Food and Agriculture Organization of the United Nations

EcoHealth Alliance

Policy brief

How natural resource management sectors can contribute to reducing emerging infectious diseases: *the example of forest ecosystems*

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Summary

This Policy brief is a result of a collaboration between the Food and Agriculture Organization of the United Nations (FAO) and EcoHealth Alliance. The aim of the brief is to suggest ways, using the example of forest ecosystems, in which natural resource management sector can play a more active role in reducing risk and/or mitigating the impact of emerging infectious diseases (EIDs). This would reflect and facilitate a more holistic and upstream One Health approach[1] as defined by the One Health High-Level Expert Panel, an advisory and scientific body to the Quadripartite Alliance for One Health (FAO-WOAH-WHO-UNEP). Based on guidance from FAO's Governing Bodies, *inter alia*, the Committee on Forests[2], the Committee on Agriculture[3] and its Subcommittee on Livestock[4], and FAO's Regional Forestry Commissions, the recommendations from this brief are directed at national government authorities in charge of natural resource management, in addition to other relevant stakeholders involved in environmental management and land-use planning.

1 https://www.fao.org/3/cb7869en/cb7869en.pdf

2 In 2020, the 25th session of FAO's COFO requested the Organization to strengthen the promotion of sustainable wildlife management along the entire wild meat value chain and the adoption of measures to better prevent zoonotic disease risks, including through the One Health approach and through strengthened collaboration with the World Organisation for Animal Health and the World Health Organization. URL: https://www.fao.org/3/ne205en/ne205en.pdf

3 In 2020, the 24th session of FAO's COAG requested the Organization to strengthen its actions towards a more inclusive One Health approach within the scope of FAO's Strategy on Mainstreaming Biodiversity across Agricultural Sectors. URL: http://www.fao.org/3/nd535en/nd535en.pdf

4 https://www.fao.org/3/ni966en/ni966en.pdf

Key messages

1. Robust data, expertise, and information from the natural resource management sectors complement public and animal health sector initiatives for disease risk monitoring and management, and should be integrated into One Health activities, thus providing a deeper understanding of risks of infectious disease emergence, and furthering the development of cost-effective risk management strategies.

2. National One Health platforms and other multisectoral coordination mechanisms should ensure the active involvement of natural resource management sectors in all relevant discussions and activities, for example, preserving and/or restoring resilient and healthy ecosystems, sustainable agriculture to reverse trends that lead to biodiversity changes, preventing and/or reducing disease emergence and spillover, the early detection and monitoring of disease occurrence or associated drivers or risk factors.

3. Policymakers should advocate the incorporation of emerging infectious disease risk assessment, risk management and risk communication strategies in forest and land-use planning. This involves increased awareness of context-specific drivers of disease emergence and options to make safer choices in land planning.

4. The complexity of the mechanisms involved in the emergence of infectious diseases in forest ecosystems demonstrates the need to plan, develop and implement forest management practices that consider the interrelated factors at animal–human–environment interfaces associated with pathogen emergence and spillover risks.

5. Investments are needed to strengthen the natural resource management sector's capacity and ability to take leadership or supportive roles in disease risk reduction efforts as appropriate. Doing so will also generate collateral benefits, such as better management of forest and wildlife health to support biodiversity conservation.

Background and context

The COVID-19 pandemic has demonstrated the overwhelming impact EIDs can have on food security, human health, global economies, and livelihoods. The emergence of known and novel pathogens (disease-causing microorganisms) is attributed to the increase in human population size and mobility, and to socioeconomic, ecological, and environmental factors. The interface between animals, humans and the environment is especially important, considering that around 60 percent of all emerging human infectious diseases have a zoonotic origin – in other words, they emerged in animals and were transmitted to humans. Of recent zoonotic EID events, almost three-quarters (71.8 percent) were caused by pathogens that originated in wildlife (Jones *et al.*, 2008).

Ecosystems play an important role in disease regulation. The causal factors of the emergence of infectious diseases with wildlife origins include a combination of land use changes (from deforestation, fragmentation, and degradation to reforestation), increased human and domestic animal contact with wild animal species, and pathogen adaptation. Human-induced land use changes are the primary drivers of spillover events (i.e. when pathogens cross from one species to another) and infectious disease outbreaks, while also modifying the dynamics of endemic diseases (Patz *et al.*, 2004). This association varies according to the type of ecosystem.

