Food and Agriculture Organization of the United Nations

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

Risk mapping and forecasting for FAST diseases

Report

Open Session - OS20

Virtual workshop - 19 January 2021

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

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for FAST diseases

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Background, workshop objectives and expected outcomes

Following the EuFMD's Open Session 2020 Special Edition (OS20), workshops were organized in January-February 2021 to translate into action the recommendations of the Conference.

This workshop focused on '**Risk Mapping and Forecasting for FAST diseases**' and aimed to gather technical experts from various disciplines to scrutinize what tools and methodologies to investigate animal mobility can best contribute to risk mapping for FMD and similar transboundary animal (FAST) diseases, and how risk information can be monitored and used for FAST diseases forecasting. This workshop was specifically related to Session I (Measuring animal movements and drivers for FAST disease risk mapping) and Session II (From risk to actions: making them happen) of the EuFMD OS20.

The expected outputs of this workshop were to:

- Identify the key drivers of animal mobility and opportunities to overcome common gaps in data availability;
- Identify strengths and limitations of existing methodologies and tools for FAST diseases risk mapping and forecasting, for integration in risk-based surveillance and control;
- Define challenges and opportunities in the application of capacity development initiatives for risk mapping with national animal health services;
- Reflect on the establishment of a multidisciplinary community of practice for the operationalization of tools and methodologies for animal mobility analysis and transboundary animal diseases risk mapping and forecasting.

Introduction

Fabrizio Rosso, Deputy Executive Secretary of the EuFMD, introduced the workshop, indicating that special attention was given to animal mobility during the OS20, addressing some of the following questions: how and where the disruption in the production chains and commodities' price variation affect animal mobility, generate changes in movement patterns, how this changes can be regularly monitored and forecasted, and what type of training methodologies and partnerships can be implemented to improve skills and tools to collect and analyze risk information including animal mobility data. The workshop was chaired by Dr David Redding, Senior Research Fellow at the UCL, whose research focuses on understanding links between major drivers of global environmental changes and outbreak of wildlife-borne diseases in human populations.

Three technical presentations were provided (Annex 1), as an introduction to the group discussion summarized in the following pages:

- Integration of livestock mobility in risk assessment and forecasting (Etienne Chevanne and Fabrizio Rosso, EuFMD);
- Network indicators for livestock mobility and integration in surveillance and control strategies (Andrea Apolloni, CIRAD UMR Astre).
- Training on risk mapping and implementation for national animal health (Cécile Squarzoni-Diaw, CIRAD UMR Astre).

Group work 1: Missing mobility data and drivers: how to fill data gaps

Fabrizio Rosso (EuFMD), Paolo Motta (EuFMD), David Redding (UCL) moderated the group work session #1, and 11 participants attended this session, as indicated in Annex 2.

Specific expected outputs:

- Define the key data type and sources to be prioritized for adoption of routine and robust digitized data recording of animal mobility in Low and Middle Income Countries (and opportunities to overcome common gaps in data availability);
- Reflect on the establishment of a multidisciplinary "community of practice" for the operationalization of tools and methodologies for animal mobility analysis and transboundary animal diseases risk mapping and forecasting.

Summary of the discussions

Discussions highlighted the different scales/spatial resolution of animal movements, having distinct drivers, stakeholders involved, data sources:

Spatial resolution	Drivers	Objective	Stakeholders
Local livestock movements (within-country)	Environmental, social, and cultural	Define surveillance and control measures	Farmers/livestock owners
Long-distance livestock movements (import/export, international, cross border)	Supply chain driven, trade-related	Understanding the risks, and application on TADs risk forecasting	Traders/Brokers

If animal movements are linked to availability of water or forage, satellite images could be further used to assess environmental drivers of animal mobility. However, data processing may be time and resource consuming. Monitoring climatic/environmental conditions could be used (though mechanistic models) to 'forecast' change in animal mobility patterns.

There is also a need to invest more in simulation models to overcome data gaps, or reduce uncertainty. Further focus should be on the influence of seasonality in demand for animal products (festivities, holidays) on livestock movements. Land ownership parameter should be used, due to its huge importance in animal movements in Africa.

The movements that are more interesting for animal disease transmission include for instance a farmer crossing the border for better forage and returning to the point of origin, or a trader visiting dozens livestock markets looking for a better price.

