The Future of Urban Water Supply Utilities

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Abstract:
The main theme of this paper is a better understanding of possible scenarios into the future, including implications for future infrastructure, governance and customer experiences. How can we meet the water needs of a rapidly growing urban population? Can we meet water demand and provide equitable water supply services in urban areas of a world increasingly facing water scarcity and environmental degradation? How can we achieve these challenges without further compromising the planet’s ecosystem? How wide a range of social, technological, economic, environmental, and political trends could shape the future of urban water supply in a world of increasing uncertainty and with a future most likely will be different from the world of today? What scenarios would help us better understand pathways into the future and enable discussions about how we can influence and shape future direction? Who will manage, control and be responsible for water resources in the future? How to face challenges of water utilities which include meeting future water demand in a changing climate, managing diverse sources of supply, ensuring the health of water ways and ecological systems, maintaining the affordability of water services and reducing the footprint of urban water supply and use? Would urban water utilities make innovation and investment decisions that maximize opportunities to provide services of value, while mitigating future risks and uncertainties taking into consideration consumption for agricultural purposes and the remainder for household, industrial, and commercial uses? The fact still remains that in urban areas, the main driver for demand is the population and its growth.
Understanding trends and planning for the future are essential for water supply utilities to create engaging customer experiences, enhance the livability of urban areas and get more of their current and future assets. Scenarios to explore the viability of different strategies, inspire innovation and assist in long-term planning for more sustainable and resilient urban water systems have to be used.
This paper aims at the water sector, water supply utilities, governments, cities, communities, individuals, and organizations interested / involved in shaping rather than predicting the future of urban water supply.
Implications Across Scenarios:
A) Customers Interests:
1. Focus on services that are user-centric and provide greater personal choice and control over service levels and pricing.
2. Emphasis on creating a seamless experience across multiple integrated utilities, including shared billing, pricing and services.
3. Greater focus on services that enable customers to manage and maintain autonomous water systems at building, community or cluster level.
4. Development of applications to provide customers with real-time data and information about water consumption, availability and pricing.

**B) Infrastructure Development:**
1. Increased deployment of digital infrastructures and data analysis to manage, reduce or eliminate systems’ peaks and fluctuating demand patterns.
2. Integration and sharing of assets and infrastructure across multiple utilities, including water, energy, waste and telecommunications.
3. Provision of planning and infrastructure services that enable communities to develop, run and maintain autonomous urban water systems.
4. Expansion of water systems to manage and minimize the impact of extreme fluctuations in water availability, including fast shifts from too much to too little.

**C) Governance:**
1. Higher levels of cooperation between water, energy and telecommunication companies with a focus on integrated planning and maintenance.
2. Better cooperation between urban utilities through collaborative planning, integrated asset management, shared protocols and open data.
3. Operation of autonomous systems and small scale water networks through cooperatives, virtual networks and community platforms.
4. Implementation of differential water pricing and services according to availability of supply, service plans and customer behavior.

All mentioned here above require incremental improvements, working together, autonomous communities and survival of the fittest / best. According to World Economic Forum, 2014; “Water security is one of the most tangible and fastest – growing social, political, and economic challenges being faced today. It is also a fast – unfolding environmental crisis. In every sector, the demand for water is expected to increase and analysis suggests that world will face a 40% global shortfall between forecast demand and available supply by 2030.”

