HUMAN ECOLOGY REVIEW

Volume 26, Number 1, 2020

COVID COMMENTARIES

RESEARCH AND THEORY IN HUMAN ECOLOGY

BOOK REVIEWS

COVID Commentaries

Human Ecology and COVID-19

Federico Davila[1]
Institute for Sustainable Futures, University of Technology Sydney,
New South Wales, Australia

In mid-2019, as the closing plenary speaker finishes their talk, the international conference organizers take the stage to wrap up the event. The usual things: Thank you to those who flew for 24 hours to get here, to the venue for their facilities, to the catering team. As the audience excitedly awaits the closing ceremony, the organizers announce the 2020 conference: They reveal that it will not be a face-to-face meeting but will be held online, across four time zones, over a one-week period, with everyone self-catering, and with the option of pre-recording the sessions. The audience, perplexed, shift in their seats, and quickly begin debating the shortcomings of losing the essential component of human interaction in favor of a web-based gathering.

The scenario above may well have occurred at conferences in 2019—yet no one was really prepared for it to be normalized and become the first option for organizing any kind of event in 2020. The COVID-19 pandemic has transformed day-to-day living for billions of people across the globe. Beyond the immediate health impacts, the pandemic has had profound ramifications in major sectors of society. Its effects have been highly differentiated across geographies, class, race, and gender. Within countries, a person's poverty or wealth, type of employment, and societal roles determined how much the pandemic affects them. Between countries, transport logistics, education, business, and advocacy have changed. Core economic sectors for some countries have collapsed, while some digital and informal economies have been amplified. How we talk about, see, and interact with each will take time to recover—and may prove to have transformed into something utterly different.

As human ecologists, we are tasked with analyzing why human and environmental systems change and react to specific disruptions. As a transdisciplinary field of enquiry, human ecology allows us to look at the structural dimension of a situation and question the different value systems that influence how we frame solutions to specific problems. The pandemic has had profound impacts, and has brought to light (again) the social injustices and inequalities of our world. Living in this altered world can teach us lessons in how to manage future risk and how to design public and private action to build buffers against future shocks. To do so meaningfully, we need to understand how we have responded to the impacts of the pandemic if we are to be prepared for the inevitable future shocks coming our way.

1 Corresponding author: federico.davila@uts.edu.au.

This initial set of articles in *Human Ecology Review* has been prepared by the editorial board for this issue. There is already a plethora of publications and reports on the projected impacts of the pandemic. In my research field of food systems, two major journals compiled rapid opinion pieces while the pandemic was unfolding. At the end of 2020, we have already lived through the initial impacts and are starting to understand what things have changed and how they have changed. It is now time to critically examine these impacts and identify the underlying structures and values that have driven the response (or lack thereof). The five "COVID Commentaries" assembled for inclusion in this issue cover a wide range of topics, ranging over COVID-19's effect on food procurement and waste in Portugal; food production in the Pacific; conservation tourism in Africa and the Galapagos Islands; pre-existing health stressors and lethality in Mexico; and confusion and miscommunication between medical authorities, policy-makers, and mass media in Europe. A common thread between the articles is the urgency to understand the systemic linkages between the health impacts of COVID-19 and the underlying structural factors that create higher vulnerability in peoples, economies, and environments.

We invite readers to contribute articles documenting the impacts of COVID-19 from a human ecology perspective, and which critically examine how societies and environments are recovering from, and adapting to, this major disruption. We are particularly interested in the differentiated impacts throughout the world, and want to understand how different geographies, cultures, politics, and histories have influenced the effects of COVID-19 in different sectors. We welcome submissions from scholars and researchers from all career stages, disciplines, sectors, and professions who are exploring the human ecological dimensions of COVID-19 in different contexts. As a research community, we hope to advance ideas and evidence to support our future responses to shocks. Critically examining how we respond to COVID-19 will help us advocate for more equitable and just interventions in response to the future environmental, economic, and social disruptions that are guaranteed to emerge in the coming decades.

A Systemic Assessment of COVID-19 Impacts on Pacific Islands' Food Systems

Federico Davila[1]
Institute for Sustainable Futures, University of Technology Sydney,
New South Wales, Australia

Steven Crimp
Climate Change Institute and Fenner School of Environment and Society,
The Australian National University

Bronwyn Wilkes
Fenner School of Environment and Society,
The Australian National University

Abstract

In this commentary, we present an analysis of how COVID-19 has impacted food systems in the Pacific Islands. The Pacific Islands region is home to over 10 million people across 22 countries, with hugely diverse agricultural and fisheries systems. The analysis is based on a systems framework developed by Allen and Prosperi (2016), which covers various aspects of human ecology food systems. We synthesized material from 21 interviews, news websites, emerging literature, and parallel published assessments of COVID-19 impacts in the region. We present examples of impacts across different elements of food systems throughout the region. We then apply a systems-based analysis to illustrate how the impacts of COVID-19 on Pacific food systems create an opportunity to find innovative ways of transforming localized and regional food, and create an opportunity to building resilience to future shocks.

Keywords: COVID-19, food systems, Pacific, shocks, systems thinking

Introduction

Over the six months between April 2020 and the time of writing, there has been a proliferation of reports and literature describing the projected impacts of COVID-19 on food systems.[2] This literature describes the potential impacts of trade closures, loss of income, co-occurrence with extreme weather events, and political and structural

1 Corresponding author: federico.davila@uts.edu.au.
2 See, for example, special issues in the journals *Agriculture and Human Values*, and *Food Security*.

inequalities (Altieri & Nicholls, 2020; van der Ploeg, 2020), and proposes frameworks to assess the ongoing impacts of the pandemic (Béné, 2020; Savary et al., 2020). As scholars in human ecology, we are concerned with the ethical imperative of identifying ways in which these impacts can be mitigated, managed, or overcome, and which go some way to addressing the systemic structural issues that cause and perpetuate them. To do this, we must bring out perspectives from multiple actors across various domains that go beyond disciplinary silos and focus on the multiple dimensions of the crisis across various time horizons. As 2020 comes to an end, we need to reflect on the extent to which the projected impacts of this pandemic have come to pass and unforeseen impacts have emerged. In this commentary, we present evidence of how COVID-19 has impacted food systems in the Pacific Islands. We apply a systems framework developed by Allen and Prosperi (2016), which covers various aspects of the human ecology of food systems. Our analysis is based on synthesized material from key informant interviews, webinars, blogs, policy documents, and publications collected between May and September 2020 as part of the authors' various projects in Pacific food systems, as well as a project to assess COVID-19 impacts on food systems, commissioned by the Australian Centre for International Agricultural Research (ACIAR) (Robins et al., 2020). Our reporting of emerging evidence in Pacific Islands enables us to identify potential areas of focus for future research, policy, and business interventions to support the region.

Pacific Islands' food systems and COVID-19 context

Pacific Island countries comprise more than 2,000 islands and atolls in 22 countries and territories. While the region covers one-third of the Earth's surface, the total land area is only approximately 550,000 km^2, representing 2 percent of the entire 30,000,000 km^2 of the Pacific region (Barnett, 2011). This land area is home to 11 million people including Papua New Guinea (SPC, 2020b), and, excluding Papua New Guinea, 90 percent live within 5 km of the coast (Andrew et al., 2019) and a rapidly growing number live in and around major cities. While historically a more disperse population, urbanization is increasing in Pacific Island countries, and by 2050 over 50 percent of the Pacific population is expected to live in urban areas (UNESCAP, 2018). Demographically, over 50 percent of the population is under 50 years of age, and unemployment sits at 23 percent, much higher than global average of 12 percent (SPC, 2014).

Agriculture makes important contributions to national GDP and everyday livelihoods in the region, although the extent varies widely between areas, due to the different agroecological zones and variation in rainfall across the region (see Table 1). Despite the ongoing importance of agriculture, food production has declined in the region over the last few decades. In studying changes in agriculture, Farrell et al. (2020)

found that between 1980 and 2016, crop production in the region (excluding Fiji and Papua New Guinea) declined from 1,200 to 800 g/capita/day. These declines are due to a mix of factors, including climate change, reductions in available arable land, increasing availability of cheap imported food, and diversification of livelihood strategies (Farrell et al., 2020; Plahe et al., 2013).

Table 1. Agriculture and fisheries context of Pacific Island countries.

Indicator	Unit	Kiribati	Tuvalu	Samoa	Tonga	Fiji	Solomon Islands	Vanuatu
Agricultural land	Percentage of land area	42	60	12.4	45.8	23.26	3.9	15.3
Agriculture and fisheries, value added	Percentage of gross domestic product (2018)	30.8	16.5	9.8	17.2	9.2 (2012)	35	25.8
Top staples	Ranked most to least, based on production data	coconut, banana, taro, copra, breadfruit	coconut, pulaka, banana, breadfruit, taro, cassava, sweet potato, pawpaw pumpkin	taro, chicken, fish, canned mackerel, rice, banana, brown sugar, coconut, bread, instant noodles	coconut, cassava, sweet potato, yam, taro, banana	coconut, taro, cassava, sweet potato, rice, cereal, banana, yam, maize	rice, sweet potato, cassava, yam, taro, banana, pumpkin, vegetables, coconut, livestock	taro, yam, cassava, sweet potato
UNDP Human development index ranking	Out of 189	132	N/A	111	105	98	153	141

Source: Extracted from Robins et al. (2020, pp. 98–99).

Fisheries also contribute to the region's development. In simple terms, two major types of fishing are practiced:

- oceanic—with tuna being the region's primary catch, and
- coastal—which includes multiple fish species as well as cephalopods, crustaceans, shellfish, and eels.

Coastal fisheries, where fish are caught and consumed by families and surplus sold to markets, provide the primary or secondary source of income for up to 50 percent of households, and 50–90 percent of the animal-sourced protein consumed by households (SPC, 2015). The dependence on fisheries for household food security and incomes, as well as government revenue, is pronounced in Kiribati and Tuvalu, where 8–10 percent of their gross domestic product is obtained from fisheries (Gillett, 2016).

With a surge of trade liberalization in the mid-1990s, the region experienced a rapid increase of cheap imported processed foods such as noodles, rice, and wheat (Charlton et al., 2016; Plahe et al., 2013). This has altered food environments and, coupled with increasingly sedentary lifestyles, has contributed to the growing burden of noncommunicable diseases in the region, including stunting, micronutrient deficiencies, obesity, and diabetes. It is possible to simultaneously suffer from micronutrient deficiency and obesity, which can result when an abundance of calories is available in the form of energy-dense, nutrient-poor food, such as highly processed foods. In several Pacific Islands countries, rates of obesity, diabetes, kidney disease, and nutritional deficiencies are above the global average (Global Nutrition Report, 2020; IHME, 2018).[3] The Pacific is also highly exposed to climate change, as it contains some of the most vulnerable countries in the world to sea level rise and increasing extreme weather events.

COVID-19 in the Pacific has been experienced differently from other parts of the world, as despite having isolated cases, the region is largely COVID-19 free as of September 2020. At the time of research (June–August), seven out of 22 Pacific countries had under 700 infections and 8 deaths.[4] Rapid action by governments to fully close borders managed to control outbreaks—a vital response, given the fragility of health systems in the region. However, despite the relatively low numbers of COVID-19 infections, the socioeconomic impacts of the pandemic have been severe, undermining existing food and nutritional security, and also negatively impacting livelihoods across the region. In this unfolding scenario, urban poor, rural women, and landless farmers have been disproportionately affected. In response, many nations in the region have reprioritized the importance of food activities as a core contributor to sustainable development.

For our rapid systems analysis, we synthesized material from 21 key informant interviews (including 7 women), which lasted between 30 and 60 minutes. Targeted sampling was undertaken across seven countries and conducted in June 2020, along with review of news websites, emerging literature, and parallel published assessments of COVID-19 impacts in the region (ADB, 2020; WFP, 2020). Our analysis focused on seven countries representing three categories of islands. The first category comprised of the larger Melanesian countries of Fiji, Solomon Islands, and Vanuatu. The second category comprised of the Polynesian countries of Samoa and Tonga. The third category comprised of the coral-based atoll islands of Tuvalu and Kiribati. We excluded United States, United Kingdom, and French territories; Papua New

3 We compared the prevalence of nutritional deficiencies, diabetes, and kidney disease in the following countries with that of the global average: Tonga, Samoa, Fiji, Vanuatu, Solomon Islands, and Kiribati. We used data for both sexes and all ages.

4 At the time of writing, in October 2020, the situation is more severe: over 10,000 cases and 95 deaths. Most countries remain COVID-19 free, with large clusters in Guam and French Polynesia.

Guinea was not included in our rapid analysis given its enormous agroecological diversity, substantially larger population, and the fact that a parallel assessment was conducted in that country.

In the section that follows, we first present a series of impacts across different food system components. We then analyze the material through a causal loop diagram and the broad application of a human ecology perspective to show opportunities for interventions to support Pacific Island food system recovery from COVID-19 shocks.

Impacts on food and nutrition security

Various forms of national lockdowns and movement restrictions were implemented by the seven countries between March and July 2020. These movement restrictions resulted in impacts on the normal operation of distribution networks of local food supply, and people's ability to access food. The nature of lockdowns meant farmers and distributors were confined to their home provinces, limiting the distribution of food to larger markets in cities. Similar to other recent analyses, we found that particular social groups were exposed to greater food insecurities from COVID-19 than others. Most sensitive were the urban poor, landless farmers, and rural women (CARE, 2020; PIFON, 2020).

The economic impacts of the pandemic have been many and varied, but most significant are the collapse in tourism and the reduction in remittances from family members working outside of the Pacific. The near total collapse of Pacific tourism has meant unemployment has risen dramatically. Estimates established in April for scenarios where travel bans extend for more than seven months were for US$1.9 billion in lost revenue across the Pacific (SPC, 2020a). Given travel bans now are set to extend beyond this timeframe, economic losses will be even higher. Fiji is particularly vulnerable, with tourism contributing to 40 percent of GDP, employing over 150,000 people, and facing projected losses of up to US$600 million. According to a recent analysis (SPC, 2020a), the contributions of remittances to GDP in 2018 was 40.7 percent in Tonga and 16.4 percent in Samoa. Remittances are important for cushioning economic shocks and play a critical role in household income, given the limited capacity of many Pacific governments to provide cash-based social protection (Edwards, 2020). In Fiji, income from remittances is expected to have reduced by 15 percent for the period April to September 2020 (McClure, 2020), eroding important social protection functions.

Women in the Pacific are potentially more exposed to extreme food system shocks, given their often under-recognized role in the economy (FAO, 2020). The majority of market food vendors operating in the Pacific are women—acting as middle agents between producers and consumers, on top of their traditional roles in household food procurement and preparation (UN Women, 2016). A recent study

by Clissold et al. (2020) found that after extreme cyclones, women play a crucial role in recovering economies and supporting social networks given their role in various parts of value chains. In our study, multiple interviewees noted women in Fiji self-organizing to arrange transport of produce between regions and ensuring incomes continued to flow despite movement restrictions. Our interviews also highlighted that with unemployed urban people moving back to rural households, local women have been exposed to increased household demands and are potentially eating less to accommodate larger households. Recovery strategies seeking to liberate the entrepreneurial skills of women must also address the multiple additional roles they perform in post-crisis response, such that women do not shoulder a disproportionate share of the burdens of recovery and resilience building.

Impacts on ecosystems

During the early days of the pandemic, a surge in demand for localizing food production and increased fresh vegetable production was experienced by many rural communities. Between April and July 2020, increased pressure on rural areas from urban–rural migration was exacerbated. In Tuvalu, the only rural village in the island of Funafuti received new arrivals of people from the capital on a daily basis. Most of the arrivals came in using a new road—nicknamed the "COVID-19 Road"—which was created to enable transport and new housing. These movements of people have led to widespread clearing of land for food production. Recent analysis from Malaita and the Russell Islands in Solomon Islands found rural populations have increased by as much as 7.1 percent (Eriksson et al., 2020; Wale & LMMA Network, 2020). Local fishers in Yandina, Russell Islands, estimated 25–50 percent more fish being caught to service the demands of this growing population, which has resulted in contraventions of existing marine regulations related to size limits for clams, crayfish, trochus, and coconut crabs (Wale & LMMA Network, 2020). It is unclear what the specific long-term impacts of increased pressures in rural areas will be on ecosystems, beyond the immediate observations of increased fishing practices or land clearing, which are likely to have implications for biodiversity, soil health, and erosion, among other things.

In April 2020, as the region enforced COVID-19 restrictions, the Category 5 Tropical Cyclone (TC) Harold impacted Fiji, Solomon Islands, Vanuatu, and Tonga. Some communities in northern Vanuatu have experienced serious food scarcity resulting from the strong winds and localized flooding. The effect of the cyclone combined with COVID-19 control measures to further impact food production in some provinces. The effects of TC Harold in Vanuatu were severe, with 95 percent of homes destroyed on the island of Pentecost, where crop damage ranged from 50 percent to 100 percent, and 27 percent of the population were estimated to have been displaced (Ober & Bakumenko, 2020). With the loss of home gardens and crops, increases in fishing were identified, with 15 out of 23 sites recording an increase in fishing pressure on reefs or near community shore lines (Steenbergen et al., 2020).

Impacts from changing policies and institutions

As a response to the economic impacts described above, public institutions have focused on agricultural incentives, subsidies, and stimulus packages to support existing and new forms of agriculture. Home gardening has been promoted throughout the region as a way of securing immediate vegetable supplies for those able to grow their own food. Common barriers to establishing home gardens, including access to planting material, seeds, and composting, have been partially addressed through various stimulus packages, using agriculture as a social protection measure to generate economic activities. In Fiji, the government's stimulus package distributed 11,602 seedling packages to citizens, focusing on corporate employees who became unemployed due to the COVID-19 crisis. In Solomon Islands, government and farmer organizations have enhanced seed distribution and access via a stimulus package offered to larger-scale agricultural and fisheries operators. Despite these production limitations in peri-urban areas, a recent analysis (PIFON, 2020) found that there has been a surplus in labor, overall food outputs have remained stable, and the drop in demand from international markets and tourists has now created surplus of some foods in domestic markets.

Price fluctuations have varied throughout the region, depending on the supply and availability of food. Reports from Fiji indicate that the price for a whole fish had declined from FJ$45 to FJ$25. The price of pineapples was also down from FJ$5 for a heap to FJ$2.50.[5] Part of the reason for reduced prices has been the surplus of commodities in markets resulting from suppressed hotel demand and more fishing. While this has left more produce available to locals, the types of produce grown for tourists are not always the same as those desired by locals for culturally appropriate nutrition and food security. Complementing our findings on price fluctuations, a study in the Solomon Islands found a doubling in price of commodities outside Honiara. In Malaita, 48 percent of respondents noticed higher prices for rice and 46 percent noticed higher prices for canned tuna (Eriksson et al., 2020). There have been some government responses to manage food prices. For example, in Vanuatu the COVID-19 Food Security Response Plan supported commercial food baskets, where produce from farmers was packaged for urban citizens at affordable prices.

Reduced income has meant some people have had to find new ways of making money—for example, in Tonga there have been reports of new food outlets and informal stalls opening as new businesses in main towns. The lockdowns have also reignited interest in informal bartering systems for e-commerce. In Fiji, the Barter

5 A heap of fruit or single fish is common unit of measurement in Pacific Islands' local markets.

for Better Fiji group established in April 2020 now has over 180,000 members. While not food-specific, the group has enabled non-cash-based product exchanges during the lockdowns.

Human ecology systems analysis

The brief examples above show how COVID-19 has impacted different aspects of food systems, ranging from production to consumption activities. The context of Pacific Island food systems, where agriculture and fisheries continue to play crucial role for everyday livelihoods, meant that institutions and policies had to rapidly support these sectors. Our findings indicate that governments and communities have been swift in adapting to lockdown measures, and narratives of home gardening and focusing on domestic food production to buffer further shocks have gained momentum. However, the long-term economic impacts from the loss of tourism, remittances, and international food markets means that there are long-term risks to livelihoods, and potentially to ecosystems as increased pressure on land and marine systems increases.

To synthesize the various impacts above in the context of a human ecology system, we drew from an existing analytical framework developed by Allen and Prosperi (2016). Their framework helps identify feedbacks between food system levels of exposure, sensitivity, impacts, recovery, and overall resilience to a particular disturbance. We organized the emerging material from our study into these categories to help understand how COVID-19 was impacting different aspects of the food system. Using causal loops as a tool for capturing linkages between system variables (Proust & Newell, 2017), we developed Figure 1 as a representation of key feedback structures and to identify intervention points that would promote both short-term recovery as well as long-term resilience of food systems in the region.

Agriculture, fishing, and rural livelihoods are seen in Figure 1 as core components of recovery for the region, and which can also contribute to culturally appropriate food security and nutrition outcomes, and potentially contribute to reducing the burden of noncommunicable disease in the region. The increased interest in home gardening and a focus on agriculture as an economic recovery strategy can provide immediate opportunities for increasing the supply of essential fresh foods in the region and support culturally embedded healthy eating practices. However, it remains unclear if there will be sufficient adoption of these agricultural practices in the long term, especially for those new to farming and working on previously "idle" land. If the emerging COVID-19 recovery paradigm is one that focuses more on supporting local food systems, this needs to be done in a way that also supports building resilience to extreme climate shocks and sudden food shortages. Efforts to enhance production will need to be embedded in ecological- and climate-sensitive methods, and coupled with innovative business models to support the particular logistics and distribution needs of the region.

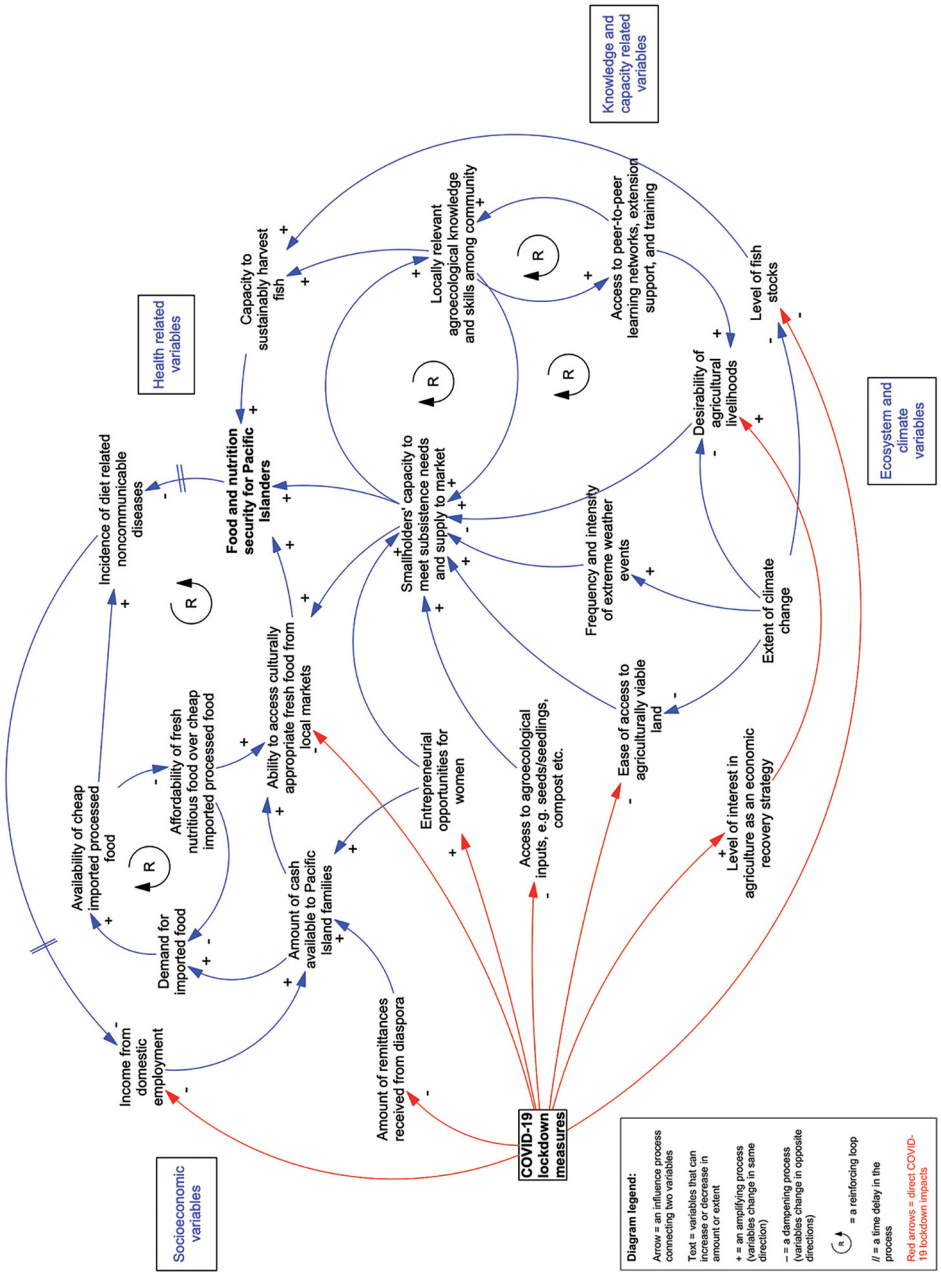

Figure 1. Feedbacks between major food system variables, COVID-19 impacts, and immediate responses.

R = a reinforcing loop.

Source: Authors' representation.

Efforts to enhance and achieve nutrition security create opportunities to support new ways of farming that focus on sustainable practices and include women and youth. This could create greater long-term diversity of farming communities, and hence greater food system resilience. Codesigning such strategies with local women will be important to achieve socially desirable outcomes that avoid women bearing a disproportionate burden of efforts to achieve resilient food and nutrition security.

To ensure the long-term future of food systems in the region, agricultural recovery strategies will also have to ensure equitable economic development. COVID-19 recovery provides an opportunity to redress underlying inequalities and use agriculture as an inclusive economic recovery strategy. This can go some way towards creating spaces for greater food sovereignty, where communities and governments determine their own food production systems that support social inclusion and the sustainable production of culturally appropriate nourishing food. Agriculture and fishing activities can also form part of important social protection and stimulus activities that promote better management of natural resources, livelihoods, and nutritional security.

While COVID-19 continues to have multiple impacts on Pacific food systems, it also provides an opportunity to reshape how we frame our research and practice. As we continue to learn and understand how food systems have responded to COVID-19 and other disruptions, systems thinking tools and a human ecological perspective can support the identification and development of interventions that simultaneously assist with recovery and address existing health problems and structural inequalities, while building resilience to future food system risks.

Acknowledgements

This study was supported by the Australian Centre for International Agricultural Research, contract CS/2020/146. We thank all the people involved in continuing to support food security and recovery during COVID-19, and the time and different types of input provided by participants.

References

ADB. (2020). *Food security in Asia and the Pacific amid the COVID-19 pandemic*. Asian Development Bank. doi.org/10.22617/brf200176-2

Allen, T., & Prosperi, P. (2016). Modeling sustainable food systems. *Environmental Management*, 57(5), 956–975. doi.org/10.1007/s00267-016-0664-8

Altieri, M. A., & Nicholls, C. I. (2020). Agroecology and the reconstruction of a post-COVID-19 agriculture. *The Journal of Peasant Studies*, 47(5), 881–898. doi.org/10.1080/03066150.2020.1782891

Andrew, N. L., Bright, P., de la Rua, L., Teoh, S. J., & Vickers, M. (2019). Coastal proximity of populations in 22 Pacific Island countries and territories. *PLOS ONE*, 14(9), e0223249. doi.org/10.1371/journal.pone.0223249

Barnett, J. (2011). Dangerous climate change in the Pacific Islands: Food production and food security. *Regional Environmental Change*, 11(1), 229–237. doi.org/10.1007/s10113-010-0160-2

Béné, C. (2020). Resilience of local food systems and links to food security—A review of some important concepts in the context of COVID-19 and other shocks. *Food Security*, 12, 805–822. doi.org/10.1007/s12571-020-01076-1

CARE. (2020). *Rapid gender analysis of COVID-19 Pacific region* [Version 1, March 26]. CARE International. www.care.org.au/rapid-gender-analysis-covid-19/

Charlton, K. E., Russell, J., Gorman, E., Hanich, Q., Delisle, A., Campbell, B., & Bell, J. (2016). Fish, food security and health in Pacific Island countries and territories: A systematic literature review. *BMC Public Health*, 16, 285. doi.org/10.1186/s12889-016-2953-9

Clissold, R., Westoby, R., & McNamara, K. E. (2020). Women as recovery enablers in the face of disasters in Vanuatu. *Geoforum*, 113, 101–110. doi.org/10.1016/j.geoforum.2020.05.003

Edwards, R. (2020). Bubble in, bubble out: Lessons for the COVID-19 recovery and future crises from the Pacific. *World Development*, 135, 105072. doi.org/10.1016/j.worlddev.2020.105072

Eriksson, H., Ride, A., Boso, D., Sukulu, M., Batalofo, M., Siota, F., & Gomese, C. (2020). *Changes and adaptations in village food systems in Solomon Islands: A rapid appraisal during the early stages of the COVID-19 pandemic*. WorldFish. hdl.handle.net/20.500.12348/4195

FAO. (2020). *Gendered impacts of COVID-19 and equitable policy responses in agriculture, food security and nutrition* [Policy brief]. Food and Agriculture Organization. www.fao.org/policy-support/tools-and-publications/resources-details/en/c/1276740/

Farrell, P., Thow, A. M., Wate, J. T., Nonga, N., Vatucawaqa, P., Brewer, T., … Andrew, N. L. (2020). COVID-19 and Pacific food system resilience: Opportunities to build a robust response. *Food Security*, 12, 789–791. doi.org/10.1007/s12571-020-01087-y

Gillett, R. (2016). *Fisheries in the economies of Pacific Island countries and territories*. The Pacific Community (SPC). www.spc.int/sites/default/files/resources/2018-05/Gillett_16_Benefish.pdf

Global Nutrition Report. (2020). *Country nutrition profiles* [Data set]. Retrieved July 10 and November 6, 2020, from globalnutritionreport.org/resources/nutrition-profiles/

IHME. (2018). *Global burden of disease compare* [2017 Data set]. Institute for Health Metrics and Evaluation. Retrieved July 12, 2020, from vizhub.healthdata.org/gbd-compare

McClure, H. (2020, July 22). *COVID-19—The Pacific response: 22 July*. Asia & The Pacific Policy Society. www.policyforum.net/covid-19-the-pacific-response-22-july/

Ober, K., & Bakumenko, S. (2020). *A new vulnerability: COVID-19 and Tropical Cyclone Harold create the perfect storm in the Pacific* [Issue brief]. Refugees International. www.refugeesinternational.org/reports/2020/6/1/a-new-vulnerability-covid-19-and-tropical-cyclone-harold-create-the-perfect-storm-in-the-pacific

PIFON. (2020). *COVID-19 Overview: Expected impacts in the Pacific*. Pacific Island Farmer Organizations. pacificfarmers.com/resource/covid-19-overview-expected-impacts-in-the-pacific/

Plahe, J. K., Hawkes, S., & Ponnamperuma, S. (2013). The corporate food regime and food sovereignty in the Pacific Islands. *The Contemporary Pacific*, 25(2), 309–338. doi.org/10.1353/cp.2013.0034

Proust, K., & Newell, B. (2020). *Constructing influence diagrams and causal loop diagrams* [Student guide]. Fenner School of Environment & Society, The Australian National University. hdl.handle.net/1885/201846

Robins, L., Crimp, S., van Wensveen, M., Alders, R. G., Bourke, R. M., Butler, J., … Webb, M. (2020). *COVID-19 and food systems in the Indo-Pacific: An assessment of vulnerabilities, impacts and opportunities for action* (ACIAR Technical Report TR096). Australian Centre for International Agricultural Research. aciar.gov.au/publication/covid-19-and-food-systems

Savary, S., Akter, S., Almekinders, C., Harris, J., Korsten, L., Rötter, R., … Watson, D. (2020). Mapping disruption and resilience mechanisms in food systems. *Food Security*, 12, 695–717. doi.org/10.1007/s12571-020-01093-0

SPC. (2014). *The Pacific Youth Development Framework 2014–2023*. Secretariat of the Pacific Community. www.spc.int/sites/default/files/resources/2018-05/Pacific_Youth_Development_Framework.pdf

SPC. (2015). *A new song for coastal fisheries—pathways to change: The Noumea strategy*. The Pacific Community (SPC). coastfish.spc.int/component/content/article/461-a-new-song-for-coastal-fisheries.html

SPC. (2020a). *Economic and social vulnerability indicators in Pacific Island countries and territories* [Data set]. Statistics and Development Division (SDD), The Pacific Community (SPC). Retrieved June 5, 2020, from sdd.spc.int/disasters-data/covid-19

SPC. (2020b). *Pacific Island populations 2020*. Statistics for Development Division, the Pacific Community (SPC). sdd.spc.int/digital_library/pacific-islands-2020-populations-poster

Steenbergen, D. J., Neihapi, P. T., Koran, D., Sami, A., Malverus, V., Ephraim, R., & Andrew, N. (2020). COVID-19 restrictions amidst cyclones and volcanoes: A rapid assessment of early impacts on livelihoods and food security in coastal communities in Vanuatu. *Marine Policy*, 121, Article 104199. doi.org/10.1016/j.marpol.2020.104199

UN Women. (2016). *Markets for change Vanuatu*. asiapacific.unwomen.org/en/digital-library/publications/2016/02/markets-for-change-vanuatu

UNESCAP. (2018). *Ocean cities of the Pacific Islands: Policy brief #1 The ocean and the city*. United Nations Economic and Social Commission for Asia and the Pacific. www.unescap.org/resources/ocean-cities-policy-brief-1-ocean-and-city

van der Ploeg, J. D. (2020). From biomedical to politico-economic crisis: The food system in times of Covid-19. *The Journal of Peasant Studies*, 47(5), 944–972. doi.org/10.1080/03066150.2020.1794843

Wale, J., & LMMA Network. (2020). *COVID-19 impacts on fishing and coastal communities—Update #2: Russell Islands, Solomon Islands*. Locally-Managed Marine Area Network. lmmanetwork.org/wp-content/uploads/2020/08/LMMA-Network-and-Wale.-Covid-Update-2-Russell-Islands.-30.05.2020.pdf

WFP. (2020). *Macro analysis of COVID-19—threats to food security and livelihoods in Asia and the Pacific*. World Food Programme. www.wfp.org/publications/macro-analysis-covid-19-threats-food-security-and-livelihoods-asia-and-pacific

Commonsense Preparedness for Uncommon Adversities: Lessons from Facing COVID-19 in Mexico, from a Human Ecology Perspective

Federico Dickinson[1]
Department of Human Ecology, Cinvestav-Mérida, Yucatán, Mexico

María Eloísa Dickinson Bannack
Mexican Faculty of Medicine, La Salle University, Mexico City

Hugo Azcorra
Centro de Investigaciones Silvio Zavala, Universidad Modelo, Yucatán, Mexico

Teresa (Tere) Castillo-Burguete
Department of Human Ecology, Cinvestav-Mérida, Yucatán, Mexico

Nina Méndez-Domínguez
Hospital Regional de Alta Especialidad de la Península de Yucatán

Abstract

In 2020, while living through unprecedented health outcomes from the COVID-19 epidemic in Mexico, a human ecology perspective provides us with an unconventional way to analyze the role of the mediate effects of Mexican nutritional impacts and their prevalence in COVID-19-related mortality. According to official data, by the end of September 2020, mortality by COVID-19 surpassed 76,000 confirmed deaths across Mexico; by August 2020, COVID-19 mortality was lower in the center of the country where hospital infrastructure and human resources such as specialized health personnel are concentrated. This regional difference corresponds to the serious socioeconomic inequality characteristic of Mexican society, where southeastern states are poorer. A human ecology perspective allows us to identify and discuss similarities and discrepancies between the prevalence of obesity distribution and COVID-19 lethality across Mexico, and ultimately to provide our thoughts on the preparedness of Mexican society, with epidemiological evidence and a preventive, transdisciplinary scope.

Keywords: COVID-19, human ecology, lethality, Mexico, obesity, prevalence

1 Corresponding author: federico.dickinson@cinvestav.mx.

Introduction

Every day, people and their societies are both protagonists and spectators of the dynamic interactions between their own biology and the predominant norms, traditions, and customs that take place in a complex environment where the only constant is continuous change. Any society's main resource is its own population, not only including adult women and men, but also the elderly, youth, and children. People shape societies with their unique characteristics, and in that uniqueness, certain traits may coexist across societies, as people produce and reproduce behaviors and customs throughout the world and across time and space. This reproduction is both biological and sociocultural: biological through gestation, upbringing, and education, in the broadest sense, of the individuals who will replace those who die; and sociocultural through the maintenance of strong social bonds and institutions such as family, community, commerce, and religion. This biological and sociocultural reproduction occurs in a natural environment, within one or more ecosystems. Through daily life, members of a society or culture produce and reproduce customs and traditions. Cultural production and reproduction includes health and healthcare avenues as part of the sociocultural system.

Azcorra and Dickinson (2020) understand human ecology as the study of complex interactions between ecosystems, sociocultural systems, and *Homo sapiens*' biology. These interactions always occur in a certain place and time (Figure 1) and result in a certain level of health and well-being. If any of the aforementioned elements have suboptimal conditions, the wellbeing of society itself is afflicted. Specifically, when the biological status of a society's individuals is healthy, the health impacts of events, such as pandemics, that exert pressure on ecosystems and sociocultural systems will be lessened. On the contrary, in the face of a deteriorated biological state, impacts on people's health and well-being will be greater, in terms of diseases and fatalities.

The current epidemiological context of world human population and global environmental changes suggest that humanity will face new pandemics of known or unknown pathogens, and that any society must be prepared—with appropriate healthcare personnel, in terms of quantity and capabilities, and robust health infrastructure, but primarily with a healthy population. Obesity prevalence may partially explain the high lethality rates of COVID-19 in Mexico compared to other countries. From these premises, the aims of this article are to estimate mortality due to COVID-19 that can be attributable to the secondary or direct effects of obesity on the Mexican population, and to describe the state cluster prevalence of obesity and lethality rates as well as hospital mortality.

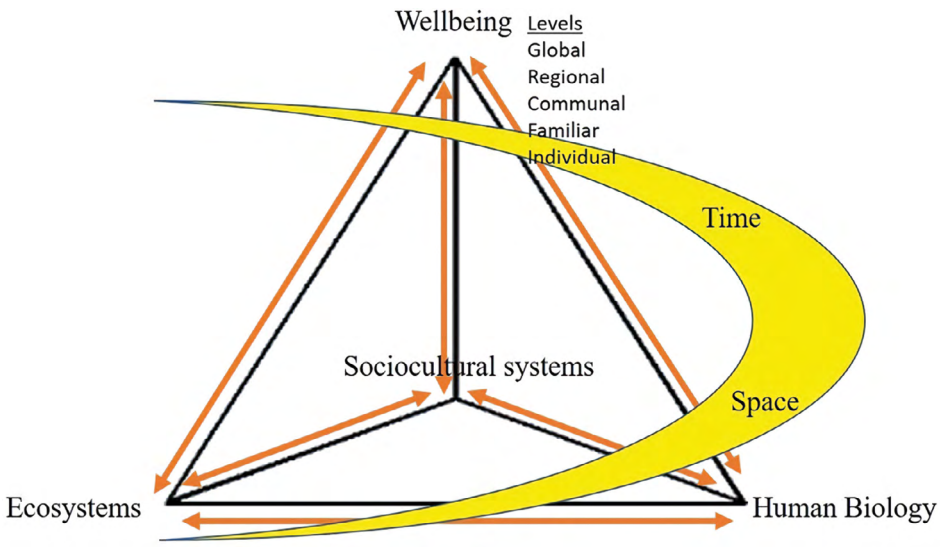

Figure 1. Conceptualization of human ecology showing the interactions between three subsystems.

Source: Azcorra and Dickinson (2020, p. 2).

Background

COVID-19's severe manifestations generate a cascade of detrimental changes in human physiology that can directly derive from respiratory system alterations, but there are also complex mechanisms involving every system in the human body (Yang X. et al., 2020). When an individual with underlying health problems is afflicted by an acute infection due to COVID-19, he/she may be at higher risk for developing severe consequences, including death (Tamara & Tahapary, 2020). In a population where the burden of obesity-related diseases is widespread enough to affect a large proportion of individuals, severe and fatal outcomes are expected to have a greater impact. In their 2018 report on the *State of Food Security and Nutrition in the World*, the Food and Agriculture Organization (FAO) of the United Nations asserted that obesity among Mexico's adult population reached, in 2016, 24.3 million people. Mexico now ranks sixth in obesity among all 150 countries in the world. In this sense, countries such as Mexico may face a more trying pandemic (FAO et al., 2018). From a human ecology perspective, where environment may be understood in a broad sense when it comes to health and well-being, access to and availability of healthcare infrastructure are fundamental environmental resources within socio-administrative and political constraints regarding its use and distribution.

In studies from across the world, underlying chronic diseases (also known as comorbidities), obesity, and smoking have been identified as prognostic factors associated with adverse COVID-19 outcomes (Espinosa et al., 2020). Political discourse in Mexico, since the arrival of the first confirmed case on February 28 (Mendez-Dominguez et al., 2020), has stressed the disadvantages of COVID-19 infection compounded by underlying chronic diseases, with emphasis on obesity, and that the aforementioned constraints may also explain to some degree Mexico's high mortality rates. At some point, this continuous discourse has seemed to indicate that citizens' individual health conditions are a main determinant of COVID-19 mortality in Mexico (Secretaría de Salud, 2020a), but although individual biological aspects such as genetics and heredity are important for the presence of diseases in the population, the factors most strongly associated with disease have to do with the social and environmental aspects that determine living conditions and styles of life of individuals and groups, including their eating habits. The fact that health is, always, a consequence of the complex interactions depicted in Figure 1 calls for a human ecology approach to factors correlated with nutritional status and risk for obesity and its proximate or distant outcomes.

Studies from different nations have estimated lethality from comorbidities in regard to hospitalized COVID-19 patients, finding that habits such as smoking and underlying diseases including obesity, hypertension, and diabetes, as well as respiratory, cardiovascular, renal, and immune system diseases, involve a greater risk for adverse outcomes. In this case, as in other health issues, individuals and social groups with poor health are more vulnerable to any environmental changes, including new pathogens.

Obesity and COVID-19 in Mexico

Obesity can be defined in pathophysiological terms as a chronic disease derived from the increased storage of energy as lipocytes, causing both hypertrophy and hyperplasia of the lipocytes with a consequent increase in adipose tissue volume, with free fatty acids impacting endocrine and mechanical function. Dyspnea can derive from impaired vital breathing capacity, even with increased abdominal pressure (Bray, 2003). Obesity over time facilitates the onset of diseases such as hypertension and diabetes, as part of a metabolic syndrome (OECD, 2017).

Rates of excess body weight (overweight and obesity) in Mexico, both in adults and children, are among the highest in the world. Official reports indicate that 36 percent of children and youth between ages 6 and 19 have excess body weight, and that, for adults, 73 percent of men and 77 percent of women meet criteria as overweight/obese (Instituto Nacional de Salud Pública, n.d.-a). Several sociocultural and political factors such as globalization, poverty, and poor investment in health education have shaped a food environment characterized by Mexican families'

increased dependence on foods with high caloric content and poor nutritional value, which impacts the nutritional and health status of the population in urban and rural contexts. In less favored socioeconomic contexts, excess weight and obesity coexist with chronic malnutrition, generating a cascade of complex biological processes that increase susceptibility to obesity from early stages of development and spread phenotypic and metabolic traits between generations. Obesity plays a determining role in the presence of cardiometabolic diseases. By 2018, it was estimated that nearly 9 million Mexicans lived with a diagnosis of type 2 diabetes mellitus and an unconfirmed proportion of people live unknowingly with this disease. Moreover, nearly 20 percent of Mexicans older than 20 live with hypertension. In recent decades, this epidemiological profile has exerted significant pressure on the country's health system in terms of human resources, materials, and infrastructure.

In Mexico, as of July 30, 2020, COVID-19 in-hospital mortality was 33.5 percent (Carrillo et al., 2020) and included both patients with (53 percent) and without comorbidities; 23 percent of all hospitalized patients were obese. Overall, COVID-19 lethality (among non-severe and severe cases) surpassed 12 percent for patients with and without comorbidities, both ambulatory and under hospital management.

Therefore, understanding the role of such differences in mortality is pertinent in order to prepare Mexican society, its health system, and its citizens with preventive behaviors that may help reduce the adverse impact of possible COVID-19 recurrences and foresee any other eventual emergent human infections.

Material and methods

This is a retrospective study, based on open-access datasets from COVID-19 Epidemiological Surveillance from the General Directorate of Health Information (DGIS), and other official Mexican sources (Secretaría de Salud, 2020a, 2020b; Conapo,[2] 2018). All information was anonymized, obtained from open access digital resources, and transformed into variables for further statistical analysis.

From hospitalization records, we obtained sociodemographic information of each patient, and the type and number of comorbidities, if any. Hospital mortality, here presented in percentages, was obtained from patients' conditions at discharge and considered as caused by COVID-19 when the primary diagnosis was coded as U07.1, meaning "due to COVID-19" according to the International Diseases Coding System.

2 Consejo Nacional de la Población [National Council for Population] (Conapo).

General COVID-19 lethality by state was obtained by accounting for confirmed cases multiplied by 100,000 inhabitants and divided by the population size of each Mexican state, when the primary diagnosis was coded as U07.1. Obesity prevalence by state was determined using height and weight of adult participants (aged >18) from the last National Health and Nutrition Survey (Instituto Nacional de Salud Pública, n.d.-a) to calculate Body Mass Index (BMI), and all cases with BMI ≥30 were coded as obese. Hospital mortality due to COVID-19 was employed for descriptive purposes, while general COVID-19 lethality by state was analyzed as a dependent variable in separate Poisson regression models, with average BMI and obesity prevalence by state cluster as independent variables. For statistical significance, a *p*-value <0.05 was considered significant, while lethality rate ratios were compared to 1.00 as a reference value, where significant values <1.00 were indicators of protective and >1.00 as increased lethality. Post hoc tests were performed to assess goodness of fit. All statistical analysis was performed using Stata 15 software. Maps illustrating distribution of dependent and independent variables are included.

Results

The Ensanut survey sample (Instituto Nacional de Salud Pública, n.d.-b) included 8,446 participants (with 65 percent women) aged >18, including complete anthropometric information. All 32 states were represented in the analysis. The Ensanut 2018 sample, representative of the Mexican population, included 3,128 individuals with a BMI of ≥30kg/m^2 (obesity), representing 37.02 percent of all adult participants, with a prevalence by sex of 41.72 percent among females and 28.40 percent among males. Average BMI was significantly higher for women (28.74±.079) than for men (26.95±.093) (Figure 2). According to epidemiological data, by the end of September 2020, mortality by COVID-19 surpassed 76,000 confirmed deaths, including ambulatory and hospitalized patients (Secretaría de Salud, 2020b); COVID-19 mortality is lower in the center of the country, surrounding the capital city, where hospital infrastructure and human resources such as specialized health personnel are concentrated (Figure 3), corresponding to the serious socioeconomic inequality characteristic of Mexican society.

Figure 2. Prevalence distribution of obese adult population (BMI≥30kg/m²).

Source: Authors' summary, based on National Health and Nutrition Survey (Instituto Nacional de Salud Pública, n.d.-a).

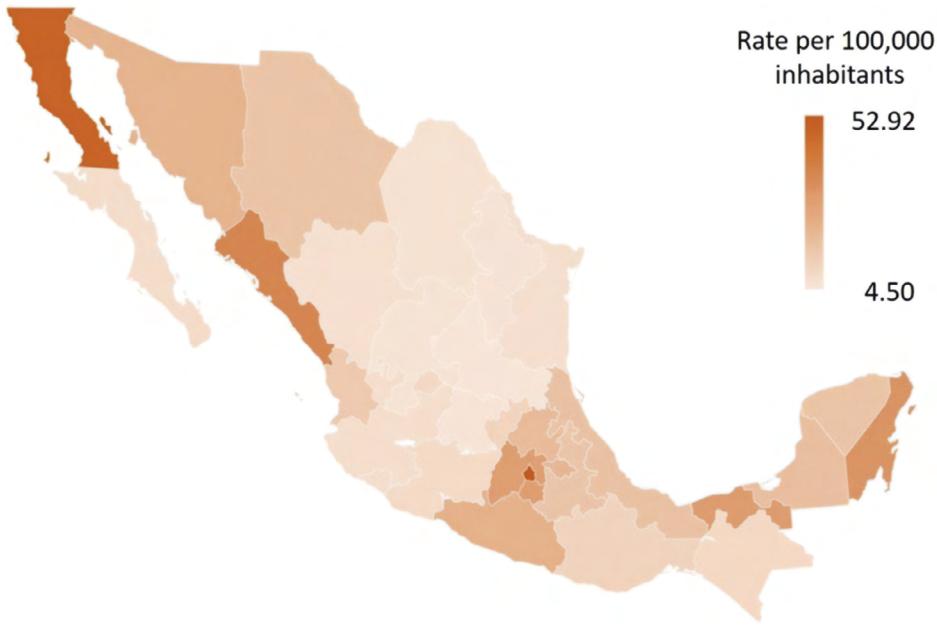

Figure 3. COVID-19 mortality rate per 100,000 inhabitants, as of July 30, 2020.

Source: Authors' summary (see 'Material and methods' for further details).

Nationwide average obesity prevalence, average BMI, mortality, and hospital mortality due to COVID-19 are presented in Table 1.

Table 1. Descriptive statistics regarding anthropometric status and death frequency due to COVID-19 in the 32 Mexican States.

Variable	Mean/percentage	Standard deviation	95% confidence intervals	
Hospital mortality (%)	33.62	6.32	18.60	47.74
Mortality rate*	17.18	12.67	4.50	52.93
Obesity prevalence (%)	40.63	49.90	0.00	100.00
Mean BMI#	28.57	5.89	17.16	38.96

* Mortality rate was calculated by 100,000 inhabitants according to population projections for mid-2020 decade.

BMI: Body Mass Index = weight (kg) ÷ height (m^2).

Source: Authors' summary (see 'Material and methods' for further details).

Lethality rate variability was significantly associated with the most recent obesity prevalence in each state, indicating a direct association between lethality and obesity across Mexican states (Table 2). Post hoc tests ensured goodness of fit with p values of 0.20.

Table 2. Poisson regression indicating association between state lethality rate ratio due to COVID-19 per 100,000 inhabitants and anthropometrics of the state population in Mexico as of July 30, 2020.

State lethality	LRR	Standard error	Z	*P*	95% confidence interval	
Obesity prevalence	1.82	0.16	7.00	<0.001	1.54	2.16
Average BMI#	1.05	0.01	5.88	<0.001	1.03	1.06
Post hoc test =	Deviance goodness of fit = 36.09 = 0.2051				Pseudo R2 = 0.1231	

BMI: Body Mass Index = weight (kg) ÷ height (m2); LRR: lethality rate ratio.

Source: Authors' summary.

Discussion

The Mexican population is largely afflicted by obesity and its related proximate and distant health consequences, as we have mentioned above. From our understanding, this fact is a consequence of a deep imbalance in the interactions between ecosystems and sociocultural systems, reflected in the biological status of the Mexican population (Figure 1). Such imbalance increases the vulnerability of population not only to known disease agents, but to new, unknown, pathogens such as SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2, the virus that causes COVID-19),

to which no human population had immunological experience. This great challenge must teach us, from a human ecology perspective, how to face future contingencies similar to this one.

