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EMIDA Call Progress Report

(FINAL)

Project Title: Vector-borne Infections: risk based and cost effective surveillance systems

Acronym: VICE

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1. Summary of the project's progress

Consider each of the following items:

- *Main activities and achievements of the consortium*
- *Your opinion on the internal cooperation and added value to the project*

Please state if developments within the projects or outside have caused you to amend any of the project's goals and, if so, in what way

Overall

The steering committee (one member from each partner institute) held monthly telephone conferences and met face to face annually (Brighton, June 2012 , Brussels, September 2013, Copenhagen, 2015 and Brussels, April 2015). A consortium agreement including a data sharing agreement is signed by all partners. Four partners (SVA, NVI, DTU and FLI) have acquired an extension to reach the project aims in 2015 (see section 4).

The consortium has produced 4 accepted papers and 1 submitted paper. Currently the participants are, however, still working on 18 articles. These will partially being written in the extensions provided to some of the countries (see point 4), in the finishing process of PhD projects or on own budget. The consortium targets to have the majority submitted before the end of 2015.

Workpackage 0

A data exchange server was set up at the FLI and a description how to access the server was developed. All partners had an individual account to the server. Within the project, all data and results necessary to fulfill the project aims were stored on the server. Within the steering committee it was agreed to store the data until the end of 2015 to be sure to have access to the data until the results are published.

Workpackage 1

A joint PhD project between CVI and INRA-EpiA was started. In WP 1 this PhD student (Céline Faverjon) worked on the introduction of African Horse Sickness in France. The PhD student developed a risk pathway model and collected data to parameterize this model. The result of the work have been accepted for publication.

An MSc student was recruited in January 2014 to work on the introduction of a second infection (Equine Encephalosis Virus) and closely worked with the PhD student. The MSc student produced a Masters-thesis on this subject and graduated in September 2014. The content of the thesis is currently being rewritten to be submitted for publication.

Several visits of the PhD student to the CVI and regular telephone meetings have provided good opportunity to combine risk analyses and modelling expertise from CVI with knowledge on horse disease from INRA-EpiA.

Based on the experiences with the work, a technical report was written on the requirements of introduction risk models for different purposes. This report has been presented during the workshop in Brussels, April 2015.

Workpackage 2

Detailed field data on mosquitoes and biting midges were collected in 2012/13 in Germany by a PhD student of the University of Oldenburg. Also SVA has successfully carried out intensive vector mapping during the 2012 and 2013 seasons as a part of a PhD study. The analyses of vector and breeding site data for Germany were conducted. For Sweden analysis is currently under way (also see extension to the project for some partners under point 4).

Two generic frameworks for disease transmission models adapted for risk based surveillance were developed. The models for Culicoides borne viral diseases are fully parameterized and

will be used to compare the two frameworks in a publication which is currently in preparation. The models for mosquito infections are parameterized.

Some microclimatic data were recorded in Denmark, and preliminary analysis showed a consistent impact of microclimate. However this part of VICE was severely affected by the final budgets adaptions at DTU, and modelling of the data was not done as ambitiously as originally described and budgeted for. However DTU was able to attach a PhD student (Najmul Haider) to the VICE project in 2015 and was granted a project extension by the national funder to the end of 2015 (see under point 4). Micro climatic temperature data will therefore be recorded during the field season 2015 at 80 positions. Another PhD student (Ana Cuellar) was attached to VICE at DTU to continue work on the vector models for Culicoides and mosquitoes.

In FLI a scientist (Maya Gussmann) was employed and within WP2 a disease transmission simulation model based on data of BTV was developed. A combined simulation model was developed based on the models of Gerbier et al. (2008), de Koeijer et al. (2011) and Santman-Berends et al. (2011) to simulate the bluetongue outbreaks in 2006 and 2007 (see D2). We subsequently used the outcome of the simulation model to test different surveillance strategies for an early detection of Bluetongue disease that is active surveillance, passive surveillance or a combination of both. For active surveillance, we tested different levels of detection (0.5, 1, 2 and 5% on animal level). Because of the delay in the development of the simulation model, we have only preliminary results on the surveillance strategies. The calculations including the surveillance cost calculations will be provide at the end of 2015.

Workpackage 3

Literature search has been performed by all partners in WP3 to provide an overview of syndromes relevant for the VBD included in the project. From this overview it was concluded that the principal types of data sources in animal health have been reviewed by others and the actual data sources available in each country develop rapidly as more and more information is registered electronically. Therefore, an inventory list would soon be obsolete. For this project, Norway and France evaluated the data sources accessible nationally and choose the data sources that were currently accessible for the project and that could be used to identify time periods, geographical areas, or animal populations with a higher probability of having selected VBD.

NVI are working on syndromic surveillance for bluetongue and West Nile virus in Norway. The work is delayed as NVI hasn't been able to dedicate sufficient time for the project.
For syndromic surveillance of bluetongue in Norway, NVI will use data on events in the dairy herd population. Data on mortality and late abortions in the Norwegian dairy herd population for 2004 to 2012 have been gathered from the Norwegian Dairy Herd Recording System (Tine dairies). In addition, a previously developed simulation model for bluetongue has been reprogrammed into R software and adapted to Norwegian conditions by preparing Norwegian input data as Norwegian cattle demography (herd geo-coordinates, production type and herd size) and Norwegian temperature data. The simulation model has been extended so that the number of late abortions in dairy herds is simulated in addition to number of dead animals. Several different scenarios concerning introduction of bluetongue and temperature will be run. The output from the simulations will be used in three different studies. The first study will have as a starting point the actual situation in 2008 to 2009, when Norway experienced introduction of bluetongue into four herds. The aim of the study will be to evaluate the use of syndromic surveillance in the hypothetical situation that bluetongue was not eliminated but

spread further in 2009. Multivariate statistical process control will be used to identify aberrant cases, i.e. cases that exceeds normal and thereby indicate that an outbreak of bluetongue occur.
In the second paper, bluetongue will be introduced in the population at random times and locations and SatScan will be evaluated as a method for identifying aberrant events.
In addition, output from simulations will be used as one of three examples in the review paper "A general framework for syndromic surveillance based on Bayesian modelling". For this paper, higher mortality and or abortion rate than expected with bluetongue may be simulated to ensure that the data can be used as an example to illustrate the methodology.

