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A Vulnerability Index and Analysis for the Road Network of Rural Chile

Andreas Braun (1), Johanna Stötzer (2), Susanne Kubisch (1), Andre Dittrich (2), and Sina Keller (2)

(1) Karlsruhe Institute of Technology, Institute of Regional Science, Karlsruhe, Germany, (2) Karlsruhe Institute of Technology, Institute of Photogrammetry and Remote Sensing, Karlsruhe, Germany

Natural hazards impose considerable threats to the physical and socio-economic wellbeing of people, a fact, which is well understood and investigated for many regions. However, not only people are vulnerable. During the last decades, a considerable amount of literature has focussed the particular vulnerability of the critical infrastructure: for example road networks. Considering critical infrastructure, far less reliable information exists for many regions worldwide – particularly, regions outside of the so called developed world.

Critical infrastructure is destroyed in many disasters, causing cascade and follow up effects, for instance, impediments during evacuation, rescue and during the resilience phase.

These circumstances, which are general enough to be applied to most regions, aggravate in regions characterized by high disparities between the urban and the rural sphere. Peripheral rural areas are especially prone to get isolated due to defects of the few roads which connect them to larger urban centres (where, frequently, disaster and emergency actors are situated).

The rural area of Central Chile is a appropriate example for these circumstances. It is prone to destruction by several geo-hazards and furthermore, characterized by the aforementioned disparities. Past disasters, e.g. the 1991 Cerro Hudson eruption and the 2010 Maule earthquake have led to follow up effects (e.g. farmers, being unable to evacuate their animals due to road failures in the first case, and difficultires to evacuate people from places such as Caleta Tumbes or Dichato, which are connected by just a single road only in the second).

The contribution develops a methodology to investigate into the critical infrastructure of such places. It develops a remoteness index for Chile, which identifies remote, peripheral rural areas, prone to get isolated due to road network failures during disasters. The approach is graph based. It offers particular advantages for regions like rural Chile since 1. it does not require traffic flow data which do not exist, 2. identifies peripheral areas particularly well, 3. identifies both nodes (places) prone to isolation and edges (roads) critical for the connectivity of rural areas, 4. based on a mathematical structure, it implies several possible planning solutions to reduce vulnerability of the critical infrastructure and people dependent on it.

The methodology is presented and elaborated theoretically. Afterwards, it is demonstrated on an actual dataset from central Chile. It is demonstrated, how the methodology can be applied to derive planning solutions for peripheral rural areas.