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The fractal dimension of landslide group and its application to the mitigation of landslide disasters with mapping of legal restriction areas

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Landslides are important natural hazard in the mountainous areas. For landslide mitigation and land use restriction, it is important to detect moving directions and travel distances as well as to find out the susceptible slopes with appropriate indexes. Fractal dimension "D" is expected as an index of complexity level of the landslide moving direction or overlapping ratio that are needed in the screening method for detail site investigation of landslide in order to designate the restriction area of land use or countermeasures. This "D" is a mathematical theory that describes the quality of complex shapes. Countermeasures planning for areas that has complicated and concentrated landslides with high fractal dimension should be able to cover holistic area. Areas that have single landslides scattered over wide region with low fractal dimension should only have a simple plan for each local landslides. On the other hand, moving (traveling) or deforming directions of individual landslides are often difficult to decide, although they have conspicuous importance to the mitigation measures or the restriction designation of landslide hazard areas.

Fractal dimension of landslide group is calculated for eight different orientations of the rotated grid with the box counting method. Relief energy, average slope, landslide area density, and moving directions have been calculated for each landslide group and their relation with fractal dimension D has been studied in western Japan.

The landslide perimeters lie on a plane, so theoretically the D value for landslide group should lie between 1.0 and 2.0. Consequently, the fractal dimension "D" from the different grid orientations for each landslide ranges 1.05˜1.35. The other important

results are referred below. 1) Optimum values of D that are obtained from minimum grid number covering landslide perimeters should be used theoretically for the accurate judgment. 2) In the area of Tertiary, they have a rather clear trend that as the relief energy increases the fractal dimension value also increases. In the Mesozoic, the trend is not clear. 3) There is a clear trend in both of the geology that as the area density and overlapping ratio increase the value of fractal dimension also increases. So fractal dimension can express the area density and the overlapping ratio of the landslide simultaneously. The higher the overlapping ratio increases, the more complex the traveling distance is and the more detail investigation for mitigation is needed. 4) The moving direction doesn't have clear relation with D. However, it tends to decrease as D increases in the high D region. It suggests that moving directions are similar in landslide groups that have high D characteristics. Adding to that, in some districts landslides tends to move simply towards the bottom of valley with the direction angle of 76-94 degree against the valley (coefficient of variation of the moving direction, in this case, is almost less than 0.30).