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Anthrax Surveillance and Analysis Protocol

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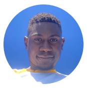
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We use this protocol and it's working

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Disclaimer

- Potential underreporting of anthrax cases in grey data sources.
- Variability in surveillance intensity across different regions.

Abstract

This study employs a systematic review and retrospective analysis to assess anthrax incidence, prevalence, and risk factors in Zimbabwe. Data were sourced from peer-reviewed literature, grey veterinary records from the Central Veterinary Laboratory (CVL), and geospatial analysis using GIS. Anthrax prevalence was estimated using weighted prevalence analysis, with a calculated regional prevalence of 17.33% across Zimbabwe, Kenya, Botswana, and Namibia. Logistic regression modelling was applied to examine climate influences, revealing a positive correlation (OR = 2.41, $p < 0.05$) between outbreaks and post-drought rainfall events. Spatial analysis identified high-risk zones in Midlands, Mashonaland Central, and Matabeleland North using the *Getis-Ord Gi hotspot detection method**. This methodology provides a reproducible framework for anthrax surveillance, incorporating epidemiological, statistical, and GIS-based approaches to inform climate-adaptive risk mapping and targeted intervention strategies.

Guidelines

1. Intended Use and Scope

✅ This protocol is designed for **researchers, epidemiologists, veterinarians, and public health officials** working on anthrax surveillance and analysis.

✅ It provides **step-by-step instructions** for **data collection, statistical modeling, GIS-based risk mapping, and climate-anthrax correlation analysis**.

✅ The methodology is applicable to **Zimbabwe and other anthrax-endemic regions** with similar ecological and epidemiological conditions.

2. Experimental Controls and Quality Assurance

✅ **Data Validation:** Cross-check anthrax incidence data from **peer-reviewed sources** and **grey literature reports** to ensure consistency.

✅ **GIS Accuracy:** Validate **hotspot mapping results** by comparing them with **historical outbreak records**.

✅ **Statistical Robustness:** Test logistic regression model sensitivity using **bootstrap resampling**.

✅ **Reproducibility Check:** Ensure that different analysts using the same dataset **obtain the same spatial and statistical results**.

3. Key Considerations Before Running the Protocol

⚠️ **Ethical and Data Access Considerations**

- If using laboratory-confirmed anthrax data, ensure **institutional review board (IRB) approvals** where required.
- Some datasets, such as **national disease surveillance reports**, may require permission from **government agencies** before access.

⚠️ **Common Pitfalls to Avoid**

- **GIS Mapping Errors:** Ensure that **spatial coordinate systems are correctly set** before overlaying anthrax case data onto base maps.
- **Statistical Model Assumptions:** Verify that data meets **logistic regression assumptions** (e.g., no perfect multicollinearity, balanced classes).
- **Climate Data Handling:** Climate raster data may need **pre-processing (e.g., resampling to uniform grid resolution)** before analysis.

4. Troubleshooting & FAQ

Q1: What if my GIS mapping outputs do not align with known anthrax outbreak locations?

✔️ Check that your **spatial reference system (SRS)** is set correctly (use WGS 84 projection for global datasets).

Q2: How do I validate my statistical results?

✔️ Run **bootstrap resampling** to confirm logistic regression output consistency.

Q3: How do I modify this protocol for another region?

✔️ Replace **Zimbabwe-specific datasets** with your local anthrax case records, rainfall/temperature data, and land-use maps.

5. Citation and Attribution

📌 **How to Cite This Protocol:**

"Researcher(s) Name, Year. 'Anthrax Surveillance and Analysis Protocol: A Statistical and GIS-Based Approach.'

Protocols.io, DOI: XXXX-XXXX."

📌 **How to Acknowledge Data Sources:**

- If using SILAB laboratory data, cite **Zimbabwe Central Veterinary Laboratory (CVL)**.
- Climate data must be cited according to **ERA5 Reanalysis Data (Copernicus Climate Change Service)**.

6. Versioning and Updates

🔄 This protocol will be updated **annually** to include **new anthrax surveillance techniques** and **advancements in spatial epidemiology methods**.

🔄 Users are encouraged to **comment and suggest modifications** to improve reproducibility and applicability.

Materials

1. Data

Sources and Input Datasets

These datasets are essential for conducting epidemiological,
statistical, and geospatial analyses.

