

Supplementary Information

Auditing observability bias in InSAR-derived subsidence exposure estimates with a reproducible geospatial workflow

This Supplementary Information provides reviewer-facing robustness and traceability material for the main manuscript. The figures and table support the same bounded claim as the main text: weakly observed exposure is retained for audit, not interpreted as confirmed damage or dense site-level validation.

Supplementary Figures

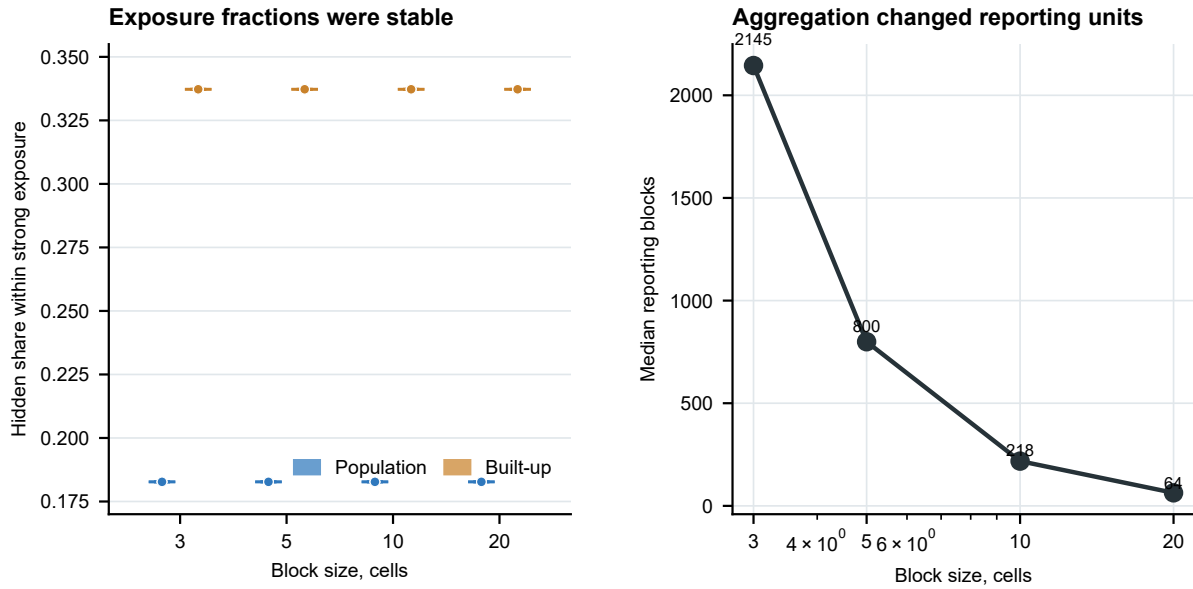


Figure 1: MAUP and shifted-origin sensitivity. The left panel shows that hidden population and built-up shares within the strong-exposure layer remained stable across tested block sizes and shifted origins. The right panel shows that the reporting units changed substantially as block size increased. The result supports the interpretation that the retained hidden exposure is not an artefact of one reporting partition.

Supplementary Tables

Supplementary Source Data

The supplementary figures are generated from the MAUP sensitivity table, placebo randomization outputs, multi-region meta-closure tables and external-control summaries included in the submission package. The corresponding source files are:

