

# Human-Environment-Health and reinforcement of individual resilience

Didier SORNETTE<sup>1-3</sup>, Peter CAUWELS<sup>1</sup>, Euan MEARNNS<sup>1</sup> and Ke WU<sup>1,2</sup>

<sup>1</sup> Chair of Entrepreneurial Risks, D-MTEC, ETH Zurich, Zurich, Switzerland

<sup>2</sup> Institute of Risk Analysis, Prediction and Management (Risks-X), Academy of Interdisciplinary and Advanced Studies, Southern University of Science and Technology (SUSTech), Shenzhen, China

<sup>3</sup> Tokyo Tech World Research Hub Initiative, Institute of Innovative Research, Tokyo Institute of Technology, Japan

## Contacts:

dsornette@ethz.ch   pcawwels@ethz.ch   emearns@ethz.ch   kwu@ethz.ch

The ongoing SARS-CoV-2 pandemic is stressing the world population, health care system and economies at a level not experienced since WWII or the last “Spanish flu” pandemic of 1918. This shock provides a real-life test of the resilience of human societies, challenging our understanding and level of preparation. We suggest that a decay of global individual health resilience, due to cumulative multi-factor pollutions and modern ways of life, has made the whole population strongly susceptible to the Covid 19 pandemic. To ensure future resilient societies, we propose to prioritize economic development fostering depollution of the ecosystem and of individuals, and training individual responsibility.

## 1. Resilience

**1.1 System resilience.** Under stressors such as the presently experienced infection by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), a system’s ability to cope, endure, recover and adapt reveals its level of resilience<sup>1,2</sup>. Further qualities of a resilient system include avoidance, deflection, regeneration, flexibility and adaptation<sup>3</sup>. Resilience is the capacity to survive, adapt and grow when faced with alterations and uncertainty. In the present context, several different types of resilience should be considered: 1) Immunity of individuals to disease; 2) immunity at the population level to disease, 3) resilience of society to cope with changed circumstances and 4) resilience of the economy. Most of the research on and implementation of resilience methods have been and are still focused on system level approaches (resilience of type 2-4), emphasizing the need for improved management techniques with accountability at the top and strong engagement and influence of people at the bottom<sup>4</sup>. In the past decade, there has been a strong push for the need to develop resilient societies<sup>5</sup>, resilient firms<sup>6</sup>, resilient organisations<sup>7</sup>, resilient nations and a resilient world in the face of global climate change<sup>8,9</sup>. This has led to the development of numerous research programs, and national as well as international initiatives. And there is hope that big data, machine learning and artificial intelligence, allowing optimal analysis and exploitation of feedback loops, will catalyse a new generation of resilient systems.

**1.2 Individual resilience.** In standard approaches to resilience, the system’s properties are understood as emerging at the macroscopic level from the repetitive interactions between what is

considered to be simple constituents at the microscopic level with feedback loops between them. For epidemics and health, the constituents (i.e., each of us) of a society are themselves complex and we argue that the resilience of the whole is also dependent on the resilience of each individual. The emphasis on system-level improvement of resilience has obfuscated that the most important level of defense is the individual. The blind spot has been to only emphasize the system level and act on it almost uniquely, and not sufficiently recognizing that the strength and resilience of the system is first built on that of each individual. Epidemics of the magnitude of the Covid-19 pandemic provides a stark reminder of this fundamental fact.

By resilience of each individual, we do not mean the ability for an individual to resist the stresses of confinement, and the anxiety coming from over-exposition to a media dramatizing each hiccup of the epidemics, overwhelming the typical citizens with “noise” at the expense of carefully assessed balanced information communicating facts and numbers in the right context. Nor do we refer to the ability of the individual to bounce back to a normal life and learn useful lessons to become stronger and fitter, after the pandemic has receded. Of course, these qualities are good and important and should be strengthened. But one dimension that is out of sight is the need for each of us to build a resilient immune system (and more generally a strong biological body and psychological mind) against the aggression of SARS-CoV-2 and other viruses and bacteria that may combine and interfere. We thus call attention to the fundamental component in the “war” against epidemics such as SARS-CoV-2 to build individual defenses, in addition to collective measures.

