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Authors:	Nicola Ferrè, Matteo Mazzucato, Paolo Mulatti, Federica Sbettega
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TECHNICAL GUIDANCE TO TRANSFER ZONE GEOSPATIAL DATA

This guidance has been developed to assist GIS technicians, staff of NVS/VMO, and staff of Live Animal Import/Export Unit in creating, transferring, and acquiring zone geospatial information defined according to the GeoZone data specification. Specifically, it defines the organizational model to (i) organize a protocol for transferring zone geographical data and (ii) outline formatting and content requirements for transferring zone geospatial dataset to WOAH or to another partner.

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Acronyms

GIS: Geographic Information System

NVS: National Veterinary Services

VMO: Veterinary Medical Officer

WOAH: World Organisation for Animal Health

Disclaimer

The views expressed in this document are those of the authors and do not necessarily reflect the views or policies of WOAH.

Abstract

Chapter 4.4 of the WOAH Terrestrial Code outlines how zones can be used by Members to establish animal subpopulations with specific health statuses for the purposes of international trade, disease prevention, or disease control. However, the Code does not provide guidance on how to geographically represent these zones or how to effectively communicate zone information to other Members.

To address this gap, the WOAH project, GeoZone, has developed a data model for geographically representing zones and has provided a series of use cases designed to support Members establish protocols for transferring zone data to trade partners. This document describes these use cases in detail.

The primary objective of these use cases is to identify situations in which a Member needs to transfer zone data structured according to the GeoZone data model and to propose potential solutions for organizing this data transfer. These solutions are presented as logical frameworks, with their practical implementation depending on the specific technologies and organizational structures available to each Member.

Preface

The GeoZone data model is detailed in the “GeoZone - Data Product Specification” document, available at the GeoZone website[1]. This data model provides guidelines for representing zones from a geographic perspective and includes a set of attributes useful for inventorying zones and facilitating their identification, classification, and exploratory visual analysis. The model specifies the geometrical, spatial, and temporal representation of zones, along with a comprehensive list of attributes. Each attribute is clearly defined both syntactically and semantically to ensure consistent and interpretable data exchange. This enables trade partners to process and seamlessly integrate the information into their decision-making frameworks. The data model is described by using the Unified Modelling Language (UML) as required by the ISO TC211 – Geomatics family of standards. UML is a standardized visual language used to describe, specify, design, and document the structure and behaviour of information systems. However, due to their complexity and specificity, interpreting UML models typically requires Information Technology (IT) expertise. To make the GeoZone data model accessible to non-IT experts, physical implementation in ESRI shapefile encoding format has been included in the data specification document, alongside implementations in the GeoPackage data format. Additionally, an ESRI File geodatabase format has been developed and is available on the GeoZone website.

While the data model defines how to represent a zone in compliance with GeoZone, it does not specify how to create a dataset for transfer to a Member or how to execute the transfer itself. To address this, the technical guidance provided in this document has been developed.

The purpose of this technical guideline is to provide practical examples of how to organize a protocol for creating a zone dataset, encoding it in a recognized format, and generating a metadata "envelope" containing descriptive information about the dataset. This dataset can be then transmitted to another Member, who can acquire and process it using GIS software. This guidance uses the technique of use cases, a detailed description of a specific methods for using a system, tool, or process to achieve a particular goal. In this document, use cases are employed to demonstrate practical scenarios and offer structured, step-by-step examples, helping users understand how to apply protocols or workflows in real-world situations. These use cases are presented with a practical-logical focus rather than a practical-implementative one. Creating fully implementative case studies would require a defined technological context, which cannot be generalized across all Members. Instead, the use cases provide a flexible framework that can be adapted to various technological contexts and infrastructures.

[1] http://gis.izsvenezie.it/cooperation/woah/geozone/specification.php

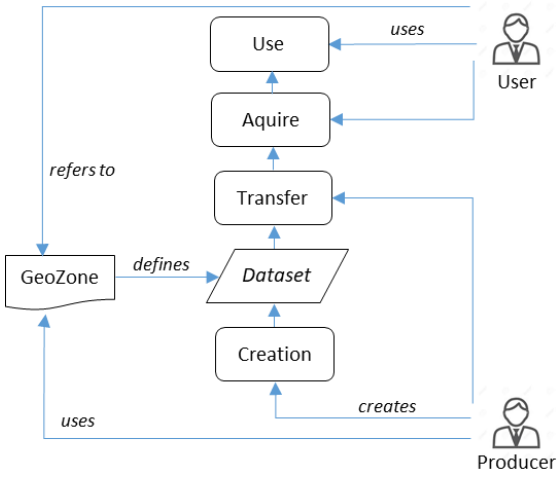
Basic Information of GeoZone

What is GeoZone?

GeoZone is a data model designed to provide a detailed description of the geospatial characteristics of zones, as defined in Chapter 4.4 of the WOAH Terrestrial Code. It also includes additional information to facilitate the transfer of zone data to a trade partner.

Why should we use GeoZone?

GeoZone helps overcome semantic and syntactic barriers in the representation of zone geospatial data, making them accessible to trade partners using GIS software. The GeoZone data model serves as a schema for storing zone geospatial data, allowing partners to describe their zone datasets, or specify their requirements. In essence, GeoZone ensures the accurate transfer of geospatial zone data between partners, reducing misinterpretation. Additionally, it supports integration with existing systems for managing zone data, providing a standardized foundation for describing the characteristics of zones.



