SuperGen UK Centre for Marine Energy Research Annual Assembly 2012

Interactions of flow, tidal stream turbines and local sediment bed under combined waves and tidal conditions (INSTRON)

The Study Team

The University of Dundee - Ping Dong， Peter Davies, Mohammad Baba-Ahmadi (PDRA)

Numerical modelling of flow-turbine-sediment interactions, overall project management

University of Hull - S. McLelland, D. Parsons, S. Lukaschuk plus a PDRA

Experimental study of flow and sediment motions around TSTs

National Oceanography Centre Liverpool and
The University of Liverpool (UoL) L. Amoudry, P. Thorne, R. Cooke and Ming Li plus a PDRA

Large scale flow and sediment regimes of the selected TST sites

The University of Strathclyde - Richard Brown plus a PDRA

Refined modelling of vortex flows around turbines

Aim and Objectives

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1) to conduct physical model tests of a scaled TST in a large laboratory flume, and to provide essential understanding of the interaction processes between flow, TST and mobile sediment bed.

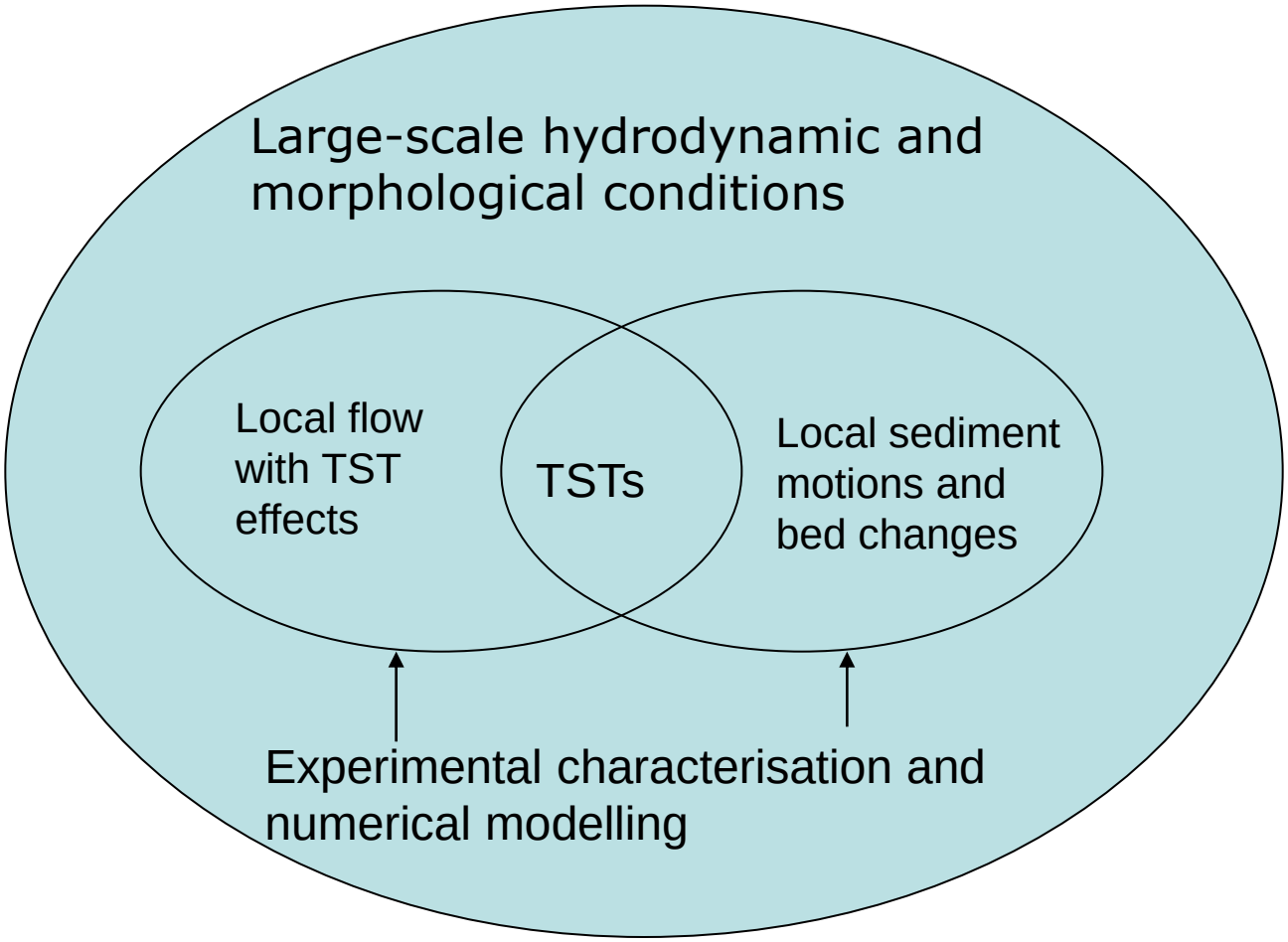
2) to develop an advanced numerical model to capture the detailed vorticity field in the wake behind the turbine and its effects on sediment uplift and bed shear stress development.