Several data sources including veterinary practitioner data have been evaluated as potential source data for the study of syndromic surveillance for West Nile virus. NVI has got access to the information on no-start of trotter horses in Norway from 2005 to 2012 from The Norwegian Trotting Company. The data has been organised and preliminary explorative analysis has been performed. Evaluation of the use of these data for syndromic surveillance for West Nile virus and other diseases has started.

EPIA has worked on syndromic surveillance for West Nile virus in France. Data on nervous syndrome in horses, collected by the RESPE (Epidemiological network for infectious diseases in horses), have been analysed by the PhD student recruited jointly by CVI and INRA-EpiA and with the collaboration of SVA and VPHI. A paper was published in Plos One (Anderson et al. 2014).

The work further focused on the evaluation of the added value for combining multiple sources of syndromic data for the early detection of West Nile virus. For this purpose, data from dead horses and birds have been collected and are currently under analysis. A paper on this topic should be submitted in June-15.
In this work we propose the adoption of a statistical framework used in the evaluation of forensic evidence as a tool for evaluating and presenting circumstantial ‘‘evidence’’ of a disease outbreak from syndromic surveillance. The basic idea is to exploit the predicted distributions of reported cases to calculate the ratio of the likelihood of observing n cases given an ongoing outbreak over the likelihood of observing n cases given no outbreak. The likelihood ratio defines the Value of Evidence (V). Using Bayes’ rule, the prior odds for an ongoing outbreak are multiplied by V to obtain the posterior odds. This approach was applied to time series on the number of horses showing clinical respiratory symptoms or neurological symptoms. The separation between prior beliefs about the probability of an outbreak and the strength of evidence from syndromic surveillance offers a transparent reasoning process suitable for supporting decision makers. The value of evidence can be translated into a verbal statement, as often done in forensics or used for the production of risk maps. Furthermore, a Bayesian approach offers seamless integration of data from syndromic surveillance with results from predictive modelling and with information from other sources such as disease introduction risk assessments.
Further work aims at testing the use of syndromic surveillance in horses combined with mortality in horses and birds to improve the sensitivity and specificity of WNV syndromic surveillance. A paper is currently in preparation and should be submitted in July-15.

A Bayesian framework based on principles for evaluation of forensic evidence was proposed as a general means of combining probability estimates from modelling of introduction and transmission with the outcome from surveillance and presenting the outcome to decision makers. A simple application of the framework to non-spatial syndromic surveillance for west Nile Virus and Equine Influenza was presented in a paper by Andersson et al. 2014.

Manuscripts in preparation describe the application of the framework to situations with multiple data streams, delayed reporting and spatiotemporal data.
In addition, we are reviewing Bayesian models for syndromic surveillance and discussing the application of the framework for analysing and presenting results from syndromic surveillance. The report is planned for publication in the format of a review or discussion paper.

Workpackage 4
Objective of the work in this WP is to propose a general framework for calculating a joint risk score (JRS) based on the output of WPs 1, 2 and 3.
Because this JRS requires information from all partners and provides input for further analyses, this WP involved all the partners of the project. Brainstorming sessions have been organized between partners to propose different methods that would be able to produce such a JRS, both by telephone conferences (Febr.-12, June-13, Sept.-13, Oct.-13,) and by face to face meetings (Amsterdam Apr.-13 and Brussels Oct.-13). The workshop in Amsterdam (April 11, 2013) allowed to do a review of the bibliography on the subject and two methods were selected to be tested for the calculation of JRS. A statistician from SVA was involved from Sept-13 onwards and a second face-to-face meeting organized in Oct-13 in Brussels. Preliminary results for the JSR were presented and discussed.

A 2nd workshop on Joint Risk Score (JRS) was held in Paris on Feb. 25-26th, 2014 with all the partners. We agreed on working with a simulated "imaginary area" in which we create input data reflecting what we would expect from a real area. The input files allowed us to produce output files for the calculation of JRS: "introduction", "transmission" and "syndrome surveillance". Furthermore, the imaginary area constitutes a way of technical testing the JSR on all our outputs, making the modelling tasks more concrete and allows simulating different situations if we want to explore the sensitivity of different parameters regarding the JRS.
Finally, a 3rd workshop for the validation, application and presentation of the JRS to risk assessors was held in Paris, 26-27th Feb 2015. Thirty persons attended the workshop, amongst them 14 persons from 8 countries external to VICE project and one person representing EFSA. Persons were from state agency or veterinary services, involved in surveillance data collection and management, risk assessment, risk management and/or research. Objectives of the workshop were (1) to disseminate information on JRS to inform decision making (e.g. the design/targeting of surveillance activities), explain how it works and demonstrate how it could be used, so that decision makers understand why the JRS could be interesting, (2) get feedback on advantages/disadvantages, validity and utility of the concept, transparency, discuss concepts and assumptions, optimize communication/explanation of JRS and finally (3) obtain feedback and ideas for possible follow-up project, what would it take to make it (even more) useful.
A paper is in preparation for submission in October 2015 to an international journal to present the general framework for the method and its application on the example of Equine Encephalosis in France (Fisher EAJ and al., in preparation).

