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CURRENT ANIMAL HEALTH SITUATION WORLDWIDE: ANALYSIS OF EVENTS AND TRENDS

World Animal Health Information and Analysis Department,
Montserrat Arroyo Kuribreña, Lina Awada, Lina Mur and Paolo Tizzani

This report has been prepared based on the notifications and reports that countries submitted to the OIE via the World Animal Health Information System (WAHIS) up to and including 20 March 2019. The report begins with an evaluation of the global compliance of Members with their reporting obligations and the general quality of the reports submitted. This is followed by a description of the global situation regarding six OIE-listed diseases and infections of major interest, divided into two groups based on their main routes of spread: namely, three vector-borne diseases (infection with Rift Valley fever virus [RVF], West Nile fever [WNF] and infection with bluetongue virus [BT]) and three diseases spread through movements of animals and animal products (infection with avian influenza viruses, infection with koi herpesvirus and infection with *Batrachochytrium salamandrivorans*).

1. Global compliance with reporting obligations

On becoming Members of the OIE, countries are required to comply with the reporting obligations described in Chapter 1.1. of the OIE *Terrestrial Animal Health Code* (*Terrestrial Code*) and the *Aquatic Animal Health Code* (*Aquatic Code*). This section firstly provides an evaluation of compliance with these requirements, in terms of mandatory report submission from 2005 up to 20 March 2019, and submission of the optional annual report for non-OIE-listed diseases in wildlife since 2008. The section finally assesses the quality of the reports submitted based on selected indicators.

This analysis describes the notification behaviours of Member Countries with respect to the different types of report and evaluates the level of transparency achieved for the communication of information. The OIE will subsequently use these results to facilitate and improve the notification process in the modernised OIE-WAHIS system. In this context, it is important to point out that although the World Animal Health Information and Analysis Department is responsible for verifying the information submitted to the OIE, the Members are responsible for submitting good quality information.

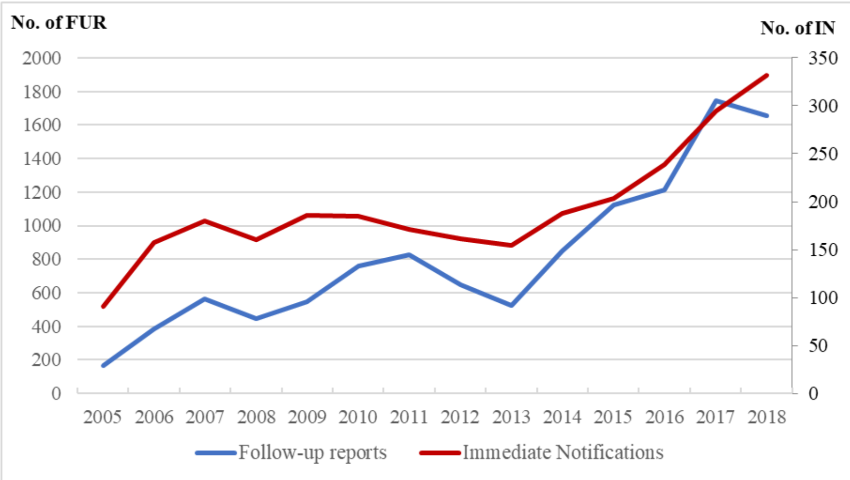
1.1. Early warning

1.1.1. Report submission

Articles 1.1.3. and 1.1.4. of the OIE *Terrestrial Code* and the *Aquatic Code* (hereafter referred to collectively as ‘the OIE *Codes*’) set out the reporting obligations of Members relating to early warning reporting (i.e. the submission of immediate notification reports and follow-up reports). National Authorities are required to send an immediate notification of any of the exceptional events described in the OIE *Codes* within 24 hours of confirmation of the event followed thereafter by weekly follow-up reports to provide further information on the evolution of the event. These reports should continue until the disease has been eradicated or the situation has become sufficiently stable for six-monthly reporting to satisfy the Member’s reporting obligations.

Figure 1 shows that the number of immediate notifications that Members submitted to the OIE increased from 91 in 2005 to 332 in 2018, with a statistically significant upward trend (Spearman's rank correlation test, rho=0.7, p-value<0.01). Similarly, the number of follow-up reports that Members submitted to the OIE increased from 164 in 2005 to 1 746 in 2017 and then slightly decreased to 1 655 in 2018. This overall increase is remarkable (Spearman's rank correlation test, rho=0.9, p-value<0.01), corresponding to a tenfold increase in the number of follow-up reports submitted by Members over a period of 13 years.

Figure 1. Number of early warning reports submitted by OIE Members, by year from 2005 to 2018*

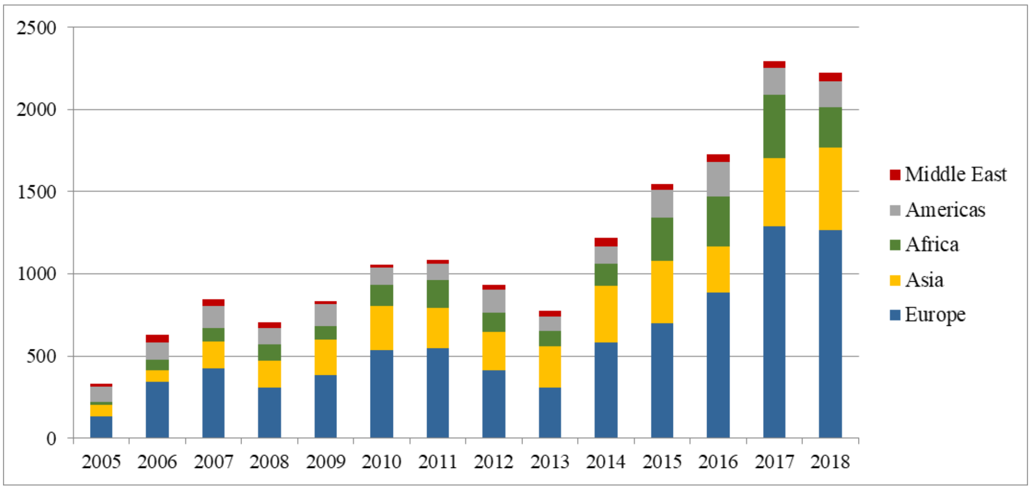


**2019 results are not shown as they were still partial as of 20 March 2019*

When analysing the diseases for which these types of reports were submitted we observed that more than half of the reports were concentrated in only four diseases, all of which have a high impact on trade. Specifically, infection with highly pathogenic avian influenza viruses (HPAI) (considering both OIE-listed diseases for domestic and wild birds) was the most frequently reported disease, with 23% of all reports, followed by African swine fever (ASF) (17%), foot and mouth disease (FMD) (10%) and bluetongue (BT) (7%). Consequently, the epidemiological situation of these four diseases has had a strong impact on the total number of reports (e.g. the increase in the number of ASF reports since 2014 has contributed to the increase in the total number of reports, as was also the case with the HPAI epizootics of 2006, 2015 and 2017). In contrast, the annual number of reports for FMD and for BT has been far more constant over the years, regularly contributing to the total number of reports.

Throughout the years since 2005, the OIE Region that has submitted the highest number of early warning reports is Europe (average of 55% of all reports), followed by Asia, the Far East and Oceania (26%), the Americas (15%), Africa (14%) and the Middle East (4%). However, as shown in Figure 2, the contribution of the different Regions to the total number of reports varied slightly over the years, chiefly due to the animal health situation in the Regions (e.g. the reports from Europe have drastically increased since 2014 due to the increase in notifications of ASF in the European Union). When comparing the Regions, it is also important to note that they differ considerably in size, and that the overall number of Member Countries has increased slightly in recent years, which has had an effect on the number of reports in some Regions.

Figure 2: Number of early warning reports submitted by each OIE Region per year between 2005 and 2018*



**2019 results are not shown as they were still partial as of 20 March 2019*

Although the number of early warning reports submitted and the percentage of Members submitting these reports are highly dependent on the number of Members, the global animal health situation and its yearly evolution, the constant and marked increase observed during the period of analysis suggests improvements in Members' transparency over time and better compliance with their early warning reporting obligations. This is, overall, a remarkable achievement on the part of OIE Members and one that deserves to be highlighted.

1.1.2. Report quality indicators

Article 1.1.3. of the OIE *Codes* stipulates the time within which Members are required to submit immediate notifications of OIE-listed diseases (i.e. within 24 hours of event confirmation) and follow-up reports (weekly, subsequent to an immediate notification). The following analysis therefore evaluates Members' compliance with these obligations.

Countries have been required to provide the confirmation date of the event in their immediate notifications. Table 1 therefore shows the time (in days) from the reported start of the event to its confirmation and from confirmation of the event to the submission of the corresponding immediate notification to the OIE, as well as the total time from start to submission for all immediate notifications, for the period 2015 to 2018. This analysis was performed for all OIE Members, for all OIE-listed diseases as a group, and individually for three of the diseases with a major economic and human/animal health impact and most frequently reported through immediate notifications (i.e. HPAI, ASF and FMD). The median time from the start of the first outbreak to the confirmation of the event was 5 days, although marked variations were observed, with a maximum delay of 352 days. The time from confirmation to the submission of the report was shorter, with a median of 3 days and a maximum delay of 280 days. The median overall delay in reporting from the start of the event to the submission of the immediate notification was 11 days. The observed wide ranges in notification delay strongly influenced the averages, which were much higher than the median for the time to confirmation (average of 15 days vs a median of 5 days) and time to notification (average of 11 days vs a median of 3 days). These results can be explained as follows: most of the notifications were sent within a relatively short time, whereas some were sent with a very long delay (up to more than one year). Importantly, only 29% of immediate notification reports were submitted within the prescribed time limit of 24 hours after confirmation of the event.

Some differences were observed when we compared the three selected diseases. Specifically, the ‘start to confirmation’ and ‘confirmation to submission’ delays for FMD events were longer than the global average, whereas ASF and HPAI were confirmed, and especially reported, much faster. These findings might be influenced not only by the characteristics of the diseases, but also by the countries currently affected by the diseases (i.e. level of surveillance, country epidemic status, etc.). Although differences between Regions were observed, no OIE Region reached median submission times of one day after confirmation, the requirement stated in the OIE *Codes.*

Table 1: ‘Start to confirmation’, ‘Confirmation to submission’, and ‘Total’ delays for immediate notification submission. Data are reported for all the diseases together, and separated for FMD, ASF and HPAI.

	Start to confirmation (days)		**Confirmation to Submission (days)**		**Total time (days)**	
	Median (Average)	**Range**	**Median (Average)**	**Range**	**Median (Average)**	**Range**
All diseases	**5 (15)**	**(0-352)**	**3 (11)**	**(0-280)**	**11 (26)**	**(0-359)**
FMD	6 (17)	(0-157)	4 (10)	(0-185)	14 (28)	(0-259)
ASF	2 (5)	(0-52)	2 (4)	(0-45)	5 (8)	(0-57)
HPAI	5 (8)	(0-274)	2 (7)	(0-125)	9 (17)	(1-329)

These results show that Members encounter difficulties in confirming the disease and submitting immediate notifications within 24 hours of event confirmation, as required in the OIE *Codes.* The maximum values measured each year from 2015 to 2018 are a cause for concern in the context of early warning. Indeed, Members may face difficulties in protecting themselves against disease introduction from other countries when events are confirmed and notified to the OIE with such long delays. In 2018, the median value for submission time was three days after confirmation, meaning that for half of the events notified that year, Members were able to report them within three days after laboratory or clinical confirmation. This is encouraging, but more efforts should be put into improving response times for the notification of events, in order to comply with OIE requirements. In line with this, the OIE is planning to integrate in its new OIE-WAHIS system, which is currently under development, some functionalities designed to facilitate the flow of official animal disease information from the local to the international level, under the responsibility of the Delegate.

Another indicator of report compliance is the time (in days) between submission of an early warning report and submission of the first or subsequent follow-up report. According to the OIE *Codes*, follow-up reports should be submitted on a weekly basis. During the analysis period (from 2005 to 2018), the median time value between a report and the next follow-up report varied between 10 days (measured for the year 2017) and 29 days (measured for one month of 2008), compared with the overall median value of 12.5 days. However, some extreme delays were detected and these need to be taken into account when interpreting the findings.

These results show that Members encounter difficulties in sending regular weekly follow-up reports, as required by the OIE *Codes.* Weekly follow-up reports are intended to inform other Members of the evolution of exceptional disease events and are an essential tool in the regulation of international movements of animals and animal products. The OIE is planning to integrate functionalities in its new OIE-WAHIS that are designed to facilitate the submission of more regular and timely follow-up reports. Members are strongly urged to submit follow-up reports within a reasonable time after the previous early warning report.

1.2. Six-monthly reports

1.2.1. Report submission

Article 1.1.3. of the OIE *Codes* also sets out the obligations of Members to submit six-monthly reports on the absence or presence and evolution of OIE-listed diseases. These six-monthly reports are essential for monitoring the global evolution of listed diseases over time, sharing information on the control measures applied, and establishing the baseline disease situation in each country, so that exceptional events can be identified. From 2005 to 2011, OIE-listed diseases in terrestrial and aquatic animals were reportable through a single six-monthly report, whereas, from 2012, Members have been expected to submit a specific report for terrestrial animals and a separate for aquatic animals each semester, to facilitate data collection and improve reporting timeliness.

The percentage of Members that submitted their mandatory joint six-monthly report remained very stable (between 96% and 97%) during the period from 2005 to 2011. This percentage then remained similar for the submission of terrestrial reports from 2012 to 2017. In contrast, the percentage of Members that submitted their six-monthly report for aquatic animals during this period was much lower (between 65% and 77%). However, the figures for aquatic reporting since 2012 are more truly representative, as many of the joint reports previously submitted could be empty, thereby giving a false impression of the reporting situation. The results presented for 2018 are still only partially complete, as Members were still submitting their six-monthly reports for 2018 as of 20 March 2019.

The percentage of Members that submitted their six-monthly reports for terrestrial animals was very high in all OIE Regions, while major differences between Regions were observed for aquatic animal reports. Europe was the Region with the highest submission rate for aquatic animals from 2012 to 2017 (average of 90% of Members having submitted their report), followed by the Americas Region and the Asia, the Far East and Oceania Region (each with an average of 76%), then the Middle East Region (average of 61%) and finally the Africa Region (51%).

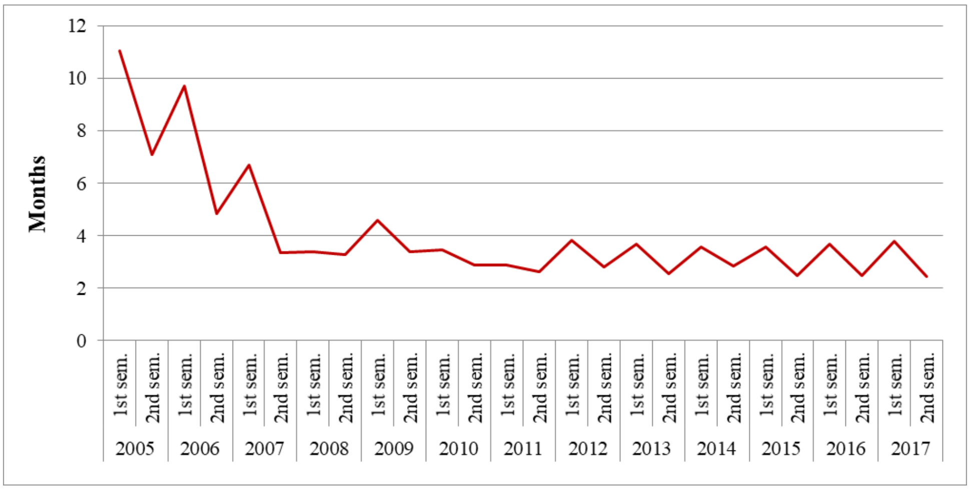
These results show that OIE Members' compliance with six-monthly reporting requirements has been very high for terrestrial animal diseases for many years and this should be highlighted as a major achievement of all OIE Members. On the other hand, the compliance level for aquatic animal disease reports has been lower, with marked regional discrepancies. In some countries, aquatic animals do not fall within the competencies of the Veterinary Authorities, a situation that can pose a challenge for the collection of information on aquatic animal health. A challenge for the coming years will be to improve the aquatic animal health networks in countries, so that aquatic animal health information can be more easily shared between all Members. In line with this, the OIE is encouraging the Focal Points for Aquatic Animals to actively take part in the notification process in all countries, under the responsibility of the Delegate. With this objective, the OIE includes training on disease notification in the seminars regularly organised for these Focal Points and encourages them to use the OIE e-learning platform on WAHIS.