In their recent systematic review, Tamara & Tahapary (2020) found that obesity is a risk factor for COVID-19 infection and the severity of COVID-19 infection in populations from several geographical regions, while Carrillo et al. (2020) found, in the analysis of nearly 70,000 cases of hospitalized patients diagnosed with COVID-19 in Mexico, that obesity was not, in itself, a predictor of death, but that it did increase the risk for other outcome severity indicators. The discrepancy from Carrillo et al. (2020) can be explained by their analysis of only hospitalized patients, while our study reflects a general population analysis stratified by state, including mortality in relation to generalized state population and not only from hospitalized individuals, since mortality has also occurred outside hospital premises.

We have identified how lethality rates across Mexico can be marginally, but significantly, explained by state obesity prevalence, which has proven to explain 12 percent of the variability in deaths across states. Nevertheless, we would be remiss not to mention that lethality is a complex phenomenon that, from a human ecology perspective, may also be understood in terms of environmental and social correlations that, for this case, may be represented by access to and availability of health infrastructure resources and the socio-administrative/sociopolitical decisions on how to employ them.

In this sense, we can certainly assert that environmental and social determinants need to be objectively evaluated to critically analyze how to find better strategies for improving access to, availability of, and use of health infrastructure resources. On the other hand, we may also seek our own opportunities for improving our lifestyles and health profile as a population and nation.

One main lesson taken from the COVID-19 epidemic in Mexico is at the individual level, and another is at the societal level. In the first case, we have learned once again the importance of self-care, healthy lifestyles, and food choices for good health; in the second case, we must strive as a society to eliminate or, at least, reduce the current poverty rate (42 percent, Coneval,[3] 2019) and the economic and social inequality of Mexican society (OECD, 2020)—structural elements that jeopardize human biology and, thus, human well-being (Figure 1). We need also to ensure that governmental public health policies, and social and economic measures, inhibit and dismantle the current obesogenic environment in which Mexican population

3 Consejo Nacional de Evaluación de la Política de Desarrollo Social [National Council for the Evaluation of Social Development Policy] (Coneval).

lives. It is necessary to hold national and transnational companies accountable for producing, distributing, and selling ultra-processed foods and beverages with aggressive advertising campaigns, many targeting children and youths.

If Mexican society takes advantage of these two lessons, it will surely be in a much better position to face future pandemics, whenever they arrive.

References

Azcorra, H., & Dickinson, F. (2020). Introduction. In: H. Azcorra & F. Dickinson (Eds.), *Culture, environment and health in the Yucatán Peninsula: A human ecology perspective* (pp. 1–8). Springer. doi.org/10.1007/978-3-030-27001-8_1

Bray, G. A. (2003). Risks of obesity. *Endocrinology and Metabolism Clinics of North America*, 32(4), 787–804. doi.org/10.1016/s0889-8529(03)00067-7

Carrillo, G., Dominguez, N. M., Zaldivar, K. D. S., Perez, A. R., Morales, M. A., Koh, O. C., & Baeza, A. A. (2020). *Clinical course and severity outcome indicators among COVID 19 hospitalized patients in relation to comorbidities distribution Mexican cohort*. medRxiv. doi.org/10.1101/2020.07.31.20165480

Conapo. (2018). *Proyecciones de población de México y de las Entidades Federativas, 2016–2050 y Conciliación Demográfica de México, 1950–2015* [Population projections for Mexico and the Federal Entities, 2016–2050, and reconciliation with demographic records, 1950–2015]. Consejo Nacional de la Población (Conapo) [National Council for Population]. www.gob.mx/conapo/acciones-y-programas/conciliacion-demografica-de-mexico-1950-2015-y-proyecciones-de-la-poblacion-de-mexico-y-de-las-entidades-federativas-2016-2050

Coneval. (2019). *Diez años de medición de pobreza multidimensional en México: Avances y desafíos en política social* [Ten years of multidimensional poverty measurement in Mexico: Advances and challenges in social policy]. Consejo Nacional de Evaluación de la Política de Desarrollo Social (Coneval) [National Council for the Evaluation of Social Development Policy]. www.coneval.org.mx/Medicion/Paginas/PobrezaInicio.aspx

Espinosa, O. A., Zanetti, A. D. S., Antunes, E. F., Longhi, F. G., Matos, T. A. D., & Battaglini, P. F. (2020). Prevalence of comorbidities in patients and mortality cases affected by SARS-CoV2: A systematic review and meta-analysis. *Revista do Instituto de Medicina Tropical de São Paulo* [Journal of the São Paulo Institute of Tropical Medicine], 62, e43. doi.org/10.1590/s1678-9946202062043

FAO, IFAD, UNICEF, WFP, & WHO. (2018). *The state of food security and nutrition in the world 2018: Building climate resilience for food security and nutrition*. Food and Agriculture Organization of the United Nations. www.fao.org/3/i9553en/i9553en.pdf

Instituto Nacional de Salud Pública [Institute of Public Health]. (n.d.-a). *Ensanut 100K 2018: Encuesta Nacional de Salud y Nutrición* [Ensanut 100K 2018: National health and nutrition survey] [Data set]. Secretaría de Salud: Instituto Nacional de Salud Pública. ensanut.insp.mx/encuestas/ensanut100k2018/descargas.php

Instituto Nacional de Salud Pública [Institute of Public Health]. (n.d.-b). *Ensanut 2018: Encuesta Nacional de Salud y Nutrición* [Ensanut 2018: National health and nutrition survey] [Data set]. Secretaría de Salud: Instituto Nacional de Salud Pública. ensanut.insp.mx/encuestas/ensanut2018/descargas.php

Mendez-Dominguez, N., Alvarez-Baeza, A., & Carrillo, G. (2020). Demographic and health indicators in correlation to interstate variability of incidence, confirmation, hospitalization, and lethality in Mexico: Preliminary analysis from imported and community acquired cases during COVID-19 outbreak. *International Journal of Environmental Research and Public Health*, 17(12), 4281. doi.org/10.3390/ijerph17124281

OECD. (2017). *Obesity update 2017*. Organisation for Economic Co-operation and Development. www.oecd.org/els/health-systems/Obesity-Update-2017.pdf

OECD. (2020). *¿Cómo va la vida en México?* [How's life in Mexico?]. In *How's life? 2020: Measuring well-being*. OECD Publishing. doi.org/10.1787/b4d2bb29-en

Secretaría de Salud [Health Secretariat]. (2020a). *Información referente a casos COVID-19 en México* [Information on COVID-19 cases in Mexico] [Data set]. Dirección General de Información en Salud (DGIS) [General Directorate of Health Information]. datos.gob.mx/busca/dataset/informacion-referente-a-casos-covid-19-en-mexico

Secretaría de Salud [Health Secretariat]. (2020b, September 30). *Coronavirus (COVID-19) Informe tecnico diario Mexico: Agosto 30, 2020* [Coronavirus (COVID-19) daily technical statement September 30, 2020]. Dirección General de Epidemiología (DGIS) [General Directorate of Epidemiology]. www.gob.mx/cms/uploads/attachment/file/581797/Comunicado_Tecnico_Diario_COVID-19_2020.09.30.pdf

Tamara, A., & Tahapary, D. L. (2020). Obesity as a predictor for a poor prognosis of COVID-19: A systematic review. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, 14(4), 655–659. doi.org/10.1016/j.dsx.2020.05.020

Yang, X., Yu, Y., Xu, J., Shu, H., Liu, H., Wu, Y., … & Wang, Y. (2020). Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: A single-centered, retrospective, observational study. *The Lancet—Respiratory Medicine*, 8(5), 475–481 doi.org/10.1016/s2213-2600(20)30079-5

COVID-19: Science, Politics, Media, and the Public—A Systemic View

Felix Tretter[1]
Bertalanffy Center for the Study of Systems Science, Vienna, Austria

Angela Franz-Balsen
Deutsche Gesellschaft für Humanökologie, Berlin, Germany

Abstract

The COVID-19 pandemic is taken as an opportunity to analyze the role and performance of medical science, the political acceptance of scientific advice, and the importance of mass media as the intermediate link in the "information supply chain." We demonstrate the confusion about indicators of the "dangerousness of the virus SARS-Cov2" by number of deaths. The elective use of one of various possible indicators implies different assessments of risk and, in consequence, different public health measures.

Results and discussion show that COVID-19 pandemic management uncovered the lack of inter- and transdisciplinary culture in medicine and public health, as well as the lack of a conceptual framework. In a systemic human ecological view the framework would be expanded, including the link between ecology and medicine. A perspective of a "human ecology of health" (EHO, 2020) could improve multidimensional understanding of the pandemic and enable connections to other systemic approaches and to sustainability research.

Keywords: corona crisis, public health, medical knowledge integration, systemic ecology of health

Introduction

COVID-19 is basically a zoonotic disease, as SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2, the virus that causes COVID-19) stems from natural ecosystems that obviously have been overexploited by the human sphere (Cazzolla Gatti, 2020). In this view, the COVID-19 crisis is essentially a *human ecological problem* (Tretter et al., 2020). Right now, these ecological aspects of COVID-19 are superseded by the medical discourse, although many experts from different disciplines

1 Corresponding author: felix.tretter@bsss.org.

have warned of pandemics induced by viruses for years (Morse et al., 2012). For this reason, the conceptual integration of medical and ecological aspects is discussed here with focus on medical science and media-based communication. The COVID-19 pandemic shows the relevance of medicine and science in general as guidance for politics, an issue that has frequently been discussed regarding environmental climate policies ("evidence-based politics"). Currently, societal legitimization and responsibility of science is extremely prominent, as during this pandemic political decisions are based on medical advice, even though scientists—being confronted with an unknown, highly "virtual," and invisible new phenomenon—were not able to offer certainties on how to understand COVID-19 and control the pandemic appropriately. Coping with uncertainty is an essential element of managing disturbances, and was one of the major challenges in COVID-19 management at all levels.

Guidelines for action are rooted in (medical) science, and this medical knowledge is processed by politics and presented by mass media to the public. Finally, it is used to orient people's behavior. This "information supply chain" is rooted in medical science and should be consistent, comprehensive, integrative, and sufficiently coherent in order to enable preventive health behavior of the population (distancing, mask-wearing, etc.). Searching for verified information was a key issue, especially as the World Health Organization has described an "infodemic" as a second pathogenic level of the disease: "an overabundance of information, both online and offline. It includes accurate information as well as mis- and disinformation" (WHO, 2020c; see also WHO, 2020b; UNESCO, 2020).

In addition, the COVID-19 pandemic and its management not only coincides with the climate crisis, it also enhances risks for a new economic and financial crisis, enforces the migration crisis, etc. This extensive spectrum of effects of the pandemic demands a broad scope of integrated scientific knowledge in order to foster evidence-based and rational politics. As medical science plays a central role in handling the pandemic, some hidden questions of philosophy of science pop up (Bunge, 1998; Solomon, 2015): Who knows the truth and the appropriate answers to the various societal COVID-19 challenges? Are medical sciences (and their "auxiliary sciences") valid enough? Are the side effects of public health measures on the economy, human rights, etc. considered appropriately?

The so-called medialization of science (Heckl, 2020; Peters et al., 2008) was a necessary step in the information supply chain. Medialization of politics and of science were in fact parallel processes during the pandemic: both politics and medical science/public health needed the fast and far-reaching channels of mass media to have daily or even hourly access to the public. Media and journalists all over the world have responded as a means of science communication, health communication, and risk communication (Arinze-Umobi & Chiweta-Oduah, 2020; Balarabe, 2020) and sometimes—where freedom of press is guaranteed—as critical

commentators of national political decision-making (UNESCO, 2020). These processes confirm the sociological view of societies being essentially communication systems (Luhmann, 1984/2012).

Here, we try to touch on some of the manifold challenges a knowledge society has to meet in order to guarantee a well-functioning information supply chain on the pandemic. The central example in our study is the risk of death (mortality/fatality rates) from COVID-19.

Methods

Focusing on the communicative aspects of crisis management, we present a rough sketch by a selective, comparative, and qualitative assessment of perception, evaluation, and management of the COVID-19 pandemic. We focus on Europe and on the spring period (from March 1 to May 25, 2020) because during summer (June till August) a second period occurred due to travelling activities. Again, internationally varying lockdowns and border closures were ordered. In fall 2020 (the third period), most European countries exhibited nearly the same national intensity of the epidemic as in spring.

The available data for empirical research is soft, because of severe differences in indication of testing, as well as in the time elapsed between taking samples and reporting test results to the subjects, to the local authorities, and to federal institutions. Finally, the time of day of reporting—8 AM, 2 PM, or 5 PM—changed over time, resulting in differences of reported numbers in international dashboards. For instance, the Robert Koch Institute in Germany had to revise published data several times and had to admit intrinsic variations of daily reported new infected cases and finally decided to report in "nowcasting mode," which estimates the "real" point of time when the tests were positive (RKI, 2020a). This is important for calculation of the reproduction number R_{eff}, which indicates the number of individuals infected by one infected individual. This kind of careful data management is not practiced in all other countries. For this reason, and because we only aim at an exploratory study, we do not use official higher order databases, as provided by the European Union or WHO. All those secondary databases might suffer from these failures of primary data acquisition. In consequence, the number of new infected per day can differ by around +/–10 percent between reporting institutions, but not in the range of multiples of the reference value. For convenience we used the "dashboard" of country data available at Worldometer (Worldometer, 2020), after cross-checking it with other dashboards (AGES, 2020; RKI, 2020b; WHO, 2020a). For our comparison, we selected European countries with widely differing medical advice and management strategies regarding public health and public order measures: Austria (A) and Germany (GER) vs. Sweden (S) and United Kingdom (UK).

We also analyzed reports from the scientific community, examples of mass media reporting, and examples of journalists' inner professional discourses (see websites of e.g., Science Media Centre, UK; DJU (Deutsche Journalisten Union); WPK (Die Wissenschaftsjournalisten), Medien Doktor Gesundheit) in order to describe the challenges and problems of credible and verified data communication towards decision-makers and the public. Focus of our analysis is the meaning of "dangerousness" of the virus, measured by the risk of death if infected.

Results

Basically, we see severe conceptual differences, terminological fallacies, and methodological diversities (e.g., laboratory view of virology and data-centered view of epidemiology) that undermine "intradisciplinary" and in consequence also "extradisciplinary"[2] medical communication to other societal fields.

1) Lack of integration across medicine as a discipline

Medicine as a diversified academic discipline (virology, epidemiology, hygiene, internal medicine, immunology, etc.) lacks intradisciplinary integration (Tretter & Löffler-Stastka, 2019a). The resulting inconsistencies in evaluating the pandemic cannot be resolved by mass media (see below, "two experts, two opinions") and in consequence the public trust in medicine could decline. The following weaknesses are sources of contradictory statements:

- Underestimation of clinical experience: according to evidence-based medicine, clinical experience is heavily underestimated. In case of COVID-19, randomized controlled studies—especially regarding public health affairs—are not possible. More casuistic reports would have helped to understand the health risk of COVID-19 and to dampen the dynamics of the pandemic.
- The dominance of abstract information by virology (molecular biology) and epidemiology (mathematics, statistics) over concrete information by internal medicine and the consecutive neglect of the pathophysiological mechanisms of symptoms of COVID-19 (from nose to lungs) corresponds essentially with the absence of a *theoretical medicine* that could explain the severe pathological conditions of the disease (Figure 1). Currently medicine favors "dataism" as everything appears rational as long as "numbers" are presented, even if it is hard to interpret them conceptually.

2 Extradisciplinary means one-directional messaging to politics and public, therefore we don't use the term "transdisciplinary."

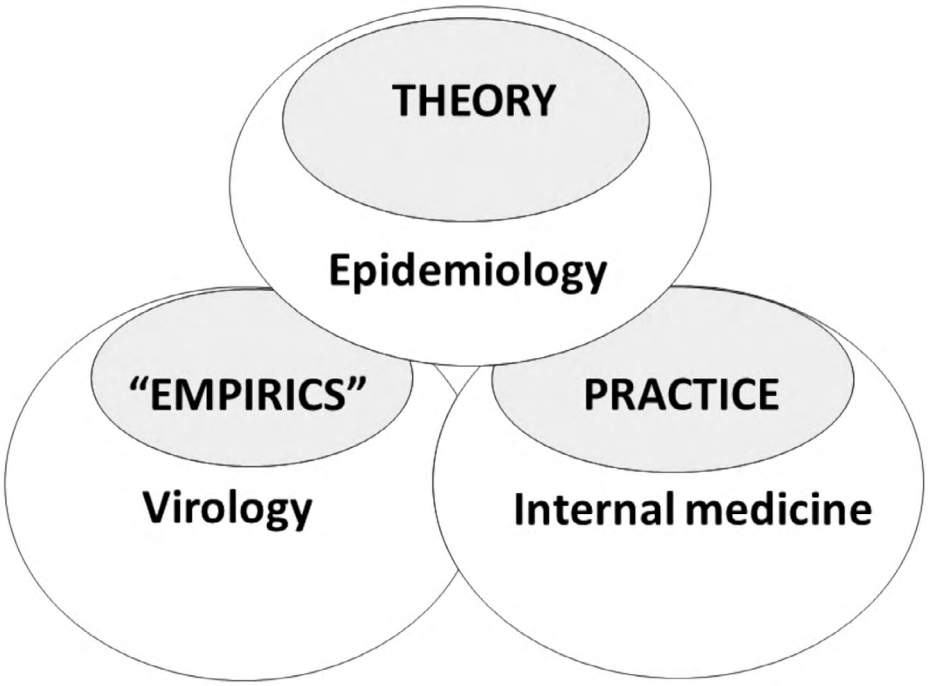

Figure 1. Dominant and marginalized COVID-19 discourses.

Note: Virology and epidemiology dominate the internal and external COVID-19-related discourse with a neglect of practical medicine, represented in this graphic by the field of internal medicine. Theoretically, only the integrated view of these specialties of medicine could provide a balanced picture of the COVID-19 problem. "Empirics" subsumes experimental, field, and statistical research.

Source: Authors' representation.

2) Inaccuracies of language

The different medical subdisciplines obviously implicate preferences for different categories to characterize the *risk of death*. Epidemiologists might prefer the concept of "mortality" (deaths/100,000 inhabitants) as mortality helps to indicate the general *comparative risk* of death. For instance, for Germany and Austria, the mortality of COVID-19 is about 0.1‰.[3] Other medical experts (e.g., virologists) prefer the "case fatality rate" for deceased persons who were tested positively, which results in a 400-times larger number, namely 4 percent. Infectiologists often use the "infected fatality rate," which is calculated by serological antibody ratio in representative samples. These different numbers are not used correctly within medicine, as became public when medical experts discussed mortality risk (see below). By fall 2020, public opinion in Germany and Austria (and obviously in other countries too) had become widely polarized regarding the "dangerousness" of SARS-CoV-2.

3 At time of writing, October 2020.

These differences of indicators imply the necessity for consensus and consistency conferences in medicine (and for the public) about the appropriate choice of indicator. The societal relevance of this difference, especially in context of politics, is that the mortality number is calming the public, whereas lethality number induces anxieties, as will be discussed in more detail later.

3) Fuzziness of virological and epidemiological measurements

These terminological issues are closely related to the quality of testing, such as *number of diagnostic tests* being applied (correlation between percentage of tested population and percentage of test-positives), the indication of testing (symptom carrier or coming from a "hot spot"), *quality of the tests* (validity, reliability, specificity, etc.), and the temporal contingency of measurement and presentation of the *data* to politics (variable time delays). All these factors attenuate the power of evidence of epidemiological research. In consequence, the strength of empirical evidence of dynamics of national epidemics is relatively weak.

4) Overevaluated data analytics and models for forecasting

This complex methodological fuzziness of data acquisition implicates severe restrictions in *data analysis*, although these data are used for *forecasting* of future development of the pandemic and for assessment of public health measures. Simple epidemiological indicators such as doubling interval or reproduction number, indicating the number of individuals infected by one infected individual (R_{eff}), are only appropriate in brief phases of exponential development of the epidemic/pandemic. In consequence, predictive modeling of the development of the pandemic is mathematical extrapolation and simulation with increasing error probability (Ioannidis et al., in press).

Regardless of these methodological restrictions, some politicians did use the primary scientific information in a wrong way (e.g., without presentation of the "prediction interval" of forecasts), and maybe even intentionally to induce collective anxieties ("There will be 100,000 deaths (in Austria)"; Bartlau, 2020). This was directly communicated by mass media to the public. By this kind of uncritical information transfer, the credibility of science could suffer. Whenever such predictions do not eventuate in reality, public trust in science could decrease—as we already see by the growing number of COVID-deniers.

This increasing public distrust, however, is also partially rooted in the diversity of medical specialities that present their results and recommendations to the public without a common reference frame. In particular, the subjective situation of the people as "situated subjects" is overseen, as humans should be seen in their ecological and social context (Dreier, 2020; Tretter, 2008). Interestingly, WHO, in a recent publication, recognized pandemic fatigue and recommends human-centered and community-based interventions (WHO, 2020d).

5) Lack of valid studies into pandemic interventions

The assessment of the *control* of *dynamics* of the COVID-19 pandemic still lacks valid studies that clearly identify which intervention strategies successfully dampened the pandemic.

It is hard to define differences that make a difference. For a while, the effective reproduction number (R_{eff}) was used to characterize the dynamics of the pandemic. This was communicated to the public. But it turned out that many assumptions underlying this indicator (e.g., estimation of latency between infection and symptoms that lead to testing, maximum of spreading of the virus, etc.) diminish its validity, and more indicators must be used for this purpose. For example, by mid-March, a significant starting point of the pandemic in Europe, some politicians (e.g., UK Prime Minister Boris Johnson) followed scientists (e.g., Sir Patrick Vallance—a pharmacologist, not a virologist, not an epidemiologist) who emphasized "herd immunity," aiming at an infection rate of 60 percent of the population in order to attenuate the dynamics of the epidemic. In consequence, the UK applied only "soft" hygiene measures (e.g., recommendations for distancing) and only at the end of March was lockdown ordered. Boris Johnson, on March 27, tested positive to the virus and after four weeks of illness, including a hospital stay, came back to office on April 28. His personal affectedness changed general COVID-19 assessment in the UK. Obviously too late, as the UK had an extremely high number of infected until summer 2020 and—compared to Germany—also a very high death rate. This is also true for Sweden, if we compare it with Austria, a country with a hard lockdown (e.g., obligatory distancing) and about the same number of inhabitants (see Table 1). Depending on the figure used—such as mortality or case fatality—these differences can be higher or lower. This could be abused for political aims, for instance to criticize hard lockdown policies by their lower impacts on the case fatality rate (CFR) compared with mortality reduction.

Table 1. Country-related epidemiological indicators of COVID-19.

Date: May 25, 2020	Tests/Million inhabitants	Cases/Million inhabitants	Cases/ Tests	Deaths/Million inhabitants	Deaths/ Cases
Germany (GER)	42,923 (0.4%)	2,153 (0.2%)	5%	100 (0.01%)	5%
United Kingdom (UK)	50,979 (0.5%)?	**3,825 (0.4%)**	7%	**542 (0.05%)**	14%
Austria (A)	44,645 (0.4%)	1,839 (0.2%)	4%	71 (0.01%)	3%
Sweden (S)	29,797 (0.3%)	**3,313 (0.3%)**	11%	**396 (0.04%)**	12%

Soft lockdown (UK, S) is accompanied with doubling of population-based rate of infected (bold numbers) and with a 5- to 6-fold higher rate of deaths compared to countries with hard lockdown (GER, A). If deaths/cases (CFR) are used as indicators the difference is only 3- to 4-times higher.

Source: Worldometer (2020) and (rounded) calculations by authors.

Role of media in the information supply chain

In regard to the information flow, the next step following after science is mass media. Their output in spring 2020 mirrored the above-mentioned inconsistencies of medicine.

Mass media had to inform the public about the nature of the virus and its dangerousness (science communication, risk communication), had to disseminate hygiene measures (health communication), and had to report on the sociopolitical dimension of the pandemic (core of traditional, political journalism). Science itself had difficulties in correctly communicating data and gathering first findings under pressure and uncertainty; media were overstrained as well, especially regarding the data for risk and health communication. Public health authorities or politicians passed on absolute numbers of cases or deaths mixed up with mortality or fatality numbers (see above). During the first wave of the virus, incidents like the following were characteristic:

- May 24, 2020: Austrian TV program *Im Zentrum* (ORF):

  The moderator finds herself between two medical doctors who use different languages: Dr. Montgomery (President of the World Federation of Physicians) talks about the "case fatality rate," while the other expert presents mortality numbers. The numbers they give don't match. The discrepancy (4% vs. 0.2‰) cannot be clarified by the doctors, so the moderator ends the discussion by stating "two experts, two opinions."

- 30 March, 2020: *Kurier* (an Austrian daily newspaper):

  Based on experts' calculations and forecasting, the Austrian Government issues a press release that confounds "replication rate" (intracellular replication rate of virus) and "reproduction number R" (the number of susceptible persons being infected by a single infected person). Journalists don't question the authority of scientists and Chancellor, and copy the mistake.[4]

The blame for such confusions was mainly attributed to the media by the medical sector (e.g., EbM Netzwerk, 2020). Over time, an intensive learning process in health and risk communication can be observed, especially regarding data management in mass media. Self-reflective articles on ethics and the responsibility of journalists in the face of COVID-19 are to be found on the discussions of professional associations[5] or broadcast stations.[6] Tool boxes (e.g., glossary of epidemiological terminology) are offered also by public health institutions (Wegwarth et al., 2020; WHO 2020b, 2020c).

Media now recommend visiting their online services, where ambiguity of data can be better explained; they turn to weekly reporting, commenting on validity of data, and explaining their choice of terms and parameters. This seems highly acknowledged by the audience. An example from the UK, where government policies were not transparent and scientific advice arbitrary (see above), is the rise of *The Guardian* from a minority paper to the most trusted source of information in the UK. There has been an increase of website visitors from 191 million in February 2020 to 366 million in March, with 2.17 billion page views in March 2020 (UNESCO, 2020).

In summary, the results from some European lead media show that they tried hard to deliver responsible journalism, based on verified data, as some media researchers attest (Boberg et al., 2020). But media professionals were also not free from flaws: the shock/impact of the first wave of the pandemic influenced their choice of subjects and style of reporting. A study on German special TV documentaries on COVID-19 shows that critical comments on policies of crisis management were missing, while iteration of gloomy descriptions of the crisis fostered the social construction of crisis (Gräf & Hennig, 2020). Further and comparative studies are needed to elicit how the media complied with their extremely important role as mediators between science, politics, and public.

4 kurier.at/wissen/gesundheit/coronavirus-prognose-deutlich-strengere-massnahmen-notwendig/400796975.

5 For example: Science Media Centre, UK (www.sciencemediacentre.org); DJU (Deutsche Journalisten Union); WPK (Die Wissenschaftsjournalisten); Medien Doktor Gesundheit.

6 For example: Deutsche Welle: www.dw.com/en/data-journalism-in-times-of-coronavirus/a-54116323.

Discussion

Methodological and epistemological diversification of medicine implies a loss of conceptual and theoretical integration (the relationship between "empirics" and theory). Also, the conceptual weakness of medicine uncovered by COVID-19 pandemic is an intrinsic problem of hyper-diversification of medical specialties. In consequence, this diversity of medical viewpoints on the COVID-19 pandemic seem to create contradictions, which can be enforced in the information supply chain by mass media. These contradictions might result in splitting of public opinion. Obviously, in this discourse "the limits of my language mean the limits of the world" (Wittgenstein, 1921/1981). This situation shows the need for an integrative conceptual framework, such as an integrative ecological "systems medicine" that considers health and disease top-down from the whole, situated person (Tretter & Löffler-Stastka, 2019b).

In addition, COVID-19 shows that medicine has to be able to communicate with other disciplines—for instance, with economics. Regarding the wide societal consequences of COVID-19, an even wider scientific framework seems to be useful to ensure comprehensive "evidence-based" policies.

The human ecology perspective: A "big picture" of COVID-19

In order to connect these different academic perspectives in an integrative conceptual framework, we suggest using a systemic socioecological feedback template (Dyball & Newell, 2015). This approach might be useful to relativize some controversies. It captures the interconnections between the ecosystem, human well-being, societal institutions, and cultural paradigms. This template is useful for a broader view of social ecological systems in general (Figure 2A). For the purposes of framing the "big picture" of COVID-19, we map the variables to those more specific to this pandemic (Figure 2B). This application of the template summarizes most of the points we have discussed. They will be elaborated in more detail (Tretter & Reichel, 2020), but serve well here to represent the main functional structure of the COVID-19 system, as follows.

The human community manipulates natural ecosystems to yield resources that it values (activities and processes, represented by link 1). Unintentionally, these manipulated ecosystems also create conditions favoring the evolution and flourishing of pathogenic viruses that impair human health, leading infected human individuals to infect other humans (pathways transmitting the virus are represented in link 2). Medical reports on empirical evidence of the health status of the population stimulate discussions in politics, mass media, and public opinion that push for a new societal concern to take the pandemic seriously, which comes to constitute a new paradigm.

(The process of observing and learning about the pandemic and the pressure for a change in dominant values are captured in link 3.) Whether the dominant paradigm does change depends on the relative strength of concerns prioritizing health over counterarguments that prioritize the strength of the economy. This "new normality" is institutionalized by measures for public health and public order like distancing, use of masks, etc. (The process of generating these guidelines and behavioral rules is represented by link 4). These rules and norms of behavior directly change the state of human well-being, through activities such as limited group sizes, reduced handshaking, and increased mask-wearing (activities represented by link 5), creating conditions less conducive to the spread of the virus, as measured by reduction in epidemiological indicators. Observations of the success of the behavioral change further reinforce the new emerging "health first" cultural paradigm (learning processes represented by link 3′). In turn, this paradigm is also influenced by the perception of the value of levels of institutionalized regulations (a process of formally and informally reviewing policies represented by link 6). This perception might result in, for example, a reduction of lockdown measures, if it was judged that the regulations were unnecessarily restrictive, or creating countervailing indicators of harms to well-being, such as depression or domestic violence (the process of creating new, more relaxed guidelines is represented by link 4′). In the long run, even the collectively perceived health risks of interpenetration of human systems with natural ecosystems (i.e., zoonoses) might change the priorities of the cultural paradigm of unlimited use of ecosystems (process of reevaluation represented by link 7). In time, this could lead to new collective behaviors (represented in link 1′) that do not create novel ecosystem niches conducive to zoonotic crossover to humans.

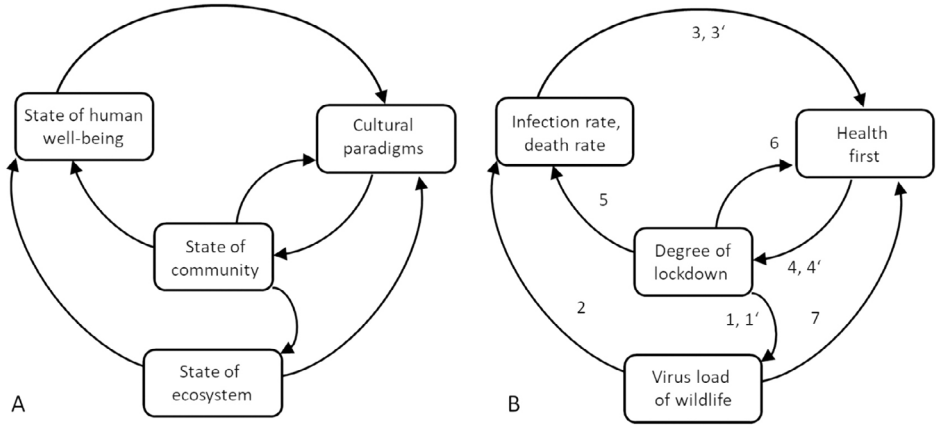

Figure 2. Application of a human ecological framework. The basic template (A) and the adaptation to the "big picture" of COVID-19 (B).

Source: Dyball and Newell (2015).

Conclusion

In summary, some evidence is provided that medicine and public health lack intradisciplinary conceptual integration and inter- and transdisciplinary methodological culture. This can be seen in the current medical COVID-19 discourse, which also ignores the valuable conceptual linkages between ecology and medicine. Bridging such gaps might enhance consistency and coherence of medical advice in managing COVID-19 pandemic. In line with this, an elaborated perspective of a "human ecology of health" (EHO, 2020; see also WHO, 2005) could provide a theoretical bridge to other research approaches, such as *One Health* (see WCS, 2020; WHO, 2017, 2018) and also to sustainability research. This kind of integrative ecological systems medicine is needed to participate in and shape public and political discourses regarding further global crises.

References

AGES. (2020). *COVID-19 dashboard*. Österreichische Agentur für Gesundheit und Ernärhungssicherheit (AGES) [(Austrian) Agency for Health and Food Safety]. Retrieved May 5, 2020, from covid19-dashboard.ages.at

Arinze-Umobi, S. O., & Chiweta-Oduah, O. (2020). COVID-19 crisis response strategies: The place of mass media. *International Journal of Advanced Research*, 8, 1102–1109. doi.org/10.21474/ijar01/10883

Balarabe, U. B. (2020). Impact of COVID-19 and pandemic lockdown in India: Role of media during lockdown. In A. Shukla (Ed.), *Impact of COVID-19 & pandemic lockdown in India: Ramification in environment and human life* (pp. 175–184). Eureka Publications.

Bartlau, C. (2020). Er, nur er allein [He, just him]. *ZEIT ONLINE.* www.zeit.de/politik/ausland/2020-04/sebastian-kurz-coronavirus-krisenmanagement-strategie/komplettansicht

Boberg, S., Quandt, T., Schatto-Eckrodt, T., & Frischlich, L. (2020). *Pandemic news: Facebook pages of mainstream news media and the coronavirus crisis—a computational content analysis*. (Münster Online Research (MOR) Working Paper 2/2020). University of Münster. ArXiv. arxiv.org/pdf/2004.02566.pdf

Bunge, M. (1998). *Philosophy of science* (Vol. 2). Routledge. doi.org/10.4324/9781315126371

Cazzolla Gatti, R. (2020). The pangolin's revenge: SARS-CoV-2 did not emerge from a lab but from wildlife exploitation. *GAIA*, 29(2), 79–82. doi.org/10.14512/gaia.29.2.3

Dreier, O. (2020). Critical psychology: Subjects in situated social practices. In M. Fleer, F. González Rey, & P. Jones (Eds.), *Perspectives in cultural-historical research: Vol. 8. Cultural-historical and critical psychology*. Springer. doi.org/10.1007/978-981-15-2209-3_2

Dyball, R., & Newell, B. (2015). *Understanding human ecology: A systems approach to sustainability*. Earthscan. doi.org/10.4324/9780203109557

EbM Netzwerk. (2020). *Risikokommunikation zu COVID-19 in den Medien* [Risk communication for COVID-19 in the media]. www.ebm-netzwerk.de/de/veroeffentlichungen/pdf/stn-risikokommunikation-covid19-20200820.pdf

EHO. (2020). *Developing the human ecology of health*. European Health Organisation. Retrieved August 3, 2020, from www.organisation-europeenne-sante.ch/en

Gräf, D., & Hennig, M. (2020, September 17). Die Verengung der Welt. Zur medialen Konstruktion Deutschlands unter SARS-CoV-2 und COVID-19 anhand der Formate "ARD Extra—Die Coronalage" und "ZDF Spezial" [The narrowing of the world. The media construction of Germany under SARS-CoV-2 and COVID-19 in the formats of "ARD Extra—the Corona situation" and "ZDF Special"]. *Magazin des Graduiertenkollegs Privatheit der Universität Passau*, 14(2020), 14–21. issuu.com/grkprivatheitdigitalisierung/docs/magazin__cov-19__september_2020__issuu/14

Heckl, W. M. (2020). Wissenschaftskommunikation—in Corona und Post-Corona-Zeiten wichtiger denn je [Science communication—more important than ever in Corona and post-Corona times]. In M. Molls, & J. Eberspächter (Eds.), *Wissenschaft, Vernunft, Nachhaltigkeit—Denkanstöße für die Zeit nach Corona* [Science, reason, and sustainability—food for thought for the time after Corona] (pp. 72–75). Technische Universität München (TUM) Forum Sustainability: TUM Senior Excellence Faculty & TUM Institute for Advanced Study. mediatum.ub.tum.de/doc/1548492/1548492.pdf

Ioannidis, J. P. A., Cripps, S., & Tanner, M. A. (in press). Forecasting for COVID-19 has failed. *International Journal of Forecasting*. Available online 25 August 2020. In Press, Corrected Proof doi.org/10.1016/j.ijforecast.2020.08.004

Luhmann, N. (2012). *Introduction to systems theory* (P. Gilgen, Trans.) Polity Press. (Original work published 1984).

Morse, S. S., Mazet, J. A., Woolhouse, M., Parrish, C. R., Carroll, D., Karesh, W. B., … Daszak, P. (2012). Prediction and prevention of the next pandemic zoonosis. *The Lancet*, 380(9857), 1956–1965. doi.org/10.1016/S0140-6736(12)61684-5

Peters, H. P., Heinrichs, H., Jung, A., Kallfass, M., & Petersen, I. (2008). Medialization of science as a prerequisite of its legimitization and political relevance. In D. Cheng, M. Claessens, T. Gascoigne, J. Metcalfe, B. Schiele, & S. Shi (Eds.), *Science communication in social context: New models, new practices*. Springer. doi.org/10.1007/978-1-4020-8598-7_5

RKI. (2020a). *Nowcasting und R-Schätzung: Schätzung der aktuellen Entwicklung der SARS-CoV-2-Epidemie in Deutschland* [Nowcasting and R-estimation: Estimation of the current development of the SARS-CoV-2 epidemic in Germany]. Robert Koch Institute. www.rki.de/DE/Content/InfAZ/N/Neuartiges_Coronavirus/Projekte_RKI/Nowcasting.html

RKI. (2020b). COVID-19: Fallzahlen in Deutschland und weltweit [COVID-19: Case numbers in Germany and worldwide] (Daily report). Robert Koch Institute. www.rki.de/DE/Content/InfAZ/N/Neuartiges_Coronavirus/Fallzahlen.html

Solomon M. (2015). *Making medical knowledge*. Oxford University Press.

Tretter, F. (2008). *Ökologie der Person: Auf dem Weg zu einem sytemischen Menschenbild* [The ecology of the Person : Toward a systemic picture of humans]. Pabst Science Publishers.

Tretter, F., Gaugler, T., Bieling, C., Tretter, C., Underberg, E., Harrer-Puchner, G., & Franz-Balsen, A. (2020). Ein Virus verändert unser Weltverhältnis [A virus changes our relationship to the world]. *GAIA*, 29(2), 83–87. doi.org/10.14512/gaia.29.2.4

Tretter, F., & Löffler-Stastka, H. (2019a). Medical knowledge integration and "systems medicine": Needs, ambitions, limitations and options. *Medical Hypotheses*, 133, 109386. doi.org/10.1016/j.mehy.2019.109386

Tretter, F., & Löffler-Stastka, H. (2019b). The human ecological perspective and biopsychosocial medicine. *International Journal of Environmental Research*, 16, 7230. doi.org/10.3390/ijerph16214230

Tretter, F., & Reichel, C. (2020). Humanökologie der Krisen: Systemische Annäherungen an COVID-19 (The human ecology of crises: Systemic approaches to COVID-19). *GAIA*, 29(4), 278–280. doi.org/10.14512/gaia.29.4.16

UNESCO. (2020). *Journalism, press freedom and COVID-19* [Issue brief in series: World Trends in Freedom of Expression and Media Development]. United Nations Educational, Scientific and Cultural Organization. en.unesco.org/sites/default/files/unesco_covid_brief_en.pdf

WCS. (2020). *One planet, one health, one future*. World Conservation Society. www.wcs.org/one-planet-one-health-one-future

Wegwarth, O., Kendel, F., Tomsic, I., von Lengerke, T., & Härter, M. (2020). *Risikokommunikation unter Unsicherheit* [Risk communication during uncertainty]. Kompetenznetz Public Health COVID-19. www.public-health-covid19.de/images/2020/Ergebnisse/Corr_20200626_Kommunikation_Handreichung_COVID_Kommunikation_Unsicherheit_Risiken_Revision_FINAL_CLEAN.pdf

WHO. (2005). *Ecosystems and human well-being: Health synthesis*. World Health Organization. www.who.int/globalchange/publications/ecosystems05/en/

WHO. (2017). *One health*. World Health Organization. www.who.int/news-room/q-a-detail/one-health

WHO. (2018, November 12). *Of all human diseases, 60 percent originate in animals—"One Health" is the only way to keep antibiotics working* [News release]. World Health Organization Regional office for Europe. www.euro.who.int/en/health-topics/disease-prevention/antimicrobial-resistance/news/news/2018/11/of-all-human-diseases,-60-originate-in-animals-one-health-is-the-only-way-to-keep-antibiotics-working

WHO. (2020a). *WHO Coronavirus disease (COVID-19) dashboard* [Data set]. World Health Organization. Retrieved May 25, 2020, from covid19.who.int

WHO. (2020b, April 14). *COVID-19 strategy update*. World Health Organization. www.who.int/docs/default-source/coronaviruse/covid-strategy-update-14april2020.pdf?sfvrsn=29da3ba0_19

WHO. (2020c, September 23). *COVID-19 pandemic: Countries urged to take stronger action to stop spread of harmful information* [News release]. World Health Organization. www.who.int/news/item/23-09-2020-covid-19-pandemic-countries-urged-to-take-stronger-action-to-stop-spread-of-harmful-information

WHO. (2020d). *Pandemic fatigue—Reinvigorating the public to prevent COVID-19: Policy framework for supporting pandemic prevention and management*. World Health Organization Regional office for Europe. apps.who.int/iris/bitstream/handle/10665/335820/WHO-EURO-2020-1160-40906-55390-eng.pdf

Wittgenstein, L. (1921/1981). *Tractatus Logico-Philosophicus (TLP)*. (C. K. Ogden, trans.). Routledge & Kegan Paul. (Original work published 1921)

Worldometer. (2020). *COVID-19 Coronavirus pandemic* [Data set]. Retrieved May 25, 2020, from www.worldometers.info/coronavirus/

Vulnerabilities in the Conservation–Tourism Alliance: The Impacts of COVID-19 in Laikipia and the Galapagos Islands

Thomas Meredith[1]
Department of Geography, McGill University, Quebec, Canada

Alec Blair
Department of Geography, University of British Columbia (Vancouver), Canada

Diana V. Burbano
Department of Geography, McGill University, Quebec, Canada

Abstract

In East Africa and the Galapagos Archipelago, as in other important biodiversity conservation areas, tourism has been presented as a means of addressing community development aspirations in a way that is compatible with conservation objectives. Local livelihood practices are an important element in this, and in order to advance conservation and tourism goals, strategies derived from a conservation–tourism alliance may aim either to support traditional livelihood practices, to modify those practices, or to encourage transitions from those practices to new livelihoods. While this has proven successful in many areas, and tourism revenue has succeeded in supporting conservation and in opening new opportunities for communities, it has also created vulnerabilities that have been highlighted by the COVID-19 pandemic. The paper explores implications for two areas—Laikipia, Kenya, and the Galapagos Islands, Ecuador—and draws conclusions about engineered livelihood transitions.

Keywords: biodiversity conservation, COVID-19, livelihoods, nature-based tourism, protected areas

Introduction

Homo sapiens evolved in East Africa, and has occupied the landscape there continuously for 200,000 years. The Galapagos Islands, by contrast, were discovered only in 1535 and have been settled for less than 200 years. However, in both areas, human communities have coexisted to the present with what we now call *charismatic*

1 Corresponding author: tom.meredith@mcgill.ca.

megafauna and, consequently, both areas have been identified as priority conservation areas (IUCN, 2016). Both areas have attracted international attention through conservation organizations that advance the perspective that the local ecological resources are part of a global heritage that must be protected (Gunter, 2004) and, significantly, in both cases, the prospects of an enduring, sustainable, and lucrative alliance with tourism has been presented to local communities as a means of meeting development aspirations.

The sustained loss of biodiversity, often described as the "Sixth Extinction" (Ceballos et al., 2020), threatens human well-being (Wilson, 2016), and so successful strategies for conservation are essential. Early efforts to protect biodiversity were rooted in the "fortress" approach to conservation, which aimed to isolate natural systems from human activity (Adams, 2004). While areas that are deemed as important conservation sites are valuable precisely because they have not been extensively developed or converted, a corollary is that communities associated with conservation sites are likely to have a distinct cultural heritage and an established dependency on local resources. This implies important "human dimensions" to conservation initiatives and, as early as 1980, The World Conservation Strategy recognized the need to link biodiversity conservation with economic development (IUCN, 1980), and to identify new collaborative approaches (Adams & Hulme, 2001; Roe, 1991) that would reverse "top-down, center-driven conservation by focusing on the people who bear the costs of conservation" (Western & Wright, 1994, p. 7). Major conservation advocates proposed that tourism could advance conservation objectives, while also enhancing "local people's quality of life" (IUCN, 1993), and while many factors have been cited to demonstrate the potential value of conservation management to local communities (Buckley, 2008; Wardle, et al., 2018), tourism has been the most explored and promoted (CBD, 2010).

Clearly, tourism can play an important role in protecting biodiversity. An alliance between conservation and tourism effectively means that tourists—who will be drawn by landscapes and wildlife (and perhaps local cultures)—will pay to see precisely what conservationists wish to protect (Boley & Green, 2016; Buckley et al., 2012). This conservation–tourism alliance (CTA) rests on the presumed compatibility of the interests of these two stakeholder groups, but also on the assumption that benefits from tourism can be made appealing to a third group, arguably the most important group: the members of the local community.

Livelihoods link members of a community to their environment, and the sustainable livelihood approach (Chambers & Conway, 1992) and social ecological system (SES) models (Ostrom, 2009) outline parameters of these linkages. Within livelihood diversification studies, Turner (2007) has demonstrated how important selective livelihood diversification is as a means of adapting to changing local conditions. Communities that have persisted in areas important for biodiversity conservation have necessarily found mechanisms to adapt to ecological variability. For example,

in pastoral systems, such as those in East Africa, "new range ecology" describes a resilient SES with multiple-stables states, functioning adaptively in response to environmental variability and uncertainty. The ability to adapt to circumstantial change is essential to survival. Where conservation and tourism influence an SES, tourism may provide a stabilizing alternative, but it may also introduce new vulnerabilities by altering the pressures that drive or inhibit livelihood change (Burbano & Meredith, 2020).

This paper summarizes research on how three stakeholder groups—conservationists, tourism promoters, and local communities—have interacted in Laikipia, Kenya, and in the Galapagos Islands, Ecuador, where the promise of the CTA has been great, and the impacts to date have been transformative. However, the emergence of the COVID-19 pandemic has exposed vulnerabilities linked to the CTA that must be acknowledged in order to optimize the prospects of sustainable long-term development. COVID-19 has seriously affected both countries: at the time of writing (October 2020), there is a total of over 44,000 reported cases and 825 deaths in Kenya and over 150,000 cases and 12,375 deaths in Ecuador (WHO, 2020). The research is based on over 15 years of direct engagement with communities in Laikipia, and over 10 years of engagement in the Galapagos. Assessments of the impact of COVID-19 are drawn from government reports, local agency reports, media coverage, and from interviews with key informants in affected communities. In this paper we briefly describe the history of the CTA in the two sites and discuss the immediate impacts of the collapse of tourism following the pandemic. We conclude with comments about retaining human adaptability in these unique conservation areas.

The conservation–tourism alliance and COVID-19 impacts

Laikipia, Kenya

Tourism is critically important in Kenya, as the country's third largest source of foreign exchange and employing up to 1.5 million people (World Bank, 2017). The decline of tourism in Kenya could cost the country 3–5 percent of its GDP (UNCTAD, 2020). Laikipia is a biodiversity-rich area (9,700 km^2) in north-central Kenya where tourism has become an important economic factor. It is a semi-arid landscape where land uses include communal rangelands, large-scale ranches, and, increasingly, areas of small-scale cultivation. The rich biodiversity persists due to centuries of semi-nomadic pastoralist land use across "soft-boundary" rangeland ecosystems (Reid, 2012), and contemporary large parcels of open rangeland, on both private and group ranches. Severe drought is common, and has necessitated cultural and institutional strategies to deal with uncertainty. Recent droughts highlight the

extreme livelihood stress, with many pastoral communities losing 70 percent of livestock in 1997–2000 (Flintan & Puyo, 2012), and estimated cattle and sheep losses of over 60 percent in 2008–2009 (Zwaagstra et al., 2010). In the past 25 years, many of these communities have shifted into wildlife conservation management and the CTA is promoted as a way to address vulnerabilities exacerbated by rangelands that have become constricted, fenced, and developed.

Laikipia's abundant wildlife—the second highest density in Kenya (Kinnaird & O'Brien, 2012)—is found entirely outside of state-run protected areas. Tourism in Kenya is the leading foreign exchange earner (KWCA, 2019) and Nairobi, a short distance from Laikipia, is the international tourism hub. Wildlife tourism accounts for approximately 70 percent of Kenya's tourism and, prior to 2020, the sector experienced sustained growth, employed thousands, and provided critical individual and community income and support, justifying an optimistic view of the contribution conservancies could make (KWCA, 2019). In Laikipia, regional nongovernmental organizations (NGOs), including the Laikipia Wildlife Forum (LWF, founded 1992) and the Northern Rangelands Trust (NRT, founded 2004), have coordinated agreements among private land owners and group ranch leaders on managing land to protect wildlife and to benefit from tourism (Blair & Meredith, 2017; LWF, 2017). Tourist visitors increased 1,400 percent between 1996 and 2009 (LWF, 2013). Tourism's proliferation in Laikipia provides an important opportunity for examining whether, or how, the CTA functions.

Estimates indicate that 90 percent of revenue generated by community-based tourism in Laikipia each year comes from philanthropic sources, with only 10 percent coming directly from tourist spending (King et al., 2015; LWF, 2013). While this philanthropy clearly supports development of the tourism sector, and provides a buffer during setbacks, it also shows clearly the extent to which outside agencies, motivated by an interest in conservation, have intervened to advance the CTA. Few, if any, of the projects are financially self-sufficient, yet because of the administrative and financial intervention of outside agencies, local support for conservation projects has grown, and new ecotourism projects involving partnerships with investors, NGOs, and government have emerged. But as the influence of the CTA has grown, so too have government regulations that restrict the freedom of landholders to engage in commercial land uses that are not seen as being compatible with conservation. Such regulations have the potential to inhibit traditional, adaptive, rangeland livelihood strategies that have been critical to pastoralist survival (Mwangi & Ostrom, 2009). These constraints must be considered when assessing options for adaptive livelihood diversification arising from the CTA. The long-term commitments of tourism contracts, government land-use regulations, and increasing partnerships with regional and international NGOs may open opportunities, but may also challenge the autonomy and flexibility of communities when inevitable shocks arise.

