

# BUILDINGS AND INFRASTRUCTURE ON COASTAL DUNES

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## Introduction

Coastal dunes have an important water defence function to protect a low hinterland against flooding. On the other hand, coastal towns benefit from the tourist industry related to a sandy coast, which leads to urbanization of coastal dunes. This means an increase in the number and size of buildings, which is not only visible above ground surface, but leads to an increase of pipelines, cables and underground car parks, as well. Other structures on coastal dunes are related to infrastructure for industries and national security. We think of pipelines for oil and gas, power plants, wind mills, water treatment, navigation support, harbours and military objects. All these objects may weaken the water defence function that may lead to loss of human lives, and damage of infrastructure with a large environmental and social impact.

In this paper we discuss the possible effects of building and infrastructure on the strength of coastal dunes, and describe the roadmap to legislative guidelines by coastal research. We give examples from the Netherlands where guidelines will be developed for spatial planning in the coastal area [Boers et al. (2011)].

Effects of buildings and infrastructure on coastal dunes Building and infrastructure objects on coastal dunes can have a number of effects:

- **Leakage:** When an object is disrupted, moved away by waves and current, or blown out by the wind, a breach in the dune may occur, which can be a pathway for flooding.
- **Flow contraction:** The presence of an object above ground surface may lead to flow contraction besides and behind the object. These currents are a threat to people and other objects.
- **Erosion:** The flow contraction leads to scour around the object. When the object is below ground surface, there can be additional dune erosion besides the object.
- **Contact damage:** Remains of objects that are moved by currents and wind may lead to contact damage to other objects or the water defence.

The presence of building and infrastructure is not always a treat. In some situations, they can strengthen the water defence or give shelter during a storm surge.

## Typology of Storm surge, Coastal dune and Object

The possible effects of buildings and infrastructure on coastal dunes are determined by the storm surge, the coastal dune and the features of the objects. Figure 1 gives an overview of the relevant parameters. In this overview, we define the morphodynamics of dune, beach and foreshore as the bathymetry and grain size, which change in time due to natural processes and human activities. Sometimes hard structures are present for an additional protection of the coastal dune. The cumulative effect of multiple objects is addressed by the parameter “distance to other objects”.

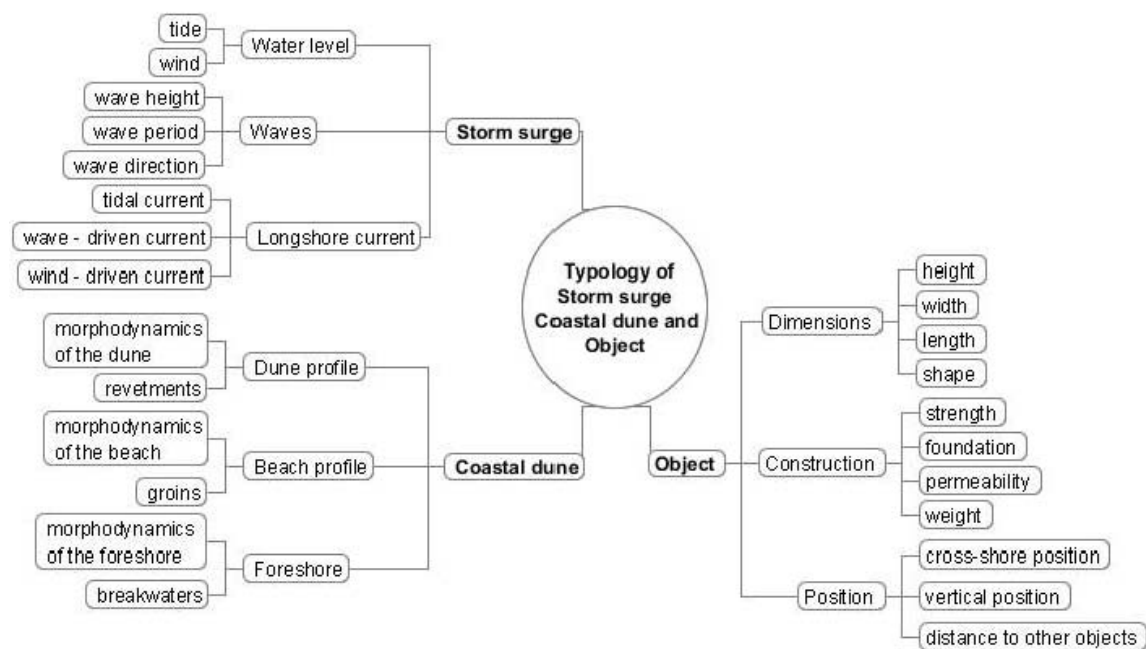


Figure 1: Typology of storm surge, coastal dune and object

### Development of legislative guidelines by coastal research

Coastal zone managers face the challenge to balance between safety against flooding, spatial planning and the costs for water defence works and prevention of coastal erosion. Legislative guidelines that include the knowledge on the behaviour of building and infrastructure objects on coastal dunes during a flood hazard are very relevant for them. Coastal research gives an essential contribution to these guidelines, and is carried out by the following ways:

- **Empirical knowledge:** Catastrophic events do not only lead to awareness of the risks of buildings and infrastructure on coastal dunes, but also give insight in the physical processes during a storm surge.
- **Laboratory experiments:** Detailed insight in the physical processes related to hydraulic load and morphological response is obtained by laboratory experiments.
- **Numerical models:** Numerical models like XBeach ([www.xbeach.org](http://www.xbeach.org)) that combine the physical laws of waves, currents and sediment transport are used to predict the possible effects of a storm surge [Van Geer et al. (2012)].

### References

- Boers M., F. Diermanse, A. Van Dongeren. 2011. Flood hazard maps in coastal areas. Proceedings of Coastgis 2011. Vol 4. pp 67 – 74.
- Van Geer P., B. De Vries, A. Van Dongeren, J. Van Thiel De Vries. 2012. Dune erosion near sea walls: model-data comparison. Accepted for ICCE 2012.