Appendix 2

Summary of sediment processes including definition and plotting of transport rate

Southern North Sea Sediment Transport Study, Phase 2
Sediment Transport Report

Appendix 2 Summary of sediment processes including definition and plotting of transport rate

The seabed sediments at any one location will be moved by:

- a temporally varying combination of wave and current forcing – see Figure A2.1(a).

Spatial variations in forcing also occur. In a wave-dominated environment (exposed coast or shallow water) the waves will be the dominant mechanism for stirring up the sediment, which is then moved by the current (a wave-induced current in the case of the littoral drift[1]). In a current-dominated environment (offshore deeper water or estuary) the currents and waves may both be important stirring mechanisms, and again the current transports the mobilised sediment. The currents may be a combination of tidal, wind-induced and wave-induced currents. Because sediment will only move once the waves and/or currents are strong enough to exceed its threshold of motion[2] the sediment transport rate is proportional to something like the third or fourth power of (excess) current speed or wave height. Hence, the residual sediment transport pathways may be very different to the residual current distribution.

In addition to the primary mode of sediment transport described above, a number of secondary transport mechanisms may take place, which may nevertheless be important for the net outflux and influx of sediment in the nearshore zone. A summary of the different mechanisms and their direction of movement is given below:

Sediment will be transported onshore as a result of:

(a) wave asymmetry (bigger orbital velocity beneath wave crest)
(b) wave-induced mass transport
(c) combined wave-and-current effects
(d) wind-induced current circulation

Sediment will be transported offshore as a result of:

(e) undertow (to limit of surfzone)
(f) rip currents
(g) wind-induced current circulation

Onshore and offshore sediment exchange may also result from tidal flow past headlands or other coastal features which result in locally strong tidal eddies which can transfer sediment across the main tidal flow direction.

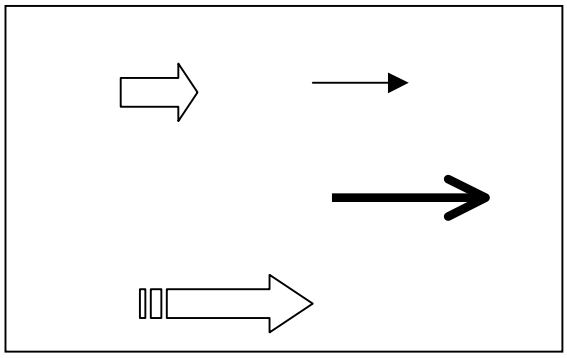
[1] Longshore sediment transport is discussed further in Appendix 11 of the main report.

[2] The conditions under which non-cohesive sand and gravel starts to move by the action of waves and currents is dictated by the size, density (and shape and packing) of the sediment particles. The conditions under which muds and silts begin to move is usually controlled by the bulk properties of the deposited sediment (bulk density, cohesion). The term usually used to define the condition at which a sediment begins to erode is *threshold of motion* (sands and gravels) or *threshold of erosion* (muds and silts).

These (and possibly other mechanisms such as the influence and link with seabed flora and fauna) may need to be considered in an appreciation of sediment transport issues in the study area.

Definition and plotting of sediment transport

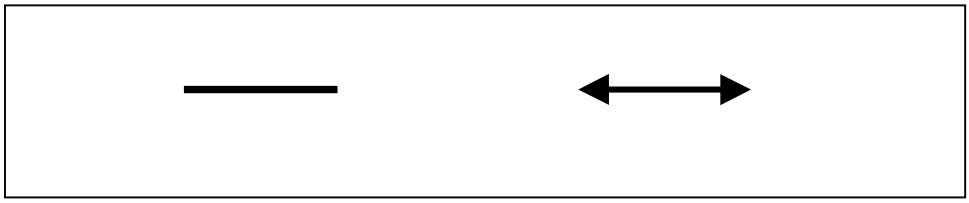
The sediment transport rate is often defined either as the dry mass (kg) or the volume (m^3) of sediment



moving over a unit width of seabed (m) per unit time (s), i.e. kg/m/s or $m^3/m/s$, as indicated in Figure A2.1(b). This value may be represented on a map as a vector arrow with the direction of the arrow indicating the transport direction and the colour, length or weight of the arrow indicating the magnitude. There is no standard for plotting of such data and each study uses its own definition.

