# Where Is Saint Lucia's Household Infrastructure Divide? Household Co-Deprivation, District Burden, and Change Across the 2010–2022 Censuses

Kevin L. Michel

Saint Lucia Policy Analysis

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Data, code, audit logs, an analytical workbook, and output tables accompany this manuscript.

## Abstract

Infrastructure disadvantage is often represented by one geographic rank, although deficits can affect different households, require different delivery systems, and produce different priorities when measured by local prevalence versus national caseload. This study uses Saint Lucia's 2022 Population and Housing Census REDATAM database to recover the exact weighted joint distribution of seven published household unmet-basic-needs proxies for 65,951 private households across 12 census districts. It combines household profiles, pairwise co-occurrence, district incidence and burden, a secondary latent-class sensitivity, and a fixed-item comparison with the 2010 Census. In 2022, 28.19% of households experienced at least one transparent disadvantage, 8.24% at least two, and 3.44% at least three; the first estimate is 26.77% under the technical note's stricter overcrowding threshold. Housing inadequacy was most prevalent (16.74%) but often occurred alone. The strongest overlaps instead linked deficient lighting, polluting or absent cooking fuel, information isolation, and sanitation. Micoud and Dennery had virtually tied highest incidence; Canaries had the deepest co-deprivation; and Castries Rural contained the largest national caseload. Harmonized endpoints show broad 2010–2022 improvements in access to a pipe inside the dwelling, severe sanitation, cooking fuel, and overcrowding, but much smaller change in weak housing materials. Internet access expanded far faster than desktop or laptop ownership. The resulting divide is not one gradient or household type. Policy should distinguish network presence, service reliability and safety, affordability, and dwelling or capability constraints, while treating 2022 as a baseline for current validation.


*Keywords:* household infrastructure; multidimensional deprivation; census; latent class analysis; small-area policy; Saint Lucia; REDATAM

## Introduction

“Where is the infrastructure divide?” sounds like a request for a map. For public policy, however, it is at least three different questions. One concerns household co-deprivation: whether the same households lack several basic services or capabilities. A second concerns local incidence: the share of households affected within a place. A third concerns national burden: the share of all affected households living in that place. These quantities need not identify the same districts, and they do not automatically imply the same intervention. A small district can have acute prevalence but contain a modest share of the national caseload; a populous district can have moderate incidence but account for many households requiring assistance. A weak roof, an unreliable water source, non-electric lighting, and lack of a computer also point to different delivery institutions and diagnostic questions.

Saint Lucia’s 2022 Population and Housing Census provides an unusually rich basis for separating these questions. Its public REDATAM database contains weighted household variables on water supply and continuity, toilet facilities, lighting, cooking fuel, refuse disposal, internet access, computers and other assets, housing materials, crowding, tenure, and vehicles. Person-level tables add education, illness, employment, and migration context. More importantly for this study, the public processor permits joint household tabulation rather than only district-level marginal percentages. It is therefore possible to observe the complete weighted distribution of seven documented household infrastructure-disadvantage flags without obtaining or reconstructing confidential microdata.

That capability matters because district correlations cannot establish household clustering. If high rates of poor sanitation and information isolation occur in the same district, the two conditions may still affect different households. Exact joint household profiles avoid that ecological inference. At the same time, public geography imposes a hard limit: household infrastructure is exposed for 12 census districts, not the named communities, settlements, constituencies, or enumeration districts for which the provisional report provides only population and household counts. The present paper consequently offers a district analysis with household-level co-occurrence, not a neighbourhood map.

The study also revisits how Saint Lucia measures small-area disadvantage. The official 2010 Basic Needs Index was an important early attempt to combine household and person conditions at community level (St. Catherine, 2011). It assigned scores to assets partly according to their rarity, included education and employment alongside infrastructure, aggregated household scores to communities, and divided communities into relative quintiles. Those choices served a ranking purpose but make the index difficult to interpret as an absolute infrastructure standard or to compare across time. Technologies, asset prevalence, item definitions, and relative cut points all changed. Rather than compare incomparable composite ranks, this paper constructs a fixed-item 2010–2022 panel for endpoints whose category meanings can be harmonized directly.

The paper asks four questions. First, which of the seven published household infrastructure disadvantages co-occurred in 2022, and which commonly appeared alone? Second, where were local incidence, deeper co-deprivation, and absolute national burden concentrated? Third, how did a restricted set of comparable conditions change between the 2010 and 2022 censuses? Fourth, what type and scale of intervention is consistent with each observed pattern, subject to validation of the mechanism?

The main findings are that the divide is both multidimensional and intervention-specific. Housing inadequacy dominated the national count, yet its household association with other domains was weak. A smaller service-deficit bundle linked lighting, cooking fuel, information isolation, and sanitation much more closely. About two fifths of households in Micoud and Dennery experienced at least one transparent disadvantage, while Canaries recorded the highest shares with at least two or at least three. Castries Rural, not the highest-incidence district, contained the largest share of all affected households. Across censuses, severe sanitation, non-piped water, polluting or absent cooking fuel, and overcrowding improved nationally and in all 10 administrative districts, but weak construction changed much less and remained geographically persistent. The paper's contribution is therefore not a new definitive rank. It is a reproducible separation of household profiles, place-specific rates, national caseload, and change, followed by an intervention-matching framework that preserves the distinction between an observed census symptom and its unmeasured cause.

## Conceptual and Empirical Background

### Multidimensional measurement without a black-box rank

Multidimensional counting methods clarify how many conditions a household experiences and how conclusions change with the cutoff used to define multiple disadvantage (Alkire & Foster, 2011). Composite measures can also conceal consequential normative choices about indicators, weights, aggregation, and thresholds (Decancq & Lugo, 2013; Greco et al., 2019; OECD et al., 2008). Ravallion (2012) cautioned that a composite can look precise while mixing dimensions whose trade-offs have no clear substantive meaning. Those concerns are particularly relevant to infrastructure. A household cannot necessarily compensate for unsafe sanitation with internet access, and a network extension cannot repair a weak dwelling.

The primary measurement strategy here is consequently transparent and minimally aggregative. Seven binary domains are counted with equal weight, but the component dashboard and exact profiles remain the principal evidence. The count answers how many published conditions were present; it does not assert that every condition is equally harmful or that any threshold defines poverty. The terms "infrastructure disadvantage," "co-deprivation," and "unmet-basic-needs proxy" are used instead of "poor household." Counts, rates, and domain identities are reported together.

Small-area deprivation studies also show the value of combining incidence with absolute burden and of preserving domain-specific results (Allik et al., 2016; Exeter et al., 2017). Relative ranks are useful for allocation under a fixed budget, but they do not show whether conditions meet an external service standard or whether differences between adjacent ranks are meaningful. They can also change when geography changes, an instance of the modifiable areal unit problem (Fotheringham & Wong, 1991). With only 12 public infrastructure geographies, this paper does not use district principal components or data-driven district clustering. Such models would attempt to infer a multivariate structure from too few areas. Instead, districts are descriptive roll-ups of exact household distributions.

## Household profiles and latent classes

Latent class analysis can summarize recurrent patterns among binary household indicators and is preferable to clustering dummy-coded households when its conditional-independence and identification assumptions are credible (Nylund et al., 2007; Weller et al., 2020). Census-sized data create a particular complication: information criteria can favor additional small classes for minor improvements in fit. Solutions should therefore be judged by replicated likelihoods, class size, local fit, classification diagnostics, interpretability, and stability, not one statistic alone.

For that reason, latent classes are secondary in this paper. Exact bit patterns and pairwise associations answer the clustering question without a model. A parsimonious two-class model is shown only as an exploratory summary because it is stable and interpretable; conventional information criteria favor more classes, while the higher-class likelihood solutions are not securely replicated and the two-class model retains substantial local dependence. No class is treated as a natural, immutable household type.

### From observed condition to intervention mechanism

A census item usually records a symptom, not the full delivery failure. A household’s main water source does not establish continuity, pressure, potability, or affordability. Toilet type does not reveal whether excreta are safely contained, transported, and treated. The WHO/UNICEF service ladders require information beyond source and facility categories before “safely managed” water or sanitation can be claimed (World Health Organization & United Nations Children’s Fund, 2023). Main lighting source is not a complete grid-connection measure; no internet does not identify coverage, price, devices, or skills; and vehicle non-ownership is not inherently deprivation.

The policy interpretation therefore distinguishes four mechanisms: network presence, service reliability or safety, affordability, and dwelling, tenure, or capability constraints. It then distinguishes four response scales: household support, settlement upgrading, utility- or system-level investment, and integrated case management. Census patterns identify where to validate these mechanisms and where outreach may be warranted. They do not establish project feasibility, costs, causal impacts, or present-day household eligibility.

## Policy and Institutional Setting

Saint Lucia has institutional instruments relevant to each of these response scales. Water-sector investment includes rehabilitation of the Theobalds and Patience systems and a Caribbean Development Bank-supported climate-resilient water-supply and wastewater master plan (Caribbean Development Bank, 2024; Government of Saint Lucia, 2025b). The National Utilities Regulatory Commission’s tariff-review process treats affordability and service quality as distinct considerations (National Utilities Regulatory Commission, 2026). These programmes make a water-source pattern policy-relevant, but they do not show that a 2022 census condition has since been resolved or that network expansion is the appropriate response in every location.

Energy policy similarly extends beyond nominal connection. The National Energy Policy 2023–2030 emphasizes security, reliability, resilience, and greening, while imported-fuel dependence has contributed to high electricity costs (Government of Saint Lucia, 2024b; World Bank, 2022). A household reporting non-electric lighting may face a last-mile network gap, disconnection, unaffordable wiring or bills, unsafe dwelling conditions, informal tenure, or response error. Grid proximity, account status, wiring safety, and household circumstances must therefore be checked before an extension, connection grant, repair, or income-support response is selected.

Digital-policy tools include the Caribbean Digital Transformation Project and the National Telecommunications Regulatory Commission’s Universal Service Fund, which can support access, devices, institutions, and underserved groups (National Telecommunications Regulatory Commission, n.d.; World Bank, 2020). The distinction between internet connection and computer ownership is especially important. Mobile connectivity may support communication while remaining inadequate for some educational, employment, business, or public-service tasks. Public Wi-Fi and digital centres can complement but do not necessarily replace secure, usable household access.