1.2.2 Report quality indicators

The OIE *Codes* do not set any requirement for the submission times of six-monthly reports. However, it is essential that these reports are submitted within a few months after the end of the relevant semester, so that other countries are aware in due time of the sanitary situation of all OIE-listed diseases in their neighbouring or trade partner countries.

Figure 3 shows the median submission time of Members' six-monthly reports, expressed as the number of months after the end of the relevant semester. For the analysis, we considered data for the period 2006 to 2017. Although WAHIS was launched in 2005, during the first year the countries were not able to submit information on their own, so that year was excluded from the analysis. The median submission time decreased from 9 months for the 1st semester 2006 to four months for the 1st semester of 2008. It then remained relatively stable at between three and four months. The longest delays observed during the first years were most likely related to the training required on how to use the software. As a common trend, the median submission time for the 1st semester reports was slightly higher than that for the 2nd semester reports of the same year. This might be partially explained by the fact that Members are invited every year to submit their two six-monthly reports for the previous year before the General Session of the World Assembly of Delegates of the OIE, which takes place each year in May. Over the whole period of analysis, median submission times were comparable between all OIE Regions.

Figure 3. Median submission time of Members six-monthly reports after the end of the relevant semester, in months*



**Results for 2018 are not presented on the graph, as Members were still submitting their six-monthly reports as of 20 March 2019.*

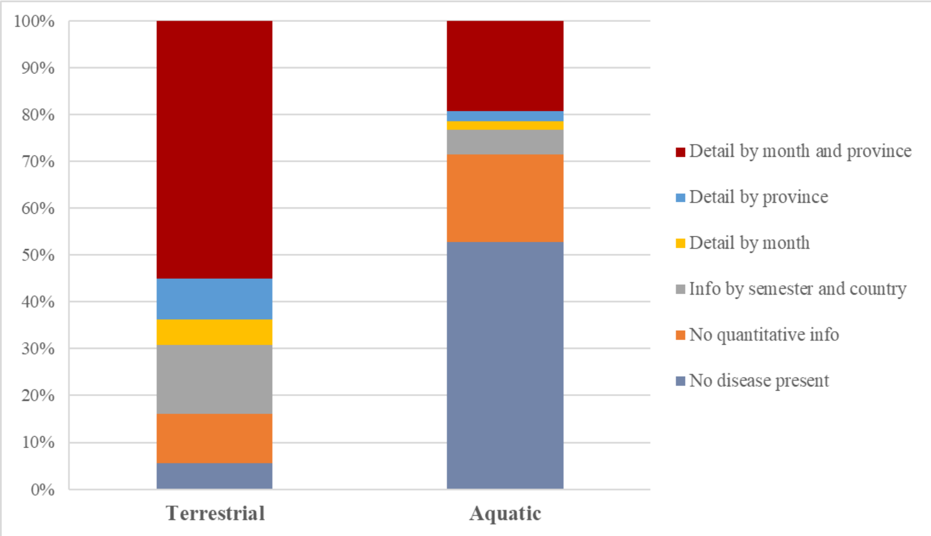
The result for the most recent years (i.e. a median delay of three to four months after the end of the semester) can be considered satisfactory. However, to facilitate early sharing of information, the OIE is planning to integrate in its new OIE-WAHIS some functionalities to allow data to be entered and shared before the end of the relevant semester, so that Focal Points can provide the OIE with subsets of data as soon as they are available.

The timing of the submission of reports is important, but it is also essential to analyse the content of the reports, such as the number of OIE-listed diseases for which no information was provided in the six-monthly reports and the level of detail of the quantitative information provided (if any). In 2014, the World Animal Health Information and Analysis Department started collecting statistics on these indicators.

Between 2014 and 2017, Members were, on average, able to provide information for 81% of the terrestrial OIE-listed diseases and 77% of the aquatic ones, which means that no information was provided for 18 terrestrial animal diseases (out of 96) on average and 7 (out of 29) aquatic animal diseases on average in the respective six-monthly reports. However, when comparing the information available for domestic animals versus that available for wild animals (this refers to OIE-listed diseases, not the optional report for non-OIE listed diseases), major differences were observed between the reports. Specifically, for terrestrial diseases, information on 86% of diseases was reported for domestic animals, while information on only 76% of those diseases was reported for wild animals. Similarly, in aquatic reports, information on 81% of diseases was reported for farmed aquatic animals while information on only 73% of those diseases was reported for captured aquatic animals. These percentages were stable over the period of analysis.

In addition, we analysed the content of these reports in relation to the level of detail provided for the diseases by type of report (aquatic vs terrestrial). Specifically, the reports were classified as: (i) does not report any disease as present (all of them reported as absent or no information); (ii) does not provide any quantitative information for the diseases present; (iii) provides quantitative information with the lowest level of detail (by country and semester); (iv) provides quantitative information by month and country; (v) provides quantitative information by province and semester; and (vi) provides quantitative information at the most detailed level, by province and month. As shown in Figure 4, terrestrial and aquatic types of reports present very different characteristics. Very few terrestrial reports indicated no disease present (5%) or provided no quantitative information (10%). However, more than half (52%) of the aquatic reports reported no diseases present, many of them (18%) not providing any quantitative information. In both cases, the most detailed template (by month and province) was the one most commonly used when providing quantitative information. However, while this type of report with the highest level of detail constituted the majority of terrestrial reports (54%), it was only applied in less than 20% of the aquatic reports.

Figure 4: Percentage of reports by level of quantitative information provided by countries: 2014 to 2017*



**Results for 2018 are not presented on the graph, as Members were still submitting their six-monthly reports as of 20 March 2019.*

Overall, the percentages of OIE-listed diseases with information provided, with the more accurate level of information (quantitative information provided by month and by administrative divisions) are high for terrestrial reports, which is satisfactory. These quality indicators were lower for the aquatic reports, as the number of diseases for which no information was provided and the level of quantitative detail of the information provided was in each case lower than in the terrestrial reports. As expected, the same pattern was observed for terrestrial and aquatic animals, with more data available for domestic animals and aquaculture compared to wildlife and captured animals. In general, although the data provided for disease presence can be considered of good quality, the data provided for disease absence should be put in perspective with the surveillance and control measures reported. Finally, it is interesting to note that, for seven of the OIE-listed diseases, more than 30% of Members (median value for the whole period) have not provided any information since 2005. Most of the unreported diseases are aquatic animal diseases (5[1]/7); the others are a disease of birds (turkey rhinotracheitis) and a disease of bees (small hive beetle infestation).

1.3. Annual reports

Lastly, for mandatory reports, Article 1.1.3. of the OIE *Codes* stipulates the reporting obligations of Members relating to annual reports, which include information on the capacities of the national animal health services in terms of staff, diagnostic laboratories and vaccine production, information on the situation regarding zoonoses in humans and the livestock and aquatic production figures. This report is meant to provide OIE Members with contextual information, so that the reported disease situation in each country can be properly interpreted.

The percentage of Members that submitted their mandatory annual report remained high at between 81% and 97% for the period 2005 to 2017. The results for 2018 are not presented, as Members were still submitting their annual reports as of 20 March 2019. These percentages were comparable in all OIE Regions.

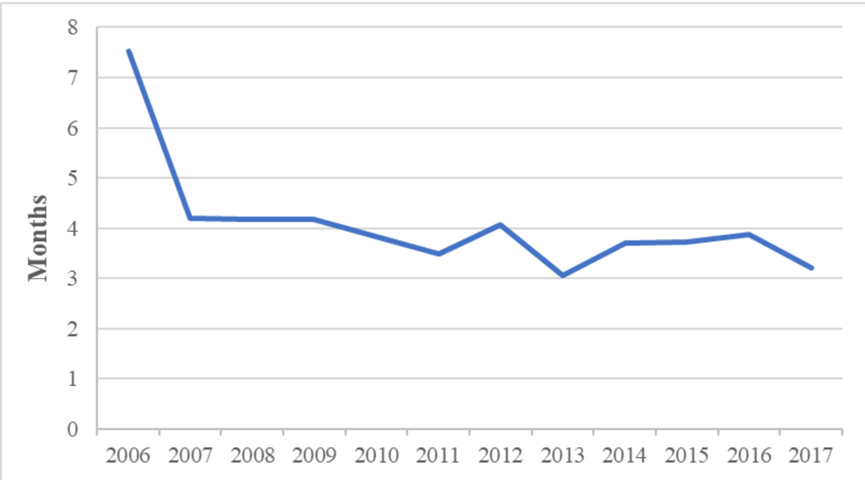
These results show that the compliance of OIE Members with annual reporting requirements has been very high for many years and this should be highlighted as another major achievement of all OIE Members. Members are encouraged to make full use of this information.

[1] Crayfish plague (*Aphanomyces astaci*), Infection with *Batrachochytrium dendrobatidis*, Infectious hypodermal and haematopoietic necrosis, Infection with *Perkinsus olseni*, and Infection with *Xenohaliotis californiensis*.

1.3.1. Report quality indicators

As for six-monthly reports, the OIE *Codes* do not set any requirement for the submission time of annual reports. Figure 5 shows that the median submission time of Members' annual reports after the end of the relevant year decreased from 8 months in 2006 to 3 months in 2017. As discussed above for six-monthly reports, the launch of WAHIS and the training required most likely accounted for the initial delay observed. The downward trend in length of submission time was statistically significant (Spearman's rank correlation test, rho= -0.7, p-value<0.01). The results show that, over the years, Members have made greater efforts to submit their annual reports in a timely manner. Over the whole period of analysis, median submission times were comparable between all OIE Regions. However, there is room still for improvement, as on average, Members provided information for only four out of five sections of the annual report, 'national vaccine production' being the section most often left blank.

Figure 5. Median submission time of Members' annual reports after the end of the relevant year, in months*



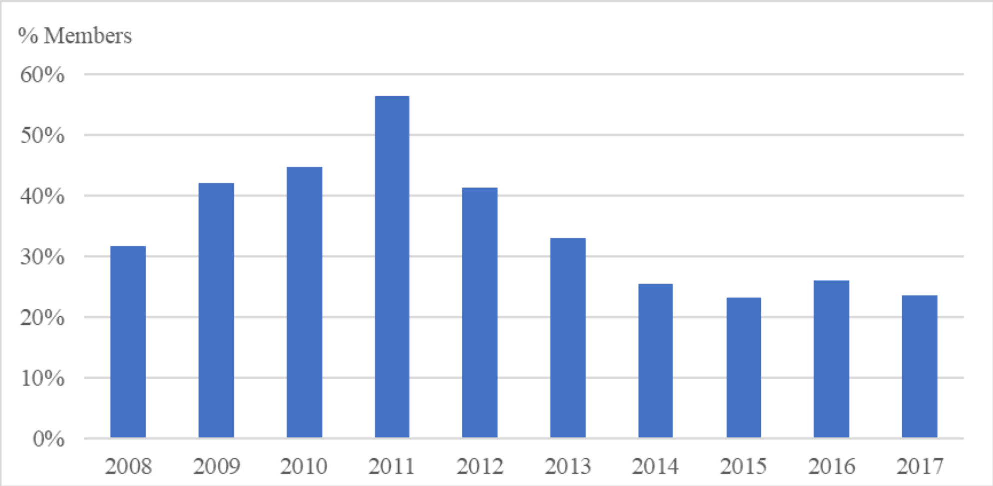
**Results for 2018 are not presented on the graph, as Members were still submitting their annual reports as of 20 March 2019.*

1.4. Optional annual report for non-OIE-listed diseases in wildlife

The OIE recognises the importance of wildlife and has been collecting worldwide information on wildlife diseases since 1993. Since then, OIE Members have had the opportunity to contribute in an optional way to the knowledge of the global situation of about fifty diseases. These diseases, which do not meet the OIE's criteria to be listed, have been selected by the experts of the OIE Working Group on Wildlife Diseases to be monitored, both because of their importance for wild animals in terms of biodiversity protection and for early warning purposes, in order to protect human and livestock health. Information contained in the reports submitted since 2008 is available online via the specific interface *WAHIS-Wild*.

Figure 6 indicates the percentage of Members that submitted the optional annual report for non-OIE-listed diseases in wildlife for the years 2008 to 2017. The figure shows that the percentage initially increased from 2008 (32%) to 2011 (56%) and then decreased up to 2015 (23%). The percentage then remained relatively stable for 2016 (26%) and 2017 (24%). The results for 2018 are not presented, as Members were still submitting their optional annual report for non-OIE-listed diseases in wildlife as of 20 March 2019. Regional discrepancies were observed, with a higher average submission rate across the period of analysis in Europe (57%) compared with other OIE Regions: the Americas (30%); Asia, the Far East and Oceania (29%), the Middle East (28%) and Africa (22%).

Figure 6. Percentage of OIE Members having submitted their optional annual report for non-OIE listed diseases in wildlife, by year



**Results for 2018 are not presented on the graph, as Members were still submitting their optional annual report for non-OIE listed diseases in wildlife as of 20 March 2019.*

These results suggest that Members' interest in providing this optional information has evolved with time. In 2013, a new section was added to WAHIS for countries to provide this information online, thus replacing the previous Excel® questionnaire that had been used since 1993.Afterwards, the number of reports submitted decreased and, as a result, only a quarter of OIE Members contributed to the global effort of providing information on diseases in wildlife populations for 2017. In addition, it should be noted that, in a considerable number of reports submitted, all diseases were notified as absent or without information. Each year, only around half of the reports contained information for the presence or suspicion of at least one disease. Although the data provided for disease presence can be considered of good quality, the data provided for disease absence should be put in perspective with the surveillance strategies implemented.

These facts raise questions about the concrete impact and added value for Members of sharing and centralising this information. These results also suggest that a number of Delegates experience difficulty in collecting and sharing reliable information on wildlife health. The OIE therefore invites its Members to provide feedback on their interest in this topic and the challenges they face in doing so. They are also requested to define, together with the OIE, suitable targets for the coming years.

Through this analysis, several main successes were identified. Firstly, the amount of early warning reports received from Members significantly increased during the study periods, which suggests improvements in Members' transparency and compliance with the requirements of the OIE *Codes*. Secondly, the high rates of report submission measured for six-monthly reports on terrestrial animal diseases and annual reports, together with the reasonable submission times observed in recent years for these reports are very encouraging. Lastly, the analysis showed that within their six-monthly reports, Members were able to provide information and detailed quantitative data for a high proportion of OIE-listed terrestrial animal diseases. All these results should be considered as great achievements by OIE Members and demonstrate the success of the reporting process implemented by the OIE and its Members over the years.

On the other hand, the analysis has also highlighted some gaps in reporting that the OIE and its Members should take into consideration:

1. Regarding early warning, this section of the report demonstrated that Members have not achieved full compliance with the requirements of the OIE *Codes* in terms of reactivity for the confirmation of events and the submission of immediate notifications after event confirmation, and in terms of the regularity with which they share follow-up information on exceptional disease events after the initial notification.