The full extent of COVID-19 impacts in Laikipia remain to be determined, but initial indications are huge losses in income for enterprises and in employment for community members. Full-time employee numbers have dropped significantly, with staff released on unpaid leave or with heavy (often 50 percent) pay cuts (LTA, 2020; NRT, 2020). Over 80 percent of hospitality operations reported being closed in May 2020, and revenue losses of over 50 percent were experienced by over three-quarters of businesses (LTA, 2020), and are estimated to be up to 90 percent overall (LWF, 2020). For local conservation organizations, concerns over illegal grazing, charcoal burning, and wildlife poaching have increased as tourism-based benefits been reduced (NRT, 2020). In response, local stakeholders are looking for support from international agencies or local government to maintain operations for conservancies and business (LTA, 2020; NRT, 2020). Though the scale of the current crisis is unprecedented, disruptions such as this are not novel: political violence and global economic crises have caused volatility in the past. Learning from this case may help protect the adaptive capacity that will be essential to community resilience and sustainable development.

Galapagos, Ecuador

In 2018, Ecuador reported over 2.5 million foreign tourists, generating over US$1.5 billion, and accounting for over 7 percent of its foreign earnings (World Bank, 2020). The Galapagos Islands are a major attraction, and in 2018 the islands received almost 276,000 visitors (GNPS, 2018). The Galapagos Archipelago is located in the Pacific Ocean, about 1,000 km west of mainland Ecuador. The islands were discovered in 1535, but settlement began only in the early nineteenth century and, even now, only four of the 13 main islands have human settlements, and they occupy only 3 percent of the total land territory. Subsistence agriculture was the main livelihood but, over time, the development of commercial fishing drew people away from agriculture. Charles Darwin famously visited the islands in 1835 and made observations based on the islands' unique ecology that became central to the understanding of processes driving evolution. The same ecological resources that intrigued Darwin attracted international biodiversity conservation interests, and as fishing increased significantly in the 1980s, and increased immigration in the 1990s intensified pressure on land and marine resources, more regulatory restrictions were imposed on established livelihood practices. For example, agriculture is permitted only in very limited areas and is strictly controlled by the Ministry of Agriculture and Cattle Ranching, and only coffee can be exported from the islands. Only local small-scale fishing is allowed within the Galapagos Marine Reserve and is regulated by the Galapagos National Park Service (GNPS).

Tourism began during the early 1900s with foreign sailboats stopping occasionally on the islands. In the 1960s, local fishers began taking occasional visitors around the islands. The cruise ship tourism model followed, and expanded dramatically, but with operations managed by foreign or mainland companies (Quiroga, 2014),

the uneven distribution of benefits resulted in local rejection of this model. Land-based tourism has subsequently grown in importance—by 2015, 68 percent of tourists were land-based (Izurieta, 2017)—and tourism has become the main driver of the island economy, where, unlike Laikipia, it is not dependent on external philanthropists.

The CTA has been proactive in the islands. Three resulting factors have influenced the human ecology of the islands. First, regulatory constraints have been imposed on both farming and fishing sectors that have limited their viability. Second, new opportunities have opened in tourism, which have encouraged livelihood shifts, bringing new benefits but also new risks. Third, government programs have been introduced with the deliberate aim of promoting transitions into tourism—for example, the *experiential artisanal fishing* initiative, advanced by the GNPS and local NGOs, was intended to convert commercial fishers to tourism operators (Burbano & Meredith, 2020). These factors have advanced conservation goals, have supported the growing tourism sector, and have provided economic development opportunities for those in the local communities. But they have also created vulnerabilities.

The vulnerability became evident in 2019 when political uncertainty in Ecuador caused a 10 percent decline in tourism to the Galapagos Islands (GNPS, 2019). But with the outbreak of COVID-19 in mid-March 2020, non-essential economic activities and travel to the Galapagos were banned (Villón, 2020), generating an economic impact without precedent. Prior to the pandemic, between 70 and 75 percent of the Galapagos economy was based on tourism, with important multiplier effects on other economic sectors (Gozzer, 2020). With the outbreak of COVID-19, the entrance to the Galapagos' protected areas were closed to all tourists with an estimated loss from entry fees alone of US$9.5 million (Díaz-Sánchez & Obaco, 2020). The loss of tourism revenue has affected livelihoods and conservation efforts, and the reduction of air and sea cargo transportation to the archipelago has led to shortages of basic commodities, including food normally supplied from the mainland (España, 2020). This has also prevented the export of fish to the continent and abroad, meaning severe economic impacts on the fishing sector (local informant, personal communication, April 23, 2020).

Even though the government reopened the islands to tourists on July 1, only 387 tourists entered the Galapagos during the month (*El Comercio*, 2020), compared with about 25,000 in the same period in 2019 (GNPS, 2019). The governor of the islands reports that "the base of [the] economy has entirely collapsed" (in Gozzer, 2020): hotels and restaurants have closed and farm and fish sales have declined. Local authorities are supporting the agricultural and fishing sectors to ensure production, but acknowledge that as the island population has grown in response to the tourism expansion, and farming and fishing have been restricted by conservation, food production on the island can no longer meet the needs of the resident population (Gozzer, 2020).

These conditions led to protests demanding government action to address pressure arising from the collapse of tourism (*El Comercio*, 2020). Civil society and local and national government are working together to develop a plan to reactivate the economy (Villón, 2020), but a former director of the GNP noted that the Galapagos should rethink two elements related to its economy: one, that the islands should reduce their economic dependency on tourism; and two, that they should reduce dependency on the continent for goods and food. He suggests that it is the time to rethink the sustainability model of the Galapagos (Carrere, 2020). The CTA will continue to be important, but in rethinking, can vulnerabilities be reduced?

Discussion and conclusion

In both Laikipia and the Galapagos, the CTA has demonstrated the potential to help balance the interests of three implicated stakeholder groups: the conservation advocates, the tourism proponents, and the members of the local community. The ramifications of COVID-19 have been felt globally and the effects on the tourism sector have been profound; there is no reason to assume that these two areas would be spared serious impacts. However, the collapse of tourism has exposed a vulnerability particular to communities in conservation areas that must be considered, and from which insights can be drawn that could be beneficial to each of the stakeholder groups.

For conservationists, tourism is not, in itself, an asset but is rather a surrogate means of giving fungible economic value to local resources. Conversely, for the tourism industry, the success of biodiversity protection is important: without charismatic megafauna and natural landscapes, tourists will not be drawn. As these two case studies show, for the third stakeholder group, those living in or near conservation areas, the cost–benefit assessment of participation in the CTA can include both material and cultural considerations, but must also include consideration of opportunity costs—that is, consideration of what might be lost from being unable to develop, use, or sell local assets in an open market (Norton-Griffiths, 2007).

While conservation areas are valued because they have not been extensively modified, the human ecology of the areas—including the relation between human livelihoods and local resources—must be considered in attempting to advance a CTA. As shown in these cases, conservation initiatives may aim to protect resources that have sustained local communities, but they may do so by limiting access to them; tourism may provide valued economic opportunities, but those opportunities may compromise community adaptability, resilience, self-sufficiency, and cohesion. Targeting livelihoods to address conservation and tourism goals may be seen as supporting community development, but it may also be seen as attempting to engineer livelihood transitions.

In both Laikipia and the Galapagos, outside agencies actively promoted the CTA as being beneficial to local populations, and they supported programs designed to promote livelihood transitions. In both cases there have been community members who have been drawn to and successful in activities arising from the CTA, but, also, in both cases there has been resistance: in Laikipia, based on the loss of access to grazing, and on human–wildlife conflicts; in the Galapagos, based on fishing and land use restrictions and on concerns that revenues from tourism do not accrue to local communities; and in both areas, based on frustrations regarding promised employment opportunities that have not materialized. The CTA may be the most promising avenue for addressing the human dimensions in conservation, including concerns of cultural autonomy, locally adapted livelihood strategies, and community development aspirations. However, the pandemic has shown the vulnerability that comes with restrictive and narrow reliance on a sector where demand can always be volatile.

Given concerns about biodiversity loss, communities in or near biodiversity-rich areas will continue to be affected by conservation interests, and this may well imply potential benefits from the CTA. However, for the CTA to be beneficial to all three stakeholder groups, consideration must be given to the unique position of communities inhabiting environments that have, to date, supported rich biodiversity assets, but which have also demanded flexible and adaptive responses in livelihoods. The ability to adapt to circumstantial change has been essential to survival in these areas, and may continue to be so. Outside of the exclusionary fortress approach to conservation, the proponents of the CTA must attempt to find ways to ensure that communities in biodiversity-rich areas retain the ability to respond sustainably to variability and uncertainty.

References

Adams, W. M. (2004). *Against extinction: The story of conservation*. Earthscan.

Adams, W., & Hulme, D. (2001). If community conservation is the answer in Africa, what is the question? *Oryx*, 35(3), 193–200. doi.org/10.1017/s0030605300031847

Blair, A. G., & Meredith, T. C. (2017). Community perception of the real impacts of human–wildlife conflict in Laikipia, Kenya: Capturing the relative significance of high-frequency, low-severity events. *Oryx*, 52(3), 497–507. doi.org/10.1017/s0030605316001216

Boley, B. B., & Green, G. (2016). Ecotourism and natural resource conservation: The 'potential' for a sustainable symbiotic relationship. *Journal of Ecotourism*, 15(1), 36–50. doi.org/10.1080/14724049.2015.1094080

Buckley, R. C. (2008). Tourism as a conservation tool. In A. Raschi & S. Trampetti (Eds.), *Management for protection and sustainable development: Proceedings of the Fourth International Conference on Monitoring and Management of Visitor Flows in Recreational and Protected Areas* (pp. 19–25). Consiglio Nationale della Ricerche. 141.244.189.82/downloads/mmv4-proceedings.pdf

Buckley, R., Castley, J. G., Pegas, F. d. V., Mossaz, A. C., & Steven, R. (2012). A population accounting approach to assess tourism contributions to conservation of IUCN red-listed mammal species. *PLoS ONE*, 7(9). doi.org/10.1371/journal.pone.0044134

Burbano, D. V., & Meredith, T. C. (2020). Conservation strategies through the lens of small-scale fishers in the Galapagos Islands, Ecuador: Perceptions underlying local resistance to marine planning. *Society & Natural Resources,* 33(10), 1–19. doi.org/10.1080/08941920.2020.1765058

Carrere, M. (2020, May 21). *Sin turismo no hay dinero: COVID-19 detiene el 60 percent de los ingresos de Galápagos* [Without tourism, no money: COVID-19 blocks 60 percent of Galapagos' income]. Mongabay Independent News. es.mongabay.com/2020/05/ecuador-turismo-en-galapagos-covid-19/

CBD. (2010). *Linking biodiversity conservation and poverty alleviation: A state of knowledge review* (CBD Technical Series 55). Secretariat of the Convention on Biological Diversity. www.cbd.int/doc/publications/cbd-ts-55-en.pdf

Ceballos, G., Ehrlich, P. R., & Raven, P. H. (2020). Vertebrates on the brink as indicators of biological annihilation and the sixth mass extinction. *Proceedings of the National Academy of Sciences*, 117(24), 13596–13602. doi.org/10.1073/pnas.1922686117

Chambers, R., & Conway, G. (1992). *Sustainable Rural Livelihoods: Practical concepts for the 21st century* (IDS Discussion Paper 296). Institute for Development Studies.

Díaz-Sánchez, J. P., & Obaco, M. (2020). The effects of Coronavirus (COVID-19) on expected tourism revenues for natural preservation: The case of the Galapagos Islands. *Journal of Policy Research in Tourism, Leisure and Events*. Online publication. doi.org/10.1080/19407963.2020.1813149

El Comercio. (2020, September 6). Transportistas bloquearon la vía entre el aeropuerto de Baltra y Puerto Ayora, en Galápagos [Transport workers block road between Baltra airport and Puerto Ayora in Galapagos]. www.elcomercio.com/actualidad/transportistas-bloqueo-via-baltra-gapalagos.html

España, S. (2020, July 5). Galápagos: la joya de la corona no da de comer [Galapagos: The jewel in the crown provides no food to eat]. *El País*. elpais.com/internacional/2020-07-06/galapagos-la-joya-de-la-corona-ya-no-da-de-comer.html

Flintan, F., & Puyo, D. (2012). *Naibunga Conservancy Trust Laikipia, Kenya* [Unpublished report]. Naibunga Conservancy Trust.

GNPS [Galapagos National Park Service]. (2018). *Informe anual 2018 de visitantes a las áreas protegidas de Galápagos* [Annual report 2018 on visitors to the protected areas of Galapagos]. www.galapagos.gob.ec/wp-content/uploads/downloads/2019/01/INFORME-ANUAL-DE-VISITANTES-A-LAS-A%CC%81REAS-PROTEGIDAS-DE-GALA%CC%81PAGOS-2018.pdf

GNPS (Galapagos National Park Service). (2019). *Informe anual 2019 de visitantes a las áreas protegidas de Galápagos* [Annual report 2019 on visitors to the protected areas of Galapagos]. www.galapagos.gob.ec/wp-content/uploads/2020/01/INFORME-ANUAL-DE-VISITANTES-2019.pdf

Gozzer, S. (2020, April 29). *Coronavirus en Ecuador: el reto de detener el avance de la enfermedad en las islas Galápagos* [Coronavirus in Ecuador: The challenge of stopping the advance of the disease in the Galapagos Islands]. BBC Mundo News. www.bbc.com/mundo/noticias-america-latina-52457484

Gunter, M. (2004). *Building the next ark: How NGOs work to protect biodiversity*. Dartmouth College Press.

IUCN (with UNEP and WWF). (1980). *World conservation strategy*. International Union for Conservation of Nature, United Nations Environment Programme, and World Wildlife Fund. portals.iucn.org/library/efiles/documents/wcs-004.pdf

IUCN. (1993). *Parks for life: Report of the IVth World Congress on National Parks and Protected Areas*. International Union for Conservation of Nature. portals.iucn.org/library/node/6584

IUCN. (2016). *Natural world heritage: Facts and figures 2016* [Fact sheet]. www.iucn.org/sites/dev/files/fact_sheet_wh_2016_desert.pdf

Izurieta, J. C. (2017). Behavior and trends in tourism in Galapagos between 2007 and 2015. In Galapagos National Park Directorate (GNPD), Governing Council of Galapagos (GCREG), Charles Darwin Foundation (CDF), and Galapagos Conservancy (CG) (Eds.), *Galapagos Report, 2015–2016* (pp. 83–89). Galapagos Conservancy. www.galapagos.org/wp-content/uploads/2017/12/3-GR-2015-16-Tourism-section.pdf

King, J., Lalampaa, T., Craig, I., & Harrison, M. (2015). *A guide to establishing community conservancies: The NRT model*. Northern Rangelands Trust. www.academia.edu/17039125/A_guide_to_establishing_community_conservancies_the_NRT_model?auto=download

Kinnaird, M. F., & O'Brien, T. G. (2012). Effects of private-land use, livestock management, and human tolerance on diversity, distribution, and abundance of large African mammals. *Conservation Biology*, 26(6), 1026–1039. doi.org/10.1111/j.1523-1739.2012.01942.x

KWCA. (2019). *KWCA strategic plan 2019–2023*. Kenya Wildlife Conservancy Association. kwcakenya.com/download/kwca-strategic-plan-2019-2023/

LTA. (2020). *Covid-19 and Laikipia hospitality survey findings May 2020*. Laikipia Tourism Association. mcusercontent.com/d53d01de8887e62f430469897/files/481ae063-cc21-4c6a-8876-616b3c8a2de4/LTA_Covid_19_and_Laikipia_Hospitality_Survey_Findings.pdf

LWF. (2013). *The contribution of the rural economy of Laikipia as the basis of a model county*. Laikipia Wildlife Forum. web.archive.org/web/20170918050310/http://www.laikipia.org/wp-content/uploads/2015/07/Summary-Laikipia-Economic-Study-2013-E-VERSION-not-to-print-3.pdf

LWF. (2017). *The forum: A strategic plan: 2017–2030*. Laikipia Wildlife Forum. laikipia.org/wp-content/uploads/2020/03/Final-Version-Strategic-Plan.pdf

LWF. (2020, July 30). *Covid continues to take a bite out of tourism*. Laikipia Wildlife Forum. laikipia.org/covid-continues-to-take-a-bite-out-of-tourism/

Mwangi, E., & Ostrom, E. (2009). A century of institutions and ecology in East Africa's rangelands: Linking institutional robustness with the ecological resilience of Kenya's Maasailand. In V. Beckmann & M. Padmanabhan (Eds.), *Institutions and sustainability* (pp. 195–222). Springer. doi.org/10.1007/978-1-4020-9690-7_10

Norton-Griffiths, M. (2007). How many wildebeest do you need? *World Economics*, 8(2), 41–64.

NRT. (2020). *The community-level impact of COVID-19 in northern and coastal Kenya: Insights from NRT*. Northern Rangelands Trust. www.nrt-kenya.org/covid19-impact

Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. *Science*, 325(5939), 419–422. doi.org/10.1126/science.1172133

Quiroga, D. (2014). Ecotourism in the Galapagos: Management of a dynamic emergent system. *The George Wright Forum*, 31(3), 280–289. www.georgewright.org/313quiroga.pdf

Reid, R. S. (2012). *Savannas of our birth: People, wildlife and change in East Africa*. University of California Press. doi.org/10.1525/9780520954076

Roe, E. M. (1991). Development narratives, or making the best of blueprint development. *World Development*, 19(4), 287–300. doi.org/10.1016/0305-750x(91)90177-j

Turner, S. (2007). Trading old textiles: The selective diversification of highland livelihoods in Northern Vietnam. *Human Organization*, 66(4), 389–404. doi.org/10.17730/humo.66.4.g514622w58g47527

UNCTAD. (2020). *COVID-19 and tourism: Assessing the economic consequences*. United Nations Conference on Trade and Development. unctad.org/system/files/official-document/ditcinf2020d3_en.pdf

Villón, J. (2020, March 2). *Galápagos fija restricciones para prevenir casos de coronavirus en su territorio* [Galapagos sets restrictions to prevent Coronavirus cases in its territory]. El Universo. www.eluniverso.com/noticias/2020/03/02/nota/7763859/coronavirus-galapagos-medidas-viajeros

Wardle, C., Buckley, R., Shakeela, A., & Castley, J. G. (2018). Ecotourism's contributions to conservation: Analyzing patterns in published studies. *Journal of Ecotourism*. Online publication. doi.org/10.1080/14724049.2018.1424173

Western, D., & Wright, M. (Eds.). (1994). *Natural connections: Perspectives in community-based conservation*. Island Press.

WHO (World Health Organization). (2020). *WHO Coronavirus disease (COVID-19) dashboard* [Data table]. Update: 2020/10/19, 2:01pm CEST. covid19.who.int/table

Wilson, E. O. (2016). *Half-earth: Our planet's fight for life*. Liveright.

World Bank. (2017). *Standing out from the herd: An economic assessment of tourism in Kenya*. World Bank. hdl.handle.net/10986/28577

World Bank. (2020). *International tourism, number of arrivals—Ecuador* [Data set]. World Bank. data.worldbank.org/indicator/ST.INT.ARVL?locations=EC

Zwaagstra, L., Sharif, Z., Wambile, A., Leeuw, J., & Said, M. Y. (2010). *An assessment of the response to the 2008–2009 drought in Kenya. A report to the European Union Delegation to the Republic of Kenya*. International Livestock Research Institute. cgspace.cgiar.org/bitstream/handle/10568/2057/assessment_drought_2010.pdf?sequence=3

The Impact of COVID-19 Lockdown on Portuguese Households' Food Waste Behaviors

Iva Miranda Pires[1]
Interdisciplinary Center of Social Sciences (CICS.NOVA), Faculty of Social Sciences and Humanities (FCSH/NOVA), NOVA University of Lisbon, Portugal

María Ángeles Fernández-Zamudio
Centro para el Desarrollo de la Agricultura Sostenible (CDAS), Instituto Valenciano de Investigaciones Agrarias, Valencia, Spain

Berta Vidal-Mones
Center for Agro-Food Economy and Development (CREDA-UPC-IRTA), Barcelona, Spain

Rita Beltrão Martins
Centre for the Research and Technology of Agro-Environmental and Biological Sciences (CITAB), and Centro de Química—Vila Real, Universidade de Trás-os-Montes e Alto Douro

Abstract

On March 19, 2020, a State of Emergency was declared in Portugal as a way to contain the spread of the COVID-19. Restriction measures were adopted, limiting the mobility of the population.

This paper presents preliminary results of an online survey to Portuguese households on the impact of COVID-19 lockdown on food purchase, storage, management, and waste generation. A total of 841 questionnaires were collected.

The main changes observed were in food purchasing behavior, as 77 percent stated that they had reduced the frequency of grocery shopping, and 68 percent had bought more in local shops than before. Regarding food waste generation, the majority (60 percent), stated that during lockdown they threw away the same amount of food as before. 36 percent answered less than before, reporting that they had adopted strategies to reduce food waste. Vegetables, milk, and fruit were the goods with the highest reduction of food waste.

Keywords: COVID-19, food management, households, lockdown

1 Corresponding author: im.pires@fcsh.unl.pt.

Introduction

COVID-19 is the infectious disease caused by the most recently discovered coronavirus. In Europe, cases began to be detected from late January 2020 and the infection spread rapidly, affecting all countries to a greater or lesser extent. Portugal's first cases were detected on March 2, with two Portuguese citizens arriving from Italy. On March 11, the World Health Organization declared COVID-19 a global pandemic.

In this initial phase, as the virus spread around the world, Portugal decreed a State of Emergency, with three fortnightly periods of containment, which took place between March 19 and May 2, 2020. On May 3, the State of Calamity replaced the State of Emergency, allowing a gradual and slow reopening of the economy. From September 15, the State of Emergency was enforced again, to prepare for a second wave of the outbreak but lockdown was not applied— just the recommendation to stay at home and telework whenever possible.

There were only three deaths by COVID-19 (and 785 cases) recorded in Portugal when the first State of Emergency was declared on March 19, imposing restrictions on circulation in public spaces. Citizens were confined at home, allowed to leave only for health reasons, purchase of goods and services, family support, professional activities (whenever it was not possible to use telework), and short trips for the purposes of physical activity and pet walking. Recreational, cultural, sports, and catering activities and retail trade—except for those selling essential goods—were closed. In education, universities were the first to close, switching to online learning, followed closely by all other schools.

We present the results of an online survey to Portuguese households to understand how the lockdown affected their purchasing habits, food storage, and waste generation, together with how families perceived these changes. This survey was also carried out in Spain, Germany, and Ecuador, and was prepared by a group of professionals from the agrifood sector, research centers, universities, and other institutions from different countries, which created a network about food loss and waste (FLW) named "*Red Sin Desperdicio.*"

Food loss and waste

The issue of food is highly relevant for human ecology. As Valera (2014) argues, it intercepts the three directions of the human relationship—the one they build with the environments in which they live, the one the individual human being interweaves with other human beings, and the one that every human individual builds in dialogue with himself or herself. On the other hand, the way food is

nowadays produced, processed, distributed, consumed, discarded, and finally treated is dynamic, creating externalities and environmental, health, economic and social costs. Food losses and waste (FLW) is an inefficiency of global food systems (Willett et al., 2019), and its reduction is part of the solution for a transition to more sustainable food systems (Benton & Bailey, 2019).

In Portugal, we waste about a million tons of food every year along the food supply chain. This equals roughly 17 percent of all food produced for human consumption in Portugal; of that million tons of waste, households contribute around 32 percent (Baptista et al., 2012).

The data for Portugal is not particularly good, considering that the country is not self-sufficient in food production; in some products, the level of self-provisioning is only 20 percent and imports are needed to meet demand. Besides that, in some parts of the country soil erosion and lack of water threatens the ability to produce food; a situation that will be aggravated with climate change. On top of that, according to the National Food, Nutrition and Physical Activity Survey 2015–2016 (Lopes et al., 2017), the prevalence of food insecurity was 10.1 percent among the Portuguese population.

All this points to the urgency to reduce FLW in Portugal, especially at the latter stages of the food supply chain, such as households, where environmental, social, and economic impacts are higher.

Reducing FLW in households implies changing behaviors, attitudes, routines, and collective consumers' culture (Evans, 2011, 2014; Schanes, et al., 2018). FLW is usually a result of the interaction between multiple behaviors that occur at different moments of dealing with food, such as planning, shopping, storage, preparation, consumption, leftovers management, and assessment of suitability for consumption before being thrown away (Hebrok & Heidenstrøm, 2019). The importance given to aesthetics, routines, family dynamics, and shopping location (Dobernig & Schanes, 2019; Lee, 2018) are key factors that contribute to explaining a greater or lesser amount of FLW. Other less-studied factors influencing FLW generation in households are price and dietary importance (Diaz-Ruiz et al., 2018). Current food chains mainly lead by mega-retailers aim at economic efficiency, providing customers with a wide choice of cheap, high-quality goods and services, which makes it easy to purchase food without requiring much organization or planning. However, these convenient mega-retailer chains hide enormous environmental and social impacts (Christensen, 2015). The author argues that having more time would help people consume in a more political way, for instance, purchasing in local shops or farmer's markets, or using less plastics by buying bulk and local products (Christensen, 2015). Planning for purchases and making meal plans are other practices of organizing temporality that can contribute to avoiding food ending up as waste (Mattila et al., 2018).

During lockdown, the routines associated with food purchasing, stocking, preparation, and consumption changed dramatically, with most meals being consumed at home. This scenario raised some questions: Which strategies were adopted by families to cope with and adapt to the new reality? Did they change their purchasing practices? Did they purchase more food? At local grocery shops or in large supermarkets? Did they shop online more than before? Did they order takeaway more often than before? And what was the impact of all this in household food waste?

Methodology

A survey was carried out in Portugal, Spain, Germany, and Ecuador, between May 14 and June 11, 2020, coordinated by *Red Sin Desperdicio*, to which all the authors belong. The members of *Red Sin Desperdicio* participate in international networks on FLW, and during the preparation and design of the survey have collaborated with similar initiatives that were being carried out in the United Kingdom by WRAP,[2] in the Netherlands by the University of Wageningen, and in Italy by the University of Bologna.

An online questionnaire, composed of 36 questions and about 10 minutes' length, was rapidly distributed, addressing households in Portugal. Since the sample is non-probabilistic, we cannot say that the respondents are a faithful reflection of all the social strata in Portuguese society, but rather the response given by a part of the population who received the survey through social networks, institutional mailings, or from other organizations.

In Portugal, the survey was carried out between May 22 and June 5 (around three weeks after the end of the third State of Emergency, on May 1). A total of 841 valid questionnaires were collected from all regions, except Azores, with Lisbon and Oporto Metropolitan areas the most relevant groups, representing 39 percent of the answers.

The questionnaires were filled out mostly by women (71 percent), aged 19 to 76, and the rest by men aged 23 to 84. This gender bias in food- and cooking-related surveys is common and our current results are in line with what is indicated by work in Tunisian (Jribi et al., 2020) and Dutch households (van der Haar et al., 2020).

2 The Waste and Resources Action Programme (operating as WRAP).

Main results and discussion

Different authors report that when any type of crisis occurs, there are changes in attitudes towards how food is acquired or managed (Fanelli & Di Florio, 2016; Martinengo, 2014) and, by extension, an increase in waste is also to be expected.

The results of our online survey indicated that the main changes were observed in food purchasing behavior. However, in Portugal, these changes did not translate into an increase in online shopping, which had been observed in other countries that applied the same survey, but rather a reduction in the frequency of purchases, and much more shopping in local shops than before. Of the overall number of respondents, less than half (45 percent) responded that they did not buy more than usual during confinement. Next, when asked why they might buy more, only 24 percent said they were afraid or anxious. Thus, storing more food could be a consequence of having the family eating all meals at home, together with the mobility restrictions, so the need to store more food than usual might not be out of fear or anxiety, similar to what led consumers to rush into supermarkets, stockpiling nonperishable items at the beginning of confinement.

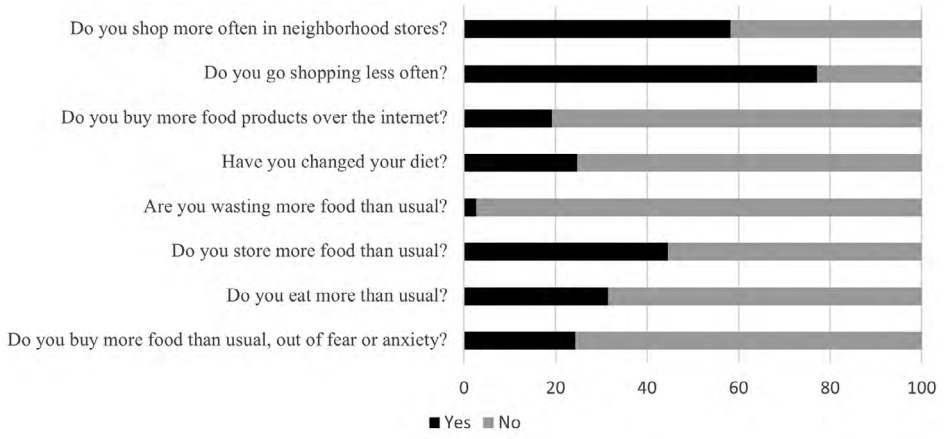

Figure 1. Survey responses to the question, "Please indicate whether you recognize some of these behaviors since lockdown started."

Source: Authors' summary of survey results.

A sudden increase in online shopping is one of the changes in purchasing behaviors associated with COVID-19, which had been reported in several countries. Online grocery shopping emerged as the pandemic spread, attracting new customers not used to purchasing from home (Charlebois, 2020). This change could be relevant: online shopping is more likely to push consumers to make more intentional choices, and to stick to their planned shopping list, therefore avoiding unnecessary purchases, which can potentially contribute to food waste reduction (Mattila et al., 2018).

Only 20 percent of survey respondents said that during lockdown they bought more food online than usual, but 77 percent stated that they reduced the number of times they went shopping (in another national survey,[3] 71 percent confirmed changes in the frequency of shopping) and almost 60 percent indicated buying more now in nearby grocery shops. These results coincide with those of other studies conducted in other countries during the lockdown (Jribi et al., 2020; Roberts & Downing, 2020; van der Haar et al., 2020).

Respondents said they were more careful when shopping; 30 percent prepared a shopping list more than in the past and only 2.6 percent said they used a shopping list less than before. Nevertheless, 58 percent admitted to maintaining their level of impulse purchases, buying goods that were not planned, and only a minority said this happened less than previously.

Respondents also stated (75.3 percent) they did not change their usual diets. Nevertheless, a survey from the National Health Service about changes in food consumption behaviors among Portuguese consumers during lockdown reported the following variations: an increase in water consumption (31.1 percent), in sweet snacks (30.9 percent), in fruit (29.7 percent) and in vegetables (21.0 percent). On the other hand, this official study registered a decrease in takeaway consumption (43.8 percent), precooked meals (40.7 percent), soft drinks (32.8 percent) and alcoholic beverages (28.2 percent)—practices associated with a more healthy way of eating (National Health Service, 2020, p. 6).

Proceeding with our survey analysis, 97 percent of the respondents stated that they did not waste more food than before and have adopted food management behaviors more often than before COVID-19. Some of the main changes reported were: 25 percent said they prepared creative and different recipes to take advantage both of all food leftovers and all edible parts of food; 13 percent affirmed they adjusted the amount of cooked food to what was actually going to be consumed; 10 percent mentioned they organized food by expiration date, to be aware of what to eat first; 9 percent affirmed they checked the fridge to monitor the state of stored food; and 6 percent said if they had leftovers, it would be used in another meal.

Eating at home more frequently, and buying more food, are the main reasons pointed out by those who admitted wasting more food during lockdown. On the other hand, those who mentioned wasting less gave the following reasons: making better use of leftovers (19 percent), cooking more efficiently (14 percent), and having less unpredictable situations (11 percent).

3 Cross-sectional observational study, with a non-probabilistic baseline sample of individuals aged 16 or more in situation of quarantine at home due to the COVID-19 pandemic. Data collection (5,874 respondents) was carried out during the period of confinement, between 04 April, 2020 and 04 May, 2020 (National Health Service (Serviço Nacional de Saúde), 2020).

Another consequence of confinement was the fall in demand for hospitality products, and the consequences this could have for increasing the overall generation of FLW in the food chain. In Portugal in particular, producers' associations reported that they had been forced to discard large quantities of food, namely perishable products such as fruit, vegetables, and milk, during the outbreak, due to the cancellation of purchases in food services and supermarkets (Mateus, 2020).

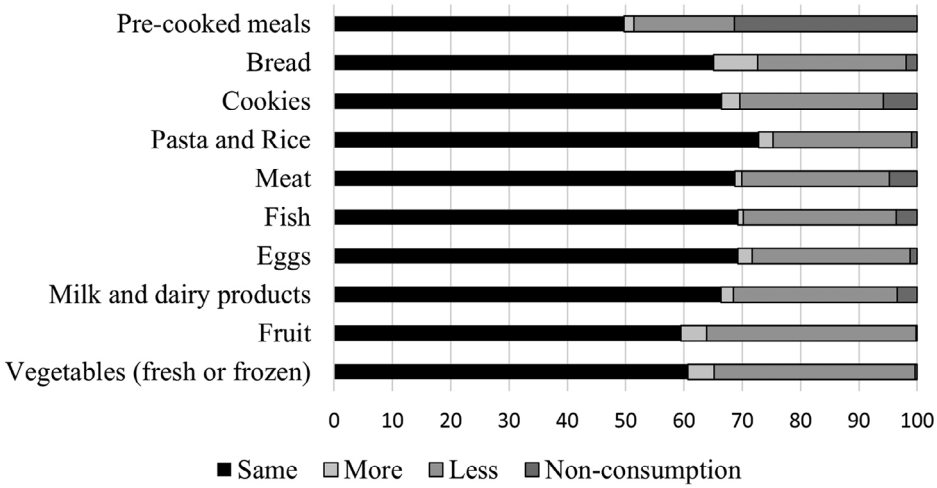

Figure 2. Survey responses to the question, "Regarding these foods, did you throw away more or less quantity during confinement?"

Source: Authors' summary of survey results.

The type of food bought may also be related to the amount of food that is wasted: the shelf life of different foods varies a lot, and when it comes to storing them at home, the best means of avoiding waste are not always available. In our survey we found that during lockdown, respondents did not change the type of food they were already throwing away, but reduced the amount between 25 percent to 36 percent, the majority being perishable goods. As an example, the reduction in fruit waste represented 36 percent, while for vegetables, 34.5 percent (Figure 2). These savings resulted from more careful management of the available food, as already discussed.

This decrease in FLW could be a result of having more time at home, which allowed better planning and organization of the tasks associated with food, giving more efficient use of the food available at home. Staying at home implies having more time, which could be used to better plan the shopping list and meals, something already confirmed in previous studies (Mattila et al., 2018). In our study, those who answered that they perceived they were wasting less mentioned: "We spend more time at home, so there is more time and a willingness to cook;" "We cook more efficiently;" "I cook food for longer so that food has more flavor;" and "We make the most of leftovers." When asked if they could estimate the amount of food that is

wasted per week, one out of two respondents said yes. But only 44 percent mentioned a value, and of these 28 percent said they waste less than 30 grams per week, even in the case of families with five members. Even if households have a positive perception that during lockdown they have reduced their food waste, that perception, when related to the amounts they are still generating, is far from the real numbers.

Having more time at home for planning and cooking, being aware of stored food and leftovers, and storing products according to their expiration dates, are some of the habits that Portuguese households implemented during the lockdown. Surely, having more time to think and act regarding food may have raised awareness of the environmental, economic, and social impacts of what we consume, leading to more responsible behaviors. If so, the perceived food waste reduction among Portuguese households may have reduced the environmental, social, and economic impacts of the food being lost or wasted at the consumer stage.

Conclusion

Based on Portuguese survey results, COVID-19 lockdown lead to a positive perception of behavior change regarding food waste. In spite of the fact that some respondents have maintained their impulse purchases, respondents said they have planned meals more in advance, and used a shopping list more often than before, from which a positive change in behavior on daily food consumption can be deduced. During this period, respondents shopped more frequently in local shops, and considerably reduced the frequency of grocery shopping visits. Some respondents mentioned reducing grocery shopping trips in order to prevent the risk of infection, creating room for new household strategies of food management, thus indirectly leading to a decrease in food waste. Apart from better shopping planning and using shopping lists, they also mentioned using leftovers to prepare new meals, using all edible parts of food, and adjusting the amount of food cooked to what was actually going to be consumed. Better food organization according to expiry dates, together with regular fridge monitoring to check the state of stored food, were also strategies adopted. As a result, 25 percent to 36 percent of the respondents have reported being successful in reducing food waste, in particular fruit and vegetables.

In conclusion, a problem as serious and global in scope as COVID-19 seems to be showing that it could contribute to reducing FLW. A change in conventional consumption models is essential, and adopting responsible consumption of food seems to be approachable. For this, the practices of buying, preserving, cooking, and consuming food at home have to change. Despite this, some questions remain unanswered: Will consumers' food behaviors observed during lockdown persist in the future? Or is this change in behavior just a belief of those who responded to the surveys, and these best practices will not have a real impact, nor be consolidated

in the future? We would like to think that there are a number of positive learnings resulting from this pandemic, but this is something we can only confirm with future studies.

Acknowledgement

This work is financed by national funds through FCT—Foundation for Science and Technology, I.P., within the scope of the project UIDB / 04647/2020 of CICS.NOVA—Centro Interdisciplinar de Ciências Sociais da Universidade Nova de Lisboa.

References

Baptista, P., Campos, I., Pires, I., & Vaz, S. (2012). *Do Campo ao Garfo. Desperdício Alimentar em Portugal, Lisboa* [From the field to the fork: Food waste in Lisbon, Portugal]. CESTRAS.

Benton, T. G., & Bailey, R. (2019). The paradox of productivity: Agricultural productivity promotes food system inefficiency. *Global Sustainability*, 2, e6. doi.org/10.1017/sus.2019.3

Charlebois, S. (2020, March 26). Why COVID-19 will change Canadian grocery industry forever. *Retail Insider E-News*. www.retail-insider.com/retail-insider/2020/3/why-covid-19-will-change-the-food-industry-forever

Christensen, C. B. (2015). Two kinds of economy, two kinds of self—toward more manageable, hence more sustainable and just supply chains. *Human Ecology Review*, 21(2), 3–22. doi.org/10.22459/her.21.02.2015.01

Diaz-Ruiz, R., Costa-Font, M., & Gil, J. M. (2018). Moving ahead from food-related behaviours: An alternative approach to understand household food waste generation. *Journal of Cleaner Production*, 172, 1140–1151. doi.org/10.1016/j.jclepro.2017.10.148

Dobernig, K., & Schanes, K. (2019). Domestic spaces and beyond: Consumer food waste in the context of shopping and storing routines. *International Journal of Consumer Studies*, 43(5), 480–489. doi.org/10.1111/ijcs.12527

Evans, D. (2011). Blaming the consumer—once again: The social and material contexts of everyday food waste practices in some English households. *Critical Public Health*, 21(4), 429–440. doi.org/10.1080/09581596.2011.608797

Evans, D. (2014). *Food waste: Home consumption, material culture and everyday life*. Bloomsbury Academic.

Fanelli, R. M., & Di Florio, A. (2016). Domestic food waste, gap in times of crisis. *Italian Review of Agricultural Economics*, 71(2), 111–125. doi.org/10.13128/REA-20075

Hebrok, M., & Heidenstrøm, N. (2019). Contextualising food waste prevention—Decisive moments within everyday practices. *Journal of Cleaner Production*, 210, 1435–1448. doi.org/10.1016/j.jclepro.2018.11.141

Jribi, S., Ben Ismail, H., Doggui, D., & Debbabi, H. (2020). COVID-19 virus outbreak lockdown: What impacts on household food wastage? *Environment, Development and Sustainability*, 22, 3939–3955. doi.org/10.1007/s10668-020-00740-y

Lee, K. C. L. (2018). Grocery shopping, food waste, and the retail landscape of cities: The case of Seoul. *Journal of Cleaner Production*, 172, 325–334. doi.org/10.1016/j.jclepro.2017.10.085

Lopes, C., Torres, D., Oliveira, A., Severo, M., Alarcão, V., Guiomar, S., … Ramos, E. (2017). *Inquérito Alimentar Nacional e de Atividade Física, IAN-AF 2015–2016: Relatório de resultados* [National food, nutrition and physical activity survey, 2015–2016]. Universidade do Porto. ian-af.up.pt/sites/default/files/IAN-AF%20Relat%C3%B3rio%20Resultados_0.pdf

Martinengo, M. C. (2014). Household food waste and consumer culture: Reflections on Italian behaviour. *Journal of Nutritional Ecology and Food Research*, 2(1), 73–77. doi.org/10.1166/jnef.2014.1062

Mateus, C. (2020, May 16). *Covid-19. Toneladas de alimentos estão a ser deitados ao lixo. E nem a cerveja escapa* [COVID-19. Tons of food are being thrown away. And not even the beer escapes]. Expresso. expresso.pt/economia/2020-05-16-Covid-19.-Toneladas-de-alimentos-estao-a-ser-deitados-ao-lixo.-E-nem-a-cerveja-escapa

Mattila, M., Mesiranta, N., Narvanen, E., Koskinen, O., & Sutinen, U-M. (2018). Dances with potential food waste: Organising temporality in food waste reduction practices. *Time & Society*, 28(4), 1619–1644. doi.org/10.1177/0961463x18784123

National Health Service (Serviço Nacional de Saúde). (2020). *REACT-COVID, Inquérito sobre alimentação e atividade física em contexto de contenção social* [REACT-COVID: Survey on food and physical activity in the context of social containment] [Survey report]. www.dgs.pt/programa-nacional-para-a-promocao-da-atvidade-fisica/ficheiros-externos-pnpaf/rel_resultados-survey-covid-19-pdf.aspx

Roberts, M., & Downing, P. (2020). *Citizen responses to the COVID-19 lockdown—Food purchasing, management and waste*. WRAP. wrap.org.uk/sites/default/files/2020-10/WRAP-Citizen_responses_to_the_Covid-19_lockdown_0.pdf

Schanes, K., Dobernig, K., & Gozet, B. (2018). Food waste matters—A systematic review of household food waste practices and their policy implications. *Journal of Cleaner Production*, 182(1), 978–991. doi.org/10.1016/j.jclepro.2018.02.030

Valera, L. (2014). *Human ecology and food. Encyclopedia of food and agricultural ethics*. Springer. doi.org/10.1007/978-94-007-6167-4_168-1

van der Haar, S., Zeinstra, G., Bos-Brouwers, H., & Janssen, A. (2020). *COVID-19 and the effects on Dutch consumers' food waste behavior* [Survey report]. Wageningen University. www.wur.nl/upload_mm/1/6/3/c0927cca-db6e-441c-ac25-8fe8c9c87ade_200702%20Results%20Covid19%20Food%20Waste%20study%20FINAL.PDF

Willett, W., Rockström, J., Loken B., Springmann M., Lang, T., Vermuelen, S., … Murray, C. J. L. (2019). Food in the Anthropocene: The EAT-Lancet Commission on healthy diets from sustainable food systems. *The Lancet*, 393(10170), 447–492. dx.doi.org/10.1016/S0140-6736(18)31788-4

Research and Theory in Human Ecology

Beyond Challenges in Community-Based Adaptation: Critical Insights from the Human Ecology Framework

Hannah M. Barrowman[1]
Centre for Deliberative Democracy and Global Governance, University of Canberra, Australian Capital Territory, Australia.

James R. A. Butler
Sustainable Pathways Program—Land and Water, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Queensland, Australia.

Abstract

Community-based adaptation (CBA) is a common policy response in international development yet often encounters challenges with implementation and longevity. Using a human ecology and systems thinking framework and data from the Climate Change Adaptation Project (CCAP), implemented in Akar Akar village, Indonesia, this study explores the drivers of challenges affecting CBA. Results demonstrate that challenges affecting CBA are numerous, interconnected, and can derive from the disconnect between the world views of implementors and the politics, social structures, and historical processes influencing local activities. Challenges encountered in the CCAP project, for example, were found to derive from the implementors' emphasis on agency, self-organization, and responsibilization of women as a way to alleviate community poverty and improve adaptive capacity and its failure to comprehend the sociopolitical position of women in Akar Akar. With these findings in hand, this study advocates the use of systems thinking in future CBA research and intervention design.

Keywords: adaptation challenges, Climate Change Adaptation Project, community-based adaptation, human ecology framework, Indonesia

Introduction

Community-based adaptation and emerging challenges

Community-based adaptation (CBA) is now a common policy response in international development efforts in mid- to low-income nations considered vulnerable to climate change (Kirkby et al., 2015), including Indonesia. CBA can be

1 Corresponding author: hannah.barrowman@canberra.edu.au.

defined as adaptation—"an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC,[2] 2014, p. 838)—that operates at the community level and is "based on community priorities, needs knowledge and capabilities" (Reid et al., 2009, p. 1). The guiding premise behind CBA is to equip communities with the information and tools necessary for them to make decisions and take action that will increase livelihood resilience to climate change and contribute to their well-being over the longer term. While CBA aims to be community-driven and bottom-up, in practice it tends to be driven and supported by external organizations—namely nongovernmental organizations (NGOs) and donor organizations (Osman-Elasha & Sanjak, 2008).

With increasing application of CBA across different geographical contexts, it has become apparent that there are numerous challenges facing CBA, which may delay or prevent desirable adaptation outcomes (Spires et al., 2014). This is not a novel claim but one that has been, and continues to be, actively scrutinized in both the CBA and broader climate change adaptation literatures. Scholars have found, for example, that CBA is often constrained by the small-scale, short-term, and stand-alone nature of such projects and the artificial channels of resources and support (i.e., delivered through donor agencies and not through existing government mechanisms), which are effectively cut off when projects end (Simane & Zaitchik, 2014). Others have found that external groups tend to utilize the notion of "community" in project design, rendering CBA activities ignorant of or unable to deal with surrounding social dynamics, power imbalances, and the personal interests of particular groups, as well as the changes that are currently taking place in traditional structures and norms (Dumaru, 2010; McNamara & Buggy, 2017). Genuine collaboration among stakeholders to facilitate CBA has also been found to be difficult to achieve due to entrenched government planning processes, vested political interests, and rapid change (Butler, Bohensky, Suadnya, et al., 2016; Butler, Suadnya, et al., 2016; Butler et al., 2015).

Such studies have been important in directing research efforts towards more appropriate solutions in CBA, such as the need to consider traditional power dynamics that exist at the local level (Ensor et al., 2018; McNamara & Buggy, 2017), to work with local institutions such as markets (Simane & Zaitchik, 2014), as well as the need to consider how challenges encountered in CBA interact and overlap across scales, from the international to the local (Spires et al., 2014), and therefore require multi-stakeholder collaboration (Butler et al., 2015). However, while taking stock of the nature and extent of challenges is a fast-growing component of the CBA literature, rarely are challenges explored through a systems lens. For the most part, scholarly discussions of challenges encountered in CBA remain fixed on processes

2 Intergovernmental Panel on Climate Change.

and events at a single scale and often fail to acknowledge, at least explicitly, the causal linkages between local-level challenges and broader-level geopolitical and economic activities (Butler et al., 2014).

We argue that such a framing and analysis is now essential for the CBA field if more effective and sustained adaptation is to occur. In this paper, we present a human ecology framework for assessing CBA challenges: one that embraces a systems approach in research and focuses not only on the phenomena of concern (i.e., CBA challenges), but also on the causal linkages and interrelationships that exist between them.

The human ecology framework

What is human ecology?

Human ecology is a research discipline concerned with understanding the interrelationships between humans, their cultures, and their ecosystems (Dyball, 2010), and some of the earliest attempts to integrate social determinants into assessments of natural hazards and disaster risk reduction can be found in the work of human ecologists (see Pelling, 2001). The field has progressed significantly over the past century, and while early contributions in human ecology emphasized environmental variation as a key causal mechanism influencing social change, vulnerability, and adaptation, contemporary human ecologists have adopted a more systems-based approach whereby humans and their environment exist as "parts of a single, complex interacting system" (Dyball, 2010, p. 12), rather than as separate entities. Dyball and Newell (2015) go further and identify four broad and categories of variables, or subsystems, of the human ecological system: (1) the state of the environment; (2) the state of human health and well-being; (3) the state of community; and (4) the state of cultural paradigms. Table 2 describes these subsystems in greater detail and draws links between human ecology and the CBA research agenda.

According to Dyball and Newell (2015), these subsystems interact with one another through feedback processes that constrain, adjust, and/or reinforce each other's quantity and extent, and thus the behavior of the system as a whole. As such, the broader human ecological system can be seen as existing primarily as a feedback system and definable not necessarily by its parts but by the way its parts interact across time and space. To analyze this complex human ecological system and its interacting parts, Dyball and Newell (2015) develop the Cultural Adaptation Template (CAT), which promotes "feedback-guided analysis" as a means of understanding change in complex human ecological systems and suggesting points of appropriate and just interventions. The CAT applied in our study is presented in Figure 1 and detailed in Table 1.

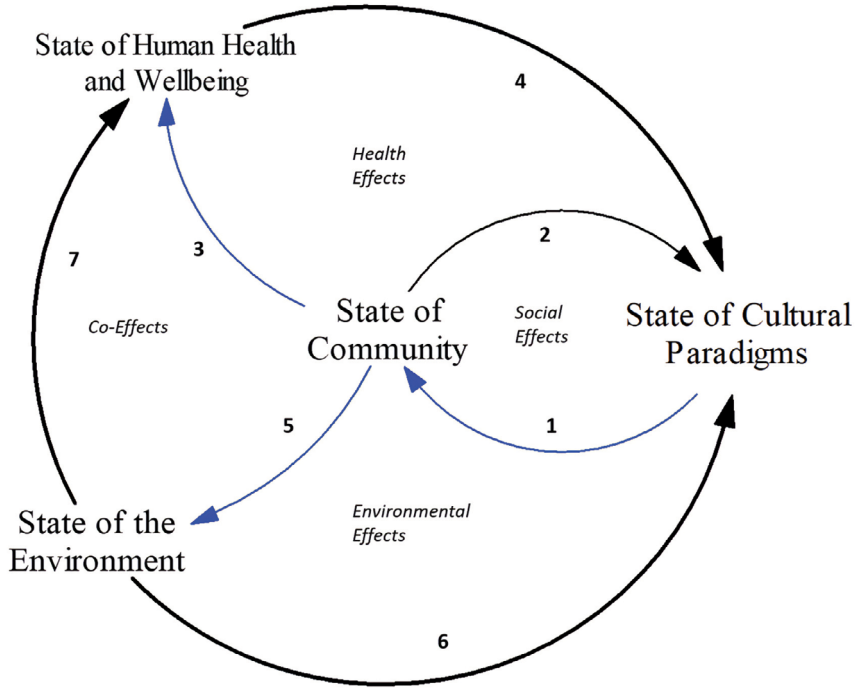

Figure 1. The human ecology framework, also termed the Cultural Adaptation Template (CAT). See Table 1 for descriptions of the links.

Source: Adapted from Dyball and Newell (2015).

Table 1. Description of links between the different variables (or states) in the CAT. See Figure 1 for linkages.