As each region has its own characteristics, research studies are needed in different contexts/settings to connect the local and large scale movements with putative drivers. Animal mobility is a socio-cultural aspect in West Africa. Pastoralists have "*laisser-passer sanitaire*" where key data is stored (volumes, vaccination status, origin-destination), which can be used retrospectively, and is supplemented by specific animal mobility survey. There are some bilateral agreement between countries to allow, for a specific period in the year, cross-border livestock movements.

Group work 2: Strengths and limitations for integration of network indicators and risk mapping and forecasting into surveillance and control interventions for FAST diseases

Andrea Apolloni (CIRAD UMR Astre) and Beatriz Vidondo (UNIBE) moderated the group work session #2, and 12 participants attended this session, as indicated in Annex 2.

Specific expected outputs:

- Identify strengths and limitations of existing methodologies and tools of network analysis that could be integrated in risk-based surveillance and control;
- Reflect on the establishment of a multidisciplinary "community of practice" for the operationalization of tools and methodologies for animal mobility analysis and transboundary animal diseases risk mapping and forecasting.

Summary of the discussions:

- State-of-the-art in network approaches: which network indicators have already been used in risk mapping for FAST diseases forecasting and in which contexts?

Type of network	Network (node) indicator	Context of use	Strengths	Limitations
Static	In/out degree		Interesting for diversity of sources (diffusion/spread of disease)	Not taking account for Volume (i.e. a contact of one animal would be the same as a 1000 animals)
Static	In/out strength			
Static	Node betweenness	Actor-level, the importance of this indicator will vary depending on the disease of interest	Endemic /slow spreading disease Good for actions that hold upon an actor (farmer/market)	Hard to communicate the difference with below to policy makers.
Static	Link betweenness	Route-level, the importance of this indicator will vary depending on the disease of interest		Hard to communicate the difference with above. Depending of the disease change importance Sensible to temporality of things
Static	Clustering coefficient			
Static	Closeness			
Static	Eigenvalue centrality			Impossible to implement in the field and communicate what it is to policy-makers. Develop skill to communicate and Efficacy
Static	In/out contact chains			
Temporal	Epidemic threshold (critical transmissibility value) related to accessibility	Critical value (>1 invasion) impact by temporality of network and disease characteristic It gives how accessible is a network		Depend on the disease
Temporal	Latency times/dormancy time	When node is active/dormant		
Temporal	Causal fidelity	Relate temporal metrics to static one		Depends on network

The importance of one network measure depends on the disease considered.

In terms of data sources for animal mobility, in Europe, TRACE is a database of daily trade data from farms to farm. In Africa however, although daily data can be accessed, it is mostly on paper, and related to cross-border (district) movements. Most Veterinary Services collect animal mobility data through surveys. In Africa, fixed networks would be developed as there is not enough data to account for the temporality of things.

One should start from the data, rather than speculating what could be done if high resolution data were available, and ask how data can tell something more than the Veterinary Services? Is there a real need for high-resolution network to inform animal disease surveillance? What should be the spatial scale of interest for disease control?
Experience based on recent research in Europe with very comprehensive datasets showed that, in order to estimate/predict the risk with a reasonable degree of confidence, there is no need to have the full network information. In settings where data is scarce (LMIC), simple network indicators might be the best ones (as less biased and more robust to network sample issues): in/out degrees, and in/out contact chains. The network sampling is paramount, although the theory of how to sample a network is complex. In real-world networks, there is a correlation between degree, strengths, centrality and closeness centrality indicators.

- Areas of current research

Active research fields are:
- The rewiring of networks on dynamical network: importance of farmer decisions in the trade that create the network, influence of the decision process on changing network structure;
- Multilayer networks: for different species, different livestock diseases, sharing trucks etc.
- Network reconstruction inferring missing links (to reconstruct trade or surveillance data), but these are high-resolution studies requiring high-resolution data.
Machine learning approaches can be used for high-resolution data, to summarize the movements or associate the movements to diseases.
Concerning the importance of markets, it is often assumed markets are important. Since the 2001 UK FMD epidemic, there are huge efforts allocated for market closures for disease control, but this can be queried and ethically questionable.

- Research and application: how to transfer research outcomes to the Veterinary Services? What could be transferred? What are the limitations? and the data to be collected?

Experience from Africa showed that data is scarce and / or poor quality and databases are often not available in many regional Veterinary Services. When surveying the livestock markets, traders are usually reluctant to share information on animal origin, destination or price.

