Through COVID-19 – A Systems Perspective: from Square to Circular Systems

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Abstract: The corona virus that causes COVID-19 jumped from monkeys to humans in the context of deliberately designed systems of economic, environmental, and social organization which are referred to in this piece as "square". These systems are not compatible with the circular patterns of nature that sustain life. The current pandemic is a symptom of complex mechanisms, and solutions must go beyond reductionist strategies. In order to truly address this crisis, we must critically examine its causes and their relationship to our worldview. Naturopathic philosophy can help orient us to a more holistic and complex way of seeing both how we arrived here, and how we can hope to move forward in a regenerative way.

COVID-19 has been described as a "wicked problem" — a complex issue involving multiple interlinked systems with no single cause and no clear solution.[1,2,3] Although the actual infectious agent evolved and jumped to humans within a Chinese context, the origins and impacts of COVID-19 have emerged within deliberately designed systems of economic, environmental, and social organization established by dominant Eurocentric worldviews, which we refer to here as "square". These systems are not compatible with the circular patterns of nature, the ecological systems that sustain life. The solution to the current pandemic must go beyond reductionist strategies, which are strategies that seek to understand complex systems through understanding their individual parts. In order to truly address this crisis, we must critically examine its causes and their relationship to our worldview. Naturopathic philosophy can help orient us to a more holistic and complex way of seeing both how we arrived here, and how we can hope to move forward in a regenerative way.

Tolle causam — Identify the root (route) cause

Throughout this piece, we are deliberately using both homonyms of root and route to draw attention to both the "where" and the "how" of the underlying causes of COVID-19. The word root refers to the roots of a tree that are hidden underground, rooted in place. It represents the "where" of the underlying causes: where the disease originates from. The word route is in reference to the pathways — the means by which the disease is carried out. It represents the "how" of the underlying causes. For example, if we are identifying Eurocentric square systems thinking as a *root* cause, then systemic racial oppression and environmental devastation to drive wealth concentration are *route* causes[4,5] (a means by which Eurocentrism is carried out).

We argue that both the origins and consequences of the COVID-19 pandemic are firmly rooted in square systems thinking, which is in direct contrast to circular thinking. We elaborate on these systems throughout the piece; Table 1 provides a brief comparison between these two paradigms.

Square systems

During the European Scientific Revolution in the 16th and 17th centuries, systems of scientific, economic and social organization were invented that broke from the circular patterns of nature.[8] These new systems followed linear principles and displayed linear patterns. They are referred to here as square systems. Capitalism, as a linear economic model, is characterized by unlimited growth, concentration of wealth, and measurement of national health as gross domestic product (GDP). These systems can only function through principles of competition and oppression, as opposed to cooperative cycles of exchange; and linear supply and waste chains (extraction from the earth to make products that end up in waste bins) rather than sustainable, regenerative cycles.[11] Humans invented scientific theories to rationalize these systems: Euclidean geometry and calculus that imposed linear abstractions onto nonlinear systems of nature, and biological theories of survival of the fittest that support capitalism and the systemic oppression on which it depends.[12,13] Modern science applies a mechanistic lens that sees the world as a giant watch with linear cause and effect mechanisms; that divides disciplines into siloed subjects that result in a lack of understanding of the complex circular connections between biology, ecology, economy.[14] The consequence is a reductionist worldview that carves bodies into components, the earth into resources we can extract, and people into beasts of labour that can be exploited for capital gain.[15,16,17]

TABLE 1: Comparison between dominant paradigms of square vs. circular systems

	SQUARE [6,7,8] **Linear principles and patterns of organization**	**CIRCULAR** [9,10] **Nonlinear principles and patterns of organization**
Worldview	▪ People-centric ▪ Linear ▪ Self ▪ Spirit separate from matter ▪ Discrete	▪ Land-centric ▪ Circular ▪ Self-in-relationship ▪ Spirit-in-matter ▪ Interconnected
Perceptions	▪ Parts ▪ Objects ▪ Quantities ▪ Products ▪ Structure	▪ Wholes ▪ Relationships ▪ Qualities ▪ Processes ▪ Patterns
Principles and Patterns of Organization	▪ Top-down, centralized hierarchy, concentration of power and wealth ▪ Individual, Siloed (dividing and categorizing knowledge into separate boxes and systems for decision-making) ▪ Darwinian survival of the fittest ▪ Linear cause and effect (a mechanical view of the world; linear principles of Newtonian physics are implemented to force change) ▪ Determinism (designing systems with linear mathematics in order to predict and control; the belief that events are determined by causes outside of free will) ▪ Euclidean geometry (imposing man-made, linear mathematics onto nature and culture)	▪ Self-organization (the "rules" of organization emerge from within the system itself; not imposed by a single leader at the top or outside of the system) ▪ Decentralization (leadership and decision-making is not located in one person or place but distributed throughout the system) ▪ Feedback loops (each part of a system constantly receives and responds to feedback from all other parts of the system as a means to achieve homeostasis) ▪ Fractal patterns (utilizing the nonlinear geometry of nature to guide systems of organization; similar patterns of shapes tend to emerge across scales of organization) ▪ Deterministic Chaos (recognizing and working within the inherent unpredictability and chaos of nature's systems as opposed to attempting to determine and control a system's outcome) ▪ Network/web (moving away from disconnected and siloed organization towards designing interconnected epistemologies and decision-making systems)

Square systems have been deliberately designed and perpetuated by those with social, economic and political power for personal gain through the use of oppression, division, and exploitation. European feudalism was the foundation of classical liberalism which went on to become capitalism, creating the socioeconomic conditions for the concentration of wealth and power.[18,19] This worldview has manifested through worldwide imperial/colonial expansion, and destruction of Indigenous and traditional ways of knowing across the planet. Even within "eastern" cultures - such as the one in which the COVID-19 virus emerged - capitalism is the predominant square force driving the global economic system.[20] Capitalism is rationalized through the false theory of trickle-down economics. Instead, what it "trickles down" are classism, racism, sexism, xenophobia, and the belief in white superiority:[21,22,23,24] Each of these are clearly manifested in the fallout of COVID-19 and its disproportionate effects on Black, Indigenous, and People of Color (BIPOC), women, and people living in poverty.[25,26,27]