What are the benefits of adopting the GeoZone framework?

Adopting the GeoZone data model and its associated data transfer protocols provides several advantages for managing and sharing zone data. GeoZone establishes a common language and set of standards for zone data, ensuring consistency in information shared with trade partners and other Members. By standardizing the format, structure, and semantics of zone data, GeoZone minimizes misinterpretation and data errors during transfer. This clarity in data representation facilitates the establishment of reliable, geospatially-defined health zones, enhancing disease monitoring, control, and eradication efforts. The framework integrates seamlessly with both existing and new GIS solutions, enabling the use of zone data not only for trade purposes, but also for effective disease response and control.

What are the specific geospatial characteristics that GeoZone describes?

GeoZone describes the following geospatial characteristics:

- Geographical extent: The zone's geographical limits, delineated using natural landmarks and/or administrative boundaries, enabling the creation of detailed maps.
- Disease: The specific disease for which the zone was established.
- Type of zone: The category of the zone established by the country. WOAH, in Chapter 4.4 of the Terrestrial Code, identifies four types of zones (i.e., free, protection, infected, containment). However, other types of zones can also be established for disease control or trade purposes.
- Validity period: The duration for which the zone is effective.
- Control measures: The measures implemented within the zone (e.g., surveillance and monitoring, movement restriction, etc.)
- Accuracy: For certain data providers and zone types (e.g., infected zones, containment zones), confidentiality regarding geographical boundaries may be required. In such cases, approximate zone boundaries can be represented.
- Zone Status: Applicable only to free and protection zones and for diseases AHS, BSE, CSF, CBPP, FMD, and PPR. This specifies whether the zone has a proposed status or is officially recognized by WOAH.

What features of GeoZone simplify the process of data sharing and communication between Members?

GeoZone incorporates data formats and semantic and syntactic structures to streamline data sharing and interpretation among different partners.

- Standardized data formats: Using standardized formats ensures data are stored and exchanged consistently, reducing the risk of errors and ensuring compatibility across different GIS software. The standardized formats implemented and tested for GeoZone include:
  - Shapefile: A widely accepted format for vector data in GIS, ensuring easy sharing across various software systems.
  - GeoPackage: An open standard designed for seamless data exchange, supporting both vector and raster data in a single file.
  - ESRI file geodatabase: A proprietary database format developed by ESRI for efficiently storing, managing, and analyzing large volumes of geographic data, enabling advanced geospatial analysis and modelling in ESRI's ArcGIS software.
- Semantic[2] and syntactic[3]: These structures define the meaning and interpretation of data. By clarifying the semantics of the features that describe zones, GeoZone uses consistent terms and definitions across systems and Members. This approach helps prevent misunderstandings and inconsistencies when sharing and interpreting data.
- Streamlined data sharing: The use of standardized formats and semantics simplifies the process of sharing and uploading data, minimizing the time and effort required to prepare and exchange information. For example, if partner A transfers zone data to partner B using the GeoZone data model and in a format such as GeoPackage, partner B, using the same data structure, can directly access and use the data for cross-border trade evaluations without needing to convert or reformat it.
- Easier data Interpretation: Standardized formats and semantics help users with differing levels of GIS expertise interpret the data accurately. For example, an organization analyzing disease zones in two different countries can easily compare zone data because both countries use the GeoZone data model, ensuring consistent definitions for boundaries, health statuses, and other geospatial features.

In what ways does GeoZone enhance the accuracy and reliability of zone data transfer?

GeoZone enhances data accuracy and reliability by utilizing well-defined formats and semantics, which minimize errors during data transfer. Through standardized data formats and clearly defined semantic and syntactic structures, GeoZone improves the data consistency (uniform representation of data across partners) and reliability (accurate and trustworthy data for informed decision-making) when shared between partners.

For example, when partner A needs to transfer data about disease-free zones to partner B for trade purposes, inconsistent formats, local coordinate systems, or incompatible attribute naming could lead to errors. GeoZone eliminates these issues by enforcing: uniform zone boundaries (e.g., using WGS 84 coordinate system), consistent attribute names, such as "zoneType", or "localIdentifier", or "designationPeriod", formats (i.e., date formats as "YYYY-MM-DD"), and a standardized file format (e.g., GeoPackage, Shapefile). This allows partner B to process zone data from partner A without additional conversions.

[2] In GIS, semantics refers to the meaning and interpretation of geographic data, emphasizing the content and the concepts that the data represent for the Information Community using the terms. It involves understanding what the data elements signify and ensures that data from different sources are interpreted consistently.

[3] Syntactic refers to the structure, format, and rules that govern how data are stored and organized in GIS. It focuses on the technical format and syntax of the data—how they are encoded, structured, and processed by software, rather than their meanings.

What training or IT expertise is required for users to effectively implement and utilize GeoZone?

Users with basic GIS knowledge and an understanding of zone data management concepts can effectively use GeoZone. The GeoZone website provides access to technical support, training materials, and documentation, ensuring users can successfully implement the data model.

Can GeoZone be considered as a possible standard for zone geospatial data communication?

Yes, GeoZone can be considered a potential standard for zone geospatial data communication. It employs standardized formats and well-defined structures to enhance the clarity and intelligibility of zone-related information. GeoZone complies with ISO TC211 standards, which are internationally recognized benchmarks for geospatial data management and interoperability. Additionally, GeoZone supports multiple encoding formats, including ESRI shapefile, GeoPackage, and ESRI file geodatabase, further ensuring broad usability and acceptance.