Housing and settlement responses include repair and finance instruments, settlement upgrading, and the Programme for the Regularisation of Unplanned Developments (Caribbean Development Bank, n.d.; Government of Saint Lucia, 2016, 2025c). Physical condition, tenure, hazard exposure, and displacement risk must be considered jointly. Credit may be appropriate for some stable-income owners, grants or blended finance for poorer owners, and habitability incentives with displacement protection for renters. Regularisation is not appropriate on intolerable-risk sites without mitigation or fair relocation.

Solid-waste services and transport require similarly specific diagnostics. Burning or dumping may reflect route access, collection frequency, storage, distance to a communal point, information, or compliance; enforcement is credible only when service is available (Government of Saint Lucia, n.d.). Vehicle non-ownership becomes a mobility-risk indicator only when combined with remoteness, disability, school or employment access, or weak transport service. Saint Lucia's public-transport planning has considered routes, tariffs, fleets, terminals, regulation, and vulnerable users rather than vehicle ownership subsidies (Government of Saint Lucia, 2022).

Finally, infrastructure disadvantage can interact with illness, disability, unemployment, low education, age, or household dependency. Koudmen Sent Lisi and the National Social Protection Policy monitoring framework provide an institutional basis for coordinated household pathways spanning housing, health, education, income, employment, counselling, and social networks (Government of Saint Lucia, 2024a, 2025a). Area indicators can guide outreach and service placement, but current assessment, transparent eligibility criteria, and redress should determine household support.

## Data and Methods

### 2022 Census, universe, and weights

The primary source is the public Saint Lucia 2022 Population and Housing Census REDATAM database and its provisional report, questionnaire, technical notes, and data dictionary (Central Statistical Office of Saint Lucia [CSO], 2024a, 2024b; CSO & United Nations Economic Commission for Latin America and the Caribbean [ECLAC], n.d.-b, n.d.-c).

The Census is de jure and refers to usual residence on the night of March 12–13, 2022. The household infrastructure universe is private households, analyzed with the household coverage-adjustment weight, HHOLD.HHLD_WEIGHT.

The provisional report documents 60,244 households in the mapping and listing operation, 50,588 enumerated through the census process, and a coverage-adjusted estimate of 65,951 households. No post-enumeration survey was conducted. Geographically varying adjustment factors were applied to address underenumeration, and the public sources provide no replicate weights or coverage-error variance. The exact REDATAM household-weight sum is 65,951.115. Rounding each of the 12 district margins separately produces 65,952, while the national margin rounds to 65,951; this is independent rounding of fractional weighted values, not an omitted household.

The public REDATAM application was accessed August 12, 2026. Every processing program, HTML response, and fractional XLSX output used in the analysis was frozen and hashed. The generated HTML rounds joint cells to integers even when decimals are requested, whereas the XLSX retains fractional weights. All joint results therefore use the XLSX values. Person-level context measures use the separate person weight and person denominator; they are not treated as household rates.

## Geography and disclosure boundary

The finest defensible public infrastructure geography is 12 census districts: Castries City, Castries Suburban, Castries Rural, Anse La Raye, Canaries, Soufriere, Choiseul, Laborie, Vieux Fort, Micoud, Dennery, and Gros Islet. The common 10-district presentation combines the three Castries units. The provisional report prints household and population counts for constituencies, communities, and settlements, but those identifiers are not publicly exposed with household infrastructure. Forced enumeration-district output returned only synthetic district-total codes.

Accordingly, no result is labeled community- or neighbourhood-level, and no household coordinate or confidential record is used.

### Seven transparent 2022 domains

The technical notes document seven household unmet-basic-needs components. The analysis reproduces their executable REDATAM logic:

1. Housing: a makeshift roof; makeshift, plywood, or mixed plywood-concrete walls; squatted tenure; or at least three persons per bedroom under the live executable. 2. Water: spring or river as the main supply, supply only once every two weeks or monthly, an unprotected spring, or surface drinking water. 3. Sanitation: an open pit, bucket or bag, hanging latrine, or no facility/bush/field. 4. Lighting: gas lantern, kerosene, candles, or no lighting. 5. Cooking fuel: coal, wood, or no cooking fuel. 6. Refuse: burning or dumping on land, in water, or elsewhere. 7. Information: no television, no radio, and neither paid nor unpaid household internet.

These are called transparent UBN proxies because their formulas are observable and reproducible. They do not establish safely managed water or sanitation, reliable electricity, affordable connectivity, structural safety, or welfare impact. The information component is more restrictive than "no internet," and the water component is narrower than "no pipe into the dwelling."

The executable programs generally default missing or out-of-range inputs to nondeprived. This conservative behavior is reproduced for comparability and disclosed. The housing technical-note prose says "more than three persons per bedroom," but the executable flags three or more. The executable threshold is primary; the strict prose threshold is a sensitivity. A separate precomputed variable, NUMUBN_R, does not reconcile with the sum of the current seven formulas for 4.12% of weighted households and is not used in the main analysis.

**Table 1**

***Transparent 2022 Household Infrastructure Domains***

| Domain | Executable flag | Weighted households | Rate (%) | Measurement boundary |
|---|---|---|---|---|
| Housing | Weak roof/walls, squatting, or ≥3 persons per bedroom | 11,039 | 16.74 | Composite condition, not a structural inspection; executable crowding threshold is ≥3 |
| Information | No television, radio, paid internet, or unpaid internet | 5,720 | 8.67 | Stricter than no internet; missing components conservatively prevent the flag |
| Lighting | Gas lantern, kerosene, candles, or no lighting | 2,760 | 4.18 | Main source is not comprehensive grid connection, reliability, or affordability |
| Cooking-fuel disadvantage | Coal, wood, or no cooking fuel | 2,692 | 4.08 | Fuel category does not measure exposure, stove quality, or affordability |
| Sanitation | Open pit, bucket/bag, hanging latrine, or no facility/bush/field | 2,015 | 3.06 | Facility category does not establish safe containment, transport, or treatment |
| Refuse | Burning or dumping on land, in water, or elsewhere | 1,757 | 2.66 | Disposal mode does not identify collection availability or the reason for use |
| Water | Spring/river supply, very infrequent supply, unprotected spring, or surface drinking water | 1,725 | 2.62 | Does not establish safely managed water or flag every household without indoor pipe |

*Note.* All estimates use the 2022 household coverage-adjustment weight. The labels reproduce documented REDATAM proxy rules; they are not measures of safely managed, reliable, or affordable service.

### Exact household profiles and co-occurrence

Each binary domain is assigned one bit in a seven-bit code ranging from 0 to 127. A single REDATAM cross-tabulation recovers the exact weighted frequency of every observed pattern by district. Five patterns have zero frequency and are restored explicitly as zeros. The cells reproduce the national and all district margins exactly.

For household h and domain j, let z_hj equal 1 when the transparent proxy is present. The deprivation count is c_h = sum_j z_hj. The paper reports the full distribution of c_h; the shares with at least one, two, and three domains; and the most frequent exact profiles. These are counting summaries, not an official poverty measure. No cross-dimensional cutoff is used to declare a household poor.

Pairwise household association is summarized with the weighted phi coefficient for two binary domains. The coefficient is calculated from the exact weighted 2 by 2 margin implied by the pattern table. Both the joint household rate and phi are retained because a strong association can involve a small number of households when marginal prevalence is low.

### District incidence, intensity, and burden

For domain j in district g, local incidence is r_gj = d_gj/n_g, where d_gj is the weighted number of affected households and n_g is the district’s weighted household count. National burden is b_gj = d_gj/sum_g d_gj, the district’s share of all households affected by that domain. The location quotient is LQ_gj = r_gj/r_.j, where r_.j is national incidence. For the cumulative count, the analysis reports local shares with at least one, two, and three domains, mean number of domains, and share of the national at-least-one caseload.

This dual presentation prevents a common allocation error. Incidence indicates local prevalence; deeper co-deprivation is described separately by the shares with at least two or three domains and the mean count. Burden indicates how much of a national programme’s potential caseload is located in the district. Location quotients identify relative specialization but are not severity ranks, especially where the national rate is small.

### Fixed-item 2010–2022 comparison

The 2010 source is the public Saint Lucia 2010 Census REDATAM database (CSO & ECLAC, n.d.-a). Its 50,241 household records represent 58,920 weighted households using HHOLD.HWEIGHT; the mean weight is 1.173 and varies across districts. Codes and labels align for 12 statistical districts, but that nominal match is not sufficient evidence of stable boundaries. In particular, the weighted household margins shift sharply among Castries City, Castries Suburban, and Castries Rural while their combined total is much more stable, consistent with boundary or classification change. National comparisons are therefore primary. Subnational trends aggregate the three Castries units and use 10 administrative districts; the 12-unit geography is retained only for the 2022 cross-section.

Only fixed items with defensible semantic correspondence are compared. Primary endpoints are no piped water into the dwelling, spring or river as the main water supply, no toilet facility, coal/wood/no cooking fuel, improvised housing, fixed weak roof or wall materials, and at least three persons per bedroom. Squatted tenure is shown separately because it is not physical quality. No household internet and neither electric nor solar lighting are caveated contrasts because technologies and questionnaire categories changed. No desktop or laptop is a sensitivity because 2010 used sparse positive-flag storage and did not ask about tablets. Waste is side-by-side only because 2010 allowed one disposal response and 2022 allowed several. Richer water, sanitation, refuse, and information UBNs are not trended.

Rates use item-specific valid-response denominators and wave-specific weights. Percentage-point change is descriptive; conventional sampling confidence intervals are not calculated for these coverage-adjusted census estimates. Ten-district rank correlations and extremes are exploratory summaries of persistence, not tests of programme impact. No change is attributed to a policy, investment, migration, or economic condition.

