Project Name: WALOWA
Notes on data postproceesing of water surface elevation
By T. Suzuki and C. Altomare
Draft: 15-05-2019

1. Postprocessing of water surface elevation measurement

The water surface elevation was measured at 7 locations along the flat bottom part of the flume, the sloping foreshore and at the dike toe with resistive type wave gauges attached to the flume side wall. The gauges starting from the paddle are termed whm2-whm4, whm7, whm11, whm13 and whm14 and detailed locations are given in the data storage report. The measured signals of the wave gauges whm2-whm4, whm7, whm11, whm13 and whm14 are given in the files <Testname>_Waves_40Hz.asc. The wave gauges whm2-whm4 in the flat bottom part of the flume close to the paddle were used to determine the wave parameters using the Wavelab software and reflection analysis based on Mansard & Funke method. A spectra independent high-pass filter at 0.03Hz and a spectra dependant low-pass filter at 3/Tp were used (model scale). Additionally, the fft block size was selected automatically and the taper width and overlap set to 20%. Furthermore, a number of data points were skipped at the beginning and end of each test to focus the analysis on a fully developed wave field. The incident wave parameters are given in the document 'Wave_Parameters_Offshore.xlsc'.

2. SWASH simulation of the water surface elevation using

SWASH model was set-up using the measured bathymetry and the realized paddle motion as wave boundary condition to remodel the same experiment and finally to determine the incident wave conditions at the toe of the dike (incident wave conditions are determined by artificially removing the dike from the model to avoid reflection and determine only the incoming waves at the toe of the dike). First, SWASH model had to be validated for a set-up with dike present.

Numerical simulations were carried out with SWASH (version 4.01 from swash.sf.net). The physical model layouts in the WaLoWa initial profile were reproduced in the SWASH numerical domain. The upstream boundary of the numerical model was delineated at the first wave gauge of the three offshore wave gauges used for incident wave analysis. The grid size in the x-direction was set as 0.2 m.

The model was run with one layer in the vertical direction since the kd value was less than 1, indicating that the estimated phase velocity error is insignificant (where k is the wave number and d the water depth).

The time series of water surface elevation was obtained from incident wave analysis by Mansard and Funke (1980) using the three offshore wave gauges in the physical models. The incident wave time series was prescribed at the wave boundary in the numerical model simulations with a weakly reflective boundary condition. This means that target waves are generated at this boundary however reflected waves from onshore are radiated. A still water level was set at +4.0 m. The time duration of the numerical simulations was 1 hour and 40 min. The numerical time step is automatically changed during SWASH calculations to satisfy the Courant–Friedrichs–Lewy (CFL) condition. A Manning coefficient of n=0.019 s/m1/3 was adopted in all numerical simulations. The breaking parameters are fixed as default values. The non-hydrostatic pressure term was applied with a Keller-box scheme, which has significant influence on wave transformation.

Explicit time integration was used with a time step restriction set to a maximum Courant number of 0.5 as recommended in SWASH user Manual.

The numerically computed time-series for water surface elevation are given for the same locations of the wave gauges in the physical experiment. Additionally, a numerical wave gauge was placed at the dike toe location. The time-series of water surface elevation are given in <>_FOR_TS.txt for a situation with the dike present and in <>_INC_TS.txt for a situation with the dike, promenade and wall removed. The later served to determine the incident wave conditions without reflections from the dike, promenade and wall.

The measured and calculated wave data were post-processed using MATLAB scripts. Time series data was transformed into spectra by Fast Fourier Transform (FFT) algorithms and wave parameters such as Hm0, Tp and Tm-1,0 were calculated. A Hanning window was applied for visualization of the calculated wave spectra. However no smoothing filter was applied to calculated wave parameters. A cut-off frequency of 0.025 Hz was applied for the low frequency waves.

3. Results from SWASH calculation for test Irr_1_F

Hm0: very good, Set-up: very good except WG4 and WG7.-> see time series (measurement will be something wrong), Tm-1,0: Very good (since cutoff 0.025HZ=40s is applied-> see spectrum. SWASH and measurement is perfect fit upto 0.025 Hz).