Workpackage 5
A joint Master student (Rebbeca Nafzger) and post-doc (Simon Ruegg) was initiated between the institutes CODA-CERVA (BE, Brussels) and IPH (CH, Bern) for the work in workpackage 5 & 6.
Within WP5, the aim was to evaluate surveillance systems for three different surveillance purposes: (1) early warning or detection of emerging exotic VBD (2) increased spread and/or occurrence of endemic VBD, and (3) documenting freedom from diseases. For this Bluetongue (BT) was taken as a case study. During the first year, information describing the

BT virus surveillance activities was collected from relevant veterinary services or institutes by a comprehensive questionnaire. For each of the countries information about the whole population (animal), the number of samples taken per population, the type of sample and the diagnostic test used, the design of sampling, the surveillance components used in the country, the costs related to design and sampling were collected. While all countries, which provided data, fulfilled the requirements of European Commission regulation 1266/2007, surveillance systems differed substantially regarding target population, type and number of samples analysed, and diagnostic test used.
The sensitivity of the surveillance systems of Belgium and Switzerland for bluetongue as was investigated more in depth using scenario tree modelling. The output was the per annum sensitivity of the surveillance systems and their components such as passive surveillance and test method. The estimated overall sensitivity of surveillance systems in both countries was approximately 100%. In both countries, a main contributor to the high sensitivity was passive surveillance, i.e. case detection by farmers and veterinarians, due to the very large population under observation and the relatively long observation time of one year. Our results showed that for demonstrating disease freedom, investment in keeping disease awareness at a high level might be more effective than expensive active data collection. A manuscript for a peer-reviewed journal on the conclusions from the survey as well as the results for Belgium and Switzerland is submitted.
At FLI, the SIR model (see WP2) was used to analyse the sensitivity of different surveillance systems for early detection. The probability to detect the disease per month was analysed and the different surveillance systems were compared. First results were presented at the workshop in Paris. A publication about the findings is in preparation.

Workpackage 6
A model calculating cost of surveillance based on output from surveillance system- and transmission models (WP5) was developed at the Wageningen University by a post doc (Hurria Yassin). A model in the format of an Excel workbook has been completed, and made available to the project partners. This Excel workbook can support the decision making process on how many resources should be invested in surveillance. The method of incremental effectiveness analysis is used to analyse which gain of sensitivity of the surveillance system can be achieved by an additional investment of resources. The model was applied in the context of optimising surveillance efforts taking into account both the technical performance of specific surveillance approaches as well as their respective costs. Using the example of Bluetongue surveillance, an in-depth comparison and evaluation of alternative designs was conducted. However, the approach is applicable more widely in the context of surveillance of other hazards or pathogens.
International collaboration consisted primarily in coordinating the interface between the economic model (WUR, NL) and the scenario tree model (VPHI, Switzerland) or the SIR model (FLI, Germany), respectively. The added value of this international collaboration consisted of the complementary expertise in economics and veterinary epidemiology. Between the partners there were 3 face-to-face meetings (Wageningen (NL), Schiphol (NL) & Bern (CH)) and regular Skype or Telephone conferences.

Vector borne diseases are highly driven by temperatures, and hence the expected future warming may increase the potential for spread in Europe and hence also the future cost of surveillance. We explore this by running the R0 model with temperature predictions for the next 50 years and comparing the transmission risk with the risk at present temperatures. When the Culicoides vector models are finalised (during the DTU extension June-December 2015) they will be used to update the developed R0 model and the results presented in a web-atlas.

2. Achievement of planned objectives

Describe the activities that have been performed to meet the objectives set in the proposal.

WP 0:
D1: Relevant public data for disease biology, vector biology, animal density and movements, reporting systems, environmental and geographical risk factors and meteorological data available to partners.
D1.1 A data exchange server will be set up at the FLI and a user manual will be developed.
D1.2A data sharing agreement will be prepared and verified with the partners. The agreement has to be signed by the partners before they get access to the database
D1.3 The relevant and available data for the WPs is uploaded to the data exchange server
D1.4 Support to access the data exchange server

The data exchange server was set up in time and a user manual was developed by FLI and sent to all partners.
The data sharing agreement was included in the consortium agreement. After the partners signed this agreement, they got access to the data server.
All partners uploaded the relevant data and results on the data exchange server.
FLI supported the partners, if they had problems to get access to the server.

WP1:
D2: A general method for ranking risk of introduction presented with spatio-temporal (monthly) maps of the relative risk of introduction in disease free areas will be created for a selection of diseases.
Two specific diseases (AHSV and EEV) were selected to produce detailed spatio-temporal analyses of the risk of introduction of these infections. The methods and results have been accepted publication for AHS in France and are in preparation for EEV in the Netherlands and France.
Based on these specific results a generic review is reported for the use of introduction models for other diseases, which has been presented during the final project meeting in Brussels.

WP2:
D3: Microclimatic temperature model.
D3.1: Vector resting sites will be identified in the field and the microclimatic temperatures recorded
D3.2: Development of a model able to convert standard temperature data into estimates of microclimatic temperatures

Microclimatic data were recorded in Denmark, and preliminary analysis showed a consistent impact of microclimate. However this part of VICE was severely affected by the final budget adaptations at DTU, and modelling of the data was not done as originally described and budgeted for. Only in 2015 was it financially possible to attach a PhD student (Najmul Haider) to the micro climatic project. From May-June 2015, 80 dataloggers are operated in the field including farms and urban areas. DTU was therefore granted a seven months project extension (to December 2015) to finalise the originally describe microclimate project (also see point 4).

