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Complete Tsunami Hazard Assessment, Vulnerability and Risk Analysis for the Marmara Coast of Istanbul Metropolitan Area

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According to east to west propagation of major earthquakes along the North Anatolian Fault (NAF) since seventeenth century, a large magnitude (at least M=7.2) earthquake is expected to occur in the Sea of Marmara where the megacity of Istanbul located at the northern coast of the sea. There are numerous possibilities about the tsunami generation in the Sea of Marmara. In order to assess tsunami risk properly; collection and processing of high-resolution data and tsunami numerical modeling are necessary. In this regard, a complete project on tsunami hazard assessment, vulnerability and risk analysis has been carried out in three stages. In stage 1, high resolution Digital Elevation Model (DEM) data is used and enhanced to include buildings for analyzing 17 different coastal districts of Istanbul Metropolitan Area bordering Marmara Sea. In stage 2, NAF sourced 14 different co-seismic and 3 submarine landslide areas are considered based on the results of previous marine surveys and related publications and then tsunami simulations are carried out for each scenario with the use of NAMI DANCE GPU software. For each 17 districts, most critical co-seismic and landslide sourced tsunami scenarios are selected and their hazard levels (distribution of maximum flow depth at land) are computed. In stage 3, a detailed vulnerability analysis is performed by using the MeTHuVA (METU Metropolitan Tsunami Human Vulnerability Assessment) Method (Tufekci et al., 2018) that covers human vulnerability assessment with GIS-based multi criteria decision analysis (MCDA). Using analytical hierarchy process (AHP), a hierarchical structure is established, composed of two main elements; vulnerability at location and evacuation resilience. Tsunami risk assessment for each district is calculated by integrating result of hazard and vulnerability assessments with a risk relation that includes a parameter (n), which represents the preparedness and awareness level of the community.

As a result of this research; detailed tsunami hazard analysis is performed and flow depths of tsunami inundation in coasts are calculated precisely. Moreover, based on the MeTHuVA model; vulnerability level of the assets and associated risk are evaluated in detail. As supplementary calculations, heavily used critical structures such as Yenikapı and Maltepe meeting areas, entrances of Metro stations such as Marmaray Kazlıçeşme, Yenikapı, Sirkeci, Üsküdar, Ayrılık Çeşmesi, Eurasia Tunnel Haydarpaşa and Kumkapı tunnel entrances, Haydarpaşa, Ambarlı, Tuzla, Yenikapı ports are analyzed in more detail to produce possible precautions to prevent losses in these facilities. Overall, it is believed that the outputs of the study will help increasing preparedness of the megacity İstanbul against possible tsunamis in the Marmara Sea and enable tangible actions to foster resiliency of the city.

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