World Organisation for Animal Health
Organisation mondiale de la santé animale
Organización Mundial de Sanidad Animal

The World Animal Health Information System as a tool to support decision-making and research in animal health

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Summary

The World Animal Health Information System (WAHIS) collects and publishes a wealth of information gathered by individual countries' Veterinary Services, including detailed country-specific information on outbreaks of diseases listed by the World Organisation for Animal Health (WOAH, founded as OIE), including emerging diseases, in domestic animals and wildlife, and non-listed diseases in wildlife. The data set is one of the most comprehensive in the world, with 182 Members obliged to report this information to WOAH in a timely manner. As such, the data provide invaluable input for Veterinary Services, animal health researchers and stakeholders to gain insight into risk from infectious diseases, for example through the development of predictive models and risk assessments to address the risk from trade of animal products, globalisation, or movement of wildlife or vectors across country borders. This paper reviews previous analyses that have been conducted using WAHIS data and outlines ways in which these data can be used for preparedness and risk assessment.

Keywords

Animal disease notification – Early detection – Early response – Information dissemination – International trade of animals – Official disease status recognised by WOAH – Risk analysis – Transparency – WAHIS – World Animal Health Information System – World Organisation for Animal Health – Self-declarations.

Introduction to the World Organisation for Animal Health and its mission

The World Organisation for Animal Health (WOAH, founded as OIE) is the international organisation in charge of animal health and welfare. Since its creation in 1924, one of its main missions has been to ensure the transparency of the global animal health situation and improve knowledge of animal diseases. To enable WOAH to fulfil this mission, its Members are required to notify all relevant information concerning their animal health situation, in compliance with the provisions of their Organic Statutes and WOAH Standards [1, 2, 3]. The information submitted by Veterinary Authorities to WOAH on events involving diseases listed by WOAH and emerging diseases is then verified, translated into WOAH's official languages and made publicly available through an online worldwide reference information system known as the World Animal Health Information System (WAHIS). The verification process consists of a) checking the scientific consistency of the data and its alignment with WOAH Standards, b) checking consistency with previously submitted information and c) checking consistency with what is known about the regional and global context of the disease. If inconsistencies are detected, clarifications are requested from the reporting Member. Information is validated by WOAH only after all inconsistencies have been clarified. This information is subsequently shared publicly through the WAHIS public interface [2, 3, 4, 5].

Members of WOAH have the obligation to report on their situation for a list of selected diseases. This list is updated each year following a robust process involving WOAH Specialist

Commissions and Members. In 2022, WOAH Members were required to report on a total of 120 diseases. In addition, as part of their mandate to also notify emerging diseases, WOAH Members reported a total of 15 emerging diseases between 2005 and 2021. Finally, countries may report, on a voluntary basis, information on around 50 wildlife diseases not listed by WOAH, complementing the information compulsorily provided on WOAH-listed wildlife diseases. As a result, WAHIS contains information collected since 2005 on approximately 230 terrestrial and aquatic animal diseases affecting domestic and wild species, including zoonoses.

How is the information from this data source used for preparedness and risk assessment? Who is using the data? This article seeks to answer these questions by briefly summarising the legally binding mechanisms for disease notification to WOAH and the implications of disease notification for international trade, risk analysis and preparedness against disease spread from a national or country-to-country perspective and at the regional and international levels. It also outlines ways in which this information can be used in the future, as well as its use for research and impact assessments. Examples of the use of WOAH data are provided by way of a non-systematic review of papers published in international journals that have analysed and used WAHIS data.

The World Animal Health Information System: a comprehensive, sensitive and modern system to collect information on animal diseases

System overview

The World Animal Health Information System is an internet-based information and early warning system that processes data on animal diseases in real time (https://wahis.woah.org). In 2022, WAHIS data reflected the information gathered by the Veterinary Authorities of WOAH Members and non-Members on 120 WOAH-listed diseases in domestic animals and wildlife, including zoonotic diseases, in addition to emerging diseases. Access to the secure reporting site is available only to WOAH Delegates – oftentimes the Chief Veterinary Officers – and their nominees (Focal Points). This limited access under the Delegate's supervision means that WAHIS animal health data are both official and confirmed [6, 7].