### Exploratory latent-class sensitivity

A grouped-data Bernoulli latent class model is fitted to the 123 observed seven-bit patterns using exact household weights. One- through six-class solutions use 120 random starts. For a constrained compression exercise, two operational admissibility screens are applied: at least 3% in the smallest class and recovery of the best likelihood in at least 10% of starts. Among the two- through six-class solutions satisfying both screens, the retained solution is the one with the lowest BIC; this yields two classes. Conventional unconstrained BIC instead favors six classes and CAIC five; best likelihoods for three through six classes are each recovered only once in 120 starts. The 3% threshold itself is consequential, so this sensitivity is not presented as a definitive typology.

The two-class solution is diagnosed with entropy, average posterior probability, global deviance and Pearson discrepancy, expected-cell counts, and full 2 by 2 bivariate Pearson residuals. Conditional multinomial perturbations provide 5th–95th percentile algorithmic stability ranges, not design-based confidence intervals. District mixing proportions are estimated with national item-response profiles fixed. The LCA is used only as a low-dimensional compression of the exact profiles; exact patterns remain primary.

### Contextual benchmarks and intervention matching

Education, illness, employment, internet access, computing devices, and vehicle ownership are excluded from the seven-domain count unless they are already part of an official component. They are used as contextual or convergent benchmarks so that the infrastructure construct is not broadened until it becomes circular. Internet access is not an independent validator because internet is one input to the information UBN. Spearman associations between district mean UBN count and selected district context measures are reported descriptively for 12 areas. These correlations mix household and person denominators, are sensitive to a single district, and cannot establish household-level or causal relationships.

The final intervention matrix maps observed patterns to diagnostic questions and response scales. It does not estimate treatment effects. For each pattern, the paper asks whether the likely constraint is network presence, reliability or safety, affordability, or dwelling/tenure/capability; whether the response belongs at household, settlement, system, or case-management scale; and what evidence remains necessary before implementation.

### Reproducibility and analytic uncertainty

The replication package contains source catalogs and hashes, geographic and variable crosswalks, exact REDATAM programs and outputs, processing code, model diagnostics, all tables and figures, an analytical workbook, and a documented exceptions log. Decimal weighted cells are retained until display. The principal uncertainty is not ordinary sampling error but undercount adjustment, missingness, classification, threshold choice, provisional data revision, geographic aggregation, and model specification. Sensitivity analyses therefore focus on those sources.

## Results

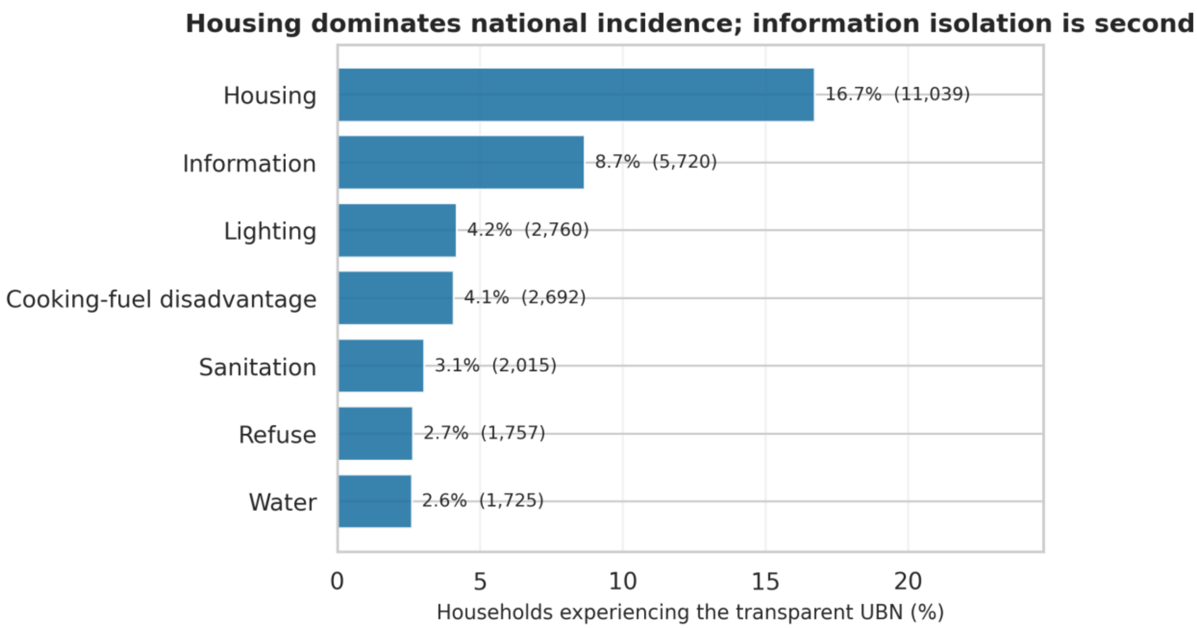
### National incidence and the depth of co-deprivation

The seven transparent domains identify 18,593.875 weighted households with at least one disadvantage, 28.19% of the national total. Most of these households experienced a single flagged domain: 19.96% of all households had exactly one, 4.80% exactly two, 1.96% exactly three, and 1.48% four or more. The at-least-two rate was 8.24%, and the at-least-three rate 3.44%. The mean number of flagged domains across all households was 0.420.

Housing had the highest national incidence, 16.74% or approximately 11,039 weighted households. Information isolation was second at 8.67% or 5,720. The remaining domain rates were 4.18% for lighting, 4.08% for cooking fuel, 3.06% for sanitation, 2.66% for refuse, and 2.62% for the narrow water UBN. These magnitudes should be read against the exact definitions. The information indicator requires simultaneous absence of television, radio, and paid or unpaid internet. The water indicator flags selected severe-source, continuity, and drinking-water conditions; it does not flag every household without a pipe into the dwelling.

**Figure 1**

***National Incidence of Transparent Household Infrastructure Disadvantages***




The national count is not dominated by deeply deprived households. The most common nonzero profile was housing alone, affecting 12.35% of all households. Information alone affected 3.30%, water alone 1.27%, and refuse alone 1.16%. Housing plus information was the most common two-domain profile at 1.19%. No other exact nonzero pattern exceeded 1% of all households. This concentration in a small set of profiles is useful for programme design: the marginal housing rate does not imply that most housing-flagged households require a seven-service package.

**Table 2**
***Most Frequent Nonzero Household Infrastructure Profiles***

| Exact profile | Domains | Weighted households | All households (%) |
|---|---|---|---|
| Housing | 1 | 8,148 | 12.35 |
| Information | 1 | 2,178 | 3.30 |
| Water | 1 | 837 | 1.27 |
| Housing + Information | 2 | 783 | 1.19 |
| Refuse | 1 | 764 | 1.16 |
| Cooking-fuel disadvantage | 1 | 535 | 0.81 |
| Sanitation | 1 | 371 | 0.56 |
| Lighting + Information | 2 | 371 | 0.56 |
| Lighting | 1 | 328 | 0.50 |
| Housing + Sanitation | 2 | 298 | 0.45 |
| Lighting + Cooking-fuel disadvantage + Information | 3 | 293 | 0.44 |
| Cooking-fuel disadvantage + Information | 2 | 271 | 0.41 |
| Housing + Refuse | 2 | 246 | 0.37 |
| Sanitation + Lighting + Cooking-fuel disadvantage + Information | 4 | 228 | 0.35 |
| Housing + Water | 2 | 212 | 0.32 |

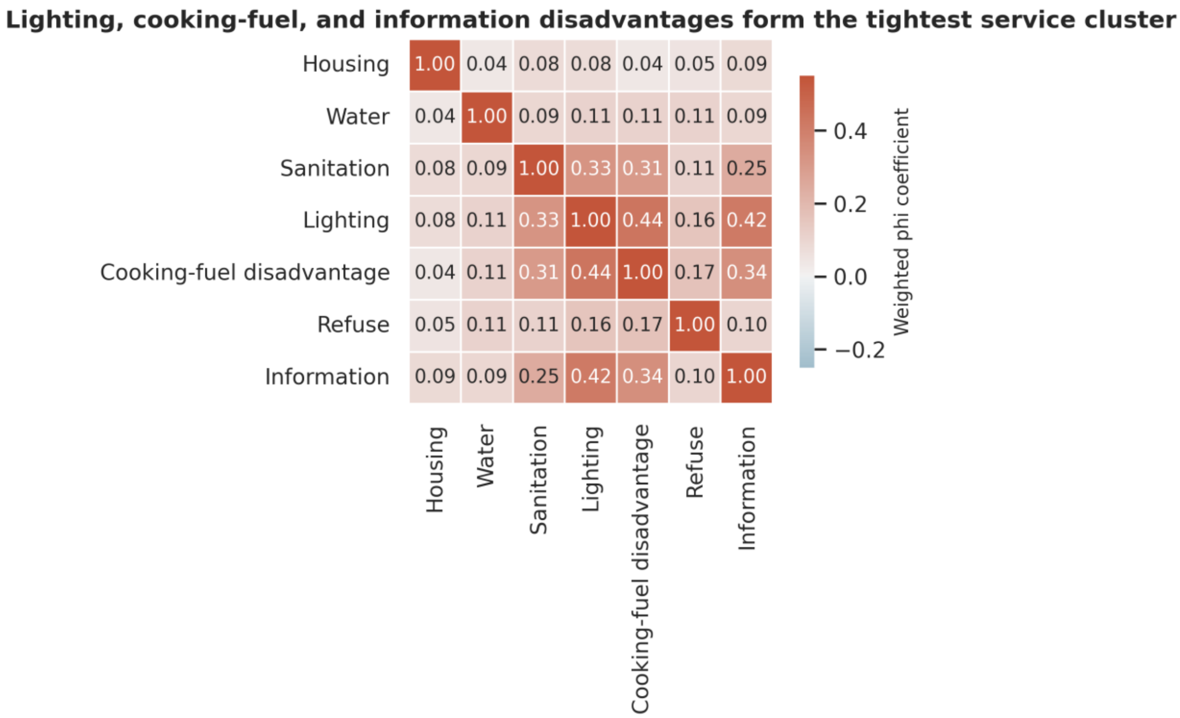
*Note.* Profiles are mutually exclusive. Housing alone represents 12.35% of all households; no multi-domain profile exceeds 1.19%.

