Land-Use Change and Human Health

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The Burden of Disease on Children:

Morbidity and Mortality Pattern of Childhood Illnesses Seen at the Children Emergency Unity of Federal Medical Center, Asaba, Nigeria:
Method: An observational study was carried out on 3890 children's admissions between 2007-2011.

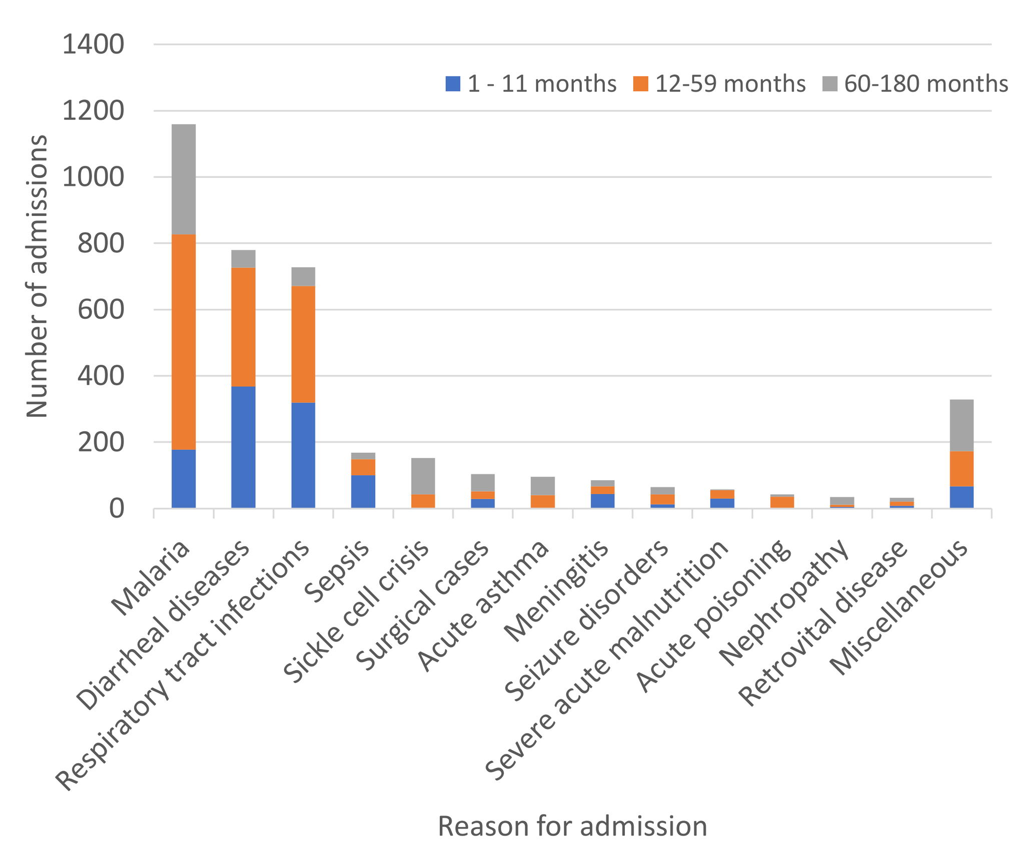

Figure 1: Common indicators for admission in CHER (Children Emergency Room) by age group. Adapted from (Ezeonwu, Chima, Oguonu, Ikefuna, & Nwafor, 2014).

This study shows children under 5 (1-59 months) bear the brunt of the burden of disease in CHER (Children Emergency Room), with the highest number of admissions recorded in this age group. The most common reasons for admissions were malaria, followed by diarrheal diseases.

The authors explained this pattern to be due to the lack of healthcare services in Nigeria, however, as the paper was from a Global Health perspective, the focus was mostly on healthcare services. The study was also an observational study so didn't test any hypotheses on why children held the burden of disease. This therefore indicates the paper fails to completely explain the conditions for which these children are admitted.

