Food and Agriculture Organization of the United Nations

europhmd
european commission for the control of foot-and-mouth disease

Transboundary high-risk area coordinated epidemio-surveillance programme

Countries' data requirements and database user manual

European Commission for the Control of Foot-and-Mouth Disease

Funded by the European Union

EuFMD's programme, tools and initiatives

FAST
Foot-and-mouth And Similar Transboundary animal diseases

Dt
EuFMD Digital transformation

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vlearning
EuFMD Virtual learning

microLearning
EuFMD Micro learning

Tom
EuFMD Training management system

SimExOn
Simulation exercises online

KnowBank
EuFMD Knowledge bank

GetPrepared
Emergency preparedness toolbox

RiskComms
Risk communications

SQRA
A method for spatial qualitative risk analysis applied to fmd.

Pragmatist
Prioritization of antigen management with international surveillance tool

EuFMDiS
EuFMD Spread model

RMT-FAST
Risk monitoring tool for foot-and-mouth and similar transboundary animal diseases

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Vademos
FMD Vaccine demand estimation model

GVS
Global vaccine security

PQv
Vaccine prequalification

PCP
Progressive control pathway

PSO
Pcp practicioner officers

VPP
Veterinary paraprofessionals

PPP
Public private partnership

Sustainable Development Goals, UN-SDGs. EuFMD's programme has a focus on

Together against wasting resources, think twice before printing.

Contents

Abbreviations and acronyms

EuFMD	European Commission for the Control of Foot-and-Mouth Disease
FAST diseases	Foot-and-mouth and Similar Transboundary Animal Diseases
FMD	foot-and-mouth disease
IZSLT	Istituto Zooprofilattico Sperimentale del Lazio e della Toscana
LSD	lumpy skin disease
NSP	non-structural proteins
PPR	peste des petits ruminants
SPGP	sheep and goat pox
THRACE	Transboundary High-Risk Area Coordinated Epidemio-surveillance Programme

1. Introduction

1.1. Aim of the manual

The purpose of this manual is to explain how the Transboundary High-Risk Area Coordinated Epidemio-surveillance Programme (THRACE) database and the probability of freedom model operate and provide a comprehensive user guide for the web-based data analysis and visualization platform. Parameters required and outputs returned by the model are described in detail.

1.2. Background

The workplan of the European Commission for the Control of Foot-and-Mouth Disease (EuFMD), and in particular Pillar I - Improved preparedness, is aimed at increasing European expertise in foot-and-mouth disease (FMD) crisis management and improving national FMD preparedness.

The improvement of surveillance and emergency preparedness against Foot-and-mouth and Similar Transboundary Animal Diseases (FAST diseases) in southeastern Europe is a strategic objective for the implementation of the Pillar I programme, achieved through increased collaboration in the region, implementation of risk-based surveillance approaches, assessment and improvement of contingency plans, and access to a diagnostic bank.

Historically, specific areas of Greece, Bulgaria and Türkiye have been at high risk for incursion FAST diseases. The THRACE programme was developed to support risk-based surveillance activities in these areas (Figure 1). The specific objectives of THRACE are to:

- promote joint, coordinated and harmonized surveillance for FAST diseases (FMD, sheep and goat pox [SPGP], peste des petits ruminants [PPR], lumpy skin disease [LSD]) in the high-risk areas of Türkiye, Bulgaria and Greece;
- improve awareness and early detection of FAST diseases;
- facilitate communication and cooperation between national competent authorities; and
- create an enabling environment for other joint international initiatives.

With the aim to consistently maintain confidence in disease-free status, **each country** involved in THRACE agreed to:

- undertake active surveillance for FMD and other FAST diseases in high-risk areas;
- ensure timely and regular sharing of data with the EuFMD deriving from surveillance activities;
- provide livestock census data to the EuFMD on an annual basis; and
- notify the EuFMD Secretariat and the other participating countries about the occurrence of significant epidemiological events related to FMD and other FAST diseases.

The **EuFMD secretariat** committed to:

- design the data collection and analysis methods;
- gather, analyse and evaluate the epidemiological information generated by surveillance activities;
- produce quarterly reports available to all parties involved; and
- organize regular review meetings and training activities to improve the implementation of the programme.

