

Global Systemic Risk and Resilience for Novel Coronavirus and COVID-19

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Abstract:

This Special Issue is dedicated to issues and challenges related to pandemic risk and resilience, with a focus on policy and operations of global systems in the COVID-19 pandemic. The cascading effects of emerging and re-emerging infectious diseases to the global economy are a critical interest. Measures to confront the ongoing pandemic are an urgent need. Data analysis at regional and global scales is helping to prioritize response and resilience across locations of high risks. The risk sciences are available for addressing human health and infection risks; the evaluation of risk management strategies and trade-offs; risk perception as it relates to information processing and receiving risk communication; and tracking system resilience as it relates to various imposed measures.

Keywords: Data analytics; risk analysis; artificial intelligence; pandemic; resilience; cascading effects; engineering systems

1. Introduction

At the Fifth World Congress on Risk (May 2019), three-hundred scientists met in Cape Town, South Africa, to address the conference theme of *Development and Resilience*. That landmark meeting was convened by the Society for Risk Analysis with key support of the Society for Environmental Toxicology and Chemistry. Since late in 2019, an outbreak of a novel coronavirus, referred to as severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) and resulting in coronavirus disease-19 (COVID-19) has rapidly become a global public health threat. The pandemic has

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precipitated social disruption, exceptional health-care utilization, and economic instability worldwide. In the past, three major, countrywide outbreaks have occurred including the “Severe Acute Respiratory Syndrome” (SARS) outbreak in 2003 in mainland China, the “Middle East Respiratory Syndrome” (MERS) outbreak in 2012 in Saudi Arabia, and the MERS outbreak in 2015 in South Korea. These infectious diseases can be quickly spread through several types of interactions, and threaten the health of many people over widespread regional areas in a short time leading to epidemics or pandemics. From a systems perspective, the breadth of the Society for Risk Analysis (SRA) and its varied Specialty Groups can offer new tools for public health practitioners, infrastructure owners/operators and policy makers to coordinate global and local, context-specific interventions, with expanded access to health information and services. (Wang et al. [3], Zhu et al.[4], Collier et al. [16], Donnan et al. [17]).

This Special Issue collects a sample of insights and viewpoints from scholars across risk sciences and resilience analytics to guide decision making and operations related to the latest global pandemic. Content within this issues addresses modeling needs for human health and infection risks through environmental media as both direct and indirect transmission through indoor air and contaminated surfaces are well established pathways for infectious viruses. Such models of exposure dose and probability of response (infection, illness or death) are needed to facilitate the use of quantitative microbial risk assessment (QMRA) as a tool to design and measure the effectiveness of risk management strategies including air filtration, ventilation, and chemical or UV inactivation. In addition to these strategies, public health interventions like isolation, quarantine, social distancing and mask wearing along with clinical measures to include testing of symptomatic and asymptomatic individuals for COVID-19 have been predominant forms of risk mitigation. Papers in this issue evaluate the risk and benefits of specific strategies like masks and testing as well as the overall impact of resources allocated to prevention/containment measures or treatment/recovery measures. Additionally, Robinson et al. [10] explore methods for valuing a statistical life (VSF) in such cost-benefit evaluations of risk management strategies. Two papers in this issue,

investigate risk perception, information processing and subsequent decision making about following government mandates developed to mitigate risks of COVID-19 transmission. Three papers explore place-based risk and resilience. Two of these papers address risk and resilience from exploring causal relationships between paired variables as indicators of increases in COVID-19 to the development of multivariable regionally specific indices to prioritize locations of high risk for epidemic spread. Finally, lessons learned from the Ebola outbreaks in West Africa shed light on the low to moderate risk and high resilience of the African continent as it relates to COVID-19. This Special Issue addresses various aspects of systemic risk and resilience in the global pandemic. This collection of eleven papers addresses a breadth of risk sciences represented by the Society: (i) human health and infection risk; (ii) risk management strategies and economic evaluation; (iii) risk perception; and (iv) risk and resilience.

2. Content of this issue

Human Health and Infection Risks

Since quantitative microbial risk assessment has been used to develop criteria for exposure to many microorganisms via various exposures. In Haas's work [15], it shows that the dose-response curve for Coronavirus 229E is used to develop a preliminary risk based exposure criteria for SARS-CoV-2 via the respiratory portals of entry.

Manheim et al. [8] introduce an interactive model for exploring some risks of a SARS-COV-2 dosing study, a prerequisite for any COVID-19 challenge trials. The risk estimates they use are based on a Bayesian evidence synthesis model which can incorporate new data on infection fatality risks (IFRs) to patients, and infer rates of hospitalization. They provide a web tool to explore risk under different study designs.

