objectives

Eagre aims:

1. The overall objective is to create computational and mathematical modelling tools, for solving problems in maritime engineering, based on advanced mathematical and numerical analysis and the efficient implementation and testing of this analysis in a general finite-element simulation environment.

2. Our key task is to *offer training and research* such that this numerical wavetank can be established by the ESRs for maritime-engineering wave basins, such as those currently operational for consultation at MARIN Academy BV.

3. To create a numerical wavetank, developed by ESR1 and ESR2, on the modelling of *extreme or rogue waves* in wave basins (WP1-ESR1) and on wave-structure interactions, especially wave-impact, on a dynamic wind-turbine mast (WP2-ESR2).

ESR1 –"ExtremeWaves"

Extreme water-wave computational modeling using advanced geometric methods with wave generation, breaking, and currents.

WP1.1 Create a ***complete numerical finite-element wavetank for high-amplitude potential-flow water waves*** with a breaking-wave parameterization, optimized for parallel computing, wave generation and wave damping at beaches, in both two and three dimensions (2D and 3D). Explore coordinate transformations as well as dynamic mesh motion.

WP1.2 Develop and deliver a (new) series of ***benchmark cases*** (soliton splashes, Stokes, Rienecker-Fenton, (ir)regular, short-crested waves, random waves, etc.) for the wavetank of WP1.1.

ESR2 –"WaveTurbineImpact"

Water-wave impact on dynamic and flexible (wind-turbine) structures.

WP2.1. Formulate the *nonlinear mathematical theory* of potential-flow water waves coupled to a nonlinear hyperelastic beam (wind-turbine mast) in 2D and 3D, also using the applicants' new asymptotic analysis of the two-way feedback mechanism (cf. Salwa *et al*. 2017; Kelmanson 2018/2019).

WP2.2 Derive a *compatible numerical discretization* of potential-flow water-wave motion and a prescribed beam (or waveflap) motion in 2D.

--with MK.

ESR2 –"WaveTurbineImpact" cont.

WP2.7 *Provide and explore the variational formulation of a mixture-theory water-wave model in the Eulerian framework*, using Euler-Poincaré theory and its Euler-Boussinesq-equation limit. Couple the resulting water-wave model variationally to the nonlinear beam (wind-turbine mast). Consider and explore numerical water-wave motion in a compressible Van-der-Waals-fluid model, in its potential-flow limit, and compare this computational model with a classic finite-volume formulation using a continuous equation of state. Explore the imposition of incompressibility (*optional explorations*).

The proposal is to consider replacing WP2.7 at the mid-term review by a particular applied and end-user topic of interest to MARIN Academy BV, to be defined by the MARIN Academy BV supervisors depending on the progress at the time in discussion with ESR2 and the academic advisors.

Deliverables first ~6 months

Completed:
- Kick-off meeting 29-02-2020; took place on 02-03-2020.
- Supervisor board established 29-02-2020; done in 03-2020.
- WP5 D46 Establish data management plan 30 June 2020.
- See minutes: GitHubEagre
  https://github.com/obokhove/EagreEUEID20202023

Delayed:
- Kick-of meeting 01-10-2020 now 18-01-2021; make minutes; place on GitHub.
- Fluid dynamics course (exam done, 2 numerical tasks to go) & ~~self-study course~~ in semester 1 moved to semester 2: FSI course, ….

Note that:
- Month 1 is 01-2020
- Month 9 is 09-2020; ESRs were supposed to be starting 09/10-2020.
- ESRs started 01-11 to 21-11-2020 due to Covid-19 (hiring UoL delayed, hiring-freeze, and self-isolation).
- Teaching *out-of–sinc*: OB had to teach numerics twice (1x CDT, 1x ESRs).
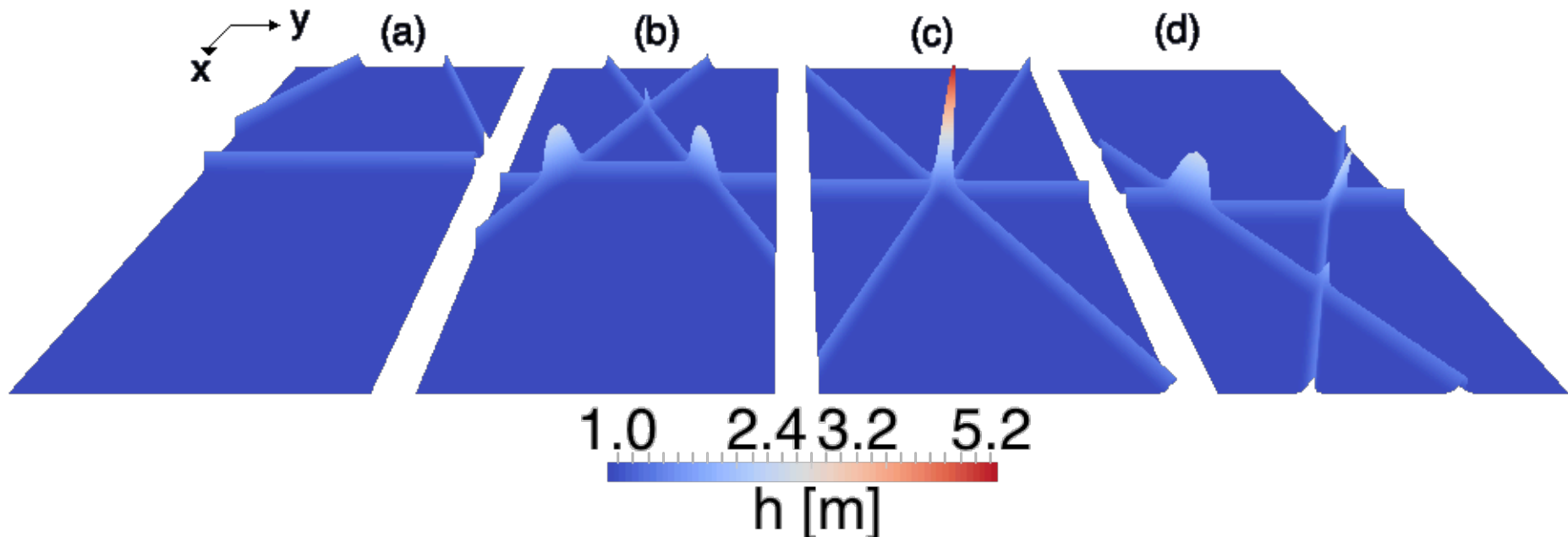
Deliverables first ~6 months outreach