**Global Water Situation:**
The World Economic Forum’s report “Global Risks 2014”identifies water crisis as one of the top five global risks posing the highest concern. Water crises were ranked as the third biggest risk in terms of impact; however, strictly speaking, four of the identified top 10 risks are water-related, namely: (i) water crisis, (ii) climate change mitigation and adaptation,(iii) extreme weather events, and (iv) food crises. In addition to increasing water scarcity and pollution, rapid population growth and urbanization are major factors posing fundamental challenges to the global hydrological / water cycle with a particular pressure on the urban water supply. Since 1950, cities have increased their water usage five-fold, not only through population growth but considerably through increased per-capita demand. Cities increasingly struggle to access enough water supplies in order to sustain their population, and currently, half of the world’s cities with more than 100,000. Inhabitants are situated in areas experiencing water scarcity. Meanwhile, there is increased de-coupling of urban and rural systems and diminishing holistic consideration of the global water cycle, with urban areas being considered as isolated entities. Overlaying and intensifying all of these pressures is
climate change, including rising temperatures, extreme weather events, rising sea levels, and reduction in river discharges / flows and groundwater levels. The exploding global demand for water – heavy goods including food and technological products is another critical factor, with agriculture already responsible for around 70% of fresh water use. The 2030 Water Resources Group predicts a global gap between safe fresh water demand and supply of 40% by 2030 if business-as-usual water management continues, thus not supporting the predicted population. With a possibility for water depletion and increasing competition through scarcity, new thinking and new ways of managing water become fundamental.

Drivers of Change:
Around 100 trends of the global drivers of change linked to the future of urban water utilities, including the future of urban water access, supply and services were identified from global megatrends to sector – specific drivers. A full list of drivers designed as workshop cards, researched and written by Arup’s Foresight+ Research + Innovation team, is shown in the diagram (Fig. 1) in the next page. The responses to these drivers will be critical in determining the nature of urban water supply in the future. Furthermore, businesses operating in this world of rapid social, technological, economic, environmental and political changes face a number of uncertainties and challenges. Drivers of change assist in identifying risks and opportunities and help well understand the long-terms issues, preparing for the world ahead.

Trends and Drivers
1. Social
1.1. Population Growth and Increasing Urbanization:
The global population is expected to reach around 9.5 billion in 2050. At this point, the population will still be growing but the rate of growth will have slowed. An estimated 90% of population growth is expected to occur in the cities of the developing world. It is estimated that the global urban population is growing at 2 people per second; adding around 173,000 new city-dwellers every day. This rapid urbanization means that by 2050 around 70% of the global population will be urban dwellers. Population growth and urbanization pose great challenges to utilities- they must serve more people while facing greater scarcity of resources. Increasing demand will heighten focus on water conservation and re-us. There will be a need to manage and influence demand through behavior change and to increase the efficiency of the system; which involves understanding its squeezing points, investigating new technologies and providing incentives for behavior change. Another factor is an ageing population due to an increase in life expectancy. As total birth rates decline, the impact of the baby-boomer generation is highlighted with an increasing proportion of the older generations. By 2050, more than 20% of the global population will be 60 years old or more. This demographic change could lead to the need for different shifting services such as water for health care provision. More people at home and not working due to retirement could have an impact on services and the reporting of service interruptions. Affordability of water services could also be affected.
Sustainable Behaviors and Healthy Lifestyles

Rising global consumption of raw materials is intensifying resource scarcity and competition for resources. With increased awareness of environmental concerns and greater global regulation, individuals and corporations are attempting to engage in more sustainable behaviors. There is also a trend towards increasing self-responsibility for health and wellbeing. Greater concern for the environment and health means that water companies / utilities will be held to account for environmental impacts and water quality. There will also be greater scrutiny of the use of water in urban landscapes and access to good quality water in public spaces. There will also be greater scrutiny of how new technologies and new products affect water supply (e.g. micro plastics). However, people all over the developed and developing world seem to live with contradiction; they express concern about the environment yet live materialistic lifestyles that result in high levels of waste and most of this
waste is food-related. When considering the amount of water used in producing food, food waste is simultaneously a waste of water. This is especially true when considering the globally increasing meat demand—it takes 13,220 liters of water to produce one kilogram of beef compared to 900 liters of water for one kilogram potatoes. The United Nations Food and Agricultural Organization forecasts global meat production to increase by 65% in the next 30 years.

