**Note: Charts below are illustrative placeholders and should be replaced with official series before publication.**

# CHAPTER 10

# Medical Geography of Ethiopia (Ethiopia focus plus global lens)

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• 10.2 Climatic & environmental drivers: rainfall, temperature, elevation and hydrology.

• 10.3 Water, sanitation & hygiene (WASH) and enteric disease risk.

• 10.4 Vector ecology & malaria risk stratification (altitude, seasonality, suitability).

• 10.5 Health service availability, readiness & geographic access (T60/T120).

• 10.6 Maternal, newborn & child health: spatial inequities and service catchments.

• 10.7 Nutrition geography & food security: markets, seasons, and climate shocks.

• 10.8 Infectious disease ecology: transmission landscapes, surveillance and AMR.

• 10.9 Noncommunicable diseases & environmental exposures (air pollution, heat, injuries).

• 10.10 Biodiversity, protected areas & human pressure (One Health linkages).

• 10.11 Integrated planning: co-benefits, trade-offs and just transitions.

• 10.12 Section-level dashboards, data governance, and ethical safeguards.

# 10.1) Concepts, Scope & Value of Medical Geography

Medical geography studies how location, environment, and spatial relationships influence health. In Ethiopia, where altitude, climate, settlement patterns, and access to services vary widely, spatial analysis helps explain disease risks, target scarce resources, and monitor equity. This section introduces core ideas, typical data, and the value proposition for policy.

## Figures (illustrative concepts)

Figure . Distance–decay of service utilization

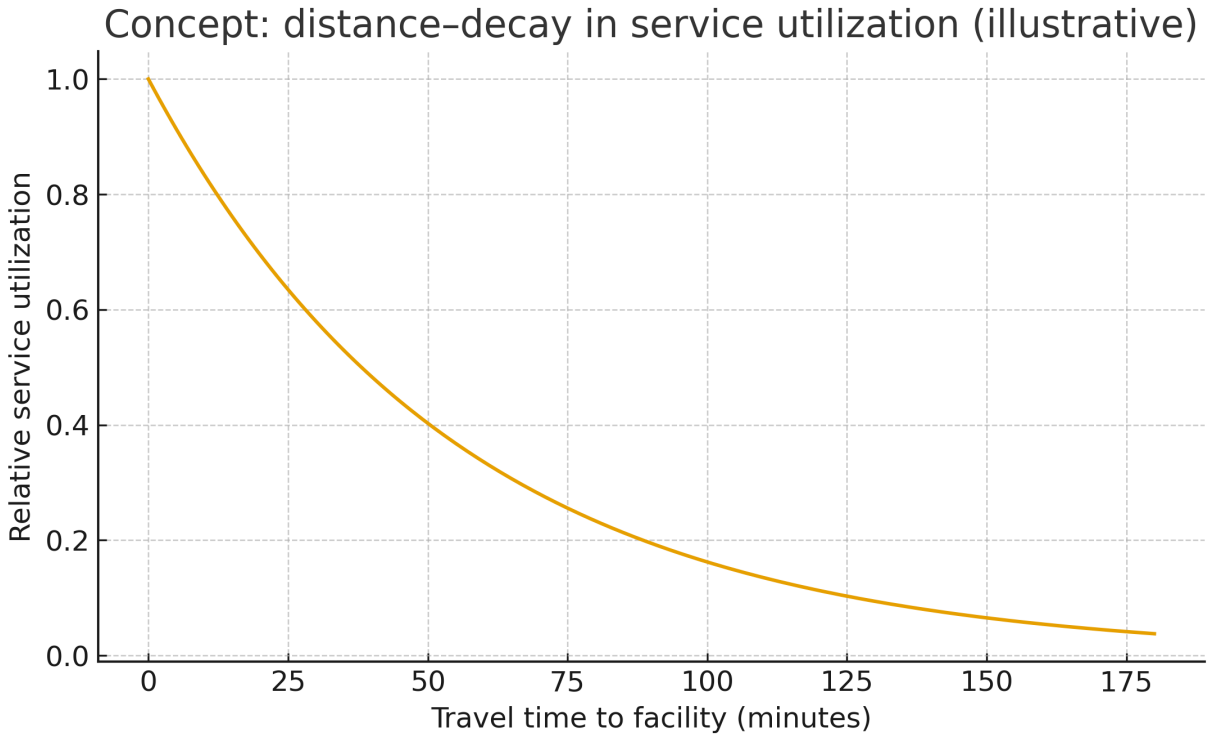
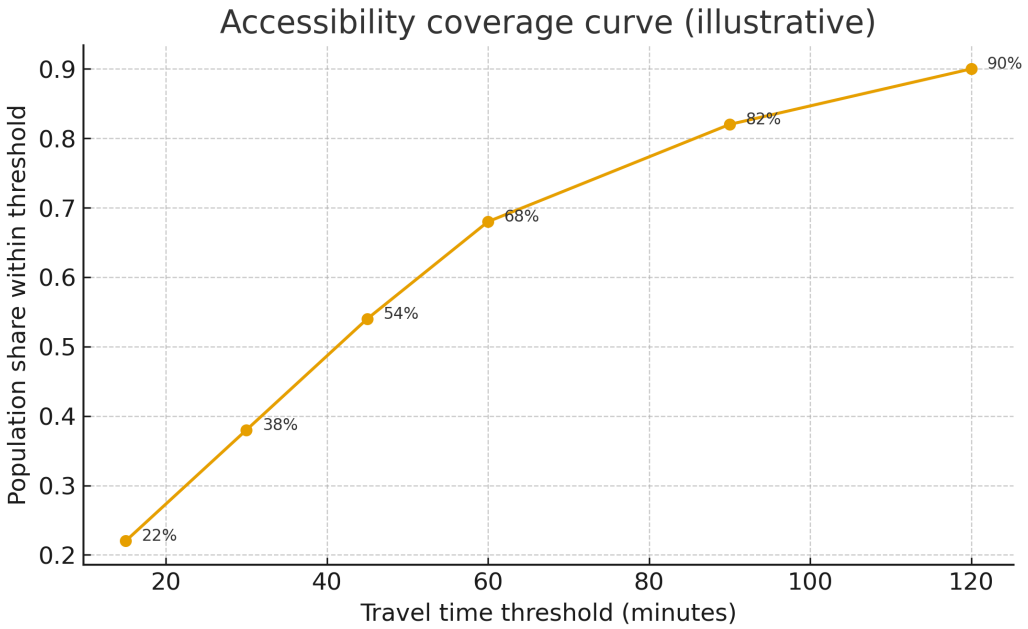


Figure . Accessibility coverage curve (T thresholds)




## Table 10.1-A. Core terms in medical geography

| Key term | Short definition |
|---|---|
| Place | A location with social, cultural, and environmental meaning (e.g., a kebele, market town). |
| Space | Abstract geographic surface used to quantify distance and spatial relations. |
| Scale | Spatial or temporal level of analysis (household, kebele, woreda, region, nation). |
| Context | Features around a person/place that shape health risk (e.g., housing, water, pollution). |
| Spatial accessibility | Ease of reaching services (distance, time, cost, transport, terrain). |
| Catchment | Population that realistically seeks care at a facility or school. |
| Hotspot / cold-spot | Area with significantly higher / lower value than expected (cluster). |

### Table 10.1-B. Ethiopia use-cases enabled by spatial analysis

| Ethiopia use-case | What spatial analysis enables |
|---|---|
| Malaria stratification | Overlay temperature, elevation, water bodies, vector habitat with case data to stratify for LLIN/IRS and surveillance. |
| Maternal & newborn care | Map travel time to EmONC, maternity waiting homes, and referral networks to close gaps. |
| Immunization micro-planning | Use gridded population and facility lists to design outreach routes and session sites. |
| WASH & diarrheal disease | Link water points, sanitation coverage, and remote sensing (flood/dry) to target investments. |
| Nutrition & food security | Combine market access, prices, agro-ecology, and survey rates to detect stunting hotspots. |
| NTDs elimination | Map endemicity and MDA coverage to plan verification and focused surveys. |

### Table 10.1-C. Data foundations for geo-health work in Ethiopia

| Data asset | Notes for use in Ethiopia |
|---|---|
| Facility master list (FML) | Name, geocode, type, ownership; link to HMIS/LMIS; update quarterly. |
| HMIS/IDSR | Routine case and service volumes; ensure stable coordinates and denominators. |
| CRVS & ID | Vital events; spatial completeness checks and linkage with residence. |
| DHS/MICS/ESS | Representative survey indicators; small-area estimation with geospatial covariates. |
| Remote sensing | Rainfall, temperature, NDVI, night lights, land cover, elevation. |

| | |
|---|---|
| Gridded populations | WorldPop, HRSL, GHS-POP; validate with census and local counts. |
| Roads & transport | OSM, official road classes, terrain/land-cover for impedance surfaces. |

### Table 10.1-D. Standard indicators for dashboards & planning

| Indicator | Definition / construction idea |
|---|---|
| T15/T30/T60 coverage | % population within 15/30/60 minutes of target facility/service. |
| EmONC readiness index | Composite of signal functions, HRH, commodities, blood. |
| E2E cold-chain time | Time from regional store to outreach session; risk of breaks. |
| Malaria suitability index | Temperature × elevation × water proximity × cases. |
| Under-5 mortality risk map | Small-area estimates from survey + covariates. |
| Equity gradient | Service coverage difference between poorest/remote vs richest/central quintiles. |

### Table 10.1-E. Common pitfalls & how to avoid them

| Common pitfall | How to avoid in Ethiopia |
|---|---|
| Misclassified coordinates | Wrong facility points can flip accessibility results; verify with field photos or GPS. |
| Denominator mismatch | Coverage rates off if catchment denoms differ from reporting areas. |
| Urban bias | Short distances but long times due to congestion; use travel time, not Euclidean distance. |
| Ecological fallacy | Area averages may not reflect individual risk; complement with microdata. |
| Privacy risk | Don’t map sensitive point data (e.g., HIV status) at identifiable resolution. |

## Why this matters for Ethiopia (value proposition)

• Targeting: Map who is underserved (by distance, cost, or terrain) and direct mobile/outreach teams accordingly.
• Preparedness: Anticipate outbreaks by tracking climate anomalies, vector habitats, and mobility.
• Efficiency: Optimize facility locations, referral routes, and supply chains to reduce delays and stock-outs.
• Equity: Monitor urban–rural and regional gaps; publish access and quality by wealth and remoteness.
• Accountability: Public dashboards with clear thresholds (e.g., T30 to basic care, T60 to EmONC) support results-based management.

## Plain-language summary

Where people live affects their health. Mountains, climate, roads, and distance to clinics all change the risks people face and the care they can reach. By putting health data on a map and combining them with information on the environment and transport, Ethiopia can see which places need help first. This saves lives and money, because actions are focused where they have the biggest impact.

## References — Section 10.1

- Cromley & McLafferty. GIS and Public Health.

- Meade & Emch. Medical Geography.

- WHO. Service Availability and Readiness Assessment (SARA) methods.

- UNICEF/WHO. Global accessibility mapping guidance.

- DHS Program. Spatial data and displacement documentation.

# 10.2) Data Foundations (HMIS, CRVS, DHS/MICS, Facility Master Lists, Remote Sensing)

Robust medical geography depends on reliable, linkable data. This section summarizes Ethiopia’s core health and spatial data assets, key quality indicators, metadata standards, and ethical safeguards. Charts below are illustrative placeholders and should be replaced with official series before publication.

## Figures (illustrative)

Figure . HMIS reporting timeliness

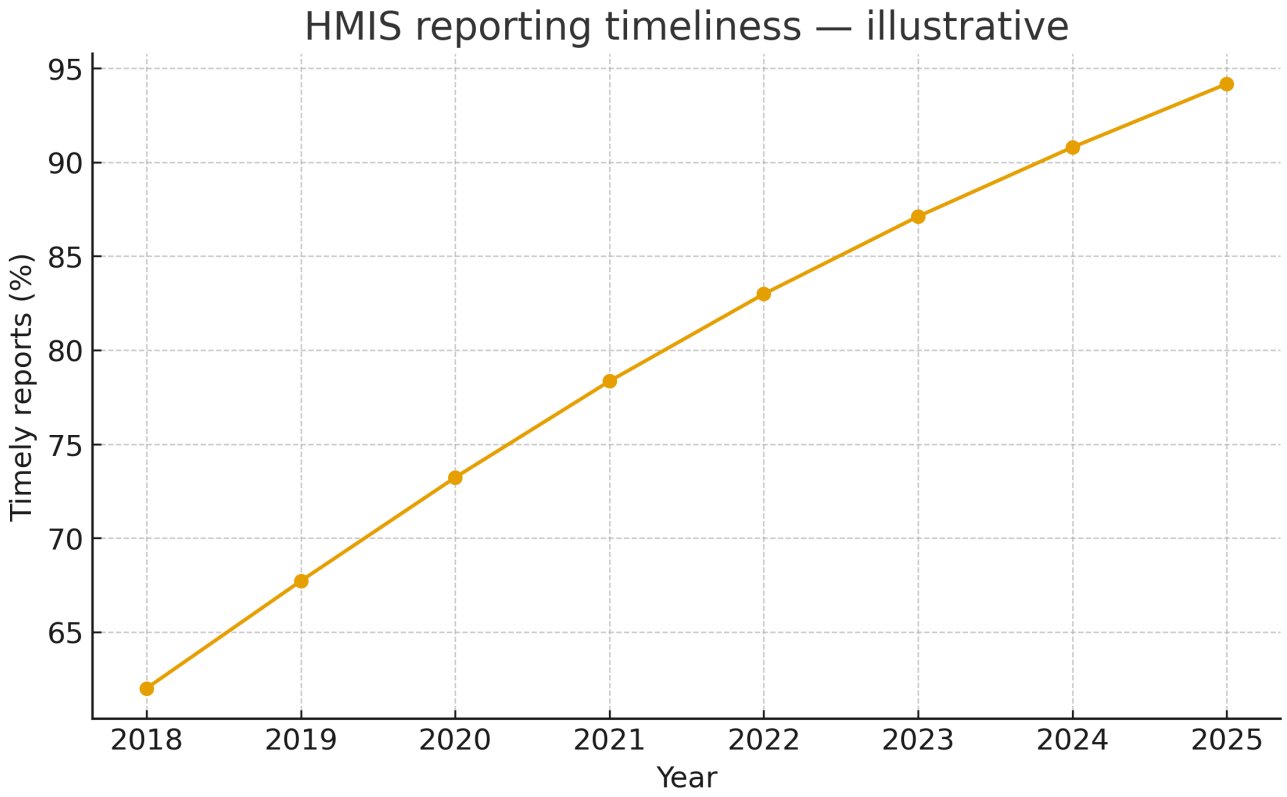


Figure . CRVS completeness (births, deaths)

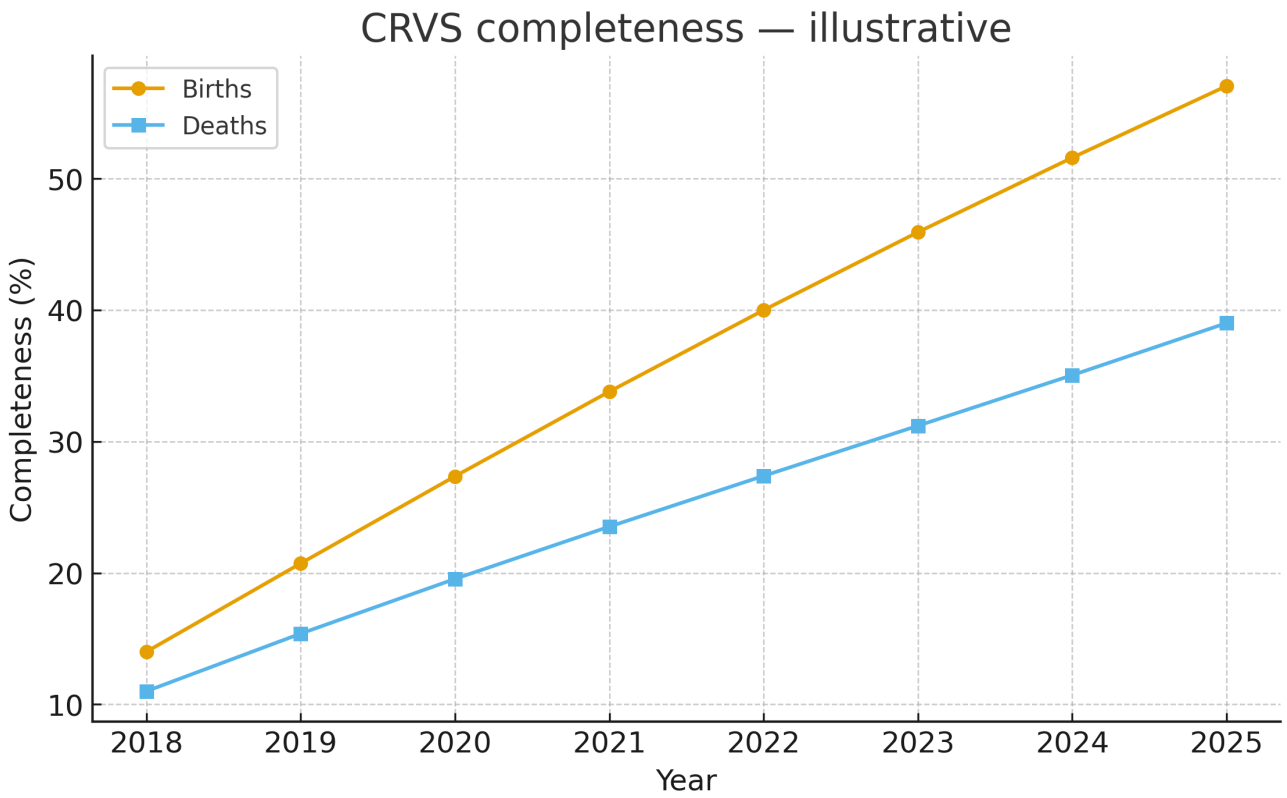



Figure . Facility geocode completeness (FML)

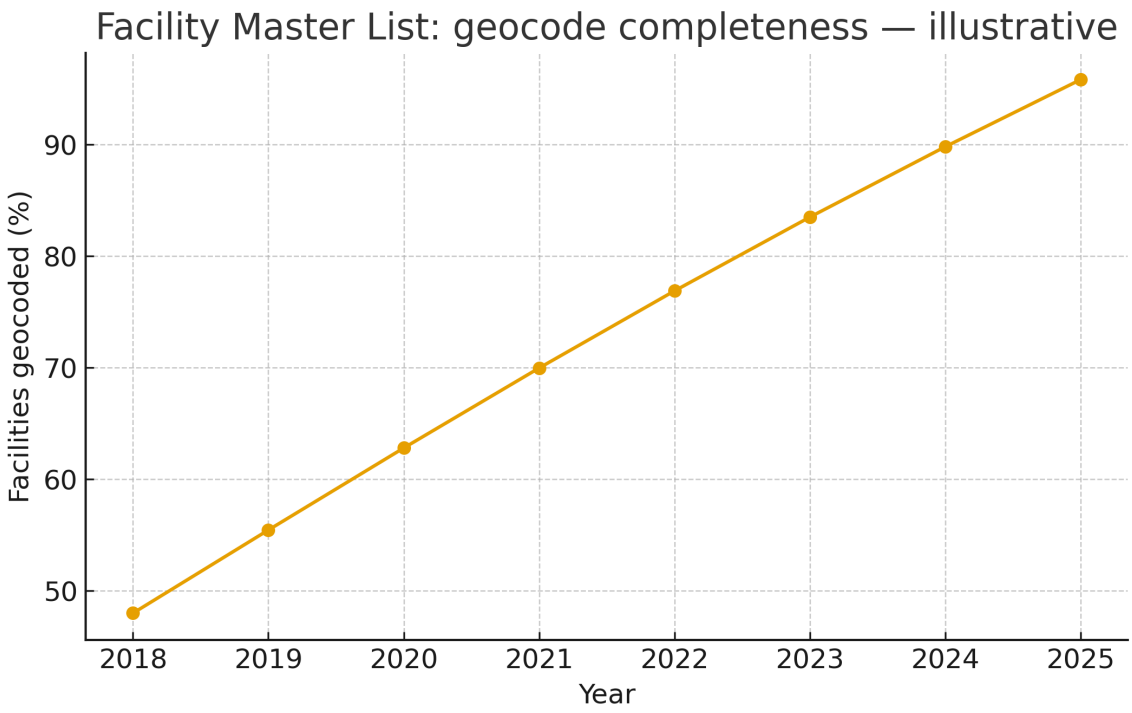


Figure . Remote sensing availability index

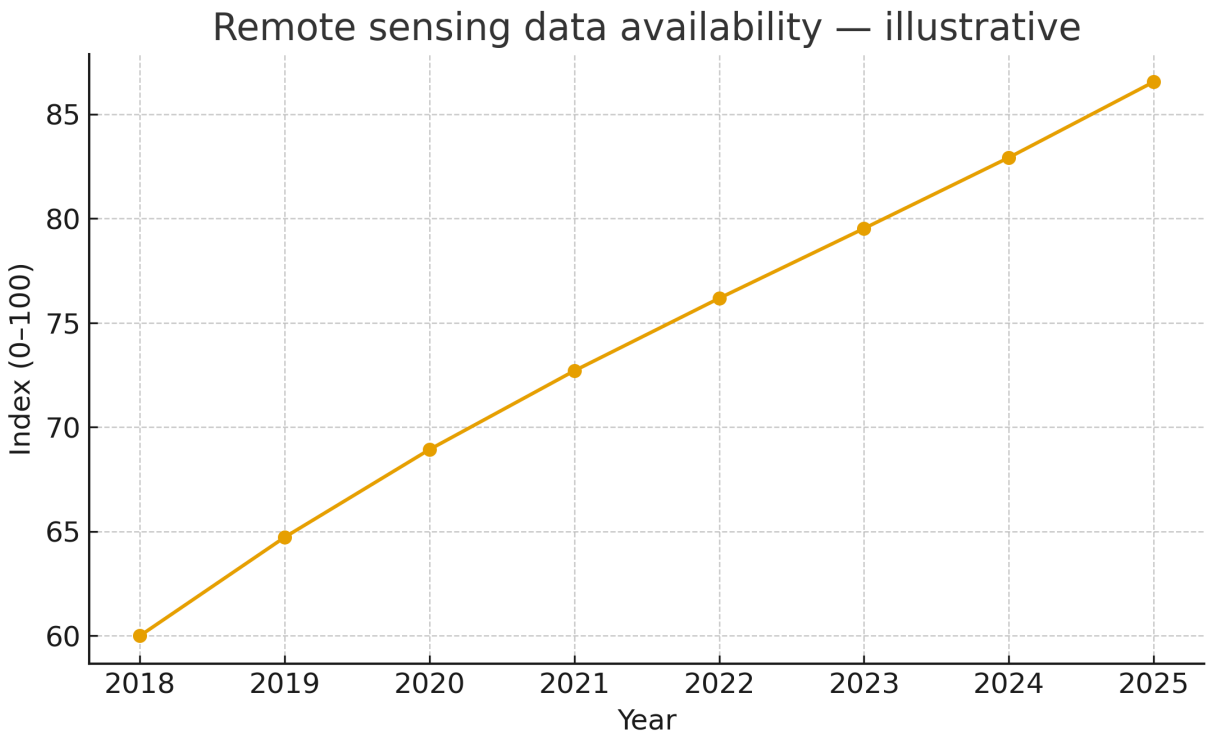
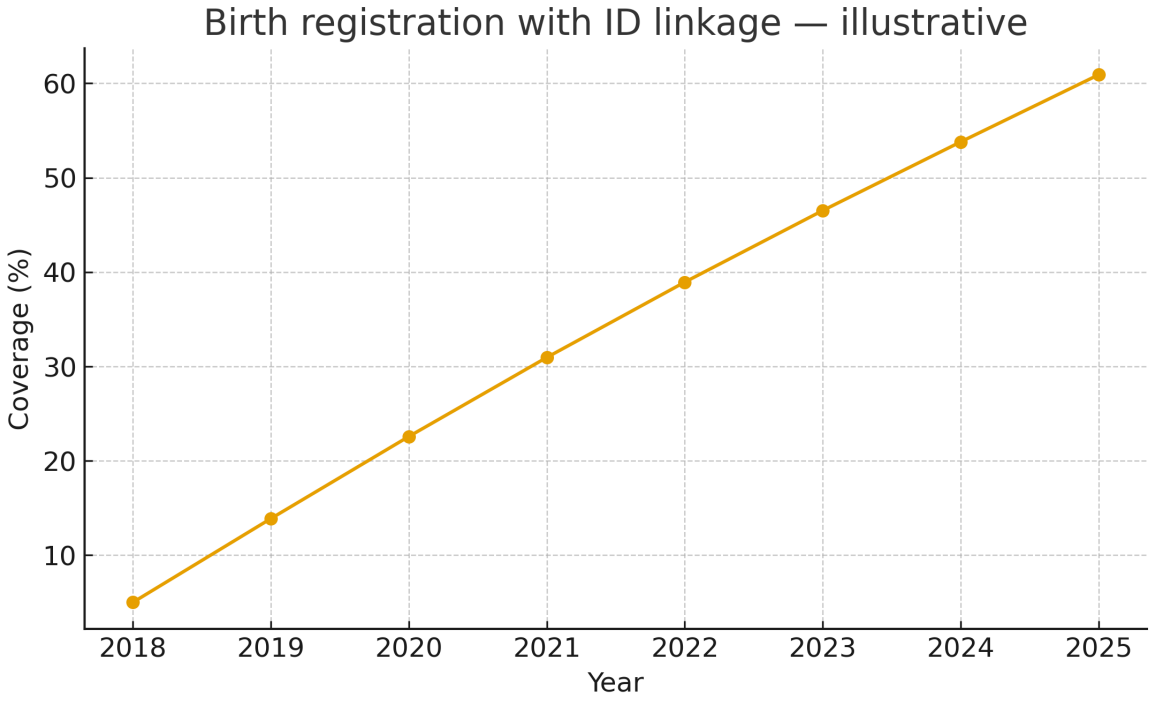



Figure . Birth registration with ID linkag



### Table 10.2-A. Core data assets & custodians (Ethiopia)

| Data asset | Lead(s) | Notes for use |
|---|---|---|
| HMIS (DHIS2/EMR) | MoH + regions | Monthly service volumes, cases; facility-level; needs stable denominators |
| CRVS / Vital Events | Vital Events Registration Agency (VERA) + MoH | Continuous births, deaths, causes; completeness improving |
| Facility Master List (FML) | MoH + CSA + regions | Unique IDs, geocodes, attributes; quarterly reconciliation |
| DHS/MICS/ESS | CSA with partners | Representative surveys; geospatially masked clusters |
| ID (National ID / Civil ID) | National ID program | Linkable identifiers for person-level records |
| Remote sensing & geospatial layers | EMA, international sources | Rainfall, temperature, NDVI, land cover, elevation, roads |
| Supply Chain (LMIS/eLMIS) | EPSA/MoH | Stock levels, cold chain, routings; link to facilities |

### Table 10.2-B. Minimum metadata & standards

| Item | Specification (Ethiopia practice) |
|---|---|
| Unique IDs | Facility ID, person ID (hashed), admin codes; versioned |
| Spatial refs | WGS84 lat/long; admin area codes (CSA) |
| Time | Reporting period start/end; timestamp of extraction |
| Quality flags | Outlier tags, late/missing, duplicates, heaping indicators |
| Privacy | De-identification, suppression rules, min cell sizes |

| | |
|---|---|
| Interoperability | Crosswalks between IDs; master code lists; API endpoints |

### Table 10.2-C. Data quality checks — dashboard metrics

| Dimension | Example metrics |
|---|---|
| Completeness | % facilities reporting; % events registered |
| Timeliness | % on-time submissions; lag days |
| Consistency | Month-over-month change within bounds; rolling medians |
| Plausibility | Rates within expected ranges by age/sex/region |
| Spatial checks | Coordinate validity, admin boundary alignment |
| Linkage quality | Match rates FML↔HMIS↔LMIS, CRVS↔ID |
| Feedback loop | Ticketing for data corrections; closure times |

### Table 10.2-D. Geocoding & linkage workflow

| Step | What to do |
|---|---|
| 1. Clean facility list | Deduplicate names; standardize types/ownership |
| 2. Validate coordinates | Snap to settlements/roads; fix obvious errors |
| 3. Assign master IDs | Immutable IDs + crosswalk to legacy codes |
| 4. Link systems | Map HMIS/LMIS/CRVS/ID to FML IDs |
| 5. QA & publish | Dashboards, data dictionary, update cycle |
| 6. Field verification | Spot-checks, GPS/photo evidence, partner feedback |

### Table 10.2-E. Data ethics & sharing

| Principle | Application in Ethiopia |
|---|---|
| Purpose limitation | Use data only for defined public-health tasks |
| Minimum necessary | Aggregate/suppress where small numbers risk re-ID |
| Consent/notice | Use clear notices; respect legal bases where applicable |
| Data sharing MOUs | Define roles, retention, breach protocols |
| Community safeguards | Engage local leaders when mapping sensitive issues |

## Plain-language summary

Maps are only as good as the data behind them. Ethiopia's health maps depend on a clean list of facilities with correct GPS points, regular reports from clinics and hospitals, proper registration of births and deaths, national surveys, and satellite information about the environment and roads. We track basic checks like: Are reports on time? Are events registered? Do coordinates look right? With good standards and privacy rules, these data can be linked together to show where needs are greatest and how services are improving.

## References — Section 10.2


- WHO. Health Facility Master List (FML) guideline.

- WHO. Standards-based data quality review (DQR) for routine health data.

- UNICEF/WHO. Civil Registration and Vital Statistics (CRVS) guidance.

- DHS Program & MICS surveys — sampling and geospatial documentation.

- Weiss et al. Global travel-time to cities; global accessibility layers (methods).

# 10.3) Population, Settlement & Mobility Patterns

Ethiopia’s people are unevenly distributed across highlands and lowlands, with growing corridors of towns and cities. Mobility ranges from daily commuting to seasonal pastoral movements and long-distance trade. Understanding these patterns helps anticipate disease risk, size service catchments, plan referral networks, and align investments in roads, health, and education.