	Anthrax Case Data (2013–2024)	Zimbabwe Central Veterinary Laboratory (CVL) SILAB Database	CSV, Excel
	Historical Anthrax Outbreaks	Peer-reviewed studies, Ministry of Health reports	CSV, PDF
	Climate Data (Rainfall, Temperature, Drought Index)	ERA5 Reanalysis, Zimbabwe Meteorological Services	NetCDF, CSV
	GIS Base Maps (Country Boundaries, Land Use)	OpenStreetMap, FAO GeoNetwork	SHP (Shapefile), GeoTIFF
	Soil & Vegetation Data	MODIS NDVI, FAO Soil Database	GeoTIFF, CSV
	Livestock Density Data	FAO, World Bank	CSV, Shapefile

*Ensure that all datasets are in the correct
format before analysis (e.g., coordinate systems in WGS 84 for GIS data).*

2. Software & Computational Tools

These tools are used for data processing,
statistical modeling, GIS mapping, and climate analysis.

	Statistical Analysis	R (StatsModels), Python (SciPy, Pandas), SPSS	Prevalence calculations, logistic regression
	GIS & Mapping	QGIS, ArcGIS, Google Earth Pro	Hotspot detection, spatial risk mapping
	Climate Data Processing	ERA5 Climate Toolbox, Python xarray	Extracting climate variables for modeling
	Data Cleaning & Management	Microsoft Excel, OpenRefine	Cleaning raw epidemiological and climate data

	Remote Sensing Analysis	Google Earth Engine (GEE)	Processing MODIS NDVI for vegetation mapping
	Visualization & Reporting	Tableau, Matplotlib, Seaborn	Graphing trends, spatial visualizations

Ensure Python and R packages are installed before running scripts (e.g., geopandas, matplotlib, xarray).

3. GIS Data

Layers for Spatial Analysis

These spatial datasets are used for risk mapping, outbreak clustering, and environmental correlation analysis.

	Administrative Boundaries	OpenStreetMap, FAO GeoNetwork	SHP, GeoJSON
	Population Density Data	WorldPop, UN Data	GeoTIFF, CSV
	Land Cover & Land Use Data	MODIS, FAO Land Cover Database	GeoTIFF
	Road & River Networks	OpenStreetMap, Hydrosheds	SHP, GeoJSON
	Livestock Movement Data	FAO Animal Movement Database	CSV, Shapefile
	Anthrax Case Locations	CVL, Ministry of Health	CSV, SHP

Ensure all GIS data is correctly georeferenced to avoid misalignment in mapping outputs.

4.

Computational Requirements

Due to large datasets and complex GIS processing, ensure the computational system meets these minimum specifications:

	Processor	Intel i7 or AMD Ryzen 7 (or better)
	RAM	Minimum 16GB (32GB recommended for GIS analysis)
	Storage	Minimum 500GB SSD (1TB recommended for large datasets)

	Graphics Card (for GIS Processing)	NVIDIA GTX 1650 or equivalent
	Operating System	Windows 10/11, macOS, or Linux (Ubuntu recommended)

For cloud-based processing, use Google Colab (for Python), Google Earth Engine (for remote sensing), or AWS EC2 (for GIS workloads).

5. Optional Resources (For Advanced Analysis & Machine Learning)

If applying **machine learning models** to predict future anthrax outbreaks, the following resources may be required:

	Deep Learning for Image Analysis	TensorFlow, PyTorch	Analyzing remote sensing images for anthrax risk mapping
	Climate-Anthrax Prediction Models	XGBoost, Random Forest	Predicting outbreak likelihood based on climate trends
	Big Data Processing	Google Cloud, AWS S3	Handling large datasets

Advanced modeling techniques require expertise in machine learning and high-performance computing (HPC) resources.

Safety warnings

1. Risk of Outdated Information

- **Warning**: Be cautious of using outdated studies, particularly in rapidly evolving fields such as public health and infectious diseases. Ensure the majority of your sources are from the **last 10-20 years**, unless historical context is necessary.

2. Reliability of Grey Literature

- **Warning**: While grey literature (such as dissertations, reports, and unpublished works) can offer valuable insights, it may lack the rigorous peer-review process found in published journals. Always critically assess the reliability and validity of these sources. 00:00:00

Ethics statement

Ethical Considerations: According to Zimbabwean guidelines, ethical approval was not needed for this animal-based review article. However, acknowledge all sources properly and avoid plagiarism.
When including unpublished studies or grey literature, ensure appropriate permissions are obtained

Before start

The protocol can be edited to better suit your literature search criteria.

Study Design

1

- **Type:** Systematic review and retrospective analysis.
- **Study Period:** 2013–2024.
- **Scope:** Evaluation of anthrax prevalence in **livestock, wildlife, and human cases**.
- **Primary Outcomes:** Identification of anthrax hotspots, climate-related outbreak patterns, and policy intervention areas.

