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Solid Waste and Soil Pollution in Mexico: Environmental Implications and Conditional Projections

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Abstract :
Municipal solid waste (MSW) presents a persistent management challenge in Mexico and contributes to soil contamination through uncontrolled disposal, leachate migration, litter fragmentation, and burning residues. This study integrates a systematic evidence review with a reproducible statistical analysis of official collection data and exploratory generation scenarios. Seven biennial INEGI observations from 2012 to 2024 inform the estimation of a linear collection trend, which is evaluated against persistence and drift benchmarks using expanding-window validation. The fitted annual increase is 999 t/day, with an in-sample R^2 of 0.894 and a validation root mean square error of 2,583 t/day. Projected conditional collection reaches 128,186 t/day in 2040, with a 95% prediction interval of 118,426–137,947 t/day. An alternative scenario applies the fitted relative trend to SEMARNAT's 2026 generation estimate of 139,902 t/day, resulting in 57.32 million t/year by 2040. Assuming a 20% prevention rate and a reduction in the unmanaged fraction from 30% to 15% decreases the 2040 unmanaged-waste pressure indicator by 60%, from 17.20 to 6.88 million t/year. These results represent conditional material-flow scenarios rather than forecasts of pollutant concentrations or measured contaminated land. The findings underscore the importance of coordinated waste prevention, reliable collection, controlled residual disposal, and site-specific soil monitoring, while highlighting the substantial uncertainty that separates national waste statistics from local environmental exposure.

Keywords: *municipal solid waste; soil pollution; leachate; waste forecasting; environmental justice; circular economy.*

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I. INTRODUCTION

Soil sustains food production, stores carbon, regulates water flows, and supports biological communities. Waste deposited without adequate containment can impair these functions, but the quantity of refuse does not itself measure toxic contamination. A national assessment therefore needs to distinguish the material flow that must be managed from the substances released, their environmental transport, and the people and ecosystems exposed. This distinction is especially relevant in Mexico, where collection statistics and national generation estimates originate from different instruments [1]-[4].

INEGI provides an observable historical series for collected MSW, including the 2024 reference year reported in the 2025 municipal census [1], [2]. SEMARNAT's diagnostics instead estimate generation and assess infrastructure [3], [4]. Its 2026 public presentation reports approximately 139,902 t/day generated nationally, a limited treatment share, and substantial shortcomings in final disposal [5]. These quantities describe different stages of the waste system and cannot be pooled as repeated observations of one variable.

Waste management influences municipal budgets, resource recovery, land use, and the distribution of environmental burdens. Mexico's national waste program defines prevention and integrated management as coordinated responsibilities across all levels of government [6]. International assessments link soil pollution to ecosystem degradation [7] and identify significant global costs resulting from inadequate waste management [8]. However, global monetary estimates do not capture the cost of soil pollution in Mexico and should not be applied directly to the national context. This article aims to examine the contribution of municipal waste to soil pollution in Mexico, discuss environmental and socioeconomic consequences, and develop transparent conditional projections to 2040. The study links a small, verifiable collection series to a distinct generation scenario and an unmanaged-waste pressure indicator. The analysis addresses three questions: what does the recent official collection series indicate; how do prevention and management assumptions alter future material

flows; and what further measurements are required to translate these flows into robust estimates of soil contamination?

II. THEORETICAL BACKGROUND

2.1 Waste flows and soil contamination mechanisms

Generation refers to the mass discarded by households and comparable municipal sources, while collection denotes the portion gathered by a service or reported collection operation. Recovery, treatment, controlled disposal, and environmental leakage represent subsequent destinations. Residues may be collected and then dumped under inadequate conditions. Collection does not necessarily indicate recycling, and treatment does not always result in the recovery of a marketable material. This terminology is intended to prevent misleading interpretations of infrastructure and performance indicators [2], [6].

