International Journal of Trend in Scientific Research and Development (IJTSRD)
Advanced Studies of Multidisciplinary Research and Analysis – November 2023
Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

# Urbanization and Water Stress: Analyzing the Impact of Rapid Urbanization on Local Water Resources and Proposing Sustainable Management Strategies

**Udai Bhanu Pratap Singh Rathore**

Research Scholar, Geoinformatics, Suresh Gyan Vihar University, Jaipur, Rajasthan, India

**ABSTRACT**

Most people live in towns and cities. Urban areas are expected to absorb all of the world's population growth in the coming decades, as well as accommodate rural-to-urban migration. The majority of urbanites live in overcrowded, unplanned settlements with inadequate water and sanitation services. Reaching poorer communities will be vital to protecting public health as a whole, and to withstanding the impacts of climate change.

***KEYWORDS:*** *urbanization, water stress, resources, management, strategies*

## INTRODUCTION

Urban centres are concentrations of deprivation. Fast growing towns and cities across the developing world are home to millions of people living without access to basic services such as safely managed water and sanitation services.

Urban planning is not keeping pace with population growth. Planning, budgets and infrastructure are failing to serve most urban residents in the developing world with water and sanitation, contributing to poor health conditions and heavy pollution loads in wastewater.[1,2,3]

Unplanned 'slum' areas pose a wider health risk. Unsanitary conditions in neighbourhoods without water and sanitation services create a constant threat of a disease outbreak, such as cholera, that can devastate poor communities and spread through the city and beyond.

Unserved urban communities are vulnerable to shocks. The poorest neighbourhoods are often in areas more exposed to natural hazards such as flooding, sea level rise, forest fires, landslides, volcanic eruptions and tsunamis. A lack of resilient water and sanitation systems and hygiene facilities means that the community's ability to stay healthy during environmental shocks is severely compromised.

Governments must reach unserved urban communities to accelerate global progress. The density and volume of unserved urban populations in developing country cities means that interventions to improve water and sanitation services will reach many people in a short timeframe.

Public health in urban areas must be a top priority. Water and sanitation interventions in towns and cities, including safe wastewater treatment, has positive impacts on public and environmental health that transform target communities and ecosystems, and spread rapidly through the municipality and into the rest of the country.

Urban water and sanitation must be at the heart of a circular economy. Climate goals and service delivery obligations will only be met if governments implement technology that delivers sustainable water and sanitation services and wastewater treatment for every urban resident.

The New Urban Agenda must be implemented. The New Urban Agenda, adopted by world leaders in 2016, is a roadmap for building cities that can serve as engines of prosperity and centres of cultural and social wellbeing while protecting the environment. The Agenda also provides guidance for achieving the Sustainable Development Goals and addressing climate change.[4,5,6]

## DISCUSSION

Water is a critical natural resource for both natural ecosystems and human subsistence, including human needs related to consumption, agricultural, municipal, industrial, and recreational uses. Freshwater resources are limited yet global water use has grown at twice the rate of population growth over the past 100 years. Humans affect the global water cycle in a variety of ways. There are (i) direct effects, including the construction of dams, diversion of major rivers, and the withdrawal of surface and groundwater reserves for industrial, agricultural, and domestic usages; and (ii) indirect effects, mainly via climate change, which has the potential to significantly modify the water cycle and thus influence global water availability and alter demand.