## Which disadvantages clustered within households?

The pairwise results reveal a tighter service-related cluster than a general deprivation syndrome. Lighting and cooking-fuel disadvantage had the strongest association (phi = .437), followed by lighting and information (.417), cooking fuel and information (.344), sanitation and lighting (.329), and sanitation and cooking fuel (.306). Sanitation and information also overlapped meaningfully (.247). By contrast, housing's association with every other domain was below .10. Housing was common, but it was not the statistical centre of the service cluster.

The joint rates put those coefficients in scale. Lighting and information co-occurred in 2.71% of all households; cooking fuel and information in 2.27%; lighting and cooking fuel in 1.90%; and sanitation with lighting in 1.26%. Water and refuse each had low prevalence, so even a policy-relevant relative association involved a modest national count. The complete matrix therefore supports two simultaneous claims: a recognizable lighting–cooking–information–sanitation bundle exists, and no single bundle accounts for most household infrastructure disadvantage.

**Figure 2**
***Pairwise Household Association Among Seven Infrastructure Domains***




|  | Housing | Water | Sanitation | Lighting | Cooking-fuel disadvantage | Refuse | Information |
|---|---|---|---|---|---|---|---|
| Housing | 1.00 | 0.04 | 0.08 | 0.08 | 0.04 | 0.05 | 0.09 |
| Water | 0.04 | 1.00 | 0.09 | 0.11 | 0.11 | 0.11 | 0.09 |
| Sanitation | 0.08 | 0.09 | 1.00 | 0.33 | 0.31 | 0.11 | 0.25 |
| Lighting | 0.08 | 0.11 | 0.33 | 1.00 | 0.44 | 0.16 | 0.42 |
| Cooking-fuel disadvantage | 0.04 | 0.11 | 0.31 | 0.44 | 1.00 | 0.17 | 0.34 |
| Refuse | 0.05 | 0.11 | 0.11 | 0.16 | 0.17 | 1.00 | 0.10 |
| Information | 0.09 | 0.09 | 0.25 | 0.42 | 0.34 | 0.10 | 1.00 |

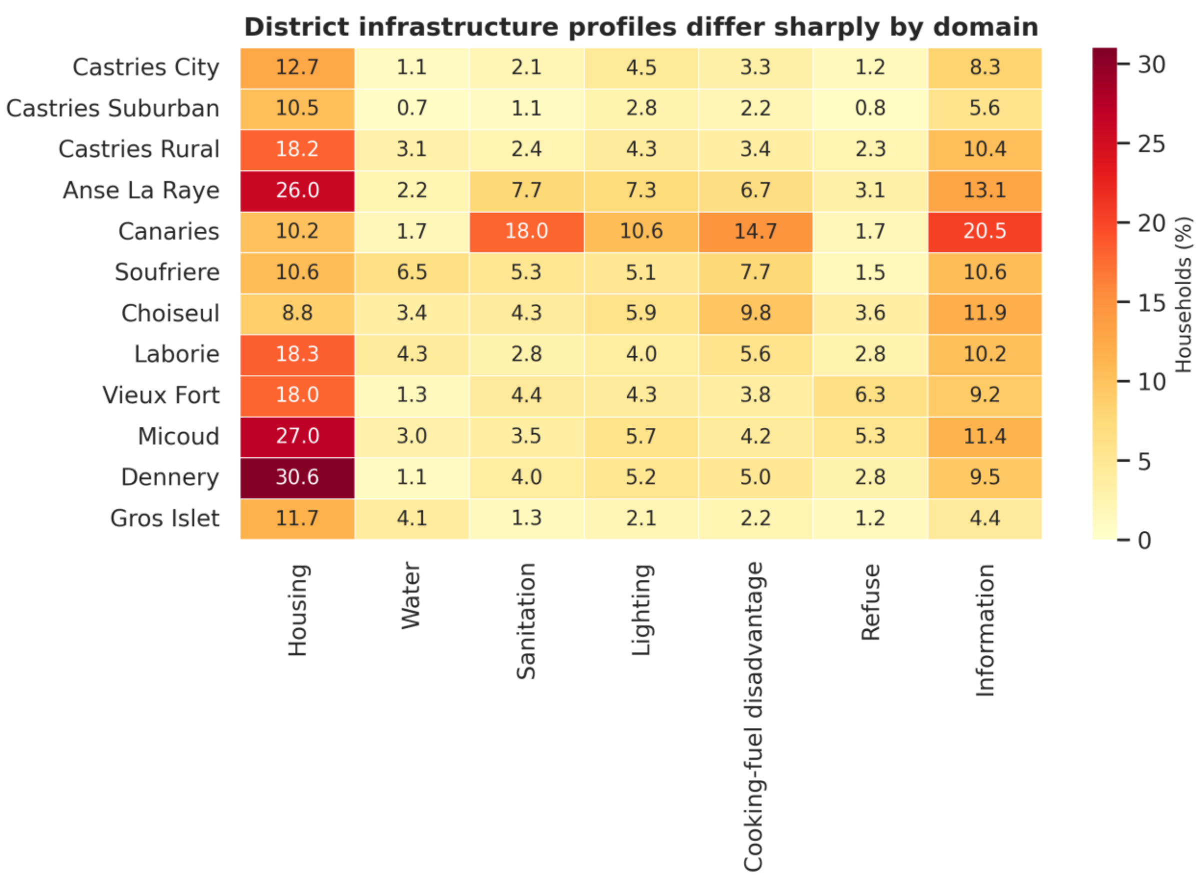
Appendix B reports a constrained two-class compression as a sensitivity. Although its best likelihood was recovered in all 120 starts, conventional BIC and CAIC favored higher-class solutions and the two-class model retained large global and pairwise discrepancies. It is therefore not used as a household typology or to support any substantive conclusion; the exact profiles and overlap matrix remain the evidence.

## District incidence, deep co-deprivation, and national burden

The district results cannot be reduced descriptively to one gradient. Micoud and Dennery had virtually tied highest shares of households with at least one transparent domain (40.08% and 40.04%), followed by Anse La Raye (39.26%) and Canaries (38.20%). Yet Canaries had substantially deeper co-deprivation: 20.03% of households experienced at least two domains and 11.02% at least three. The corresponding rates were 14.78% and 6.91% in Anse La Raye, 12.24% and 4.93% in Micoud, and 10.52% and 4.58% in Dennery. Castries Suburban had the lowest cumulative incidence: 18.01% at least one, 3.74% at least two, and 1.32% at least three.

Domain profiles explain the differences. Housing incidence reached 30.65% in Dennery, 27.00% in Micoud, and 25.95% in Anse La Raye. Canaries instead combined high information isolation (20.46%), sanitation disadvantage (18.03%), cooking-fuel disadvantage (14.74%), and lighting disadvantage (10.59%). Vieux Fort had the highest refuse incidence (6.31%) and contained 26.53% of all refuse-flagged households nationally. Soufriere's narrow water UBN rate was highest at 6.53%, while Gros Islet's rate was 4.08%; because Gros Islet is populous, it contained 27.91% of all households flagged by the narrow water domain. These results illustrate why a location quotient or a highest-rate label cannot substitute for counts.

**Figure 3**
***District Infrastructure Profiles by Domain***




National burden produced a different ordering from cumulative incidence. Castries Rural contained the largest share of all households with at least one transparent disadvantage, 15.11%, followed by Micoud at 13.73%, Vieux Fort at 12.59%, Gros Islet at 12.48%, and Dennery at 10.59%. Canaries, despite the deepest local intensity, accounted for 1.81% of the national at-least-one caseload because it had fewer than 900 weighted households. A national programme designed for household reach would therefore prioritize Castries Rural, Micoud, Vieux Fort, and Gros Islet differently from a place-based programme designed to address concentrated multi-service disadvantage in Canaries.

