# Episodic waves — Freak threat of the seas

*In certain areas of the world, natural sea conditions sometimes combine to create gigantic, devastating walls of water — episodic waves. At NRC's Hydraulics Laboratory, experimental and theoretical studies of this little-known phenomenon are under way.*

A strange curse seems to hang over certain areas of the world. Off the coast of South Africa, at the Cape of Good Hope — one of the busiest shipping lanes of the world — giant tankers laden with Persian Gulf crude oil sometimes face isolated waves of gigantic proportions; on occasion, they have reached an incredible 34 m (100 feet) in height. Sometimes the huge waves bypass the ship and the astonished crew lives to tell about it; at other times, however, they do not, and in the offices of Lloyds of London, the Lutine bell is rung, signalling another tragedy at sea.

Such freak or "episodic" waves are known to occur at several locations where the continental shelf drops off to the ocean floor, including the Grand Banks of Newfoundland and Cape Horn on the southern tip of South America; they might also be partly responsible for the infamous reputation of the so-called Bermuda Triangle. Indeed, in March 1977, the TASS news agency announced a cooperative research program between the Soviet Union and the USA to study the peculiar interaction of the sea and the atmosphere in the Bermuda Triangle.

In Canada, the Hydraulics Laboratory of NRC's Division of Mechanical Engineering has become actively involved in a study of episodic waves, both from a theoretical and a practical point of view. Joe Ploeg, head of the Hydraulics Laboratory, explains: "We first became interested in episodic waves a year ago, during an investigation of breakwaters. These massive structures of concrete or stone are used to protect harbors from the destructive action of ocean waves. Our aim was to explain why some breakwaters that had been properly designed and built still failed, often in situations where wave heights were reported to be less than the maximum they were designed to handle. It was at this point that we started to examine more precisely the actual wave conditions to which they were exposed.

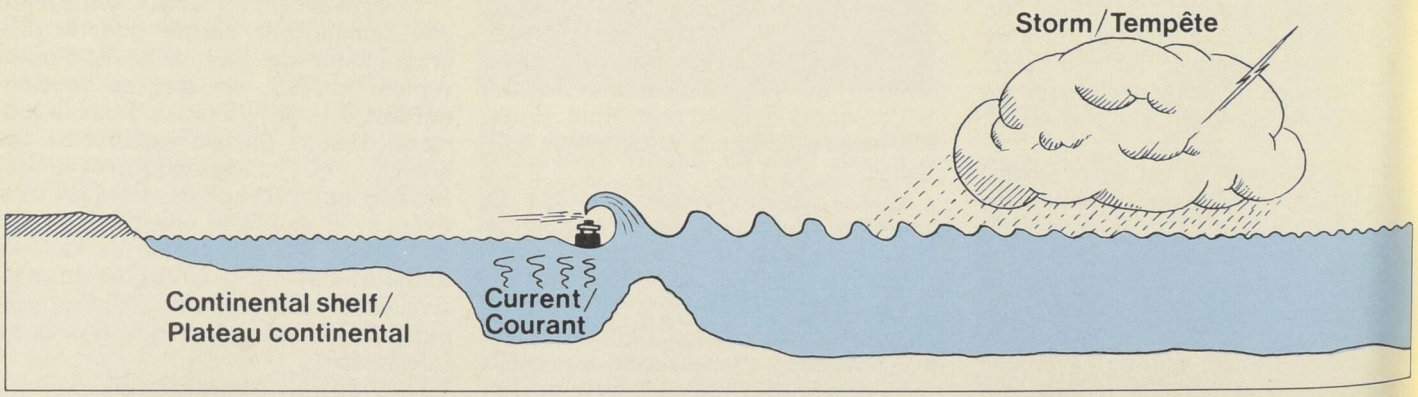
"Back in the 1950's and the early 1960's, laboratories devoted to the study of wave effects on harbors and breakwaters tested models of proposed structures by using regular sinusoidal waves to represent ocean waves. These waves were the only kind that could be produced with the wave machines available at the time. Later, however, the technical knowledge became available for the generation of what we call a random wave spectrum, that is, an irregular mixture of many different wave frequencies and amplitudes. In acoustic terms, this is similar to what one hears at a large cocktail party, where the many voices of the guests blend into an indistinct background noise. Most sea study laboratories began buying wave machines capable of generating these "random seas", the assumption being that ocean waves are normally random. On deep sea surfaces, blowing winds (the chief cause of waves) tend to generate random wave patterns. Over considerable distances, however, a certain amount of filtering takes place, with some frequencies disappearing and others being re-inforced. Further, another filtering effect takes place that has not previously been considered — that due to the shape of the sea floor."

The implications of sea bottom effects turned out to be intriguing. Old mariners used to say that at seashores, depending on the local tradition (in fact, on the local bathymetric conditions), the seventh, ninth or eleventh wave was the biggest. Indeed, the NRC researchers have discovered that there is some truth to the lore of these old mariners. They are now finding out that in deep water where bottom effects are negligible, waves are mostly random; but as soon as they approach the shore, the combined effect of countercurrents, bottom effects and the wave breaking process causes a certain amount of wave grouping to take place. Waves become sorted by frequency, and in some cases those of different frequencies can catch up with one another, adding up to form a much bigger wave (as one would expect) but one so exceeding the critical steepness for breaking as to be much more dangerous and devastating than would be expected from simple addition of component heights.

This phenomenon was displayed in a spectacular manner in a film produced by scientists from the Hydraulics Laboratory and shown at a recent sea engineering conference. "To make

**Episodic waves are a little-known threat of the seas. Under certain conditions, sea waves, currents and the sea bottom profile can interact to create gigantic, devastating waves that can sink large ships. In Canada, the Hydraulics Laboratory of NRC's Division of Mechanical Engineering, is studying this phenomenon, both from a theoretical and an experimental point of view.**

**Les «supervagues» sont un danger à la navigation de nature encore mal connue. Dans certaines conditions, les vagues, les courants marins et le relief sous-marin peuvent contribuer à la formation de vagues gigantesques capables de couler de grands navires. Au Canada, le Laboratoire d'hydraulique de la Division de génie mécanique du CNRC se penche sur ce phénomène tant au point de vue théorique qu'expérimental.**

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