Square systems thinking has resulted in neoliberal economics, white supremacy, patriarchy, anthropocentrism, imperial colonialism, genocide, and extractive capitalism (including wealth concentration, privatization of the commons, and waste generation).[16,28,29,30] All of these systems are interlinked and reinforcing of each other. The consequences are devastating:[16,17,31] systemic oppression, inequity of wealth and health, disparities in access to resources and education; mass extinction, loss of biodiversity, extreme weather events, loss of

arable soil, global warming, environmental intoxication, increased acidity of oceans; perpetual conflict and war, mass migration; and the arising of novel infectious disease, leading to pandemics.[3,5,32,33,34,35]

Linear thinking leads to perceiving solutions that are also linear. These neither consider the complexity of the problem nor address its fundamental causes. For example, although public health strategies such as wearing masks, washing hands, physical distancing and a potential vaccine may be essential to mitigate the spread of this COVID, these strategies are proving to be problematic in unintended and inequitably distributed ways due to pre-existing faults in the underlying structures.[3,34,36] Moreover, these strategies will fail to prevent future catastrophic consequences of the harmful systems that set the stage for this one.[37]

Inequitable consequences associated with the global response to COVID-19

- Mental health crises and increased rates of suicide[38,39]
- Increased domestic violence[40,41]
- Educational deficiencies and inequities[42]
- Perpetuation of health inequities[43]
- Inability to physically distance or work from home[36,44]
- Loss of employment (highly correlated with poor health)[45,46]
- Harm due to excessive hygiene by some[36,47,48] and lack of access to soap and clean water by others[49]
- The environmental impact of increased use of single-use materials[50,51]

Tolle totum — Consider the Whole

Technological "solutions" are manifestations of square systems thinking. These have only been needed for survival since the agricultural revolution radically shifted the relationship between the human species and the natural environment.[52] The (temporarily) successful attempt to control nature has for millennia reinforced the faulty worldview that we are capable of doing so. Rachel Carson ardently cautioned of this nearly sixty years ago,[53] yet our efforts and their catastrophic impacts have only accelerated since that time.[54] Technological strategies that preserve human life and support a growing population lead to further imbalance in the biosphere, and thus the need for more technological solutions.[52] A litany of inventions and technologies have aimed to improve quality of life, address hunger or reduce waste, but have ultimately created harm on a systemic scale. For example, the invention of the internal combustion engine has led to anthropogenic climate change, artificial introduction of predator species has led to greater imbalances in ecosystems, and genetic modification of foods has led to loss of food sovereignty. Techno-scientific solutions typically complicate the problem by failing to consider the whole picture.

A Circular Systems View

The academic discipline of "systems science" emerged in the 20th century, born from Eurocentric scientists who questioned the limits of reductionism[55]. Albert Einstein's theories on relativity revolutionized science: they revealed the fundamental nature of reality to not be made up of independent parts, but of inseparable energy-mass systems in constant flux and relative relationship.[8] This fundamental shift in worldview gave rise to systems thinking which aligns more with a circular worldview as we are using the term here.

What we call "parts" are, themselves, coherent sets of relationships.[56] Life is composed of systems embedded within systems, embedded within systems. When we peer deeper into any one part of life, we see more systems of relationships:[8] an organism is made up of a system of organs. An organ is made up of a system of cells. A cell is made up of a system of organelles. An organelle is made up of a system of molecules, and so on, down to the atom and its inner system of parts. Living systems, from cellular systems to organisms to ecosystems are made of parts in relationship with one another. The whole system is always more than the sum of parts, where the "more" is an emergent property of the relationships within the system. These patterns and principles of organization are not linear, and give rise to systems that are referred to, here, as circular systems.

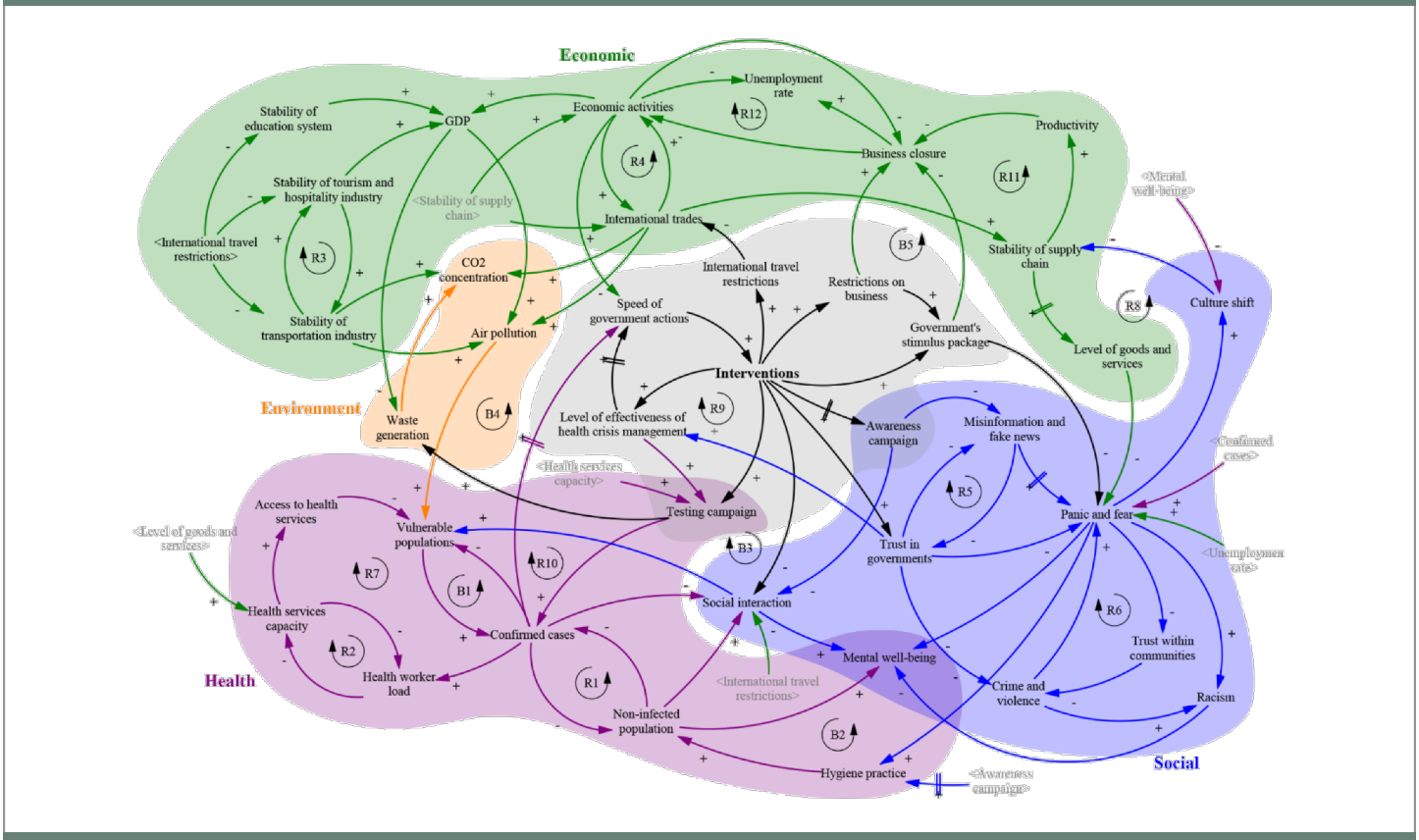
Circular systems are characterized by reinforcing and balancing loops; a shift in one part of a complex system inherently will result in reverberations throughout the system. This is the crux of chaos theory - commonly appreciated as the butterfly wing effect.[57] It is impossible to attempt to correct one component without considering the entire system. As Sahin et al. attempt to illustrate in figure 1 with respect to the complex factors that resulted in the emergence of COVID-19, "feedback loops illustrate reciprocal relationships between actions and consequences in the system. Reinforcing loops (R) create exponential growth or decay. Balancing loops (B) stabilize a system until equilibrium is achieved. There is an excess of reinforcing loops in the current systems, creating erosion, failure, and near-collapse."[3] Unless we perceive the complex, messy whole, and approach this pandemic from a circular holistic perspective (rather than a square reductionist one), we will continue to propel the planetary system towards that predicted collapse.