Link	Process or interaction represented by link
1	The influence that a cultural paradigm has on the state of institutions. This may include the nature of and the way in which particular paradigms construct policy and plans, and help societies determine right from wrong (e.g., bureaucratic or legislative norms towards issues of corruption and clientelism, and stereotypes and prejudices around gender or class). These affect cognitive biases (or framings of logic), intergroup relations, trust, and social cohesion needed to support collective and collaborative actions.
2	The process of observing and learning from past experiences. As societies learn from experiences, they may question, reinforce, or alter the dominant paradigm under which they work. The questioning of dominant beliefs, or making them redundant, allows new institutions to emerge and take shape.
3	The effects that human rules and institutions may have on an individual or a society's health and well-being, including physical and psychological stress.
4	The process of observing and learning from rules and institutions, and their impacts. As individuals and societies reinforce or modify their institutions, dominant paradigms may shift, and new ones may emerge. As with Link 2, this process may lead to the emergence of new paradigms with which to guide society.
5	The implications and/or benefits that human rules and institutions may have on the biophysical environment, including natural ecosystems, the climate, and essential life-sustaining systems.

Link	Process or interaction represented by link
6	The process of observing and learning from environmental change and human impact. As ecosystems change, adapt, or degrade in response to human rules and institutions, dominant paradigms may be reinforced or questioned, resulting in the perpetuation of paradigms or the emergence of new ones.
7	The direct effect that environmental conditions have on human health and well-being, including the availability of natural resources and ecosystem services, and the intrinsic conditions providing for the maintenance of culture and identity.

Source: Adapted from Davila (2018).

Human ecology and community-based adaptation

Building on Table 1 and the theoretical framing outlined by Dyball and Newell (2015), human ecology is used here as an analytical framework to capture those variables that influence or result in challenges encountered in CBA, be they underlying paradigms, human institutions, or ecosystems (Figure 1 and Table 1). We work with the four generic variables considered important under the human ecology lens—cultural paradigms, community, the environment, and human well-being—and align these with the major elements of the CBA approach (Table 2). By highlighting the complementarities between human ecology and CBA, we hope to not only examine the complex nature and systemic drivers of challenges in CBA, but to also highlight why human ecology and the systems approach may play an important role in future CBA research.

Table 2. Description of the four human ecology categories and their specific relationships to CBA.

State of cultural paradigms	Describes the collectively held knowledge, beliefs, and values that govern society's judgments. Importantly, these values or belief systems may be held and shared collectively, by a broader community, or they may instead be held by a small but powerful group of elites who use paradigms, or discourses, to extend control over marginalized and oppressed groups.
relationship to CBA	Cultural paradigms or framings of the climate change problem give rise to different conceptualizations of vulnerability which, in turn, determine the nature of adaptation activities to be carried out, at what scale, and who should be involved.
State of community	Describes the formal and informal institutions or social rules that guide collective action and everyday life. Formal rules can be thought of in terms of the state-based institutions as well as state-enforced rules. Informal institutions relate to the socially shared rules, usually unwritten, that are communicated, created, and enforced outside officially sanctioned channels (Helmke & Levitsky, 2003).
relationship to CBA	CBA relies on formal institutions to build an enabling environment. By prioritizing adaptation or other national issues, formal institutions can work to support or constrain adaptation opportunities and activities at the local level. Similarly, informal institutions can help to guide and normalize new, adaptive behavior, as well as constrain such behavior. Both formal and informal institutions can work to promote or restrict inclusive forms of decision-making at the local level and thereby discriminate against, either positively or negatively, marginalized or minority groups including women, children, disabled groups, or religious or ethnic minorities, potentially leading to maladaptation.

State of the environment	Describes the state of the biophysical system and its elements, including both the natural environment and its man-made features such as transport infrastructure, buildings and urban spaces, and agriculture landscapes.
relationship to CBA	The capacity of local communities to adapt to a changing climate is linked to, among other things, the biophysical environment (natural and man-made), and its health. Natural environments provide buffers against climate change impacts including sea level rise, storm surge, and coastal flooding, and thus the health of the natural environment is integral for vulnerability reduction and effective adaptation. Similarly, man-made physical infrastructure maintains and improves access to important resources that may be scarce during times of hardship. At the same time, physical infrastructure may degrade the health of natural environments, such as new roads degrading storm-buffering mangrove forests, increasing societies' vulnerability to storm damage.
State of human health and well-being	Describes all of those factors that constitute "living well." This includes indicators of good health, such as adequate nutrition, as well as indicators of well-being, such as mental stability, identity, and cultural health.
relationship to CBA	The capacities of local communities to adapt to climate change is dependent on, among other things, a community's physical and material capacity to make necessary and sometimes substantial changes to their livelihood or lifestyle. Human health and well-being are projected to be significantly impacted by climate change due to the expansion in distribution of vector-borne diseases, increased heat stress, and reduction in crop production and nutrient value of crops.

Source: Author's summary of approach.

The aims of this paper are: (1) to apply the human ecology framework (Table 1) to develop novel understandings of the nature of challenges encountered in CBA, including their drivers and impacts, and (2) to demonstrate the usefulness of the human ecology framework for future research on CBA. Here, we are particularly interested in demonstrating how human ecology may elucidate systemic drivers of local challenges encountered in CBA. To test our approach, we use a CBA case study recently implemented in villages on the island of Lombok, Nusa Tenggara Barat, Indonesia: the Climate Change Adaptation Project (CCAP). The rest of the paper is organized as follows: In the next section, we describe the case study in which this research is set, introduce the CCAP, illustrate the CCAP's mental model of the Akar Akar social–environmental system, and describe how the system would, ideally, respond to the CCAP team's intervention. The research methods are then outlined and, following on from this, the four system states of the case study are described. Their relationship with one another is then analyzed and discussed and contrasted to the mental model set out in Figure 3. The paper concludes by highlighting the novel contributions this study provides to the CBA literature and the opportunities the human ecology framework has for future CBA research.

Case study and research methods

Case study: Climate Change Adaptation Project in Akar Akar, Nusa Tenggara Barat, Indonesia

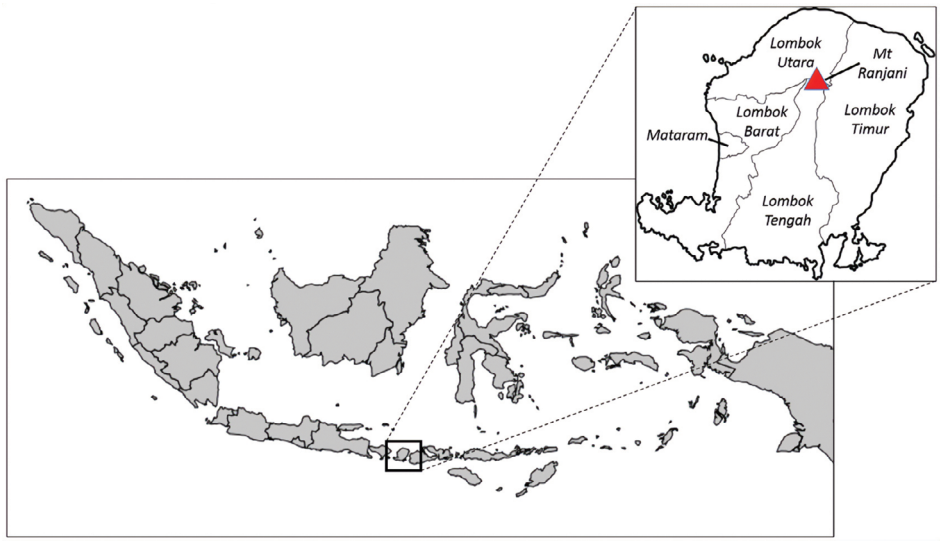

Figure 2. Map of Indonesia showing Lombok Island and the district government boundaries of Lombok.

Source: Authors' own.

Akar Akar village, Lombok Utara

Akar Akar is located in Bayan subdistrict, Lombok Utara district, in Indonesia's eastern province of Nusa Tenggara Barat (NTB) (Figure 2). Like much of the province, the climate of the Bayan is tropical and strongly influenced by the Asian monsoon, which produces wet and dry seasons, and the El Niño Southern Oscillation weather phenomenon, which generates drought periods or wetter-than-average years. The presence of Mount Ranjani creates a microclimate for western and northwestern parts of Lombok Island, including Akar Akar village, that has relatively wetter conditions than eastern parts. Climate projections suggest that annual rainfall in this area could decline significantly (McGregor et al., 2016), and the wet season may become truncated, resulting in negative impacts on water availability and agriculture (Kirono et al., 2016).

According to the last national census data (Badan Pusat Statistik, 2010), Lombok Utara had a population of just over 200,000 inhabitants. The predominant language is Sasak, however Bahasa Indonesia is also widely spoken, particularly with outsiders. Though Islam remains the dominant religion in Bayan subdistrict, many residents throughout the area, including those in Akar Akar, are characterized as *Wetu Telu,*

or "three prayers" (Budiwanti, 2014). Wetu Telu practice a less orthodox version of Islam whereby they pray three times a day and remain more concerned with ancestry worship, local spirits, and supernatural powers residing in certain objects and locations (Budiwanti, 2014). Akar Akar village is headed by a *kepala desa* and governed by a village government.

Livelihood systems in Akar Akar rely heavily on agriculture, and cassava is the predominant crop type. Income for agriculture is sometimes supplemented by seasonal migration of people to urban areas in Indonesia, but unlike many other parts of Indonesia emigration to other nations for labor is not a dominant livelihood strategy.

Climate Change Adaptation Project (CCAP)

The CCAP was implemented between 2010 and 2014 (see summary in Butler, Bohensky, Darbas, et al., 2016). Adaptation strategies were designed and implemented across NTB province, with a majority on Lombok Island. The CCAP differed from a typical CBA project in that it focused on building the adaptation planning capacity of government, universities, civil society, and private sector groups operating at different jurisdictional levels. In particular, it aimed to build the capacity of local researchers to become "system-thinkers" and "change agents," who could then integrate climate change and adaptation considerations into future development initiatives in the region. This multi-stakeholder platform helped to engage stakeholders, from the village to the international level, to identify livelihoods most vulnerable to future changes in climate in NTB; codesign appropriate adaptation strategies, which could be mainstreamed into development planning at national, provincial, and local levels; provide evidence-based climate adaptation policies linked to poverty alleviation; and trial novel adaptation strategies in vulnerable villages.

Different adaptation strategies were trialed in different villages (Butler, Bohensky, Suadnya, et al., 2016). In Akar Akar, the CCAP introduced a cassava-processing project. On top of reducing the vulnerability of Akar Akar to the increasing risk of drought (e.g., by shifting local diets away from rice and towards cassava), this strategy also aimed to provide additional income for local women (through the selling of processed cassava) and improve nutrition by diversifying local diets. This strategy involved three main activities: (1) training in food processing and packaging; (2) distribution of cassavaprocessing equipment to local households; and (3) the development of a local women's group to help support participating women. A mental model (schema) of the CCAP's adaptation strategy in Akar Akar, in the form of a systems diagram, is presented in Figure 3 and the ideal processes taking place between each variable are described in Table 3. This systems diagram demonstrates how the system would behave, under ideal circumstances, after the intervention to empower women and build broader adaptive capacity is undertaken. Study results (described in the following section), which depict what actually took place, contradict this schema.

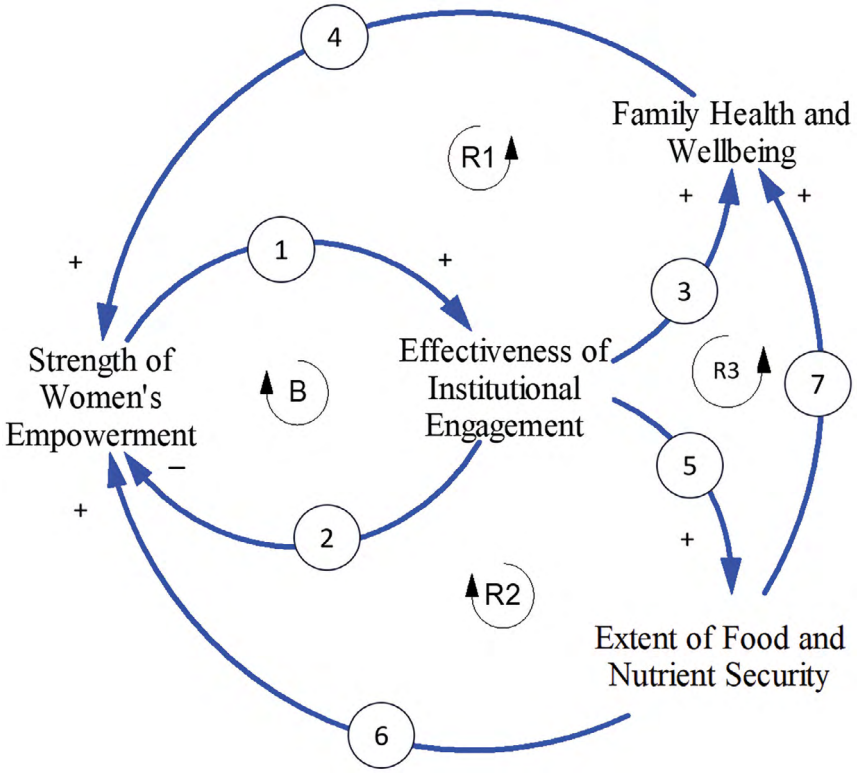

Figure 3. A systems diagram representing CCAP's mental model of the Akar Akar social–environmental system and how it would respond to the team's intervention.

Table 3 below describes the ideal processes taking place.

Source: Authors' representation.

Table 3. Description of processes (links) represented by arrows linking categories of variables indicated in Figure 3.

Link	Process or interaction represented by that link
1	The process of empowering women (through collective decision-making and income generation) is believed to lead to a change in the formal and informal institutional effectiveness in the same (+) direction—that is, increasing it.
2	The process of observing increased institutional effectiveness—as indicated by success in developing collective behavioral guidelines, support, market engagement, and policies at local and regional levels—changes, in the opposite (–) sense, the belief in further strengthening because at some point, a sense of optimum effectiveness has been achieved and no further strengthening is needed. L1 and L2 form a balancing social effects feedback loop (B) that ensures the system grows to a point of desired climate change resilience, food security, and family health. This system then self-regulates, driving new cycles of corrective adaptive behavior if key variables start to change the system in an undesirable direction.

Link	Process or interaction represented by that link
3	The process of developing effective engaged institutions (e.g., the market and government support) drives change in family health and well-being in the same direction (+). For example, as policies and market incentives encouraging processing of cassava are developed, income from cassava sales increases.
4	The process of observing increases in family health and well-being, such as through observing reductions in levels of poverty and increases in nutrition, drives change in the belief that empowering women is a good idea in the same direction (+)—thereby reinforcing this belief. L1, L3, and L4 form a virtuous reinforcing well-being effects feedback loop (R1).
5	The process of developing effective engaged institutions drives change in food and nutrient security in the same (+) direction, as represented by diversity of crops grown, notably the amount of cassava, and a movement away from reliance on rice.
6	The process of observing successful flourishing of diverse crops feeds back to drive change in the belief that empowering women is a good idea in the same direction (+)—here reinforcing it again. L1, L5, and L6 form a virtuous reinforcing feedback loop (R2).
7	The process of changing the level of food and nutrient security directly effects family health and well-being through the provision of nutrients and dietary diversity, ecosystem resilience, and other environmental services. L1, L5, L7, and L4 form a virtuous reinforcing co-benefits feedback loop (R3).

Source: Authors' summary (see Figure 3).

Research methods

This study relies on data collected from 22 open-ended interviews and two focus group discussions (FGDs). Interviews were conducted with individuals including farmers, local businesspeople, village heads, local government staff (district and provincial levels), local and international NGOs, and researchers. FGDs and interviews were conducted in February and March 2016 and again in February and March 2017. Interviews with those at the village level (e.g., farmers, village leaders, local businesspeople, and local NGOs) were conducted in Akar Akar village, while interviews with government staff, researchers, and staff from international NGOs were carried out in the Mataram, the provincial capital. Interviews were conducted in Bahasa Indonesia and, with the support of a local translator, were later translated and transcribed into English. While interviews required individuals to discuss the opportunities and challenges they had encountered in participating in the CCAP, and in sustaining adaptation strategies beyond the project's lifecycle, FGDs required participants to discuss the expectations they had for CCAP at its commencement in 2011, and then to consider whether these expectations had or had not been met.

Transcripts from interviews and FGDs were coded and analyzed using *NVivo*, a qualitative data processing software program. Data were coded into predefined themes or categories of barriers and challenges that were highlighted or discussed by interviewees. These themes/categories related directly to the categories of the human ecology framework described in Table 2. In order to populate the CAT

diagram, we addressed the overall research question: "with regards to CCAP, what were the challenges that you encountered when trying to implement and maintain the adaptation activities specific to the project?"

In the following section, we summarize the various challenges encountered by different actors in the Akar Akar case study, which is divided into the categories of the human ecology framework. We then populate the feedback system model and discuss the key variables or drivers that are influencing the outcomes of the case study's adaptation activities.

State of the environment

Changing climate and degrading environmental conditions were the original justifications for the CCAP. Rather than discuss the state of the environment, we take global climate change and associated local impacts (e.g., increases in drought conditions, shifts in seasonal rainfall patterns) as likely, and examine how other system states interact with climate change impacts to affect community vulnerability. Here, we therefore describe the state of the environment as perceived by the project design.

In 2010, when project scoping was being carried out, NTB was considered highly sensitive to climate change. According to the World Food Programme (WFP), climate threats to NTB region, including Akar Akar, included increasingly drier conditions over the coming decades, changes in existing seasonal patterns and an increase in average air temperatures (World Food Programme, 2013). Given the region's reliance on agriculture for income and subsistence, climate change was expected to have significant impacts on food security through reduction in crop production and increases in the cost of staple, nutritious food (World Food Programme, 2013). These projections were confirmed and refined by subsequent modeling, which showed that Lombok Utara was likely to become one of the most impacted districts in NTB (Kirono et al., 2016; McGregor et al., 2016).

State of human health and well-being

As with the state of the environment, concerns about the state of human health and well-being at the local level in NTB provided justification for CCAP to implement a cassava-processing intervention in Akar Akar village. Again, rather than discuss the state of human health and well-being in Akar Akar, we describe it from the perspectives of CCAP, and examine how other system states interact with health and well-being.

According to the CCAP team, climate change is projected to have a strong impact on crop production in Lombok Utara, particularly rice, potentially resulting in shortages in rice production and increases in local rice prices. The CCAP's multi-stakeholder, codesigned process had identified the diversification of agricultural production as an important "no regrets" adaptation strategy to reduce the community's vulnerability to drought conditions—which particularly affect rice. At the same time, rice was also seen to have less nutritional value than other carbohydrates, such as wheat, corn, and tubers (i.e., cassava, sweet potato, and taro). Indeed, there was a general concern in the project team about the high consumption of white rice in the region and its impact on increasing rates of noncommunicable diseases, such as diabetes, and the lack of diversity in local diets, particularly in poorer rural areas. Currently, 1.3 percent of the population in NTB suffer from diabetes and diabetes-like symptoms, and over 2 percent suffer from coronary heart disease, which is one of the highest rates in the country (Cardiovascular Division & Health Services Research Centre, 2017).

Another justification was concern about the degree of poverty in NTB. Currently, 14.8 percent of the NTB population lives below the national poverty line (Badan Pusat Statistik Provinsi Nusa Tenggara Barat,[3] 2018), compared to a national rate of 9.8 percent (World Bank Group, n.d.). By selling processed cassava products, rather than in its raw form, community members and women in particular would be able to generate greater income as well as receive income throughout the year as opposed to only seasonally.

Thus, by encouraging a shift away from a reliance on a rice-based diet, the CCAP process had identified an adaptation strategy which would increase food security, improve the nutrition of local diets, and generate additional income for women and poorer households. However, as is discussed below, this strategy had implications for community members participating in the project.

State of cultural paradigms

To implement the strategy, the CCAP team sought to establish a women's association, which was to become known as "Mekar Makmur," or "women's group," to carry out village-based cassava processing. Through the women's group, women were educated in the importance of nutrition in the family, trained how to use the cassava-processing technology (to make *sawut* or shredded cassava, chips, and flour), and trained in product promotion. A leader was selected to engage with others in the village, when needed, particularly with the CCAP team, village government, and extension officers from the local government (Women's FGD, March 2016).

3 Central Bureau of Statistics, West Nusa Tenggara Province.

According to the CCAP team, women were targeted "due to the fact that all household food activities such as getting groceries, and their distribution, food preparation and processing are their responsibility."[4] In this sense, women were therefore seen as "change agents" who could address environmental degradation problems and other social issues including health—an emerging discourse or strategy in international development—helping "diversify their families' diets and provide alternative employment at home" (CSIRO Land and Water, n.d., p. 7). While the approach was seen as one of "empowerment of the most vulnerable beneficiaries … including women and children" (Meharg et al., 2015, p. 17), it does, at the same time, force responsibility for the health and well-being of families and the broader community on individual women in Akar Akar.

Such discourses (development through empowerment and self-organization) have been criticized by critical development scholars as taking the "distinctly neo-liberal formulation" of the World Bank (Li, 2006, p. 5), whereby communities of poor, rural, and/or remote people are encouraged to take on the responsibility of their own poverty alleviation by engaging with markets, learning how to conduct themselves in a competitive arena, and making the appropriate and rational choices where needed. At the same time, by focusing specifically on women and using women as tools to achieve project outcomes, the project effectively engaged in determining the role of women in the village. In this case it was the role of overseeing family diets, health, and well-being and, by extension, the community's health and well-being. In other words, women were seen as mothers and not much else.

As will be discussed below in the "State of Community," this approach did not have the desired effect on improving health and well-being and, instead, the targeting of women resulted in significant challenges for the project and the continuation of cassava processing.

State of community

In this example, the state of institutions, which relates largely to the state of institutions influencing the social ecological environment, is divided into two subsets: formal institutions and informal institutions.

With regard to the formal institutions, interviews with community members uncovered challenges to gaining and maintaining interest, and therefore support, from local government. For the most part, there was limited formal government involvement in the project, despite government staff participating in meetings and workshops earlier in the CCAP process. Villages highlighted how "they just turn

4 Quote taken from a CCAP project proposal to research cassava processing, accessed during the research and now unavailable.

up to meetings," "only send junior staff," "never respond to requests for support/ resources" (Men's FGD, March 2016). Some attributed this to the fact that local governments are rarely supportive of or interested in projects that do not align with national priorities. For example, villages highlighted how the government only gave support when projects/activities focused on "priority" crops, namely rice and corn, and not cassava, and, more broadly, focused on economic and infrastructure development. Others highlighted how, by having women run and facilitate the project, it was always destined to fail as "women in the village don't talk to men from outside the village" (interview with extension officer, Akar Akar, March 2016).

This then relates to informal institutional barriers. In Akar Akar village, women do not usually interact with local government or, more broadly, men from outside the village and, for the most part, it was this subordinate role of women in Akar Akar village that proved to be a major hurdle for both project participants and the project team. For example, during the FGDs, female participants reiterated that "we didn't communicate with the [local] government at all … we usually don't communicate with people outside our village" (Women's FGD, Akar Akar, March 2016). Upon reflection, the project leader also highlighted that one of the team's main challenges was the support and drive of the women's group, mentioning that "in thinking about why the woman's group is not so successful we realized it was because it's only woman … [but] woman don't know how to go to Mataram, they are very shy and they never leave the village, and never speak out" (interview with project team leader, April, 2016). Indeed, members of the women's group highlighted how it is not common practice for them, as women, to interact with those in higher or more influential positions or, in fact, anyone from outside the community (Women's FGD, March 2016). Instead, this type of interaction typically takes place between men. As such, this led to challenges when women tried to obtain new and more appropriate cassava-processing tools and facilities from local government. Rather than engaging directly with government, members of the women's group had to go through their husbands or other men, delaying the communication process, or curtailing it entirely.

Discussion

This study provides a novel understanding of the nature of challenges experienced in CBA and the drivers of, or interactions between those challenges. In doing so, this study also provides an additional important contribution by demonstrating how the human ecology framework can be used to extend existing framings of problems and solutions in CBA scholarship, and climate change adaptation scholarship more broadly.

The feedback diagram outlined in Figure 3 represents the CCAP's mental model of how the system would behave after the intervention in Akar Akar was carried out. However, as the results from this study highlight, the process of empowering women (L1) was never actually achieved in reality (proving to be a negative polarity) and the ideal outcomes of the intervention could not be met. The following discussion aims to explain why this ideal was never met in reality and starts to link challenges encountered in one state with those challenges encountered in other states. In doing so, the following discussion is able to demonstrate the complexity and multidimensional nature of challenges experienced in CBA.

Subordination of women and vulnerable people through CBA

First, the strength of the "women empowerment" discourse meant that women became the target of the project and the driver for cassava-processing activities going forward. However, as encountered in this study, one of the core challenges highlighted by nearly all participants of the women's group was the lack of access to formal decision-making platforms or to individuals holding influential positions. The limited access they had to local government was exacerbated when women needed new or better cassava-processing technology. The fact that men tended to be the primary actors in decision-making and in communicating and interacting with those from outside the community, including local government, meant that it was difficult for members of the women's group to follow up with other groups/stakeholders on project needs. Therefore, any problem encountered in the project, such as the need for more, or more appropriate, cassava-processing tools and equipment, had to be communicated by women to village men, mostly husbands, and then on to village and district government. The result was that response from government was rare, limited, or ill-informed.

At the same time, the process of responsibilizing women, not only for the purposes of reaching project objectives, but for improving the health and well-being of the community as a whole, is, we argue, not too dissimilar to the various state-based ideologies used to control women throughout Indonesia's recent history (Blackburn, 1994; Hadiwinata, 2003; Purba, 2011). For example, Suharto's political rhetoric of "family unity and strength" was used to reinforce specific gender-based roles within Indonesian families and broader Indonesian society (Purba, 2011). For the most part, this rhetoric had the effect of characterizing the role of women in Indonesian society as mere mothers and wives, whose functions and status were to support their husbands in performing public roles to achieve economic development (Purba, 2011). Such roles oriented around domestic life and tended to be undervalued and had the effect of reducing women's access to higher socioeconomic status and political power in Indonesia, meaning that women experienced greater levels of subordination

and marginalization. Consequently, many women in Indonesia now face social structures that have and continue to disadvantage them in becoming more involved in public affairs, where male domination remains common and uncontested.

During the FGDs, women also discussed the roles that they carried out on a daily basis such as domestic chores of cooking for the family, cleaning the house, and assisting their husbands in agricultural work; all of which were encouraged under the New Order Regime (Berninghausen & Kerstan, 1992; Thorbecke & Pluijm, 1993). Importantly, the project in Akar Akar tried to counteract these roles, at least to some extent, by offering women an alternative and independent means of income generation. In doing so, we argue that this was a key shortcoming of the project design as it purposefully set out to generate women change agents in the community, and manipulated the role of women, albeit through alternative practices and for different goals. Furthermore, by focusing specifically on women, emphasizing women's empowerment and self-organization in this way and ignoring the social dynamics of Akar Akar and their historical roots, the project weakened the capacity of the community as a whole to make or act on decisions. This state is represented by the variable "strength of decision-making mechanisms in the community."

Bypassing local government

Second, by focusing on "autotomising" (Rose, 1999) community residents and researchers, the project essentially reduced the need for local government to be involved in the project, represented by the variable "extent of government involvement in community-based adaptation project." Members of the Akar Akar community found it difficult to generate and maintain interest from local government and were unable to get support when needed. Indeed, this lack of government support is a common outcome for many development projects engaging with the discourse of community self-organization, agency, and responsibilization in poverty alleviation (Harriss et al., 2005; Li, 2006), and in contexts where working with local government is seen as too risky by development partners. Prominent examples of this in Indonesia can be seen in the actions of the international development community in the wake of the Indonesian tsunami in 2004 when the World Bank, and its development partners, used the World Bank's own village funding mechanism—the Community Driven Development program—as the primary vehicle for aid delivery to villages across affected regions of Indonesia. As Cliffe et al. (2003) highlight, such a process has seen the systematic undermining of local government ownership over service delivery in Indonesian villages and has placed subnational governments in a weaker position than their development partners to deal with local development issues (Li, 2006). As a result of emphasizing agency, as can be seen in CCAP's attempt to build researchers' capacity, and not engaging directly with local government and the local politics associated with this engagement (see above), the need and capacity of local government to support project initiatives over the longer term was

undermined. In this study, we argue that this has the flow-on effect of reducing the influence of community decision-making mechanisms, as their calls are not responded to by local government.

We therefore argue that the strength of particular discourses held by the international development community and the limited involvement of the government have had detrimental impacts on the strength of decision-making mechanisms at the local level. In turn, the reduced effectiveness of local decision-making mechanisms has a negative, or negligible, impact on family health and well-being. In turn this increases the reliance on external support in the form of international development. Combined, our results highlight the need for a reorientation of the current CBA discourse held by the international development community away from one that values individual agency and the power of the individual, to one that focuses on the collective or, more importantly, the strengths of current capacities.

Human ecology and future research in CBA

As our analysis demonstrates, the human ecology framework can contribute to the field of CBA, and to adaptation scholarship more broadly. First, it offers a robust tool to systematically characterize challenges encountered in CBA. In turn, this allows for systemic comparison of what works and what doesn't, and the identification of patterns or, more deductively, "deviations" from the norm. More importantly, this human ecology framework holds systems thinking at its analytical core and, as such, it allows the researcher to start analyzing CBA challenges within the broader sociopolitical system in which CBA operates, meeting the call from adaptation scholars for CBA to become more politically aware and politically responsive (e.g., Eguavoen et al., 2014; Eriksen et al., 2015). As we have shown here, while an initial screening of CBA challenges may tell us that, in some cases, women may play a more subordinate role in some contexts and, thus, adaptation actions may be hard to sustain if not inclusive; a more systems-oriented analysis uncovers the discourses at play and the range of processes and practices that are continuing to marginalize already marginalized voices, thus repeating historical injustices (Sovacool, 2018).

Had the CCAP team engaged more with the broader system during the design of this project, they may have been able to realize that their guiding discourses or project assumptions were at odds with the local social and political context. Given that CBA projects will almost always take place in the context of a complex social ecological system, we therefore argue that a variable or system state of interest should never be treated in isolation from other variables. Accordingly, a systems approach should be used in the development and framing of any CBA project and, ideally, this approach should be used alongside strong engagement with the community affected by the intervention, so to establish what *their* mental model of *their* system is. In this way, CBA practitioners may be able to avoid imposing their own discourses or worldviews onto the project logic and avoid "surprising" system responses.

Conclusion

This study has used the human ecology framework to assess challenges encountered in CBA. Importantly, the framework emphasizes the use of a systems lens, which encourages analysis to go beyond singular processes and events and instead examines the causalities of challenges operating at levels far beyond the local. Using this framework, our study provides a novel first step towards uncovering why some CBA interventions may be more sustainable and resilient than others.

The CCAP worked to facilitate nutrition diversity and security and generate greater household income, particularly for women. However, our analysis illustrated how the strategy trialed in Akar Akar met numerous challenges, which were interconnected and derived from the discourses, practices, and world views of groups operating at higher jurisdictional levels. The international development community, for example, with their focus on agency, self-organization, and responsibilization of individuals as a way to alleviate broader social issues, failed to acknowledge the complexities of local politics and social structures, and the historical and political processes which have placed women into particular roles in society. Any CBA project will always take place within a complex social ecological system and, as such, one variable (e.g., women's empowerment) can never be treated or changed in isolation from other variables. We therefore argue that a systems approach should be used in the development and framing of any CBA project. More importantly, this approach should be carried out with engagement with the women and men of "the community" so to establish what *their* mental model of *their* system is. In this way, CBA practitioners may be able to avoid any "surprising" system responses to the intervention and, as a broader research community, CBA scholars may be able to go beyond what we see as and how we treat "CBA challenges."

References

Badan Pusat Statistik [Central Bureau of Statistics]. (2010). *Sensus penduduk 2010*. Retrieved January 15, 2017 from sp2010.bps.go.id/index.php/navigation/wilayah

Badan Pusat Statistik Provinsi Nusa Tenggara Barat [Central Bureau of Statistics, West Nusa Tenggara Province]. (2018). *Percentage of poor: Nusa Tenggara Barat Province, 2002–2018*. Retrieved October 27, 2019 from ntb.bps.go.id/dynamictable/2016/07/22/25/persentase-penduduk-miskin-provinsi-ntb-2002---2018-keadaan-bulan-maret-.html

Berninghausen, J., & Kerstan, B. (1992). *Forging new paths: Feminist social methodology and rural women in Java* (B. A. Reeves, Trans.). Zed Books.

Blackburn, S. (1994). Gender interests and Indonesian democracy. *Australian Journal of Political Science*, 29(3), 556–574. doi.org/10.1080/00323269408402312

Budiwanti, E. (2014). The purification movement in Bayan, North Lombok: Orthodox Islam vis-à-vis religious syncretism. In M. C. Ricklefs & B. Lockhart (Eds.), *Between harmony and discrimination: Negotiating religious identities within majority–minority relationships in Bali and Lombok* (pp. 144–162). Brill. doi.org/10.1163/9789004271494_007

Butler, J. R. A., Bohensky, E. L., Darbas, T., Kirono, D. G. C., Wise, R. M., & Sutaryono, Y. (2016). Building capacity for adaptation pathways in eastern Indonesian islands: Synthesis and lessons learned [Editorial]. *Climate Risk Management*, 12, A1–A10. doi.org/10.1016/j.crm.2016.05.002

Butler, J. R. A., Bohensky, E. L., Suadnya, W., Yanuartati, Y., Handayani, T., Habibi, P., … & Sutaryono, Y. (2016). Scenario planning to leap-frog the Sustainable Development Goals: An adaptation pathways approach. *Climate Risk Management*, 12, 83–99. doi.org/10.1016/j.crm.2015.11.003

Butler, J. R. A., Suadnya, W., Puspadi, K., Sutaryono, Y., Wise, R. M., Skewes, T. D., … & Ash, A. (2014). Framing the application of adaptation pathways for rural livelihoods and global change in eastern Indonesian islands. *Global Environmental Change*, 28, 368–382. doi.org/10.1016/j.gloenvcha.2013.12.004

Butler, J. R. A., Suadnya, W., Yanuartati, Y., Meharg, S., Wise, R. M., Sutaryono, Y., & Duggan, K. (2016). Priming adaptation pathways through adaptive co-management: Design and evaluation for developing countries. *Climate Risk Management*, 12, 1–16. doi.org/10.1016/j.crm.2016.01.001

Butler, J. R. A., Wise, R. M., Skewes, T. D., Bohensky, E. L., Peterson, N., Suadnya, W., … & Rochester, W. (2015). Integrating top-down and bottom-up adaptation planning to build adaptive capacity: A structured learning approach. *Coastal Management*, 43(4), 346–364. doi.org/10.1080/08920753.2015.1046802

Cardiovascular Division & Health Services Research Centre. (2017). *Reducing the burden of cardiovascular disease in Indonesia: Evidence review*. The George Institute for Global Health. www.georgeinstitute.org/sites/default/files/reducing-the-burden-of-cvd-in-indonesia-evidence-review.pdf

Cliffe, S., Guggenheim, S., & Kostner, M. (2003). *Community-driven reconstruction as an instrument in war-to-peace transitions*. (Social Development Papers. Conflict prevention and reconstruction series, no. CPR 7). World Bank Group. documents.worldbank.org/curated/en/307821468764666040/Community-driven-reconstruction-as-an-instrument-in-war-to-peace-transitions

CSIRO Land and Water. (n.d.). *No regrets – Sustaining adaptive rural livelihoods in Eastern Indonesia: Enhancing the adaptive capacity of rural communities in Indonesia's Nusa Tenggara Barat Province, one of the world's least-developed regions* [Project evaluation brochure]. Commonwealth Scientific and Industrial Research Organisation. wp.csiro.au/r4da/files/2015/09/15-00227_LWF_R4DA_NTB-Indonesia_8ppSummary_WEB_150831.pdf

Davila, F. (2018). Human ecology and food systems: Insights from the Philippines. *Human Ecology Review*, 24(1), 23–49. doi.org/10.22459/HER.24.01.2018.02

Dumaru, P. (2010). Community-based adaptation: Enhancing community adaptive capacity in Druadrua Island, Fiji. *Wiley Interdisciplinary Reviews: Climate Change*, 1(5), 751–763. doi.org/10.1002/wcc.65

Dyball, R. (2010). Human ecology and open transdisciplinary inquiry. In V. A. Brown, J. A. Harris, & J. Y. Russell (Eds.), *Tackling wicked problems through the transdisciplinary imagination* (pp. 273–284). Earthscan Publications Ltd. doi.org/10.4324/9781849776530

Dyball, R., & Newell, B. (2015). *Understanding human ecology: A systems approach to sustainability*. Routledge. doi.org/10.4324/9780203109557

Eguavoen, I., Schulz, K., Wit, S. d., Weisser, F., & Müller-Mahn, D. (2014). Political dimensions of climate change adaptation: Conceptual reflections and African examples. In W. Leal Filho (Ed.), *Handbook of climate change adaptation*. Springer. doi.org/10.1007/978-3-642-40455-9_82-1

Ensor, J. E., Abernethy, K. E., Hoddy, E. T., Aswani, S., Albert, S., Vaccaro, I., Benedict, J. J., & Beare, D. J. (2018). Variation in perception of environmental change in nine Solomon Islands communities: Implications for securing fairness in community-based adaptation. *Regional Environmental Change*, 18, 1131–1143. doi.org/10.1007/s10113-017-1242-1

Eriksen, S. H., Nightingale, A. J., & Eakin, H. (2015). Reframing adaptation: The political nature of climate change adaptation. *Global Environmental Change*, 35, 523–533. doi.org/10.1016/j.gloenvcha.2015.09.014

Hadiwinata, B. S. (2003). *The politics of NGOs in Indonesia: Developing democracy and managing a movement*. Routledge. doi.org/10.4324/9780203200124

Harriss, J., Stokke, K., & Törnquist, O. (2005). Introduction: Politicising democracy. In J. Harriss, K. Stokke, & O. Törnquist (Eds.), *Politicising democracy: The new local politics of democratisation*. Palgrave Macmillan. doi.org/10.1057/9780230502802_1

Helmke, G., & Levitsky, S. (2003). *Informal institutions and comparative politics: A research agenda*. (Kellogg Working Paper Series, Issue 307). Kellogg Institute for International Studies. kellogg.nd.edu/sites/default/files/old_files/documents/307_0.pdf

IPCC. (2014). Adaptation needs and options. In *Climate Change 2014 – Impacts, Adaptation and Vulnerability: Part A: Global and Sectoral Aspects: Working Group II Contribution to the IPCC Fifth Assessment Report* (pp. 833–868). Intergovernmental Panel on Climate Change. Cambridge University Press. doi.org/10.1017/CBO9781107415379.019

Kirkby, P., Williams, C., & Huq, S. (2015). *A brief overview of community-based adaptation* [Briefing paper]. International Centre for Climate Change and Development, Independent University, Bangladesh. icccad.net/wp-content/uploads/2015/12/A-brief-overview-of-Community-Based-Adaptation.pdf

Kirono, D. G. C., Butler, J. R. A., McGregor, J. L., Ripaldi, A., Katzfey, J., & Nguyen, K. (2016). Historical and future seasonal rainfall variability in Nusa Tenggara Barat Province, Indonesia: Implications for the agriculture and water sectors. *Climate Risk Management*, 12, 45–58. doi.org/10.1016/j.crm.2015.12.002

Li, T. M. (2006). *Neo-liberal strategies of government through community: The social development program of the World Bank in Indonesia*. (IILJ Working Paper 2006/2: Global Administrative Law Series). New York University School of Law. iilj.org/wp-content/uploads/2016/08/Li-Neo-Liberal-Strategies-of-Government-through-Community-2006-2.pdf

McGregor, J. L., Nguyen, K. C., Kirono, D. G. C., & Katzfey, J. J. (2016). High-resolution climate projections for the islands of Lombok and Sumbawa, Nusa Tenggara Barat Province, Indonesia: Challenges and implications. *Climate Risk Management*, 12, 32–44. doi.org/10.1016/j.crm.2015.10.001

McNamara, K. E., & Buggy, L. (2017). Community-based climate change adaptation: A review of academic literature. *Local Environment*, 22(4), 443–460. doi.org/10.1080/13549839.2016.1216954

Meharg, S., Butler, J. R. A., Kirono, D. G. C., Lazarow, N., Barrowman, H. M., & Duggan, K. (2015). *Evaluating the impacts of participatory planning for urban water infrastructure and rural livelihoods adaptation in Indonesia* [Small Grant Report to the Australia Indonesia Centre]. CSIRO Land and Water. bridges.monash.edu/articles/Report_Evaluating_the_impacts_of_participatory_planning_for_urban_water_infrastructure_and_rural_livelihoods_adaptation_in_Indonesia_/4625884/1

Osman-Elasha, B., & Sanjak, E. A. (2008). Livelihoods and drought in Sudan. In N. Leary, C. Conde, J. Kulkarni, A. Nyong, J. Adejuwon, V. Barros, … & J. Pulhin (Eds.), *Climate change and vulnerability and adaptation* (pp. 239–256). Routledge. doi.org/10.4324/9781315067179

Pelling, M. (2001). Natural disasters? In N. Castree & B. Braun (Eds.), *Social nature: Theory, practice and politics* (pp. 170–188). Wiley-Blackwell.

Purba, R. E. (2011). Public participation in development planning: A case study of Indonesian Musrenbang. *International Journal of Interdisciplinary Social Sciences*, 5(12), 265–277. doi.org/10.18848/1833-1882/cgp/v05i12/51964

Reid, H., Alam, M., Berger, R., Cannon, T., Huq, S., & Milligan, A. (2009). Community-based adaptation to climate change: An overview. *Participatory Learning and Action*, 60, 11–31. pubs.iied.org/pdfs/G02608.pdf

Rose, N. (1999). *Powers of freedom: Reframing political thought*. Cambridge University Press. doi.org/10.1017/CBO9780511488856

Simane, B., & Zaitchik, B. F. (2014). The sustainability of community-based adaptation projects in the Blue Nile Highlands of Ethiopia. *Sustainability*, 6(7), 4308–4325. doi.org/10.3390/su6074308

Sovacool, B. K. (2018). Bamboo beating bandits: Conflict, inequality, and vulnerability in the political ecology of climate change adaptation in Bangladesh. *World Development*, 102, 183–194. doi.org/10.1016/j.worlddev.2017.10.014

Spires, M., Shackleton, S., & Cundill, G. (2014). Barriers to implementing planned community-based adaptation in developing countries: A systematic literature review. *Climate and Development*, 6(3), 277–287. doi.org/10.1080/17565529.2014.886995

Thorbecke, E., & Pluijm, T. van der. (1993). *Rural Indonesia: Socio-economic development in a changing environment*. New York University Press.

World Bank Group. (n.d.). *Poverty headcount ratio at national poverty lines (% of population)—Indonesia* [Data set]. Retrieved October 27, 2019 from data.worldbank.org/indicator/SI.POV.NAHC?locations=ID

World Food Programme. (2013). West Nusa Tenggara Profile. cdn.wfp.org/wfp.org/publications/NTB%20Factsheet%20ENG%2012oct12.pdf

Overcoming Barriers to Implementing Sustainable Development Goals: Human Ecology Matters

Roderick J. Lawrence[1]
Geneva School of Social Sciences (G3S), University of Geneva, Switzerland

Abstract

This article criticizes the framework provided by the United Nations 2030 Agenda for Sustainable Development, commonly used to implement sustainable development goals (SDGs). We argue that instrumental rationalism has been used to define cause–effect relations between "means" (all kinds of resources) and "ends" (the goals and targets) involved in implementing sustainable development. This linear thinking, commonly used during the last century, is applied again in the current agenda. Hence, too little attention has been attributed to human intentions, motives, preferences, and fundamental values that frame the constitution of societal institutions and structures, as well as individual and collective behaviors. These core constituents of human ecology are barriers to a new eco–social contact that endorses radical societal change for implementing sustainable development. Our research shows that innovative contributions are being achieved by local authorities and community-based initiatives in contrast to the denial and inertia of many national governments, public administrations, and private enterprises.

Keywords: anthropo-logic, eco–social contract, fundamental values, instrumental rationalism, means–ends model

> In other words, sustainability requires a social avalanche of unprecedented proportions; to start this avalanche, enough momentum needs to be created for a snowball effect to develop, so that appropriate measures will be widely adopted. The question is: who or what might start this avalanche? (Fischer et al., 2012, pp. 158–159)

Introduction

Many national governments and public administrations have not been motivated to forgo short-term political interests and use sustainable development goals and targets to define and implement policies and programs. This inertia contradicts international acceptance of an agenda and framework for sustainable development

1 Corresponding author: roderick.lawrence@unige.ch.

at the United Nations Conference on Sustainable Development (Rio+20) in June 2012 (United Nations, 2017). The main purpose of this article is to critically reconsider why the framework provided by the 17 Sustainable Development Goals (SDG 17), 169 targets, and their indicators has not been more effective in enabling societal change for overcoming the implementation deficit since 2015. Our research about the different types of barriers to implementing sustainable development highlights a strong focus on the core principles of sustainable development in many documents, even though the notion itself is still contested, three decades after it was endorsed by member states of the United Nations (Dovers & Handmer, 1993). We posit that the core principles (e.g., the 5P Model) are founded on generalizations that have been used repeatedly to define development agendas during the last century. We argue that this framework does not provide a new eco–social contract for implementation; whereas it would have if the 5P Model had explicitly included human beliefs, intentions, motivations, preferences, and fundamental values. These core constituents of human culture define and are mutually defined by individual–society–environment–biosphere interrelations (Lawrence, 2001). We argue that deciphering and acting with these constituents enables us to explain the persistence of conceptual, administrative, political, and sociobehavioral barriers, which are the root causes of ineffective individual and collective actions for implementing sustainable development. Until these core constituents, especially fundamental values, are counteracted and replaced by others, the "social avalanche" requested by Fischer et al. (2012, p. 158) will not happen.

We consider that core principles of sustainability (known as the "three pillars of sustainability," and the more recent 5P Model), used to formulate the 17 SDGs and 169 targets, have clearly presented the need to understand and respond to global challenges (such as loss of biodiversity, climate change, persistent poverty, etc.). However, responses to these global challenges are framed as "the ends" or outcomes that should be achieved and sustained by countries even though there may be a lack of agreement about them. Some goals and targets present "the means" (e.g., SDG 17 includes education, funding, training, and partnerships) required to achieve the goals and targets. There is an implicit assumption, based on linear causality, that if enough means are allocated then the desired ends will be achieved. This assumption ignores the societal context and preconditions that underline using "the means" to achieve "the ends;" it ignores human intentionality, interests, motives, preferences, and fundamental values that individuals and institutions use, explicitly and implicitly, to position themselves regarding personal and social change for sustainable development. We argue that these behavioral, institutional, and political dimensions should be addressed explicitly because they are the cultural foundations on which societal barriers persist and are sustained in a value-laden world (Fischer et al., 2012; Lawrence, 2005). Finally, we argue that these cultural

and societal conditions should be understood from a human ecology perspective before more effective implementation of the United Nations 2030 Agenda for Sustainable Development can be achieved.

Method

The research method for this article is the documentary analysis of published databases, statistics, and reports that record contributions about implementing sustainable development goals and targets since the 1990s. These official documents indicate ineffective societal responses to global challenges (including climate change, loss of biodiversity, poverty, and malnutrition) at international and national levels, despite concordant empirical data and increasing scientific knowledge about them (Lawrence & Gatzweiler, 2017). In contrast, the author's collaboration with some international programs since the 1990s has documented numerous achievements at the level of local authorities. Moreover, the author's review of the *Global Sustainable Development Report 2019,* on behalf of the Swiss Academy of Sciences, indicates that international diplomacy and national political agendas can provide contextual conditions for effective responses to societal challenges at the geopolitical level of cities and local authorities (United Nations, 2019). Our research confirms that innovative projects and programs about active living, food, housing, and transport can serve as beacons for societal change towards more sustainable cities and communities, and some of these exemplary cases will be mentioned.

Understanding anthropo-logic

The term *anthropo-logic* designates an integrated knowledge domain of human groups and societies, including their aesthetic, conceptual, ethical, and technical knowledge, as well as their technical and practical know-how, and how these are expressed by cultural traits. The term is derived from *anthropos*, which designates what is specifically human; "logic" is derived from the ancient Greek word *logos* and designates thought, reasoning, and discourse. The proposed anthropo-logic is derived from a holistic and systemic conceptual framework of human ecology that includes the content and symbiotic interrelations between an eco-logic and a bio-logic in addition to an anthropo-logic (see Figure 1). Anthropo-logic is the primary focus here because, in general, sustainability research and policy has not attributed sufficient attention to core cultural dimensions of the themes or situations studied, including climate change, loss of biodiversity, malnutrition and poverty, and increasing socioeconomic inequalities.

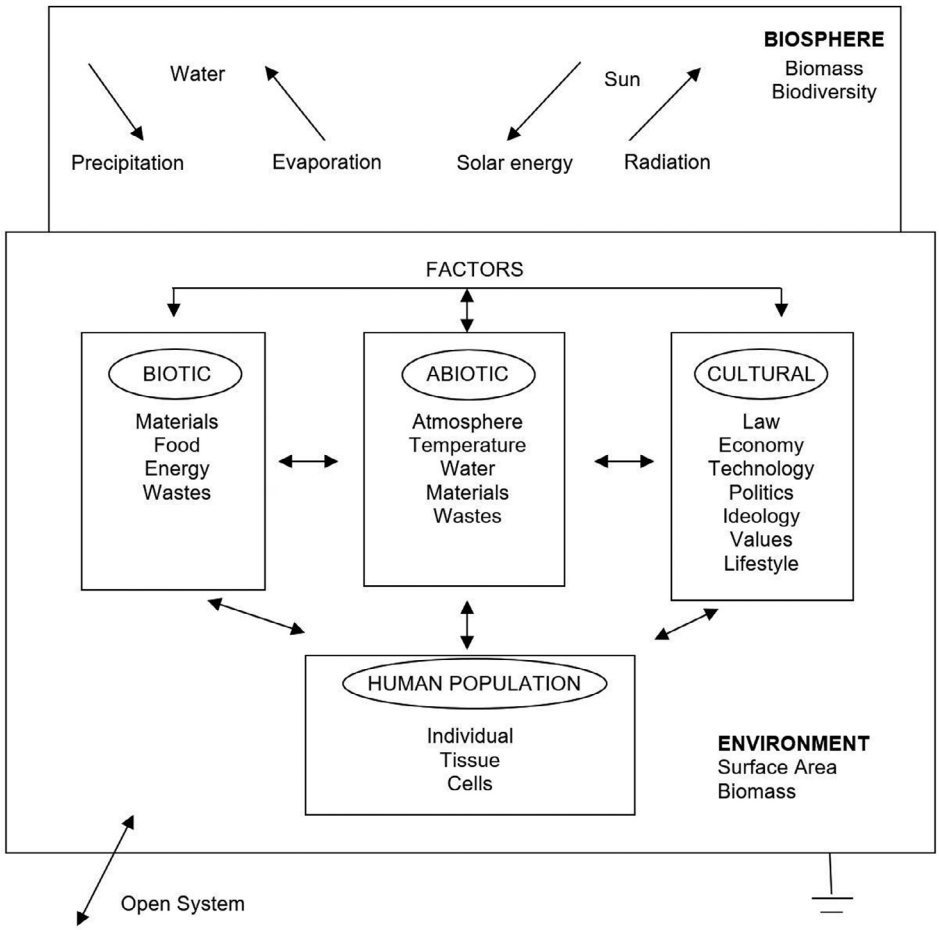

Figure 1. The holistic and systemic framework of a human ecology perspective, showing the interrelations between biotic factors, abiotic factors; cultural, social, and individual human factors; and artifacts which are delimited by situations, habitats, or larger ecosystems.

