



Exotic diseases approaching EU EFSA mandates on PPR, sheep pox, lumpy skin disease

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PAFF meeting -13-14 Jan 2015



BACKGROUND

- PPR, SPP/GTP, LSD are exotic to the EU, but present in countries neighbouring EU (Turkey, n. Africa) >> increasing chance of incursion
- SPP outbreaks occurred in Greece and Bulgaria in 2013-2014
- EC needs update assessment of the risk of introduction and spread of PPR, SPP/GTP, LSD, and to determine if further measures are justified



TERMS OF REFERENCE – WHAT TO BE ASSESSED

1. Characterise the disease and global occurrence
2. Mapping of **animal movements** in the Mediterranean Basin and Black sea
3. Evaluate **pathways of introduction into the EU** and ranking them
4. Assess the risk of **introduction and speed of propagation** into the EU and neighbouring countries
5. Assess the **risk of endemicity** in animal population in the EU and neighbouring countries
6. Assess the **impact** if enter the EU considering different scenarios
7. Review the feasibility, availability and effectiveness of the main disease **prevention and control measures**





APPROACH, METHODOLOGY, OUTPUTS – TOR1

Characterise the disease and global occurrence

- Literature review
- Mapping
- Case studies

Case studies		
SPP	PPR	LSD
Greece	Northern African countries	Israel
Bulgaria	Turkey	Turkey
	China	Jordan

SELECTED CONCLUSIONS – TOR 1

POX

SPP and GTP **endemic in many African, Middle Eastern and Asian countries**, with **recurrent incursions of SPP into Greece and Bulgaria** (the most recent of which caused 91 outbreaks in Greece and four in Bulgaria from August 2013 until April 2014)

PPR

- PPR **transmission** is essentially via **contact with infected animals**
- **Goats** considered **more susceptible than sheep** to PPR.
- **Cattle and pigs can be infected**, but show **no clinical signs**.
- **Camels and several wild ruminants can be infected and show clinical disease**, although their role in the epidemiology needs to be clarified.

LSD

- **endemic in most African countries**. Since 2012–2013 **spreading largely to Middle Eastern countries including Turkey** (endemic)
- involvement of **haematophagous arthropod vectors** (flies, ticks) in LSDV transmission
- spread with very low abundances of vectors may occur, thus **direct and/or indirect transmission (fomites) may occur**



APPROACH, METHODOLOGY, OUTPUTS – TOR 2

Mapping animal movements

- Screening different database (Eurostat, TRACES, UN COMTRADE, national authorities)
- Topics considered: trade of animals and products relevant for transmission, animal migration, socio-political drivers
- Outputs: Flow maps



SELECTED CONCLUSIONS – TOR 2

General

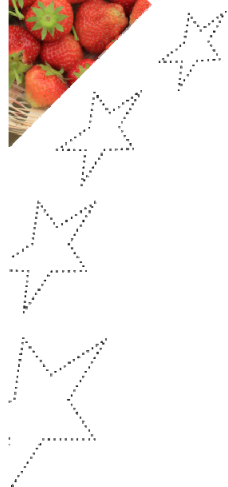
Movement of live animals from third countries into the EU is **currently forbidden**. However, **illegal movements** of animals cannot be quantified

PPR

- The **movement of small ruminants** related to trade (both legal and illegal) is the **most likely reason for the spread** of PPR across borders (East Africa and the Arabian Peninsula)

LSD

- **Skins and hides processed only by drying or salting treatments may pose a risk** for introduction of SPPV/GTPV into the EU >> more detailed information needed to complete import risk assessment



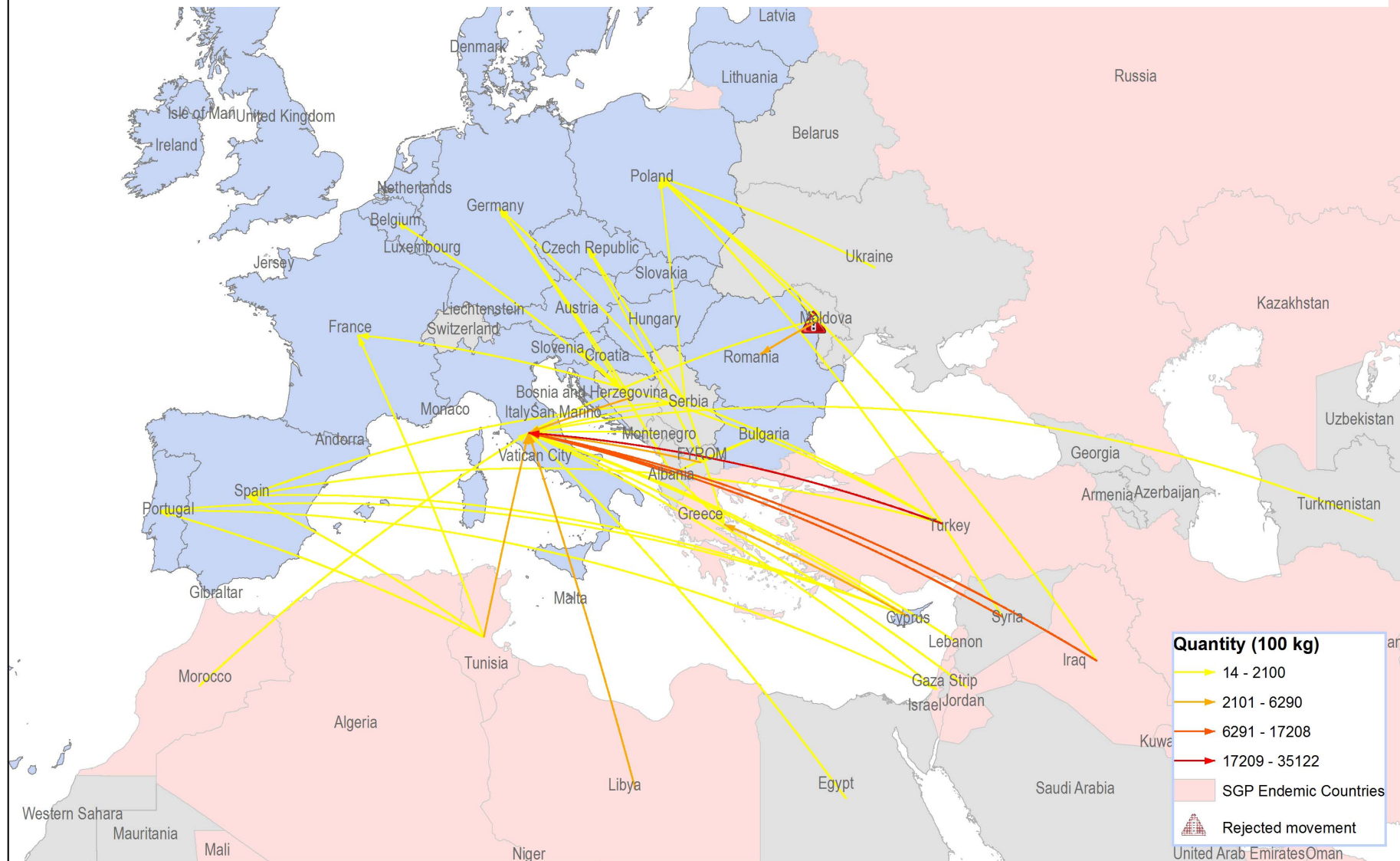
Animal trade movements (number of animals) of breeding/fattening animals from affected provinces/prefectures to other provinces/prefectures in Bulgaria and Greece in 2012.

