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A Fast Heuristic Approach for Large-Scale Cell-Transmission-Based Evacuation Route Planning

– *Online Supplement* –

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The usage of Cell-Transmission-based optimization models also requires the transformation of a given road network into a cell based network. Figure 1 demonstrates a possible conversion for a small network consisting of six street segments. Each street segment has to be represented by at least one cell, but it can also easily be seen that an adequate network representation may require more than one cell per street segment. Figure 1 also displays that cells only correspond to specific attributes of a street segment, i.e., length and driving speed, but not to the number of lanes, respectively.

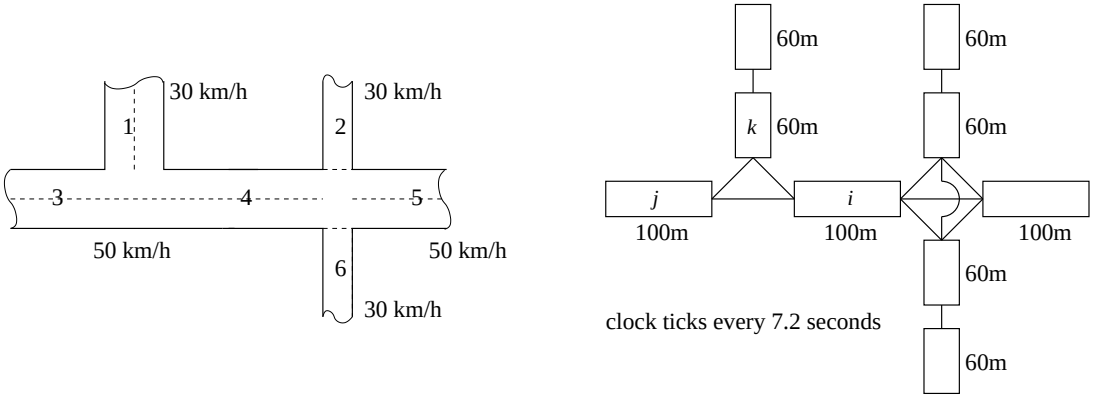

Figure 1: Cell based network representation.

We can argue that in the case of an evacuation there is a highly endangered emergency planning zone (EPZ_0) in the center of the threat (with very high measure of risk) which actually raises the need for evacuation. Furthermore, the highly endangered EPZ (EPZ_0) is surrounded by "regular" EPZs ($EPZ_1, EPZ_2, \ldots$, with (different) lower levels of risk) which also have to be evacuated. Figure 2 illustrates these relations for a threat (e.g., disarming a large unexploded bomb) in the center of an urban area with one highly endangered EPZ and two less endangered EPZs.

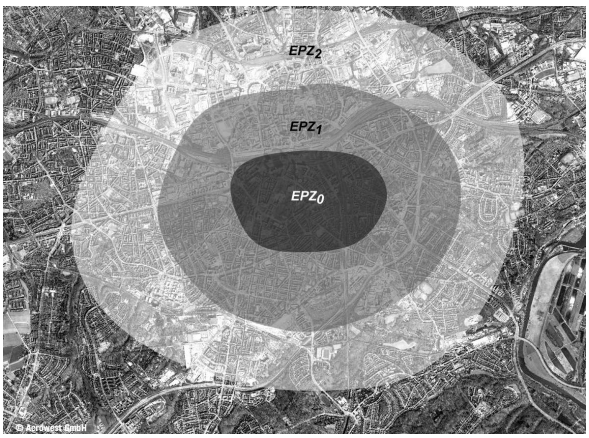

Figure 2: Possible locations of Emergency Planning Zones (EPZ_h).

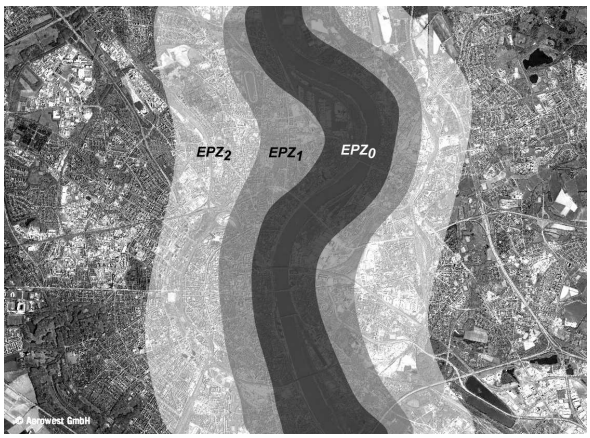

Figure 3: Other possible locations of Emergency Planning Zones (EPZ_h).