Waste affects soil through multiple interacting pathways. Leachate transports soluble organic and inorganic constituents, contaminated runoff redistributes particles, wind disperses litter and dust, and plastic fragments accumulate or migrate through soil. Burning generates ash and atmospheric deposition, potentially shifting the burden between environmental media. Reviews highlight the importance of landfill management in these processes [9]. Research on tropical leachate demonstrates that climate, waste age, composition, and operating conditions influence pollution potential [10]. As a result, identical waste tonnages can produce significant differences. Chemical risk is determined by concentration, bioavailability, and exposure. Metal retention is influenced by pH, mineralogy, organic matter, and redox conditions. While retention can delay contaminant migration, it does not eliminate the contaminant. Biological remediation may be effective for certain contaminated soils, but its performance depends on the specific contaminant and site conditions; notably, metals cannot be destroyed by microbial degradation [11]. Therefore, a national tonnage trend cannot be used to infer national trends in lead, arsenic, hydrocarbon, or microplastic concentrations.

2.2 Modeling choices and the scope of inference

Waste forecasting methods encompass regression, time-series analysis, system dynamics, and machine learning. The suitability of a model depends on the number and quality of observations, the forecast horizon, and the availability of explanatory variables [12]. Dynamic modeling for Mexico City demonstrates the importance of representing institutional and behavioral interactions [13]. However, with only seven national observations, a transparent two-parameter model is more easily audited than a high-dimensional model, which may exhibit apparent accuracy due to overfitting.

Material-flow inventories support environmental analysis when emission pathways are clearly specified. A global macroplastic inventory demonstrates the importance of linking waste handling to release mechanisms, rather than presuming that all discarded plastic immediately becomes pollution [14]. Mexican soil research further emphasizes spatial heterogeneity and source attribution. For example, the Matehuala study integrates soil sampling, geographical analysis, and receptor modeling to distinguish multiple sources [15]. The mining-affected context of this study should not be generalized as representative of national municipal solid waste (MSW) effects.

2.3 Social and economic dimensions

Population, consumption, income, urban form, and service provision influence waste flows and reporting. Reviews of socioeconomic and sociocultural predictors indicate that these relationships vary across locations and waste streams [16], [17]. Growth in collection may reflect increased generation, improved coverage, altered reporting, or combinations of these factors. The current univariate model estimates a time trend rather than the causal contribution of any individual driver. Households located near uncontrolled disposal sites may experience nuisance, restricted land use, and potential contact with contaminated media. Waste workers and informal recyclers are exposed to sharp objects, mixed hazardous materials, and unsafe working conditions. Economic consequences include expenditures for transport and treatment, monitoring and remediation liabilities, and lost opportunities to recover valuable materials. These represent plausible impact

categories rather than quantified national losses. Distributional analysis requires data on income, occupations, settlement patterns, and actual exposure, rather than assuming uniform risk across communities [9], [13].

III. DEVELOPMENT

3.1 Study design and source identification

This study employs a targeted evidence review in conjunction with secondary-data modeling. Searches conducted on 2026 prioritized INEGI and SEMARNAT for Mexican waste statistics, institutional assessments for international context, and publisher pages for peer-reviewed research. Search expressions included "Mexico municipal solid waste statistics", "INEGI CNGMD 2025 residues", "landfill leachate soil pollution", and "municipal solid waste forecasting review". Sources were retained only when they directly supported data definitions, release mechanisms, modeling choices, or policy interpretation. This review is neither systematic nor a meta-analysis, and does not claim exhaustive screening or database coverage.

The primary statistical input consists of the 2012–2024 collection series presented in Table 1. Earlier values are sourced from the historical graphic in INEGI's 2023 geographic and environmental results [1], while the most recent data point is obtained from the March 2026 results report [2]. This period spans twelve years and includes seven biennial observations. Earlier data points are not interpolated to avoid artificially increasing the sample size. The 2010 value is reserved for a window-sensitivity analysis. Data from 2012 to 2022 are reported in rounded t/day, whereas the 2024 value is converted from reported kg/day; this variation in precision does not materially affect the rounded results.

Table 1. Official collection observations used for model estimation

Reference year	Collected MSW t/day	Source
2012	99,770	INEGI [1]
2014	102,887	INEGI [1]
2016	104,734	INEGI [1]
2018	107,055	INEGI [1]
2020	106,523	INEGI [1]
2022	108,146	INEGI [1]
2024	114,318.734	INEGI [2]

Note: The census edition is not the reference year. These observations measure collected waste, not total generated waste or measured soil pollution

For generation, the 2020 diagnostic reports 120,128 t/day [3], while the 2026 presentation reports 139,902 t/day [5]. These diagnostic snapshots provide context but are not fitted as a homogeneous annual series: their methods and underlying reference periods may differ. The 2026 published estimate is used only as the anchor of an exploratory scenario, without implying that all contributing measurements were collected during 2026. No mixed-year collection-to-generation ratio is presented as an observed collection efficiency.