file

EXAMPLE OF FLOW MAPS SHOWN IN THE OPINIONS



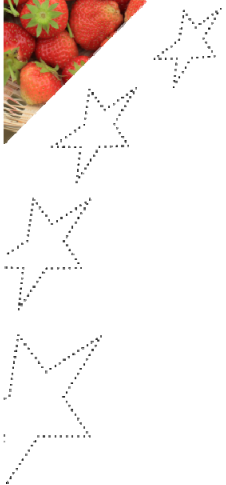
Consignments of raw hides or skins of small ruminants from North African countries, Middle East countries facing the Mediterranean Sea and third countries around the Black Sea to EU MSs in 2013 (Data source: Eurostat)




APPROACH, METHODOLOGY, OUTPUTS – TOR 3

Pathways of introduction

- Literature review
- Field evidence
- information on sources of outbreaks from OIE + ADNS
- Expert knowledge elicitation (questionnaire + analysis – for SPP)



PATHWAY OF INTRODUCTION - SELECTED CONCLUSIONS

- 
- SPP**
- people having contact with animals (e.g. immigrants, traders, visitors, animal workers)
 - vehicles
 - illegal movement of animals
 - Insects, wildlife (to be clarified)

- PPR**
- people having contact with animals (e.g. immigrants, traders, visitors, animal workers)
 - vehicles
 - illegal movement of animals
 - Insects, wildlife (to be clarified for SPP)

- LSD**
- infected animals (long-distance spread) . The spread of limited in distance when sick animals are not moved.
 - The active movement of flying vectors > pathway for LSD introduction from a short distance.
 - windborne transmission of vectors carrying the virus could be a potential route of LSDV introduction into a country



RISK OF INTRODUCTION - APPROACH, METHODOLOGY, OUTPUTS

Risk of introduction (for LSD and PPR)

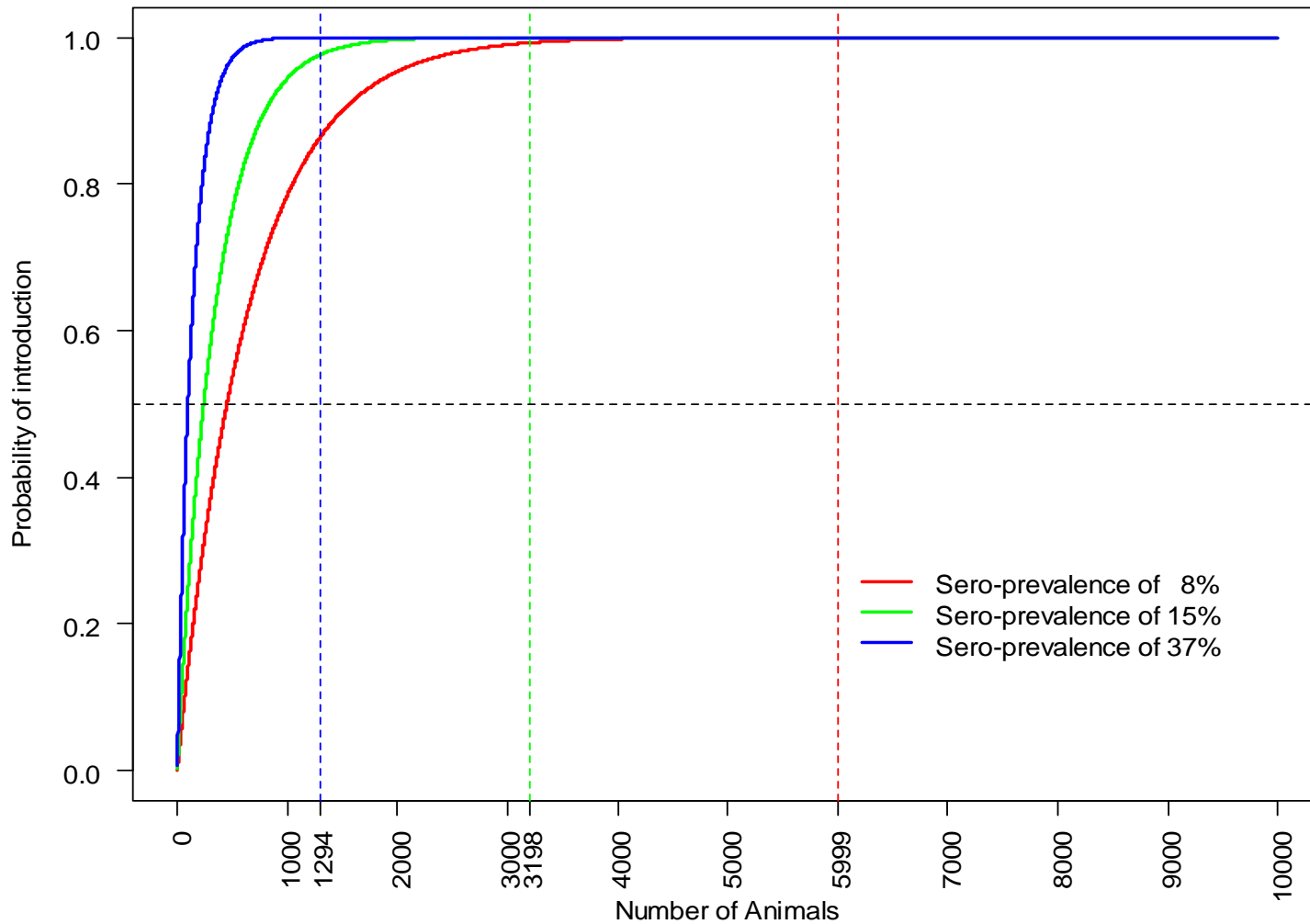
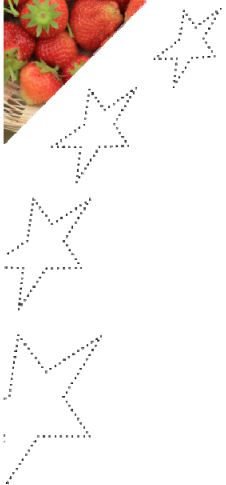
- Probability of introduction to EU via illegal movement of animals
- Scenario analysis with different values of seroprevalence in the country of origin and different shipment size of illegal animals

$$P(x > 0) = 1 - \left(1 - \frac{\text{Mean Infectious Period} \times \text{Sero-Prevalence}}{\text{Mean Duration of Immunity}} \right)^N$$

- **Output:** estimation of number of animals to be moved to have probability >0.95 to introduce PPR/LSD in Europe



PROBABILITY OF INTRODUCTION - F: (SERO-PREVALENCE LEVELS, AMOUNT OF ANIMALS ILLEGALLY MOVED)