Delayed:

- **WP4 D4.1** D41 old DD1; **Launch public media pages**; WP4; UoL; Media online; *01-09-2020 -> 18-01-2021*
- E.g., wavetank in Maths Lab: https://github.com/obokhove/MathslaboratoryUoL https://blogsurfsup.wordpress.com/
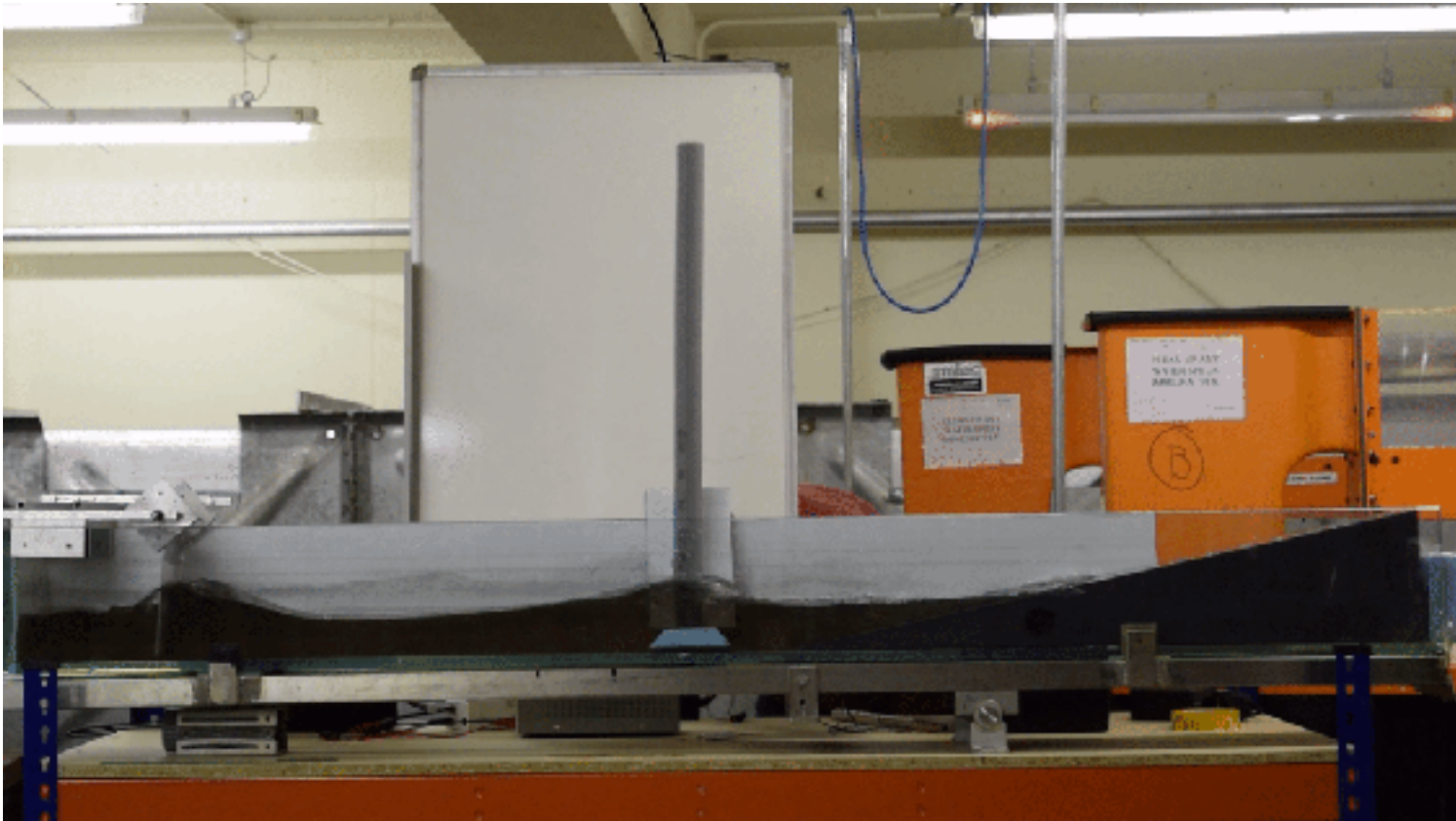
Deliverables first ~6 months ESR1

