ZOONOSES

The land use–food–coronavirus nexus

Land use change, livestock production and human encroachment into wildlife habitats drive zoonotic emergence. Quantitative analyses of horseshoe bat populations provide evidence for how food systems may contribute to hotspots of potential zoonotic spillover.

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Human encroachment into natural habitats, resulting in deforestation and land use and other environmental changes, can exacerbate virus spillover from wildlife hosts to humans[1]. Some wild animal species, such as bats, find advantageous habitats in the transitional areas between forest and adjacent settled environments that meet their roosting and nutrition needs. For their part, bats promote biodiversity and ecosystem health by eating insects and pollinating plants, and can be hunted for food or other purposes[2] — but problems arise when humans come into contact with infected bats[3] or with intermediate hosts[4,5]. The virus involved in the COVID-19 pandemic (SARS-CoV-2) was found to be closely related to CoVs from bats[6] and other wild mammals[7], suggesting that the virus may have an animal origin.

Intensive livestock farming can threaten human health through exposure to new zoonotic diseases[8]. This narrative has frequently appeared in media and commentaries as the COVID-19 pandemic has progressed, and yet — especially in the case of CoVs — empirical evidence supporting this is weak. In this issue, Rulli et al.[9] provide quantitative analyses supporting the claims that higher spillover risks are associated with forest fragmentation, urbanization dynamics and intensified livestock production. The study approaches the topic from a One Health perspective (Fig. 1), investigating land cover and land use features to identify regions where potential bat hosts for SARS-CoV-2 could be found. Rulli and colleagues combined highly accurate datasets at fine spatial resolution compared to the extent of the analysis domain (covering South, East, and Southeast Asia as well as Southern Europe and North Africa). Forest cover and related fragmentation were reconstructed from Landsat images at 30-m grid spacing; urbanization (people and settlements) and livestock density data were reconstructed at 1-km scale. The IUCN Red List database was another authoritative data source to identify the overall distribution range of Rhinolophidae bats ('horseshoe' bats), the only species that have been consistently reported to be potential SARS-CoV-2 hosts, with Rulli and colleagues then extrapolating, from extensive literature review, the locations in China where these bats were really observed.

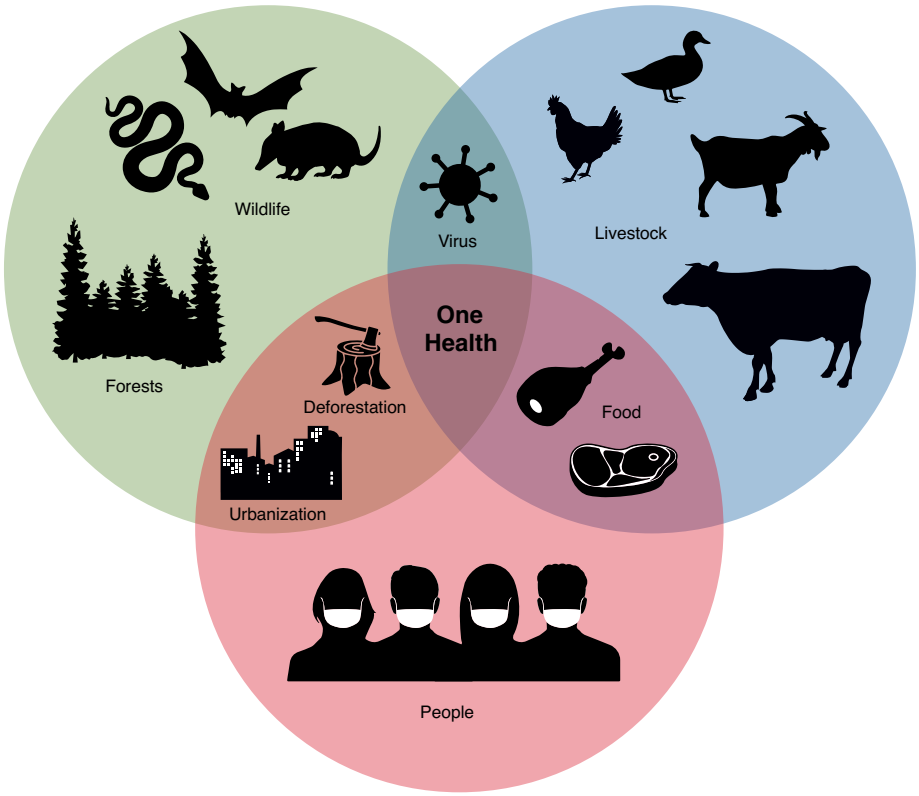

Fig. 1 | An overview of the One Health concept in the context of the land use–food system–coronavirus nexus. The emerging holistic paradigm known as One Health means that people's health is strongly connected to the health of animals and of the environment. Here, the One Health concept is represented through the potential nexus among land use change, food systems and coronavirus.

The authors show that forest fragmentation, livestock production and urbanization density are significantly higher within a 30-km radius of actual bat locations in China compared to random locations outside China (still within the bat distribution range). Random sampling of potential locations of bats in China based on their typical distribution range confirmed these findings, with stronger degrees of forest fragmentation, livestock production and urbanization density compared to regions sampled outside of China. Finally, they identified extreme south China, Japan and north Philippines to be more vulnerable to becoming risk hotspots due to forest fragmentation, while some areas in Indochina are at risk of becoming hotspots due to increasing concentrations of humans or livestock. By considering multiple territorial features together through a multivariate geostatistical

analysis, Rulli and colleagues highlight that bat locations are hotspots of combined high forest fragmentation, livestock density and urbanization.

Data on the first SARS-CoV-2 outbreak locations are not currently available, so studying locations linked to observed horseshoe bat presence was the next best option for exploring potential CoV hotspots. However, this does not exclude the possibility that bats present in other areas may have had a role in the COVID-19 pandemic. Rulli and co-authors acknowledge that follow-up analyses should consider climate change impacts on bat habitats[10] — entailing more complex feedback with ecosystems[11], as well as trade-offs and synergies among dietary shifts, food security, wild meat trade and food system shocks[12,13]. Indeed, any zoonotic disease emergence is a complex process also involving societal and economic aspects[14]. In the context of COVID-19, development of therapeutic options, surveillance systems and vaccines are urgent, but strategic actions related to intersectoral collaboration, collective education and awareness raising about the multiple benefits of the One Health approach implementation[15] can mitigate risks associated with anthropized environments[16]. By assessing combined human–ecosystem dynamics through a One Health perspective, Rulli and colleagues demonstrate how these interaction patterns can contribute to zoonotic spillover, emphasizing the potential nexus among land use change, food systems and coronavirus in the COVID-19 pandemic — and highlighting potential hotspots for future zoonotic pandemic emergence. ❐

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Competing interests

The author declares no competing interests.