The goal of this paper is to provide policy makers, urban planners, and other pandemic-related prevention and response interests with the justification to proactively integrate distributed microchip bioelectrical sensors into the Fourth Industrial Revolution (4IR)-supported built and natural environments. Sensors are outfitted with Internet of Things (IoT) networking via mobile Wi-Fi, Lo-Ra, or satellite communications for air and liquid pathogen detection in centralized and decentralized water supplies, wastewater treatment systems, and other distributed applications.

Urban populations are the most susceptible to pathogen spread in part due to interconnected infrastructure and population density [1]. From a wastewater treatment standpoint, fecal transmission pathways via the aerosolization of liquid waste is now known to transmit COVID-19, with a virus survival timeline in water and sewage between numerous days and weeks [2]. Aerosolization of human excrement can take place at any point of the wastewater service chain, such as during the flush of a toilet, in pipeline leaks, and wastewater treatment plant effluent discharge [3].

The global systemic risks associated with the COVID-19 pandemic and rapid global urbanization can have debilitating effects on life and activities within human populations [4]. COVID-19, caused by a new strain of the coronavirus family, SARS-CoV-2 [5], starting at the onset of 2020, became the latest infectious disease to rapidly evolve into a global pandemic. As of the week of Dec 15, 2020, there were over 70 million cumulative COVID-19 cases and 1.6 million deaths reported globally since the start of the pandemic. Of the 195 countries recognized by the United Nations (2020), only 11 have reported no COVID-19 cases.

Along with the effects on public health, the global economy has greatly suffered. Nearly 90 per cent of the world economy has been under some form of lockdown, disrupting supply chains, depressing consumer demand, and putting millions out of work. Under the baseline scenario, developed economies are expected to contract by 5.0 per cent in 2020, while the output of developing countries will shrink by 0.7 per cent [6].
Distributed IoT connected microchip pathogen sensor systems can be customized to remotely detect COVID-19 and other target water and airborne pathogens throughout the built and natural environments, with buildings, urban areas, public transit, and public parks/waterways with human interaction as a priority. Authorities can further analyze systems integration applications for further resiliency and sustainability measures. See Figure 1 below for questions and methodological steps that governmental authorities can utilize to establish policy.

**Figure 1. Main Methodological Steps to Establish Policy**

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<th>Questions For Authorities</th>
<th>Methodological Steps</th>
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| Do infectious diseases alter water supply and sanitation in the built and natural environments? | Review historical pandemics and emerging case studies from the centralized and decentralized perspectives:  
- Water supply and sanitation changes  
- Health implications. |
| What beneficial pathogen measures evolve from considering the environments? | Potential systems integration to be made to building and urban areas for adapting to current and future pandemics. |
| Is there opportunity to apply these new systems to other purposes? | Analyze other potential environment integration applications for further resiliency and sustainability (public transit, industry, public parks/waterways, etc.) |
| Are the solutions long or short term? | Discuss the potential duration of the systems integration, identify benefits and any harms. |
| Could distributed pathogen monitoring influence sustainable building and urban zones design? | Considering the duration of the solution, analyze other aspects of resiliency and sustainability that could benefit from systems integration. |
| **Could pathogen monitoring influence both sustainable built and natural environments?** | |

Distributed measurements will alleviate the challenges previously described, as well as decrease public interaction concerns and provide global societies the means to find a “new normal” that is reflective of the “old normal”. USA based Water Life Systems Inc., along with a university partner in British Columbia, Canada, have developed a multiple use bioelectrical sensor with mobile Wi-Fi, Lo-Ra, or satellite communications capabilities. The sensor can be applied to air and water borne pathogen detection. Built infrastructure applications are extensive and can include public/shared/private toilet bowl and washroom integration, building entrances and pedestrian throughways, public transportation vehicles and facilities, wearables for frontline emergency personnel, and distributed wastewater infrastructure applications.
A primary goal is to immediately, and as accurately as possible, detect a potential pandemic inducing pathogen species before it is distributed throughout centralized drinking water and wastewater systems, especially where the concentration of residual disinfectant is a norm. It is a common understanding that bacteria in biofilms enter individual homes, such as with distribution of legionella. Showerheads, sink taps, and toilets provide the sources of aerosolization to distribute COVID-19-containing water droplets. The development of a distributed network of mobile SARS-CoV2 and other pathogen detection systems that can be exposed to various environments is critical to quickly trace and confirm suspected cases, as well as asymptomatic infected cases without costly centralized laboratories [7].

The ethical concerns of distributed pathogen monitoring technology integration into the built and natural environments can be alleviated with the integration of Blockchain technologies.

**Methods:**

Various sources of primary literature were examined using Google Scholar, Thomson Reuters, and Scopus have provided a plethora of information. As presented in the following sections of this argument, the support for formed ideas consists of a collection of perspectives, information, and studies formed and published primarily during the progression of the COVID-19 pandemic, chosen for their clear illustration of environmental, urban and public health issues.

For full disclosure, author Thomas Murphy is President of Water Life Systems Inc, a USA corporation with Canadian, South African, and other international operations that holds Intellectual Property Ownership Rights to hardware and software components and integrated systems including, but not limited to, groundwater, surface water, and wastewater treatment; resource and nutrient recovery; and remote digital sensors and monitoring systems.
References:


4. Desai (2020)