Materials & Resources

2 **Data Sources:** Peer-reviewed publications, grey literature from veterinary databases.

3 **Software & Tools:**

- Statistical analysis: **R, SPSS, Python (SciPy, StatsModels)**.
- GIS mapping: **QGIS, ArcGIS**.
- Climate data: **ERA5 Reanalysis, Zimbabwe Meteorological Services data**.
- Disease surveillance: **SILAB Veterinary Laboratory Database**

Data Collection

4 **Literature Review**

4.1 **Databases Used:** PubMed, Web of Science, JSTOR, AGRICOLA, HINDARI, Google Scholar, Scopus.

4.2 **Search Terms:** "Anthrax", "Zimbabwe", "livestock anthrax", "wildlife anthrax", "zoonotic diseases", "Bacillus anthracis", "transboundary disease".

4.3 **Inclusion Criteria:** Peer-reviewed studies on anthrax in Zimbabwe (2013–2024). Reports on livestock, wildlife, and human anthrax cases. English language publications.

4.4 **Exclusion Criteria:** Studies without outbreak data. Environmental studies lacking direct epidemiology insights.

5 **Grey Data Collection from the Central Veterinary Laboratory (CVL)**

5.1 **Source:** Zimbabwe's **National Veterinary Laboratory (SILAB database)**.

5.2 **Data Extracted:** Anthrax-positive cases in livestock, wildlife, and humans. Sample types: swabs, spleen, soil, tissue. Geographic and temporal distribution of cases.

Statistical Analysis

6 **Prevalence Calculation:** Prevalence = (Positive Cases / Total Cases) x 100

7 **Weighted Prevalence Analysis**

7.1 To compare anthrax trends in Zimbabwe, Kenya, Botswana, Namibia, a weighted prevalence was calculated: Weighted Prevalence = å (Prevalence x Weight)

7.2 **Weighting Factor:** (Sample size of each region) / (Total sample size across regions).

8 **Confidence Interval Estimation**

8.1 Wilson Score Interval for 95% CI:

$$\mathrm{CI} = \frac{X + z^2/2N \pm z\sqrt{\frac{X(N-X)}{N} + z^2/4N^2}}{N + z^2/N}$$

Where:
- X = Positive cases.
- N = Total cases.
- z = 1.96 (for 95% CI).

9 **Logistic Regression for Climate-Anthrax Relationship**

9.1 Model:

$$\log\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1(\text{rainfall}) + \beta_2(\text{temperature}) + \beta_3(\text{drought index})$$

Dependent Variable: Anthrax outbreak occurrence (Binary: 1 = outbreak, 0 = no outbreak).

Independent Variables: Rainfall (mm), Temperature (°C), Drought Index (SPI)

10

Geospatial Analysis & GIS Mapping

11 **GIS-Based Spatial Analysis**

Software: QGIS, R

12 **Hotspot Detection:** Getis-Ord Gi* statistic:

$$G_i^* = \frac{\sum w_{i,j} x_j - \bar{X} \sum w_{i,j}}{S\sqrt{\frac{n \sum w_{i,j}^2 - (\sum w_{i,j})^2}{n-1}}}$$

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- **Ministry of Health and Child Care, Zimbabwe** – For epidemiological records and disease control strategies.
- **Zimbabwe Meteorological Services Department** – For climate datasets used in the study.

Data and Technical Support

- **Google Earth Engine (GEE)** – For remote sensing and vegetation analysis.
- **OpenStreetMap & FAO GeoNetwork** – For GIS base maps and administrative boundary data.
- **R & Python Open-Source Communities** – For providing statistical modelling and spatial analysis tools.

Acknowledgement of Local Communities & Field Researchers

- Special thanks to field veterinarians, epidemiologists, and data collectors who contributed to anthrax surveillance in rural Zimbabwe.
- Gratitude to local livestock farmers and community health workers for reporting cases and providing field data.

Software and Computational Resources

- **QGIS & ArcGIS Teams** – For GIS spatial analysis support.
- **Google Colab & AWS EC2** – For computational resources in large-scale climate-anthrax modelling.
- **Scikit-learn & TensorFlow Developers** – For machine learning tools used in predictive outbreak modelling.

Final Statement of Integrity

We affirm that all data sources, methodologies, and collaborations have been fully acknowledged to maintain scientific integrity, transparency, and credibility. This protocol follows the principles of open science and FAIR data practices (Findable, Accessible, Interoperable, and Reusable).

For any enquiries or collaborations related to this protocol, please contact
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