Correlation between ecosystem changes and disease emergence or spillover risk: the forest ecosystem example

Conceptually, the type and level of risk associated with infectious disease emergence changes along the forest transition process. The process is not linear and may involve a variety of changes that could increase or reduce EID risk, including microclimate, light intensity, water availability, and encroachment by people, domestic animals, and non-native plants or animals. The forest transition curve, which differentiates conceptually between four types of forest situations, illustrates the diversity of dynamics in forest ecosystems that affect EID risk (Mather, 1992).

These situations are:

HIGH FOREST COVER, LOW DEFORESTATION

This type of forest typically experiences low direct human impact outside of uses by Indigenous Peoples and Local Communities (IPLC), or selected logging[5]. It may include primary or old growth forests and often contains high levels of biodiversity, though different forest biomes encompass different levels of species richness. The potential for pathogen spillover to humans is low if the ecosystem is left intact with low human presence, while risk increases with incursions of people into forests and potential contact with wildlife and vectors, thus increasing exposure.

[5] It should be noted that there are some exceptions to this generalization, particularly for some Nordic countries where high forest cover and low deforestation rates are maintained together with significant forest harvesting activities.

→ HIGH FOREST COVER, HIGH DEFORESTATION

This typically refers to the deforestation frontier where agricultural expansion in particular – sometimes along logging roads – leads to high forest cover loss (FAO, 2022), causing more severe modifications, disruptions and increased human presence. The main change in disease dynamics here derives from high fragmentation and degradation, which are associated with increased infectious disease emergence risk. Increased risk stems from ecosystem simplification via loss of species richness, biodiversity and habitat (Patz *et al.*, 2004; Pardini *et al.*, 2010; Gibb *et al.*, 2020; Morand and Lajaunie 2021), denser aggregations of species in remaining forest patches (Lebarbenchon *et al.*, 2008), and increased "edge effect" (the contact zones where disease transmission may occur between humans, domestic animals and wildlife) (Suzan *et al.*, 2008; Muylaert *et al.*, 2019).

→ LOW FOREST COVER, LOW DEFORESTATION

This includes mixed and modified forest landscapes that have an ongoing functionality for humans in the area. They may serve as foraging space for food or wood, terrain for livestock to graze, or be managed as an agroforestry system. The main disease dynamics derive from the shift from forest to shared agricultural spaces. The increased disease risk stems from supplemental food resources for wildlife that are thus attracted to these sites, increased contact with domestic species that can act as bridges for pathogen transmission, and frequent human exposure by regular incursions and use of forest or agriculture products.

→ LOW FOREST COVER/REGREENING

This includes restoration, reforestation and afforestation leading to an increase in forest cover. Forest restoration implies returning degraded areas to an increased state of tree stocking that may more closely resemble original forests. Forest restoration can generate benefits for ecosystem functionality and biodiversity and even restore ecosystems' disease regulating functions. However, the establishment of planted forests must be carefully planned to avoid inadvertently increasing disease risk. For instance, monoculture rubber plantations create humid, shaded, and cool environments, ideal for mosquitos that may acquire pathogens causing malaria, dengue, chikungunya and others from infected people and transmit them to others (Tangena *et al.*, 2016).

The association between forest ecosystem changes and diseases demonstrates the need to improve prevention measures and enhance detection and response actions that take into consideration all aspects of the animal–human–environment interface using a One Health approach. Over the past decade, infectious disease initiatives have largely emphasized human and domestic animal connections, with natural resource management sectors being considerably less involved and under-utilized in efforts to face and prevent epidemic threats (Berthe *et al.*, 2018). Engaging the natural resource management sector is therefore crucial to ensuring a more holistic One Health approach as endorsed by the Quadripartite Alliance[6] (Box 1) in a more upstream reduction of risk and mitigation of consequences from EIDs.

Box 1.

One Health working definition by the One Health High-Level Expert panel (OHHLEP)

One Health is an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems.

It recognizes the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and interdependent.

The approach mobilizes multiple sectors, disciplines and communities at varying levels of society to work together to foster well-being and tackle threats to health and ecosystems, while addressing the collective need for clean water, energy and air, safe and nutritious food, taking action on climate change, and contributing to sustainable development.

Source: OHHLEP. 2022. One Health: A new definition for a sustainable and healthy future. *PLOS Pathogens*. 18(6).

[6] https://www.fao.org/3/cb7869en/cb7869en.pdf

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Recommendations

The recommendations are structured around eight illustrative entry points whereby the natural resource management sector can increase participation in efforts to reduce EID risk, thus applying a more holistic One Health approach:

1 Implement ecosystem monitoring programmes to understand ecosystem dynamics that can drive the risk of disease emergence, re-emergence and spillover.