However, this study can be connected to others from a Planetary Health perspective, which give alternate explanations for the burden of disease on children by testing the relationship between children's health and the environment.

Land-Use Change and Disease:

Land-Use Change Alters Host and Vector Communities and May Elevate Disease Risk:
Method: A meta-analysis of 37 studies done from 1975-2016 that compared disease host or vector communities in disturbed and undisturbed habitats. Effect sizes were calculated using the random-effects model.

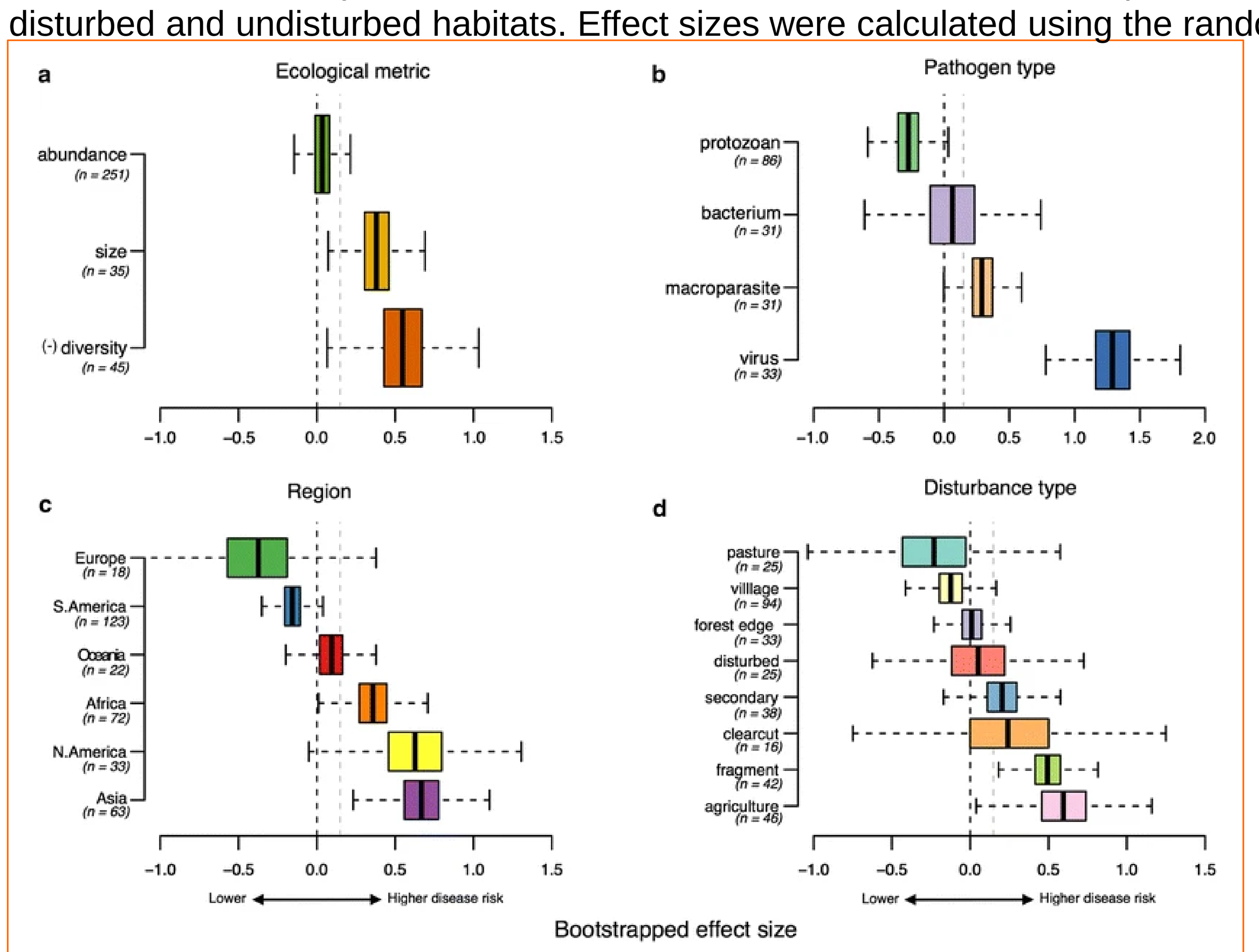

Figure 4: Box plots of bootstrapped effect sizes of disease hosts/vector competence based on a ecological metric; b pathogen type; c region; and d disturbance type. Boxes display the median values and interquartile ranges (IQR) of 10,000 resampled (with replacement) effect size calculations for each group; whiskers represent either (i) the most extreme upper or lower value or (ii) 1.5 times the IQR from the edge of the box. Grey dashed lines represent the median effect size for the entire dataset.

This study found there is a statistically significant relationship between disturbed land and host/vector size and diversity; causing a increase in disease risk. Larger host body size indicates the ability to harbour greater abundance of parasites, and larger sized vectors could lay more eggs. A decrease in species diversity suggests the hosts/vectors eliminated are the less competent at spreading disease.

The meta-analysis also found different types of disturbance have different impacts on disease risk. Pastures and villages seem to reduce disease risk (although this isn't statistically significant); hypothesized to be because these habitat disturbances are too extreme for survival of host/vectors, although this hasn't been tested. Forest fragmentation and agricultural land have a statistically significant relationship with disease risk, and increase it most. Whilst the study hypothesizes this is due to a lack of top predators or presence of many resources that can be exploited, these hypotheses have also not been tested.

This study's data can be held highly as it is a meta-analysis, but, as it is coming from a Planetary Health perspective, it can also be expanded upon with an ecological study that focuses more on the environment and its systems that can potentially impact health.

The Burden of Disease on Children, and Its Link to Land-Use Change:

Empirical Evidence of the Public Health Benefits of Tropical Forest Conservation in Cambodia: a generalised linear mixed-effects model analysis:
Method: An observational study looking at data for 35,547 households from 2005-14. Statistical analysis was carried out to ascertain a relationship between land-use and change in illness.