Source: Provided by the author.

Human ecology provides a holistic framework and systemic interpretation of different knowledge domains, including the arts, humanities, social sciences, and natural sciences. It illustrates the reciprocal relations between sets of biotic, abiotic, and anthropogenic factors. Hence, it considers the whole system as the unit of study in precise localities. The broad conceptual and methodological framework proposed here is grounded in understanding societal contexts, in stark opposition to reductionism. Contextualism underlines that meanings of knowledge and applications of know-how are grounded in specific situations. This conceptual model can be applied at different geographical scales to deal with specific themes or situations about sustainability (Lawrence, 2005). It offers a synchronic representation of a human ecosystem that is open and linked to others. The model is meant to be

reapplied at different times to explicitly address a short- and long- term historical perspective. This dual temporal perspective can identify change to any of the specific components as well as the interrelations between them.

The next section summarizes the international background, the institutional framework, and the rational thinking used to formulate the United Nations 2030 Agenda for Sustainable Development endorsed in 2015 (United Nations, 2015). Then, we critically analyze the pragmatic thinking used to formulate the 17 SDGs, the 169 targets, and their indicators, which we consider as applied instrumental rationalism (see later). Despite its good intentions, this agenda for implementing transitions to sustainable development has not been wholly successful, especially at the national geopolitical level (Lopez-Claros et al., 2020; United Nations, 2017). Surprisingly, our research found that there are few contributions about different types of barriers to more effective implementation. In that global context, we explain how local authorities and community-based associations have bypassed the denial or inertia of many national authorities to implement creative and innovative programs and projects that are exemplary examples of transitions to sustainability. These contributions confirm the necessity of removing conceptual, administrative, and sociopolitical barriers that inhibit a new anthropo-logic and an eco–social contract which enable more effective implementation. This way forward endorses the importance of fundamental values and the core principle of subsidiarity included in Agenda 21 in 1992 (United Nations, 1992); both should be more widely acknowledged, because cities, local authorities, and community-based initiatives have become beacons for change for sustainable development, especially in response to many global challenges including: climate change and extreme weather events; provision-efficient energy infrastructure; supplies of renewable energy sources; malnutrition and access to affordable fresh food; and public health campaigns concerning infectious and noncommunicable diseases (Lawrence, 2021).

Transitions to sustainability: Taking stock

In 2015, the United Nations General Assembly endorsed 17 Sustainable Development Goals that enlarged and replaced the 8 Millennium Development Goals and 18 targets that were implemented and monitored between 2000 and 2015 (Kenny, 2015). Each goal represents a global challenge that should be understood and addressed in order to transit towards sustainable development. The SDGs have been developed and endorsed by member states of the United Nations on the understanding that they will be accepted and implemented nationally, with international financial and technical support where deemed necessary (United Nations, 2015). This approach is envisaged in *Transforming Our World* as a generic blueprint that can be adjusted in precise situations to achieve sustainable development using core principles of "universality," "leaving no one behind," "interconnectedness and indivisibility," "inclusiveness," and "multi-stakeholder partnerships" (United Nations, 2015).

The United Nations identified the 17 SDGs, their 169 targets, and their quantifiable indicators as outcomes ("the ends") that are achievable, quantifiable, and can be monitored from 2016 to 2030 (e.g., SDGs 6 and 7), and "the means" of achieving a broad range of urgent and universal issues for the period (e.g., SDG 17) through multi-stakeholder partnerships that recognize the benefits of cooperation between the private sector, public administrations, and civil society (Monkelbaan, 2019). Since the publication of Agenda 21 (United Nations, 1992), the United Nations has emphasized the importance of allocating enough means for the implementation of sustainable development. The range of means proposed are not limited to financial resources and funding, because capacity-building, education and training, scientific research, and partnerships have been discussed during the last two decades.

In operational terms, the United Nations 2030 Agenda for Sustainable Development does not provide new insights about impediments, despite contention about the amount of financial resources allocated to implement the SDGs, especially given that many countries have not respected their commitments. Notably, there is no clear statement of how "means" and "ends" should be interpreted. According to Elder et al. (2016), some goals and targets have several functions because they can be considered as 'intermediate means' to achieve predefined targets. Consequently, these authors underline that "goals as means" should be a key concept that was not used when the SDGs and their targets were formulated and agreed.

There is broad agreement that the 17 SDGs and 169 targets provide a framework for country-effective responses to major global challenges, if appropriate means and measures are available. This is an example of thinking based on linear causality that assumes a direct relationship between "means" and "ends," without considering plausible intervening variables, notably human motivations, that modify this cause–effect relationship. It ignores the societal context, especially the administrative, economic, financial, institutional, political, and social variables that can modify this binary relationship; contextual variables account for differences between countries, states, and cities. This way of thinking also underlies other shortcomings: for example, a paragraph in *Transforming Our World* states that "in accordance with the Charter of the United Nations, the need to respect the territorial integrity and political independence of States" is reaffirmed (United Nations, 2015, para. 38). Notably, the overall legal and institutional frameworks of non-binding, voluntary commitment and "soft law" that is not legally binding, are not challenged even though they are well-known barriers that do not guarantee compliance with international agreements or implementation. Lopez-Claros et al. (2020) describe in much detail why this institutional, legal, and political system has not been effective in facilitating and enacting societal change for sustainable development by countries since the 1970s. Despite these persistent shortcomings, it is assumed that current institutional, fiscal, and legal frameworks and mechanisms for implementation can be reformed, whereas we agree with Lopez-Claros et al. (2020) that they should be replaced.

Christian Berg (2020) stated that barriers to achieving societal change for sustainable development have rarely been studied systematically. He proposed an actor/institutional framework to help overcome the inertia between the goals and targets ("the ends") formulated and endorsed in numerous official documents, and the lack of resources ("the means") restricting or prohibiting programs and projects that are meant to achieve them. We note that the German Advisory Council on Global Change (WBGU[2]) discussed barriers for societal change for sustainable development in terms of "path dependencies," "tight time frame," "obstruction of global cooperation," "rapid urbanization," and "easily available supply of coal" (WBGU, 2011). This small heterogenous set of topics proposed a decade ago should have been complemented by numerous others, including ineffective institutional, legal, and political arrangements; growing neoliberal market economies with the subservience of politicians and public administrations to multinational corporations; and individual and collective lifestyles that champion consumerism and self-interests for the sake of "the good life."

Notably, the *Global Sustainable Development Report 2019* acknowledges the need for intentional change but continues to propose current institutional, fiscal, and legal arrangements and mechanisms for implementation (United Nations, 2019). That report, written by an independent group of scientists, has followed the thinking of academic authors of many other documents which have presented the major pressures that threaten natural and human-made ecosystems, health, and well-being without analyzing the root causes of these pressures (more on this later).

Here we apply a different reasoning, by extending the contribution by Joern Fischer et al. on behalf of the Earth Stewardship Initiative (Fischer et al., 2012). Their contribution indicated why contributions of scientific research had not served as a catalyst for societal change towards sustainability. They concluded that the primary barrier to societal change was not lack of data, information, and knowledge about persistent problems; instead, inertia is grounded in human behavior, intentionality, preferences, values, and worldviews. Hence, societal change is dependent on "reflecting on deeply held value and belief systems, which fundamentally shape behaviour" (Fischer et al., 2012, p. 153). We live in a value-laden world; therefore, it is the personal and shared experiences, perceptions, and values associated with persistent problems and global challenges that count, not just the addition of the number of people concerned. Until current fundamental values are identified, counteracted, and replaced, there will be no "social avalanche" (Fischer et al., 2012, p. 158).

2 Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen (WBGU) [German Advisory Council on Global Change].

Values convey the relative importance of objects, events, situations, challenges, and problems. They are guiding principles that influence human aspirations, choices, intentions, and goals, and which are embedded in human interpretations of these challenges and problems, and responses to them (Lawrence, 2005). Individual, group, societal, and fundamental cultural values coexist in precise localities and with respect to specific themes. Notably, Dyball and Newell (2015) confirm that human ecologists have accounted for values, but they have often used the term narrowly, referring to a numerical amount, magnitude, or monetary value of objects, or a quantity of material things (e.g., the stocks of ecosystems). We enlarge common interpretations of *value* to include aesthetic, cultural, moral, and spiritual values, because these are embedded in the core principles of sustainable development that endorses human rights, as well as environmental and social justice.

Values are incorporated in the anthropo-logic of the human ecology framework we proposed in Figure 1. Given that sustainable development is anthropocentric, and a normative concept, it is difficult to understand why much more attention has not been paid to improving understanding of the diversity of human beliefs, goals, priorities, and values that coexist in a heterogenous world. Notably, different and especially conflicting experiences, intentions, perceptions, and values should be understood and dealt with more effectively than they are by conventional processes for consensus-building, which do not confront incommensurability.

The following section of this paper summarizes the 5P Model endorsed by the United Nations and discusses this framework for formulating the 17 SDGs and 169 targets in terms of outcomes and means. We posit that the rationale for this approach included encouraging the implementation of the United Nations 2030 Agenda for Sustainable Development. This approach applies the logic of instrumental rationalism (described later), as a way of thinking that dominated development agendas, and many interpretations of economic growth and development, during the last century (Daly, 1973). We argue that this kind of pragmatic thinking has rarely dealt with the human beliefs, intentions, meanings, perceptions, and values that are embedded in the conceptual, administrative, political, and sociobehavioral barriers that have inhibited societal transitions for sustainable development during the last 30 years, not just since 2015. We then present an alternative forward look which explicitly addresses an anthropo-logic that should be incorporated in a new eco–social contract that is not prescribed or imposed by international or national authorities but supported by local and national authorities and produced communally (Fischer et al., 2012). Our research since 2015 confirms that local authorities and community-based initiatives are implementing innovative programs and projects in many cities (Lawrence, 2021).

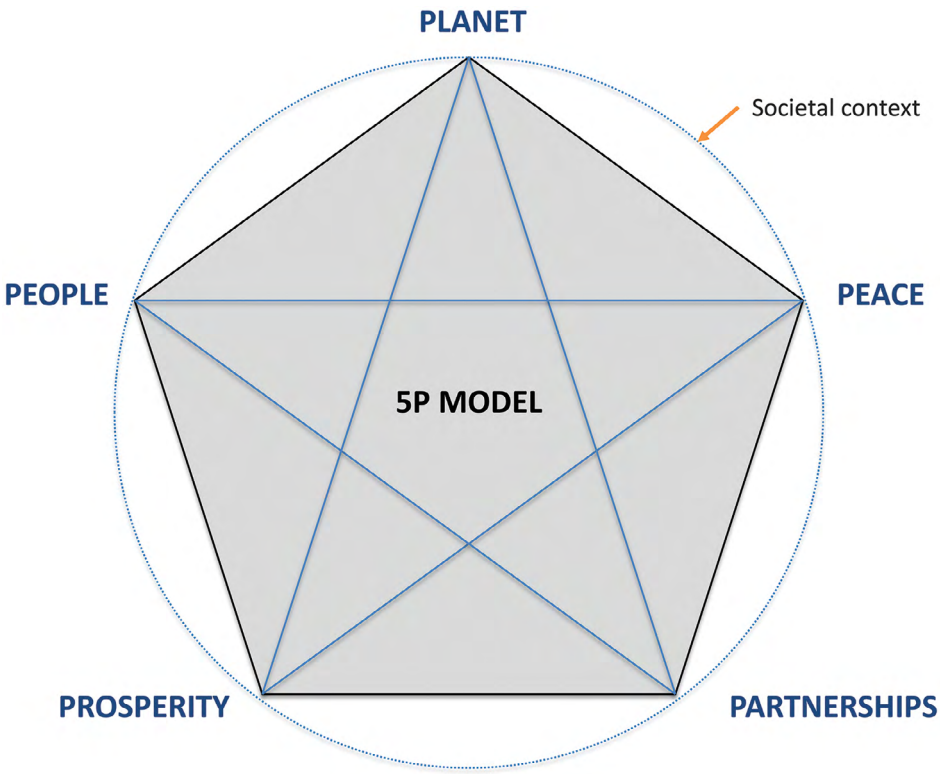

Figure 2. Author's representation of the 5P Model of sustainable development endorsed at the United Nations Conference (RIO+20) held in June 2012.

Source: United Nations (2015).

The United Nations 5P Model

The United Nations 2030 Agenda for Sustainable Development provides a broad and global framework that has been named the 5P Model, shown in Figure 2, which denotes: people, planet, prosperity, peace, and partnerships (United Nations, 2015). This framework was meant to reiterate principles and recommit the 193 member states of the United Nations to implementing sustainable development using a broader framework for action than the well-known three pillars of environmental, economic, and social parameters proposed in the Brundtland Report (World Commission on Environment and Development, 1987), and endorsed at the United Nations Conference on Sustainable Development in 1992.

The 5P Model for sustainable development presented in *Transforming Our World*: *The 2030 Agenda for Sustainable Development* is founded on the following meanings and their applications (United Nations, 2015). First, *people* denotes a humane approach, founded on the core principles of environmental and social justice, that should reduce poverty and hunger while promoting secure and safe living

conditions that encourage health and well-being. This interpretation endorses the primary definition of sustainable development given in the Brundtland Report (World Commission on Environment and Development, 1987); the first principle of the Rio Declaration on sustainable development (United Nations, 1992); and the first Millennium Development Goal applied between 2000 and 2015. However, this *people* component does not explicitly address the influence of human beliefs, motivations, values, and worldviews that are the foundations of an anthropo-logic that frames individual–society–environment–biosphere interrelations (Lawrence, 2005). These interrelations define and are defined by the way that individuals and groups think they should live, sustain their livelihoods, and relate to others in a world of uncertain futures and unpredictable change.

Second, *planet* refers to evolving global environmental conditions, including climate change and loss of biodiversity, and how these trends are influenced by human activities, including consumption and production processes, uses of natural resources, and whether human needs of current and future generations will be met. During the last 30 years this has been known as the environmental pillar of sustainable development and it was founded to encourage environmental protection and nature conservation. Arthur Dahl (1996) explained that sustainable development denotes a process (rather than an outcome) that is voluntary, not mandatory, and that environmental concerns are constructs of human thinking and behavior.

Third, *prosperity* refers to the livelihoods for all human beings provided by economic, social, and technological progress. This equates development with economic growth, technological development, and income; it was the foundation of the original economic pillar of sustainable development in *Our Common Future* (World Commission on Environment and Development, 1987). Notably, that landmark document emphasized moral values that express fundamental ethical principles about environmental and social justice that have been included in the current agenda.

Fourth, *peace* denotes fostering just and inclusive societies without violence, warfare, or a sense of insecurity. However, fundamental human values and ethical principles about increasing ethnic, gender, and socioeconomic differences should have been underlined, whereas this component endorses the social pillar of the original sustainable development triad.

Fifth, *partnership* refers to "the means" required to implement the United Nations Agenda for Sustainable Development by public–private partnerships, based on a spirit of strengthened global solidarity, with the participation of all countries, stakeholders, and laypeople. Partnerships were endorsed at the World Summit on Sustainable Development held in Johannesburg in 2002 (United Nations, 2002). They require a fundamental shift in values that has not been highlighted.

In addition, the pertinence of human-centered contributions by major groups, founded on the principle of subsidiarity endorsed in Agenda 21 in 1992, should have been underscored in the current agenda.

Morton et al. (2017) suggested that the 5P Model accepted by member states of the United Nations in 2015 is related to the 17 SDGs in the following way. They associate SDGs 1, 2, 3, 4, 5 and 6 to *people*; then SDGs 13, 14 and 15 are classified with *planet*, whereas SDGs 7, 8, 9, 10, 11 and 12 are associated with *prosperity*. *Peace* is related to SDG 16 and *partnership* with SDG 17. This unilateral classification ignores plausible multiple interconnections between the 17 SDGs that should be identified by relational and systems thinking because the SDGs are not independent of each other and some can be located in more than one of the 5P categories: for example, decent work is a constituent of SDG 8 that should also be allocated within *people*, not just *prosperity*, because it has an influence on health and well-being, gender equality and poverty (Lawrence & Werna, 2009). The issue of categorization has been discussed by Mark Elder et al. (2016).

A functional classification of the 17 SDGs has been proposed by Elder et al. (2016) according to six categories: social objectives (SDGs 1, 3, 4, 5, 10); resources (SDGs 2, 6, 7); economy (SDGs 8, 9, 11, 12); environment (SDGs 13, 14, 15); education (SDG 4); governance (SDG 16); and SDG 17 is a means of implementation. Then the authors analyze scientific and political debate about implementing all SDGs as an extension of the plan for implementation of sustainable development, defined in conjunction with the World Summit on Sustainable Development held in Johannesburg in 2002 (United Nations, 2002). The authors emphasize that one or more goals can be a means to achieving other goals. They question common distinctions between "the means" proposed to achieve all goals ("the ends"), and the functions of each goal, because some goals can serve as enablers to achieve other goals; for example, sustained supplies of energy (SDG 7) and water (SDG 8) are necessary for food production that reduces hunger (SDG 2) and alleviates poverty (SDG 1) while enabling health (SDG 3). This broad interpretation of means extends well beyond that proposed for SDG 17 in the United Nations documentation, and highlights the importance of understanding interrelations between all 17 goals and their targets.

There is a regrettable lack of relational thinking in the definition of the SDGs and their connectivity. For example, SDG 17 proposes partnerships as an important means for implementing sustainable development, whereas partnerships are not mentioned in the other 16 SDGs. Some operational frameworks have attempted to define connections between different goals and targets in terms of the type and strength of interrelations between them. For example, a report by the International Council for Science (2017) presents a conceptual tool for evaluating target-level interactions between various SDGs in precise situations. Scores are assigned to specific interactions based only on expert judgment and scientific evidence. Notably, scores

implicitly express values, but the core issue of whose values is not addressed. Instead, the approach is based on the premise that understanding both the positive synergies and the trade-offs among SDGs is critical to prioritizing action. Such understanding can help to predict whether progress towards a goal will facilitate or hinder progress in another. Hence the International Council for Science report presents an expert approach to evaluating and scoring plausible interactions between SDGs (Nilsson et al., 2016). The approach is applicable in different situations and at different geopolitical levels. However, because it is grounded only in scientific expertise that does not account for fundamental cultural, social, and personal values, it does not incorporate core constituents of societal conditions on which change for sustainable development depend. Consequently, the objective of implementing the SDGs and advancing towards their targets can be jeopardized at the outset because sustainable development cannot be achieved in a vacuum. We argue that this fundamental shortcoming can be attributed to instrumental rationalism, which we briefly explain in the following section.

Sustaining what: Instrumental rationalism?

Instrumental rationalism is pragmatic and denotes human actions that associate "the means" or inputs to achieve "the ends" (e.g., desired goals or outputs). It means that individuals and institutions use those means (e.g., the provisions deemed necessary) to achieve desired ends. Conversely, human action that is incoherent or contradictory to achieving desired goals or outcomes is deemed irrational. Research confirms that "the means" do not guarantee "the ends," but they do influence the interrelation between them. The term "end" can refer to a state or condition, or an action or process. Hence, the issue of whether appropriate and enough means have been attributed to achieve desired goals and targets is dynamic; a core challenge involves identifying and applying adequate means to achieve desired outcomes in a dynamic and changing world (Kolodny & Brunero, 2018).

The United Nations 2030 Agenda for Sustainable Development has applied instrumental rationalism to deal with societal challenges that require effective responses for transitions to sustainable development. Indeed, instrumental rationalism is also pertinent for understanding contributions of specific governments, public institutions, and firms in the private sector to sustainable development programs and projects during the last 40 years. Notably, Herman Daly (1973, p. 8), a founder of ecological economics committed to sustainable development, proposed a means–end model, which included a hierarchy of intermediate and ultimate means for sustainable development. In this context, "ultimate means" denotes the underlying natural resource base and the life-support system of the planet; whereas "ends" and "ultimate ends" denote human well-being measured by a composite index not limited to gross domestic product.

Twenty-five years after this contribution, Donella Meadows (1998) adapted this hierarchical means–end model into a circular one that represented systems thinking. She explained that "means" denotes "inputs" in systems thinking, whereas intermediate and ultimate "ends" denote "outputs" in systems thinking, and represent the goals for sustainable development. Mark Elder et al. (2016) explained that this model has been used implicitly or explicitly during the last two decades by organizations, researchers, and policy-makers who have formulated sets of indicators for sustainable development. Notably, since 1992, the means–ends model has been a recommended framework for developing indicators for sustainable development, according to Chapter 40 of Agenda 21 (Meadows, 1998).

Arthur Dahl (2018) described the history of the development of indicators of sustainable development coordinated by the United Nations Environment Programme. This history builds on contributions from international organizations, including the Environment Division of the Organisation for Economic Co-operation and Development (OECD) and the World Health Organization (Pintér et al., 2014). All the frameworks discussed in this history represent linear causal pathways between drivers or pressures on environmental, economic, or social conditions, and their consequences (state, exposures, and effects, which are "outcomes") for components of natural ecosystems, human health, and well-being. The drivers and the outcomes are tangible and measurable conditions or processes, whereas the human motives, objectives, and values underlying them are not identified and analyzed. The global indicator framework continued this approach for the United Nations 2030 Agenda for Sustainable Development; it was developed by the Inter-Agency and Expert Group on SDG Indicators and agreed to as a practical starting point at the 47th session of the UN Statistical Commission held in March 2016. This framework has not questioned the shortcomings of instrumental rationalism, or linear causality, that overlook fundamental human values. We argue that the drivers of unstainable human activities are the motives, objectives, and values that prioritize individualism above communalism, egoism above altruism, self-interest above the common good. They are core components of an anthropo-logic that has gathered strength during the last century (Dahl, 1996). The remaining sections of this article propose a fundamentally different way forward that includes fundamental values that need to be addressed if societal transitions towards sustainability are to overcome the implementation deficit.

Rehumanizing sustainability: A forward look

The United Nations' *Global Sustainable Development Report* (United Nations, 2019) mentioned earlier presents the contribution of a group of 15 academic researchers and scientists about achieving the desired societal change for sustainable development using extant legal and institutional arrangements, market mechanisms,

and partnerships with public authorities and community associations. The report discusses the urgency and expectations about implementing change by proposing six entry points that are interrelated with the 17 SDGs and 169 targets. These entry points are:

- human well-being and capabilities;
- sustainable and just economies;
- food systems and nutrition patterns;
- energy decarbonization with universal access;
- urban and peri-urban development; and
- global environmental commons.

The report also identifies four levers, which can be coherently deployed through each entry point to bring about required change:

- governance;
- economy and finance;
- individual and collective action; and
- science and technology.

These four levers are related to the means of implementation discussed in SDG 17.

Each lever can contribute individually to systemic change. However, the report argues that it is only through their context-dependent combinations that it will be possible to bring about the transformations necessary for balancing across the dimensions of sustainable development in order to implement the United Nations 2030 Agenda for Sustainable Development. We endorse this approach, and emphasize that it should address fundamental human intentions, motives, preferences, and core values that have been drivers of the globalization of production and consumption processes, the increasing privatization of community services and infrastructure, and the retreat of the state interventions and lower expenditure on public health, education, and welfare services in many countries.

Notably, this report, like other official documents published before it, overlooks the consequences of globalization, and the shift to neoliberal market economies since the 1980s, coupled with the erosion of the role and responsibility of the state and public administrations. These ongoing processes around the globe have reduced the resilience of many countries and cities to counteract global threats, because they have lost their capacity to act autonomously after becoming subservient to global production processes and trade with foreign countries in international markets. In this international geopolitical context, the individual initiative of

citizens, households, and communities cannot counteract the global trend towards centralization resulting from the power and influence of multinational corporations and their collusion with political authorities across all geopolitical levels.

Whereas numerous contributions discuss the need for more data and information, we agree with Fischer at al. (2012) that this is not always the case (Lawrence & Gatzweiler, 2017). Likewise, there are alternative technologies, alternative institutional and legal frameworks, and alternative business models that can replace "business as usual." We argue that a new eco–social contract is required but it has not been provided by the United Nations 2030 Agenda for Sustainable Development. This eco–social contract should be founded on ethical principles and moral values, incorporating both fundamental monetary and non-monetary values, which are the root causes of egocentric human behavior and short-term institutional and political actions that should be challenged and replaced by collective eco-centric visions about a common future. Our research confirms that innovative community-based initiatives are now being scaled up to have a broader societal impact (Lawrence, 2021). These innovative projects, among numerous others, highlight the need to understand and remove different types of barriers to societal change.

Henceforth, international organizations, national institutions, and local authorities should not ignore the reasoning of individuals, households, community associations, private enterprises, and public administrations to adhere to, or reject, certain sustainable development goals or targets and the allocation of the resources necessary to achieve them. There is too little research that documents why initiatives that are meant to respond to the risks of climate change and extreme weather events, or to epidemics of contagious diseases as well as the growing incidence of noncommunicable diseases, or to increasing economic, housing, and health inequalities between countries and within large cities, are not being implemented where they are most needed. We have called this dilemma "the applicability gap" (Lawrence, 2015) and explained that the distinction between "what we know" and "what we do" does not depend only on availability of data and information, but primarily on beliefs, desires, intentions, motives, perceptions, and values that may be egocentric and self-centered, or altruistic and communal. These core constituents of human culture form an anthropo-logic which is the foundation of the conceptual, administrative, and sociopolitical barriers that hinder social change for sustainable development before and since 2015. These types of barriers will be described in the following section. While some authors, including Fischer et al. (2012) and Berg (2020), have confirmed their importance, we stress that dismantling them to their foundations is a precondition before more effective programs and projects will overcome the implementation deficit.

Overcoming the implementation deficit

Beyond radical reforms required in international and national governance, and the redefinition of legal, fiscal, and institutional arrangements, we consider that the lack of attention given to human beliefs, intentions, motives, preferences, and values needs correcting because they are the foundations of conceptual frameworks and models, administrative and legal arrangements, and cultural values, behavioral norms, and social conventions that have commonly been used uncritically by authors and institutions to define and implement sustainable development. We explain our position in the following paragraphs.

First, *conceptual barriers* refers to the common use of inapt analogies, metaphors, and models that are meant to represent relations between *anthropos* and *cosmos*, and between natural ecosystems and human-made environments (Lawrence, 2001). Although sustainable development is anthropocentric, this does not mean that humans are separated from natural ecosystems, or the biosphere, on which they are dependent. We have argued that human ecology provides a holistic conceptual framework that combines abiotic, biotic, and cultural (or anthropo-) logics and the symbiotic relations between them (see Figure 1). This model is meant to replace a hierarchical one in which humans have dominion and can manipulate natural ecosystems. Human ecology applies a radically different set of fundamental values to that used in hierarchical models that rank humans at the pinnacle, or mechanical models that express rational, utilitarian approaches including instrumental rationality. We have noted that systemic thinking and models are still rarely applied for understanding the multiple relations between sustainable development goals and targets. Hence contradictions or trade-offs are ignored in specific situations, including key questions about the purpose of sustainable or other types of development.

Second, *administrative and institutional barriers* are the segmented and uncoordinated formulation and conduct of projects and programs that fail to adopt a compound and coordinated understanding of individual–society–environment–biosphere interrelations. Unfortunately, formal education and training have created roles and responsibilities for scientists, professionals, public administrators, and citizens from "all walks of life," delimited by discipline-based knowledge and professional know-how. This specialization and segmentation of functions in both public and private sectors has created specialists that isolate their concern about a situation or problem from its real-world context, as Rittel and Webber noted (1973); they explained how core values are embedded in human interpretations of societal problems. In contrast, scientific problems are meant to be value-neutral; experts apply instrumental rationalism largely driven by quantitative data and statistical analysis, whereas qualitative meanings and preferences that express values and worldviews are rarely included. Consequently, many administrative and institutional contributions grounded only on the results of this kind of scientific research have failed because

they have only addressed the measurable conditions of economic, environmental, and social conditions of problems rather than their root causes. If these causes are not understood, then effective corrective measures cannot be implemented.

Third, *behavioral and social barriers* refers to the attitudes and actions of all humans—politicians, property owners, public servants, and laypeople—who have personal and shared beliefs, intentions, motives, and preferences about what constitutes quality of life, well-being, and the common good, and what behaviors are acceptable to achieve them. In heterogenous societies, there is rarely consensus about how these core constituents of culture and behavior are associated with individual–society–environment–biosphere interrelations. Indeed, there frequently are conflicts between contrasting viewpoints; this also explains why sustainable development is still strongly contested by some and distorted by others for egocentric benefit.

We argue that until these three sets of barriers are understood, they cannot be removed. The contribution of Otto Scharmer is one approach that has been applied successfully in different situations to achieve this objective. Theory U was formulated by Otto Scharmer (2016, 2018), who posits that there is an urgent need for a societal shift from the strong focus on individualism and egocentric thinking to ecosystems awareness and a shared consciousness. This collective mindset is needed before persistent global trends, including climate change, loss of biodiversity, and increasing socioeconomic inequalities can be counteracted by concerted action. Scharmer has consistently explained that human awareness and consciousness of leading decision-makers is a common obstacle to societal change. In order to change the mindset of leaders, Theory U proposes the rethinking of fundamental existential issues of our identity in society and our status in the world. This critical thinking should consider core values about the position and status of humans and all other living beings on the planet. According to Scharmer (2018), any fundamental societal change will require a shift from an egocentric society to an ecosystemic one that cares about nurturing all beings on Earth.

Scharmer's approach enables participants from all sectors in society to converge and collaborate in order to change existing situations that are problematic. His collaborative contribution includes five phases: co-imitating and listening to others in order to establish a common ground for participants; co-sensing, observing, and reflecting with an open mind about the position of oneself and others; presencing by systemic thinking about where each participants would like to be and what changes are required to get there; cocreating prototypes that can serve as experiments to test change in real-world situations; and coevolving in order to review, confirm, and sustain the outcomes of the collaborative process that has formulated and tested plausible futures. The approach identifies "blind spots" (including hidden assumptions, misconceptions, and unknowns) in common debate about problematic situations and societal trends. Once these blind spots have been identified and understood by all participants, then it is possible for them

to reposition themselves in relation to a problematic situation of mutual concern by considering alternative futures rather than reacting only to patterns or processes of the past.

Conclusion

This article highlights the limitations of conventional contributions that discuss implementing sustainable development using frameworks, including the United Nations 2030 Agenda for Sustainable Development since 2015. The article presents the content and rationale of a more comprehensive approach than the framework provided in the 5P Model for sustainable development and the 17 SDGs and 169 targets that are meant to encourage implementation of societal change for sustainable development. This societal shift should combine and coordinate individual, group, and societal change using the anthropo-logic of human ecology. This enlarged approach, illustrated by Theory U, includes initiatives that have bridged the knowledge–practice divide in numerous sectors at the level of cities and community initiatives (e.g., environment, energy, food, health, housing, land use, and transport). Many innovative programs and projects involving laypeople have been studied since 2015 (Lawrence, 2021). We conclude that community-based transdisciplinary project implementation has shifted beyond conventional project and policy-making agendas to address fundamental values and shared concerns about living conditions of current and future generations in a world undergoing rapid change. Hence the fundamental constituents of an anthropo-logic have been deciphered, understood, and then used creatively during concerted action at the city and community level. This article concludes that although there has been no "social avalanche" as requested by Fischer et al. (2012, p. 158), major barriers to implementing sustainable development have and are being removed by concerted action that applies the subsidiarity principle despite the inertia of many national governments and denial of private enterprises to address persistent problems in a rapidly changing world.

Acknowledgement

Dr. Arthur Dahl, former Deputy Assistant Executive Director of the United Nations Environment Programme (UNEP) has kindly provided feedback on an earlier draft of this article despite his busy schedule during his active retirement. His generosity is acknowledged with sincere thanks.

References

Berg, C. (2020). *Sustainable action: Overcoming the barriers*. Routledge.

Dahl, A. L. (1996). *The eco principle: Ecology and economics in symbiosis*. Zed Books.

Dahl, A. L. (2018). UNEP and CSD process for sustainable development indicators. In S. Bell and S. Morse (Eds.), *Routledge handbook of sustainability indicators* (pp. 347–363). Routledge. doi.org/10.4324/9781315561103-23

Daly, H. (1973). *Toward a steady-state economy*. W. H. Freeman.

Dovers, S. R., & Handmer, J. W. (1993). Contradictions in sustainability. *Environmental Conservation*, 20(3), 217–222. doi.org/10.1017/s0376892900022992

Dyball, R., & Newell, B. (2015). *Understanding human ecology: A systems approach to sustainability*. Routledge.

Elder, M., Bengtsson, M., & Akenji, L. (2016). An optimistic analysis of the means of implementation for Sustainable Development Goals: Thinking about goals as means. *Sustainability,* 8(9), 962. doi.org/10.3390/su8090962

Fischer, J., Dyball, R., Fazey, I., Gross, C., Dovers, S., Ehrlich, P. R., … Borden, R. (2012). Human behavior and sustainability. *Frontiers in Ecology and the Environment,* 10(3), 153–160. doi.org/10.1890/110079

International Council for Science. (2017). *A guide to SDG interactions: From science to implementation*. International Council for Science. council.science/wp-content/uploads/2017/05/SDGs-Guide-to-Interactions.pdf

Kenny, C. (2015). *From MDGs to SDGs: Have we lost the plot?* [Essay]. Center for Global Development. www.cgdev.org/publication/mdgs-sdgs-have-we-lost-plot

Kolodny, N., & Brunero, J. (2018). Instrumental rationality. In E. N. Zalta (Ed.), *The Stanford encyclopedia of philosophy* (Spring 2020 ed.). Stanford University. plato.stanford.edu/archives/spr2020/entries/rationality-instrumental/

Lawrence, R. (2001). Human ecology. In M. Tolba (Ed.), *Our fragile world: Challenges and opportunities for sustainable development* (Vol. 1; pp. 675–693). EOLSS Publishers.

Lawrence, R. (2005). Human ecology and its applications for sustainability research. In W. Leal Filho (Ed.), *Handbook of sustainability research* (pp. 121–145). Peter Lang.

Lawrence, R. (2015). Mind the gap: Bridging the divide between knowledge, policy and practice. In H. Barton, S. Thompson, S. Burgess, & M. Grant (Eds.), *The Routledge handbook of planning for health and well-being* (pp. 74–84). Routledge. doi.org/10.4324/9781315728261

Lawrence, R. (2020). *Creating built environments: Bridging knowledge and practice divides*. Routledge. doi.org/10.4324/9781351201674

Lawrence, R., & Gatzweiler, F. (2017). Wanted: A transdisciplinary knowledge domain for urban health. *Journal of Urban Health*, 94(4), 592–596. doi.org/10.1007/s11524-017-0182-x

Lawrence, R., & Werna, E. (2009). *Labour conditions for construction: Building cities, decent work and the role of local authorities*. Wiley-Blackwell.

Lopez-Claros, A., Dahl, A., & Groff, M. (2020). *Global governance and the emergence of global institutions for the 21st century*. Cambridge University Press. doi.org/10.1017/9781108569293

Meadows, D. H. (1998). *Indicators and information systems for sustainable development: A report to the Balaton Group*. The Sustainability Institute. donellameadows.org/wp-content/user files/IndicatorsInformation.pdf

Monkelbaan, J. (2019). *Governance for the Sustainable Development Goals: Exploring an integrative framework of theories, tools, and competencies*. Springer Nature. doi.org/10.1007/978-981-13-0475-0

Morton, S., Pencheon, D., & Squires, N. (2017). Sustainable Development Goals (SDGs), and their implementation: A national global framework for health, development and equity needs a systems approach at every level. *British Medical Bulletin*, 124(1), 81–90. doi.org/10.1093/bmb/ldx031

Nilsson, M., Griggs, D., & Visbeck, M. (2016). Map the interactions between Sustainable Development Goals. *Nature*, 534(7607), 320–322. doi.org/10.1038/534320a

Pintér, L., Almassy, D., Antonio, E., Hatakeyama, S., Niestroy, I., Olsen, S., & Pulawska, G. (2014). *Sustainable Development Goals and indicators for a small planet: Part I—methodology and global framework*. Asia-Europe Foundation.

Rittel, H., & Webber, M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, 4, 155–169. doi.org/10.1007/bf01405730

Scharmer, C. O. (2016). *Theory U: Leading from the future as it emerges* (2nd ed.). Berrett-Koehler Publishers.

Scharmer, C. O. (2018). *The essentials of Theory U: Core principles and applications*. Berrett-Koehler Publishers.

United Nations. (1992). *Agenda 21: Programme of action for sustainable development.* United Nations Conference on Environment and Development, Rio de Janeiro, Brazil, 3–14 June. United Nations. sustainabledevelopment.un.org/content/documents/Agenda21.pdf

United Nations. (2002). *Report of the World Summit on Sustainable Development*. United Nations. digitallibrary.un.org/record/478154?ln=en

United Nations. (2015). *Transforming our world: The 2030 agenda for sustainable development*. United Nations. sustainabledevelopment.un.org/post2015/transformingourworld/publication

United Nations. (2017). *Progress towards the Sustainable Development Goals: Report of the Secretary-General*. United Nations. digitallibrary.un.org/record/1288024?ln=en

United Nations. (2019). *Global sustainable development report 2019: The future is now—Science for achieving sustainable development*. United Nations. doi.org/10.18356/5d04ad97-en

WBGU. (2011). *World in transition: A social contract for sustainability*. Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen [German Advisory Council on Global Change] (WGBU). issuu.com/wbgu/docs/wbgu_jg2011_en?e=37591641/69400200

World Commission on Environment and Development. (1987). *Our common future* [The Brundtland Report]. Oxford University Press.

Are Global Neighborhoods in Houston Less Polluted? A Spatial Analysis of Twenty-First-Century Urban Demographics

Maggie Leon-Corwin
Department of Sociology, Oklahoma State University, United States

Matthew Thomas Clement[1]
Department of Sociology, Texas State University, United States

Chad L. Smith
Department of Sociology, Texas State University, United States

Abstract

Suburban metropolitan areas across the United States have become racially diverse. We examine this novel spatial demography in relation to pollution levels across census tracts within the greater Houston area for the year 2015. We integrate a multigroup measure of racial diversity (the Entropy Index) with information on pollution levels from the Toxics Release Inventory. Maps of these two variables show that racial diversity tends to be higher in the Houston suburbs where pollution levels tend to be lower. Indeed, across five different spatial regression models, we find that tract-level racial diversity is negatively correlated with pollution levels, controlling for a host of other factors, including population size and land area. We outline this finding as a human ecology approach to urban environmental inequality; specifically, we speculate that recent demographic shifts, like the "back-to-the-city" movement, are modifying the dynamics of environmental inequality in cities.

Keywords: environmental inequality, Houston, multigroup entropy index, spatial analysis, urban demography

Introduction

Environmental social scientists have long drawn on the various threads of human ecology to study the ecological implications of population change (e.g., Buttel & Humphrey, 2002; Catton, 1980; Rudel, 2012). Yet the original formulations of human ecology were focused on the urban environment, using ecological forces

1 Corresponding author: mtc73@txstate.edu.

as metaphors to study the demographic evolution of cities (see Michelson, 1968). In that light, some urban environmental scholars have refocused human ecology's attention back on cities to study the environmental implications of population change in terms of pollution and land use within urban spaces (e.g., Elliott & Frickel, 2013). In our study, we make use of that general framework to analyze the environmental implications of twenty-first-century urban demographics in the United States. Specifically, we look at the relationship between multigroup racial diversity and pollution levels in the context of the greater Houston area in 2015.[2] Given our focus on the relationship between racial demographics and pollution levels within cities, we outline our study as a human ecology approach to urban environmental inequality in line with recent scholarship on the topic (McKinney et al., 2015).

In the social sciences, much quantitative research has examined the connection between race and environmental change (Mohai et al., 2009). One track of this scholarship has relied on singular measures of the racial distribution of a community (e.g., percent black or percent white) (Crowder & Downey, 2010; Smith, 2009); another track has begun to incorporate multigroup measures of racial segregation and racial/ethnic diversity (e.g., Ard, 2016; Downey et al., 2008; Jones et al., 2014; Morello-Frosch & Jesdale, 2006). Much of the research on the environmental implications of diversity/segregation has utilized measures of evenness (e.g., Ard, 2016; Downey et al., 2008; Morello-Frosch & Jesdale, 2006), which generally represent the spatial distribution of a combination of racial groups relative to each group's proportion in the population of the urban area. While we recognize that there are many measures of evenness (see Ard, 2016), our focus is on the multigroup entropy index, a measure of evenness among racial/ethnic groups distributed across a geographic unit (Massey & Denton, 1988). We do this for two reasons: The entropy index represents an intuitive measure of the spatial evenness of racial groups; and, as the subject of news reports in the popular press, the entropy index has influenced public policy discussions of segregation (Boschma, 2016; ProPublica, 2017; Williams & Emamdjomeh, 2018).

The racial distribution of the Houston metropolitan region in the 2010s represents a unique urban demography, making the area an ideal site for investigating the relationship between racial demographics and pollution levels. During this time, Houston has become one of the most diverse urban areas in the United States (Lappie et al., 2018). In fact, according to Lappie et al. (2018), Fort Bend County, one of the nine counties making up the Houston Metropolitan Statistical Area (MSA), is the most diverse county in the United States. Moreover, over the past

2 Throughout the manuscript, we use the term "racial diversity" to refer to the heterogeneity of racial categories in a census tract (or other areal unit). In other words, a census tract that is predominantly comprised of individuals from one racial category (i.e., a racially homogeneous tract) is less diverse than a census tract with individuals from multiple racial categories. Racial diversity does not simply mean the presence of racial minority residents.

several years, many of the city's neighborhoods have "rapidly integrated" (Williams & Emamdjomeh, 2018); their racial composition more closely resembles what urban scholars have called "global neighborhoods" (Zhang & Logan, 2016); that is, places with a relatively balanced proportion of whites, blacks, Hispanics, and Asians. While the Houston area continues to experience gentrification and still has high levels of segregation (Binkovitz, 2018; Strait & Gong, 2010), many of its residents express positive views of ethnic diversity (Klineberg, 2019). Moreover, its diverse global neighborhoods tend to be found outside of the inner urban core, especially in the western ring of suburbs (Williams & Emamdjomeh, 2018).

Houston's racial diversity makes it "one of the most ethnically and culturally diverse metro areas in the entire country" (Klineberg, 2019, p. 15). Nevertheless, some of the changes it is experiencing are also being observed in other parts of the country (Zhang & Logan, 2016). Indeed, what scholars have called the "urban revival" or "urban renaissance" is a dual spatial-demographic process unfolding around the country: the "back-to-the-city" movement is counterbalanced with the "suburbanization of poverty" (Couture & Handbury, 2017; Florida, 2016; Logan, 2014; Podagrosi et al., 2011). Not just the urban core, but metropolitan suburbs across the United States have experienced a unique transformation. In Houston, this inner-city movement has coincided with the emergence of racially diverse suburban neighborhoods. In the following study, we examine the implications of this new urban demography in terms of pollution levels, asking the question: Are these new "rapidly integrated" neighborhoods in Houston associated with higher or lower levels of pollution?

The following analysis provides a preliminary answer to this question, laying the groundwork for future scholarship to examine the environmental justice implications of the twenty-first-century urban revival. To that end, we first review the relevant literature, describing the current spatial demographics of America's cities, with an emphasis on Houston and underscoring, as mentioned above, the utility of multigroup measures of race for quantitative environmental justice scholarship. Based on this literature review, we identify a gap in the quantitative environmental justice research. On the one hand, there has been a growing inquiry into the environmental implications of multigroup measures of race and ethnic heterogeneity (Ard, 2016; Chakraborty et al., 2017; Downey et al., 2008; Jones et al., 2014; Morello-Frosch & Jesdale, 2006).[3] On the other hand, the Houston area has served as a case study and research site for numerous quantitative analyses, the results of which have advanced our understanding of environmental justice (Chakraborty, 2015; Collins et al., 2015; Elliott & Smiley, 2019; Hernandez et al., 2015; Linder et al., 2008). Yet the

3 Here, we simply recognize the distinction between environmental justice research addressing multigroup racial diversity (e.g., Ard, 2016) and intra-ethnic heterogeneity (e.g., Chakraborty et al., 2017). We situate our project within the former line of research, which estimates diversity strictly in terms of multiple different racial groups rather than racial variation within a single ethnicity.

studies relying on more recent data have not considered the environmental justice implications of the urban revival in Houston, with its racially diverse suburban neighborhoods. To fill this gap, we present results from a quantitative analysis, examining the relationship between racial diversity and pollution levels for the greater Houston area.

We organize our analysis as follows. First, based on 2015 data from the Toxics Release Inventory (United States Environmental Protection Agency [EPA], 2017) and the 2010–2015 five-year estimates from the United States Census American Community Survey[4] (US Census ACS, 2019), we juxtapose two maps displaying spatial variation in a multigroup measure of racial diversity (i.e., the entropy index) and pollution levels for all census tracts across the greater Houston area (n = 1,036) (see Figure 1). A visual inspection of these maps suggests that pollution levels are negatively correlated with neighborhood-level diversity. Second, we integrate these variables into cross-sectional spatial regression models. In these models, we regress pollution levels (standardized by population size and land area) on the entropy index, while controlling for a host of other factors, including spatial autocorrelation. Consistent with Figure 1, we find that, across five different spatial regression models, census tracts that are comprised of increased levels of racial diversity have lower pollution levels.

In the conclusion, we emphasize the preliminary nature of these findings, and we note that, like other studies utilizing multigroup measures of racial diversity (e.g., Ard, 2016; Downey et al., 2008; Jones et al., 2014; Morello-Frosch & Jesdale, 2006), we do not examine change over time. Our cross-sectional snapshot finds a negative correlation between tract-level racial diversity and pollution levels; this negative correlation may be an artifact of the historically contingent location in which non-white populations have settled in the Houston area in the 2010s. As noted above, white residents have been moving "back to the city," not just in Houston but in cities across the United States. Future scholarship, using longitudinal data, will be better able to address what this new geographic distribution means for conventional frameworks on environmental inequality and how it applies in emerging global neighborhoods across cities in the United States.

4 Quality concerns with both Toxics Release Inventory and ACS data sources have been raised but both provide consistent measures of the variables of interest and are commonly used across social science research.

Twenty-first-century urban demographics and environmental inequality in Houston

Pellow (2018) notes that the "second generation" of environmental justice scholarship has evolved into a multidimensional discipline, with multiple levels of analysis and foci of investigation. Environmental justice scholars discuss and evaluate elements of inequality as related to exposure to health and natural hazards at home and in the workplace, the institutional and policy responses to environmental crises, and the structural responses to environmental crises, as well as community access to green space, to name only a few (e.g., Ard, 2016; Chakraborty et al., 2017; Chakraborty et al., 2019; Elliott & Smiley, 2019; Gould & Lewis, 2017; Liévanos, 2012). Moreover, environmental justice scholarship has kept pace with changes in the unequal exposure to pollution; one line of inquiry derives insights from the legacy of human ecology and its interest in the social and natural changes happening in urban spaces. For instance, Elliott and Frickel (2013) examine the "churning" of urban land uses, highlighting what this process means for exposure to those pollutants forgotten and often buried inside old urban cores.

Connected to this churning of land use is a recent demographic shift; although with much variation across the United States, the general trend is that white, affluent, and highly educated households are returning to the inner city (Florida, 2016). Old industrial sites, abandoned factories, and neglected commercial centers are being remodeled and redeveloped to house and accommodate the activities of these new residents. Yet, this process is two-sided. As white, affluent, and highly educated households start to reside in the inner city, poor residents and communities of color are displaced from the old urban cores (Podagrosi et al., 2011); these households then take up residence in cheaper areas outside the city (Logan, 2014).

Situated within this new urban landscape, we frame our research as a human ecology approach to urban environmental inequality (McKinney et al., 2015), considering the relationship between racial demographic changes and pollution and asking generally: what are the environmental consequences of demographics in a large, diverse twenty-first-century metropolitan area? Our focus is on the racial dynamics underlying pollution levels in the Houston area in the mid-2010s. Houston has historical significance to both environmental justice scholarship and activism (Bullard, 1983), and continues to be the focus of numerous environmental justice–oriented academic studies (e.g., Chakraborty, 2015; Collins et al., 2015; Elliott & Smiley, 2019; Hernandez et al., 2015; Linder et al., 2008). Meanwhile, Houston historically has also been a segregated city (Strait & Gong, 2010), and its recent redevelopment has resulted in some of the most intensely gentrified neighborhoods

in the country (Binkovitz, 2018; Podagrosi et al., 2011).[5] Nevertheless, the racial composition of its neighborhoods has changed dramatically, especially in the past few years (Williams & Emamdjomeh, 2018). As of 2015, relatively speaking, while the inner city has attracted more white residents, the city's suburbs have become racially diverse (see Figure 1).

Given the experience of "urban disinvestment" and "white flight," which continued through the end of the twentieth century, the novel spatial demographics of the twenty-first century have encouraged social scientists to develop new conceptual tools. Some scholars have described these diverse urban areas as being comprised of "global neighborhoods" (Logan & Zhang, 2010, p. 1070), which are characterized by the neighborhood-level presence of multiple racial/ethnic groups (e.g., non-Hispanic white, black, Hispanic, and Asian) in the same proportions observed in the greater metropolitan area. Houston's "rapidly integrated" suburban neighborhoods are an expression of this "global neighborhood" phenomenon, serving as the motivation of our analysis of environmental inequality in terms of pollution levels.

Estimating pollution and measuring race

A great deal of the quantitative literature on environmental inequality uses data from the Toxics Release Inventory (TRI), an annual inventory published by the Environmental Protection Agency (EPA, 2017) that documents the site-level release of pollutants known to cause harm to human health and the environment. Though the TRI only reports chemical releases, these measures are used as a way to approximate pollution levels in areas surrounding TRI sites. Scholars have found that residential proximity to a TRI site has a wide range of consequences for human health and social cohesion (Bevc et al., 2005; Johnson et al., 2014; Natural Resources Defense Council, 2004). Focused on urban areas, these scholars use methods ranging from straightforward unit hazard analysis, one of the earliest methods developed to investigate spatial proximity to pollutants, to more complex pollution plume modeling; significant research considers potential exposure to environmental toxins in relation to demographic composition of the area near or around a TRI site.