Information obtained by monitoring trends and patterns in ecological dynamics and human behaviour in and around ecosystems can be used before or after a disease or spillover event. Before an event, this information can be used to detect ecosystem changes that may signal changes in disease risk (Box 2), thus warranting a disease risk assessment by the relevant authorities. It can also provide information for disease risk assessment and management.[7] After the event, the information can be used together with epidemiological information to determine whether and how recent ecosystem changes may have led to the event. Where relevant, contextual data inputs from ecosystem monitoring should be available to human and animal health authorities.

Box 2.

Examples of relevant ecosystem changes for EID risk

Increase in human access to forests may signal increased risk of disease spillover due to increased human-animal contact (e.g. via hunting or harvesting of forest products)

Increase in rainfall and change in vegetation may signal increased risk of vector-borne diseases. See how FAO uses this information for the real-time monitoring and forecasting of Rift Valley fever in Africa.

[7] Useful terms and definitions

- **Hazard** is something that is potentially harmful to animals, humans, plants or the environment. For infectious diseases, the hazard is a disease-causing microorganism, i.e. pathogens.
- **Risk** is a combination of the probability that the hazard will cause an unwanted outcome and the level of impact of this unwanted outcome.
- **Risk assessment** is the assessment of the likelihood of an unwanted outcome (or outcomes) and the impact or costs associated with the unwanted outcome(s).
- **Risk management** is the identification and implementation of risk reduction measures based on results of the risk assessment (WOAH, 2022).

2 Share data and information and enhance collaboration with public and animal health sectors on One Health initiatives.

Robust data and expertise from the natural resource management sector can complement public and animal health sector initiatives for disease risk monitoring, assessment and management. This will allow a deeper understanding of EID risks, earlier alerts of potential EID occurrences and consequently earlier responses to or even prevention of such events, implying more cost-effective interventions. To this end, information exchange and coordination channels need to be established or strengthened for a more equitable involvement of the natural resource management sector in One Health initiatives. This can be done by either building on existing mechanisms (e.g. One Health platforms, integrated databases, such as the as Global Early Warning System [GLEWS+]) for major animal diseases, or by creating new mechanisms. Additionally, the national resource management sector may explore options for engagement of non-governmental entities, such as companies and IPLC land rights representatives, which may have valuable contributions.

See the **FAO-WOAH-WHO Tripartite Zoonosis Guide** and read more on establishing multisectoral, One Health coordination mechanisms, which is an important step towards enabling regular, systematic information sharing.

GLEWS+ is the Global Early Warning System for health threats and emerging risks at the human–animal–ecosystems interface that was consolidated between FAO, WHO and WOAH. GLEWS+ now aims to incorporate environmental and ecosystem data through UNEP, based on the recommendations of **the Quadripartite One Health Intelligence Scoping study**. Involving UNEP would foster understanding of how environmental health can be included in early warning and intelligence for better global health. Read more **here**.

3 Participate in evidence-based disease risk assessments by public and animal health sectors, when warranted.

The relationship between ecosystem changes and disease emergence and spillover cannot be generalized. It is affected by numerous factors such as geographic location, type of ecosystem, animal species and pathogens involved, and so on. Risks should therefore be assessed on a case-by-case basis whenever warranted, with the involvement of experts and using information not only from the animal and public health sectors but also from the natural resource management sector. Ideally, risk assessments may be conducted when changes in ecosystems signal potential changes in disease risk (see Recommendation 1) or during land-use planning (see Recommendation 6). Collaboration between the natural resource, animal health and public health sectors will help determine when these risk assessments are needed.

See the **Tripartite Joint Risk Assessment (JRA) Operational Tool** developed by Tripartite agencies (FAO, WOAH and WHO) in 2020. Readers are encouraged to consult the tool to examine how forest authorities can initiate and/or meaningfully engage in risk assessment processes in line with the One Health approach.

4 Based on cross-sectoral monitoring and risk assessment findings, jointly design risk management interventions, including mitigation measures.

To comprehensively reduce disease emergence and spillover risks, risk management interventions involving the animal health, public health, natural resource management and other relevant sectors should be designed and implemented based on the results of risk monitoring programmes and intersectoral risk assessments at all levels (national, subnational, local), involving relevant stakeholders (government, industry and community) and considering all dimensions (epidemiologic, environmental, economic, social, cultural, and others). These may include strategies to deter risk-associated behaviours (occupational, recreational, food acquisition, cultural or religious, etc.) or other environmental interventions (Box 3).