D4: Europe-wide relative risk maps of vector density.
D4.1: Rough vector abundance models for key mosquito, biting midges and ticks in Europe
D4.2: New data recorded for mosquitoes and biting midges in Germany. Additionally, data on breeding sites and their environmental data (abiotic and biotic) will be collected

D4.3: New data recorded for mosquitoes and biting midges in Denmark
D4.4: New data recorded for mosquitoes and biting midges in Sweden
D4.5: Improved vector abundance models for key mosquito, biting midges and ticks in Europe based on new data created in D4.2, D4.3, and D4.4

New vector data were collected in Germany, Sweden and Denmark (D4.1, D4.2, D4.3). Due to delays in the compilation of Europe-wide vector abundance data, we directly proceeded with "improved vector abundance models (D4.5)" without developing preliminary "rough vector abundance models (D4.1)" as soon as all data was present. DTU collated Europe-wide Culicoides data including the newly collected data within VICE (D4.5). In collaboration with the subcontracted AviaGIS, DTU developed Europe-wide Culicoides abundance models. These Culicoides models will be further improved by exploring additional techniques by a second PhD (Ana Cuellar) attached to VICE at DTU in 2015, and made possible by an extension of the project period at DTU until end of 2015 (also see point 4). The availability of Europe-wide mosquito data has been evaluated intensively, but it was not possible to get access to sufficient data. Therefore, only a mosquito models for Northern Europe with data from Czech Republic, Germany, Denmark and Sweden will be developed within the extension to the project in collaboration of the partners Germany, Denmark, and Sweden (D4.5; also see point 4).
Due to budget reduction of the VICE consortium, modelling of tick vector abundances was not feasible within the project as was reported in the midterm report and agreed with national funder in the Nederlands.

D5: A minimum of two national high spatial resolution mosquito density maps.
D5.1: Detailed information on abiotic and biotic parameters of mosquito and biting midge breeding sites in Germany
D5.2: Mosquito and biting midge abundance models supported by breeding site field work
D5.3: A minimum of two national high spatial resolution mosquito and biting midge density maps

Detailed field data on mosquito and biting midge breeding sites were collected 2012/13 in Germany (D5.1). These analyses were already included in two publications. Within the self-financing extension for the University of Oldenburg until 31.10.2015 (also see point 4), mosquito and biting midge abundance models and maps will be finished (D5.2, D5.3). National mosquito models for Northern Europe with data from Czech Republic, Germany, Denmark and Sweden will be developed within the extension to the project in collaboration of the partners Germany, Denmark, Sweden and Norway (D5.3; also see point 4). High-resolution Culicoides density maps on a monthly basis has been produced for all of Europe, but anticipate that these predictions can be further improved.

D6: A generic R0 model (including a generic model for temporal spread in one outbreak season) for insect borne diseases and a generic model for tick borne diseases.
D6.1: R0 model for selected mosquito, biting midge and tick borne disease from transmission models driven by standard
D6.2: R0 model from transmission models for selected mosquito and biting midge borne disease driven by temperatures microclimatic
D6.3: R0 model from transmission models for selected mosquito and biting midge borne disease driven by temperatures microclimatic
D6.4: Temporal and (if there is sufficient information) spatial SIR outbreak model of for vector borne diseases (example: bluetongue disease) driven by temperature

Two generic disease transmission models adapted for risk based surveillance of Culicoides borne viral diseases and mosquito borne diseases has been developed. Modelling of tick borne diseases was reduced, because of entire project budget reductions. CVI investigated the possibilities of a tick-borne transmission model and produced this in a very limited fashion within the available budget (a concept). This was already reported in the midterm report. The Culicoides and mosquito models all use the available climate data on the VICE data server and utilise the vector abundance models (D6.1 and D6.2).
The development of microclimatic temperature models was severely affected by the final budget adaptations at DTU, and modelling of the data was not done as originally described and budgeted for. Therefore, R0 models driven by improved vector abundance models and microclimatic temperature data were not produced (D6.2, D6.3) in the scheduled project period. But with the two new PhD students at DTU attached to VICE for 2015 this will be done by end of 2015 (see point 4).
The FLI developed a temporal-spatial disease transmission simulation model based on data of BTV from Germany, Belgium and the Netherlands, which was used in workpackages 4 and 5 (D6.4).

WP3:
D7: A system for syndromic surveillance for the selected VBD.
D7.1: A literature search will provide an overview of syndromes for the selected diseases
D7.2: Availability and description of potential data sources for syndromic surveillance for vector borne disease in animals
D7.3: Space-time data on probability/risk of Bluetongue in Norway due to occurrence of syndromes
D7.4: Space-time data on probability/risk of West Nile virus in Norway due to occurrence of syndromes
D7.5: Space-time data on probability/risk of West Nile virus in France due to occurrence of syndromes

Literature search has been performed by all partners in WP3 to provide an overview of syndromes relevant for the VBD included in the project. The information has not been found publishable (D7.1).
As reported in the midterm report, the value of producing an inventory of the available data sources for syndromic surveillance on national and international level for the remaining deliverables in this project was questioned. Therefore, it was decided not to make an official publication of this overview (D7.2).

D 7.3 is delayed, as NVI hasn't been able to dedicate sufficient time for the project. Data collection and programming of analyses algorithms have started. The Research Council of Norway has extended the project for NVI to 31th December 2015.

A part of D7.4 is delayed, as NVI hasn't been able to dedicate sufficient time for the project. Available data has been organised and preliminary explorative analysis has been performed. The Research Council of Norway has extended the project for NVI to 31th December 2015. See also point 4.