Across the environmental justice literature, there is robust evidence that race plays a primary role in structuring environmental inequality (Cushing et al., 2015; Johnston et al., 2016; Mohai & Saha, 2015). In these studies, many operational measures of race are based on single-group racial variables; there has been less quantitative work explicitly looking at the role that multigroup measures of

5 Unfortunately, we do not have the space to fully explain the legacy of segregation. However, we point interested readers to a large swatch of research that explains segregation across the United States, including in Houston (Feagin, 2000; Feagin & Sikes, 1994; Massey & Denton, 1993).

race play in pollution levels (e.g., Ard, 2016; Downey et al., 2008; Jones et al., 2014; Morello-Frosch & Jesdale, 2006).[6] Multigroup measures of race, measures that allow for the inclusion of multiple racial or ethnic groups in analysis, can facilitate an analysis of the relative racial/ethnic diversity of a neighborhood and help continue to incorporate a discussion of segregation into environmental justice research (Jones et al., 2014; Smith, 2007, 2009). Furthermore, including multiple group measures best represents the reality of contemporary urban demographics in metropolitan areas like Houston. To be sure, the concepts of racial/ethnic diversity and segregation figure into the theoretical frameworks of environmental inequality; for instance, scholars identify segregation as "a major contributor to the creation and maintenance of environmental inequality" (Mohai & Saha, 2015, p. 317). Yet, compared to single-group variables, in the environmental justice literature, there has been less work incorporating multigroup measures of race into quantitative analyses of pollution levels.

The evidence there is about how pollution levels vary by racial diversity/segregation is not consistent. For instance, Downey et al. (2008) find no evidence of a significant effect of segregation. While Ard (2016) was looking at the health risks of pollution exposure, she did find that these risks were exacerbated significantly by most measures of segregation, including entropy, which is the focus of our analysis; in other words, less segregation attenuates the health risk of pollution exposure, which suggests that tracts with greater racial diversity have lower levels of pollution. We note that these studies tend to analyze data from the 2000 census and Toxics Release Inventory. Yet the demographics of cities across the United States have changed since that time, especially in the greater Houston area. To assess the environmental implications of racial diversity in the Houston area we focus on the entropy index, known as Theil's H (described below in more detail). As Ard (2016) explains, this multigroup measure of evenness allows scholars to utilize a more nuanced approach to investigate the complex and historically contested relationship between race and pollution exposure. This measure is often seen in investigations of racial residential patterns and other forms of social inequality, such as in employment (Gorelick & Bertram, 2010). Moreover, as noted above, the entropy index has been incorporated into news reports on racial/ethnic diversity and segregation by the popular press (Boschma, 2016; ProPublica, 2017; Williams & Emamdjomeh, 2018).

6 To be clear, much of this literature looks at the health consequences of pollution exposure.

Data and analysis

Unit of analysis

For the analysis, we collect information on sociodemographic, economic, and chemical release variables at the level of the census tract across the Houston–Sugarland–Baytown MSA. The census tract is the smallest and most common unit of analysis, with readily accessible information on a variety of social and environmental variables. In the Houston-Sugarland-Baytown MSA, there are 1,070 census tracts spread across 9 counties. Of the 1,070 tracts in the greater Houston area, there are 34 tracts that are either large bodies of water, contain little or no residential population, and/or have a special function (e.g., airports, public parks, employment areas, prisons, universities, etc.). While they serve administrative purposes, these special tracts are functionally dissimilar from the standard tracts, which tend to contain thousands of non-institutionalized residents. Moreover, these special use tracts do not have complete coverage for all variables in the study (e.g., population size, racial distribution, education, home value, etc.). Rather than imputing values, we delete the 34 special use tracts from the analysis, yielding a final sample size of n = 1,036.

Dependent variable

The data for the dependent variable come from the TRI. At the time of analysis, the most recently available and completed version of the TRI was collected in 2015 (EPA, 2017). For that year, we compute the total amount of chemical releases, measured continuously in millions of pounds, released both on- and off-site into the surrounding air, water, and land, as reported on the 2015 TRI for the Houston–Sugarland–Baytown MSA. For the analysis, we divide pounds of pollutants as reported by TRI by the number of people living in the census tract and then divide that value by the area of the tract, yielding a measure of pollution that is standardized by the population density of the census tract. As such, the dependent variable controls for variation in the population size and land area of neighborhoods across the Houston metropolitan area. Because a few tracts have very high levels of pollution, the pollution levels are positively skewed; to address this, we first compute the natural logarithm before incorporating the dependent variable into the bivariate and multivariate analyses. For the tracts that have zero values for air pollution levels, we add a constant of "1" before computing the natural logarithm, which yields a normally distributed dependent variable. All variables, their descriptions, and sources are displayed in Table 1.

Independent variables

The primary independent variables for the study include the measure of *entropy* as well as four separate predictors for the percentage of the population that is (i) *Hispanic*, (ii) *Black*, (iii) *White*, or (iv) *Other*. The entropy index used here measures patterns of evenness among groups distributed across a geographic unit (Massey & Denton, 1988) and was calculated as follows:

where k is the number of racial/ethnic groups of interest, pij is the proportion of the j^{th} racial/ethnic group in tract i, nj is the total population of the j^{th} racial/ethnic group in tract i, and Ni is the total population in tract i (White, 1986). Note that the absolute value was taken from final scores generated by the entropy equation. As such, the maximum score for hi is dependent on the number of racial ethnic groups examined, or $\ln(k)$, with tracts that hold higher values being more diverse, or less segregated, than tracts with lower values. For this project, the maximum value of hi is 1.386. So, a tract with a score of 1.386 would have proportional amounts of persons from each racial/ethnic category examined, whereas a tract with a score of 0 would have only a single racial/ethnic group represented in its population.[7]

Race items are measured continuously from 0 to 100 percent, with (i) *Hispanic* measuring the percent of the population that self-reports as Hispanic (from any race category not already identified as non-Hispanic white, black, etc.) and (ii) *Black* reporting the percent total of non-Hispanic black persons residing in each tract. The (iii) *White* measure reports the percent total of non-Hispanic white persons residing in each tract, and (iv) *Other* reports the percent total of persons residing in each tract that fall into one or more of the following racial/ethnic groups: American Cherokee, American Chippewa, American Navajo tribal, American Sioux tribal, Asian, Native Guamanian, Native Samoan, Native Other Pacific Islander, Some Other Race, and Two or More races. The aforementioned racial/ethnic groups were combined as a result of the low population numbers of each of these groups.[8]

We also include the following six variables as controls: (i) percentage of the labor force that works in *Manufacturing*, (ii) percentage of the population who is *Non-Native*, (iii) *Educational Attainment*, the percentage of the population who have a high school degree or higher, (iv) percentage who live in *Poverty*, (v) median *Household Income*, and (vi) the median *Home Value*. These selected variables have been used as proxy measures of the "path of least resistance," a perspective that supports the notion that pollutants and polluting industries, such as the industrial manufacturing industry, make siting decisions based on a combination of factors

7 An alternative equation for the entropy index includes a minus sign in front of the summation command, yielding negative values for greater racial/ethnic diversity.

8 For a sensitivity check, in a supplemental analysis, we also computed a variable for the percent of the population who is non-white. In two additional spatial error models, displayed in the appendix in Table 3S, we find that the slope estimate for this variable is non-significant, which is consistent with the results displayed in Table 3.

that present the least resistance to their efforts (Anderton et al., 1994; Schelly & Stretesky, 2009). This perspective considers environmental inequality as arising from a variety of political, social, and economic forces. *Manufacturing* scores per tract percentages of persons above the age of 16 employed in a manufacturing job in any industry, while *Non-Native* reports the tract-level composition of all persons reported as being US citizens by naturalization or who report not being a US citizen. *Poverty* is measured as a percent total per tract of persons for whom poverty status has been determined in the 12 months prior. Finally, median *Household Income* and median *Home Value* are measured continuously in US dollars based on 2015 estimates and are reported per tract by the Census (US Census ACS, 2019). All variables have been logged, which facilitates interpretation of the slope estimates in the spatial regression models. The slope estimate is interpreted roughly as the percent change in the dependent variable for every 1 percent change in the predictor variable, holding the rest of the factors constant (see York et al., 2003).

Table 1. Variables, descriptions, and sources.

Variable	Description	Source
1. Pollution	Pollution standardized by the population density of the census tract; pollution level per person per area	Toxics Release Inventory (TRI)
2. Entropy	Measure of diversity, representing the distribution of the racial groups relative to their population proportion in the metropolitan area	US Census
3. Hispanic	Percentage who are Hispanic	US Census
4. Black	Percentage who are Black	US Census
5. White	Percentage who are White	US Census
6. Other	Percentage who are Other	US Census
7. Manufacturing	Percentage of labor force employed in manufacturing	US Census
8. Non-Native	Percentage of the population who were not born in the United States	US Census
9. Educational Attainment	Percentage of the population who have a high school degree or higher	US Census
10. Poverty	Percentage of the population who live in poverty	US Census
11. Household Income	Median household income	US Census
12. Home Value	Median home value	US Census

Note: All variables measured in 2015; all values have been logged.

Source: Toxics Release Inventory 2015 (EPA, 2017; US Census ACS, 2019).

Table 2. Univariate and bivariate statistics.*

Variable	Mean Unlogged	Mean Logged	SD Logged	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. Pollution	0.000	−10.660	1.697	1.000											
2. Entropy	0.868	−0.141	0.356	−0.078	1.000										
3. Hispanic	28.991	3.367	0.741	0.158	−0.066	1.000									
4. Black	10.186	2.321	1.148	0.092	0.474	0.057	1.000								
5. White	23.406	3.153	1.242	−0.233	0.287	−0.467	−0.521	1.000							
6. Other	5.871	1.770	0.936	−0.100	0.614	−0.396	0.024	0.347	1.000						
7. Manufacturing	9.365	2.237	0.538	−0.179	−0.148	0.128	−0.263	0.131	−0.144	1.000					
8. Non-Native	18.120	2.897	0.710	0.128	0.143	0.581	0.030	−0.326	0.230	−0.112	1.000				
9. Educational Attainment	9.699	2.272	0.920	−0.144	0.391	−0.671	−0.119	0.601	0.620	−0.167	−0.201	1.000			
10. Poverty	12.268	2.507	0.924	0.183	−0.124	0.599	0.347	−0.593	−0.416	−0.115	0.282	−0.658	1.000		
11. Household Income	55,714.739	10.928	0.689	−0.158	0.142	−0.364	−0.253	0.451	0.310	0.089	−0.165	0.479	−0.555	1.000	
12. Home Value	138,551.863	11.839	0.593	−0.163	0.140	−0.596	−0.373	0.611	0.486	−0.079	−0.124	0.757	−0.647	0.418	1.000

* Note: For consistency with the results from the spatial error models, we report the bivariate statistics using logged values for all variables. All bivariate correlations are significant ($p < 0.05$) except the correlations between *Black* and *Other*, and *Black* and *Non-Native*.

Source: Authors' summary of findings.

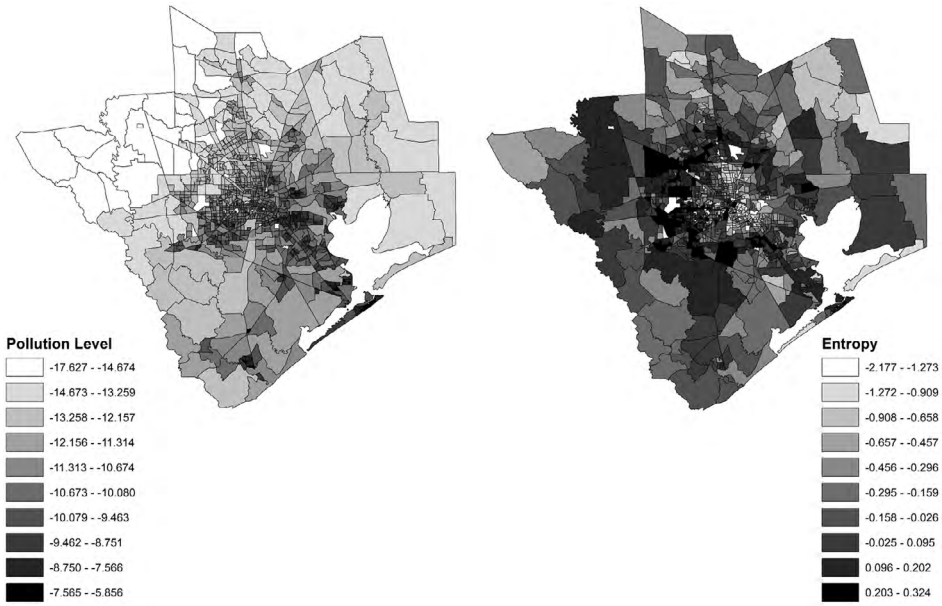

Figure 1. Pollution levels and racial diversity across the Houston Metropolitan Area, 2015.

Note: Units are census tracts (n = 1,036). Values are logged. Pollution level equals pounds of pollutants as reported by TRI divided by the number of people living in the census tract and by the area of the tract, yielding a measure of pollution that is standardized by the population density of the census tract. Racial diversity is measured in terms of entropy, representing the spatial distribution of four racial categories, relative to their proportions in the population. The higher the entropy, the greater the racial diversity of the census tract.

Source: EPA (2017); US Census ACS (2019).

Bivariate analysis and results

Table 2 reports the univariate and bivariate statistics. Looking at Table 2, we note that the bivariate correlation between pollution and entropy is negative ($r = -0.078$; $p < 0.05$). Figure 1 displays spatial variation in our dependent variable and the entropy index across the greater Houston area. A visual inspection of these maps suggests a negative correlation between pollution level and racial diversity. Generally speaking, as one moves from the city center in a west and northwest direction, racial diversity goes up and pollution levels decrease. Likewise, the area immediately southeast of the city center is characterized by low racial diversity and high pollution levels. In a supplemental analysis, we also estimated the bivariate Moran's I between these two variables ($I = -0.051$; $p < 0.01$), which shows that pollution and entropy are negatively correlated across space. Taken together, these results suggest the following exploratory hypothesis:

Hypothesis: At the tract level, there is a negative association between the racial diversity of the tract and its pollution level. In other words, tracts with greater racial diversity have lower pollution levels.

Table 3. Results from spatial error model.

	Model 1		Model 2		Model 3		Model 4		Model 5	
Variable	b	SE	b	SE	b	SE	b	SE	b	SE
Primary Variables										
Entropy	–0.437	**0.140	–0.440	**0.142	–0.497	**0.181	–0.428	**0.142	–0.308	*0.155
Hispanic			0.011	0.103						
Black					0.030	0.058				
White							–0.020	0.059		
Other									–0.133	0.071
Controls										
Manufacturing	–0.282	**0.083	–0.282	**0.084	–0.277	**0.084	–0.279	**0.084	–0.273	**0.083
Non-Native	–0.016	0.075	–0.021	0.089	0.000	0.081	–0.017	0.075	0.020	0.077
Educational Attainment	0.073	0.085	0.076	0.088	0.075	0.085	0.078	0.086	0.104	0.086
Poverty	–0.115	0.065	–0.117	0.066	–0.120	0.066	–0.118	0.066	–0.133	*0.066
Household Income	–0.018	0.064	–0.018	0.065	–0.013	0.065	–0.015	0.065	–0.015	0.064
Home Value	–0.508	***0.115	–0.505	***0.118	–0.492	***0.119	–0.496	***0.120	–0.472	***0.116
Constant	–0.352	2.154	–0.405	2.207	–0.739	2.257	–0.499	2.171	–0.675	2.163
λ	0.977	***0.013	0.977	***0.013	0.977	***0.013	0.977	***0.013	0.977	***0.013
Moran's I (Residuals)	0.008	0.007	0.008	0.006	0.008	0.007	0.008	0.006	0.008	0.006
Max/Mean VIF	3.71/2.02		4.16/2.37		3.72/2.17		3.72/2.14		4.02/2.26	
N	1,036		1,036		1,036		1,036		1,036	

Note: In order to minimize spatial autocorrelation in the residuals to non-significant levels, the spatial parameter λ was estimated using a 3rd order queen contiguity weights matrix. VIF (variation influence factor) values were derived from separate OLS (ordinary least squares) models. SE: standard error. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Source: Authors' summary of findings.

Spatial regression analysis and results

To evaluate our exploratory hypothesis, we turn to results from a multivariate analysis. Here, we regress our dependent variable on the primary predictors as well as the control variables in a spatial error model, which controls for spatial dependence in the error term. The generic equation for a spatial error model is written as follows:

$$y_i = x_{ik}\beta_k + \upsilon_i$$
$$\upsilon_i = \lambda W\upsilon_i + \varepsilon_i$$

wherein y_i indicates the value of the dependent variable for the i^{th} census tract; x_{ik} indicates the value of the k^{th} predictor for the i^{th} tract, with β_k representing the effect of the k^{th} predictor on the dependent variable. Because we have logged both the dependent and independent variables, the estimate for β_k represents, generally speaking, the percent change in pollution levels for every one percent change in the predictor, all else equal. The error term υ_i is decomposed into two parts. The first part estimates the spatial error term λ, which is based on a queen 3rd order contiguity weights matrix W, and the second part ε_i represents all the leftover unobserved variation in the dependent variable.[9]

Table 3 displays the results from the spatial error model. Our primary focus is on the association between *Pollution* and *Entropy*. Given the results from the bivariate analyses, the results from the multivariate analysis will indicate whether the negative bivariate association holds after controlling for potentially confounding variables, including spatial autocorrelation. Looking at Table 3, we first note the significant positive estimates for the spatial error parameter λ in all five models, indicating that there is positive spatial dependency in the error term. While there is not an intuitive interpretation of the estimate for λ, its inclusion in the model has helped reduce spatial autocorrelation of the residuals to non-significant levels (as seen in the values for Moran's I) and minimize any spatially induced bias in the slope estimates of the predictor variables.[10]

Model 1 includes the measure of *Entropy* along with the five non-racial control variables; Models 2–5 then incorporate an additional variable separately for *Hispanic*, *Black*, *White*, and *Other*. While *Entropy* is a multigroup measure of racial diversity, we include separate variables for the other racial groups as a sensitivity check and to ensure that the estimate for *Entropy* is not being influenced by any one particular racial category. Indeed, across all five models, the slope estimate for *Entropy* is consistently negative and significant. In Models 1–4, a 1 percent increase in the entropy of

9 We also estimated spatial error models with spatial weights based on queen 1st and 2nd order contiguity as well as inverse distance; while the slope estimates from these supplemental models (available upon request) were substantively identical, the model residuals using these lower orders still exhibited significant spatial autocorrelation.
10 In Table 3, we also report the max/mean VIFs (variance inflation factors). In all the models, the VIFs are well below the threshold of 10, indicating that there is no problem with multicollinearity.

a census tract is approximately associated with a 0.4 percent decrease in pollution levels ($p < 0.01$); in Model 5, the magnitude of the slope estimate declines slightly but is still significantly negative ($b = -0.308$; $p < 0.05$). Given that the dependent and independent variables have been logged, the slope estimate for the entropy variable is interpreted roughly as follows: For every 1 percent increase in entropy at the level of the census tract, there is between 0.497 percent and 0.308 percent decrease in density-standardized pollution levels across the Houston area.

There are two points to make regarding these results. First, the significant, negative coefficient for *Entropy* is not substantively moderated by the inclusion of any of the single-group race variables, which indicates that it is a robust finding. Second, controlling for multigroup racial/ethnic diversity, none of the slopes estimates for the single-group race variables are significant. To be clear, we included the single-race measures as a sensitivity check to observe whether the estimate for *Entropy* was being influenced by a particular racial category. With this caveat in mind, we speculate whether the cross-sectional effect of race is most evident not with single-group measures but with multigroup diversity measures; we encourage future scholarship to consider incorporating a multigroup measure of racial/ethnic diversity when assessing the effect of race on pollution exposure.

Before we turn to a discussion of these results in the conclusion, we briefly report the results from two control variables that are consistently significant across the five different models. First, while the negative slope estimate for *Manufacturing* may seem contradictory, this variable measures the percentage of the residents of the census tract who are employed in manufacturing industries; it does not directly represent the level of manufacturing activity within the census tract. Either way, the negative slope estimate is inconsistent with previous work by Elliott and Smiley (2019), who also conducted a cross-sectional snapshot analysis of pollution levels within the Houston area. Aside from a different research question, Elliott and Smiley analyzed data for the year 2010 and did not control for land area, as we did. Future research can delve into whether the inconsistency for *Manufacturing* is the result of differences in the year analyzed and/or differences in the operational measures used in the analysis. Second, the estimate for median *Home Value* is significantly negative. In other words, neighborhoods with higher property values are associated with lower pollution levels. This result is consistent with previous analyses looking at the independent effect of socioeconomic status on exposure to environmental pollutants (Crowder & Downey, 2010).

Discussion and conclusion

Given our interest in changing urban demographics, we frame the above project as a human ecology approach to urban environmental inequality (Elliott & Frickel, 2013; McKinney et al., 2015). Specifically, we look at the relationship between multigroup racial diversity and pollution levels in the context of the greater Houston area in 2015. While many quantitative environmental justice scholars utilize single-group measures of race, there is also a growing body of research incorporating multigroup measures of racial diversity and ethnic heterogeneity (e.g., Ard, 2016; Chakraborty et al., 2017; Downey et al., 2008; Jones et al., 2014; Morello-Frosch & Jesdale, 2006). This academic trend is concurrent with the increasing diversity of the American population. In fact, not just environmental scholars, but social scientists in general have been building analytic techniques and conceptual frameworks to study the novel demographics of America's urban areas, especially with the emergence of "multi-ethnic" "global neighborhoods" (Zhang & Logan, 2016). In this new metropolitan landscape, Logan and Zhang (2010) argue that "the simple place categories of predominantly white, predominantly black, or racially mixed are no longer adequate" (p. 1070). Instead, operational measures of race should adequately capture the demographic diversity of the unit of analysis. One contribution of our analysis is that we utilize a multigroup measure of race to assess the role that neighborhood diversity plays in pollution levels within a "multi-ethnic" "rapidly integrated" metropolitan region.

As mentioned above, some scholars have found that higher levels of segregation are associated with more toxic industries and increased health risk from air pollution (Ard, 2016; Smith, 2009). To be clear, these findings do not contradict the results of our study; instead, they reflect the obverse of what we observe: lower diversity is associated with higher pollution levels, and greater diversity is associated with lower pollution levels. In other words, those locations with the highest levels of diversity have the lowest TRI levels and vice versa. Yet, in another way, the results of the models presented above do run counter to quantitative work on environmental inequality, at least with respect to the use of single-group race variables. Again, much of this research has demonstrated that single-group measures of race are reliable predictors of a wide range of environmental contaminants (Brulle & Pellow, 2006; Mohai et al., 2009). However, in our analysis, given that the slope estimates for the single-group variables are non-significant, the multigroup variable is a more consistent predictor of pollution levels than the single-group measures. This finding could point to emergent trends that researchers should be mindful of in their future research.

Nevertheless, we underscore that the results of our study are based on a single metropolitan area (Houston, Texas) using cross-sectional data for the year 2015. We are careful in drawing conclusions about the mechanism involved here and we seek to provide suggested reasons for this finding, pointing to two limitations of this work while highlighting fruitful opportunities for future research.

First, we reiterate that, not just Houston, but other diverse cities, such as Chicago, continue to have large pockets of neighborhoods, especially in the urban core, that remain highly segregated (e.g., Podagrosi et al., 2011). Yet, these cities' suburban neighborhoods are the places that are undergoing "rapid" integration (Williams & Emamdjomeh, 2018). This is important as the shifts in environmental inequality highlighted in this research may point to quickly changing demographic trends that require not only new theoretical lenses (e.g., global neighborhoods) but also innovative methodological strategies that incorporate longitudinal data. To be clear, previous environmental research on diversity/segregation also tends to rely on cross-sectional snapshots (e.g., Ard, 2016; Downey et al., 2008; Jones et al., 2014; Morello-Frosch & Jesdale, 2006). Likewise, since we do not have longitudinal data, we can only identify a cross-sectional relationship between racial/ethnic diversity and pollution levels in Houston. Our cross-sectional analysis captures the spatial but not the temporal dimension of variation; as such, our models do not adequately analyze processes like gentrification.

On that note, as seen in Figure 1, much of the pollution associated with TRI levels in Houston is located in the southeastern parts of the city, while the suburban areas west of the city are less polluted (cf. Downey, 2005). Again, it is these suburban areas that are also undergoing rapid integration as the central part of the city is gentrifying. We suspect that as affluent, white households abandon the suburbs for the inner city, the suburbs of Houston are undergoing a transformation in which a more diverse, non-white population is becoming more commonplace. Hence, it is in these suburban areas where there is a confluence of increased racial/ethnic diversity and decreased levels of pollution. Yet, while our cross-sectional analysis, controlling for spatial autocorrelation as well as a host of potentially confounding variables, reveals an inverse correlation between racial/ethnic diversity and pollution levels, it precludes a more thorough evaluation of whether and how over time these demographic shifts are contributing to temporal changes in pollution levels. As the shift towards multi-ethnic neighborhoods continues across American cities, environmental justice scholarship would benefit from the incorporation of longitudinal data to test whether the results we observe for the Houston area in 2015 are generalizable across time and space.

Secondly, among other strategies, Pellow (2018) argues that environmental justice research should include multiple levels of analysis and foci of investigation. To that end, we recognize that inequality in pollution levels is experienced in many settings, not just where people live but also where they spend their time in leisure, their daily rounds, and work (e.g., Bullard, 1996). Our focus was on the racial dynamics of pollution level within the neighborhood of residence. Nevertheless, following the lead of previous research (e.g., Elliott & Smiley, 2019), future scholarship can consider whether the daily rounds of residents and workers might also play a role in pollution exposure within the context of the shifting demographics of American

cities. Perhaps, while diverse neighborhoods experience lower levels of pollution, the residents of these neighborhoods may be working in toxic conditions. As noted by other social scientists utilizing spatial data (Anderson, 2018), answering these questions will require not only longitudinal data but also multilevel methods to assess the neighborhood and workplace impacts on individuals.

References

Anderson, K. F. (2018). Racial/ethnic residential segregation, the distribution of physician's offices and access to health care: The case of Houston, Texas. *Social Sciences*, 7(8), 119. doi.org/10.3390/socsci7080119

Anderton, D. L, Anderson A. B., Oakes J. M., & Fraser M. R. (1994). Environmental equity: The demographics of dumping. *Demography*, 31, 229–248. doi.org/10.2307/2061884

Ard, K. (2016). By all measures: An examination of the relationship between segregation and health risk from air pollution. *Population and Environment*, 38(1), 1–20. doi.org/10.1007/s11111-015-0251-6

Bevc, C. A., Marshall, B. K., & Picou, J. S. (2005). Environmental justice and toxic exposure: Toward a spatial model of physical health and psychological well-being. *Social Science Research*, 36(1), 48–67. doi.org/10.1016/j.ssresearch.2005.11.001

Binkovitz, L. (2018, March 14). Two Houston zip codes among the 'most gentrified' in the country. *Urban Edge*. Rice University: The Kinder Institute. kinder.rice.edu/2018/03/16/two-houston-zip-codes-among-most-gentrified-country

Boschma, J. (2016, March 1). Separate and still unequal. *The Atlantic*. www.theatlantic.com/education/archive/2016/03/separate-still-unequal/471720/

Brulle, R. J., & Pellow, D. N. (2006). Environmental justice: Human health and environmental inequalities. *Annual Review of Public Health*, 27, 103–124. doi.org/10.1146/annurev.publhealth.27.021405.102124

Bullard, R. D. (1983). Solid waste sites and the black Houston community. *Sociological Inquiry*, 53(2–3), 273–288. doi.org/10.1111/j.1475-682x.1983.tb00037.x

Bullard, R. D. (1996). Environmental justice: It's more than waste facility siting. *Social Science Quarterly*, 77(3), 493–499. www.jstor.org/stable/42863495

Buttel, F. H., & Humphrey, C. R. (2002). Sociological theory and the natural environment. In R. E. Dunlap and W. Michelson (Eds.), *Handbook of Environmental Sociology* (pp. 33–69). Greenwood Press.

Catton, W. R. Jr. (1980). *Overshoot: The ecological basis of revolutionary change*. University of Illinois Press.

Chakraborty, J. (2015). Proximity to extremely hazardous substances for people with disabilities: A case study in Houston, Texas. *Disability and Health Journal*, 12(1), 121–125. doi.org/10.1016/j.dhjo.2018.08.004

Chakraborty, J., Collins, T. W., & Grineski, S. E. (2017). Cancer risks from exposure to vehicular air pollution: A household level analysis of intra-ethnic heterogeneity in Miami, Florida. *Urban Geography*, 38(1), 112–136. doi.org/10.1080/02723638.2016.1150112

Chakraborty, J., Collins, T. W., & Grineski, S. E. (2019). Exploring the environmental justice implications of Hurricane Harvey flooding in greater Houston, Texas. *American Journal of Public Health*, 109(2), 244–250. doi.org/10.2105/ajph.2018.304846

Collins, T. W., Grineski, S. E., Chakraborty, J., Montgomery, M. C., & Hernandez, M. (2015). Downscaling environmental justice analysis: Determinants of household-level hazardous air pollutant exposure in greater Houston. *Annals of the Association of American Geographers*, 105(4), 684–703. doi.org/10.1080/00045608.2015.1050754

Couture, V., & Handbury, J. (2017). *Urban revival in America, 2000 to 2010* (NBER Working Paper Series 24084). National Bureau of Economic Research. doi.org/10.3386/w24084

Crowder, K., & Downey, L. (2010). Interneighborhood migration, race, and environmental hazards: Modeling micro-level processes of environmental inequality. *American Journal of Sociology*, 115(4), 1110–1149. doi.org/10.1086/649576

Cushing, L., Faust, J., August, L. M., Cendak, R., Wieland, W., & Alexeeff, G. (2015). Racial/ethnic disparities in cumulative environmental health impacts in California: Evidence from a statewide environmental justice screening tool (CalEnviroScreen 1.1). *American Journal of Public Health*, 105(111), 2341–2348. doi.org/10.2105/ajph.2015.302643

Downey, L. (2005). The unintended significance of race: Environmental racial inequality in Detroit. *Social Forces*, 83(3), 971–1007. doi.org/10.1353/sof.2005.0026

Downey, L., Dubois, S., Hawkins, B., & Walker, M. (2008). Environmental inequality in metropolitan America. *Organization & Environment*, 21(3), 270–294. doi.org/10.1177/1086026608321327

Elliott, J. R., & Frickel, S. (2013). The historical nature of cities: A study of urbanization and hazardous waste accumulation. *American Sociological Review*, 78(4), 521–543. doi.org/10.1177/0003122413493285

Elliott, J. R., & Smiley, K. T. (2019). Place, space, and racially unequal exposure at home and work. *Social Currents*, 6(1), 32–50. doi.org/10.1177/2329496517704873

Feagin, J. R. (2000). *Racist America: Roots, current realities, and future reparations*. Routledge. doi.org/10.4324/9780203800270

Feagin, J. R., & Sikes, M. P. (1994). *Living with racism: The Black middle-class experience*. Beacon Press.

Florida, R. (2016, September 30). The downsides of the back-to-the-city movement: A tale of winners and losers. *Citylab*. www.citylab.com/equity/2016/09/downsides-of-the-back-to-the-city-movement/501476/

Gorelick, R., & Bertram, S. M. (2010). Multi-way multi-group segregation and diversity indices. *PLOS ONE* 5(6): e10912. doi.org/10.1371/journal.pone.0010912

Gould, K. A., & Lewis, T. L. (2017). *Green gentrification: Urban sustainability and the struggle for environmental justice*. Routledge. doi.org/10.4324/9781315687322

Hernandez, M., Collins, T. W., & Grineski, S. E. (2015). Immigration, mobility, and environmental injustice: A comparative study of Hispanic people's residential decision-making and exposure to hazardous air pollutants in Greater Houston, Texas. *Geoforum*, 60, 83–94. doi.org/10.1016/j.geoforum.2015.01.013

Johnson, G. S., Washington, S. C., Kind, D. W., & Gomez, J. M. (2014). Air quality and health issues along Houston's ship channel: An exploratory environmental justice analysis of a vulnerable community (Pleasantville). *Race, Gender & Class*, 21(3/4), 273–303. www.jstor.org/stable/43496996

Johnston, J. E., Werder, E., & Sebastian, D. (2016). Wastewater disposal wells, fracking and environmental injustice in southern Texas. *American Journal of Public Health*, 106(3), 550–556. doi.org/10.2105/ajph.2015.303000

Jones, M. R., Diez-Roux, A. V., Hajat, A., Kershaw, K. N., O'Neill, M. S., Guallar, E., … Navas-Acien, A. (2014). Race/ethnicity, residential segregation, and exposure to ambient air pollution: The Multi-Ethnic Study of Atherosclerosis (MESA). *American Journal of Public Health*, 104(11), 2130–2137. doi.org/10.2105/ajph.2014.302135

Klineberg, S. L. (2019). *The 2019 Kinder Houston Area Survey: Tracking responses to income inequalities, demographic transformations, and threatening storms*. Kinder Institute for Urban Research, Rice University. kinder.rice.edu/houstonsurvey2019

Lappie, J., Coates, J., & Matthews, L. (2018). *2018 Houston civic health index*. Kinder Institute for Urban Research, Rice University. doi.org/10.25611/1m7d-erox

Liévanos, R. S. (2012). Certainty, fairness, and balance: State resonance and environmental justice policy implementation. *Sociological Forum*, 27(2), 481–503. doi.org/10.1111/j.1573-7861.2012.01327.x

Linder, S. H., Marko, D., & Sexton, K. (2008). Cumulative cancer risk from air pollution in Houston: Disparities in risk burden and social disadvantage. *Environmental Science & Technology*, 42(12), 4312–4322. doi.org/10.1021/es072042u

Logan, J. R. (2014). *Separate and unequal in suburbia*. US2010 Project, Brown University. s4.ad.brown.edu/Projects/Diversity/Data/Report/report12012014.pdf

Logan, J. R., & Zhang, C. (2010). Global neighborhoods: New pathways to diversity and separation. *American Journal of Sociology*, 115(4), 1069–1109. doi.org/10.1086/649498

Massey, D. S., & Denton, N. A. (1988). The dimensions of residential segregation. *Social Forces*, 67(2), 281–315. doi.org/10.1093/sf/67.2.281

Massey, D. S., & Denton, N. A. (1993). *American apartheid: Segregation and the making of the underclass*. Harvard University Press.

McKinney, L., Kick, E., & Cannon, C. (2015). A human ecology approach to environmental inequality: A county-level analysis of natural disasters and the distribution of landfills in the southeastern United States. *Human Ecology Review*, 21(1), 109–132. doi.org/10.22459/her.21.01.2015.05

Michelson, W. (1968). A Parsonian scheme for the study of man and environment, or what human ecology left behind in the dust. *Sociological Inquiry*, 38(2),197–208. doi.org/10.1111/j.1475-682x.1968.tb00682.x

Mohai, P., Pellow, D., & Roberts, J. T. (2009). Environmental justice. *Annual Review of Environment and Resources*, 34, 405–430. doi.org/10.1146/annurev-environ-082508-094348

Mohai, P., & Saha, R. (2015). Which came first, people or pollution? Assessing the disparate siting and post siting demographic change hypotheses of environmental injustice. *Environmental Research Letters*, 10(11), 1–18. doi.org/10.1088/1748-9326/10/11/115008

Morello-Frosch, R., & Jesdale, B. M. (2006). Separate and unequal: Residential segregation and estimated cancer risks associated with ambient air toxics in US metropolitan areas. *Environmental Health Perspectives*, 114(3), 386–393. doi.org/10.1289/ehp.8500

Natural Resources Defense Council. (2004). *Hidden danger: Environmental health threats in the Latino community*. NRDC. www.nrdc.org/sites/default/files/latino_en.pdf

Pellow, D. N. (2018). *What is critical environmental justice?* Polity.

Podagrosi, A., Vojnovic, I., & Pigozzi, B. (2011). The diversity of gentrification in Houston's urban renaissance: From cleansing the urban poor to supergentrification. *Environment and Planning A*, 43(8), 1910–1929. doi.org/10.1068/a43526

ProPublica (2017). School segregation data [Data set]. Retrieved August 16, 2018 www.propublica.org/datastore/dataset/school-segregation-charter-district-data

Rudel, T. K. (2012). The human ecology of regrowth in the tropics. *Journal of Sustainable Forestry*, 31(4–5), 340–354. doi.org/10.1080/10549811.2011.588457

Schelly, D., & Stretesky, P. B. (2009). An analysis of the "path of least resistance" argument in three environmental justice success cases. *Society & Natural Resources*, 22(4), 369–380. doi.org/10.1080/08941920802119648

Smith, C. L. (2007). Economic deprivation and environmental inequality in postindustrial Detroit: A comparison of landfill and superfund site locations. *Organization & Environment*, 20 (1), 25–43. doi.org/10.1177%2F1086026607300245

Smith, C. L. (2009). Economic deprivation and racial segregation: Comparing superfund sites in Portland, Oregon and Detroit, Michigan. *Social Science Research*, 3(3), 681–692. doi.org/10.1016/j.ssresearch.2009.03.005

Strait, J. B., & Gong, G. (2010). Ethnic diversity in Houston, Texas: The evolution of residential segregation in the Bayou City, 1990–2000. *Population Review*, 49(1), 53–81. doi.org/10.1353/prv.2010.0001

United States Census American Community Survey. (2019). *2011–2015 ACS 5-year estimates*. United States Census Bureau. www.census.gov/programs-surveys/acs/technical-documentation/table-and-geography-changes/2015/5-year.html

United States Environmental Protection Agency. (2017). *2015 TRI national analysis: Toxics Release Inventory releases at various summary levels*. edg.epa.gov/metadata/catalog/search/resource/details.page?uuid=%7B0BE49093-FBFF-4EC0-9B3A-F96FB8282B88%7D

White, M. J. (1986). Segregation and diversity measures in population distribution. *Population Index*, 52(2), 198–221. doi.org/10.2307/3644339

Williams, A., & Emamdjomeh, A. (2018, May 10). America is more diverse than ever—but still segregated. *Washington Post*. www.washingtonpost.com/graphics/2018/national/segregation-us-cities/

York, R., Rosa, E. A., & Dietz, T. (2003). STIRPAT, IPAT and ImPACT: Analytic tools for unpacking the driving forces of environmental impacts. *Ecological Economics*, 46(3), 351–365. doi.org/10.1016/s0921-8009(03)00188-5

Zhang, W., & Logan, J. R. (2016). Global neighborhoods: Beyond the multiethnic metropolis. *Demography*, 53(6), 1933–1953. doi.org/10.1007/s13524-016-0516-4

Appendix: Supplemental results

Table 3S. Supplemental results from spatial error model.

	Model 1S		Model 2S	
Variable	b	SE	B	SE
Primary Variables				
Entropy	−0.385	**0.132		
Black				
Hispanic (Non-White)				
Other				
All Non-White	0.222	0.135	0.039	0.120
White				
Controls				
Manufacturing	−0.241	**0.070	−0.237	**0.084
Non-Native	0.014	0.068	0.003	0.068

	Model 1S		Model 2S	
Educational Attainment	0.078	0.073	–0.079	0.067
Poverty	–0.116	*0.056	–0.124	*0.056
Household Income	–0.014	0.054	0.012	0.054
Home Value	–0.354	***0.102	–0.371	***0.102
Constant	0.960	2.506	2.466	2.514
λ	0.985	***0.009	0.985	***0.009
Moran's I (Residuals)	0.018	**0.006	0.018	**0.006
Max/Mean VIF	3.80/2.38		3.20/2.33	
N	1,036		1,036	

Note: In order to minimize spatial autocorrelation in the residuals to non-significant levels, the spatial parameter λ was estimated using a 3rd order queen contiguity weights matrix. VIF (variance inflation factor) values were derived from separate OLS (ordinary least squares) models. SE: standard error. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Source: Authors' summary.

Environmental Decision-Making Shaped by the Home: Situating Consumption in the Household

William Lytle[1]
Department of Social Sciences, Michigan Technological University, United States

Chelsea Schelly
Department of Social Sciences, Michigan Technological University, United States

Kristin Floress
USDA Forest Service—Northern Research Station, Illinois, United States

Rachael L. Shwom
Department of Human Ecology, Rutgers University, New Jersey, United States

Kathleen E. Halvorsen
Research Development Department, Department of Social Sciences, College of Forest Resources and Environmental Sciences, Michigan Technological University, United States

Abstract

Research on environmentally consequential human decision-making often begins from the premise that consumption decisions are motivated by individual values. However, we argue that social science research aiming to understand consumer decision-making will benefit from integrating the lived experiences of people in households, where decisions are often influenced or mitigated by the presence of those who share homes. Conducting research on consumption decisions regarding household resources revealed the embedded nature of these decisions, which are situated in the context of the socially contingent dynamics of residential life. In this paper, we identify five social dynamic processes that influence consumption within the household: (1) referring, (2) norming, (3) enhancing, (4) constraining, and (5) allocating. These processes, embedded within the dynamic social relationships of the residential household, moderate household resource use in ways that future social science research may strive to better understand.

Keywords: consumption, environmental decision-making, environmentally responsible behavior

1 Corresponding author: wjlytle@mtu.edu.

Introduction

The average resident in the United States consumes significantly more natural resources than those living in other comparably developed nations (Chow et al., 2003; OECD, 2016). To understand environmentally consequential consumer choices and the potential for reducing the impacts of such consumption, researchers often turn to measures of individual knowledge, values, beliefs, and attitudes, presuming that consumption decisions are based on some combination of these factors (Dietz et al., 2009).

However, the research presented here suggests that consumption practices are embedded and negotiated within the physical and social household context, likely shaping both attitudes and behaviors. The ways in which household members have shaped each other's behaviors has been studied for decades, and this approach is closely aligned with theories of social practice (Spaargaren et al., 2016) and involves a variety of practice-based considerations that guide researchers' choices (Sharma & Ruud, 2003; Strengers et al., 2016). Social practice theories recognize the role of the built environment in shaping and constraining household practice choices (Warde, 2005). In this paper, we present evidence supporting a practice theory perspective: both the physical and social environment of the home shape household consumption practices.

The average American consumer will likely spend some part of their life as a child in a home with one or more adults and some part of their life as an adult sharing their home with one or more other adults and one or more children. In the 2018 census, 72 percent of Americans lived in a home with at least one other person (United States Census Bureau, 2018). As household composition shifts, so will resource consumption. Many of us have experienced firsthand the ways that parents, partners, children, and pets may shape our household practices, either by encouraging us to reduce consumption or by limiting the extent to which we can change our consumption behavior out of concern for someone else's needs, comforts, or preferences.

In this paper, we examine ways in which factors often relegated to "context" are potentially larger contributors to decision-making in a household than more dominant theories of environmental behaviors. We argue that environmental behavior research must more fully incorporate how household dynamics, specifically social dynamics, contribute to environmentally consequential consumption practices. This paper is based on interviews with American householders and aims to understand the values, motivations, opportunities, and barriers associated with current and potential future household consumption of food, energy, and water resources. Throughout the paper, we use the language of "household dynamics" because we recognize that many households may be composed of socially, legally,

and institutionally constructed family units, often more diversified than nuclear family units. This is particularly true when we consider the role that past household members (such as deceased spouses, as described below) can have in shaping both attitudes and behaviors regarding environmentally consequential practices.

Research on environmental decision-making

There are multiple social science theories utilized to explain what drives different types of environmental practices (e.g., Shwom & Lorenzen, 2012; Stern, 2014; Wilson & Dowlatabadi, 2007). Research in social psychology has sought to understand individual values, norms, beliefs, and attitudes and their link to environmentally consequential consumer behavior. However, the vast majority of this work draws from paradigms of consumption emerging from economics and psychology, which emphasize individualistic decision-making and identify social influences as merely external to the decision-making process (Shove, 2010). Becker (1998) may recognize that using the individual as the unit of analysis, rather than a unit that corresponds with the lived experience of the family or household, perpetuates the flawed imagery that individual attitudes, behaviors, and choices should be the focal point of research designs related to environmentally consequential decisions. Almost 50 years ago, Davis expressed discomfort with the focus on individuals, writing: "the view of consumers as individual decision makers is still very much alive despite commonsense observations that the family is the relevant decision-making unit and a growing research interest in the field" (Davis, 1976, p. 242).

Shove (2010) describes much of the environmental decision-making and consumption research from this orientation to be characterized by the "ABC" model of consumption, in which "A" stands for attitude, "B" for behavior, and "C" for choice. The main argument made by Shove (2010) regarding the ABC model of consumption is that individual attitudes are presumed to influence behavioral intentions, ultimately influencing actual behavioral choices. She contends this presumption is flawed at best and, at worst, consequentially misleading for decision-makers regarding how to understand consumer behavior. This debate regarding the role of values, norms, beliefs, knowledge, and attitudes in shaping behavior is long-standing. The presumptions have held over decades of scholarship (e.g., Ajzen, 1991; Bamberg & Möser, 2007; Fishbein et al., 1980; Hines et al., 1987) but have done very little to advance our ability to understand, predict, or change consumption choices (Heberlein, 2012). Black et al. (1985) suggest that understanding household energy consumption using survey methodology must go beyond bivariate analysis; it requires multivariate analyses that include contextual variables and social dynamics. Bolstering theories of decision-making with broader contextual information helps to develop explanations for how consumers make choices (Shwom & Lorenzen, 2012).

Considering relationships, role models, social dynamics, and lifestyle identities may enhance the knowledge gained through studying theories of planned behavior, theories of practice, and value–belief–norm models. Kennedy et al. (2009) keenly note that *household variables*, or the factors that are bigger than an individual in the home such as income, support network, and available time, may explain the gap between people's environmental values and environmentally responsible behaviors. Holdert and Antonides (1997) describe how a person's role in the household moderates their influence over certain stages and types of decision-making, with differences seen in traditional and modern family structures. Davis (1976) says that when you are investigating who decides something for the household, it is not only internal roles, how invested individuals are in the decision, or cultural expectations that impact the weight of their opinions, but also education and occupational status. With an expanded unit of analysis, we ask not only how the individual functions within the community, but also how the community itself functions. In pursuit of understanding the community, Staats et al. (2004) found groups with strong social influence and social support for environmental behaviors helped produce durable interventions to targeted behaviors.

Methods

In the summer of 2017, interviews were conducted with 44 residential dwellers in a suburban county outside a major metropolitan area in the Midwestern United States. A wide range of recruiting efforts (social media, public posters, information packets delivered to homes, face-to-face) were undertaken in the county that referred potential participants to the study and a form to input their contact information. These interviews were conducted in association with a much larger research project examining and ultimately aiming to make food, energy, and water consumption more sustainable in the residential home (Watkins et al., 2019). The interviews were conducted as exploratory research into the motivations for and challenges of shifting behaviors to reduce the negative environmental impacts associated with residential consumption patterns.

Most interviews took place within the participant's home and many were punctuated with a tour of their property. Each interview lasted approximately one hour and was recorded and fully transcribed. There was no structured collection of sociodemographic data, but following the interview participants were asked for recommendations of other people they knew who may be willing to discuss their consumption. This would often result in an informal listing of names and connections to neighbors, coworkers, friends, family, and organizational members. Recommendations of people with differing lifestyles, perspectives, and household composition were actively pursued to ensure data saturation.

Data processing included inductive open coding of each transcript, focused on the challenges of changing environmentally consequential consumption in the home aligned with an interpretive grounded theory approach (Charmaz, 2014; Sebastian, 2019). This analysis revealed the importance of household composition and dynamics and the need to view households as holistic units for analysis rather than as comprised of discrete individual decision-makers.

This exploratory research was designed based on the most typical methodological approach to studying consumption behaviors: by asking individuals about their behavioral patterns and what motivates them. Interviews with individuals focused on decisions in the home and the contexts that shaped environmentally consequential consumption choices. Examples of the open-ended interview questions about specific resource consumption and household contexts include:

> Can you begin by telling us a little bit about your home?
>
> Do you think you use a little or a lot of [food, energy, or water]?
>
> Do you try to reduce your resource [food, energy, or water] use at home? If so, how?
>
> Are there things you wish you could do to reduce your [food, energy, or water] consumption, but can't?
>
> Thinking about [food, energy, or water], what kinds of changes do you think would be easiest for your family to implement to reduce consumption?
>
> What kinds of changes would be the hardest?
>
> What kind of impacts do you associate with your [food, energy, or water] consumption?

Results: Environmental practices with others in the home

It was only through emergent data analysis that the importance of locating individuals within the context of the household became clear. Among the participants in this study, almost every interview included discussion of the role other household members played in shaping resource consumption. An example of the influence of household dynamics are highlighted in responses to the question, "What do you think are the biggest contributors to your water use at home?" We thought this question would help gauge the basic cognitive understanding of the participants regarding household consumption, with expected answers such as toilets, laundry, swimming pool, and perhaps indirect consumption via diet preference. Their answers varied greatly, as some participants cited the biggest contributors to be persons within the home (e.g., Mark), practices (e.g., Mark taking a bath), or objects (e.g., the bathtub). In some cases, participants were describing the social dynamics that lead

to consumption in the household to reduce their personal responsibility, but many descriptions of social dynamics appeared to have the intent of accurately portraying their lived experience in the household, not as a means obfuscating blame.

Five social dynamic processes are outlined in Table 1: (1) preferring, (2) norming, (3) enhancing, (4) constraining, and (5) allocating. These processes may overlap in certain scenarios and are not intended to be either exclusive or exhaustive. The processes are described and accompanied by an example quotation that appears with additional context later in the results. The five processes represent recurring themes in the data that build upon traditional understandings of "context" within individual decision-making models.

Table 1. Five social dynamic processes that influence household consumption.

Process	Description	Example Quotation
(1) preferring	individual preferences or requirements dictate group behavior	"My wife has allergies and you can't leave the window open."
(2) norming	internal family social norms insulate individual behaviors	"I have three other people in this family who like to sit in a tub or take a long hot shower. Can I talk them out of it?"
(3) enhancing	enhancing or supporting other members' efforts to be more sustainable	"I am trying to like vegetables. My wife loves them, she makes a lot of salads but I am not that fond of it, but I am trying to."
(4) constraining	constraining or deterring other members' efforts to be more sustainable	"I don't think we need to wash the clothes as much as we do but my sister has a habit of just washing them."
(5) allocating	decision-making or practices are allocated to another member of the household	"The easiest [thing we do to conserve resources at home], and this is going to sound goofy, is I do everybody's laundry."

Source: Authors' summary.

The only interviewees who did not discuss the role of household dynamics in shaping resource consumption in *their own* homes were those who lived alone, but almost all of those who lived alone discussed the role of household composition in shaping resource use, either through reference to their own past experience or through reference to friends and neighbors whose behavior is at least partially shaped through interactions and compromises among household members. Interviewees with children mentioned the role of children in shaping household consumption through behaviors and expectations; even people whose spouses had passed away mentioned their continued influence on their consumption behaviors, and people who lived with adults other than spouses (such as adult siblings living together) discussed the role of other adults in the home in shaping household resource use. One participant described how the decisions made for the household in the past shaped their current consumption:

> When I retired, I put the addition on the house for my mother and my mother-in-law. But while I started the addition, the wife died. And then the mother-in-law went to live with her son in California. And my mother died. So, I am sitting here with a four-bedroom house by myself.

In other words, although they were asked about their individual motivations and choices, almost every single participant demonstrated that the individual is not the sole unit of analysis for understanding residential consumption behaviors.

Some married participants discussed how their spouse limited or enhanced household efforts to be efficient consumers. For example, one said:

> From my standpoint, and you will understand this if you are married. Your wife is probably cold all of the time and you are hot. She wants it 75°F [24°C] and you want it 65°F [18°C] so obviously the people that live in the household have different internal thermometers.