Following the notification of a disease event by a country's Veterinary Authority, WOAH has a duty to disclose and disseminate this information among its Members and the international community. This essential information allows them to take appropriate action to prevent the transboundary spread of WOAH-listed diseases and emerging diseases. In practice, WOAH disseminates this information through WAHIS, which comprises two complementary information systems:

1) an early warning system to collect and inform the international community, by means of immediate notifications and follow-up reports, of relevant epidemiological events as notified by WOAH Members and non-Members;
2) a monitoring system to keep track of the animal health situation for WOAH-listed diseases in terrestrial and aquatic animals (presence or absence) over time, by means of six-monthly reports.

For both systems, the information submitted by WOAH Members (and non-Members) is verified, translated into the three WOAH official languages as needed and then made publicly available. While this dissemination always includes a publication on the WAHIS public interface, the early warning system also involves an email alert message to all Delegates (Veterinary Authorities), as well as to a large list of subscribers (around 17,000 people worldwide) [2, 3, 4, 5].

Epidemic intelligence activity

With the aim of minimising the number of unreported events warranting an immediate notification report and improving the transparency and timeliness of notifications, WOAH has actively searched for non-official information, rumours and signals relating to animal health and veterinary public health events around the world since 2002. This information is subsequently checked with Members. Since 2018, advanced software applications have also been used to perform epidemiological intelligence activities. Currently, WOAH retrieves information from a variety of sources using two platforms for automatic search: the International Biosecurity Intelligence System, managed by the Government of Australia, and Epidemic Intelligence from Open Sources, managed by the World Health Organization (WHO). Thanks to this activity, the verification output rose from 10,000 manually verified news items per year through 2017 to 120,000 items verified through automation in 2021 alone, thus further increasing the capacity of WAHIS to detect disease events [8, 9]. As a direct consequence, an average of around 14% of immediate notification reports were annually submitted thanks to active search and subsequent confirmation with WOAH Members, with large variability across the period. This percentage has stabilised to around 10% in the last few years. This value represents the increased capacity of WAHIS to report disease events due to epidemic intelligence activity.

Sensitivity

One of the unique features of WAHIS is its high sensitivity to detect numerous diseases events of high commercial impact (e.g. avian influenza). More specifically, the sensitivity of the system, or the capacity of WAHIS to identify the reporting countries that have tested positive for the presence of a specific disease, has increased. Several studies have demonstrated WAHIS's high sensitivity. In addition, the

number of Members and non-Members notifying their animal disease situation to WOAH has increased considerably over the years. A study conducted in 2016 showed that the sensitivity of the system to collect disease-event information through spontaneous notification from Members was very high for diseases like bluetongue, low pathogenic avian influenza, foot and mouth disease and African swine fever [10]. For emerging diseases, such as SARS-CoV-2 in animals, WAHIS is considered one of the most complete and relevant sources for registering animal diseases and chronicling their distribution [11, 12]. A recent study using the capture-recapture technique evaluated the sensitivity of the system for tularemia events in lagomorphs among selected North American and European countries as between 70% and 90%, depending on the source used [13]. Another study using a similar approach highlighted a very high global sensitivity of WAHIS for exceptional epidemiological events as defined by WOAH Standards (sensitivity higher than 90%) [14].

In summary, WAHIS data are confirmed and official, specific and sensitive, and quite comprehensive, as they cover endemic situations and exceptional events for more than 120 diseases in more than 200 countries and territories.

Use of global animal health information systems to regulate international movement, support risk analysis and improve preparedness against disease spread

Animal disease information to regulate trade

The notification of animal diseases to WOAH by its Members plays an important role in limiting the spread of pathogenic agents to other countries and territories, facilitating the safe trade of animals and animal products. Accurate and timely communication of animal disease information by WOAH Members is an indication of their national capacity for disease surveillance. When this information is transferred to WOAH for dissemination, it allows countries at risk to take appropriate action, in a timely manner, to prevent or prepare for the transboundary spread of diseases and allows trade partners to adjust their import conditions and thereby mitigate, also in a timely manner, the associated animal and public health risks [7].

