

# E-17 DEVELOPMENT OF A SCALE INVARIANT MUSKINGUM-CUNGE ROUTING METHOD

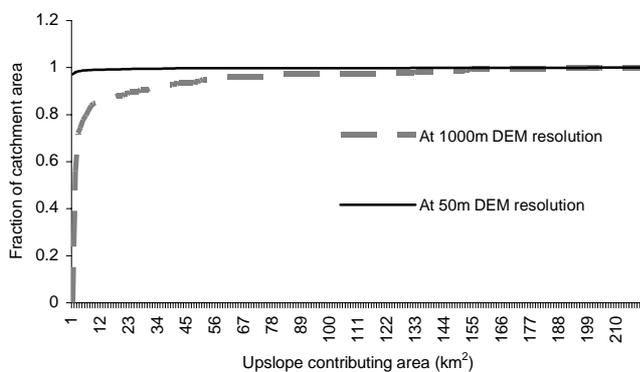
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## ABSTRACT

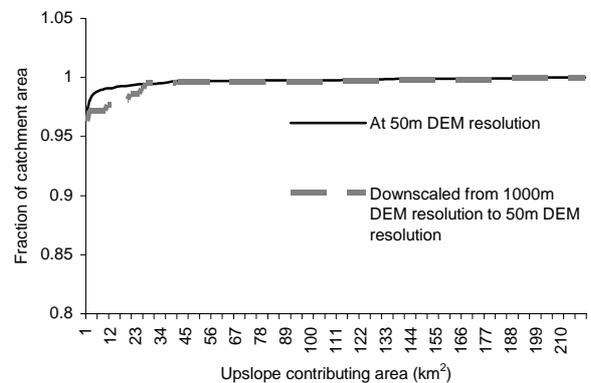
In surface flow hydrology, wave characteristics constitute the hydraulics of flow routing or propagation and are greatly affected by the geometric characteristics of channels. The flow variables whose propagation characteristics are of interest are discharge, velocity, depth, cross-section, volume and duration. In catchment hill slope channel routing these flow variables is a function of upslope contributing area. Figure 1(a) shows how the smaller contributing area (less than a km<sup>2</sup>) that appears in more than 95% of the all contributing area at 50m DEM resolution is lost when 1000m DEM resolution is used. Thus higher frequency upslope contributing area information contained in finer DEM resolution is lost as the larger sampling dimensions of the grids in a coarse resolution act as filter. This scale effect leads identified catchment channel routing effective parameters values to be dependent on DEM resolution. This makes difficult to use model parameter values identified with different resolution model. Moreover, a model may be physically based in theory but not consistent with observations. This results primarily from the mismatch in scales between the scale at which the parameters are identified and the scale of application.

To overcome this problem, scale laws that govern the relation in digital elevation data resolution on geomorphometric parameters in Muskingum-Cunge

routing method have been analyzed. We have developed a fractal method for scaled steepest slope as an approach to account for the effect of scale on slopes. In this research a mathematical formulation has been derived that successfully downscaled the upslope contributing area from coarse resolution DEM to target fine resolution DEM as shown in Figure 1(b). The method to downscale the upslope contributing area is used to obtain the similar distribution of velocity, depth, cross-section from different DEM resolutions in Kamishiiba catchment (210 km<sup>2</sup>) and to develop a Scale Invariant model in the surface flow hydrology (Muskingum-Cunge routing method). It is shown that the simulated runoff from the Scale Invariant Muskingum-Cunge routing method applied at 1000m grid resolution DEM, with the same effective parameter value (Manning's roughness coefficient) derived from 50m grid resolution DEM, has matched with the simulated runoff at the 50m DEM resolution without recalibration. It is hoped that the findings of this research seeks its applicability as a tool to a wider range of boundary as per the scale problems in hydrology and solution approach is concerned.



(a)



(b)

**Figure 1.** Comparison of the distribution of upslope contributing area in Kamishiiba catchment (210 km<sup>2</sup>), (a) without downscaling method and (b) with downscaling method.