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Urban and agricultural ecosystems may increase risk and emergence of animal-to-human disease transmission

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Land-use change, environmental degradation and related human interaction with animals in the food systems are widely recognised to influence the risk and emergence of zoonotic diseases (those that can be transmitted from animals to people) in humans[1]. Using a large global dataset, this study examines whether this influence is underpinned by predictable ecological changes. The analysis reveals that, as ecosystems become increasingly dominated by humans, zoonotic host diversity also increases — creating hazardous interfaces between people, livestock and wildlife reservoirs of zoonotic disease.

Globally, the way we use land is changing. Increasingly, natural habitats are being converted to human-dominated agricultural or urban ecosystems. When natural habitats are disturbed, the identity and abundance of species within their ecosystems are likely to change. It has been suggested that this may lead to a rise in animals that are potential hosts of zoonotic diseases, and that this may be because many of these species have specific traits that make them resilient to human pressures.

To determine whether this is the case, a study was conducted using a large global biodiversity dataset of 6 801 ecological assemblages (communities of plant and animal species within a specific ecosystem)[2]. In total, the study analysed 376 host species, with a range broadly representative of known zoonotic host diversity. State-of-the-art methodological approaches were used to compare host response to land use with the responses of all other species at the same location.

The findings demonstrate that changes in land use are indeed associated with a rise in potential zoonotic disease host species within our ecosystems. Such animals account for a greater proportion (18–72%) of species in human-disturbed ecosystems, compared to nearby undisturbed habitats. Moreover, these species are present in higher numbers (21 to 144%) in

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human-disturbed ecosystems than in nearby habitats. This effect is particularly pronounced in rodent, bat and passerine bird species — animals already considered to be zoonotic reservoirs of global importance. The study also shows that mammals, which harbour more pathogens than other species, are more likely to occur in human-managed ecosystems[3].

This research suggests, in addition, that the decreasing biodiversity associated with global land-use changes has produced systematic changes to local zoonotic host communities. This may be one factor underpinning links between human-disturbed ecosystems and disease emergence.

It is worth noting that proximity to reservoir hosts (i.e. an animal or species which is infected by a parasite and which serves as a source of infection for humans or other species) is just one of several factors necessary for animal-to-human disease transmission to occur; other contextual factors include pathogen prevalence, the presence of pathogen host-species populations, landscape structures and socioeconomics. Nonetheless, land use increases the potential for human-wildlife contact and predictably affects other factors that can increase within-species and cross-species transmission, such as how resources (e.g. food and habitat) are provisioned within the ecosystem and the diversity of disease vectors (i.e. agents such as parasites, which carry and transmit an infectious pathogen to another organism) present.

In the coming decades it is likely that agricultural and urban land will continue to expand globally, particularly in low- and middle-income countries with existing vulnerabilities to natural hazards[4]. The study suggests that such global changes in the mode and intensity of land use are expected to create hazardous interfaces for zoonotic pathogen exposure. To minimise this risk, they support calls for additional policy aimed at: enhancing proactive human and animal surveillance within agricultural, pastoral and urbanising ecosystems; and ensuring that disease-related health impacts are considered in land-use and conservation planning.

1. A report from the European Environment Agency: *COVID-19 and Europe's Environment: impacts of a global pandemic (2020)*, states that 60% of human infectious diseases are of animal origin and three-quarters of new diseases are transmitted from animals.

2. Hudson, L. N. *et al.* (2017) The database of the PREDICTS (Projecting Responses of Ecological Diversity In Changing Terrestrial Systems) project. *Ecology & Evolution*, 7: 145–188.

3. More than 50% of zoonotic infectious diseases that have emerged since 1940 have been associated with measures to intensify agriculture (Rohr et al., (2019) Emerging human infectious diseases and the links to global food production. *Nature Sustainability*, 2(6), 445–456. https://doi.org/10.1038/s41893-019-0293-3).

4. Popp, A. *et al.* (2017) Land-use futures in the shared socio-economic pathways. *Glob. Environ.* Change 42: 331–345.