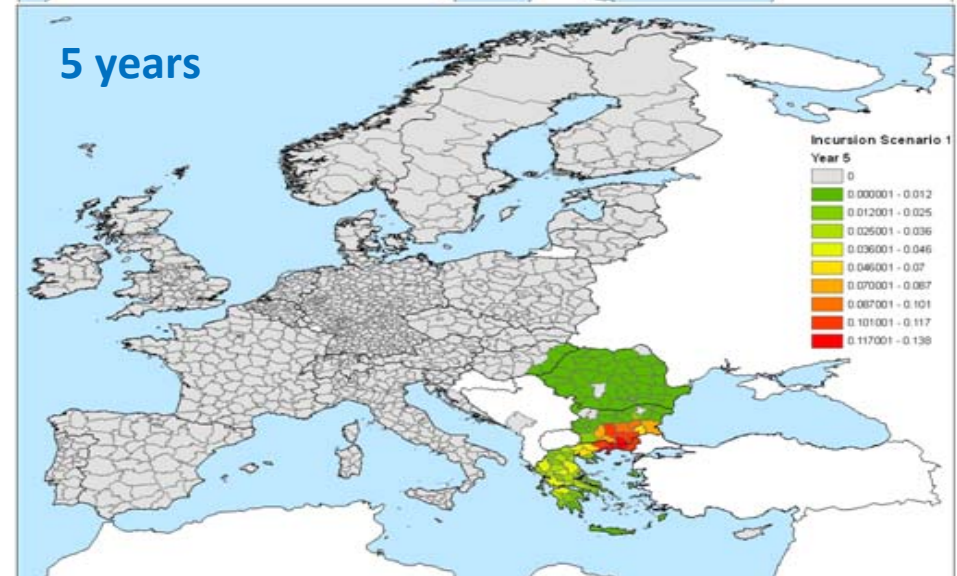
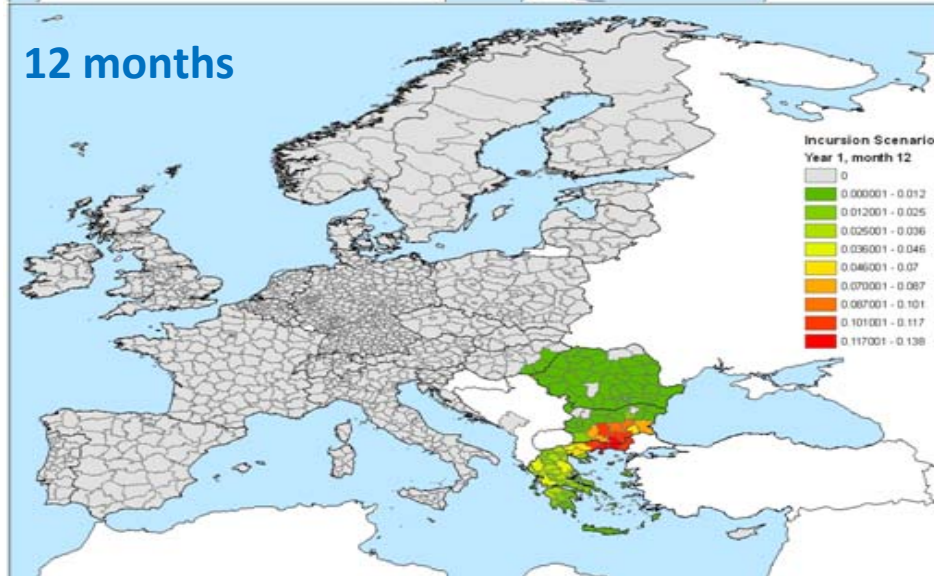
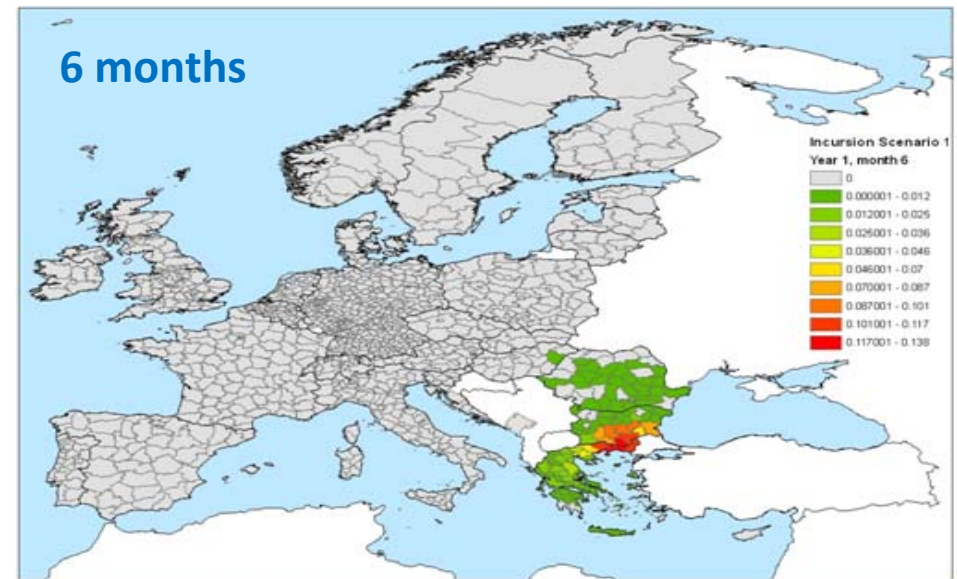
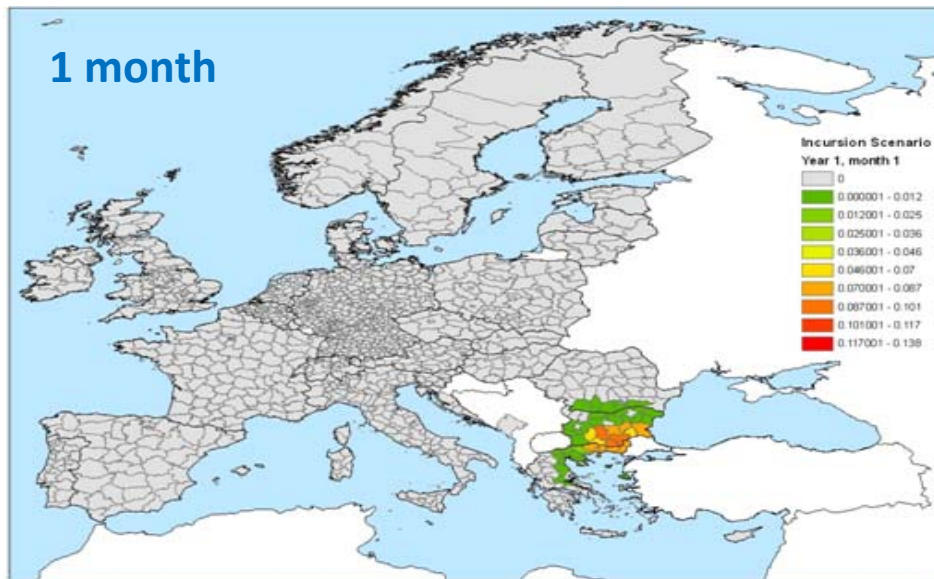
APPROACH, METHODOLOGY, OUTPUTS – TOR 4

Spread and speed of propagation for sheep pox

- **Mathematical model** of spread (kernel based) using data from the 2013/14 outbreaks in the EU (GR+BG) and European Turkey.
- **Prediction** of SPP spread between NUTS3 regions in Europe.
- **Different scenarios** of spread after incursion

Presented extensively in July 2014





Simulation of SPP/GTP spread over EU after incursion in Greece and Bulgaria

- probability of an area becoming infected, the force of infection between regions is proportional to the number of sheep /NUTS3 and given the control measures as applied in Greece and Bulgaria.



