Spatial and Temporal Dynamics of Urbanization and its Impacts on Flash Flood Risk: A Case Study from Jordan's Wadi System

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CapTainRain
Capture and Retain Heavy Rainfalls in Jordan

Introduction

- Middle Eastern cities including Amman have experienced high rates of urbanization since the second half of 19th century, resulting in increased risks from flash floods.
- We analyzed the drivers and causes of land use land cover changes (LULCC) and how this may have affected flash flood risk in space and time.

Methodology

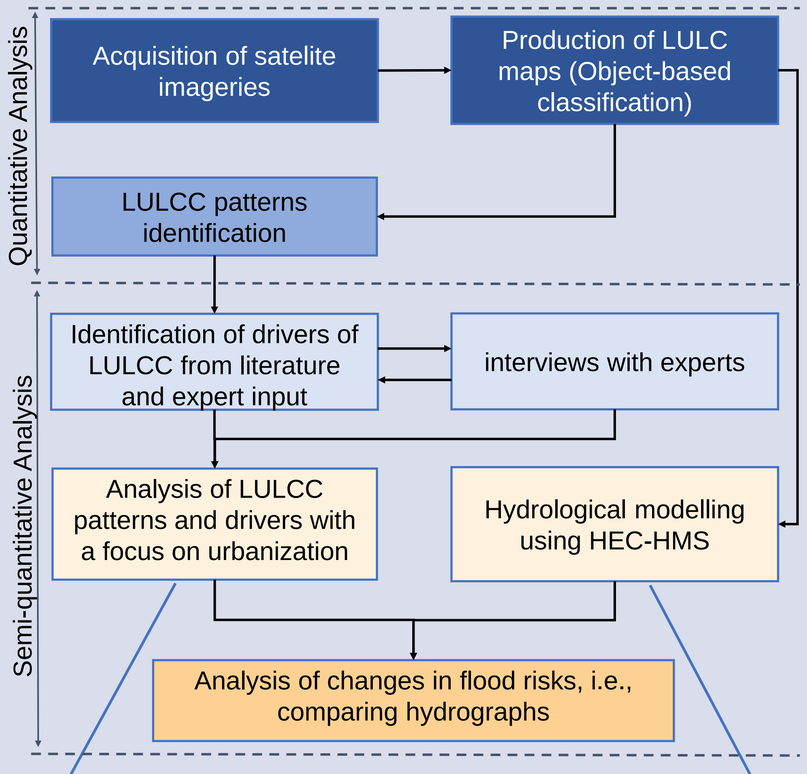

Fig. 2: Sequence of methods and analysis used in this study.

Study area

- Amman city, the capital of Jordan (Fig. 1).
- Mediterranean to semi-arid conditions.
- Basin area at around 660 km².

Fig. 1: Location of the study area, and picture of the flooded Roman Theater in downtown Amman (28. Feb. 2019).

Results

- Urban expansion was highest during the 80s, and 90s (Fig. 3).

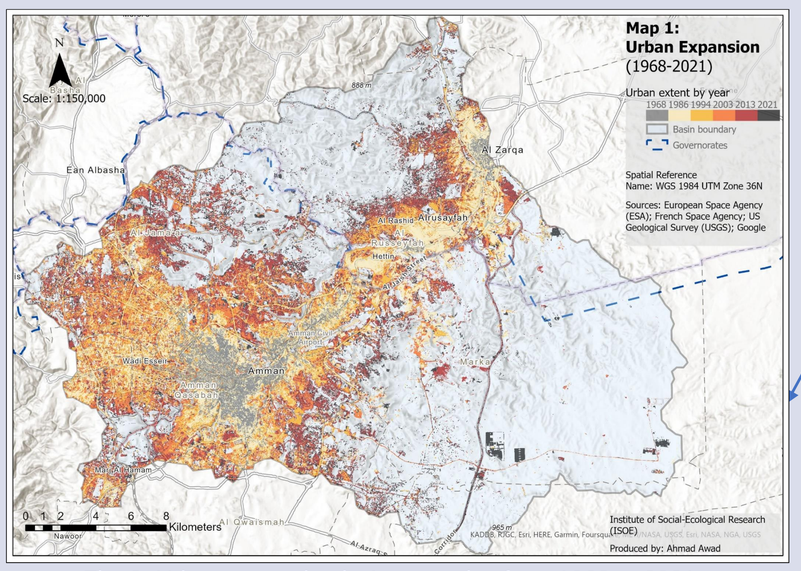

Fig. 3: Urban expansion in Amman city from 1968 to 2021.

- Built-up areas increased from a mere 19 km² (3%) in 1968 to 223 km² (34%) in 2021 mostly at the expense of croplands (70 km²) (Fig. 4).
- Underlying driving forces for LULCC were population increase, the unequal regional distribution of jobs, citizens interest in having a city's lifestyle, weak planning, and further political trigger events (Fig. 5).

Conclusion

- The underlying driving forces triggered LULCC.
- Frequent regional disturbances aggravated the situation of unplanned LULCC.
- The LULCC increased the flash flood risk in the area.
- The runoff results are one step for a more holistic assessment of flood risk changes in Amman that includes other physical and social dimensions.

Results

- Amount of runoff change depends on the intensity and duration of rainfall events (Fig. 6).
- Higher apparent change exist in less intense rainfall events.
- More built-up surfaces lead to decreased channel roughness, faster runoff (30mins of shorter response time) and higher runoff curves (Fig.6).

