Can we use long-term ecological data to help understand changes in human use impacts on ecosystems during the COVID-19 pandemic?

Long-term ecological research and the COVID-19 anthropause: A window to understanding social-ecological disturbance

Citation Gaiser, E.E., Kominoski, J.S., McKnight, D.M., Bahlai, C.A., Cheng, C., Record, S., Wollheim, W.M., Christianson, K.R., Downs, M.R., Hawman, P.A., Holbrook, S.J., Kumar, A., Mishra, D.R., Molotch, N.P., Primack, R.B., Rassweiler, A., Schmitt, R.J., & Sutter, L.A. (2022). Long-term ecological research and the COVID-19 anthropause: A window to understanding social-ecological disturbance. *Ecosphere* 13(4): e4019. https://doi.org/10.1002/ecs2.4019

How did human interactions with ecosystems change during the COVID-19 pandemic and what is an anthropause?

Human activities impact ecosystems relatively consistently. Human responses to COVID-19 caused the level of impact on land, water, and atmosphere to change abruptly. This period has been termed an anthropause and has provided a period of comparison with which to examine human impacts on natural systems on a global scale. Human interactions with natural systems changed during the pandemic and whether patterns of impact return to pre-pandemic levels or stabilize at a different level is unresolved.

How did patterns of nutrient inputs change during the anthropause?

- Lower CO_2 and NO_x levels were anticipated in urban areas because of decreased emissions, leading to decreased nutrient loading and tree growth rates.
- Increased septic usage and fertilizer application in suburban and exurban areas would increase the amount of N loading in local waterways.

What ecological effects cascade from the change in nutrient input patterns?

- Decreases in atmospheric pollutants resulted in decreased snowfall, increased and earlier snowmelt, improved air quality and increased atmospheric brightness. Aerosols are also delivered to the atmosphere from wildfires, which fluctuates from year to year, making the impact of the anthropause more difficult to ascertain.
- In Georgia, coastal marshes and estuaries experienced earlier green-up and higher concentrations of dissolved organic matter. Nutrient inputs may have been higher because of greater septic use and agricultural waste. Additionally, accumulated coastal N was delivered to waterways by high precipitation.

How can researchers determine the impacts from the anthropause pulse disturbance and what role does long-term data play? Can remote data collection increase our understanding?

- Coastal areas are expected to have decreased N from atmospheric deposition and increased N from fertilization and septic. Determining whether there was an overall increase or decrease and overall impact on productivity will require comparison with long term data from a variety of monitoring sites.

- Remotely collected data, from nutrient sensors to wildlife cameras, can be successfully used to increase the scale of data collection geographically and through time.

How are wildlife populations affected by changes in patterns of human use? Are these impacts transitory or lasting?

- Human impacts increased in some systems because recreation or subsistence activity increased, and decreased in others because commercial activity decreased. Impacts of the anthropause pulse disturbance can be determined by comparing population trends between protected and fished areas, or between ecologically similar targeted and non-targeted species.
- In wildlife populations, pressures from human impacts can change population trajectories and these changes can persist over long time scales. Populations may be connected to outside sources or isolated by geography or distance.

Do single-household changes actually make impacts at an ecosystem scale?

- Small-scale changes, such as increased gardening or use of natural areas, by large numbers of people have the potential to impact nutrient cycling, productivity, and biodiversity at a large scale.
- Household landscaping changes specifically impact water usage with potentially inequitable impacts for vulnerable populations.

Are there feedback loops between ecosystems and human systems and social behaviors?

- Long term data from socio-ecological networks is just as important for understanding pulse disturbances, such as the anthropause, as it is for identifying ways to build ecosystem resilience and sustainability relative to multiple disturbances.
- The time of recovery after a crisis or disaster provides an opportunity to rebuild with better systems for sustainable and equitable recovery.

