

The destruction of Gaza: Satellite measurements of the economic cost of war

Combining radar damage maps and night-time lights to estimate economic loss

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CONTEXT AND QUESTION

Measuring a war when conventional data fail

The conflict that followed the 7 October 2023 Hamas attacks has generated widespread physical destruction and disruption, while timely and comprehensive economic data were scarce.

The paper asks whether open satellite observations can reveal where built-environment damage occurred and quantify the economic activity lost.

The approach links two independent signals: radar-detected damage and changes in night-time luminosity.

STUDY DESIGN

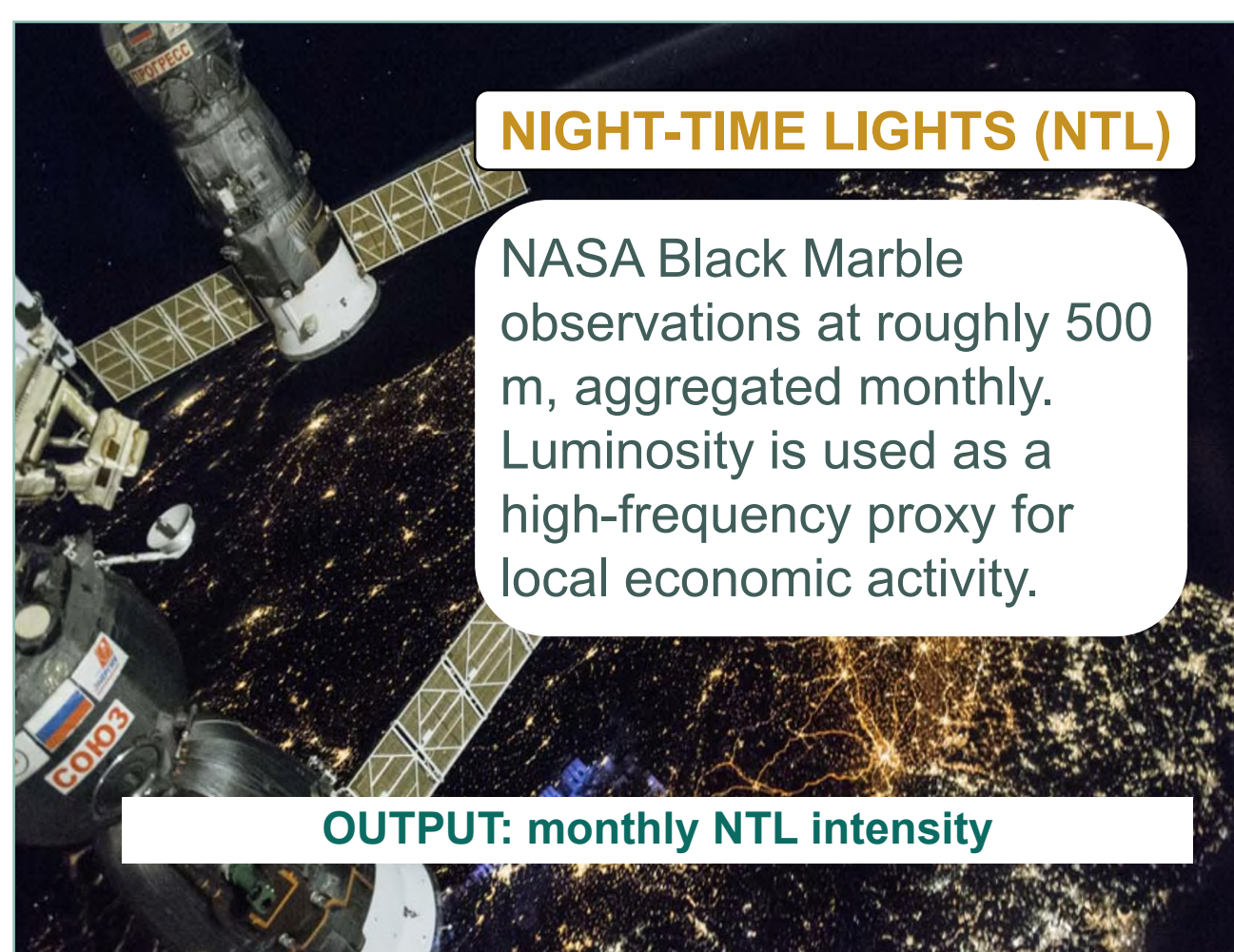
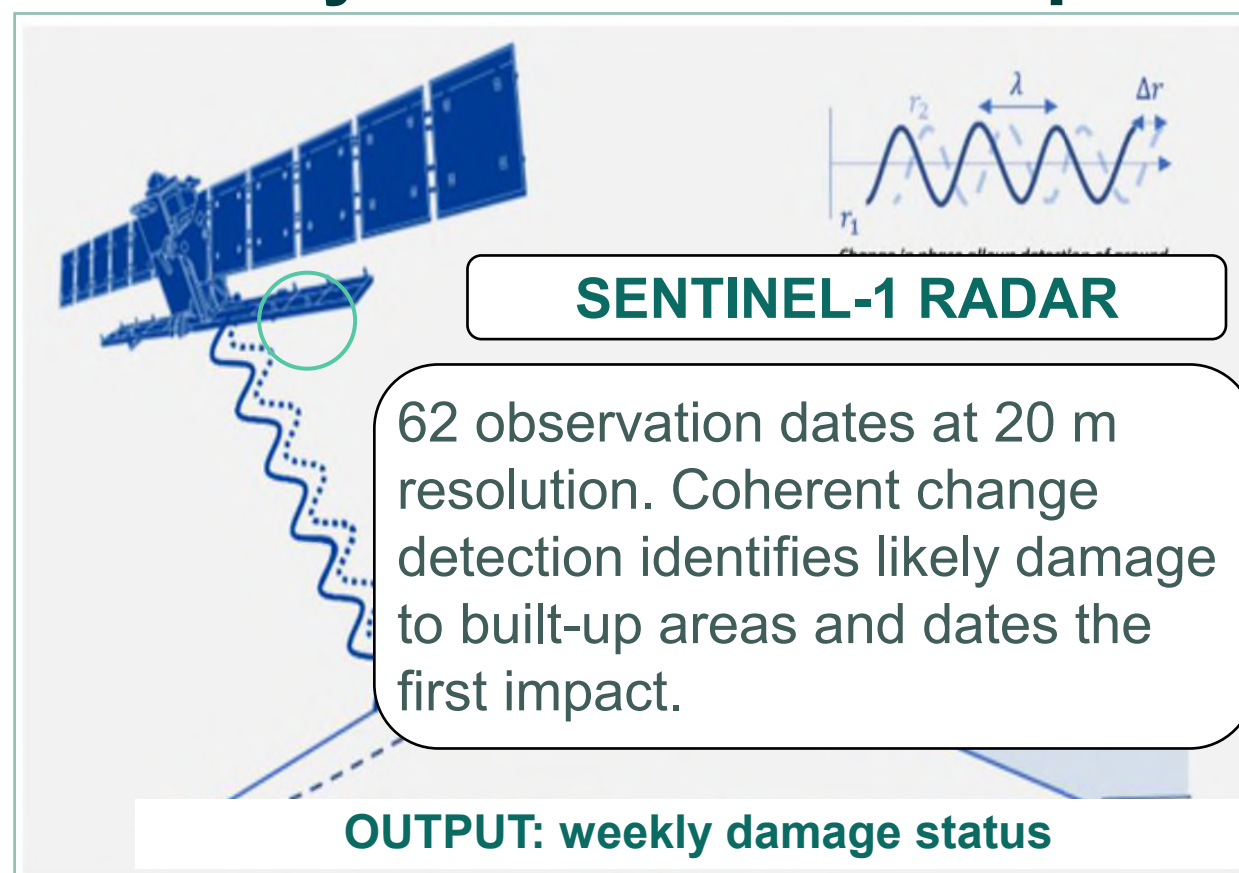
Gaza Strip | 12 Oct 2023-31 Oct 2024
441 one-km² cells | 106 weeks | 26 months

Satellites provide a low-latency, spatially detailed measure when ground data are incomplete or contested.

Scope: direct built damage and economic-activity proxies - not the full human cost of war.

