LAND MARINE ATMOSPHERE EMERGENCY MANAGEMENT CLIMATE CHANGE SECURITY

Copernicus

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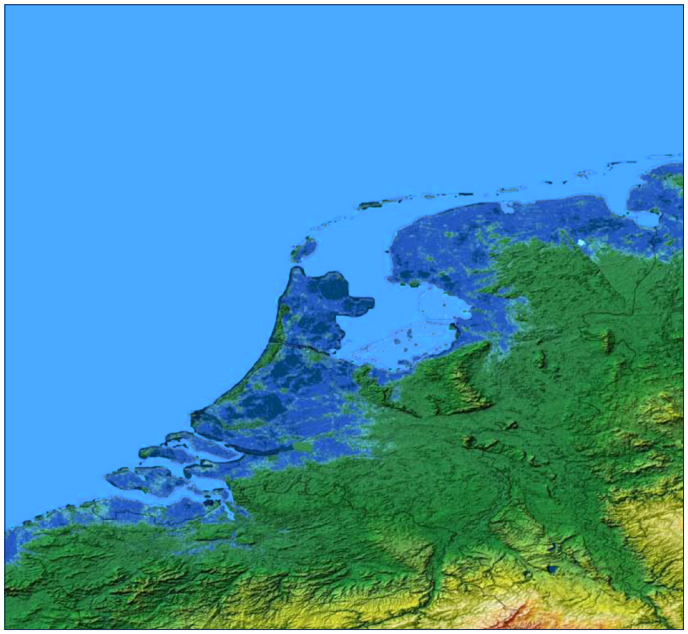
SATELLITES REVEAL HOW SEA LEVEL RISE CHANGES OUR COASTLINES

With much of the population living near the sea, coastal regions are of particular social, economic and ecological value. Thus, even a small but permanent rise in sea level could have major consequences. According to the International Panel on Climate Change, climate change may also contribute to upward trends in extremely high waters around the coasts. The effects would be particularly significant for tropical atolls. Nevertheless, also low-lying areas near the shore in Europe are at risk of inundation and storm surges, loss of wetlands, increased erosion and salt intrusion into groundwater basins. Precise monitoring of changes in the mean level of the oceans is key for understanding potential socio-economic threats and for planning coastal management activities, including adaptation measures such as coastal defence systems, improved building codes and restrictions.

Copernicus delivers continuous and reliable information about the extent and effects of sea-level rise in Europe's low-lying coastal areas.

Satellites support the global, continuous and effective monitoring of our coasts with different kinds of instruments. Optical and radar imagers provide information about the changing shape of coastlines and the effects of coastal subsidence while radar altimeters provide high-precision measurements of mean sea level and its variations. Altimetry measurements that have been routinely collected for almost 20 years now show an average global trend of a rise of about 3 mm/year which is almost double the one recorded in the last century by tide gauges. In coastal areas, within 20 km off the coast, estimates are particularly challenging because the mixed land/sea background, water vapour and tides "contaminate" the measurements.



With almost half of the country at or below sea level, the Netherlands is a European country particularly threatened by sea-level rise. After the disastrous floods of 1953, which claimed almost 2000 lives, the 'Delta Works' project was started to build a new dam system to defend the country from the sea.

The image shows, over a reference topographic model, the potential effects and modification of the coastline which could happen if there were permanent sea-level rises of 0.65 m (dark blue) and 1.3 m (light blue): the bluish area corresponds to very densely populated and industrialised regions. Depending on the potential sea level rise, these areas would sink under the water level.

Source: ESA/De Montfort University-EAPRS Lab

Facts

> About one third of the EU population lives within 50 km off the coast and these areas generate over 30% of the total GDP

> In the EU models predict possible sea level rise up to 59 cm by the end of the century (IPCC 2007)

> The annual cost of damage from coastal flooding along with other effects of sea-level rise in the EU (e.g. erosion, salinisation and land loss) is expected to be €11 billion by the 2050s

> Damage related to sea-level rise costs the Netherlands, Belgium, Denmark, UK and Portugal more (relative to GDP) than other EU countries

Benefits

Radar altimeters on satellites:

> Improve the accuracy of measurements of sea-level rise

> allow large coastal zones to be monitored

> provide input for regional climate impact studies and environmental monitoring

Policy Objectives

> Maritime Policy

> EU Water Framework Directive

> EU Floods Directive

> Marine Strategy Framework Directive

> Integrated Coastal Zone Management

Copernicus services

The Copernicus Marine Monitoring Service makes use of satellite data to provide regular and systematic reference information about the extent and effects of sea-level rise, thereby supporting coastal management activities and adaptation measures.