1.2. Digital Lifestyles

The digital lifestyle increasingly links consumers’ life to the internet. Smart phones are becoming the hub of our digital lifestyles; allowing us to constantly connect to social media, work and leisure activities. Mobile subscriptions in 2014 almost equal the earth’s population and the number of people using social media almost doubled in 2017 reaching around 2.5 billion. This connectivity also means that traditional models of ownership are changing. The trend towards a shred economy of service provision rather than product ownership means, for example, that consumers are increasingly likely to purchase access to a car rather than buy their own car. With growing connectivity and smart technology such as smart phones, people will be able to monitor the consumption and cost of water in real time. More awareness of the issue could lead to increased scrutiny of water utilities and pricing of services. The availability of data provides an opportunity to educate customers about consumption and managing resource use. The possibility of technology to allow urban water trading could result in changes to demand system characteristics.

2. Technological
2.1. Smart Infrastructure and Large-Size Data

Smart infrastructure responds intelligently to changes in its environment to improve performance. It is estimated that the market size for smart grid technologies will almost triple by 2030. Smart water networks could save the industry US$ 12.5 billion a year. Some utility companies around the world collect information supplied by electronic sensors and meters dotted around a water company’s supply network to build a sophisticated picture of how the network is performing. It can spot anomalies in its behavior; from a small leak to a burst water main. Many organizations are already using large-size data techniques and advanced analytics to manage complex processes and supply chains. It is expected that there will be a 4300% increase in annual data generation by 2020 and more than a third of the data produced will live in or pass through the cloud. The analysis of big data can provide valuable information to help identify innovation opportunities, transform the management of assets, enhance interaction with customers and suppliers, and ensure that key risks to a business are proactively managed. The integration of different sets of data from utilities will provide business insights. For example customer data will provide insights on service needs and expectations. Information such as this can be a competitive advantage for utility providers. The connection of a huge range of devices, sensors, and machines to the internet will enable new technologies and innovation to spread and multiply. Currently, 99% of physical objects that may one day be a part of this network are still unconnected. Digital infrastructure is however, growing exponentially and an important part of a nation’s strategic infrastructure. In the UK, it is estimated that digital infrastructure contributes 102 billion pound in gross value-added and employs over 2.5 million people. These technologies enable the delivery of many
services by both the private sector and government. Digital infrastructure enables large-size data and broadens the base of data acquisition. There is, however, a threat from technology reliance and exposure to external control.

2.2. Advanced Technologies and Innovation

(a) **Nano-and Biotechnology** can enable breakthrough products and technologies to tackle pressing global challenges, such as reducing environmental footprints, using less and cleaner energy, and decreasing water usage and waste generation. For example, microorganisms are being used to treat water that has been contaminated by hazardous waste. The global market for non-structured products used in water treatment was worth an estimated US$1.4 billion in 2010 and reached about US$2.1 billion in 2015. This is an area that could be a game changer for the water industry, allowing use of more water sources. It could help in tackling scarcity, quality and distribution. It also raises the possibility of the utility as self-healing ecosystem. Nanotechnology is being used to develop solutions to three different problems in water quality. One is the removal of industrial water pollution from groundwater. The second concerns the removal of salt or metals from water. The third involves a Nano filter to remove virus cells from water that standard filters cannot eliminate. Nanotechnology will change the methods used to purify water and therefore the infrastructure required for water treatment.

(b) **Intelligent Robots** will play a greater role in the inspection of infrastructure such as tunnels and bridges, and in the efficient maintenance of ageing structures. Smart robots are being used to repair and retrofit ageing water pipes, while crawling robots can test load-bearing cables and tethers of bridges, elevators and cable cars.

(c) **New Materials** that are lighter, stronger, smarter and greener. Materials like graphene, which is revolutionary in its strength, flexibility, and conductivity, could have numerous applications and support completely new structures. Recently developed cellulose fibers stronger than steel but made from natural materials and biodegradable could revolutionize the materials industry. Maintenance costs are significant for the water sector, especially as the infrastructure ages. New materials could provide greater resilience and less energy and lower cost. Advances could lower the cost of infrastructure and new and new products.