TWO SATELLITE SIGNALS

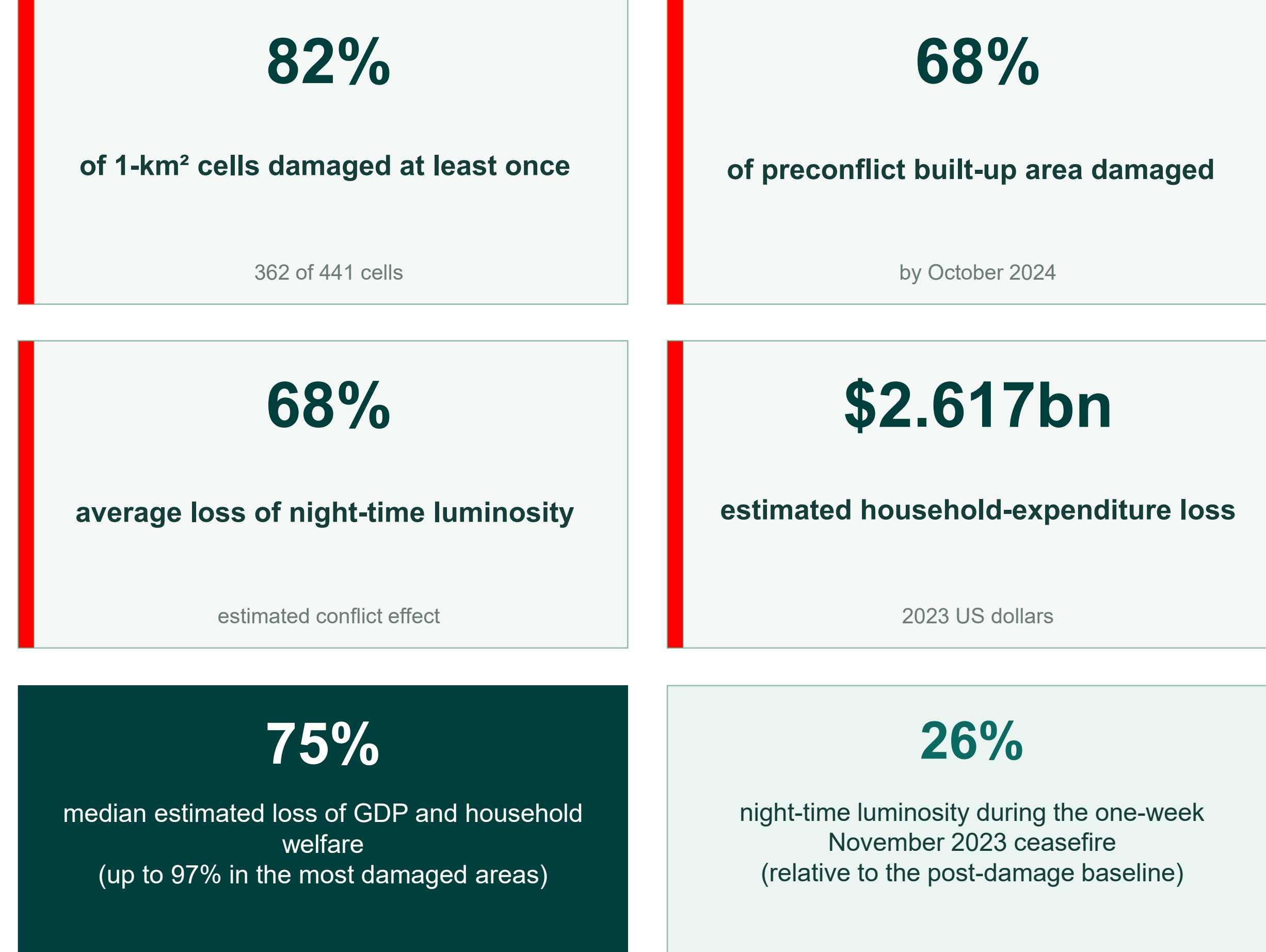
Damage and economic activity observed from space



Both signals are matched at the one-km² grid-cell level

HEADLINE FINDINGS

The first year of war, measured from satellite data



Areas hit for three or more months experienced losses of at least 65% in luminosity.