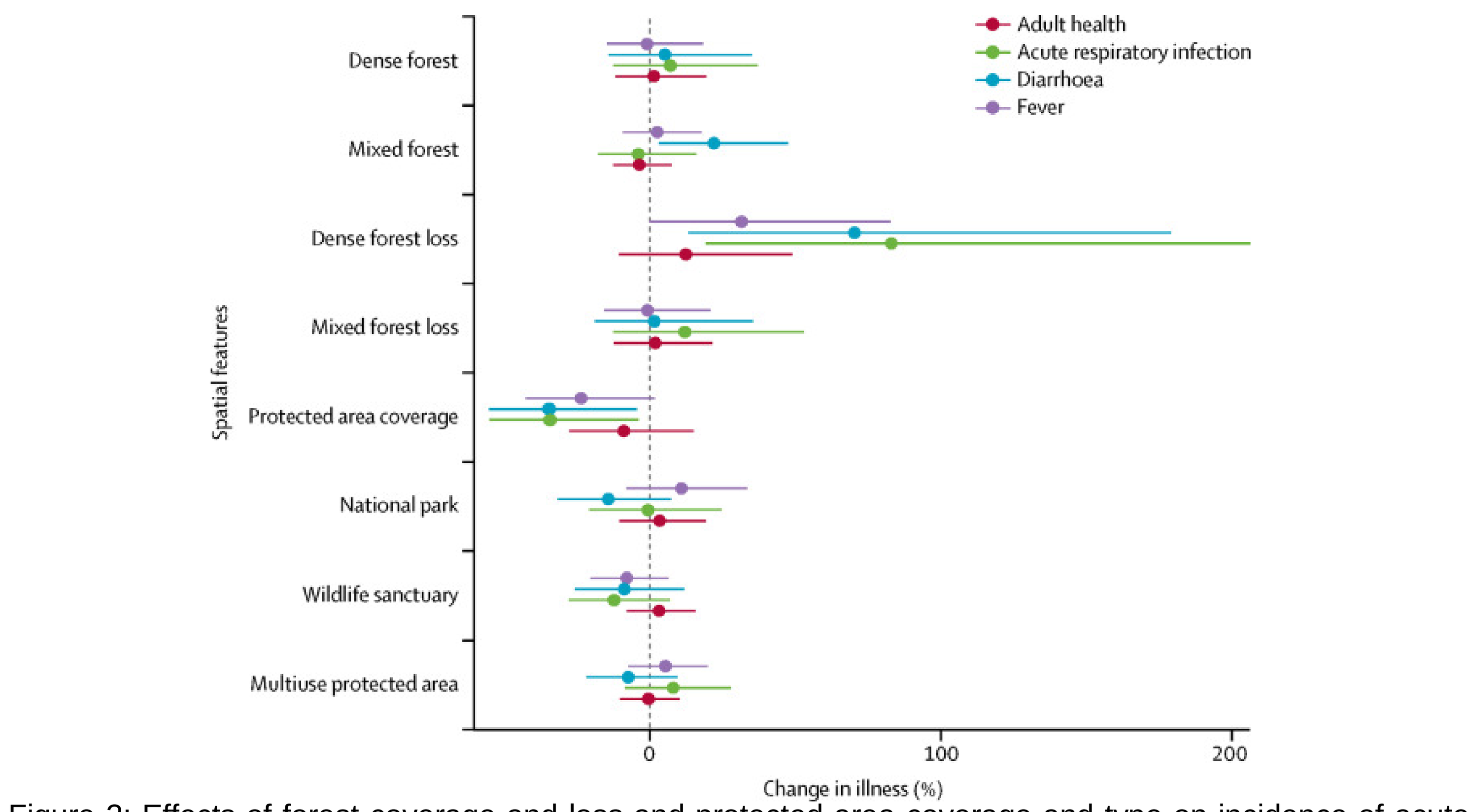

Figure 2: Effects of forest coverage and loss and protected area coverage and type on incidence of acute respiratory infection, diarrhoea, and fever in children, and overall adult health. Data are point estimates and 95% CIs associated.

This study found that the relationship between dense forest loss and illness was statistically significant for diahorrea, fever and acute respiratory infection, showing these illnesses are worsened by deforestation. It also found children are worse effected. The study found a statistically significant relationship between protected area coverage and a decrease in the frequency of diahorrea and acute respiratory infection, also benefitting children (under 5) more than adults.

Neither dense nor mixed forest coverage were found to be significantly associated with improved health, indicating it is the process of deforestation itself that damages health. Protected areas are suggested to have better health and this is not only through lack of deforestation, but also through protected ecosystem services and restricted access; although these hypotheses have not been formally tested.

This study can also be connected to other Planetary Health studies, such as that on host and vector communities, to expand upon the relationship between other forms of land-use change and health.

