

# Probability of Volcanic Ash Falls in Singapore Based on the Analysis of a Database of Volcanic Activities in South East Asia and Reviews of Literature Records

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Singapore is a large economic center and a major transportation hub in South East Asia. It is the most densely populated country in the region. Because Singapore is a highly built up city, it is difficult to find natural outcrops to study the potential impact of volcanic eruptions. In order to reconstruct the frequency of volcanic ash fall and its consequences, we have reviewed a large amount of literature, ranging from scientific publications and websites to archives of the Lee Kong Chian National Library. The most likely sources of volcanic ash reaching Singapore are Indonesian and Filipino volcanoes. An analysis of volcanic activity during the Quaternary in South East Asia shows that out of 114 Quaternary volcanoes in Indonesia, 67 volcanoes erupted during historical times (31%) and 36 of them erupted with a  $VEI > 3$  (17%). Out of 45 Quaternary volcanoes in the Philippines, 23 were active during historical times (27%), and 17 of those had a  $VEI > 3$  (20%). If we consider that all eruptions with a  $VEI > 4$  have sent ash to Singapore, we would expect 38 tephra layers in Singapore and a probability of 0,02 ash falls/year. Since 1879 two ash falls were recorded in Singapore (Krakatoa in 1883 and Pinatubo in 1991). This corresponds to a probability of 0,014 ash falls/year, during 138 years of observations. According to isopach maps of the largest caldera-forming eruptions in Indonesia, volcanic ash reached Singapore at least four times (Rinjani in 1257, Tambora in 1815 prior to Krakatoa and Pinatubo). The probability is thus of 0,005 ash falls/year for 760 years of observations. Despite the fact that Singapore is located far from active volcanic centers, the city was covered in volcanic ash several times according to historical records. Consequently, studies of the effects of strong volcanic explosions on densely populated areas, such as Singapore should be further developed.