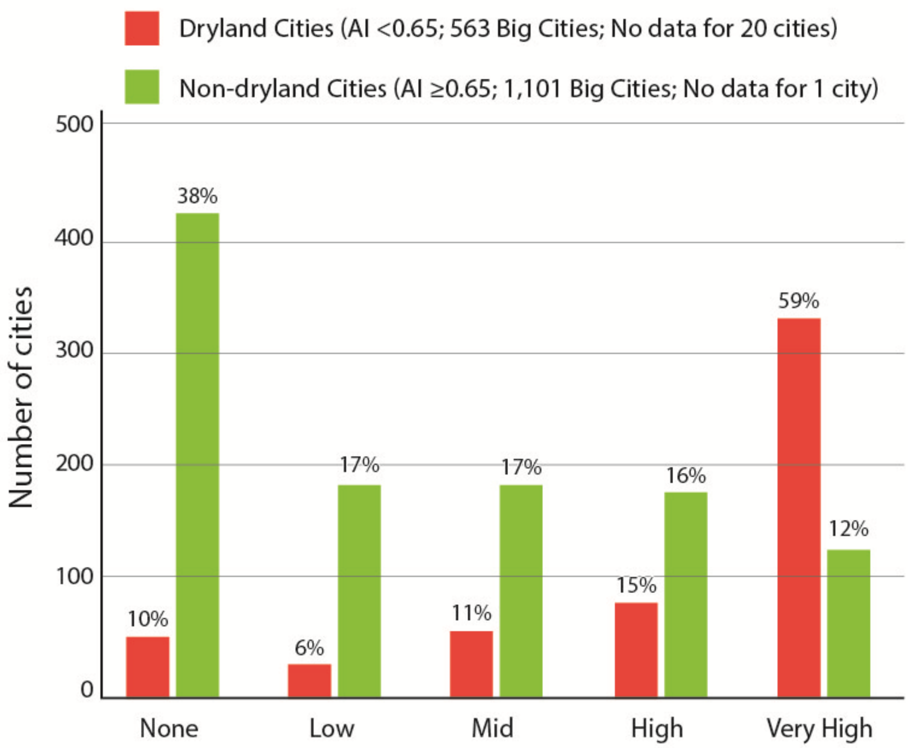
Access to, and sustainability of, freshwater resources sufficient to meet human demands is one of the most critical challenges of the near future. The World Economic Forum asserted that the global economy failure to meet human demands for water would represent the greatest shared risk to the global economy. The only way to avoid a global water crisis is to limit water consumption, increase water-use efficiencies, and develop efficient, cooperative, international strategies to share limited freshwater resources. However, the magnitude of this challenge is illustrated by the fact that currently about two-thirds of the global population – half of whom reside in India and China – subsist under conditions of severe water scarcity at least one month of the year; over 120 million people in the European region do not have access to safe drinking water; and half a billion people in the world face severe water scarcity year round.

To prepare, manage, and adapt to water shortages, there is a need for different sectors of human society (private, nation states, their institutions and organisations, etc.) to better understand the scope of the problem. However, quantifying water dynamics at the scale of the globe is a difficult task due to the inherent complexity of the hydrologic cycle, which includes many nonlinear interactions and feedbacks between climate, water availability, water quality, human interventions, and water demand. In part to aid in this understanding, the World Resources Institute developed the

Aqueduct water risk mapping tool. Generally, Aqueduct provides insight into the complex topic of water risk by using available data, indicators, and modelling. It combines data on 12 different indicators of water risk – from water stress to access to clean drinking water. Here, we present the Water Stress Indicator, which is from the Aqueduct Global Maps.[7,8,9]

Big Cities, climate change, water resources and land degradation Climate change, e.g. processes that lead to increased global aridity, will affect Big Cities. Since urban areas are particularly vulnerable to water shortages, this is one of the greatest risks of urbanisation. The graphs suggest that under current climate conditions, 44 % of the Big Cities face High- to Very High water stress. In a study of 71 Cities with more than 750 000 inhabitants, it was estimated that 35 % of the Megacities are presently vulnerable to water shortages.

