10.1002/2014JF003137

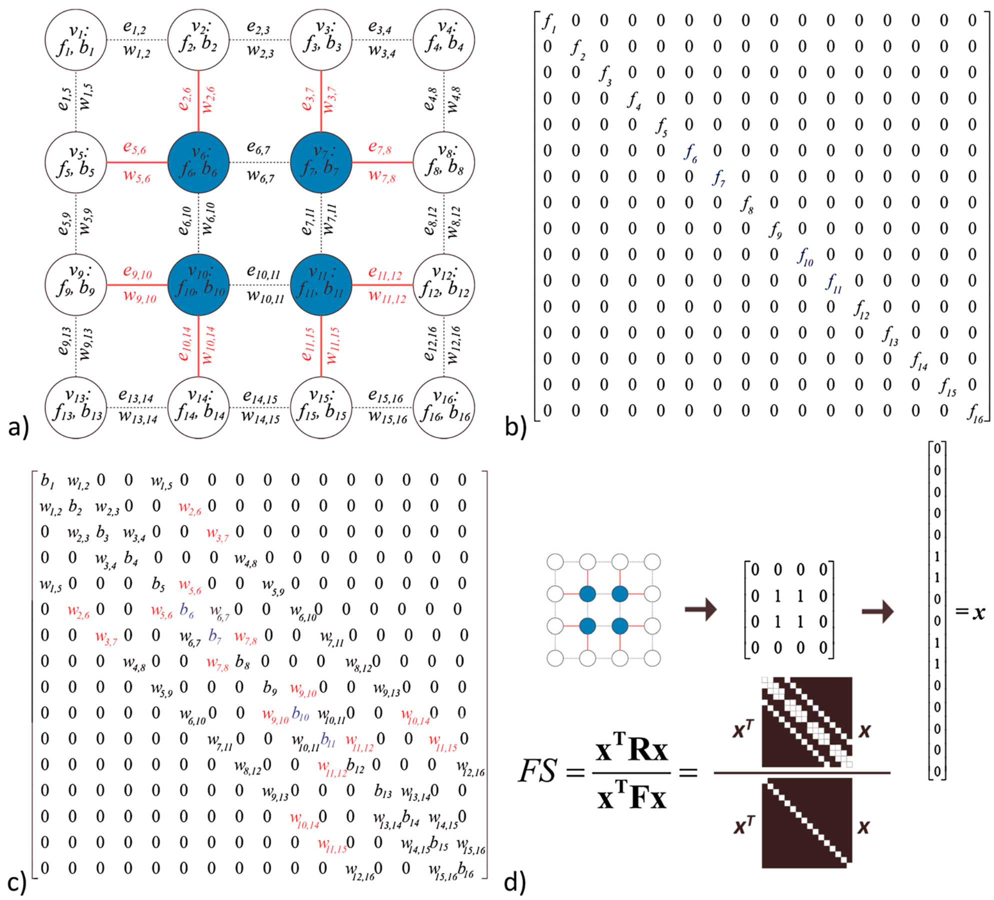

Figure 3. (a) Graph $G = (V,E)$ of a discretized landscape, consisting of 16 grid cells. The vertices, labeled v_1–v_{16}, are associated with the mobilizing forces f_i, as well as the frictional and cohesion forces b_i, contributed by each grid cell. The edges represent the resistive forces between grid cells: the edge labeled $e_{i,j}$, encodes the symmetrized weights $w_{i,j}$ between vertices v_i and v_j. For the partition S (the blue vertices) to fail as a landslide, their mobilizing forces must exceed the resistive forces of the red edges combined with their frictional forces. (b) The driving force matrix **F** for the graph G; the f_i, values are computed using equation (7). (c) The resistive force matrix **R** for the graph G; the r_i, values are computed using equations (8) and (9). Red, blue, and black colors of entries in Figures 3b and 3c correspond to the colors in Figure 3a. (d) The indicator vector **x** for partition S of G and its FS in matrix form.

shown in Figure 3a. For this group of cells to fail it must overcome the resistances that develop at its boundary, which is equivalent to cutting the red edges shown in Figure 3a.

Choosing which vertices to include in a cluster, and therefore which edges to cut, depends on the objective, in our case to minimize the stability of the cluster. This is a combinatorial problem involving a global optimization (i.e., applied to all vertices and edges). In the context of image segmentation, *Shi and Malik* [2000] associate each image pixel with a vertex of the graph, and a measure of pixel similarity to the edges of the graph. To identify clusters of similar pixels, they introduced an objective function defined by the normalized cut, which computes the cut cost (the sum of the edges that must be cut to form the cluster) as a fraction of the total edge connections to all the vertices in the graph. They then use a spectral method to find partitions that minimize the normalized cut. The advantage of the normalized cut is that it minimizes cost by removing weak (low similarity) edges between clusters and maximizes benefit by including more similar vertices in a cluster. In contrast to other graph cut definitions (e.g., the minimum cut [see *Papadimitriou and Steiglitz*, 1998]) that mostly focus on removing weak edges, the normalized cut combines global and local information resulting in more balanced graph partitions.

In the case of landslides costs and benefits derive from the resistive and driving forces experienced by a cluster of unstable cells, and the objective function is the Factor of Safety of that cluster. Thus, we can identify