In Figure 2, the threat (e.g., a large unexploded bomb) is localized on a single spot and

risk is uniformly distributed around the place of discovery since all surrounding buildings have the same level of protection against a possible bomb explosion. In the case of a city with a large river and an upcoming flood, the shape of the EPZs may look like displayed in Figure 3. Of course, the floodwater would first hit the area next to the river. Therefore, this area can be declared as the most endangered EPZ (EPZ_0). The measure of risk decreases with increasing distance to the river so that EPZ_1 and EPZ_2 can be specified as shown in Figure 3. The shape of the EPZs can also take irregular forms, e.g., in the case of a Tsunami heading towards a city on a mountained area, different levels of altitude may define the EPZs.

The complete network used in Scenarios 1–6 is displayed in Figure 4.

Figure 4: Medium urban road network (Neudorf).

Network details for Scenarios 7–9 can be extracted from Figure 5.

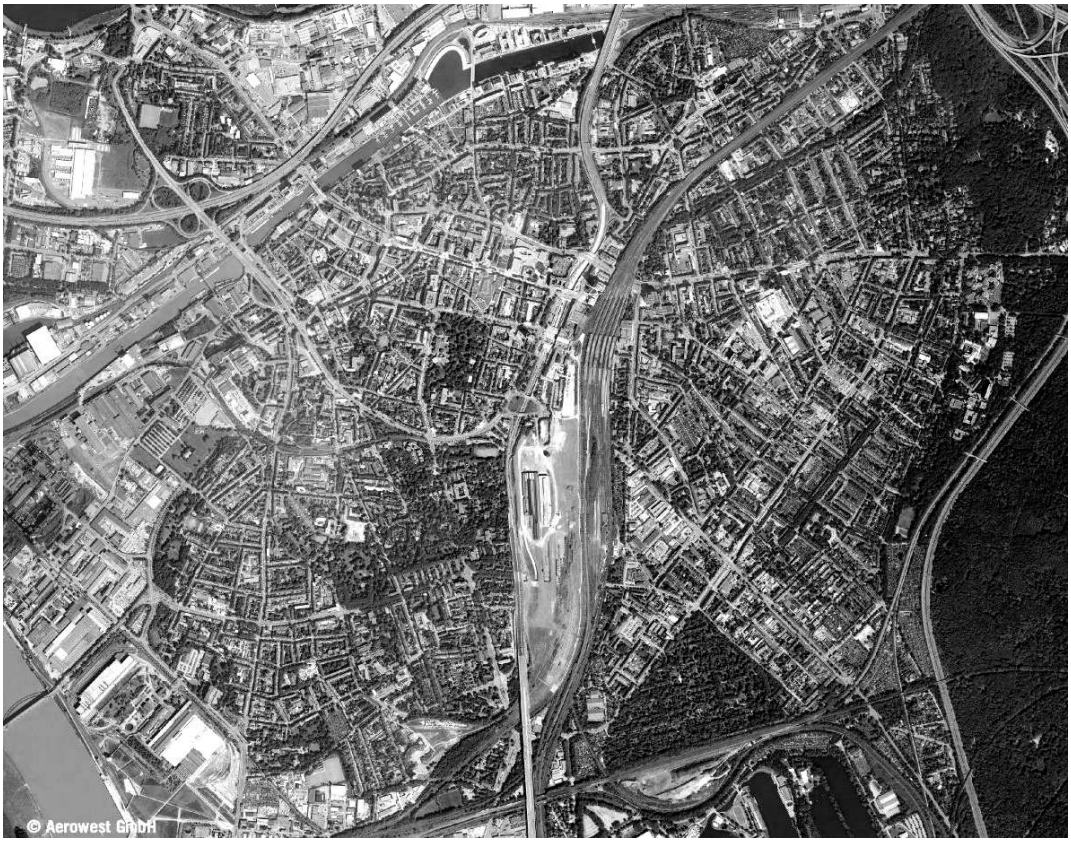

Figure 5: Large urban road network (Duisburg).

Figures 6–14 illustrate the distribution of danger for Scenarios 1–9. The darker the color of the EPZ the higher the danger in this EPZ.

Figure 6: Scenario 1.

Figure 7: Scenario 2.

Figure 8: Scenario 3.

Figure 9: Scenario 4.