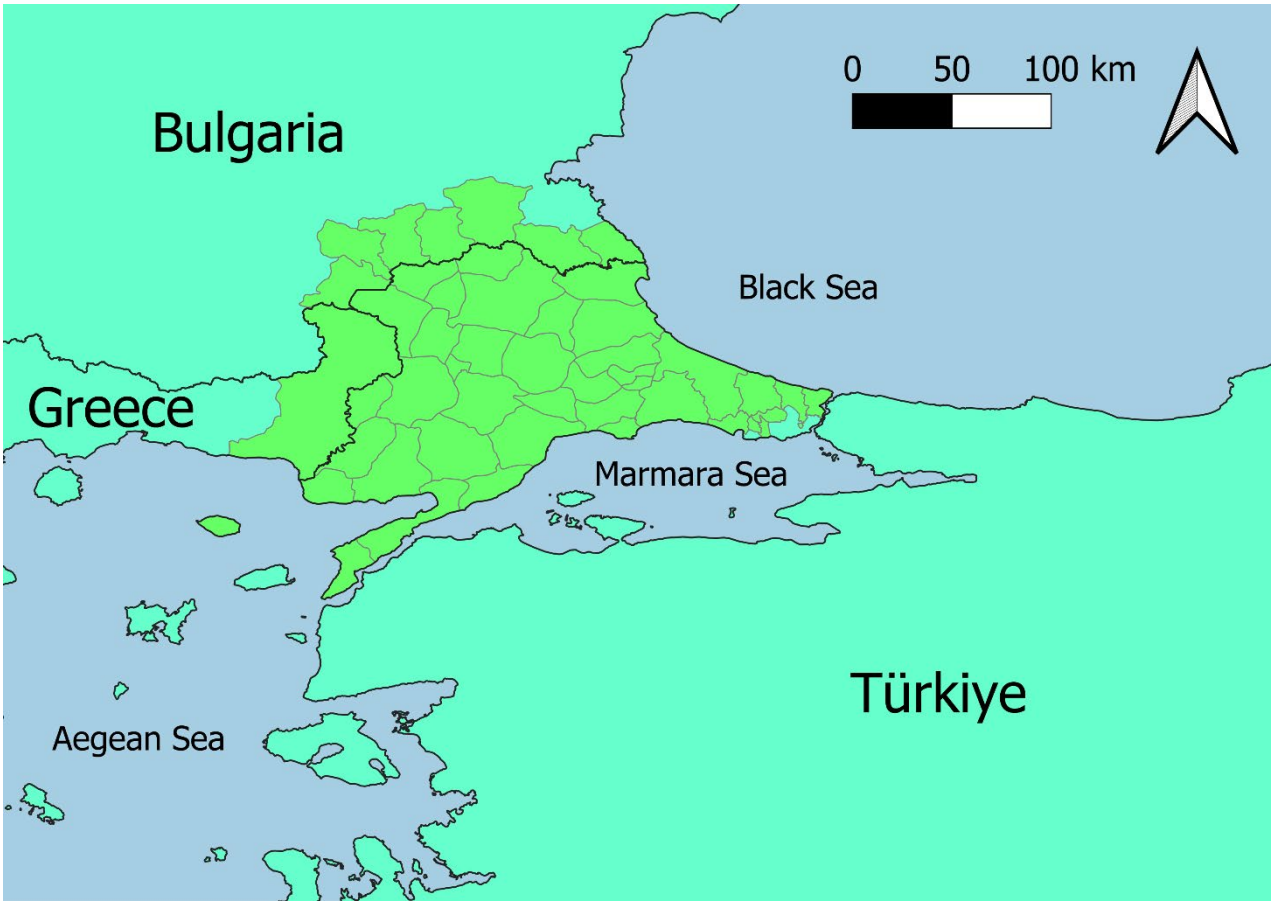


Figure 1. Map showing areas of Bulgaria, Greece and Türkiye involved in THRACE risk-based surveillance activities highlighted in light green

Source: Adapted from **FAO**. 2022. FAO Hand-in-Hand Geospatial Platform. In: *FAO*. Rome. Cited 19 August 2022. https://data.apps.fao.org/.

The designations employed and the presentation of material in the map do not imply the expression of any opinion whatsoever on the part of FAO concerning the legal or constitutional status of any country, territory or sea area, or concerning the delimitation of frontiers.

1.3. Definitions

Bayesian statistics
Bayesian statistical models use Bayes' theorem to update the probability for a hypothesis as more information becomes available. In fact, Bayes' theorem enables computing the probability of an event based on new data and prior information about the event. In the case of the THRACE model, the probability of being disease-free before carrying out a new three-month surveillance cycle is updated with the results of the new cycle. The model is therefore updated regularly as new surveillance evidence becomes available after each surveillance cycle: the posterior probability of freedom computed from the analysis of data derived from one surveillance cycle is used as the prior probability of the next one (Martin *et al*., 2007).

Epidemiological unit
A group of animals presenting the same likelihood of exposure to a pathogenic agent (OIE, 2021). For example, an epidemiological unit can consist of the animals hosted in the same farm and, thus, exposed to the same environmental characteristics, management practices, and so on.

