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Changes in large daily rainfall magnitude-frequency in Borneo and Peninsular Malaysia over the last hundred years

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Increases in rainstorm magnitude-frequency (stemming from a warmer atmosphere and warmer seas) are widely predicted to accompany global warming, but objective detection and assessment of changes are hampered by (1) a lack of long, reliable climatic data series, particularly in the tropics, and (2) the truism that the more extreme an event, the smaller the sample size of events from which to draw inferences. Previous studies in the tropics have generally used data series extending back only to the (climatically atypical) 1960s. This paper analyses daily rainfall series for stations in Sabah, Sarawak and Peninsular Malaysia extending back to the early twentieth century. Readily available records from 1960 onwards were extended backwards to 1910-1920 by assembling records of the colonial period from a range of archival sources in Malaysia and London. First, changes in the frequency and seasonal distribution of daily falls exceeding 50 mm and 100 mm thresholds over the period 1915-2007 are explored. Then extreme value analysis is applied to overlapping twenty-year periods (e.g. 1915-34, 1916-35Ěto 1987-2006 and 1988-2007) to derive annual series of daily rainfalls of 1, 5 and 10-year return periods. Evidence is presented demonstrating that large daily falls have increased in frequency in recent years at some but by no means all stations in the region; at some stations large rainstorm frequency was higher in the period prior to the Second World War. More marked is a recent increase in the year-to-year variability in large rainstorm frequency - a feature that can be linked to a more pronounced ENSO cycle with stronger La Niña phases. Thus the frequencies of

years with anomalously high and anomalously low frequencies of large daily rainfalls have increased. Inter-station differences may be in part linked to changes in wind direction and strength of the monsoonal circulation in relation to local relief and coastal alignment. As is the case also with some other extreme climatic events in the tropics (for example droughts and tropical cyclones), caution needs to be used before firm conclusions can be drawn that recent increases in rainstorm magnitude-frequency are unprecedented compared with peak periods in the historical record of the last 100-300 years. Implications for erosion and flooding in the region of the changes are also considered.