Example products:

> Sea-surface topography parameters at global and regional scales

Sentinel contribution

The Sentinel-3 mission will improve the understanding of sea-level rise and variability, and will help to reduce the uncertainties associated with future sea level projections by:

> carrying an altimeter, optical and infrared radiometers for ocean and global land monitoring

> providing precise measurements of sea-surface height, which are essential for ocean forecasting systems and climate monitoring

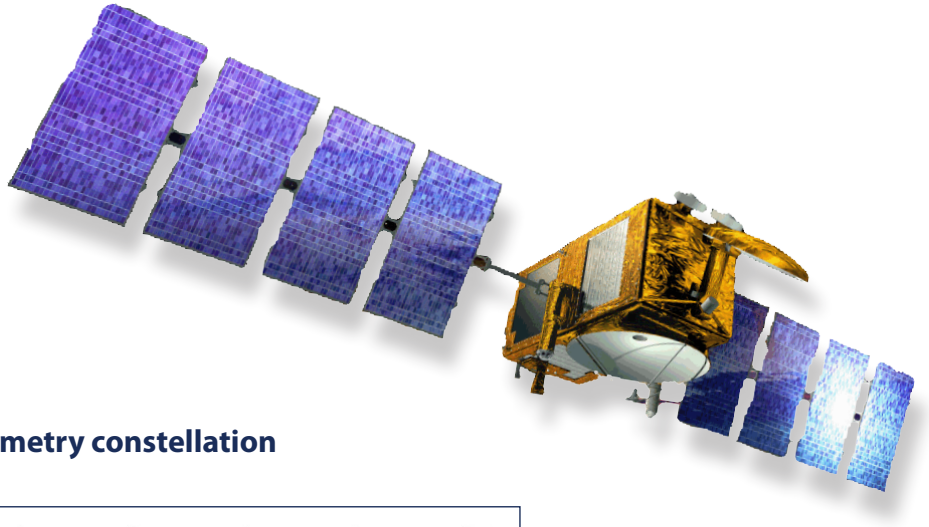
Next steps

> Refine algorithms to extract information about sea level in coastal zones

> Provide a longer perspective with continuous sea-level monitoring capacity from space

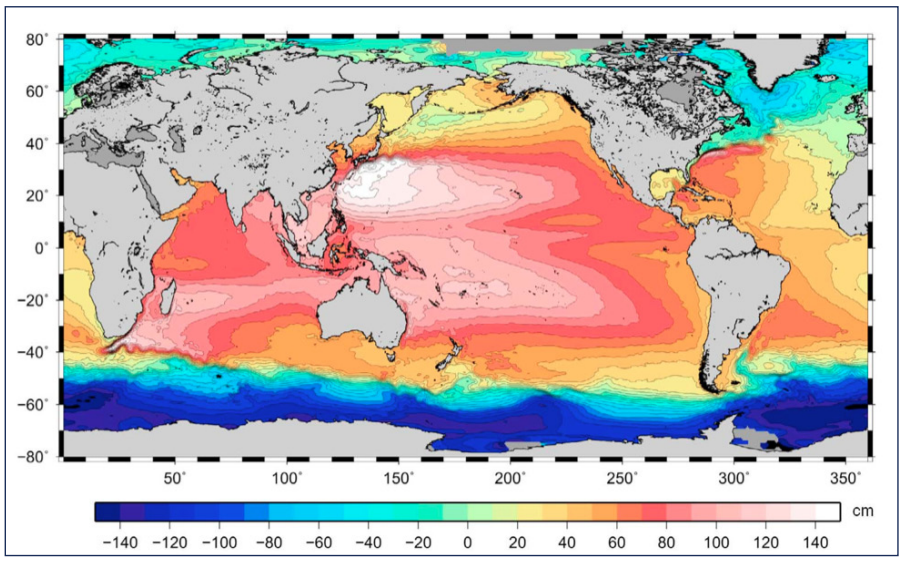
> Support the assessment of mitigation and adaptation policies on sea level rise with detailed satellite derived information

> Integrate satellite altimetry data with Global Navigation Satellite System data



Jason

The pillar of the radar altimetry constellation



At AVISO (i.e. the Archiving, Validation and Interpretation of Satellite Oceanographic data) all the available altimetry missions are being used since 1993 to obtain the most accurate estimates of sea-surface height. The data come from Jason-1 and -2, Envisat, Geosat Follow-On, ERS-1, ERS-2, Cryosat and Topex/Poseidon.

The figure shows the global oceanic mean dynamic topography as computed from the AVISO altimetry database, in combination with gravimetry-derived geoid and in-situ data.

Source: Rio, M.-H. et al. (2011), J. Geophys. Res., 116, C07018, 25 PP.

Jason, also known as the Ocean Surface Topography Mission, is a low-inclination high-precision altimetry mission series contributing to Copernicus. Jason-2 is currently in orbit and Jason-3 will be ready for launch in 2015. Jason-CS (Continuity of Service), expected ready for launch in 2019, will ensure continuity of the Jason series.

Jason measurements are complementary to those of Sentinel-3. In fact, a constellation of different satellites is required to map the ocean and monitor its movements precisely, including a low-inclination orbit mission (like the Jason series) that serves as a reference plus two, preferably three, complementary high-inclination orbit satellites to allow for meso-scale variability and ocean weather applications.

Sentinel-3 will be ready for launch in 2014, to be soon followed by a second satellite to provide the required level of coverage for Copernicus services.