Risk Management Strategies and Economic Evaluation

Rode and Fischbeck [11] propose that scarce testing resources should be diverted away from confirmatory analysis of symptomatic people, as laboratory diagnosis appears to have little decision value in treatment choice over clinical diagnosis in patients presenting with symptoms. In contrast, the exploratory use of testing resources

to reduce ambiguity in estimates of the base rate of infection appears to have significant value and great practical import for public policy purposes. As these stances may be at odds with triage practices among medical practitioners, they highlight the important role the decision analyst can play in responding to the challenges of the COVID-19 pandemic.

Salter [12] points out that countries could rapidly implement Effective Fiber Mask Programs (EFMPs) to use local resources to mass-produce effective and affordable cloth masks, and to engage the public in their correct use during the COVID-19 pandemic. EFMPs could be a cost-effective measure to ease isolation while limiting new infections during pandemics. EFMPs could also protect healthcare workers by increasing the supply of respirators for their use, reducing their risk of acquiring the illness from their communities, and reducing the number of patients they must treat.

Huang et al. [14] build a mathematical model to optimize investments into two types of measures for mitigating the risks of epidemic propagation: prevention/containment measures and treatment/recovery measures. Their analysis shows that, to combat an epidemic that can cause a significant negative impact, optimal investment in either category increases with a higher level of connectivity and intrinsic loss, but it is limited to a fraction of that total potential loss. However, when a fixed and limited mitigation investment is to be apportioned among the two types of measures, the optimal proportion of investment for prevention and containment increases when the investment limit goes up, and when the network connectivity decreases.

Robinson et al. [10] explore the implications of theory and empirical studies, which suggest that the relationship between age and value per statistical life is uncertain. They compare the effects of three approaches: (1) an invariant population-average value per statistical life; (2) a constant value per statistical life-year (VSLY); and (3) a value per statistical life that follows an inverse-U pattern, peaking in the middle age. They find that when applied to the U.S. age distribution of COVID-19 deaths, these approaches result in average value per statistical life estimates of \$10.63 million, \$4.47 million, and \$8.31 million.

Risk Perception

Wong et al. [13] establish how two different information processing modes are influenced by individuals' responsibility attribution, discrete negative emotions, and risk perception. Their results reveal that exposure to the responsibility attribution frame led individuals to engage in more heuristic processing, but it did not influence systematic processing. In particular, information processing styles seem to be determined by social judgment surrounding the coronavirus pandemic.

Siegrist et al. [6] conduct a survey in the German-speaking part of Switzerland (N = 1,585) at the peak of confirmed COVID-19 cases during the first wave of infections in Switzerland (March–April 2020). The results suggest that how trust is measured is crucial because general trust and social trust have opposite effects on the participants' risk perceptions. People with high general trust perceive less risks associated with COVID-19 compared with people who have low general trust, and people with high social trust perceive more risks compared with people who have low social trust. The results further indicate that perceived risks are important drivers for the acceptance of the government's implemented measures to control COVID-19 and for more precautionary behavior.

Risk and Resilience

Kanga et al. [5] propose a risk-based assessment framework for analyzing risk of high transmission and prevalence for COVID-19 in spatial areas, using integrated hazard and vulnerability components associated with this pandemic for effective risk mitigation. They hypothesize different COVID-19 risk indices (C19Ri) of the wards of JMC such as proximity to hotspots, total population, population density, availability of clean water, and associated land use/ land cover and calculated them in a GIS-based multi-criteria risk reduction method. The results show disparateness in COVID-19 risk areas with a higher risk in north-eastern and south-eastern zone wards within the boundary of JMC. This study aims to serve as a baseline study to be replicated in other parts of the country or world to eradicate the increased threat of COVID-19 in at risk populations effectively.

Stavroglou et al. [7] propose a novel risk-based, decision-making methodology capable of unveiling causal relationships between pairs of variables. Motivated by the ongoing global emergency of the coronavirus pandemic, the article elaborates on this powerful quantitative framework drawing on data from the United States at the county level aiming at assisting policy and decision-makers in taking timely action amid this emergency. This methodology offers a basis for identifying potential scenarios and consequences of the ongoing 2020 pandemic by drawing on weather variables to examine the causal impact of changing weather on the trend of daily coronavirus cases.

Renzaho [9] discusses how lessons learned during the 2014–2016 Ebola outbreak in West Africa help to mitigate the likelihood of a long-term devastating effect of the coronavirus disease (COVID-19) outbreak on the African continent. Despite COVID-19 spreading quickly across the globe, African countries remained relatively unaffected until the second week of March 2020. The author points out that the majority of Africa countries have been at low to moderate risk and there needs to be strong country-level leadership to coordinate and own all aspects of the responses to the COVID-19 pandemic in a collaborative, transparent and accountable way.

We would like to extend our appreciation to all the authors who submitted manuscripts aimed for this special issue. We hope you will enjoy reading this selection of papers as we did.

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