Early warning reporting, by means of immediate notifications and follow-up report alerts, is the most widely used dissemination mechanism for Members and stakeholders to take rapid preventive measures against a disease. Moreover, these alerts are often used for risk analysis for different purposes (e.g. to assess the risk of introduction of a disease through the importation of animal products or the risk of exposure and spread of a disease into new areas). According to Chapter 1.1. of the WOAH *Terrestrial* and *Aquatic Animal Health Codes*, and under specific circumstances, WOAH

Delegates have 24 hours after confirmation of a disease to send an immediate notification report through WAHIS. The update of an event and all its epidemiologically associated outbreaks is provided by countries on a weekly basis through follow-up reports [2, 3]. The information in these follow-up reports is essential to understand and assess the risk of disease spread and to describe the actions taken to mitigate the risk.

Another important WOAH mandate is to ensure safe international trade of live animals and their products. International standards have been developed since 1968 and are regularly revised based on the latest scientific evidence to provide recommendations to trade and move animals and products without spreading diseases and pathogens. Since 1995, the standards established by WOAH have been recognised by the World Trade Organization (WTO) and its Agreement on the Application of Sanitary and Phytosanitary Measures as science-based reference standards for international trade to prevent and control animal diseases, including zoonoses [15]. These standards, which allow the worldwide harmonisation of sanitary measures, enable WOAH Members to protect themselves from the introduction of animal diseases and pathogens, while avoiding the implementation of unjustified barriers to the international trade of animals and their products and by-products. When importing animals and their products, it is critically important to know the animal health status of the exporting (and importing) country prior to trade transactions, in order to adjust potential mitigating measures.

Animal disease information and risk assessment

In this context, WAHIS information on the absence of a disease, available in the six-monthly reports, is highly useful and complementary to the alert messages from the early warning system. Both pieces of information should be used to inform risk analysis at global, regional and national levels, especially when combined with data such as control measures applied, including specific active or passive surveillance in place, thus reinforcing the value of the reported absence of a disease and the data collected [16, 17]. From a quantitative point of view, in WAHIS, entry of control measures such as targeted surveillance or vaccination (official vaccination or ring vaccination in response to an outbreak) allows Members to add the total number of animals tested/vaccinated, which makes the analysis more robust and provides additional information to be used in qualitative and quantitative risk assessments. The information on targeted surveillance and vaccination can be provided at country level and by animal categories for domestic animals (e.g. cattle, sheep, goat, horses) and for wildlife in general.

From a risk assessment perspective, with the exception of disease absence data, the quantitative data on number of outbreaks, cases, susceptible animals and culled animals

can also be used for risk assessment purposes. All the information provided in WAHIS is spatially localised (at country, administrative division or outbreak level), thus providing additional relevant and useful information for decision-makers, experts, researchers and other stakeholders.

Animal disease information to identify disease patterns and improve preparedness

Animal health information systems not only are indispensable for animal health surveillance and early warning, but also allow the identification of disease patterns and their evolution. These systems also inform risk assessments and preparedness regarding the origin and spread of animal diseases. In a recent study, the most sought-after features in risk analysis tools were pathways of introduction and spread assessment [18]. While this information can be reported in the immediate notification reports, it is often unavailable when these immediate notification reports are submitted to WOAH. Between 2005 and March 2021, only 27% of immediate notification reports contained this information. It is usually after an epidemiological investigation, which can take several months, that the introduction of the disease is identified, or it can sometimes remain unknown. Therefore, the monitoring of these events through follow-up reports is essential to understand disease dynamics.

An online questionnaire administered in 2020 to assess the use of animal health platforms surveyed 213 respondents from 132 countries and concluded that there was high variability among the different types of information available in animal health systems and their degree of usefulness. According to the experts surveyed, the most useful information extracted from these systems related to disease prevention and control measures. In this study, respondents from government, research and university institutions reported using WAHIS as their main platform, followed by the Emergency Prevention System (EMPRES) Global Animal Disease Information System (EMPRES-i), the Program for Monitoring Emerging Diseases (ProMED) and the Animal Disease Notification System of the European Union (EU) [18].

A large number of enquiries are also sent to WOAH by individuals looking to find out whether their country is free of certain animal diseases, especially before travelling with their pets to other countries. Typically, the Veterinary Authorities of the destination country ask for different diagnostic tests, vaccinations or animal health certificates as part of the import requirements. While all animal health certificates are issued by the Veterinary Authority of the country of origin, and based on requests received by WOAH, destination countries usually refer to the sanitary information declared by the Veterinary Authority in WAHIS through six-monthly reports in order to confirm the sanitary status of the country of origin and proceed, if appropriate, with quarantine measures upon entry of the animals. In this context, a major challenge is the international movement of equids throughout the world, which has increased significantly in the past 15 years as a result of the participation of competition horses in international equestrian and racing events [19]. As a consequence, the introduction of pathogens in previously disease-free areas is very well documented [20, 21, 22].