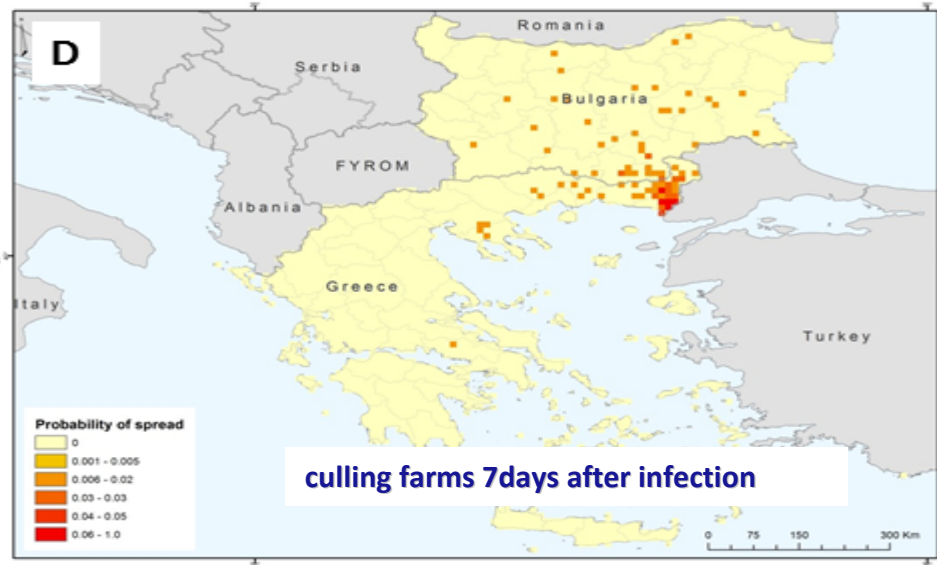
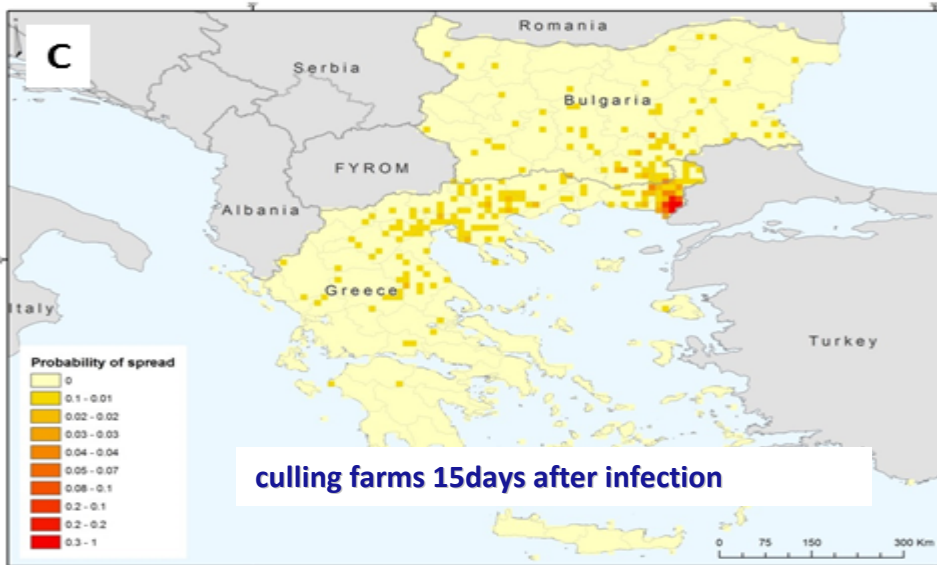
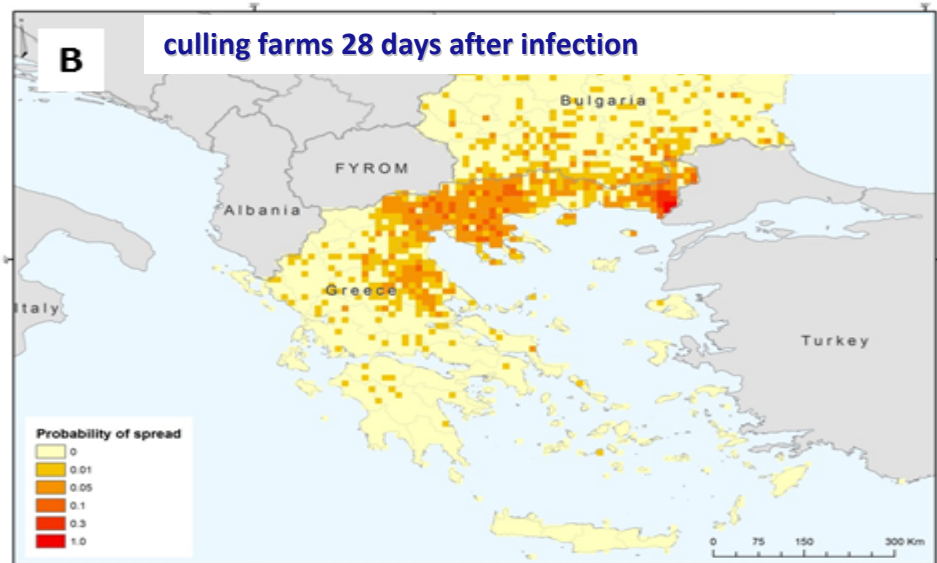
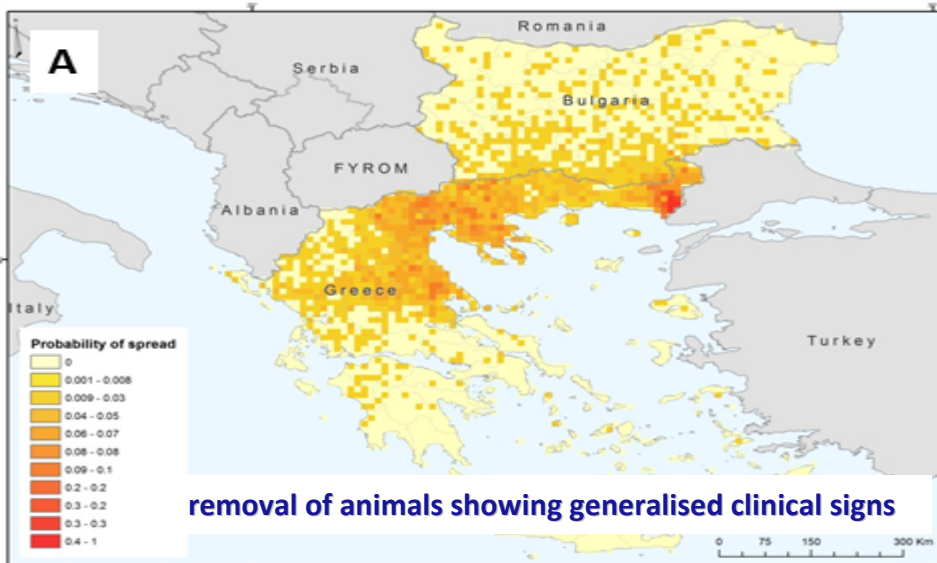
APPROACH, METHODOLOGY, OUTPUTS – TOR 4

Spread and speed of propagation for PPR

- **Plot of temporal and spatial linkages** between PPR outbreaks in Tunisia
- estimation of potential ranges of speed of propagation (km/day)

Spread and speed of propagation for lumpy skin disease

- **Mathematical model** of LSD spread based on between-farms transmission in Israel and spread simulation after incursion into EU.