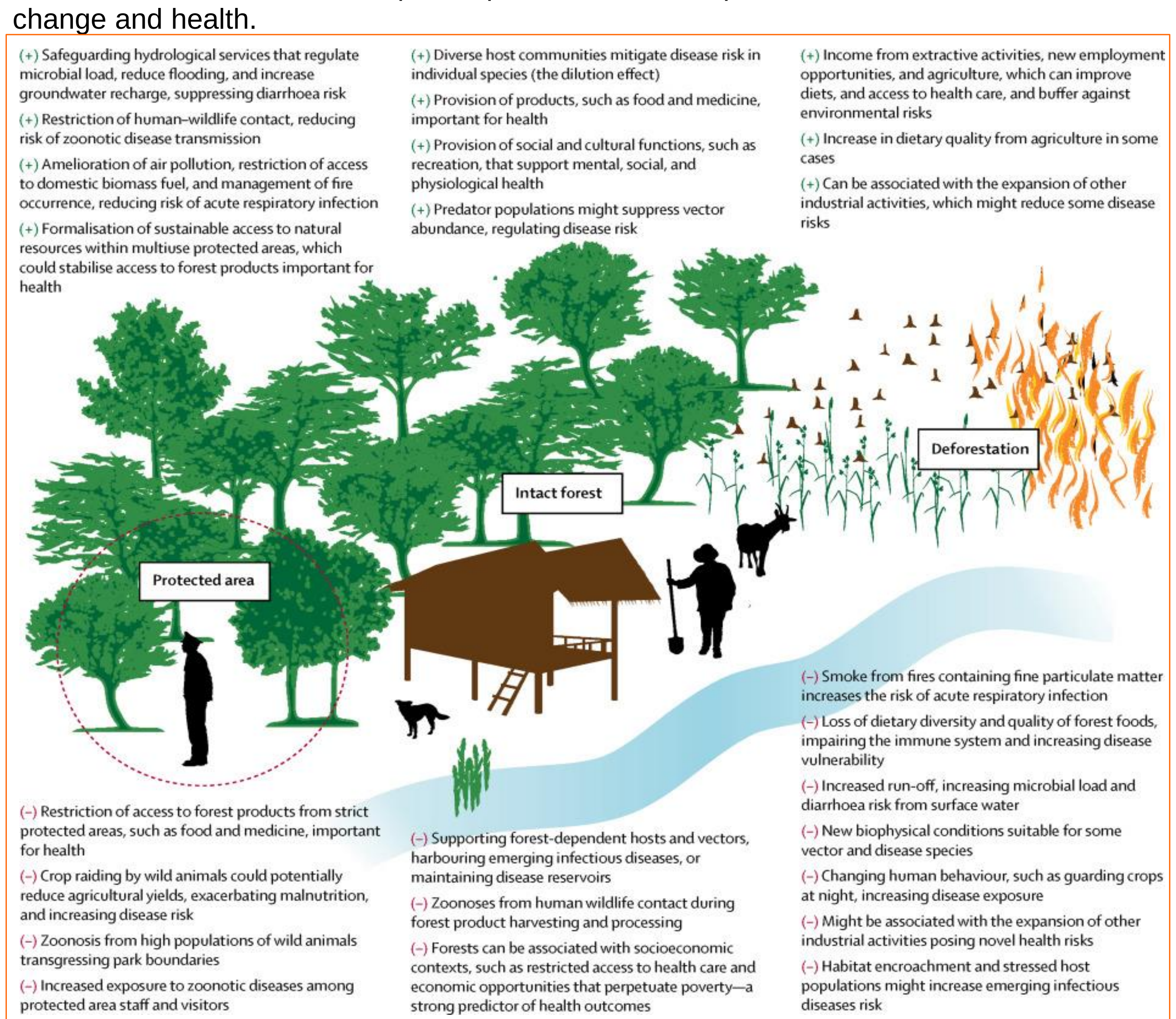

Figure 3: Examples of potential links between protected areas, forest coverage, deforestation and health.

Conclusion

Overall, this collection of data shows land-use change (including deforestation) does increase disease/illness risk, with children under 5 being impacted most. Although each article varies in terms of what perspective it is coming from, the location it is focused on, and the methods used; the data all supplements each other and by looking at key findings from each, it strongly draws the conclusion that land-use change largely does increase illness/disease risk, and children under 5 are worse effected. The various locations this is apparent in, as shown by the collection of papers used, also indicate this is a global problem.

Forest Fragmentation and Its Impact on Disease:

The Fate of Amazonian Forest Fragments: A 32-year investigation:
Method: A 32-year experimental study of fragmentation in the Amazon rainforest.