## Figures (illustrative)

Figure . Urban hierarchy (rank–size plot)

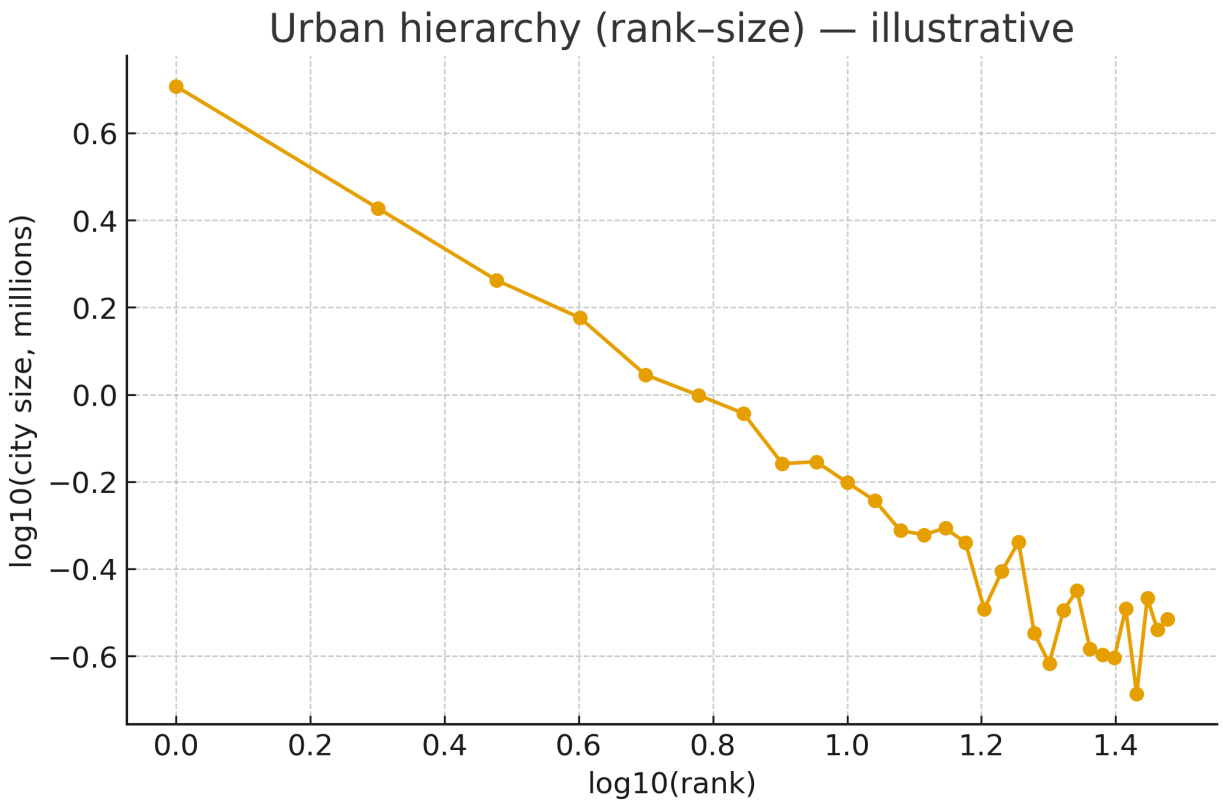


Figure . Commuting time distributions (urban vs rural)

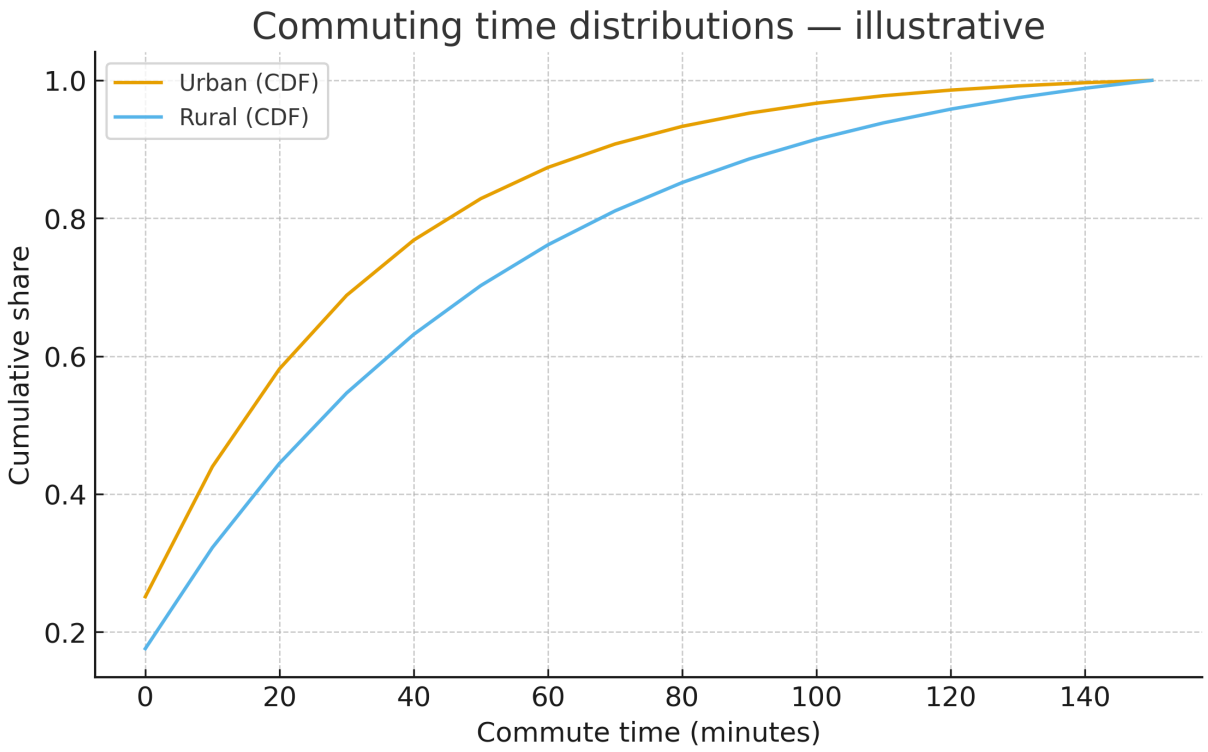



Figure . Seasonal mobility index (monthly)

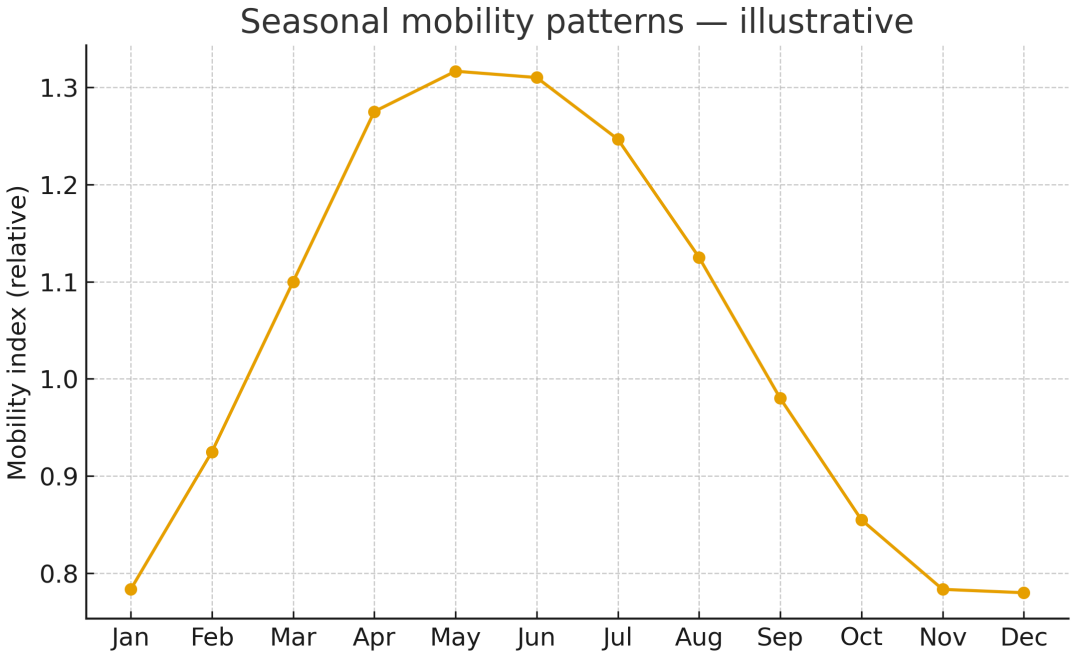


Figure . Accessibility coverage curves (urban vs rural)

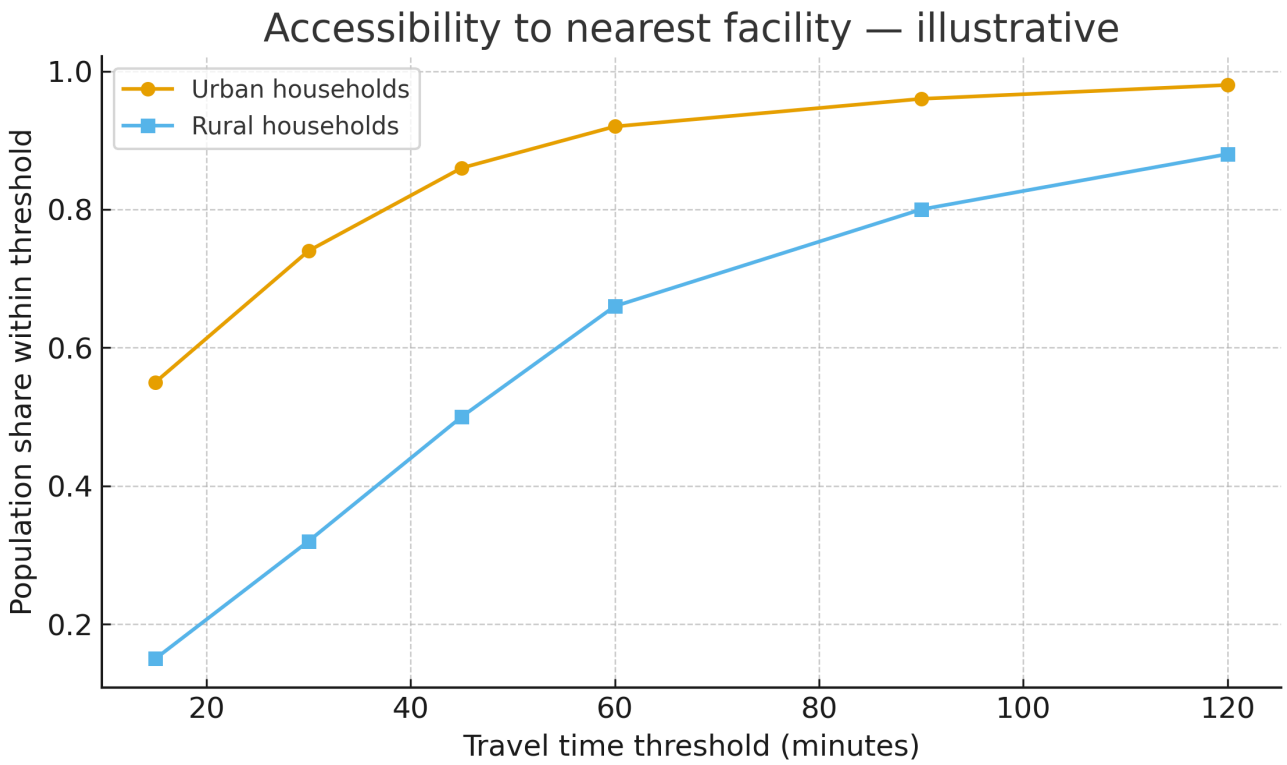



**Table 10.3-A. Settlement types & characteristics (Ethiopia)**

| Settlement type | Typical characteristics in Ethiopia |
|---|---|
| Metropolitan core (e.g., Addis Ababa) | High density, diversified economy, tertiary services, referral hospitals |
| Secondary cities (e.g., Adama, Hawassa, Mekelle) | Regional markets, universities, specialized care |
| Intermediate/Small towns | Basic services, feeder markets, primary care |
| Rural agrarian highlands | Dispersed villages, road density moderate, seasonal labor moves |
| Pastoral/agro-pastoral lowlands | Mobile settlements, seasonal wells, market-linked migration |

**Table 10.3-B. Mobility typology & data sources**

| Mobility type | Primary data sources |
|---|---|

| | |
|---|---|
| Daily commuting | Household travel surveys; mobile positioning data; transit counts |
| Seasonal/pastoral movement | Key informant mapping; satellite water/vegetation; livestock routes |
| Education- and care-seeking flows | School catchments; facility registers; referral logs |
| Trade & freight corridors | Road sensors, weigh stations, customs/border stats |
| Displacement & returns | DTM/IDP assessments; registration; geofenced shelters |

### Table 10.3-C. Indicators for population & mobility geography

| Indicator | Why it matters |
|---|---|
| Urbanization share | % population in urban areas (consistent definition) |
| Rank–size slope | Hierarchy concentration; planning for secondary cities |
| T30/T60 coverage | % population within 30/60 min of primary/emergency care |
| School and facility catchments | Population served; equity of access |
| OD flow centrality | Network hubs and bottlenecks for services & outbreaks |

### Table 10.3-D. Ethiopia patterns & health implications (examples)

| Pattern | Implication for health planning |
|---|---|
| Highland concentration | Majority of population lives 1500–2500 m; malaria risk lower above ~2000 m |
| Urban corridors | Addis–Adama–Hawassa and Addis–Ambo corridors concentrate flows |
| Pastoral routes | Somali/Afar transhumance follows rainfall and pasture patterns |
| Seasonal peaks | Holiday and harvest periods produce mobility spikes affecting services |

### Table 10.3-E. Common pitfalls & remedies

| Common pitfall | Remedy |
|---|---|
| Inconsistent urban definition | Adopt stable, documented urban criteria; test sensitivity |
| Euclidean distances used | Switch to travel time surfaces; validate with field times |
| Ignoring seasonality | Use monthly data; incorporate RS rainfall/NDVI proxies |
| Overfitting to one data source | Triangulate surveys, admin, and remote-sensing data |

## Plain-language summary

Most Ethiopians live in the highlands, where the climate is cooler and farms are common. Cities are growing along major roads, and many people travel every day for work or school. In the lowlands, some communities move with their herds depending on the rains. These movements change when and where people need health services. By looking at elevation, city size, travel times, and movement between cities, planners can place clinics and supplies where they will help the most.

## References — Section 10.3


- CSA Ethiopia — Census & survey urbanization statistics; regional profiles.

- WorldPop/HRSL/GHS-POP — Gridded population datasets (methods).

- Weiss et al. Global travel-time to cities; accessibility modeling.

- UN-Habitat & World Bank — Ethiopia urbanization diagnostics.

- IOM DTM — Mobility tracking methods (for displacement/mobility context).

# 10.4) Physical Geography, Altitude & Climate Zones

Ethiopia’s dramatic relief and climate gradients shape health risks and service access. Traditional altitude belts (Kolla, Weyna Dega, Dega) align with temperature and rainfall patterns that influence vectors, crops, and mobility. This section summarizes key geographies and how programs can use them.

## Figures (illustrative)

Figure . Population by altitude belt

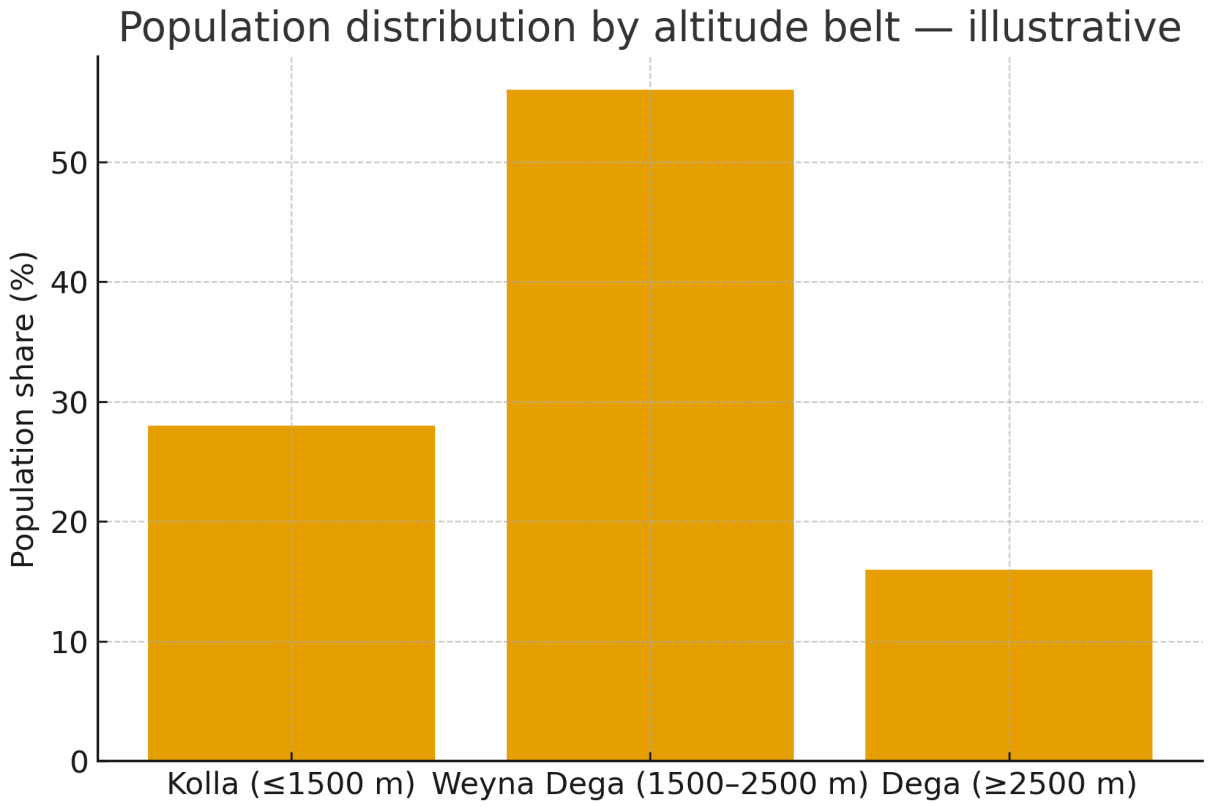


Figure . Temperature vs altitude (lapse rate)

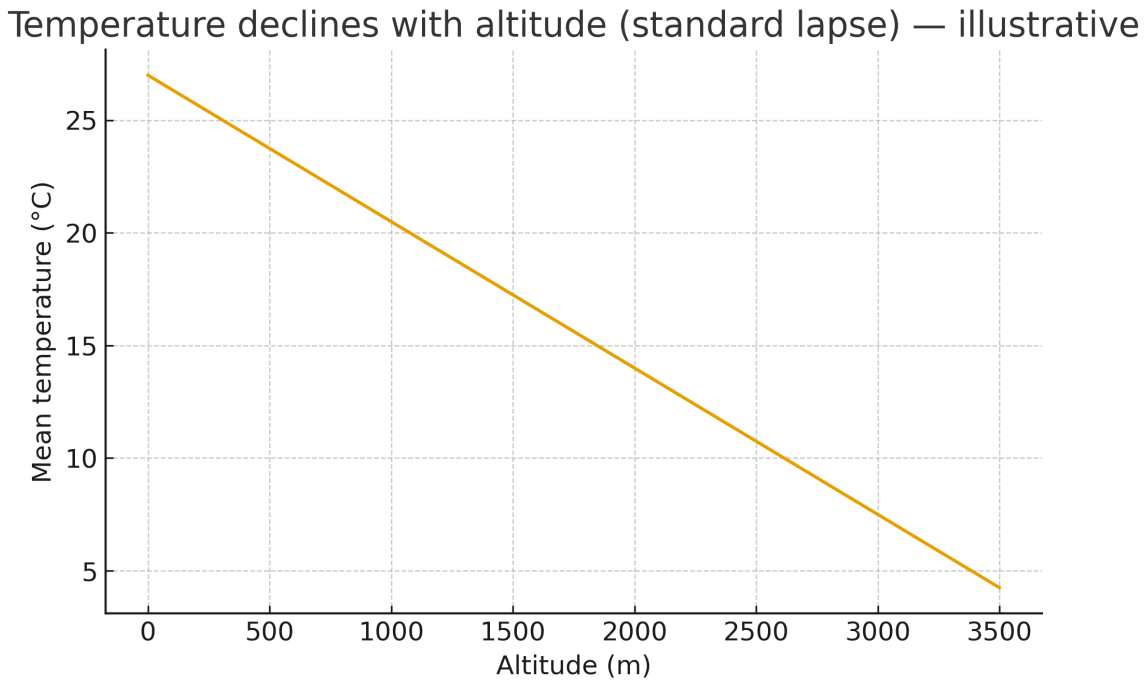



Figure . Malaria suitability vs altitude

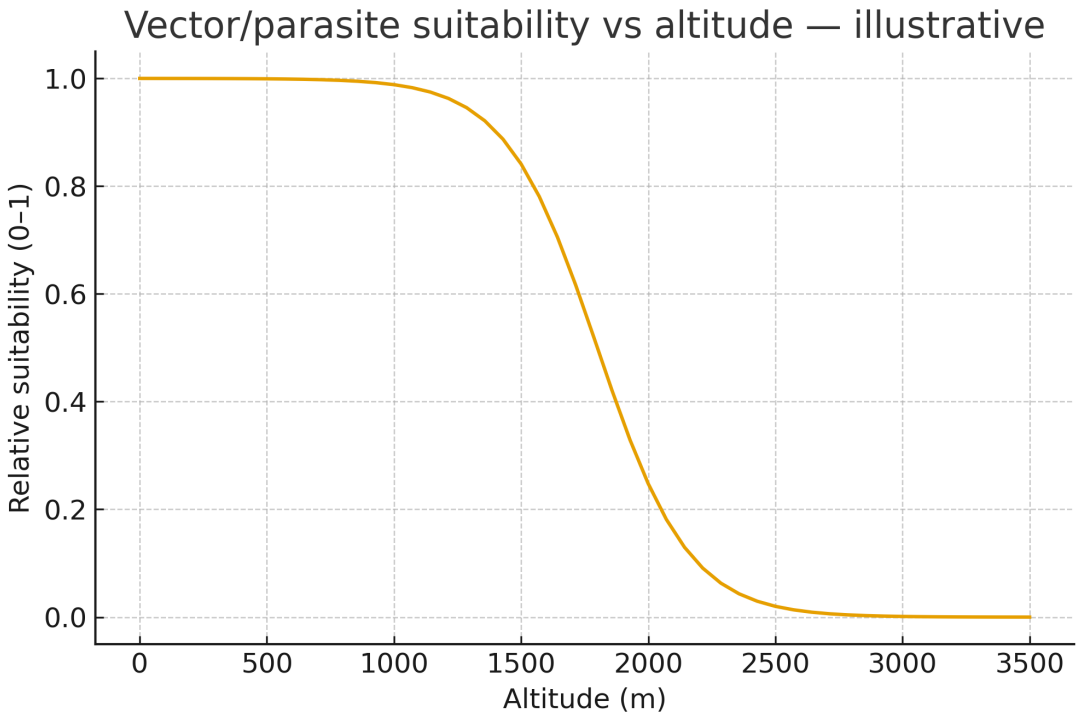


Figure . Rainfall seasonality by eco-zone

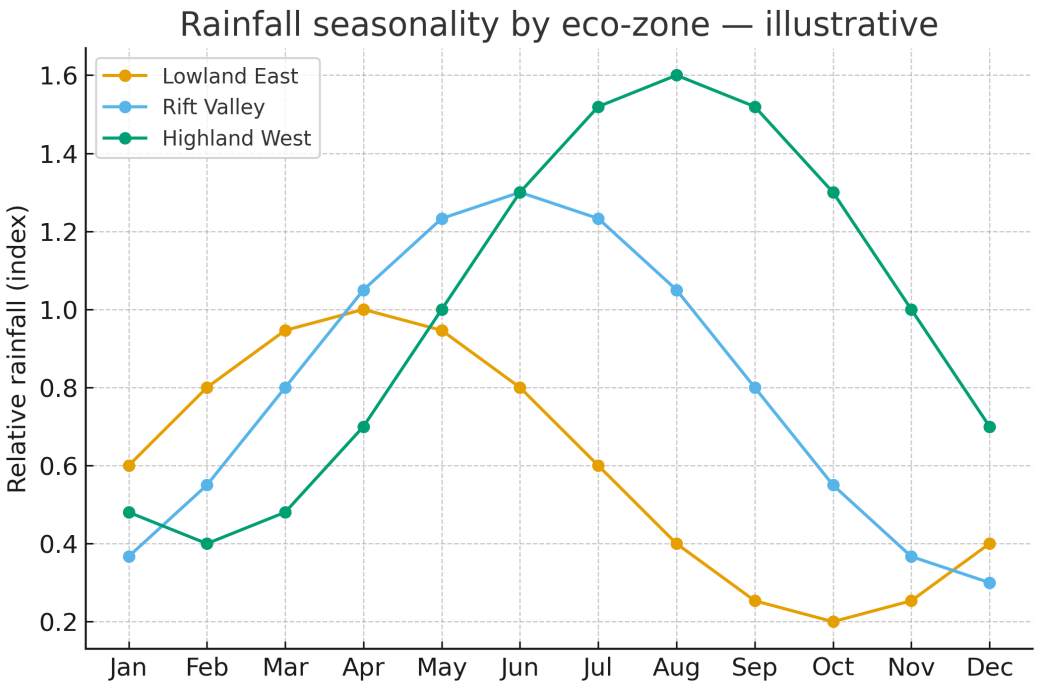



**Table 10.4-A. Altitude belts, climate traits & health relevance**

| Altitude belt | Typical climate & terrain | Selected health relevance in Ethiopia |
|---|---|---|
| Kolla (≤1500 m) | Warmer; vector-friendly in many areas; water scarcity pockets | Malaria/arboviruses; heat stress; water-borne disease risk |
| Weyna Dega (1500–2500 m) | Temperate; major settlement zone; mixed agriculture | Lower malaria risk but outbreaks possible in fringes; ARI seasonality |
| Dega (≥2500 m) | Cooler; steep slopes; frost risk | Hypoxia in high passes; lower |

| | | |
|---|---|---|
| | | malaria risk; indoor air pollution (cold) |

**Table 10.4-B. Climate variables & common data sources**

| Variable | Common sources |
|---|---|
| Temperature (°C) | Reanalysis (ERA5), station data (NMA), MODIS LST |
| Rainfall (mm) | CHIRPS, TAMSAT, station data |
| Humidity/vapour pressure | ERA5 |
| Vegetation (NDVI/EVI) | MODIS, Sentinel-2 |
| Surface water/wetlands | JRC Global Surface Water, Sentinel-1/2 |
| Elevation/slope | SRTM/ALOS DEM |
| Land cover | Copernicus, ESA CCI |

**Table 10.4-C. Health pathways linking climate to outcomes**

| Pathway | Mechanism (simplified) |
|---|---|
| Vector-borne | Temp & rainfall → vector abundance; altitude thresholds for malaria |
| Water-borne | Flood/dry spells → contamination; storage → Aedes breeding |
| Respiratory | Cold season → indoor crowding/air pollution; dust events → ARI/asthma |
| Nutrition | Rain/temperature → yields & prices → wasting/stunting risk |
| Heat-related | Extremes → dehydration, CKD, pregnancy risks |

### Table 10.4-D. Program uses in Ethiopia

| Program use | Operational decision |
|---|---|
| Malaria stratification | Exclude high-altitude kebeles from IRS; focus LLIN & surveillance in suitable fringes |
| Immunization & outreach | Time sessions before heavy rain; adjust cold-chain routes during floods |
| WASH | Prioritize drought-prone lowlands and flood-prone riverine zones |
| NTDs | Snail habitat mapping for schisto; soil type for STH |
| Maternal/Newborn care | Travel-time risk rises in rainy season; plan maternity waiting homes accordingly |

### Table 10.4-E. Pitfalls & cautions

| Pitfall | How to avoid |
|---|---|
| Altitude as proxy for risk | Use with temperature data; local micro-climates can differ |
| Static thresholds | Re-check as climate warms; suitability fringes can shift upward |
| County/zone averages | Mask hot-spots; use high-resolution rasters and local verification |
| Data gaps | Blend station and satellite products; validate against ground truth |

## Plain-language summary

Ethiopia has lowlands, middle-altitude lands, and highlands. As you go higher, it gets cooler and some diseases become less common. Rain also changes across the country and through the year. These patterns affect crops, water, mosquitoes, and how easily people can travel. By using altitude, temperature, and rainfall together, health programs can choose the right mix of prevention and care for each place.

## References — Section 10.4

- National Meteorology Agency (NMA) — Climate normals and station data.

- CHIRPS/TAMSAT — Satellite-gauge rainfall products.

- MODIS/ERA5 — Land surface temperature and reanalysis.

- WHO & FMOH — Ethiopia malaria stratification guidance.

- USGS & ESA — DEM and land-cover datasets.

# 10.5) Environmental Determinants: Land Cover, Hydrology & Soils

Environmental layers help explain when and where disease risks rise and how people reach care. In Ethiopia, land cover, rivers and wetlands, irrigation schemes, and soils interact with climate and settlement to shape malaria, diarrheal disease, NTDs, and access challenges. This section outlines practical variables, pathways, indicators, and pitfalls.

