

Challenges of Post-War Building Assessment in Gaza and Rule-Based Solutions

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Date: December 24, 2024

Abstract

Post-war building damage assessment is critical for rebuilding efforts, especially in Gaza, where conflicts have left many buildings destroyed and resources limited. This report explores challenges such as data gaps, resource shortages, environmental hazards, and overcrowding in damaged buildings. Solutions are proposed using a rule-based framework, drawing from various studies to provide practical recommendations for resource allocation and prioritization. Simplified explanations of technical terms like SAR and load-bearing wall thresholds are included for accessibility.

Introduction

Rebuilding after a war is never easy, and in Gaza, this process is even more challenging. Years of conflict have destroyed homes, schools, and infrastructure, leaving communities in urgent need of safe housing and functional facilities. The main obstacles to rebuilding include:

- **Data gaps:** Reliable records of pre- and post-war building conditions are often missing or incomplete [1].
- **Limited resources:** Materials for reconstruction are hard to find, and financial constraints make the process slower [2].
- **Environmental hazards:** Contaminated soil, debris, and even minefields make rebuilding unsafe without proper cleanup [3].
- **Overcrowding:** With so many buildings damaged, more families are crammed into fewer homes, which creates additional stress [5].
- **Public Health Risks:** Damaged water and sanitation infrastructure poses risks of disease outbreaks [6].
- **Uncertainty in assessments:** Visual inspections alone may miss hidden damage, and different inspectors often provide inconsistent evaluations [7].

This report proposes a set of rules to address these challenges, using insights from various studies to prioritize reconstruction and ensure resources are used efficiently.

Definition of Terms

To help non-engineers better understand the report, here are simplified explanations of technical terms used throughout:

1. **Synthetic Aperture Radar (SAR):**
 - SAR has been widely used since the 1990s for disaster mapping and emergency response, including in war zones like Gaza, where it helps identify structural damage even in areas covered by debris or clouds [1].
 2. **Radiation Thresholds:**
 - Safe levels of radiation in materials or soil. For building materials, the limit is 1 mSv/year (millisieverts per year), and for soil, it's 0.3 μ Sv/hour (microsieverts per hour) [4].
 3. **Load-Bearing Walls:**
 - These are the walls that support the building's weight. Cracks larger than 20 mm (2 cm) in these walls can indicate a risk of collapse [7].
 4. **Overcrowding Threshold:**
 - If more than 20 people live in a single unit or building, it is considered overcrowded and prioritized for reconstruction [5].
 5. **Income Threshold:**
 - In Gaza, the poverty line is \$5.50/day per person. Those earning less than this are considered in need of financial assistance for rebuilding [6].
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Proposed Rules Framework

Below is the finalized set of 31 rules categorized by themes:

Structural Damage Assessment Rules

1. IF SAR backscatter decreases significantly THEN classify as "Severe Damage: Reconstruction Priority."
2. IF visible cracks are in load-bearing walls THEN classify as "Severe: Immediate Repairs Required."
3. IF cracks are present in non-load-bearing walls BUT no deformation is observed THEN classify as "Moderate: Repairs Suggested."
4. IF no visible damage BUT computational model predicts instability THEN classify as "Moderate: Further Inspection Needed."
5. IF cracks in load-bearing walls exceed 20 mm THEN classify as "Severe: Immediate action required."

6. IF minor surface cracks AND no deformation THEN classify as "Minor Damage: Routine Repairs."

Hazard and Environmental Challenges

7. IF property is within 500 meters of a hazardous zone THEN classify as "High Risk: Reconstruction Delayed."
8. IF soil or material radiation > 1 mSv/year OR $0.3 \mu\text{Sv/hour}$ THEN prohibit rebuilding without remediation.
9. IF minefields or unexploded ordnance present THEN delay reconstruction until cleared.

Data and Inspection Uncertainty

10. IF data from SAR and optical imagery are conflicting THEN flag as "Uncertain: Requires Field Validation."
11. IF damage assessments differ significantly THEN flag for expert review and further analysis.
12. IF pre- and post-war property records are missing THEN use geospatial data and neighboring properties for estimation.

Reconstruction and Resource Allocation

13. IF damage points are clustered near critical infrastructure THEN prioritize those zones for repair.
14. IF infrastructure includes hospitals or schools THEN prioritize reconstruction in this zone.
15. IF population displacement $>$ capacity of permanent housing THEN prioritize pallet or container homes.
16. IF the number of people living in a building > 20 individuals per unit THEN prioritize reconstruction of this building.

Sustainability and Material Considerations

17. IF local materials are contaminated THEN import certified building materials.
18. IF building design predates modern codes THEN recommend retrofitting.
19. IF renewable energy systems can be installed THEN recommend eco-friendly rebuilding options.

Temporary and Emergency Housing

20. IF displacement occurs THEN prioritize emergency shelters like container or pallet homes.
21. IF urban center proximity is high AND infrastructure is damaged THEN recommend temporary housing first.

Monitoring and Maintenance

22. IF radar backscatter remains stable over multiple intervals THEN classify as "No Damage: Low Priority."
23. IF cracks appear minor BUT damage is increasing over time THEN reclassify as "Moderate Damage."

Utility and Community Rules

24. IF a building has damaged sewer or water pipes AND it significantly impacts sanitation THEN classify as "Moderate Priority: Repairs Suggested."
25. IF a person has access to electric power (via motor or solar system) THEN classify as "Lower Priority for Energy Resource Allocation."
26. IF a person owns multiple properties THEN prioritize those with no other properties for reconstruction.
27. IF at least one of the properties is livable THEN deprioritize reconstruction for the remaining properties.
28. IF a building serves multiple families AND is located in a densely populated neighborhood THEN prioritize its reconstruction.
29. IF a person's income level is below \$5.50/day per person THEN prioritize rebuilding assistance for their property.
30. IF a building houses vulnerable populations (elderly, disabled, children) THEN prioritize reconstruction and repairs.
31. IF a building is inaccessible due to road damage THEN prioritize clearing access routes before reconstruction.

Conclusion

Rebuilding Gaza after conflict requires addressing unique challenges like data gaps, material shortages, and overcrowding. This report presents a rule-based framework to guide reconstruction efforts while ensuring resources are used efficiently. By simplifying technical terms, the framework is accessible to both engineers and non-experts, making it a practical tool for real-world application.

References

1. Braun et al., 2018. *Assessment of Building Damage Using Radar Satellite Imagery*.
2. MDPI, 2022. *Remote Sensing for Damage Assessment*.
3. Tortorici & Fiorito, 2017. *War Damage and Reconstruction Strategies*.
4. IAEA, 2021. *Radiation Safety Standards for Materials*.
5. UN Emergency Housing Guidelines, 2021.
6. UNRWA, 2021. *Gaza Poverty Line and Economic Conditions*.

7. Frontiers in Built Environment, 2018. *Post-Earthquake Damage Assessment*.