ENVIRONMENT

Venice's massive flood gates could wreck ecosystem

Proposed system comes under renewed scrutiny following recent floods.

BY LOU DEL BELLO

An ambitious plan to prevent the Italian city of Venice from being swallowed by the sea could spell disaster for the lagoon that surrounds it.

The system, called MOSE (from the Italian for Experimental Electromechanical Module), is in the final stages of construction and is expected to be completed in 2022. It would consist of a complex network of 78 flap gates designed to separate the lagoon that hosts the city from the Adriatic Sea in times of high tide that would otherwise lead to flooding.

But according to modelling studies, as sea levels keep rising, MOSE will become less effective at preventing flooding in the city while increasingly compromising the lagoon's delicate ecosystem.

The environmental impacts of the €6-billion (US$6.5-billion) project have been a sore spot since its conception in 1992. MOSE has come under renewed scrutiny in recent weeks, following both exceptionally extensive flooding this October that submerged large parts of the city in 156 centimetres of water, and the release of new data and simulations highlighting the city's vulnerability to the rising sea (L. Reimann *et al. Nature Commun.* **9**, 4161; 2018).

Researchers now say that MOSE's monumental structure, whose gates lift to provide an artificial barrier to the sea and stem unusually high tides, will damage the lagoon's ecosystem and the maritime economy in just a few decades.

Luigi D'Alpaos, a hydrologist at the University of Padua in Italy, says that the problem is not the structure itself, but how often the gates would need to be closed when the sea level rises and exceptionally high tides become more frequent.

D'Alpaos simulated the potential outcomes of different sea levels by looking at all high tides between 2000 and 2012. Earlier this year, his team found that with a sea-level rise of 50 centimetres — the level predicted by the latest Intergovernmental Panel on Climate Change report (see go.nature.com/2rkasia) — the lagoon would have to be closed for up to 187 days each year, occasionally for weeks at a time (R. Mel and L. D'Alpaos *Atti dell'Istituto Veneto di Scienze, Lettere ed Arti* **176**, 1–58; 2018). This would quickly deplete the lagoon's oxygen, they say, and in turn harm the populations of fish and many bird species nesting in the area, such as flamingo, peregrine falcon, black swan and cattle egret. This pits MOSE's anti-flood measures against conservation efforts.

"To save the lagoon, we would have to open the gates — removing the only barrier against flooding," says D'Alpaos.

To avoid oxygen depletion in the lagoon, the Venezia Nuova, a consortium tasked with the implementation of the project, says that MOSE will be activated only on days when the water level rises 110 centimetres above average.

But this measure is unlikely to spare the city from regular flooding, say scientists, including D'Alpaos. Floods caused by water levels between 70 and 100 centimetres above average are common, and inundate the city's iconic St Mark's Square and other attractions for long periods.

The floods this October lasted for 30 hours. Had MOSE been active, the gates would have been raised for 20 hours of that period, says Monica Ambrosini, a spokesperson for the Venezia Nuova. Models show that future floods are expected to occur more frequently and to last for days at a time, which would require longer closures.

THINKING DEEPER

Andreina Zitelli, an environmental scientist at the University of Venice, who has criticized MOSE's green credentials, is one of several people who have been exploring alternatives.

One such proposal, originally dating back to the 1970s, involves injecting fluid cement, or even water, beneath the city to raise it above floodwater thresholds. Officials tested this technique on the small island of Poveglia in the Venetian lagoon in the 1970s. When workers injected a cement compound 10 metres underground, the tactic raised the island by 10 centimetres.

Other flood-adaptation proposals include injecting water hundreds of metres underground, through 12 wells surrounding Venice, mirroring a method widely used to stabilize oil rigs as they extract fluid.

The science behind this idea is solid and widely tested by oil companies worldwide, says Georg Umgiesser, an oceanographer with the Italian National Research Council, in Venice.

"The case of Venice would be more complex, because the city has a fragile structure and has already experienced 25 centimetres of subsidence, so any intervention should correct that problem first," says Umgiesser. He adds that too much money and time have been invested in MOSE to abandon the project now, "but once it's completed, at that point we can think about something else". ■

STEFANO MAZZOLA/AWAKENING/GETTY

Severe floods hit Venice in October; in future, they will occur more frequently and last for longer.