The same interviewee also said: "I don't have a problem keeping the house cool in the winter and I don't have a problem leaving the windows open on warmer nights, with the fan … [but] my wife has allergies and you can't leave the window open then." Other interviewees, instead of having wives who preferred a warmer heating setting, claimed that they used more energy in thermal cooling "because my wife likes it cool." When asked about the biggest challenge to reducing resource consumption at home, one participant said, "The hardest is trying to get my wife on board." Later, when discussing specifically the possibilities for reduction in water usage, the same interviewee said, "Showers [would be hard to reduce], hot showers. Tell my wife. The easiest is to not get in that fight." Yet the same participant acknowledged that their wife also has some preferences for what was perceived as more environmentally responsible consumption that they do not share: "My wife will try to buy organic. I will look at costs. I am not going to spend eight bucks on a dozen eggs when I can get them for two. That's not going to happen."

In other words, married individuals recognized the role of their spouse in shaping resource consumption at home; however, the extent to which they increased or decreased the environmental impacts of consumption depended on the particular person, the particular resource, and the interpretive perception of the interviewee. For example, one participant said that their partner's practices were constraining conservation efforts, "I think, particularly for my husband, turning things off that he is not using is probably one of the hardest things for him. He'll start watching TV and then he will get distracted doing something else and leave the TV going." Another said, "My wife likes gardening a lot and when it gets dry she does use a lot of water." Yet they also acknowledged that their wife also influences food choices based upon her preference: "I am trying to like vegetables. My wife loves them, she makes a lot of salads but I am not that fond of it, but I am trying to." Others also described how their spouses encouraged or enhanced resource conservation;

for example, one participant said, "I think of getting out of the shower a little bit sooner, because my wife gets annoyed," and another said, "My wife is a very healthy eater. She is a vegetarian; I am more or less a vegetarian just because I live with her."

These dynamics also held across adults living with other adults in non-romantic or unmarried relationships, such as adult siblings living together. One interviewee, for example, who lives with her adult sister, said, "I don't think we need to wash the clothes as much as we do but my sister has a habit of just washing them. I think she could wash twice a week instead of every other day." Another participant, who lives in a household of four related but unmarried adults ranging in age from 40 to 70 talked about norms in the home, saying:

> I have three other people in this family who like to sit in a tub or take a long hot shower. Can I talk them out of it? Not if they are in aches and pains and need that to relieve their pain.

These descriptions of how others limit the ability to reduce total household consumption may involve some degree of shifting accountability to placate presumptions about the interviewer, but they also demonstrate how dynamics in a home shape overall residential resource use.

Children were, perhaps expectedly, identified as hugely influential for overall household consumption patterns. Even people without children recognized the role of children in shaping consumption; as one participant said, "It is not like we have kids that are in and out of the refrigerator all the time." Some of the influence from children has to do with household space usage. One participant with grown kids said, "We don't use the basement as much as we used to because the kids aren't really goofing around down there as much as they used to." Another said:

> We bought this house with intention that all of the kids would have their own room. Three boys and now they are gone. We have a lot of extra space but in reality, the market is not in our favor right now to sell.

Others raised issues regarding resource use in a home with kids; one participant said:

> Over the years we have kind of figured out that a lot of it has to do with phantom usage, we had with the kids three or four computers on at all times in the house, that sort of thing. When they moved out and we kind of adjusted that, I think that helped quite a bit.

Another said, "We always try to be aware, that we always shut off lights and yell at kids when they take 30-minute showers." The phrase phantom usage may be described as usage that has become normalized in the home to support a certain activity but only becomes apparent when the utility bill arrives or a practice is altered. The phrase appears again in a separate interview about long showers:

> It seems a little bit of a phantom, but for certain people that could say oh yeah, it is so and so in my house. Takes one-hour showers twice a day sometimes. Can't stop him, he doesn't understand, blah blah blah. There is usually some sort of a guzzler going on.

Some participants mentioned how children limit the ability to reduce the environmental impact of food consumption because they have limited food preferences; one interviewee said:

> Growing up on a farm was something that made me think about my own consumption. Having kids made me think about it. I made all my own baby food when my kids were little. And then once they were able to reject all that, what did they want? They wanted Kraft macaroni and cheese. "No, I want the orange stuff, not yours." So, I did the best I could in that.

Yet another mentioned that children, even after they are grown and no longer living at home, can influence parents to engage in healthier food choices, discussed in terms of both organics and more plant-based diets. Parents were likely biased in their reporting of grown children's behavior: some were described with disappointment because they did not seem to internalize the resource conservation values their parents attempted to instill and others were described with pride as they shared knowledge and inspiration for new behaviors such as using reusable shopping bags and aiming to recycle.

The influence of spouses on household resource consumption can continue on, even after death separates those who once lived together. One participant, in describing her recent transition to being a widow and living in a new home, said, "My husband was a German and you didn't have a light on unless you were in that room. And the amount of energy [use] here [in my new home] drives me nuts." This becomes particularly salient for accurately operationalizing and modeling the role of household composition in shaping consumption behaviors, as past household characteristics not captured by contemporary data may continue to influence consumption choices. The examples of grown children and deceased spouses both suggest that attempting to realistically capture and predict consumption choices must likely account for both present and past household compositions and how they influence behaviors.

Sometimes decisions were described within the context of existing social norms and expectations, particularly within the context of family as a social institution, such as when one participant said, "Every time I eat a pork chop I feel bad actually. Maybe we go back to lentil loaf for Thanksgiving. Although I'll tell you, my family nearly killed me that year when I did that." Others even talked about the strategies they use to balance the tensions in household dynamics with regard to conservation-related behaviors; for example, one mother was allocated the responsibility for washing laundry saying, "The easiest [thing we do to conserve resources at home],

and this is going to sound goofy, is I do everybody's laundry, so we are not having 15 loads of two sweaters. Cause this is a thing teenage girls do." Another participant describes the difficulty when choosing between meal options, whether to eat fast-food while shuttling children around town during a busy day. They try to calculate cost, convenience, family health, and planet health saying, "Every family kind of does this equation," which also represents the allocation of managing a network of consumptive impacts. We see from this quotation that individual values can be in synergy or in conflict with others in the home which may lead to a variety of behaviors.

Discussion: Incorporating household dynamics into research

This paper echoes Shove's (2010) argument that policy-making intended to lessen the harmful environmental consequences of consumption often wrongly assumes that people are isolated individuals who make deliberative and calculative choices based on existing attitudes. Interviews with individuals about household consumption behaviors indicate that even individuals who do live alone understand how household dynamics shape resource use. Here, we argue that research on environmental decision-making could be advanced by considering how embeddedness within households shapes consumptive practices. Gaining a true understanding of the impact of household consumption on the environment requires recognition that there are vast numbers of diverse ways in which households can exist. While some consist only of nuclear family members, others include extended family or unrelated members. Yet household environmental impact, based on the amount of resources they consume in their day-to-day practices, is dependent on not only the number of members of a household but also on the dynamics between them (Ellegård & Palm, 2015). These results strengthen the claims made by other researchers that individuals are best understood as embedded in particular social contexts that shape consumption patterns (Kennedy et al., 2009; Lutzenhiser, 1992; Spaargaren, 2003). Recognizing the impact of household dynamics is essential for building more accurate models to explain and ultimately predict resource consumption in the home. Conceptually moving away from imagery of isolated and calculative individuals, towards individuals that are embedded within household practices and processes, can improve both research design and the accuracy of research findings attempting to explain and predict environmentally consequential consumption patterns.

It is important to recognize the household's role in generating external impacts, achieving global conservation goals, and developing habits in house members. Social contexts that influence resource consumption are often defined at levels above the household, including the national level. The interaction between population and

consumption has long been a focus of environmental research (Ehrlich, 1968; York et al., 2003). At the macro level, the STIRPAT (stochastic impacts by regression on population, affluence and technology) model illustrates that population has a multiplicative relationship with consumption and its resultant environmental impacts; for instance, a person's carbon footprint is multiplied by 5.7 for every child they have (York et al., 2002). However, assigning individual responsibility for consumption can become more difficult in group settings (Takács-Sánta, 2007). Affluence also changes the way resources are consumed, not by reducing consumption, but by shifting the sectors from which resources are consumed. An example of this shift has been observed in water usage: from the agricultural sector in developing and low socioeconomic regions to increasing usage in industrial and domestic sectors in modern developed nations (Longo & York, 2009). Thoughtful interventions intended to shift resource consumption in the home may be able to optimize the positive output of a group of people working together to accomplish a goal if attentive to household and perhaps also community dynamics (Flint, 2010).

Other spatial and demographic factors have been shown to impact consumption. Population density, or the number of households in an area, is a stronger direct determinant of the environmental impact of consumption than population (Dietz et al., 2007; Liu et al., 2003). In addition to population and household composition, research shows that each stage in one's life course affects lifestyle choices differently, directly influencing consumption intensity (Weiss, 2000). These studies relating to consumption over the life course often focus on the commodification of a particular time in one's life course, especially in relation to young children and teenagers (Schor, 2004; Thomas, 2007). The consumption of the young is actualized by the decisions of the parents; whether to have children and how many children to have, perhaps the largest consumptive decision individuals can make (Davis, 1976). Calls have been made for the examination of gender dynamics as part of understanding environmentally consequential decision-making in the household (Kennedy & Kmec, 2018; Niehof, 2011). In a consumer culture, parenting is often reduced to provisioning. Across social classes, there is a "commercialization of childhood" resulting from media and corporate marketing aimed at children (Schor, 2004). The overwhelming social pressure to participate in child-rearing, especially for women, along with the fact that the measure of good parenting has been reduced to what parents provide their children (Wilson & Wood, 2004), illustrates how the socially constructed institution of the family, as embedded in household consumption dynamics, can create environmentally damaging positive feedback loops.

Yet as Cook (2008) argues, children are not perfectly socialized extra expenses, but rather active co-participants in the consumption experience, capable of influencing parents to shift consumption to reduce its environmental impact (Damerell, et al., 2013). Thinking of children as merely inputs into individually comprised consumer decisions inadequately captures their role in shaping consumption behaviors in

the home. Pets are another consumer within the home that are dependent on the decision-making of the household. Pets and domesticated animals are overlooked by traditional sociological measurements of individual consumption yet are considered to function as part of the family by much of the public (Cohen, 2002). Pets and animals are also capable of sparking ethical revelations that result in the changed behavior of their human families (Hribal, 2007). Rather than conceptualizing consumptive practices in the home as the result of the head of the household's decisions, it is more accurate to consider a range of humans, nonhumans, pets, plants, appliances, and microbes as cocreators of consumption (Latour, 2004; Strengers et al., 2016).

Studies of individuals' environmentally responsible behavior typically proceed on the assumption that individual norms, values, beliefs, or knowledge are the predominant influences on behavioral choices (e.g., Ajzen, 1991; Shwom & Lorenzen, 2012). Accurately predicting environmentally responsible consumer choices requires moving beyond this assumption, as Shove (2010) describes, to consider choices within the context of household dynamics (this study) and systems of provision (as discussed in scholarship on theories of practice: see Spaargaren, 2003) as well as the regional resource context (including resource availability and the policies that shape it). Research on environmental decision-making can be improved by incorporating both the challenges and the opportunities provided by household dynamics and characteristics. Recognizing household norms that govern current consumptive practices also sheds light on the transmission of behaviors across time and generations (Kleinschafer & Morrison, 2013). Environmental policy-making may also be improved by moving away from the imagery of the isolated individual, perhaps by including decision-making and consumptive processes like the five listed in Table 1 (Shove, 2010).

The compositions of households differ around the world and are dynamic. It is important to formalize the study of these factors as they relate to environmentally consequential decision-making. Many countries project that their number of single-person households will grow significantly by 2030, with numerous European countries having 40 percent of their households being comprised of single-person households (OECD, 2011). In the next 10–15 years, the number of couples without children will increase across most of the countries that participate in Organisation for Economic Co-operation and Development (OECD) data collection and projections. Immigration is expected to increase in European countries as well as the United States. Degraded environments can act as the catalyst for migration as well as be the outcome of migration.

According to projections, migration and high fertility levels will increase the percentage of minorities in these countries and, in the case of the United States, minority groups will become the largest groups within the next three decades. Changes in marriage, fertility, life expectancy, and employment demographics

create unknowns for intergenerational living, cohabitation, family composition, and household dynamics (OECD, 2011). An advantage of setting the research frame at the household level is that shifts in social structures within households can be captured within future data (Niehof, 2011).

Data procurement and analysis considering household dynamics may be collected from an individual within the household, a representative of the household, or from every individual within the household. An individual's perceived role within the research study and household may influence their responses to survey and interview questions (Bowen et al., 2019). Yet participants would likely be able to ascribe household behavioral patterns related to themselves and others within their household as active spenders, conscious occupiers, average users, conservers, and inactive users (Ben & Steemers, 2018). Pairing those data with demographic information about household compositions would provide a richer landscape for understanding household consumption. Utilizing that information may allow for exploration of household practices that would right-size consumption, valuable in understanding the ever-changing projections for household composition where no factor exists as a constant. A drawback to this approach is the amount of time required by researchers and participants to share information. Institutional review boards also have individuals as a focus, rather than households, making data collection on a group which may contain minors an added challenge.

Conclusion

Viewing consumption as not only shaped by individual attitudes and behaviors but also by the composition and dynamics of life within the home sheds light on how the social institutions that structure our lives may act to shape the environmental impacts of resource consumption (Ellegård & Palm, 2015). These dynamics are often but not always connected to the social institution of the family and remain influential even when the household has changed. Taking the household seriously also moves farther from the rational actor paradigm, with its assumptions of individuals making planned or rational choices (Ajzen, 1991; Shwom & Lorenzen, 2012). The individual may perceive themselves to have limited agency or efficacy for practicing environmentally responsible behaviors, based on both household dynamics and societal limitations (Kennedy et al., 2009). Unfortunately, research focused on individual values as predictive of individual behaviors may act to reinforce these limitations rather than promote collective action within and beyond the home. Conceptual approaches that consider individuals as isolated decision-makers introduce flaws into research design, data collection, and analyses. Future studies of environmentally consequential household practices may be able to more fully account for the constellation of influences that shape consumption decisions by situating an individual within the context of their household, as we have done by

identifying five processes that influence consumption: (1) preferring, (2) norming, (3) enhancing, (4) constraining, and (5) allocating. Researchers can more clearly explain and ultimately seek to change behaviors in order to lessen the damaging consequences of human consumptive practices on the resources required to sustain current and future human lives by understanding social dynamics within the home.

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, 50(2), 179–211. doi.org/10.1016/0749-5978(91)90020-t

Bamberg, S., & Möser, G. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of Environmental Psychology*, 27(1), 14–25. doi.org/10.1016/j.jenvp.2006.12.002

Becker, H. S. (1998). *Tricks of the trade*. University of Chicago Press.

Ben, H., & Steemers, K. (2018). Household archetypes and behavioural patterns in UK domestic energy use. *Energy Efficiency*, 11(3), 761–771. doi.org/10.1007/s12053-017-9609-1

Black, J. S., Stern, P. C., & Elworth, J. T. (1985). Personal and contextual influences on household energy adaptations. *Journal of Applied Psychology*, 70(1), 3–21. doi.org/10.1037/0021-9010.70.1.3

Bowen, S., Brenton, J., & Elliott, S. (2019). *Pressure cooker: Why home cooking won't solve our problems and what we can do about it*. Oxford University Press.

Charmaz, K. (2014). *Constructing grounded theory*. Sage.

Chow, J., Kopp, R. J., & Portney, P. R. (2003). Energy resources and global development. *Science*, 302(5650), 1528–1531. doi.org/10.1126/science.1091939

Cohen, S. P. (2002). Can pets function as family members? *Western Journal of Nursing Research*, 24(6), 621–638. doi.org/10.1177/019394502320555386

Cook, D. T. (2008). The missing child in consumption theory. *Journal of Consumer Culture*, 8(2), 219–243. doi.org/10.1177/1469540508090087

Damerell, P., Howe, C., & Milner-Gulland, E. J. (2013). Child-orientated environmental education influences adult knowledge and household behaviour. *Environmental Research Letters*, 8(1). doi.org/10.1088/1748-9326/8/1/015016

Davis, H. L. (1976). Decision making within the household. *Journal of Consumer Research*, 2(4), 241–260. doi.org/10.1086/208639

Dietz, T., Gardner, G. T., Gilligan, J., Stern, P. C., & Vandenbergh, M. P. (2009). Household actions can provide a behavioral wedge to rapidly reduce US carbon emissions. *Proceedings of the National Academy of Sciences*, 106(44), 18452–18456. doi.org/10.1073/pnas.0908738106

Dietz, T., Rosa, E. A., & York, R. (2007). Driving the human ecological footprint. *Frontiers in Ecology and the Environment*, 5(1), 13–18. doi.org/10.1890/1540-9295(2007)5[13:dthef]2.0.co;2

Ehrlich, P. R. (1968). *The population bomb*. Ballantine Books.

Ellegård, K., & Palm, J. (2015). Who is behaving? Consequences for energy policy of concept confusion. *Energies*, 8(8), 7618–7637. doi.org/10.3390/en8087618

Fishbein, M., Jaccard, J., Davidson, A. R., Ajzen, I., & Loken, B. (1980). Predicting and understanding family planning behaviors. In I. Ajzen, & M. Fishbein (Eds.), *Understanding attitudes and predicting social behavior* (pp. 132–147). Prentice-Hall.

Flint, R. W. (2010). Seeking resiliency in the development of sustainable communities. *Human Ecology Review*, 17(1), 44–57. www.jstor.org/stable/24707514

Heberlein, T. A. (2012). *Navigating environmental attitudes*. Oxford University Press. doi.org/10.1093/acprof:oso/9780199773329.001.0001

Hines, J. M., Hungerford, H. R., & Tomera, A. N. (1987). Analysis and synthesis of research on responsible environmental behavior: A meta-analysis. *The Journal of Environmental Education*, 18(2), 1–8. doi.org/10.1080/00958964.1987.9943482

Holdert, F., & Antonides, G. (1997). Family type effects on household members' decision making. In M. Brucks & D. J. MacInnis (Eds.), *NA—Advances in consumer research* (Vol. 24; pp. 48–54). Association for Consumer Research. www.acrwebsite.org/volumes/8007/volumes/v24/na-24

Hribal, J. C. (2007). Animals, agency, and class: Writing the history of animals from below. *Human Ecology Review*, 14(1), 101–112. www.jstor.org/stable/24707647

Kennedy, E. H., Beckley, T. M., McFarlane, B. L., & Nadeau, S. (2009). Why we don't "walk the talk": Understanding the environmental values–behaviour gap in Canada. *Human Ecology Review*, 16(2), 151–160. www.jstor.org/stable/24707539

Kennedy, E. H., & Kmec, J. (2018). Reinterpreting the gender gap in household pro-environmental behaviour. *Environmental Sociology*, 4(3), 299–310. doi.org/10.1080/23251042.2018.1436891

Kleinschafer, J., & Morrison, M. (2013). Household norms and their role in reducing household electricity consumption. *International Journal of Consumer Studies*, 38(1), 75–81. doi.org/10.1111/ijcs.12066

Latour, B. (2004). Nonhumans. In S. Harris, S. Pile, & N. Thrift (Eds.), *Patterned ground: Entanglements of nature and culture* (pp. 224–227). Reaktion Books.

Liu, J., Daily, G. C., Ehrlich, P. R., & Luck, G. W. (2003). Effects of household dynamics on resource consumption and biodiversity. *Nature*, 421(6922), 530–533. doi.org/10.1038/nature01359

Longo, S. B., & York, R. (2009). Structural influences on water withdrawals: An exploratory macro-comparative analysis. *Human Ecology Review*, 16(1), 75–83. www.jstor.org/stable/24707738

Lutzenhiser, L. (1992). A cultural model of household energy consumption. *Energy*, 17(1), 47–60. doi.org/10.1016/0360-5442(92)90032-u

Niehof, A. (2011). Conceptualizing the household as an object of study. *International Journal of Consumer Studies*, 35(5), 488–497. doi.org/10.1111/j.1470-6431.2011.01026.x

OECD. (2011). *The future of families to 2030: Projections, policy challenges, and policy options. A synthesis report*. Organisation for Economic Co-operation and Development. www.oecd.org/futures/49093502.pdf

OECD. (2016). *National accounts at a glance 2015* [Data set]. Organisation for Economic Co-operation and Development. stats.oecd.org/Index.aspx?DataSetCode=NAAG

Schor, J. B. (2004). *Born to buy: The commercialized child and the new consumer culture*. Scribner.

Sebastian, K. (2019). Distinguishing between the strains grounded theory: Classical, interpretive and constructivist. *Journal for Social Thought*, 3(1). ojs.lib.uwo.ca/index.php/jst/article/view/4116

Sharma, S., & Ruud, A. (2003). On the path to sustainability: Integrating social dimensions into the research and practice of environmental management. *Business Strategy and the Environment*, 12(4), 205–214. doi.org/10.1002/bse.366

Shove, E. (2010). Beyond the ABC: Climate change policy and theories of social change. *Environment and Planning A: Economy and Space*, 42(6), 1273–1285. doi.org/10.1068/a42282

Shwom, R., & Lorenzen, J. A. (2012). Changing household consumption to address climate change: Social scientific insights and challenges. *Wiley Interdisciplinary Reviews: Climate Change*, 3(5), 379–395. doi.org/10.1002/wcc.182

Spaargaren, G. (2003). Sustainable consumption: A theoretical and environmental policy perspective. *Society and Natural Resources*, 16(8), 687–701. doi.org/10.1080/08941920309192

Spaargaren, G., Lamers, M., & Weenink, D. (2016). Introduction: Using practice theory to research social life. In G. Spaargaren, M. Lamers, & D. Weenink (Eds.), *Practice theory and research: Exploring the dynamics of social life* (pp. 3–27). Routledge. doi.org/10.4324/9781315656908

Staats, H., Harland, P., & Wilke, H. A. M. (2004). Effecting durable change: A team approach to improve environmental behavior in the household. *Environment and Behavior*, 36(3), 341–367. doi.org/10.1177/0013916503260163

Stern, P. (2014). Individual and household interactions with energy systems: Toward integrated understanding. *Energy Research & Social Science*, 1, 41–48. doi.org/10.1016/j.erss.2014.03.003

Strengers, Y., Nicholls, L., & Maller, C. (2016). Curious energy consumers: Humans and nonhumans in assemblages of household practice. *Journal of Consumer Culture*, 16(3), 761–780. doi.org/10.1177/1469540514536194

Takács-Sánta, A. (2007). Barriers to environmental concern. *Human Ecology Review*, 14(1), 26–38. www.jstor.org/stable/i24707637

Thomas, S. G. (2007). *Buy, buy baby: How consumer culture manipulates parents and harms young minds*. Houghton Mifflin Harcourt.

United States Census Bureau. (2018). *U.S. Census Bureau releases 2018 families and living arrangements tables* [Press Release]. www.census.gov/newsroom/press-releases/2018/families.html

Warde, A. (2005). Consumption and theories of practice. *Journal of Consumer Culture*, 5(2), 131–153. doi.org/10.1177/1469540505053090

Watkins, D., Shwom, R., Schelley, C., Agusdinata, D. B., Floress, K., & Halvorsen, K. E. (2019). Understanding household conservation, climate change and the food–energy–water nexus from a transdisciplinary perspective. In K. E. Halvorsen, C. Schelly, R. M. Handler, E. C. Pischke, & J. L. Knowlton (Eds.), *A research agenda for environmental management* (pp. 145–158). Edward Elgar Publishing. doi.org/10.4337/9781788115193.00023

Weiss, M. J. (2000). *The clustered world : How we live, what we buy, and what it all means about who we are*. Little, Brown and Company.

Wilson, C., & Dowlatabadi, H. (2007). Models of decision making and residential energy use. *Annual Review of Environment and Resources*, 32(1), 169–203. doi.org/10.1146/annurev.energy.32.053006.141137

Wilson, G., & Wood, K. (2004). The influence of children on parental purchases during supermarket shopping. *International Journal of Consumer Studies*, 28(4), 329–336. doi.org/10.1111/j.1470-6431.2004.00393.x

York, R., Rosa, E. A., & Dietz, T. (2002). Bridging environmental science with environmental policy: Plasticity of population, affluence, and technology. *Social Science Quarterly*, 83(1), 18–34. doi.org/10.1111/1540-6237.00068

York, R., Rosa, E. A., & Dietz, T. (2003). Footprints on the earth: The environmental consequences of modernity. *American Sociological Review*, 68(2), 279–300. doi.org/10.2307/1519769

Conceptualizing Transdisciplinary Human Ecology

Sue L. T. McGregor[1]
McGregor Consulting Group, Nova Scotia, Canada

Abstract

Broadening theoretical and methodological underpinnings will help human ecology professionals remain effective in responding to complex crises facing humanity (e.g., climate change, environmental degradation, social inequality). Diversified theoretical offerings strengthen academic and professional work, because diversity drives innovation in practice. This paper explores *transdisciplinary human ecology,* a neologism proposed in the early 1990s by both ecological scientists and home economists. After describing home economics and ecological sciences' approaches to human ecology theory, the Nicolescuian transdisciplinary methodology, and transdisciplinary human ecology as conceived by home economics and ecological sciences, the paper shifts to an inaugural discussion of how human ecology theory can be augmented with Nicolescuian transdisciplinary axioms and transdisciplinary human ecology. This paper served as a seed catalyzing the uptake of transdisciplinary human ecology.

Keywords: ecological sciences, home economics, human ecology, transdisciplinarity, transdisciplinary human ecology

Introduction

Individuals and families face an array of deeply complex problems: "The severe challenges of climate change, resource depletion, environmental and social disintegration, and national and international inequality, are converging into a global crisis that confronts humanity as a whole" (Wahl, 2006, p. 288). Scholars in many disciplines are calling for transdisciplinarity, because they realize that knowledge from one discipline is insufficient. *Trans* means between, across, and beyond academic disciplines to include knowledge from the lifeworld (Nicolescu, 2002, 2014). Transdisciplinarity provides a solid foundation for investigating the complex interactions of human and socioecological systems that inform today's complex crises (Vaughan et al., 2019).

1 Corresponding author: sue.mcgregor@msvu.ca.

Vaughan et al.'s (2019) comment links two long-standing lines of thinking: human ecology and transdisciplinarity. This paper focuses on *transdisciplinary human ecology* as understood within home economics (Brown, 1993) and ecological sciences (e.g., Dyball, 2010). Ecology is the science of the relationships between *living organisms* and their environments. *Human* ecology is the study of the relationships of a particular living organism—*people*—and their environments (Marten, 2001). "Ecologists study systems of interactions among differentiated organisms and between them and the nonliving components of their environment. … Human ecology then, ought to mean simply and straightforwardly *the study of ecosystems that involve humans*" (Catton, 1994, p. 77, emphasis in original).

But human ecology is not a speciality contained within one discipline (Catton, 1994). Dyball (2010) concurred, explaining that human ecology "is adisciplinary, in that it is inclusive of the disciplines but is not bound by any" (p. 13) (see also Christensen, 2014). Biologists use it to study interactions between living organisms and their environments. Sociologists apply it to study human communities. Psychologists use it to explore interpersonal behavior and the adaptation of groups to resources available in their environments. Environmental design and engineering apply it to understand environmental psychology. Anthropologists, archaeologists, and geographers use it to study cultures and civilizations in environmental contexts. Political ecologists employ it to study the impact of colonialism, neoliberalism, and transnational corporations on resource management and environmental problems (Knapp, 2007; Touliatos & Compton, 1988; Wolanski, 1990).

Of interest in this paper is that the ecological science discipline's approach to human ecology, as exemplified by Marten (2001), focuses on the interactions between *social systems* and *ecosystems* using complex adaptive systems theory. The home economics discipline is more narrowly focused on the *family ecosystem* as it interacts with levels of environments using general systems theory (Bubolz & Sontag, 1993; Touliatos & Compton, 1988). Indeed, home economics has long been concerned with human ecology; a fact recently recognized by leading ecological scientists in a paper titled "Ellen Swallow Richards: Mother of Human Ecology?" (Dyball & Carlsson, 2017).

Dyball and Carlsson (2017) also acknowledged Richards as the founder of home economics during the late 1800s and early 1900s Lake Placid conferences in New York state. Richards's desire to call the new discipline human ecology was thwarted, because the name was already being used in the Dewey Library Decimal System with another definition (Joyce Beery Miles, personal communication, January 15, 2019). Richards is credited with being the first person to use the term *human ecology* in her 1907 book *Sanitation in Daily Life*, but attendees at the founding conferences (1899–1909) settled on *home economics* for the name of the new academic discipline and profession (Dyball & Carlsson, 2017; Merchant, 2007).

As a caveat, home economics is both a discipline (academic area of study) and mission-oriented profession (licensed, sanctioned provider of public service). Each depends on and thrives because of the other (McGregor, 2011a). *Discipline* is used herein, because professional practitioners depend on fellow academicians to develop theory. Also, American practitioners changed the name in 1994 to "family and consumer sciences" (FCS) (Vincenti, 1997). While respecting this preferred identity shift, the term home economics[2] is used in this paper unless deemed too narrow in scope for the idea being developed.

Since the 1970s, the home economics discipline and profession have consistently drawn on human ecology theory (e.g., Bubolz & Sontag, 1988, 1993; Touliatos & Compton, 1988) with recent entreatment to embrace transdisciplinarity (McGregor, 2004, 2010, 2019a). The original thesis of this paper was that neither the home economics discipline nor profession has taken up *transdisciplinary human ecology* as recommended by Brown in 1993. In the course of developing this thesis, the author discovered that ecological scientists have been (and continue to be) drawn to and advocate for its usage (antithesis). This discovery shaped the argument herein.

After describing both home economics' (Brown, 1993) and ecological science's (Marten, 2001) approach to human ecology theory followed with Nicolescuian transdisciplinarity, the discussion turns to an overview of how both home economists and ecological scientists envisioned *transdisciplinary* human ecology. The paper ends with inaugural thoughts on how human ecology theory can be augmented with Nicolescuian transdisciplinary axioms and transdisciplinary human ecology (synthesis).

Home economics' approach to human ecology theory

A theory is a system of ideas intended to account for a phenomenon—Greek *phainomenon*, "a thing appearing, then seen or viewed." Theory is Greek *theoria*, "contemplation, speculation" (Harper, 2020). Theories help researchers explain, describe, predict, or control a phenomenon by arranging what is known about it "into a logical and understandable framework" (Touliatos & Compton, 1988, p. 12). Any theoretical framework comprises three key building blocks: (a) assumptions (premises, tenets) about the phenomenon; (b) constructs and concepts with attendant definitions; and (c) propositions about how these concepts are related (McGregor, 2018b).

2 Ideas in this paper pertain to home economics (a term commonly used outside of the United States), FCS, human ecology, home sciences, home ecology, consumer sciences, family studies and other monikers for home economics around the world.

In their scholarship focused on the well-being and quality of life of individuals and families in communities, home economists rely on several dominant theories including systems, conflict, exchange, symbolic interaction, family development, communication, and life course theory (Boss et al., 1993). The discipline also draws on consumer behavior, education, psychology, sociology, economic, political, and other theories (McGregor, 2009). Human ecology theory was introduced to home economics in the 1970s and early 1980s (see Bubolz et al., 1979; Bubolz, et al., 1980; Hook & Paolucci, 1970). As noted, the discipline's founders considered *human ecology* as its preferred name, but they were told they could not adopt it, because the biological sciences were already using it (Bubolz & Sontag, 1993; Dyball & Carlsson, 2017; Vincenti, 1997).

In their seminal work about human ecology theory, home economists Bubolz and Sontag (1993) identified a comprehensive list of assumptions and premises about the phenomenon of individuals and families (including households) in interaction with their environments (see pp. 425–426). Briefly, human ecology theory assumes that families are: (a) an *ecosystem* where the parts and the whole are interdependent: (b) a key democratic social *institution* that carries out functions for its members and the common good; and (c) a key player in the *ecological* health of the Earth and the world—families are part of the total life system of the planet and deeply intertwined with nonhuman life and environments. It further assumes that: (d) all of their decisions impact society, culture, and environments; and (e) humans (families) can control their decisions, which are not determined by environments. Instead, environments pose restrictions on and provide opportunities for human action (Bubolz & Sontag, 1993).

Bubolz and Sontag (1993) then identified and defined an array of constructs and concepts shaping human ecology theory (pp. 429–437) with propositions (pp. 438–439). Briefly, when using human ecology theory in their practice with individuals and families, home economics and FCS practitioners can *assume* that individuals, families, and households procure, use, and dispose of resources over time to meet basic needs and fulfill the basic functions of the family as a democratic unit. They do so by engaging in reciprocal relationships along four levels of environment: (a) human group, (b), human-built, (c), sociocultural, and (d) natural (Bubolz, 1990; Bubolz & Sontag, 1988, 1993; Touliatos & Compton, 1988) (see Figure 1).

Conceptually, these reciprocal relationships (i.e., humans with environments) require interaction, interdependence, adaptive behavior, and self-organization. People work with matter (material objects and artifacts), energy, resources, information, space, and time, augmented with technology. They engage in decision-making, choice-making, communication, and management. They exhibit a concern for values, norms, goals, attitudes, perceptions, and complexity as they strive to optimize the quality of both human life and environments (Bubolz & Sontag, 1993).

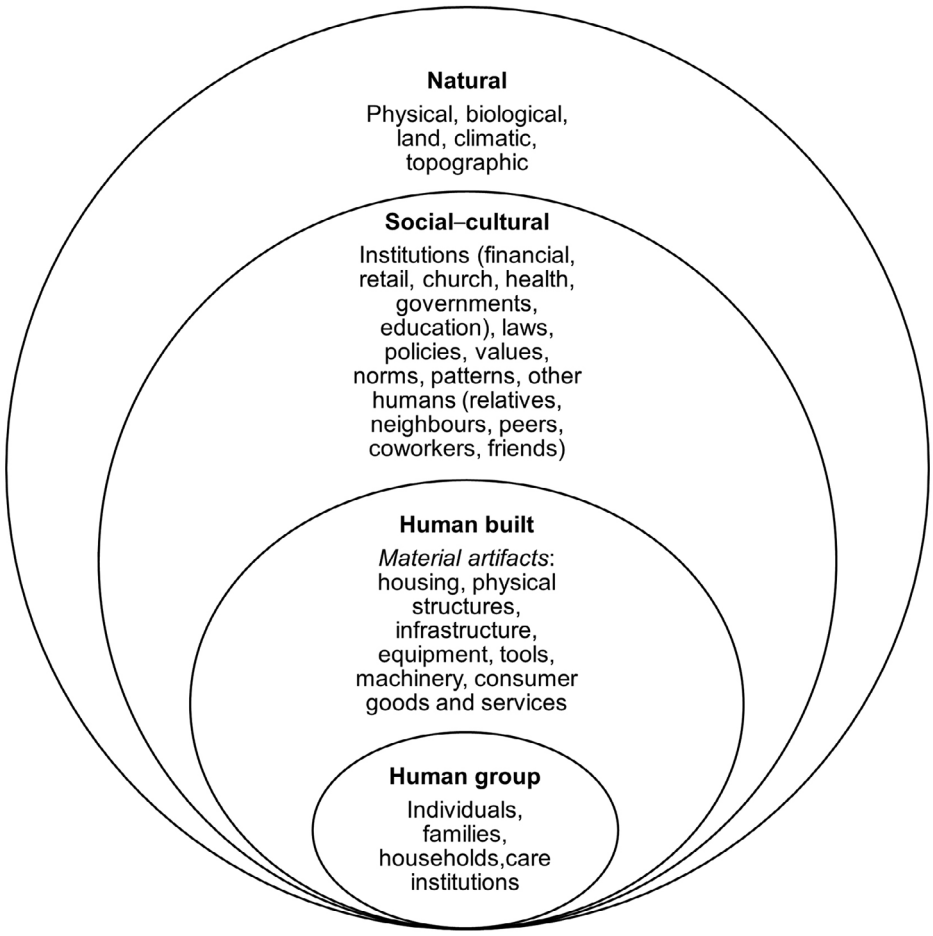

Figure 1. Levels of environment in home economics' human ecology theory.
Source: Author's summary of principles.

Ecological scientists' approach to human ecology theory

Home economics views human ecology theory as grounded in general systems theory concepts. They believe this theory provides a valuable perspective from which to focus on human–environmental interactions (Bubolz & Sontag, 1993). Marten (2001) took a different approach. An ecological scientist, he turned to complex adaptive systems (CAS) theory to develop a theory of human ecology. As an aside, McGregor (2015b, 2019a) has also urged home economists to engage with CAS theory.

Systems theory deals with input, throughput, output, and feedback while striving for equilibrium—picture a thermostat or paddling a canoe. On the other hand, CAS theory deals with complexity, chaos, and impermanent equilibrium—picture an undulating swarm of birds or a shifting herd of wildebeest. These complex systems are leaderless with no coordination; yet, things still happen. Patterns emerge, but no one was told to make a pattern. They are governed by chance and randomness, yet people trust that something will emerge (Mason, 2008). Other examples of CAS include the stock market, an anthill, and a family.

Using this well-established theory, Marten (2001) conceived human ecology theory through the lens of CAS principles and concepts. The most important of these are now introduced. A key concept is complexity, which refers to many intertwined, interdependent parts creating a complex whole that is difficult to untangle. CAS have the key property of emergence, which means gradually coming into existence. Emergence involves coadaptation, community assembly, and coevolution. CAS are resilient due to redundancy (i.e., the intentional duplication of system parts and functions to increase dependability). Of special importance, CAS are self-organizing—that is, they are adaptable (flexible) and can adjust to change without the need of external control or directions. They are also prone to interconnections and forming networks.

CAS are counterintuitive (do not act as expected) and unpredictable. They are chaotic, meaning order is emerging unpredictably. But they have stability domains (i.e., instances when they are stable) that accommodate tensions and switching in ecosystem states. They can experience distortion followed by a complex system cycle wherein they move from growth, equilibrium (stability), dissolution, and reorganization to a new stability domain. And they can create ecological niches whereby they respond to environmental conditions and create a suitable and sustainable role for themselves. Marten presented these and other CAS constructs as a "clear, understandable and coherent system of concepts for comprehending how ecosystems function and how human societies interact with ecosystems" (2001, p. xvi). Since then, other ecological scientists have acknowledged the merit of drawing on CAS theory to inform human ecology theory (Reyers et al., 2010).

Nicolescuian transdisciplinary methodology

Theories conceptualize a phenomenon. To learn more, scholars use research *methodologies* to gain knowledge of the phenomenon. Methodology (not the same as methods) is a "branch of logic that shows how abstract logical principles [axioms] are to be applied to the production of knowledge" (Harper, 2020). Home economics and FCS academics and practitioners basically draw on three methodologies: empirical, interpretive, and critical (Brown & Paolucci, 1979). McGregor (2018a, 2018b)

explained elsewhere the respective philosophical axioms for each methodology: (a) what counts as reality, being, and existing—*ontology*; (b) what counts as knowing and knowledge—*epistemology*; (c) *logic* and reasoning (habits of the mind); and (d) the role of values in research—*axiology*.

Transdisciplinarity is offered here as a fourth research methodology in its own right with its own take on the four axioms. Transdisciplinarity refers to creating knowledge using a combination of disciplinary knowledge *and* ways of knowing in sectors other than the university setting (Nicolescu, 2002, 2014). To clarify, *inter*disciplinary knowledge creation is limited to *between* or *among* disciplines with no concern for *beyond* the higher education academy (Nicolescu, 2014). For more than a century, home economics has been interdisciplinary (Vincenti, 2009). Ecological science is also interdisciplinary (Dyball, 2010; Reyers et al., 2010; Wolanski, 1990).

Daniels (1980), a British home economist, first called for a shift to transdisciplinarity in the profession, followed 13 years later with Brown's (1993) recommendation. Another decade lapsed before home economist McGregor (2004) took up the cause. How the discipline and profession view transdisciplinarity has changed over time (McGregor, 2010) with McGregor (2018a, 2019a) now using the Nicolescuian formulation rather than the Zurich approach (distinctions at McGregor, 2015a). Each would offer a different conceptualization of transdisciplinarity, with this paper opting for Nicolescu's (2002) approach. Ecological scientists are also advocating for a shift to transdisciplinarity with most not referencing any particular approach (e.g., Brown et al., 2010; Reyers et al., 2010; Steiner, 1993; Vaughan et al., 2019).

Nicolescuian transdisciplinarity

Drawing on complexity science (including CAS theory), chaos theory, and quantum physics (rather than classical, Newtonian sciences), Basarab Nicolescu (2002, 2014), a quantum theoretical physicist, formulated a transdisciplinary methodology (shortened in his explanations below to TD) with its own unique axioms (see Figure 2). McGregor (2018a) tendered a detailed discussion of these axioms, presented here in their most rudimentary format. Nicolescu's (2014) intent was to push back against disciplinary fragmentation and specializations, reductionism, dualism, positivism (the scientific method), capitalism, and corporate- and techno-led globalization. The alienation of humans from science and technology has created the crises that Wahl (2006) lamented, crises that cannot be solved using just disciplinary or sectoral knowledge (Brown, 1993; Nicolescu, 2002). Uniting humans (subjective) and science (objective) will nullify dualism, unify knowledge, and augment understandings of complexity and the world (Nicolescu, 2014).

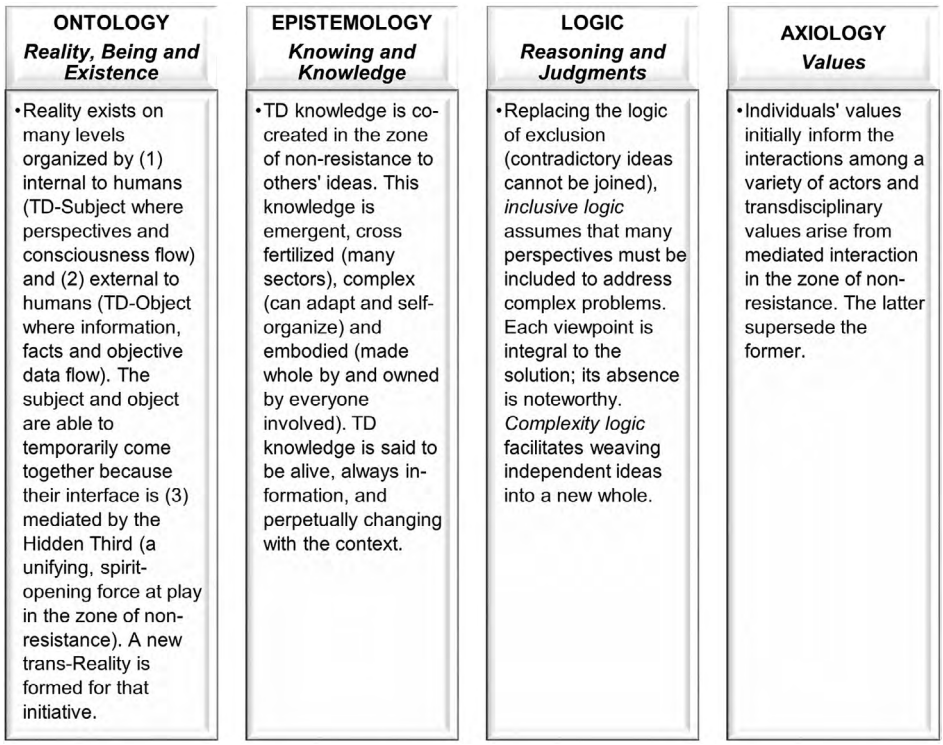

Figure 2. Nicolescuian transdisciplinary methodology axioms.

Source: Author's summary of axioms.

Ontology

Nicolescu believed that mixing what is inside people's minds (subjective, value-laden perceptions and consciousness) with what is outside their minds (external flow of objective, value-free information, facts, data, and statistics) is possible *if* the "included middle" interface is mediated with what he called the Hidden Third in conjunction with movement along multiple levels of Reality (ontology) (he capitalizes Reality—a convention used in this paper). The internal TD-Subject comprises individual (psychology and personal philosophy), social and cultural, political, and historical levels of Reality. The external TD-Object comprises other levels of Reality: economics and business, science and medicine, technology, environment and ecology, and planetary and cosmic (universe). Human movement between and among these levels of Reality is difficult because of their contradictory assumptions of the world (Nicolescu, 2002, 2014).

People need help to do this. To that end, Nicolescu conceptualized the mediating Hidden Third (like a third party during contentious negotiations), which entails culture, art, spirituality, religions, faith, and the Sacred (connections). These unifying modalities are a means to create a fertile space (called the *zone of non-resistance*),

whereby antagonistic ideas from the TD-Subject and TD-Object can be smoothed over (ontology) so that new, integrated TD knowledge can emerge (epistemology). A new trans-Reality (beyond all Realities but existing at the time) arises that is multifaceted, pliable, in flux, and unique to the problem scenario being addressed (ontology) (Nicolescu, 2002, 2014).

Epistemology

Nicolescu's (2002, 2014) basic premise is that researchers and problem solvers need a way to reconcile natural resistance to contradictory ideas so they can integrate divergent worldviews. Knowledge can arise from this fusion of viewpoints when people willingly set aside their own views to make room for others. The resultant knowledge created in the fertile space where diverse minds interface (called the "fertile included middle") is emergent, complex, cross-fertilized, and embodied. It is cocreated and belongs to everyone involved (epistemology).

Logic

This conceptualization of ontology (Reality) is possible, because people can draw on both inclusive logic and the logic of complexity (Nicolescu, 2002)—Latin *complexus*, "plaited, interlaced strands" (Harper, 2020). Respectively, these logics (i.e., habits of the mind) (a) temporarily reconcile contradictions and antagonisms inherent in multiple perspectives and information (Realities), and (b) allow for different ways of knowing to be interwoven to form new TD knowledge (epistemology) (Nicolescu, 2002, 2014).

Axiology

Inherent in this process is a respect for both (a) personal value sets held when people enter the TD inquiry process, and (b) resultant TD values that emerge during and at the end (axiology) (e.g., respect, compromise, innovation). The new TD knowledge that is formed would not exist without these particular TD values (McGregor, 2018a; Nicolescu, 2014). Although Nicolescu (2006) did not formulate an axiology axiom, it is included here because home economics has long been concerned with values, values clarification (own values), values analysis (others' values), and values reasoning (Brown & Paolucci, 1979). For those who are interested, McGregor (2011b) has made a case for a TD axiology.

To summarize, because transdisciplinary research is inquiry based (*not* discipline based), the focus is on investigating a complex issue and seeking information (object) and perspectives (subject) from academic disciplines *and* other sectors (e.g., civil society, industry, and government). Those involved integrate rather than exclude everyone into the inquiry process. All perspectives must be vetted to accommodate the complexity of the situation. Some points of view and/or facts may be integral to the final solution; their absence would be noteworthy and consequential. They are necessary for completeness (McGregor, 2018a; Montouri, 2013).

To continue, TD researchers work across and with many sets of assumptions; that is, they use a meta-paradigmatic approach (Montouri, 2013). *Meta* is Greek, "across, with" (Harper, 2020). While accepting that each discipline and sector draws on its own set of assumptions (intra-paradigms), transdisciplinary researchers go further and tease out and challenge these assumptions (meta-paradigms). If unquestioned, they can place blinders on the inquiry process and preclude TD knowledge creation. Finally, reductionist, dualistic thinking is rejected in favor of complexity thinking (Montouri, 2013). The former reduces things to their bare essence, while the latter weaves things together to create a new essence (Nicolescu, 2016).

Home economics' conceptualization of transdisciplinary human ecology

Although it took ecological scientists until the end of the twentieth century to acquiesce to humanity's centrality to ecology (Reyers et al., 2010), Ellen Swallow Richards had proposed this connection at the end of the 1800s. Yet home economists did not embrace human ecology until the late 1970s (Brown, 1993; Dyball & Carlsson, 2017; Vincenti, 1997). And unlike the growing cadre of ecological scientists who have conceptualized transdisciplinary human ecology (see next section), Brown (1993) is the only home economist who has engaged with the construct. She said that if the discipline intended to continue to align with human ecology, it should be a "broad, transdisciplinary human ecology" (Brown, 1993, p. 413). She reasoned (at pp. 408–409) that, because home economics is concerned with human problems that do not fit within one discipline, any human ecology framework it adopted must be transdisciplinary.

Brown (1993) envisioned a transdisciplinary human ecology framework as overarching, embracing the global level, far beyond the human group. It would be normative in nature (i.e., asking should and ought questions privileging justice and rights) and focused on achieving valued ends that contribute to the potential of humankind, not just individuals and families. Transdisciplinary human ecology would also embrace all ways of knowing and be concerned with all "forms of relationships between humans and their environment" (p. 408). A transdisciplinary human ecology would assume that what constitutes a human problem is broadly defined, meaning it is large in scope while conceptually clear. It is a problem if it interferes with humans meeting their potential in society, which has implications for the human condition.

Brown (1993) proposed that transdisciplinary human ecology would provide a unified view of both the world and knowledge. It would appreciate "the contributions made by [all modes] of knowing" (p. 408). Unifying both the world and knowledge would require various disciplines and professions to work

together to solve society's fundamental problems. This would necessitate using both a holistic view and reflection, otherwise home economists would not be able to synthesize knowledge. Transdisciplinary human ecology would also require specializations to rethink their orientation, so they can effectively bring their "special competence [to] political–moral activity [that is focused on solving issues] within human–environment relations" (p. 409).

Ecological sciences' conceptualization of transdisciplinary human ecology

Neither home economics nor FCS has engaged with Brown's (1993) vanguard idea of transdisciplinary human ecology as a new direction. However, her ecological science contemporaries saw the connection (e.g., Steiner, 1993; Wolanski, 1990), and their colleagues have been advocating for human ecology as transdisciplinary for the last 30 years (Christensen, 2014; Dyball, 2010; Reyers et al., 2010; Wakefield-Rann & Fam, 2018).

To illustrate, Wolanski (1990) proposed that the human ecology discipline had moved through four stages—mono, multi, inter and transdisciplinary (spanning 70 years)—entering the last stage in the early nineties. This was evident by the concern for a "transdisciplinary synthesis of the study of 'man and his culture as a dynamic part of ecosystems'" (p. 110). Wolanski felt it timely to conjoin human ecology with transdisciplinarity because of "the necessity of understanding man's essence in the light of the infinite complexity and temporariness of relations in the universe" (pp. 110–111). To clarify, *man* inclusively meant "organism, population, society" (p. 111).

Shortly thereafter, Steiner (1993) wrote of "human ecology as transdisciplinary" (p. 47) calling it "a trans-scientific endeavour" (p. 49), because human ecology goes beyond science to include philosophy and the lifeworld. Humans encounter their world on these "three levels of world reference which should be connected to each other" (p. 50). From a transdisciplinary perspective, "human ecology … as an undertaking … develops a capability of establishing a conceptual framework within which structured conversations about problems can take place and a new kind of consciousness can develop" (p. 51).

Steiner called this framework "general human ecology" (1993, p. 56). For him, the transdisciplinary perspective included (a) *extended ecological* (the transformation of existing systems) and (b) *evolutionary* (the emergence of new systems). The former is recursive and acknowledges that "interactions make possible an enduring existence of the elements [of a system] and the elements continue their very existence by further interactions" (p. 56). *Evolutionary* pertains to the emergence of new systems that

arise from successive generations of recursive evolution and ongoing development. Steiner's (1993) approach to transdisciplinary human ecology thus depended on the transdisciplinary principles of recursive systems, self-organization, levels of reality, emergence, and evolution (in effect, CAS theory).