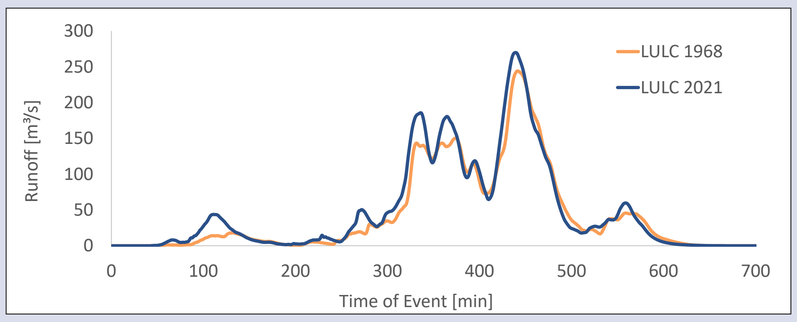

Fig. 6: Simulated runoff in downtown Amman with adapted LULC information for 1968 and 2021.

- Average calculated curve numbers of the area are very high with a CN of 90 and 94 for the years 1968 and 2021, respectively.
  → Due to low soil infiltration rates in this area.

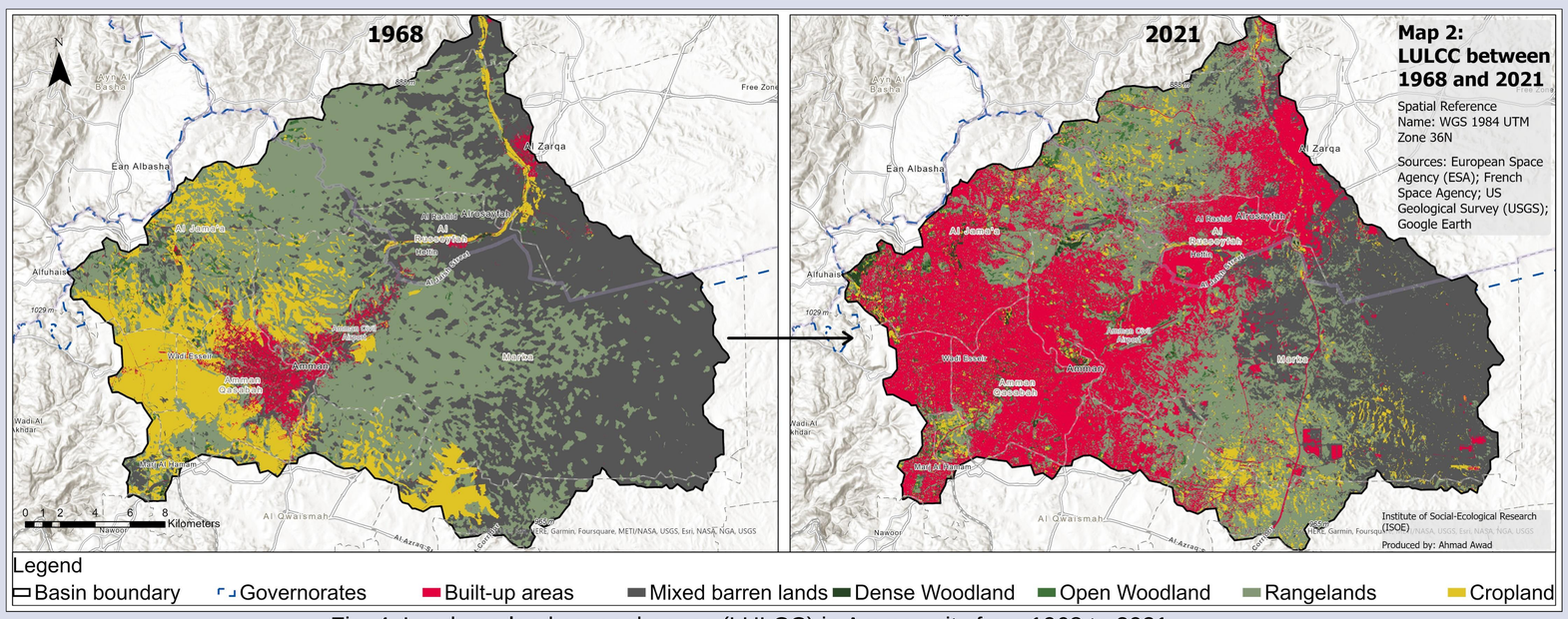

Fig. 4: Land-use land cover changes (LULCC) in Amman city from 1968 to 2021.

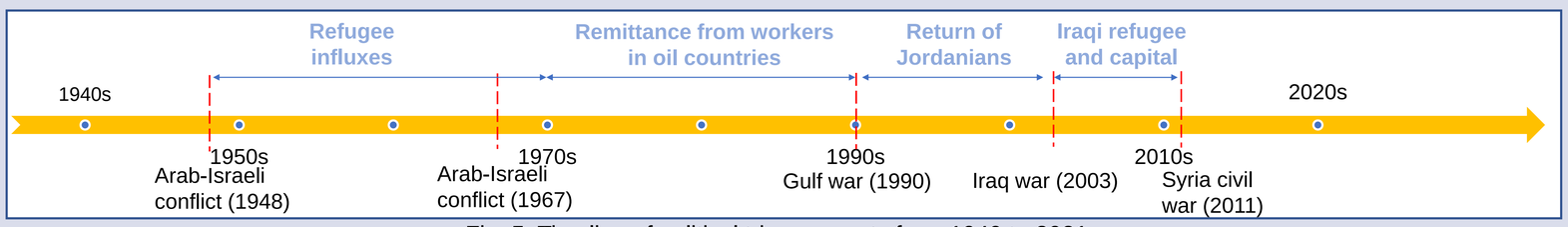

Fig. 5: Timeline of political trigger events from 1940 to 2021.

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