Spatial Analysis of Large-Scale Man-Made Disasters Using GIS
– An Exemplary Implementation for Air Traffic Incidents –

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(1) Motivation: Starting point for this study was the question whether it is possible to spatially analyze factors facilitating man-made disasters in the same way as is done with natural disasters and terrorism.

(2) Approach: A GIS tool was developed and implemented to prove the existence and measure the significance of those factors using geostatistical methods, and to evaluate their spatial determinacy on a per-country basis. The severity of the incidents was parameterized by the bodily injury and the tangible loss, while the availability of certain safety features at, as well as location and spatial surroundings of the respective airports were used to operationalize the present safety standards. Figure 1 shows a screenshot of the GIS tool.

(3) Originality: Expert talks with leading reinsurance underwriters confirmed the usefulness of this unique approach to analyze the interrelation between man-made incidents and their spatial locations.

(4) Characteristics: Air traffic incidents during parking, taxiing, take-off and landing were chosen as an exemplary topic for a prototype implementation of this approach. Research was focused on the correlation between the incidents themselves and the safety levels of the airports they were occurring at. The analysis was based on two datasets: a unique air traffic incident database (property of Munich Re) and the Digital Aeronautical Flight Information File (DAFIF) provided by the United States National Geospatial-Intelligence Agency (NGA) (Fig. 2). Both contain extremely detailed information about the incidents and the airport safety features, respectively. For the analysis both descriptive statistics (minimum, maxi-mum, mean, median, skewness) as well as spatial (Moran's *I*, semivariogram) and non-spatial correlation measures (Pearson's product moment correlation coefficient *r*) were employed.

(5) Results: In the course of this conceptual study about the usefulness of spatial analysis of man-made disasters it could be shown that 1) large-scale man-made disasters are related to the spatial surroundings they are occurring in, 2) this correlation can be operationalized on a per-country basis, and 3) a semantically, spatially, and timely consistent collection and preparation of the underlying data are imperative.
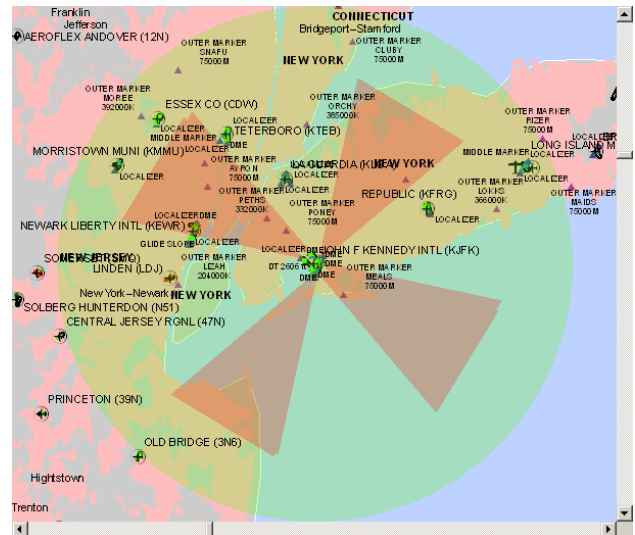

Fig. 1: Spatial analysis of surroundings (green) and high-risk areas (red) for New York John F. Kennedy Int'l Airport.
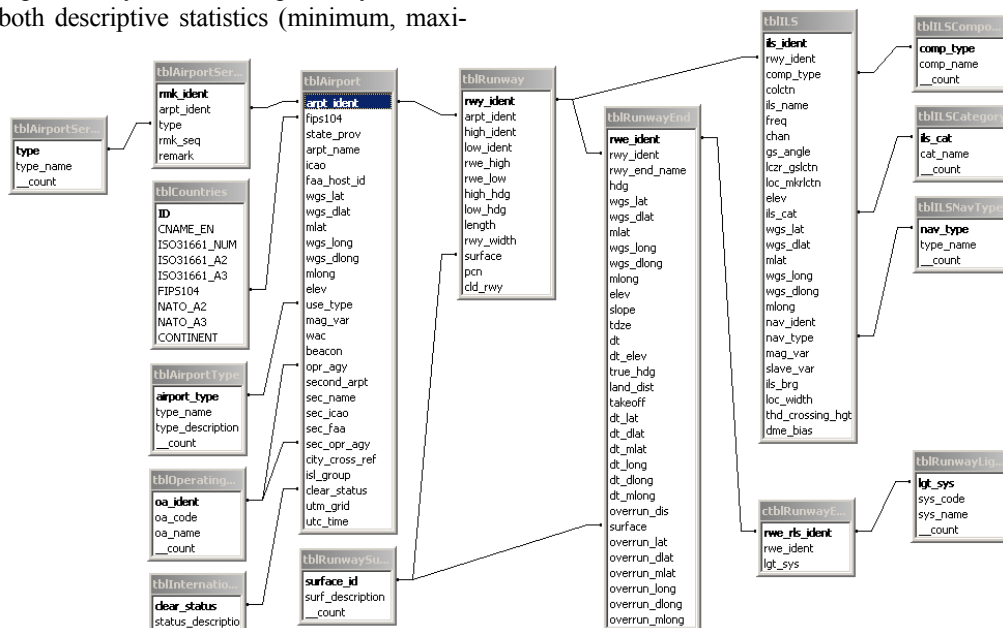

Fig. 2: Relational data model of the NGA DAFIF database used.