How are zone data transferred?

Zone data are transferred using the "GeoZone package", a compressed file containing multiple files that GIS technicians can use for mapping and spatial analysis.

The GeoZone package contains:

- Zone shapefile: A set of ESRI shapefiles containing zone geospatial data, serving as a template for the GeoZone data model and having dictionaries for data insertion.
- Metadata: A metadata file with descriptive information about the zone dataset, also serving as a template.

Documentation, accessible via the GeoZone website (GeoZone Website), supports the transfer process. Key resources include:

- Data product specification: A document outlining the content of the zone shapefile data.
- Technical guidance: A document detailing the procedures for preparing the zipped zone file for transfer.
- GeoZone training course: A course designed to introduce the GeoZone framework, alternating between theoretical discussions on ISO TC211 and practical examples.

Can GeoZone be used for purposes beyond international trade?

Yes, GeoZone is highly versatile and supports more than just international trade. It is invaluable in zoning for disease response, allowing Members to effectively delineate and manage zones during outbreaks. This includes identifying infected and containment zones, implementing targeted control measures, and responding swiftly to animal health threats. GeoZone thus enhances trade facilitation and disease management efforts.

Do I need to discard my current system to adopt GeoZone?

No, adopting GeoZone doesn't require discarding your current system. GeoZone provides a standardized framework that can often be integrated with existing systems. Adjustments may involve adding or modifying elements of your current setup to align with GeoZone standards. This approach allows you to retain your existing infrastructure while benefiting from GeoZone's consistency and interoperability for data exchange.

What should I do if I don't have a system for managing zone data?

If you don't have a system for managing zone data, you can set up a straightforward data management process aligned with the GeoZone data model. Follow these steps:

1. **Choose GIS software**. Start by selecting GIS software. If you already have GIS software in use, continue with it. If not, you can choose between free options (e.g., QGIS) and paid options (e.g., ESRI ArcMap).
2. **Follow the GeoZone data model**. Use the GeoZone documentation to structure your feature data. You can download feature templates directly from the GeoZone website. Options include using a

straightforward ESRI shapefile or a more advanced database format, like GeoPackage or an ESRI file geodatabase.

3. **Organize a data collection protocol**. Form a team including GIS technicians, personnel from the import/export unit, and National Veterinary Service (NVS) or Veterinary Medical Officer (VMO) staff. Together, define a protocol for collecting, storing, and validating zone data.
4. **Establish a protocol to create zone datasets for transfer**. Follow the recommendations in this technical guide to use GIS software tools for creating the dataset and preparing the "package" for transfer to the Member partner.

In addition to supporting international trade, the described GIS solution can also be a valuable tool for disease response, eradication, and control efforts. By organizing and visualizing zone data according to the GeoZone model, the system enables the mapping of information on disease-affected or disease-free areas, which is essential during outbreaks or control efforts. Implementing this GIS solution can, thus, provide a dual benefit: supporting international trade requirements and strengthening the ability of national and regional authorities to respond promptly and effectively to animal health threats.

What are the potential costs associated with implementing GeoZone?

The cost of implementing GeoZone depends on the resources a Member already has. For Members with an existing GIS system and trained personnel, costs may be limited to adapting current workflows and ensuring data align with the GeoZone model. For those without GIS tools, initial expenses might include acquiring GIS software (with free options like QGIS available and paid options like ESRI ArcMap offering advanced features) and training personnel to manage and maintain zone data in line with the GeoZone framework. However, the investment in GeoZone can often lead to long-term savings by reducing errors, streamlining data transfer, and improving overall efficiency in managing and sharing zone data.

Use cases

The use cases are built around the scenario where a Member uses GeoZone to transfer information about a set of zones, intending to update a trade partner on the health status of animal populations or sub-populations within its territory. In this context, the exporting country refers to the Member preparing and transmitting the dataset containing the zones, while the importing country refers to the Member receiving the dataset for evaluation, often in the context of bilateral agreement negotiations.

The transfer process consists of three steps:

1. The exporting country prepares the zone dataset according to specific criteria (e.g., active infected zones for a particular disease, active free zones for a specific species, and protection zones for a given disease within the past year).
2. The exporting country organizes the dataset following GeoZone specifications and transmits it via email or makes it available through FTP, depending on available IT infrastructure.
3. The importing country receives the dataset and processes it using GIS software (e.g., QGIS, ArcMap) for various purposes such as creating choropleth maps or conducting exploratory spatial analysis.

The outlined transfer process can occur in four primary scenarios, depending on the exporting country's system for managing zone data:

- No system in place for managing zones;
- A system in place that manages zones contains information that conforms to the GeoZone data model;
- A system in place for managing zones that does not conform to the GeoZone data model;
- A system in place that only manages infected and containment zones.

The first scenario (*I currently lack a GIS specifically designed to manage geospatial data for zones*) involves the partner equipping itself with a GIS solution that uses the GeoZone data schema and related dictionaries as features. The GeoZone data encoding formats (i.e., ESRI shapefile, GeoPackage, ESRI file geodatabase) are available on the GeoZone website.

The second scenario (*I already have a GIS in place to manage geospatial data for zones that complies with the GeoZone data model*) focuses on the need to extract data from the zone management system, transform them to the GeoZone schema, and create the dataset for transfer.