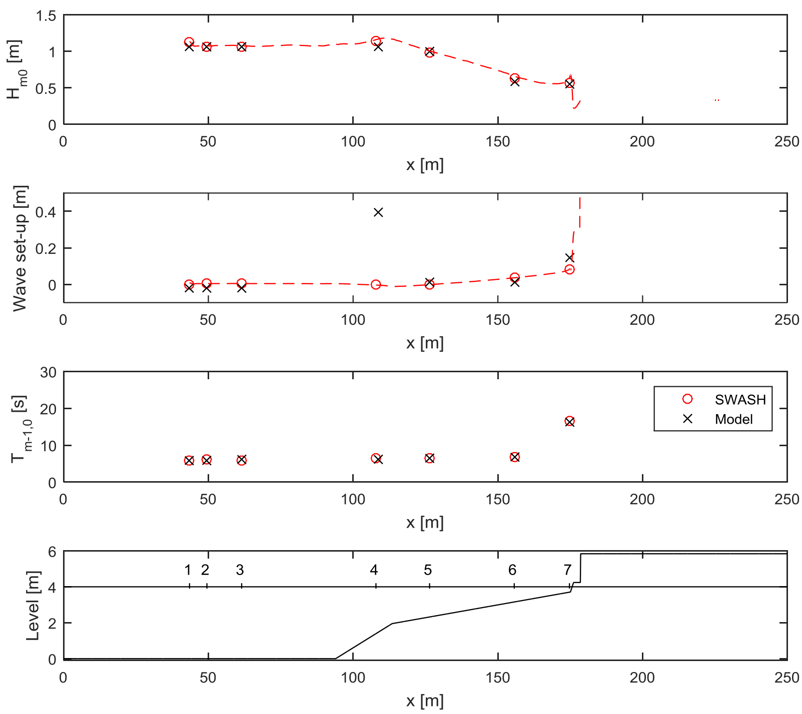

Fig 1. Wave height, set-up and Tm-1,0 (dotted line is also from SWASH: processed value inside SWASH calculation)

