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Earthquake Risk Assessment for Irbid City, Jordan

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Tectonics of the Jordan is mainly dominated by the Dead Sea Transform fault, a N-S strike-slip transform fault. It Connects the Gulf of Aqaba-Red sea spreading system to convergence zone in the Taurus–Zagrous Mountains. It defines the plate boundary between the Arabian plate and Sinai-Palestine subplate. The objectives of this work were: a) analysis of earthquake hazard specific to Irbid City, b) mapping elements at risk (buildings, population), c) vulnerability analysis of elements at risk, and d) estimation of risk for buildings and population. Irbid is the 3rd largest city in Jordan with population about 317,000 inhabitants (this project, 2012) with about 29,352 buildings and 46.36 km^2 in area. Irbid is a major ground transportation hub between Amman, Syria to the north, and Mafraq to the east. It is a hub of educational and commercial activity in Jordan.

For seismic scenario development the followings were carried out:

- Seismic area sources developed by our team based on previous studies and local expertise.
- Area source parameters were identified using both instrumental and historical data.
- PSHA is carried out in an attempt to identify potential earthquake scenarios using de-aggregation of PGA.

Upon results the maximum worst case scenarios were assumed:

	Scenario I	Scenario II
Mw	7.7	6.55
Depth (km)	20	20

The model was calibrated using the Dead Sea seismic event of 11/2/2004 (Mw= 5.354 and depth=20 km). A shear wave map (Vs30) for the study area was created using 1D Multichannel Analysis of Surface waves (MASW). For data collection, the study area was divided into grids with 1 km^2 each. 122 seismic records were obtained using 1D passive and active MASW approach. Seventy five boreholes logs were collected and investigated for depth to bed rock, bearing capacity, etc.

The Department of Statistics (DOS) in Jordan provided the needed raw data (2004) to build the elements at risk inventory (buildings and population), which was then populated over a grid of 250 x 250 m using area weighted method. The areal unit of DOS data is called “a block”, which defined as a group of buildings forming a locality or part of it, with clear man-made boundaries such as paved or

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unpaved streets, lanes, passages, electricity posts, telephone posts, railways,…etc, or natural boundaries as mountains, rivers, and valleys and are easily identified on ground. There are 717 blocks in the study area. From an engineering point of view, the residential building stock in Jordan was first classified into the following:

Date of construction:

1) Non engineered = Pre 1960
2) Pre-code = pre-1985
3) Post-code= post-1985
4) High-code= post 2005

Building materials and structural system:

1) Bearing wall construction
2) Reinforced concrete skeleton with stone-concrete walls
3) Reinforced concrete skeleton with concrete brick walls
4) RC Shear walls

Number of stories:

1) 1-3
2) 4-6
3) >6

Structural testing and modeling were carried out to build capacity and fragility curves for different building typologies. ELER v3.0 (Earthquake Loss Estimation Routine) developed under the JRA-3 component of the EU FP-6 NERIES Project, was used to estimate the seismic hazard and risk assessment. Tables 1 present the estimated proportions of buildings losses for the two proposed earthquake scenarios. The total numbers of casualties for the four levels of casualty severities based on the two proposed earthquake scenarios are given in table 2. Figure 1 presents the spatial distribution of extensively and completely damaged buildings of all types for both scenarios.

Table 1: Statistics of building damages losses for all earthquake scenarios.

Damage Grade	Scenario I %	Scenario II %
D1 (None)	46.57	74.13
D2 (Slight)	18.19	12.71
D3 (Moderate)	24.80	11.39
D4 (Extensive)	8.51	1.45
D5 (Complete)	1.84	0.23
D4+D5	10.35	1.67
D3+D4+D5	35.15	13.06

Table 2: Casualty estimates for all Earthquake Scenarios

Severity Level	Scenario I	Scenario II
Severity level I (S1)	4312	931
Severity level II (S2)	890	141
Severity level III (S3)	98	10
Severity level IV (S4)	192	20

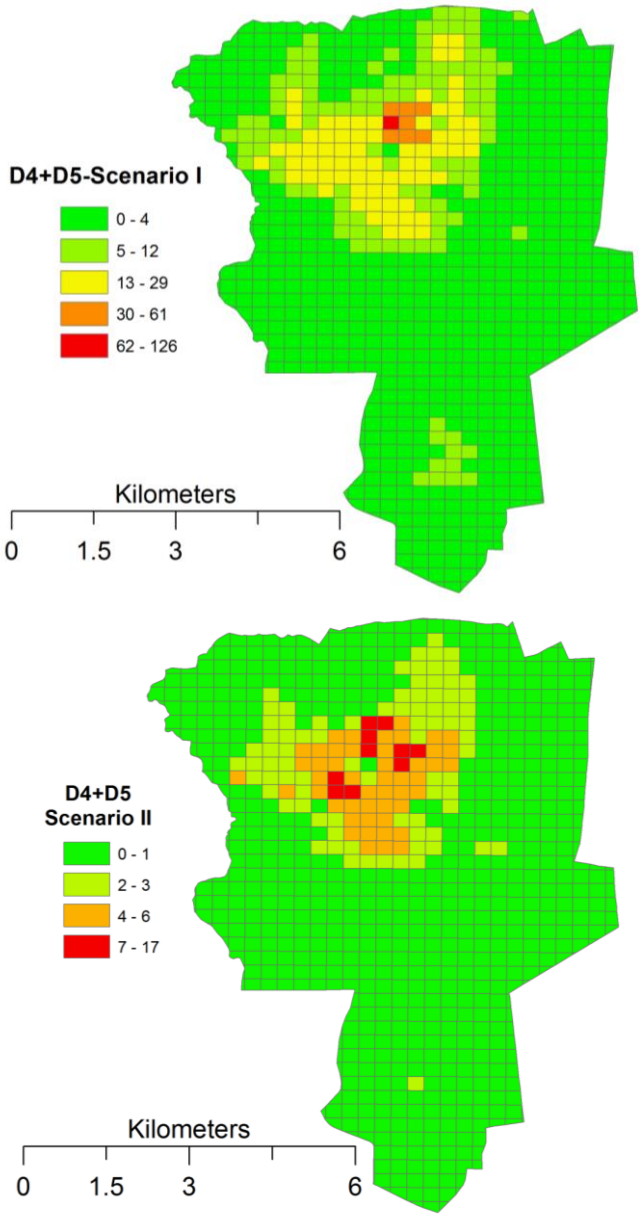

Figure 1: Extensively and completely damaged buildings distribution for all building classes-scenario I and scenario II.