2. The analysis underlined gaps in reporting on certain topics that are not related to livestock production, in particular aquatic animal diseases, wildlife diseases and national vaccine production.

3. Although high reporting rates were measured for OIE-listed diseases within six-monthly reports, the question of the true meaning of disease absence was raised. The interpretation of this information is complex and should be put in perspective with the surveillance strategies reported. The information provided in these reports should always be considered together with surveillance policies at country level, to better understand the sensitivity of National Veterinary Services in terms of disease detection and reporting.

4. Lastly, the analysis underlined the relatively low participation of Members in the optional annual reporting on selected non-OIE-listed diseases in wildlife and raised questions about the quality of the information provided in these reports.

To address these gaps and challenges and support its Members, the OIE has put in place several measures including, among others: training for Focal Points; active search for non-official information; permanent communication with countries to accompany OIE Members in their notification activity; and development of new functionalities in the upcoming OIE-WAHIS. These functionalities will be designed to facilitate the reporting process, the flow of information from national to international level and the management of access to the data entry platform for Delegates and Focal Points. Some new functionalities in OIE-WAHIS will also aim to provide Delegates and Focal Points with improved decision-making tools.

However, to address the gaps identified in this section, these OIE activities might not be enough and Members are also encouraged to think about achievable targets that can be defined for the coming years and possible actions that could be implemented at national level to improve the reporting performance.

2. Global situation regarding six OIE-listed diseases and infections of major interest, based on their main routes of spread

Climate change and international trade are likely among the most significant drivers for infectious disease spread and epidemics[2,3]. Climate change has an unquestionable effect on the distribution of vector-borne diseases (i.e. increase in the distribution of vectors, influences of temperature on epidemics, etc.), while globalisation and the movement of animals and their products continue to be the major routes for animal disease introduction into new territories. Nevertheless, the natural movement of animals (e.g. migration of birds) can also be influenced by climate change, and some consequences of globalisation (e.g. land-use practices and population changes) have a direct impact on climate change[4].

This section reviews the situation of six OIE-listed diseases of major interest as examples of these two transmission routes based on the information provided to the OIE by Member Countries through their official notifications. Three vector-borne diseases with important events during 2018 were selected (i.e. RVF, WNF and BT), as well as three other diseases typically spread through movements of animals or animal products (infection with avian influenza, infection with koi herpesvirus and infection with *Batrachochytrium salamandrivorans*).

[2] Semenza, J., 2015. Prototype early warning systems for vector-borne diseases in Europe. *International journal of environmental research and public health*, 12(6), pp.6333-6351.
[3] Fèvre, E. M., Bronsvoort, B. M. D. C., Hamilton, K. A., & Cleaveland, S. (2006). Animal movements and the spread of infectious diseases. *Trends in Microbiology*, 14(3), 125-131.
[4] Jan C Semenza, Jonathan E Suk; Vector-borne diseases and climate change: a European perspective, *FEMS Microbiology Letters*, Volume 365, Issue 2, 1 January 2018, fnx244, https://doi.org/10.1093/femsle/fnx244

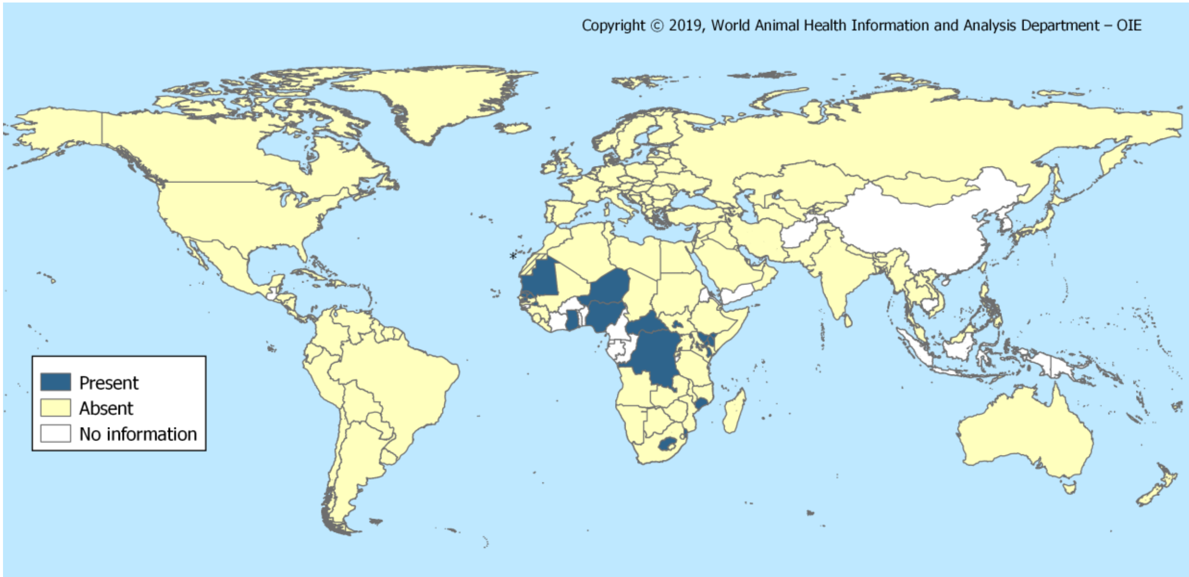
2.1. Vector-borne diseases

2.1.1. Infection with Rift Valley fever virus

Infection with Rift Valley fever virus is an important viral zoonosis transmitted through arthropods and can cause severe disease in ruminants and humans. Its epidemiological cycle is very characteristic, consisting of epizootics (occurrence of high incidence outbreaks) separated by inter-epizootic periods. These factors (vector-borne disease plus different epidemiological patterns) create major difficulties for the prevention and reporting of the disease.

The recent reported distribution of RVF in 2018 and early 2019 is presented in Figure 7. As of 20 March 2019, a total of 186 countries and territories have provided information on the RVF situation through their reports to the OIE. During this period, the disease has been reported as present in 8% (15[5]/186) of the reporting countries and territories, all of them located in the African continent and nearby islands.

Figure 7. Distribution of RVF in countries and territories in 2018 and early 2019 (up to 20 March 2019)



** Data provided by Morocco*

During this period, a total of six immediate notifications were submitted through WAHIS from five different countries[6]. One of these notifications reported the first occurrence of the disease in a country, South Sudan, while the other five immediate notifications reported the recurrence of RVF in nearby countries. In March 2018, South Sudan reported the first occurrence of RVF and indicated that cases of cattle abortion had been observed in December 2017. Those cases were observed after heavy flooding in November, which had led to the appearance of swampy areas accompanied by a drastic increase in the number of mosquitoes. Samples were sent to the OIE Reference Laboratory at the Onderstepoort Veterinary Institute (South Africa), and the results of the ELISA test in March 2018 confirmed the presence of the disease. The OIE Regional Representation for Africa and the Sub-Regional Representation for Eastern Africa and the Horn of Africa provided the country with support in complying with its reporting obligations and submitting the immediate notification. The following month (April 2018), the country submitted a final report, indicating that the event was considered sufficiently stable for follow-up reports to no longer be submitted and that future reporting of information related to the event would be done through six-monthly reports.

[5] Central African Republic, Comoros, Congo (Dem. Rep. of the), Gambia, Ghana, Kenya, Mauritania, Mayotte (France), Mozambique, Niger, Nigeria, Senegal, South Africa, South Sudan and Uganda.

[6] Kenya, Rwanda, South Africa, South Sudan, and Uganda

In May 2018, South Africa reported the recurrence of RVF, which had been absent since 2011. One single outbreak was reported, in which more than 300 sheep were affected and died. In June 2018, Kenya reported the recurrence of RVF, which had been absent since 2007. The same month, the Ministry of health for Kenya reported the first case in humans, linked to the consumption of meat from a sick animal[7]. This led to a joint investigation by the Ministry of Health and the Ministry of Livestock, which resulted in the early detection of RVF in animals and its notification the same day that the human case was declared. The first outbreak affected a few camels, which died in a pastoral area in the same region as the human case after a period of heavy rainfall. In June and July 2018, a total of 10 outbreaks affecting camels, goats and sheep in eight different provinces of the country were reported. Vaccination was applied in response to the outbreak. In Kenya, preparedness activities had started in February 2018 due to the heavy rains and flooding, and a national alert was communicated in May[7]. These mechanisms, together with the strong collaboration between the Ministry of Health and the Ministry of Livestock, certainly facilitated the early detection and timely notification of the disease. The event in animals, which had included 130 cases, was declared closed in November 2018. The event had also caused 26 human cases (as of 18 June), including 6 deaths. Fortunately, the extent of this event was much more limited in time and impact than the previous outbreaks, in 2006-2007, which affected more than 4 000 animals and caused 684 human cases, including 155 deaths[8].

The OIE, concerned about this rise in incidence in the Region, contacted the Delegates of Member Countries in East Africa and Southern Africa in July 2018 to raise awareness of the situation and encourage them to share information and report any significant outcome of their animal health investigations.

In August 2018, Rwanda reported the recurrence of RVF, which had been absent since November 2017. The first cases were observed in May 2018, when abortions occurred in dairy cows from two different provinces. The laboratory results were obtained in June 2018. The country implemented key interventions, including public awareness and vaccination in response to the outbreaks. A total of more than 250 000 animals were vaccinated, representing 84.6% of the animals present in the area at risk. As of 20 March 2019, the event in Rwanda was still open but no more outbreaks had been reported since September 2018.

In September 2018, Uganda, a country where the presence of the disease is considered to be stable, reported the recurrence of RVF through an immediate notification. Following the occurrence of human cases of RVF (6 cases in 3 different districts) and in the context of the OIE's call for raised awareness, the country decided to report this event by the means of an immediate notification. The reported event included three outbreaks in cattle, some of which died, in three different regions affected by flooding and consequent breeding of mosquitoes. This event was closed as sufficiently stable in March 2019.

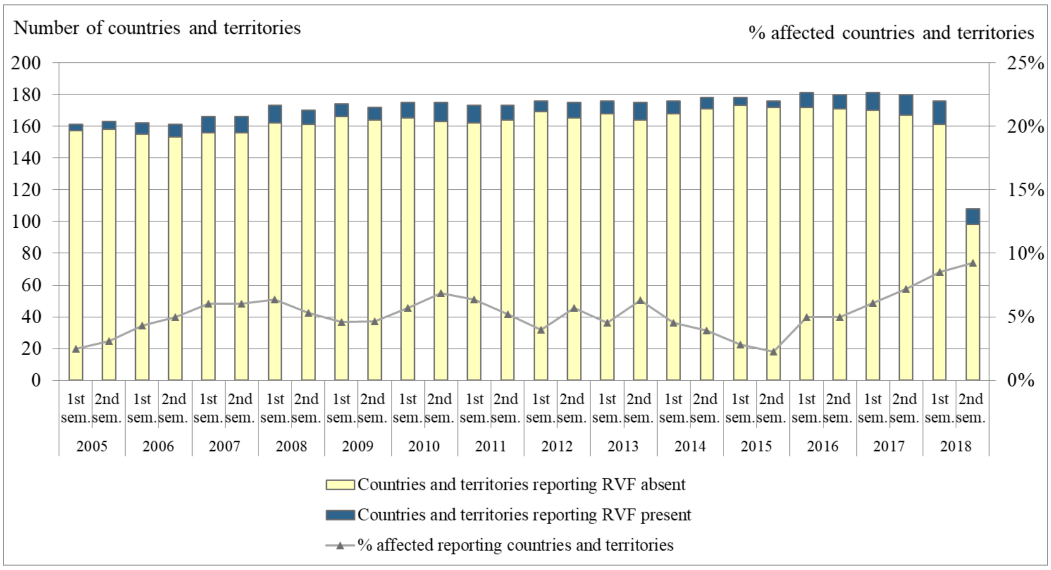
In March 2019, after eight months of RVF absence, Kenya reported the recurrence of the RVF in two provinces. Abortions in cattle and sheep were recorded in all stages of gestation. Vaccination was implemented for the outbreak control. The event was closed as resolved in March 2019.

The historical temporal distribution of RVF reporting and affected countries is shown in Figure 8. From 2005 to 2018, an average of 5% reporting countries and territories notified the presence of RVF each semester, varying from 2% in 2005 to a maximum of 9% reached in 2018. Figure 8 also shows that the number of countries and territories providing information for RVF has been very stable overtime, from 161 in the first semester of 2005 to 180 in the second semester of 2017, therefore being one of the diseases with highest rate of information. As of 20 March 2019, the number of reporting countries and territories for the second semester of 2018 was lower than for previous years, as they were still submitting their six-monthly reports for that year. The analysis of the trend in the percentage of affected countries/territories, using a generalised linear model with binomial distribution, did not show a significant increase during the whole period ($p>0.05$). Therefore, from the data we are unable to conclude that there has been a deterioration in the reported global situation during the overall period of analysis.

7 Rift Valley fever – Kenya. World Health Organization. https://www.who.int/csr/don/18-june-2018-rift-valley-fever-kenya/en/

8 Rift Valley Fever in Kenya, Somalia and the United Republic of Tanzania. World Health Organization. https://www.who.int/csr/don/2007_05_09/en/

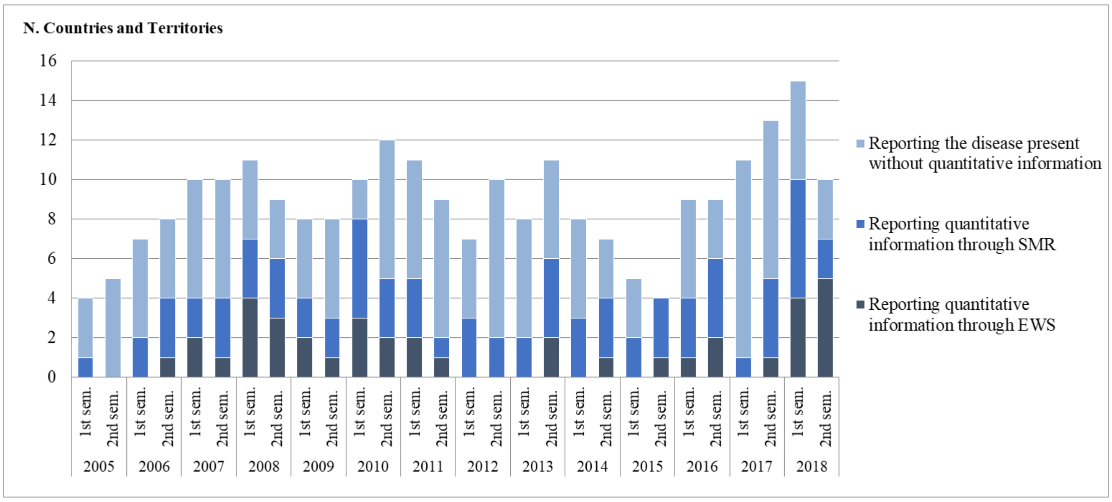
Figure 8. Percentage of the reporting countries and territories for each semester between 2005 and 2018 that notified RVF present (data based on reports received up to 20 March 2019)



On average, only 13% of the countries which reported RVF as present in any given semester, reported quantitative information through immediate notifications (and/or follow-up reports). An additional 17% reported quantitative information through six-monthly reports, as they considered the disease to be constantly present in their territory (including during the inter-epidemic periods) (Figure 9). The 70% remaining countries did not report any quantitative information despite reporting the disease as present. This lack of quantitative information can reflect several situations, including the absence of outbreaks during inter-epizootic periods[9] in most of the countries where RVF is reported present, but it can be also influenced by the potential lack of surveillance and/or laboratory capacity for detecting animal cases, or additional difficulties in obtaining and sharing information.