Research Approach/Methods

- The authors used disturbance ecology theory to investigate how the anthropause affected social-ecological interactions. They used long-term datasets to investigate slow, continuous (press) and short-term, abrupt (pulse) disturbances.
- Researchers asked primary investigators at LTER sites to qualitatively predict the impacts of reduced agriculture and emissions and increased use of natural areas.
- They considered the anthropause a pulse disturbance and attempted to identify a signal distinct from long-term variance in ecosystem structure and processes.
- The authors looked specifically at potential direct and indirect effects on biogeochemical responses to reduced atmospheric pollutants.
- They then investigated plant, wildlife, and agricultural responses to the biogeochemical changes and to changes in land use patterns such as for fishing, hunting, and farming.
- The researchers also examine feedback between human impacts and ecosystem processes as well as potentially changing views on ecosystem value and environmental and socio-economic justice.

Keywords ecosystems, feedback, LTER, press, pulse, recovery, reorganization, resilience

Images

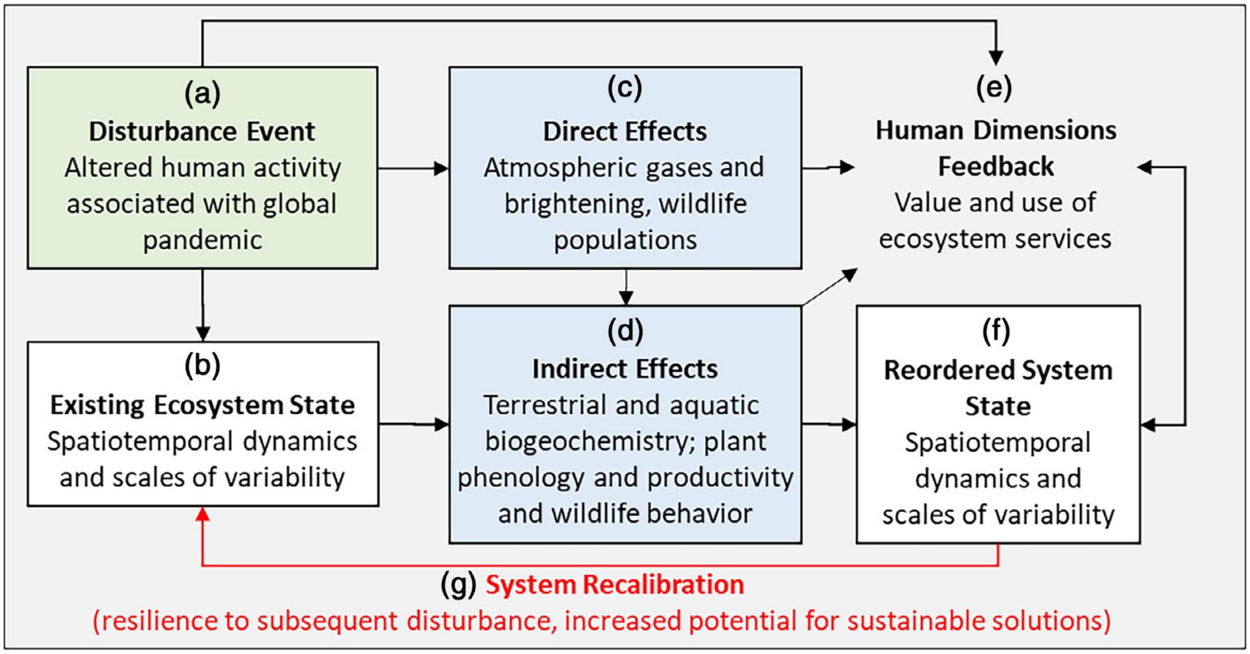

Figure 1 in Gaiser et al. 2022. A framework for understanding the pause in human activity resulting from a global pandemic as a disturbance event (a) that disrupts the existing ecosystem state dynamics (b) through direct and indirect effects on air, water soils, and biota (c, d) and via social–ecological feedback (e) that results in a reordered ecosystem state with different spatiotemporal dynamics (f). A key attribute of longterm ecological research is the ability to capture whether this reorganization occurs, and if it does, how it affects resilience to subsequent disturbance and the potential for sustainable solutions (g). Simplified from Gaiser et al. (2020).