- `chao_phraya_maup_sensitivity_v1.csv`

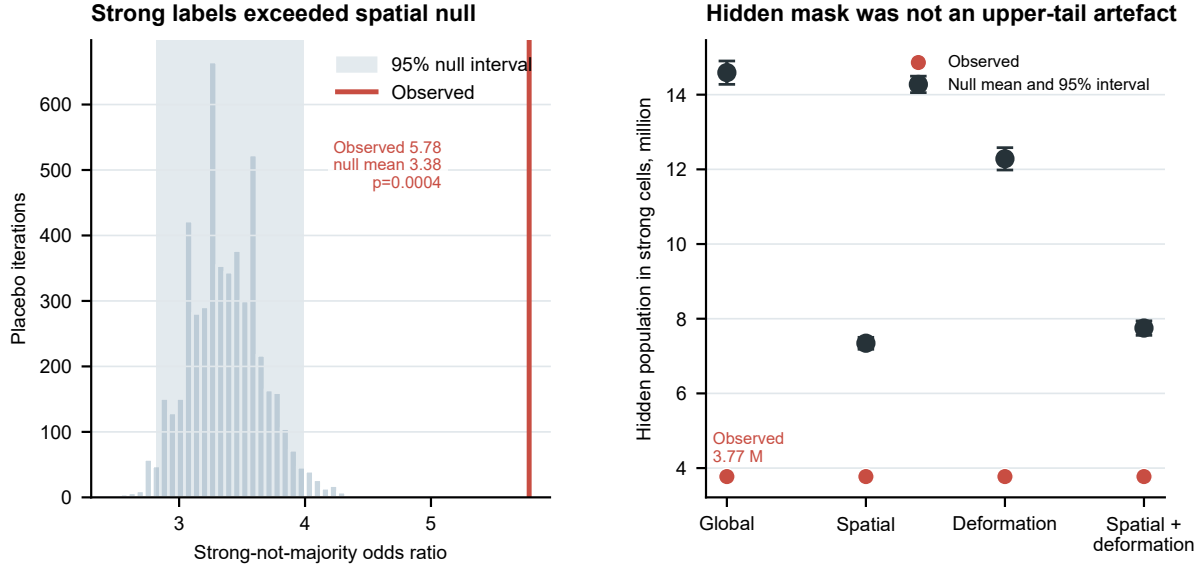
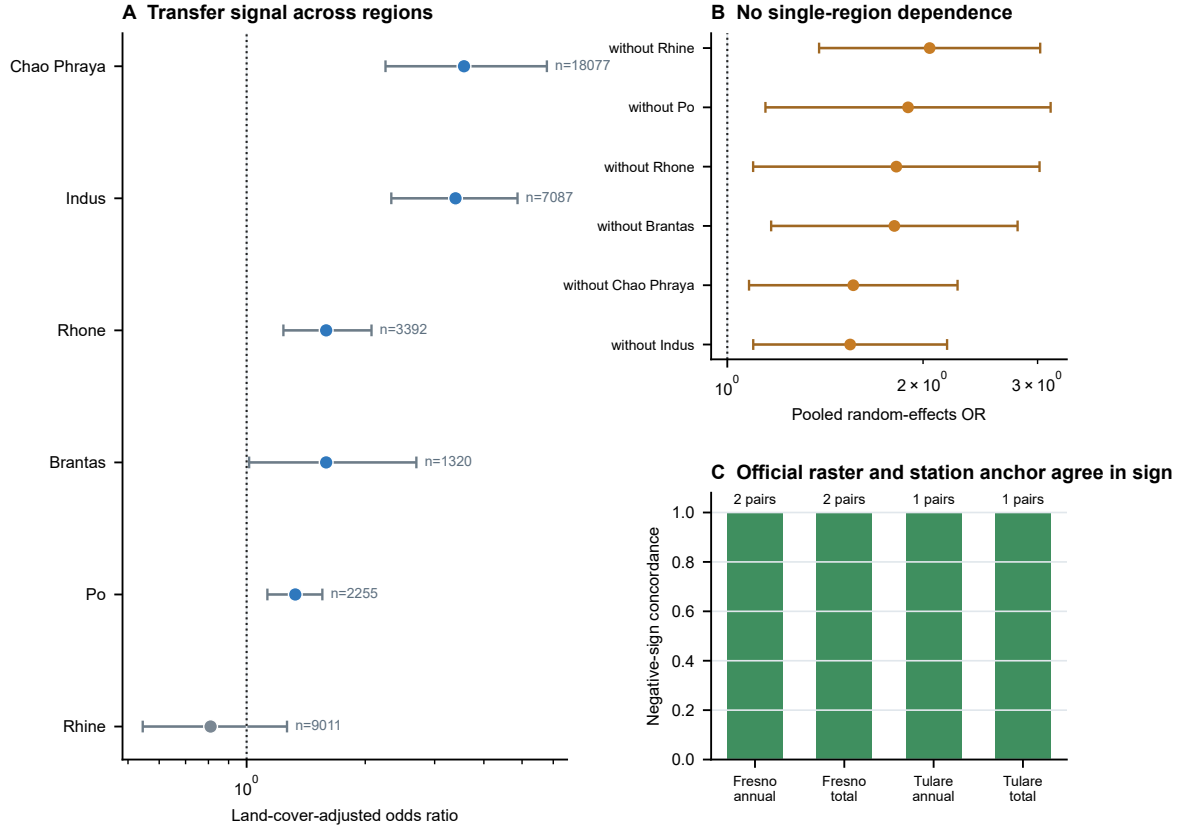


Figure 2: Placebo randomization checks. The left panel compares the observed strong-not-majority-observable odds ratio with the spatial placebo null distribution. The right panel compares the observed hidden population in strong cells with null expectations from random hidden-mask models. The checks are falsification tests for random label or mask placement and are not interpreted as independent deformation validation.