Table 2. Evidence types and analytical limits

Evidence	Use in this article	What it cannot establish
INEGI collection series [1], [2]	Estimate a historical collection trend	Total generation or soil contaminant levels
SEMARNAT diagnostics [3]–[5]	Generation context and scenario anchor	A homogeneous annual generation series
Landfill and leachate reviews [9]–[11]	Explain pathways and site controls	A national Mexican dose response
Mexico City modeling [13]	Support a systems perspective	Nationally calibrated intervention effects
Matehuala field evidence [15]	Illustrate source attribution and spatial analysis	MSW as the origin of all Mexican soil pollution

3.2 Collection model and temporal validation

Let C(t) denote collected MSW in t/day for calendar year t. Centering time on 2024 improves interpretability. Ordinary least squares minimize the sum of squared residuals in Eq. (1), with an intercept a, an annual slope b, and residual error e(t).

$$C(t) = a + b(t - 2024) + e(t) \quad (1)$$

$$C_{fit}(t) = 112199.805 + 999.164(t - 2024) \quad (2)$$

Here $C_{fit}(t)$ is the fitted conditional mean. The coefficient *b* has units (t/day)/year; it is not a percentage growth rate. The residual standard error is 1,624.38 t/day, using five residual degrees of freedom. The conventional R^2 is reported as an in-sample summary, not as evidence of future forecasting accuracy.

Expanding-window validation uses four chronological folds. Training initially contains 2012, 2014, and 2016; the forecast target is 2018. Each subsequent fold adds the preceding observed point and forecasts 2020, 2022, or 2024, respectively. The two-year observation spacing is retained. Three methods are compared: OLS trend, persistence using the last observation, and drift extrapolating the average historical change between the first and last training years. All methods use identical training information and targets.

$$MAE = mean(|forecast - observed|);\ RMSE = \sqrt{mean((forecast - observed)^2)} \quad (3)$$

For a future collection observation, an illustrative prediction interval uses the Student t distribution and includes both parameter uncertainty and residual variability. Let $z^* = t - 2024$, z_{mean} be the mean centered training year, Szz be the sum of squared centered-year deviations, n = 7, and s be the residual standard error.

$$PI95(t) = C_{fit}(t) \pm t(0.975, n - 2)\, s \sqrt{1 + \frac{1}{n} + \frac{(z* - z_{mean})^2}{Szz}} \quad (4)$$

Eq. (4) assumes a stable linear relationship and independent, approximately normal errors of constant variance. Seven observations cannot adequately test these assumptions. The interval excludes unmodeled reporting revisions, structural changes, and policy shifts. It is a conditional statistical interval for collection, not an uncertainty interval for generation or contamination.

3.3 Separate generation and intervention scenarios

Because a harmonized generation time series is not fitted, generation is projected conditionally by transferring the relative fitted collection trend to the SEMARNAT anchor. Let G0 = 139,902 t/day and t0 = 2026 represent the published diagnostic anchor. Annual generated mass $W(t)$, in million t/year, is defined by Eq. (5). Every annualization uses 365 days as a constant planning convention, including leap years.

$$W(t) = (365/10^6)\, G0\, C_{fit}(t)/C_{fit}(2026) \quad (5)$$

Eq. (5) assumes that generated waste follows the same relative change as the modeled collection mean after the anchor. It does not assume that collected and generated waste are equal. The trend-transfer assumption is unverified, so W(t) is an exploratory planning scenario, not a statistically validated generation forecast. Generation uncertainty is wider than, and cannot be recovered from, the collection prediction interval alone.

