

XXIII SIMPÓSIO BRASILEIRO DE RECURSOS HÍDRICOS

HAZARD CONNECTIVITY INDEX

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1. INTRODUCTION

The connectivity concept has been widely discussed and applied to environmental studies such as ecology, hydrology and geomorphology in the world (Wohl *et al.*, 2019). As this concept can be very useful also in debris-flow disaster management, the objective of the present study was to propose the Hazard Connectivity Index related to debris flows in the hazard mapping context.

2. PROPOSAL OF HAZARD CONNECTIVITY INDEX

To analyze mass movement in hillslope-channel system, Zanandrea *et al.* (2017) proposed the hydrosedimentological connectivity index (*ICHS*):

$$ICHS = ICL + ICV = \frac{l^*}{l} + \frac{V^*}{V} \quad (1)$$

where *ICL* is the rate of the sediments traveling path (l^*) in relation to the total path from the generation point to the channel (l); and *ICV* is the rate of the volume that reaches the channel (V^*) in relation to the total volume (V). In case the debris-flow disasters, the *ICV* value is not very important, because a small value of V^* is just sufficient to generate the huge damage. Hence, only distance-related parameters could be considered for debris-flow disasters management. Therefore, a kind of safety parameter (*SP*) is firstly introduced as follows:

$$SP = \frac{x}{x+L} \quad (2)$$

where x is the shortest distance between the debris flow trajectory and the interesting point such as house location; and L is the runout distance of the debris flow. For convenience, these distances are measured horizontally. The range of *SP* values is from 0 to 1, where $SP=1$ means that the house (person) is totally safe, meanwhile, $SP=0$ indicates the house destruction and/or human loss. In other words, smaller *SP*, larger hazard and stronger connectivity, and vice versa. Then, the Hazard Connectivity Index (*HCI*) which varies from 0 to 1 and is dimensionless is defined:

$$HCI = 1 - SP = 1 - \frac{x}{x+L} = \frac{L}{x+L} \quad (3)$$

Figure 1 demonstrates how to measure the values of L and x . With some examples, Figure 2 explains how to calculate the *HCI* value as the hazard degree or connectivity degree of the house locality in relation to debris flow. The situation $HCI = 1$ indicates the disaster occurrence. In the disaster management, the places with larger values of *HCI* are at dangerous situation.

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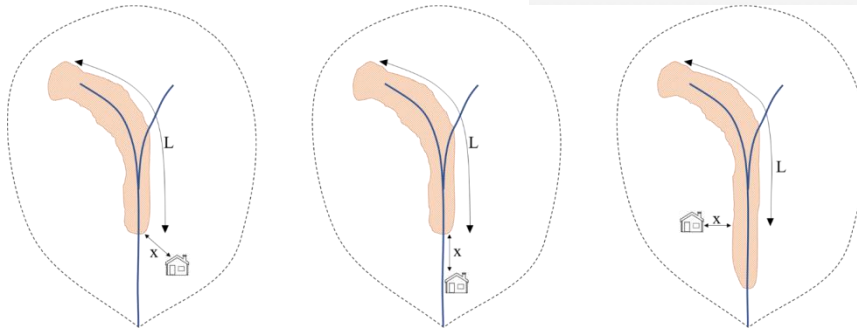


Figure 1 – Determination of the shortest distance between the debris flow trajectory and the interesting point such as house location (x); and the runout distance of the debris flow or just mass movement (L). Note that the final point of L is located at the shortest distance to the house.

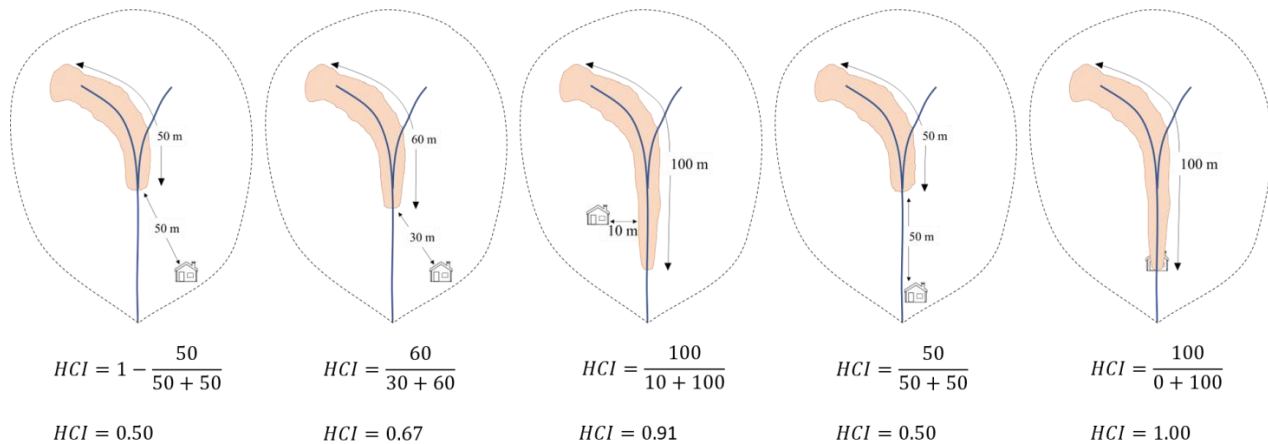


Figure 2 – Some examples to calculate HCI values.

The proposed HCI was applied to three different debris-flow disasters: Kumamoto (Japan), Hiroshima (Japan) and Mocoá (Colombia). Three elaborated maps of HCI zoning show vast utility of this index.

3 – FINAL REMARKS

Many scientists interested in sediment dynamics in catchment levels have been discussing the sediment connectivity to understand the geomorphic features of such dynamics. Since sediment connectivity (or hydrosedimentological connectivity) also treats of debris flow occurrence, this connectivity can be used for debris-flow disaster management. Then, the Hazard Connectivity Index (HCI) associated to debris flow was introduced as the connectivity degree between the debris flow occurrence (trajectory) and the interesting point (locality of house, person and so on). The HCI calculation is very simple and easy, especially when the digital elevation models and geographic information system are available for mapping. Three case-studies showed that several types of maps with the HCI application can be constructed. In future, it will be necessary to use this index for various objectives in order to find other utilities.

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