These percentages vary over time as shown in Figure 9, potentially depending on the epidemic periods, as for example, during the major RVF epidemics in 2010 and the last year 2018, when the proportion of affected Members reporting quantitative data and submitting early warning reports was very high in comparison with other periods.

Figure 9: Overlap between countries and territories reporting RVF present without quantitative information, those reporting RVF quantitative information through Six-Monthly Reports (SMR) and through the Early Warning System (EWS) for each semester between 2005 and 2018 (data based on reports received up to 20 March 2019)



[9] inter-epizootic period' means the period of variable duration, often long, with intermittent low level of vector activity and low rate of virus transmission, which is often not detected

The complexity of the epidemiological cycles of RVF (inter-epidemic and epidemic periods) coupled with the different approaches of the countries in RVF reporting creates difficulties for the harmonisation and interpretation of RVF reports. To resolve this issue and clarify the notification requirements, Chapter 8.15. "Infection with Rift Valley fever virus" of the OIE *Terrestrial Code* has been submitted for revision to the relevant OIE Commissions. Any proposed changes to the chapter will be circulated to Member Countries for consultation prior to potential adoption.

RVF outbreaks are known to be significantly associated with heavy rains, which cause flooding in natural depressions where infected mosquito eggs can hatch and initiate an outbreak[10]. In West Africa, RVF was present before 1987 but went unnoticed due to the absence of clinical manifestations. However, during that year, the first observed outbreak of RVF occurred in the region, with more than 200 human deaths after the building of a dam in the framework of the Senegal River project. This construction and the concurrent flooding led to changes in the local ecological characteristics that facilitated water accumulation and subsequent mosquito breeding[11]. In East Africa, RVF epidemics occur periodically and are closely linked to heavy and prolonged rainfalls associated with warming of the Indian Ocean during the El Niño Southern Oscillations phenomenon[12].

Hence, the distribution and occurrence of RVF epidemics is likely to be directly affected by climate change, as global warming could affect the three main components of the RVF cycle (i.e. vectors, virus and hosts)[13]. Based on those associations, several climatic forecasting models have been developed to enable early detection of RVF epidemics. Some of these models have been demonstrated to be useful to predict the start of RVF epidemics[14]. As an example, in February 2018 Kenya identified a risk of RVF and raised a national alert one month before the first cases occurred[15]. This awareness could have potentially facilitated the early detection of the disease, helping to reduce the impact of the outbreak relative to previous outbreaks, as previously discussed. However, the prediction of RVF epidemics is not always simple, as other important factors such as host immunity or the drivers for RVF emergence in West Africa have not yet been so clearly elucidated[14].

Consequently, the OIE is continuing to work closely with FAO and WHO through the Global Early Warning System (GLEWS) to try to detect high-risk and emergency situations as early as possible and coordinate the response at the human–animal interface. Among its other activities, the GLEWS network shares information between the three organisations to ensure transparency and promote disease notification. This collaboration was crucial in the case of the RVF outbreaks in 2018 to encourage countries to report animal cases to the OIE, in accordance with provisions of the Chapters 1.1. and 8.15. of the OIE *Terrestrial Code*.

RVF is recognised as a priority disease for Africa and as such is integrated in the 5-year Regional Action Plan of the FAO/OIE Global Framework for the Progressive Control of Transboundary Animal Diseases (GF-TADS). The last Regional event on RVF took place in 2015 in Djibouti, where approximately 70 veterinarians, medical professionals and scientists got together to reassess the situation of the disease[16]. The conclusions of that meeting are still relevant and applicable to the RVF situation today, as they encourage countries to adopt an attitude of preparedness instead of reaction, including raised awareness, the updating and development of their national contingency plans and heightened surveillance in high-risk areas in coordination with the public health authorities. Targeted vaccination should also be considered in high-risk areas during high risk-periods. Important advances have been achieved in the search for a safe and effective DIVA[17] vaccine. However, there are difficulties over vaccine licensing that make this process very long and seriously limit the availability of vaccines in the market[18].

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10 https://www.aphis.usda.gov/animal_health/emergency_management/downloads/ppr_rvf_disease_strategy.pdf

11 Ripani, A., Bouguedour, B., 2015: Recent RVF outbreaks in north-western Africa. In Abstract book: Rift Valley fever: new options for trade, prevention and control, April 2015, Djibouti,

12 Anyamba A, Linthicum KJ, Small JL, Collins KM, Tucker CJ, et al. (2012) Climate Teleconnections and Recent Patterns of Human and Animal Disease Outbreaks. *PLOS Neglected Tropical Diseases* 6(1): e1465. https://doi.org/10.1371/journal.pntd.0001465

13 Martin, Vincent, et al. The impact of climate change on the epidemiology and control of Rift Valley fever. (2008): 413-426

14 Food and Agriculture Organization Emergency Prevention Systems-Animal Health (EMPRES). Empres Watch. El Nino and increased risk of Rift Valley fever-warning to countries. 2015. http://www.fao.org/emergencies/resources/documents/resources-detail/en/c/370027/ (or http://www.fao.org/3/a-i5282e.pdf

15 Rift Valley fever – Kenya. World Health Organization. https://www.who.int/csr/don/18-june-2018-rift-valley-fever-kenya/en/

16 GF-TADS, Report of the Conference: "Rift Valley fever: new options for trade, prevention and control", April 2015, Djibouti,

17 DIVA: Differentiating Infected from Vaccinated Animals.

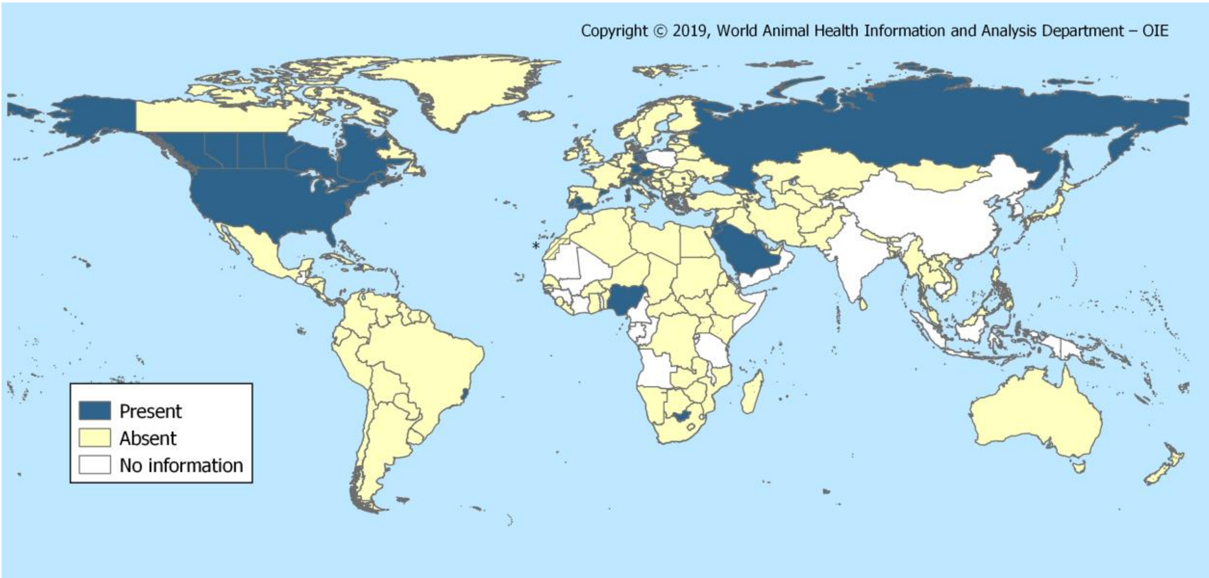
18 Faburay B, LaBeaud AD, McVey DS, Wilson WC, Richt JA. Current Status of Rift Valley Fever Vaccine Development. *Vaccines (Basel)*. 2017;5(3):29. Published 2017 Sep 19. doi:10.3390/vaccines5030029

2.1.2. West Nile fever

West Nile fever (WNF) is a zoonotic disease caused by certain strains of West Nile virus (WNV) and has a wide distribution and a complex epidemiological cycle involving mosquitoes, creating challenges for veterinary and public health services around the world. The disease is characterised by an enzootic transmission cycle between mosquitoes and birds, which act as amplifiers of the virus, and humans and equidae as dead-end hosts.

As of 20 March 2019, a total of 186 countries and territories had provided information on their WNF situation for 2018 and early 2019 through their reports to the OIE. During this period, the disease was reported present in 14% (26[19]/186) of the reporting countries, which were widely distributed in four different continents. The recent reported distribution of WNF in 2018 and early 2019 is presented in Figure 10. As shown on the map, half of the affected countries during the last year were located in Europe (14/26), although the disease was also reported as present in other continents including America, Africa and Asia (Middle East).

Figure 10. distribution of WNF in countries and territories in 2018 and early 2019 (up to 20 March 2019)



** Data provided by Morocco*

A total of 18 immediate notifications were sent through WAHIS from 11[20] different countries between 1 January 2018 and 20 March 2019. All these immediate notifications were submitted by European countries with the exception of one report from Brazil. Two of the countries reported their first ever occurrence of the disease. Specifically, Germany reported in August 2018 the first occurrence of WNF in the country, involving two owls that died at a zoo in the region of Sachsen-Anhalt. In the following month (September 2018), Germany submitted five more immediate notifications informing about further occurrences of the disease in five new areas. In all those areas the disease was mainly detected in wild birds (12 cases); two horses also tested positive. All the events in Germany have already been resolved, the latest ones in January 2019. Likewise, Slovenia reported in September 2018 the first occurrence of WNF in the country, involving one corvid found dead and one horse with neurological clinical signs. The event was also declared closed later in the same month.

In addition to Germany, three more countries reported the first occurrence of WNF in specific areas; Brazil, Bulgaria and Romania. In Brazil, disease investigations started due to observed mortality in equidae associated with neurological signs in the State of Espirito Santo. As of 20 March 2019, only horses had been reported affected in the country. The last cases occurred in August 2018 and, by December 2018, the event was considered resolved. In October 2018, Bulgaria reported the first occurrence of WNF in the country: a WNF-positive corvid was found dead in the region of Burgas close to the Black Sea. This was the only case reported, and the event was declared closed the same month. In August 2018, Romania reported the first occurrence of WNF in the country: two horses in the region of Ilfov tested positive for WNF virus (WNV). This event was declared resolved in November 2018.

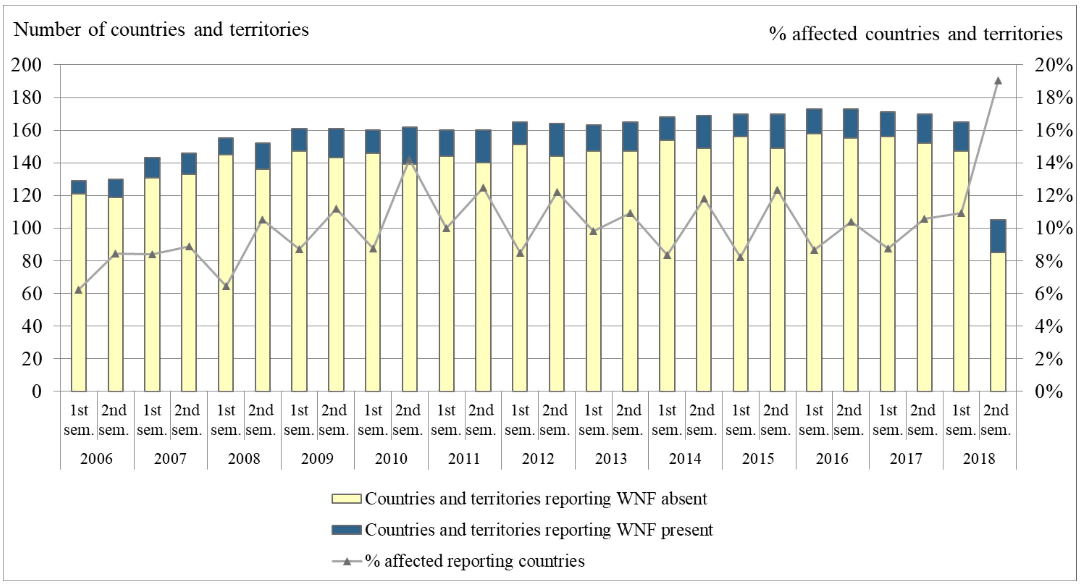
[19] Austria, Brazil, Bulgaria, Canada, Costa Rica, Croatia, France, Germany, Greece, Haiti, Hungary, Israel, Italy, Jordan, Nigeria, Portugal, Romania, Russia, Saudi Arabia, Serbia, Slovenia, South Africa, Spain, Tunisia, Turkey and United States of America.

[20] Brazil, Bulgaria, Croatia, France, Germany, Greece, Portugal, Romania, Slovenia, Tunisia and Turkey.

Six countries reported a recurrence of WNF in immediate notifications submitted through WAHIS. In July 2018, Greece reported a WNF recurrence that affected horses, wild birds and, interestingly, a dog. The dog was tested in the framework of passive surveillance as it had shown neurological signs, and was found to be positive for WNV. The last outbreak in the country was reported in November 2018, and this event was declared closed. In August 2018, France and Croatia reported the recurrence of WNF, with wild birds and several horses being affected in the case of France. Although no further outbreaks have been reported in either France or Croatia, since October and September, respectively, both events are still open. Portugal and Turkey in October 2018 and Tunisia in November 2018, reported a recurrence of WNF, in each involving a single outbreak affecting horses. The events in these three countries have been declared closed. In most of these countries reporting a recurrence of WNF (France, Croatia, Greece and Portugal), the disease had previously been reported in 2017, following the typical yearly seasonal pattern of the disease. However, Tunisia and Turkey reported the recurrence of WNF with cases in horses in their countries after it had been reported as absent since 2015 and 2014, respectively.

The historical trend of WNF notifications between 2006 (year that WNF was included in the OIE list) and 2018 was analysed. Figure 11 shows that the number of countries and territories providing information for WNF increased overtime, from 129 in the first semester of 2006 to 170 in the second semester of 2017. As of 20 March 2019, the number of reporting countries and territories for 2018 was low, as they were still submitting their six-monthly reports for that year. An average of 10% of the reporting countries and territories by semester notified the presence of WNF during the period analysed, which varied from 6% in 2006 to 19% in the second semester of 2018. The analysis of the trend in the percentage of affected countries/territories, using a generalised linear model with binomial distribution, shows a significant increase during the whole period (estimate: 0.01; $p<0.05$), indicating a gradual slight increase in WNF global prevalence.

Figure 11. Percentage of the reporting countries and territories for each semester between 2006 and 2018 that notified WNF present (data based on reports received up to 20 March 2019)



However, as can be seen in Figure 11, there is a seasonality in the reported occurrence of the disease, with an increase in number of affected countries during the second semester of each year (average of 11% in the second semester vs 8% in the first semester), which corresponds to the transmission period of WNF in the Mediterranean Basin due to the period of peak mosquito activity (June to November). Despite the confounding effect of inverse seasonality in other affected regions (i.e. Brazil in the Southern Hemisphere which reported WNF in April), as the majority of affected countries are Mediterranean countries, their seasonality strongly influences the global reporting trends. This seasonality overlaps with the WNF cases reported in Europe in humans, which usually peak between mid-August and mid-September[21].

[21] Haussig Joana M., Young Johanna J., Gossner Céline M., Mezei Eszter, Bella Antonino, Sirbu Anca, Pervanidou Danai, Drakulovic Mitra B., Sudre Bertrand. Early start of the West Nile fever transmission season 2018 in Europe. *Euro Surveill.* 2018;23(32):pii=1800428.