Let u(t) = (t − 2026)/14 for 2026 ≤ t ≤ 2040. The prevention scenario reduces generation progressively relative to Eq. (5), reaching 20% in 2040. The management scenario reduces an assumed unmanaged fraction q(t) from 0.30 to 0.15 over the same period. These endpoints are analyst-selected examples, not observed national rates or predictions of policy success.

$$W_{pre}(t) = W(t)[1 - 0.20u(t)];\ q_{improve}(t) = 0.30 - 0.15u(t) \quad (6)$$

$$U(t) = q(t)\, W_s(t) \quad (7)$$

$W_s(t)$ is either $W(t)$ or $W_{pre}(t)$, depending on the scenario. U denotes potentially unmanaged MSW in million t/year. The baseline uses W and constant q = 0.30; prevention alone uses $W_{pre}(t)$ and constant q; management improvement uses W and $q_{improve}(t)$; the combined scenario uses $W_{pre}(t)$ and $q_{improve}(t)$. "Unmanaged" denotes material hypothetically escaping environmentally controlled management; it is not synonymous with uncollected, untreated, or unrecycled waste. In particular, neither the reported treatment share nor the number of sanitary landfills is used to estimate q.

3.4 Connecting pressure with measurable soil contamination

U(t) quantifies a potential source pressure. For a particular contaminant j at a particular site, a possible future mass-balance extension is Eq. (8). It is provided as a research framework and is not numerically simulated or calibrated in this study.

$$M_j(t + 1) = [1 - k_j(t)]\, M_j(t) + \alpha_j(t)\, U_{site}(t) - R_j(t) \quad (8)$$

M_j is contaminant stock in soil in kg; k_j is the annual fractional net export or transformation loss from that stock; U_{site} is unmanaged waste at that site in t/year; α_j is the contaminant mass reaching soil per tonne of waste in kg/t; and R_j is active removal during the year in kg. The one-year step makes $\alpha_j(t)\, U_{site}(t)$ an annual input in kg. Removal must be bounded to keep stocks nonnegative. For metals, transformation is not destruction: loss from a soil compartment may instead contaminate another compartment. National U cannot be substituted for U_{site} without a spatial allocation model.

$$c_j(t) = \frac{10^6 M_j(t)}{M_{soil}} \quad (9)$$

Eq. (9) converts stock to an average concentration c_j in mg/kg when M_{soil} is the dry soil mass in kg. Its use requires a defined area, mixing depth, bulk density, background concentration, and representative sampling. Without $\alpha_j(t)$, k_j, R_j, initial stock, and soil mass, no chemical concentration or contaminated area can be inferred. This limitation prevents the material-flow scenario from becoming a false national contamination forecast.

IV. RESULTS

4.1 Historical change and model performance

Collected MSW rose from 99,770 t/day in 2012 to 114,318.734 t/day in 2024, an increase of 14.58%. The series includes a small decline between 2018 and 2020 and a larger increase in the latest interval. These movements are descriptive and cannot be assigned to the pandemic, economic recovery, or service expansion without additional evidence. The fitted slope is 999.164 t/day per year and R^2 is 0.894.

Table 3. Expanding-window validation over four two-year forecasts

Method	MAE t/day	RMSE t/day
OLS linear trend	2,173	2,583
Persistence	2,662	3,406
Historical drift	1,921	2,694

OLS has the lowest validation RMSE, while drift has the lowest MAE. Thus, model superiority depends on whether large individual errors receive additional weight. With only four validation targets, the evidence supports keeping simple alternatives under review. It does not justify claiming a universally best model or selecting a complex forecasting algorithm.