FROM SATELLITE PIXELS TO ECONOMIC INDICATORS: A low-latency, spatially explicit identification strategy

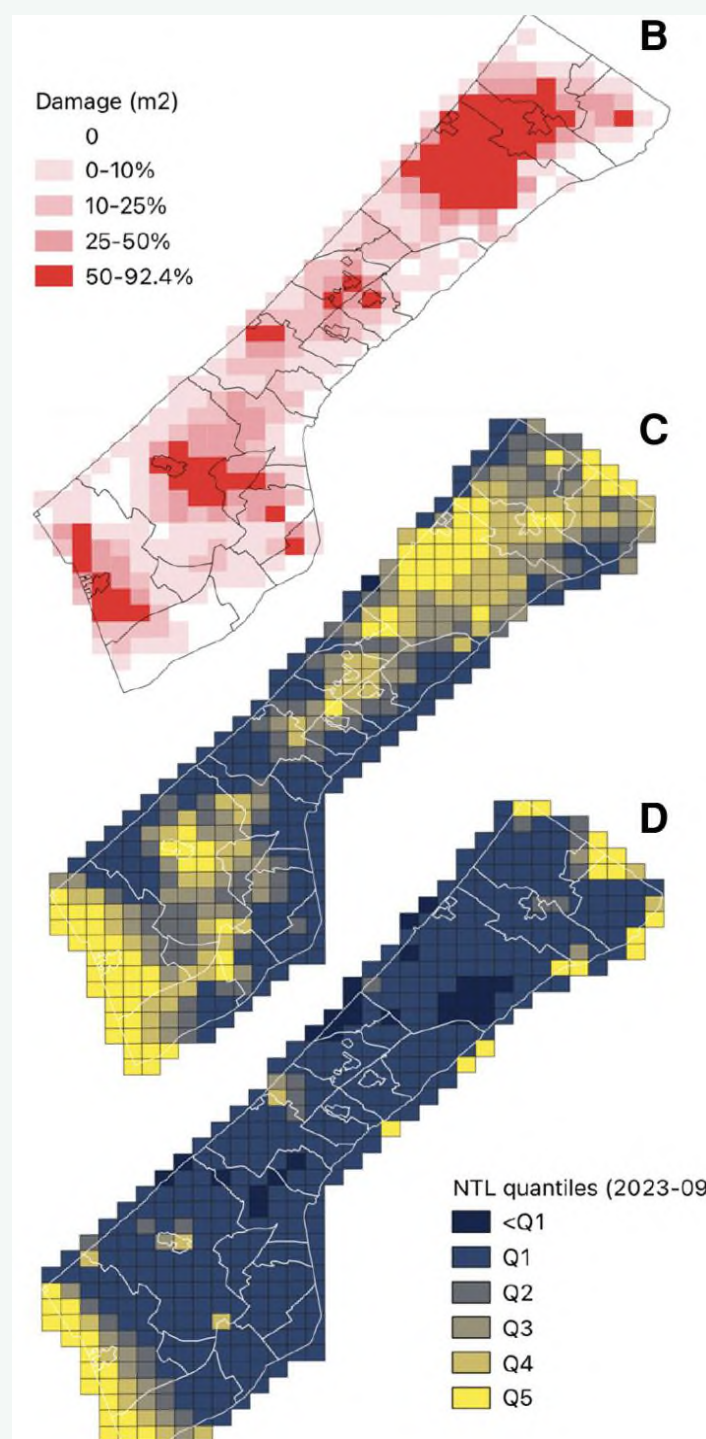
1 DETECT PHYSICAL DAMAGE



Sentinel-1 radar identifies coherent changes in the urban fabric and dates likely first damage.