The Circular Nature of an Indigenous Worldview

The "discoveries" by systems scientists in the 20th century were actually a realization of Indigenous knowledge systems that are and have always been circular. Indigenous worldviews have been described as holistic, circular, land-informed, place-based, relational, perceptive of interconnectedness and constant flux, and integrative of spiritual knowledge.[58,59,60] These knowledge systems were oppressed during colonial imperialism when the invasion of dominant Eurocentric worldviews spread across the globe.

Dr. Sandra Styres, author and scholar of North American Indigenous knowledge, writes: "Themes of relationality, circularity, spirituality,

FIGURE 1: Balancing and Reinforcing Loops in the Complexity of the COVID Pandemic



Sahin O, Salim H, Suprun E, Richards R, MacAskill S, Heilgeist S, Rutherford S, Stewart RA, Beal CD. Developing a Preliminary Causal Loop Diagram for Understanding the Wicked Complexity of the COVID-19 Pandemic. *Systems*. 2020; 8(2):20.

and consciousness of Land provide the unifying context of shared world views among Indigenous people throughout Turtle Island and indeed across the great waters. The notion of a singular world view is steeped in dominant Eurocentric imperial and colonial ideologies and is framed within discourse based on privilege and power."[60] Dr. Gloria Emeagwali, author and scholar of African Indigenous knowledge or AIK, identifies the epistemological foundations of AIK systems as recognizing "the holistic, organic, and multidimensional interconnections of body, mind, soul, and spirit, as well as the interface of society, culture, and nature,"… "and a methodological approach to knowledge inquiry that emphasizes principles of circularity, association with the Land and environments, and the integrative nature of social facts."[61]

Indigenous knowledge systems, through the ways and resilience of the circle, are (re)emerging and (re)membering their way back into the knowledge systems of the world (figure 2).

Naturopathic Circular Thinking

In contrast to the above search for "solutions" to square systems thinking, naturopathic doctors are trained to support patients with the whole person (and their environment) in mind--a perspective that more closely resembles a circular systems approach to health. A square systems approach to metabolic syndrome might be to prescribe statins and hypotensive medications that may cause unpleasant or harmful side effects, but would otherwise allow the patient to continue living their life without altering habits or lifestyle. A naturopathic approach, however, would seek to address a patient's underlying systemic weaknesses, such as dysbiosis or a proinflammatory phenotype.[63] This approach requires the patient to shift their lifestyle, worldview, and habits in order to address the underlying cause of their afflictions. Ultimately, the naturopathic approach requires the patient to acknowledge that an unhealthy lifestyle is manifesting itself through physical symptoms and to truly reverse those symptoms, the most harmful elements of their lifestyle must be altered. Planetary healing depends on a parallel perspective. In order to radically (from the Latin *radix*, or root) and sustainably address this crisis and those that will inevitably follow, we must consider this pandemic as a symptom of deeply problematic worldviews.[64] It is our moral responsibility to see this moment as an opportunity to not just respond to the current crisis, but to expose and connect dots between its complex causes in order to improve the health of our patients and our planet.[65]

Vis medicatrix naturae — COVID-19 is an activation of the *Vis*

As Hippocrates proposed, and foundational to the practice of naturopathic medicine, is that the body is often able to heal itself

FIGURE 2: First Nations Perspective on Health and Wellness[62]

Gallagher, J. (2019). Indigenous approaches to health and wellness leadership: A BC First Nations perspective. *Healthcare Management Forum*, 32(1), 5–10. https://doi.org/10.1177/0840470418788090

if conditions are optimal. Physical bodies follow circular systems in which symptoms of poor health are evidence of the *vis* responding to suboptimal circumstances. Just as a naturopathic doctor uses signs and symptoms of poor health to guide a correction in the body system, we can view the emergence of COVID-19 (along with increasingly severe weather patterns and collapsing ecosystems) as an expression of the Earth's *vis* to deeply imbalanced and unhealthy planetary system. The COVID-19 pandemic is a predictable and natural response to overpopulation, globalization, and other properties of the Anthropocene, our current geological age.[17,33,66] All historical pandemics can be framed as a consequence of human beings stepping out of the bounds of natural systems, resulting in the decimation of human populations.[67,68] As Foster and Suwandi write so succinctly:

"SARS-CoV-2 (COVID-19), like other dangerous pathogens that have emerged or reemerged in recent years, is closely related to a complex set of factors including: (1) the development of global agribusiness with its expanding genetic monocultures that increase susceptibility to the contraction of zoonotic diseases from wild to domestic animals to humans; (2) destruction of wild habitats and disruption of the activities of wild species; and (3) human beings living in closer proximity. There is little doubt that global commodity chains and the kinds of connectivity that they have produced have become vectors for the rapid transmission of disease, throwing this whole globally exploitative pattern of development into question."[5]

An awareness of the interconnectedness of humans (and the global socioeconomic systems we have created), the environment and wildlife has led to the interdisciplinary approach referred to as One Health. Proponents of this paradigm advocate that global decision-making prioritizes social and ecological well-being, as opposed to capitalistic trade and wealth concentration in order to mitigate further planetary crises.[69] If we see these crises as expressions of the Earth's *vis*, we may have an increased capacity to perceive and address the root/route causes.