EPIA has worked on syndromic surveillance for West Nile virus in France. Data on nervous syndrome in horses, collected by the RESPE (Epidemiological network for infectious diseases in horses), have been analysed by the PhD student recruited jointly by CVI and INRA-EpiA and with the collaboration of SVA and VPHI. A paper was published in PlosOne (Anderson et al. 2014) (D7.4).

D8: A validated system for the selected VBD and a general framework for syndromic surveillance of VBD in the EU.

A Bayesian framework based on principles for evaluation of forensic evidence was proposed as a general means of combining probability estimates from modelling of introduction and transmission with the outcome from surveillance and presenting the outcome to decision makers. Non-spatial syndromic surveillance for west Nile Virus and Equine Influenza was studied (Andersson et al. 2014). The application of the framework to situations with multiple data streams, delayed reporting and spatiotemporal data is in progress.
In addition, we are reviewing Bayesian models for syndromic surveillance and discussing the application of the framework for analysing and presenting results from syndromic surveillance. The report is planned for publication in the format of a review or discussion paper (D8).

WP4:
D9: A general method to calculate a single joint score for the 'risk of an outbreak'.

A general framework using Bayesian inference and decision theory to combine introduction risk assessment (WP1), transmission risk (WP2) and health and production data (WP3) – and demonstrate how it may be included in GIS system to communicate to risk managers/decision makers has been developed.

D10: A web based dynamic atlas showing (retrospectively) the weekly 'risk of an outbreak' for the insect borne diseases and monthly risk of an outbreak' for the tick borne diseases, for two selected recent years.

A tool has been implemented for Equine Encephalosis virus (EEV) and Bluetongue. The former model was extended into a demonstration decision support system featuring a web based interactive graphical user interface (GUI) with risk-maps supported by computer generated texts and graphs.
Before being ready to be implemented on a web page, the tool needs further development. Persons involved in risk-assessment during Paris's workshop in 2015 asked for more automatic analysis.

WP5:
D 11: Report comparing the new surveillance system with current mass screening/blanket surveillance.

A report has been prepared which compares existing surveillance systems for bluetongue with risk-based surveillance (publication in preparation).

WP6:
D12: A calculation of the discounted costs of selected levels of surveillance activities over a five year period and a rank of individual VBD's according to cost efficiency.

A calculation of the discounted costs of selected levels of surveillance activities has been prepared for bluetongue. Individual surveillance components have been rankedaccording to cost efficiency (publication in preparation).

D13: Weekly spatial risk 1980-2010 presented as dynamic maps for Europe supplemented with temporal risk charts for selected locations.

Weekly spatial risk 1980-2010 will be presented as dynamic maps for Europe supplemented with temporal risk charts for selected locations. This deliverable will be completed during the DTU extension June-December 2015

D14: Weekly spatial risk 2010-2060 presented as dynamic maps for Europe supplemented with temporal risk charts for selected locations.

Weekly spatial risk 2010-2060 presented as dynamic maps for Europe supplemented with temporal risk charts for selected locations. This deliverable will be completed during the DTU extension June-December 2015

3. International collaboration added value

Describe the activities that have been accomplished in collaboration within the consortium. Refer explicitly to joint milestones and deliverables produced.
Describe any sharing of facilities, databases within the consortium.

Infrastructure
VICE has set up a joint project database at a FLI server accessible for all partners. The server holds external data, project data as well as project management files.

Data sharing and collection
Modelled climate data from Institute for Environment and Sustainability, European Commission have been received in WP2 and are now available at the project server in a daily resolution and a detailed spatial grid from 1970 to 2012. Detailed vector data from Sweden, Denmark and Germany have been collected (constitutes 3/5 of deliverable 4),
These data form the basis for PhD student Ana Cuellar at DTU and Sonja Steinke at University at Oldenburg.
A contract has been negotiated with the subcontracted private company AviaGIS in Belgium describing the joint modelling of vector data between DTU, NVI and AviaGIS for deliverable four. A large amount of Culicoides and mosquito data for this task have been received from project partners and importantly also from other research groups in Poland, Spain and France interested in the VICE vector models.

Knowledge exchange, networking and collaboration
VICE partners heave collaborated across work packages. Coordination occurred during the monthly steering committee meetings by telephone conference. The collaborations have resulted in an intention for further collaborations and in the submission of a new proposal with a larger proportion of the consortium.
The backbone of the project exists of the Joint Risk Score as to be developed in WP4. This work is primarily theoretical and discussion is the main method to design the Joint Risk Score. This work package formed a working group existing of researchers from several partners (CVI, SVA, DTU-VET, INRA-EpiA, FLI and CODA-CERVA). The partners worked together during the workshops in Amsterdam, Brussels and Paris, where also the other partners were present. Furthermore, the working group collaborated by discussion through telephone conferences. The other partners were updated during joint meetings and the steering committee meeting.
French PhD student Céline Faverjon is supervised by both CVI and INRA-EpiA in WP1 and WP3. She has also visited DTU-VET in Denmark to work on the model developed by the

