Nuclear plants in Arabian Sea face tsunami risk

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The Kudankulam Nuclear Power Plant (KKNPP). Nuclear power plants are located along coasts because the water can be used to help cool these down. Credit: The Kudankulam Nuclear Power Plant (KKNPP) (CC BY-SA 2.0)

A major tsunami in the northern Arabian Sea could severely impact the coastlines of India and Pakistan, which are studded with sensitive installations including several nuclear plants, says the author of a new study.

"A magnitude 9 earthquake is a possibility in the Makran subduction zone and consequent high tsunami waves," says C.P. Rajendran, lead author of the study, which was published this September in Pure and Applied Geophysics.

"Our study is a step towards understanding the tsunami hazards of the northern Arabian Sea," says Rajendran. "The entire northern Arabian Sea region, with its critical facilities, including nuclear power stations, needs to take this danger into consideration in hazard perceptions."

Atomic power stations functioning along the Arabian Sea include Tarapur (1,400 megawatts) in India's Maharashtra state, Kaiga (being expanded to 2,200 megawatts) in Karnataka state and Karachi in Pakistan (also being expanded to 2,200 megawatts). A mega nuclear power plant coming up at Jaitapur, Maharashtra will generate 9,900 megawatts, while another project at Mithi Virdi in Gujarat may be shelved because of public opposition.

Nuclear power plants are located along coasts because their enormous cooling needs can be taken care of easily and cheaply by making using abundant seawater.

"Siting nuclear reactors in areas prone to natural disasters is not very wise," says M.V. Ramana, Simons Chair in Disarmament, Global and Human Security and Director, Liu Institute for Global Issues, University of British Columbia, tells SciDev.Net. "In principle, one could add safety systems to lower the risk of accidents—a very high sea wall, for instance. Such safety systems, however, add to the cost of nuclear plants and make them even more uncompetitive when compared with other ways of generating electricity."

"All nuclear plants can be subject to severe accidents due to purely internal causes, but natural disasters like earthquakes, tsunamis,

hurricanes, and storm surges make accidents more likely because they cause stresses on the reactor that could lead to some failures while simultaneously disabling one or more safety systems," says Ramana, who has worked extensively on nuclear energy.

Rajendran and his team embarked on the study after noticing that, compared to peninsular India's eastern coast, tsunami hazards on the west coast were under-recognized. This despite the 8.1 magnitude earthquake that occurred in the Makran subduction zone in 1945.

The study relies on historical reports of a major disturbance that struck the coast of western India in 1524 that was recorded by a Portuguese fleet off Dabhol and the Gulf of Cambay, and corroborated by geological evidence and radiocarbon dating of seashells transported inland which are preserved in a dune complex at Kelshi village near Dabhol.

Modeling carried out by the team produced results suggesting that the high impact in Kelshi could have been generated by a magnitude 9 earthquake sourced in the Makran subduction zone during the 1508—1681 period, says Rajendran. Subduction zones occur where one tectonic plate slides over another, releasing seismic energy.

As per radiocarbon dating of the shells, the inundation may have occurred during 1432—1681 and overlaps the historical reports of major sea disturbances in 1524 that were recorded by a Portuguese fleet of 14 ships led by Vasco da Gama, the man who discovered the sea-route between India and Europe.

A future mega-tsunami originating in the Makran subduction zone could not only devastate the coasts of Iran, Pakistan and Oman but also the west coast of India, says Rajendran, adding that alternate offshore quake sources are yet to be identified in the Arabian Sea.

The larger Indian Ocean features another tectonically active tsunamigenic source—in the Andaman-Sumatra region where the devastating 2004 Asian tsunami occurred. "The next tsunami, after our experience in 2004, will likely be on the west coast," says Rajendran.

The 2004 tsunami claimed more than 250,000 lives and devastated the beaches of Indonesia, Thailand and Sri Lanka, and claimed lives as far away as Yemen, Somalia and South Africa. Significantly, an atomic power plant at Kalpakkam, on the coast of India's south-eastern, Tamil Nadu state, was flooded.

Earlier studies, such as the one published in 2013 in *Geophysical Research Letters*, have indicated that tsunamis, similar in magnitude to the one caused by the 2004 Sumatra earthquake, could occur at the Makran subduction zone where the Arabian plate is subducting beneath the Eurasian plate by about 1.5 inches per year.

According to the 2013 study, the Makran is a wide-potential seismogenic zone that may be capable of generating a very significant (greater than 8.5 in magnitude) tsunamigenic earthquake that poses risks to the coastlines of Pakistan, Iran, Oman, and India.

Vinod Menon, a founder member of India's National Disaster Management Authority tells SciDev.Net that the new study "raises pertinent questions on the seismic and tsunamigenic risks from a potential rupture of the Makran subduction zone."

"The tsunami risk and vulnerability of the west coast has not received adequate attention in spite of a history of occurrence in the past as curated by the authors as well as previous studies," says Menon, who adds that it is worth noting that there are far more sensitive installations around the northern Arabian Sea than in the Andaman-Sumatra region.

Ramana says that such studies serve as a warning against the risks and costs of setting up nuclear power plants in seismically vulnerable areas. "A decade after the 2011 disaster in Fukushima, the prefecture retains radioactive hotspots and the cost of clean-up has been variously estimated to range between US$20 billion and US$600 billion."

More information: C. P. Rajendran et al. The Orphan Tsunami of 1524 on the Konkan Coast, Western India, and Its Implications, *Pure and Applied Geophysics* (2020). DOI: 10.1007/s00024-020-02575-0

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