Journal Pre-proof


# COVID-19: Analogues and lessons for tackling the extinction and climate crises

Andrew Balmford, Brendan Fisher, Georgina M. Mace, David S. Wilcove, Ben Balmford

PII: S0960-9822(20)30936-2

DOI: https://doi.org/10.1016/j.cub.2020.06.084

Reference: CURBIO 16642

To appear in: *Current Biology*

Please cite this article as: Balmford A, Fisher B, Mace GM, Wilcove DS, Balmford B, COVID-19: Analogues and lessons for tackling the extinction and climate crises, *Current Biology* (2020), doi: https://doi.org/10.1016/j.cub.2020.06.084.

# COVID-19: Analogues and lessons for tackling the extinction and climate crises

Andrew Balmford[1,6*], Brendan Fisher[2], Georgina M. Mace[3], David S. Wilcove[4] & Ben Balmford[5]

[1] Department of Zoology, University of Cambridge, Downing St, Cambridge CB2 3EJ, UK

[2] Environmental Program, Gund Institute for Environment, Rubenstein School of Environment & Natural Resources, University of Vermont, Burlington VT, 05405, USA

[3] Centre of Biodiversity & Environment Research, Medawar Building, University College London, London WC1E 6BT, UK

[4] Woodrow Wilson School of Public & International Affairs, Princeton University, Princeton, NJ 08544, USA

[5] Land, Environment, Economics & Policy Institute. University of Exeter Business School, Prince of Wales Rd, Exeter EX4 4PJ, UK

[6] Lead contact

* Correspondence: a.balmford@zoo.cam.ac.uk



Writing as environmental scientists in countries whose COVID-linked deaths already exceed their military casualties from all campaigns since 1945, we believe there are significant messages from the handling of this horrific disease for efforts addressing the enormous challenges posed by the ongoing extinction and climate emergencies.

Like these twin environmental crises, the SARS-CoV-2 pandemic perhaps at first seemed a relatively localised problem, far-removed from most people's everyday lives. But a disease epidemic is, at heart, a phenomenon of positive feedbacks, with each new case spawning others. Human impacts on our planet are also characterised by positive feedbacks. Unravelling ecological inter-dependencies and interacting threats accelerate the extinction of species. Anthropogenic warming triggers state shifts in ecosystems, which further increase net emissions. Moreover, lags in the dynamics of each problem – between infection and presentation of symptoms; between removal of habitat and the protracted extinction of species whose small and disconnected populations are thereby all but doomed to extinction; and between greenhouse gas emissions and the full effects of thermal expansion and ice-sheet melting on sea-level rise – mean all three systems are also characterised by considerable momentum. As a result, left unchecked for too long, our ecological and climate impacts, like those of COVID-19, have swiftly grown to become existential threats [1,2].

Their lagged impacts, non-linear escalation and complex, still poorly-understood dynamics mean that recognising and mounting effective responses to each challenge requires governments to listen to independent scientists. But, as we now know, such voices were tragically ignored during the earliest stages of this pandemic, as indeed were many years of warnings from epidemiologists and wildlife-disease experts of the immense risks of novel zoonoses emerging from wildlife markets [3,4]. Scientists have likewise been warning for decades of the probability that human actions are triggering a sixth mass extinction, and of the dire consequences of major human-induced shifts in the earth's climate. Yet with these environmental catastrophes unfolding over decades (rather than

months in the case of COVID), even now government responses to them, as reflected in international commitments, are patchy and inadequate [5,6].

We suggest there are three other striking similarities in the COVID, extinction and climate crises. The first is that there is no substitute for early action. In the case of the pandemic, epidemiological modelling highlights the importance of early intervention [7,8]. Empirical analysis using date of lockdown as a proxy for the timing of intervention confirms this, revealing a clear link across OECD countries between when they issued strong "stay at home" instructions and COVID-attributed mortality (Fig. 1). A regression controlling for potential economic, and demographic confounds suggests that had lockdown been enacted a week earlier, there would have been approximately 17,000 fewer deaths through to 21 May 2020 in the UK, and nearly 45,000 fewer in the USA. Likewise, delaying action on climate change such that the world experiences +2.0$^{o}$C rather than +1.5$^{o}$C warming will expose an estimated 62-457M more of the world's poorest people to multi-sector climate risks [8]. Species conservation actions are less likely to succeed the longer they are delayed [9], and the power-function relationship between species number and habitat area means that as conversion proceeds, marginal reductions in habitat area cause ever-greater species losses.