About 20 years later, Reyers et al. (2010) aligned transdisciplinarity with ecology. They explained that transdisciplinarity is best able to "tackle complexity and the fragmentation of knowledge, work with local contexts and uncertainty, and promote close collaboration and communication during all phases" (p. 503). This alignment happened because ecologists had finally accepted that ecosystem management and conservation is about people and their choices, not just about biology. For 50 years, ecologists had treated humans as external factors. No human ecological (reciprocal) relationship was appreciated, *until* it became self-evident that humans play a major role in what happens to natural environments and other biological species. Steiner (1993) agreed, claiming that "the ecological crisis is really a human crisis" (p. 57).

Dyball (2010) described human ecology as "necessarily transdisciplinary" (p. 274) because of its attributes. Human ecology "is about the interrelationships between humans, their cultures and their ecosystems" (p. 273). To that end, it uses a holistic approach, is concerned with the ethical dimensions of issues (especially for future generations), and is normative (asking should and ought questions). It also envisions a humane and sustainable future evidenced through a motivation of care and concern for a worthwhile world. These attributes make human ecology transdisciplinary whether intended or not (Dyball, 2010).

Christensen (2014) believed that "human ecology is inherently philosophical" (p. 47). He affirmed that "human ecology seeks knowledge useful for transforming human–environment interactions in the direction of sustainable living" (p. 44). Seeking such knowledge requires "reflectiveness, social and political engagement, and inner composure" (p. 44). He concluded that "human ecology [is] the distinctively philosophical appropriation of the results of whatever disciplines, techniques, and … everyday knowledge are needed for … generating a creative, practical response to the most serious crises human beings have ever confronted" (p. 47). With this description, he thus intimated that human ecology *is* transdisciplinary.

Very recently, Wakefield-Rann and Fam (2018) enticed their ecological science peers to view "indoor ecosystems as a complex issue [that requires the application of] the principles of transdisciplinarity" (p. 6). Transdisciplinary human ecology would involve "critical reflection in relation to one's own and others' perspectives, values, data, and methodological approaches [and conventions] that inevitably creates challenges" (p. 6). By engaging in collaborative research that transgresses disciplinary boundaries and uses multiple sources of knowledge from stakeholders and disciplines, ecological scholars could generate normative research yielding broad societal outcomes that would be communicated using language accessible across fields of inquiry and outside the academy.

Conceptualizing transdisciplinary human ecology

This final section draws on home economics' and ecological scientists' conceptualizations of transdisciplinary human ecology to formulate an inaugural discussion of (a) transdisciplinary methodology and human ecology theory compatibility, (b) suggested realignments of particular human ecology theoretical concepts with transdisciplinary methodology, and (c) augmentations to human ecology theory so it can accommodate both (i) Nicolescuian transdisciplinarity axioms and (ii) home economists' and ecologists' views on transdisciplinary human ecology. (d) Implications for research are briefly acknowledged.

Transdisciplinary methodology and human ecology theory compatibility

Brown (1993) felt that "a transdisciplinary framework of human ecology … provides a perspective which home economists *could* use but it does not provide the answers as to *how* this perspective can be used in home economics. That home economists must do themselves" (p. 409, emphases in the original). In that spirit, human ecology professionals and researchers can rest assured that the two are deeply complementary. To explain, any research methodology (i.e., assumptions about reality, knowledge, logic, and values) must align with the chosen theory (i.e., assumptions about the phenomenon under study) (McGregor, 2018b). Fortuitously, the transdisciplinary research methodology is concerned with inclusiveness, integration, complexity, and levels of Reality. This means it aligns closely with human ecology theory, which assumes people are in complex, reciprocal relationships within levels of environments.

Individuals, the family unit, and households are encountering incredibly complex problems that single disciplines cannot address (Brown, 1993). Fortunately, the transdisciplinary methodology is concerned with creating complex knowledge to address complex problems, which human ecology theory assumes people contribute to daily with their resource management choices (Bubolz & Sontag, 1993; Reyers et al., 2010; Steiner, 1993). Transdisciplinary human ecology is an even more promising way to address complex societal concerns.

On another encouraging note, transdisciplinarity takes different forms in different practices and contexts: "There is no single such practice" (Riedy, 2016, p. 93). Because there are many ways to *do* transdisciplinarity, home economics, FCS, and ecological science theorists can choose to bring transdisciplinarity to human ecology. Already interdisciplinarians and adherents of human ecology theory, home economics, FCS, and ecology researchers should feel comfortable embracing transdisciplinary human ecology.

Home economists and FCS theorists and practitioners already value humans, ecologies, levels, integration, holism, and cross fertilization (Bubolz & Sontag, 1988; McGregor, 2019b), which are all key components of transdisciplinary work. Similarly, human ecology theory and the transdisciplinary methodology share key concepts: interaction, adaptation, self-organization, interdependence, complexity, reciprocity, and a concern for environments. In short, transdisciplinary methodology (axioms) and human ecology theory (assumptions) are compatible.

Suggested conceptual realignments

Several human ecology theoretical concepts can be realigned with aspects of transdisciplinary methodology. First, both approaches have a concern for space, time, cyber technology, energy, and material artifacts. Nicolescu (1998, 2002, 2014) added the notion of *cyber–space–time* (CST) (ontology), which is a connecting principle bridging mind and matter to make levels of perception more evident as people cross Realities. CST is "the transcultural, transnational and transpolitical … space of human choice" (Nicolescu, 2002, p. 82); that is, people choose to work with disparate minds to problem solve.

Inclusive logic (not leaving anything out) is at work in CST, which is simultaneously artificial (e.g., information technology, Internet, virtual reality) and real, just with different degrees of materiality (more than dualistic, either real or virtual) (Nicolescu, 2002). "'Cyber'space is a ritually created space of liminality with transformative properties" (Barbatsis et al., 1999). Liminal space is barely perceptible, neither here nor there. When people enter it, they stand on a threshold, where something can cease to exist or can come into existence—transform (Turner, 1974). Respectively, people can let go of old ways of seeing things and create new knowledge in CST.

On a second front, transdisciplinarity's respect for religion, faith, spirituality, and the Sacred are not an explicit part of human ecology theory now except for the inclusion of church and culture in the social–cultural environment level (Bubolz & Sontag, 1993) (see Figure 1). It makes conceptual sense to add these ontological elements of transdisciplinarity's Hidden Third to human ecology theory. (a) Church represents institutionalized religion as a political and social force. (b) Religions are historical and cultural systems and rituals built around a deity. (c) Faith is an individual's belief in the deity, Church, or religious system. (d) Spirituality is the essential essence of humanity—an inner force. (e) The Sacred represents an absolute respect for others and attendant life-affecting connections (e.g., humans and nature) (McGregor, 2018a; Nicolescu, 2002, 2014, 2016). Along with culture and art, these elements are considered "spirit-opening modalities" that relax people's minds to receive others' ideas (Eric Reynolds, personal communication, August 15, 2018).

Third, human ecology theory concerns the phenomenon of individuals and families in relation with environments (Bubolz & Sontag, 1993). If the ecological crisis *is* a human crisis (Reyers et al., 2010; Steiner, 1993), the human group at the center of human ecology theory would have to be reconceptualized. This could include adding subjective perceptions, perspectives, and consciousness as well as human psychology, and philosophy of life (ontology) (Nicolescu, 2014). Human ecology is, by its nature, philosophical (Christensen, 2014). The human group would also have to include ethics and morality and have a normative dimension (Brown, 1993; Dyball, 2010).

Augmented human ecology theoretical assumptions

If the home economics and ecological disciplines heed the call to move forward with transdisciplinary human ecology, they will have to augment some of human ecology theory's assumptions (Bubolz & Sontag, 1993; Marten, 2001) with transdisciplinary philosophical axioms (Nicolescu, 2002, 2014). The following augmentations are offered for consideration, organized by the four transdisciplinarity axioms. The preponderance of ontological ideas may align with Christensen's (2014) (ecological scientist) assertion that human ecology has a unique ontology, enriched here with transdisciplinarity ontology (i.e., multiple levels of Reality and the Hidden Third):

Ontology

- assuming humans are in relation with environments would require another, outermost, level of environment: the cosmos, universe, and lifeworld (see Figure 1);
- resources available for meeting basic needs and fulfilling the role of a democratic social institution would expand to include the CST construct;
- per the above, it is assumed that as they create their Reality, they will self-organize and move through complex system cycles;
- the inclusion of church and culture in the social–cultural level of environment would expand to include spirituality, religion, faith, and the Sacred;
- human consciousness would come into play during resource management and be affected by interfacing with others;
- although human ecology theory assumes humans can control their decisions and choices, this process would now be understood in the context of many other actors instead of just the home or household;
- as humans engage with four levels of environments, they would do so along multiple levels of Reality (internal subjective and external objective);
- the reciprocal relationship between humans and levels of environments would require mediation (the Hidden Third) if people intended to move through levels of Reality at the same time;

Epistemology

- because *family knowing* and *family knowledge* are key to transdisciplinary knowledge creation, how families come to know things and what counts as family knowledge must be conceptualized and studied. This knowledge would be complex (more than complicated), emergent, and embodied;
- as they interact to create new knowledge, they would be construed as counterintuitive and unpredictable yet able to deal with chaos, which is order emerging unpredictably;
- individual and family ecosystem resource management would be construed as complex, emergent, and evolving rather than just complicated and ongoing;
- individuals and families would be viewed as resourceful ecological niches;

Logic

- the above mediation would involve considering inclusive logic and complexity logic (habits of the mind) as part of family reasoning and judgments and any articulation of insights and perspectives;
- assuming individuals and families are key players in the health of the world means their voices need to be heard in transdisciplinary work (inclusive);
- people would come to expect patterns to emerge, which will inform their logic and reasoning;

Axiology

- values are part of human ecology theory (in the sociocultural environment). Transdisciplinary human ecology would have to expand to make room for the emergence of transdisciplinary values, which are not explicitly created by humans but arise from the mediated interface where incompatibility and complexity are addressed to mutual satisfaction.

Research implications

On the research front, the empirical, scientific, positivistic approach is still needed—just not privileged (Nicolescu, 2014). The interpretive and critical research methodologies align most closely with transdisciplinarity, a research methodology in its own right. Interpretive methodology focuses on the meanings people assign to their lived experiences, while critical methodology is concerned with the role of power in people's lives. Appropriate research methods (sampling, data collection, analysis, and reporting conventions) include phenomenology (assigning meaning to lived experiences), hermeneutic inquiry (interpreting communications to find meaning), and discourse analysis (revealing power). Narrative inquiry (people's stories), action research (personal research and activism combined), and participatory research (collective research and activism combined) are also relevant (McGregor,

2018b). Home economics, FCS, and ecological science practitioners should also engage with challenging but necessary collaborative initiatives (McGregor, 2017; Vincenti, 2009; Wakefield-Rann & Fam, 2018).

Conclusion

Home economics', FCS's, and ecological science's current theoretical understandings of human ecology would change if informed by Nicolescuian transdisciplinarity. Discourse, meanings, processes, and outcomes pursuant to the use of human ecology theory would change too. Taking inspiration from Riedy (2016), this paper served as a seed catalyzing the uptake of transdisciplinary human ecology. Diversifying theoretical and methodological offerings (i.e., embracing transdisciplinary human ecology) would strengthen disciplinary and professional work because "diversity … drives innovation in practice" (Riedy, 2016, p. 105). Innovative next practice better ensures continued effectiveness in responding to complex crises.

With a synthesis of contributions from both home economics and ecological sciences, a conceptualization of transdisciplinary human ecology was offered. The ideas herein should stimulate future discussions about the diverse, overall conceptual framework of human ecology as it pertains to traditional and contemporary intellectual offerings. As a mix of long-standing historical traditions and current and complex thinking, this paper can serve as a stimulus piece for people from a range of disciplinary and theoretical dimensions to reflect and comment on conceptualizing transdisciplinary human ecology.

References

Barbatsis, G., Fegan, M., & Hansen, K. (1999). The performance of cyberspace: An exploration into computer-mediated reality. *Journal of Computer-Mediated Communication*, 5(1). doi.org/10.1111/j.1083-6101.1999.tb00332.x

Boss, P., Doherty, W. J., LaRossa, R., Schumm, W. R., & Steinmetz, S. K. (Eds.). (1993). *Sourcebook of family theories and methods*. Springer. doi.org/10.1007/978-0-387-85764-0

Brown, M. M. (1993). *Philosophical studies of home economics in the United States: Basic ideas by which home economists understand themselves* (Vol. 3). Michigan State University Press.

Brown, M. M., & Paolucci, B. (1979). *Home economics: A definition* [augmented version]. American Association for Family and Consumer Sciences.

Brown, V. A., Harris, J. A., & Russell, J. Y. (Eds.). (2010). *Tackling wicked problems through the transdisciplinary imagination*. Earthscan. doi.org/10.4324/9781849776530

Bubolz, M. M. (1990, April 20–22). *The family ecosystem: Macro and micro interdependence* [Paper presentation]. Society for Human Ecology Conference, East Lansing, Michigan, United States.

Bubolz, M. M., Eicher, J., Evers, S. J., & Sontag, M. S. (1980). A human ecological approach to quality of life: Conceptual framework and results of a preliminary study. *Social Indicators Research*, 7(1–4), 103–136. doi.org/10.1007/bf00305595

Bubolz, M. M., Eicher, J., & Sontag, M. S. (1979). The human ecosystem: A model. *Journal of Home Economics*, 71(1), 28–31. hdl.handle.net/11299/162560

Bubolz, M. M., & Sontag, S. (1988). Integration in home economics and human ecology. *Journal of Consumer Studies & Home Economics*, 12(1), 1–14. doi.org/10.1111/j.1470-6431.1988.tb00462.x

Bubolz, M. M., & Sontag, S. (1993). Human ecology theory. In P. Boss, W. J. Doherty, R. LaRossa, W. R. Schumm, & S. K. Steinmetz (Eds.), *Sourcebook of family theories and methods: A contextual approach* (pp. 419–448). Plenum Press. doi.org/10.1007/978-0-387-85764-0_17

Catton, W. R., Jr. (1994). Foundations of human ecology. *Sociological Perspectives*, 37(1), 75–96.

Christensen, C. B. (2014). Human ecology as philosophy. *Human Ecology Review*, 20(2), 31–49. doi.org/10.22459/her.20.02.2014.02

Daniels, C. E. J. (1980). The organizational structure of home economics: A consideration of terminology. *Journal of Consumer Studies and Home Economics*, 4(4), 323–339. doi.org/10.1111/j.1470-6431.1980.tb00385.x

Dyball, R. (2010). Human ecology and open transdisciplinary inquiry. In V. A. Brown, J. A. Harris, & J. Y. Russell (Eds.), *Tackling wicked problems through the transdisciplinary imagination* (pp. 273–284). Earthscan. doi.org/10.4324/9781849776530

Dyball, R., & Carlsson, L. (2017). Ellen Swallow Richards: Mother of human ecology? *Human Ecology Review*, 23(2), 17–28. doi.org/10.22459/her.23.02.2017.03

Harper, D. (2020). *Online etymology dictionary*. etymonline.com/

Hook, N., & Paolucci, B. (1970). The family as an ecosystem. *Journal of Home Economics*, 62(5), 315–318.

Knapp, G. (2007). Human ecology. In P. Robbins (Ed.), *Encyclopedia of environment and society* (Vol. 3) (pp. 880–884). Sage.

Marten, G. (2001). *Human ecology: Basic concepts for sustainable development*. Earthscan. doi.org/10.4324/9781849776028

Mason, M. (Ed.). (2008). *Complexity theory and the philosophy of education*. Wiley-Blackwell.

McGregor, S. L. T. (2004). The nature of transdisciplinary research and practice. *Kappa Omicron Nu Human Sciences Working Paper Series*. kon.org/resources/the-nature-of-transdiscipliary-research-and-practice.html

McGregor, S. L. T. (2009). Integral metatheory: Beyond specializations, theoretical pluralism and conventional metatheory. *Family and Consumer Sciences Research Journal*, 38(2), 142–157. doi.org/10.1111/j.1552-3934.2009.00014.x

McGregor, S. L. T. (2010). Historical notions of transdisciplinarity in home economics. *Kappa Omicron Nu FORUM*, 16(2). www.kon.org/archives/forum/16-2/mcgregor.html

McGregor, S. L. T. (2011a). Home economics in higher education: Pre-professional socialization. *International Journal of Consumer Studies*, 35(5), 560–568. doi.org/10.1111/j.1470-6431.2011.01025.x

McGregor, S. L. T. (2011b). Transdisciplinary axiology: To be or not to be. *Integral Leadership Review*, 11(3). integralleadershipreview.com/3388-transdisciplinary-axiology-to-be-or-not-to-be/

McGregor, S. L. T. (2015a). The Nicolescuian and Zurich approaches to transdisciplinarity. *Integral Leadership Review*, 15(3). integralleadershipreview.com/13135-616-the-nicolescuian-and-zurich-approaches-to-transdisciplinarity/

McGregor, S. L. T. (2015b). Vanguard next practice for home economics: Complexity thinking, integral thinking, and the human condition. *International Journal of Home Economics*, 8(1), 64–77.

McGregor, S. L. T. (2017). Challenges to transdisciplinary collaboration: A conceptual literature review. *Integral Leadership Review*, 17(1). integralleadershipreview.com/15402-challenges-of-transdisciplinary-collaboration-a-conceptual-literature-review/

McGregor, S. L. T. (2018a). Philosophical underpinnings of the transdisciplinary research methodology. *Transdisciplinary Journal of Engineering & Science*, 9, 182–198. doi.org/10.22545/2018/00109

McGregor, S. L. T. (2018b). *Understanding and evaluating research: A critical guide*. Sage. dx.doi.org/10.4135/9781071802656

McGregor, S. L. T. (2019a). Paradigms and normativity: What should FCS do in light of 21st century change? *Journal of Family & Consumer Sciences*, 111(3), 10–25. doi.org/10.14307/jfcs111.3.10

McGregor, S. L. T. (2019b). Valuing the holistic approach. *International Journal of Home Economics*, 12(1), 55–62.

Merchant, C. (2007). *American Environmental History*. Columbia University Press.

Montouri, A. (2013). The complexity of transdisciplinary literature reviews. *Complicity*, 10(1–2), 45–55. doi.org/10.29173/cmplct20399

Nicolescu, B. (1998). Relativité et physique quantique [Relativity and quantum physics]. In M. Cazenave (Ed.), *Dictionnaire de l'ignorance* (pp.108–120). Albin Michel.

Nicolescu, B. (2002). *Manifesto of transdisciplinarity* (K-C. Voss, Trans.). SUNY Press.

Nicolescu, B. (2006). Transdisciplinarity—Past, present and future. In B. Haverkort & C. Reijntjes (Eds.), *Moving worldviews: Reshaping sciences, policies and practices for endogenous sustainable development* (Vol. 4) (pp. 142–163). ETC/Compas. bibalex.org/Search4Dev/files/416884/362466.pdf

Nicolescu, B. (2014). *From modernity to cosmodernity*. SUNY Press.

Nicolescu, B. (2016). *The hidden third* (W. Garvin, Trans.). Quantum Prose.

Reyers, B., Roux, D. J., & O' Farrell, P. J. (2010). Can ecosystem services lead ecology on a transdisciplinary pathway? *Environmental Conservation*, 37(4), 501–511. doi.org/10.1017/s0376892910000846

Richards, E. H. (1907). *Sanitation in daily life*. Whitcomb & Burrows.

Riedy, C. (2016). Seeding a new transdisciplinary community of practice. In D. Fam, J. Palmer, C. Riedy, & C. Mitchell (Eds.), *Transdisciplinary research and practice for sustainability outcomes* (pp. 93–106). Earthscan. doi.org/10.4324/9781315652184

Steiner, D. (1993). Human ecology as transdisciplinary science and science as part of human ecology. In M. Nauser & D. Steiner (Eds.), *Human ecology* (pp. 47–76). Routledge. doi.org/10.4324/9780203414989

Touliatos, J., & Compton, N. H. (1988). *Research methods in human ecology/home economics*. Iowa State University Press.

Turner, V. (1974). Liminal to liminoid, in play, flow, and ritual: An essay in comparative symbology. *Rice University Studies*, 60(3), 52–92.

Vaughan, J., Mallett, C. J., Davids, K., Potrac, P., & Lópex-Felip, M. A. (2019). Developing creativity to enhance human potential in sport: A wicked transdisciplinary challenge. *Frontiers in Psychology*, 10, Article 2090. doi.org/10.3389/fpsyg.2019.02090

Vincenti, V. B. (1997). Home economics moves into the twenty-first century. In S. Stage & V. Vincenti (Eds.), *Rethinking home economics* (pp. 301–320). Cornell University Press. doi.org/10.7591/9781501729942-017

Vincenti, V. B. (2009). Family and consumer sciences university faculty perceptions of interdisciplinary work. *Family and Consumer Sciences Research Journal*, 34(1), 81–104. doi.org/10.1177/1077727x05277742

Wahl, D. C. (2006). Design for human and planetary health: A transdisciplinary approach to sustainability. In C. A. Brebbia, M. E. Conti, & E. Tiezzi (Eds.), *Management of natural resources, sustainable development and ecological hazards* (pp. 285–296). WIT Press. doi.org/10.2495/rav060281

Wakefield-Rann, R., & Fam, D. (2018). Initiating a transdisciplinary conversation to improve indoor ecologies. *Human Ecology Review*, 24(2), 3–22. doi.org/10.22459/her.24.02.2018.01

Wolanski, N. (1990). Origin and methodology of human ecology. *Journal of Human Ecology*, 1(2), 109–119. doi.org/10.1080/09709274.1990.11907665

Book Reviews

Extreme Cities: The Peril and Promise of Urban Life in the Age of Climate Change

By Ashley Dawson

London, UK: Verso, 384 pp., 2017
ISBN: 978-1-78478-036-4 (hbk)

Reviewed by John Hedlund[1]

Extreme Cities begins, appropriately enough, in the midst of Superstorm Sandy's devastation of much of the New York metropolitan area in 2012. One of the pivotal environmental events in the twenty-first-century United States, this storm revealed to millions the fragility and tenuity of urban life, even in the richest city in the world. If where the storm inflicted the most damage was initially determined by purely geological factors—the areas in flood zones were hit hardest—it quickly exposed how the gaping chasm between the haves and have-nots would impact relief efforts. Downtown Manhattan was pummeled, but life returned to relative normalcy there within a few days. In similarly low-lying but significantly less wealthy neighborhoods, such as Red Hook in Brooklyn or the Rockaways in Queens, relief efforts were spearheaded by Occupy Wall Street activists and largely ignored by official relief agencies. People remained without power for weeks, and many were left homeless, or stranded in high-rise public housing buildings without access to running water or electricity.

"Cities," Dawson argues "are the defining social and ecological phenomenon of the twenty-first century" (p. 5). As both the main contributor to climate change and the sites most vulnerable to its effects, cities are central to the climate crisis. However, much of the urbanization literature promotes an optimistic outlook on cities, as places of condensed populations that allow for a lower ecological footprint, geared toward the development of climate-resistant technologies and architecture that will serve as resilient safe spaces from the coming effects of climate change. Further, cities are largely ignored in much of the environmentalist movement. This contradiction—between, on the one hand, cities as the driving force behind climate change and the sites of greatest vulnerability to its effects, and on the other, the absence of cities in much of environmentalism and the climate justice movement, coupled with the rosy prognoses of city life by many urban scholars—is a central theme of Dawson's *Extreme Cities*.

1 Department of Sociology and Anthropology, North Carolina State University, United States; jhedlun@ncsu.edu.

In the chapter titled "Sea Change," Dawson wages a polemical rebuttal at whom he calls "the citerati," contemporary urban scholars "who frame planetary urbanization as a relatively unmitigated good" (p. 136). Urbanization, according to the so-called citerati, is both ecologically and economically beneficial, as cities concentrate people, thus allowing for greener living, and concentrate resources, generating entrepreneurial opportunities for the world's poor and raising the global standard of living. This argument, however, ignores the fact that cities are the greatest contributor to climate change, and that what drives much global urbanization is not the "pull" factors of urban opportunity, but the "push" factors of rural dispossession, and changes in the agricultural economy that drive peasants off the land and into the cities.

Dawson also critically examines the concept of "resiliency," which has been imported from the ecological sciences to describe social systems by everyone from policy-makers and urban scholars, to sociologists and economists. While the use of resilience in mainstream urban studies is a welcome departure from the antiquated view of cities as an aggregation of atomized buildings and objects, toward an integrated perspective of cities as ecosystems, its application has significant shortcomings. As Dawson argues, the jargon of resiliency tends to ignore the political-economic conditions that make urban spaces in need of resilient development in the first place. In doing so, resiliency discourse tends to naturalize globalization, climate change, capitalism, and social inequality. In this way, there is a "snug fit between the concept of resilience and contemporary neoliberalism" (p. 175).

In the chapter titled "Disaster Communism," Dawson returns to Superstorm Sandy, and provides a critical overview of the horizontalist, anarchist-inspired mutual aid approaches to dealing with environmental crises in cities, including the experience of Occupy Sandy (OS). Especially in the crucial first few days following the storm, activists who were previously involved in Occupy Wall Street were the main relief force mobilized in the less affluent parts of New York. While large-scale relief organizations, such as the Federal Emergency Management Agency (FEMA) and Red Cross, were rendered inert by their top-down bureaucratic structure and size, OS activists fanned out throughout the city, setting up relief hubs in the most hard-hit and underserved neighborhoods. OS was animated by principles of mutual aid, which include "individual ingenuity … spontaneous response to a need," and the construction of "survivors as capable and willing to help themselves and their neighbors" (pp. 244–245). Further, they also saw existing inequalities as exacerbating the effects of the storm, and envisaged relief efforts as encompassing the tackling of these inequalities, along with the more immediate problems.

In spite of OS's immediate organizational capacities and focus on systemic inequalities along with solving pressing post-Sandy relief needs, Dawson argues that "for a neoliberal state … the bootstrapping ingenuity of Occupy Sandy was actually a boon," demonstrated in part by the Department of Homeland Security's

official praise of OS efforts (p. 253). This is because OS served to fill the gaps left by neoliberalism's gutting of the public sector, and philosophy of self-reliance and privatization. While OS may have been concerned about the oppressive nature of the interlocking systems of capitalism and racism, they were organizationally and strategically unequipped to tackle these larger issues in any meaningful way. OS was disembedded from the communities they served, and organized according to decentralized and horizontalist political philosophies, which prevented it from withstanding attacks from both the state (once it stopped serving its purpose) and from local community organizers, some of whom saw OS activists as "outside agitators." Such localized, horizontalist movements on the Left do not offer long-term, viable solutions to capitalism and climate change. Instead, Dawson argues that "the movement for climate justice … will have to confront many of the dilemmas central to the communist tradition," such as internationalism, widespread collective action, working-class solidarity, and the role of state power in marshalling the level of resources and collaborative action necessary to tackle a set of problems on the scale of the climate crisis (p. 239).

One of Dawson's key arguments, to which he returns in the conclusion of *Extreme Cities*, is that we must begin now to seriously grapple with the question of retreating from the coastal regions most in jeopardy. The question is not *whether* to retreat from coastal cities that are sinking and threatened by both sea level rise and increased storm activity, but *when* and *under what conditions*. Part of a just, radical transition away from a carbon-intensive economy must include systemic adaptive measures that take into account the changing climatic and geographic conditions brought on by global warming. A majority of the global population lives within 120 miles of the coastline, and most of the world's megacities are on the coast (p. 5). If retreat began today, it could potentially be planned, phased, organized, and socially just. If not, retreat will occur all the same, but it will likely be chaotic, reactive, and leave the most vulnerable to fend for themselves.

Resistance to a just retreat comes from many quarters. Dawson contends that the concept of "retreat" is in conflict with "the broader cultural zeitgeist of imperial masculinity" that sees retreat as a form of military defeat, or surrender (p. 278). This reaction to retreat can be seen in Mayor Mike Bloomberg's post-Sandy "Build It Back" plan, which committed to redeveloping the coastal communities devastated by the storm. Retreat is perhaps a politically unpopular position, and contradicts the short-term, election cycle–dictated logic of political leaders. But more fundamentally, retreat contradicts the logic of capital accumulation. Not only are cities the global centers of capital, but beachfront coastal properties often command some of the highest returns in the real estate industry. The anarchic, profit-driven logic of capitalism compels continued development in Miami Beach and Long Beach, Long Island, even if these developments will inevitably be destroyed in the not-too-distant future.

Capitalism is incapable of the kind of coordinated, long-term planning required to both stop construction on vulnerable coastlines and transition away from living in precarious, low-lying regions that will be completely uninhabitable within a few decades. It has also proved itself incapable of stopping the profligate consumption of fossil fuels which drives the need for such monumental coastal retreat in the first place. Dawson expertly demonstrates this point throughout *Extreme Cities*, critiquing a number of half-measures along the way such as programs of "urban resilience;" localized and horizontalist reform efforts; as well as "green" urban development that ignores systemic inequality and leads to a type of "green gentrification."

However, while Dawson deftly analyzes these social ills, and critiques programs that fall short of addressing these ills, he does so without presenting much of an adequate alternative, beyond very broad strokes. Diagnosis without prognosis is still important, of course, but this becomes a problem when scholars in fact attempt to present solutions but do so in only vague, limited ways. The chapter entitled "Disaster Communism," for example, elicits the promise of a "communist horizon, the sense that the oppressive conditions of the present can be overcome and new forms of solidarity discovered" (p. 236). It is here where Dawson makes his pointed critique of OS's limitations, of where it falls short of "disaster communism." However, it is unclear what, exactly, distinguishes disaster communism as a unique political idea. Dawson defines it as "communal solidarities forged in the teeth of calamity … [where] people begin to organize themselves to meet one another's basic needs and collectively survive" (p. 236). He notes that under such circumstances these forms of solidarity *may* lead to more long-term, ecologically, and socially just forms of human organization, but it is unclear what criteria must be met in order for them to do so. His apt critique of OS's leaderless, horizontal approach to organizing is clearly meant to demarcate mere mutual aid from disaster communism—or at least as a limited form of it, as he states that disaster communism "on purely a local scale … does not actually constitute an inherent threat to the capitalist social order" (p. 253)—but does so without clarifying what distinguishes the latter. Thus, while an intriguing concept that opens vistas beyond "the kinds of localized, horizontalist experiments in radical democracy that much of the Left currently favors" (p. 238), there is much left to be fleshed out here by future scholars and activists.

Extreme Cities is an important contribution to the critical urban studies literature, and crucially brings the climate justice movement to the cities. It centers cities as both the main drivers and the main victims of climate change, and explores a plethora of proposals and experiments in green urban design while maintaining a critical perspective that recognizes the pitfalls of purely technical solutions to the climate crisis. It is a clarion call—for both climate justice activists to recognize cities as the frontlines of the climate crisis, and for urban scholars to focus on the ways in which cities are embedded in and inextricably linked to the natural environment.

From the Inside Out: The Fight for Environmental Justice within Government Agencies

By Jill Lindsey Harrison

Cambridge MA, United States: The MIT Press, 328 pp., 2019
ISBN: 978-0-26253-774-2 (pbk)

Reviewed by Nicholas Theis[1]

Jill Lindsey Harrison's *From the Inside Out: The Fight for Environmental Justice within Government Agencies* tells the story of how governmental agencies, in their organizational contexts, influence the relative efficacy of environmental justice (EJ) policy implementation. Harrison directly builds from prior work that documented the struggles for EJ endured by activists against toxic exposure (Cole & Foster, 2001). Harrison uses the key tenets of EJ as outlined by movement activists, such as equal protection for all, democratic decision-making, and prioritizing overburdened communities, to analyze and evaluate the discourses and practices within US government agencies, such the Environmental Protection Agency (EPA). These analyses show how the organizational culture of environmental agencies, through their everyday practices and discourse, inhibit the ability of federal and state regulatory agencies to achieve meaningful justice in the distribution of environmental harms and goods.

In her words:

> This book is about the shapes staff resistance to EJ takes, how persistent it has been, where it comes from, and what its consequences are. Importantly, this pushback against EJ reforms endures from one administration to the next. Staff make these agencies what they are and will continue their work into future administrations … To truly support environmental justice, government agencies not only need supportive leadership and resources, but also need to look within and address their own cultural dynamics through which some bureaucrats undermine EJ reforms. (p. xii)

The book's primary contribution is showing the enduring nature of staff resistance to EJ principles—it is not simply a matter of leadership change at the executive level of government, but intra-organizational culture and inertia. Using data from more than 150 interviews, Harrison compellingly demonstrates that the "standard

1 Department of Sociology, University of Oregon, United States; ntheis@uoregon.edu.

narrative" of external pressures limiting resources is a necessary but insufficient approach to understanding how and why EJ policy fails to be effectively implemented by government agencies.

Harrison explores the "standard narrative" in environmental agencies first, setting the foundation upon which cultural dynamics are built. The slow progress of programs and reforms typically falls under three explanations under the rubric of the standard narrative: limited resources, regulatory authority, and/or analytic tools. Limited resources (e.g., lack of funding) influence the ability for staff to perform outreach in EJ communities. Moreover, it is coupled with an economic logic whereby staff are expected to report "returns on investment" to justify their labor. Agency workers also feel pressure from the threat of industrial lawsuits for pursuing regulatory action that may not be explicitly codified in law. Because of this threat, regulatory authority is severely restricted, with agency workers resorting to asking industry to *voluntarily* improve environmental conditions in overburdened communities. Lastly, the lack of analytic tools in EJ agencies inhibits their ability to empirically demonstrate the presence of environmental inequalities. EJ analysis involves cumulative impact assessment to contextualize regulatory decisions in terms of which kinds of hazards are present and how the combination of hazards could influence human health. Since real-world data about facility emissions and individual impacts are lacking and/or much data is aggregated to coarse geographical levels (e.g., counties), local zones of cumulative impact are often obscured from view and therefore overlooked.

Agency staffers who do not work directly on EJ-related projects challenge the work of EJ workers discursively within the organizations themselves. For example, staff frame EJ as an ephemeral "fad" that does not fit within organizational identity due to its particularistic nature. This is accomplished through boundary work, claiming that EJ is outside the purview of "ecology" and therefore not scientific. Perhaps the most interesting finding dealing with discursive limitations is that staff workers adopt the norm of bureaucratic neutrality, claiming that the race-conscious tenet of EJ is equivalent to favoritism or bias in favor of overburdened communities of color. In asking one staff worker about race-conscious policy-making, Harrison writes "he responded that he would remove discussion of race from the agency's EJ policy and not take a community's racial composition into account when doing its regulatory work" (p. 99). In this way, environmental regulatory agencies exemplify an organizational culture in opposition to anti-racist EJ goals, and through the ideological commitments of staffers can reproduce "colorblind racism" (Bonilla-Silva, 2003), as staffers espouse a desire for race-neutral policies which disproportionately affect people of color. In other words, the bureaucratic norms of environmental regulatory agencies have conflicting frames with EJ's central tenets (e.g., race-conscious policies). This frame misalignment fosters dissonance between regulatory workers and EJ activists (Liévanos, 2012) and contributes to perpetuation of environmental inequality.

Bureaucrats also challenge EJ work through the minutia of everyday practice, exemplified through organizational inertia. For example, Harrison documents that in EJ reform meetings, coworkers give positive feedback and encouragement but do not follow through in actual practice—paying lip service to EJ without actual implementation is pervasive. A similar tactic is simply claiming to incorporate EJ while not doing so in practice. For example, EJ is often a "box to check" with no serious analysis of unequal impacts conducted. This is compounded by managerial decisions to not consider EJ in performance reviews but to consider permit volume, which eschews meaningful EJ analysis for each permit. In other words, bureaucratic practices implicitly benefit industry (e.g., heightened permits) relative to the EJ movement (e.g., less community engagement). Investigations, grievances, and bullying of EJ staff also hinder the implementation of EJ in governmental agencies. Auditing new EJ programs and assigning EJ tasks to staff unfamiliar with that line of work are some of the strategies adopted by bureaucrats to undermine EJ staff workers.

While most of the book portrays EJ staff as a united front who face pressures from other agency staff, Harrison illuminates how EJ staff definitions of their work differ, and how these definitions influence the types of programs being implemented. Traditionally, EJ staff followed the movement in pursuing state regulations on environmental hazards in overburdened communities, as well as building green infrastructure and environmental amenities (e.g., parks and community gardens). However, such approaches have declined over time as some EJ staffers no longer hold a model of change involving state regulation, or the substantive focus of hazard reduction. In general, voluntary agreements with industry are reached to build natural amenities in overburdened communities to improve environmental conditions (for example, EPA's Collaborative Problem-Solving model). This "new guard" views traditional EJ as inherently "oppositional" and focused on fighting, whereas their approach is "propositional" and focused on collaboration. The new EJ framing by some staff workers is contested and controversial among workers in general. It is also an example of a neoliberal politics which forgoes regulating industry as a way to implement change in favor of a business-friendly government. Implicitly, the neoliberal turn benefits industrial actors and perpetuates the reality of unequal exposure to environmental harms for communities on the ground.

Harrison provides a detailed account of the cultural dynamics in organizational contexts that inhibit EJ policy development. In so doing, she thoughtfully applies sociological theories on organizations and racial formation (Omi & Winant, 1994) to her wealth of interview data, identifying and explaining the external, organizational, and discursive impositions on EJ staff. These insights contribute to scholarship on organizational and institutional effects on EJ programs (Liévanos et al., 2011). In particular, they further nuanced accounts of the state's role in producing and reproducing environmental inequalities (Liévanos, 2012; Pellow, 2017; Pulido, 2017).

For the EJ movement, this book is important because it underscores the conclusion that a new administration that gives more funding is not enough to result in effective policy. A part of the problem is the organizational culture inhibiting EJ staff through discourse, everyday practices, and differing definitions among EJ staff themselves. Based on these findings, this book ends with recommendations for what environmental agencies can (and should) do to achieve equal protection from environmental hazards to communities of color and working-class communities.

From the Inside Out is an important, timely, and insightful contribution to research on EJ and environmental regulatory agencies. While some may have confronted Harrison's work with hesitation during the time when the Trump administration was in active combat with environmental regulatory agencies, she rightfully points out that "crisis is not a time to abandon our standards and principles, especially our commitments to equity and justice … Federal agencies' current predicament" does not "mean we should turn a blind eye to government's oversights" (p. xiii). This book, in its critique of regulatory agencies, holds government to the high standard of ensuring equal protection from environmental hazards for overburdened communities. I recommend environmental agency workers, EJ activists, and academics read this book so that they can too.

References

Bonilla-Silva, E. (2003). *Racism without racists: Color-blind racism and the persistence of racial inequality in America* (5th ed.). Rowman & Littlefield.

Cole, L., & Foster, S. R. (2001). *From the ground up: Environmental racism and the rise of the environmental justice movement*. NYU Press.

Liévanos, R. S. (2012). Certainty, fairness, and balance: State resonance and environmental justice policy implementation. *Sociological Forum*, 27(2), 481–503. doi.org/10.1111/j.1573-7861.2012.01327.x

Liévanos, R. S., London, J. K., & Sze, J. (2011). Uneven transformations and environmental justice: Regulatory science, street science, and pesticide regulation in California. In G. Ottinger & B. R. Cohen, *Technoscience and environmental justice: Expert cultures in a grassroots movement* (pp. 201–208). MIT Press. doi.org/10.7551/mitpress/9780262015790.003.0009

Omi, M., & Winant, H. (1994). *Racial formation in the United States: From the 1960s to 1990s*. Routledge.

Pellow, D. (2017). *What is critical environmental justice?* Polity.

Pulido, L. (2017). Geographies of race and ethnicity II: Environmental racism, racial capitalism and state-sanctioned violence. *Progress in Human Geography*, 41(4), 524–533. doi.org/10.1177/0309132516646495

Contributors to this Issue

Hugo Azcorra is a researcher with the Centro de Investigaciones Silvio Zavala at the Universidad Modelo in Yucatán, Mexico. He received his PhD in human biology from Loughborough University, United Kingdom, in 2014. He is interested in early and intergenerational factors that shape the phenotype and health risk factors of populations. In recent years his research has been focused on the nutritional status of the Mayan population from the Yucatán Peninsula in Mexico.

Hannah M. Barrowman is a researcher at the Australia Pacific Climate Partnership and a research affiliate at the Centre for Deliberative Democracy and Global Governance at the University of Canberra in Australia. Her research interests include adaptive governance, political ecology, social–ecological systems, environmental and social change, and Southeast Asian politics. She holds a PhD in climate change adaptation and development.

Rita Beltrão Martins studied animal production at the University of Trás-os-Montes and Alto Douro (UTAD (2005). She went on to attain a Masters degree in food safety and innovation at UTAD (2010). In 2017 she began a PhD in the UTAD doctoral program, "Agrichains—From fork to farm," in conjunction with Wageningen University and Universidad Politecnica de Valencia. Her PhD subject is: "Using by-products and non-valuable natural products as flour sources to produce gluten free bread," with the objective of reducing waste and adding value to underexploited raw materials, from a circular economy perspective.

Alec Blair is a lecturer in the University of British Columbia geography department and has been working in Kenya since 2006, focusing on the engagement of local communities with conservation agendas. His research interests include the dynamics and challenges of livelihood diversification, the costs and benefits of ecotourism initiatives, the interaction of international conservation interests with local decision-making, human–wildlife interactions, and, recently, the role of art in reflecting and shaping human–environment relations.

Diana V. Burbano is a doctoral candidate in geography at McGill University. She is particularly interested in the intersection of tourism, biodiversity conservation, and local livelihoods. Other interests include marine governance, the human dimensions of marine protected areas, public participation in environmental decision-making, sustainable tourism, and resource-based livelihoods in protected settings. She has participated in several multidisciplinary projects in Ecuador and the Galapagos related to environmental change, biodiversity protection, and tourism development.

James R. A. Butler is a sustainability scientist with a background in agricultural economics; terrestrial, freshwater, and marine ecology; and development studies. He is a principal research scientist in CSIRO Land and Water's Sustainability Pathways Program. His research analyzes complex development problems in the Asia–Pacific region, focusing on regional security and climate-compatible development. He applies concepts of social–ecological systems, resilience, transformation, and well-being through participatory action research to build individual and institutional capacity for change.

Teresa (Tere) Castillo-Burguete was born in Chiapas, Mexico, where she was profoundly steeped in Zoque indigenous culture and Chiapanecan roots, growing up proud of her Zapotec indigenous ancestry. She has a PhD in social anthropology and since 1991 has been a researcher in the Department of Human Ecology, Cinvestav-Merida, Mexico. She focuses her research on gender relations in community participation in Yucatán using participatory action research, and one of her goals is to collaborate in interdisciplinary research into sociocultural aspects of population health.

Matthew Thomas Clement is an assistant professor in the Department of Sociology at Texas State University, where he teaches classes on quantitative data analysis and environmental sociology. In his scholarly research, he focuses on the socioecological implications of urbanization and land development.

Steven Crimp is a research fellow at The Australian National University (ANU) Climate Change Institute with over 20 years of experience in designing, implementing, and managing research to examine opportunities for improved climate risk management within primary industries, both in Australia and internationally. This work has involved working with a number of multinational and global food producers, telecommunications, and other primary industries as well as smallholder farming communities.

Federico Davila is an interdisciplinary social science researcher working in sustainability and international development. He is currently a research principal (food systems) at the Institute for Sustainable Futures, University of Technology Sydney. Federico specialises in systems thinking and the social sciences, and works in the fields of food systems, agriculture, and fisheries in Australia and the Indo-Pacific; research impact assessment; and the social dimensions of biodiversity conservation.

Federico Dickinson is a Mexican physical anthropologist who attained his science doctorate in human ecology at the Polish Academy of Sciences. For him, human bodies are produced by social systems at given times and places, and express social and political relations and cultural practices. He is interested to explore whether

the historical trauma experienced by the original peoples of Yucatán in the last five centuries, since their conquest by Spain, has consequences in the present at the level of human biology.

María Eloísa Dickinson Bannack is a physician with a Masters degree in applied epidemiology and public health, with decades of field experience. She has taught at undergraduate and graduate levels in the Faculty of Medicine of the National Autonomous University (NAU), where she was a researcher, and in the Mexican Faculty of Medicine of La Salle University in Mexico City. She has been an assessor of undergraduate and graduate students of the Faculty of Medicine of the NAU and the National Institute of Public Health. She the author or coauthor of 25 publications.

María Ángeles Fernández-Zamudio has a doctorate in agricultural engineering from the Universidad Politecnica de Valencia. She is responsible for the studies in agricultural economics at the Instituto Valenciano de Investigaciones Agrarias (IVIA), in Valencia, Spain. Her main work focuses on the analysis of crop costs and the economic sustainability of farms. She is currently coordinating the agenda of activities that form the plan against food waste in this region.

Kristin Floress is a research social scientist with the United States Department of Agriculture Forest Service. She examines the ways in which individuals and groups—including residential homeowners, agricultural producers, family forest owners, and collaborative resource management participants—engage in conservation and restoration actions.

Angela Franz-Balsen is a biologist specialising in environment/sustainability communication. As senior researcher at the German Institute of Adult Education (DIE) and at the Institute of Environmental and Sustainability Communication (INFU), University of Lüneburg, her teaching and research interests included media performance in environmental risk communication. Another focus became the link between gender issues and (un)sustainability, in which context she held the Maria-Göppert-Mayer guest professorship for "International Women's and Gender Studies" in 2006. She is currently the communications officer for the German Society of Human Ecology.

Kathleen E. Halvorsen is the associate vice president for research development at Michigan Technological University. She is a policy scientist who studies strategies to mitigate climate change. Her current work includes leading the MICARES (Michigan Community & Anishinaabe Renewable Energy Sovereignty—a project funded by the National Science Foundation's Convergence Program) team, advancing understandings of sociotechnological system transitions through a study of renewable energy transitions in Michigan, United States.

John Hedlund is a PhD candidate at North Carolina State University in the Department of Sociology and Anthropology, in the graduate specialization area concentrating on food and environmental sociology. His dissertation research focuses on the development of the plastics industry.

Roderick J. Lawrence (DSc, EPFL) has been an honorary professor at the University of Geneva since 2015. He was founding director of the Certificate of Advanced Studies in Sustainable Development at the University of Geneva (2003–2015), and Invited Professor at the International Institute for Global Health at the United Nations University (IIGH-UNU) in 2014–2016. He has been a member of the Scientific Advisory Board for Interdisciplinary and Transdisciplinary Research at the Swiss Academy of Sciences (SCNAT) since 2009.

Maggie Leon-Corwin is a PhD student in the Department of Sociology at Oklahoma State University. Maggie's expertise is in environmental justice and environmental hazards and disasters. Her research interests include environmental justice issues in changing urban contexts, risk perception of natural and human-caused environmental disasters, and student social movements.

William Lytle is a candidate in the Environmental and Energy Policy PhD program at Michigan Technological University. Will is using his background in ecology and sustainability to critically investigate the food–energy–water nexus. Will's passion is re-envisioning how institutions and decision-making processes can reflect the needs of human and more than human beings.

Sue L. T. McGregor (PhD, IPHE, Professor Emerita MSVU) is an active Canadian independent researcher and scholar in home economics/human ecology philosophy, leadership, and education; consumer studies; transdisciplinarity; and research paradigms and methodologies. She is a transdisciplinary ATLAS fellow (Academy of Transdisciplinary Learning & Advanced Studies), a Karpatkin International Consumer fellow, and received the TOPACE (Tower Person Award for Consumer Education) International Award (Berlin) for her distinguished international consumer scholarship and education. She recently published *Understanding and Evaluating Research* (SAGE, 2018). Her scholarship is at her professional website: www.consultmcgregor.com

Nina Méndez-Domínguez is a medical doctor, Master of Sciences, PhD, and Doctor of Health Sciences from Merida, Mexico, and Master of Bioethics candidate. She is dedicated to health sciences research, clinical epidemiology, and the social context of diseases in southern Mexico, with expertise in translating epidemiological and clinical findings into medical education innovation. Until recently she was a professor and researcher at the Universidad Marista in Merida, Mexico. She is now coordinator of clinical learning at the Hospital Regional de Alta Especialidad de la Península de Yucatán.

Thomas Meredith is an associate professor at the Department of Geography at McGill University. He was the founding director of McGill's Environmental Studies Program and of McGill's Canadian Field Study in Africa program. His interests include the management of ecological resources, environmental impact assessment, and community-based strategies that bring both scientific and local information into environmental decision-making. Research sites include Quebec, British Columbia, Mexico, East Africa, and the Galapagos Islands.

Iva Miranda Pires is an associate professor at the Faculdade Ciências Sociais e Humanas, NOVA University of Lisbon (UNL). She holds a PhD in human geography from the University of Lisbon. She lectures at the sociology department and is the coordinator of the Masters and PhD programs in human ecology. She is a senior researcher at CICS.Nova, the Interdisciplinary Centre of Social Sciences. She is a member of the Society for Human Ecology (SHE).

Chelsea Schelly received her PhD from the Department of Sociology at the University of Wisconsin-Madison and is an associate professor of sociology in the Department of Social Sciences at Michigan Technological University. Her work explores how the sociotechnological systems used to support residential dwelling shape the organization of social life and conceptions of human–nature relationships. She researches and writes about a wide array of alternative sociotechnological systems.

Rachael L. Shwom is an associate professor in the School of Environmental and Biological Science's Department of Human Ecology and director of the Rutgers Energy Institute. She conducts research that links sociology, psychology, engineering, economics, and public policy to investigate how social and political factors influence society's responses to energy and climate problems.

Chad L. Smith is professor and chair in the Department of Sociology at Texas State University. His research focuses on the treadmills of production and destruction, and environmental inequality. His prior research appears in *American Sociological Review*, *Journal of World-System Research*, and *Social Science Research*.

Nicholas Theis is a graduate student in sociology at the University of Oregon, with interests in environmental sociology, environmental justice, and political economy.

Felix Tretter has studied statistics, psychology, philosophy (Dr. phil.), sociology, economics, management, (Dr. rer. pol.), and medicine (Dr. med.), and ultimately qualified as a neurologist, psychiatrist, and psychotherapist. He was a senior physician in a psychiatric hospital (Munich) and is professor for clinical psychology at Ludwig Maximilian University in Munich. His research interests have encompassed brain research, public health, addictions, philosophy of science, human ecology, and systems science. He is currently Vice President of Bertalanffy Center for the Study of Systems Science (Vienna) and President of the German Society of Human Ecology (Berlin).

Berta Vidal-Mones graduated in biochemistry in the University of Barcelona, going on to attain a Master of Science degree at Wageningen University in international nutrition and health, specializing in epidemiology and public health. She then undertook international research on topics related to nutrition, food insecurity, and food waste prevention. Currently she is a PhD candidate at the Center for Agro-Food Economics and Development (CREDA) in Barcelona, Spain, studying quantification methodologies and prevention strategies for food loss and waste, and their potential contributions to achieving more sustainable diets.

Bronwyn Wilkes is a PhD scholar in human ecology at the ANU Fenner School of Environment and Society. She uses system dynamics in her research and teaching, both of which focus on food systems and explore transitions to biosensitive societies: those that are sensitive to and respectful of the life processes that underpin our existence.