'Today's greatest global challenges and health threats are the result of human activity affecting the natural environment. Discuss, with examples relevant to pathology specialties.'

It is hard to imagine a world without the influence of human activity. One of its most profound consequences on the natural environment is perhaps climate change. There is little doubt that we are driving climate change at a staggering rate[1]. Increasing greenhouse gas emissions leads to atmospheric warming, causing multiple climate hazards (Figure 1)[2]. The consequences of these present many challenges relevant to pathology specialties. In addition to climate change, our construction of urban environments and use of man-made materials may also detriment our health and that of the environment.

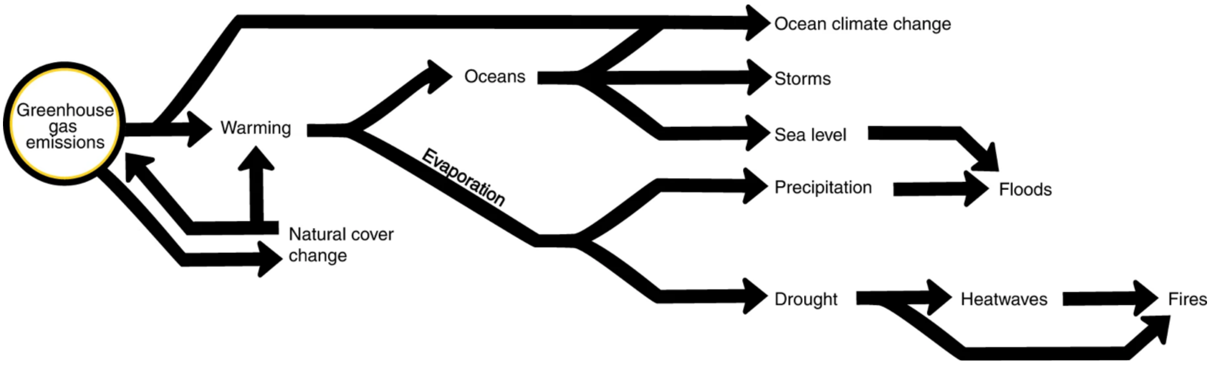

Figure 1 – A summary of the climate hazards which can occur secondary to increased greenhouse gas emissions[2].

Climate change can increase the transmission of infectious diseases. It can increase interactions between pathogen and human populations[2,3]; enhance pathogen's survival, reproductive ability, and virulence[2]; and increase human's susceptibility to disease[2]. For example, vector-borne disease transmission is increased when climatic suitability enhances the geographical range or period over which vectors can interact with humans[4]. The malaria-carrying *Anopheles* mosquitoes' range is predicted to expand due to warming and increased rainy season duration in tropical regions of Africa[5]. This may over-burden current healthcare facilities, expose immunologically naïve populations, and expose healthcare systems which are less developed to respond to these diseases[4]. Additionally, climate change may cause novel pathogen exposures due to the expansion of zoonotic diseases[3] and thawing of ice and permafrost[2]. These changes are likely to increase the pressure upon microbiology and virology services. These services will be vital in monitoring for, and rapidly responding to new outbreaks; identifying causative agents; identifying or developing diagnostic tests and treatment; and advising public health strategies[6]. The COVID-19 pandemic highlighted these pressures, and how instrumental pathology services were in responding to global health threats[7]. For example, there was a reliance on lateral flow assays to rapidly identify COVID-19 infected persons[8]. This highlighted our need for innovative technologies to quickly and accurately identify infected persons, to control the spread of disease.

Another health risk posed by climate change is food insecurity and malnutrition. Climate change can impair crop production and the nutritional quality of food[9,10], increase food prices[11], and disrupt supply chain infrastructure[9,11]. The effects of malnutrition are widespread. They range from impairing immunocompetence and increasing the risk of infectious diseases in the short-term[2], to increasing the risk of development of cancer in offspring[12]. Consequentially, malnutrition can increase the demand upon histopathology and haematology services, especially in the context of an already growing and ageing population[13,14].

Furthermore, these pressures on food production lead to sub-optimal farming practices for long-term planetary and human health, including a growing reliance on herbicides and pesticides. In 2023, over 50% of fruits and vegetable samples in the United Kingdom were found to contain pesticide residues, with 3% containing levels above the Maximum Residue Level[15]. Although consuming a wholefood diet is considered protective of health, exposure to pesticides in fruits and vegetables may offset the benefits of their consumption in relation to all-cause mortality[16]. Furthermore, Cavalier et al. detected a causal relationship between pesticide exposure and acute lymphoblastic leukaemia and colorectal cancer[17], of relevance to the histopathology and haematology disciplines. Similarly, the use of antimicrobials in animal farming is likely contributing to antimicrobial resistance[18]. Microbiologists are already facing increasing pressures to reduce antimicrobial prescription, and challenges in treating multi-drug resistant bacterial infections[19].

Climate change is also increasing the incidence of severe weather events, such as wildfires and droughts. These increase transmission of infectious diseases[2], and convey longer-term health threats. For example, wildfires are associated with an increased incidence of asthma[20], as particulate matter can penetrate alveoli and bronchioles and induce inflammatory processes[21].

The manipulation of the natural environment to support human activities, as seen in our construction of urban environments, has also generated challenges aside from climate change. Urban design may promote physical inactivity, poor food choices[22,23], and exposure to air and noise pollution[26]. Urban environments with poor walkability are associated with an increasing burden of obesity[24,25] and cardiometabolic diseases, including hypertension[24,25] and type 2 diabetes mellitus[25]. Similarly, increased exposure to noise and air pollution may increase the risk of developing cardiovascular disease[26]. These are all long-term diseases with significant sequalae, which rely on pathology services for their diagnosis and monitoring. Additionally, human activity may be a factor in the dramatic increase in allergic disorders seen in recent years[27]. Many environmental and lifestyle changes have been implicated in this, including air pollution, which may also be related to the severity of presentation[27].Of course, urban design may also promote climate change, for example by increasing air pollution, thereby exacerbating the problems previously discussed[28].

Another global threat is the widespread use of plastics, leading to accumulation of microplastics in the environment, food chain, and human tissue[29]. The full extent of the risk that this poses to human health is unknown, but it is thought to potentially contribute to carcinogenesis, metabolic disorders, and immune system dysfunction, all of which would burden pathology services[29]. Of course, plastics are also heavily used by healthcare services, including pathology services themselves.

Despite all these factors, global life expectancy is generally increasing[30], and rates of death from infectious disease are falling[31]. Perhaps this is due to the tremendous efforts by humans to improve the prevention, detection and management of diseases; promote health equity; and mitigate climate change. Urbanicity also improves access to healthcare services, sanitation, education and employment. It is therefore difficult to label human's effects on the natural environment as purely damaging, despite the challenges it presents.

In conclusion, human activity has profoundly impacted the equilibrium of the natural environment, the consequences of which are now being unmasked. Currently, it appears that we are somewhat compensating for these changes – death rates from infectious diseases are static, for example - but it is unknown whether human activity can continue to buffer these changes. It seems likely that pathology services' workload will increase and will need to be adaptable to meet evolving demands in the context of a rapidly changing health landscape. It remains to be seen whether human activity can evade the so-called tipping point, both in terms of climate stability and healthcare service provision.

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