The third scenario (*I currently possess a GIS designed for managing zone data; however, it is not compliant with the GeoZone data model*) highlights the need to integrate the existing system's information with the additional information required by the GeoZone data model. This integration process could involve the types of zones (e.g., the system only manages infected zones) and/or their attributes (e.g., the system does not address measures information).

An additional scenario developed is dedicated to using the zone data received from a trade partner (*I have acquired the zone dataset from a trading partner and am currently working on developing a thematic map to illustrate the partner's animal health status*).

I currently lack a GIS specifically designed to manage geospatial data for zones.

Your organization does not have a GIS or an information system dedicated to manage zone geospatial data. The intention is to develop a QGIS project based on the GeoZone data model.

Case study – Creating a QGIS[4] project to manage zone data compliant with GeoZone data model

Actors	- **GIS technician**: Person with GIS expertise responsible for implementing the GIS project. - **Staff of NVS/VMO**: Person (or team) involved in zone establishment and management, and who collaborates with the GIS technician to create, update, and modify zone geospatial data.
Goals	- Create the zone GIS project. - Use the GeoZone shapefile[5] for storing zone geospatial data. - Manage and export the area of interest along with various attributes following the GeoZone dictionaries.
Description	The GIS technician is responsible for implementing the GIS project, focused on managing zone data as outlined in Chapter 4.4 of the WOAH Terrestrial Code. This zone data will be used for creating zone maps and transferring geospatial information to other Members. The technician should use a tool that simplifies the management of zone entries, attributes, and data exportation, as well as provide corresponding metadata.
Pre-condition	- The GIS technician already has installed QGIS software. - A QGIS plugin software dedicated to manage zone geospatial data according to the GeoZone data model is available in the QGIS plugin official repository. - The GIS technician is capable of installing the QGIS plugin from the official repository. - The Staff of NVS/VMO already has a protocol for defining zones.
Post-condition	- Zones are ready for use in GIS projects or for transfer to WOAH or partners. - A dedicated GeoZone folder is created in the home directory to store exported zip files.
Successful scenario	The zone GIS project has been successfully implemented, and zone geospatial data are stored in the zone file ready for use.
Steps	
Step 1: Preparing for changes	The GIS technician, who has competences in QGIS, starts by ensuring that all necessary tools are in place: 1. QGIS installation: The GIS technician confirms the latest version of QGIS is installed. 2. GeoZone plugin setup: From the QGIS plugin repository, the GeoZone plugin is downloaded and installed; the plugin is designed specifically to manage zone geospatial data according to the GeoZone model. 3. GeoZone folder creation: A dedicated folder is set up in the home directory to store GeoZone exports, ensuring all outputs are organized for future use.

[4] This refers to a QGIS solution integrated with a custom-developed QGIS plugin. Other solutions based on different GIS software (e.g., ESRI ArcMap) are also possible. A demo of a potential QGIS plugin dedicated to the GeoZone framework, along with a demo of an ArcMap project optimized for GeoZone feature types, is available on the GeoZone website.

[5] The solution using GeoPackage and ESRI file geodatabase formats (limited to ESRI software like ArcMap) is always feasible, as the three formats are compatible in terms of content.

I currently lack a Geographic Information System specifically designed to manage geospatial data for zones

	Meanwhile, the Staff of NVS/VMO, who is familiar with their organization's zone protocols, provides the parameters and boundaries for the zones to be created.
Step 2: Project creation	1. Start the project: The GIS technician opens QGIS and creates a new project titled Zone Management, and saves it in the designated folder for organizational purposes. 2. Define the table of context: The GIS technician creates the base layers by importing existing geospatial data.
Step 3: Data management	1. Create zone features: Using the GeoZone plugin, the GIS technician starts to create the zone polygon (e.g., draws the buffer, selects municipalities). 2. Add zone attributes: The GIS technician collaborates with Staff of NVS/VMO to input details for the zone directly in QGIS using the GeoZone plugin's user-friendly interface. 3. Quality assurance: After entering all data, the GIS technician reviews the zone features for accuracy, ensuring that zone boundaries align with the background maps and that attributes are complete.

Case study – Managing zone data

Actors	- **GIS technician**: Person with GIS expertise responsible for implementing the GIS project. - **Staff of NVS/VMO**: Person (or team) involved in zone establishment and management, and who collaborates with the GIS technician to create, update, and modify zone geospatial data.
Goals	Manage the zone to generate maps and create a dataset for transfer to a Member.
Description	A GIS technician is responsible for managing zone data. Possible actions include: - Creating a new zone (already described in the "Creating a QGIS project to manage zone data compliant with GeoZone data model" case study). - Closing a zone (by updating the end validity period). - Modifying zone information (by extending or reducing zone boundaries, changing control measures, adjusting zone status, or altering geographical names). - Replacing any incorrect values associated with the zone. - Deleting zones that were mistakenly included.
Pre-condition	- The GIS technician has received instructions from NVS/VMO to create, close, or modify a zone, or replace values, or delete a zone. - The GIS technician has sufficient experience with QGIS tools and the GeoZone QGIS plugin. - The Staff of NVS/VMO has a protocol in place for updating, changing, replacing, and deleting zone values.
Post-condition	- The data have been created, updated, changed, or deleted, and the data quality has been verified.
Successful scenario	The zone geospatial dataset is ready for use in creating maps or for transfer to a partner.
Steps	
Step 1: Receiving instructions	The Staff of NVS/VMO identifies a need to update the zone dataset. This might involve: • Closing a zone due to changes in disease status. • Modifying boundaries to reflect updated epidemiological data. • Correcting errors in attributes or geographical representation.

