Relationship between fan area and catchment area for small fans in Japan

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Numerous alluvial fans are distributed in the tectonically active and intensely denuded Japanese Islands. Large fans are formed mainly by fluvial processes. Their spatial distribution and geomorphic development have been comprehensively investigated by several studies (e.g. Saito, 1982; Saito, 1988; Saito and Oguchi, 2005). On the other hand, there have been comparatively fewer studies on small fans, especially on their significance towards long-term geomorphic development. This study deals with small fans in Japan that are substantially developed by debris flows. The target fans are those in the whole of Japan (503 fans in 15 regions); about 7 km^2 at the maximum, many of them are less than 2 km^2 in A_f. The relationship between the fan area (A_f) and its corresponding catchment area (A_d) is expressed by a regression formula as $A_d=cA_f^n$. Both coefficient values c and n are discussed here. The results are briefly summarized as follows.

1) Depositional processes
There is no distinct difference in values of the intercept coefficient (c), regardless of the depositional processes that developed the fans (fluvial: 0.26 and debris flow: 0.30). However, with regard to the slope coefficient (n), debris flow fans have much larger values (fluvial: 0.66 and debris flow: 0.87). A similar case is seen in the Kofu basin in the previous studies but with much fewer samples (Nakayama and Takagi, 1987). The debris flow is more likely to carry sediment effectively to downstream areas from the fan apex, possibly resulting in the higher “rate” of increase in A_f.
2) Active faults at the foot of the mountains
There is still no clear difference in the values of n (presence: 0.84 and absence: 0.80). However, the values of c differ significantly. Where active faults are present, the value of c is 3–4 times larger (presence: 0.30 and absence: 0.09) than its value when active faults are absent. This suggests that A_f increases by the acceleration of sediment supply from the catchments due to the temporal devastation that is caused by episodic seismic motion.
3) Periglacial environment during the last glacial period
The development of small fans is unlikely to be influenced by the existence of periglacial environment in the catchments.
4) Catchment geology
Values of both c and n are larger for fans with plutonic rocks in their catchments and smaller for fans with metamorphic rocks in their catchments. These results are similar to those obtained in the southwestern part of the United States (Hooke, 1968; Lecce, 1991).

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