Rising seas could make yesterday's rare coastal floods tomorrow's routine disasters

July 21 2026, by Sayan Tribedi

Men maneuvering a makeshift raft through floodwaters in Jakarta. Credit: pexels

Think of a tsunami that used to crash over a city once in a lifetime, but now comes crashing every year. Who is guilty? Coastal flooding results when a high tide coincides with a storm surge, waves, and an ocean

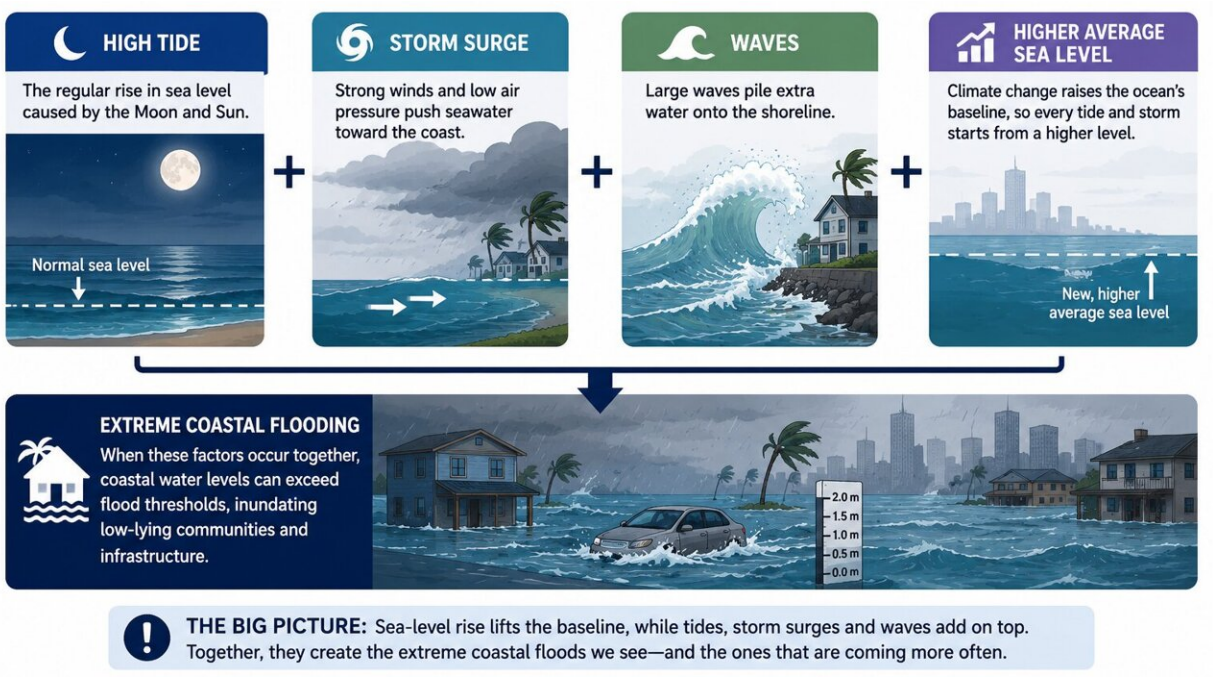
surface that is rising steadily.

Southeast Asia is the most vulnerable, where coastal zones—often located on sinking river deltas or atolls—are home to about 75% of the region's population. People and key infrastructure are already preparing to cope with storms, but climate change is gradually altering the course of events. Sea level continues to rise, and storms may be less frequent but could pack more punch or follow different tracks.

A recent study, published in *Earth's Future,* has shown that it is going to be the future reality of equatorial Southeast Asia. It is predicted that by 2100, flooding that now occurs only once in 100 years will happen annually or even more often than that.

Tides and storms: The double threat

Most climate assessments of sea-level rise (SLR) have focused on the smooth creep of average ocean height. In reality, however, extreme water levels come from several sources combined. "Coastal floods happen when high tides, storm surges, waves, and rising average sea level combine." In Southeast Asia, powerful tropical cyclones and monsoon surges ride on what researchers call the baseline sea level. When that baseline lifts, even ordinary tides can cause floods.