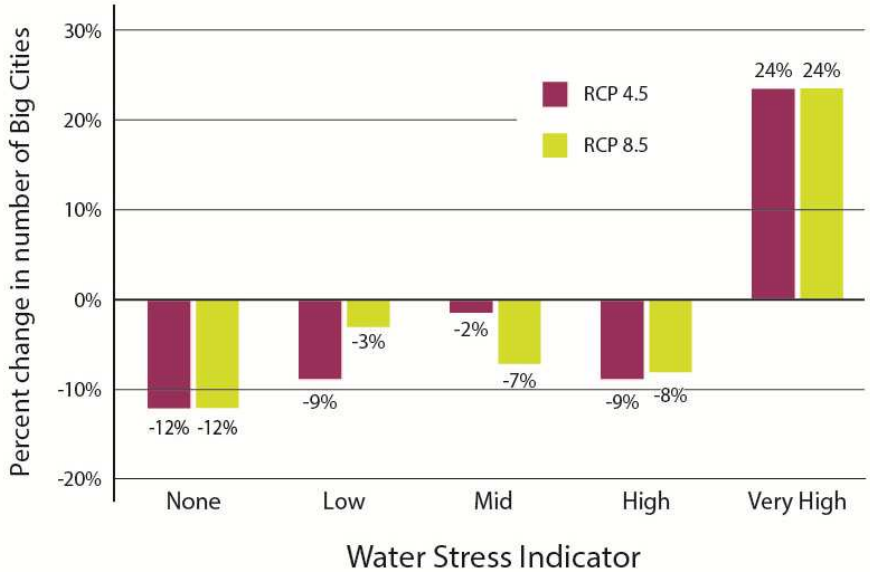
How might these trends change in the future? To explore this, the Water Stress Indicator was recalculated for the Imminent Future scenario (2011-2040) using both the RCP 4.5 and RCP 8.5 scenarios. Overall, water stress becomes more severe with a 24 % increase in the number of Big Cities with Very High stress (from 463 to 572). For the Megacities, it was estimated that 29 % more of them would be vulnerable to water shortages by 2040 if no action is taken.




Water stress indicator calculated for the Imminent Future scenario (2011-2040) (using RCP 4.5 and RCP 8.5 scenarios - differences in RCP scenarios were slight).

While climate change is an important driver of global water shortages, increases in population growth and rapid economic development will have a much stronger effect on water stress than climate change per se. This is especially the case for many developing nations. The rate of social and economic development associated with urbanisation poses serious threats to the environment and often leads to serious land degradation. Some of the most immediate pressures on land that lead to degradation include diversion of surface waters and the removal of groundwater reserves to meet human, industrial and agricultural demands, construction of domestic and industrial landfills, air pollution, the conversion of adjacent grasslands, forests and wetlands to agriculture, building of infrastructure to support urban needs and various industrial activities, e.g. thermoelectric production and mining. In addition, urban areas are major local sources of pollutants into waterways and groundwater reservoirs. Paradoxically, another cost is that as urban expansion inescapably spreads over existing agricultural lands, the increasing land values and markets around cities often result in the abandonment of productive agricultural land as owners anticipate profits for development.

The interactions and feedbacks between urbanisation, climate change, population growth, land use, land cover, land degradation and water resources are highly complex.



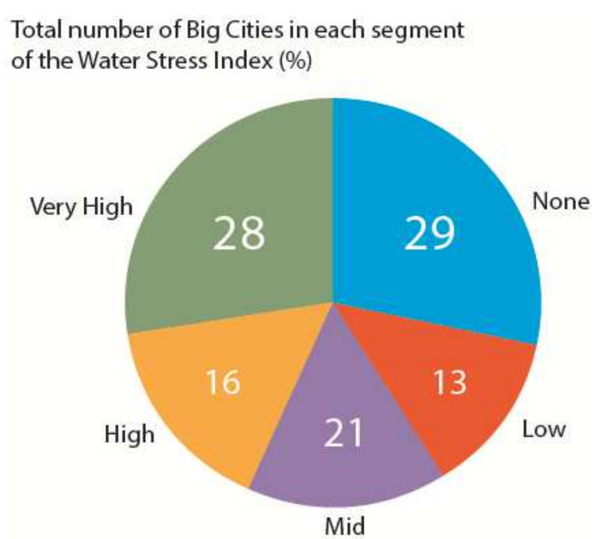

**Trends in Water Stress Indicator: Dryland vs. Non-Dryland Cities:**

The number and percentage of dryland and non-dryland cities in each of the Water Stress Indicator categories under current climate conditions. A total of 74 % of the dryland cities are found in High to Very High stress regions whereas 55% of non-dryland cities are located in None- to Low-stress regions. (Note: water stress data missing for some cities hence, total percentage with negative change is not equal to percentage with positive change).

With regard to water resources and water security, activities such as reducing water consumption via greening cities and water recycling and the development of resilient infrastructures are needed to help reduce the vulnerability of these cities to climate change and projected water shortages.[10,11,12] Although there is no single best policy that can be universally applied, water conservation is increasingly being singled out as the most important strategy for water planning and management for the future decades.