Despite the partial data for 2018, the trend graph also reflects a marked increase in the incidence of WNF last year, confirmed by the reports submitted through the Early Warning System during 2018. This increase in WNF notifications in animals coincides with an exceptional increase in the number of human cases of WNF in Europe, as reported by the World Health Organisation (WHO)[22]. Specifically, the European Centre for Disease Prevention and Control (ECDC) reported 2083 autochthonous human WNV infections in Europe in 2018, which far exceeds the data for previous years (7.2-fold increase vs the 2017 season)[23]. In addition, the WNF transmission season in Europe in 2018 started earlier than in previous years. The weather conditions observed in Europe in summer 2018 (high temperatures and heavy rain followed by dry weather) were perfect for the propagation of mosquitoes. These factors could have favoured an earlier upsurge of the mosquito population in South-Eastern Europe leading to an earlier and higher incidence of the disease[24].

In the United States of America, an upsurge in the number of human cases of WNF was also observed in 2018[25]. These cases represented an increase of 20% in comparison with human cases during the previous year.

2.1.3. Infection with bluetongue virus

Climate changes can significantly modify and broaden the distribution of vector-borne diseases over time. Infection with bluetongue virus (bluetongue) was long estimated to be limited to a latitude range between 35°S and 40°N. Since 1998, however, several bluetongue strains have begun to spread outside of this range. Currently, according to the notifications submitted to the OIE, the disease spread to almost 60°N. Therefore, bluetongue is a disease of global interest, since competent vectors are present in numerous areas in Africa, the Americas, Asia, Europe and Oceania.

The recent geographical distribution of bluetongue in countries and territories, based on information collected through WAHIS during the period from 1 January 2018 to 20 March 2019, is shown in Figure 12. During this period, 186 countries and territories provided information on bluetongue, which was reported present by 24% (45[26]/186) of them. Ten percent of countries and territories (18/186) did not provide information on their bluetongue situation (presence or absence) for the period 2018 and early 2019.

Between 1 January 2018 and 20 March 2019, bluetongue was reported by means of immediate notifications by eight countries[27], as described below.

In July 2018, Kenya notified the recurrence of the disease in the country (serotype not confirmed). The first outbreaks were reported in the administrative divisions of Samburu and Nakuru, and the source of infection was reported to be illegal movement of animals, contact with infected animal(s) at grazing/watering and vectors. Vaccination in response to the outbreaks was applied and the event was declared resolved in November 2018.

In October 2018, Italy reported the first occurrence of a new strain in the country (serotype 3). The event started in September 2018, in the administrative division of Sardinia, and, as of 20 March 2019, was still ongoing. No information has been provided as to the source of infection.

In the same month, Cyprus and Portugal both reported the recurrence of the disease in the country (serotype 4). Cyprus reported the first outbreaks in the administrative divisions of Acheritou. The disease spread to other administrative divisions and in December 2018 the event was declared resolved. Portugal reported an outbreak in the administrative division of Coruche. Previous bluetongue outbreaks in the country had been reported in January 2017 (serotype 1) and November 2013 (serotype 4). As of 20 March 2019, the event was still ongoing.

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[22] West Nile virus infections spike in southern and central Europe. WHO, 2018: http://www.euro.who.int/en/countries/italy/news/news/2018/8/west-nile-virus-infections-spike-in-southern-and-central-europe

[23] Epidemiological update: West Nile virus transmission season in Europe, 2018 https://ecdc.europa.eu/en/news-events/epidemiological-update-west-nile-virus-transmission-season-europe-2018

[24] Haussig Joana M., Young Johanna J., Gossner Céline M., Mezei Eszter, Bella Antonino, Sirbu Anca, Pervanidou Danai, Drakulovic Mitra B., Sudre Bertrand. Early start of the West Nile fever transmission season 2018 in Europe. *Euro Surveill.* 2018;23(32):pii=1800428.

[25] https://www.cdc.gov/westnile/statsmaps/preliminarymapsdata2018/disease-cases-state-2018.html

[26] Afghanistan, Argentina, Australia, Botswana, Brazil, Canada, Costa Rica, Cyprus, Dominican Republic, Ecuador, Egypt, France, French Guiana, Germany, Greece, Guadeloupe (France), India, Iran, Israel, Italy, Jordan, Kenya, Lesotho, Madagascar, Mayotte (France), Montenegro, Morocco, Oman, Pakistan, Palestine, Papua New Guinea, Paraguay, Philippines, Portugal, Reunion (France), Saudi Arabia, South Africa, Spain, Switzerland, Timor-Leste, Tunisia, Turkey, Uganda, Venezuela, and United States of America.

[27] Cyprus, Egypt, Germany, Italy, Kenya, Portugal, Tunisia and Turkey.

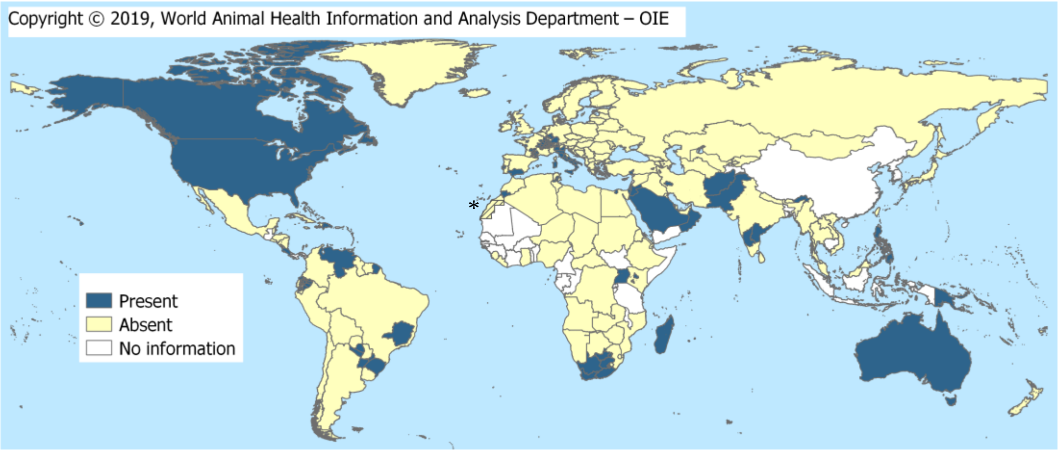
In November 2018, Tunisia reported the recurrence of the disease in the country (serotype 2), and a week later Turkey reported the detection of a new strain in the country (serotype 8). The first outbreaks in Tunisia started in October 2018, in two different administrative divisions. The previous occurrence of serotype 2 in Tunisia dated back to 2000. In December 2018, the country decided to close the event as the situation was considered to be sufficiently stable for follow-up reports no longer to be submitted and for reporting of information related to this event to be done through six-monthly reports only.

The first outbreak in Turkey was declared in the administrative division of Adana, and was reported to have started in September 2018. Serotype 8 was reported, but mixed outbreaks with serotype 4 were also declared. Vaccination in response to the outbreaks was applied and, in the absence of any further spread of the disease, the event was declared resolved in December 2018.

In December 2018, Germany notified the recurrence of the disease, which occurred in Baden-Wurttemberg (serotype 8). The last reported occurrence of the disease in the country dated back to 2009. As of 20 March 2019, the event was still ongoing.

Finally, in March 2019 Egypt reported the recurrence of the disease in the country (serotype 4), with date of previous occurrence 1974. The event started in August 2018, in the administrative division of Al-Buhayrah. In November 2018 the outbreak was reported as resolved but the event, as of 20 March 2019, was still ongoing. No information has been provided as to the source of infection.

Figure 12. Distribution of bluetongue in countries and territories in 2018 and early 2019 (up to 20 March 2019)

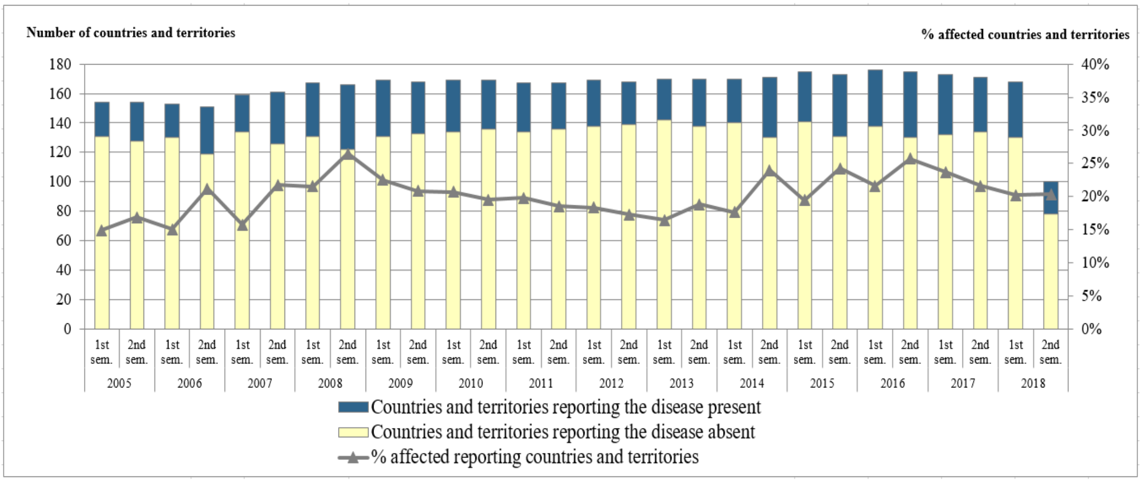


** Data provided by Morocco*

The following analysis describes the global trend of the disease since 2005. Figure 13 shows that the percentage of reporting countries and territories notifying bluetongue as present increased from 15% in the 1st semester of 2005 to 20% in the 1st semester of 2018. A peak in the proportion of countries reporting the disease present was reached in the 2nd semester of 2008 (27%). The trend in the percentage of affected countries/territories, analysed using a generalised linear model with binomial distribution, shows a significant increase during the whole period (estimate: 0.01; $p<0.05$), indicating a deterioration of the reported global situation during the overall period of analysis. Based on this estimate, the odds ratio was calculated to be OR[28] = 1.01 (95%CI= [1.00-1.02]), meaning that each year, the odds for the reporting of bluetongue presence increased by 1.01.

[28] The odds of an event of interest occurring is defined by odds = p/(1-p) where p is the probability of the event occurring.

Figure 13. Percentage of the reporting countries and territories for each semester between 2005 and 2018 that notified bluetongue present (data based on reports received up to 20 March 2019)



During the period 2018 and early 2019, 15 different serotypes[29] have been reported and 35% of the reporting countries and territories were able to provide information on the circulating serotype. Considering data collected in WAHIS since 2005, it appears that countries have significantly improved the quality of the information they provide for bluetongue. In fact, for the first semester of 2005, only 9% of the affected countries identified and reported the circulating serotype(s) to the OIE; since then this percentage increased up to 41% in the second semester of 2017. This percentage is still low and needs to be improved in order to provide a better picture on the variability of the circulating serotypes. Not only has the percentage of countries reporting information on the circulating serotype increased over the years, the number of serotypes reported has also increased. In 2005 (1st semester) only 2 serotypes[30] were reported, whereas in 2017 (2nd semester) 17 different circulating serotypes[31] were reported. The increasing number of reported serotypes can be interpreted either as a result of the complex epidemiological situation of the disease, or as a consequence of the improved diagnostic capabilities of OIE Members. WAHIS can be a useful tool to monitor the changing epidemiology of the disease and the diversity of circulating serotypes.

Focusing on the epidemiology of the disease, the spatiotemporal distribution of bluetongue is known to be strongly influenced by climate. Therefore, climate change could have a strong influence on disease dynamics. A paper published in 2005 stated that "*Sero-surveys indicate that many BTV serotypes have been circulating on the fringes of Europe for several decades.* […] *The potential has, therefore, long existed for BTV to enter Europe, either by the movement of infected ruminants or by the wind-dispersal of infected midges*. […] *Despite these potential entry routes, both BTV and African horse sickness virus (AHSV) (which is a closely related orbivirus that is transmitted by the same* Culicoides *species) made only brief periodic incursions into southern Europe before 1998*". After that year, the epidemiological situation of the disease changed significantly. In particular, the traditional range of bluetongue before 1998 was between 35°S and 40°N[32], and the spread outside this range is recent[33].

To better understand the disease dynamics in space and time, a map representing information on disease occurrence since 1996 was plotted. Data for the period 1996 – 2004 were extracted from Handistatus, using accuracy of the information at country level. For the period 2005 – 2019, only information from early warning notifications was used, representing information at outbreak (coordinates) level (number of outbreaks = 28 211).

In the period 1996 – 2004, 79 countries and territories reported the presence of the disease. In particular, 42 countries and territories reported bluetongue presence in 1996-1997 (i.e. before the spread of the disease to Southern Europe and northern Africa) and 71 countries and territories in the period 1998 – 2004 (Figure 14).

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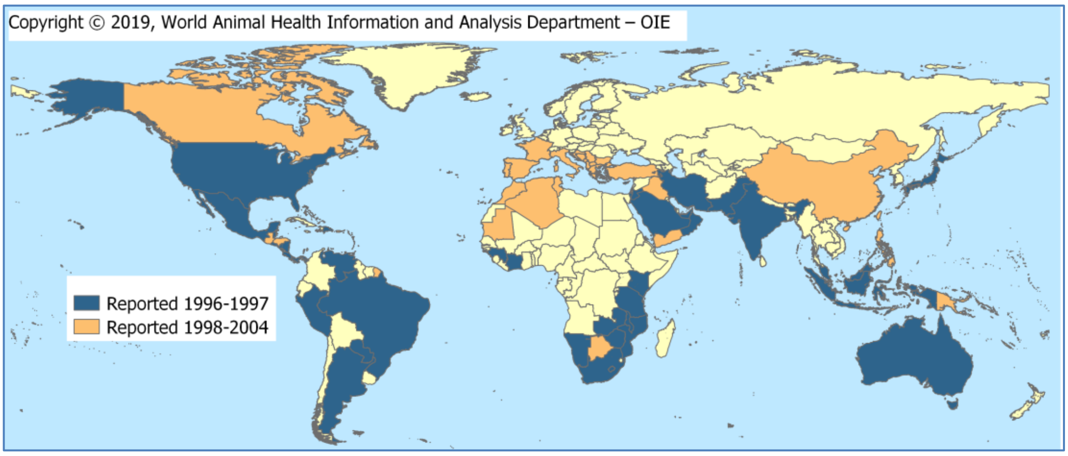
29 Serotypes 1, 2, 3, 4, 8, 9, 11, 12, 13, 14, 15, 16, 17, 22 and 24
30 Serotypes 4 and 16
31 Serotypes 1, 2, 3, 4, 6, 8, 9, 11, 12, 13, 14, 15, 16, 17, 19, 22, and 24
32 Purse B.V., Mellor P.S., Rogers D.J., Samuel A.R., Mertens P.P., Baylis M. (2005 Feb.) Climate change and the recent emergence of bluetongue in Europe. *Nature Reviews Microbiology*; 3(2):171-81.
33 Wilson A.J., Mellor P.S. (2009 Sep.) Bluetongue in Europe: past, present and future, *Philosophical Transactions of the Royal Society B: Biological Sciences*; 27; 364 (1530):2669-81.

Between 2005 and 2019 (as of 20 March 2019), 43 countries reported the presence or suspicion of bluetongue through 178 immediate notifications. The highest number of immediate notifications was submitted in 2008 (N=26) and 2015 (N=20). The years 2007 and 2008 were associated with the most significant change in the number of immediate notifications submitted, as a result of the spread of serotype 8 to Northern Europe and the first occurrence of serotype 1 in some European countries[34].