A simple infographic illustrates the four ingredients of extreme coastal flooding. High tide, storm surge, waves and a higher average sea level each contribute to raising coastal water levels. As climate change lifts the ocean's baseline, tides, storm surges and waves build on top of an already higher sea, making coastal flooding more frequent and severe. The graphic shows how these factors combine to inundate low-lying communities and infrastructure. Credit: Generated using AI for illustrative purposes

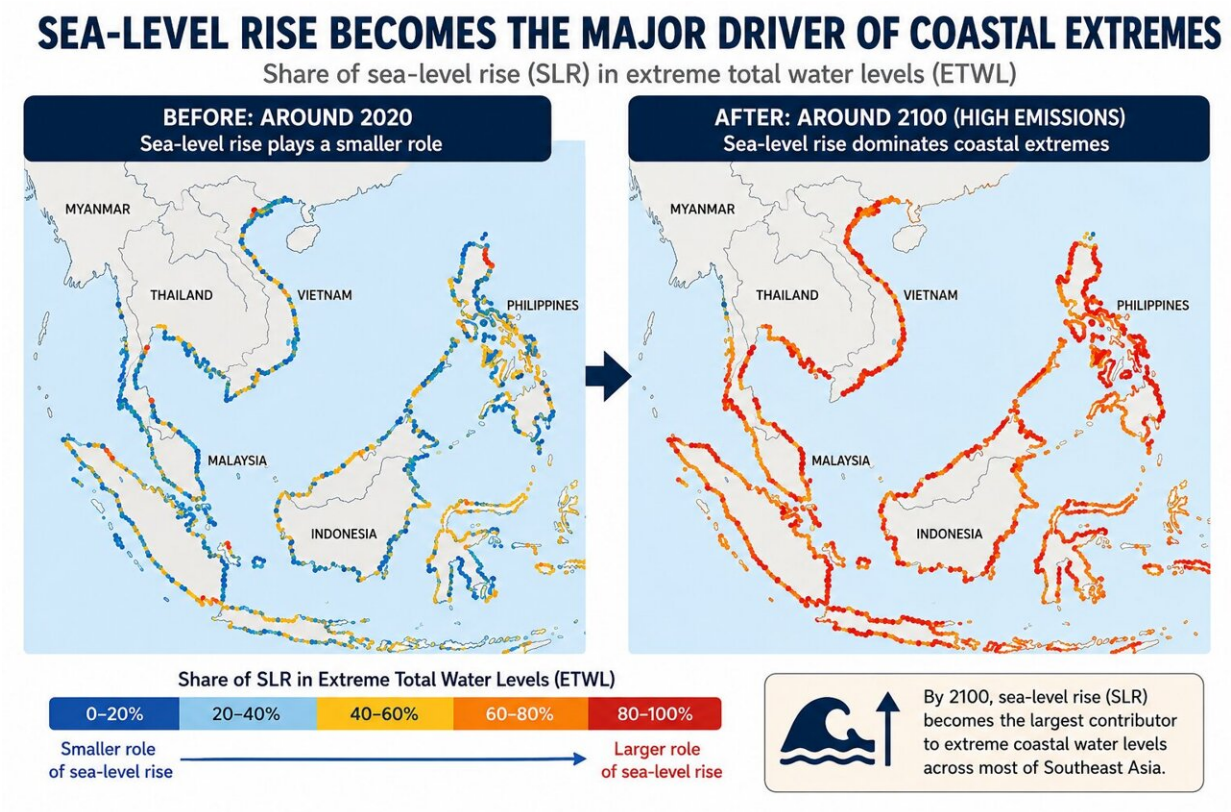
To get a clearer picture, researchers conducted an extensive study of 1,256 coastal sites around Southeast Asia. They did not consider just one factor but analyzed a combination of high-resolution climate projections of storm surges and waves alongside sea-level rise, tide, and satellite data. Thus, they were able to estimate the cumulative effect of these factors throughout the 21st century under the scenario of high emissions. Most importantly, their statistical analysis permitted the probability of extreme events to vary throughout time, instead of assuming that history would repeat itself.

Numerous past forecasts failed to account for this. According to the authors, earlier models "assume constant conditions of wind wave and storm surge components" under global warming. In fact, many climate models throughout the world can't even get tropical cyclones right.

This new analysis fills that gap for Southeast Asia, a region "exposed to intense tropical cyclones, monsoon systems, and equatorial climate variability." The study found that about half the coastline is already showing noticeable shifts in extreme storm surge or wave behavior. However, the most significant factor remains the rise in sea levels.

Rising seas steal the show

The scientists' striking conclusion is that SLR will overshadow any future increase in extreme water levels. In simple terms, the storms will have to start from a new, elevated base level.



