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RESEARCH ARTICLE

WATER QUALITY AND SECURITY

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Abstract

Water security has been defined as "the reliable availability of an acceptable quantity and quality of water for health, livelihoods and production, coupled with an acceptable level of water-related risks" It is realized to the degree that water scarcity is non-existent, or has been decreased or eliminated, and to the degree that floods and contamination of freshwater supplies are non-threatening. Water security is considered to be a necessity of sustainable development for its importance in the quality of life of the people in a region. Sustainable development would result in lowered poverty and increased living standards for those most susceptible to the impacts of insecure water resources in the region, especially women and children. By clearly defining the responsibilities and control over water management for high usage sectors in terms of finance, planning, agriculture, energy, industry, and health, development may progress to the point of sustainable living for all.

Keywords: Water quality, security, scarcity, water conservation, contamination, floods

Introduction

The areas of the world that are most likely to have water insecurity are places with low rainfall, places with rapid population growth in a freshwater scarce area, and areas with international competition over a water source. In regions with water security issues and some water scarcity, changes in the local and global environment may soon lead to more intense regulation of water. Already in countries with high water usage, such as the United States and China, these regulations are prominent and grow in number still. International and international water conflicts have long been mediated by regulations and treaties, but instances involving worsening situations show some dire outlooks.

Definition and scale:

Water security is achieved when there is enough water for everyone in a region and the water supply is not at risk of disappearing. United Nations

Water considers both quantity and quality factors of accessible water when describing water security. The water should be of sufficient quantity to enable sustainable livelihood and socio-economic development, and be managed well enough to avoid water-borne pollution and disasters as well as preserve water-related ecosystems. According to the Pacific Institute "While regional impacts will vary, global climate change will potentially alter agricultural productivity, freshwater availability and quality, access to vital minerals, coastal and island flooding, and more. Among the consequences of these impacts will be challenges to political relationships, realignment of energy markets and regional economies, and threats to security".

It impacts regions, states and countries. Tensions exist between upstream and downstream users of water within individual jurisdictions.

Results and discussion

According to *Nature* (2010), about 80% of the world's population (5.6 billion in 2011) live in areas with threats to water security. The water security is a shared threat to human and nature and it is pandemic. Human water-management strategies can be detrimental to wildlife, such as migrating fish. Regions with intensive agriculture and dense populations, such as the US and Europe, have a high threat of water security. Water is increasingly being used as a weapon in conflict. Water insecurity is always accompanied by one or more issues such as poverty, war and conflict, low women's development and environmental degradation. Researchers estimate that during 2010–2015, ca US$800 billion will be required to cover the annual global investment in water infrastructure. Good management of water resources can jointly manage biodiversity protection and human water security. Preserving flood plains rather than constructing flood-control reservoirs would provide a cost-effective way to control floods while protecting the biodiversity of wildlife that occupies such areas.

The term water security encompasses ideas and concepts regarding sustainability, integration and adaptiveness of water resource management. There are four key areas of focus: increasing economic welfare, enhancing social equity, moving towards long-term sustainability and reducing water related risks. Risks can be further classified as hazards (droughts, floods and quality deterioration), exposure and vulnerability. Water security is sometimes sought byimplementing water desalination, pipelines between sources and users, water licences with different security levels and war.

Urban water security could be understood from a systems perspective, given its complexity and cross-disciplinary nature. This involves understanding the types of pressures on the water system (such as climate change and urbanization), the state of the water system (water stocks and flows), the impact of the water system on water services provision (such as affordability and availability), and responses (including institutional reforms).

Water allocation between competing users is increasingly determined by application of market-based pricing for either water licenses or actual water important King is here.

Fresh water

Water, in absolute terms, is not in short supply planet-wide. But, according to the United Nations water organization, UN-Water, the total usable freshwater supply for ecosystems and humans is only about 200,000 km^3 of water – less than one percent (<1%) of all freshwater resources. Usable fresh water includes water not contaminated or degraded by water-altering chemicals, such as sewage or any other harmful chemicals from continuous previous use. In the 20th century, water use has been growing at more than twice the rate of the population increase. Specifically, water withdrawals are predicted to increase by 50 percent by 2025 in developing countries, and 18 per cent in developed countries. One continent, for example, Africa, has been predicted to have 75 to 250 million inhabitants lacking access to fresh water. By 2025, 1.8 billion people will be living in countries or regions with absolute water scarcity, and two-thirds of the world population could be under stress conditions. By 2050, more than half of the world's population will live in water-stressed areas, and another billion may lack sufficient water, MIT researchers find.

The Earth has a limited though renewable supply of fresh water, stored in aquifers, surface waters and the atmosphere. Oceans are a good source of usable water, but the amount of energy needed to convert saline water to potable water is prohibitive with conventional approaches, explaining why only a very small fraction of the world's water supply is derived from desalination. However, modern technologies, such as the Seawater Greenhouse, use solar energy to desalinate seawater for agriculture and drinking uses in an extremely cost-effective manner.

