

## Can pandemics like COVID-19 be linked to forest degradation and biodiversity loss?

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Studies on forest degradation, climate change, poverty and human safety within its broader framework did not consider the impact of forest degradation on human health till the 1980s (ref. 1). In 2005, ecosystem goods and services essential for sustaining human life on earth were listed by the Millennium Ecosystem Assessment Report<sup>2</sup>. Besides providing crucial tangible products essential for degraded ecosystem restoration and a healthy living environment, forests help mediate climatological shifts<sup>3</sup>, reduce the impacts of toxic pollutants, maintain soil productivity and regulate infectious diseases in humans and animals<sup>1,4,5</sup>.

A study indicated that 3/5th of all infectious diseases in humans and about 3/4th of all emerging contagious diseases are zoonotic<sup>6</sup>, i.e. naturally transmitted between vertebrate animals and humans, as defined by WHO<sup>7</sup>. Research on man-animal conflict and forest fragmentation suggests that forest deterioration compels wild fauna to enter inside human habitations<sup>8,9</sup>. This infiltration becomes relatively more accessible for smaller animal species ranging from genus *Rattus*, *Pholidota* to *Chiroptera*, reducing the proximity between humans and wild animals and their body fluids, thereby magnifying the chances of ‘disease spilling over’<sup>10</sup>. ‘Zoonotic spilling over’ has been found mainly in threatened and endangered faunal species, the same animals targeted for hunting and illegal wildlife crimes<sup>5</sup>. An example of a disease spill over is the Ebola virus epidemic, caused by megabats<sup>4</sup>, which caused the death of about 13,000 human lives<sup>11</sup>. Studies pointed out a prominent relationship between Ebola outbreaks along the edge of rainforests and forest losses within the previous two years and concluded that preventing forest degradation is directly linked to such disease control<sup>12</sup>. The most recent example is COVID-19, which killed over 53 lakh humans<sup>13</sup>. Although the initial viral source has not been ascertained, studies indicate that it has escaped from wild zoonotic faunal reservoirs involving bats, pangolins or civets<sup>5</sup>. Another significant bridge for spilling over such zoonotic pathogens is related to consumption of meat<sup>14</sup>. The FAO states that increasing meat-eaters enhance pandemic-related pro-

blems<sup>5</sup>, explaining the reason behind linking the COVID-19 outbreak to a fresh meat market<sup>15</sup>. COVID-19 could have resulted from the combined effect of three mechanisms: the zoonotic pool<sup>16</sup>, the impact of environmental imbalances on pathogen prevalence of wild populations, and the reduction in proximity between humans and/or domestic animals with wildlife reservoirs of potential zoonoses<sup>17</sup>. The concepts of amplification and dilution effect establish the relationship between biodiversity and pathogen transmission<sup>18</sup>. Dilution effect will occur when an increment in species diversity causes a reduction in contact rates and/or pathogen transmissibility and/or host population density resulting in a decrease in the disease transmission and prevalence. Alternatively, the amplification effect occurs if the increment in species diversity causes an increment in host population density, with higher contact rates and/or higher transmissibility rates increasing disease transmission and prevalence<sup>19</sup>.

Global warming, rise in sea levels, shifts in rainfall and drought patterns contribute to climate change posing a significant impact on zoonotic disease spill overs<sup>5</sup>. Intentional human trespassing into natural habitats, disturbing the host-pathogen balance and causing unnecessary damage to habitats of wild fauna are driving an abrupt environmental deterioration making us more susceptible to such disease spill overs<sup>5</sup>. In the first quarter of 2021, French researchers correlated the outbreaks of zoonotic diseases with changes in forest cover and reported that the increase in the number of outbreaks of zoonotic diseases in tropical regions was directly proportional to forest loss<sup>20</sup>. The study also highlighted the positive link between afforestation and disease outbreaks in temperate regions<sup>20</sup>. Therefore, it is imperative to understand that the link between forest degradation and human health is not exclusive and is governed by various direct and indirect factors. Practices like forest conservation and restoration, restricting wildlife crimes and overall reduction in dependence on wild animals can minimize the chances of future disease outbreaks in the world<sup>5,21</sup>. Besides, the United Nations Decade on

Ecosystem Restoration (2021–2030) can play a pivotal role in degraded ecosystem restoration. Ultimately the restored degraded ecosystems will provide natural habitats to wild animals and prevent the zoonotic disease outbreaks on one hand, reduce poverty, combat climate change and ensure a healthier future of human being on the other.

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