I currently lack a Geographic Information System specifically designed to manage geospatial data for zones

	The staff of NVS/VMO provides detailed instructions to the GIS technician, outlining the specific changes required, including any supporting documentation like updated maps or new regulations.
Step 2: Preparing for changes	1. Load the zone project: The GIS technician opens the Zone QGIS project and ensures the latest version of the zone feature (e.g., geozone.shp) is loaded. 2. Create Backup: Before making changes, the GIS technician creates a backup of the existing feature to safeguard against accidental data loss or errors.
Step 3: Implementing updates	The GIS technician uses the QGIS search tool to find the zone to manage and then uses the QGIS tools to carry out the required actions: 1. Close zones (if a zone needs to be closed): The GIS technician updates the end validity period in the attribute table. 2. Modify zone boundaries (if boundaries need adjustment): The GIS technician uses QGIS editing tools to extend or reduce the zone polygon. 3. Modify zone information (if zone attributes like zone status or control measures require updates): The GIS technician makes changes to attributes directly in the feature attribute table. 4. Delete mistakenly added zones (if zones were mistakenly created): The GIS technician deletes the polygon from the feature using QGIS tools.
Step 4: Quality assurance	Once the updates are complete, the GIS technician performs a quality assurance check: 1. Validate Geometry: The GIS technician ensures polygons are closed, non-overlapping, and error-free. 2. Check Attribute consistency: The GIS technician confirms that all required fields are filled in correctly and adhere to GeoZone standards.

Case study – Create a zone dataset to transfer to a Member

Actors	- **GIS technician**: Person with GIS and IT competencies responsible for managing the GeoZone GIS project. - **Live Animal Import/Export Unit:** Person (or team) responsible for providing zone spatial information to a trade partner Member.
Goals	Generate a zone shapefile according to the GeoZone data model for transfer to another partner.
Description	A partner needs to transfer a zone dataset to another partner. The Live Animal Import/Export Unit informs the GIS technician of the specific set of zones that need to be transferred. The GIS technician selects the relevant zones and creates the GeoZone package. This package is then made accessible to the Live Animal Import/Export Unit for transfer.
Pre-condition	- The GIS technician has an existing GIS project for managing zone geospatial data according to the GeoZone data model. - The GIS technician has a procedure in place for generating the GeoZone package. - The Staff of NVS/VMO is aware of which zones needs to be transferred.
Post-condition	The GeoZone package has been created.
Successful scenario	The zone shapefile and its corresponding metadata file are properly structured within the GeoZone package and are ready for transfer to another member.
Steps	
Step 1: Receiving instructions	The Live Animal Import/Export Unit receives a request from a trade partner for specific geospatial data. The Unit staff identify the zones that need to be shared and inform the GIS technician about the list of zones to be included in the dataset.

I currently lack a Geographic Information System specifically designed to manage geospatial data for zones

Step 2: Preparing for changes	1. Load the zone project: The GIS technician opens the Zone QGIS project and ensures the latest version of the zone feature (e.g., geozone.shp) is loaded. 2. Verify zone data: Before proceeding, the GIS technician checks the zone data for: • Accuracy of attributes (e.g., validity periods, control measures). • Geometry errors, ensuring polygons are valid and follow GeoZone standards.
Step 3: Selecting zones	1. Selection: By using the QGIS tools, the GIS technician selects the zones (e.g., filter on the attribute table, manual selection). 2. Review the selection: The GIS technician reviews the selection by checking the attribute table or by printing a map that is used for a visual check.
Step 4: Exporting the GeoZone package	The GIS technician uses the GeoZone plugin to export the selected zones as a shapefile (geozone.shp) and compile the related dataset metadata. Finally the GeoZone plugin creates the compressed package (i.e., ZIP file) that contains the geozone.shp shapefile and the metadata.
Step 5: Quality assurance	The GIS technician ensures the GeoZone package is complete, error-free, and adheres to the agreed standards and data transfer protocol. The package is then shared with the Live Animal Import/Export Unit, typically via a secure file-sharing platform or email.
Step 6: Data transfer	The Live Animal Import/Export Unit reviews the package. The package is sent to the requesting trade partner, along with any necessary explanations or documentation.

I already have a GIS in place to manage geospatial data for zones that complies with the GeoZone data model.

I already have a GIS in place to manage geospatial data for zones that comply with the GeoZone data model.

Your organization already has a system for managing zones geospatial data. The objective is not to modify this existing system but to extract, transform, and organize the stored zone geospatial data to ensure they are compatible with the GeoZone data model standard before sharing the data with WOAH or a partner.

This process involves schema matching, which identifies correspondences or relationships between elements of two data schemas, enabling the alignment of attributes for effective data integration or comparison.

The key steps in the schema matching process are:

1. Schema analysis: The staff of NVS/VMO and the GIS technician collaboratively review both the GeoZone structure (the *target* schema) and the local system (the *source* schema), including names, data types, and semantics.
2. Attribute correspondence: The staff of NVS/VMO identifies correspondences between attributes in the source and target schema. For example, they could match the "pathogen" field in the source schema to the "disease" field in the target schema.
3. Data type compatibility: The GIS technician ensures compatibility between source and target data types (e.g., strings, integers, dates).
4. Attribute matching: Staff of NVS/VMO and the GIS technician map individual attributes from the source schema to the target schema, taking into account naming conventions, semantics, and structural differences.
5. Transformation rules: The GIS technician defines rules for transforming source data to match the GeoZone schema.