2.3. New Solutions for Water Supply

About 96% of the earth’s total water supply is found in oceans, and there is broad agreement that extensive use of desalination will be required to meet the needs of a growing world population. Worldwide in 2014, desalination plants are producing over 32 million cubic meters of fresh water per day. However, energy costs are currently the principle barrier to its greater use. As limited water supplies come under pressure, businesses are turning to Technological Innovation. New technologies are promising to transform wastewater into a resource for energy generation and humidity into a source of drinking water. Devices for extracting drinking water from air and other devices such as Fog Catchers / thick mesh nets for collecting water contained in fog have been successfully implemented in many areas of low rainfall. New Technologies are likely to broaden the source and use of water and its by-products, while new methods of treatment also enable decentralized treatment centers. However, water treatment can come at a high price. Technological innovation and data
analytics capability are fundamental to the future of the water industry, and there is an opportunity for water utilities monitoring and net to get better at real–time monitoring and network optimization.

3. Economic

3.1. Finance and Investment

(a) **Infrastructure Finance** has become a global business. While most infrastructure investments are normally local, the sources of finance are increasingly global. The (OECD) has estimated that around US$ 50 trillion would be needed worldwide during the period up to 2030 to satisfy the global demand for infrastructure. However, accessing sources of funding is an increasing challenge. The cost of infrastructure could lead to the financial re-cycling of assets and capital where old assets are sold or leased to fund the new. It could also lead to greater application of the **Circular Economy**, which will help stretch resources through end-of-life e-cycling and re-use; new technologies and processes are increasing ability to re-cycle more and more material goods. With growing concerns around water scarcity, environmental pollution and upgrade and infrastructure costs, users will likely have to pay the real cost of water in the near future. Water prices will reflect the full cost of water services, and companies will need to integrate the true cost of water into their decision making.

(b) **User Centricity and Open Innovation:** As business strives to differentiate itself and customer expectations increase, the need to innovate around the **consumer experience** is becoming a critical factor for good design. As a result, **user-centered design practices** are becoming the de facto methodology in product design and services, including influencing the design of the built environment. Water services could become more individual and tailored to user needs. This could result in a move from an asset-based focus to a customer-centric view – for example, data is currently collected at a property level and not at an individual level. This trend highlights a need to customize service, products and prices, and to be more responsive to customer preferences. More and more companies are tapping into the public’s intellectual capital by “crowd sourcing” product ideas and solutions. In exchange they are giving creative consumers a direct say in what gets developed, designed or manufactured. **Crowd funding** was expected to add at least 270,000 jobs and inject more than US$65 billion into the global economy by the end of 2014 and the industry was expected to grow by 92% in 2014. The desire for greater choice and more customized services can lead to greater complexity. For water utilities this could mean a different way of doing business that challenges traditional thinking and processes to include more engagement with the public, more transparency, and shared ownership, responding to new ideas, forming partnership, and engaging with customers through social media.

(c) **Resources Availability and Production Efficiency:** With increasing scarcity and cost of natural resources, efficiency is a driving force for manufacturing companies. Manufacturing expenditures on raw materials, energy and water can be as much as 50% of total manufacturing costs. **Green manufacturing** can improve energy productivity and operational efficiency by switching to less water-intensive equipment and minimizing waste. Another way of increasing efficiency is through coopetition which occurs when companies forge alliances across traditional boundaries, for example in order to share common costs. The auto industry
has used coopetition to a great effect as evidenced in the teamwork of Peugeot and Toyota in 2005, where shared components were created for a new city car. In the water industry coopetition manifests as knowledge sharing and contributions to joint research and development across catchment boundaries rather than competitive boundaries. Coopetition could enable utilities to be more agile through the sharing of experiences and by not holding a monopoly on good ideas, as a pooled resources can drive efficiency and innovation. Coopetition could move the idea of the smart house and smart city closer to reality. Through using resources more efficiently, countries could become active trading partners.