Hazard
Any "*biological, chemical, or physical agent in, or a condition of, an animal or animal product with the potential to cause an adverse health effect*" (OIE, 2021)

Probability of freedom
Probability that the geographic area of interest is truly free of disease, given that all surveillance results are negative

Risk
In animal health surveillance systems, the definition of risk often corresponds to that employed in risk analysis: the likelihood of the occurrence of an adverse event derived from a hazard for animal or human health and the magnitude of its biological and economic consequences (OIE, 2021). This concept considers therefore both the probability and impact of an unwanted outcome deriving from a hazard. However, within the context of the THRACE model, the distinction between high-risk and low-risk areas is based solely on the likelihood of occurrence of the adverse event (disease incursion), without considering its consequences.

Scenario-tree model
A model based on a scenario tree, which is a visual tool representing all possible pathways from the starting point (the population of interest infected) to the outcomes (infection detected or not), including probabilities associated with each step of the pathways. When fed with sufficient data, the scenario-tree model returns a quantitative estimate of the probability of the outcome of interest (in the case of the THRACE model, detection of the infection and consequent probability of freedom).

Surveillance
"*The systematic (continuous or repeated) measurement, collection, collation, analysis, interpretation, and timely dissemination of animal-health and -welfare data from defined populations. These data are essential for describing health-hazard occurrence and to contribute to the planning, implementation, and evaluation of risk-mitigation actions*" (Hoinville *et al*., 2013).
Scope of surveillance activities (Hoinville *et al.,* 2013):

- **Surveillance component**: a single activity focusing on the investigation of one or more hazards in a specified population (e.g. clinical examinations of cattle in farms)
- **Surveillance system**: a collection of surveillance components used to generate data about the

status of a particular hazard in a specified population (e.g. clinical examination of cattle in farms, laboratory testing, and inspection at the abattoir for detection of lumpy skin disease)

- **Surveillance programme or portfolio**: a collection of surveillance systems used to generate data about the status of more than one hazard in a specified population

Types of surveillance:

- **Passive surveillance**: reporting of animal health data initiated spontaneously by the observer (e.g. farmer, private veterinarian). The term "enhanced passive surveillance" is employed to describe passive surveillance with active involvement of the investigator who, for example, follows up suspect disease reports (Hoinville *et al.,* 2013).
- **Active surveillance**: investigator-initiated provision of data, carried out via structured services and activities (Hoinville *et al*., 2013)
- **Early-warning surveillance**: surveillance carried out to monitor health indicators or diseases in defined populations with the aim of increasing the likelihood of timely detection of new or unexpected diseases (Hoinville *et al*., 2013). As passive surveillance, it is observer initiated but more structured because it requires the collection of specific information.
- **Hazard-specific surveillance**: surveillance employed to investigate defined (known) diseases in a defined population (Hoinville *et al*., 2013)
- **Risk-based surveillance**: The probability of occurrence and the magnitude of the consequence of health hazards are considered when planning, designing or interpreting the results obtained from the surveillance system (Hoinville *et al*., 2013; Stärk *et al*., 2006) (e.g. the sampling strategy or the analysis of data collected in each district of a country are based on the probability of occurrence of the disease or the magnitude of consequences in each district).

For more information on animal health surveillance, please consult Hoinville *et al*. (2013), Stärk *et al*. (2006), and Cameron (2012).

1.4. Implementation

Data collection

A surveillance protocol, including sampling strategy and sample size, was established for each country participating in the programme:

- **Type of epidemiological unit**: village or holding
- **Surveillance target** per three-month surveillance cycle:
    - **Serological surveillance**: the number of animals to be tested in each epidemiological unit to detect a defined prevalence among animals in each epidemiological unit with a defined confidence level (e.g. collection and testing of ten samples from bovines and/or small ruminants vaccinated against FMD, from every epidemiological unit, to detect a 25 percent prevalence of FMD among animals of each epidemiological unit with a 95 percent level of confidence)
    - **Clinical surveillance**: the number of animals to be clinically examined in each epidemiological unit to detect a defined prevalence of clinical signs among animals in each epidemiological unit with a defined confidence level (e.g. clinical examination of 50 bovines and/or small ruminants, from every epidemiological unit, to detect a 5 percent prevalence of FMD clinical signs among susceptible animals of each epidemiological unit with a 95 percent level of confidence)

Analysis

A statistical model was developed to analyse the epidemiological data collected through THRACE. The model uses the scenario-tree modelling approach developed by Martin *et al*. (2007) to estimate the progressive probability of freedom from disease over time. To do so, the model combines the evidence deriving from the two surveillance components of the programme (serological surveillance and clinical surveillance) considering the Bayesian accumulation of historical surveillance evidence. Since the analytical methodology is based on risk-based sampling, the model takes into account the risk of introduction of disease: epidemiological units (villages or holdings) are classified as “high” or “low” risk.

Originally designed for FMD, the model can be extended to support the analysis of all the data collected, providing separate analysis by:

- species and species group
- disease
- participating country

This methodology provides therefore a flexible approach that can be adjusted for different species, diseases, regions, and risk classifications as new information becomes available.