62 dates |
20 m
resolution

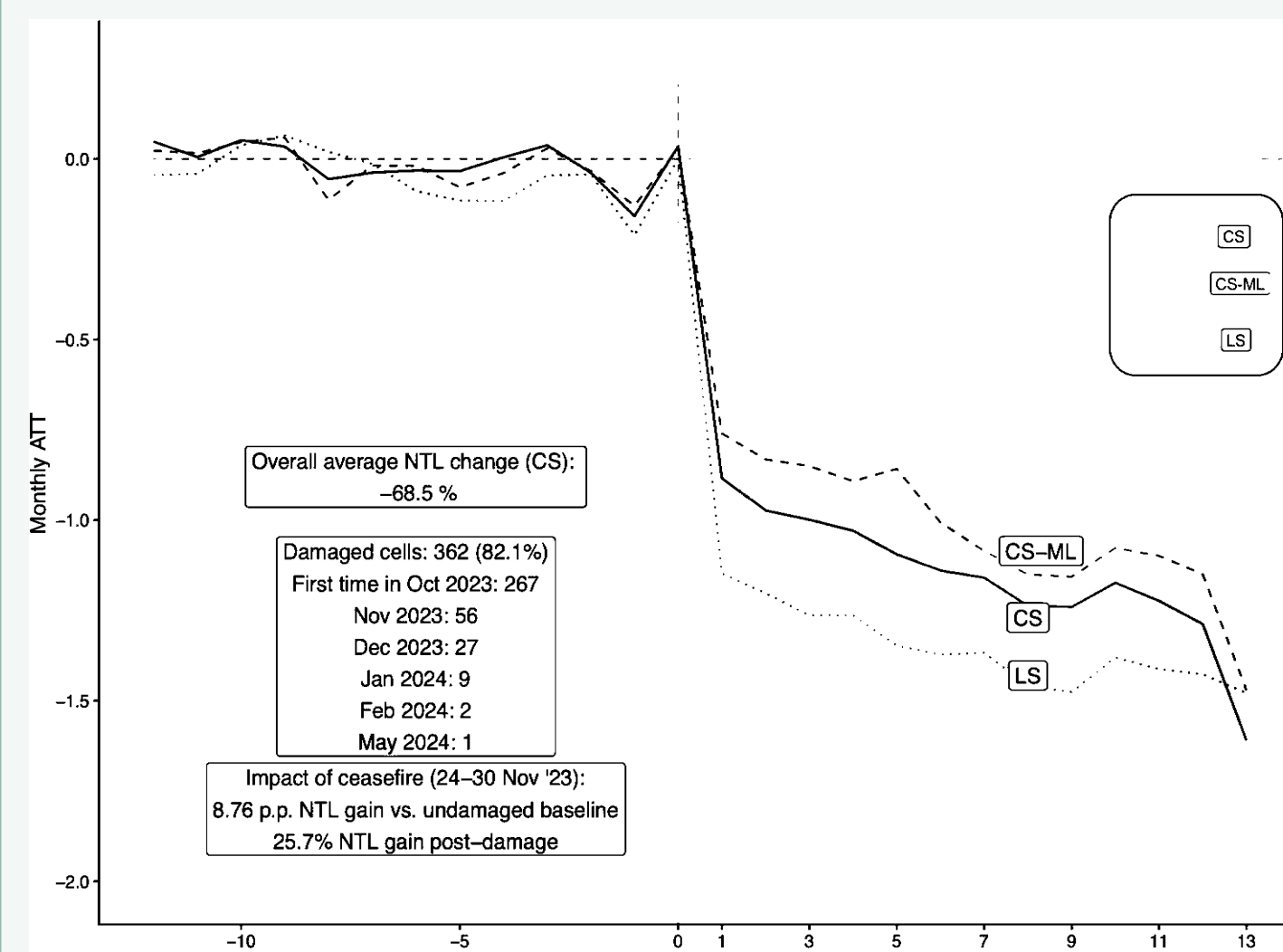
2 ALIGN THE TWO SIGNALS



Damage and monthly night-time lights are aggregated to the same 441 one-km² grid cells.