## Figures (illustrative)

Figure . Land cover shares

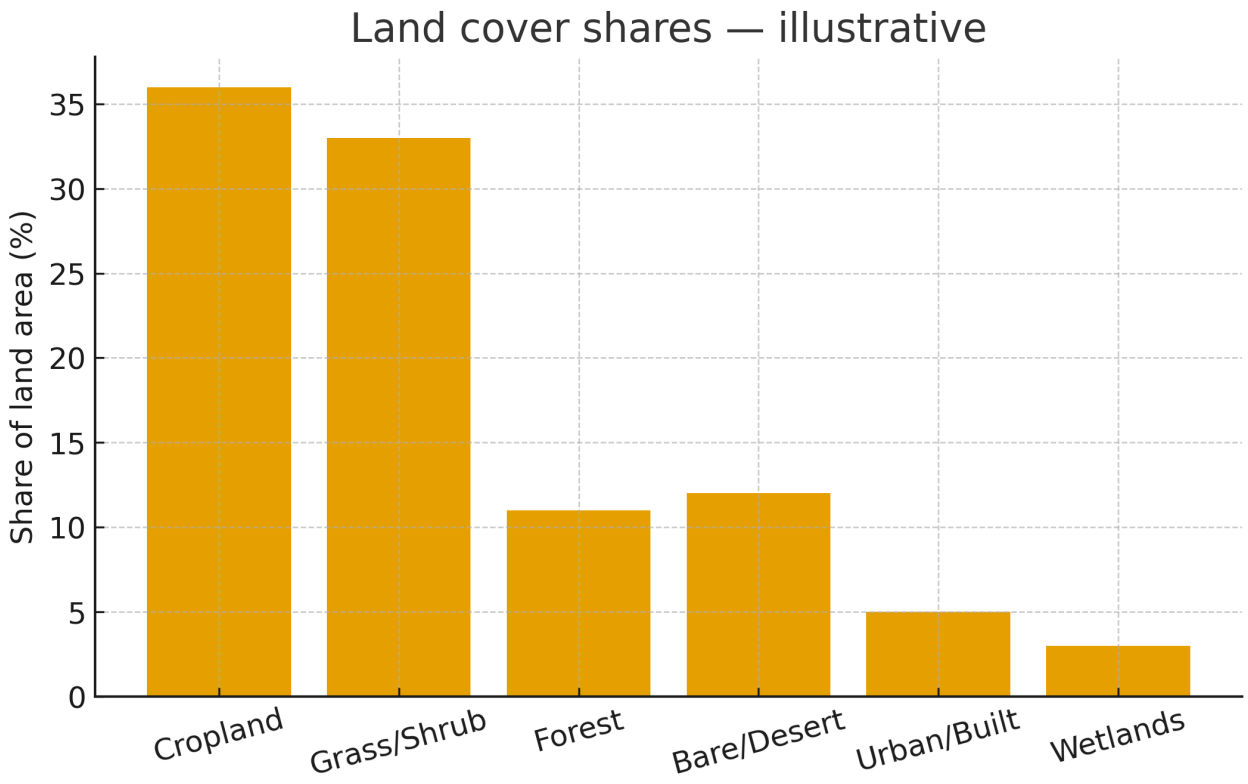


Figure . Seasonal flood exposure by basin

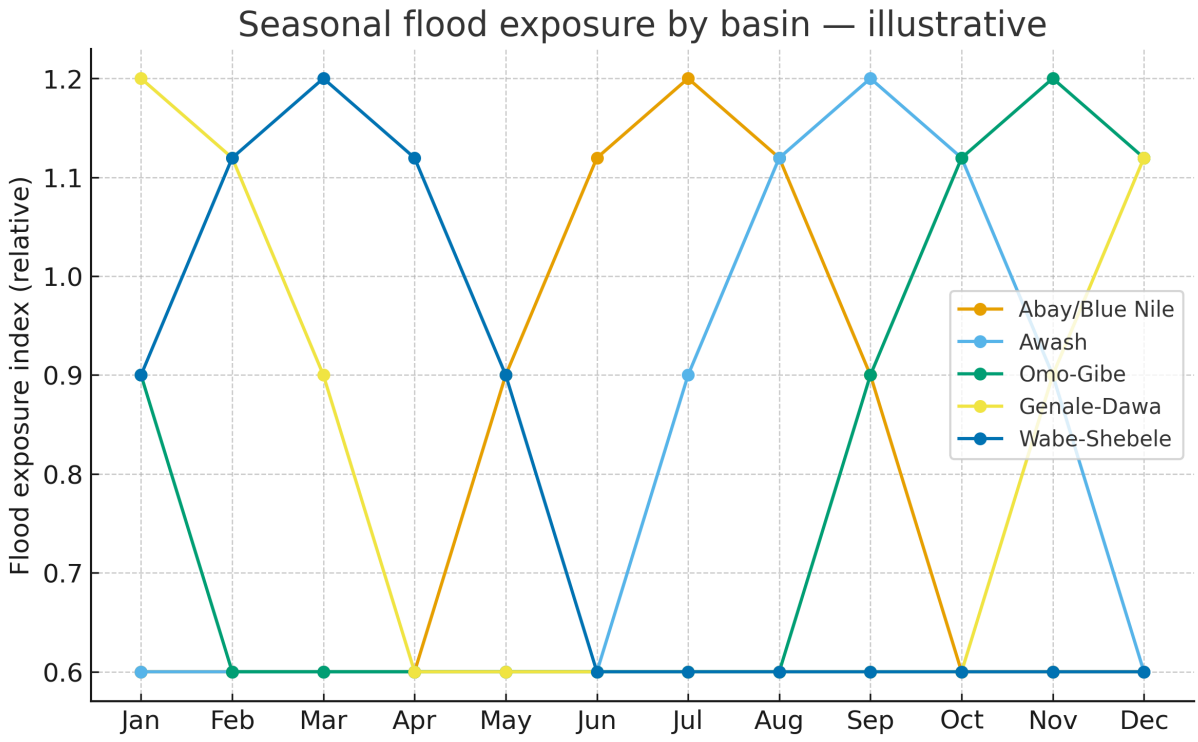
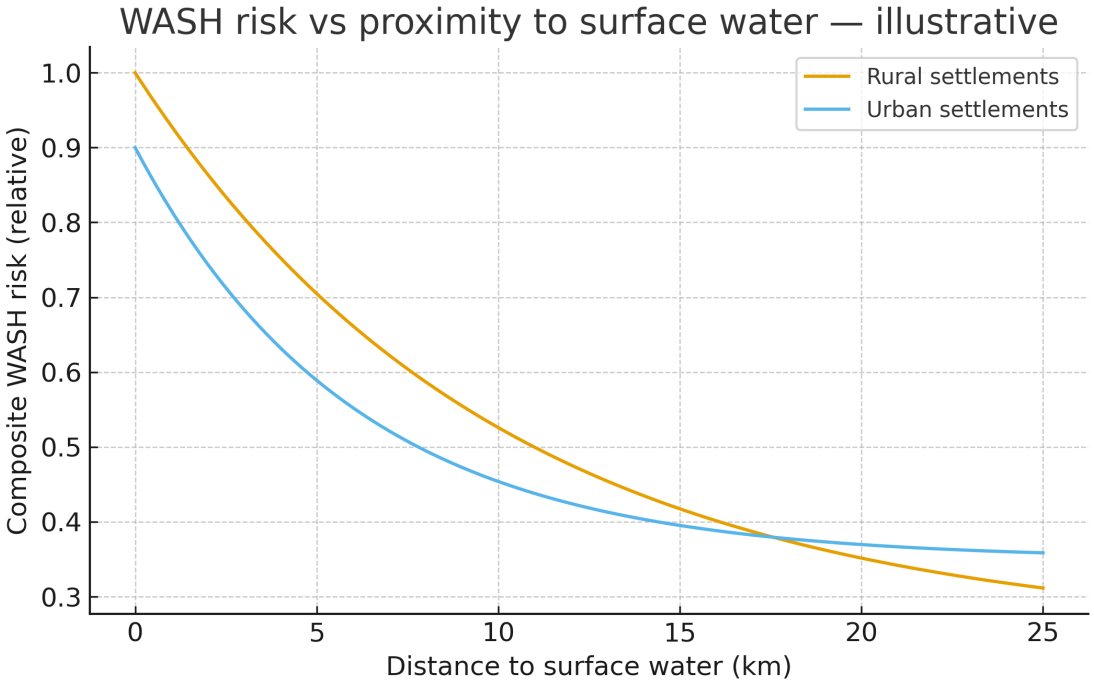



Figure . WASH risk vs proximity to water (urban vs rural)



### Table 10.5-A. Key environmental variables & sources

| Variable | Common sources for Ethiopia |
|---|---|
| Land cover | Copernicus Global Land Cover, ESA CCI, local land-use maps |
| Surface water & wetlands | JRC Global Surface Water, HydroSHEDS, national hydrology |
| Soils | FAO/ISRIC SoilGrids, Ethiopia soils maps |
| Elevation & slope | SRTM/ALOS DEM; derivatives for slope/roughness |
| Irrigation & canals | National irrigation datasets; RS irrigated extents |
| Urban extents | HRSL/GHS-BUILT, Sentinel-derived built-up |
| Roads/paths | OSM + official road network; tracks/footpaths |

### Table 10.5-B. Environment → health pathways

| Environmental feature | Health pathway (simplified) |
|---|---|
| Standing water | Mosquito breeding → malaria/dengue risk |
| Soils (clay/Vertisols) | Drainage & latrine stability; schisto snail habitats |
| Slope/relief | Travel time to care; flood run-off risk |
| Bare/Desert & drought | Dust/ARI; water scarcity; meningitis dynamics |
| Urban/built surfaces | Heat islands; drainage; waste-borne vectors |
| River networks | Cholera & diarrheal outbreaks; flood exposure |

### Table 10.5-C. Ethiopia program use-cases

| Program area | How environmental layers inform action |
|---|---|

| | |
|---|---|
| Malaria & arboviruses | Combine temperature, water, land cover to stratify risk and plan LLIN/IRS & larval control |
| Schistosomiasis & STH | Map water bodies, soils and schools; target MDA & WASH |
| Cholera/diarrhea | Overlay rivers/floodplains with sanitation and water points; pre-position supplies |
| Maternal/newborn access | Include slope and river crossings in travel-time models |
| Immunization | Plan dry-season outreach in flood-prone kebeles; protect cold chain near hot zones |

### Table 10.5-D. Indicators for dashboards

| Indicator | Interpretation/use |
|---|---|
| Population ≤2 km water | Flood/water-borne risk vs. water access |
| % facilities in floodplain | Service continuity risk |
| Slope-adjusted T30/T60 | Accessibility with terrain |
| Built-up near wetlands (%) | Urban drainage/vector risk |
| Irrigated area near settlements | Larval habitat potential |

### Table 10.5-E. Pitfalls & safeguards

| Pitfall | Safeguard |
|---|---|
| Equating water presence with risk | Consider flow, seasonality, contact |
| Static maps used year-round | Use seasonal composites; monitor anomalies |
| Coarse classes | Validate locally; increase resolution for micro-planning |
| Ignoring behavior | Add mobility & WASH behaviors to environment maps |

## Plain-language summary

Health is shaped by the land. Farms, forests, deserts, rivers, and slopes all affect which diseases are common and how quickly people can get help. For example, mosquitoes breed in standing water, floods can spread cholera, and steep hills make ambulance travel slow. By combining maps of land cover, water, and soil with data on people and clinics, Ethiopia can target prevention, plan safe routes, and prepare for seasonal risks.

## References — Section 10.5


- Copernicus/ESA CCI Land Cover — documentation and products.

- JRC Global Surface Water & HydroSHEDS — surface water datasets.

- ISRIC SoilGrids & FAO soils — soil properties and classes.

- USGS SRTM & ALOS — elevation/slope datasets.

- WHO & MoH Ethiopia — environmental health and malaria/NTD stratification guidance.

# 10.6) Climate Variability & Change

Ethiopia experiences strong climate variability across seasons and regions, with long-term warming. Health planners need to monitor anomalies, anticipate risks, and adapt services. The charts below are illustrative placeholders.

## Figures (illustrative)

Figure . National temperature anomalies

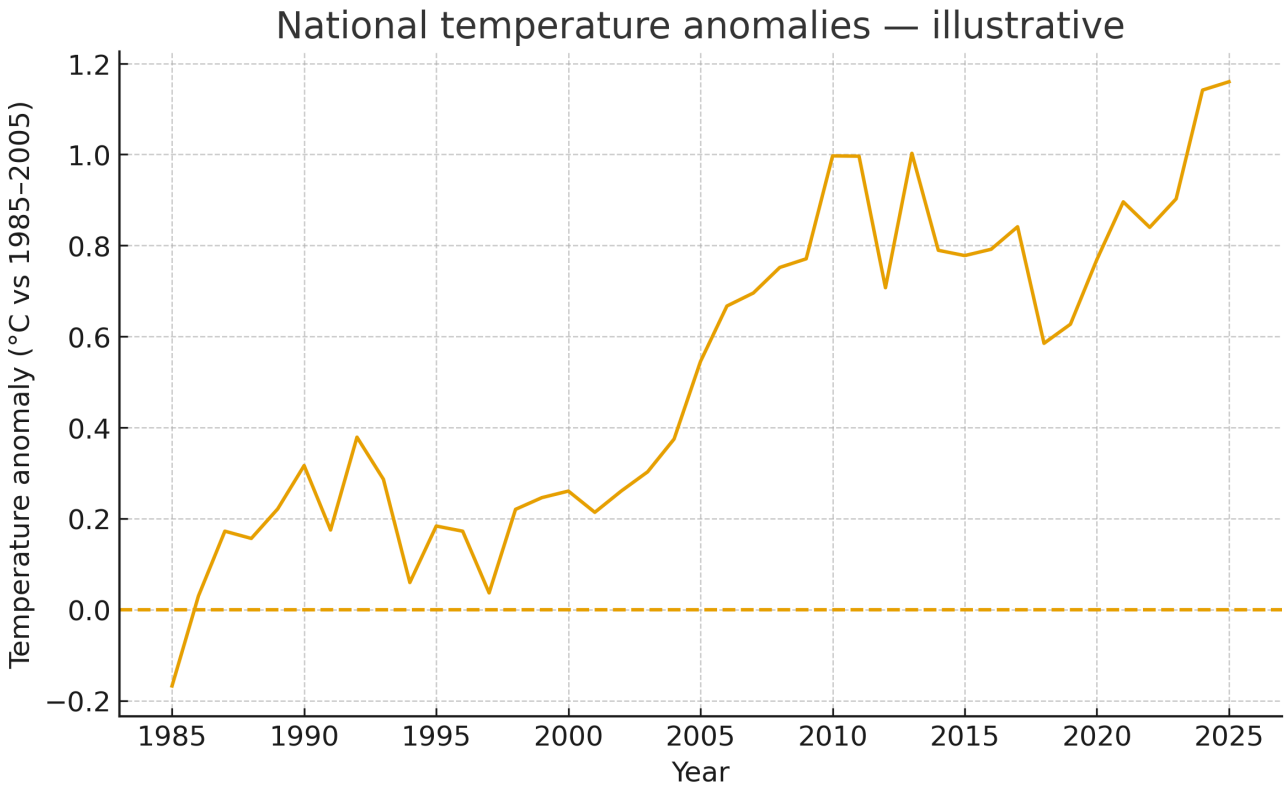


Figure . Rainfall anomalies (% of normal)

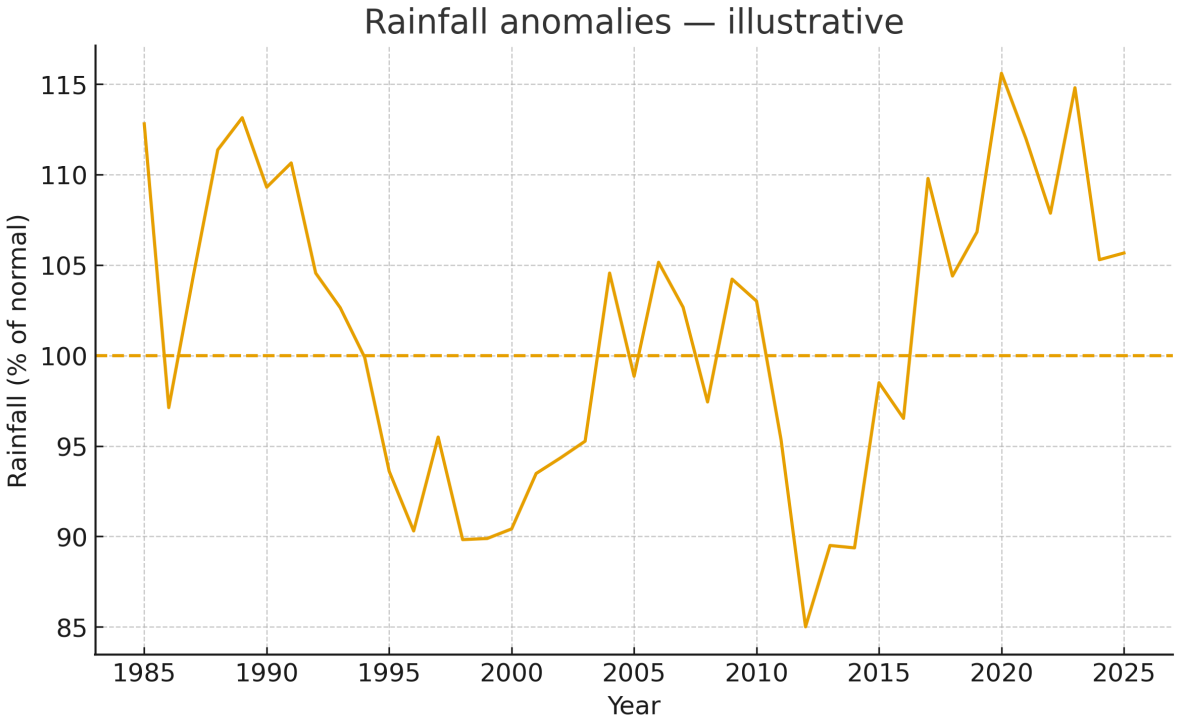



Figure . SPI-12 drought/wetness index

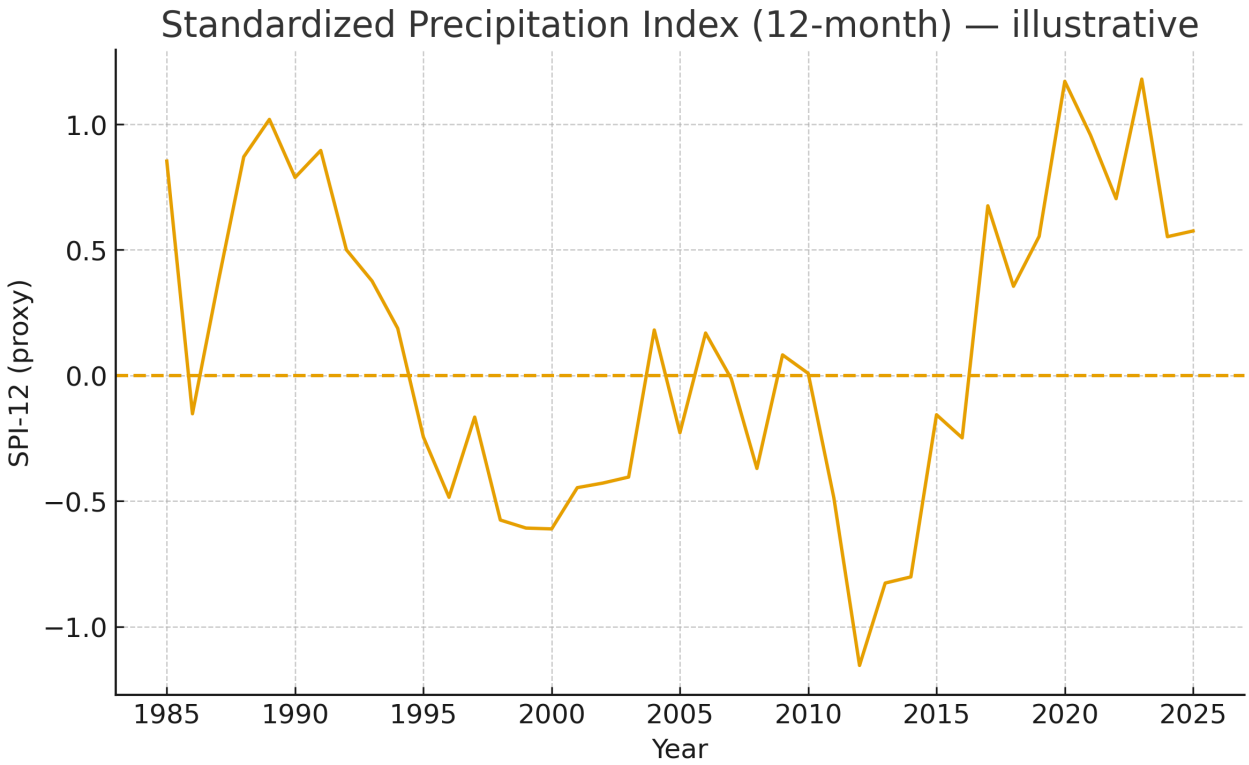


Figure . Annual heatwave days (≥35°C)

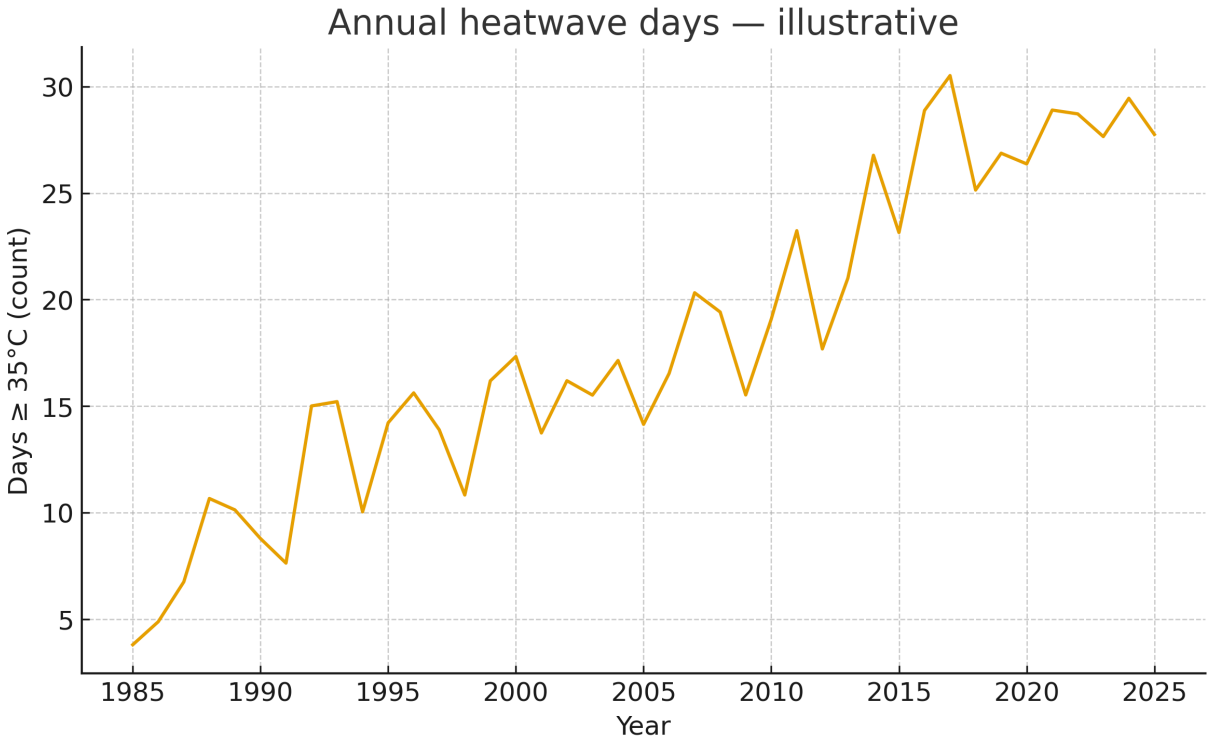



Figure . Flood exposure index

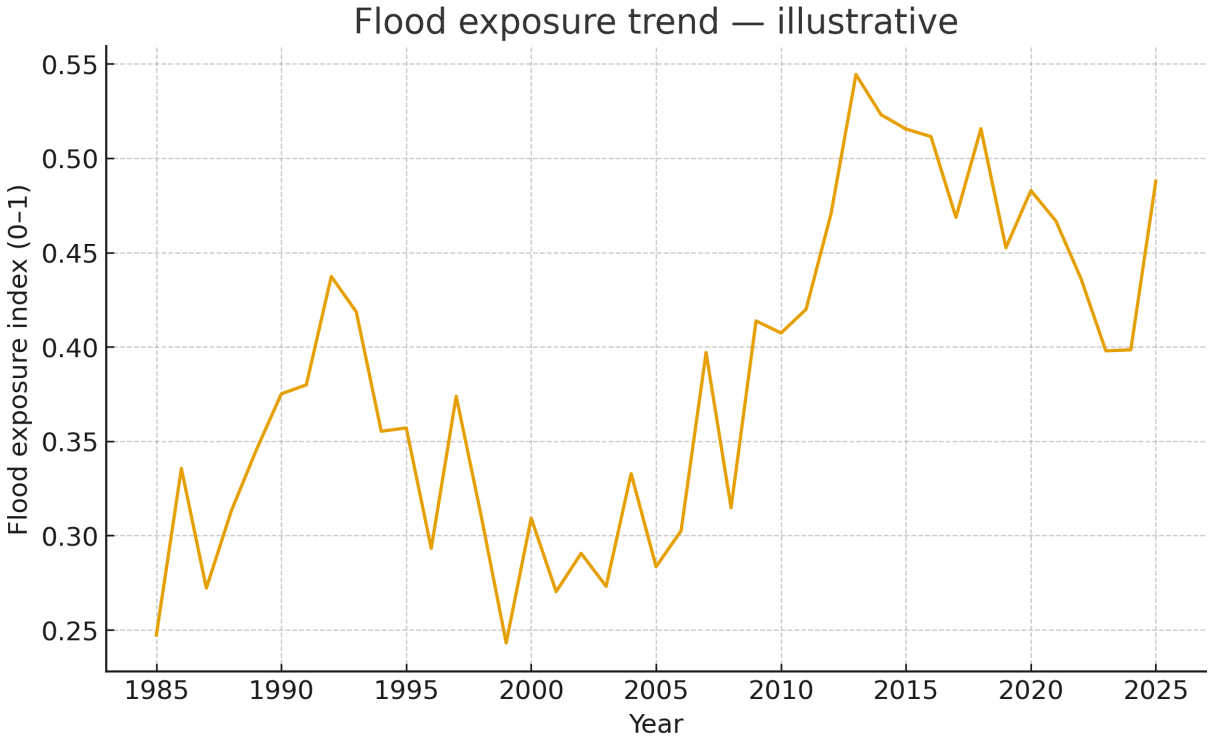
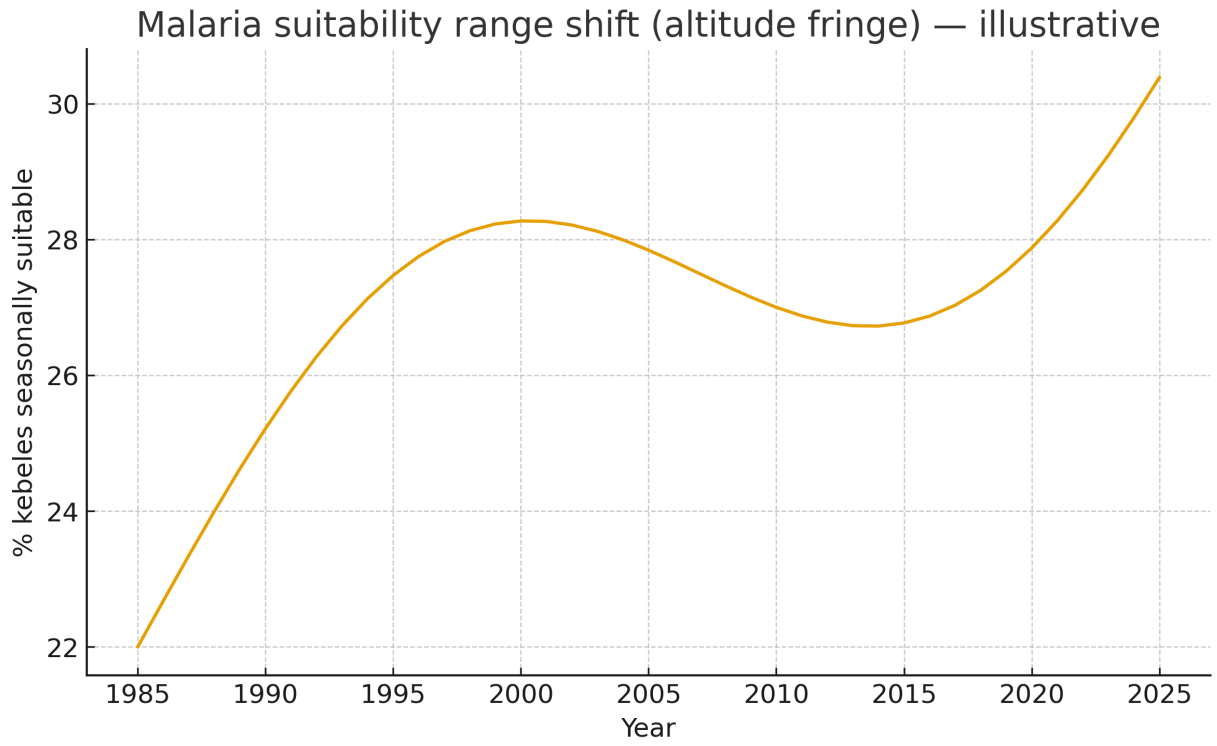


Figure . Malaria suitability range shift




### Table 10.6-A. Climate hazards relevant to Ethiopia

| Hazard | Context in Ethiopia |
|---|---|
| Drought (meteorological/agricultural) | Long dry periods; failed rains (Belg/Kiremt) |
| Floods & flash floods | Riverine & urban drainage; dam releases |
| Heatwaves | Extended hot spells; high nighttime temperatures |
| Vector range shifts | Altitude/temperature enabling malaria/arboviruses |
| Dust & air quality | Dry-season dust; biomass burning; urban pollution |
| Landslides | Steep slopes + heavy rainfall |

### Table 10.6-B. Climate → health pathways

| Outcome | Climate pathway |
|---|---|

| | |
|---|---|
| Undernutrition | Crop failure → food prices → wasting/stunting; water scarcity |
| Enteric diseases | Floods contaminate water; cholera/diarrhea outbreaks |
| Vector-borne | Temp/rain/humidity affect vectors & parasites (malaria, dengue) |
| Heat stress | Dehydration, CKD of unknown etiology; pregnancy risks |
| Respiratory | Dust & smoke → ARI/asthma; wildfire/charcoal exposures |
| Injuries & disruption | Flood/landslide injuries; facility and supply-chain outages |

### Table 10.6-C. Early-warning indicators & sources

| Indicator | Use in early warning |
|---|---|
| Rainfall anomalies (CHIRPS/TAMSAT) | Drought/flood alerts by woreda |
| NDVI (vegetation index) | Pasture/bio-mass shortfalls for pastoral zones |
| Temp anomalies (ERA5/MODIS) | Heatwave monitoring & malaria suitability |
| River levels & soil moisture | Flood forecasts & landslide risk |
| Market prices & IPC phases | Food security & nutrition early warning |
| Disease surveillance (IDSR/HMIS) | Spikes in AWD/cholera, malaria, measles |

### Table 10.6-D. Adaptation & risk-management actions

| Action | Health application in Ethiopia |
|---|---|
| Integrated surveillance | Link climate dashboards with HMIS/IDSR; trigger thresholds |
| Seasonal micro-planning | Pre-position supplies; schedule outreach before heavy rains |
| Climate-smart WASH | Protect wells/latrines from floods; chlorination surge plans |

| | |
|---|---|
| Vector control targeting | Altitude/temperature-informed LLIN/IRS timing |
| Heat-health plans | Cooling/shade, work-rest cycles, maternal guidance |
| Resilient infrastructure | Elevate clinics in flood zones; all-weather access roads |

### Table 10.6-E. Metrics for dashboards & MEL

| Metric | Interpretation/use |
|---|---|
| Drought severity (SPI-3/6/12) | Track by woreda/region; link to nutrition admissions |
| Flood exposure (% pop within floodplain) | Facility & household exposure |
| Heat days (≥35°C) | Work stoppage guidance; maternal advisories |
| Malaria suitability (degree-days) | Shifts in fringe kebeles; outbreak risk |
| Service continuity index | % facilities functional during shocks |
| Lead time achieved (days) | From alert to action (supplies deployed) |

### Table 10.6-F. Pitfalls & safeguards

| Pitfall | Safeguard |
|---|---|
| Using global thresholds blindly | Calibrate to Ethiopian climate/altitude and sector thresholds |
| Confusing correlation with causation | Triangulate with local data; account for confounders |
| Ignoring uncertainty | Show bands & scenario ranges; document revisions |
| Static risk maps | Update with seasons and ENSO/IOD phases |
| Equity blind spots | Track impacts by wealth, remoteness, and gender |

## Plain-language summary

Ethiopia’s climate has always had dry and wet years, but heat is rising over time. Droughts, floods, and heatwaves affect health by changing food supplies, water safety, and the spread of diseases like malaria. By tracking weather and climate signals and linking them to health data, the country can act earlier—moving supplies, scheduling outreach, and protecting the most exposed families.

