

Indicator	
26	Coastal erosion and accretion
Measurement	
26.3	Area and volume of sand nourishment
What should the measurement tell us?	
<p>Periodic beach restoration and nourishment have become common approaches to the problem of shore protection as a preferred solution to hard armouring. Actually the trend is not to resort to hard armouring unless this is really needed for protection of a structure or an investment, so hard armouring is the approach where restoration and nourishment is not feasible. Beach restoration is defined as the first time sand is pumped onto a beach, while nourishment or re-nourishment is considered to be the maintenance of a restored beach. Restoration and re-nourishment provide a protective barrier and are methods of maintaining the economic value of the original beach. However, there are a few environmental problems related to beach re-nourishment (use of different sediment types, effects to the benthic communities and marine resources due to marine dredges, etc.).</p> <p>Benefits provided by beach nourishment include enhanced recreation afforded by wide beaches and the protection of landward development from flooding and storm damage. Beach nourishment can significantly reduce damage to structures by increasing their distance from the shoreline so providing a buffer to dissipate and reflect wave energy. Apart from the strictly recreational values it offers, beach re-nourishment, is mostly undertaken when critical erosion has progressed to the point of immediately endangering property and/or significantly reducing the economic value of the beach. The length of re-nourished coastline may provide an indication of the level of erosion rates in critically eroding areas but also on the amount of money spent on re-nourishment and the volume of supplied sand.</p>	
Parameters	
(i)	Volume of sand nourishment (m ³) (for entire coastline of reference region)
(ii)	Length of re/nourished coastline as a percentage of total coastline
Coverage	
Spatial	Temporal
Entire coastline for the reference region.	Annually (or every 5 years, dependent on the frequency of nourishment) since at least 2000 but earlier if possible.
Data sources	
National mapping agency/sources	
Administrations responsible for the environment and coastal management (national and regional).	

Methodology																						
Steps	Products																					
1	Delimit the extent of your reference region (municipality, county, province or region)	Specified wider reference area																				
2	Choose an adequate base map with the appropriate reference scale. Select all the coastline segments ⁽¹⁾ and combine them in order to obtain the summation of the total length ^(2,3) .	Total coastline length (km)																				
3	For each year and from your national/regional agency, collect data on the number of sites nourished, the volume of sand nourishment(m ³) at each site, coordinates of each site and length of coastline nourished at each site	<u>Location, length of coastline re/nourished and volume of sand nourishment at each site re/nourished.</u> (Thematic Map)																				
4	For each year, add up the volume of sand nourishment within all sites	<u>Annual volume of sand nourishment in m³</u> (Graph 1)																				
5	For each year, add up the total length of nourished coastline in your reference region	Annual length of re/nourished coastline in km																				
6	For each year, divide the product of step 5 by the product of step 2 and multiply it by 100	<u>Annual length of re/nourished coastline length as a percentage of total coastline length</u> (Graph 1)																				
Presentation of the data																						
Maps	Base map with the location and extent of re/nourished coastline. Segments can be marked with different colour lines according to volume of sand nourishment at each segment.																					
Graph 1	<p>Bar chart/lines showing the trend in the volume of sand nourishment and the annual percentage of nourished coastline.</p> <p>The volume of sand nourishment in sites/regions/shoreline management units A, B, C... can be incorporated as part of stacked bars per year, which all together make up</p> <div style="text-align: center;"> <p>Area and volume of sand nourishment</p> <table border="1"> <caption>Data for Graph 1: Area and volume of sand nourishment</caption> <thead> <tr> <th>Year</th> <th>Amount (x1000m³)</th> <th>% renourished coastline length</th> </tr> </thead> <tbody> <tr> <td>2000</td> <td>0.5</td> <td>0.5</td> </tr> <tr> <td>2001</td> <td>1.0</td> <td>1.0</td> </tr> <tr> <td>2002</td> <td>1.0</td> <td>1.0</td> </tr> <tr> <td>2003</td> <td>2.5</td> <td>1.0</td> </tr> <tr> <td>2004</td> <td>5.0</td> <td>3.0</td> </tr> <tr> <td>2005</td> <td>12.5</td> <td>4.5</td> </tr> </tbody> </table> </div>	Year	Amount (x1000m ³)	% renourished coastline length	2000	0.5	0.5	2001	1.0	1.0	2002	1.0	1.0	2003	2.5	1.0	2004	5.0	3.0	2005	12.5	4.5
Year	Amount (x1000m ³)	% renourished coastline length																				
2000	0.5	0.5																				
2001	1.0	1.0																				
2002	1.0	1.0																				
2003	2.5	1.0																				
2004	5.0	3.0																				
2005	12.5	4.5																				

	the total as indicated in graph 1. With appropriate selection of the units, this kind of graph might help to indicate in which area/region most effort needs to be conducted for beach nourishment, hence indicating where the 'problem' areas are located.
Adding value to the data	
(i)	Number of re/nourished sites
(ii)	Volume of sand nourishment and length of re/nourished coastline per body of surface water ⁽³⁾
Further interesting/important information is the proportion of the nourishment conducted at the forefront of the beach or the so-called underwater replenishment or nourishment. This is increasingly gaining importance. In The Netherlands, for example, erosion is monitored at the level of the 'kustfundament' or an entire sediment cell including dunes, beaches and foreshore	
Aggregation and disaggregation	

Notes

- ⁽¹⁾ The term "coastal segment" is used because it greatly depends on the coastline calculation method used and the size may vary in accordance with the techniques employed.
- ⁽²⁾ In measuring the length of the coastline, the inner perimeter of the harbours and other shelter constructions (such as marinas) is not considered. It is very important that, the sum of re/nourished coastline length plus unnourished coastline length, must equate to the total coastline length. Segments where data is not available can be labelled as "no data"
- ⁽³⁾ The Water Framework Directive 2000/60/EC defines the "Body of surface water". This implies a discrete and significant element of surface water such as a lake, a reservoir, a stream, river or canal, part of a stream, river or canal, a transitional waterway or a **stretch of coastal water**. Therefore, the necessary implementation of the Directive divides the coast into stretches of uniform coastal water masses according to the criteria of Annex II of the Directive and the COAST guidance document.