

Emerging infectious diseases,
health surveillance and agricultural transitions

The urgency of adopting systemic approaches

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FEEDBACK

Research and analyses conducted by CIRAD and its partners on certain infectious diseases: MERS-CoV, Nipah, Rift Valley fever and West Nile virus

MERS-CoV and analysis of risks of transmission to humans

Middle East Respiratory Syndrome is a fatal disease, caused by a coronavirus (MERS-CoV) affecting dromedaries, closely related to the Severe Acute Respiratory Syndrome virus (SARS-CoV). In 2002, SARS-CoV contaminated 8000 people in record time in 25 countries, causing 800 deaths. As for MERS-CoV, since its first identification in humans in 2012 in Saudi Arabia, it has infected more than 2100 people, causing the death of 813. With a fatality rate in humans of around 35%, and with no treatment or vaccine available, this viral disease is now, for the World Health Organization, one of the ten priority emerging diseases in terms of research and diagnosis. So far, only the Arabian Peninsula has seen cases of human infection, although the dromedary is also a carrier of MERS-CoV in numerous African countries. An international collaboration led by HKU-Pasteur Research Pole and associating CIRAD and IRD has revealed genetic differences between the strains of MERS-CoV circulating in African dromedaries and those in the Arabian Peninsula, indicating that these strains are genetically isolated from one another. Moreover, there are differences in other determinants and cofactors linked to the transmission of the virus to humans that have not yet been elucidated.

Nipah, bats and ecological studies

Some species of bats are considered to be the main reservoir of the Nipah virus (NiV), which has caused the death of more than 500 people since its emergence in Malaysia and Bangladesh. Although the circulation of NiV has been documented in Cambodia and Thailand, little is known in Southeast Asia about the risk of transmission of NiV to domestic animals and to humans. To better assess the risk of emergence of NiV in Cambodia while taking account of the conservation threats to bats, multidisciplinary studies involving researchers (in ecology, epidemiology, virology, genetics, anthropology and modelling), conservationists and local and national authorities were launched. The population dynamics and the diet of a Lyle's flying fox (*Pteropus lylei*) colony as well as the circulation of NiV in the urine of these bats were studied. The perception of these bats by local communities and their practices with respect to them (such as hunting, collecting guano, gathering fruit, and harvesting and drinking palm juice) were investigated. The bat/human interface was monitored by fitting 14 bats with GPS collars. The results showed seasonal patterns in both population dynamics and virus circulation, making it

possible to identify a period when local communities' practices may put them at a higher risk of infection. The telemetry study revealed areas with increased potential contacts between humans and bats. Interviews showed limited conflict between bats and humans, and an absence of perceived risk by local communities. An integrative model is currently being developed and participatory approaches are being used to transfer knowledge about the risk of emergence and the ecosystem services associated with flying foxes, in order to recommend prevention measures that reconcile public health and conservation.

Vector-borne diseases and environmental and climate change: Rift Valley fever, West Nile virus

Les maladies transmises par des insectes vecteurs ont un impact majeur sur la santé humaine et animale, ainsi que sur l'économie des sociétés. De par leurs modes de transmission, ces maladies, zoonotiques ou non, sont particulièrement sensibles aux changements climatiques. Les processus biologiques en jeu sont complexes. Le Cirad et ses partenaires développent depuis plusieurs années des modèles qui permettent de mieux comprendre ces phénomènes et d'identifier les périodes et/ou les zones les plus à risque afin d'améliorer la surveillance et la détection précoce de nouveaux cas.

Diseases transmitted by insect vectors have a major impact on human and animal health, as well as on the economy. Due to their modes of transmission, these diseases, whether zoonotic or not, are particularly sensitive to climate change. The biological processes involved are complex. For several years, CIRAD and its partners have been developing models to enable them to better understand these phenomena and to identify the highest-risk periods and/or areas in order to improve the surveillance and early detection of new cases.

The climate and its variations are often involved, but only rarely explain by themselves the vector-borne disease outbreaks observed in recent decades. Indeed, the co-occurrence in space and time of hosts – birds, ruminants – and vectors, and their capacity to transmit or host pathogens, are essential. The distribution and density of reservoirs, the seasonality and geography of their migrations, the structure of the landscape and the trophic preferences of the vectors present should therefore be taken into account in the future in order to refine our predictions and to thereby reduce the health and economic impacts of these diseases.

FOCUS ON

MOOD (MOonitoring Outbreak events for Disease surveillance in a data science context)

An innovative epidemic intelligence project demonstrating the utility of analysing weak signals from informal sources at an early stage.

CIRAD is coordinating the MOOD project, financed by the EU Horizon 2020 programme with a budget of 14 million euros. It began in January 2020 and brings together 25 partners – research institutions, public health agencies, veterinary services – in 12 countries. When it ends, in late 2023, its participants will have developed new monitoring tools.