## References — Section 10.6

- National Meteorology Agency (NMA) — climate normals, advisories, and seasonal forecasts.

- CHIRPS/TAMSAT — rainfall anomalies; SPI construction guidance.

- ERA5/MODIS — temperature anomalies and heat indicators.

- WHO — Climate change and health country profiles; heat-health action planning.

- IPCC — Africa regional chapters; risk framing and adaptation options.

# 10.7) WASH, Housing & Built Environment

Water, sanitation, hygiene, housing, and city infrastructure strongly influence health in Ethiopia. This section compiles key indicators, trends, and planning levers. All charts are illustrative placeholders.

## Figures (illustrative — replace with official series)

Figure . Basic water & sanitation coverage by residence

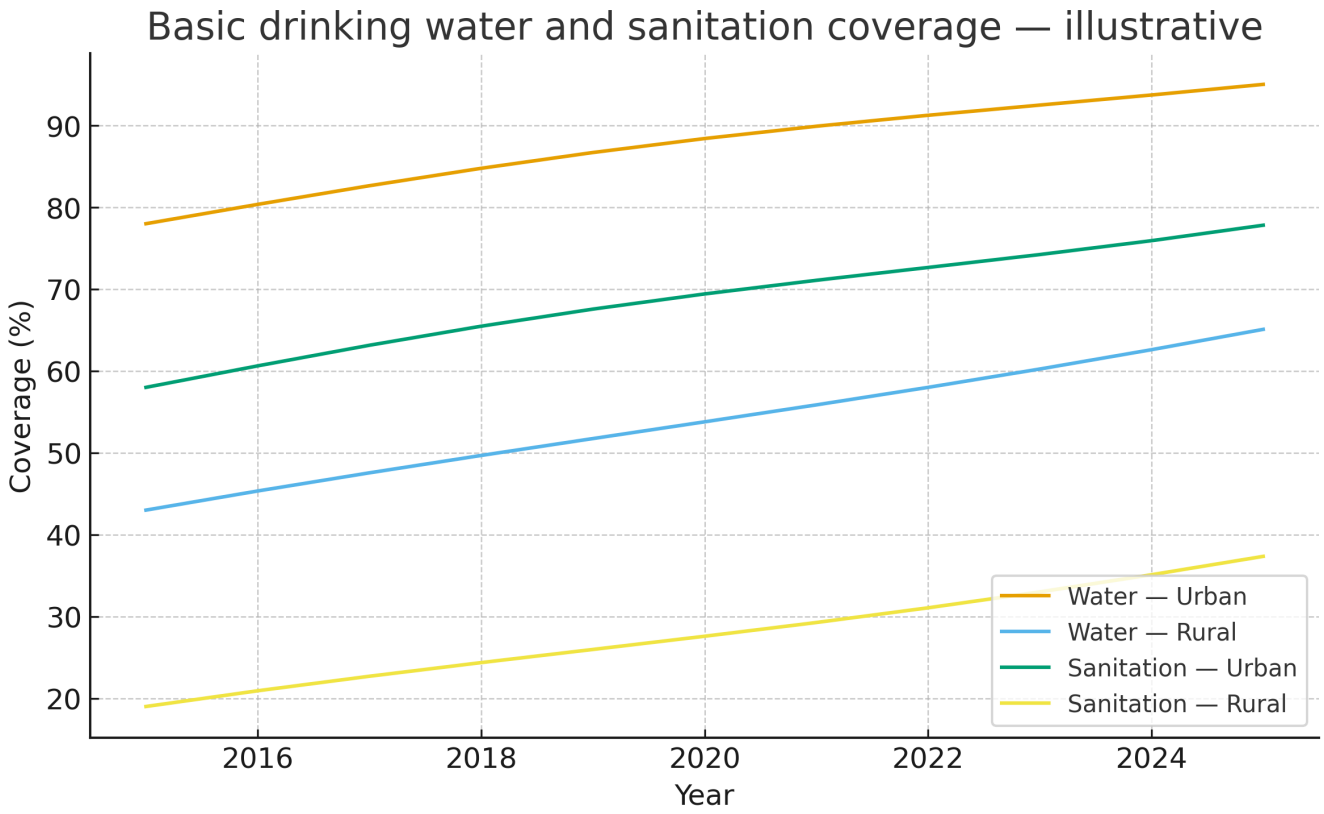


Figure . Handwashing facilities with soap

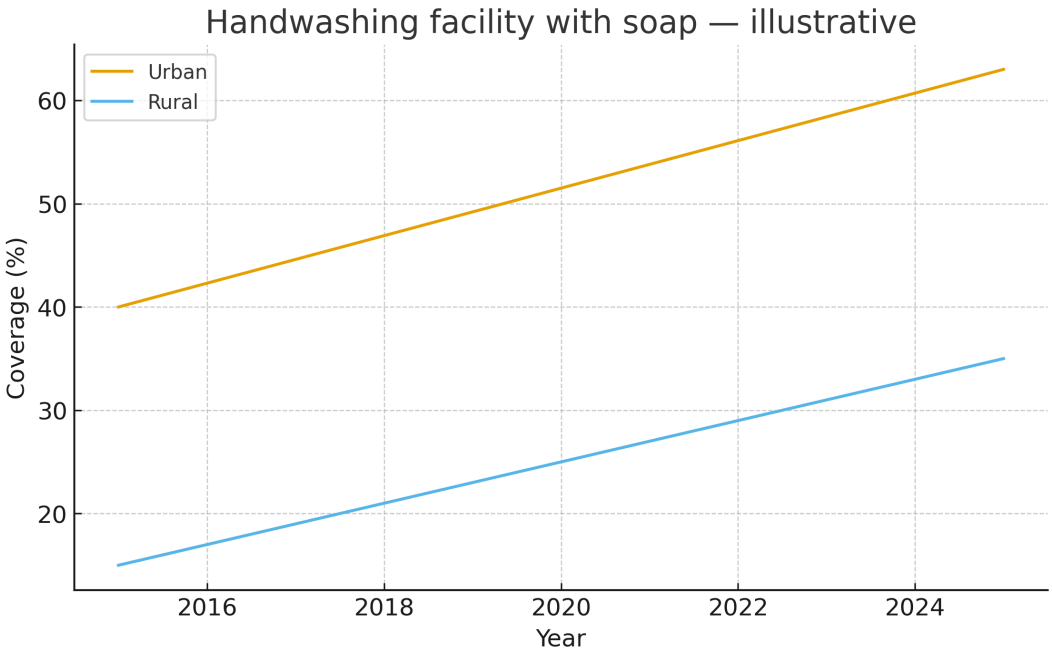



Figure . Housing quality index (urban vs rural)

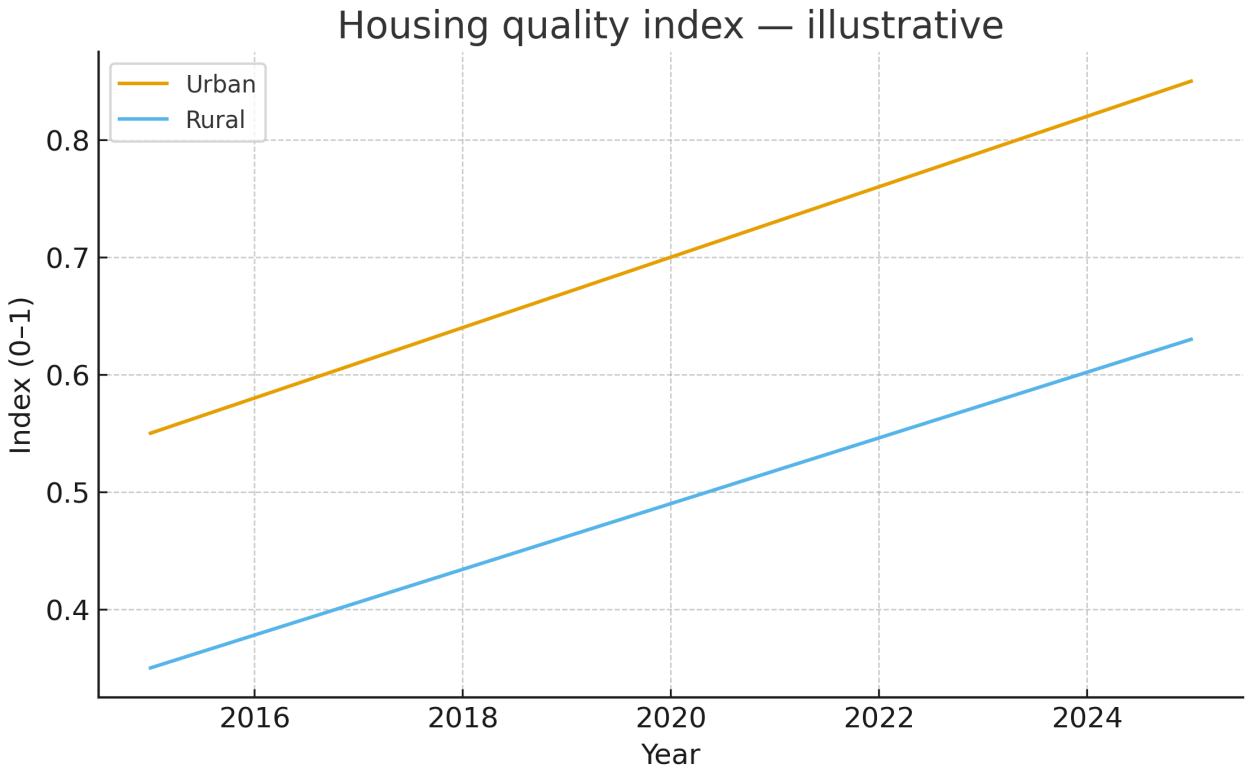


Figure . Ambient PM2.5 exposure (urban vs rural)

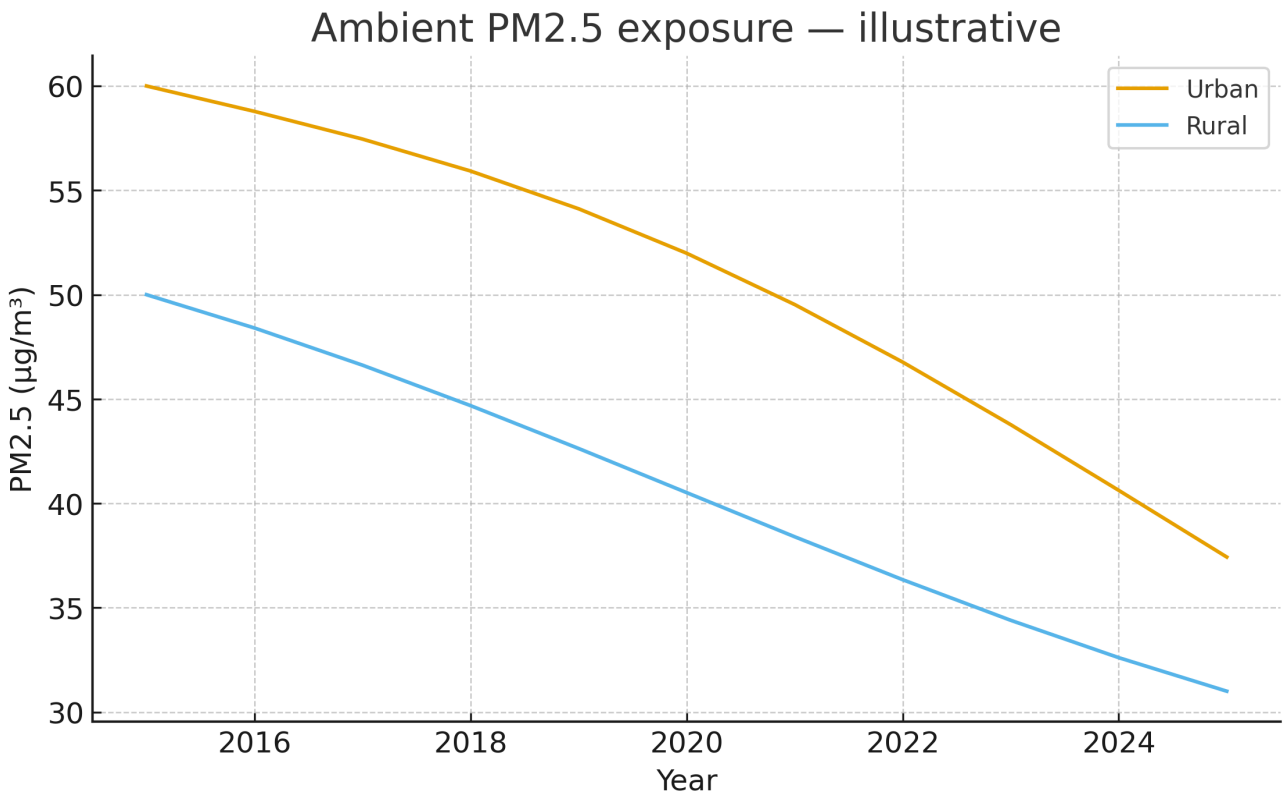



Figure . Urban storm-drainage coverage

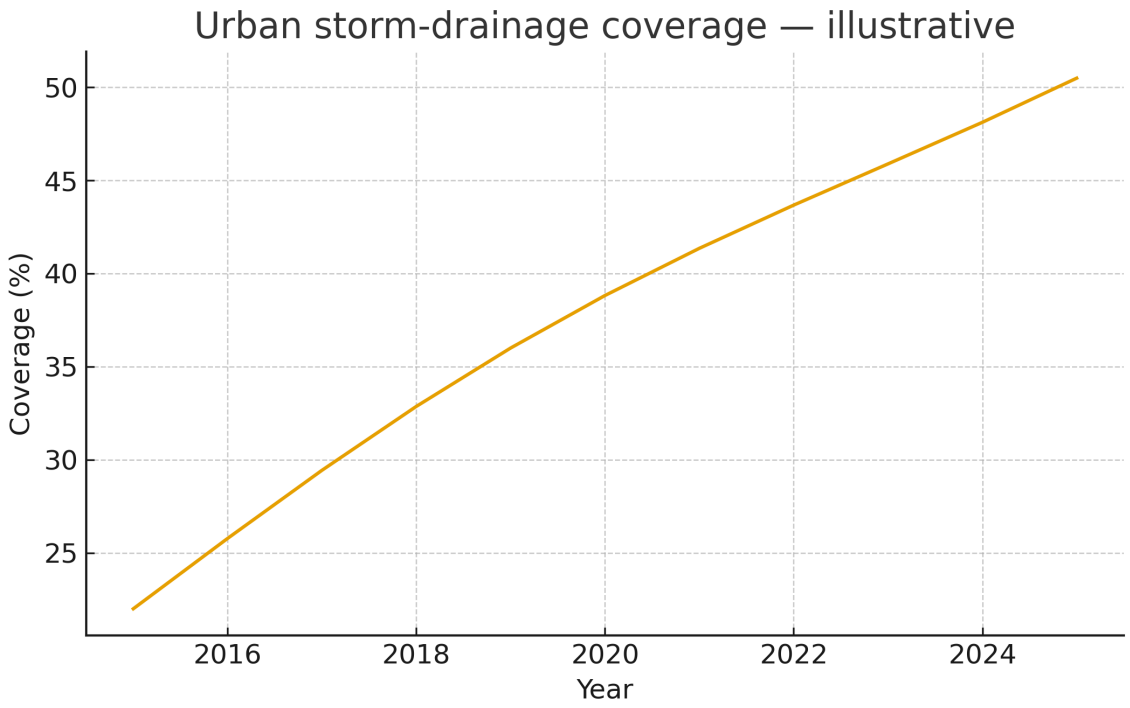


Figure . Informal settlement (slum) share

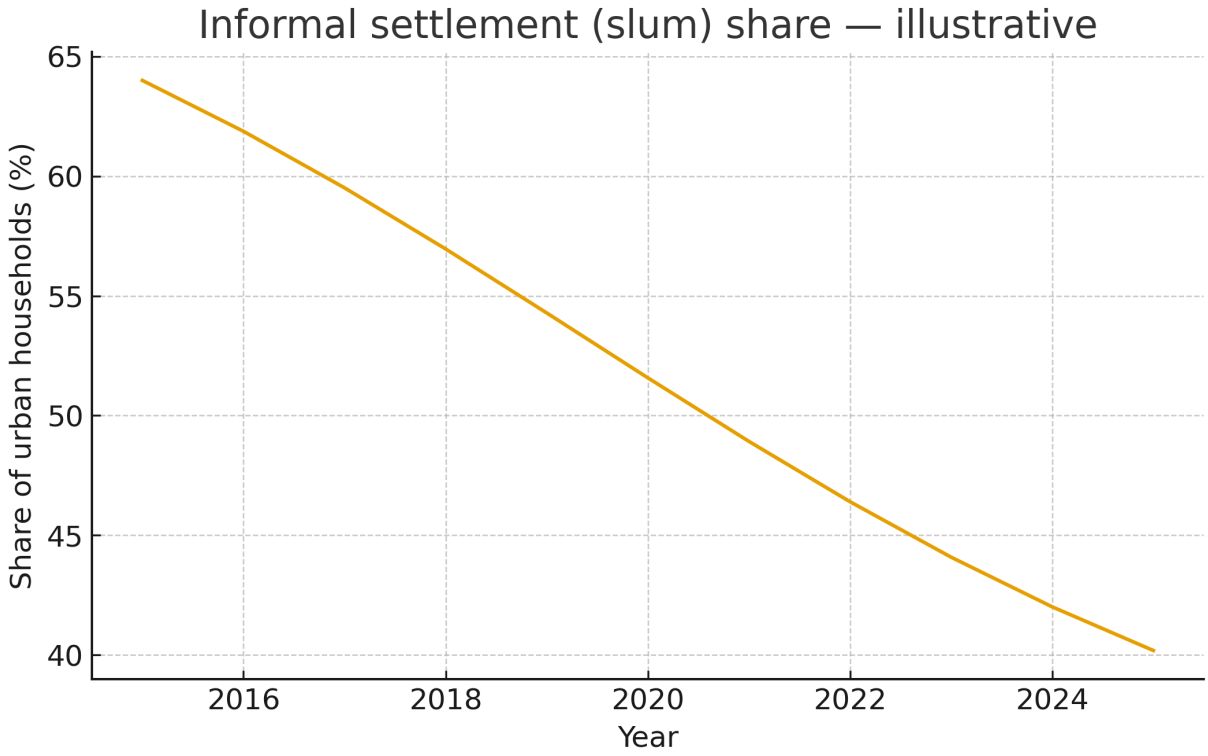
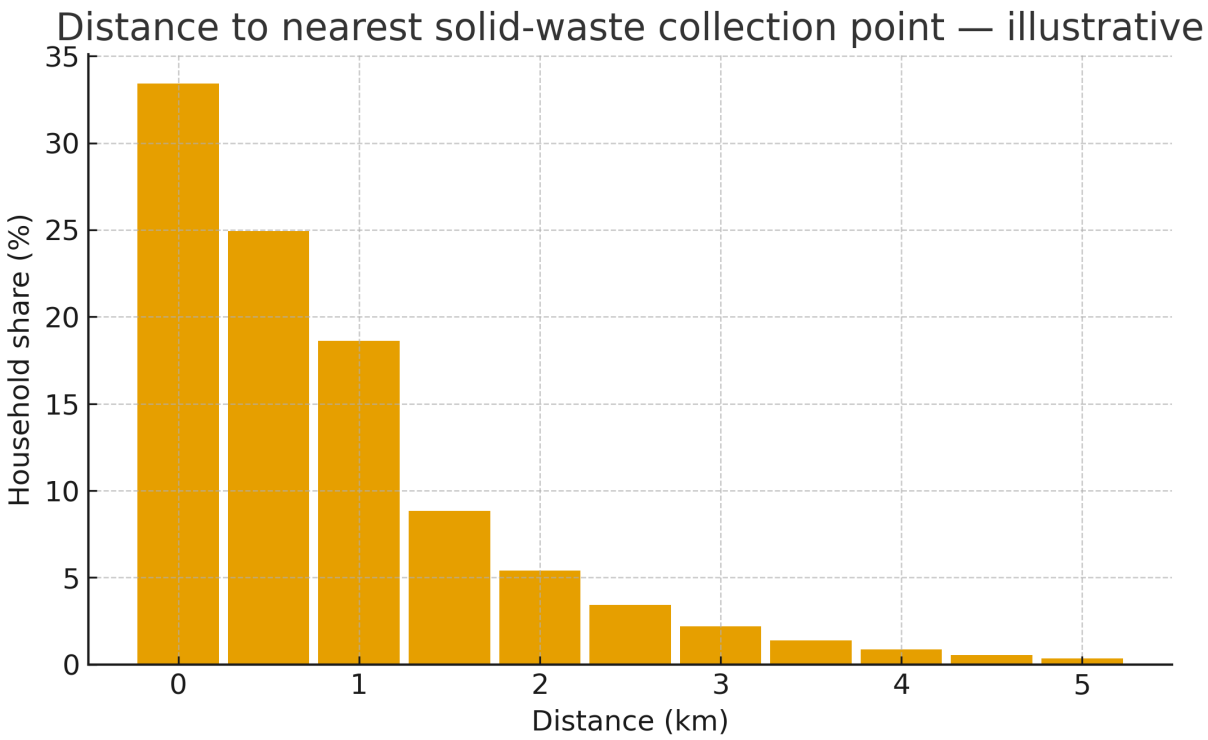



Figure 10.7-7. Distance to solid-waste collection point (urban)



### Table 10.7-A. Built environment indicators & sources

| Indicator | Notes & data sources (Ethiopia practice) |
|---|---|
| Basic water (JMP definition) | Safely managed/ basic source; household survey & admin |
| Basic sanitation (JMP) | Improved facility not shared; survey & admin |
| Handwashing facility with soap | Observation in surveys; behavior promotion tracking |
| Housing quality index | Materials, crowding, ventilation, electricity |
| PM2.5 exposure | Ground monitors + satellite; WHO methods |
| Storm drainage coverage | Municipal asset data; city surveys |
| Solid-waste collection access | Distance/time to point; service frequency |

### Table 10.7-B. Built environment → health pathways

| Built environment factor | Health pathway (simplified) |
|---|---|
| Unsafe water & sanitation | Diarrhea, cholera, typhoid; under-5 morbidity & mortality |
| Crowding & poor ventilation | Respiratory infections, TB transmission |
| Household air pollution | Biomass fuels → ARI, COPD; pregnancy risks |
| Poor drainage & waste | Vector breeding (Aedes/Culex), floods |
| Heat islands (urban) | Heat stress; cardiovascular risks |

### Table 10.7-C. Urban-planning levers for health

| Lever | Operational hints for Ethiopia |
|---|---|
| Network expansion | Piped water, sewers, drains; pro-poor connections |
| On-site sanitation upgrades | Septic/pit upgrades; fecal-sludge management (FSM) |

| | |
|---|---|
| Housing standards | Materials, ventilation, density caps; rental regulation |
| Clean energy transition | LPG/electric cooking; improved stoves; grid/off-grid |
| Solid-waste systems | Door-to-door collection; transfer stations; safe disposal |
| Nature-based solutions | Urban trees/parks; permeable surfaces; wetlands restoration |

### Table 10.7-D. Dashboard & MEL metrics

| Metric | How to use |
|---|---|
| JMP ladder positions | Distribution by wealth/region over time |
| Service safely-managed share | Water quality, continuity, point-of-use treatment |
| FSM coverage | % fecal sludge safely contained/emptied/treated |
| PM2.5 compliance | % population under WHO guideline thresholds |
| Flood-risk households | % in 100-year floodplain; mitigation coverage |
| Slum share | Share of urban households in informal settlements |
| Access distance to services | % households within 500 m of standpipe, 1 km of collection point |

### Table 10.7-E. Pitfalls & safeguards

| Pitfall | Safeguard |
|---|---|
| Counting taps, not service | Measure continuity/quality and affordability |
| Ignoring informal areas | Include slums/peri-urban; participatory mapping |
| City averages hide gaps | Disaggregate by woreda/kebele; map hot-spots |
| Indoor vs outdoor air | Track both PM2.5 and cooking fuels |
| Static flood maps | Update with drainage works and new development |

## Plain-language summary

Clean water, safe toilets, handwashing, good houses, and well-planned streets protect health. In Ethiopia’s fast-growing towns and cities, some neighborhoods still lack these basics. The maps and charts in this section help leaders see where to extend networks, upgrade sanitation, improve drainage, reduce smoke and dust, and manage flood risks. Small improvements at the neighborhood level can quickly reduce diarrhea, lung disease, and injuries.

## References — Section 10.7


- WHO/UNICEF JMP — Water, sanitation and hygiene definitions and estimates.

- World Bank & UN-Habitat — Urbanization and slum upgrading guidance.

- WHO — Air quality guidelines; PM2.5 methods.

- City administrations & MoH Ethiopia — WASH and drainage asset data; FSM guidelines.

# 10.8) Nutrition Geography & Food Security

Nutrition outcomes vary across Ethiopia with climate, markets, culture, and services. This section links spatial determinants to stunting, wasting, and diet diversity, and shows how market access and seasonal greenness relate to prices and admissions (illustrative charts).

## Figures (illustrative)

Figure . Under-5 stunting trends (urban vs rural)

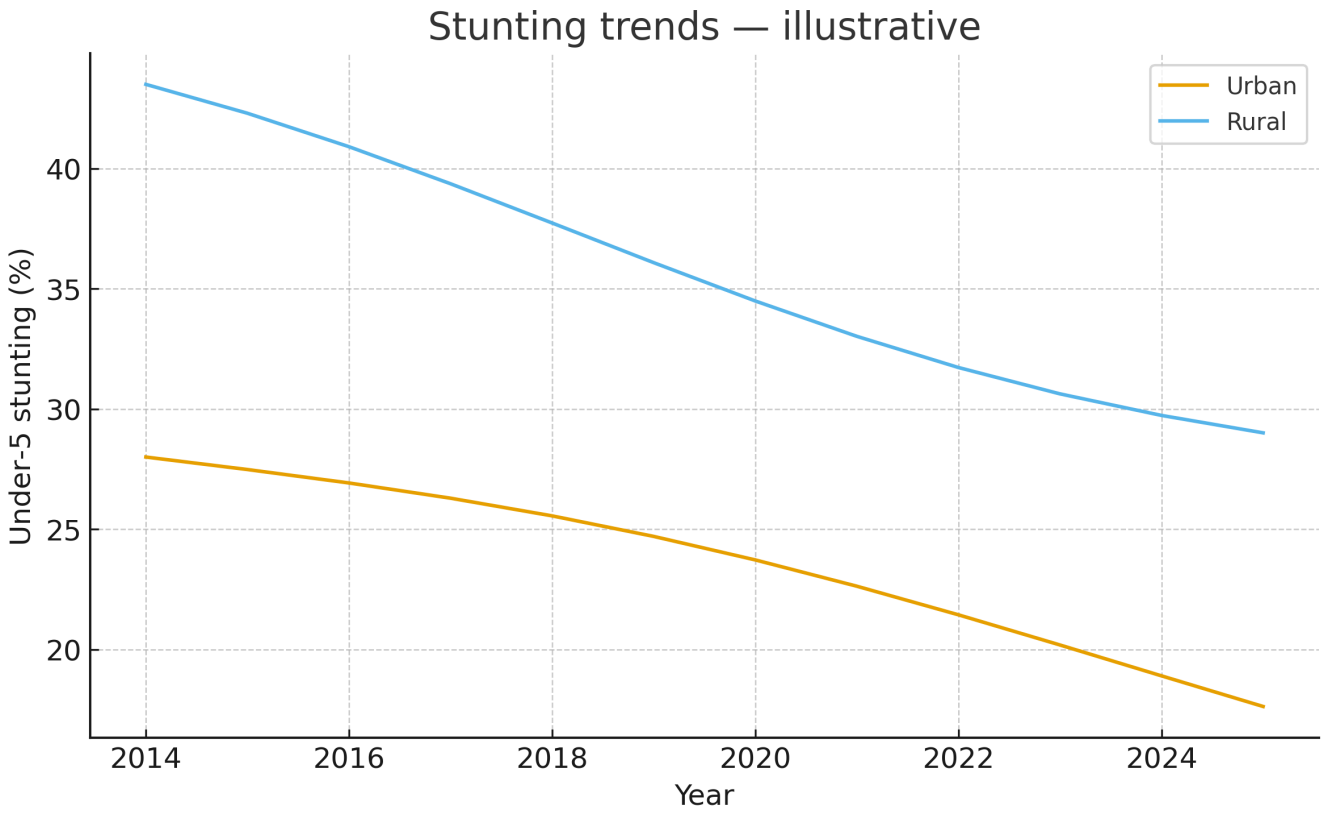


Figure . Under-5 wasting trends (urban vs rural)

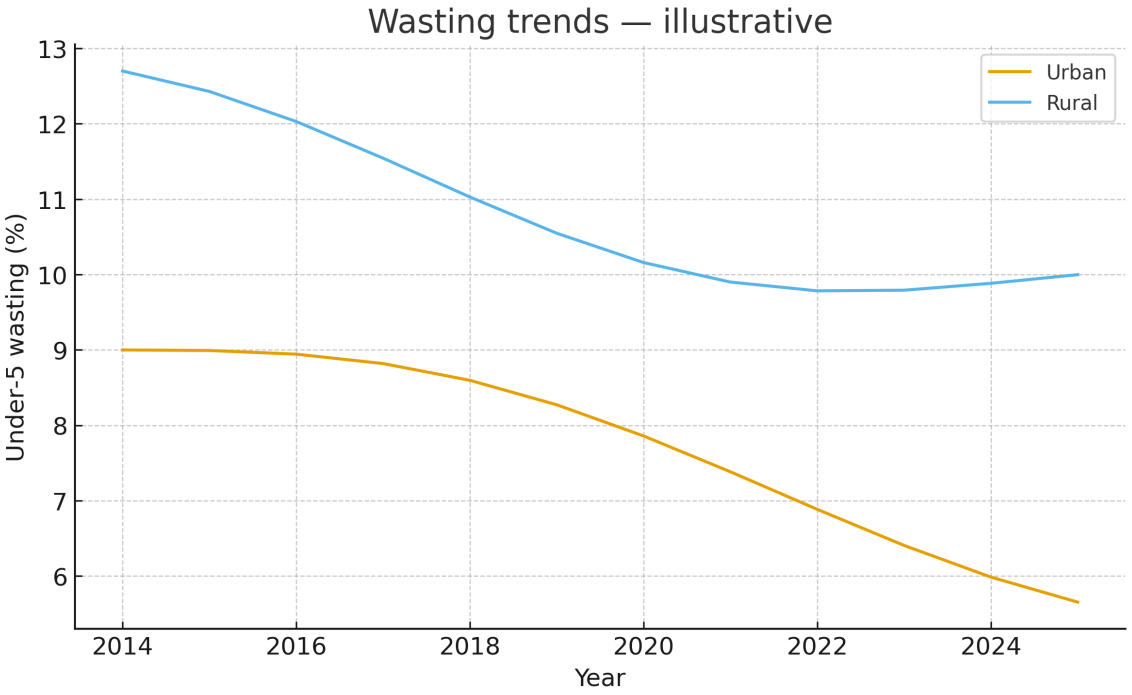



Figure . Minimum dietary diversity (6–23 months)