Danish partner, and visited the Swedish partner in order to work on the syndromic surveillance.
The University of Oldenburg, SVA and DTU-VET coordinated in WP2 on the collection of new data on resting sites and vector abundances. DTU-VET and CVI both developed a transmission model and had regular contact on parameterization and are preparing a joint publication for the comparison of the methods.
The achievements of WP5 and WP6 there were a close collaboration between CODA-CERVA and VPHI as both countries share a Doctoral Student (Rebekka Nafzger) and Post Doc assistant (Simon Ruegg). The Wageningen University has been subcontracted in order to do the economic analysis. Between both institutes there were 3 face to face meetings (Wageningen (NL), Schiphol (NL) & Bern (CH)) and regular Skype or Telephone conferences. The Doctoral Student worked at 6 months between CODA-CERVA and during one year at VPHI institute. It is noteworthy that the different working environments of CODA-CERVA (government agency, Belgium) and VPHI (university institute, Switzerland) give rise to fruitful discussions in terms of methodology and focus of the analysis. The combination of these cultures contributes significantly to scientific rigor and practical relevance of the work. Furthermore, they warrant a more generic significance of the work in an international context.
International collaboration consisted further for WP2, WP5 & WP6 in coordinating the interface between the economic model (WUR, NL) and the scenario tree model (VPHI, Switzerland) or the SIR model (FLI, Germany), respectively. The added value of this international collaboration consisted of the complementary expertise in economics and veterinary epidemiology.

4. Problems and changes in objectives

Describe any difficulties and problems that have hindered the achievement of the planned objectives and any alternative plans or changes with respect to the original proposal.

Extensions of the project
It was agreed within the steering committee that the server should be online until the end of 2015 to be sure that the partners are able to publish the result of the work.
A self-financing extension was granted for the University of Oldenburg until 31.10.2015 (original date: 31.03.2015) to allow the employment of PhD candidates, in order to ensure the completion of Culicoides and mosquito modelling. Further, the identification of a fraction of Culicoides specimen is pursued under application of molecular methods (award of contracts) to enhance analysis of breeding site data. Self-financing extensions were given at DTU and SVA to 31.12.2015 to allow for collaboration with two PhD students at DTU and joint mosquito modelling between SVA and DTU.
NVI has not been able to dedicate sufficient time for the project and consequently D7.3 and 7.4 and D8 is delayed. The Research Council of Norway has extended the project for NVI to 31th December 2015 to allow NVI to finish these tasks.

This final report will be updated when all partners have finished the work in the extension.

Reduction and changes of the objectives
In the mid-term report was already reported that the main difficulties in the VICE project had arisen from the last minute adaptations in the budget necessary to fit the available funds in EMIDA. This especially affected the budget for WP2 deliverable D3 micro climate model and therefore this part of the project will be done less detailed. Preliminary data however are encouraging and we aim for a model where microclimate is modelled as a range of variation instead of the planned predictive model. Also in WP2, modelling of tick borne diseases was

reduced, because of budget reduction. CVI investigated the possibilities of a tick-borne transmission model and introduction risk (WP1), produced this in a very limited fashion within the available budget. A report has been prepared indicating the conceptual challenges for developing transmission models of tick-borne diseases for use in the Joint Risk Score framework. Further developments have been stopped to focus on the general aims of the project.

According to the project plan, VICE wanted to attempt to compare risk based surveillance (based on the developed joint risk score from WP4) with the present non-risk based approach. This was changed for two reasons. (1) All participating countries already have included some risk-based sample collection in their surveillance, and (2) the model on joint risk scores may not provide enough detail on relative risks and population size in different risk strata to allow calculation of sensitivity of the surveillance.

5. Project-derived publications and patents

*Publications **with** the involvement of other partners of the consortium*	Published – and – accepted peer reviewed papers • Mats Gunnar Andersson , Céline Faverjon , Flavie Vial, Loïc Legrand, Agnès Leblond , Using Bayes' Rule to Define the Value of Evidence from Syndromic Surveillance, PLoS One, 2014 • Céline Faverjon, Agnès Leblond, Pascal Hendrikx, Thomas Balenghien, Clazien J. de Vos, Egil A. J. Fischer and Aline A de Koeijer, A spatiotemporal model to assess the introduction risk of African horse sickness to Europe: France as a model system, BMC Veterinary Research, In press Submitted papers for peer review • Rebekka Nafzger Bigler, Simon Rüegg, Katharina D.C. Stärk, Gertraud Schüpbach-Regula, Yves Van der Stede, Sarah Welby Assessment of the effectiveness of bluetongue surveillance in Belgium and Switzerland Papers in preparation (targeted submission date in brackets) • Egil Fischer, E. Pamela Martinez-Lopez, Céline Faverjon, Risk of introduction of EEV in the Netherlands (August 2015) • Maya Gussmann, Jörn Gethmann, Yves Van der Stede, Simulation model to compare surveillance system for Bluetongue disease (September 2015) • Mats Gunnar Andersson, Egil Andreas Joor Fischer, Céline Faverjon, Maya Gussman, Jörn Gethmann, Petter Hop, Yves Van der Stede n.n, Agnès Leblond, René Bødker A joint risk score method for risk-based surveillance of vector-borne animal diseases (September 2015) • Petter Hopp, Solveig Jore, Agnès Leblond, Malin Jonsson, Madelaine Norström, Hildegunn Viljugrein, N.N. Evaluating the use of non-return of trotter horses for syndromic surveillance (January 2016) • Céline Faverjon, Gunnar Andersson, Agnes Leblond JRS for WNV in southern France based on predictive modeling and multi syndrome surveillance (September 2015)