Addressing the root (route) cause

Human beings have created a complex of intertwined systems that are responsible for COVID-19, the climate catastrophe, and structural oppression. An argument could be made for letting nature take its course - allowing the *vis* to express itself until homeostasis is re-attained. However, we believe this approach is deeply unjust and unethical. We know that we are not "all in this together".[27] Myriad evidence shows the inequitable distribution of the impacts of COVID-19 and our collective response to it due to differences in access to healthcare, the ability to work from home, the space to self-isolate, and the absence of pre-existing risk factors.[34,70] BIPOC people and communities have suffered the most from this pandemic, just as they do from all global crises.[5,71] The recent uprisings against police brutality and systemic racism are an attempt to resist the inequitable outcomes of structural privilege that were present before and will be present after COVID-19. The square systems that brought us here and are currently being used to get us out favour the elite--white, global north, wealthy, etc.--whom they were designed by and for.[30,72,73] Letting nature take its course would further reinforce existing inequity and injustice and is therefore not a viable option.[67,70,74]

Rather than allowing square responses to this pandemic to further entrench social inequities, we can view COVID-19 as a stark reminder that planetary healing is dependent on a deliberate return to circular, regenerative systems. A key principle of most Indigenous traditions is honouring all sentient beings and the Earth for their worth beyond their economic value to humans. The values of taking only what we need, of leaving enough for others both now and in the future, and of not leaving a mess behind are the essence of the Dish with One Spoon Wampum Belt Covenant into which European settlers were invited in the Great Lakes Region (the territory on which the Canadian College of Naturopathic Medicine sits).[75] These values also reflect the Seventh Generation Principle common to many Indigenous traditions (considering those who are not yet born, but will inherit the world),[76] and are an explicit component of the naturopathic oath. Acknowledging the position of the human species within the complex, interdependent web of the biosphere rather than superior to it requires humility.[17,77] Yet, entering into a reciprocal relationship with the planet and other beings (human and otherwise) that share it, rather than trying to dominate it/them, is the most promising path toward healing.[6,78]

It would be easier to accept that the COVID-19 pandemic (or global climate degradation, or systemic poverty) could be reduced to a simple problem of contagion with a simple solution. However,

we can't escape the reality that we are all complicit in the systems that have created this complicated crisis; everything we do or don't do either perpetuates or challenges it. Guilt, anxiety and fear are natural responses to this truth, and can be paralyzing - the authors experienced it deeply during the writing of this piece. The human brain is not well-designed to cope with persistent stress, especially when it is novel, and feels beyond our control.[79] We have a moral obligation to act, but the problems feel overwhelming.[80] How can we bounce forward to a "better new" when so many systems require simultaneous change, all while attending to immediate needs and suffering?

Fortunately, there is a spectrum of opportunities that individuals and groups can grasp. If nothing else, COVID-19 has deeply exposed the cracks in the systems, highlighting the impacts of wealth concentration, austerity measures, social polarization, oppression and unearned privilege.[44,81,82] It has also illustrated how rapidly change can occur if a window of opportunity opens.[6,37,83] The pandemic has resulted in a number of radical shifts that had previously been deemed impossible, such as grounding of unnecessary air travel, and recognition of the importance of effective social healthcare by typically conservative political leaders.[83] Given a temporary break from the plague of humanity, natural environments have provided a taste of what a healthy future can look like if we fundamentally shift our relationship with the planet.[84] Previous pandemics have dramatically shaped the course of social progression; COVID-19 too presents a global opportunity to evolve.[34,69]

Taking loving action is one of the most optimistic and radical things any of us can do, and is a powerful antidote to fear and guilt. The diffusion of innovation theory describes that only a few innovative thinkers will initially take on leadership, with a group of early adopters following closely behind.[85] Naturopathic doctors are inherently innovative. We are used to thinking in systems, challenging the status quo, and seeking radical - or root - solutions to problems.

Primum non nocere - Do no harm

Any radical action must begin with examining our values.[64] To which worldview do we ascribe? How do we view our own position in relation to the Earth and the other beings with whom we share our home? Nora Bateson demonstrates in her warm data labs that a deeply human response to complexity is possible when we tend to relationships,[86] just as tending to soil nurtures resilient trees. We must tend to the relationships that build fertile and resilient bodies, ecologies, and communities/societies, all of which are interrelated and interdependent. From this perspective, the ill-health of our beings (COVID and the pre-existing health crisis), the environment (ecological breakdown) and society (white supremacy and widening social inequity) are all the result of a breakdown in relationships. Feeling our way into a deeper relationship with self, other, and nature is at the heart of what is needed to heal. The solutions will not come from hard data-driven mind maps connecting the dots and then deriving a set of "calls to action" for each of our siloed systems. Radical, relationship based actions can address all crises simultaneously. The most simple example is planting a garden. Proximally, you are nourishing your relationship with the earth and capturing the carbon that is warming our environment; eating a salad made from these foods nourishes the cellular relationships within your biological being and establishes food sovereignty; sharing this meal or the land on which your garden grows with a neighbour nourishes relationships within your community. Once we have taken the time to reflect and critically examine our values and relations to others, we can seek opportunities for personally meaningful and sustainable action that challenges the existing systems.