- What are the tools (software/codes) readily available? How to share them (group repository, google doc)? How to maintain this practice alive?

R packages: SimInf for epidemiological and mathematical modelling (simulations) with animal mobility data; Gephi, SNA, igraph to analyze data on animal movements; Mnet for multilayers network. Temporal network Python packages are available. Github could be a sharing platform.

Group work 3: Capacity building approaches and mentoring, how to maximize impact

Cécile Squarzoni-Diaw (CIRAD UMR Astre) and Barbara Wieland (ILRI) moderated group work session #3, and 3 participants attended this session, as indicated in **Annex 2**.

Specific expected outputs:

- Define challenges and opportunities in the application of capacity development initiatives for risk mapping with national animal health services;
- Reflect on the establishment of a multidisciplinary "community of practice" for the operationalization of tools and methodologies for animal mobility analysis and transboundary animal diseases risk mapping and forecasting.

Summary of the discussions:

Training objectives	Modality & format	Audience	Field application
Survey on animal mobility	2-3 days, digital tools available, ideal to have some sort of a hybrid model (virtual & physical)	Field vets, official vets in DVS, vet para-professionals	National protocols, SOPs, questionnaire tools available, training of trainers
Risk assessment and risk analysis	Longer process, 5-10 days, over time, depending on level, hybrid of e-learning and face-to-face training	DVS, researchers, experts, coordinators of control programs, decision-makers	
Risk mapping and GIS tools	Longer process, 5-10 days, over time, depending on level, hybrid of e-learning and face-to-face training	DVS	
Data collection (incl. ensuring good quality data)	Can also be longer iterative process	DVS, field vets, slaughterhouse vets	National protocols, SOPs, questionnaire tools available, training of trainers
Data management	Can also be longer iterative process	DVS	
Risk-based surveillance and control strategies	Different levels (field level and decision makers)	DVS, coordinators of control programs, decision makers	

High turn-over of staff in the LMIC Veterinary Services is one of the key challenges, to overcome this challenge was proposed systems like training successor, or certificates for training (reflecting the different levels of proficiency).

With regards to the potential integration of these trainings into **CPD**, this would depend on country, and would need discussion with national training centers that provide the CPD trainings, credits for the training courses depending on national system.

Selection of trainees must consider their skills, and their roles in the Central Veterinary Services; usually DVS support the selection process. The tools/trainings should be reflected in the trainee's job description of DVS staff.

A **community of practice** (CoP) would be useful in the field of data collection and management (support network). A CoP would also allow batches of trainees to remain in contact, former trainees teaching new staff, or online twinning for new staff.

To measure **training impact**, indicators should be developed based on training objectives of the different modules, which would allow to monitor and quantify impact, with global indicators for twinning program.

Workshop plenary discussion and conclusion

There is the need to understand at **which scale** risk-based surveillance and control will be implemented in target countries, and fit trainings and tools to this scale.

Is **real-time** updated animal movement data needed? Or are the general patterns of animal mobility stable enough over time to allow periodic (every four years for e.g.) update of network analysis, that would be good enough to support decision-making?

The 'data gap' concept was questioned. There is a lot of data available on paper e.g. movement permitting data (although the quality of this existing data is unknown) but there is a lack of funds to digitalize data. Instead of developing a new tool that would need a technology uptake, and may be costly to implement, digitalization of data might be a practical way forward for the short-term in LMIC. This would help national stakeholders to understand the value of the data they actually own. However, even in the fields of **digitalization**, capacity building training would be required. Digitalization of data is a FAO priority for the coming years.

The **purpose of the data collection** should not be forgotten, large animal mobility datasets in Europe were designed for food safety purpose, and researchers in epidemiology used these datasets in a second stage. In the context of LMIC, epidemiologists would have to assist the creation of datasets, and reviewing existing forms and historical data is paramount to design the tools LMIC would need for risk assessment in the future.

Discussions showed the audience's interest for the workshop topics, to keep the **discussion alive**, and the possibility to establish a community of practice was indicated as good initiative to ensure regular meetings and discussions. The EuFMD will look at the possibility of sustaining the network. The present report will be shared among the audience and experts.