	• Céline Faverjon, Agnès Leblond, Aline de Koeijer, René Bødker, Egil Fischer Risk of introduction/transmission of EEV in France – comparison with AHS (September 2015) • René Bødker, Egil Fischer Comparison of two modelling strategies to determine the risk of an on-going outbreak (September 2015) • Gunnar Andersson, Flavie Vial, Jörn Gethmann, Agnes Leblond, Petter Hopp A general framework for syndromic surveillance based on Bayesian modeling. (December 2015) • Gunnar Andersson, René Bødker, Renke Lühken, , Matthias Obst (Biovel), Anders Lindström Ecological Niche modeling of Distribuition of Mosquitos in Scandinavia (December 2015) • Ana Carolina Cuéllar, Gunnar Andersson, Rene Bødker Modelling species distribution of Culicoides in time and space (December 2015) • Simon Rüegg, Yves van der Stede, Rebekka Nafzger, Helmut Saatcamp, Hurria Yassin, Gertraud Schüpbach, Katharina Stärk Optimising freedom from disease surveillance for sensitivity and cost-effectiveness - An example for Bluetongue (August 2015) Conference presentations Oral • Multivariate syndromic surveillance to detect West Nile Virus outbreaks Faverjon C, Andersson G, Tapprest J, Sala C, Decors A, Tritz P, et al.,ISVEE 14, Merida, Mexico, 2015 • The Joint Risk Score for vector-borne diseases used for early detection, Egil Fischer, GERI-Edenext, April 2015 • Risk of entry and transmission for two Culicoides-borne diseases in horse: comparison of African horse sickness and Equine encephalosis for France, Leblond A, Faverjon C, Lecollinet S, de Koeijer A, Bodker R, Fischer EAJ, ISVEE 14, Merida, Mexico, 2015 Posters • Spatio temporal risk of introducing African horse sickness into Western Europe C. Faverjon, A. Leblond, P. Hendrikx, T. Balenghien, S. Zientara, C. J. de Vos, A. de Koeijer, 7th Epizone annual meeting, Bruxelles, 2013 • The value of evidence from syndromic surveillance, M.G. Anderson, C. Faverjon, F. Vial, L. Legrand, A. Leblond, International Meeting on Emerging Diseases and Surveillance Vienna, 2014 • Quantitative Risk Analysis of Equine encephalosis virus (EEV) entry into France.C. Faverjon, Pamela Martinez-Lopez , Agnes Leblond , Aline de Koeijer , Egil Fischer, Journées de l'école doctorale, 2015 • West Nile Virus surveillance based on nervous syndromes in horses, C. Faverjon, F. Vial, MG. Anderson Conference of the Society for Veterinary Epidemiology and Preventive Medicine, Ghent, 2015

	• Quantitative risk analysis of equine encephalosis introduction into the Netherlands, E.P. Martinez, C. Faverjon, C.J. De Vos, E.A.J. Fischer, Conference of the Society for Veterinary Epidemiology and Preventive Medicine, Ghent, 2015 • The Joint Risk Score for vector-borne diseases used for early detection, Egil Fischer, ISVEE 14, Merida, Mexico, 2015 • The Joint Risk Score for vector-borne diseases used for early detection, Egil Fischer, International One Health Conference, March 2015
*Publications **without** the involvement of other partners of the consortium*	Published – and – accepted peer reviewed papers • René Bødker, Kirstine Klitgård, David Bille Byriel and Birgit Kristensen, West Nile virus vector Culex modestus established in residential area in Denmark, Journal of Vector Ecology, 2014 • Renke Lühken, Sonja Steinke, Maike Leggewie, Egbert Tannich, Andreas Krüger, Stefanie Becker, Ellen Kiel, Physico-chemical characteristics of Culex pipiens s.l. and Culex torrentium breeding sites in Germany, Journal of Entomology, In press Other publications • C. Faverjon, S. Lecollinet, S. Zientara, A. Leblond, Peste équine, quel risque pour la France ? (In French), Bulletin épidémiologique du RESPE, 2013 • S. Zientara, C. Faverjon, A. Leblond, S. Lecollinet, La peste équine : épidémiologie, diagnostic et prévention., N° spécial de Pratique Vétérinaire Equine, 2014 • Céline Faverjon, Aide à la décision en surveillance syndromique par le calcul de la probabilité de circulation d'un pathogène (In French), Bulletin Epidemiologie et santé animale, In press. Submitted papers for peer review • Renke Lühken, Christina Czajka, Sonja Steinke, Hanna Jöst, Jonas Schmidt-Chanasit, Ellen Kiel, Andreas Krüger, Egbert Tannich, Distribution of individual members of the Anopheles maculipennis complex in Germany identified by newly developed real-time polymerase chain reaction assays, Parasites & Vectors Papers in preparation (targeted submission date in brackets) • Petter Hopp, Anne Cathrine Whist, Madeleine Norström, Malin Jonsson, Kristian H. Liland, Simon Gubbins, Kåre Græsbøl, N.N Evaluating the use of syndromic surveillance for detecting a Bluetongue serotype 8 outbreak in Norway(December 2015) • Madelaine Norström, Malin Jonsson, Anne Cathrine Whist, Anja Bråthen Kristoffersen, Petter Hopp N.N Application of SatScan for syndromic surveillance of Bluetongue in Norway (December 2015) • Flavie Vial, Gunnar Andersson, Rahel Struchen Syndromic surveillance with delayed reporting

	• Helmut Saatkamp, Hurria Hassin, n.n Economic model to evaluate surveillance • Sonja Steinke, Renke Lühken, Ellen Kiel Emergence of Obsoletus group species from farm-associated breeding habitats in Germany (September 2015) • Renke Lühken, Sonja Steinke, Ellen Kiel Modelling the prevalence and abundance of Culicoides Obsoletus Group species on the level of breeding sites (December 2015) Conference presentations Oral • Risk based surveillance for vector borne diseases, René Bødker,NJF seminar 457 Sustainable Agriculture in The Baltic Sea Region with focus on climate change, Sweden, Invited speaker, 30-31 October 2012 • Aide à la décision en surveillance syndromique par le calcul de la probabilité de circulation d'un pathogène, C. Faverjon, Journées de l'AEEMA,, 2015 • Culicoides breeding ecology studied in farm associated habitats in Germany, Sonja Steinke, Entomology Congress of the "German Society for General and Applied Entomology", March 2015 Posters • Breeding Habitats of the Culicoides Obsoletus Group, Sonja Steinke, Entomology Congress of the "German Society for General and Applied Entomology", March 2013 • VICE – Risk-based and cost-efficient surveillance systems for vector-borne diseases, Gertraud Schüpbach, Swiss Vector Entomology Conference, March 2013
*Patents **with** the involvement of other partners of the consortium*	NA
*Patents **without** the involvement of other partners of the consortium*	NA

