

MARITIME

Research efforts concentrated on understanding and quantifying extreme marine events (storm waves and surges), ensuring the safety of port infrastructure to cope with such events, coastal protection, restoring coastal wetlands, and improving knowledge concerning the fate of sediment dredged from estuaries. Significant development was likewise achieved in marine energy and in complex numerical and physical modelling.

Severe storms continue to be a decisive natural factor in designing coastal development works. One of the main challenges in any coastal project is therefore to forecast such events, which will then determine the size of all the structures. Artelia continued working to improve the reliability of its weather and marine databases, and develop sophisticated statistical methods for extrapolating data and defining the associated confidence level. Progress was also made in understanding the complex interactions between waves and currents in extreme situations and in modelling them numerically.

Rubble-mound breakwaters are the most common form of external protection for harbour installations. Artelia is continuing to work on breakwater protection technology by carrying out fundamental research in the form of physical simulations (in its laboratory) and numerical simulations of the behaviour of a single-layer armour made of artificial blocks. Improving construction methods likewise remains on our research agenda.

New methods for calculating **forces acting on ships and floating structures** were developed, in particular by using new tools.

Research into the feasibility of **coastal defences using submerged or exposed breakwaters** continued with new morphodynamic numerical simulation methods for complex coasts. Artelia is also contributing to an international collaborative research programme concerning the design and maintenance of breakwaters providing protection against flooding and marine submersion (International Levee Handbook project), with responsibility for the maritime and river applications aspects.

The study of two new **coastal wetland restoration** pilot sites in the Loire and Seine estuaries enabled us to continue developing our ecological engineering activities. In addition, efforts were devoted to the feasibility of depolderisation techniques along the Channel coast.

The **sustainable management of sediments** removed during maintenance dredging in estuarine ports requires better knowledge of their fate. To this end Artelia is developing a unique **hydrosedimentary modelling tool** for estuaries that combines 3D fluid dynamics modelling with detailed knowledge of parameter definition for the complex processes governing the transport of sand-mud mixtures. This can be used to simulate the fate of sediment dumped

Innovation and R&D in the maritime area are driven by the challenges related to rising sea levels and climate change, to risks of coastal erosion and marine submersion aggravated by ever-increasing occupation of coastal field, to the search for renewable energy sources, and to the need to protect and restore coastal wetlands, all essential links in the chain of marine and terrestrial ecosystems. Improvements in knowledge mean we have to adapt constantly to stay at the forefront of our profession. That is why we have set up an effective organisation to assist our research efforts in conjunction with French, European and international networks.



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at sea and the impact of suction dredging on the dynamics of an estuary. Progress was also made in understanding the processes associated with the new water injection dredging technology thanks to measurements in the field.