**RESULTS**

Trends in all Big Cities Based on current climate, Big Cities are roughly split evenly in terms of their water stress ratings: 44 % of them experience High- to Very High-water stress, compared 42 % that are in None- to Low-water stress regions. The remaining 16 % are in Mid-water stress.




In the summer of 2019, Chennai's reservoirs ran dry, forcing the government to truck in 10 million litres of water a day. For a city that gets an average of 1,400 mm of rainfall a year, more than twice what London receives, this was unprecedented. And not just Chennai, cities across India have been facing acute water shortages due to massive population growth and rapid, unplanned urbanisation. A 2018 study published in Nature projected that by 2050, Jaipur would have the second-highest water deficit in the world, with Chennai at #20. A 2020 report by the World Wide Fund for Nature (WWF) projected that 30 Indian cities would face a 'grave water risk' by 2050 due to sharp increases in population.

The situation is already alarming. In the 91 most important reservoirs tracked by the Central Water Commission, storage levels have never crossed more than half their total capacity in recent years. More alarmingly, the long-term, indiscriminate extraction of groundwater is making water tables fall rapidly in most Indian cities. According to a study by the Centre for Science and Environment, 48 per cent of India's urban water supply comes from groundwater, and in seven of India's 10 most populous cities, groundwater levels have dropped significantly over the past two decades. [13,14,15]

Urban dwellers also face a crisis because of limited supply networks. More than 34 per cent of India's population lives in cities; however, 31 per cent of urban households, mostly those in unauthorised colonies and slums, lack access to piped water or public tap water. And the existing pipes are in danger of running dry. Most Indian cities can't meet the per capita water supply limit set by the Central Public Health and Environmental Engineering Organisation, 135 litres per day. Even the quality of supplied water has been suspect. Samples collected last year from 21 cities across India failed to meet standards. A NITI Aayog report says that nearly 70 per cent of India's water is contaminated, impacting three in four people. Responding to the situation, the Union ministry of Jal Shakti launched the Jal Jeevan Mission, aiming to expand the piped water network to all households in India by 2024. However, success depends on the states, as water is a state subject.

While the WWF proposes nature-based solutions and enhancing the health of river basins, watersheds and wetlands to build resilience to water risks, these would tackle only the scarcity issue, not distribution. Another oft-quoted solution is rainwater harvesting, but progress in this has been abysmal. Most experts, therefore, propose an integrated approach, which includes increasing the efficiency of distribution networks and utilising waste water. Since water sources are finite, cities and citizens must focus on efficient and judicious use. That's the first step towards a sustainable water conservation policy.[16,17,18]

**CONCLUSION**

To some degree, "urbanization" (people living together in groups), has been taking place since ancient times. As populations rose and people mastered techniques to grow food in fixed locations, groups of people became settlements and then towns and cities. In the United States, the speed of this urbanization picked up after World War II, and now many urban areas are growing at a record pace. What are the effects on the local hydrologic system when a rural area is turned into an area full of housing developments, shopping centers, industrial buildings, and roads?

**Beginning of urbanization**

**Change in Land Use:**

Remove trees and vegetation. Begin building houses, some with sewers and some with septic tanks. Begin drilling wells.

**Effect on Water System:**

More storm runoff and erosion because there is less vegetation to slow water as it runs down hills. More sediment is washed into streams. Flooding can occur because water-drainage patterns are changed.

**Continuing urbanization**

**Change in Land Use:**

Urbanization is finished by the addition of more roads, houses, and commercial and industrial buildings. More wastewater is discharged into local streams. New water-supply and distribution systems are built to supply the growing population. Reservoirs may be built to supply water. Some stream channels are changed to accommodate building construction. Industries might drill some deep, large-capacity wells.

**Effect on Water System:**

More pavement means less water will soak into the ground, meaning that the underground water table will have less water to recharge it. This will lower the water table. Some existing wells will not be deep enough to get water and might run dry.

The runoff from the increased pavement goes into storm sewers, which then goes into streams. This runoff, which used to soak into the ground, now goes into streams, causing flooding. Changing a stream channel can cause flooding and erosion along the stream banks. More sewage is discharged into streams that weren't "designed by nature" to handle that much water.

The use of too many large wells can lower the underground water table. This can cause other wells to run dry, can cause saltwater to be drawn into drinking-water wells, and can cause land that was formerly "held up" by underground water to subside, resulting in sinkholes and land subsidence.