Box 3.

Examples of disease risk management interventions for natural resource management sector:

- Maintain or create sufficient space between forest areas and human settlements or farms (buffer zones) to reduce risk of spillover to domestic animals or humans.
- Limit cave visits during periods of potential higher risk of pathogen shedding by bats and implement biosecurity measures (e.g. use of masks and hair covers) during cave visitations.

5 Design and adequately implement risk communication strategies on how to reduce emerging infectious disease risk.

Risk communication ensures that people and communities are aware of current or future threats and can be used to change behaviour to reduce associated risks. In general, risk communication is part of the science of risk assessment and the process of risk management. It can take different forms depending on the objective of the communication strategy (see example objectives in Box 4). The strategy should also consider relevant target populations (e.g. hunters, forest sector companies) and adapt messages to each stakeholder so they are culturally appropriate.

Box 4.

Examples of objectives of disease risk strategies

- Educate and raise awareness about wildlife-related diseases and risks linked to specific practices. For further details, see the Sustainable Wildlife Management Programme and its Policy brief on building back better in a post-COVID-19 world.
- Raise the awareness of other authorities concerning the relevance of information on ecosystem changes and the role of the natural resource management sector in EID risk reduction.

6 Incorporate emerging infectious disease risk assessment and management into forest and land-use planning.

Land use change (deforestation, encroachment, urban development, etc.) is a primary driver in disease emergence and spillover. Ecosystem restoration and nature-based methods to re-establish natural functions and processes can recover or enhance ecosystem services, including disease regulation. However, any land-use planning, including ecosystem restoration, should involve natural resource

Box 5.

Example of EID risk assessment and risk management in land-use planning:

In São Paulo, Brazil, the environmental licensing of real estate enterprises includes a risk assessment for Brazilian Spotted Fever, a tick-borne disease that can reach fatality rates of 80 percent in humans. A similar

management, public health, animal health and other relevant sectors (e.g. the infrastructure sector) with risk mitigation in mind. This would ensure environmentally friendly mitigation strategies and promote preparedness and efficient and effective response to potential outbreaks. See how this was done in São Paulo, Brazil in Box 5.

approach of incorporating disease risk assessments in Environmental Impact Assessments can be replicated in other countries. Read more here.

Source: Government for the State of São Paulo. 2018. *Programs and Actions of the Environmental System of the State of São Paulo.* Environmental Quality Report Section. São Paulo.

7 Incorporate emerging infectious disease considerations into forest management policies, practices, standards and regulations.

These considerations may include routine ecosystem monitoring (see Recommendation 1), land-use planning procedures (see Recommendations 6 and 8), or the application of intervention measures to identify and manage risk of spillover (see Recommendation 4). While expanding voluntary or mandatory standards to include health considerations could in principle be an interesting avenue, it does require careful consideration of the additional costs and benefits, and of how it can ensure that compliance or adherence to the standard remain an incentive for forest managers. For some practical examples of how this Recommendation can be implemented, see Box 6.

Box 6.

Examples of how to incorporate disease considerations into forestry management standards:

- Standards for infection prevention, control, and screening protocols to minimize risk of disease introduction in species restoration efforts (i.e. wild animal translocations).
- Standards requiring logging companies to destroy secondary roads after selective logging to minimize forest access by human populations.
- Standards requiring implementation of biosecurity measures during livestock and/or crop introduction in/around wildlife habitat.

8 Build the institutional and technical capacity to lead and/or support relevant disease risk reduction efforts.

As outlined in this Policy brief and its recommendations, the natural resource management sector has the information and expertise to support or even lead several disease risk reduction efforts. However, integration of the natural resource management sectors into One Health may require new working relationships and may result in the identification of gaps in workforce capacity, resourcing, mandates, baseline information, and infrastructure that warrant investment. Strengthening the capacities of traditional One Health stakeholders (e.g. public and animal health) to understand and utilize linkages with environment, forestry, habitat degradation, climate change, and ecosystem and biodiversity loss and management can benefit their efforts in disease risk reduction. Public and animal health sector agencies may not be familiar with natural resource management sector mandates or capacities, or their relevance to disease risk reduction, and may require sensitization. At the same time, the focus should also be on vigorously developing the internal capacity of the natural resource management sector to make a broad contribution to One Health, and in this case, to provide disease risk mitigation information and risk reduction solutions.

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