Second, in each case mounting effective and acceptable interventions requires decision-makers and citizens to act in the interests of society as a whole, and of future generations. In the COVID crisis this means young and working people making sacrifices for the older and more vulnerable. For the climate and extinction crises effective action requires wealthier people forgoing extravagance both for the present-day poor and for all future generations. Just as the "harvest" of at-risk elderly people is not a socially acceptable price to pay for an early return to pre-pandemic economic activity, neither is giving pre-eminence to economic growth at the expense of a substantial fraction of all species [1] or a stable climate. Instead, at the very least, the people, species and ecosystems most vulnerable to our everyday behaviours must be safeguarded through deliberate and well-enforced protection. More generally, viruses, circulating greenhouse gases and the processes by which we threaten nature do not remain within local or even national boundaries. Hence tackling them effectively necessitates coordinated and simultaneous cooperation among individuals, subnational authorities and nations. The actions of powerful mavericks can threaten us all.

Last, even examined in narrow financial terms, as the immense toll of the COVID crisis on livelihoods and the global economy becomes clearer, estimates suggest that delaying action may ironically reduce prosperity as well as cost lives. IMF forecasts [10] of economic growth through to the end of 2021 are lower in those countries with higher current death rates (compound growth in GDP per capita 2019-2021 vs COVID-related deaths per million has $\beta$=-3.63x10$^{-5}$, SE=-1.56x10$^{-5}$, n=37 OECD countries, p=0.03). The notion that paying short-term costs may be vital to securing longer-term prosperity is echoed in several assessments of the overall economic consequences of responding to the climate and extinction crises. On both environmental fronts intervening now rather than delaying further is critical to securing our future wellbeing and that of our children and grandchildren.

Scientists are not inventing the threats of catastrophic climate change or of mass extinction. They are real, and they are upon us. There are many steps we can take even now to greatly diminish both crises. The consequences of continued inaction are too grave to contemplate.

References

1. Barnosky, A.D., Matzke, N., Tomiya, S., Wogan, G.O.U., Swartz, B., Quental, T.B., Marshall, C., McGuire, J.L., Lindsey, E.L., Maguire, K.C. et al. (2011). Has the Earth's sixth mass extinction already arrived? Nature *471*, 51-57.

2. Barnosky, A.D., Hadly, E.A., Bascompte, J., Berlow, E.L., Brown, J.H., Fortelius, M., Getz, W.M., Harte, J., Hastings, A., Marquet, P.A. et al. (2012). Approaching a state shift in Earth's biosphere. Nature *486*, 52-58.

3. Webster, R. G. (2004). Wet markets - A continuing source of severe acute respiratory syndrome and influenza? Lancet *363*, 234–236.

4. Fan, Y., Zhao, K., Shi, Z.-L. and Zhou, P. (2019). Bat coronaviruses in China. Viruses *11*, 210.

5. Tittensor, D.P., Walpole, M., Hill, S.L.L., Boyce, D.G., Britten, G.I., Burgess, N.D., Butchart, S.H.M., Leadley, P.W., Regan, E.C., Alkemade, R. et al. (2014). A mid-term analysis of progress toward international biodiversity targets. Science *346*, 241-244.

6. Watson, R., McCarthy, J.J., Canziani, P., Nakicenovic, N., and Hisas, L. (2019). The truth behind the climate pledges. Fundación Ecológica Universal-US. Available at https://drive.google.com/file/d/1nFx8UKTyjEteYO87-x06mVEkTs6RSPBi/view

7. Dagpunar, J. (2020). Sensitivity of UK Covid-19 deaths to the timing of suppression measures and their relaxation. medRxiv preprint doi: https://doi.org/10.1101/2020.05.09.20096859

8. Pei, S. Kandula, S. and Sharman, J. (2020). Differential effects of intervention timing on COVID-19 spread in the United States. medRxiv preprint doi: https://doi.org/10.1101/2020.05.15.20103655

9. Roy, J., Tschakert, P., Abudul Halim, S., Antwi-Agyei, P., Dasgupta, P., Hayward, B., Kanninen, M., Liverman, D., Okereke, C., Pinho P.F. et al. (2018). Sustainable development, poverty eradication and reducing inequalities. In Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty, V. Masson-Delmotte et al., eds. (Geneva, Switzerland, IPCC).