**Local community takes steps to fix some problems**

**Change in Land Use:**

Improvements in the storm drainage system are made. Wells are drilled to recharge underground aquifers. Projects to reuse wastewater might be started. Ecological-designed recharge ponds disperse some storm drainage to artificially recharge shallow aquifers.[19]

**Effect on Water System:**

New storm-drainage systems reduce flooding during storms. Less damage is done to basements, yards, and streets. Water is actually injected into recharge wells to put water back into underground aquifers. Reusing wastewater means less pollution, more water conservation, and additional water for recharging aquifers.

Today water stress is a major concern in many urban areas. The core aspect of urbanisation is the rapid urban population growth together with inadequate planning, pollution, poverty, competing demands on the resource, all contribute to water stress: and consequently the urban water consumption is likely to double by 2025. Climate change is expected to cause significant changes as well in precipitation patterns which will affect the availability of water and induce water related disasters.

The world urban population is expected to increase by 72 % by 2050, from 3.6 billion in 2011 to 6.3 billion in 2050. African and Asian urban population is expected to be around 57.7 and 64.4% at urbanisation rate of 1% and 0.9% respectively. In developing countries, average sanitation coverage (56%) is far less than water coverage (85%). For example in Africa, even in urban area coverage for sanitation is 46% and water is 84% and the coverage is even significantly lower in the rural areas.

Current models of urban planning and water management have already failed or likely to fail from the perspective of cost effectiveness, technical performance, social equity, and environmental sustainability. A paradigm shift is required at the system-wide level. Integrated Urban Water Management (IUWM) provides a framework for interventions over the entire water cycle and a reconsideration of the way water is used (and reused). And IUWM balances competing demands among water users: agriculture, industry, household, and ecosystems. More governments recognise the importance of taking such an approach to address the challenges of cities. There is growing consensuses around the principles of Integrated Urban Water Management (IUWM) which include the three main inter connected dimensions:

- Governance: It is a critical aspect for supporting IUWM. Without government policy and framework support and comprehensive stakeholder participation, optimum management of water resources cannot be achieved.
- Service: This component includes closed loop systems for water supply and sanitation (making whole water cycle as one), stormwater management, good Operation & Maintenance and at the same time maintaining the water quality as required for use. Decentralised wastewater treatment systems and innovative and affordable technologies are recommended.
- Resource: It is of utmost importance to make use of all available resources; conventional or unconventional in the form of wastewater, rainwater, surfacewater, greywater, blackwater etc. Wastewater is not wasted water! Simultaneously, demand side management should be utilised to lessen the stress on water resources.

Cities: a wealth of opportunities. Urbanisation also brings with it opportunities for more efficient water management as well as for the provision of drinking water supply and sanitation services to many people. Cities are generators of wealth and employment, incubators of innovation and creativity, and provide the best opportunities to improve livelihoods.[20]

**REFERENCES**


[1] "Urbanization". MeSH browser. National Library of Medicine. Archived from the original on 16 March 2016. Retrieved 5 November 2014. The process whereby a society changes from a rural to an urban way of life. It refers also to the gradual increase in the proportion of people living in urban areas.

[2] "Urbanization in". demographic partitions. Archived from the original on 22 October 2018. Retrieved 8 July 2015.

[3] Tacoli, Cecilia (2015). Urbanisation, rural-urban migration and urban poverty. McGranahan, Gordon, Satterthwaite, David. London: International Institute for Environment and Development. ISBN 9781784311377. OCLC 942419887.

[4] "Urban life: Open-air computers". The Economist. 27 October 2012. Archived from the original on 5 September 2017. Retrieved 20 March 2013.

[5] "Urbanization". UNFPA – United Nations Population Fund. Archived from the original on 26 May 2020. Retrieved 11 May 2015.

[6] Barney Cohen (2015). "Urbanization, City Growth, and the New United Nations Development Agenda". Vol. 3, no. 2. Cornerstone, The Official Journal of the World Coal Industry. pp. 4–7. Archived from the original on 27 June 2015. Retrieved 26 June 2015.

