How to save a sinking city

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What do Venice, Jakarta, Manilla and Bangkok have in common? They are or were sinking cities. Wageningen researcher Philip Minderhoud studies the causes of subsidence in these cities. Groundwater extraction plays an important part in all cases. The good news is that this can be avoided.

The best-known example of a sinking city is Jakarta. Large sections of the Indonesian city have dropped by three to four meters since the '80s, and continue to do so by up to ten centimeters annually. Some 40% of the city is below sea level, prompting the Indonesian government to move the capital to Kalimantan.

Sinking cities are mainly the result of groundwater extraction, says Minderhoud. Tragically, in the case of Jakarta, this cause has been ignored for many years.

"A professor of tectonics in Jakarta claimed that subterranean tectonic shifts were causing the subsidence. This may, indeed, cause subsidence, but the effect of groundwater extraction was not sufficiently considered," Minderhoud notes.

The fact that water extraction delivers clean drinking water and drives economic development, and as such, benefits many may have contributed, says Minderhoud. "Although it is technically simple to stop extracting groundwater, doing so is a socioeconomic challenge."

Succumbed to the sea

Minderhoud has studied subsidence in the Mekong Delta in Vietnam for a decade.

"There, subsidence has been accelerating in recent years by some 7 cm per year. This acceleration can be attributed to groundwater extraction, which benefits cities and agriculture," he explains.

The same pattern is seen in deltas in India. He also contributes to studies in the coastal areas surrounding Manila in the Philippines, and adds, "There, the soil drops by 10 to 12 centimeters per year. Part of the coastal region is already submerged. Several villages have already

succumbed to the sea and have been abandoned."

Minderhoud explains that the local population is often unaware of the subsidence: "They see rising water levels and experience more floods during spring tides and typhoons. They assume sea levels are rising, but that is not the main cause. The key lies in subsidence in these cases."

Strict policy

According to Minderhoud, this can be perceived as good news. Global sea water levels rising due to climate change are something that local governments can hardly influence. However, subsidence resulting from human interventions can be reduced or even stopped. There are some striking examples. The Japanese capital, Tokyo, dropped four meters in the last century due to subsidence. The subsidence was halted when the local authorities implemented a strict water policy, constructing water reservoirs around the city and all but ceasing water extraction.

Similar measures taken in Bangkok (Thailand) halted subsidence.

"Bangkok was sinking by some ten cm per year when the director of the water management institute took a bold decision," Minderhoud explains. "Despite protests, he decided to shut down many pumps and levy hefty taxes on the extraction of groundwater. Strict enforcement was also introduced. The city invested in alternative water sources. All of these measures have stabilized the situation in Bangkok. A true story of success."

Venice also managed to get a grip on subsidence. The world heritage site in the Italian lagoon was sinking due to a combination of compaction of sediments and water extraction beneath the city. The city's administration stopped extracting groundwater and now acquires its drinking water from the Italian mainland. As a result, Venice now sinks

by only one millimeter per year.

The Netherlands, an exception

The Dutch delta is also sinking. However, groundwater extraction plays no part in this fact. In the Dutch peat fields region, subsidence is caused by drainage and pumping of the polders, which causes the water levels in the peat field areas to be artificially lowered. Hence, surface water levels and the management thereof play a crucial role in subsidence in the Netherlands, making this country an exception to the rule that subsidence is chiefly the result of groundwater extraction, Minderhoud says, noting, "Therefore, investigating the causes on the spot is of the essence, as is exchanging knowledge."

This approach is taken more and more often. Vietnam is to organize the first UN conference on river deltas next year, at which Minderhoud will deliver a presentation on sinking cities and deltas.

According to the scientist, research is needed to identify and prevent subsidence in coastal areas sooner. He is currently involved in a research project in West Africa.

"There, the urban population increase in coastal cities is enormous. As a result, more groundwater is extracted, and the first signs of subsidence in metropolises such as Lagos are showing. Mapping the causes and solutions may enable us to nip it in the bud," he states.

Climate panel

Minderhoud will also make the IPCC climate panel aware of his research. To date, the climate panel only reports on rising sea levels. Still, Minderhoud feels that soil subsidence in coastal areas should be

included to achieve a comprehensive view of the issues for the benefit of governments: "We should make projections of subsidence similar to the IPCC projections of sea level increase to provide a clear view of the challenges we face. Additionally, we may draft options for action to prevent subsidence in and around urban areas in lower coastal regions."

This is far from easy, as Minderhoud's experience in Vietnam has shown. The country drafted the Mekong Delta Plan with WUR's help a decade ago. In it, nature-based solutions replaced the traditional solution of building dikes. The nature-based approach allows more flooding in the delta so that the sediment deposits can cushion the effects of the rising sea levels. But this alone will not suffice, says Minderhoud.

"There is not enough sediment available to elevate the delta, partly due to the many dams in the Mekong. The soil subsidence in the region is more extensive and faster."

The delta plan has since been detailed to indicate that economic development may not contribute to soil subsidence.

"But combating subsidence is a point of attention in the plan and not a point of departure," the researcher says. That is fighting a running battle. In his view, the Mekong Delta, like Bangkok, requires an effective implementation of new policies restricting water extraction.

"An unpleasant message in a coastal region facing salination and drying out. But the alternative invites much graver issues in the long run."

Provided by Wageningen University