For a better graphic representation of the disease dynamics, figure 15 focuses on the Mediterranean basin, from which most of the outbreaks were reported in the period 2005 – 2019. During this period, the further spread of the disease to northern and Eastern Europe is quite evident. The most recent change in disease dynamics was characterized by the recurrence in several European countries and in Northern Africa and the occurrence of new strains in some other countries. Finally, in March 2019 Egypt reported the recurrence of the disease since 1974.

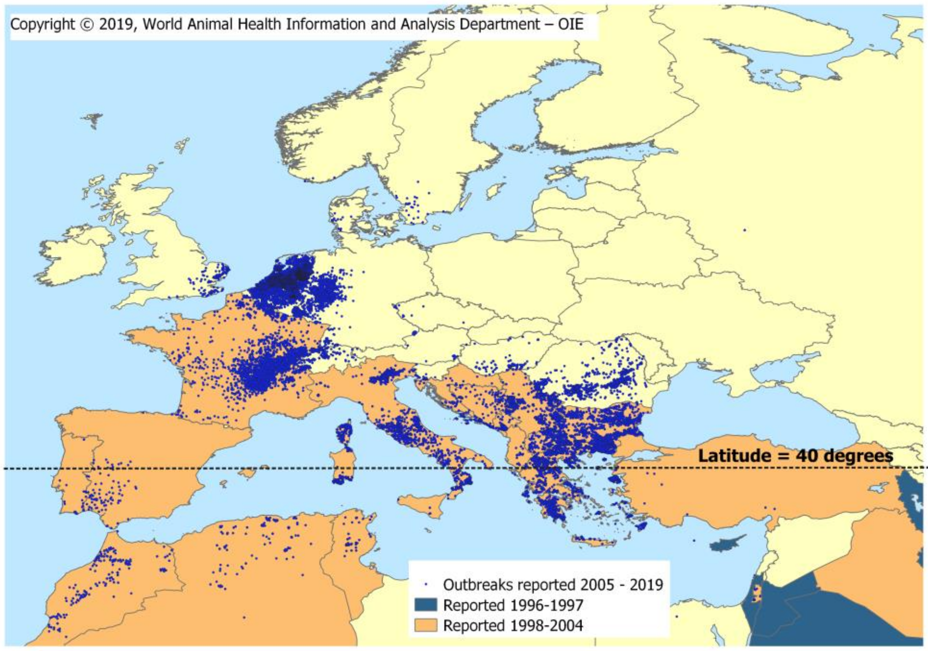
In the other OIE Regions, the disease is mainly reported through six-monthly reports.

Figure 14. Bluetongue distribution between 1996 and 2004: countries reporting the presence of the disease in 1996-1997 are in blue and those reporting the disease present in 20 March 2019)



34 Conraths, F. J., Gethmann, J. M., Staubach, C., Mettenleiter, T. C., Beer, M., & Hoffmann, B. (2009). Epidemiology of bluetongue virus serotype 8, Germany. *Emerging infectious diseases*, 15(3), 433.

Figure 15. Bluetongue distribution in the Mediterranean basin between 1996 and 2004: countries reporting the presence of the disease in 1996-1997 are in blue and those reporting the disease present in the period 1998 – 2004 are in orange; information reported through immediate notifications is represented by blue dots (data based on reports received up to 20 March 2019)



General conclusions for vector borne diseases

This section reviewed the epidemiological situation of three vector-borne diseases with a high impact on animal health, and for which important events occurred in 2018. Specifically,

- An increase in the incidence of RVF outbreaks, including human cases, was observed in East Africa in 2018, affecting several countries of the Region. This situation was a source of concern for public and animal health services in the Region. The OIE, concerned about this rise in incidence, contacted the countries to raise awareness and encourage notification of any events.

- An upsurge in WNF incidence was observed in 2018 in European countries, where a large number of humans were affected by the disease. In addition, WNF, which was traditionally considered a Mediterranean problem, was reported for the first time this year in animals in Germany and Slovenia.

- Bluetongue continues to be a disease of global interest, given its spread in recent years and its potential for further spread in the future. Climate change effects are very important for all vector-borne diseases and the spread of bluetongue in recent years provides a clear example of the need for better preparedness and control of these diseases. Several studies have confirmed the effects of temperature on bluetongue virus transmission[34,35,36].

[35] Boender G.J., Hagenaars T.J., Elbers A.R.W., Gethmann J.M., Meroc E., Guis H. and de Koeijer A.A. (2014) Confirmation of spatial patterns and temperature effects in Bluetongue virus serotype-8 transmission in NW-Europe from the 2007 reported case data, *Veterinary Research, 45(1), pp.75.*

[36] Geoghegan J.L., Walker P.J., Duchemin J.B., Jeanne I., Holmes E.C. (2014 Nov. 20) Seasonal drivers of the epidemiology of arthropod-borne viruses in Australia., *PLoS Neglected Tropical Diseases.;8(11).*

Considering that:

- Climatic factors such as the El Niño Southern Oscillations phenomenon and heavy prolonged rains are linked to the occurrence of RVF epidemics[37].

- The wide distribution of competent vectors and susceptible mammals in non-endemic areas, coupled with climate change, land use changes and globalisation (increased animal trade and human travel), increase the risk of RVF occurring in the near future in territories not previously affected[38].

- The change in patterns of WNF transmission (earlier season, a higher incidence and changes in distribution) has also been reported for other vector-borne diseases (e.g. Zika and Chikungunya) and climate change has been pointed out as a contributing factor[39].

- Several studies have confirmed the effects of temperature on bluetongue virus transmission[8], where its dissemination in recent years has been affected by climate change. The peak of activity of the vector depends on climatic conditions and is directly related to the likelihood of animals becoming infected. Therefore, bluetongue provides a clear example of the need for better preparedness and control of vector-borne diseases.

The OIE issues the following recommendations:

- Surveillance activities for these vector-borne diseases should be stepped up in high-risk areas during high-risk periods, applying a One Health approach when applicable. Dead wild birds and horses showing neurological signs during high risk periods should always be considered as potential cases of WNF and should be tested for differential diagnosis. In the same context, the occurrence of abortion storms in animals and/or potential RVF suspected human cases should lead to further investigations on RVF.

- Countries are strongly encouraged to report the occurrence of any case of the aforementioned diseases through WAHIS in a timely manner to inform the international community and allow the implementation of awareness and prevention efforts.

- Detailed information of good quality should be provided, to enable a better evaluation of the past and recent disease dynamics, with the aim of better informing countries so that they can take steps to improve their preparedness. Even if information on circulating serotypes is constantly improving (increase in the proportion of countries providing data on bluetongue serotypes from 9% to 41%), there is still room for improvement.

- The provision of high-quality information is especially important to improve preparedness in relation to climate change. Future integration of good quality WAHIS data with other sources of information, such as climatic series, environmental data and vector distribution maps, will allow the development of better epidemiological analyses and will help countries to implement early disease detection and control. In this context it is very important to note that countries should continue to improve their efforts to provide accurate information on the circulating serotypes.

- Countries are encouraged to use WAHIS for the early reporting of cases. The future OIE-WAHIS tool will enable better quality data to be collected, information to be more effectively integrated with other sources, and data display and access to be improved.

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[37] Food and Agriculture Organization Emergency Prevention Systems-Animal Health (EMPRES). Empres Watch. El Nino and increased risk of Rift Valley fever-warning to countries. 2015. http://www.fao.org/emergencies/resources/documents/resources-detail/en/c/370027/ (or http://www.fao.org/3/a-i5282e.pdf

[38] Paweska JT. 2015. Rift valley fever. *Rev Sci Tech Off Int Epiz* 34(2):375.

[39] Jan C Semenza, Jonathan E Suk; Vector-borne diseases and climate change: a European perspective, *FEMS Microbiology Letters*, Volume 365, Issue 2, 1 January 2018, fnx244, https://doi.org/10.1093/femsle/fnx244

2.2. Diseases spread though movements of animal and animal products

2.2.1. Infection with avian influenza viruses

Infection with avian influenza viruses (AI) has captured the attention of the international community over the years, with outbreaks in poultry having serious consequences for both livelihoods and international trade in many countries. In addition, although most AI viruses do not infect humans, some, such as AI H5N1 and H7N9, are well known to the public because of their involvement in serious and sometimes fatal infections in humans. Due to the ongoing circulation of zoonotic subtypes, outbreaks of AI continue to be a global public health concern. Faced with this situation, the OIE's objectives of promoting transparency and understanding of the global animal disease situation continue to be a priority, both to protect public health and to ensure the safety of world trade in animals and animal products. In addition, the OIE has strengthened international coordination and cooperation in the control of AI through collaboration with WHO and FAO: the three organisations regularly exchange follow-up information on the global zoonotic influenza situation. This section reviews the recent AI global situation, and its evolution since 2005.

The recent global geographical distribution of infection with AI, based on the information collected through WAHIS during the period from 1 January 2018 to 20 March 2019, is shown in Figure 16. The upper part shows the distribution of AI (both, high pathogenic AI "HPAI" and low pathogenic AI "LPAI") in poultry and the lower part shows the distribution of HPAI in birds other than poultry (including wild birds).

During this period, 183 countries and territories provided information on AI in poultry, which was reported as present by 24% (44/183) of them. Seven countries and territories[40] reported both HPAI and AI of low pathogenicity (LPAI), 25[41] reported only HPAI and 12[42] reported only LPAI. The subtype most commonly reported in poultry was H5N1 (by 14[43]countries/territories), followed by H5N8 (by 12[44] countries/territories), H5N2 (by nine[45] countries/territories) and H5N6 (by seven[46] countries/territories). Other subtypes were only reported by few countries each: H5 (neuraminidase not typed in Afghanistan, Chinese Taipei, Denmark, Russia and Sweden), H5N3 (France), H5N5 (France), H5N7 (Italy), H7 (neuraminidase not typed) in Denmark, H7N1 (United States of America), H7N2 (South Africa), H7N3 (Mexico and United States of America), H7N7 (France), H7N9 (China [People's Rep. of]). The diversity of subtypes reported in poultry for the period of interest is remarkable. When circulating in the same geographical areas, co-infections of different influenza viruses in the same animals create the risk of reassortment, and these situations can generate new influenza viruses[47].

Concerning HPAI in birds other than poultry (including wild birds), 180 countries and territories provided information, and the disease was reported as present by 14% (25[48]/180) of them. The subtype most commonly reported in birds other than poultry (including wild birds) was H5N6 (by 13[49] countries/territories), followed by H5N8 (by five[50] countries/territories), H5N1 (by India) and H5 (neuraminidase not typed in Afghanistan). The diversity of subtypes reported in birds other than poultry is much lower than that reported in poultry. This might be due to a lower level of surveillance and typing in this category of birds, compared to poultry.

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[40] China (People's Rep. of), Chinese Taipei, Ghana, Italy, Mexico, Netherlands and South Africa

[41] Afghanistan, Bangladesh, Bhutan, Bulgaria, Cambodia, Congo (Dem. Rep. of), Egypt, Ghana, Hong Kong (SAR - PRC), India, Iran, Iraq, Japan, Korea (Rep. of), Laos, Liberia, Malaysia, Myanmar, Nepal, Nigeria, Philippines, Russia, Saudi Arabia, Togo and Vietnam

[42] Denmark, Dominican Republic, France, Haiti, Pakistan, Palestine, Papua New Guinea, Samoa, Sao Tome and Principe, Senegal, Sweden and United States of America

[43] Bangladesh, Bhutan, Cambodia, China (People's Rep. of), Egypt, France, Ghana, India, Italy, Laos, Malaysia, Nepal, Togo and Vietnam

[44] Bulgaria, Chinese Taipei, Congo (Dem. Rep. of), Egypt, India, Iran, Iraq, Italy, Nigeria, Russia, Saudi Arabia and South Africa

[45] Chinese Taipei, Denmark, Dominican Republic, Egypt, France, Mexico, Russia, South Africa and United States of America

[46] China (People's Rep. of), Chinese Taipei, Hong Kong (SAR - PRC), Japan, Korea (Rep. of), Netherlands and Vietnam

[47] Marshall N., Priyamvada L, Ende Z., Steel J., Lowen A.C., Influenza Virus Reassortment Occurs with High Frequency in the Absence of Segment Mismatch, *PLoS Pathog*. 2013 Jun; 9(6): e1003421.

[48] Afghanistan, Bangladesh, China (People's Rep. of), Chinese Taipei, Denmark, Egypt, Finland, Germany, Ghana, Hong Kong (SAR - PRC), India, Iran, Ireland, Israel, Italy, Japan, Kazakhstan, Kuwait, Namibia, Netherlands, Pakistan, Slovakia, South Africa, Sweden and United Kingdom

[49] Bangladesh, Bhutan, Cambodia, China (People's Rep. of), Egypt, France, Ghana, Italy, Laos, Malaysia, Nepal, Togo and Vietnam

[50] Israel, Kuwait, Namibia, Pakistan and South Africa

As of 20 March 2019, only eight OIE Members had not provided information on their national AI situation (presence or absence) in poultry for 2018 and early 2019, and, among affected countries and territories, nine[51] had not reported any information on the circulating subtypes. Similarly, 19 OIE Members had not provided information on their national situation regarding AI of high pathogenicity in birds other than poultry (including wild birds) for 2018 and early 2019, and, among affected countries and territories, seven[52] had not reported any information on the circulating subtypes.

In accordance with the provisions of the *Terrestrial Code*, OIE Members may self-declare freedom of their country, zone or compartment from AI. A Member wishing to publish its self-declaration for disease freedom, should provide the relevant documented evidence of compliance with the provisions of Chapter 10.4. of the *Terrestrial Code*. As of 20 March 2019, 14 Members[53] had declared themselves free from AI in poultry, Turkey declared 27 zones free from AI in poultry, and seven Members[54] declared themselves free from HPAI, with no reported subsequent outbreaks.

During the period from 1 January 2018 to 20 March 2019, AI was reported by 36 countries and territories by means of 92 immediate notifications. Among these notifications, 76 were for recurrences.

