Fairway adjustments on the river Weser, Germany
Measurements of Ship inducted Waves on the outer Weser River and Estuaries 2014.
A brief overview

Joerg R. Gutkuhn
Argus Gesellschaft für
Umweltmesstechnik mbH
Ritterhude, Germany

Abstract

Measurements of ship inducted wave impacts on estuaries and waterways are always of interest. The most necessary scope to be focused on is the hydro geography and the coastline. The main purpose to run this monitoring program is the fact that the river Weser needs to be deepened to allow bigger ships to pass under high and low tide conditions. This process will have a big influence on the environment. Rivers will run faster, tides got higher, coast lines are more strained and sediments will be more rearranged. Fluid mud layers will get stronger and will interfere with the ship traffic. Higher turbidities will affect the biology and will change fauna and flora populations. More erosion on coast constructions will be seen.

The Project had been realized in a partnership with Ramboll IMS, Dr.-Ing. Karsten Peters for the Waterways And Shipping Office, Bremerhaven (WSA) and the Federal Institute For Waterways Engineering, Hamburg (BAW), Germany. Ramboll IMS was responsible for post processing wave data and issuing the report. Argus delivered the project adapted AWGS system technology, hard- and software and provided the verified data.

Introduction

To actualize the present state of the outer Weser regarding ship inducted stresses, the Waterways And Shipping Office Bremerhaven (WSA) set up a monitoring campaign to detect ship inducted wave impacts at three defined locations (Argus was the winner of the tender). Figure 1 shows the three locations for shipways in Germany. Bremerhaven EUROGATE at the river Weser estuary has one of the longest container terminals in Europe (approx. 2 km). The city state belongs to the county of Bremen.

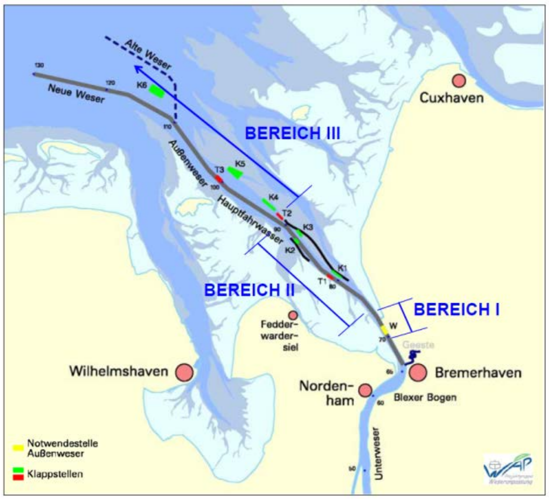


Figure 1 Map of the outer territory of the river Weser

Both cities are located on the river Weser divided by the county of Niedersachsen. Feeders are connecting the inland harbor of Bremen with the container terminals in Bremerhaven. To keep up the rapidly growing traffic the government decided to dredge the river deeper. This will create more impact on constructions and the nature and will increase the tides. The monitoring is needed to feed mathematically models for constructions and estimates the risk of damage related to deeper waterways.

For a complete overview three locations have been selected. The first is located close to the container terminals, second at a narrow river part with long stretched mud flats and third close to the outer Weser tide gage station "Dwarsgat". All three stations run self-contained and are time synchronized through a GSM (GPRS) radio terminal. All time series are coherent. Time series for all stations had been linked to the AIS data from every individual ship plus meteorological data. This way it is possible to detect the specific ship inducted waves and currents at each single location. This was related to the ship speed over ground, wind parameters and ship specific wave induction. Currents had been measured at different location in the center and on the slope section of the river bed.

