Sea-level is rising

Benoît Meyssignac

For approximately 3000 years, sea-level had been stable but recent observations indicated an increase in the average speed of sea-level rise, currently at 3.5 millimetres per year. The heat distribution in the climate system causes thermal expansion of oceans, continental glaciers melts and mass loss of ice caps, all evenly contributing to the phenomenon. If these processes intensify, recent estimates suggest a mean sea-level rise of 60 cm to 1 meter by 2100. Sea-level rise significantly varies from one region to another. Moreover, this process is further accentuated when combined with other non-climate factors such as soil compaction or loss of sediment supply by rivers… The impacts of sea-level rise are uncertain in many regions and the use of evolution models to address climate forcing is an important tool to help decision-making in urban planning.

As sea-level stabilised 3000 years ago, at the end of the last glacial period deglaciation, tide gauge observations over the past 150 years indicate that sea-level has once again started to rise during the 20th century. During these last two decades the speed of sea-level rise has practically doubled in comparison to previous decades. It has reached 3.5 millimeters per year on average, which French American altimetric satellite Topex/Poseidon, Jason 1 and Jason 2, observations highlighted. These satellites have been developed by the Centre National d'Études Spatiales and NASA since 1992.

Everything suggests that the current global mean sea-level rise is linked to global warming that has been affecting the planet for several decades, as it is due to ocean thermal expansion and the melting of the continental ice sheet.

Over the second half of the 20th century, the ocean has significantly warmed. It currently stores nearly 90% of excess heat accumulated in the climate system over the course of the past 50 years. Ocean thermal expansion caused by the rise of the sea's temperature explains part of the observed sea-level rise.

A significant decline of the continental ice sheet has occurred in the last few years. Mountain glaciers are melting and peripheral glaciers of Greenland and western Antarctica are flowing directly in the ocean at an accelerated speed. This is another major cause of the current sea-level rise.

For the last two decades, each of these factors (ocean thermal expansion, mountain glacier melts, loss of mass of polar caps), contribute to one third of the observed sea-level rise.

Thanks to their complete coverage of the ocean area, altimetric satellites also show that sea-level rise is far from being the same everywhere. For instance, in the West Pacific, the sea has risen 2 to 3 times faster than the average in the last 20 years. It is now known that this significant regional variability is due to the uneven distribution of heat in the ocean. As a result, the sea-level rises faster in some regions than in others.

Sea-level rise is a serious threat for many low-lying coastal regions, often largely populated. A significant sea-level rise is expected over the course of the 21st century because ocean thermal expansion will continue, and mostly because of the melting continental ice sheet. If Greenland's polar ice caps were to disappear, the sea-level would rise by 7 meters! However if such an event happened, it would take several centuries or even several millennia. It is still unknown what polar ice caps will precisely contribute to sea-level rise in the next decades. However, some recent estimates suggest a mean sea-level rise of 60 cm to 1 meter by 2100, with significant variations from one region to another.

In many low-lying coastal regions, sea-level rise is combined with other non-climate factors. This makes them even more vulnerable. For instance, it is the case of soil compaction due to natural events (for instance, sediment overload in large river deltas) or human activity (underground water or oil pumping).

Other factors, such as loss of sediment supply to the ocean by rivers due to dam constructions, intensive urbanization of coastal areas, variations of coastal currents, etc., also contribute to modifying coastal morphology. For many regions around the world (including France and its overseas departments and territories), the respective contribution of each of these factors to coastal erosion is still uncertain. Evolution and vulnerability models of coastal zones as a response to anthropogenic and climate forcing have become essential decision-making tools to help policy makers in charge of urban planning.