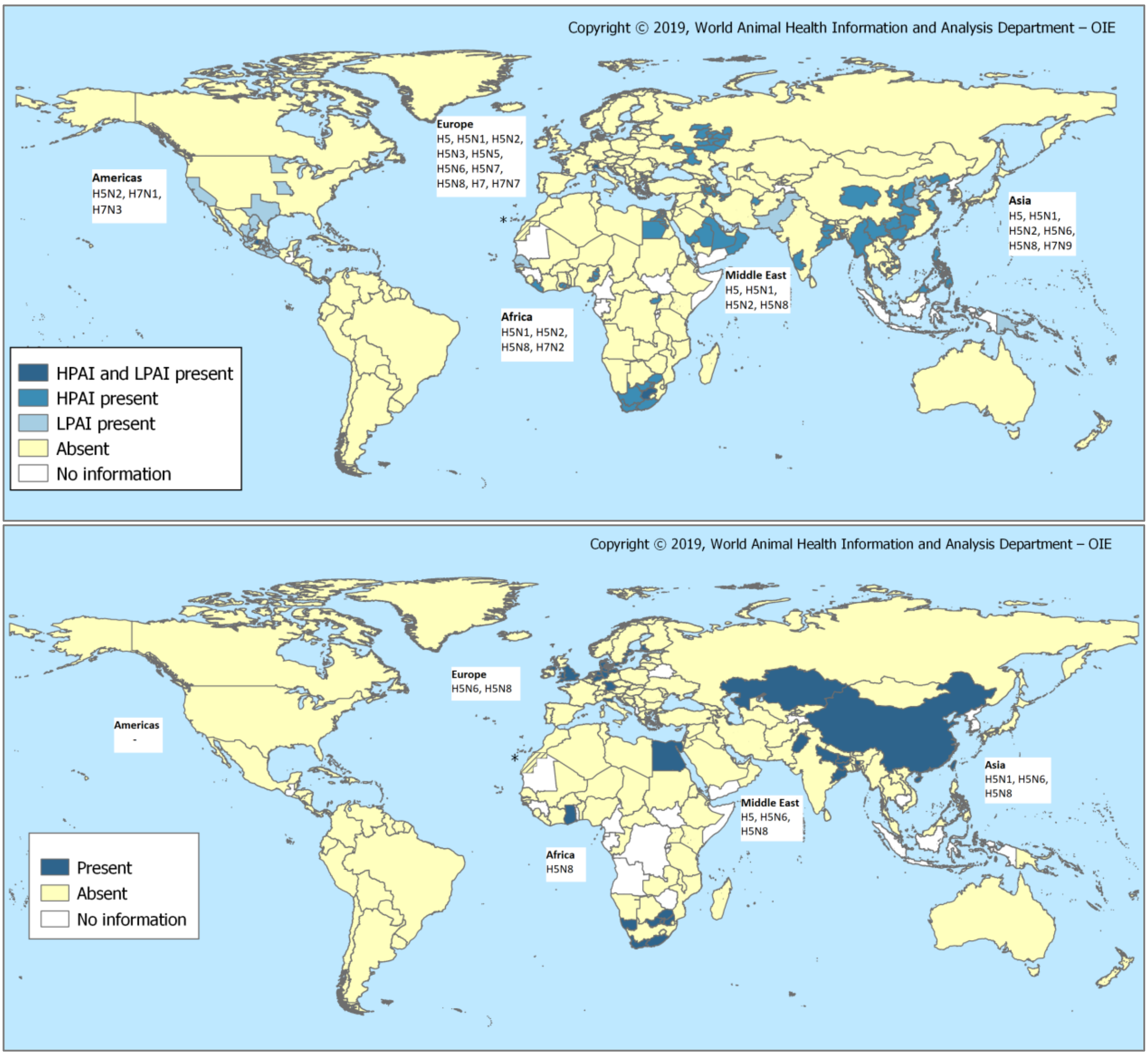
Nine countries reported first occurrences of new strains, mainly detected in wild birds. Six of these countries reported the first occurrence of HPAI – H5N6 subtype. In Germany, HPAI H5N6 was detected for the first time in January 2018, and the event was considered resolved the same month. The United Kingdom also reported the first occurrence of the same subtype a few days later. The event was declared resolved in April 2018. Sweden was the next European country to detect HPAI H5N6, also in January 2018. The event was declared resolved in February 2018. In Ireland, the same subtype was detected for the first time a few days later, also in wild birds and declared resolved in March 2018. Finland reported the first detection of the same subtype in March 2018 and the event was declared resolved the same month. HPAI H5N6 was detected for the first time in Iran in January 2018. The event was declared resolved in February 2018. In Central Asia, another HPAI subtype (H5N8) was detected for the first time in Pakistan in January 2018. The event was declared resolved in February 2018. France detected the first occurrence of LPAI H5N5 in March 2018; all the animals were killed and disposed of. The event was declared resolved in March 2018. Finally, Egypt declared the first occurrence of HPAI H5N2 in poultry in February 2019 detected during surveillance activities. The event was declared resolved the next month (March 2019).

China (People's Rep. of) reported the first occurrence of HPAI H7N9 in poultry in three provinces: Liaoning, Ningxia and Shanxi (Central and Eastern parts of the country), between March and May 2018. The event in Liaoning was declared resolved in June 2018. As of 20 March 2019, three outbreaks had been reported in Ningxia and Shanxi and the two events were still on-going.

51 Liberia, Myanmar, Oman, Pakistan, Palestine, Papua New Guinea, Samoa, Sao Tome and Principe and Senegal.
52 Bangladesh, China (People's Rep. of), Chinese Taipei, Egypt, Ghana, Italy, and Kazakhstan
53 Belgium, Colombia, Czech Republic, El Salvador, Honduras, Hungary, Japan (from 15/04/2018), Netherlands (from 10/07/2018), Peru, Slovakia, Spain, Sri Lanka, United Kingdom and Uruguay
54 Burkina Faso, France, Guatemala, Korea (Rep. of) (from 12/07/2018), Pakistan, Thailand and Turkey

Four countries reported first occurrences. In Afghanistan, HPAI in poultry (subtype H5) occurred for the first time in Hirat province (in the west of the country) in January 2018 and, as of 20 March 2019, the event was still on-going. Bulgaria reported the first occurrence of HPAI in poultry (subtype H5N8), in March 2018. The event was declared resolved in August 2018, after stamping out and disinfection had been carried out and completed. In Sweden, LPAI in poultry (subtype H5) occurred for the first time in Skåne Län (South of the country) in May 2018. The event was declared resolved in May 2018. Finally, Namibia declared in February 2019 the first occurrence of HPAI (subtype H5N8) in wild birds. As of 20 March 2019 two outbreaks in African penguins have been reported and the event is still on-going.

Figure 16. Global distribution of AI in countries and territories in 2018 and early 2019. The upper part shows the distribution of AI in poultry and the lower part shows the distribution of HPAI in birds other than poultry (including wild birds). Labels indicate the serotypes reported by region (up to 20 March 2019)



** Data provided by Morocco*

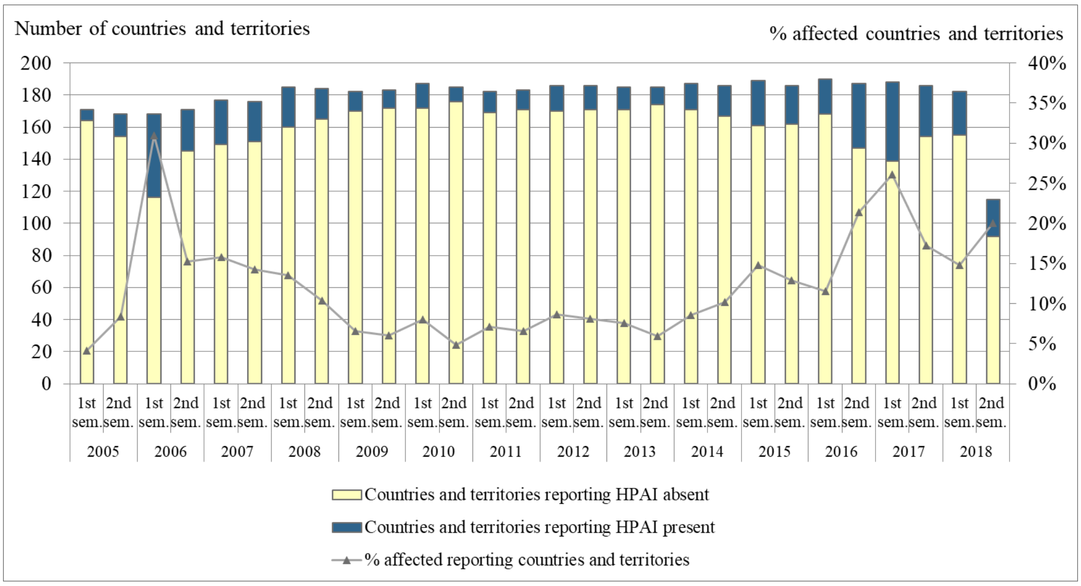
As of 20 March 2019, a few human cases of AI had been reported during the period 2018 and early 2019[55,56], according to information published by WHO. In February 2018, the national authorities of China (People's Rep. of) notified the WHO of a case of human infection with AI A(H7N4) virus, which was the first human case of infection with this subtype to be reported worldwide. It is interesting to note that this subtype was not identified in animals during this period, according to the information submitted to the OIE.

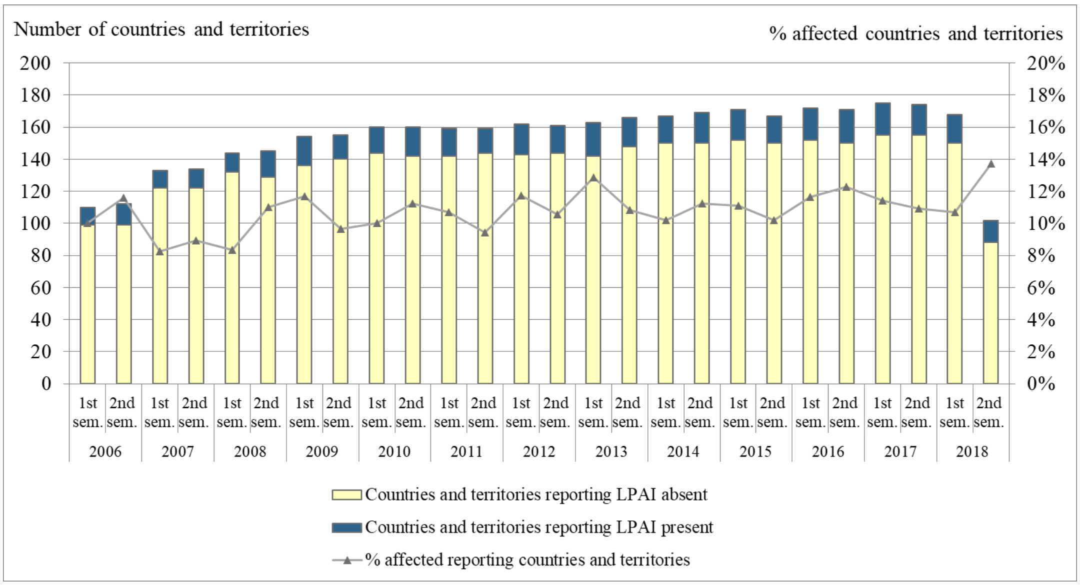
55 http://www.fao.org/ag/againfo/programmes/en/empres/H7N9/situation_update.html
56 https://www.who.int/influenza/human_animal_interface/2019_02_12_tableH5N1.pdf?ua=1

The following analysis describes the global trend of AI in poultry in recent years. The global trend of HPAI in birds other than poultry (including wild birds) is not presented in the analysis, as surveillance activities are not as high as in poultry in most Regions, and this could lead to biased information. The upper part of Figure 17 shows that the percentage of reporting countries notifying HPAI present increased from 4% in the first semester of 2005 to 31% in the first semester of 2006, which was the first peak during the period of analysis. The percentage then decreased to 7% in the first semester of 2009 and remained relatively stable and low (between 5% and 9%) from 2009 to 2014. The percentage of affected reporting countries then increased again to a second peak at 27% in the first semester of 2017, and slowly decreased in the following semesters. The years 2006 and 2017 were the two global peaks of HPAI in poultry in the past 14 years. During each peak, more than a quarter of reporting countries and territories in the world reported the disease present in poultry. The analysis of the trend in the percentage of affected countries/territories, using a generalised linear model with binomial distribution, shows a significant increase during the whole period (estimate: 0.02; $p<0.05$), indicating a gradual increase in the global prevalence of HPAI in poultry.

The lower part of Figure 17 shows that the percentage of reporting countries notifying LPAI present remained relatively stable between 8% and 14% between the first semester of 2006 and the second semester of 2018, with an average of 11%. The figure also shows that the number of countries and territories providing information for LPAI increased overtime, from 110 in the first semester of 2006 to 174 in the second semester of 2017. As of 20 March 2019, the number of reporting countries and territories for 2018 was lower, as they were still submitting their six-monthly reports for that year. The analysis of the trend in the percentage of affected countries/territories, using a generalised linear model with binomial distribution, did not show a significant increase during the whole period ($p>0.05$). Therefore, from the data we are unable to conclude that there has been a deterioration in the reported global situation of LPAI during the overall period of analysis.

Figure 17. Percentage of the reporting countries and territories for each semester that notified AI present in poultry (data based on reports received up to 20 March 2019) -
The upper graph relates to HPAI (2005-2018) and the lower graph relates to LPAI (2006-2018)*





* LPAI was included in the OIE list in 2006

- In conclusion, this section highlighted the high percentage of reporting countries and territories affected by AI in poultry in 2018 and early 2019 (24%) and the high number of circulating AI subtypes in this animal population (12 subtypes[57]). It showed that, as in previous periods, the disease in poultry affected countries and territories in all OIE Regions, which reinforces the need for international coordination and cooperation.

- The analysis showed that the percentage of reporting countries and territories notifying the presence of AI in birds other than poultry (including wild birds) was lower, with fewer circulating subtypes reported. Even if the data show a general improvement in the surveillance capacities of countries and territories this difference is likely to be due to a lower level of surveillance in this category of birds than in poultry in many Regions.

- Although the percentage of reporting countries and territories affected by HPAI in 2018 and early 2019 was relatively high, it remained lower than in 2017. However, the first detection of AI subtype H7N4 in early 2018 serves as a reminder to all countries that the high level of vigilance for the disease should be maintained, given its potential zoonotic impact.

- The OIE's standards and the transparency of reporting through WAHIS provide the framework for Veterinary Services to implement effective surveillance, reporting, and control measures for AI. The OIE continues to closely monitor the global AI situation and report back to its Members.

2.2.2. Infection with koi herpesvirus

Infection with koi herpesvirus (KHVD) is a herpesvirus infection[58] capable of inducing a contagious and acute viraemia in common carp (*Cyprinus carpio*) and varieties such as koi carp and ghost carp[59].

Naturally occurring KHV infections have only been recorded in common carp (*Cyprinus carpio*) and varieties of this species (e.g. koi carp). Following the first reports of KHVD in Israel and Germany in 1998 and the detection of KHV DNA in tissue samples taken during a mass mortality of carp in the United Kingdom in 1996[60,61], the disease spread to many countries worldwide, predominantly through the trade in koi carp, before the current knowledge of the disease and the means to detect it became available.

The disease was added to the OIE-list of notifiable diseases in 2007. The disease was selected for this chapter of the report as it was the most frequently notified aquatic disease in 2018 and early 2019. Moreover, as it is present in all OIE Regions, it is considered to be of global interest.

The recent geographical distribution of KHVD in countries and territories, based on information collected through WAHIS during the period from 1 January 2018 to 20 March 2019, is shown in Figure 18. During this period, 127 countries and territories provided information on KHVD, which was reported as present by 17% (22[62]/127). Sixteen countries and territories[63] did not provide information on their national KHVD situation (presence or absence) for 2018 and early 2019.

57 H5N1, H5N2, H5N3, H5N5, H5N6, H5N7, H5N8, H7N1, H7N2, H7N3, H7N7, and H7N9

58 HEDRICK R.P., GILAD O., YUN S., SPANGENBERG J.V., MARTY G.D., NORDHAUSEN R.W., KEBUS M.J., BERCOVIER H. & ELDAR A. (2000). A herpesvirus associated with mass mortality of juvenile and adult koi, a strain of common carp. *J. Aquat. Anim. Health*, 12, 44–57

59 HAENEN O.L.M., WAY K., BERGMANN S.M. & ARIEL E. (2004). The emergence of koi herpesvirus and its significance to European aquaculture. *Bull. Eur. Assoc. Fish Pathol.*, 24, 293–307

60 BRETZINGER A., FISCHER-SCHERL T., OUMOUNA M., HOFFMANN R. & TRUYEN U. (1999). Mass mortalities in koi carp, *Cyprinus carpio*, associated with gill and skin disease. *Bull. Eur. Assoc. Fish Pathol.*, 19, 182–185

61 PERELBERG A., SMIRNOV M., HUTORAN M., DIAMANT A., BEJERANO Y. & KOTLER M. (2003). Epidemiological description of a new viral disease afflicting cultured *Cyprinus carpio* in Israel. *Israeli J. Aquaculture*, 55, 5–12

62 Belgium, Canada, China (People's Republic of), Czech Republic, Denmark, France, Germany, Croatia, Hungary, Indonesia, Iraq, Israel, Italy, Japan, Korea (Rep. of), Lithuania, Netherlands, Romania, Singapore, South Africa, United Kingdom and United States of America

63 Afghanistan, Belarus, Botswana, Comoros, Cote d'Ivoire, Eswatini, Morocco, Myanmar, Namibia, Nicaragua, Panama, Paraguay, Peru, Togo, Turkey and Turkmenistan

During the period from 1 January 2018 to 20 March 2019, KHVD was reported by means of immediate notifications by four countries[64], as described below.

