Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

HTT032-P02 Room: Convention Hall Time: May 24 17:15-18:45

Analysis of Relationships between Morphometric Properties for Alluvial Fans and Source Areas in Japan

Sho Ochiai[1*], Takashi Oguchi[2], Yuichi S. Hayakawa[2]

[1]EPS, Tokyo Univ., [2]CSIS

Studies of alluvial fans and source basins are important and helpful to discuss land-forming processes and sediment disasters in piedmont areas. Especially, relationships between alluvial fan slope (S_F), alluvial fan area (A_F), drainage basin slope, (S_B) and drainage basin area (A_B) have often been studied. The results indicate power laws between these morphometric properties: $S_F = aA_B^b$, $A_F = cA_B^d$ and $S_B = eA_B^f$ where a, c, d and e are positive constants while b and f are negative ones. However, some studies mentioned that sediment supply, transport and sedimentation processes are different between fans with large source areas and those with small source areas. If this is the case, the above expressions might not be valid for all fans. Additionally, many of preceding studies used proxies of S_B instead of real S_B values, which is spatially-averaged slope within a basin. Therefore, this study analyzes relationships between S_F, S_B, A_F and A_B with grouping A_B, with attention to differences in A_B, using real S_B values. In total 490 alluvial fans were analyzed. The fans and source basins were also classified into seven regional groups to examine the influence of local factors. Geographical Information Systems (GIS) and a 50-m Digital Elevation Model (DEM) were used to delineate fans and drainage basins, and calculate S_F, S_B, A_F and A_B. Furthermore, gravel diameter data at fan apexes were collected because the diameter is also one of the factors determining S_F.

By analyzing relationships between S_F, S_B, $A_F$and A_B, some differences depending on $A_B$were revealed. First, for Japanese fans with large A_B, $S_F$tends to be small and nearly constant, with the lowest values being ca. 0.4 degrees. Second, fans with large $A_B$have higher incremental rates of $A_F$with increasing $A_B$while $A_B$and $A_F$have a significant positive correlation. Third, the pattern of A_B-$S_B$correlations also changes with increasing A_B. These observations become clear when fans are categorized into regional groups. Moreover, $S_B$for large $A_B$is also nearly constant at 20-25 degrees for each region. Although regression analyses for each regional group do not show significant correlations in most cases, some regional groups show statistically significant differences depending on A_B. Furthermore, the mean gravel diameter is smaller for fans with large $A_B$than those with small A_B.

These results indicate that it is inappropriate to explain the relationships between morphometric properties using uniform power laws. They also point to different fan-forming processes for groups with different A_B. The different processes may be related to sediment supply. As noted $A_B$ove, $S_B$tends to be similar if $A_B$is large, reflecting an average regional topographic condition. Similar $S_B$values lead to similar sediment supply per unit area and analogous gravel diameters. These similarities may result in $S_F$in a very narrow range. Transportation and sedimentation processes on alluvial fans may be also different according to A_B. Previous research suggests that sediment transport to a fan needs not single but several floods if $A_B$is large. In contrast, fans below basins with small $A_B$are subject to more direct sediment supply such as the deposition of a debris flow. This difference can explain smaller $S_F$for fans with large A_B. In addition, more active redistribution of fan sediments toward downstream areas on large fans can also explain decreased $S_F$for large systems having high values of $A_F$and A_B. The $A_B$ove influence is also supported by smaller gravel diameters for fans with large $A_B$and data for each regional group.

Keywords: Alluvial fan, Drainage basin, Fan slope, Basin area, Morphometric property, GIS