Case study – Develop the schema matching between the local system and the GeoZone data model

Actors	- **GIS technician**: Person with GIS and IT competencies responsible for implementing the schema matching process. - **Staff of NVS/VMO**: Person (or team) with expertise in the information handled by the local information system dedicated to zone management from a semantic perspective.
Goals	Develop a schema matching process dedicated to extract, transform, and create a zone dataset compliant with the GeoZone data model.
Description	The GIS technician needs to define the attribute matching and the transformation rules between the information handled by the local information system dedicated to zone management and the GeoZone data model. For the development of schema matching, the GIS technician has the support from the staff of NVS/VMO to identify the semantic correspondence between attributes.
Pre-condition	- The Staff of NVS/VMO knows the information handled by the local information system dedicated to zone management from a semantic perspective. - The Staff of NVS/VMO is familiar with the GeoZone data model. - The GIS technician can query, extract, and transform the local data according to the attribute correspondence defined by the staff of NVS/VMO.
Post-condition	The GIS technician has defined the attribute matching and the transformation rules.
Successful scenario	Through the schema matching process, the GIS technician successfully generates a GeoZone-compliant shapefile.

I already have a GIS in place to manage geospatial data for zones that complies with the GeoZone data model.

Steps	
Step 1: Preparing for changes	1. Understand the GeoZone data model: The GIS technician and Staff of NVS/VMO review the GeoZone data model to understand its structure, attributes, and data types. 2. Review the local system schema: The GIS technician and Staff of NVS/VMO analyze the structure and semantics of the local geospatial data system, documenting attributes, data types, and existing relationships. 3. Knowledge sharing: A workshop or meeting facilitates the GIS technician and Staff of NVS/VMO to align their understanding of both schemas.
Step 2: Schema mapping	1. Schema mapping: The GIS technician and Staff of NVS/VMO identify correspondences between attributes in the local system (source schema) and the GeoZone model (target schema). 2. Data type compatibility: The GIS technician and Staff of NVS/VMO verify that data types between the source and target schemas align or can be converted without data loss 3. Attribute matching: The GIS technician and Staff of NVS/VMO define how data will be transformed to match GeoZone requirements. This could include: • Renaming attributes. • Reformatting data (e.g., converting dates, converting coordinate reference systems). • Aggregating or splitting fields (e.g., combining city and state fields into the geographic name attribute)
Step 3: Extraction queries	Develop extraction queries. The GIS technician writes SQL queries or scripts to extract data from the local system based on the defined schema mappings.
Step 4: Validation	1. Validate dataset with NVS/VMO staff: The GIS technician shares the transformed dataset with NVS/VMO staff for semantic and structural validation. Any mismatches or discrepancies are adjusted based on feedback. 2. Final quality check: Staff of NVS/VMO verify geospatial integrity (e.g., no missing boundaries, correct coordinate reference system). Ensure all required attributes are populated and meet GeoZone standards.

Case study – Extracting, transforming, and creating the zone dataset for transfer to a partner

Actors	- **GIS technician**: A person with GIS and IT competencies responsible for managing the GeoZone GIS project. - **Live Animal Import/Export Unit:** A person (or team) that needs to provide zone spatial information to a trade partner.
Goals	Generate a zone shapefile according to the GeoZone data model for transfer to a partner.
Description	A partner is required to transfer a zone dataset to another partner. The Live Animal Import/Export Unit notifies the GIS technician of the specific zones that need to be transferred. The GIS technician selects the zones and activates the schema matching process to generate the zone dataset. The GIS technician then creates the GeoZone package and makes it accessible to the Live Animal Import/Export Unit for transfer.
Pre-condition	- The GIS technician has a schema matching process in place to generate a dataset compliant with the GeoZone data model. - The GIS technician has a procedure to generate the GeoZone package. - The Staff of NVS/VMO knows which zones need to be transferred.

I already have a GIS in place to manage geospatial data for zones that complies with the GeoZone data model.

Post-condition	The GeoZone package, including a shapefile and metadata, is created and ready for transfer.
Successful scenario	The zone shapefile and its corresponding metadata file are structured within the GeoZone package and are ready for transfer to a partner.
Steps	
Step 1: Receiving instructions	The Live Animal Import/Export Unit receives a request from a trade partner for specific geospatial data. They identify the zones that need to be shared and inform the GIS technician about the list of zones to include in the dataset.
Step 2: Selecting zones	1. Selection: By using the system tools, the GIS technician selects the zones (e.g., filter on the attribute table, manual selection). 2. Review the selection: The GIS technician reviews the selection by checking the attribute table or by printing a map that is used for a visual check.
Step 3: Generating the GeoZone package	By using the schema matching protocol, the selected zones are exported as a shapefile (geozone.shp), the related dataset metadata is compiled, and finally, the compressed package (i.e., ZIP file) that contains the geozone.shp shapefile and the metadata is created.
Step 4: Quality assurance	The GIS technician ensures the GeoZone package is complete, error-free, and adheres to the agreed standards and data transfer protocol. The package is then shared with the Live Animal Import/Export Unit, typically via a secure file-sharing platform or email.
Step 5: Data transfer	The Live Animal Import/Export Unit reviews the package. The package is sent to the requesting trade partner, along with any necessary explanations or documentation.