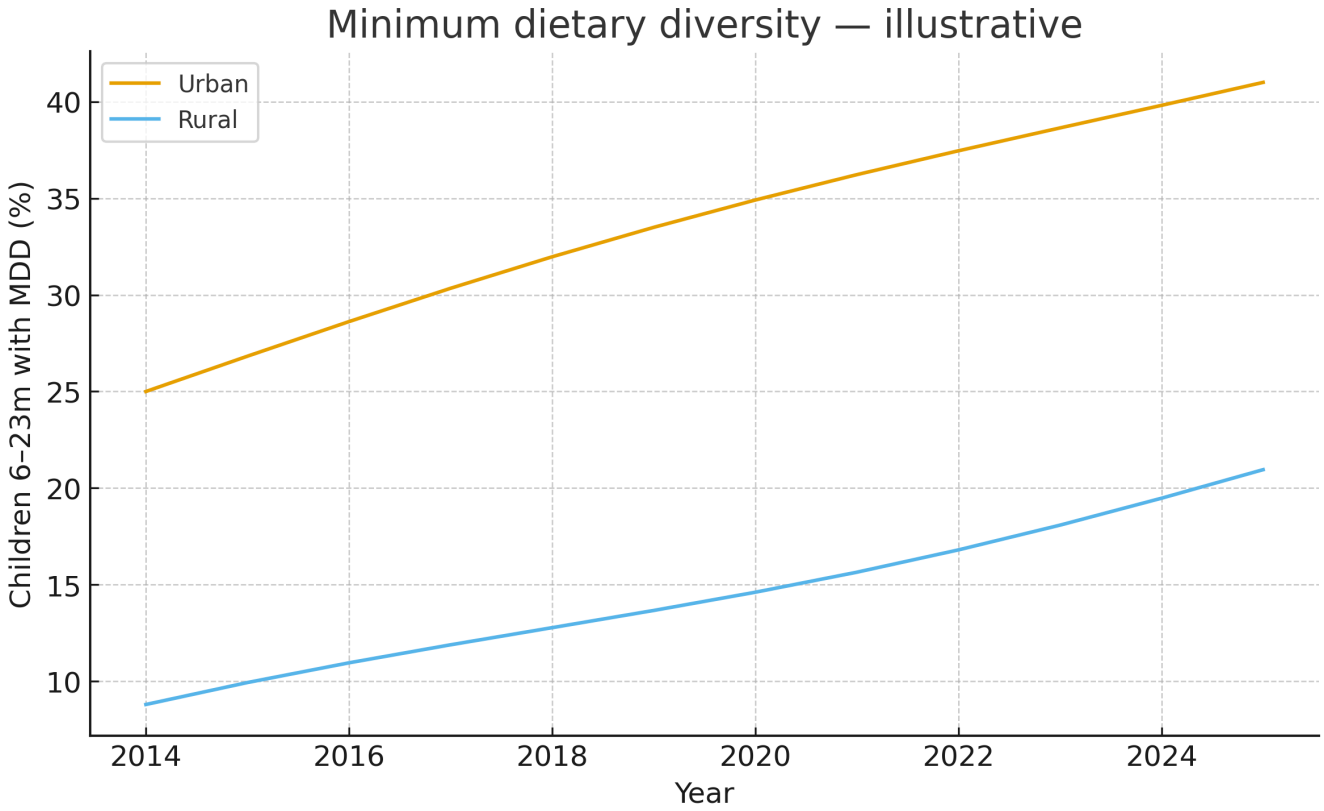


Figure . Staple food basket price index by region

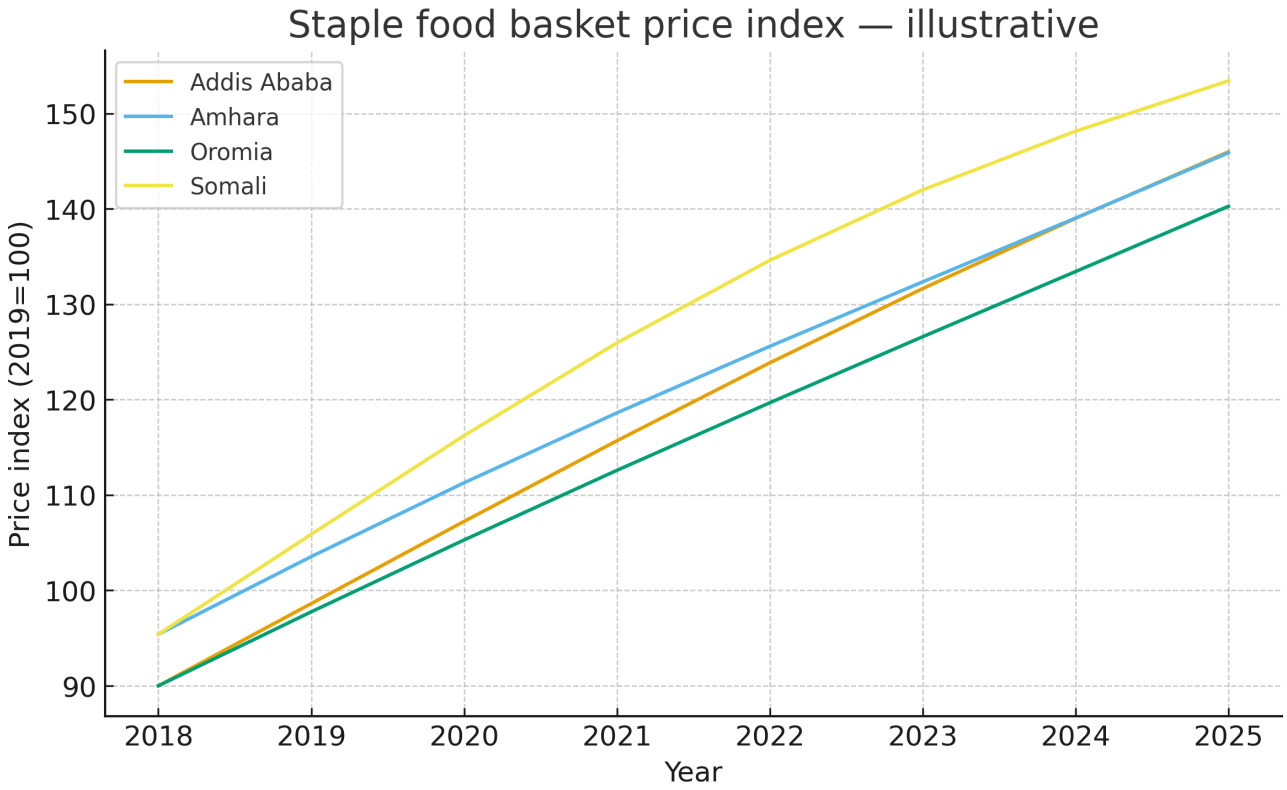



Figure . Seasonal vegetation (NDVI)

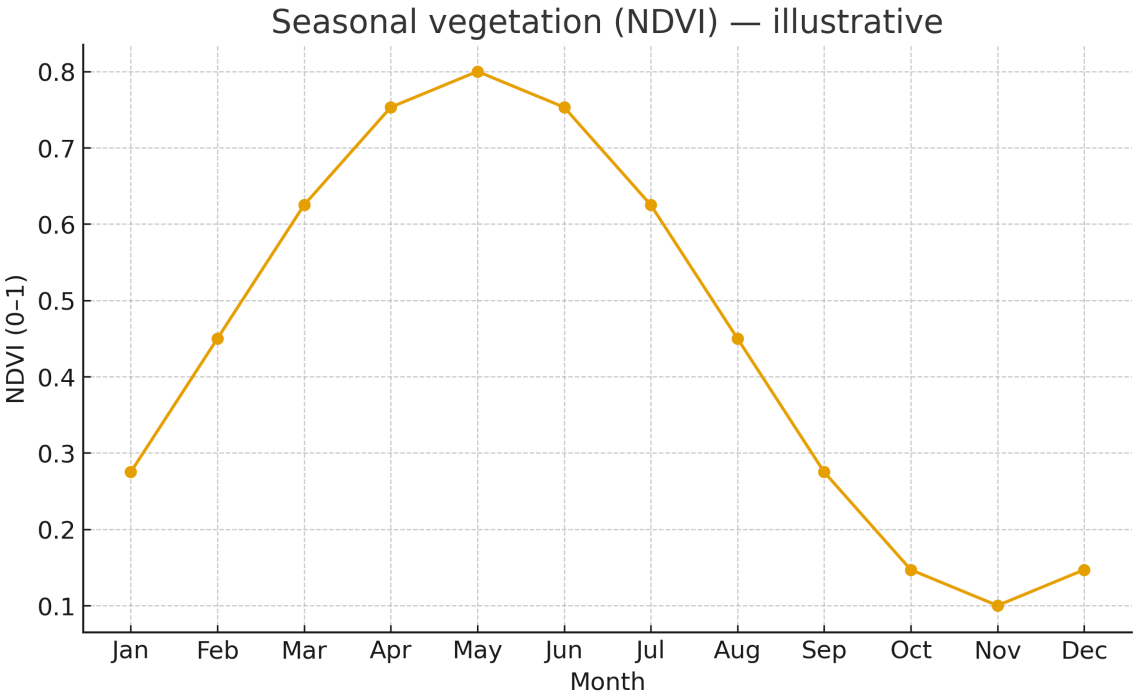


Figure . Severe acute malnutrition (SAM) admissions

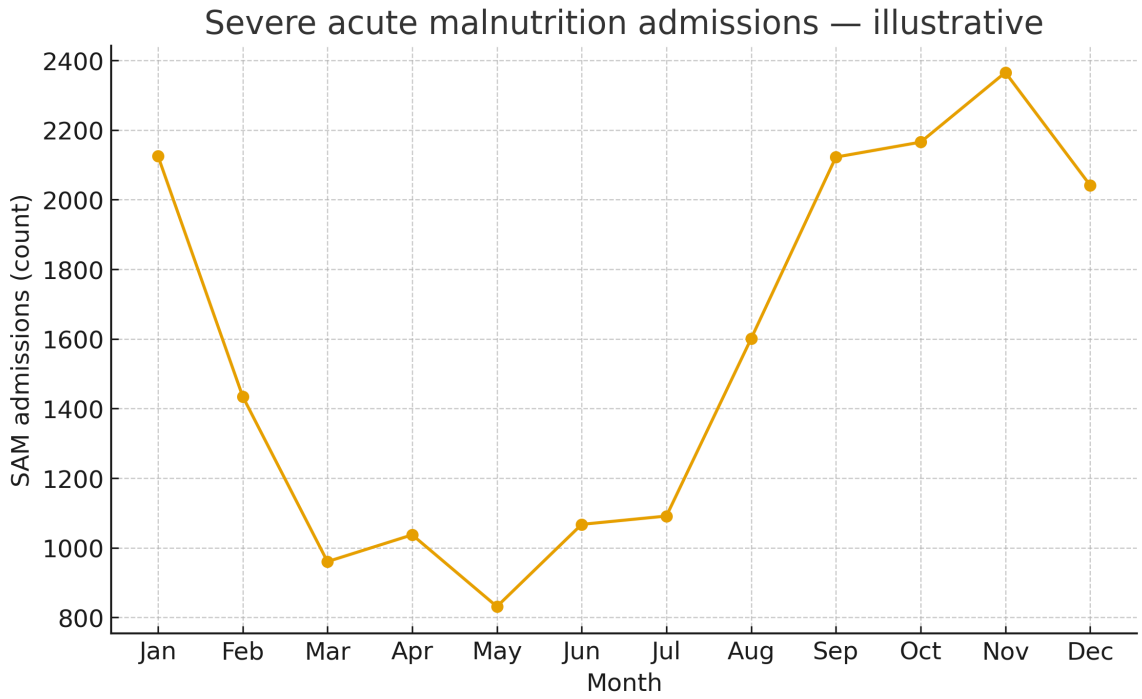



Figure . Market access vs food price volatility

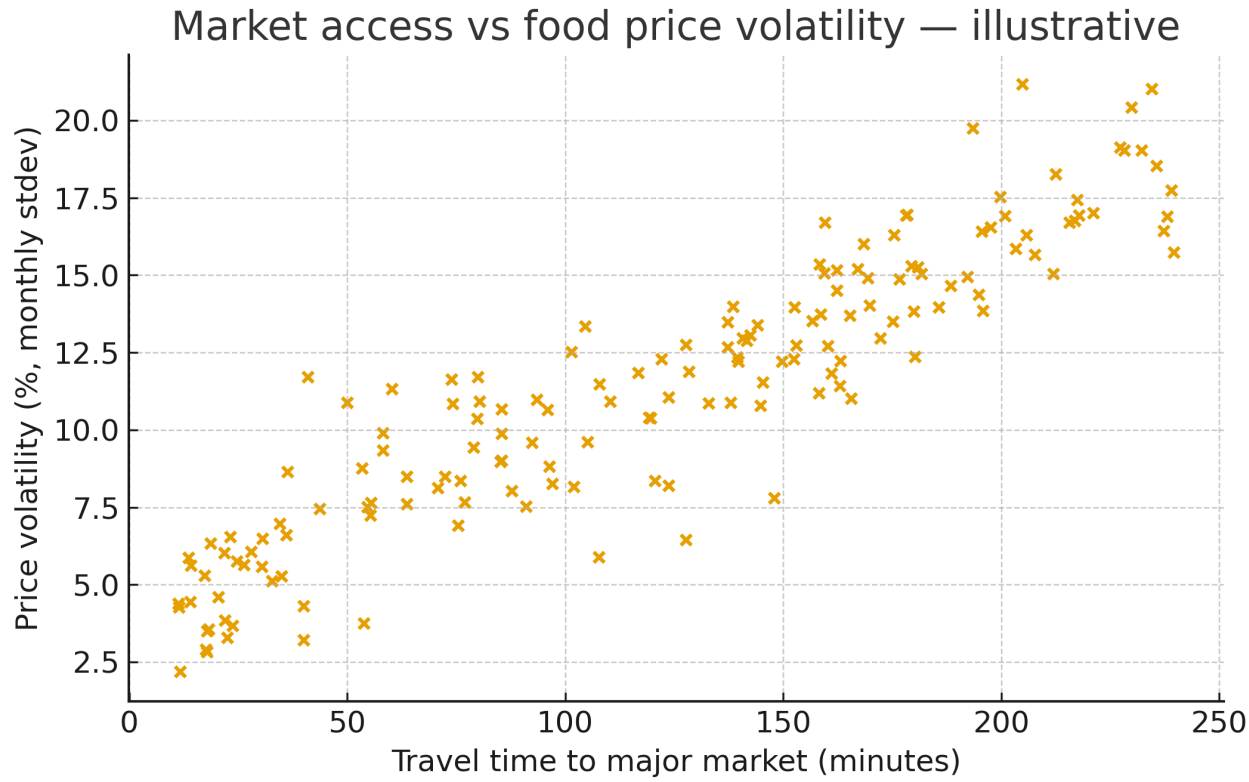
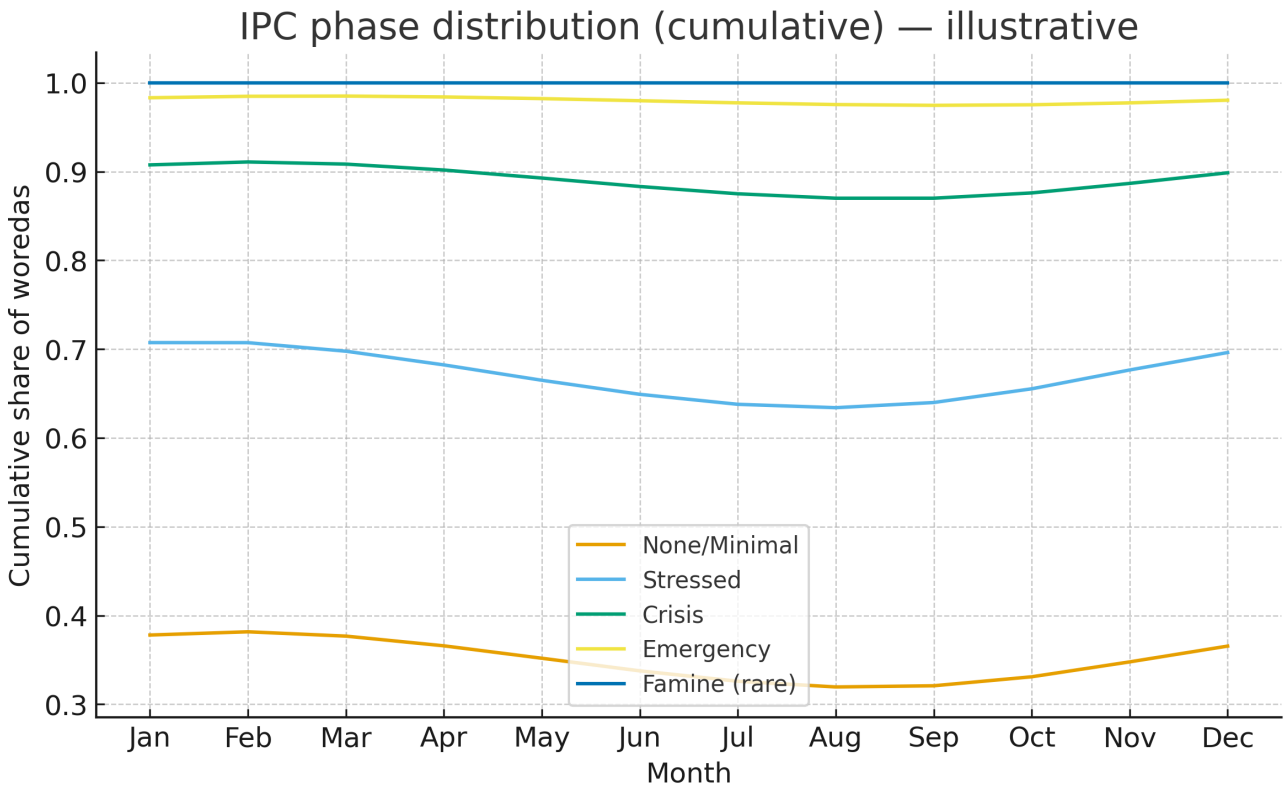


Figure . IPC phase distribution by month




## Table 10.8-A. Core indicators & sources

| Indicator | Main sources |
|---|---|
| Stunting / wasting (U5) | DHS/MICS, ENCU nutrition surveys, HMIS (SAM admissions) |
| MDD (6–23m) & IYCF | DHS/MICS modules; SBCC program data |
| Food prices & inflation | CSA CPI; WFP market monitor; MoT trade stats |
| IPC Acute Food Insecurity | FSNWG/FEWS NET/IPC analyses (woreda maps) |
| NDVI/rainfall anomalies | CHIRPS/TAMSAT/ERA5; MODIS/VIIRS vegetation |
| Market access/travel time | Roads + terrain + transport speeds; WorldPop/GHS settlements |

### Table 10.8-B. Nutrition pathways & spatial determinants

| Pathway | Spatial determinants / notes |
|---|---|
| Food availability & access | Production + prices + income; remoteness raises prices/volatility |
| Care & feeding practices | Maternal education, time, norms; health worker reach |
| Health environment (WASH) | Safe water/sanitation; disease burden (diarrhea) |
| Shocks & seasonality | Drought/flood/conflict displace households; lean seasons |
| Services & supplies | TSFP/OTP sites, stock levels, cold chain for RUTF |

### Table 10.8-C. Program levers (Ethiopia)

| Lever | Operationalization in Ethiopia |
|---|---|
| Targeted TSFP/OTP expansion | Place sites in high-need kebeles; mobile teams in pastoral zones |
| Cash/food assistance routing | Use market access & prices to set transfer values; pick pay-points |
| SBCC & IYCF counseling | Prioritize low-MDD, high-stunting areas; link to women's groups |
| WASH upgrades | Pair with nutrition hotspots; protect water in cholera-prone rivers |
| Shock-responsive safety nets | Trigger by rainfall/NDVI/price thresholds; pre-position RUSF/RUTF |

### Table 10.8-D. Dashboard & MEL metrics

| Metric | How to use |
|---|---|
| U5 stunting & wasting | Trends by region, residence, wealth; map hotspots |
| MDD & diet diversity gap | % children meeting MDD; poorest vs richest gap |
| Price index & volatility | By region and market; alerts for spikes |

| | |
|---|---|
| NDVI/rainfall anomalies | Link to admissions and IPC phase changes |
| Coverage of nutrition services | % children reached; stock-out rates; outreach sessions |

### Table 10.8-E. Pitfalls & safeguards

| Pitfall | Safeguard |
|---|---|
| Using price levels only | Track volatility and lean-season spikes; triangulate with NDVI |
| Assuming uniform diets | Diversity differs by culture/market; target SBCC accordingly |
| Single-source bias | Blend DHS/MICS, ENCU, HMIS, markets, and RS data |
| Masking pastoralist dynamics | Use mobile/outreach data; adapt indicators to mobility |
| Privacy & stigma risks | Aggregate to safe levels; protect household IDs |

## Plain-language summary

Children’s growth depends on food, care, and a healthy environment. In Ethiopia, some places face higher food prices or repeated droughts, while others have better roads and markets. By tracking diets, prices, rainfall, and clinic admissions together, leaders can send help to the right places at the right time—before children become severely malnourished.

## References — Section 10.8


- CSA Ethiopia — CPI and price bulletins; food basket methods.

- ENCU/UNICEF — Nutrition surveys and SAM admissions guidance.

- DHS Program & MICS — Nutrition and IYCF indicators; geospatial documentation.

- FEWS NET / IPC — Food security analyses and classifications.

- CHIRPS/TAMSAT & MODIS/VIIRS — Rainfall and vegetation indices; methods.

# 10.9) Infectious Disease Ecology (National Overview)

This overview summarizes Ethiopia’s infectious-disease patterns through a spatial lens: long-term trends, seasonality, regional contrasts, vector suitability, intervention coverage, and antimicrobial resistance (AMR). Charts are illustrative placeholders.

## Figures (illustrative)

Figure . Major infectious disease trends

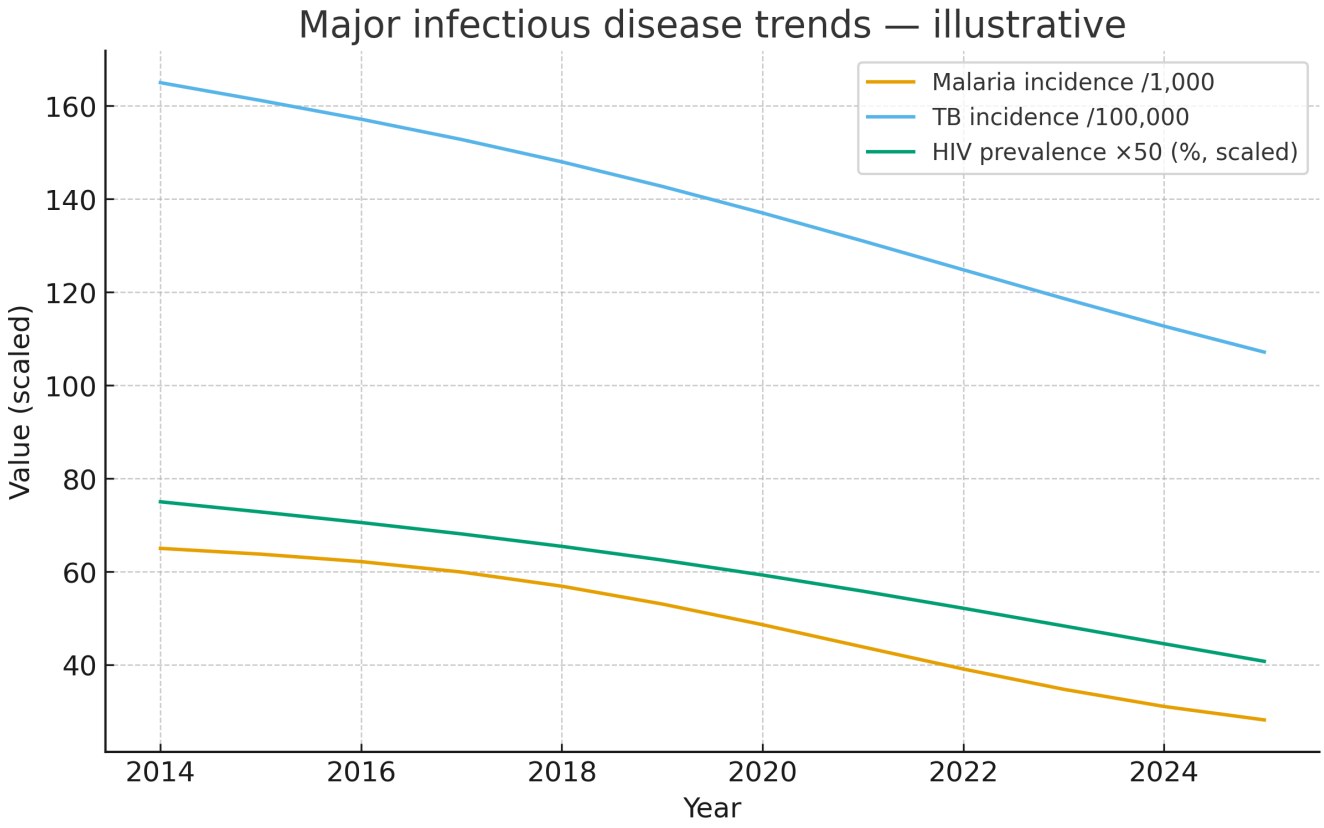


Figure . Measles reported cases

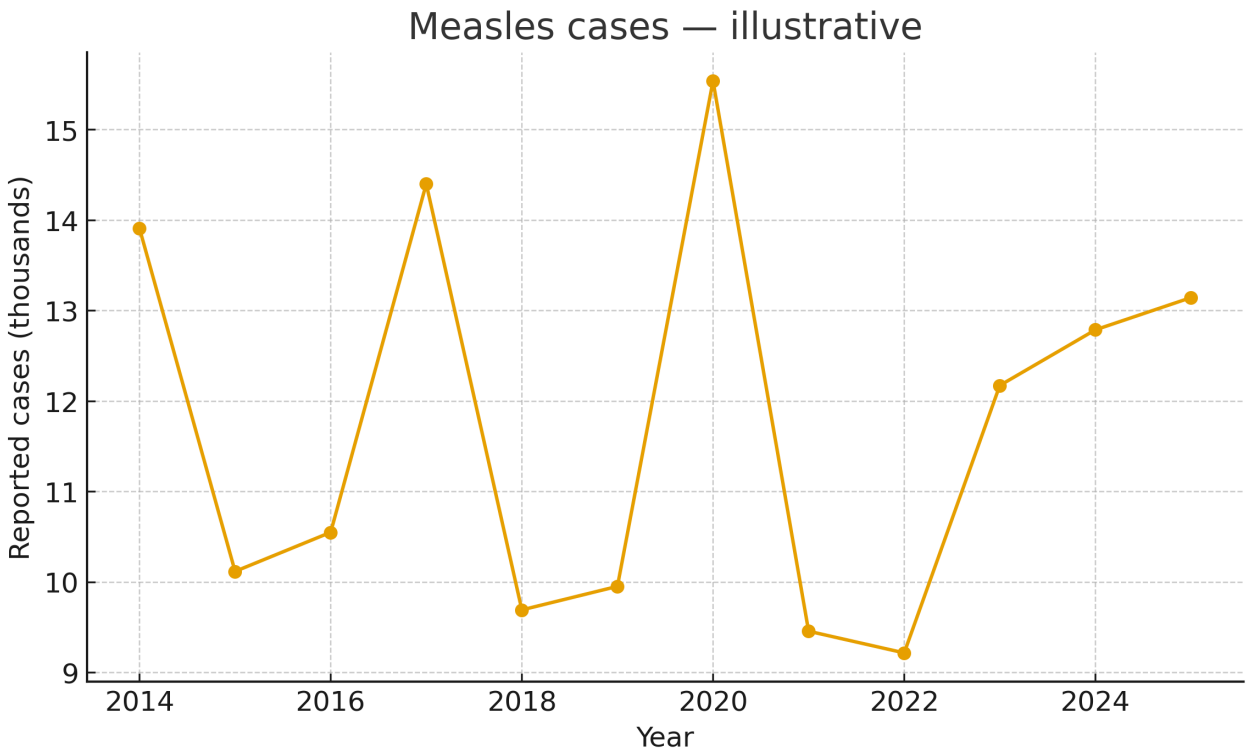



Figure . Malaria seasonality (monthly index)

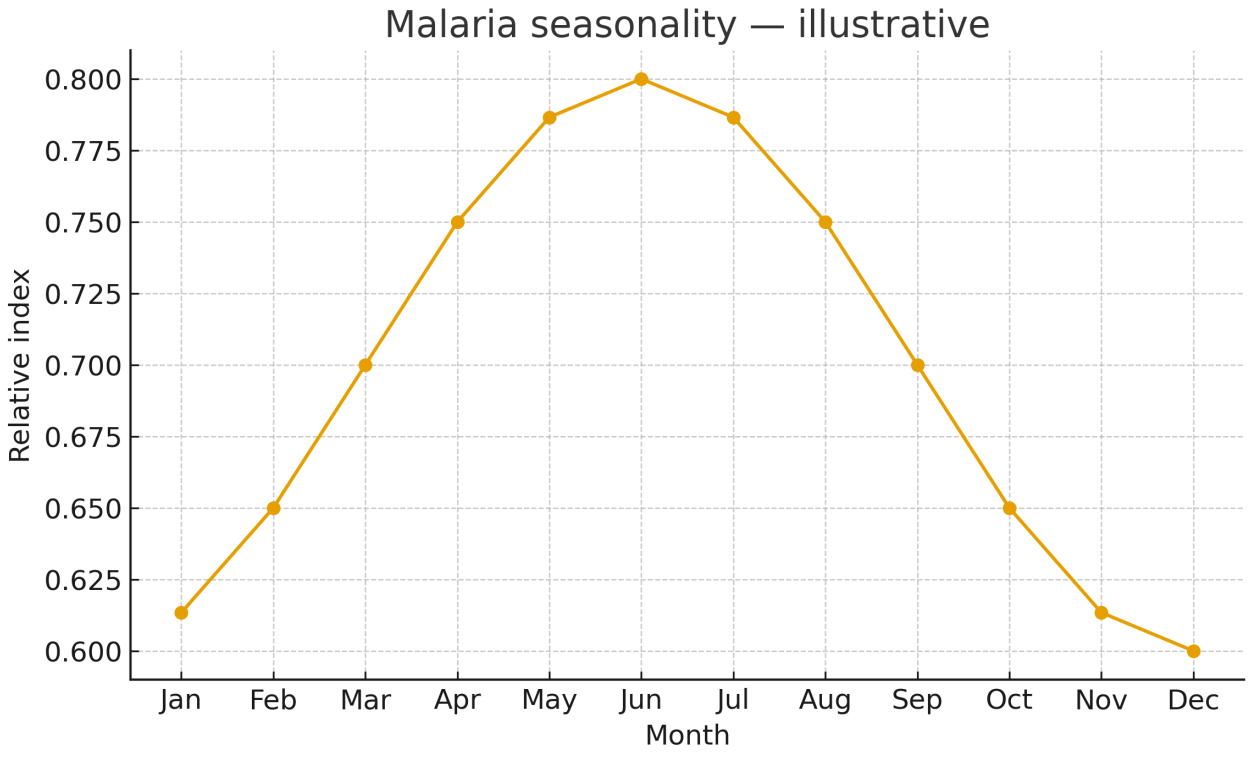


Figure . Vector suitability vs temperature (conceptual)