The goal of the MOOD project is to use new, innovative data analysis and mining techniques for big data from multiple sources in order to improve monitoring of the emergence of infectious diseases in Europe, including antimicrobial resistance and new diseases (Covid-19, disease X).

To this end, the MOOD project will set up an open-access platform that will enable the real-time analysis and interpretation of epidemiological data and genetic sequences associated with climate, environmental and socioeconomic variables, taking an interdisciplinary “One Health” approach.

The results of the MOOD project will link research institutions and national and international animal/public health organizations in Europe and beyond, in order to develop:

- 1 • Data mining methods to collect, combine and extract important information from heterogeneous, multi-source big data,
- 2 • A network of experts to define the drivers of the emergence of infectious diseases, including antimicrobial resistance (AMR) and disease X,

- 3 • Data analysis methods applied to big data, including but not limited to spatio-temporal analysis and social network analysis, to model the emergence and spread of infectious diseases,

- 4 • A ready-to-use online platform aimed at a community of users, including the public, adapted to their needs and including capacity building to facilitate risk assessment of signals detected.

The results of MOOD will be produced in collaboration with national and regional stakeholders in Europe, to ensure their common use during and after the project. Future users will be closely associated with the project in order to build and adapt it according to their needs. The MOOD project will be linked to and complement the IBS and EBS systems that exist at the international and European levels, as well as to other projects and initiatives in the “One Health” field and in the fight against antimicrobial resistance.

The functionalities of the MOOD project will be tested and adjusted following continuous assessment through simulations and case studies of airborne, vector-borne, waterborne and foodborne diseases, including antimicrobial resistance aspects. Throughout the project, in-depth consultations with future users, research on obstacles to data access and confidentiality, dissemination and training activities, and studies on the cost-effectiveness of the project will facilitate its lasting uptake by users.

FOCUS ON

SWM (Sustainable Wildlife Management)

Led by FAO, the SWM programme is being implemented by a consortium of partners including the Center for International Forestry Research (CIFOR), CIRAD and the Wildlife Conservation Society (WCS), thereby providing a solid association of complementary experience and knowledge on wildlife conservation, natural resource management and agriculture, including livestock farming and aquaculture.

With a budget of 45 million euros and a duration of seven years, the Sustainable Wildlife Management (SWM) programme is an initiative of the ACP Group of States, funded by the European Union.

CIRAD is responsible for coordinating two of the six results (R2 and R6) and implementing SWM in two of the eight sites (Gabon and Zambia/Zimbabwe), as well as in the Sahara-Sahel region (Senegal, Mali, Chad, Sudan and Egypt).

Reconciling the food needs of growing human populations, conserving an exceptional biological heritage and protecting terrestrial and aquatic ecosystems and their services is a real challenge. This is particularly true for the ACP countries, and especially those in Africa, which are experiencing high population growth and an unprecedented crisis as their natural resources diminish. In a context of poverty, emerging zoonotic diseases, political instability, weak governance and porous international borders, the combined effects of the degradation of natural habitats, poaching and climate disruption are contributing to the extinction of much of their exceptional flora and fauna. This represents the loss of an irreplaceable heritage, of resources that are vital to the way of life of local communities, and of essential environmental services.

Many rural communities throughout the world hunt and fish for food, income and/or cultural identity reasons. In tropical rural areas, wildlife and fishery resources are very often the only sources of animal protein and other nutrients, and therefore play a crucial role in food and nutrition security for human populations.

However, in most natural tropical ecosystems, the current or forecast rates of harvesting (based on population projections) exceed the production rates for wildlife and freshwater fish. The combined effects of over-exploitation and other ongoing processes (including the conversion of natural habitats) have already resulted in an alarming depletion of wildlife resources and the extinction of the least resilient species, but also in a significant increase in human-wildlife conflicts and animal and human health risks.

The goal of the SWM programme is to reconcile the challenges of wildlife conservation with those of food security in a set of key socio-ecosystems (forests, wetlands and savannas), fostering the sustainable and legal use of resilient wildlife populations by rural communities, while increasing/diversifying the meat products available to people in rural and urban areas. It directly contributes to SDGs 2 (hunger), 12 (consumption) and 15 (biodiversity), and indirectly to SDGs 3 (health), 5 (gender), 11 (urbanization), 14 (fishery resources) and 16 (peace and justice).

Achieving this ambitious objective requires a multi-sectoral approach in order to strike a fair balance between conservation efforts and wildlife use. To this end, the SWM programme is structured around four thematic results: (R1) improving institutional and legal frameworks; (R2) improving hunting and fishing of resilient species; (R3) improving the provision of alternative protein sources; and (R4) improving the sustainability of bushmeat consumption. Other results include crosscutting tools to facilitate monitoring and assessment (R5) and knowledge generation/dissemination (R6).

CIRAD is the French agricultural research and international cooperation organization working for the sustainable development of tropical and Mediterranean regions.

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