This experimental ecological study showed that species diversity declines for many species with fragment area, and smaller fragments lose species more quickly. This can therefore be connected back to the paper on vector and host communities to suggest the most capable vectors/hosts survive and so increase disease risk.

Forest fragments also cause warm, dry air to rise over clearings, creating low pressure zones which draw in moist air from nearby fragmented forests. This causes heavy rainfall over these clearings, which can lead to flooding that creates perfect breeding grounds for mosquitos, so increases disease risk.

Forest fragmentation also causes increased tree mortality as forest edges are open to fluxes of wind which kill many trees. This then disrupts the water cycle too and causes more flooding, increasing disease risk. Deforestation can also be linked to this and have the same effect.

Therefore, this ecological study expands upon other Planetary Health studies to show land-use change causes increased disease risk. Although this paper is from an Ecological perspective and so has no formal testing of the impact of fragmentation on disease, information and conclusions from Planetary Health studies can be used to predict the impacts.

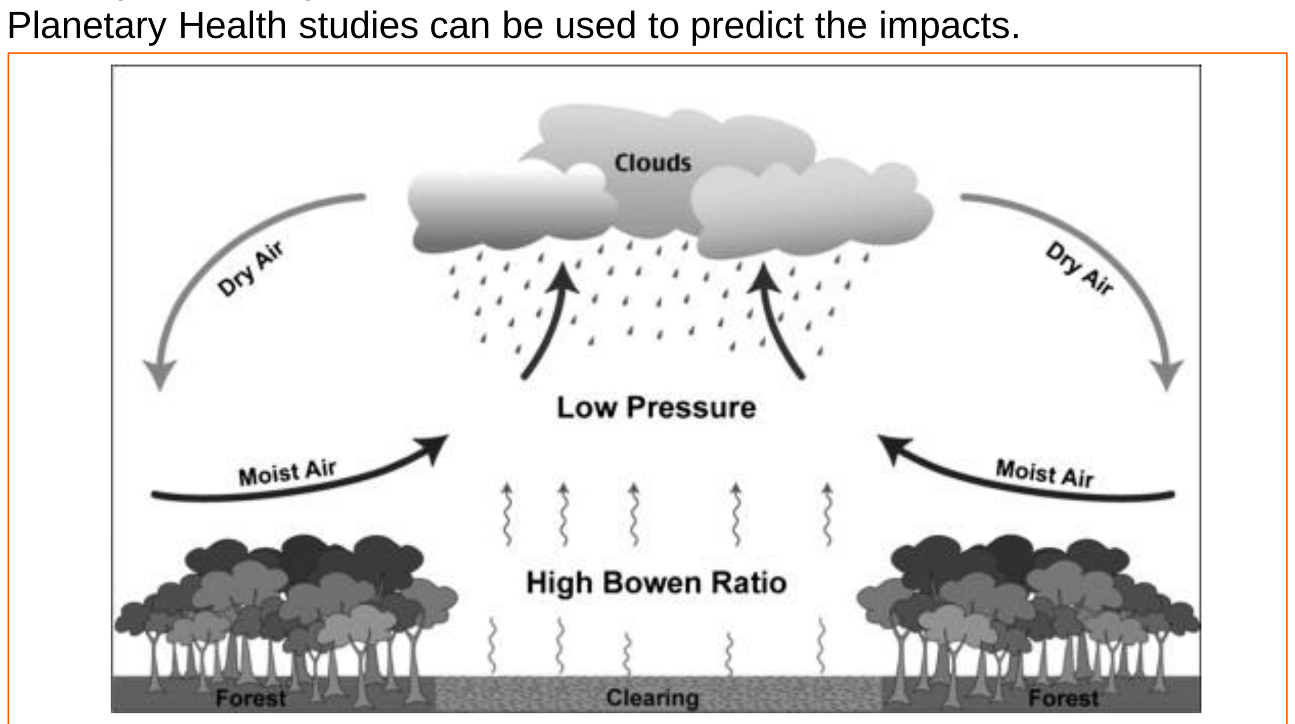

Figure 5: In fragmented tropical landscapes, clearings can create localized atmospheric circulations that rob nearby forests of moisture.