**1.3 Diagnostic of the decay of global individual health resilience by cumulative exposure.** The pollution of foods and habitats by many thousands of synthetic chemicals, the in-door pollution by cooking and heating as well as metallic particles in paints, interfere in multiple ways with our metabolism, including endocrine disruptors (substances that interfere with our hormonal system coordinating our 80 organs for homeostasis). Smoking is especially deadly, with evidence that smokers have significantly greater odds of developing COVID-associated pneumonia than non-smokers<sup>10</sup>. Atmospheric pollution is also responsible for millions of “potential years of life loss” every year<sup>11</sup>. This is particularly acute in crowded urban centres where fumes from motor vehicles choke the air and in countries like China and India where coal fired power stations are located close to urban centres, like they were in Europe 70 years ago.

Another dimension of “pollution” involves our ways of life. Western societies have become laden with unhealthy people. Lack of exercise and poor diet are known to be a principal cause. While governments have understood this for many years and may have taken steps to encourage exercise and eating healthy food, supermarket shelves are still piled high with junk and sugar. This is reflected in the “epidemics” of obesity, the exploding growth of “rich country” diseases such as diabetes and cardio-vascular disorders, and of chronic diseases including many allergies. A generation ago, a child with allergy was virtually unheard of<sup>12</sup>, while now more than one third of young children exhibit at least one form of allergy, in part due to the consumption of “junk” food<sup>13</sup>, excess sugar and saturated fat<sup>14</sup>, and deficit of regular physical exercise. Still another development is the denaturation of the quality of fruits, legumes and other foods due to selective breeding favoring size, color and speed of production at the detriment of vitamins, minerals and taste<sup>15,16</sup>. For example, the amount of vitamins in a “modern” apple is about 1% of what it was 50 years ago<sup>17</sup>. This is likely to lead to chronic deficiencies in vitamins, oligo-elements and other bio-chemicals essential for our immune system, even if direct evidence by specific bio-markers is

complex to obtain. Yet another negative development is depression and the associated soaring consumption of antidepressants, which have doubled in many western countries in the past 15 years<sup>18</sup>. The World Health Organization estimates that depression is a leading cause of disability worldwide and is a major contributor to the overall global burden of disease<sup>19</sup>. The list continues on and on.

Based on these observations, we hypothesize that the development of modern societies roughly over the last 50 years has led to the unintended consequence of making each of us individually more fragile on average against viral and bacterial infections. As a result of a complex and entangled set of developments, our immune systems seem to have become weaker and thus individual resilience has decreased. This may not be visible in the statistics, say of life expectancy, which have been globally improving: people live longer but, for many, those extra years are coming with ill health. We recognise a situation where improvements to global health, achieved through improved living standards and general levels of hygiene, immunisation, access to clean and safe drinking water, medical interventions of many kinds, are battling against global surreptitious chronic inflammation reflecting pervasive insults to our immune systems in many forms mentioned above.

It is well recognised that many more people today have pre-existing chronic health problems, which make viral infections particularly dangerous [Quote from the former director of the US Center for Disease Control and Prevention, and former commissioner of the New York City Health Department]. With the prevalence of modern “rich country” diseases<sup>20</sup>, such as cardiovascular disease, hypertension and diabetes, affected people are much more likely to die when they contract a coronavirus infection<sup>21</sup>. While the global health status has improved in the last decades according to many metrics, the impact of the Covid-19 pandemic provides a diagnostic in the form of a “response function” of the world population health level, and points at the vulnerability of certain cohorts of the population. There is accumulating evidence that the level of health and strength / adaptivity of the immune system is strongly correlated with the outcome of an infection by the Covid-19 virus, with a large majority of the young and healthy showing no or mild symptoms, while the elderly carrying several illnesses and the individuals with comorbidity are massively more at risk.