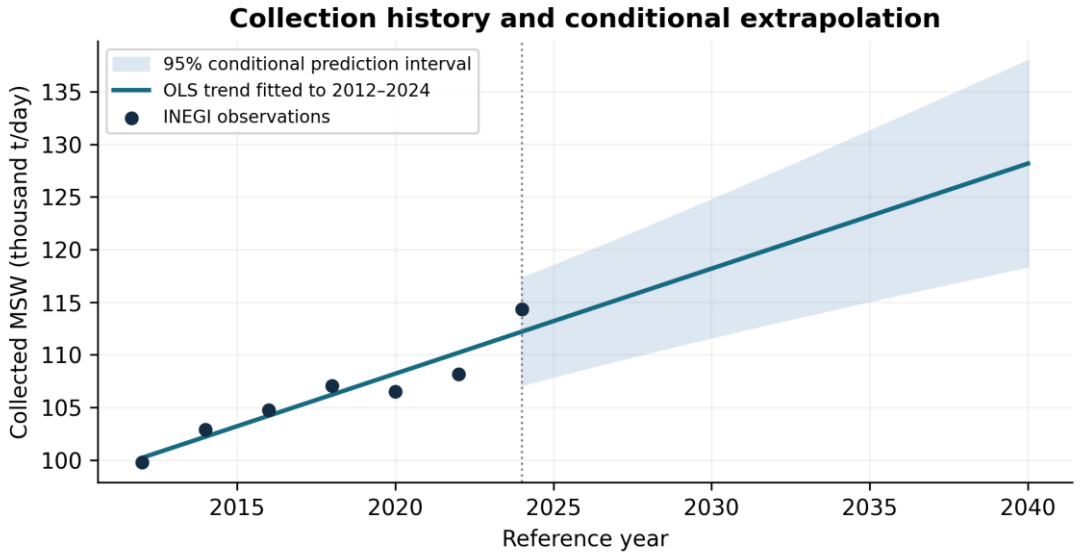


Figure 1. Observed collection [1], [2], the fitted linear trend, and its conditional prediction interval. The shaded interval concerns future collection observations only. Values after 2024 are extrapolations.

4.2 Conditional collection and generation trajectories

Table 4. Conditional projections and separate generation scenarios

Year	Collection t/day	Collection 95% PI t/day	Generation scenario million t/year
2030	118,195	111,688–124,702	52.85
2035	123,191	115,134–131,248	55.09
2040	128,186	118,426–137,947	57.32

Note: Generation uses Equation (5) and has no estimated probability interval. The collection interval must not be interpreted as covering generation.

The collection model reaches 128,186 t/day in 2040. Equation (5) separately gives approximately 157,039 t/day generated, or 57.32 million t/year, in the same year. This generation scenario is 12.25% above the 2026 anchor of 51.06 million t/year. A difference between the two modeled flows is not a measured amount of uncollected waste, because their calibration, anchor dates, and assumptions differ.

Window selection is consequential. Including the 2010 observation of 86,342 t/day changes the OLS slope to 1,493.73 t/day per year and the 2040 collection projection to approximately 138,078 t/day. Fitting only 2016–2024 produces approximately 128,416 t/day in 2040. The early value materially affects the long-run slope, showing that the principal model is a recent-period scenario rather than a stable law of national waste growth.

4.3 Scenario effects and sensitivity

Table 5. Explicitly assumed scenarios for 2040

Scenario	Generated million t/year	Assumed q	Pressure U million t/year	Reduction in U
Trend baseline	57.32	0.30	17.20	0%
Prevention alone	45.86	0.30	13.76	20%
Management alone	57.32	0.15	8.60	50%
Combined	45.86	0.15	6.88	60%

Note: Reductions compare the same year with the trend baseline. q is not an empirical estimate for Mexico.

The combined scenario generates 45.86 million t/year and yields a pressure indicator of 6.88 million t/year in 2040, compared with 17.20 million t/year under the assumed baseline. The 60% reduction follows the multiplicative structure: $1 - (0.80 \times 0.50) = 0.60$. Prevention and management improvements are therefore not additive percentage reductions. These results demonstrate the consequences of the assumptions rather than measuring intervention effectiveness.