The model was originally developed in 2013 using Microsoft Excel 2010 and was subsequently integrated into a **web-based data analysis and visualization system** to facilitate data submission and automatize the calculation of the probability freedom from disease.

The model was developed in collaboration with AUSVET Europe SAS, Lyon, France.
The surveillance database and web-based data analysis and visualization platform are hosted and managed by Istituto Zooprofilattico Sperimentale del Lazio e della Toscana (IZSLT), Rome, Italy.

2. Data requirements

2.1. Model parameters

To calculate the probability that a country or region is free from disease based on the results of a surveillance system, it is necessary to estimate the following (Hoinville *et al*., 2013; Martin *et al*., 2007):

- **Sensitivity of the surveillance system**. This can be estimated by establishing the prevalence expected if the disease were present. In fact, if the expected prevalence is high, then the ability of the surveillance system to detect the disease will be high. Conversely, if the prevalence is expected to be low, the ability to detect the disease will be low (since few positives will be present in the population, it will be more difficult to detect them). The expected prevalence is called "**design prevalence**". The design prevalence represents the hypothetical prevalence that is used to set the standard for the surveillance system (it is not a real prevalence, as the population in question should be free from disease).
- **Specificity of the surveillance system**. The objective of the surveillance system is to demonstrate that the disease is absent. Therefore, any positive test is followed by at least one confirmatory test to exclude false positives. Thus, it is possible to assume a specificity of 100 percent.
- **Prior probability of freedom**. This corresponds to the probability of being disease-free before carrying out surveillance. In the absence of valid prior information, the standard value of 50 percent can be applied, to indicate that the disease is equally likely to be present or absent before the beginning of surveillance. Even if this prior value might be an imprecise estimate, its impact on the final estimate will decrease rapidly as surveillance data starts being added to the module. In other contexts, such as absence of detection for several years, the confidence of freedom might be high. In these cases, it would be possible to adopt a higher value of prior probability of freedom.

Based on these considerations, each country participating in THRACE established the values of the parameters reported in Table 1.

Table 1. THRACE model parameters indicated by each country

Category	Parameter	Description
Design prevalence values Design prevalence is the hypothetical prevalence of infected units in the population if disease is present. The design prevalence sets the standard for surveillance. Design prevalence values may be set based on: • international standards (OIE etc.); • the biology of the disease (the minimum prevalence possible when infection has become established in a population); and • agreement between trading partners.	**Herd-level design prevalence**	Specifies the proportion of herds (or other epidemiological units) that are assumed to be infected in an infected population
	Animal-level design prevalence	Specifies the proportion of animals (or other units) that are assumed to be infected within an infected herd (or other epidemiological unit)
Probability of introduction The probability that the infection will be introduced into population	**Annual probability of introduction**	The probability that the infection will be introduced into the population in a given year
	Seasonal variation (yes/no)	Is there seasonal (monthly) variation in the probability of introduction? If yes, separate monthly values for probability of introduction are calculated. If no, a fixed monthly value for probability of introduction is used.
	Monthly relative risk scores	Relative risk score: a value indicating the relative probability of introduction for each month. Values may be greater than or less than one.

Table 1. Continues from previous page.

Category	Parameter	Description
Herd-level risk factor This is the main risk factor, operating at the herd level, that distinguishes between herds with a higher or lower probability of being infected with the disease. This is used to assess the value of risk-based sampling (preferentially sampling herds of higher risk).	**Risk factor name**	A descriptive name for the risk factor (e.g. Region)
	High-risk group	A descriptive name for the high-risk group (e.g. East)
	Low-risk group	A descriptive name for the low-risk group (e.g. West)
	Relative risk in high-risk group	The probability of being infected in one group, relative to the probability in the other group Numbers may be greater than, equal to, or less than one. If the values for both groups are equal, there is no difference in risk of infection.
	Relative risk in low-risk group	
	Proportion of the population in high-risk group	This is the proportion of the population in each risk group. These values must add to one. Only the first needs to be entered, as the second is automatically calculated.
	Proportion of the population in low-risk group	
Prior probability of freedom The starting probability of freedom before the start of surveillance. In the absence of prior surveillance evidence of freedom, or evidence of infection, a value of 0.5 is used by convention.	**Prior probability of freedom**	

Table 1. Continues from previous page.