Furthermore, since 1996 WOAH has officially recognised its Members' animal health status for six selected diseases that have been recognised by the WTO for trade purposes. In accordance with the relevant standard operating procedures (SOPs), the consistency of information reported through WAHIS is systematically assessed when applications are received for official recognition of free status, as well as for the endorsement of a national official control programme [23].

In addition, WOAH Delegates have the possibility to self-declare their country, or a zone or compartment within their territory, to be free from diseases other than those included in the official procedure mentioned above. Should Delegates request it, WOAH publishes their self-declaration(s) on its website. The SOPs for self-declarations of freedom and the publication of the establishment of an equine disease-free zone involve a screening process by WOAH to ensure the quality of the self-declaration to be published, compliance with the provisions of the *Terrestrial* and *Aquatic Animal Health Codes*, and consistency with data reported through WAHIS [2, 3, 24, 25].

Finally, WAHIS has become a tool to demonstrate the impact of certain diseases, especially transboundary diseases, on wildlife conservation. Many examples have shown how diseases can threaten the survival of endangered species, including, notably, the haemorrhagic septicaemia epidemic that occurred in Kazakhstan in 2015 [26] and the peste des petits ruminants epidemic in Mongolia in 2016 [27], threatening the Saiga antelope, as well as the African swine fever epidemics that threaten endemic wild pig species in Southeast Asia [28]. Epidemics reported in WAHIS can also be used to indirectly monitor potential effects on threatened predator species like the Amur tigers through the reduction of the populations of their main prey [29]. The collection of information is also important to prevent the spread of diseases impacting biodiversity through international trade, such as chytridiomycosis caused by *Batrachochytrium dendrobatidis* and *Batrachochytrium salamandrivorans*, which are among the most important pathogens creating a worldwide population crash in amphibians [30, 31].

In all these cases, the collection and sharing of animal health information through WAHIS highlight the importance of the availability of disease information, not only for risk assessment but also for biodiversity conservation purposes.

Use of global animal health information systems at regional and global levels: role and impact of the World Animal Health Information System

At present, there are multiple ways of communicating information on animal diseases. However, global public platforms that alert on exceptional events or outbreaks are scarce. As mentioned above, one of the specificities of WAHIS is that all information is confirmed before it is published by the competent Sanitary Authority of the notifying country. Although it is possible to report a suspected disease, very few countries use this option due to potential trade implications. This could be considered a limitation when assessing the capacity of the system to collect information on and report disease events. Nevertheless, official information published in WAHIS is particularly useful for trade purposes and to alert other international organisations to support affected countries.

The World Organisation for Animal Health contributes to the Global Early Warning System (GLEWS) set up by the Tripartite (the Food and Agriculture Organization of the United Nations [FAO], WOAH and the WHO). Its principal goal is to facilitate the rapid detection and risk assessment of health threats at the human–animal–ecosystems interface to inform and orient prevention and control measures among the members of the Tripartite organisations. Each organisation collects unofficial information (rumours/signals) through different sources. If the disease has not officially been reported to the WHO or WOAH, it is considered an event that can be treated through the GLEWS confidential platform. The WHO and WOAH confirm these signals among their Members. Once Members have confirmed the signals, the information is disseminated through the early warning mechanisms that each organisation has in place (i.e. WAHIS, FAO EMPRES-i+ and the WHO's International Health Regulations Event Information Site (Figure 1).

In the interconnected world of animal health information systems, WAHIS is a major source of information. As mentioned previously, WOAH screens on a daily basis different sources in the context of its epidemic intelligence activity to track non-official information. These activities allow WOAH to increase the sensitivity of its information system. Reciprocally, WAHIS official data are used as a primary source of data in other systems, and thus WAHIS's publications are amplified.