I currently possess a GIS designed for managing zone data; however, it is not compliant with the GeoZone data model.

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Your organization currently has a system for managing zones, but it is not fully compliant with the GeoZone data model. Two types of mismatches can be present, either individually or together: 1) the system manages only one or two types of zones (i.e., infected and containment zones), and/or 2) the system lacks some of the information required by the GeoZone data model.

You are, therefore, faced with a situation where it is necessary to integrate the current system with the missing information. The integration can be done in two ways:

a) Extending or modifying the data schema and organizational model of the current system to include all the required GeoZone data;
b) Creating a "parallel" GIS application to manage the missing information.

The two solutions cannot be generalized according to the case study framework used above, as their implementation heavily depends on the operational situation of the local system dedicated to managing zone data.

Extending the current system's data schema

The approach involves enhancing the data schema and updating the associated organizational processes. While it incurs systems updates, it ensures seamless integration of the required attributes and long-term operational efficiency. The following steps are essential to extend the existing system:

1) Initial assessment: Conduct an initial evaluation of the current schema to understand the existing data structure and identify any gaps. This involves comparing the current GeoZone schema to determine which elements are absent, such as zone types, attributes, and metadata. Additionally, assess the completeness and accuracy of the existing data to provide a comprehensive overview of the necessary actions.
2) Schema design: Develop the extended data schema by defining the new attributes that will be incorporated. It is crucial to ensure that new elements align with the data types and naming conventions established in the GeoZone schema. For instance, consider integrating additional zone types (e.g., free zones) or new attributes (e.g., control measures).
3) Implementation of changes: Implement the schema modifications by adding new fields and domain values. Utilize database management tools to adjust the structure as needed. Conduct tests to confirm that the extended schema functions correctly, ensuring that both new and existing data are effectively managed and that the system can accommodate increased complexity.
4) Updating organizational processes: Revise the organizational processes to facilitate the management of the extended schema. The updated procedures should encompass workflows related to data entry, validation, processing, and reporting. It is important to ensure the staff are trained in the handling the extended schema. Update system documentation to reflect the schema changes, and provide necessary training for staff on managing the new attributes, zones, or data structures.

If this solution is implemented, it would then fall under the scenario "I already have a GIS in place to manage geospatial data for zones that complies with the GeoZone data model".

Implementing a parallel GIS application to integrate missing information

This solution is based on the idea of not modifying the existing system, but rather, creating a parallel GIS application to integrate the missing information. This solution is quite complex, as it involves a series of steps, including an Extract Transform and Load ETL process, loading the extracted data into the GIS application, and subsequently entering the data into attributes not covered by the existing system. This series of non-

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automated steps poses the risk of generating incorrect data and requires resources capable of managing the data flow. Below are the steps to implement the outlined solution.

1) Schema matching process: Begin by performing a preliminary assessment of the current schema to gain an understanding of the existing data structure and to identify attribute correspondences with the GeoZone schema. Additionally, assess the completeness and accuracy of the current data to provide a comprehensive overview of the required actions. Following this evaluation, establish the attribute matching process and define the transformation rules necessary to extract and transform the data from the local system into a dataset designated as a "core feature" for integration into the parallel GIS application. This dataset, which will be an ESRI shapefile, should encompass all matched attributes available in the local system named according to the GeoZone schema.
2) Integration dataset creation: Conduct an analysis of the core feature to pinpoint any discrepancies in relation to the GeoZone schema. Next, develop the integration data schema, which will take the form of a table compatible with the GIS software intended for data integration. Notably, the integration schema must include the unique zone identifier to allow the use of the join function inherent in the GIS software. It is essential to ensure that all new elements comply with the data types and naming conventions as established in the GeoZone schema.
3) GIS application development: In the GIS software, import both the "core feature" and the integration table. The core feature is populated with one or more zones extracted from the local system, while the integration table is initially empty. Proceed to fill in the integration table with any missing values, ensuring inclusion of the unique zone identifiers to which the attributes values refer. After completing the edits for all attributes within the integration table, activate the join function to link the core feature with the integration table, resulting in a feature that adheres to the GeoZone schema. Finally, export the dataset to generate the GeoZone package.

Comment

The solutions for integrating the existing GIS system with the GeoZone data model each have distinct cost and resource implications.

The "Extending the current system data schema" solution, while straightforward in design, involves direct costs associated with system updates (i.e., software development to modify the current schema, staff training on the updated system to handle the new data attributes and workflows). Although these costs are measurable and typically one-time investments, they are often justified by the seamless integration and reduced ongoing manual intervention. Furthermore, this solution offers long-term stability by directly updating the system to comply with GeoZone standards, thereby reducing future inconsistencies in data management.

On the other hand, the "Implementing a Parallel GIS Application" solution avoids direct costs associated with modifying the existing system, but requires a significant amount of resources and expertise in ETL processes, as well as in managing a complex data flow. The complexity and non-automated nature of this solution make it resource-intensive, requiring ongoing labour and time investments. The need for constant data management and error-checking processes could significantly drain human resources, making this option more costly in terms of long-term operational efficiency.

