



# Environmental Monitoring

Reducing Pollution, Improving Public Health, and  
Preventing Economic Loss

IN COLLABORATION WITH

**Spectrum**

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## ENVIRONMENTAL MONITORING: AN OVERVIEW

Environmental sustainability is a key driver behind a range of smart city initiatives including water and waste management, parking solutions, traffic management, and smart grid operations. Holistic environmental sustainability, however, also includes proactive investments in systems that constantly monitor temperature variations, air and water quality, oceanic changes that impact marine life, and greenhouse emissions, vegetation cover, and ice/glacier spread. Using Internet of Things (IoT)-enabled smart sensors, cities are able to better understand and predict the impact of environmental changes on their various constituents. These solutions help city managers prepare and plan for a range of environmental and ecological disasters. These solutions also help city managers prepare and plan for a range of environmental or ecological disasters. Comprehensive environmental monitoring can also help city managers proactively identify and estimate the magnitude or impact of natural disasters while planning their response and recovery efforts.

Proactive environmental monitoring reduces the risk of ecological disasters while also improving public health outlook.

The direct and indirect costs of environmental disasters can be rather significant and their effects often extend well-beyond the occurrence timeline. For instance, apart from the higher clean-up costs, the negative ecological effects of offshore oil spills typically linger for a long period of time thereby impacting marine life, fisheries, and recreation. Similarly, ineffective environmental monitoring and control can lead to air and water contamination leading to a range of adverse health outcomes such as birth defects and terminal ailments.

## CASE FOR ENVIRONMENTAL MONITORING

The National Centers for Environmental Information (NCEI), a unit of the National Oceanic and Atmospheric Administration (NOAA), estimates that since 1980, the US has experienced a minimum of 233 climate and other natural disasters with a total cost exceeding \$1.5 trillion. Most frequent causes of these include tropical cyclones or hurricanes. While these natural disasters are unavoidable, effective environmental monitoring systems can help emergency management personnel accurately measure their size and impact and issue timely alerts, including evacuation orders, to city residents.

From an ecological/man-made disaster perspective, the inability to effectively monitor and contain chemical waste from hazardous plants and other facilities can have a significant impact on water and air quality. This leads to dire consequences for local governments, residents, and businesses. Moreover, the economic cost of an ecological disaster can be in the billions of dollars, thereby impacting the financial health of a city.

Some of the key drivers prompting cities and private sector organizations to invest in environmental monitoring solutions include:

- Increasing population has created tremendous pressure on natural resources such as land and water use. Significant increase in sewage and solid waste has created a need for monitoring of

treatment facilities to prevent inadvertent leaks which can pollute both public water sources as well as air quality.

- Rapid industrialization has led to higher concentration of population in urban areas where industrial facilities are often intertwined with residential areas. Such urban landscape creates a strong need for implementing effective, real-time environment monitoring systems to avoid ecological disasters such as those related to utility or chemical plant leaks and/or explosions.
- Rising automotive ownership and usage as well as expansion of mass transit like buses and rails continue to utilize fossil fuels thereby adding to the air quality woes.
- Aging infrastructure—undersea, underground, above-surface such as pipelines, fuel tanks, etc.,—increases the likelihood of spills and leaks. While private sector organizations often own and are responsible for the maintenance of such infrastructure, city governments are entrusted with the task of providing regulatory oversight to avoid any ecological disasters.
- Rising cost of environmental disaster clean-up and recovery efforts necessitate that proactive and predictive smart environmental monitoring tools be deployed across a broad spectrum of areas within a locality.

## **ENVIRONMENTAL MONITORING COMPONENTS AND FUNCTIONS**

Environmental monitoring is a complex area compared to other smart city solutions in that the consequences of a lapse in effective monitoring can often lead to irreparable damages to public health as well as critical infrastructure. For instance, inability to immediately detect a gas pipeline leak can lead to loss of life, long-term health complications, and may render a facility unusable resulting in substantial economic losses. Deployment of environmental monitoring solutions is also more complicated due to their geographically dispersed nature, greater need for environmental hardening of hardware, significant pressure to develop fail-safe yet cost-effective solutions, and potentially higher maintenance costs.

Despite the significant variations, typical environmental monitoring solutions employ a network of smart sensors, an IoT platform, application dashboards, analytics, data storage, and a complex mix of connectivity protocols. Environmental monitoring solutions can be used to provide a city with real-time data from sensors that could improve the quality of life by sending public alerts or plant closures.

## **ANTICIPATED BENEFITS AND OUTCOMES**

It is important to understand that implementation of a holistic environmental monitoring program requires strong and continuous coordination and information sharing between the public and private sector. For private sector organizations, high costs associated with post-disaster clean-up, threat of class-action litigation, and the risk of poor brand perception or a public call for boycott present strong justifications to engage in environmentally responsible behavior.

Effective deployment of environmental monitoring solutions delivers a multitude of benefits including:

- **Ensuring public health**—The direct effects of an environmental debacle involving water and air quality may be irreversible in that inadvertent exposure to pollutants (inhaling, ingestion) can cause loss of life, serious and long-term disability, organ failures, birth defects, and several other complications. Such ecological disasters can also lead to dire economic and legal consequences including loss of productivity, higher healthcare costs, decline in tourism, and potential criminal neglect of fiduciary responsibility.
- **Reducing likelihood of costly ecological disasters**—The post disaster clean-up costs are often likely to be higher than the cost of implementing environmental monitoring solutions. The post-disaster clean-up costs for offshore oil spills alone can be in billions of dollars. Similarly, certain ecological disasters may lead to long-term, and in some cases, permanent displacement of residents, which may further exasperate overall recovery costs.
- **Ensuring regulatory compliance**—Inaccurate and untimely detection of pollutants can lead to regulatory code violations for private sector organizations as well as cities. For instance, many cities entered into settlements with EPA for violation of various regulatory compliance requirements such as the Clean Water Act. In certain cases, cities were cited for discharging untreated sewage water into the ocean or for overflow of sewage water into streets and neighborhoods.
- **Timely response helps contain impact of environmental catastrophes**—An important function of robust and reliable environmental monitoring solutions resides in their ability to issue timely alerts, which help cities contain an environmental disaster before it can cause massive life and property loss.
- **Preserving natural resources**—Proactively monitoring and analyzing the extent of depletion of natural resources in an area can help cities deploy suitable safeguard measures.

## THE LAST WORD

As cities prepare for natural disasters, water management, air quality, etc., the role of sensors in protecting citizens and improving quality of life cannot be understated. Cities have grown at rapid rates over the past half century, surpassing the ability of city managers to add personnel to provide essential services. Sensors and environmental monitoring solutions help the city focus on essential services, while allowing them to collect data and issue public alerts to ensure quality of life for its citizens.

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