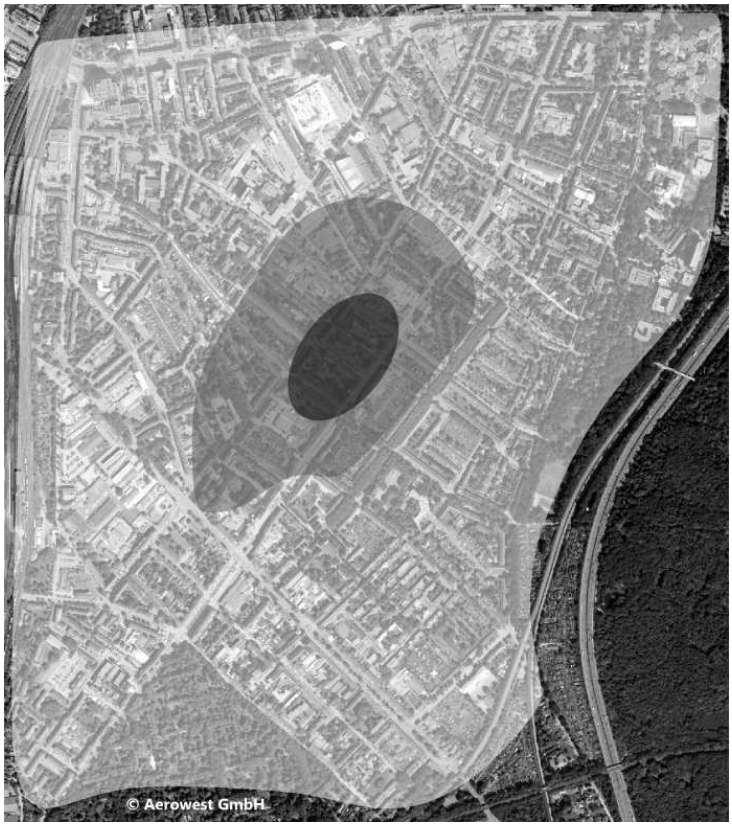

Figure 10: Scenario 5.

Figure 11: Scenario 6.

Figure 12: Scenario 7.

Figure 13: Scenario 8.

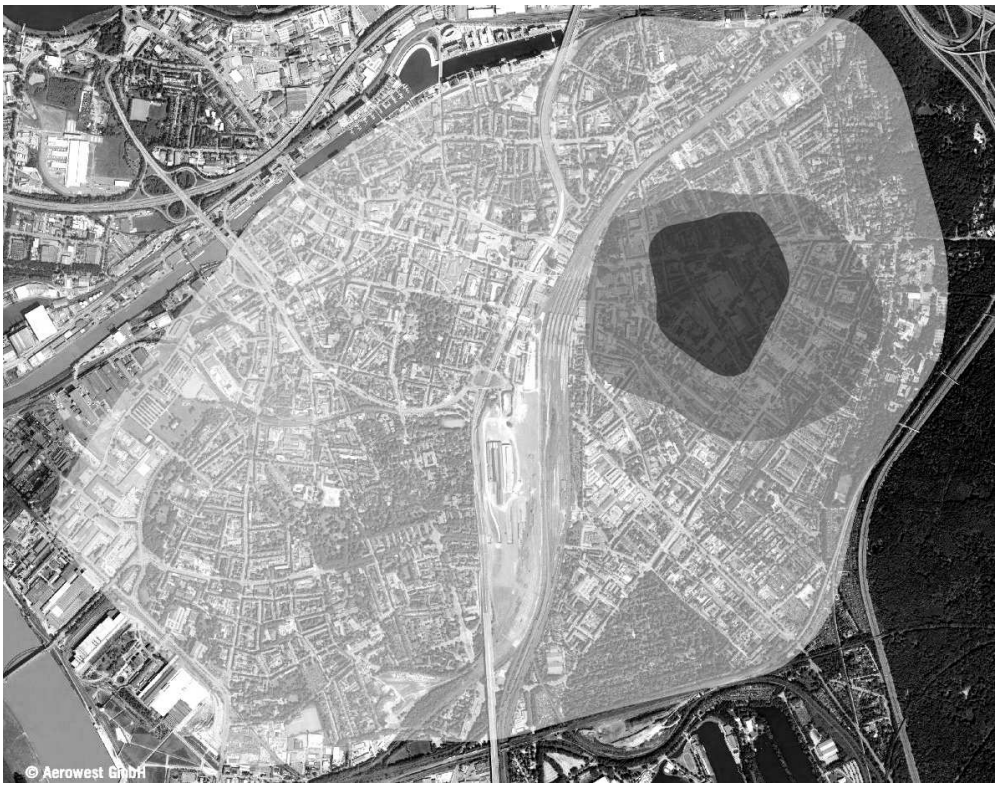

Figure 14: Scenario 9.

Acknowledgement

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