Simulated spread of lumpy skin disease (LSD) in Bulgaria and Greece when control is (A) by removal of animals showing generalised clinical signs; (B) by culling farms 28 days after infection; (C) by culling farms 15 days after infection; (D) by culling farms 7 days after infection. The map shows the proportion of simulations (indicated by the scale bar) for which at least one farm in a 0.1° by 0.1° grid square became infected. The model was run from the time of incursion (assumed to be 30 May) until 31 December.

APPROACH, METHODOLOGY, OUTPUTS – TOR5

Risk of endemicity

- Qualitative assessment
- Expert knowledge
- Field evidence from outbreak investigation





SELECTED CONCLUSIONS - RISK OF ENDEMICITY

SPP

- **long-term survival of the SPPV in the environment**

>>>>> extensive cleaning and disinfection measures of premises + waiting period before re-stocking

- Under the control measures applied in affected MSs, SPP has **not become endemic in EU**

PPR

- **lack of data** regarding PPR transmission in the EU, the international data (Tunisia) cannot be extrapolated directly to the European situation

- Given the control measures foreseen by the current EU policy, PPR **would most likely not become endemic in the EU.**



SELECTED CONCLUSIONS - RISK OF ENDEMICITY

LSD

- Owing to a **lack of data** regarding the ability of potential European vectors of disease transmission, the international data cannot be extrapolated directly to the European situation.
- Under the current EU policy, according to the scenarios produced using the spread model, if the situation and ability of vectors was the same as in Israel, LSD **would most likely not become endemic in the EU**

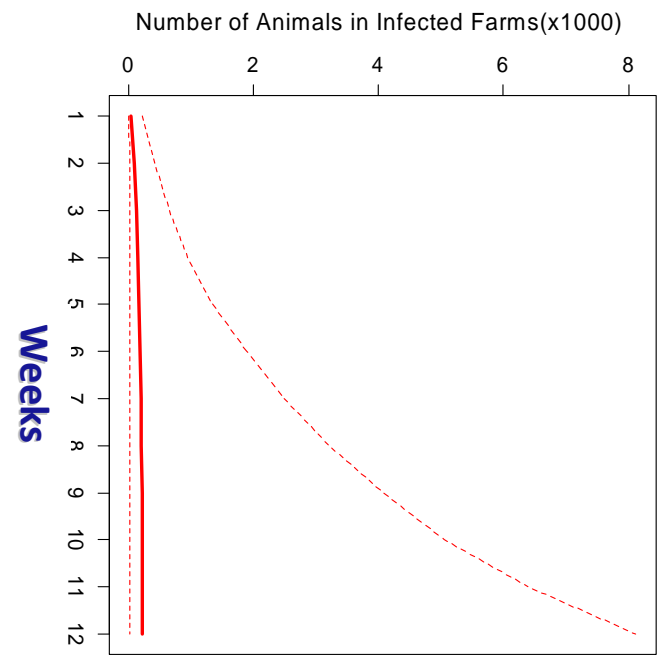
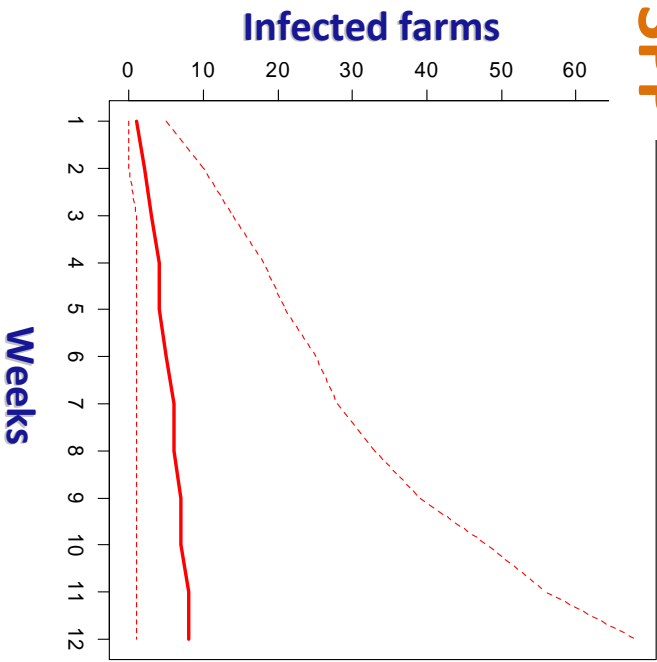


APPROACH, METHODOLOGY, OUTPUTS – TOR 6

Impact >> direct losses

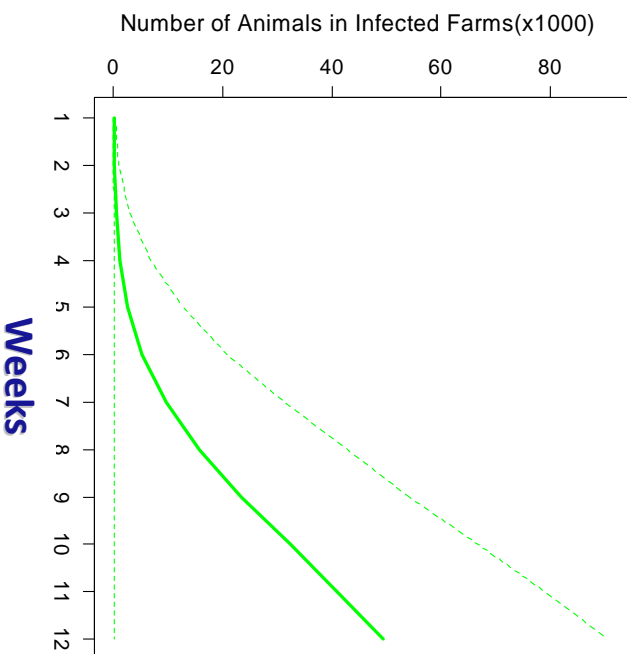
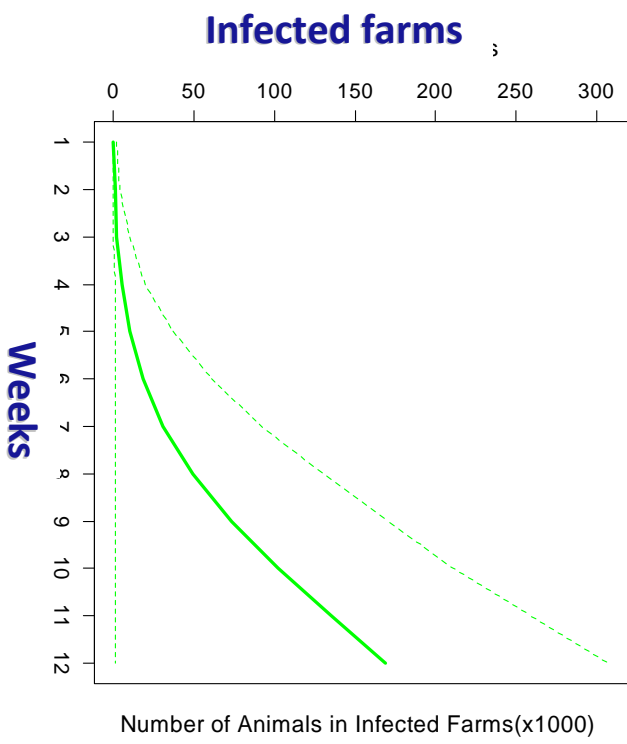
- Impact assessment with data from affected countries
- Impact assessment in endemic countries (literature review)
- Simulation of affected farms and animals in different scenarios after incursion in EU (SPP and LSD)



