Higher temperature, heavier rain

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Heavy rains from convection clouds are the most important source of precipitation in the eastern Mediterranean region. Credit: Max Pixel, CC-0

An evaluation of weather radar measurements reveals that in the eastern Mediterranean the total amount of rain decreases with increasing temperatures. But while storms are weakening, convective rain cells – the chief cause of natural hazards in the region – are intensifying.

In our area of the world, storms characterised by heavy rainfall are mainly a summer phenomenon. These storms develop according to a set pattern: during the day, the sun heats up the earth's surface and this stimulates evaporation. The moist air then rises and cools to where the water vapour condenses, forming clouds. If the upward current is rapid, cumulonimbus clouds may reach heights of many kilometres within a few hours. These clouds often unleash a brief, violent downpour in a limited area, which may result in floods and landslides.

The amount of precipitation follows a physical principle, whereby under ideal conditions and on average worldwide, rain intensity increases by seven percent for every degree Celsius of temperature rise. This means that theoretically heavy rain should become even heavier in a warmer climate.

An exceptional series of measurements

ETH researchers from the Chair of Hydrology and Water Resources Management, led by postdoctoral fellow Nadav Peleg, examined an unusually long series of measurements to ascertain how the spatial and temporal characteristics of individual extreme rainfall cells are related to temperature.

The researchers deployed the ETH mainframe computer Euler to evaluate a massive data set from an Israeli weather radar system. This radar system was used by meteorologists over a period of 25 years to measure – continuously in time and space – high-resolution rain in the eastern Mediterranean region; it was accurate enough to capture even localised rainfall cells. The researchers took into account all rain measurements in a temperature range of 5 to 25 degrees Celsius – temperatures like those prevailing in the eastern Mediterranean in spring and autumn.

Their study, which has just been published in the Journal of Hydrometeorology, also shows the relationship between air temperature and other properties of storms, such as the spatial homogeneity of rainfall.

Peak intensities increase linearly

From their analyses, the ETH researchers were able to confirm that in the eastern Mediterranean region the peak intensity of extreme rainfall increases at higher temperatures. However, at 4.3 percent per degree Celsius, this increase is lower than the theoretical average based on the physical principle described above.

Up to now, there has been dispute as to whether the seven percent rate applies for the region, with other scientists reporting that extreme rainfall in the eastern Mediterranean would even decrease with increasing temperature. However, in their studies, the temporal and spatial resolution of the rain measurement was lower.

Peleg and his colleagues also established that the area of individual rainfall cells often became smaller

at higher temperatures, and that rainfall was distributed differently across the storm: convective processes shift the moisture available in the atmosphere from areas with low rainfall intensity to areas with high rainfall intensity. "In a warming climate, the risk of local flooding in the region has the potential to increase," Peleg explains.

Trends, not predictions

But Peleg doesn't want to draw conclusions about the future warmer climate from present climate observation alone. "The data refer to the current climate and illustrate the trends of the past 25 years," he emphasizes. How the climate will change and the rainfall regime with it is not so clear." To accurately predict future changes in the occurrence of extreme storms, you need high-resolution climate models."

Nonetheless, he considers the findings important for policy and decision-makers. In general, extreme precipitation in the eastern Mediterranean region is likely to intensify. "The research results help to better assess the impact of the future climate on water availability or natural hazards – particularly local storms and floods," says the weather researcher.

In a follow-up project, Peleg and his ETH colleagues plan to investigate how extreme rain is changing in space and time in Switzerland. "Since the topography of the country is very complex, this may prove a tough nut to crack."

More information: Nadav Peleg et al. Intensification of Convective Rain Cells at Warmer Temperatures Observed from High-Resolution Weather Radar Data, *Journal of Hydrometeorology* (2018). DOI: 10.1175/JHM-D-17-0158.1

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