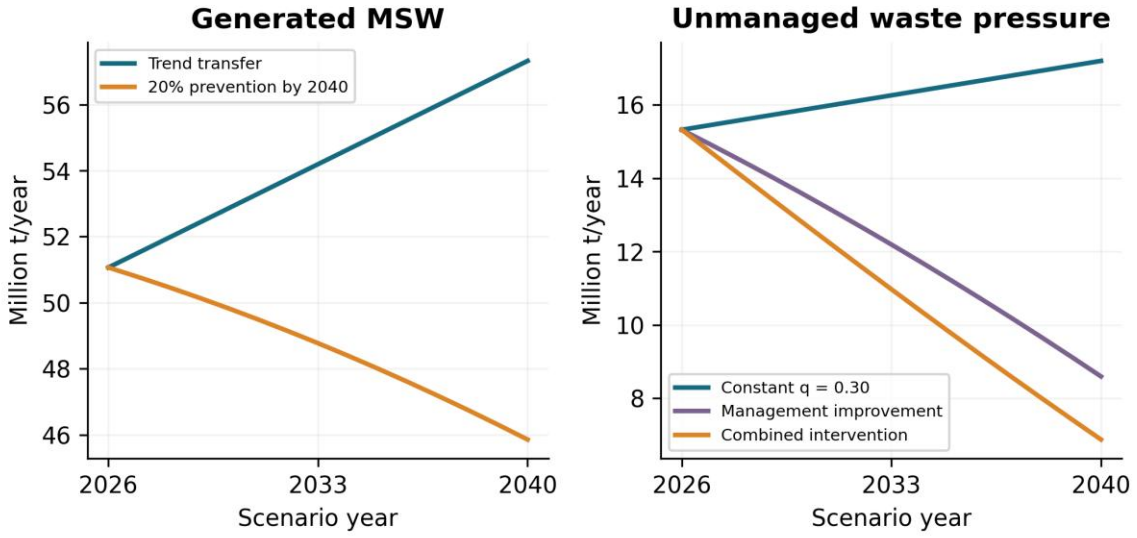


Figure 2. Conditional generation trajectories and potentially unmanaged-waste pressure under analyst-defined scenarios. All curves start from the 2026 diagnostic anchor; the pressure fraction is assumed.

Figure 3 varies 2040 prevention between 0% and 40% and q between 5% and 50%. Because U is linear in q for a fixed generation scenario, uncertainty in this parameter directly scales the pressure result. At zero prevention, changing q from 0.15 to 0.45 changes the 2040 indicator from 8.60 to 25.79 million t/year. A national baseline for q would therefore be more valuable than adding apparent precision to the fitted trend coefficients.

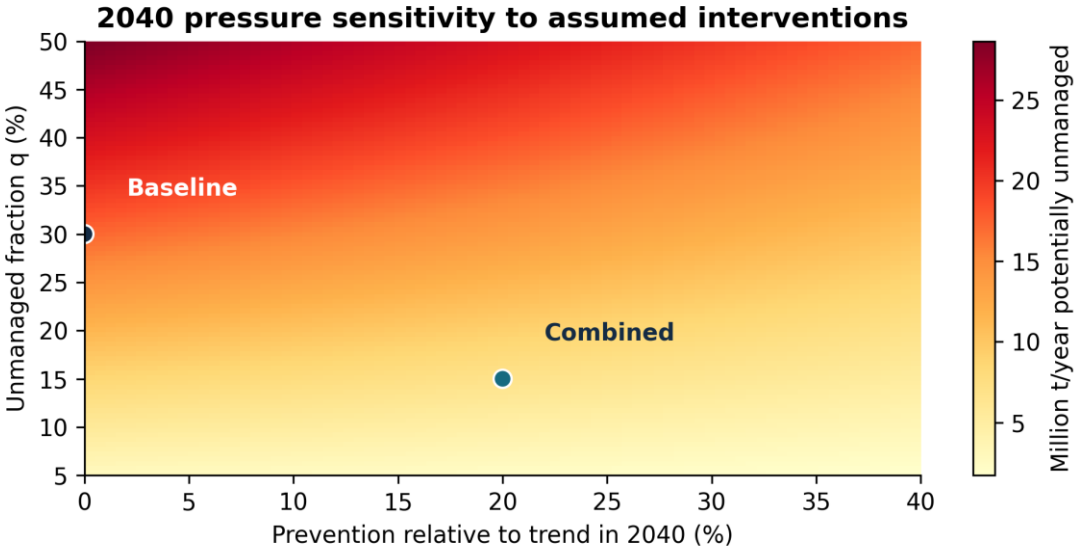


Figure 3. Sensitivity of the 2040 unmanaged-waste pressure indicator to prevention and the assumed unmanaged fraction. This is a scenario surface, not a contamination map or a confidence region.