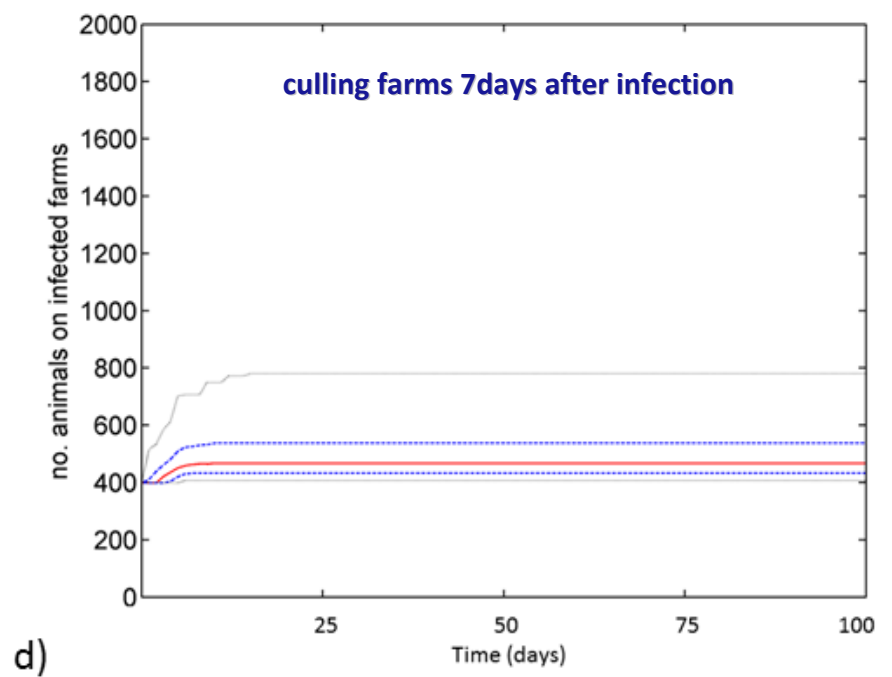
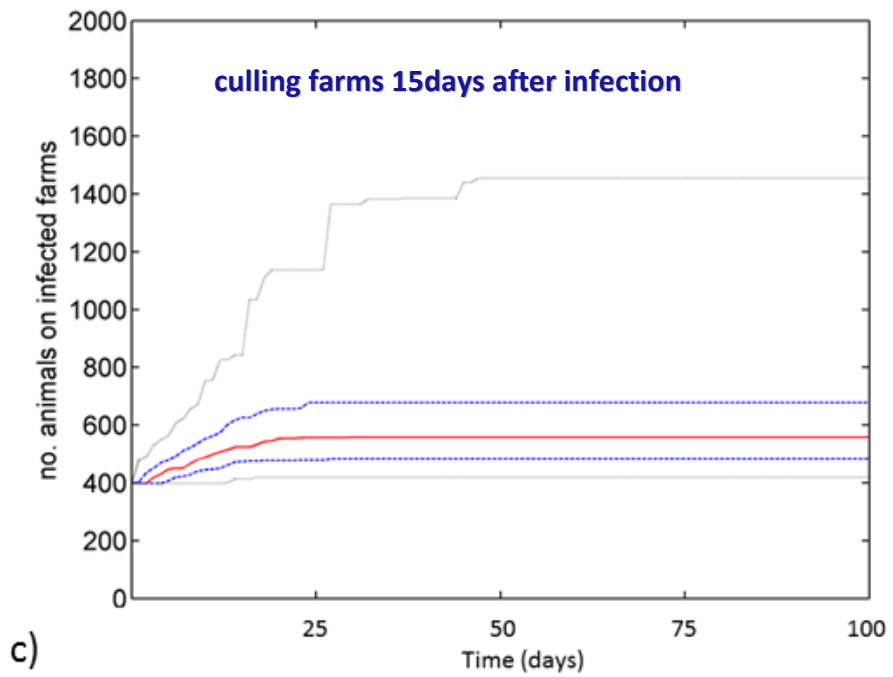
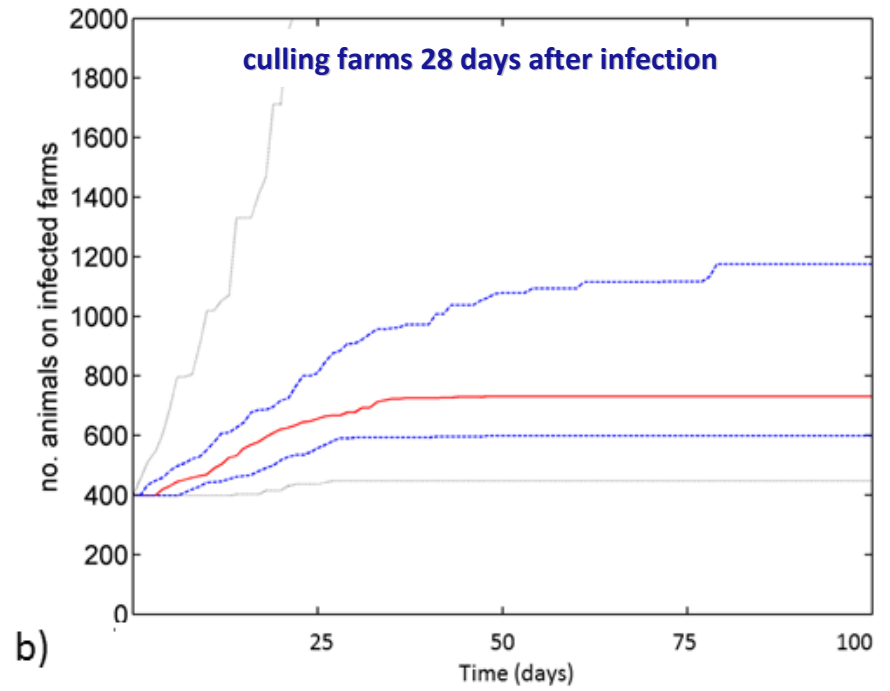
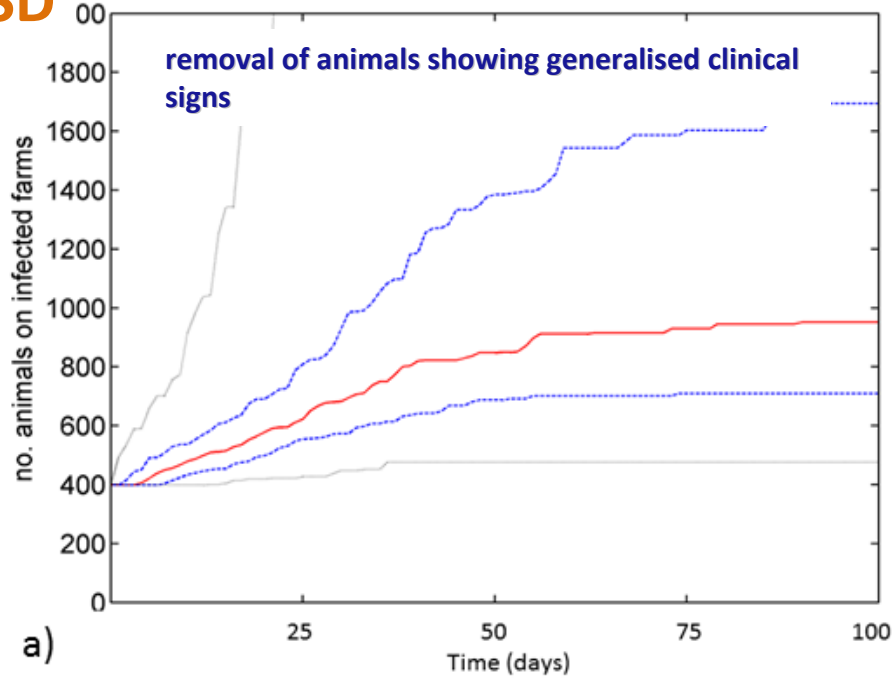


