

## Description

This dataset consists of output from a computer model that attempts to predict annual seabed disturbance caused by waves and currents. Disturbance was taken to mean physical movement of the seabed sediments and was quantified as a disturbance frequency (days per year disturbance occurred). For sandy regions the disturbance depth is also predicted (days per year disturbance occurred to a given depth below the seabed). For gravel and mud substrates the depth of disturbance was left unquantified because of a lack of accepted predictive formulae for the behaviour of these bed types.

Values are calculated on a regular grid covering the European continental Shelf (48° N to 58.5° N and 10° W to 10° E) with a grid resolution of approximately 11 km.

The disturbance frequency depends on wave and currents, driven by wind conditions that differ from year to year. Therefore separate files are given for each year covering the period 2000-2008 inclusive.

For each year two files are output, one with and one without megaripple disturbance. Megaripples typically occur in sandy regions with strong tidal currents and can cause bed disturbance to a much greater depth than the other disturbance mechanisms considered. However they tend to operate on longer time scales (hours-days) than the other bed disturbances. Because of these differences they are dealt with separately giving the user the options of whether to use results that include them or not.

Results are given in probabilistic terms because of the uncertainty in predictive ability. That is, the probabilities represent an uncertainty in knowledge rather than an inherent randomness in nature. For example, many of the formulae used in the underlying calculations are based on smooth fits to scattered data. Thus any prediction is best regarded as yielding a range of possible values rather than a single deterministic one.

## File format

Each file deals with a single year and those with a '\_m' appended to the filename include the additional disturbance predicted by megaripple occurrence. Each file can be considered as divided into groups of lines each group dealing with disturbance to a given depth (1-6 cm at 1cm intervals). Each line gives the calculated disturbance values for a single location and includes

- 1) The relevant disturbance depth, longitude, latitude and assumed bedtype.
- 2) The probability that disturbance to this depth occurred for the number of days per year indicated in the column head (only 0 to 20 days inclusive are covered).
- 3) The mean, median and 10th and 90th percentiles of the number of days of disturbance.

For gravelly and muddy sediments only the first depth group (nominally 1cm) has disturbance values set, in the deeper bins an 'undefined' value=-99 is specified. This does NOT imply that for gravelly and muddy beds disturbance occurred to 1cm, only that disturbance (with the statistics indicated) occurred to some depth. The actual disturbance depth was not calculated might be less or more than 1 cm.

## More detailed description of the methodology

Here a description is given of the methodology behind the data. Full details of the methodology can be found in Aldridge et al. (2015). Disturbance was taken to mean

physical movement of the surface layers of underlying bed substrate. Natural disturbance was quantified by estimating the number of days in a year the bed was disturbed by tides and waves. Hourly wave and current conditions for the years 2000-2009 were obtained from a model simulation on a grid with resolution 1/6 degree longitude and 1/9 degree latitude (approximately 12km) undertaken by the Proudman Oceanographic Laboratory (Brown *et al.* 2009; Bricheno & Wolf, 2015). The response of the bed to the simulated wave and current conditions was calculated based on a synthesis of existing predictive relationships derived from laboratory and field observations.

In order to make the definition of disturbance independent of the time resolution of the modelled wave and currents, a fixed 'averaging' period was adopted and the probability of a natural disturbance 'event' was calculated with each averaging period as described later. This, multiple disturbances during the averaging interval were counted as a single event. Within the averaging period predicted hydrodynamic conditions change at the resolution of the model output (in this case hourly). The averaging interval adopted was chosen to be a day on the grounds that this is a typical time scale for a storm and thus a storm would count, as far as possible, a single event. Clearly a 'storm' may extend over a day or a shorter wind event may straddle two successive days so the exact number of days disturbance is predicted may be sensitive to the particular choice of averaging period.

Seabed substrate was classified as gravel, sand or mud based on the predominant sediment type. When wave and/or current stress exceed a grain-size dependent threshold, movement of the bed occurs and the sediment is disturbed to some depth. For sand beds an attempt can be made to also estimate a disturbance depth - based on the occurrence of small scale rippled and megaripple bedforms. For mud and gravel beds it was decided there was insufficient knowledge to assign a disturbance depth.

To account for uncertainty in predicting natural disturbance thresholds and disturbance depths, a probabilistic approach was taken. Each daily averaging period was assigned a probability that natural disturbance had occurred or for sand substrates had occurred to a given depth. A cumulative record was kept for each location of the number of days in a year the bed was disturbed with a given probability. Thus the final output from the natural disturbance simulation is the number of days in a year natural disturbance was predicted to have occurred to a given probability (or confidence) level.

For locations classed as gravel, disturbance was assumed to occur when the threshold for initial movement of sediment was exceeded. This was calculated based on the non-dimensional stress (Shields number) using the total wave-current stress. Paphitis (2001) gives upper and lower Shields threshold curves based on a range of observational and laboratory data. A probability of 1 was assigned if the wave current Shields number was at, or above, the upper threshold, and zero if it was at or below the lower threshold curve limit, with a uniform logarithmic scaling in-between.

For locations classed as sand, disturbance was again assessed using the Shields threshold curve with a disturbance depth estimated using wave and current ripple height formulae (Donghue *et al.* 2006; Soulsby & Whitehouse, 2005) as a function of median grain size, and the local instantaneous wave and current conditions. The bedform height formulae were assumed to give the mean of a distribution of possible bedform heights. The probability of disturbance to a given depth was assigned from the probability distribution. A log-uniform type distribution was assumed based on the characteristics of the scatter in the observational data. Megaripple prediction was based on the work of Johnson *et al.* (1981) and Bartholdy *et al.* (2005).

The disturbance over a muddy substrate was based on the probability of extreme waves. A number of workers (e.g. Amos *et al.*, 1992) have identified distinct modes of erosion for cohesive muddy sediments. Structural (or 'type II' erosion) seems to occur when the applied hydrodynamic shear stress is of the order of  $4 - 10 \text{ Nm}^{-2}$  and is associated with breakdown of the bed structure and erosion to depths more likely to be of biological significance. Thus, for mud beds, 'disturbance' was deemed to have occurred if a type II erosion event was predicted due to the occurrence of an extreme wave. This requires an assumption about the probability distribution of wave velocity amplitude at the bed. Following You (2009) this was taken to be a modified Rayleigh distribution.

## Refs

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