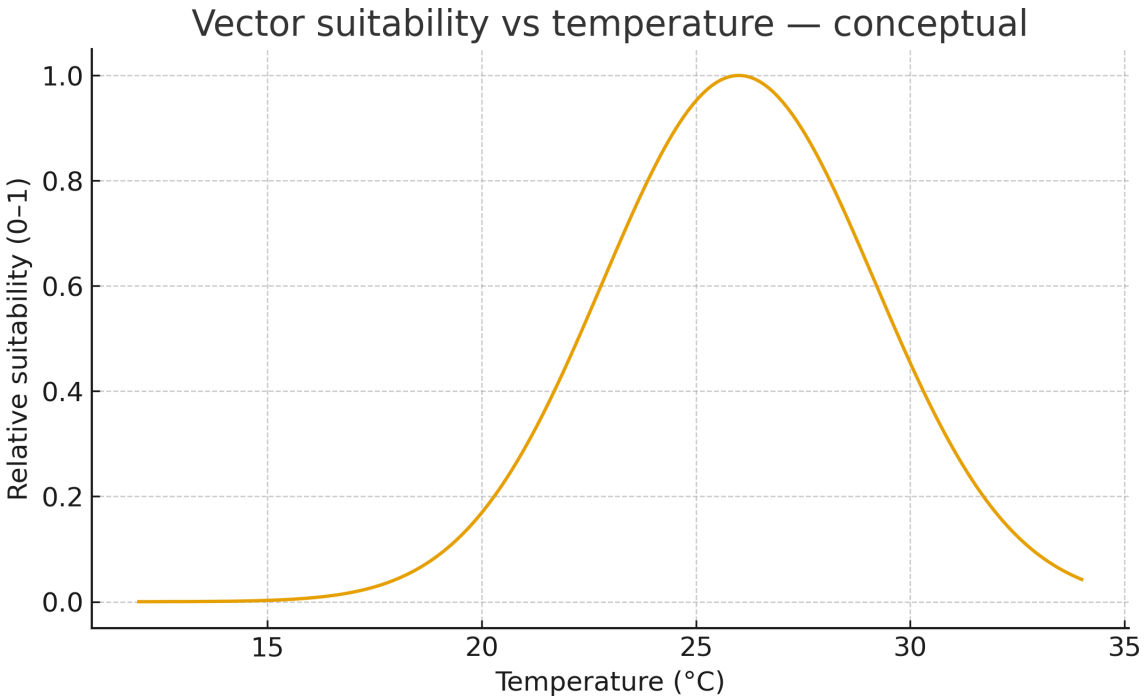



Figure . Regional composite risk (heatmap)

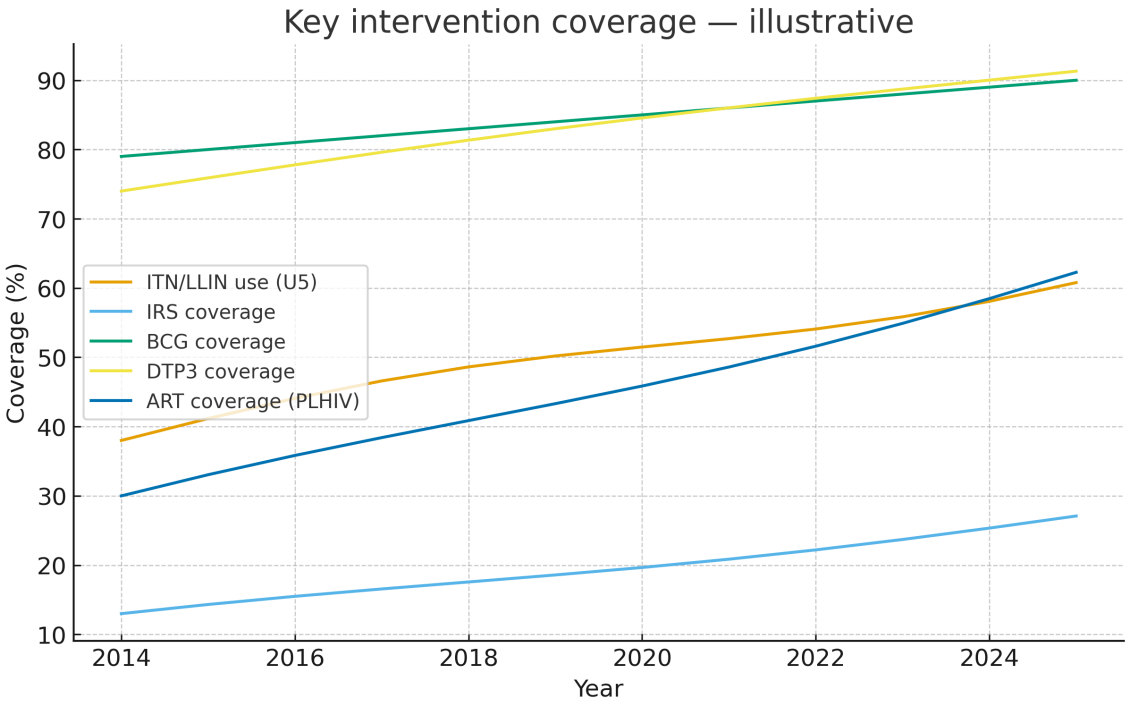
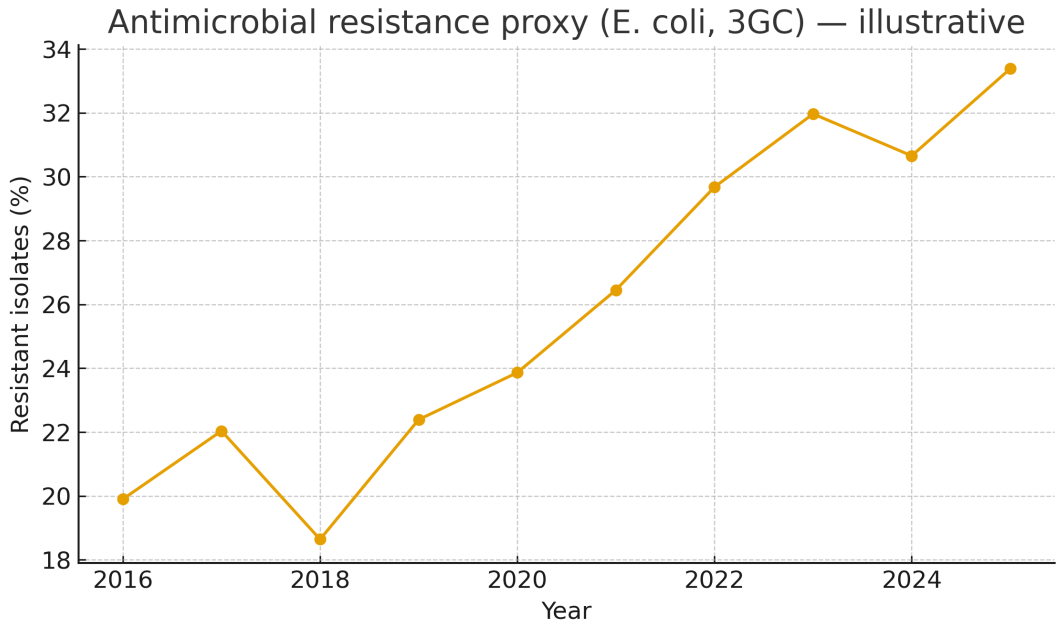


Figure . Antimicrobial resistance proxy trend




## Table 10.9-A. Priority pathogens/conditions (Ethiopia context)

| Pathogen/condition | Ethiopia context (spatial highlights) |
|---|---|
| Malaria (P. falciparum/vivax) | Highlands fringe outbreaks; vector suitability by altitude/temperature |
| Measles | Outbreaks linked to immunity gaps; urban/rural pockets |
| TB (incl. MDR) | Rural access & urban crowding dynamics; HIV co-infection |
| Cholera/AWD | Riverine/flood-prone and urban drainage hot-spots |
| Schisto & STH | Water/soil-linked; school-age MDA focus |
| Dengue/arboviruses | Emerging in lowlands/urban Aedes habitats |
| HIV | Declining prevalence; key populations require tailored outreach |

## Table 10.9-B. Data sources and spatial notes

| Source | Spatial notes |
|---|---|

| | |
|---|---|
| IDSR/HMIS (weekly/monthly) | Facility reports; ensure stable denominators & catchments |
| Lab networks (EQA) | PCR/RDT/ELISA; AMR surveillance (GLASS) |
| DHS/MICS serology modules | HIV, hepatitis, measles serosurveys if available |
| Vector/entomology data | Larval/adult surveys; insecticide resistance maps |
| WASH/urban services | Drainage, water systems; floodplain overlays |
| Mobility/displacement | IOM DTM; road/market networks affecting spread |

### Table 10.9-C. Indicators for dashboards

| Indicator | Why it matters |
|---|---|
| Incidence rate (by woreda) | Cases per population; standardized by age where possible |
| Test positivity rate (TPR) | Outbreak detection & residual transmission |
| Intervention coverage | ITN/IRS, vaccination, ART |
| Case fatality ratio (CFR) | Severity & access; watch for spikes |
| Time to care (T60) | Access proxy; links to outcomes |
| Resistance markers | Insecticide & antibiotic resistance trends |

### Table 10.9-D. Program stratification & actions

| Program | Spatial actions in Ethiopia |
|---|---|
| Malaria | Stratify by incidence/suitability; focal IRS/LLIN; surveillance in high-risk fringes |
| Measles | Close immunity gaps; SIAs in clusters; zero-dose mapping |
| TB | Active case finding in urban hot-spots; community screening in remote areas |

| | |
|---|---|
| Cholera/AWD | Chlorination & WASH surge in flood-prone woredas; OCV as needed |
| NTDs | MDA in endemic schools; WASH co-interventions |
| HIV | Target key populations; linkage to ART; prevention commodities |

### Table 10.9-E. Pitfalls & safeguards

| Pitfall | Safeguard |
|---|---|
| Surveillance artefacts mistaken for risk | Check testing rates, reporting completeness, and catchments |
| Single-disease silos | Use integrated dashboards; co-target where risks overlap |
| Ignoring seasonality | Plan campaigns before peaks; pre-position supplies |
| Over-mapping sensitive data | Aggregate; apply disclosure control; protect key populations |

## Plain-language summary

Germs spread differently in different places and seasons. In Ethiopia, malaria rises after the rains, measles outbreaks happen when too few children are vaccinated, TB spreads faster in crowded areas, and cholera appears where water is unsafe. Maps and trends help leaders act sooner—by focusing bed nets and spraying where malaria still spreads, closing vaccine gaps, improving water and sanitation, and making sure people with HIV and TB get quick treatment. Watching for drug resistance is also important so medicines keep working.

## References — Section 10.9


- FMOH Ethiopia & EPHI — IDSR/HMIS guidelines and bulletins.

- WHO — Global TB, Malaria, HIV, and AMR (GLASS) surveillance reports.

- DHS Program & MICS — Vaccination and disease-related indicators.

- UNICEF/WHO — Measles and immunization resources.

- Peer-reviewed literature — malaria altitude/temperature relationships; measles clustering; AMR trends.

# 10.10) Noncommunicable Diseases & Environmental Exposures

Noncommunicable diseases (NCDs) such as hypertension, diabetes, chronic respiratory disease, and cancers are rising in Ethiopia while infectious threats persist. Environmental exposures—ambient and household air pollution, heat, road safety, and the food and built environment—vary by place and shape risk. This section assembles key trends, indicators, and policy levers. Charts are illustrative placeholders).

## Figures (illustrative)

Figure . NCD prevalence trends (HTN & diabetes)

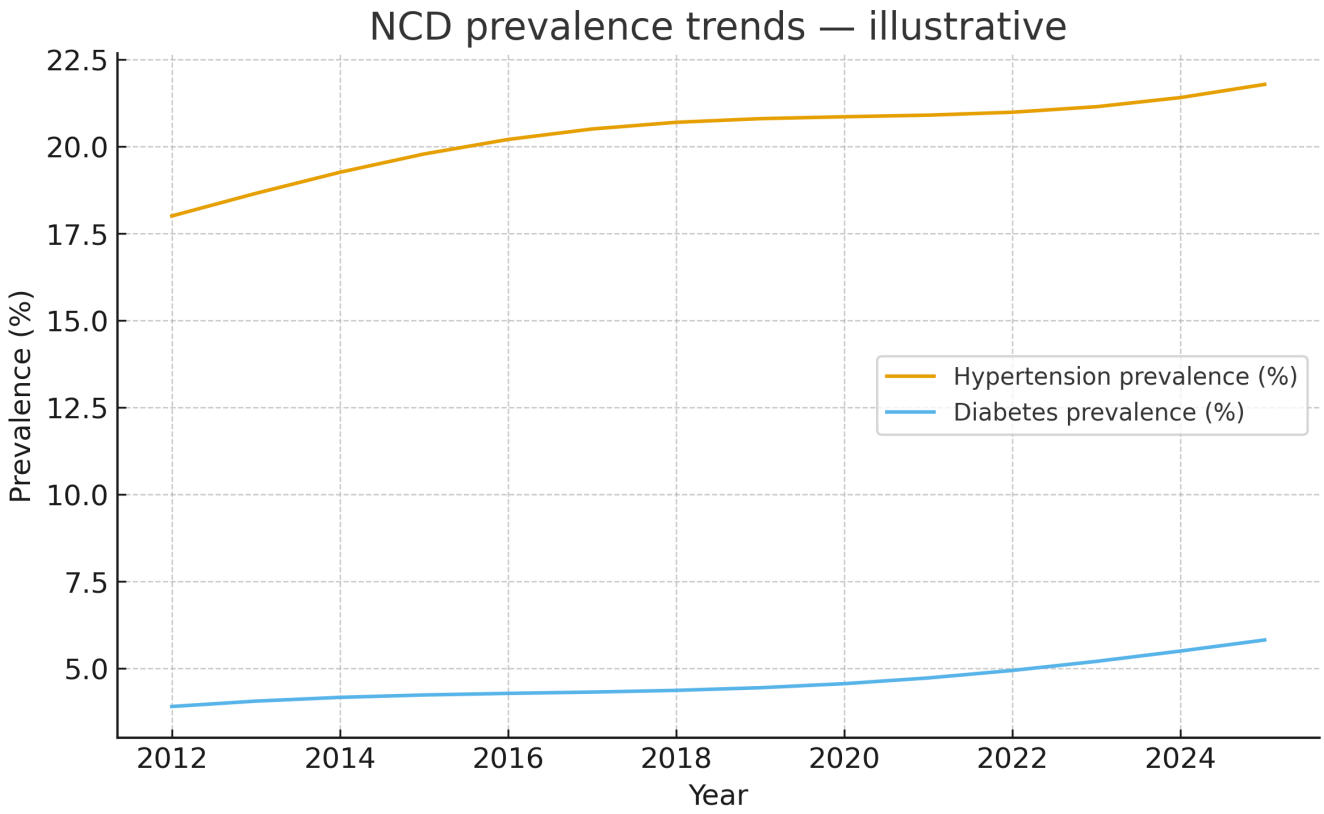


Figure . Treatment & control coverage

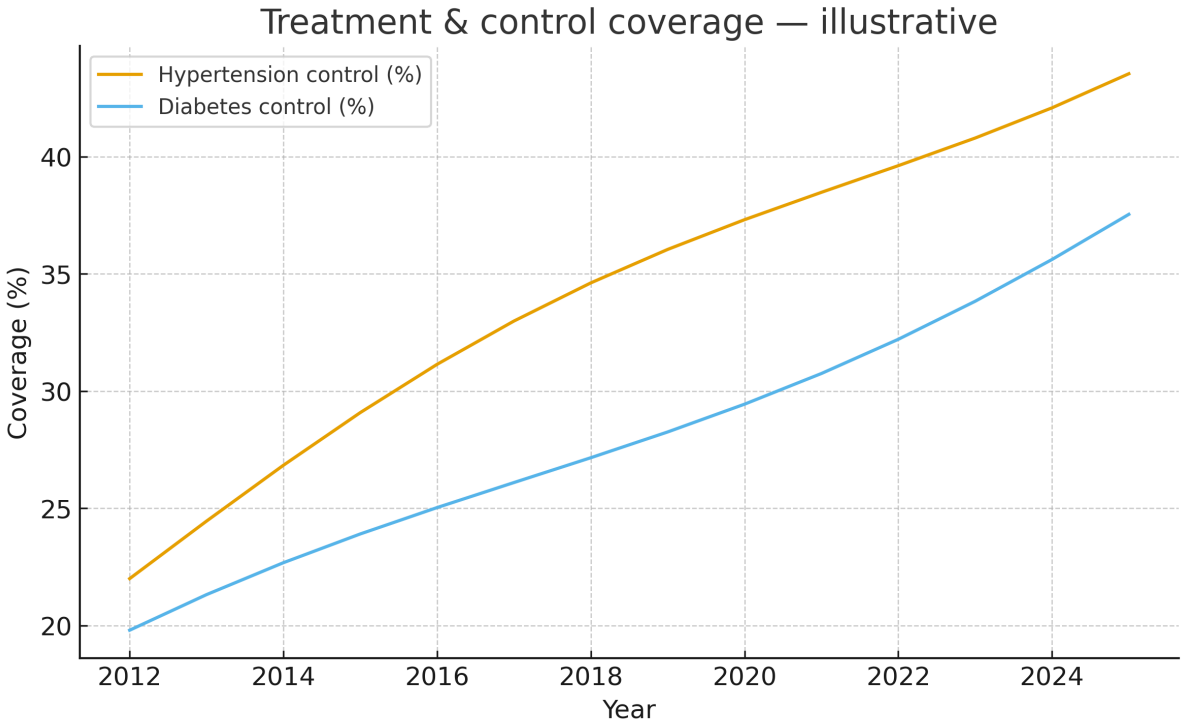



Figure . BMI distribution tails (underweight vs overweight/obese)

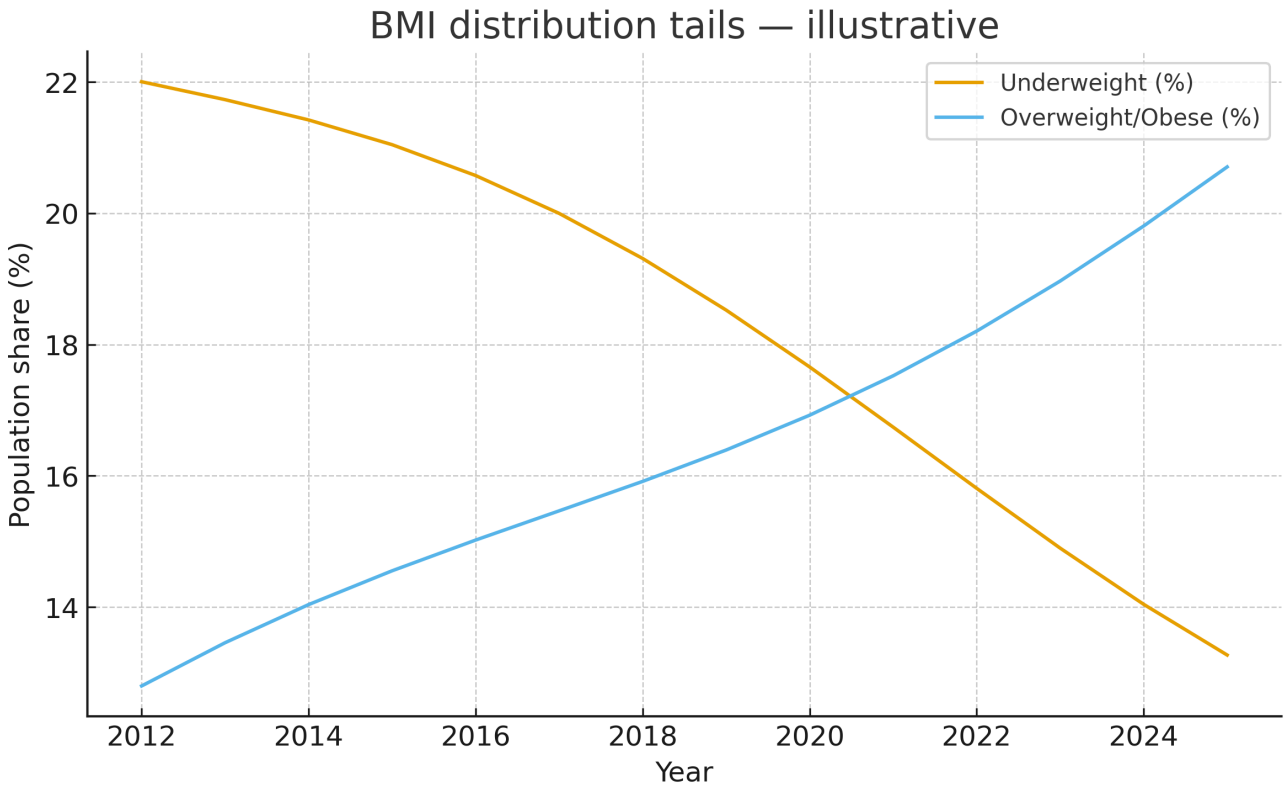


Figure . Ambient PM2.5 exposure (urban vs rural)

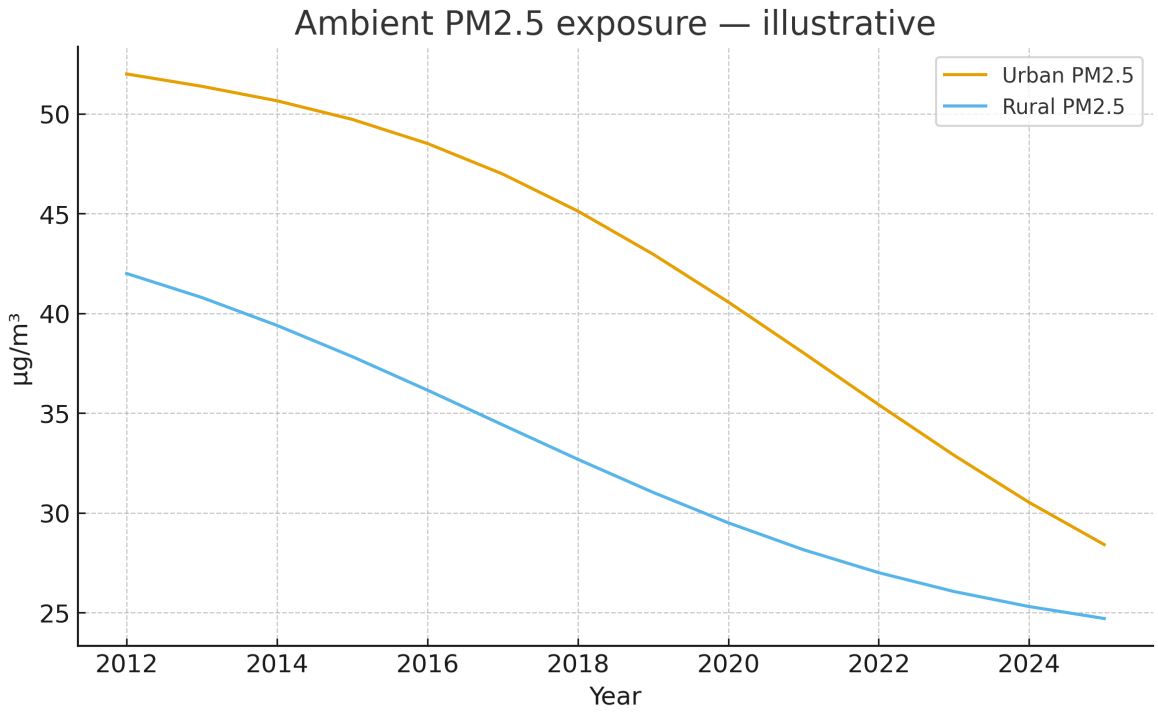



Figure . Household air pollution exposure (solid fuel use)

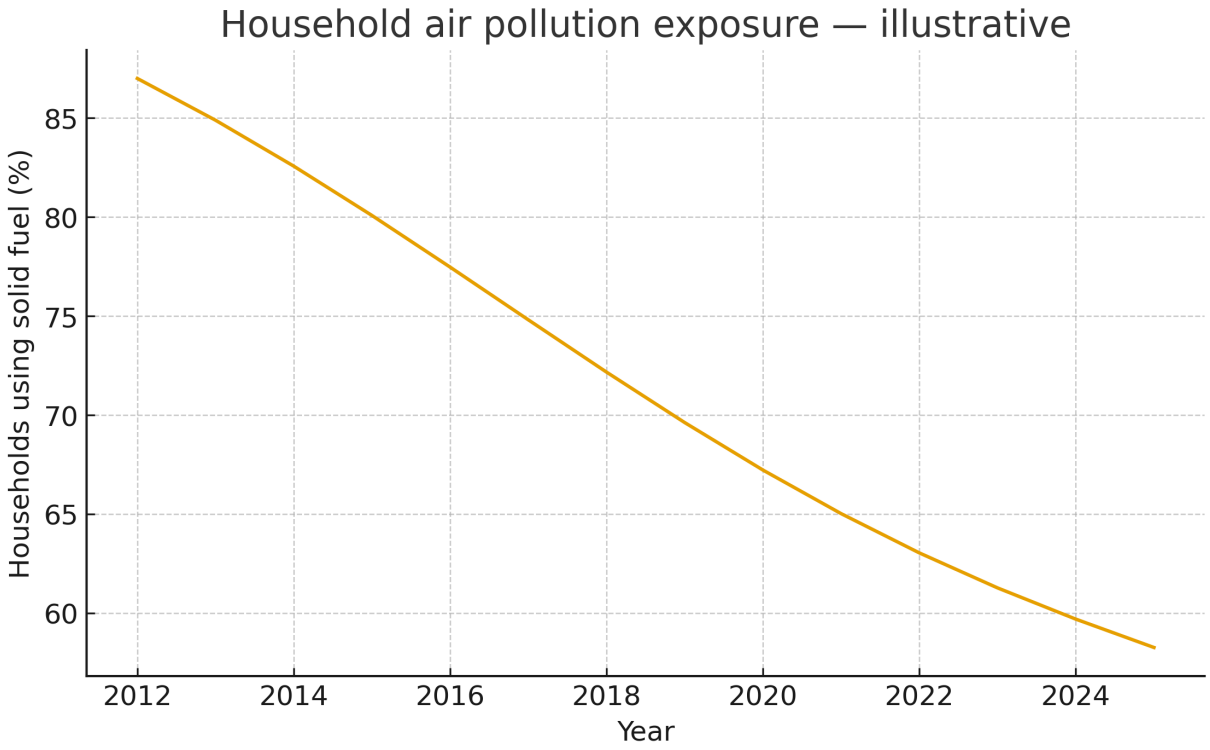


Figure . Heat–mortality relationship (conceptual)

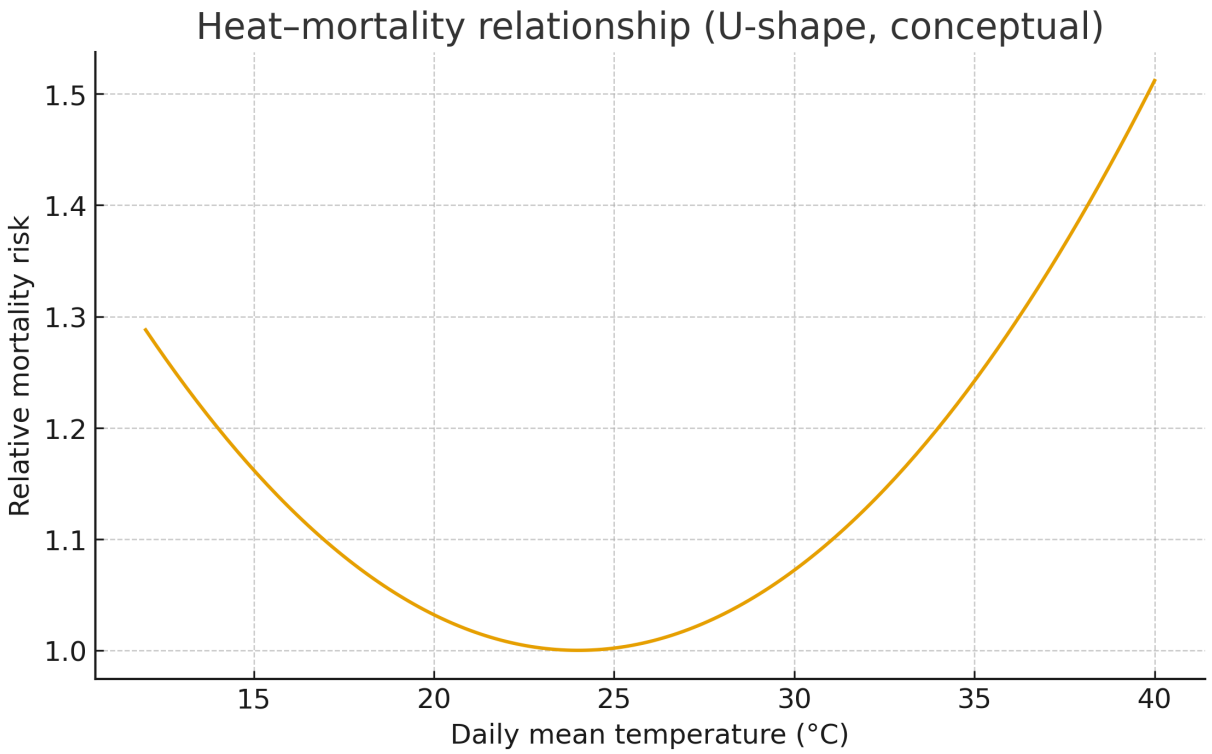



Figure . Physical inactivity (urban vs rural)