A simplified comparison of Southeast Asia's coastline shows how the contribution of sea-level rise to extreme coastal water levels is projected to increase dramatically by 2100. While storm surges and waves still play a role, rising baseline sea levels become the dominant driver of coastal flooding across much of the region. Credit: Generated by AI using image adapted from *Earth's Future* (2026). DOI: 10.1029/2025ef007530

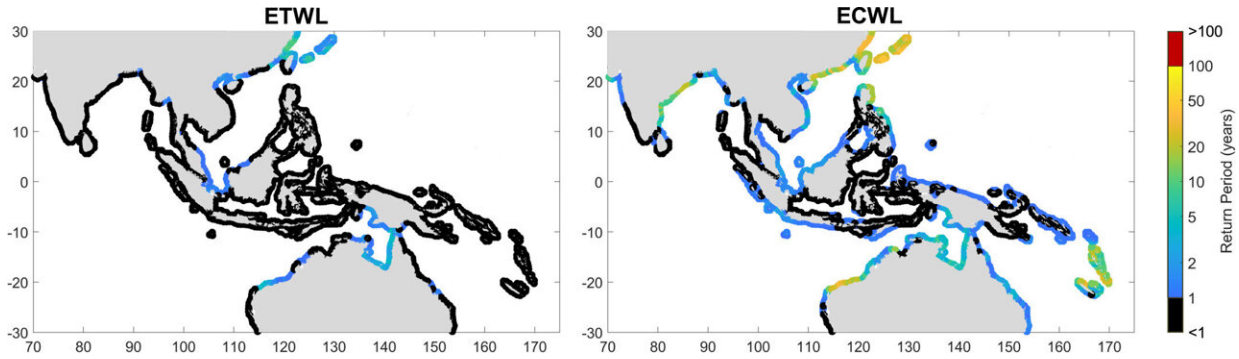
"SLR is the dominant contributor to future increases in ETWL and ECWL," the authors explain. (ETWL stands for extreme total water level and ECWL for extreme coastal water level.) Whether or not the storms get stronger, the fact remains that they start from a higher base level and thus are all the worse.

Local storms and waves also impact conditions. According to the

research, the impact of cyclones will differ greatly: Storms may divert from one location while strengthening in another. The outcome is a mixture of risks. The impact is most pronounced in equatorial belts that experience low natural variability of the ocean.

According to a projection presented in the paper, the average sea level by 2100 could be roughly 0.8–0.9 meters higher than today. The estimate is similar to the IPCC's high-emissions scenario for global oceans. In addition to that baseline, the most extreme storms will push total water levels about 0.5–1.0 m higher than today, depending on location.

The projections mean that many places will cross a flood-frequency threshold. A harrowing example: The team warns that, "By the year 2100, present-day 100-year ETWL events in equatorial regions are projected to occur annually or more often." A flood that historically had a 1% chance of happening any year could become a once-a-year event.



Future frequency of the present-day 100-year return level of ETWL (left) and extreme coastal water levels (right) under model 1. The value that falls under 1 year is represented by black color, whereas over 100 years represented by red color. Credit: *Earth's Future* (2026). DOI: 10.1029/2025ef007530

Planning for a waterlogged future

These findings have very important real-world implications and need updates to coastal defenses in the Southeast Region. They have learned that engineers can no longer rely on historical "worst storm" benchmarks because every tide and moderate storm will now occur on top of a permanently raised sea level. The traditional probability of a "once-in-a-century" flood is becoming obsolete as the flood risk increases year-on-year.

Despite their valuable contributions, the scientists have their limitations, including the use of one climate model and the exclusion of subsidence. The last limitation is particularly vital for places like Jakarta and Bangkok, where the fast-sinking ground levels intensify the threat of rising sea levels, constituting the main reason for flooding. Nonetheless, even though the effects of subsidence were not taken into account, the warming world promises a much wetter one.

Effective adaptation involves elevating levees, enhancing drainage, constructing flood protections, and altering building codes. The projections in the study provide important resources for advancing improved flood-risk maps, early-warning systems, and insurance models.

Essentially, long-lived infrastructure such as ports and power plants will require new standards for "water line." It makes the urgent point that we need to prepare for higher baselines. A flood that used to be a generation-defining disaster could become commonplace in the lifetimes of today's engineers and city-dwellers. Climate change is making the seas a co-conspirator in every storm, quietly but surely. A moment to plan for it is fast approaching.

More information: C. Sandi et al, Assessment of Future Nonstationary Changes in Extreme Sea Levels Considering Climate

Change for Southeast Asia Using High-Resolution Climate Forcing, *Earth's Future* (2026). DOI: 10.1029/2025ef007530

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