Category	Parameter	Description
Surveillance sensitivity **Type** Up to six different types of surveillance can be analysed*	**Serological surveillance**	This involves testing blood serum from a group of animals to determine the seroprevalence of antibodies (see the previous section on data collection).
	Clinical surveillance	This involves a clinical examination of a group of animals within the herd (see the previous section on data collection).
	Surveillance type 3	Even if the current model only considers the evidence collected through serological and clinical surveillance, it was designed to integrate evidence from up to six different surveillance components. Thus, four additional components might be included, based on the needs of each participating country.
	Surveillance type 4	
	Surveillance type 5	
	Surveillance type 6	
	For each type: **Combined sensitivity**	This is the overall individual animal sensitivity of the overall surveillance protocol. If the protocol includes the use of multiple tests (for example, to rule out false positives), it is the combined sensitivity including all tests.

*The current THRACE surveillance system includes two types: serological surveillance and clinical surveillance. Additional types might be included based on countries' needs.

2.2. Data shared regularly

Each participating country agreed on providing regular updates on surveillance activities carried out under the framework of THRACE:

Data shared monthly

a. Geographical information

1) Country
2) District or municipality or subregion
3) Village or subregion
4) Epidemiological unit ID

b. Date of sampling or examination

5) Year
6) Month
7) Day

c.* Geographical coordinates (decimal degrees*)

8) Longitude (East) *(value must be number 0–180, with up to 6 decimal digits)*
9) Latitude (North) *(value must be number 0–90, with up to 6 decimal digits)*

d.* Total livestock present (within epidemiological unit). Fields can accept only whole numbers*.

10) Date of the inspection
11) Inspector
12) Total cattle present during the visit
13) Total sheep present during the visit
14) Total goats present during the visit
15) Total pigs present during the visit
16) Total buffaloes present during the visit
17) Where the examination or sampling took place

***e.* The following fields can accept only whole numbers**

18) Number of cattle subject to clinical examination
19) Number of cattle clinically suspect for FMD
20) Number of cattle sampled
21) Number of cattle positive for FMD non-structural proteins (NSP) antibodies
22) Number of cattle positive for LSD antibodies

23) Number of sheep subject to clinical examination
24) Number of sheep clinically suspect for FMD
25) Number of sheep sampled
26) Number of sheep positive for FMD NSP antibodies
27) Number of sheep positive for SPGP antibodies
28) Number of sheep positive for PPR antibodies

29) Number of goats subject to clinical examination
30) Number of goats clinically suspect for FMD
31) Number of goats sampled
32) Number of goats positive for FMD NSP antibodies
33) Number of goats positive for SPGP antibodies
34) Number of goats positive for PPR antibodies

35) Number of buffaloes subject to clinical examination
36) Number of buffaloes clinically suspect for FMD
37) Number of buffaloes sampled
38) Number of buffaloes positive for FMD NSP antibodies
39) Number of buffaloes positive for LSD antibodies

40) Number of pigs sampled
41) Number of pigs positive for FMD NSP

42) Number of wild animals sampled
43) Number of wild animals positive for FMD NSP

Data shared annually

f. Livestock data

Once per year, no later than 31 April each calendar year, each country provides the EuFMD with information on the overall livestock present in the high-risk surveillance areas, in accordance with the programme.

The information should include at least the following data:

- TÜRKIYE: province, number of epidemiological units, cattle, sheep, goats, water buffalo
- BULGARIA: municipalities, number of epidemiological units, cattle, sheep, goats, pigs
- GREECE: subregions, number of epidemiological units, cattle, sheep, goats, pigs

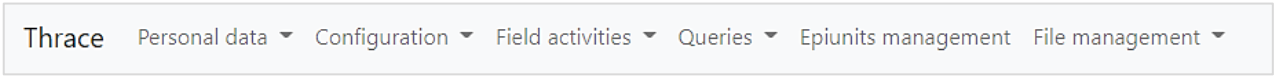
3. User guide

Log in/Access rights

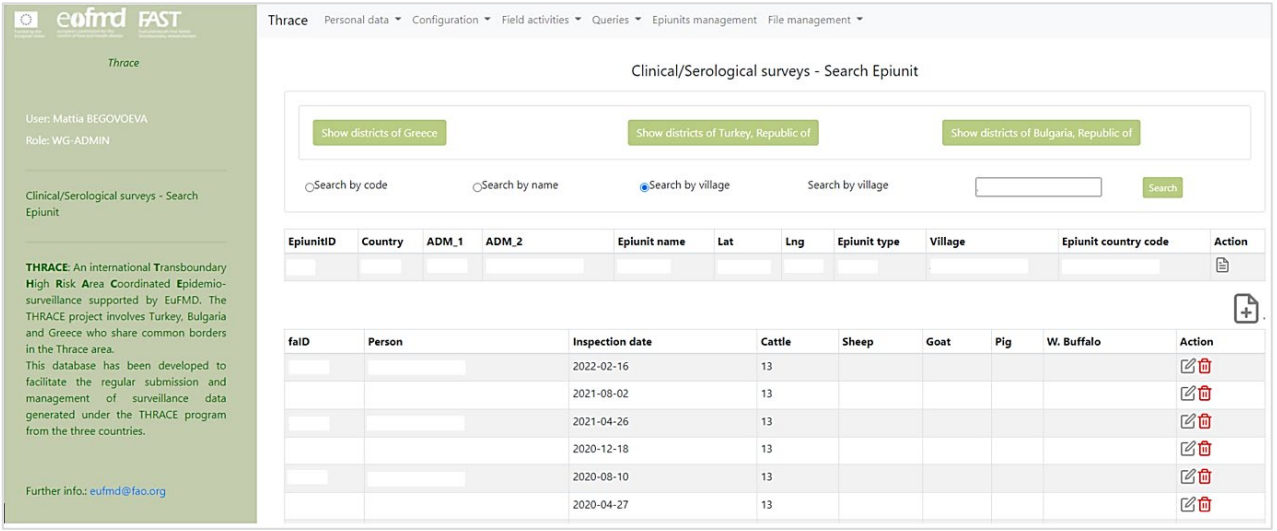
THRACE database focal points representing participating countries are responsible for sharing surveillance data on a monthly basis: They can enter the web-based data analysis and visualization system to upload and download data and visualize results of the calculation of the probability of freedom from disease.