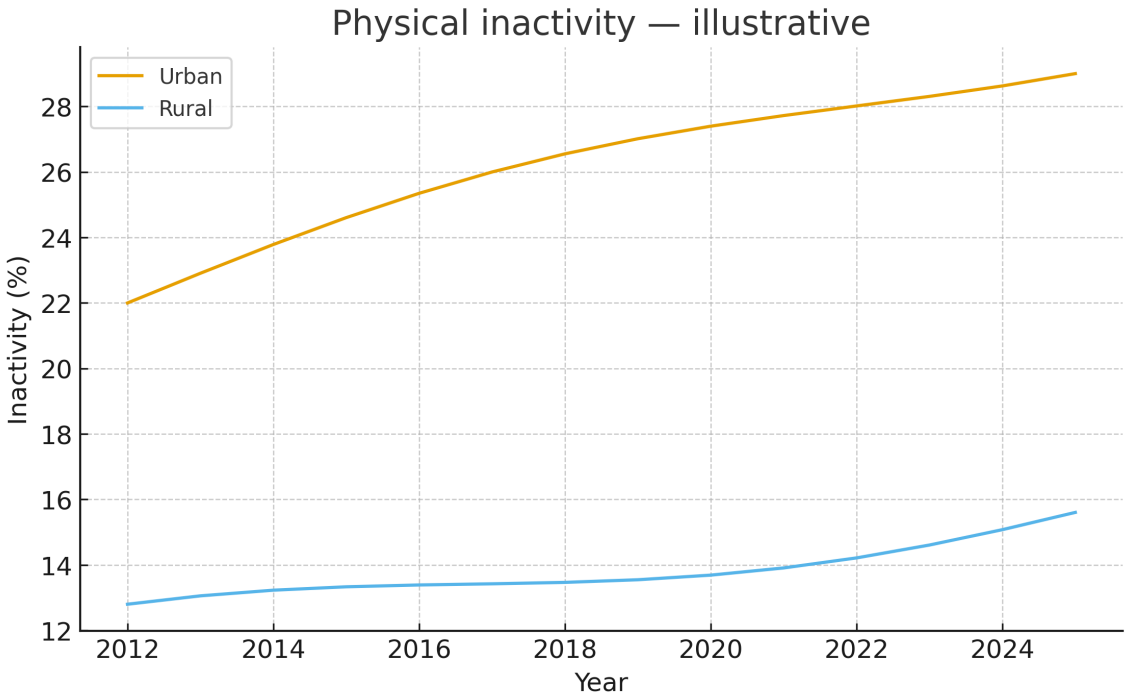


Figure . Road traffic injury mortality

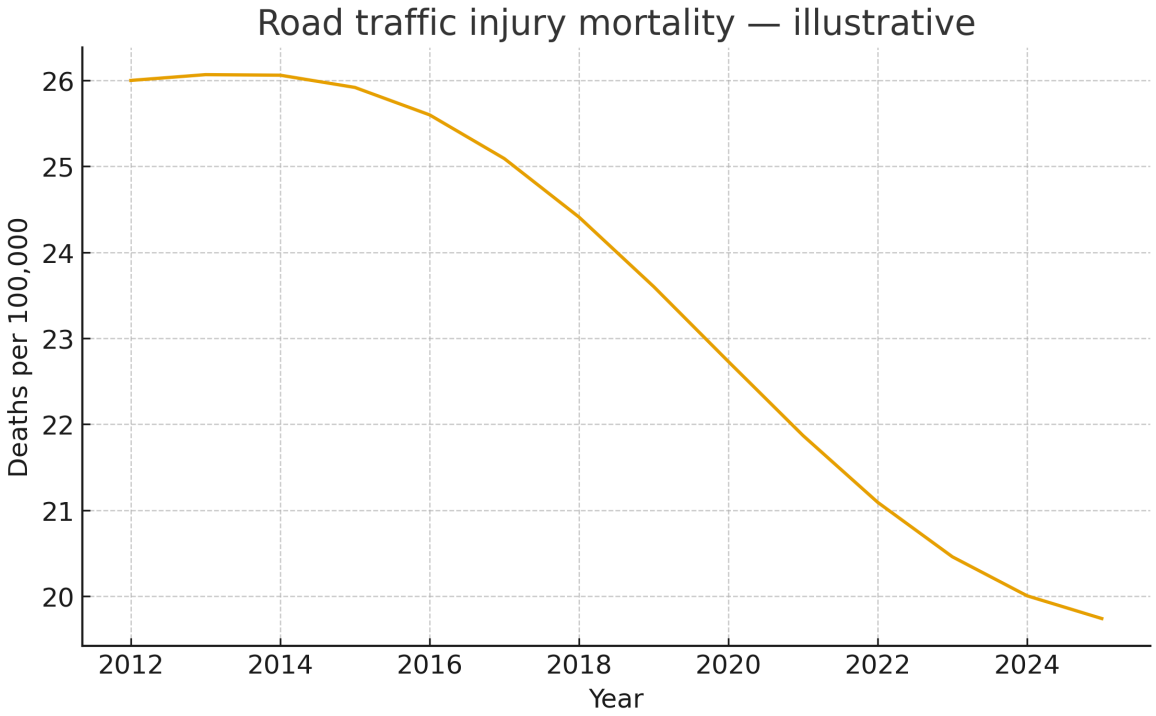



Figure . Cancer incidence (aggregate proxy)

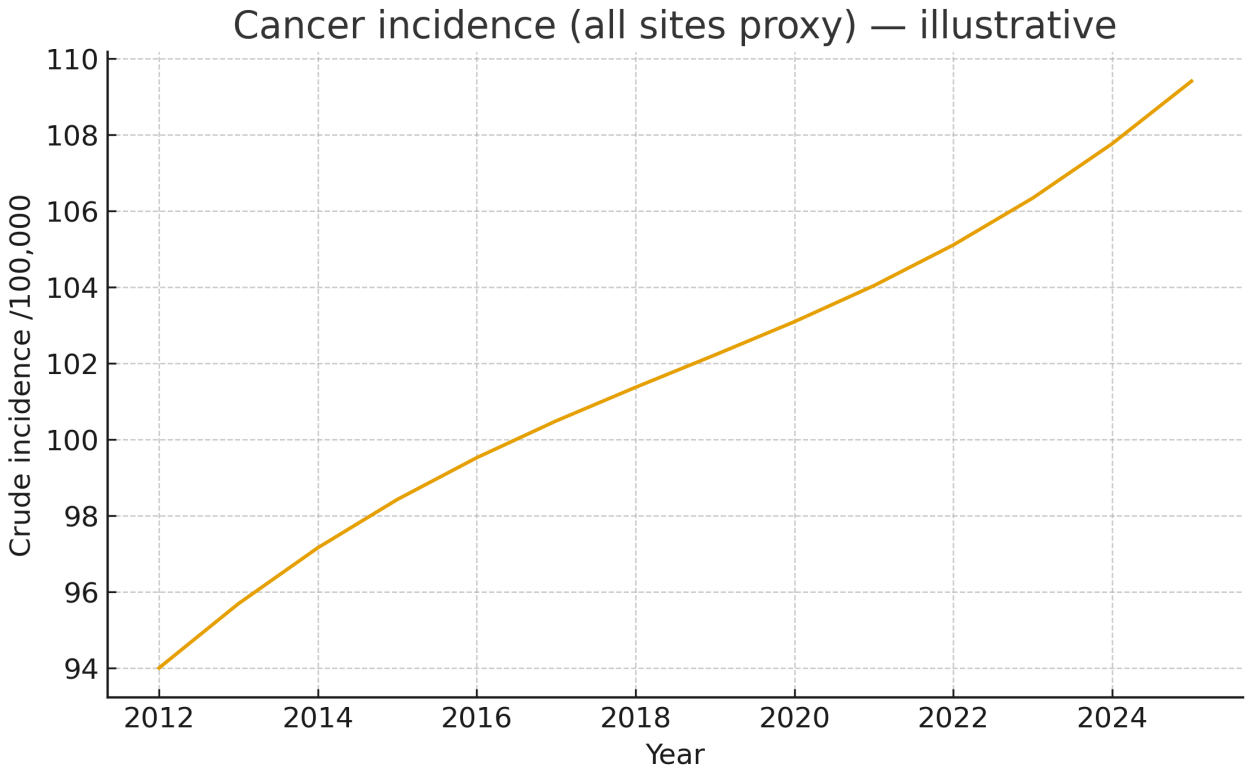


Figure . Market access & healthy diet potential

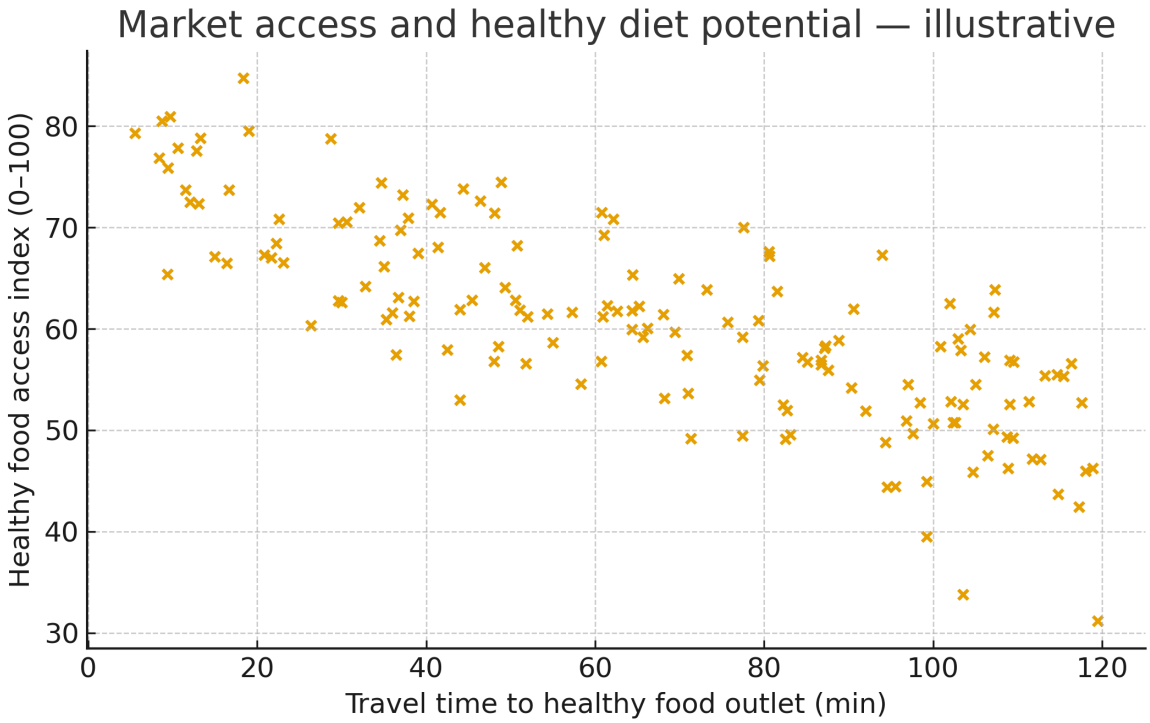



**Table 10.10-A. NCD risk factors & spatial determinants**

| Risk factor | Spatial determinants / Ethiopia notes |
|---|---|
| Air pollution (PM2.5, HAP) | Higher in cities (traffic/industry) and biomass-using households; top CVD/COPD driver |
| Diet (salt, fats, fruit/veg) | Market access, prices, culture; food deserts in peri-urban areas |
| Physical inactivity | Urban design, safety, transport options; heat discourages activity |
| Alcohol & tobacco | Outlet density, enforcement; border smuggling corridors |
| Heat & climate | Heatwaves raise cardio-respiratory mortality; night heat matters |
| Built environment | Sidewalks, parks, stairs; housing quality & ventilation |

| | |
|---|---|
| Healthcare access | Proximity to BP/diabetes screening and meds; continuity of care |

### Table 10.10-B. Data sources for NCDs & exposures

| Source | Notes for Ethiopia |
|---|---|
| STEPS survey | BP, glucose, BMI, behaviors; periodic |
| DHS/MICS (adult modules) | Anthropometry, tobacco/alcohol, cooking fuel |
| HMIS & facility EMR | Hypertension/diabetes visits, control rates, NCD clinics |
| Air quality | Ground monitors, satellite PM2.5, household stove/fuel surveys |
| Injury data | Police/traffic & hospital injury records; GIS of crash hot-spots |
| Cancer registry | Population-based or hospital-based incidence where available |

### Table 10.10-C. Indicators for dashboards & MEL

| Indicator | Definition / use |
|---|---|
| Hypertension control (%) | Of adults with HTN: controlled BP <140/90 |
| Diabetes control (HbA1c<8%) | Among treated diabetics |
| Population-weighted PM2.5 (μg/m³) | By woreda/city; WHO guideline compliance |
| Solid fuel use (%) | HAP proxy; monitor clean-cooking transition |
| Inactivity (%) | Adults meeting PA guidelines |
| RTI deaths (/100k) | Transport safety; speed & helmet/seatbelt enforcement |
| Cancer screening coverage | Cervical VIA/HPV; breast clinical exam; others as feasible |

### Table 10.10-D. Priority actions & policy levers

| Action | Notes for Ethiopia |
|---|---|
| Primary care NCD package | Task-sharing for BP/diabetes; fixed-dose meds; registers & follow-up |
| Clean cooking & fuels | Subsidies/credit; LPG/electric; improved stoves as transition |
| Air quality management | Vehicle inspection, low-sulfur fuels, brick/industry controls |
| Active cities | Sidewalks, cycling lanes, shade trees; school-to-park networks |
| Healthy food environments | Markets, cold chains, salt-reduction policies, labelling |
| Road safety | Speed calming, helmets/seatbelts, safe crossings, trauma care |
| Heat-health plans | Early warning, cooling centers, work-rest cycles |

### Table 10.10-E. Pitfalls & safeguards

| Pitfall | Safeguard |
|---|---|
| Clinic-based data bias | Complement with surveys; account for access gaps |
| One-size-fits-all targets | Tailor to urban vs rural vs pastoral contexts |
| Ignoring co-morbidities | Integrate CVD, diabetes, COPD, depression screening |
| Privacy of health data | Aggregate; protect identifiers; ethical approvals |
| Short-term pilots | Plan for scale, supply chains, financing, maintenance |

## Plain-language summary

Diseases like high blood pressure, diabetes, and some cancers are becoming more common as towns grow and lifestyles change. Dirty air—from traffic or cooking smoke—heat waves, unsafe roads, and hard-to-reach healthy foods also harm health. By checking blood pressure and sugar in clinics, improving fuels and transport, and designing walkable neighborhoods, Ethiopia can prevent many NCD deaths and keep people healthier for longer.

## References — Section 10.10


- WHO STEPS — NCD risk factor surveillance methods.
- WHO Air Quality Guidelines & Global Health Estimates for PM2.5/HAP.
- Global Burden of Disease (GBD) — NCD risk factors and causes.
- FMOH Ethiopia — NCD/HP strategic plans; facility NCD registers/guidelines.
- World Bank/UN-Habitat — Urban planning for healthy cities; road safety frameworks.

# 10.11) Biodiversity, Protected Areas & Human Pressure

Ethiopia’s exceptional biodiversity—from afro-alpine endemics to lowland savannas—faces rising pressure from settlement growth, roads, and land-use change. This section links conservation indicators to health via One Health pathways and human–wildlife interfaces. Charts are illustrative placeholders.

## Figures (illustrative)

Figure . Protected area coverage over time

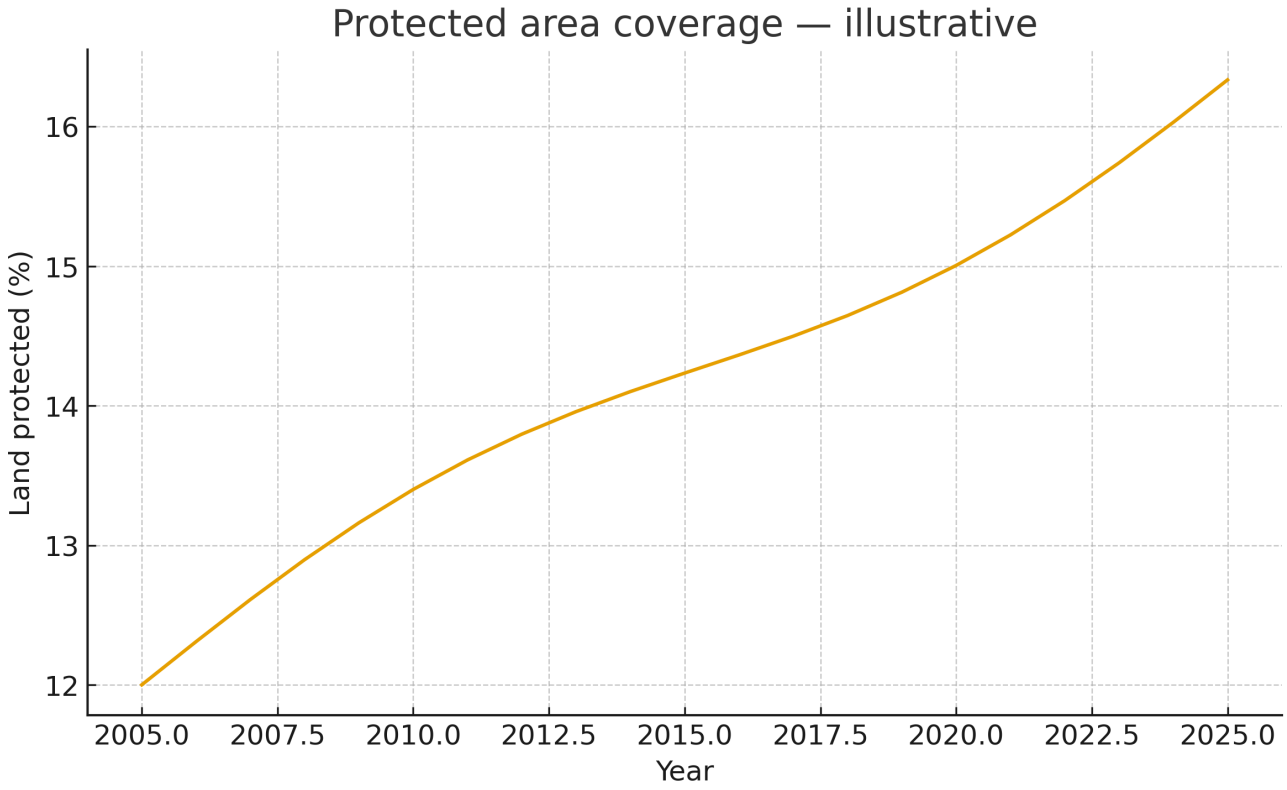


Figure . Human footprint index trend

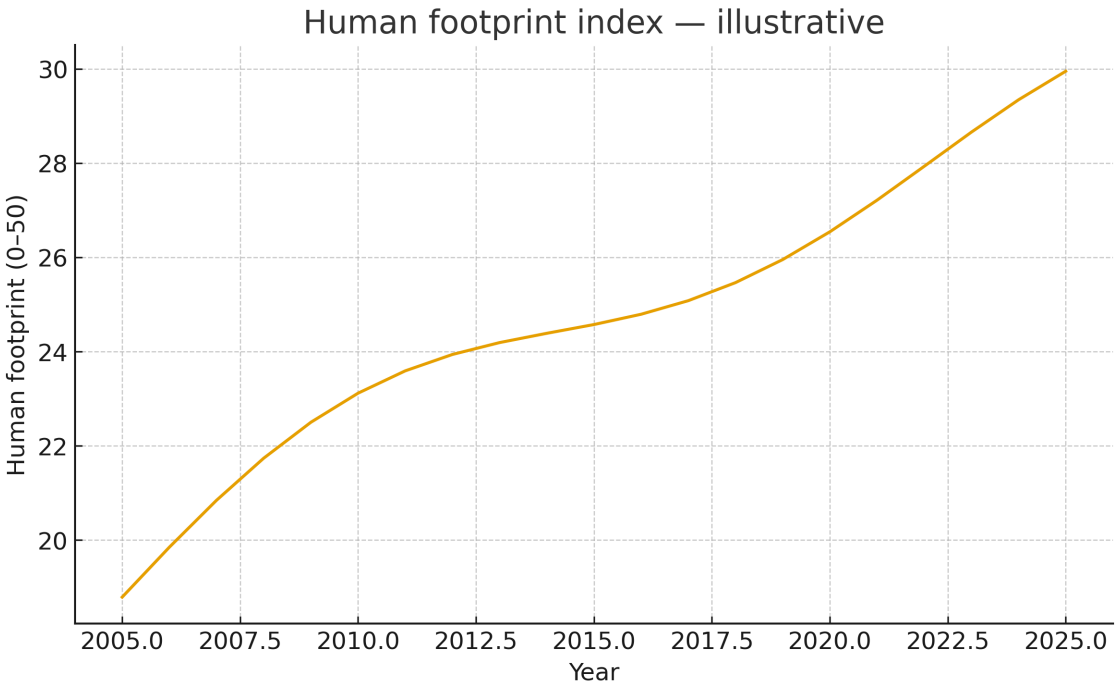



Figure . Forest cover (million ha)

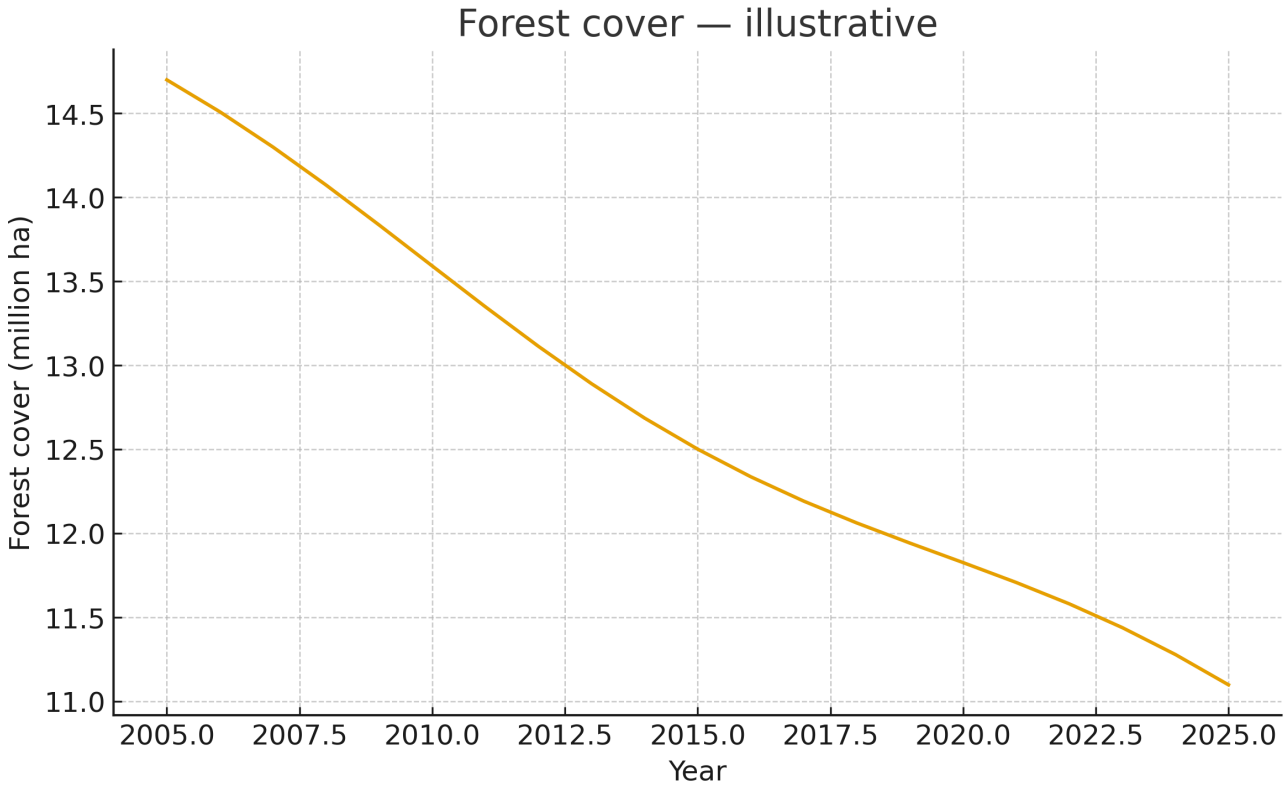


Figure . Species richness vs fragmentation

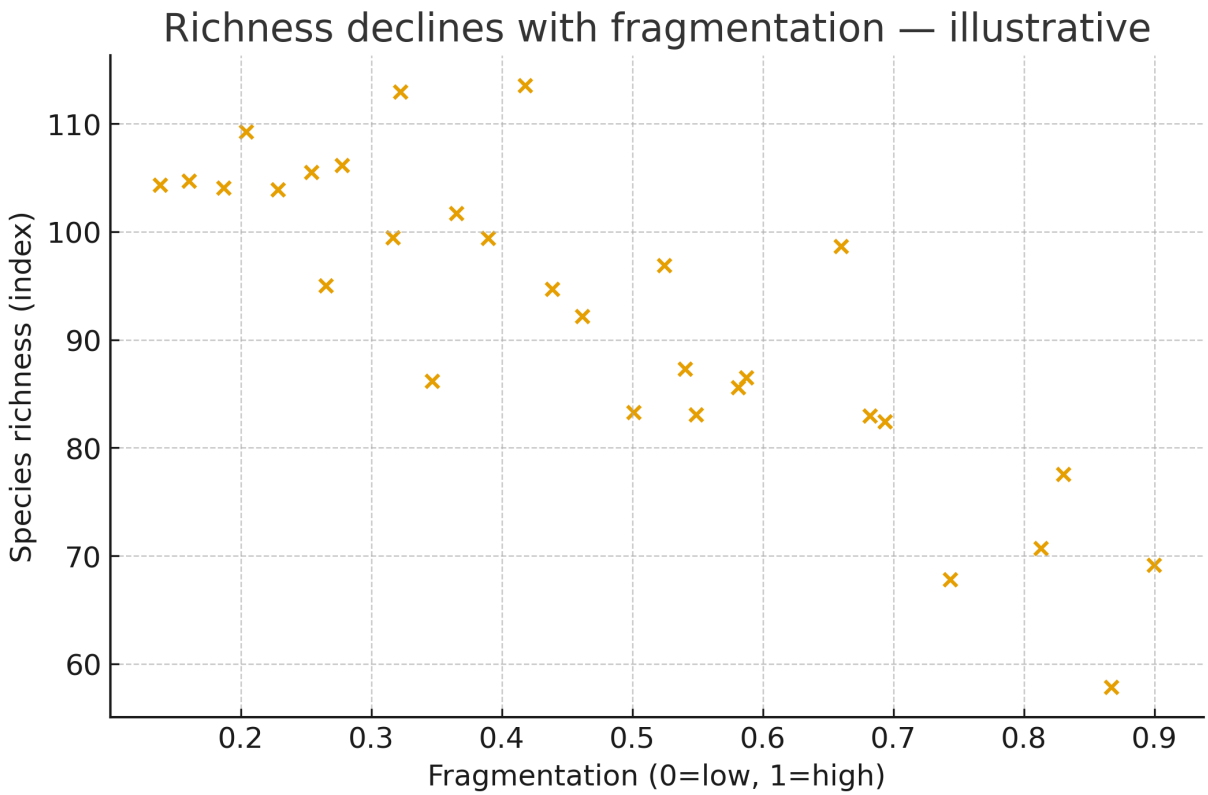



Figure . Population living near PAs (≤5 km)

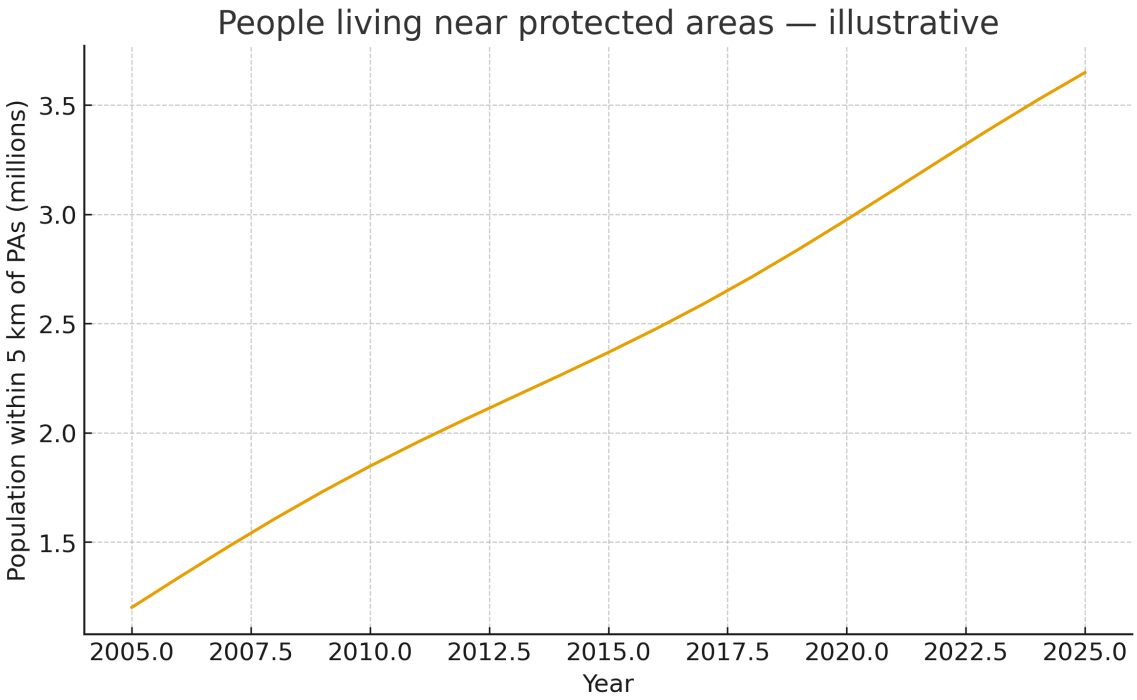


Figure . Zoonotic spillover risk proxy

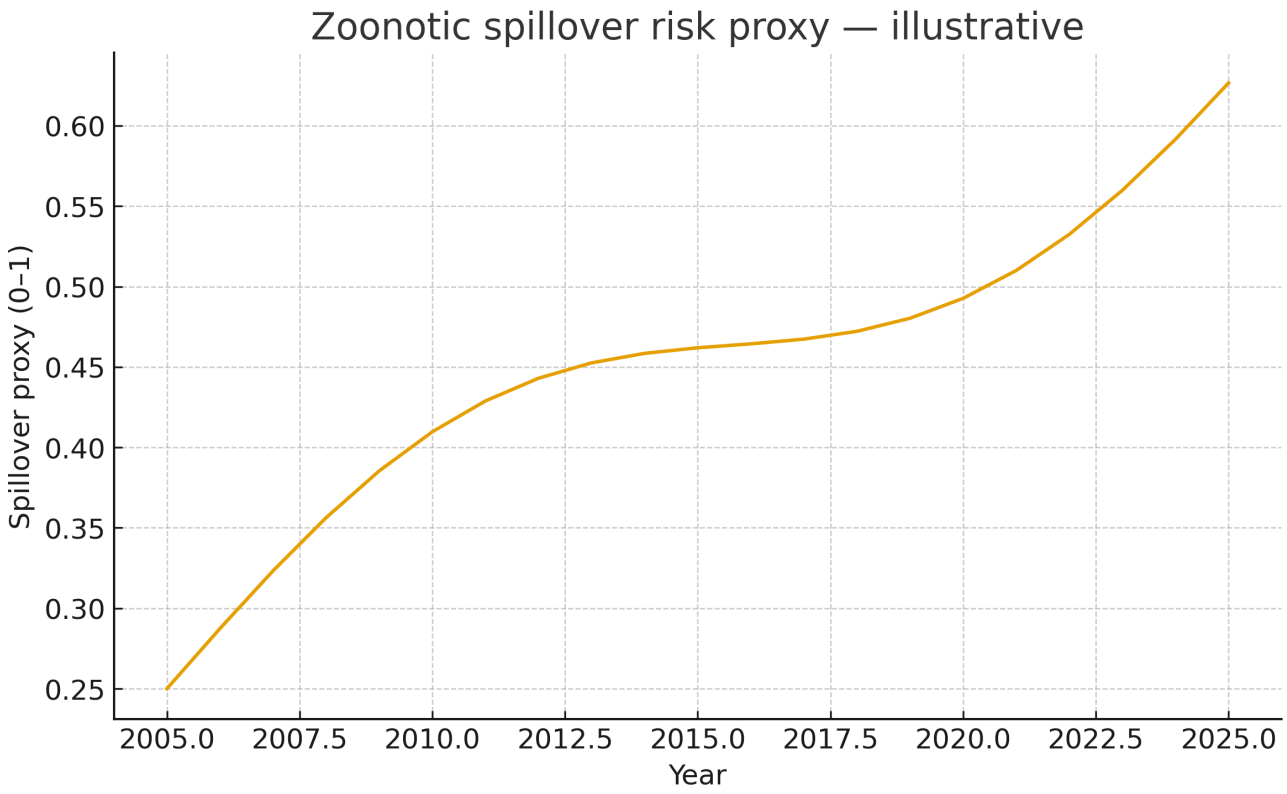



**Table 10.11-A. Protected area categories & governance (Ethiopia)**

| Category | Governance & purpose in Ethiopia |
|---|---|
| National Park | Federal or regional authority; biodiversity conservation & tourism |
| Wildlife Sanctuary/Reserve | Species protection; limited use zones |
| Community Conserved Area | Local governance; co-benefits & revenue sharing |
| Biosphere Reserve | Zonation (core, buffer, transition); UNESCO model |
| Forest Priority Area | Watershed & habitat protection; controlled use |

