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Effects of Source Area Properties on Alluvial Fan Morphology

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Studies of alluvial fans and their source basins are important to discuss not only flood and sediment hazards but also earth-scientific issues including sediment transport from mountains to plains. In geomorphological research, relationships between a morphometric property of alluvial fans and that of source basins have often been analyzed. However, there have been limited studies on the comparison of the relationships for various regions in the world, and geomorphological analyses including the characteristics of major streams in source areas along with alluvial fans and sources basins as a whole. Therefore, this study analyzes the effects of basin characteristics on fan morphology in areas with different types of natural environment. Additionally, this study deals with three geomorphological components: basins as sediment production area, trunk streams as sediment transport area, and fans as sediment depositional area. The study areas are Japan, the American Southwest, the Southern Philippines, Southwest of Turkey and East Coast of the Gulf of Alaska. Geographical Information Systems (GIS) are used to analyze digital elevation models (DEMs) and digital geological maps. Then fan area (A_f), mean fan slope (S_f), basin area (A_b), mean basin slope (S_b), mainstream length (L_s), mean mainstream slope (S_s), dominant lithology and bedrock age are obtained, and their characteristics and mutual relationships are analyzed.

The results indicate that fan area and fan slope depend on basin area, and fan slope depends on basin mean slope. This may reflect the difference in sediment production including sediment grain size and the ratio of transported sediment to water. Furthermore, regions with higher precipitation tend to have larger fan area and gentler fan slope for the same basin size. This indicates that higher precipitation leads to frequent flooding on a fan and subsequent sediment transport toward the distal area of the fan. In Japan, the same tendency is found in basins larger than 200 km^2. It is also revealed that fan slope tends to be smaller than trunk-stream slope if basin area is larger than a certain threshold value. The threshold tends to be greater in regions with smaller precipitation, reflecting sediment transport on a fan and resultant decrease in fan slope. By contrast, dominant geology of source basins hardly affects fan morphology. In summary, morphometric properties and climate conditions exert strong influences on fan morphology because they affect sediment supply, transport, re-transport and water runoff.

Keywords: Alluvial fan, Drainage basin, Morphometric property, GIS