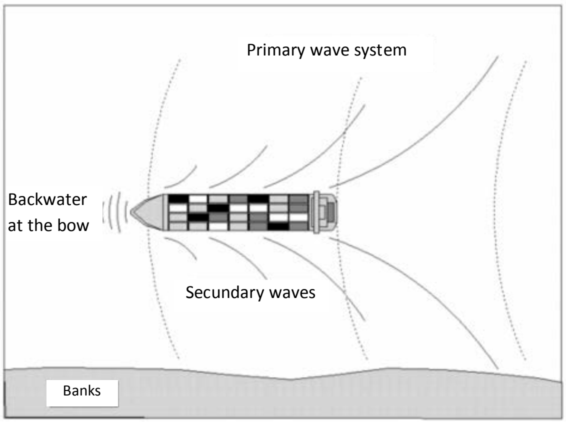
Wave measurement procedures

The following chapter briefly describes the principle for ship inducted wave monitoring and identification. To process wave spectra from raw data a minimum sampling rate of 10Hz is recommended. The ARGUS AWG Wave Sampler AWGS (Argus Wave Gauge Sampler) provides a complete wave detecting system with a maximum sampling rate of 100Hz. A resistive, conducting measuring principle allows the use of a very robust wave wire.

Wave spectra had been post processed using MATLAB algorithms in this project.

The installation is easy and can be carried out in about 2 hours of time. Regarding to the winter monitoring period this project was powered by a wind turbine combined with a fuel cell system.

In general ships are inducing a primary and secondary wave system. A viewer on a river bank (Fig. 2) will note this two wave systems when scanning the water surface. The definition of these wave systems can be read off the graphic (Fig.3).



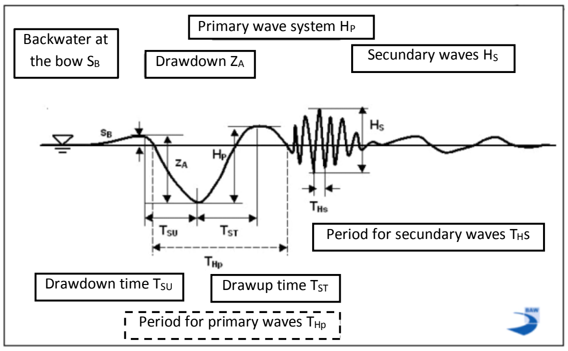


Figure 2 and 3 Definition for relevant parameters of ship inducted waves (BAW Germany)

Instrumentation

The AWGS consists of a very robust, wave wire gauge using the resistive physical principle. Regarding to the high impact by waves and possible floating elements (branches, drift wood etc.), this kind of wave sensing will stay much longer than others. The AWG needs a support like posts or sheet pilings to be mounted on. The resolution for the AWG is 3 mm and the accuracy 10 mm for a maximum wire length of 10 m. The AWG shows a very good linearity in homogeneous conductive waters. The AWG must not been used as a level meter or tide gauge. The offset may vary with inhomogeneity of waters but wave dynamics don't (*Fig.5).*

The installation takes approx..2 hours on an existing pile or other support (*Fig.4*).

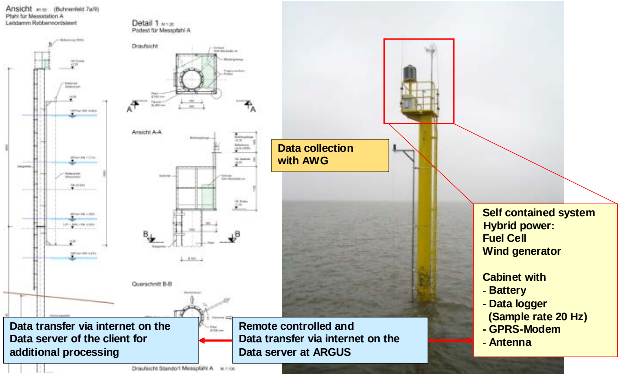


Figure 4 System configuration for a metal post; fuel cell and wind powered

The installation takes approx. 2 hours on an existing pile or other support. The AWG Sensor electronic is mounted on a metal frame to hold the sensor wire. This part can be submerged and is pressure water tight. The weight of the frame incl. Sensor is approx. 30kg for 10m frame length. PA isolators are mounted on the frame. The shape of the isolators fit on the circular pile. A stainless steel band is been adapted around the pile and sensor frame using a special tool provided with the AWGS. The controlling and energy system cabinet is been installed on the dry end of the post. It consists of a data logger and radio modem and the hybrid power controller plus battery. For calibration the three AWGS systems had been correlated to the two official tide gages “Dwarsgat” and “ The Old Lighthouse” Bremerhaven.