Table 1: Evidence-role inventory for the ESIN submission package.

Evidence layer	Role	Completed result or file status	Claim boundary
Chao Phraya GHSL closure	Lead exposure closure	3.77 M hidden people; 404.77 km ² hidden built-up; native-pixel sensitivity gives 3.63 M people	Retained exposure, not confirmed affected population
Threshold surface	Robustness check	120 combinations; 1.33–5.36 M people and 140.44–523.64 km ² built-up	Sensitivity surface, not posterior interval
MAUP and shifted origins	Reporting-partition check	3, 5, 10 and 20 cell blocks; hidden fractions preserved	Not exhaustive spatial-unit proof
Monte Carlo propagation	Scenario uncertainty	5000 iterations; population p05/p50/p95 = 1.64/3.65/5.48 M	Scenario uncertainty, not product confidence
Placebo randomization	Falsification check	OR = 5.78 versus spatial-null mean 3.38; random masks gave larger exposure totals	Tests random artefacts, not deformation truth
Decision ranking	Operational check	At 2000 cells, overlap = 0.9365; added 572,297 hidden people and 10.83 km ² built-up	Not cost-benefit or damage modelling
Po and Brantas	Transfer checks	Po OR = 2.60 (95% CI 1.95–3.47); Brantas supports positive transfer	Not dense EGMS validation
Rhone and Rhine	Conditional/control checks	Rhone conditional; Rhine non-positive control/specification case	Proxy-level evidence
DWR/TRE-GHSL	External positive control	Tulare/Corcoran strong pixels contain 102,164 people and 18.81 km ² built-up	Not Chao Phraya validation
Cyprus EGMS	Boundary/code-path control	17,340 overlays; 65 strong points and 0.31% population share at 5 mm yr ⁻¹	Near-zero tile, not strong benchmark
Po/Rhone EGMS hooks	Future benchmark	Payloads, runbook and closure code prepared	Not evidence until products are overlaid



Evidence role: panels A-B test transfer and single-region dependence; panel C is an external sign-control probe, not dense validation of the lead case.

Figure 3: Reviewer-risk experiments for transfer, single-region dependence and external sign control. Panel A reports land-cover-adjusted observability-bias odds ratios across six regions. Panel B reports leave-one-region-out random-effects estimates, showing that the pooled signal remains above unity when any single region, including the lead Chao Phraya case, is omitted. Panel C reports sign concordance between official DWR raster summaries and nearby NGL station anchors in the Central Valley positive-control setting. These checks strengthen transfer and external-control evidence but are not interpreted as dense validation of the lead hidden-exposure estimate.

Table 2: Major-revision risks addressed by added experiments.

Reviewer risk	Experiment or check	Remaining boundary
Single-case dependence	Multi-region land-cover-adjusted forest plot and leave-one-region-out random-effects analysis	Supports transfer of the audit signal, not pooled global exposure
Threshold or partition artefact	Threshold surface, MAUP shifted-origin tests and native-pixel allocation	Shows persistence across tested choices, not universal invariance
Random hidden-mask explanation	Placebo randomization of strong labels and hidden masks	Falsifies random-placement alternatives, not deformation causality
Weak external evidence	DWR/GHSL positive control, DWR/NGL sign concordance and Cyprus EGMS near-zero boundary control	Bounds code-path and sign behavior, not dense Chao Phraya validation
Overclaiming hidden exposure	Evidence-role inventory and bounded-evidence protocol	Hidden exposure remains retained weak-observability exposure, not confirmed affected population
Reproducibility concern	Source-data inventory, runbooks, figure source data and release metadata	Credentialed EGMS extensions remain prepared hooks unless product access is available

- `chao_phraya_placebo_randomization_summary_v1.csv`
- `chao_phraya_placebo_randomization_draws_v1.csv`
- `multi_region_meta_closure_region_table.csv`
- `multi_region_meta_closure_leave_one_out.csv`
- `dwr_ngl_station_validation_stats_v1.csv`
- `ESIN_Supplementary_Figure_S3_source_data.csv`
- `Q1_STYLE_EXPERIMENT_STRENGTHENING_20260719.csv`
- `external_control_synthesis_v1.csv`