The vector format can be used to show the direction and magnitude of sediment transport rates derived from the following sources:

- sediment transport predictors embedded within computational models of coastal processes – the tail of the arrow defines the location for which the prediction is made
- field observations of the sediment transport from process measurements of sediment flux – the tail of the arrow defines the location for which the prediction is made
- field observations of the sediment transport deduced from the migration of bedforms (megaripples and sandwaves) – the stem of the arrow overlies the features from which the transport was deduced



In cases where the axis of transport is known, but not the magnitude, a single line without a preferred direction can be defined, or if the transport is variable in direction a two-headed arrow can be used.

Reference

Soulsby, R L. 1997. Dynamics of Marine Sands. Thomas Telford Publications.

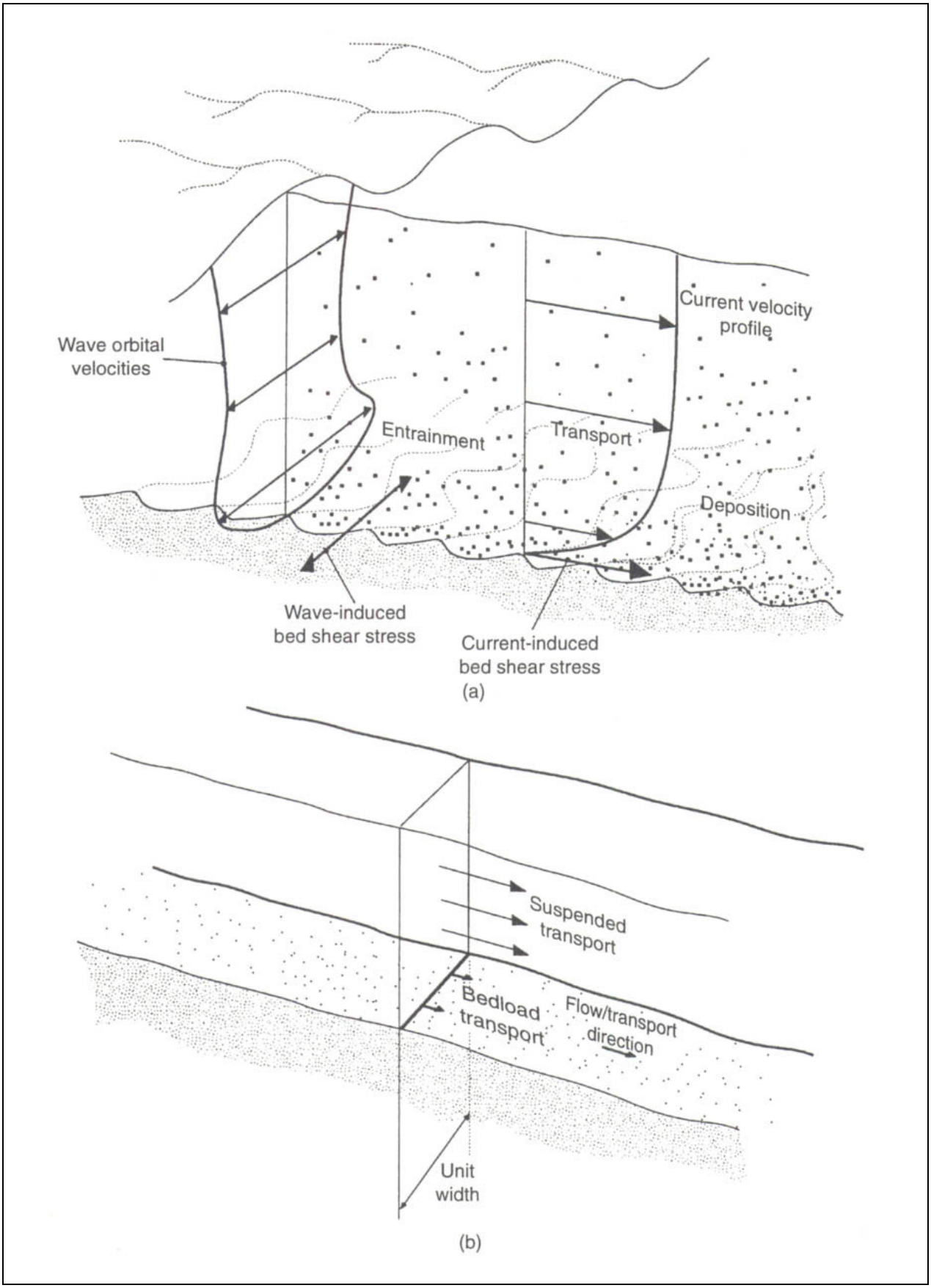


Figure A2.1 Sketch of (a) marine sediment transport processes (in practice all occur together) and of (b) plane normal to flow for defining sediment transport rate (From Soulsby, 1997 – with permission from Thomas Telford)