Delayed ESR1:

- **WP1 WP1.1** D1.1 D1: Scientific: Reformulation/reproducing & HPC; interim report I; *30-04-2021 -> 30-06-2021*
- **WP1 WP1.2** D1.2 D2; Scientific benchmarking; update interim report I; *30-06-2021 -> 30-08-2021*
- **WP1 WP1.2** 3-soliton; update interim report I; 30-08-2021 -> 30-10-2021 *3 papers (Overleaf)*

Deliverables first ~6 months ESR2

Delayed ESR2:

- **WP2 D2.1** D12 "D12; Mathematics; WP2.1; UoL (ESR2); Maths; Report I/ draftnote A; *30-04-2021 -> 30-06-2021*
- **WP2** D13 Numerics/ Mathematics WP2.2 Interim report II; *31-07-2021 -> 30-09-2021*
- *Photovoltaic power plants at sea?*

(SINN Power)

Get in touch!

http://www1.maths.leeds.ac.uk/eagreEUEID/index.html
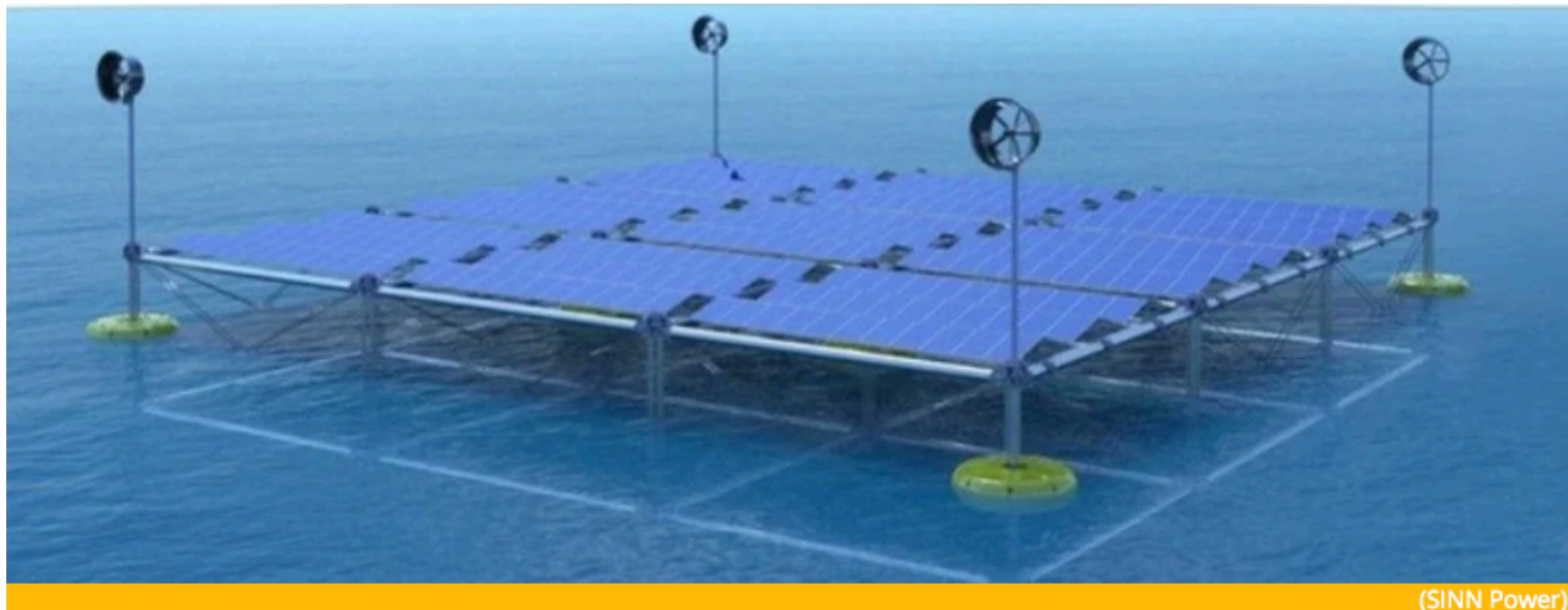
github.com/obokhoveEagreEUEID20202023

Important Dates:
- *Mid-term assessment EU: Friday 26-03-2021*