Functionalities accessible through the main menu

All functionalities can be accessed from the main menu on top of the user interface:



1. **Personal data:** enables users to update and submit their personal data and reset their password
2. **Configuration:** enables users to visualize and modify the list of administrative levels imported into the model
3. **Field activities:**
   - **Inspectors management:** The full list of country focal points and their contacts is provided. Their data can be registered and modified. The inspector is the person in charge of the field activity.
   - **Surveys:** enables users to visualize the complete list of surveys conducted in a specific epidemiological unit (village or holding)

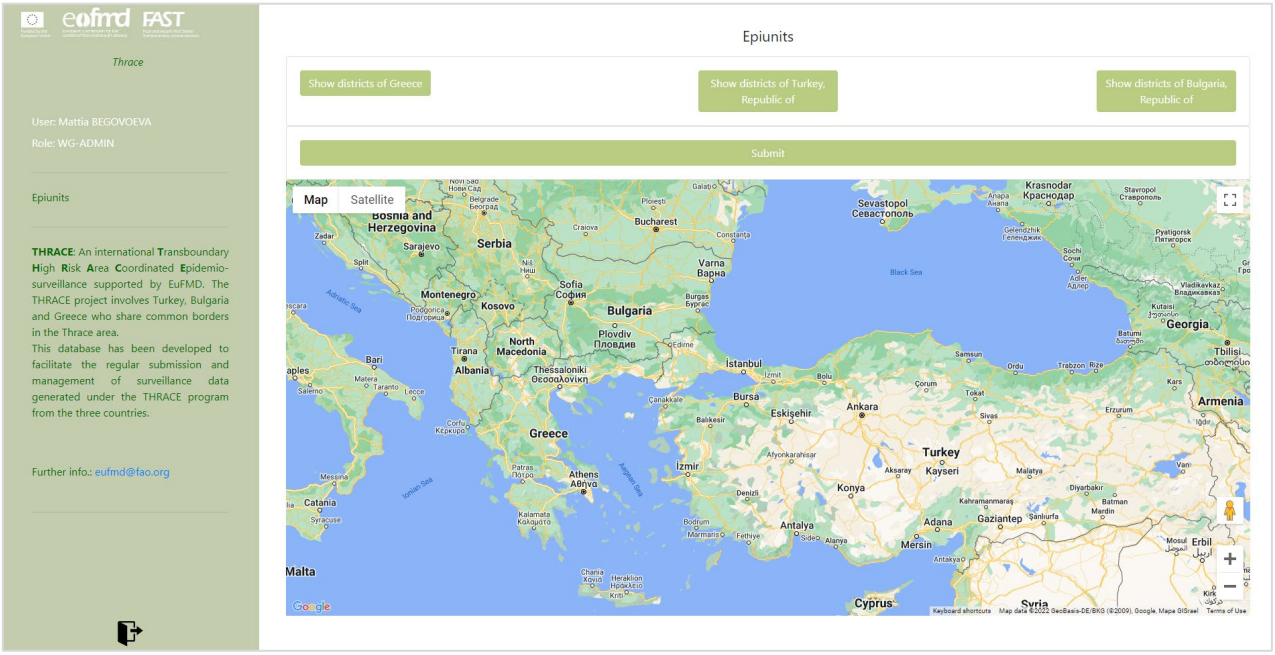


- **Inventory/Target management:** enables users to view and edit surveillance targets for every three-month cycle. These data are important for processing the cycle reports, as the inventory indicates the population of animals by species and district and the surveillance target permits checking the progress of the activities.

They must be declared at the beginning of each year and are then displayed in the quarterly cycle report.