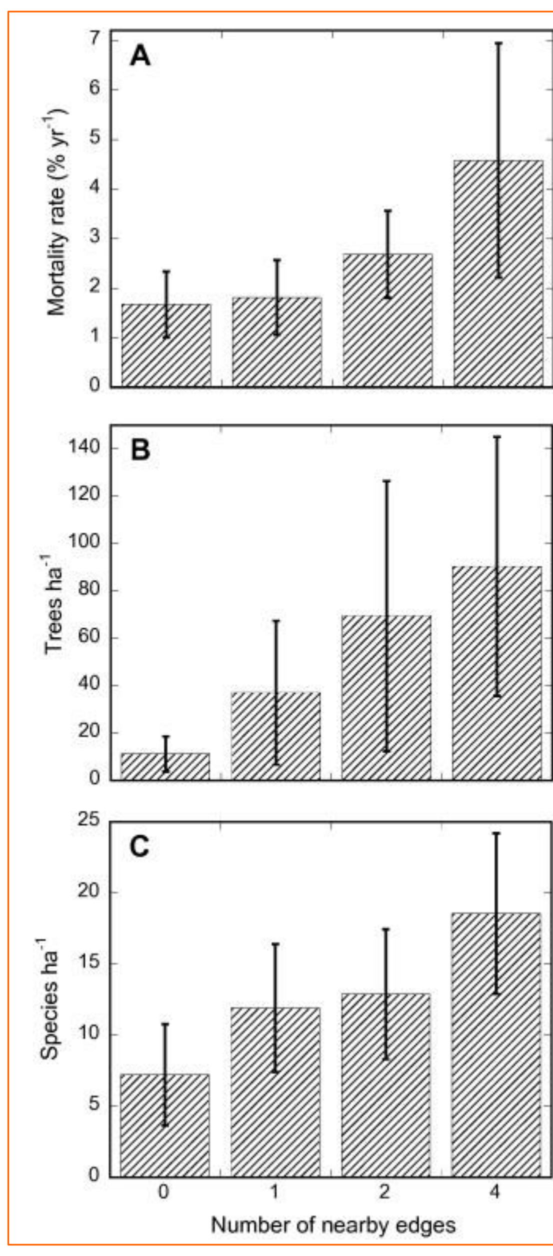

Figure 6: Forest plots affected by two or more nearby edges (plot centre <100m from edge) suffer greater tree mortality (A) and have a higher density (B) and species richness (C) of disturbance-loving pioneer trees than do plots with just one nearby edge. Values shown are the mean ± SD.

References:

Ezeonwu, B., Chima, O., Oguonu, T., Ikefuna, A., & Nwafor, I. (2014). Morbidity and mortality pattern of childhood illnesses seen at the children emergency unit of federal medical center, Asaba, Nigeria. *Annals of Medical and Health Sciences Research*, 4(3), 239–244. Retrieved March 16, 2020 from https://doi.org/10.4103/2141-9248.141966

Guo, F., Bonebrake, T. C., & Gibson, L. (2018). Land-Use Change Alters Host and Vector Communities and May Elevate Disease Risk. *EcoHealth*, 16, 647–658. Retrieved March 16, 2020 from https://doi.org/10.1007/s10393-018-1336-3

Laurance, W. F., Camargo, J. L. C., Luizão, R. C. C., Laurance, S. G., Pimm, S. L., Bruna, E. M., … Lovejoy, T. E. (2011). The fate of Amazonian forest fragments: A 32-year investigation. *Biological Conservation*, 144(1), 56–67. Retrieved March 16, 2020 from https://doi.org/10.1016/j.biocon.2010.09.021