A - Scenario in Greece and Bulgaria

B - Scenario in Iberian peninsula

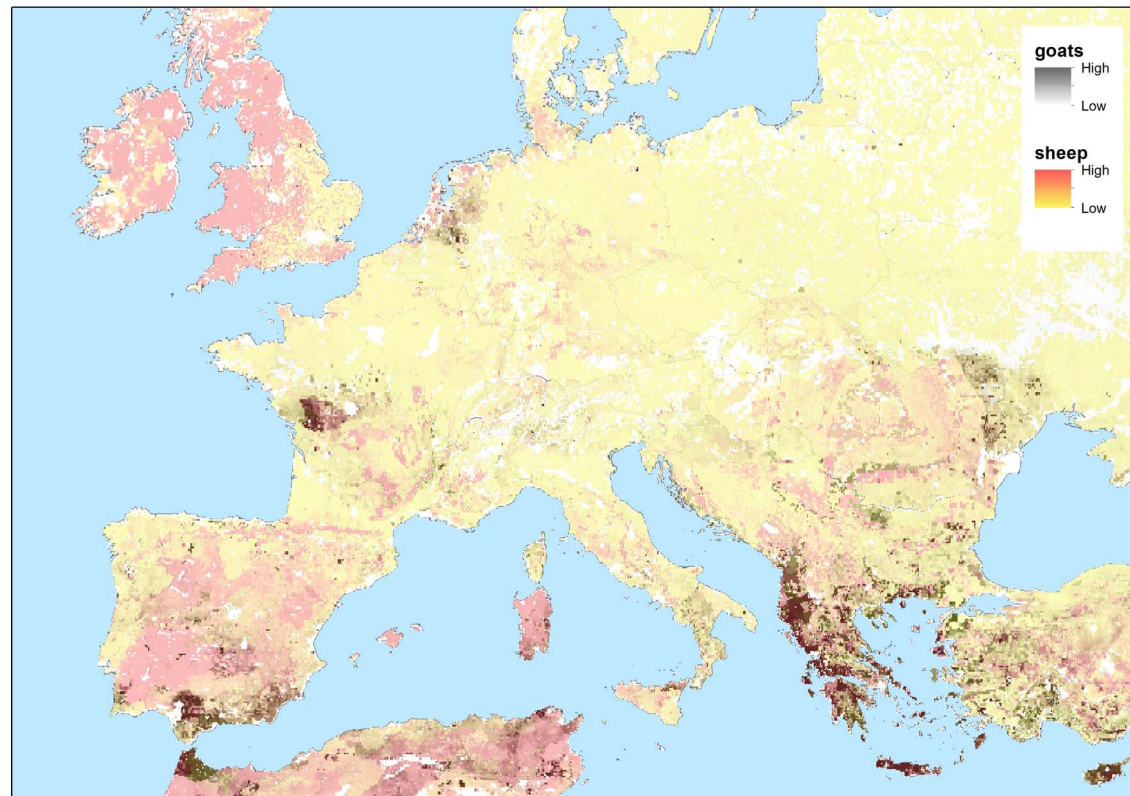


LSD



PPR IMPACT IN EU

- European goats considered more susceptible than sheep.
- **if PPR enters areas in the EU with dense sheep populations but low goat densities, it would start circulating and leading to widespread infection before being detected**





APPROACH, METHODOLOGY, OUTPUTS – TOR 7

Effectiveness of prevention and control measures

- Methodology: literature review, lessons learnt from case studies, expert knowledge
- Review of **available diagnostic tools**, sensitivity specificity, shortcomings
- **Biosecurity, movement restrictions, culling**: effectiveness and problem of their implementation at field level
- **Vaccines & vaccination**:
 - available vaccines and their effectiveness,
 - assessment of vaccination in free areas vs. endemic areas





CONCLUSIONS - CONTROL MEASURES

LUMPY SKIN DISEASE

- **Rapid laboratory confirmation** for successful eradication.
- Only live attenuated vaccines against LSD are currently commercially available. **No LSDV vaccines are licensed in the EU.**
- **limited epidemics controlled by using SPP vaccine AND culling animals with generalised skin lesions.**
- **Large epidemics controlled by vaccination with homologous vaccine AND culling of animals with generalised symptoms.**
- **RM-65 attenuated sheep pox vaccine** at the recommended dose for sheep has **limited effectiveness**. 10-times dose of RM-65 is more effective in term of protection, although less effective than vaccination with homologous strain.
- The **Neethling attenuated lumpy skin disease virus vaccine** is **highly effective BUT safety issues** have been reported linked to generalized clinical reactions due to the vaccination.
- **No evidence to prove effectiveness of insecticide** in controlling LSD morbidity



CONCLUSIONS - CONTROL MEASURES

Sheep POX

- **movement restriction** of animals appears to be an **effective measure** to prevent direct contact between animals
- **Culling** of the affected herds **on the basis of the clinical signs and lesions** is an **effective and time-saving** measure to reduce the risk of spread.
- **Homologous vaccine is more effective.**
- **Sufficiently attenuated and tested vaccines** are **safe and effective**, however some may have **residual pathogenicity**.
- **Inactivated vaccines not commercially available** (not long-lasting, up to 6 months).
- The use of **inactivated vaccines** could be considered only in case of an **emergency vaccine** and **as a safer option than the use live attenuated vaccine in non-endemic countries**.





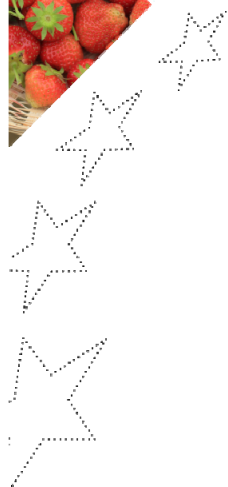
CONCLUSIONS - CONTROL MEASURES

PPR

- **Clinical signs** of PPR are not disease specific, **should be confirmed by laboratory testing.**
- **Live, attenuated PPR vaccines are available, with high safety and efficacy,** protecting against all known isolates of PPRV. **No PPR vaccines are licensed in the EU.**
- **No vaccines support the DIVA principle.** recombinant techniques at experimental stage.
- **Inactivated vaccines** are not available and **would not be fully effective.**
- **PPR can be controlled** in areas, such as Northern Africa (Morocco), **through mass vaccination** if means are available and correctly implemented.
- In **endemic areas,** assiduous vigilance is needed because **risk of PPR reoccurrence** (illegal movements of livestock).
- **Early detection of (re)occurrence is needed** for rapid response and the management of possible outbreaks of PPR.