V. FINDINGS AND COMMENTS

5.1 Environmental interpretation

The primary environmental finding is that prevention and controlled management influence distinct aspects of the material balance. Waste avoidance decreases the volume requiring collection and subsequent handling. Enhanced containment limits the fraction potentially reaching soil and water, even if overall generation remains elevated. A reduction in U is expected to lower source pressure under otherwise comparable conditions; however, this does not guarantee a proportional decrease in toxicity, exposed population, or chemical concentration. Material composition and hydrological factors may vary independently of total tonnage.

Plastic policy may target product design, reuse, collection, and material markets. Analyses by the OECD [18] and UNEP's systems-change assessment [19] recommend integrating upstream interventions with downstream waste management. These measures should not be assessed solely by collected tonnage, as improved collection may increase reported quantities while simultaneously reducing environmental leakage. Therefore, policy dashboards should separately monitor generation, collection coverage, controlled destinations, and environmental releases.

Prevention of organic waste represents another significant intervention. The Food Waste Index offers measurement guidance to support sector-specific baselines [20]. Composting and anaerobic digestion can decrease disposal requirements; however, effective source separation and product quality controls are essential to prevent the transfer of contaminants to land via substandard outputs. Nominal diversion targets should be evaluated against actual processing capacity, rejection rates, and the safety of end uses. This study does not model technology-specific performance nor assert that all organic waste is appropriate for land application.

Electronic waste demonstrates the limitations of using mass as the sole metric. The Global E-waste Monitor identifies a distinct and expanding material stream with incomplete documentation of formal recovery [21]. Mixing electronic or other hazardous materials with household refuse can disproportionately increase contaminant loads relative to their mass fraction. The municipal flow model does not include dedicated estimates for mining, industrial, or hazardous waste; these streams require separate inventories and compatible monitoring systems.

5.2 Social distribution and economic implications

The distribution of social burden is expected to be uneven in areas where disposal facilities, informal settlements, agricultural land, and vulnerable workers coincide. Potential exposure pathways include soil ingestion, dust inhalation, and consumption of contaminated food or water; however, the relative contribution of each pathway should be assessed at the local level. The results indicate the importance of involving nearby residents and waste workers in the design of monitoring programs and ensuring transparent communication of actual test results. Aggregate national waste totals are insufficient to determine which communities face the highest risk.

Economic considerations encompass routine service costs, capital investments, land requirements, revenues from recovered materials, and long-term environmental liabilities. Preventive measures can reduce downstream handling expenditures, whereas safer facilities may necessitate higher initial and operational costs. A robust cost-benefit analysis for Mexico should integrate local unit costs, processing yields, avoided disposal quantities, financing conditions, and independently estimated damages. This study does not assign monetary values to health effects, remediation, or ecosystem loss.

A practical planning metric is the annual net system cost, defined as the sum of collection and transport costs, treatment and disposal costs, and monitoring and remediation expenditures, minus net recovered-material revenue. Each component must be calculated within a clearly defined system boundary. Recovery income should be calculated net of sorting and marketing costs, and avoided costs should not be double-counted as separate revenue. Integrating informal recyclers into safer recovery arrangements may enhance livelihoods, but such improvements depend on contractual terms, material access, and working conditions rather than solely on diversion rates.

5.3 Monitoring priorities and implementation

Table 6. Measurements needed to move from scenarios to environmental assessment

Priority	Minimum information	Analytical purpose
Waste accounting	Weighed generation, collection, transfers, treatment and final destinations	Reconcile mass flows and estimate q
Waste composition	Seasonal composition and hazardous-material mixing	Estimate contaminant-specific source inputs
Soil sampling	Background sites, depth, dry-mass concentrations, pH and organic matter	Measure changes and interpret retention
Leachate and water	Flow, rainfall, contaminant chemistry and groundwater direction	Estimate transport and receiving loads
Exposure and equity	Land use, nearby households, worker tasks and exposure duration	Identify affected receptors and protection needs
Cost accounting	Local unit costs, revenues and remediation commitments	Evaluate feasible interventions

INEGI's 2025 waste questionnaire offers a foundation for standardizing service and destination reporting [22]. Administrative records must be integrated with weighbridge data and site identifiers, ensuring explicit documentation of missing reports. It is necessary to distinguish selective collection from completed recycling. Environmental monitoring protocols should incorporate appropriate background and control sites, repeated sampling during both wet and dry seasons, laboratory quality assurance, and a documented chain of custody.