Action can occur at many levels (often described as a micro/meso/macro framework;[87] see figure 3 for more ideas and examples). The most intimate is at the level of interpersonal relationships and individual choices. This could range from seeking to understand what determinants of your patients' health have been exposed by this pandemic, to seeking to understand the systems that have resulted in this wicked situation. It could include choosing to challenge the systems through personal decisions around food, waste production, and financial investment. We can seek opportunities to contribute to our immediate communities; during COVID, groups with the mandate of mobilizing grassroots community support for individuals in need have blossomed.[88]

Social and ecological determinants of health have the greatest influence on wellbeing; unfortunately, very few can be changed in the clinic room or with individual action. How can we use our privilege to influence the communities and institutions of which we are a part?[89,90] As our worldview shifts and as the bigger picture comes into focus, we can begin by sharing that perspective with others. It is deeply impactful to have hard conversations about values and worldviews with those in our circles; we must embrace productive, compassionate conflict in order to mobilize change.[91,92] We can advocate for changes that address flawed and unjust systems. Professional groups such as Naturopathic Doctors for Environmental and Social Trust (NEST)[93] was created to further opportunities for the naturopathic profession to engage in this work.

Ultimately, systems do what they are designed to do. Can we "leap forward into the past"[94] when children were raised by communities, work was shared, and relationships were prioritized? Are we able to cultivate communities that recreate the environment within which our species initially evolved and thrived?[52,95] The catastrophically harmful systems our planet is resisting must be deconstructed and redesigned; this can only occur at a global level. Individuals and organizations must demand change. At the very least, we need to *vote--and* critique the design of our electoral and governance systems.[6,34] COVID-19 has seen an increase in calls for not just temporary economic relief to individuals and families impacted by the economic consequences of the pandemic response, but for a full adoption of universal basic income.[96] Some cities are re-examining the values by which they define their economy.[97] Advocacy movements continue to mobilize, pivoting to different strategies of direct action;[98] on Turtle Island, the movement for Black Lives and Indigenous resistance have surged as the inequity of the effects of COVID-19 stirs the hot coals of centuries of Eurocentric supremacy, oppression and genocide.[99,100]

FIGURE 3: Non-exhaustive ideas for advocacy

Bouncing Forward

Resilience is often described as the capacity to bounce back from adversity.[101] This approach, however, reinforces the increasingly untenable status quo and does little to address the root causes that make the planet vulnerable to increasingly frequent and severe disruptions. We cannot strive to "go back to normal". The square systems that created both the COVID-19 pandemic and are guiding the global response to it must be critically examined, deconstructed and collaboratively redesigned if we have any hope of mitigating the worst of the avalanche of crises that will inevitably follow.[102] We must seek ways of bouncing forward[103] which not only address immediate shock events, but leverage disruptions to support a radical transition to a more sustainable and just future.[3,104] This will require active hope, loving compassion, participatory democracy - and embracing circular thinking.[29,105]