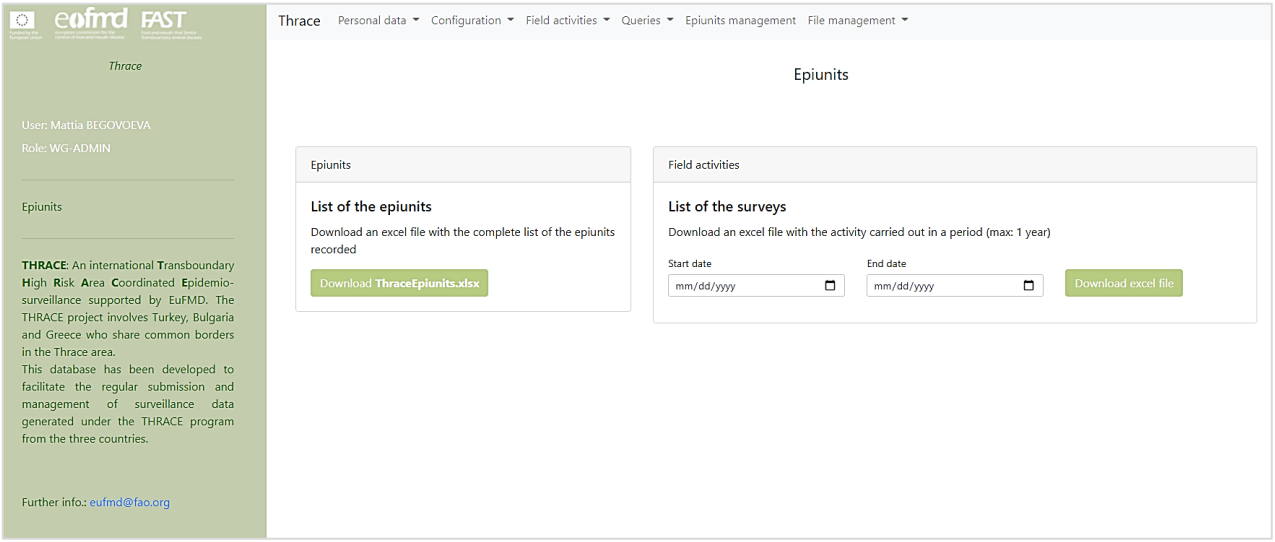
4. **Queries:**

- **Epiunit's maps:** enables users to visualize administrative divisions of each participating country. The precise location of each epiunit is visible on the map and appears as a coloured dot.