In choosing between these two solutions, it is essential to weigh the short-term versus long-term costs. The first solution, while involving upfront expenses, leads to a more integrated and reliable system in the long run. For example, a partner updating their GIS system to include all GeoZone-required attributes would ensure that future data exchanges or zone management processes are smooth and error-free. In contrast, the second solution initially appears cost-effective, but its complexity introduces significant risks. For instance, a staff member tasked with manually entering missing data into a parallel GIS system could make errors that would later affect data integrity, necessitating costly corrections and ongoing supervision.

I have acquired the zone dataset from a trading partner and am currently working on developing a thematic map to illustrate the partner's animal health status

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This scenario aims to provide an operational example of using zone data to inform stakeholders about the animal health status of the zones declared by a trading partner, specifically regarding the avian influenza virus. Similar examples might include sharing information about disease-free zones for a particular disease, the health status of multiple diseases affecting a species, or zones where specific control measures are active for a given species (e.g., vaccination).

The fundamental concept is that a country requiring information about the animal health status of a trading partner can use the provided zone data to develop maps and conduct spatial analyses. These outputs can assist stakeholders, such as the Live Animal Import/Export Unit or risk assessors, in evaluating the spatial distribution and implications of the declared zones.

Case study – Obtaining a GeoZone dataset for avian influenza.

Actors	- **GIS technician**: Person with GIS and IT competencies and the GeoZone data model. - **Live Animal Import/Export Unit**: Person (or team) focused on acquiring information regarding avian influenza virus from trade partners. This unit aims to assess the spatial distribution of zones to analyze the spatial relationship of a shipment's origin based on animal movement (trade) agreements. - **Risk assessor**: Person seeking information about zones for use in risk analysis activities.
Goals	- Create one or more thematic maps. - Develop exploratory spatial data analyses of the acquired zones with respect to other relevant geospatial data used at the local level.
Description	A Member seeks information about the spatial distribution of avian influenza zones from a trading partner. The GIS technician generates the necessary maps for the Live Animal Import/Export Unit or the risk assessor, utilizing the geospatial data for the zones supplied by the trade partner. The GIS technician may also integrate these data with additional epidemiological, environmental, and base maps for exploratory spatial data analysis.
Pre-condition	- The GIS technician has a GIS project in place for managing zone geospatial data defined according to the GeoZone data model. - The Live Animal Import/Export Unit or the risk assessor has established the required maps and, if needed, the type of exploratory spatial data analysis.
Post-condition	- Map and, if required, exploratory spatial data analyses, are integrated into the trading partner's dossier.
Successful scenario	The zone shapefile prepared by the trading partner complies with the GeoZone data model and contains all required zone geospatial data. The GIS technician prepares the maps according to the information required by the Live Animal Import/Export Unit or the risk assessor.
Steps	
Step 1: Preparing for and	1. Obtain the dataset: The Live Animal Import/Export Unit or the risk assessor acquires the zone dataset from the trading partner, ensuring it complies with the GeoZone data model. 2. Verify dataset compliance: The GIS technician confirms the dataset:

I have acquired the zone dataset from a trading partner and am currently working on developing a thematic map to illustrate the partner's animal health status

implementing changes	• Adheres to the GeoZone schema (attribute names, data types, and semantics). • Contains geospatial boundaries and relevant metadata (e.g., zone ID, disease status, date of declaration). 3. Load the data into GIS: Import the zone dataset into the GIS project. Validate spatial data for integrity, ensuring there are no missing or invalid geometries and that projections are consistent. 4. Integrate with geospatial layers: Add supplementary layers to enhance the analysis, such as: • Administrative boundaries. • Locations of animal production facilities or farms. • Transport networks or environmental factors relevant to avian influenza (e.g., migratory bird routes, wetlands).
Step 2: Stakeholder consultation	Define map requirements: Engage with the Live Animal Import/Export Unit and/or risk assessor to establish: • Purpose of the map (e.g., highlight disease-free zones, assess spatial relationships). • Required thematic layers (e.g., zones by health status, species affected, control measures). • Desired outputs (e.g., map format, spatial analysis results).
Step 3: Map creation	Develop maps based on the agreed requirements. Use GeoZone colour schemes, legends, and labels for clarity.

Terms and definitions

Data model: An abstraction of the real world that includes only the properties deemed relevant to an application. The data model defines groups of entities, their attributes, and the relationships between these entities. A data model is independent of any computer system or its associated data structure. A map is an example of an analogue data model [ref.: ISO/TC211 ISO 19109].

Data schema: A formal description of a data model [ref.: ISO 19109].

Dataset: An identifiable collection of data.

Exchange (data): The process of sending and receiving data in a manner that ensures the information content or meaning assigned of the received data accurately represents the source data.

Geospatial data: Information that describes objects, events or other features with a location on the surface of the Earth. Geospatial data typically combines location information (usually coordinates on the Earth) with attribute information (the characteristics of the object, event or phenomenon), and temporal information (the time or lifespan during which the location and attributes exist).

Schema matching = data matching: The process of identifying that two objects are semantically related in order to determine the possible method/process/software for the transformations between the objects.

Semantic: The semantic aspect refers to the meaning of data elements and the relationship between them. It involves developing vocabularies and schemas to describe data exchanges, ensuring that data elements are understood in the same way by all communicating parties.

Syntactic: The syntactic aspect refers to describing the exact format of the information to be exchanged in terms of grammar and format.

Transfer (data): The exchange of information from one location to another through some communication method. Data transfer is often used to exchange data among business partners, suppliers, or government agencies for cooperative purposes.