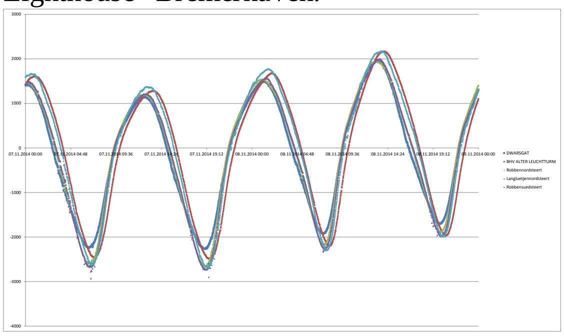


Figure 5 Static calibration for the three AWGS, related to two official tide gages on the river estuary south and north

Wave activity keeps the wire clean, no maintenance is needed in winter season. As the wire creates an electric field around itself, barnacles and mussels do not like to settle on it in summer season. But if necessary, dirt can be removed by cleaning the wire manually from time to time. But it was not necessary in this project.

The power generation is been calculated to supply sufficient energy to keep up a permanent data sampling and radio telemetry. The fuel cell backup used for winter seasons uses methanol, supplied in a sealed container.

Results

Automatic data retrieve from the monitoring stations every 10 minutes provides real time measurements for raw data.
Wave spectra calculation was post processed using MATLAB.

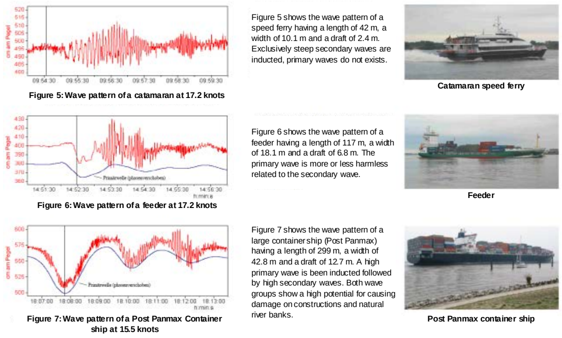


Figure 6 Three examples for inducted waves by different ship types

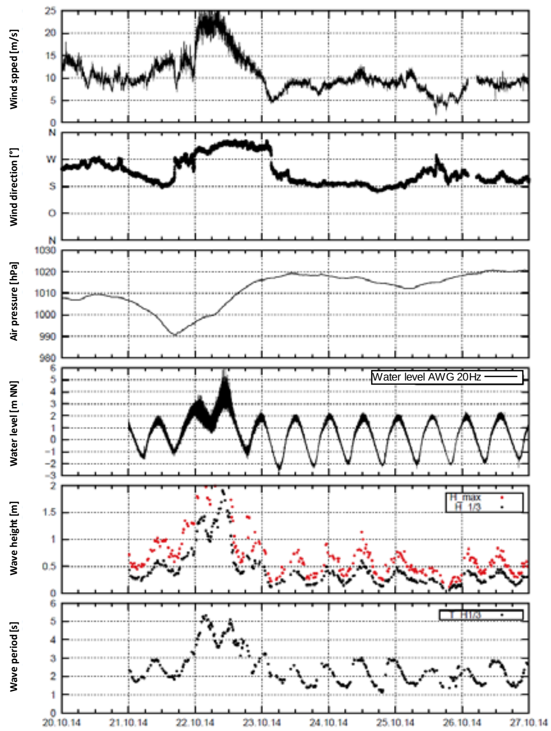


Figure 7 Time series for a storm event and some wave statistics