To measure the dissemination of WAHIS information through other information systems, the percentage of outbreaks published on FAO EMPRES-i+ with 'OIE' mentioned as a source was assessed for the period between 2005 and 2020 and for diseases in the common scope. It was found that 65% of outbreaks published in FAO EMPRES-i+ were based on WAHIS data. Similarly, the percentage of posts published on ProMED with 'OIE' mentioned as a source in the title was assessed. This analysis was done for the same period and for all WOAH-listed diseases and determined that 18% of ProMED posts were based on WAHIS data. These findings show that the dissemination of WAHIS information goes beyond the direct users of the system.

In addition to alert messages following immediate notification reports, global animal health information systems such as WAHIS allow visualisation of disease spread across regions and globally. Both WOAH and FAO prepare global disease situation reports with different frequency (biweekly to monthly) for diseases that have a high global impact (such as avian influenza, African swine fever and SARS-CoV-2). Moreover, WOAH uses the reported data to produce aggregated analyses of the animal health situation for selected diseases. These reports are usually presented and discussed during the WOAH General Session or during the WOAH Regional Conferences, and WOAH provides recommendations to its Members based on these reports [8].

Use of global animal health information systems for research purposes, evaluation of the efficacy of World Organisation for Animal Health Standards and assessment of socio-economic impact of animal diseases

One of the other advantages of large amounts of standardised data is that predictive models can be developed. Many studies have used data collected in WAHIS for predictive modelling. Among many examples, Madin used data on disease outbreaks, livestock movements and prices to predict where new outbreaks might occur, while Choi *et al.* modelled and predicted the occurrence of foot and mouth disease using WAHIS data [32, 33]. Given that WOAH provides data to researchers, institutions, decision-makers and other stakeholders on more than 200 diseases, collected consistently since 1996, from around 200 countries at global level, it is clear that these data represent an important source of information for disease modelling and prediction.

Measuring the real implementation and impact of WOAH Standards, including international disease reporting according to the *Aquatic* and *Terrestrial Animal Health Codes*, forms part of the main activities of WOAH and its Observatory. From this perspective, data collected through WAHIS are seen as a proxy to describe how WOAH Members understand and implement WOAH Standards. Several publications have been developed on this topic [34, 35, 36].

In addition, WOAH is working with the Global Burden of Animal Diseases programme, which will assess the burden of terrestrial and aquatic animal diseases and will help to quantify the positive and negative impacts of animal production systems. A diverse team of researchers will develop a detailed methodology to collect data and produce standardised and comparable information on the economic impact of animal diseases, using information systems such as WAHIS,

Disease Tracking Systems

FAO EMPRES-i + Global Animal Disease Information System
WHO Event Information Site
WOAH World Animal Health Information System

Additional data

Other FAO and UN data
Refugees movements
Climatic data
Production, Economic data
Wildlife and other migration

Analysis

Early Warning

Disease alerts
Trends and analysis
Forecasting
Risk assessment

GLEWS+

Food and Agriculture Organization of the United Nations

World Health Organization

World Organisation for Animal Health
Founded as OIE

Global Early Warning System for transboundary animal diseases including zoonosis (GLEWS+)

EMPRES: Emergency Prevention System
EMPRES-i+: EMPRES Global Animal Disease Information System
FAO: Food and Agriculture Organization of the United Nations

UN: United Nations
WHO: World Health Organization
WOAH: World Organisation for Animal Health

Figure 1

Mechanisms of the Tripartite's Global Early Warning System

the WOAH Performance of Veterinary Services Pathway, FAOSTAT and FAO EMPRES-i [37].

Data exchange and interoperability between systems to enhance collaborative efforts

Within the One Health framework, globalisation and increased international trade, coupled with technological advances in data storage and visualisation, have made animal health information systems essential tools for the management and surveillance of animal diseases.

To facilitate disease management and surveillance, interoperability between animal health information systems should be prioritised. In WOAH's 7th Strategic Plan, the Organisation launched an action plan to connect WAHIS with the EU Animal Diseases Information System by 2023. In addition, a project has been developed to generate electronic codes to some elements to facilitate the exchange of data (such as disease

names, pathogens and hosts). The elaboration of a codification system and its communication and implementation into animal health systems around the world will allow for much faster, more comprehensive and more transparent communication of animal health information. Countries around the world will benefit from this initiative as the interoperability of WAHIS and the use of the codification system will facilitate the submission of information, as well as the download of worldwide data for specific purposes (i.e. development of risk analysis, simulation spread models, etc.), which will help countries to prevent and/or control foreign animal diseases.