106 weeks |
26 months

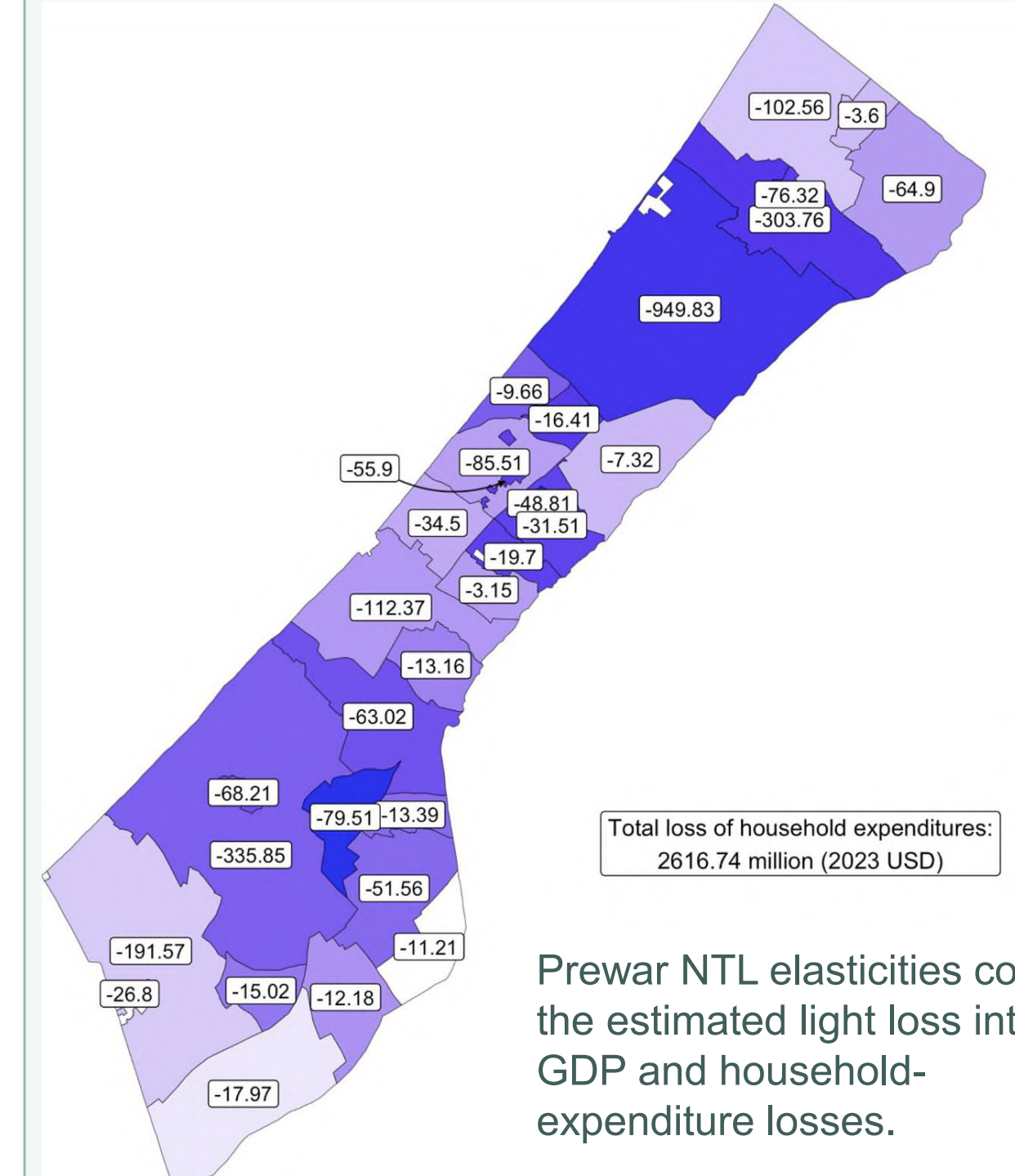
3 ESTIMATE THE CAUSAL EFFECT



Staggered difference-in-differences compares cells before and after their first detected damage.

