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When Faith Meets Heat: Climate Change Risks During the Hajj Pilgrimage

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Faiths play a central role in the lives of billions of people across the globe. Many religious rites and celebrations are performed at fixed times and locations. With the ongoing rise in global temperatures, climate change is now directly affecting how these faith-based activities are carried out. In particular, extreme heat and humidity are making large religious gatherings increasingly difficult and risky.

Muslim Pilgrimage (Hajj) to Makkah is one of the five pillars of Islam and is mandatory for every Muslim who is physically and financially able to perform it at least once in their lifetime. The pilgrimage is one of the largest religious gatherings in the world, bringing millions of pilgrims from across the globe to Makkah each year, making it one of the largest recurring human gatherings globally. Makkah is a hot region and already faces significant heat-related challenges. Previous studies suggest that in a 2.0 °C warmer world, the risk of heat stroke could increase by up to ten times, whereas limiting warming to 1.5 °C could reduce this increase to approximately five times.

Pilgrimage is an intensive five-day event involving physically demanding activities, including circling the Kaaba (Tawaf) multiple times, walking between the hills of Safa and Marwa, standing in prayer at Mount Arafat, spending nights in Mina and Muzdalifah, and stoning the pillars. During the 2024 Hajj, approximately 1,300 fatalities were reported amid extreme humid heat conditions. The Government of the Kingdom of Saudi Arabia plans to increase the number of pilgrims in the future, raising serious concerns about increased exposure to extreme heat and humidity.

In this study, we analyzed the 2024 pilgrimage in terms of human physiological limits using temperature and humidity sub daily station-based data. Our results show that survivability limits were exceeded during several hours on each day of the pilgrimage even for the younger adult group (18-40). Although the Pilgrimage will occur during relatively cooler seasons over the next 20–30 years, it is expected to shift back to hotter periods by around 2050. We therefore further utilized sub-daily CORDEX climate model outputs to investigate survivability-limit exceedances during future June pilgrimages. The results indicate that survivability limits will be breached more frequently and rapidly in the future, highlighting an urgent need for adaptation measures and, critically, mitigation efforts to reduce climate-change-related risks to pilgrims.

While adaptation strategies by the Government of Saudi Arabia may reduce some risks, the

essence and traditional practice of the pilgrimage could still be compromised under extreme heat conditions. Therefore, mitigation remains essential to limit global warming and safeguard the future of the Pilgrimage.