10. Martin, T.G., Nally, S., Burbidge, A.A., Arnall, S., Garnett, S.T., Hayward, M.W., Lumsden, L.F., Menkhorst, P., McDonald-Madden, E., and Possingham, H.P. (2012). Acting fast helps avoid extinction. Conserv. Lett. *5*, 274-280.

11. International Monetary Fund (2020). World Economic Outlook database. Available at https://www.imf.org/external/pubs/ft/weo/2020/01/weodata/download.aspx

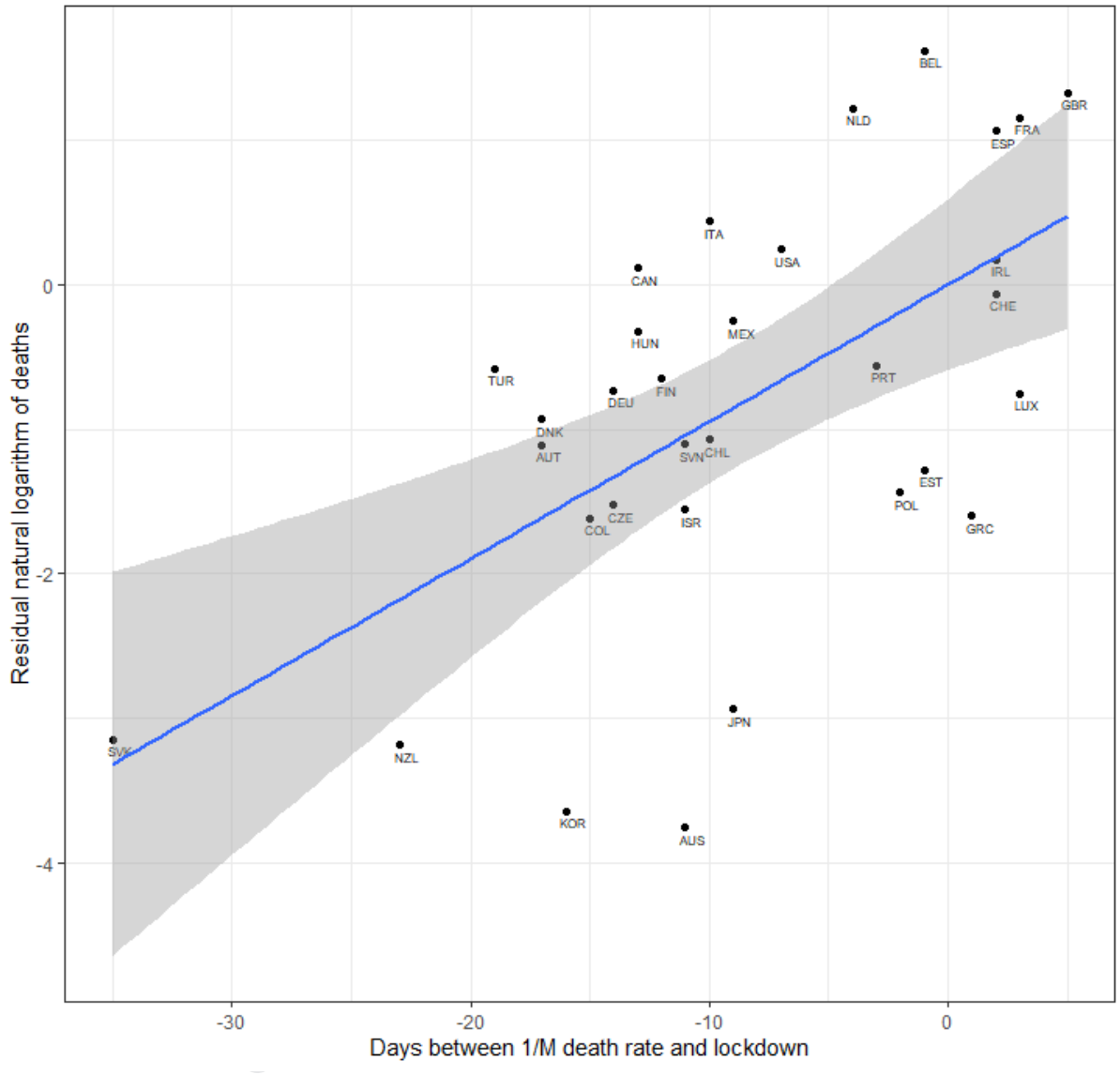


Fig. 1. The importance of early action in tackling the COVID-19 pandemic. The residual natural logarithm of COVID-related deaths per million people is plotted against when (in days) lockdown was introduced relative to when deaths reached one per million, for the 32 OECD countries which introduced restrictions on people's internal movements. To address potentially confounding variables the response variable is ln(observed deaths per million) – ln(predicted deaths per million), with the prediction derived from a linear model using as predictors national population density, % of the population that is urban, % of the population over 70, per capita GDP, Gini coefficient, the time the WHO declaring a public health emergency and the country's 100th confirmed case, and total number of tests conducted. Overall model $r^2$= 0.46; the regression line shown has β=0.0949, SE=0.0315, p=0.006; shading shows 95% confidence intervals. A simpler model with no covariates has overall model $r^2$= 0.38, β=0.1076, SE=0.0253, p<0.001. Further details in Supplemental information.

# Supplemental information

**Details of regression analysis of death rate on lockdown date**

| | Estimate | Std. Error | t | p |
|---|---|---|---|---|
| Constant | 7.01E+00 | 5.09E+00 | 1.376 | 0.18216 |
| Days between 1/M death rate and lockdown | 9.49E-02 | 3.15E-02 | 3.009 | 0.00626 |
| National population density (people/km$^2$) | -2.63E-04 | 2.36E-03 | -0.111 | 0.9123 |
| % of population that is urban | -1.18E-02 | 2.57E-02 | -0.46 | 0.64996 |
| % of population aged over 70 | -2.15E-02 | 1.28E-01 | -0.168 | 0.86817 |
| Per capita GDP (PPP$) | 4.75E-06 | 2.43E-05 | 0.195 | 0.84687 |
| Gini coefficient (%) | 9.73E-04 | 6.41E-02 | 0.015 | 0.98803 |