MAIN RECOMMENDATIONS

- Enforce biosecurity measures
- Awareness-raising campaigns and training for farmers and veterinarians
- harmonise data collection of outbreaks from MSs and neighbouring countries
- Need of protective, safe, DIVA vaccines
- Cooperation of the EU with neighbouring countries >> prevention of TADs and enhance preparedness





Thank you for your attention!

Acknowledgements to the team!

- AHAW Panel
- Experts of WGs
- Contractors
- EFSA staff



LOOKING FOR REGIONAL COOPERATION: QUESTIONNAIRE FOR REMESA MEMBERS

AIM: Increase cooperation between EU and REMESA countries

Specific objective: information sharing to enhance the level of preparedness and awareness about animal diseases and their control both in EU and northern African countries

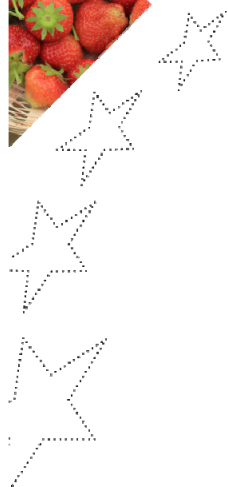
Topic: PPR epidemiology in Northern Africa, to explore possible pathways of introduction and spread



RISK AND SPEED OF SPREAD OF SPP

Methodology

- A model to evaluate the spread of SPPV over space (data 2013/14 outbreaks in EU and European Turkey)
- The continental-scale spread resolution : NUTS3
- different models and assumptions tested
- Three scenarios for the spread of SPP in the EU after 1, 6, 12 months and after 5 years:
 - incursion in the regions of Bulgaria and Greece
 - incursion in Croatia and Hungary, over Balkans
 - incursion in southern Spain, from northern Africa.



RISK AND SPEED OF SPREAD OF SPP

4 models for dependence of the force of infection on host demography:

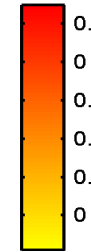
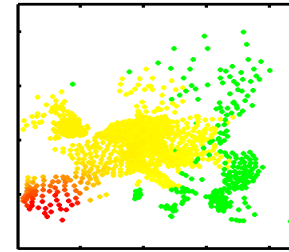
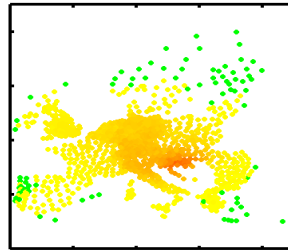
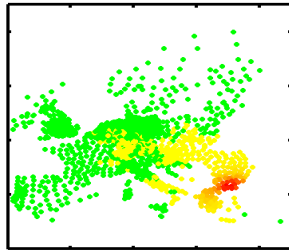
- (i) no dependence (i.e. $D_i=1$)
- (ii) proportional to the number of holdings with sheep, N_i (i.e. $D_i= N_i$)
- (iii) proportional to the number of sheep, S_i (i.e. $D_i=S_i$)
- (iv) proportional to mean holding size (i.e. $D_i=S_i/N_i$)

The best fitting model: transmission between regions proportional to the number of sheep per NUTS3

Incursion to Bulgaria/Greece

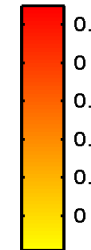
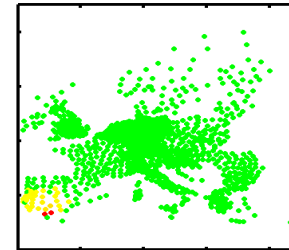
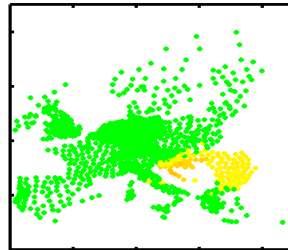
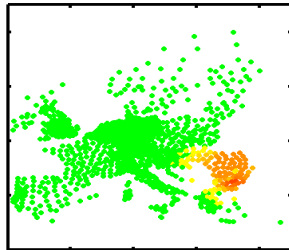
Incursion to Croatia/Hungary

Incursion to southern Spain

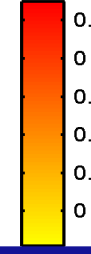
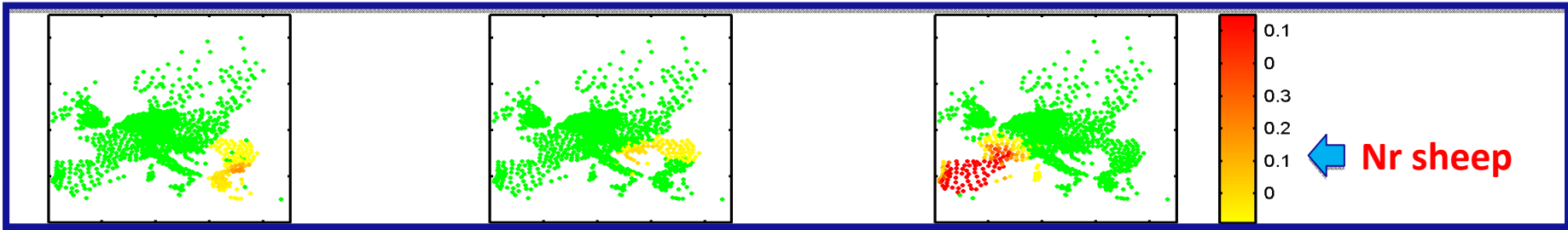


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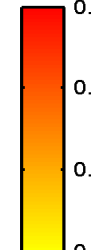
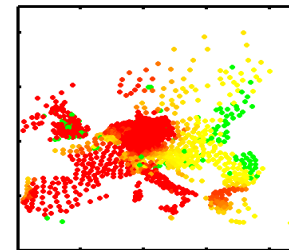
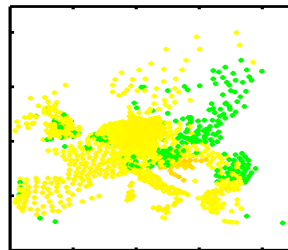
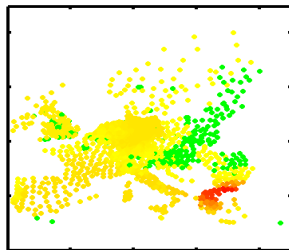
No dependence



Nr holdings



Nr sheep



holding size



Predicted spatial spread of sheep pox virus in Europe under different incursion scenarios.

ASSUMPTIONS & LIMITATIONS

- ❑ the contact patterns within Europe are similar to those in Bulgaria and Greece.
- ❑ limited availability of data
- ❑ analysis restricted to an evaluation of the probability of SPPV transmission over a given distance; $f(N_r)$ number of herds or sheep in a region)
- ❑ No distinction between possible transmission routes
- ❑ Large uncertainty in quantifying the level of transmission.
- ❑ the model predictions to be considered as an example of the options when assessing risk of SPP epidemics in EU