(d) Water Trading allows for the re-distribution of water among users. As the amount of water used in agriculture in arid regions is two to three times higher than in rain-fed regions, water trade could help save water on a global scale. This could include a global water balance concept, similar to carbon emissions reduction strategies, where water saved in one country offsets additional water use in another. At present, physical water trading typically occurs only in connected catchments where a water balance can be calculated and maintained. Water quotas and trading could extend this beyond adjacent regions.

(e) Commodity Prices have increased sharply since 2000, erasing all the declines of the 20th century. Prices for a range of raw materials are likely to remain high and volatile as global resource markets oscillate in response to surging global demand and inelastic supplies. This could drive up the cost of living and put pressure on water utilities to reduce the cost to the customer. Agriculture in arid and semi-arid countries is the main consumer of water supplies accounting for 65 – 70% of total water consumption. Commodity prices and resource scarcity also place greater focus on virtual water and embedded water. Virtual Water is the amount of fresh water used or polluted for the production of industrial products and food. There is growing recognition of virtual water being transferred from one region to another as a result of product trade. Some experts argue that importing virtual water can be a valuable solution to water scarcity. Embedded Water is the water used to produce food and other products. For example, it takes 13,220 liters of water to produce one kilogram of beef, 1,004 liters of water to produce one liter of wine and 50 liters of water to produce one orange. Increasing demand for water-intensive products could lead to water security issues. Consumers’ education could lead to a demand for goods produced with as little impact on water resources as possible. Urbanization is one of the key factors affecting growth in energy demand. World energy consumption is projected to grow by 56% between 2010 and 2040. Renewable energy and nuclear power are the worlds’ fastest –growing energy sources, each increasing 2.5% per year. However, fossil fuels will continue to make up nearly 80% of global energy use through 2040. Approximately 90% of global power generation is water intensive. Therefore, a country’s energy mix has fundamental implications for its water industry. Furthermore, resource re-cycling such as waste-to-energy or waste – to – product, offers an opportunity for growth as well as opportunities for private sector involvement.

4. Environmental
4.1. Climate Change and Climate Resilience
Climate Change has led to changes in climate extremes including increasing temperature variability and more heat waves with record high temperatures. It also includes increasing rainfall variability with heavier, shorter duration storms/events along with extended droughts, it is, for example, 90% to 100% likely that heat waves will increase in length, frequency and intensity over most land areas. Sea Level Rise is also a concern around 10% of the world’s population in coastal areas less than 10 meters above sea level, and therefore vulnerable to rising sea level. Climate change policy has developed around two themes, namely: mitigation and adaptation. Mitigation is tackling the cause of climate change through the reduction of greenhouse gas emissions. Adaptation is adjusting to the impacts of climate change, by reducing vulnerability and increasing resilience. Both bear an economic cost, and both approaches will shape efforts to avoid the worst of climate change. Due to the irreversible impacts of climate change, climate resilience has become critical. This is particularly vital in built-up urban areas, where challenges such as population growth, poverty, disease and pollution are exacerbated by the impacts of climate change. Water supply utilities need to assess their storm water and sewer systems capacities due to intensifying storms and increased rainfall. The requirement for systems to be resilient could lead to a new lens for decision making; looking at new risks with new measurements. Resilience includes understanding the integration of water systems with other systems. Looking beyond water systems at wider concerns will increase complexity in thinking.