Conclusions

Since WOAH was founded in 1924, its role has been to disseminate, as widely as possible, information on animal health from the national Veterinary Services of its Members as well as some non-Members. Prior to the publication of this information, WOAH verifies the data to ensure their consistency and quality. The nature of the notification ensures that published data are validated and official and therefore guarantees the specificity of the system. More recently, epidemic intelligence activity and the use of intelligence systems have increased the sensitivity of WAHIS to detect disease events. Finally, because WAHIS makes publicly available all the information collected by the Veterinary Services or Competent Authorities of each country, it is one of the most comprehensive animal health databases in the world.

The information available in WAHIS is paramount for establishing the animal health status of each country. Accurate and timely reporting by WOAH Members through WAHIS enables early warning and preparedness and mitigates the associated animal and public health risks.

Furthermore, information in WAHIS is used for varied purposes, such as to take preventive measures against disease outbreaks, for risk assessment of importation of animal products, to establish official status or self-declarations of country freedom, for export certification of animals (e.g. pets or horses), for risk assessment of diseases impacting wildlife conservation and for the development of predictive models.

Since its conception, WAHIS has remained a reference for other global animal health information systems. Thanks to technological advancements and the efforts made by WOAH in developing new information technologies, WAHIS is expected to remain a key source of animal health information and to become a source of metadata that will allow interoperability with multiple systems in the near future.

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Le Système mondial d'information zoosanitaire : un outil visant à soutenir la prise de décision et la recherche en santé animale

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Résumé

Le Système mondial d'information zoosanitaire (WAHIS) collecte et publie une grande quantité d'informations recueillies auprès des Services vétérinaires nationaux, parmi lesquelles des données détaillées spécifiques aux pays sur les foyers de maladies listées par l'Organisation mondiale de la santé animale (OMSA, fondée en tant qu'OIE), dont les maladies émergentes, chez les animaux domestiques et dans la faune sauvage, ainsi que de maladies non listées affectant la faune sauvage. Cet ensemble de données est l'un des plus exhaustifs du monde puisque les 182 Membres de l'OMSA ont l'obligation de lui faire remonter ces informations dans WAHIS dans des délais spécifiés. Ces données sont précieuses pour les Services vétérinaires, les chercheurs travaillant dans le domaine de la santé animale et les parties prenantes car elles permettent de mieux comprendre les risques relatifs aux maladies infectieuses, notamment grâce aux modèles prédictifs et aux évaluations de risques pour traiter le risque lié au commerce de produits d'origine animale, à la mondialisation, aux mouvements de la faune sauvage ou aux vecteurs entre les pays. Les auteurs font le point sur des analyses antérieures qui ont été menées en utilisant les données de WAHIS et soulignent comment ces données peuvent être utilisées dans le cadre d'un travail de préparation et d'évaluation des risques.

El Sistema Mundial de Información Zoosanitaria como herramienta de apoyo a los procesos decisorios y a la investigación en sanidad animal

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Resumen

El Sistema Mundial de Información Zoosanitaria (WAHIS) colecta y publica una gran cantidad de datos recogidos por los Servicios Veterinarios de cada país, en particular detallada información sobre brotes de enfermedades listadas por la Organización Mundial de Sanidad Animal (OMSA, fundada como OIE), incluidas las enfermedades emergentes, que hayan afectado a los animales domésticos o la fauna silvestre, así como enfermedades no listadas que afectan a la fauna silvestre. Se trata de uno de los conjuntos de datos más completos del mundo, ya que los 182 Miembros tienen la obligación de comunicar esta información a la OMSA dentro de plazos determinados. Estos datos son una fuente de información de gran utilidad para los Servicios Veterinarios, los investigadores que trabajan en sanidad animal y demás partes interesadas porque permiten mejorar la comprensión de los riesgos derivados de las enfermedades infecciosas, por ejemplo elaborando modelos predictivos y evaluaciones de riesgo que ayuden a manejar los riesgos ligados al comercio de productos de origen animal, la globalización o al movimiento transfronterizo de animales salvajes o vectores de enfermedad. Los autores repasan una serie de análisis previamente realizados con datos de WAHIS y explican en síntesis cómo pueden utilizarse estos datos con fines de preparación y evaluación de riesgos.

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