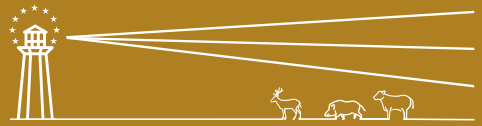
Annex 1 – Workshop agenda

Zoom link HERE – Password: 251466 – Meeting ID: 988 7831 1068		
Time CET	**Topic**	**Speakers**
13:30 – 13:40	Welcome, introduction of the workshop objectives and expected outputs	Chair: Dr D. Redding (UCL) Dr F. Rosso, Dr P. Motta (EuFMD)
13:40 – 14:00	**Technical presentation 1**: Integration of livestock mobility in risk mapping and forecasting **Technical presentation 2**: Network indicators for livestock mobility and integration in surveillance and control strategies. **Technical presentation 3**: Training on risk mapping and implementation for national animal health.	Speaker 1: Dr E. Chevanne (EuFMD) Speaker 2: Dr A. Apolloni (CIRAD) Speaker 3: Dr C. Squarzoni-Diaw (CIRAD)
14:00 – 14:30	Parallel Working Group (WG) sessions: **Topic 1**: Missing mobility data and drivers: how to fill data gaps. **Topic 2**: Strengths and limitations for integration of network indicators and risk mapping and forecasting into surveillance and control interventions for FAST diseases. **Topic 3**: Capacity building approaches and mentoring, how to maximize impact.	Moderators 1: Dr F. Rosso (EuFMD), Dr P. Motta (EuFMD), Dr D. Redding (UCL) Moderators 2: Dr A. Apolloni (CIRAD), Dr B. Vidondo (UNIBE) Moderators 3: Dr C. Squarzoni-Diaw (CIRAD), Dr B. Wieland (ILRI)
14:30 – 14:40	Break	
14:40 – 15:40	Plenary sharing of the WG conclusions (5 min. each) and discussion. Guidance for the establishment of a community of experts for translating tools and methodologies into practices.	Chair: Dr D. Redding (UCL) Moderators All

Annex 2 – List of participants

Name	Institution	Group work #
Fabrizio Rosso	EuFMD, Deputy Executive Secretary	1*
David Redding	UCL, UK	1*
Paolo Motta	EuFMD, Italy	1*
Kimberley VanderWaal	University of Minnesota, USA	1
Paul Bessell	University of Edinbrough, UK	1
Annamaria Conte	IZS Teramo, Italy	1
Ismaila Seck	FAO ECTAD Regional Office for Africa, Ghana	1
Margarida Arede	UAB, Spain	1
Fredrick Kivaria	FAO ECTAD	1
Rehab Abdelkader Sayed	GOVS, Egypt	1
Tengiz Chaligava	NFA, Georgia	1
Andrea Apolloni	CIRAD, UMR Astre	2*
Beatriz Vidondo	UNIBE	2*
Etienne Chevanne	EuFMD, Italy	2
Alberto Allepuz	UAB, Spain	2
Karl Rich	ILRI	2
Thibaud Porphyre	VetAgroSup, University of Lyon, France	2
Federica Loi	IZS Sardegna, Italy	2
Eugenio Valdano	Epicx INSERM, France	2
Daniel BeltranAlcrudo	FAO Regional Office for Europe and Central Asia, Hungary	2
Massimo Paone	FAO PAAT, Italy	2
Giuliano Cecchi	FAO PAAT, Italy	2
Kees VanMaanen	EuFMD, the Netherlands	2
Sana Kalthoum	CNVZ Tunisia	2
Mohamed Abdelazim Mohamed	GOVS, Egypt	2
Cécile Squarzoni-Diaw	CIRAD, UMR Astre	3*
Barbara Wieland	ILRI	3*
Jordi Casal	UAB, Spain	3
Muhammed Naceur Baccar	OIE Collaborating Center of training (CNVZ), Tunisia	3
Damien Barrett	Agriculture Department, Ireland	3
Filippo Pedulla	EuFMD, Operational assistant	NA
Silvia Epps	EuFMD, Operational assistant	2
Elena Salvati	EuFMD, Operational assistant	1
Ludovica Nela	EuFMD, Operational assistant	3

* moderators



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Hold-FAST tools

GET PREPARED, Vlearning, FMD-PCP, EuFMDiS, Pragmatist, Impact Risk Calculator, Virtual Learning Center, SMS Disease reporting, Global Vaccine Security, Outbreak Investigation app, PCP-Support Officers, PCP Self-Evaluation tool, AESOP, Telegram, Whatsapp, Global Monthly Reports, Real Time Training.

EuFMD Committees

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

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Funded by the European Union