**Figure 4**

***Local Incidence Versus Share of the National Affected Caseload***

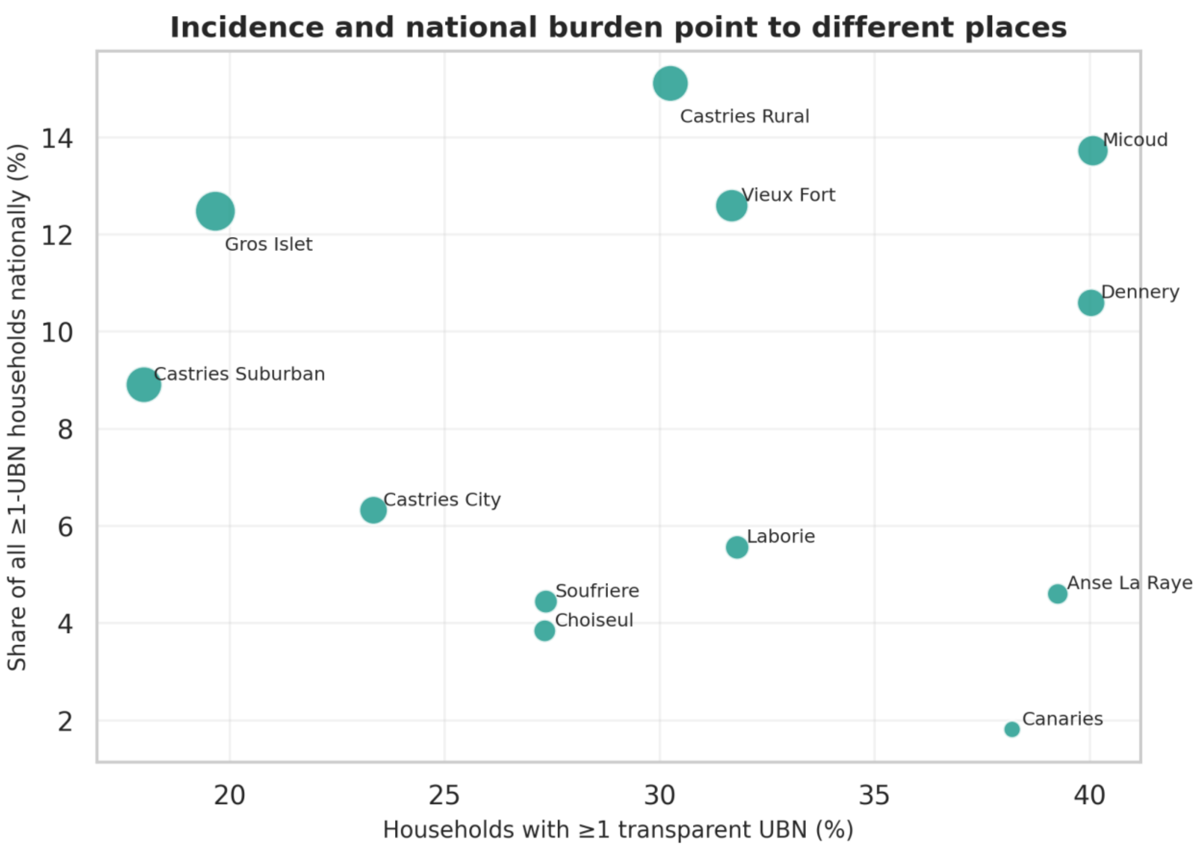



**Table 3**

***Cumulative Household Infrastructure Disadvantage by Census District***

| District | Households | ≥1 (%) | ≥2 (%) | ≥3 (%) | Mean domains | National ≥1 burden (%) |
|---|---|---|---|---|---|---|
| Castries City | 5,038 | 23.35 | 6.53 | 2.50 | 0.332 | 6.33 |
| Castries Suburban | 9,199 | 18.01 | 3.74 | 1.32 | 0.237 | 8.91 |
| Castries Rural | 9,288 | 30.25 | 8.37 | 3.26 | 0.442 | 15.11 |
| Anse La Raye | 2,180 | 39.26 | 14.78 | 6.91 | 0.661 | 4.60 |
| Canaries | 883 | 38.20 | 20.03 | 11.02 | 0.774 | 1.81 |
| Soufriere | 3,021 | 27.36 | 10.69 | 5.42 | 0.473 | 4.44 |

| District | Households | ≥1 (%) | ≥2 (%) | ≥3 (%) | Mean domains | National ≥1 burden (%) |
|---|---|---|---|---|---|---|
| Choiseul | 2,614 | 27.33 | 10.18 | 5.63 | 0.477 | 3.84 |
| Laborie | 3,251 | 31.80 | 10.34 | 3.76 | 0.480 | 5.56 |
| Vieux Fort | 7,392 | 31.68 | 9.84 | 3.94 | 0.474 | 12.59 |
| Micoud | 6,368 | 40.08 | 12.24 | 4.93 | 0.601 | 13.73 |
| Dennery | 4,920 | 40.04 | 10.52 | 4.58 | 0.583 | 10.59 |
| Gros Islet | 11,798 | 19.67 | 4.52 | 1.75 | 0.271 | 12.48 |

*Note.* Burden is each district's share of all national households with at least one transparent UBN. It is distinct from local incidence.

## What changed between 2010 and 2022?

The fixed-item comparison shows broad but uneven improvement. The share of valid-response households without a pipe into the dwelling fell from 19.94% to 11.66%, a decline of 8.28 percentage points and approximately 3,893 fewer affected weighted households despite growth in the household total. The no-toilet rate fell from 6.24% to 1.87% (−4.37 points; about 2,373 fewer households). Coal, wood, or no cooking fuel fell from 6.93% to 4.08% (−2.85 points), and at least three persons per bedroom fell from 7.13% to 4.08% (−3.04 points). Each of these four rates declined in all 10 administrative districts, with the three Castries statistical units aggregated because their cross-wave boundary stability could not be established.

The physical-housing result was less favorable. Weak roof or wall materials fell from 17.04% to 15.13%, only 1.91 points. Because the number of households increased, the estimated count was essentially unchanged: approximately 9,942 affected households in 2010 and 9,976 in 2022. The complete-case housing analog, combining weak materials, squatting, and crowding, declined from 22.31% to 17.89%, but it is a sensitivity composite rather than a pure physical-quality measure. Weak-material rates increased in Soufriere, Laborie, and Micoud, even as the national rate declined.

Digital connectivity improved on a different scale. Explicit no household internet fell from 68.64% of valid-status households to 20.39%, a 48.25-point decline. The technology and response structure changed, so this is an access contrast rather than a quality or fixed-broadband measure. It is nonetheless robust to extreme treatment of ambiguous responses: the cross-wave decline remains between approximately 44.8 and 49.3 points. By contrast, no desktop or laptop changed from 61.61% to 59.55%, a decline of only 2.05 points; the estimated number of households without either device increased by roughly 2,977. This divergence is consistent with connectivity expanding much faster than computer ownership, but the census does not establish that mobile access caused the change.

Neither electric nor solar lighting was almost flat, from 5.26% to 5.09%. The rate's small decline corresponded to about 300 more affected households because the household population expanded. Spring or river as the main water supply also did not materially decline: 0.96% in 2010 and 1.04% in 2022, or an estimated increase of about 127 weighted households. Large changes in selected source and facility categories therefore coexisted with persistent severe source use. Whether the residual categories reflect network reach, service reliability, affordability, dwelling conditions, or other mechanisms requires current validation.

**Figure 5**

*Harmonized National Household Infrastructure Change, 2010–2022*

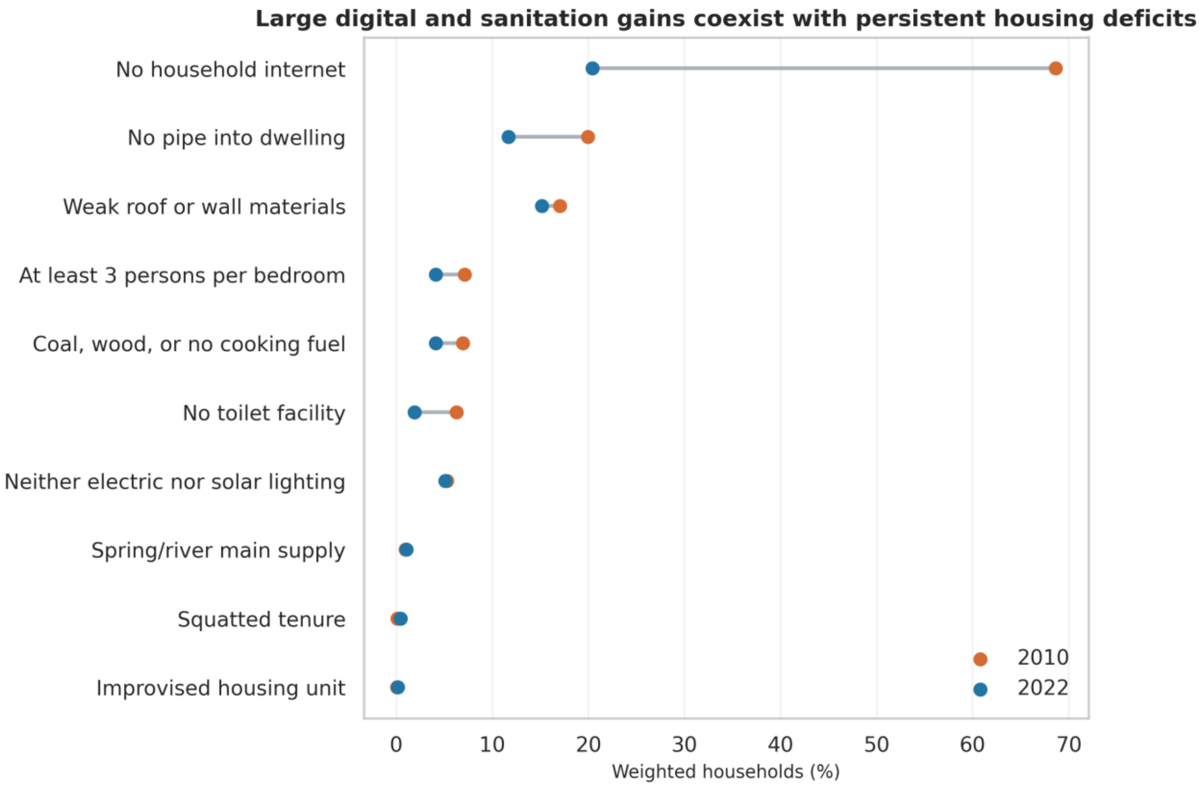


**Table 4**

***Harmonized Household Infrastructure Change, 2010–2022***

| Fixed item | Role | 2010 rate (valid N) | 2022 rate (valid N) | Change (pp) | Affected-household change |
|---|---|---|---|---|---|
| No pipe into dwelling | Primary | 19.94 (58,093) | 11.66 (65,951) | -8.28 | -3,893 |
| Spring/river main supply | Primary | 0.96 (58,093) | 1.04 (65,951) | +0.08 | +127 |
| No toilet facility | Primary | 6.24 (57,814) | 1.87 (65,951) | -4.37 | -2,373 |
| Neither electric nor solar lighting | Caveated primary | 5.26 (58,019) | 5.09 (65,951) | -0.18 | +300 |
| Coal, wood, or no cooking fuel | Primary | 6.93 (57,795) | 4.08 (65,951) | -2.85 | -1,313 |
| No household internet | Caveated primary | 68.64 (58,302) | 20.39 (63,700) | -48.25 | -27,032 |
| No desktop or laptop | Sensitivity | 61.61 (58,920) | 59.55 (65,951) | -2.05 | +2,977 |
| Weak roof or wall materials | Primary | 17.04 (58,359) | 15.13 (65,951) | -1.91 | +34 |
| At least 3 persons per bedroom | Primary | 7.13 (58,600) | 4.08 (61,713) | -3.04 | -1,656 |
| Housing composite (complete cases) | Sensitivity | 22.31 (57,750) | 17.89 (61,645) | -4.42 | -1,855 |

*Note.* Primary items have the strongest semantic match. Internet, lighting, and device contrasts carry explicit technology or questionnaire caveats. The housing composite is complete-case sensitivity. Changes are descriptive, not programme effects.