[7] Dutt, A.K.; Noble, A.G.; Venugopal, G.; Subbiah, S. (2006). Challenges to Asian Urbanization in the 21st Century. GeoJournal Library. Springer Netherlands. ISBN 978-1-4020-2531-0. Retrieved 22 March 2022.

[8] Sridhar, K.S.; Mavrotas, G. (2021). Urbanization in the Global South: Perspectives and Challenges. Taylor & Francis. ISBN 978-1-000-42636-6. Retrieved 22 March 2022.

[9] Gries, T.; Grundmann, R. (2018). "Fertility and modernization: the role of urbanization in developing countries". Journal of International Development. 30 (3): 493–506. doi:10.1002/jid.3104.

[10] Gu, Chaolin (2019). "Urbanization: Processes and driving forces". Science China Earth Sciences. 62 (9): 1351–1360. Bibcode:2019ScChD..62.1351G. doi:10.1007/s11430-018-9359-y.

[11] Introduction to Social Macrodynamics: Secular Cycles and Millennial Trends. Archived 18 September 2018 at the Wayback Machine Moscow: URSS, 2006; Korotayev A. The World System urbanization dynamics. History & Mathematics: Historical Dynamics and Development of Complex Societies Archived 29 February 2020 at the Wayback Machine. Edited by Peter Turchin, Leonid Grinin, Andrey Korotayev, and Victor C. de Munck. Moscow: KomKniga, 2006. The World System urbanization dynamics. History & Mathematics: Historical Dynamics and Development of Complex Societies Archived 29 February 2020 at the Wayback Machine. Edited by Peter Turchin, Leonid Grinin, Andrey Korotayev, and Victor C. de Munck. Moscow: KomKniga, 2006. ISBN 5-484-01002-0. P. 44-62

[12] "Urbanization over the past 500 years". Our World in Data. Archived from the original on 14 March 2020. Retrieved 6 March 2020.

[13] Stephens, Lucas; Fuller, Dorian; Boivin, Nicole; Rick, Torben; Gauthier, Nicolas; Kay, Andrea; Marwick, Ben; Armstrong, Chelsey Geralda; Barton, C. Michael (30 August 2019). "Archaeological assessment reveals Earth's early transformation through land use". Science. 365 (6456): 897–902. Bibcode:2019Sci...365..897S. doi:10.1126/science.aax1192. hdl:10150/634688. ISSN 0036-8075. PMID 31467217. S2CID 201674203.

[14] Andrey Korotayev and Leonid Grini (2006). "The Urbanization and Political Development of the World System: A comparative quantitative analysis". In Peter Turchin; Leonid Grinin; Victor C. de Munck; and Andrey Korotayev (eds.). History & Mathematics: Historical Dynamics and Development of Complex Societies. Vol. 2. pp. 115–153. Archived from the original on 16 August 2021. Retrieved 23 June 2016.

[15] "Industrial Revolution | Definition, History, Dates, Summary, & Facts". Encyclopedia Britannica. Archived from the original on 31 October 2020. Retrieved 29 October 2020.

[16] Christopher Watson (1993). K.B. Wildey; Wm H. Robinson (eds.). Trends in urbanisation. Proceedings of the First International Conference on Urban Pests. CiteSeerX 10.1.1.522.7409.

[17] Annez, Patricia Clarke; Buckley, Robert M. (2009). "Urbanization and Growth: Setting the Context" (PDF). In Spence, Michael; Annez, Patricia Clarke; Buckley, Robert M. (eds.). Urbanization and Growth. ISBN 978-0-8213-7573-0. Archived (PDF) from the original on 25 May 2017. Retrieved 9 November 2013.

[18] Reba, Meredith; Reitsma, Femke; Seto, Karen C. (7 June 2016). "Spatializing 6,000 years of global urbanization from 3700 BC to AD 2000". Scientific Data. 3: 160034. Bibcode:2016NatSD...360034R. doi:10.1038/sdata.2016.34. ISSN 2052-4463. PMC 4896125. PMID 27271481.

[19] "Research Data–Seto Lab". urban.yale.edu. Archived from the original on 18 May 2019. Retrieved 9 July 2016.

[20] "The History of Urbanization, 3700 BC – 2000 AD". YouTube. Archived from the original on 30 October 2021. Retrieved 24 September 2018.