This diagnostic is particularly paradoxical, given that our communities and nations are obsessed with developing “zero-risk” societies, claiming that economic progress, technology and policy will provide an Eden of almost perfect protection. It is important to recognize the possibility that, paradoxically, the very opposite has been happening with respect to extreme risks. The fragility of globalized supply chains to the disruptions due to the Covid-19 pandemics has been already emphasized by many commentators and can be observed by everyone<sup>22</sup>. The Great Financial Crisis (GFC) of 2008 has already shown how a globally connected and deeply integrated financial system, striving to optimize its performance and maximize its gains, has catalyzed remarkable innovations responsible for the disappearance of small risks at the cost of massive exposition to systemic risks<sup>23,24</sup>. Indeed, the GFC, as well as many large financial crashes, started with a very low financial volatility [Sornette et al., 2018] (Financial volatility is supposed to be an advanced diagnostic of risks. Small risks, measured by volatility, were absent before most crises). Here, we focus on another ignored facet of the fantastically successful economic and social developments of the past half-century, namely the unintended fragilization of the immune system and health of the human

population globally. And, given the dynamics of nonlinear complex systems, it is plausible that, without suitable action, the trend of individual resilience decay may bifurcate into nonlinear transitions with possibly catastrophic consequences for the human species (global runaway infertility, global mental disorders of born or young children, global immune system collapse, emergence of really serious pandemics and so on).

## **2. Proposed solutions.**

**2.1 Human-Earth Health focus.** The push to fight climate change towards environment sustainability should be rethought as being motivated by recovering an ecosystem in which our own personal biological ecosystem (immune system, microbiome, etc) can strive again. In other words, we propose to enlarge the fight against global climate change by linking environment depollution and sustainability to human health. While the Earth is undoubtedly under stress on many dimensions due to human actions<sup>25</sup>, we need to recognize that this has also created additional stressors to our health by degrading the functions that our bodies extract from the ecosystem. After the Covid-19 pandemic abates, this fundamental vulnerability will not go away and will leave us exposed to other epidemics as well as systemic health stressors.

Environment depollution (including in food and living environment) becomes a mandatory step to rebuild our individual immune system resilience. This requires to endogenize the negative health externalities brought by global pollutions of all types into the utility function of economic development, in a way similar to the many propositions to endogenize the adverse consequence of global climate change. In sum, we propose a global international Human-Environment-Health initiative with an economic size of a few percent of world GDP every year, a kind of super-Apollo project to develop a global depollution of the environment and of our immune systems, accounting for their strong coupling. This includes rethinking the global agri-food-pharma industrial complex, whose utility functions are in general not aligned with the imperative of improving people's health and resilience<sup>26</sup>. We need to redirect and adapt our technologies for the benefit of our individual health resilience.

**2.2 Individual build-up of resilience.** In addition to existing measures (which vary in different parts of the world as a consequence of traditions, culture, political organization as well as resources), we should be developing massive campaigns of information on how to boost our immune systems. This information campaign should not be limited to the temporary "war" on the on-going Covid-19 epidemic but should become a systematic and lasting process of educating the public on how to best care for its arguably most important individual capital, health. We propose that this should be developed in parallel to environment depollution and transition to sustainability that have been jeopardized by our modern economic and social model of development. The future course must include serious education on dietary and exercise regimes with an emphasis on individual responsibilities.

**2.3 Individual responsibility.** To improve individual resilience, society has to foster the responsibility of each individual. This is the opposite of trends evident throughout western democracies as well as other polities where increasingly individuals look to the State to take care of them and blame the State when things go wrong. If we act like young children waiting for the state-parent to decide and care about us, the system becomes vulnerable to epistemic errors and lack of diversity in personalizing health development. While very few will commit outright suicide, many do not realize or do not want to change highly detrimental habits and addictions, such as

smoking or consuming sugar or under-exercise. Education and training programs of vast amplitudes should be developed and sponsored by states to awaken the public at large to these scientifically well-established facts, when many behave in a way that suggests they do not care or do not want to make the effort. Individual responsibility enables people to intrinsically care about their own long-term health and safety, encourage them to think critically and be curious about facts and opinions, questioning them in a constructive never ending fact searching process. These are essential factors to keep long-term individual resilience that in turn build population resilience.

Building individual resilience seems beyond the will power or motivation of many. Most (all?) of us, the authors included, indulge in “innocent” excesses of various kinds, finding it difficult to resist temptation. Full of strong and good resolutions, most of us find it extremely hard to stick to a routine of physical exercises, and/or of healthy food, and so on. Innovative technologies and social network apps could help, with widely developed mutual motivating and coaching for instance. Therefore, we call for global efforts to collectively work on a Human-Environment-Health project, with the aim to develop a systematic way that can incentivize the constituents of our society to improve individual responsibility and resilience, which will fundamentally strengthen the resilience at a macro level.

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