LS | Callaway-Sant'Anna | spatial ML

4 TRANSLATE LIGHT INTO LOSS



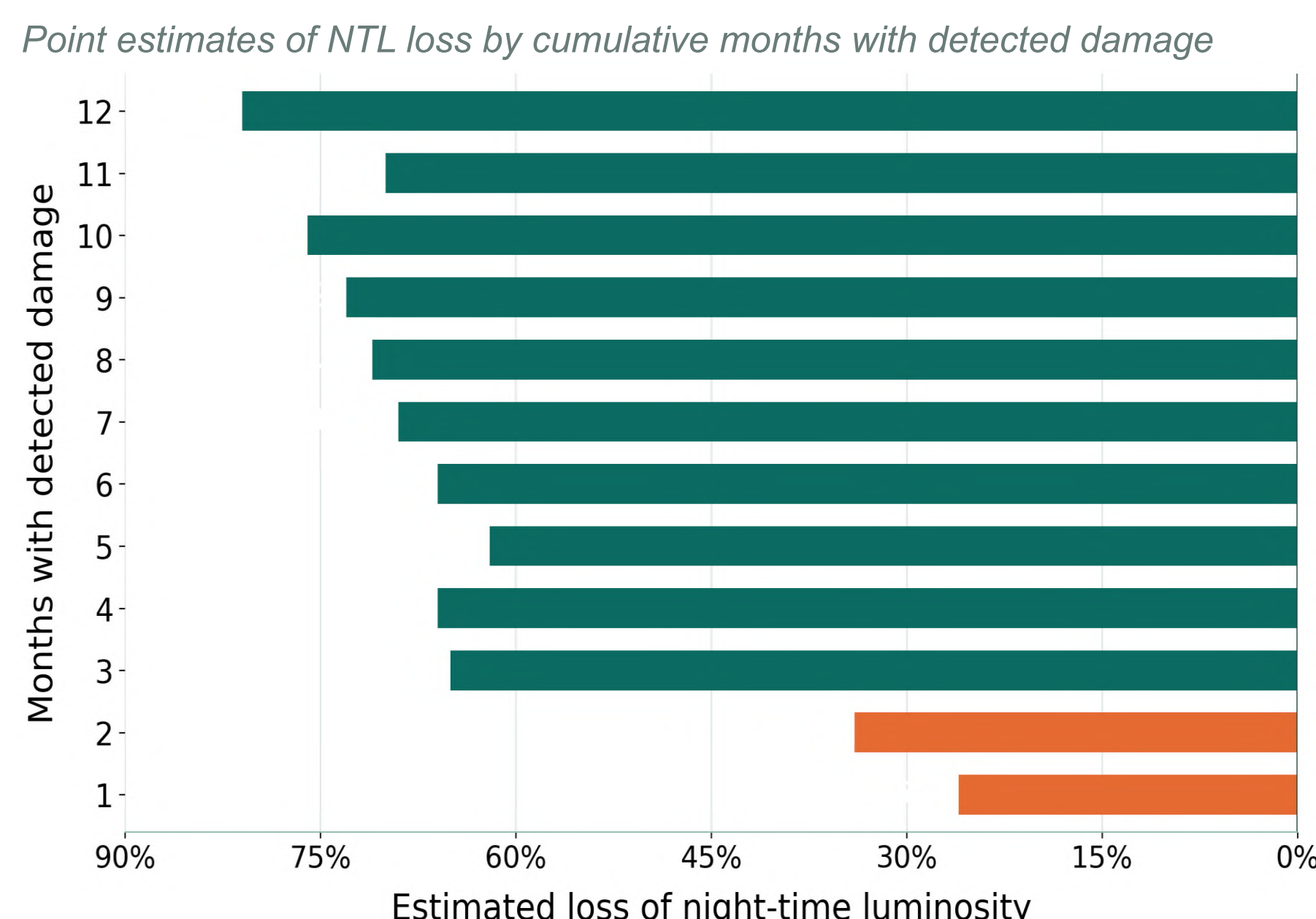
Prewar NTL elasticities convert the estimated light loss into GDP and household-expenditure losses.

IDENTIFICATION CHECKS

No detectable pre-trends • similar estimates across three estimators • Conley spatial errors and adjacency exclusions • controls for locality-wide destruction and displacement