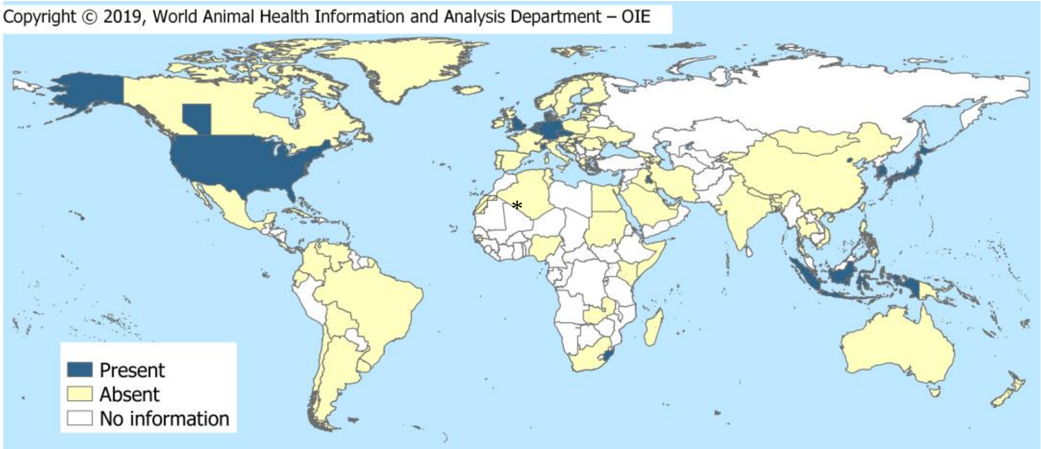
In June 2018, Romania notified the recurrence of the disease in the country. The first outbreaks were reported in the administrative divisions of Giurgiu, but no information was reported on the source of infection. As of 20 March 2019, the event was still ongoing.

In September 2018, Canada reported the first occurrence of the disease in a zone, in the administrative divisions of Alberta. The source of infection was identified as the introduction of new live animals. The event started in July, was confirmed in August and was immediately considered resolved.

In December 2018, Italy reported the recurrence of the disease and one outbreak was identified in the administrative division of Piemonte. As of 20 March 2019, the event was still ongoing.

Finally, in January 2019, Iraq reported the first occurrence of the disease in the country. Four outbreaks were reported in four different administrative divisions, with a very high mortality rate. As of 20 March 2019, the event was still ongoing.

Figure 18. Distribution of KHVD in countries and territories in 2018 and early 2019 (up to 20 March 2019)

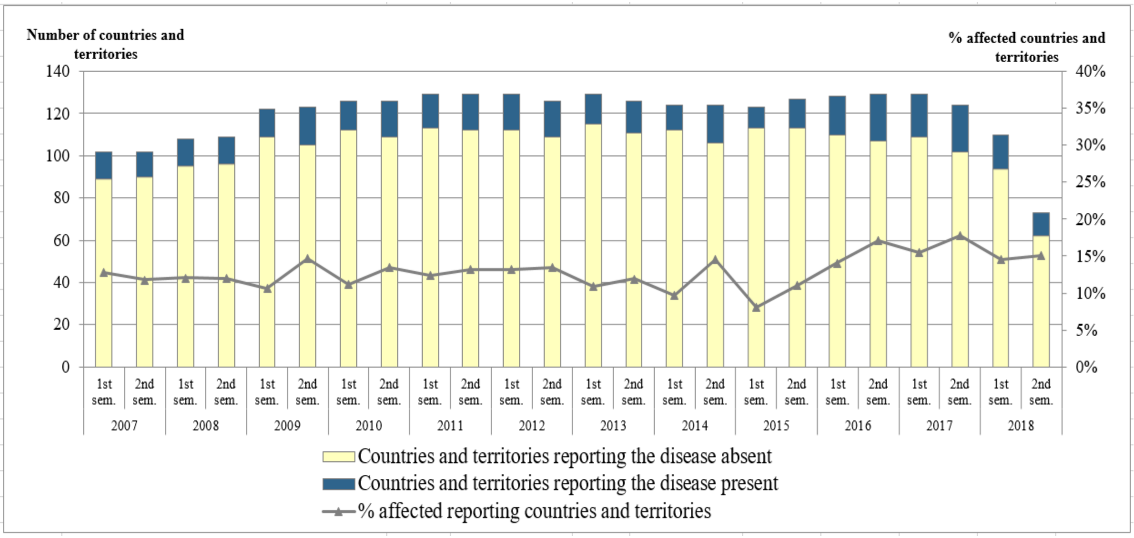


** Data provided by Morocco*

The following analysis describes the global trend of the disease since 2007. Figure 19 shows that the percentage of reporting countries and territories notifying KHVD as present remained quite stable (at around 12-13%) until 2014. In 2015, the percentage decreased to 7% before increasing to 18% in the 2nd semester of 2017. The percentage of affected countries/territories, analysed using a generalised linear model with binomial distribution, shows no significant trend during the whole period (estimate: 0.01; p=not significant), indicating that the overall reported global situation was stable during the period of analysis.

[64] Canada, Iraq, Italy, and Romania

Figure 19. Percentage of the reporting countries and territories for each semester between 2005 and 2018 that notified koi herpesvirus present (data based on reports received up to 20 March 2019)



Freshwater fish species (especially cyprinids) are an important global source of food. In particular, common carp *Cyprinus carpio* are among the most economically valuable species in aquaculture. According to FAO data, European common carp production totalled 164 066 t in 2013. Global production of the species increased from 1 535 905 to 2 956 211 t (92.5%) in the period from 1994 to 2003, but by only 59% (2 559 721 to 4 080 045 t) in the period from 2004 to 2013. Various authors have acknowledged that the spread of diseases (in particular the emergence of KHVD) is the main factor responsible for this reduction in the rate of increase[65]. The rapid spread of KHVD has been attributed to the international ornamental (pet) fish trade and regional koi exhibitions[66]. In this context, it is also interesting to note that only around 30% of countries submitting information on the disease in 2018 indicated in their six-monthly report that they apply active surveillance for the detection of the disease. This indicates a possible gap in countries' capacity for surveillance and early application of preventive and control measures.

2.2.3. Infection with Batrachochytrium salamandrivorans

B. salamandrivorans was first identified in 2013 following dramatic declines among populations of European fire salamanders (*Salamandra salamandra*) in The Netherlands (Martel et al., 2013).

After this first detection in The Netherlands in 2013, it was subsequently found in several locations in neighbouring regions of Belgium in 2013 and 2014[67]. The fungus has also been identified in captive populations of salamanders and newts in Germany and in the United Kingdom[68]. The origin of *B. salamandrivorans* is thought to lie in south-east Asia and it has been identified in Japan, Thailand, Vietnam[69] and most recently China (People's Rep. of)[70]. In areas other than Western Europe, *B. salamandrivorans* is known to infect a number of species of newts native to Asia but does not appear to cause significant disease or mortality. Current evidence strongly suggests that *B. salamandrivorans* is endemic to Asia and species within this region may act as a disease reservoir. *B. salamandrivorans* is currently considered as one of the main drivers in the global decline of amphibians[71].

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65 FAO (Food and Agriculture Organization of the United Nations) (2015) Statistics and Information Service of the Fisheries and Aquaculture Department: fishery and aquaculture statistics 2010. FAO, Rome. www. fao. org/figis/

66 Haenen O, Way K, Bergmann S, Ariel E (2004) The emergence of KHV and its significance to European aquaculture. *Bull Eur Assoc Fish Pathol* 24: 293−307

67 Spitzen-van der Sluijs, A., Martel, A., Asselberghs, J., Bales, E. K., Beukema, W., Bletz, M. C., & Kirst, K. (2016). Expanding distribution of lethal amphibian fungus *Batrachochytrium salamandrivorans* in Europe. *Emerging infectious diseases*, 22(7), 1286.

68 Cunningham AA, Beckmann K, Perkins M, Fitzpatrick L, Cromie R, Redbond J, et al. Emerging disease in UK amphibians. *Vet Rec.* 2015;176:468. 10.1136/vr.h2264

69 Laking, A. E., Ngo, H. N., Pasmans, F., Martel, A., & Nguyen, T. T. (2017). *Batrachochytrium salamandrivorans* is the predominant chytrid fungus in Vietnamese salamanders. *Scientific reports*, 7, 44443.

70 Yuan, Z., Martel, A., Jun, W., Van Praet, S., Canessa, S., & Pasmans, F. (2018). Widespread occurrence of an emerging fungal pathogen in heavily traded Chinese urodelan species. *Conservation Letters*, 1–10. https://doi.org/10.1111/conl.12436

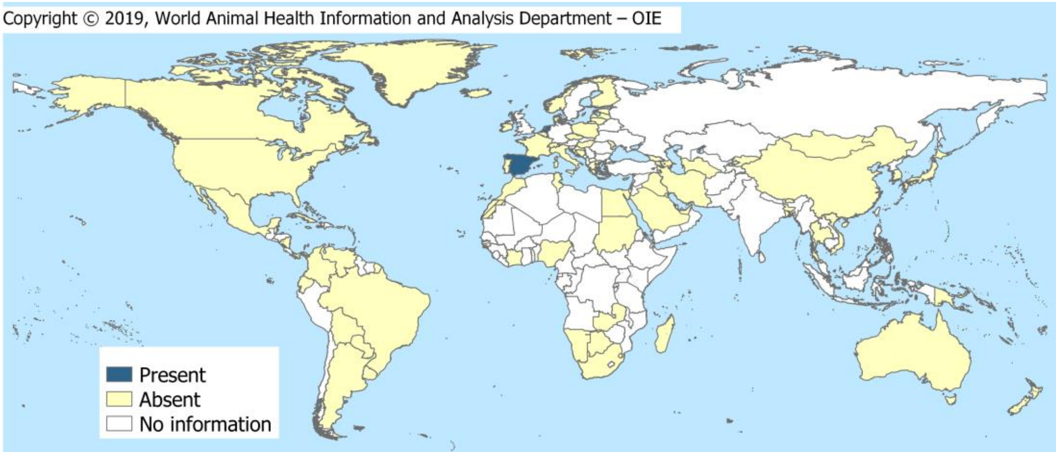
71 Blaustein, A., Urbina, J., Snyder, P., Reynolds, E., Dang, T., Hoverman, J., & Hambalek, N. (2018). Effects of emerging infectious diseases on amphibians: a review of experimental studies. *Diversity*, 10(3), 81.

Following global concern regarding the detection of the disease and its impact on biodiversity conservation, *B. salamandrivorans* was included in 2014 in the voluntary report for notifying non-OIE-listed diseases affecting wildlife. It is important to remember that one of the main purposes of including a disease in the voluntary report for wildlife is to improve our knowledge of pathogens that can have a significant detrimental impact on wildlife population conservation. In 2018, the disease was moved to the OIE-list of diseases for which reporting is compulsory, and in February 2018 a technical disease card was created[72]. In particular, the disease was added to the OIE-list as it was found to meet the criteria for listing, as specified in Article 1.2.2. 4c of the *Aquatic Code*: "*The disease has been shown to, or scientific evidence indicates that it would affect the health of wild aquatic animals resulting in significant consequences e.g. morbidity or mortality at a population level, reduced productivity or ecological impacts.*" As of March 2019, few countries have reported the disease to the OIE. In the period 2014 – 2017 the disease was reported, through the voluntary report, as present by Chile, The Netherlands and the United Kingdom.

The recent geographical distribution of *B. salamandrivorans* in countries and territories, based on information collected through WAHIS during the period from 1 January 2018 to 20 March 2019, is shown in Figure 20. During this period, 115 countries and territories provided information on infection with *B. salamandrivorans*, which was reported as present by 2% (2[73]/115). Sixteen[74] countries and territories did not provide information on their national situation regarding infection with *B. salamandrivorans* (presence or absence) for 2018 and early 2019.

To date, no Member Country has submitted an immediate notification to report the presence of the disease.

Figure 20. Distribution of infection with *B. salamandrivorans* in countries and territories in 2018 and early 2019(up to 20 March 2019)



As in the case of koi herpesvirus, the main route of spread of the disease is linked to international trade. In particular, the disease was most likely introduced into Europe through commercial trade of amphibians. Since the first outbreaks in The Netherlands, it has also been found in imported salamanders in the United Kingdom[75]. All the available scientific evidence suggests that urgent action is needed to protect global amphibian biodiversity by swift policy actions to prevent the translocation of dangerous infective agents such as *B. salamandrivorans* (and also *Batrachochytrium dendrobatidis*). Hence, a cooperative effort across nongovernmental organisations, government agencies, academic institutions, zoos and the pet industry is required to avoid the potentially catastrophic effects of *B. salamandrivorans* on amphibians outside of the pathogen's endemic regions. Considering data submitted from countries and territories in 2018, it is interesting to note that diagnostic capabilities for the disease seem to be very low, with no countries reporting that active surveillance is being applied to detect the disease.

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72 http://www.oie.int/fileadmin/Home/eng/Internationa_Standard_Setting/docs/pdf/A_BSAL_Disease_card.pdf

73 Netherlands and Spain

74 Austria, Cabo Verde, Fiji, Germany, Hong Kong (SAR - PRC), Kenya, Myanmar, Nepal, New Caledonia, Peru, Philippines, Slovakia, Sweden, Togo, Turkey, and Ukraine

75 Martel A, Blooi M, Adriaensen C, Van Rooij P, Beukema W, Fisher MC, et al. (2014) Recent introduction of a chytrid fungus endangers Western Palearctic salamanders. *Science* 346: 630–631. pmid:25359973

- Infection with koi herpesvirus and infection with *B. salamandrivorans* are two important diseases of aquatic animals: the first due to its economic impact, and the second due to its potentially devastating effects on biodiversity conservation of a whole order (amphibians).

- Risk management of the two diseases is strictly related to trade. Most of the spread of the disease during the past few years was, in fact, related to human-driven activities.

- On the other hand, the basic epidemiological information currently available on these two diseases, including that reported by OIE Members, is still limited, with a large percentage of countries apparently not able to provide data regarding the presence or absence of the disease.

- This is also confirmed by the very low capabilities in terms of surveillance and monitoring for these diseases, as reported by OIE Members.

- Despite the importance of aquatic animal diseases, the level of reporting to the OIE is much lower than that for terrestrial animal diseases. It is very important to point out that reporting on aquatic animal diseases is an obligation for all OIE Members and this includes diseases in both aquaculture and wild harvest animals. The OIE helps its Members to fulfil their obligations on notification of aquatic animal diseases by encouraging the nomination of national Focal Points for Aquatic Animals and by giving them access to WAHIS and providing regular dedicated training, including through the WAHIS e-learning platform that was launched in 2017.

- Members are therefore encouraged to take advantage of the support provided by the OIE to ensure transparent and timely notifications, which are crucial for preventing disease spread. In particular, it is recognised by several authors that communication, collaboration, and expedited action are key to avoid the international spread of diseases such as infection with *B. salamandrivorans* outside their current distribution areas[76].

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[76] Gray, M. J., Lewis, J. P., Nanjappa, P., Klocke, B., Pasmans, F., Martel, A., & Christman, M. R. (2015). *Batrachochytrium salamandrivorans*: the North American response and a call for action. *PLoS pathogens*, 11(12), e1005251.