4.2. Green Infrastructure and Ecosystem Services

Sustainable Urban Development cannot be achieved without recognizing the vital role of the natural environment and its fundamental impact on economic prosperity, health and wellbeing. According to the Millennium Ecosystem Assessment, 60% of evaluated ecosystems are in a state of degradation or non-sustainable usage. Green Infrastructure is the network of green and blue spaces such as parks, agriculture, woods, rivers, ponds in and around cities. Benefits of increased green infrastructure include the reduction of flood risk, improved health and wellbeing, as well as providing habitat for wild life. Extensive green networks can be formed overtime to create an encompassing “City Ecosystem” that can support the sustainable movement of people, rebuild biodiversity and provide substantial climate change adaptation. Ecosystem Services are benefits arising from natural ecosystems such as water purification, groundwater recharge preservation of biodiversity, pollination and decomposition of waste. While these services are seemingly free, the estimated economic value of ecosystem services from aquatic biomes, marine and fresh water, makes up about US$27 tr. Per year compared to the total economic value of ecosystem services of US$33 tr. Per year. Protecting ecosystems and achieving balance and equilibrium requires a systems approach and integration with other networks. In urban areas, solutions like wet lands will need to become more commonplace as essential hard-working city components to deliver storm protection, buffering and filtration, cleaning and purifying urban water through natural processes. These features can also support attractive and significant wild life areas to increase a city’s biodiversity. Large–species trees also form a vital component of a green infrastructure city ecosystem, as they deliver multiple benefits including acting as carbon sinks. They absorb huge amounts of carbon dioxide (CO2) from the atmosphere and convert it to oxygen; helping create healthier and liveable cities for urban dwellers. They also intercept rainfall and increase the capacity of underlying soil to absorb water.
4.3. Environmental Pollution

Pollution is the release of chemical, physical, biological or radioactive contaminants to the environment. Pollution of surface water is a problem for over half of the world’s population. Each year 250 million cases of water-borne diseases are documented, with roughly 5 to 10 million deaths. Integrating natural systems into the built environment enables the capturing and storing of water for re-use and removing pollutants.

5. Political

5.1. Water Security, Access and Pricing

Water Security is the capacity of a population to access sufficient water to meet all its needs and to limit the destructive aspects of water. It involves both the productivity and destructivity of water. By 2030, almost half of the global population of 7.5 billion people is predicted to live in areas suffering from severe water scarcity. Compared to current figures, this reflects an increase of over one billion people experiencing a lack of water. Water Pricing is being recognized as an acceptable policy instrument to respond to increasing water scarcity. Diversifying water sources helps to secure water supply systems against droughts and floods. Alternative supply options include recycling existing water such as sewage and storm water, as well as manufacturing new water through desalination. However, initiatives to secure or conserve water supply- such as water restrictions, dam expansion, water recycling or desalination- carry social consequences and costs; but how they will be managed in the future with respect to decentralization and scale will become an important consideration.

Water Policy and Regulation are typically determined on a state or national rather than international level. The fixed nature of water supply infrastructure and its history as an essential government-supplied service gives rise to natural monopolies within supply areas. This led to the desire by governments to protect consumers against the abuse of this monopoly and therefore to regulate the pricing of water. Governments, however, need to ensure the pricing policy is appropriate to balance the essential need for water; the impacts on consumers (particularly those on lower incomes) and the requirement that the suppliers remain financially viable.

5.2. Waste Minimization

Human kind is producing more waste than the environment can absorb. More than 400 million tons of hazardous wastes – wastes that can cause substantial threats to our health and the environment – are produced each year (almost 60 kg for every person in the world. Waste minimization aims at eliminating waste before it is produced in order to reduce the quantity and toxicity of waste. Prevention is the primary goal, followed by reuse, recycling, treatment and appropriate disposal. Minimizing waste can increase efficiency and save resources and energy. Although waste minimization is often the top priority of governments, in most countries the focus remains on recycling. Companies can focus on zero waste– a philosophy / concept that encourages system redesign so that all products are reused or recycled.
5.3. Public Opinion and Engagement