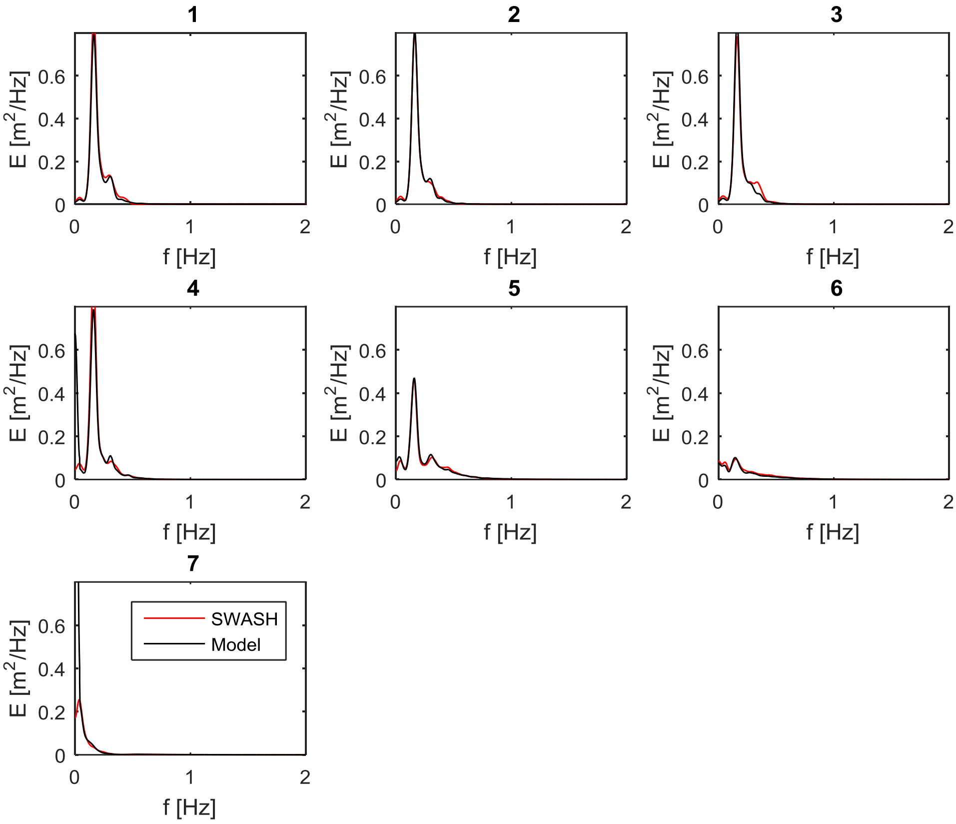

Fig 2. Spectrum

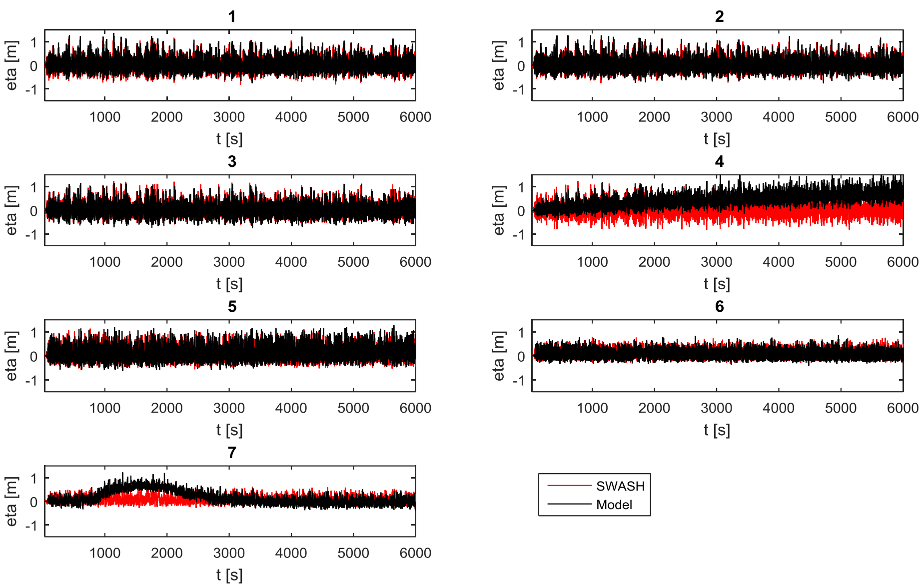

Fig 3. Time series

Incident wave test for WLW_Irr_1_F (without dike). Hm0=0.33 m, Tm-1,0=12.4 s, set-up=0.05 m

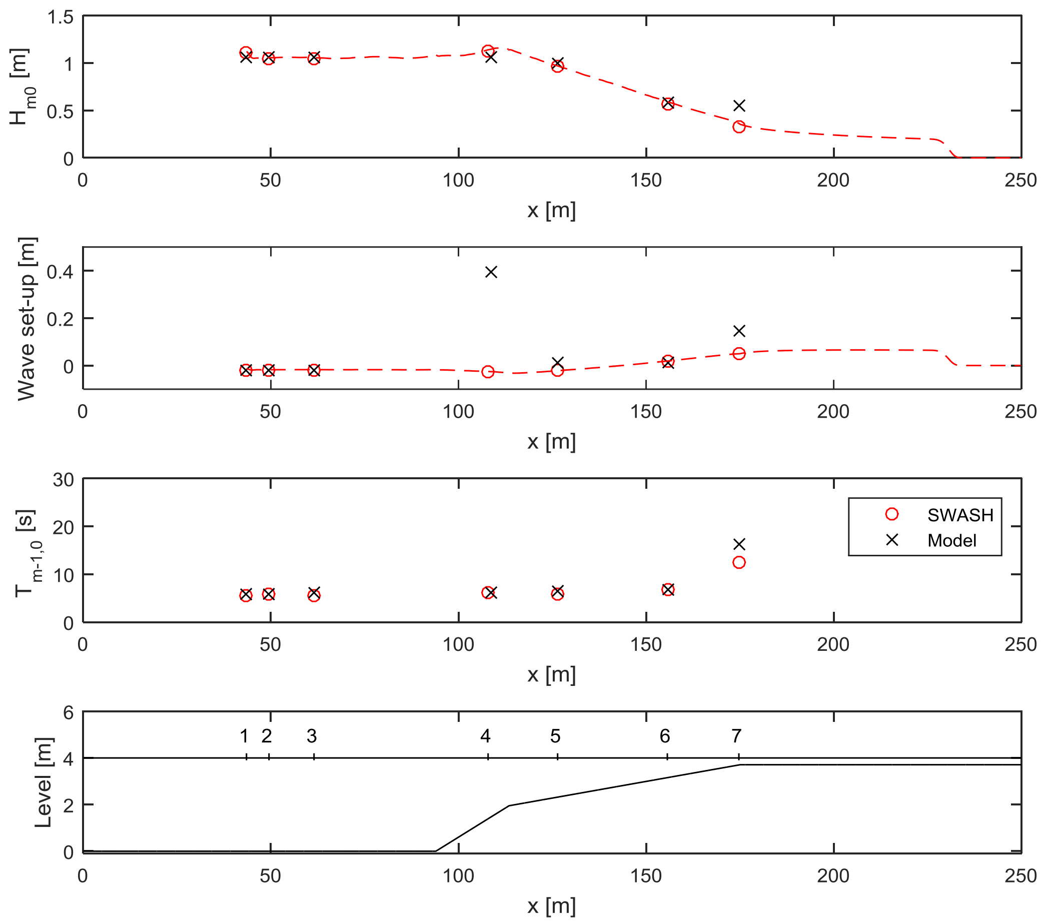

Fig 4. Wave height, set-up and Tm-1,0 (dotted line is also from SWASH: processed value inside SWASH calculation), without dike condition