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References

1. Lawrence, M. (2020, April 09). The "Wicked Problem" of the Covid-19 Pandemic. Retrieved August 12, 2020, from https://www.iass-potsdam.de/en/blog/2020/04/wicked-problem-covid-19-pandemic
2. Pourdehnad J, Starr LM, Koerwer VS & McCloskey H (2020). Our Wicked Problem. *School of Continuing and Professional Studies Coronavirus Papers.* Paper 1.
3. Sahin O, Salim H, Suprun E, Richards R, MacAskill S, Heilgeist S, Rutherford S, Stewart RA, Beal CD. Developing a Preliminary Causal Loop Diagram for Understanding the Wicked Complexity of the COVID-19 Pandemic. *Systems*. 2020; 8(2):20.
4. Laster Pirtle WN. Racial Capitalism: A Fundamental Cause of Novel Coronavirus (COVID-19) Pandemic Inequities in the United States. *Health Educ Behav*. 2020;47(4):504-508. doi:10.1177/1090198120922942
5. Foster JB, Suwandi I. COVID-19 and Catastrophe Capitalism. *Monthly Review*. 2020:1-20. doi:10.14452/mr-072-02-2020-06_1.
6. Wahl, D. (2020, August 10). "Circular & square systems thinking"-a Maori perspective on regeneration. Retrieved August 12, 2020, from https://medium.com/age-of-awareness/circular-square-systems-thinking-a-maori-perspective-on-regeneration-ba9fa5653f91
7. Mazzocchi, F., (2008). Complexity in biology: Exceeding the limits of reductionism and determinism using complexity theory. *EMBO Reports,* 9(1), p10-14.
8. Capra, F., The Web of Life: A New Scientific Understanding of Living Systems. New York: Random House, Inc.; 1996.
9. Drack, M., Apfalter, W., Pouvreau, D., (2007) On the making of a system theory of life: Paul Weiss and Ludwig Von Bertalanffy's conceptual connection. *Q Rev Biol. 82*(4): 349–373.
10. Gliek, J., Chaos: making a new science. New York: Penguin Books; 1988.
11. Lambin, Jean-Jacques. "Capitalism and sustainable development." *Symphonya. Emerging Issues in Management* 2 (2009): 3-9.
12. Klein, Sherwin. "The natural roots of capitalism and its virtues and values." *Journal of Business Ethics* 45.4 (2003): 387-401.
13. Bergman, Jerry. *Darwin's Influence on Ruthless Laissez-fair Capitalism*. Institute for Creation Research, 2001.
14. Galitski, Timothy. "Reductionism Gives Way to Systems Biology: Researchers Increasingly Rely on Holistic Studies to Obtain Greater Insights on Health and Disease." *Genetic Engineering & Biotechnology News* 32.6 (2012): 52-53.
15. Marmot, M. (2019). Winners take all. *The Lancet, 394*(10201), 819-820. doi:10.1016/s0140-6736(19)32035-5
16. Gill, S. R., & Benatar, S. R. (2019). Reflections on the political economy of planetary health. *Review of International Political Economy*, *27*(1), 167–190. https://doi.org/10.1080/09692290.2019.1607769
17. Steffen, W., Persson, Å., Deutsch, L., Zalasiewicz, J., Williams, M., Richardson, K., … Svedin, U. (2011). The Anthropocene: From Global Change to Planetary Stewardship. *Ambio*, *40*(7), 739–761. https://doi.org/10.1007/s13280-011-0185-x
18. Comninel, George C. "English feudalism and the origins of capitalism." *The Journal of Peasant Studies* 27.4 (2000): 1-53.
19. Moore, Jason W. "Nature and the Transition from Feudalism to Capitalism." *Review (Fernand Braudel Center)* (2003): 97-172.
20. Crawford, Darryl. "Chinese capitalism: cultures, the Southeast Asian region and economic globalisation." *Third World Quarterly* 21.1 (2000): 69-86.
21. Inwood, J. F. (2015). Neoliberal racism: The 'Southern Strategy' and the expanding geographies of white supremacy. Social & Cultural Geography, 16(4), 407-423. doi:10.1080/14649365.2014.994670
22. Tabb, W. K. (1971). Capitalism, Colonialism, and Racism. *Review of Radical Political Economics*, *3*(3), 90–106. https://doi.org/10.1177/048661347100300306
23. Spector, A. (2014). Racism and Capitalism—Crisis and Resistance: Exploring the Dynamic between Class Oppression and Racial Oppression. *Humanity & Society, 38*(2), 116–131. https://doi.org/10.1177/0160597614534345
24. Pulido, L. (2016). Flint, Environmental Racism, and Racial Capitalism. *Capitalism Nature Socialism, 27*(3), 1-16. doi:10.1080/10455752.2016.1213013
25. Ribeiro, H., Lima, V. M., & Waldman, E. A. (2020). In the COVID-19 pandemic in Brazil, do brown lives matter? *The Lancet Global Health, 8*(8). doi:10.1016/s2214-109x(20)30314-4
26. Saint-Girons, M., Joh-Carnella, N., Lefebvre, R., Blackstock, C., & Fallon, B. (2020). Equity Concerns in the Context of COVID-19 – A Focus on First Nations, Inuit, and Métis Communities in Canada. Toronto, ONT: Canadian Child Welfare Research Portal.
27. Ali, S., Asaria, M. & Stranges, S. COVID-19 and inequality: are we all in this together?. *Can J Public Health* 111, 415–416 (2020). https://doi.org/10.17269/s41997-020-00351-0
28. Benatar, S., Upshur, R., & Gill, S. (2018). Understanding the relationship between ethics, neoliberalism and power as a step towards improving the health of people and our planet. *The Anthropocene Review*, *5*(2), 155–176. https://doi.org/10.1177/2053019618760934
29. Schot J & Kranger L. (2018). Deep transitions: emergence, acceleration, stabilization, and directionality. *Research Policy. 47*, 1045-1959. doi: 10.1016/j.respol.2018.03.009.
30. Clark C. (2017). Law, legitimacy and activism in the Anthropocene. *AQ: Australian Quarterly, 88*(4), 3-44. Retrieved from www.jstor.org/stable/26450105
31. Moore, J. W. (2017). The Capitalocene, Part I: on the nature and origins of our ecological crisis. *The Journal of Peasant Studies*, *44*(3), 594–630. https://doi.org/10.1080/03066150.2016.1235036
32. Pourdehnad J, Starr LM, Koerwer VS and McCloskey H (2020). Disruptive Effects of the Coronavirus – Errors of Commission and of Omission?. School of Continuing and Professional Studies Coronavirus Papers. Paper 2. https://jdc.jefferson.edu/jscpscp/2
33. Saad-Filho, A. (2020). From COVID-19 to the End of Neoliberalism. *Critical Sociology*, *46*(4–5), 477–485. https://doi.org/10.1177/0896920520929966;
34. Murshed, S. (2020). Capitalism and COVID-19: Crisis at the Crossroads, *Peace Economics, Peace Science and Public Policy* (published online ahead of print), 20200026. doi: https://doi.org/10.1515/peps-2020-0026
35. Heenan N and Sturman A. (2020) Labour, nature, capitalism and COVID-19. Journal of Australian Political Economy. 85:193-199.