A staged approach should begin by reconciling municipal mass balances, followed by characterization of priority disposal sites, and subsequently fitting contaminant-specific balances such as Equation (8). Prioritization may consider receptor proximity, hydrogeological vulnerability, waste composition, and containment performance. Site counts do not represent mass-weighted measures; a few large facilities may receive significantly more waste than many small dumps. Therefore, decision-making should integrate waste throughput and environmental vulnerability, rather than ranking sites solely by size.

Evidence from Mexican case studies underscores the necessity of distinguishing waste-related liabilities from other sources of soil pollution. The investigation of the closed Morelia dump documents

hazardous materials mixed with municipal waste, the presence of metals and arsenic, and operational and closure deficiencies [23]. These findings support the evaluation of historical waste composition and post-closure liabilities when prioritizing disposal sites. However, they do not establish the national prevalence of hazardous-waste mixing or quantify the A 2024 review of soil lead in Mexico identified 36 reports, most of which were associated with mining activities; over half reported concentrations exceeding the limits applied in the review [24]. These results indicate the presence of contaminated locations and highlight monitoring gaps. However, the selected studies do not constitute a probability sample of Mexican territory, and their exceedance frequency cannot be interpreted as the proportion of contaminated soils nationwide.of the country's soils that are contaminated.

The predominant contribution from mining further demonstrates that national municipal-waste trends should not be used to attribute all soil pollution to household refuse.

5.4 Limitations and reproducibility

The statistical limitations include a small sample size, biennial data spacing, rounded values in older observations, potential changes in reporting practices and service coverage, and a projection horizon that exceeds the fitted twelve-year period. The four validation targets offer only limited evidence regarding model performance, and neither residual independence nor normality can be confidently established. The transition from collection growth to generation has not been independently validated. Scenario parameters for prevention and q are intended as illustrative examples. Reproduction of the analysis requires only the seven data pairs presented in Table 1: center the years on 2024, fit a first-degree polynomial using least squares, calculate the residual standard error with n - 2 degrees of freedom, and apply Equations (4) through (7). For validation, each of the four folds must refit the method using only preceding observations. Figure 3 applies Equation (7) across a grid of prevention and q values, while maintaining the 2040 trend-generation value constant. MATLAB functions such as polyfit, polyval, and tinv may be used; equivalent functions in other numerical software yield identical results. No field samples, randomized interventions, or machine-learning experiments. These limitations delineate the article's contribution: it presents a national material-flow and evidence analysis incorporating exploratory environmental-pressure scenarios. The study does not constitute an inventory of all contaminated Mexican soils, a causal estimate of waste-related disease, or a calibrated national soil-fate model. Future research should incorporate additional observed years, reconcile diagnostic reference periods, assess spatial disaggregation, and propagate uncertainties in composition, handling, and transport in conjunction with forecast uncertainty.

VI. CONCLUSIONS

Official statistics indicate a recent increase in collected municipal waste in Mexico, whereas separate diagnostic estimates reveal a substantial generation burden. Maintaining a clear distinction between these variables is crucial for credible projections. The 2012–2024 linear collection model demonstrates a positive annual slope and modestly outperforms simple benchmarks based on validation RMSE, although the drift model yields better results by MAE. The limited dataset and sensitivity to the starting year necessitate caution when applying long-horizon extrapolation.

Applying the relative collection trend to the 2026 generation anchor yields a conditional 2040 scenario of 57.32 million t/year. Under explicit illustrative assumptions, achieving 20% prevention and reducing the unmanaged fraction from 0.30 to 0.15 would decrease the pressure indicator by 60%. This outcome quantifies a scenario relationship and does not constitute a prediction of policy implementation or a 60% reduction in soil contaminant concentrations.

The environmental and socioeconomic response should integrate prevention, reliable collection, controlled residual disposal, worker inclusion, and site-specific monitoring. The next research priority is to develop a reconciled mass-flow inventory linked to measured contaminant inputs and local soil properties. Only this combination can translate waste trajectories into defensible projections of soil contamination and inform geographically targeted interventions.

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