Pienkowski, T., Dickens, B. L., Sun, H., & Carrasco, L. R. (2017). Empirical evidence of the public health benefits of tropical forest conservation in Cambodia: a generalised linear mixed-effects model analysis. *The Lancet Planetary Health*, 1, e180–e187. Retrieved March 16, 2020 from https://doi.org/10.1016/S2542-5196(17)30081-5

Near-Miss List:

Mastel, M., Bussalleu, A., Paz-Soldán, V. A., Salmón-Mulanovich, G., Valdés-Velásquez, A., & Hartinger, S. M. (2018). Critical linkages between land use change and human health in the Amazon region: A scoping review. *PLOS ONE*, 13(6), 1–16. Retrieved March 16, 2020 from https://doi.org/10.1371/journal.pone.0196414

Meyer Steiger, D. B., Ritchie, S. A., & Laurance, S. G. W. (2016). Mosquito communities and disease risk influenced by land use change and seasonality in the Australian tropics. *Parasites and Vectors*, 9(1), 387. Retrieved March 16, 2020 from https://doi.org/10.1186/s13071-016-1675-2

Shah, H. A., Huxley, P., Elmes, J., & Murray, K. A. (2019). Agricultural land-uses consistently exacerbate infectious disease risks in Southeast Asia. *Nature Communications*, 10(4299), 1–13. Retrieved March 16, 2020 from https://doi.org/10.1038/s41467-019-12333-z

The various studies presented on this poster, particularly the data from each, form a much greater collection together. They create a better understanding of the relationship between land-use change and human health through using data from different disciplinary perspectives (Global Health, Planetary Health and Ecology) which all complement each other despite having different focuses. All studies contribute to form the overall conclusion that land-use change largely increases illness/disease risk, and impacts children more. Initial data shows children (under 5) hold the burden of disease with high rates of malaria and diarrheal diseases; both of which can be increased by deforestation, as shown by the study on Cambodia. This then connects to data on other land-uses which increase disease risk, such as agriculture and fragmentation, due to impacting host/vector communities. Then connecting this to data on forest fragmentation specifically expands upon this by giving specific environmental insights such as that the water cycle is disrupted; which can also contribute to higher disease risk. This pathway therefore shows that combining data, particularly from 3 different disciplines that complement each other, but also have different focuses, is of more value in representing the overall system of land-use change as many different areas are covered.

Most of the research exploring the health benefits of green spaces and forests looked at in Planetary Health have often only considered the association with mental health. This topic is therefore important to show the benefits of forests and undisturbed land on diseases and other illnesses. This topic also links well to Ecology as, for example, species movements and diversity are impacted by land-use change.

As the ‘near-miss’ reference list shows, other papers were also read and analysed but omitted. A recent (2018) literature review on ‘Critical linkages between land-use change and human health in the Amazonian region’ demonstrated how very specific land-use changes, such as road building and biomass burning, impact health in different ways. However, due to the study being a narrative review, it lacked quantitative data. Another article entitled ‘Mosquito communities and disease risk influenced by land-use change and seasonality in the Australian tropics’ showed mosquito composition varies hugely between the habitats of grassland, forest edge and forest interior. The study caught mosquitos in each area and whilst it showed more disease vectors were found in human-disturbed grasslands (so land-use change does impact health), it was quite restricted in that it only investigated the impact of land-use change on mosquitos. Additionally, another recent article (2019) named ‘Agricultural land-uses consistently exacerbate infectious disease risks in Southeast Asia’ described that those who live and work on agricultural land (particularly those exposed to oil palm and rubber) are more likely to get infected with a pathogen (because certain types of agricultural land-use favour certain hosts/vectors). However, this article was limited in that whilst it was a meta-analysis, the paper itself advised caution in interpreting the data because research on agriculture and health is limited.