36. Mahmood, A., Eqan, M., Pervez, S., Alghamdi, H. A., Tabinda, A. B., Yasar, A., . . . Pugazhendhi, A. (2020). COVID-19 and frequent use of hand sanitizers; human health and environmental hazards by exposure pathways. *Science of The Total Environment, 742*, 140561. doi:10.1016/j.scitotenv.2020.140561
37. Poudel, B. (2020). Ecological solutions to prevent future pandemics like COVID-19. Banko Janakari, 30(1), 1-2.
38. McIntyre, R. S., & Lee, Y. (2020). Projected increases in suicide in Canada as a consequence of COVID-19. *Psychiatry research*, *290*, 113104. https://doi.org/10.1016/j.psychres.2020.113104
39. Cénat, J.M., Dalexis, R.D., Kokou-Kpolou, C.K. *et al.* Social inequalities and collateral damages of the COVID-19 pandemic: when basic needs challenge mental health care. *Int J Public Health* (2020). https://doi.org/10.1007/s00038-020-01426-y
40. Bradbury-Jones, C. and Isham, L. (2020), The pandemic paradox: The consequences of COVID-19 on domestic violence. J Clin Nurs, 29: 2047-2049. doi:10.1111/jocn.15296
41. Usher, K., Bhullar, N., Durkin, J., Gyamfi, N. and Jackson, D. (2020), Family violence and COVID-19: Increased vulnerability and reduced options for support. Int J Mental Health Nurs, 29: 549-552. doi:10.1111/inm.12735
42. Doyle, O. (2020, April 22). COVID-19: Exacerbating Educational Inequalities?: Public Policy. Retrieved August 12, 2020, from http://publicpolicy.ie/papers/covid-19-exacerbating-educational-inequalities/
43. Bambra C, Riordan R, Ford J, Matthews F. The COVID-19 pandemic and health inequalities. *Journal of Epidemiology and Community Health*. 2020. doi:10.1136/jech-2020-214401.
44. Perri M, Dosani N, Hwang SW. COVID-19 and people experiencing homelessness: challenges and mitigation strategies. *Canadian Medical Association Journal*. 2020;192(26). doi:10.1503/cmaj.200834.
45. Navarro V. (2020). The Consequences of Neoliberalism in the Current Pandemic. *International journal of health services : planning, administration, evaluation*, *50*(3), 271–275. https://doi.org/10.1177/0020731420925449
46. Lim J. (2020). Applications for federal income support top 4 million since the onset of the pandemic. *iPolitics Canada*. Retrieved at: https://tinyurl.com/y9jk9a2r
47. Sehrawat, S., & Rouse, B. T. (2020). Does the hygiene hypothesis apply to COVID-19 susceptibility? *Microbes and Infection*. doi:10.1016/j.micinf.2020.07.002
48. Singh, M., Pawar, M., Bothra, A., & Choudhary, N. (2020). Overzealous hand hygiene during the COVID 19 pandemic causing an increased incidence of hand eczema among general population. *Journal of the American Academy of Dermatology, 83*(1). doi:10.1016/j.jaad.2020.04.047
49. How COVID-19 is changing the world: A statistical perspective. (2020, August 04). Retrieved August 12, 2020, from https://data.unicef.org/resources/how-covid-19-is-changing-the-world-a-statistical-perspective/
50. Fadare, O. O., & Okoffo, E. D. (2020). Covid-19 face masks: A potential source of microplastic fibers in the environment. *The Science of the total environment*, *737*, 140279. https://doi.org/10.1016/j.scitotenv.2020.140279
51. Klemeš, J. J., Fan, Y. V., Tan, R. R., & Jiang, P. (2020). Minimising the present and future plastic waste, energy and environmental footprints related to COVID-19. *Renewable and Sustainable Energy Reviews, 127*, 109883. doi:10.1016/j.rser.2020.109883
52. Gardner, C., Cole, D. C., & Ryan, L. (2020). Public health for the hunter-gatherer in us all. *Canadian Journal of Public Health*. doi:10.17269/s41997-020-00341-2
53. Carson, R. L. (1962). *Silent spring*. Boston: Mifflin.
54. Steffen, W., Broadgate, W., Deutsch, L., Gaffney, O., & Ludwig, C. (2015). The trajectory of the Anthropocene: The Great Acceleration. *The Anthropocene Review*, *2*(1), 81–98. https://doi.org/10.1177/2053019614564785
55. Trewavas, A., (2006), A Brief History of Systems Biology. *The Plant Cell*, Vol. 18, 2420–2430.
56. Bateson, G., Mind and Nature: A Necessary Unity. New York: Bantam Books; 1988.
57. Bishop R. Chaos. Stanford Encyclopedia of Philosophy. https://plato.stanford.edu/archives/spr2017/entries/chaos/. Published October 13, 2015. Accessed September 8, 2020.
58. Little Bear., L., Jagged Worldviews Colliding, in Battiste, M., (Ed.) Reclaiming Indigneous Voice and Vision. Vancouver: UBC Press, 2000, 77-85.
59. Cajete, G., Native Science: Natural Laws of Interdependence. Santa Fe, New Mexico: Clear Light Publishers; 2000.
60. Styres, S., Pathways for Remembering and Recognizing Indigenous Thought in Education: Philosophies of Iethi'nihstenha Ohwentsia'kekha (Land). Toronto: University of Toronto Press; 2017, p.85.
61. Emeagwali, G., in Emeagwali, G., Dei, G.J.S, (Eds.) African Indigenous Knowledge and the Disciplines, . Boston: Sense Publishers; 2014, p. xii.
62. Gallagher, J. (2019). Indigenous approaches to health and wellness leadership: A BC First Nations perspective. *Healthcare Management Forum*, *32*(1), 5–10. https://doi.org/10.1177/0840470418788090
63. Belizário JE, Faintuch J, Garay-Malpartida M. Gut Microbiome Dysbiosis and Immunometabolism: New Frontiers for Treatment of Metabolic Diseases. Mediators Inflamm. 2018;2018:2037838. Published 2018 Dec 9. doi:10.1155/2018/2037838
64. Kendal D & Raymond CM. (2019). Understanding pathways to shifting people's values over time in the context of social-ecological systems. *Sustainability Science*. *14*, 1333-1342. doi: 10.1007/s11625-018-06480-0 ; Schill C, Anderis JM, Lindahl T (2019). A more dynamic understanding of human behaviour for the anthropocene. *Natural Sustainability*. *2*, 1075-1082. doi: 10.1038/s41893-019-0419-777.
65. Whitmee, S., Haines, A., Beyrer, C., Boltz, F., Capon, A. G., Dias, B. F. D. S., … Yach, D. (2015). Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation–Lancet Commission on planetary health. *The Lancet*, *386*(10007), 1973–2028. https://doi.org/10.1016/s0140-6736(15)60901-1
66. Folke C, Jansson A, Rockström J, et al. (2011). Reconnecting to the biosphere. *Ambio*, 40(7):719-738.
67. Kelman, I. (2020, March 16). A Professor of Disasters and Health on COVID-19 - Facts So Romantic. Retrieved August 12, 2020, from http://nautil.us/blog/a-professor-of-disasters-and-health-on-covid_19
68. Engels, J. (2020, April 20). Overpopulation, Nature's Revenge, & Pandemic. Retrieved August 12, 2020, from https://www.permaculturenews.org/2020/04/23/overpopulation-natures-revenge-pandemic/
69. Salkeld D. One Health and the COVID-19 pandemic. Front Ecol Environ. 2020;18(6):311. doi:10.1002/fee.2235