Spatial rank persistence was high for several fixed items even after national improvement. Across the 10 administrative districts, the 2010–2022 Spearman correlation was .879 for no pipe into the dwelling, .988 for polluting or absent cooking fuel, .964 for weak housing materials, and .939 for overcrowding. Canaries remained the highest district in 2022 for no pipe into the dwelling (29.76%), no toilet (16.31%), and coal/wood/no cooking fuel (14.74%). The highest weak-structure rates were in Dennery (30.78%), Micoud (25.57%), and Anse La Raye (22.09%). These are separate residual geographies: Canaries presents an acute service-access and household-energy profile, while Dennery and Micoud present a larger physical-housing problem.

## Exploratory contextual associations

District mean UBN count was positively associated with unemployment (Spearman rho = .636) and negatively associated with employment (−.601), tertiary attainment (−.657), internet access (−.601), computing-device access (−.608), and vehicle ownership (−.608). Its association with the reported health-condition measure was weaker (−.357). These 12-area associations are contextual descriptions, not significance tests; none of the nominal p values survives adjustment across seven comparisons. Internet access is also a convergent benchmark rather than an independent validator because it overlaps conceptually with the information UBN. The correlations mix household and person denominators and do not show that infrastructure disadvantage caused labor-market or educational outcomes. No individual eligibility or mechanism is inferred from them.

## Intervention Matching

The empirical results support a portfolio rather than one infrastructure-poverty programme. The portfolio should be organized by both observed pattern and delivery mechanism.

First, Canaries is a priority for current diagnostic validation of whether a coordinated service package is warranted. Its 2022 no-pipe, no-toilet, polluting-fuel, lighting, information, and deep co-deprivation rates make a single-asset explanation incomplete. The next evidence should include water continuity and quality, sanitation containment and sludge arrangements, grid proximity and account status, cooking-energy affordability, internet coverage and prices, dwelling safety, and household ability to connect. If current field and administrative evidence confirms these mechanisms, the response could span household plumbing and connection support, settlement-scale sanitation, utility rehabilitation, energy assistance, digital devices and skills, and case management. The Census alone cannot choose among them.

Second, Micoud and Dennery are priority areas for current housing-condition diagnosis with service overlays. Their cumulative incidence was high chiefly because housing disadvantage affected 27.00% and 30.65% of households, respectively, and their weak-material rates remained high in the fixed-item comparison. Assessment should distinguish structurally repairable dwellings, unsafe sites, owner and renter constraints, access to credit, grant need, and tenure or hazard barriers. Refuse collection is an additional diagnostic issue in Micoud, while sanitation and cooking fuel remain above the national rate in Dennery. If dwelling-level inspection confirms need, the results would support bundling resilient repair, wiring, plumbing, drainage, water storage, and accessibility.

Third, Anse La Raye combines housing with sanitation, lighting, cooking, and information disadvantages. Its pattern is more mixed than Micoud or Dennery and less deeply concentrated than Canaries. If current validation confirms co-location and service barriers, the pattern would support considering settlement upgrading and household repair alongside connection and affordability measures rather than as substitutes.

Fourth, Vieux Fort's 2022 refuse profile is unusually prominent in both incidence and national burden. The first operational question is whether routes, road access, collection frequency, communal points, storage, and reliable schedules remain adequate. Bins, smaller vehicles, route redesign, or transfer points are candidate responses where current service gaps are verified; monitoring and enforcement become relevant after credible access exists.

Fifth, Castries Rural, Gros Islet, and Vieux Fort demonstrate the importance of burden. Their rates were not always the highest, but their population size placed many affected households within their boundaries. Castries Rural accounted for 16.94% of national information-isolation burden and 16.91% of the narrow water burden. Gros Islet accounted for 27.91% of the narrow water burden despite a 4.08% local incidence rate. If current records confirm continuing need, these burden profiles would support scalable, targeted household outreach within otherwise lower-incidence environments, not a district-wide label of deprivation.

Sixth, lower cumulative incidence in Castries Suburban and Gros Islet does not mean that every household is adequately served. The 2022 baseline indicates that household-specific barriers and pockets hidden by district aggregation should be investigated before any universal district programme is considered. Because the public data cannot identify communities, finer targeting requires CSO custom tabulation, controlled microdata, service-administrative data, or current household assessment.

**Table 5**

***Intervention Matching for Observed 2022 Infrastructure Patterns***

| Observed pattern | Diagnostic unknowns | Potential scale | Candidate response if validated | Guardrail |
|---|---|---|---|---|
| Canaries: 38.20% with ≥1 UBN; 20.03% with ≥2; 11.02% with ≥3; sanitation 18.03%, cooking fuel 14.74%, lighting 10.59%, information 20.46% | Water continuity and quality; sanitation containment and sludge service; grid proximity, wiring and account status; cooking-energy and internet prices; dwelling safety and ability to connect | Settlement and utility system, combined with household support and case management | Coordinated WASH, energy, digital-access and household-assistance audit; sequence network or decentralized service, connection/repair grants, devices and case management to the verified constraints | The Census identifies an integrated symptom pattern but not its mechanism, engineering feasibility, cost or current 2026 status |
| Micoud and Dennery: ≥1 UBN about 40%; housing UBN 27.00% and 30.65%; weak materials 25.57% and 30.78% | Structural condition; hazard exposure; tenure; owner/renter status; repair cost; credit and grant eligibility; displacement risk | Household and settlement | Resilient repair, roof, wiring, plumbing, drainage, water-storage and accessibility packages; settlement upgrading where deficits are co-located | Housing UBN combines materials, crowding and squatting; inspection and hazard screening must precede assistance |
| Anse La Raye: 39.26% with ≥1 UBN; housing 25.95%, sanitation 7.67%, lighting 7.31%, cooking fuel 6.70%, information 13.05% | Whether services are absent, unreliable or unaffordable; dwelling barriers; sanitation density and downstream treatment; tenure and household vulnerability | Settlement plus targeted household support | Mixed upgrading package joining repair with sanitation, connection, energy-affordability and digital-capability support | A mixed district profile does not imply that every affected household experiences every listed domain |
| Vieux Fort: refuse UBN 6.31%; 26.53% of the national refuse-affected caseload | Road and route access; collection frequency and missed service; distance to communal points; storage; information and compliance | Municipal or system, with household and community logistics | Bins, reliable schedules, route redesign, smaller vehicles or transfer points; monitoring and enforcement after credible service exists | Unsafe disposal does not by itself show household noncompliance or lack of service |
| Castries Rural: 15.11% of all ≥1-UBN households; 16.94% of information burden and 16.91% of narrow-water burden | Within-district pockets; water reliability and quality; internet affordability and devices; household-specific barriers | Scalable targeted household outreach plus service-system audit | Use current administrative data or CSO custom small-area tables to target connection, device, water and case-management support | Large burden reflects population as well as incidence; district-wide labelling would be ecological |
| Gros Islet: 19.67% with ≥1 UBN but 27.91% of the narrow-water caseload | Whether the water proxy reflects source choice, network reach, reliability, price or dwelling connection; exact within-district location | Utility system and targeted households | Reliability and connection audit followed by last-mile support or safe decentralized supply where appropriate | A high burden share with modest incidence does not establish district-wide severe water deprivation |
| National digital gap: explicit no internet 20.39%, but no desktop/laptop 59.55% in 2022 | Connection technology and quality; data and fixed-service price; suitable device; repair; skills and use | Household and institutional | Affordable home access, suitable devices, repair and skills support; public access as a complement | Connectivity is not equivalent to digital capability; the 2010–2022 internet contrast does not measure quality |
| Lower-incidence districts and households outside dominant profiles | Hidden small-area pockets; affordability, disability, illness, age, transport and household composition | Targeted household support and integrated case management | Current household assessment, transparent eligibility and redress; route or fare support where transport poverty is verified | Area scores guide outreach, not individual eligibility; renting, migration and vehicle non-ownership are not automatic deprivation |

*Note.* The table maps Census symptoms to hypotheses about delivery; it does not identify causes, current household eligibility, project feasibility, costs, completion, or impact.

The matrix also indicates what should remain outside the core index. Vehicle non-ownership can signal transport risk only when combined with distance, disability, school or work access, and service availability. Renting is not inherently inadequate, old buildings are not necessarily unsafe, and appliance absence can reflect composition or preference. Migration can weaken a support network or bring remittances and opportunity. These variables are valuable for diagnosing intervention feasibility and vulnerability, but including them automatically would make the infrastructure measure normatively opaque.

## Discussion

### One divide, several geographies

The study's central result is that Saint Lucia does not have one household infrastructure divide. It has overlapping but distinct geographies of housing quality, integrated household services, water and sanitation access, waste logistics, and digital capability. A single index would obscure those differences. The contrast between Micoud and Dennery on one hand and Canaries on the other is illustrative. The former are dominated by physical housing conditions; the latter by deeper co-deprivation across sanitation, cooking, lighting, and information. Vieux Fort is more salient for refuse burden, Soufriere for the narrow water proxy, and Castries Rural for the absolute number of affected households.

This finding extends rather than dismisses Saint Lucia's earlier small-area measurement work. The 2010 Basic Needs Index showed the value of using Census data to make deprivation spatially visible (St. Catherine, 2011). The present approach makes a different trade-off: it gives up a community rank because current public infrastructure outcomes are not available at that geography, but gains exact household co-occurrence, absolute thresholds, counts, transparent definitions, and a harmonized change module. It also keeps education and employment outside the infrastructure construct so they can be used as external context rather than becoming part of the condition they are meant to validate.

### Housing is widespread but not the centre of household service clustering

Housing's dual role is substantively important. It was the largest marginal problem and explains much of the high cumulative rate in several districts. Yet housing commonly appeared alone and had weak phi associations with the other domains. This could reflect real separation between physical construction and household services, the broad internal composition of the housing flag, or measurement limits. The flag combines materials, crowding, and squatting, conditions that need not share a mechanism. A household repair programme should not assume sanitation or digital need, and a multi-service programme should not assume structural repair is always required.