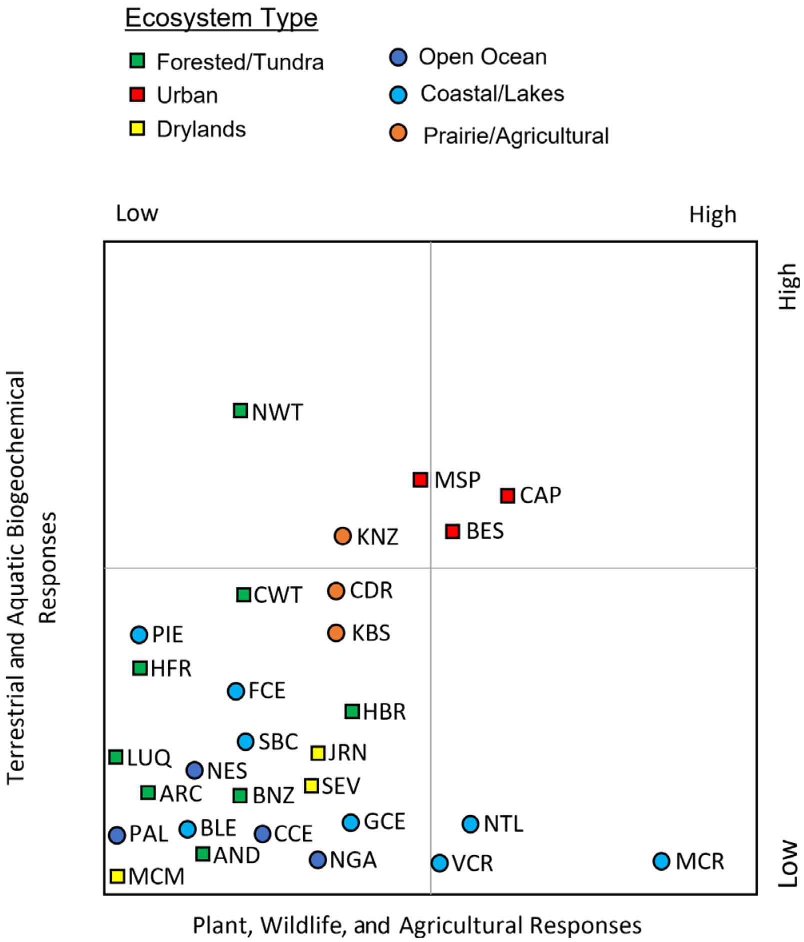

Figure 2 in Gaiser et al. 2022. Anticipated effects of the anthropause disturbance on terrestrial and aquatic biogeochemistry (y-axis) and plant, wildlife, and agriculture (x-axis) at U.S. Long Term Ecological Research network sites (see Table 1 for abbreviations and detailed rationale for the qualitative placement of sites).