REPEATED DAMAGE

The more often an area was hit, the darker it became



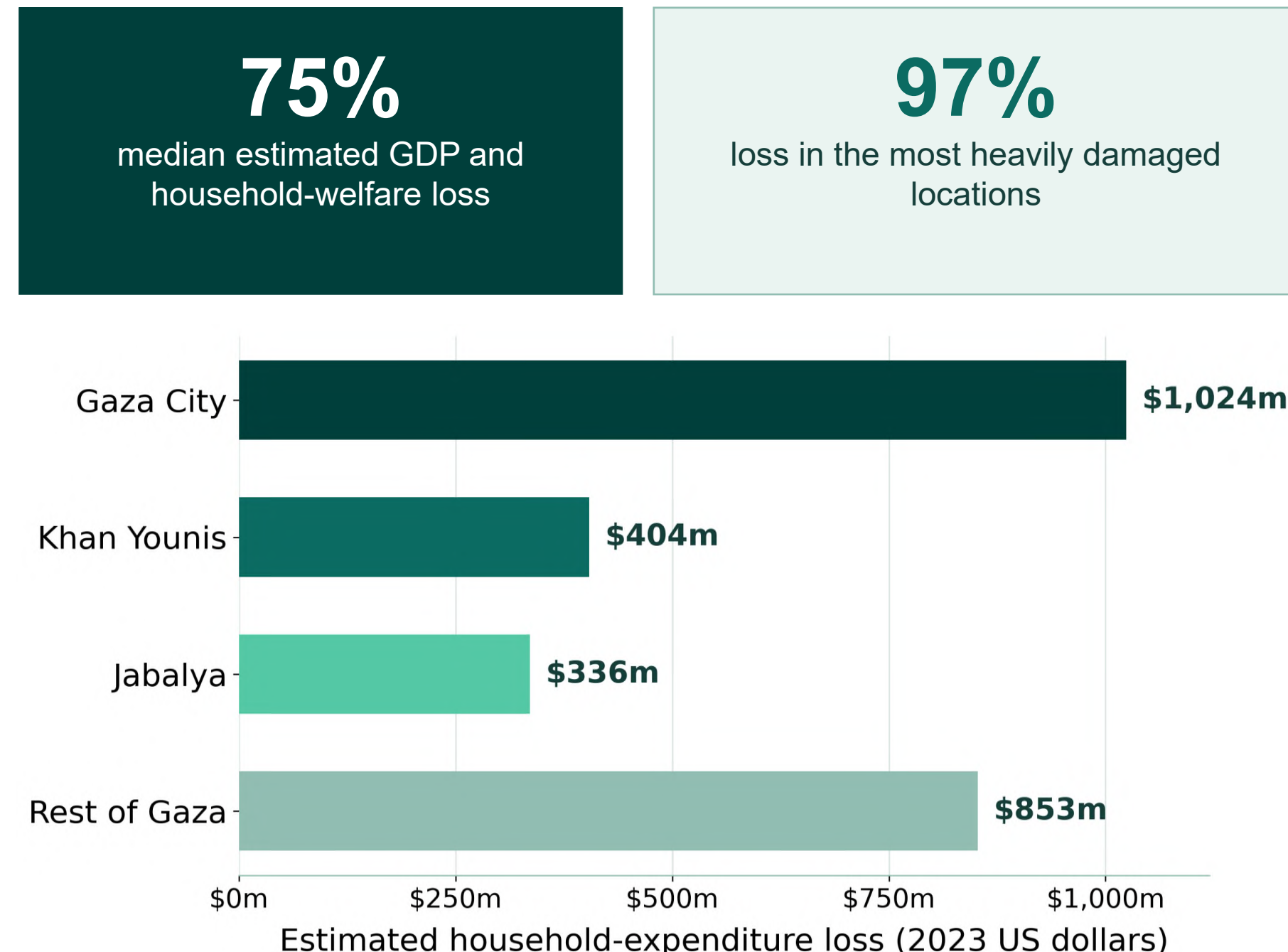
1-2 MONTHS DAMAGED
26%-34% NTL loss

3+ MONTHS DAMAGED
at least 65% NTL loss

By twelve months of repeated exposure, the estimated loss reached 81%. The relationship is nonlinear: a major break appears after the second month.

ECONOMIC DAMAGE

Light loss maps into large welfare losses



Total estimated household-expenditure loss: \$2.617bn. Gaza City alone accounts for about \$1.024bn.

The one-week ceasefire of 24-30 November 2023 was associated with +8.76 percentage points of NTL - a 25.7% rebound from the post-damage baseline.

WHY THIS MATTERS

Independent evidence for response and recovery

- 1 LOW LATENCY**
Repeated radar and light observations update the picture during a conflict.
- 2 FINE SPATIAL RESOLUTION**
One-km² estimates reveal where activity losses are most severe.
- 3 INDEPENDENT OF FIELD REPORTING**
The method does not require administrative data supplied by conflict parties.
- 4 SCALABLE**
The framework can support rapid assessment, aid targeting and recovery planning elsewhere.

SELECTED INTERNATIONAL MEDIA AND POLICY COVERAGE