70. Goldberg, C. (2020, May 20). From Tactile to Tactical. Retrieved August 12, 2020, from https://publicphilosophyjournal.org/full-record/?amplificationid=2139
71. Laurencin, C., & McClinton, A. (2020). The COVID-19 Pandemic: a Call to Action to Identify and Address Racial and Ethnic Disparities. *Journal of Racial and Ethnic Health Disparities,* 7, 398-402. https://doi.org/10.1007/s40615-020-00756-0
72. Klinsky, S., Roberts, T., Huq, S., Okereke, C., Newell, P., Dauvergne, P., … Bauer, S. (2017). Why equity is fundamental in climate change policy research. *Global Environmental Change*, *44*, 170–173. https://doi.org/10.1016/j.gloenvcha.2016.08.002
73. Hancock T. (2020, April 12). A tale of two futures - let's choose the right one this time. *The Times Colonist.* Retrieved at: https://tinyurl.com/yc4wm3z5
74. Bateson, N., & Ramphele, M. (2020, July 16). Finding a Way. Retrieved August 12, 2020, from https://medium.com/@norabateson/finding-a-way-3582b2e0c6a3
75. Lytwyn, Victor P. "A Dish with One Spoon: The Shared Hunting Grounds Agreement in the Great Lakes and St. Lawrence Valley Regio." The Algonquin Papers /Les Actes Du Congres Des Algonquinistes, vol. 28, 1 Dec. 1997, pp. 210–227.
76. Clarkson, L., Morrissette, V., & Regallet, G. (1992). *Our Responsibility to The Seventh Generation: Indigenous Peoples and Sustainable Development* (Publication). Winnipeg: International Institute for Sustainable Development. Retrieved at https://www.iisd.org/pdf/seventh_gen.pdf.
77. Stern, N. (2014). Ethics, Equity And The Economics Of Climate Change Paper 2: Economics And Politics. *Economics and Philosophy*, *30*(3), 445–501. https://doi.org/10.1017/s0266267114000303
78. Ahmad S. (2013). Collaborative resilience: moving through crisis to opportunity. *Community Development*, *44*(3), 395-397. doi: 10.1080/15575330/2013/811877
79. Abraham, C. (2020, June 18). Your Brain on COVID-19. Retrieved August 14, 2020, from https://thewalrus.ca/your-brain-on-covid-19/
80. Schmitt M, Neufeld SD, Mackay CML, & Dys-Stenbergen O. (2020). The perils of explaining climate inaction in terms of psychological barriers. *Journal of Social Issues*. *76*(1), 123-135. doi: 10.1111/josi.12;
81. Craddock E. (2020). Barriers to doing activism. In: *Living Against Austerity: A feminist investigation of doing activism and being activist*. Bristol: Bristol University Press. 95-124. doi: 10.2307/j.ctvxkn6kr.9
82. Lent J. (2019, September 17). As society unravels, the future is up for grabs. *Open Democracy*. Retrieved at: https://tinyurl.com/y8yav9ar
83. Jones A. (15 April 2020). Coronavirus: Doug Ford opens door to systemic changes to Ontario's long term care system. *Global News*. Retrieved at: https://tinyurl.com/ybvtsujc
84. Henriques M. (23 March2020). Will Covid-19 have a lasting impact on the environment? *BBC: Futures*. Retrieved at: https://tinyurl.com/wwhc5yr
85. Dearing J. W. (2009). Applying Diffusion of Innovation Theory to Intervention Development. *Research on social work practice*, 19(5), 503–518. DOI: 10.1177/1049731509335569
86. Bateson, N. (2020, May 21). Warm Data and Iced Lemonade. Retrieved August 12, 2020, from https://thesideview.co/journal/warm-data-and-iced-lemonade/
87. Buchman S, Woollard R, Meili R, Goel R. Practising social accountability: From theory to action. *Can Fam Physician*. 2016;62(1):15-18.
88. Gerken T. (2020). Coronavirus: kind Canadians start 'caremongering' trend. *BBC.* Retrieved at: https://www.bbc.com/news/world-us-canada-51915723
89. Nixon SA. The coin model of privilege and critical allyship: implications for health. BMC Public Health. 2019;19(1):1637. Published 2019 Dec 5. doi:10.1186/s12889-019-7884-9
90. The Lancet (2020). Medicine and medical science: Black lives must matter more. *Lancet (London, England)*, *395*(10240), 1813. https://doi.org/10.1016/S0140-6736(20)31353-2
91. Schulz-Hardt, S., Jochims, M., & Frey, D. (2002). Productive conflict in group decision making: Genuine and contrived dissent as strategies to counteract biased information seeking. *Organizational Behavior and Human Decision Processes, 88*(2), 563-586. doi:10.1016/s0749-5978(02)00001-8
92. Klimecki, O. M. (2019). The Role of Empathy and Compassion in Conflict Resolution. *Emotion Review*, *11*(4), 310–325. https://doi.org/10.1177/1754073919838609
93. Naturopathic Doctors for Environmental and Social Trust. (n.d.). Retrieved September 02, 2020, from https://www.nestnds.com/
94. Gabor Mate. Compassionate Inquiry: Toxic Culture (Module 5). Video Lecture. Lecture presented at Vancouver, BC.
95. Liedloff J. The Continuum Concept: Allowing Human Nature to Work Successfully. Reading, MA: Addison-Wesley; 1993.
96. Ng K. (2020). Coronavirus: Spain to become first country in Europe to roll out universal basic income. *The Independent*. Retrieved at: https://tinyurl.com/vlgy8hx
97. Boffey D. (8 April 2020). Amsterdam to embrace 'doughnut' model to mend post-coronavirus economy. *The Guardian*. Retrieved at: https://tinyurl.com/y76yasko
98. Amnesty International. (2020). Distant but Together: Activism in the time of COVID-19. *Human Rights Now: Amnesty Canada Blog*. Retrieved at: https://tinyurl.com/ya2hzsto
99. Nakhaie, R., & Nakhaie, FS (2020, August 12). Black Lives Matter movement finds new urgency and allies because of COVID-19. Retrieved August 14, 2020, from https://theconversation.com/black-lives-matter-movement-finds-new-urgency-and-allies-because-of-covid-19-141500
100. Fields, S (2020, July 31). Indigenous Communities and Pandemics, Past and Present. Retrieved August 14, 2020, from https://firelight.ca/2020/07/31/indigenous-communities-and-pandemics-past-and-present/
101. Uscher-Pines L, Chandra A, & Acosta J. (2013). The promise and pitfalls of community resilience. *Disaster Medicine and Public Health Preparedness*. *7*, 603-606. doi: 10.1017/dmp.2013.100
102. Bonneuil C & Fressoz J-B. (2017). *The Shock of the Anthropocene: The Earth, History, and Us.* Fernbach D (Translation). London: Verso Books.
103. Mazur, L., Asquith, C., Chichakly, K., & Schipper, L. (2016, January). Bounce Forward: Building Resilience for Dangerous Times. Retrieved August 14, 2020, from https://www.thesolutionsjournal.com/article/bounce-forward-building-resilience-for-dangerous-times/
104. Büyüm AM, Kenney C, Koris A, *et al*Decolonising global health: if not now, when?*BMJ Global Health* 2020;**5**:e003394.http://dx.doi.org/10.1136/bmjgh-2020-003394
105. Norris FH, Stevens SP, Pfefferbaum B, Wyche KF, & Pfefferbaum RL. (2008). Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *American Journal of Community Psychology, 41*(1-2), 127-150. doi: 10.1007/s10464-007-9156-6.