| Days between WHO emergency and 100th confirmed case | -4.06E-02 | 4.98E-02 | -0.815 | 0.42369 |
| Tests/thousand by 21 May 2020 | 1.69E-02 | 1.57E-02 | 1.072 | 0.2948 |

Multiple $r^2 = 0.46$, adjusted $r^2 = 0.27$

**Data sources**

1. Our World in Data. (2020). COVID-19 data. Available at: https://github.com/owid/covid-19-data/tree/master/public/data

2. Blavatnik School of Government, University of Oxford. (2020). Coronavirus Government Response Tracker. Available at: https://www.bsg.ox.ac.uk/research/research-projects/coronavirus-government-response-tracker

3. World Health Organisation. (2020). Rolling updates on coronavirus disease (COVID-19). Available at: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/events-as-they-happen

4. World Bank. (2020). GINI index (World Bank estimate). Available at: https://data.worldbank.org/indicator/SI.POV.GINI?view=map

5. World Bank. (2020). Urban population (% of total population). Available at: https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS

6. New Zealand Government. (2020). Household income and housing-cost statistics: Year ended June 2019. Available at: https://www.stats.govt.nz/information-releases/household-income-and-housing-cost-statistics-year-ended-june-2019#download-data

Data downloaded 21 May 2020.

**Country codes used in Fig. 1**

| Country | iso_code |
|---|---|
| Australia | AUS |
| Austria | AUT |
| Belgium | BEL |
| Canada | CAN |
| Switzerland | CHE |
| Chile | CHL |
| Colombia | COL |
| Czech Republic | CZE |
| Germany | DEU |
| Denmark | DNK |
| Spain | ESP |
| Estonia | EST |
| Finland | FIN |
| France | FRA |
| UK | GBR |
| Greece | GRC |
| Hungary | HUN |
| Ireland | IRL |
| Israel | ISR |
| Italy | ITA |
| Japan | JPN |
| Korea | KOR |
| Luxembourg | LUX |
| Latvia | LVA |
| Mexico | MEX |
| Netherlands | NLD |
| Norway | NOR |
| New Zealand | NZL |
| Poland | POL |
| Portugal | PRT |
| Slovakia | SVK |
| Slovenia | SVN |
| Sweden | SWE |
| Turkey | TUR |
| USA | USA |

OECD countries that have not gone into lockdown (Iceland, Latvia, Lithuania, Norway, Sweden) are excluded from analysis.