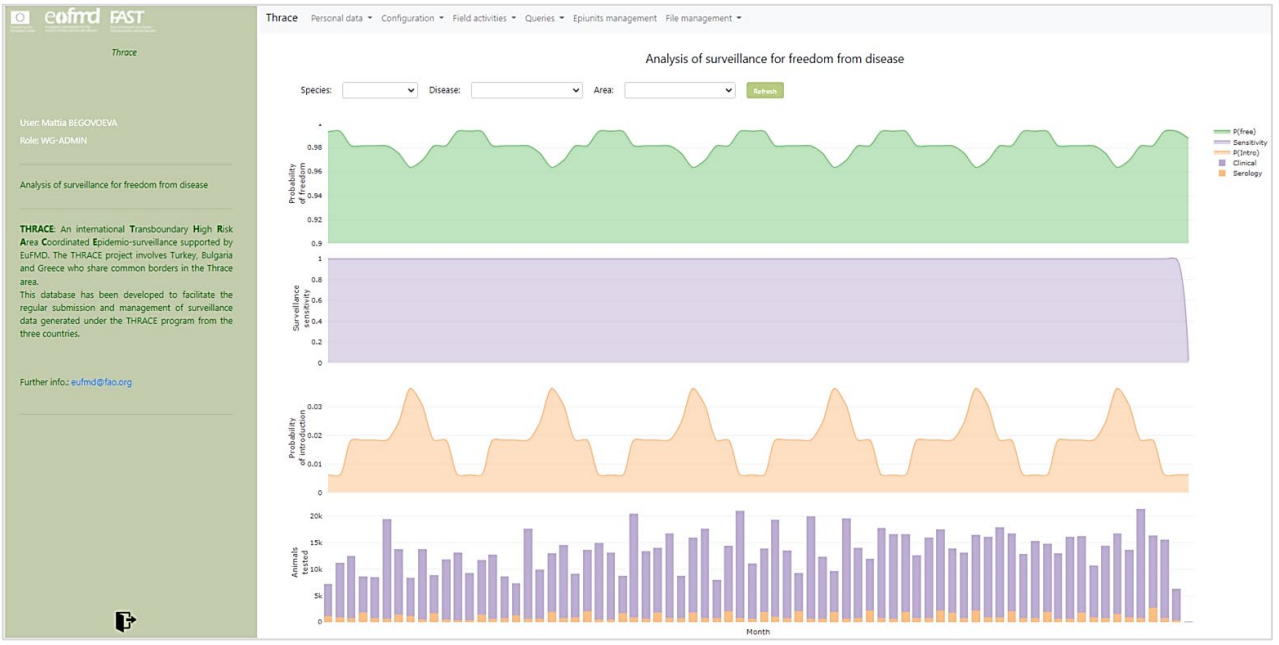


Source: Map Data ©2022 GeoBasis-DE/BKG (©2009), Google, Mapa GISrael.
The designations employed and the presentation of material in the map do not imply the expression of any opinion whatsoever on the part of FAO concerning the legal or constitutional status of any country, territory or sea area, or concerning the delimitation of frontiers.

- **Epiunits/Field activities list:** enables users to download a first Excel file with the list of the epidemiological units recorded, and a second one with the activity carried out in a specific period (max: 1 year)



- **Activities monitoring:** enables users to visualize progression of surveillance activities by district. Visited epidemiological units are shown in green. Epidemiological units not visited in the selected period are marked in red.
- **Re-entry in epiunit:** indicates the number of visits carried out in each epiunit over a selected period of time. Each epiunit is represented by a dot which is colour-coded based on the number of visits carried out.
- **Cycle report:** enables users to download an Excel file containing the three-month cycle report concerning the country and period selected. A cycle report is a comprehensive summary of surveillance activities carried out in the specified three-month period. The report includes animal population counts, number and results of clinical and serological examinations, and percentages achieved compared to the predetermined surveillance targets. All data are stratified by country, province or district, and species.
- **Freedom from disease analysis:** enables users to visualize the results of the calculations concerning the freedom from disease. Data visualized include probability of freedom from disease, surveillance sensitivity, probability of introduction (based on parameters set by participating countries), and animals tested.



5. **Epiunits management:** In this section, it is possible to modify information related to epidemiological units. ATTENTION: Take care not to modify the identification details of the epiunits as this would cause the system to malfunction.
6. **File management:**
   - **Download:**
     - Download the file containing the updated epidemiological units' codes and inspector codes. If during field activities a new epidemiological unit is examined, or a new inspector

is recruited, the country focal point must update the Thrace system with this new information and then download the updated excel file.

  - **Download updated xlsx:** Download the Excel file that country focal points must use for uploading field activities information into Thrace.

- **Upload data:** Focal points can upload data concerning monthly surveillance activities.
- **Delete field activities:** Focal points can delete data concerning surveillance activities previously uploaded into the system to replace them with an updated version.

4. Way forward

THRACE improves the chances of detecting a FAST disease outbreak at an early stage and has been providing confidence in FMD freedom in the high-risk areas of Bulgaria, Greece and Türkiye, since 2013.

The THRACE coordination framework represents a successful example of international cooperation through regular sharing of information and surveillance data. A well-established methodology to estimate the probability of freedom from disease has been developed. It ensures the balance between surveillance efforts and investments in terms of economic and human resources on the one hand, and the need to obtain trustable results on the other. As part of the programme, training activities (crisis management simulation exercises, workshops) and meetings with all stakeholders are held regularly.

This methodology provides a flexible approach that can be adjusted for different FAST diseases, species, countries, risk classifications, and surveillance components. Since surveillance data concerning SPGP, LSD, and PPR are reported regularly, since January 2022 the calculation of the probability of freedom has been extended to these diseases. The extension to countries and regions adjacent to those already involved might significantly improve the FAST disease situation in the region and facilitate international cooperation between interested parties.

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EuFMD Committees

Executive Committee, Standing Technical Committee (STC), Special Committee for Surveillance and Applied Research (SCSAR), Special Committee on Biorisk Management (SCBRM), Tripartite Groups.

Hold-FAST tools

AESOP. Assured emergency supply options; **EuFMDiS**, FMD spread model; **GET PREPARED** toolbox. Emergency preparedness; **GVS**. Global Vaccine Security; **Online Simulation Exercises**; **Outbreak Investigation application**; **Pragmatist**. Prioritization of antigen management with international surveillance management tool; **PCP-FMD**. Progressive Control Pathway for foot-and-mouth disease; **PCP-Support Officers**; **SAT**. PCP Self-Assessment Tool; **RTT**. Real Time Training; **SMS Disease reporting**; **SQRA toolkit**. A method for spatial qualitative risk analysis applied to FMD; **Telegram**; **TOM**. EuFMD training management system; **Global Monthly reports**; **VADEMOS**. Vaccine Demand Estimation Model; **VLC**. Virtual Learning Center. **Microlearning**.

United Nations Sustainable Development Goals (UN-SDGs)

EuFMD's programme has a main focus on

Thinking of the environmental footprint

Together against wasting resources, think twice before printing.

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Rome, Italy

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