Ecosystem engineering: how the Suez Canal changed the sea

Humans have been dramatically altering the Earth's surface since the first farmers took to taming the land. Since then buildings have risen, mountains have been bored and great continents have been carved apart. The Suez Canal, which joined the Red Sea with the Mediterranean some 140 years ago, was an amazing feat of engineering, but it irreversibly altered the biology of the Mediterranean basin. A new study published in Frontiers in Marine Science reveals how human activity following the canal's construction is changing the shape of the Mediterranean Sea.

Beneath the sea's surface, invertebrate larvae drift along the currents. As adults many of them won't be able to move far. Some won't be able to move at all, so this is their chance to spread as they bring their genes to a new stretch of the sea. Fish, on the other hand, swim freely in the ocean, their only hindrance being where the sea meets the land and they can swim no further. Humans, for the most part, move on the ocean in vessels capable of carrying them, their cars and cargo. Land barriers also get in their way, but unlike fish, humans have the ability to break through them.

In 1869, engineers did just that. They dug, dredged and flooded a 164-kilometre-long channel between the Red and Mediterranean Seas to form the Suez Canal. This act of engineering created a 7,000 km shortcut in the trade route to India and still presents a vital trade link between Europe and the Middle East. But the channel provides a highway for more than meets the eye. Since its construction, over 400 alien species have spread from the Red Sea to the Mediterranean, and are building strongholds in the sea's eastern margins. Some of these species are fundamentally altering Mediterranean ecosystems.

This move to the Med is known as Lessepsian migration, after Ferdinand de Lesseps, who managed the canal's construction, and most of it has occurred in the last 50 years. Most species move along the Suez in one direction. The Red Sea is extremely salty and nutrient-poor, so any species hoping to spread from the Med to the Red is faced with a more challenging environment, and one that they are not well equipped to handle. Those going the other way, however, are rewarded with a sea rich in nutrients.

While some alien species can have a positive impact on an ecosystem, either by fulfilling a need in an area under stress, or by providing an additional food source, others can become invasive, displacing native species and degrading local habitats. Roughly one fifth of the known species in the Mediterranean Sea aren't found anywhere else in the world, but many of these are at risk of being outcompeted by new arrivals from the Red Sea. Indeed, in certain areas, where there is a high concentration of alien species, they have caused a shift to a completely new habitat.

The Suez Canal, which now stretches some 193 kilometres from the Red Sea to the Mediterranean, provides a highway for ships and invasive species alike. (Credit: NASA)

In the easternmost part of the Mediterranean, fish trawls close to the coast land a catch containing so many alien species that they outnumber the natives. Some of the most destructive migrants to make the journey from the Red Sea are rabbitfish. Named for their rabbit-like mouths, these voracious herbivores graze on lush brown algae to get their energy. But in some areas, their grazing is so intense that large stretches, once covered in a rich algal carpet, are now barren rocky zones. These fish are critically altering shallow habitats in the eastern Mediterranean, and their impact is likely greater than all the alien fish in the Med combined.

Using data from the European Alien Species Information Network, Stelios Katsanevakis and his international team were able to map

One of the rabbitfish responsible for severely degrading algal forests in the eastern Medditeranean. (Credit: Roberto Pillon)

how human activities have helped spread non-native species in the Mediterranean. While the canal provides a highway for marine migration, alien species don't have to make the journey alone and many hitch a ride on shipping vessels, either on their hulls or in their ballast water, bringing new species to far stretches of the Mediterranean Sea. Some 300 species have made it to the Med as stealthy passengers and have established themselves around the sea's major ports and harbours.

The Red Sea isn't the only source of alien species. Around the world, ships shift cargo and vast volumes of oil from one coast to another and with each journey they carry the risk of introducing a new species when they come into port. One such hitchhiker is the invasive Australian grape algae, which smothers local algae communities and is now widely established along the Mediterranean coast.

Humans are aiding the spread of alien species further through aquaculture, where species are brought to a new site as commodities and contaminants, though this route makes up a much smaller contribution than shipping and the Suez. And while measures are in place to reduce the risk of alien species introduction, preventing the spread of yet more invasives in the sea is an impossible task. As the climate warms, conditions in the Med will be even better for Lessepsian migrants, so the problem – considered to be one of the greatest biogeographic changes on the planet – is set to worsen.

When we look back at the fossil record, we can see where species originated, expanded and increased their range – changes that have happened over hundreds to millions of years. If we were to look back at our impact on the planet, even in the last century alone, we would see astounding shifts in species, not only in the ocean, but also on land. Together with the collapses brought about by hunting, fishing, habitat change and more, this record is worthy of the name Anthropocene.

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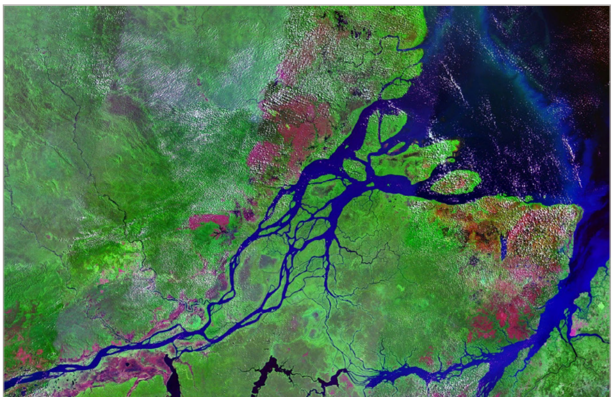
Reference

Katsanevakis, S. et al.: Invading the Mediterranean Sea: biodiversity patterns shaped by human activities, Front. Mar. Sci., 1, 32, 2014

The Amazon and the Anthropocene

The Amazon rainforest covers seven million square kilometres of the Earth's surface. It contains 2,000 different species of birds and mammals, 40,000 plant species, and around 2.5 million insect species. It is surely one of Earth's few remaining natural paradises.

Or is it? Many natural landscapes, including the Amazon rainforest, are readily romanticised in the popular imagination. But by the 1970s we had began to realise that human activity in the Amazon is not just a recent phenomenon; the Amazon isn't as pristine as we had supposed. According to Anna Roosevelt, Professor of Anthropology at the University of Illinois in Chicago, and others, the Amazon was home to as many as five million people in AD1500 and evidence of human presence extends back at least 13,000 years.



Satellite image of mouths of the Amazon River in Brazil. (Credit: NASA)

The start of the Anthropocene epoch is much debated: some scientists believe it should coincide with the start of the Industrial Revolution, whilst others suggest an Early Anthropocene, beginning thousands of years previously. However, a growing body of evidence from the Amazon would seem to imply that human impacts can be traced back a long way – evidence that would therefore support the Early Anthropocene hypothesis. So how do we know about these human activities?

Two lines of evidence are crucial: the soil and the trees themselves. So-called anthropic black soils are, in essence, buried rubbish dumps from former settlements. They tend to consist of ash, fish bones, manure, excrement and burnt plant materials, resulting in a nutrient and carbon-rich soil. Fragments of pottery have confirmed that these soils are of human origin. Some of the best studies have conducted detailed stratigraphic analysis of these soils and their surrounding horizons, anlaysing artifacts from individual layers and dating the sediments to build up a complete history of occupation.