Threats

The most common threat to water security is water scarcity. There can be several causes to water scarcity including low rainfall, climate change, high population density, and over allocation of a water source. About 27% of the world's population lived in areas affected by water scarcity in the mid 2010's. In more conservative estimates, this number is expected to increase 42% by 2050 – more dire outlooks predict an increase of 95%. An example of periodic water scarcity in the United States is droughts in California. Another category of threats to water security is environmental threats. These include contaminates such as biohazards (biological substances that can harm humans), climate change and natural disasters. Contaminants can enter a water source naturally through flooding. Contaminants can also be a problem if a population switches their water supply from surface water to groundwater. Natural disasters such as hurricanes, earthquakes, and wildfires can damage man-made structures such as dams and fill waterways with debris. Other threats to water security include terrorism and radiation due to a nuclear accident.

Water scarcity

Water scarcity (closely related to water stress or water crisis) is the lack of fresh water resources to meet the standard water demand. Two types of water scarcity have been defined: physical or economic water scarcity. Physical water scarcity is where there is not enough water to meet all demands, including that needed for ecosystems to function effectively. Arid areas (for example Central and West Asia, and North Africa) often suffer from physical water scarcity. On the other hand, economic water scarcity is caused by a lack of investment in infrastructure or technology to draw water from rivers, aquifers, or other water sources, or insufficient human capacity to satisfy the demand for water. Much of Sub-Saharan Africa is characterized by economic water scarcity.

International competition

International competition over water can arise when one country starts drawing more water from a shared water source. This is often the most efficient route to getting needed water, but in the long term can cause conflict if water is over drafted.

More than 50 countries on five continents are said to be at risk of conflict over water.

During history there has been much conflict over use of water from rivers such as the Tigris and Euphrates Rivers. Another highly politicized example is Israel's control of water resources in the Levant region since its creation, where Israel securing its water resources was one of several drivers for the 1967 Six-Day War.

Turkey's Southeastern Anatolia Project (Guneydogu Anadolu Projesi, or GAP) on the Euphrates has potentially serious consequences for water supplies in Syria and Iraq.

China is constructing dams on the Mekong, leaving Vietnam, Laos, Cambodia and Thailand without same amount of water as before investment. A huge project of reversing the flow of the Brahmaputra (Chinese: Tsangpo) river, which

after leaving Chinese Tibet flows through India and Bangladesh. The struggle for water in some afflicted regions has led inhabitants to hiring guards in order to protect wells. Moreover, the Amu Daria River, shared by Uzbekistan, Turkmenistan, Tajikistan and Afghanistan, has been almost completely dried out, so much so that it has ceased to reach the Aral Sea/Lake, which is evaporating at an alarming pace due to the fact that Turkmenistan retains much of the water before it flows into Uzbekistan.

Conflict between Egypt and Ethiopia over the Grand Ethiopian Renaissance Dam escalated in 2020. Egypt sees the dam as an existential threat, fearing that the dam will reduce the amount of water it receives from the Nile. Both countries face the threat of water shortage, as demand for water is projected to increase with growing population, increased urbanisation and pursuit of economic growth. Tensions are made worse as a result of fundamental differences in beliefs over water rights; Egypt claims its rights to the Nile water on the basis of historical practice, whereas Ethiopia claims its rights to the water based on geography, where 85% of its water comes from highland sources within its territory. While the Nile Basin Initiative provides a platform to ensure sustainable management of water resources through cooperation of riparian countries, the Cooperative Framework Agreement has only been ratified by six of 11 countries to date.

Water scarcity and water conflicts

While the demand for water grows because of growth of the global population, many places around the world are also experiencing droughts due to climate change and worsening water pollution. This could trigger intense competition for water leading to regional instability. Sometimes referred to as water conflict, regulation and disputes between water access rights most often occur in areas with low water, or worsening water situations. Approximately 60% of global river water must be shared bilaterally or multilaterally, thus, agreements are frequently implemented between all parties involved.

Even when these agreements are optimized for all parties involved some countries may still have to turn to water imports as a main source of freshwater. A severe example is Pakistan, a country in frequently in conflicts over water with India, who imports 76% of their water resources – India imports 34% of theirs. A select number of rivers serve as hotspots for neighbouring country water sources. The Nile River's resources, for example, are shared by 11 countries. Situations such as these have given rise to over 3800 unilateral, bilateral, or multilateral water declarations or conventions concerning water globally, and 286 treaties. As water scarcity issues increase, these may become more common and actively sought after.

Water utility security

According to the United States Environmental Protection Agency (EPA), "Improving the security of our nation's drinking water and wastewater infrastructures has become a top priority since the events of 9/11. Significant actions are underway to assess and reduce vulnerabilities to potential terrorist attacks; to plan for and practice response to emergencies and incidents; and to develop new security technologies to detect and monitor contaminants and prevent security breaches."