3) to predict the development of local scour by coupling the flow model with sediment transport and sediment mass conservation models.

4) to understand the impact of different turbine designs such as configuration, number of blades, blade twist, tip shape and location relative to the free surface and sea-bed on local sediment transport.

5) to promote the uptake and application of the modelling concepts, parameterisations, data and models developed in this project

Methodology



Facilities and Numerical Tools

Physical Modelling

Total Environment Simulator (TES), which is based at The Deep of University of Hull. The flume is 16m long, 6m wide and 1.8m deep and is designed for scaled physical modelling of sediment transport dynamics and flow hydraulics, enabling detailed 3D measurement of the processes operating at the sediment-fluid interface under a range of environmental conditions.

Local Flow Modelling:

Implicit Large-Eddy Simulation (ILES) model called the Vorticity Transport Model (VTM). The advantages of using this model are its 1) extensive validation for rotor-generated flows, 2) freedom from empirical tuning parameters, 3) capability to simulate flows with large Reynolds number, 4) efficient handling of complex moving boundaries.

Sediment motions:

Both concentration and transport rate based approaches will be tested and the bed evolution will be based on the Exner equation.

Large scale ambient flow and sediment processes modelling

Coupled POLCOMS and WAM model. Coupled STWAVE and ADCIRC.

Workpackages

WP 1: Physical Modelling: Led by Hull (with UoD, NOC-L)

WP 2: Development of Flow Modules: Led by Strathclyde (UoL, UoH)

WP 3: Development of Morphological Modules: Led by Dundee (UoS, UoL)

WP 4: Data Analysis and application: Led by NOC-L (all)

WP 5: Pathway to impact: Led by Liverpool (all)

Programmes

Tasks\Time blocks	1	2	3	4	5	6	7	8	9	10	11	12	PI, CI involved
Collecting and analysing data for the demonstration sites													PT, DP, SM
Website development													PD, PT
Physical model experiments (WP1)													SM, DP, SL,PT,BM,RC, RB,PAD
Development of flow models (WP2)													RB,ML
Morphodynamic model development (WP3)													PD, RB, DP,
Extreme waves and wave force modelling													ML, PD,PAD
Development of engineering tools and application (WP4)													LA, ML, PD
Management Team/External Steering Committee meetings	@		@		@		@		@		@		PD,RB,LA, SM
Preparation of journal and conference papers													ALL
Workshop/training courses								W			W		ML,RB,LA
Milestones	▲			▲	▲		▲				▲		PD,RB,SM

Note: Five milestones indicated at the end of each time block corresponds to evaluation and the management decisions on 1) overall planning; 2) evaluation of data and experiment; 3) flow model development; 4) morphological model development and 5) applications and validation

Official start date 28 September 2012