6. Brief financial report

	1st year	*2nd year*	*3rd year*	*Total*
Personnel	450,821	391,285	408,420	1,250,525
Equipment	49,196	22,245	22,950	94,390
Other costs	93,844	168,710	100,651	363,205
Total	593,860	582,240	532,021	1,708,121

7. Executive summary

The executive summary must not exceed 2 sides in total of A4 and should be understandable to non-scientist. It should cover the main objectives, methods and findings of the research, together with any other significant events and options for new work.

a. Objectives and results

The project aimed at a fully function framework for cost-effective surveillance of vector-borne animal diseases. The framework, dubbed the Joint Risk Score, was produced to combine the risk of introduction, transmission risk and signals from health or production data. The Joint Risk Score combines different risk estimates in a Bayesian framework. The Joint Risk Score is presented in a simple Graphical User Interface which shows the separate risk estimates and its combined Joint Risk score.

The Joint Risk Score utilizes the result of workpackages 1 – 3, where introduction risk, transmission and syndromic surveillance were investigated.

The project produced detailed models for the introduction of African Horse Sickness and Equine Encephalosis. Two generic methods to determine the risk of transmission were compared. Using Bayesian inference in an forensic approach was used to evaluate syndromic surveillance data.

The transmission risk models need estimates of vector-abundance. This project has increased the availability of monthly average vector abundance maps by producing Europe wide maps of Culicoides abundance and maps for Northern Europe of mosquitoes.

Temperature is another crucial input in transmission models. The project has shown the characteristics of breeding sites of Culicoides and preliminary analyses show that microclimate has a distinct impact on temperature.

A simulation model for BTV in Germany, The Netherlands and Belgium was used to assess the use of the JRS in relation to other surveillance systems. Due to the very good surveillance system and the specifics of an BTV epidemic the JRS did not add to the surveillance within these simulations.

All participating countries applied to the European standards for surveillance. Studying surveillance systems showed that by comparing the system of Belgium and Switzerland, both countries had an approximately 100% sensitivity for detection of Bluetongue. This was mainly due to passive surveillance by veterinarians and farmers.

An economic evaluation by calculation of the costs is aided by a model in an Excel workbook. The model can aid decision making in distribution of resources to different aspects of the surveillance. The model is applicable in a wider context of surveillance beyond vector-borne infections.

b. Events

The project was a highly collaborative effort which resulted in the following events:

- Monthly telephone conference of the steering committee
- Kick off meeting, Brighton (UK) June 2012
- 1st joint project meeting, Brussels (BE) September 2013
- 2nd joint project meeting, Copenhagen September 2014
- 3rd joint project meeting, Brussels (BE) April 2015

- 3 two-monthly visits of INRA PhD student to CVI
- Visit of VPHI Doctoral student to CODA CERVA
- 4 WP4 Telephone conferences
- WP5&WP6 3 face-to-face meetings in Wageningen(NL), at Schiphol airport(NL), and Bern (CH)
- 1st WP4 workshop Amsterdam(NL), April 2013
- WP4 face-to-face meeting Brussels (BE), October 2013
- 2nd WP4 workshop Paris (F), February 2014
- 3rd WP 4 workshops (with stakeholders) Paris (F), February 2015
- Final seminar, Brussels (BE), April 2015

c. Options for new work

The project provides a function framework for the combination of introduction risk, transmission risk and syndromic surveillance, and tools to evaluate sensitivity and costs of surveillance systems.

Future work should focus on implementation of the methods to aid decision making. This requires the validation of the method for different situations and uses, as well as scrutinizing the limitations of the provided methods. Using the framework on different diseases might show a range of diseases for which the methods can add more to decision making than diseases such as BTV for which farmers and veterinarians are very aware and is picked up by passive surveillance. Extension of the parameterization to other diseases is a stepwise procedure which can be aided by risk assessment projects such as Vectornet (EFSA & ECDC).

Furthermore it requires an adaptation to the demands of the users. The demands of users were evaluated in February 2015 in a workshop in Paris. This workshop showed that if information from predictive modelling and syndromic surveillance may be combined with economical information on the costs of action (or no action) this tool provides a useful help to decision-makers, flexible and transparent. Additionally, efforts for further developments should aim at displaying uncertainty, showing explicitly the assumptions behind the models and conducting a sensitivity analysis to know where more sensitive parameters are and what are the main data needed.

They also need to have a more attractive tool more for risk management team (work on reliability etc.). The tool could be used not only for decision but also for illustration, demonstration or communication between teams. This requires development of an attractive graphical user interface.

It is the intention of the EMIDA consortium to publish the executive summary of the project.

Please confirm your agreement to do so.

YES ☐

NO ☒

If no, please explain: The consortium has as such not decided on it and extension to the work are still ongoing. The update version migth be published.

I declare that the information I have given is correct to the best of my knowledge and belief.

Egil Fischer
Name

16 july 2015
Date

Vice-coordinator VICE project
Assistant Professor Utrecht University
Position held