### Table 10.11-B. One Health pathways linking biodiversity & health

| Pathway | Implications for public health |
|---|---|
| Ecosystem services | Water regulation; pollination; heat mitigation |
| Zoonotic interfaces | Wildlife-livestock-human contact at edges & markets |
| Vector habitats | Deforestation & irrigation shift vector ecology (malaria, RVF) |
| Nutrition & livelihoods | Bushmeat risks; fisheries; non-timber forest products |
| Mental & cultural health | Access to nature; cultural sites |

### Table 10.11-C. Indicators for dashboards

| Indicator | Why it matters |
|---|---|
| PA coverage (%) & representativeness | % land protected; biomes represented |
| Forest loss (km²/yr) & fire counts | Hotspots for action; restoration targeting |
| HFI trend near PAs | Encroachment pressure; buffer management |
| Buffer population (≤5/10 km) | Human–wildlife interface; conflict risk |
| Connectivity index | Corridors intact vs blocked; species movement |
| Spillover proxy index | Wildlife density × HFI × livestock density |

### Table 10.11-D. Program options, co-benefits & trade-offs

| Intervention | Co-benefits & trade-offs |
|---|---|
| Co-manage buffers | Reduce illegal use; jobs via eco-tourism; potential grazing trade-offs |
| Restoration (riparian/forest) | Water quality & flood reduction; land use conflicts possible |
| Integrated vector management | Target irrigation edges; avoid harm to non-targets |

| | |
|---|---|
| Alternative livelihoods | Reduce pressure on wildlife; requires market access |
| Health posts around PAs | Reduce conflict injuries; surveillance for zoonoses |

### Table 10.11-E. Data sources (Ethiopia & global)

| Theme | Typical sources |
|---|---|
| Protected areas | WDPA/UNEP-WCMC; national PA agency datasets |
| Forest change & fires | Global Forest Watch; MODIS/VIIRS fire alerts |
| Human footprint & built-up | GHS, HRSL, roads; human footprint indices |
| Species/richness | IUCN ranges; eBird/GBIF occurrence data |
| Livestock density | FAO Gridded Livestock; national livestock census |
| Hydrology | HydroSHEDS; national river/basin datasets |

### Table 10.11-F. Pitfalls & safeguards

| Pitfall | Safeguard |
|---|---|
| Counting % protected only | Assess representativeness, connectivity, management quality |
| Ignoring equity | Ensure communities benefit; FPIC for restrictions |
| Static buffers | Update with settlement growth and new roads |
| Attributing causation | Triangulate environmental change with enforcement & markets |
| Sensitive species data | Generalize/blur locations to prevent harm |

## Plain-language summary

Nature protects health. Forests keep water clean, trees cool cities, and animals and people share the same land and diseases. In Ethiopia, more people now live near protected areas, and some forests are shrinking. Planning with communities can protect wildlife and reduce problems like flooding, heat, and the spread of new diseases. Good maps and fair rules help everyone benefit while keeping nature alive for the future.

## References — Section 10.11


- UNEP-WCMC/WDPA — Protected areas database and guidance.

- Global Forest Watch (GFW) — Forest loss and fire alerts.

- Human Footprint / Global Human Modification datasets — methods and uses.

- IUCN Red List & range maps; GBIF/eBird occurrence data.

- FAO Gridded Livestock; national livestock census for interface metrics.

- One Health frameworks — WHO/FAO/WOAH guidance.

# 10.12) Integrated Planning: Trade-offs, Co-benefits & Just Transitions

Integrated planning aligns health, climate, transport, energy and environment goals. In Ethiopia, the aim is to expand access to quality care, cut air pollution, manage climate risks, and support livelihoods. This section offers a practical frame—trade-off frontiers, co-benefit scoring, equity lenses and just-transition safeguards. Charts are illustrative placeholders and should be replaced with official series before publication.

## Figures (illustrative — replace with official series)

Figure . Trade-off frontier: access vs emissions

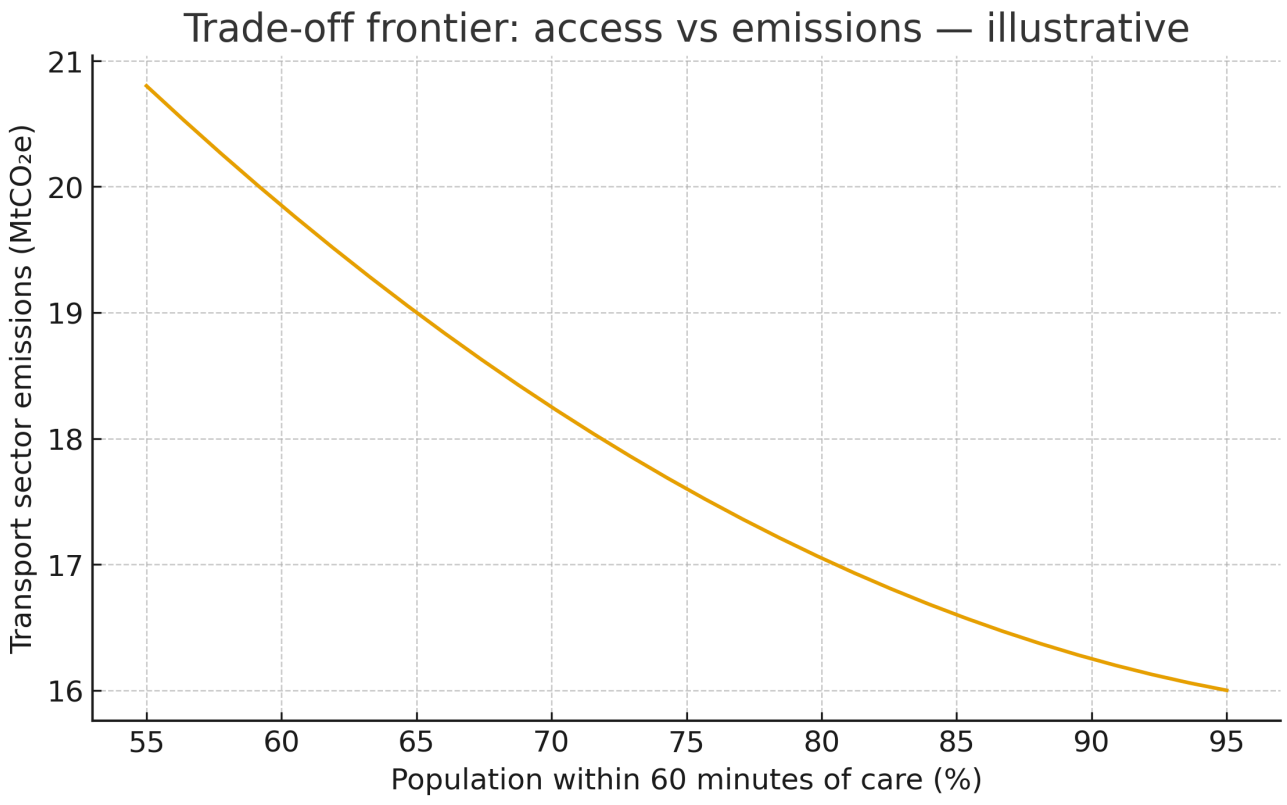


Figure 1. Co-benefits profile — example 1

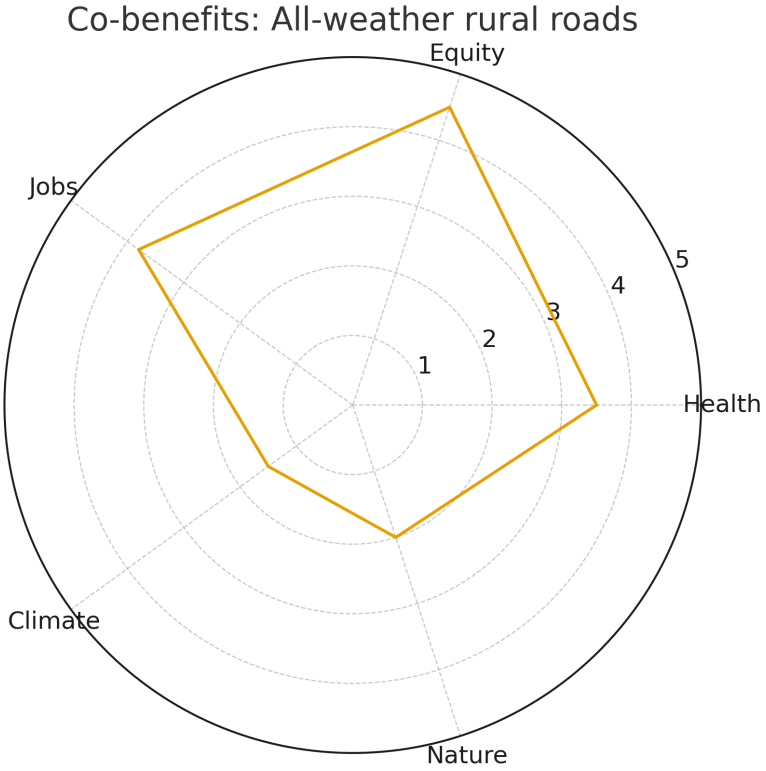



Figure . Co-benefits profile — example 2

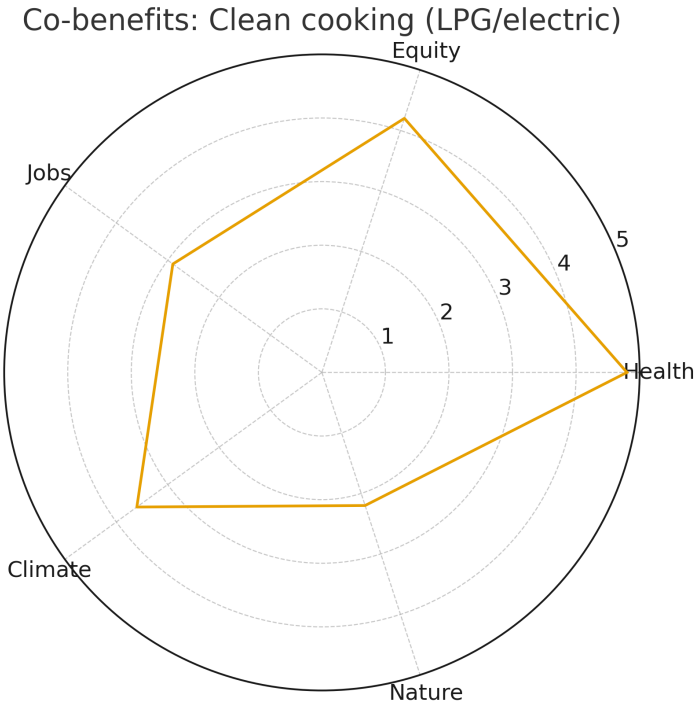


Figure . Co-benefits profile — example 3

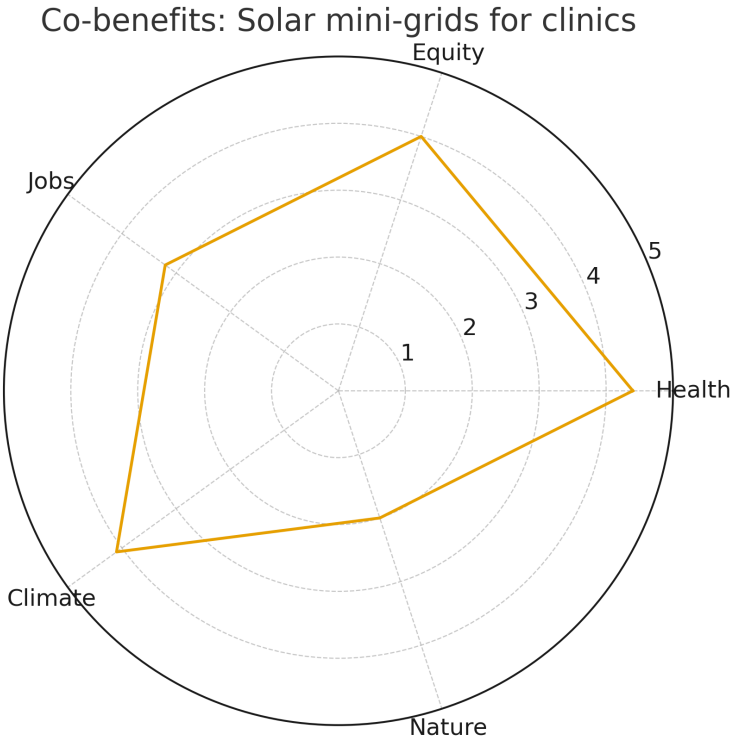



Figure . Co-benefits profile — example 4

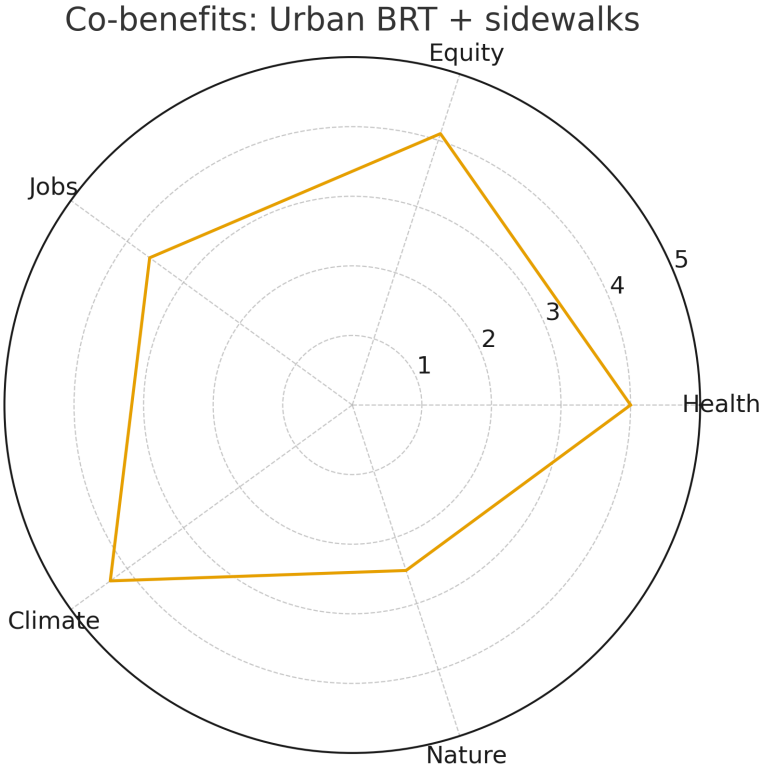


Figure . 2030 outcomes under alternative strategies

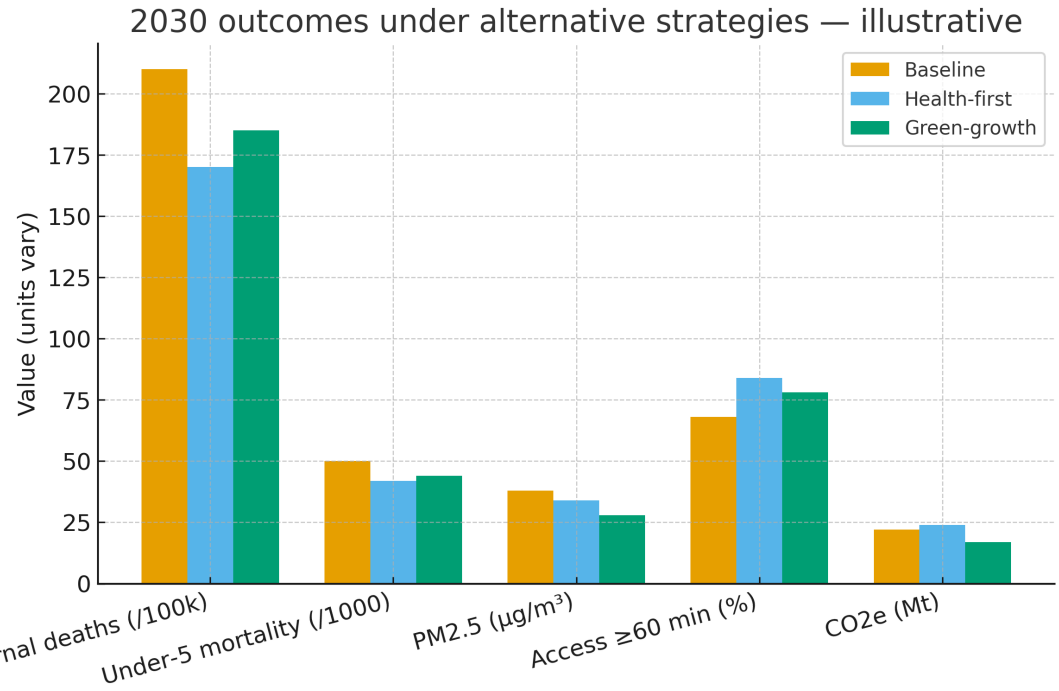
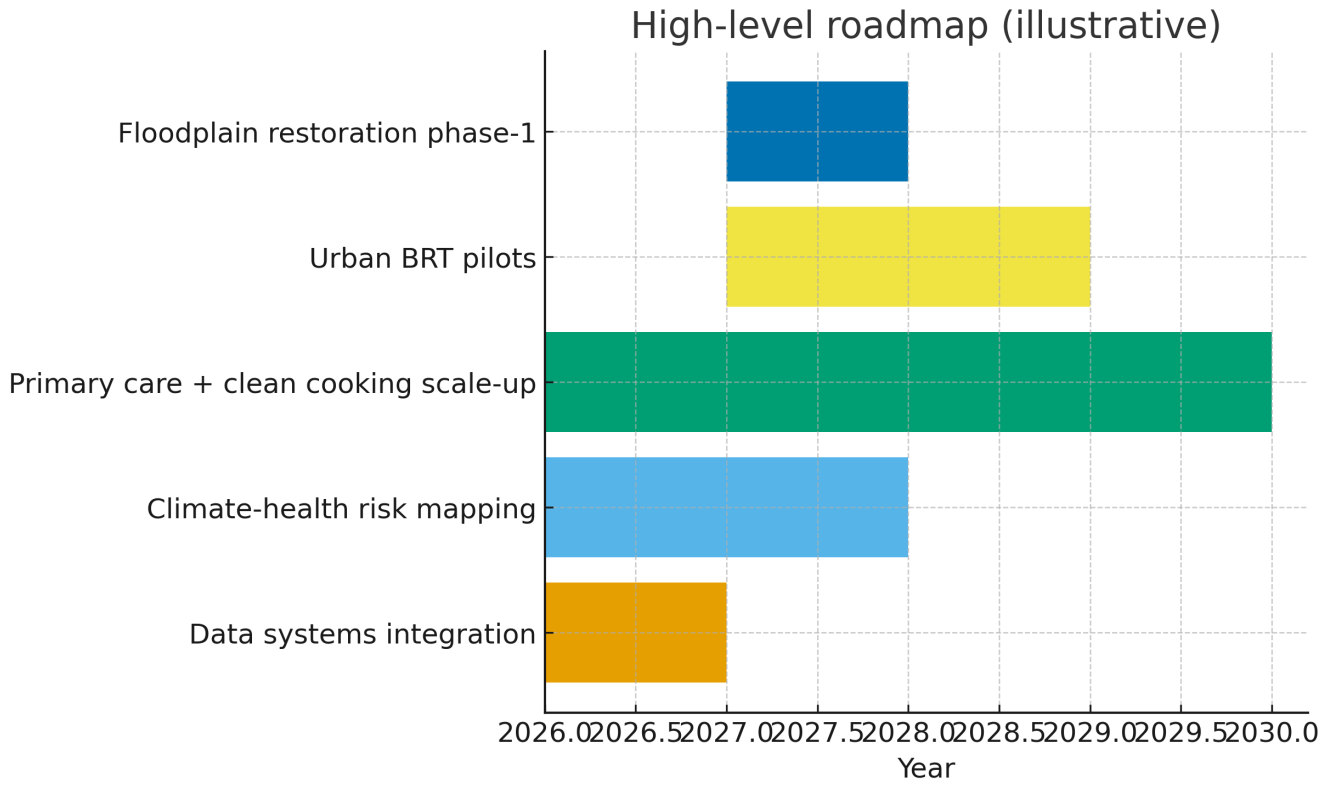



Figure 10.12-9. High-level roadmap (Gantt-like)



### Table 10.12-A. Integrated indicators for planning dashboards

| Indicator | Notes / how to use in Ethiopia |
|---|---|
| Access to care (T60/T120) | % pop within 60/120 minutes of emergency care; equity gaps |
| Service quality & continuity | Readiness index; % facilities functional in shocks |
| Air quality (PM2.5) | Population-weighted exposure; exceedance days |
| Clean cooking transition | % households with clean primary fuel; affordability |
| Transport emissions | $MtCO_2e$ from on-road; per-capita trend |
| Nature & risk | Floodplain population; deforestation; heat island index |

### Table 10.12-B. Decision matrix — co-benefits & risks (0–5)

| Intervention | Health | Equity | Jobs | Climate | Nature |
|---|---|---|---|---|---|
| All-weather rural roads | 3.5 | 4.5 | 3.8 | 1.5 | 2.0 |
| Clean cooking (LPG/electric) | 4.8 | 4.2 | 2.9 | 3.6 | 2.2 |
| Solar mini-grids for clinics | 4.4 | 4.0 | 3.2 | 4.1 | 2.0 |
| Urban BRT + sidewalks | 4.0 | 4.1 | 3.6 | 4.3 | 2.5 |
| Floodplain restoration | 3.3 | 3.8 | 3.1 | 3.5 | 4.6 |
| Malaria IVM at irrigation edges | 3.9 | 3.7 | 3.0 | 2.8 | 3.4 |

### Table 10.12-C. Just transition safeguards

| Safeguard | Operationalization in Ethiopia |
|---|---|
| Livelihood mapping | Identify workers/households affected by fuel and transport shifts |
| Cash + retraining | Temporary income support and skills programs in affected regions |
| Tariff & subsidy design | Lifeline tariffs for the poor; avoid regressive taxes |
| Community participation | FPIC and grievance redress; include women & youth |
| Geo-targeting | Direct benefits to high-risk regions (transition index) |

### Table 10.12-D. MEL framework

| Metric | Measurement & cadence |
|---|---|
| Outcome: saved time to care | Baseline T60; quarterly updates; mixed-methods validation |
| Outcome: reduced PM2.5 | Ground monitors + satellite; annual audit |
| Equity: quintile gain | Poorest vs richest service gain; disaggregate by gender/region |
| Resilience: continuity | % facilities functional during flood/heat events |
| Climate: emissions | Transport $CO_2e$ per capita; progress vs NDC targets |

### Table 10.12-E. Pitfalls & safeguards

| Pitfall | Safeguard |
|---|---|
| Shiny but inequitable projects | Use equity-weighted cost-benefit and participation |
| Silo budgets | Braided financing across health, transport, energy, environment |
| Short pilots, no scale plan | Plan O&M and procurement; build local capacity |

| | |
|---|---|
| Static risk maps | Update with new roads, climate anomalies, displacement |
| Data privacy | Aggregate outcomes; protect household and facility identifiers |

## Plain-language summary

Good plans solve more than one problem at a time. Ethiopia can choose actions that improve health, protect nature, and create jobs—like clean cooking, better roads to clinics, floodplain restoration, and safer city transport. By checking who benefits most (especially poorer families) and helping workers during change, the country can move toward a fair, healthy, low-carbon future.

## References — Section 10.12

- WHO — Health in All Policies (HiAP) and air-pollution health co-benefits.

- World Bank & AfDB — Just transition and climate-resilient development guidance.

- IPCC & UNEP — Mitigation/adaptation co-benefits; integrated assessment framing.

- Government of Ethiopia — NDCs, Health Sector Transformation Plans, and transport/energy strategies.

## In one page

Health is shaped by where people live. In Ethiopia, rains, heat, altitude and roads all change disease risks and access to care. Malaria rises after the rains and mostly at lower elevations; measles flares where vaccination is low; and diarrhea increases where water and sanitation are poor. NCDs like high blood pressure and diabetes are growing in cities, where traffic and industry raise air pollution, while many rural families still breathe smoke from cooking with wood or charcoal. Good maps help leaders act faster—putting bed nets and spraying where malaria persists, filling vaccine gaps, improving roads to clinics, protecting forests and rivers, and planning cleaner energy. This chapter offers ready-to-use indicators and tools for fair, practical decisions.

## Core indicators at a glance

• Access to care: % of people within 60/120 minutes of emergency care (T60/T120), and equity gap by wealth quintile and gender.

• WASH: safely-managed drinking water; basic sanitation; open defecation; handwashing with soap.

• Infectious diseases: malaria incidence & test positivity, measles immunity/coverage, TB case detection & treatment success, cholera alerts.

• NCDs & exposures: hypertension/diabetes control rates; PM2.5 exposure (ambient & household); physical inactivity; road-traffic deaths.

• One Health & environment: forest loss, human-footprint near protected areas, buffer-zone population, floodplain exposure.

• Programs & systems: stock-outs, facility “readiness” score, continuity during shocks, and data completeness/timeliness.

## Glossary (selected terms used in Chapter 10)

• T60/T120: Share of the population that can reach an emergency-capable facility within 60/120 minutes by typical transport, accounting for terrain and roads.

• AMR (Antimicrobial resistance): When germs no longer respond to medicines that used to kill them.

• ART coverage: Proportion of people living with HIV on antiretroviral therapy.

• BCG/DTP3 coverage: Share of children receiving BCG (tuberculosis) and three doses of diphtheria–tetanus–pertussis vaccine.

• Case fatality ratio (CFR): Deaths among confirmed cases; a severity and care-access signal.

• CHIRPS: A gridded rainfall dataset (from satellites + stations) used for drought and flood monitoring.

• ERA5 / ERA5-Land: Reanalysis datasets providing consistent weather and land-surface variables over decades.

• FEWS NET / IPC: Early-warning systems and a common scale to classify food insecurity.

• HAP: Household air pollution from solid-fuel stoves (e.g., wood, charcoal, dung).

• Human Footprint: Composite index of built-up areas, roads, lights and other pressures on ecosystems.

• Integrated Vector Management (IVM): Coordinated actions (LLINs, spraying, larval control) based on local vector ecology.

• JMP (WHO/UNICEF): Global monitoring program for water, sanitation and hygiene (WASH).

• LLIN/ITN: Long-lasting insecticidal nets / insecticide-treated nets to prevent mosquito bites.

• NDVI: Vegetation greenness index from satellites; a proxy for biomass/seasonality.

• One Health: Approach recognizing links among people, animals and the environment.

• PM2.5: Fine particles in the air (≤2.5 μm) that can harm lungs and hearts.

• Protected Areas (PA): Lands or waters managed for conservation (e.g., national parks).

• TPR (Test Positivity Rate): Share of diagnostic tests that are positive; helps detect outbreaks and monitor residual transmission.

## How to use this chapter

Pair maps with action. Use the indicators to target high-need woredas, schedule campaigns before seasonal peaks, strengthen facilities along key transport corridors, and protect nature in ways that also reduce floods, heat, and disease. Always check data quality, protect privacy, and involve communities in decisions.

## References & data portals (with URLs)


• **WHO/UNICEF Joint Monitoring Programme (JMP) — WASH data portal —** https://washdata.org/

• **DHS Program — survey methods and datasets —** https://dhsprogram.com/

• **UNICEF MICS — survey program and microdata —** https://mics.unicef.org/

• **CHIRPS rainfall dataset — Climate Hazards Center —** https://www.chc.ucsb.edu/data/chirps

• **TAMSAT African rainfall —** https://research.reading.ac.uk/tamsat/rainfall/

• **ERA5 & ERA5-Land — ECMWF reanalysis —** https://www.ecmwf.int/en/forecasts/datasets/browse-reanalysis-datasets

• **Global Surface Water Explorer — JRC —** https://global-surface-water.appspot.com/

• **HydroSHEDS (hydrology layers) —** https://www.hydrosheds.org/

• **ISRIC SoilGrids —** https://soilgrids.org/

• **ESA Climate Change Initiative — Land Cover —** https://climate.esa.int/en/projects/land-cover/

• **Global Human Settlement Layer (GHSL) — Copernicus —** https://human-settlement.emergency.copernicus.eu/

• **WorldPop gridded population —** https://www.worldpop.org/

• **Protected Planet / WDPA —** https://www.protectedplanet.net/

• **IUCN Red List of Threatened Species —** https://www.iucnredlist.org/

• **GBIF — biodiversity occurrence data —** https://www.gbif.org/

• **WHO GLASS — AMR surveillance —** https://www.who.int/initiatives/glass

• **UN-Habitat — Global Urban Indicators —** https://unhabitat.org/global-urban-indicators-database

• **World Bank — Ethiopia urban development (example portal) —** https://www.worldbank.org/en/country/ethiopia/overview

- **Federal Ministry of Health (Ethiopia) —** https://www.moh.gov.et/
- **Ethiopian Public Health Institute (EPHI) —** https://ephi.gov.et/
- **Ethiopian Meteorological Institute —** https://www.ethiomet.gov.et/

**Note: Replace any illustrative charts used in section files with official statistics before publication. Check license terms for each dataset.**