The lighting–cooking–information–sanitation bundle is more coherent. These conditions can share affordability, dwelling wiring, tenure, household income, or settlement-service constraints, although the Census cannot identify which. The exploratory two-class model recognizes the same bundle but fits the detailed pattern distribution imperfectly. Exact profiles are thus a stronger guide: they show which combinations actually occurred and how many households they represented without forcing residual heterogeneity into a class label.

### Progress did not eliminate residual and capability divides

The 2010–2022 module provides an important temporal correction to a purely cross-sectional account. Severe sanitation, non-piped water, polluting fuel, and overcrowding declined across all 10 administrative districts, so 2022 differences exist after broad national improvement rather than in the absence of it. At the same time, rank persistence was high. Districts that began with higher rates often remained relatively disadvantaged, and physical weak-material burden barely changed in absolute terms.

Digital change most clearly separates connection from capability. The large fall in explicit no-internet status alongside minimal change in desktop/laptop absence shows why "internet access" cannot stand in for full digital inclusion. Household connectivity may be adequate for messaging while constrained for long-form education, employment applications, business, or public services. Current policy diagnostics should examine device suitability, data and fixed-service prices, repair, skills, and actual use rather than treating a connection as the endpoint.

Lighting offers a parallel caution. A nearly unchanged non-electric/non-solar rate can reflect households at the last mile of an otherwise extensive network, but it can also reflect affordability, disconnection, wiring, tenure, or housing safety. The same observed category therefore supports different interventions depending on validation. Infrastructure mapping should be followed by mechanism mapping.

### Incidence and burden imply different allocation rules

The incidence–burden distinction is more than a presentational choice. Place-based upgrading has fixed costs and spillovers, so Canaries' concentrated 2022 profile makes it a candidate for feasibility and current-service assessment even with a small national caseload. Household grants, devices, or case-management programmes often scale with the number of eligible households, making Castries Rural, Micoud, Vieux Fort, and Gros Islet consequential if current household need is verified. A transparent allocation framework can use one rule for area infrastructure and another for household support, rather than forcing both through one district rank.

Location quotients add a third view but must be used cautiously. Gros Islet's water location quotient is elevated and its national burden share large, yet the local rate is still modest. Canaries' sanitation quotient is very high and its rate substantively high, but its national burden share is small. Reporting all three quantities prevents relative concentration from being mistaken for national magnitude.

### Implications for data infrastructure

The public-data boundary is itself a policy finding. The 2022 Census recorded household coordinates and reports community and settlement populations, but the public infrastructure processor exposes only district geography. District results cannot reveal pockets within Castries, Gros Islet, Vieux Fort, or other heterogeneous areas. A high-value next step would be a CSO disclosure-protected table at community or enumeration-district level, with stable denominators, suppression rules, and a crosswalk to 2010. Controlled household microdata could support multigroup models and direct validation with education, illness, employment, migration, age, disability, and household composition without ecological inference.

Administrative service data would further improve diagnosis. Water pressure, continuity, quality, and arrears; electricity connections, disconnections, and outages; broadband coverage, prices, and quality; waste routes and missed collections; building inspections; transport frequency; and programme caseloads would distinguish network, reliability, affordability, and dwelling mechanisms. Linking such information under secure governance would turn a Census baseline into an operational infrastructure-equity system.

## Limitations

Several limitations define the claims that can be made. First, the 2022 source is provisional and coverage-adjusted. Underenumeration varied geographically, no post-enumeration survey was conducted, and adjustment uncertainty is unavailable. Weighted totals are the official analytic basis, but decimal precision does not eliminate coverage error.

Second, public household infrastructure geography ends at 12 census districts. Community and settlement counts cannot be joined to infrastructure outcomes, and district averages may conceal severe local pockets. The analysis identifies district concentration, not neighbourhoods or individual households.

Third, the seven domains are questionnaire proxies. They do not fully measure safety, reliability, affordability, structural integrity, environmental exposure, service use, or welfare. Water and sanitation cannot be labeled safely managed from these items alone. Main lighting is not comprehensive electricity access. Information isolation is stricter than no internet, while internet access does not establish adequate devices or quality. Refuse behavior does not identify collection availability. Tenure and vehicles are context, not automatic deprivation.

Fourth, official UBN programs generally treat missing or out-of-range inputs as nondeprived. The information rule is especially conservative because any not-reported component prevents its all-zero flag. The executable housing threshold also conflicts with the technical prose. The primary housing rate of 16.74% falls to 15.05% under the strict greater-than-three crowding threshold, a difference of 1.69 points or about 1,112 weighted households. The cumulative at-least-one estimate falls from 28.19% to 26.77%, while the at-least-two and at-least-three rates change by only −0.20 and −0.05 points; the district priority ordering is unchanged.

Fifth, the opaque precomputed NUMUBN_R field differs from the transparent current-domain count for 4.12% of households. Its at-least-one rate is 30.59%, compared with 28.19% under the current formulas, and it places Canaries rather than the virtually tied Micoud and Dennery estimates first on at-least-one incidence. Because the construction source is not public, it is reported only as a sensitivity and should not be described as the sum of the seven documented domains. Canaries remains the clearest depth hotspot under either view.

Sixth, the latent-class model is exploratory. Higher-class information criteria, unrepeated likelihood maxima, residual local dependence, sparse expected patterns, class-number sensitivity, and conditional resampling prevent a definitive typology claim. The 3% class-size rule excludes a three-class solution whose smallest class is 2.66%, approximately 1,756 weighted households, illustrating that the threshold is consequential. District class shares depend on fixed national item profiles and do not establish measurement invariance.

Seventh, cross-wave comparison is restricted to fixed items. Internet technologies, lighting categories, equipment storage, and waste response structures changed. Richer UBN composites and the relative 2010 Basic Needs Index are not comparable. Nominally matching codes do not establish stable boundaries for the three Castries statistical units; these are aggregated for subnational trends. Percentage-point changes are descriptive and cannot be attributed to specific policies.

Eighth, contextual associations use only 12 ecological units and mix person and household denominators. Associations can be driven by omitted district characteristics and cannot establish within-household relationships or causal pathways.

Finally, 2022 is a baseline, not a definitive map of services in 2026. Subsequent projects and household changes may have altered conditions. Programme announcements document commitments, not completion or impact. Every proposed intervention requires current administrative, engineering, price, and household validation.

## Conclusion

Saint Lucia's household infrastructure divide is best understood as a set of overlapping service and dwelling problems rather than a single spatial rank. In 2022, more than one quarter of weighted private households experienced at least one of seven transparent UBN proxies, but fewer than one in twelve experienced two or more. Housing was the largest marginal problem and often stood alone. A smaller, more integrated bundle linked lighting, cooking fuel, information isolation, and sanitation. Micoud and Dennery had the highest cumulative incidence, Canaries the deepest multi-domain concentration, and Castries Rural the largest national caseload. Vieux Fort's refuse burden, Soufriere and Gros Islet's water profiles, and Micoud and Dennery's housing conditions each point to different operational questions.

The 2010–2022 comparison shows that broad progress and persistent inequality can coexist. Non-piped water, severe sanitation, polluting fuel, and overcrowding declined nationally and in all 10 administrative districts, while weak construction changed much less and lack of computer hardware remained widespread despite rapid expansion of internet access. The most defensible policy response is therefore matched and two-stage: validate whether an observed condition reflects network absence, reliability or safety, affordability, or a dwelling, tenure, or capability constraint; then choose household support, settlement upgrading, utility investment, or coordinated case management at the appropriate scale.

The Census can identify where that diagnostic work should begin and how the national caseload is distributed. It cannot, on its own, select a project or determine current eligibility. A disclosure-protected community-level release and linkage to current service-administrative data would be the strongest next step toward an infrastructure-equity system that is both geographically precise and operationally useful.

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# Appendix A: Measurement Audit and Robustness

**Table A1**

***Measurement and Specification Sensitivities***

| Sensitivity | Estimand | Primary (%) | Alternative (%) | Alternative - primary (pp) | Interpretation |
|---|---|---|---|---|---|
| Transparent current formulas versus opaque precomputed NUMUBN_R | At least 1 UBN | 28.193 | 30.591 | +2.398 | Opaque published summary is sensitivity-only because its construction does not reconcile with current component formulas. |
| Transparent current formulas versus opaque precomputed NUMUBN_R | At least 2 UBNs | 8.237 | 9.208 | +0.971 | Opaque published summary is sensitivity-only because its construction does not reconcile with current component formulas. |
| Transparent current formulas versus opaque precomputed NUMUBN_R | At least 3 UBNs | 3.439 | 3.589 | +0.150 | Opaque published summary is sensitivity-only because its construction does not reconcile with current component formulas. |
| Overcrowding threshold in housing UBN | Housing UBN | 16.738 | 15.052 | -1.686 | Primary reproduces live executable (≥3 persons/bedroom); alternative follows technical-note prose (>3). |
| Cumulative count under strict overcrowding threshold | At least 1 transparent UBN | 28.193 | 26.771 | -1.422 | Primary reproduces the live ≥3 executable; alternative uses >3 from technical-note prose. District priority ordering is unchanged. |
| Cumulative count under strict overcrowding threshold | At least 2 transparent UBNs | 8.237 | 8.036 | -0.201 | Primary reproduces the live ≥3 executable; alternative uses >3 from technical-note prose. District priority ordering is unchanged. |
| Cumulative count under strict overcrowding threshold | At least 3 transparent UBNs | 3.439 | 3.391 | -0.047 | Primary reproduces the live ≥3 executable; alternative uses >3 from technical-note prose. District priority ordering is unchanged. |
| Internet ambiguous/not-reported responses | No household internet, 2010 | 68.645 | 68.973 | +0.328 | All-household lower bound 67.925%; upper bound codes every ambiguous/conflicting response as no access. |
| Internet ambiguous/not-reported responses | No household internet, 2022 | 20.392 | 23.109 | +2.717 | All-household lower bound 19.696%; upper bound codes every ambiguous/not-reported response as no access. |
| Internet ambiguous/not-reported responses | 2010–2022 percentage-point change | -48.253 | -44.816 | +3.437 | Worst-case cross-wave bounds remain strongly negative: -49.277 to -44.816 percentage points. |

*Note.* The sign convention is alternative minus primary. Internet bounds deliberately use extreme recoding of ambiguous or conflicting responses.