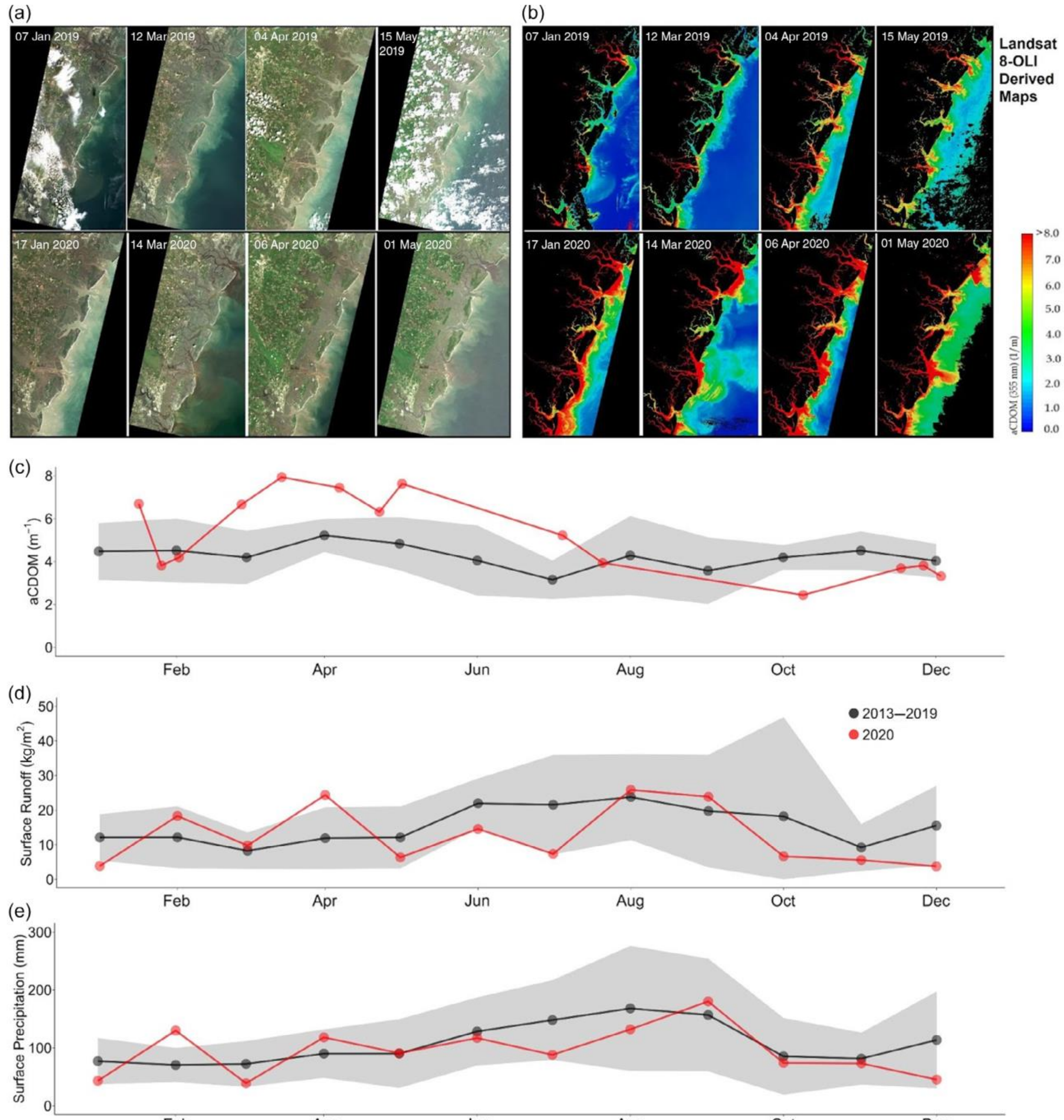

Figure 6 in Gaiser et al. 2022. Comparison of (a) monthly true color images and (b) estimates of absorption by colored dissolved organic matter (CDOM [aCDOM]) at 355 nm (m_1) in Georgia coastal waters in 2019 and 2020. Time series of (c) Landsat 8 derived a CDOM for the Georgia Coastal Ecosystems Long Term Ecological Research (LTER) domain showing monthly means for the years 2013–2019 compared to 2020. Time series of (d) area-averaged monthly means (2013–2019) of surface runoff compared to 2020 and (e) monthly means of surface precipitation (2013–2019) compared to 2020 for coastal Georgia. The surface runoff and precipitation data were derived from NASA's MERRA-2 long-term global re-analysis database (MERRA-2 Model M2TMNXLND v5.12.4). Data for 2013–2019 are represented as means (black points) and SDs (gray shaded region), and 2020 data are represented as red points. Source: Landsat 8-OLI. The CDOM model (R2 = 0.74) used in this study was originally developed for Landsat 5-TM (Joshi & D'Sa, 2015). However, both Landsat 8-OLI and Landsat 5-TM have similar green and red bands (band centers and bandwidths) that were used in the CDOM model, and therefore, we assume the impact of the sensor differences would be minimal in CDOM estimation. Note about uncertainty: The model was developed for Barataria Bay, Louisiana. We have not tuned the model for coastal Georgia because of the lack of in situ data.