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An adaptive evacuation route algorithm under flood disaster

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Adaptive Evacuation Route Algorithm (AERA) is proposed in this paper considering the effect of dynamic water depth on people's evacuation behavior such as evacuation time and walking speed under a flood disaster. Based on the idea of Dijkstra shortest path method, this algorithm pursues the goal of minimizing total evacuation time. The algorithm can be decomposed into five main steps as follows:

1) Initialization

Let a dynamic network $G = (V, A, \{(0,1,2...T)t_0\})$ be a finite graph, where V is the set of nodes that include three parts: set of source nodes, set of destination nodes, and set of intermediate nodes. A is the set of arcs and $\{(0,1,2...T)t_0\}$ is discrete time and t_0 is a time interval of calculation of water depth in the network.

2) To calculate the initial distance L_0 and time T_{init}
   - If the point is in a sub-network, then start point is the nearest and accessible node in the main network.
   - If the point is on a route, then the start node is the nearest node on this route
   - If the point is the same as a node, then start node is itself, then $L_0 = 0$
3) To calculate consumed time
   - Calculating the time from node k to those nodes j that directly connect with k and not marked yet.
   - The consumed time is $T_j = \min\{T_j, T_u + T_{uj}\}$, T_{uj} is the time consumed from u to j. If T_j is replaced then put a label (T_j, u) on V.
4) To continue with the new node
   - To compare the consumed time among all nodes that are not marked yet and select the one with minimum value as new node.
   - Mark this new node and reset the start time equal to its responding minimum time.
   - If the water depths of all nodes that are not marked yet exceed the threshold then it means the designated point is not accessible. If the new node is same as the destination node, then the algorithm ends and we can get the optimal route with the minimum consumed time, otherwise go to step 3.
5) To calculate the total consumed time
   - $T_{total}(s,d) = T_{init}(s) + T_{used}(s,d)$

This algorithm is realized by integrating database technology and spatial-temporal GIS software-DiMSIS. Respectively, database technology is used to manage the water depth data and GIS technology is used to do network analysis. As a case study, this algorithm is implemented in Nagata area with area size about 0.8km^2 in Kobe city. The time interval is five minutes and total simulation time is two hours. The result of the experiment shows that AERA can be used to provide optimal evacuation route under dynamic situations.