The transparent current-domain count and the precomputed NUMUBN_R variable agree after recoding to 0, 1, 2, and 3 or more domains for 95.88% of weighted households. Most disagreement arises because 1,732.611 households have none of the seven current flags but are coded as one UBN in the precomputed field. This unresolved difference is too large for rounding.

The housing threshold sensitivity is material but does not reverse the national conclusion that housing is the largest domain. Reproducing the executable at three or more persons per bedroom produces 16.738%; following the prose at more than three produces 15.052%. District reductions range from 1.113 points in Laborie to 3.720 in Canaries.

# Appendix B: Latent-Class Diagnostics

**Table A2**
***Exploratory Latent-Class Fit and Stability Diagnostics***

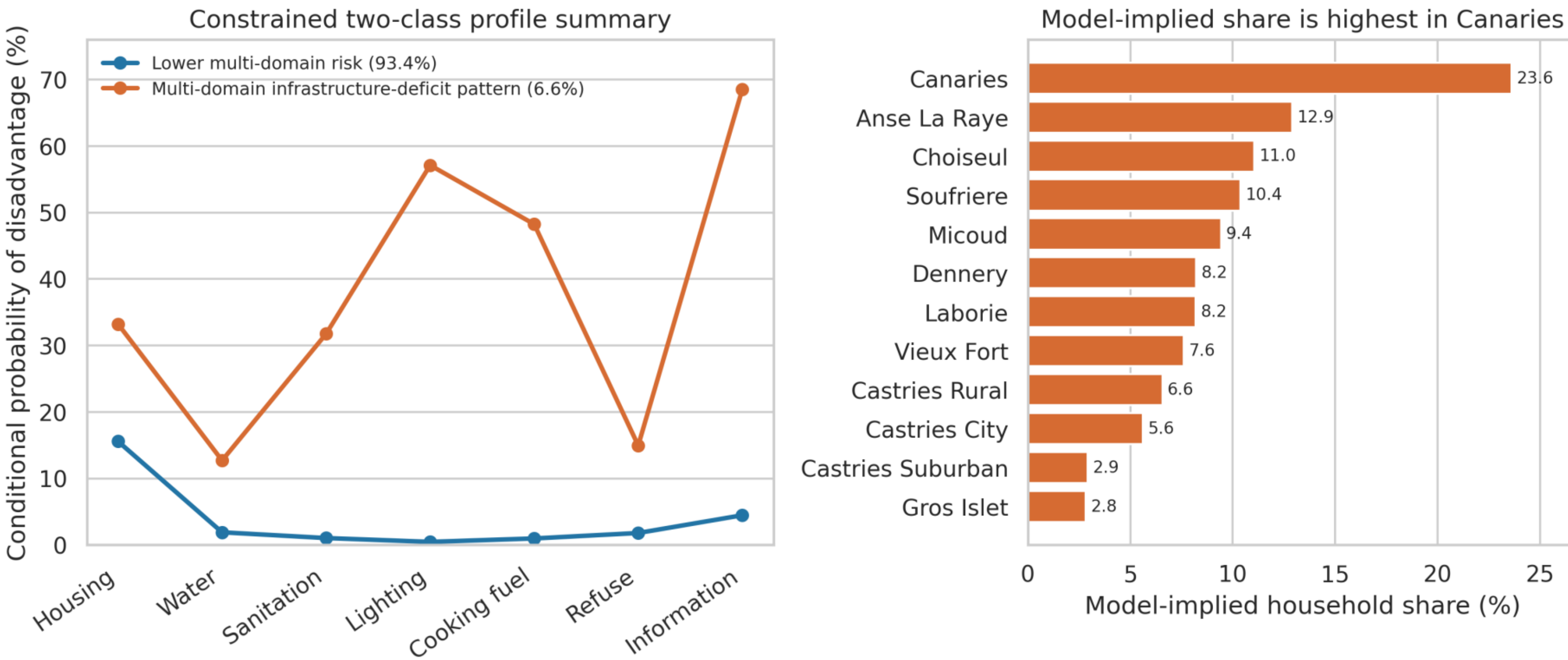
| Classes | Log likelihood | Parameters | AIC | BIC | CAIC | Entropy | Smallest class (%) | Best starts / 120 |
|---|---|---|---|---|---|---|---|---|
| 1 | -97,053.9 | 7 | 194,121.7 | 194,185.4 | 194,192.4 | 1.000 | 100.000 | 120 |
| 2 | -87,777.2 | 15 | 175,584.3 | 175,720.8 | 175,735.8 | 0.916 | 6.561 | 120 |
| 3 | -87,420.5 | 23 | 174,887.1 | 175,096.3 | 175,119.3 | 0.788 | 2.663 | 1 |
| 4 | -87,288.0 | 31 | 174,637.9 | 174,919.9 | 174,950.9 | 0.775 | 2.616 | 1 |
| 5 | -87,231.7 | 39 | 174,541.4 | 174,896.2 | 174,935.2 | 0.756 | 1.404 | 1 |
| 6 | -87,186.3 | 47 | 174,466.5 | 174,894.1 | 174,941.1 | 0.757 | 0.784 | 1 |

*Note.* The two-class model is a constrained exploratory summary, not the unconstrained information-criterion winner. Unconstrained BIC selects six classes and CAIC five; the best likelihood for each model with three or more classes was recovered only once. For the two-class model, G2 = 1,362.83, Pearson = 1,814.20, nominal df = 112, and 31 expected pattern cells are below five.

The two-class representation is retained only as a reproducible, substantively compact solution that meets the documented class-size and likelihood-replication screens. The model's residual discrepancies and the sensitivity of class number to the admissibility threshold prevent a stronger claim. The conditional 5th–95th percentile perturbation range for the multi-domain class share is approximately 6.27%–6.91%; this is an algorithmic stability range and omits coverage-adjustment, missingness, and class-number uncertainty.

**Figure A1**

***Constrained Two-Class Profile and Model-Implied District Mixing Proportions***



# Appendix C: Full District Dashboard

**Table A3a**

***District Incidence by Transparent 2022 Domain***

| District | Housing | Water | Sanitation | Lighting | Cooking | Refuse | Information |
|---|---|---|---|---|---|---|---|
| Castries City | 12.70 | 1.06 | 2.10 | 4.49 | 3.32 | 1.25 | 8.26 |
| Castries Suburban | 10.50 | 0.70 | 1.08 | 2.78 | 2.15 | 0.84 | 5.60 |
| Castries Rural | 18.15 | 3.14 | 2.38 | 4.29 | 3.44 | 2.32 | 10.43 |
| Anse La Raye | 25.95 | 2.23 | 7.67 | 7.31 | 6.70 | 3.15 | 13.05 |
| Canaries | 10.16 | 1.72 | 18.03 | 10.59 | 14.74 | 1.72 | 20.46 |
| Soufriere | 10.65 | 6.53 | 5.30 | 5.07 | 7.68 | 1.54 | 10.57 |
| Choiseul | 8.80 | 3.43 | 4.30 | 5.89 | 9.77 | 3.63 | 11.87 |
| Laborie | 18.31 | 4.31 | 2.83 | 3.99 | 5.61 | 2.78 | 10.20 |
| Vieux Fort | 18.03 | 1.32 | 4.44 | 4.30 | 3.83 | 6.31 | 9.17 |
| Micoud | 27.00 | 2.97 | 3.45 | 5.74 | 4.25 | 5.27 | 11.42 |
| Dennery | 30.65 | 1.13 | 3.98 | 5.23 | 4.98 | 2.79 | 9.54 |
| Gros Islet | 11.74 | 4.08 | 1.31 | 2.11 | 2.22 | 1.24 | 4.40 |

*Note.* All values are percentages of weighted private households in the district. Fixed national color scales are used in Figure 3.

**Table A3b**

***District Cumulative Incidence and National Burden***

| District | Weighted households | ≥1 (%) | ≥2 (%) | ≥3 (%) | Mean domains | Share of national ≥1 (%) |
|---|---|---|---|---|---|---|
| Castries City | 5,038 | 23.35 | 6.53 | 2.50 | 0.332 | 6.33 |
| Castries Suburban | 9,199 | 18.01 | 3.74 | 1.32 | 0.237 | 8.91 |
| Castries Rural | 9,288 | 30.25 | 8.37 | 3.26 | 0.442 | 15.11 |
| Anse La Raye | 2,180 | 39.26 | 14.78 | 6.91 | 0.661 | 4.60 |
| Canaries | 883 | 38.20 | 20.03 | 11.02 | 0.774 | 1.81 |
| Soufriere | 3,021 | 27.36 | 10.69 | 5.42 | 0.473 | 4.44 |
| Choiseul | 2,614 | 27.33 | 10.18 | 5.63 | 0.477 | 3.84 |
| Laborie | 3,251 | 31.80 | 10.34 | 3.76 | 0.480 | 5.56 |
| Vieux Fort | 7,392 | 31.68 | 9.84 | 3.94 | 0.474 | 12.59 |
| Micoud | 6,368 | 40.08 | 12.24 | 4.93 | 0.601 | 13.73 |
| Dennery | 4,920 | 40.04 | 10.52 | 4.58 | 0.583 | 10.59 |
| Gros Islet | 11,798 | 19.67 | 4.52 | 1.75 | 0.271 | 12.48 |

## Appendix D: Source and Reproducibility Statement

All official inputs were downloaded from the CSO or the public ECLAC/CELADE REDATAM service. The replication archive records source URL, access date, byte size, and SHA-256 hash. REDATAM sessions return temporary output URLs; the archive therefore retains the exact processing syntax and returned HTML/XLSX. The primary seven-domain pattern table uses fractional XLSX cells and reproduces the exact 65,951.115 national margin and every district margin. The analytical workbook derives headline values from detail sheets and contains an exceptions register covering geography, weighting, missing handling, the housing threshold, the NUMUBN_R discrepancy, cross-wave breaks, and LCA limitations.