One of the most important elements of water security is early and accurate contamination detection. The EPA has issued advisory material and guidelines for contamination warning systems to be implemented in water utilities and supplies. The security challenges that utilities frequently revolve around fast detection, accuracy, and the ability to take fast action when there is a water problem. If contamination is detected early enough, it can be prevented from reaching consumers, and emergency water supplies can be put into effect.

In cases where contamination might still reach consumers, fast and efficient communication systems are necessary. All these factors also point to the need for organized and practiced emergency procedures and preparedness.

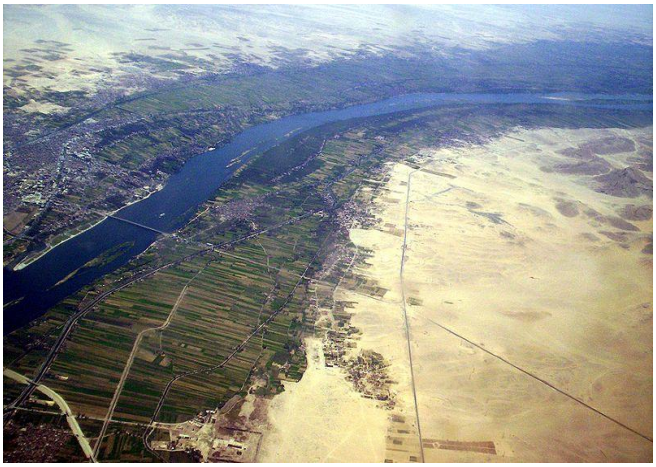
Regulation

Since 2002, under the Bioterrorism Act, a water utility supplying more than 3,300 people must take at least the following measures to ensure security of the water supply:

- Conduct an assessment of the facility's vulnerabilities to vandalism, insider sabotage, or terrorist attack, and submit the report to the EPA.
- Show that the facility has an up-to-date emergency response plan, should an incident occur.

More recently, under the Drinking Water Security Act of 2009, the EPA is now required to establish risk-based performance standards for community water systems serving more than 3,300 people.

Cincinnati Water Works, San Francisco, and New York City are among the major water utilities that have taken water security measures at their facilities, such as planning for contamination warning systems.



Security of a water supply involves a range of elements. Prevention and detection systems include some or all of the following: access to public health and customer complaint data, water quality monitoring equipment, sampling and analysis, cyber-security which includes situation management and IT systems hardware and software, and physical security. Crisis management and recovery, for when critical water events occur, includes flow control and security valves, rapid and effective communication systems, and emergency water supply equipment.

Specific technologies involved in water security are SCADA, GIS (geographic information system), online (real-time) water quality monitoring devices, contamination warning systems, intrusion detection systems (IDS), contamination detection devices, security valves, security cameras and fences, situation management/emergency management software, emergency supply tanks, manned (or human) security personnel, personal purification devices, and counter-terrorism intelligence.

Domestic regulations and policy

A number of laws have been passed in the last two decades that aimed to reduce water usage, waste, and pollution as well as increase disaster preparedness.

- Water Pollution Prevention and Control Law (Amended 2017): First passed in 1984, this amendment attempts to substantially change parameters surrounding all aspects of water security. Fully encompassing specifics for actions that constitute a violation against the law, who is subject to specific enforcements, and legal liability (including a notable increase in fines) for both the perpetrators or the agency tasked with supervision that fails to act in accordance with the laws.
- Resource Tax Law (2020): A law providing local government the ability to set local tax rates on natural resource usage with the intention of enabling them to protect specific resources more effectively. The law also, for the first time, lists water as a natural resource, giving local authorities the ability to promote water preservation and limit waste.

- Water Law (Amended 2002): First passed in 1988, this amendment provided sections relating to water allocation right, extraction rights, use and conservation parameters, pollution prevention, and basin management. This law could be seen as a turning point in the early 2000s for water security recognition.

Support and Criticism of Chinese Water Management

Some have offered praise to China's campaign over the last two decades to improve water quality, noting the significant effort on fronts regarding industrial and agricultural pollution limitations, and improved water pipe infrastructure. There has also been a great deal of focus on the exponentially higher investments and spending on water conservatory projects, a trend beginning in the early 2000s. Additionally, titling the 2011 Central Document No.1 "The Decision on Accelerating the Reform and Development of Water Conservancy" is recognized as some as having been a substantial step in committing to water security due to its place as the country's most notable policy document for the given year.

However, many have their concerns and criticisms with China's handling of the water crisis. With notable investments into conservatory projects and recognition of the issue in early 2000s legislation, many have come to criticize China for its failure to introduce effective water resource management practices earlier than their mid-2010s onset. For nearly a decade the regulations set forth in the Water Laws regulation were not effectively enforced, so although there were effective measures drafted, the issues continued to develop. Following the decision to go forth with and begin building the South-to-North Water Diversion Project in 2002, there was a great deal of pushback regarding economic justification, local community disruption and relocation, and environmental strain on southern China. Regardless, upon assessment and weighing of these criticisms against the benefits of water relocation, the project's construction continues.

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