A strong international consensus now exists among scientists that human – made climate change is a reality and warrants serious action. Global Public Opinion varies on the issue. If were to shift markedly, for example in response to a major climate change event, then politicians may force through aggressive legislation to constrain emissions further. Changing customer expectations on levels of service could force a policy intervention. Engagement with Customers, education and information can have a large effect on water demand management. Changes in water consumption or increasing the water efficiency of appliances / water saving devices can result in a large reduction of water use. Using a low-flow shower head can save 60 liters of water during a 10-minute shower. Gamification is a growing method of engaging with customers. It refers to the application of game-design techniques to non-game applications to make them more fun and engaging. Stakeholder Engagement is another tool to help companies and organizations find out what social and environmental issues matter the most, in order to improve decision-making and accountability. Stakeholder engagement can be a powerful tool in agreeing on solutions to complex issues. It gives stakeholders a say in decision-making, rather than just being informed of the decisions.

Scenarios

Scenarios provide a unique opportunity to explore and compare alternative plausible futures. They are an effective engagement and communication tool that enables us to gain a better understanding of possible pathways towards the future of urban water utilities, including the roles of different stakeholders and alternative system designs. Future scenarios build upon a well-grounded understanding of current and future trends and global benchmarks. They present a tool of strategic thinking through which we are able to make sense of uncertainty and explore future options. Scenario modelling enables businesses to develop robust and resilient business strategies as well as meaningful stakeholder engagements. The scenarios in this paper are intended to picture possible future worlds while describing the challenges and opportunities facing the water sector specifically, as well as the global water / hydrological cycle in general. Scenarios assist in identifying and developing actions and strategies towards achieving a preferred future.

(a) Scenario Assumptions

Informed assumptions, derived from those drivers of change that are most likely to occur and form the baseline for the future scenarios. All scenarios are based upon these overall assumptions, making it possible to explore and compare different futures under clearly defined conditions: (i) Developed world: Scenarios take a developed economy as a baseline; (ii) Urbanization: Continuing growth of urban populations; (iii) Climate Change: Evidence of increasing frequency and intensity of extreme weather events; (iv) Volatility: Volatility in supply of water resources and overall increasing resource scarcity; (v) Efficiency: An efficient management of the utility is assumed; independent of who owns it; and (vi) Smart Utilities: A shift towards smarter utilities and technological progression is assumed.

(b) Matrix and Key Variables

To outline the future of urban water utilities, the two critical key variables representing major uncertainties were identified; they fundamentally define the future of urban water utilities, systems and experiences.
(b.1) Centralized Vs. Decentralized System: The degree to which services and utilities are operated from a central point or from several separated locations.
(b.2) Separated Vs. Integrated Utilities: The level to which utilities are cooperated across different types of infrastructure. Integrated which is a symbiosis of a variety of infrastructure, eg. Water, energy, food. Separated which is isolated consideration of infrastructures without acknowledging potential interrelations.

**Conclusion**
Future foresight is becoming the lifeline of business worldwide, where the tidal waves of change are sweeping the most established of structures. Survival in this age requires the tact, talent and technique of predicting the future. It is the estimation of the unknown future demand for the purpose of production operations planning. It is an art or science of predicting or estimating the future demand for a product (in this case water) undertaken for the purpose of long-term decisions and planning through determining how much of what products are needed when, where and for how long. It incorporates a study of the trend of trends. Foresight is a skill we use every day that allows us to consider a problem, explore options, run mental movies and in so doing develop possible strategies and desired future outcomes. Foresight as a sub-discipline of future studies uses a systematic approach to explore how complex issues could evolve. Foresight tools help people share, explore and test their mental models about how the world is changing and what it could mean for their organizations. Foresight refers to processes of anticipation and is a part of strategic thinking designed to open up an expanded range of perceptions of the strategic options available.

Strategic foresight is a planned-oriented subset of foresight that helps policy makers improve the effectiveness of government by identifying opportunities and threats that may arise over the coming years and decades, as well as possible strategies to deal with them. Strategic foresight differs from traditional planning in that it considers plausible, possible, probable and preferred futures equally.

Additionally, where traditional planning tends towards robustness— that is trying to prevent failure—foresight favors resilience which is about early detection and fast recovery.

**List of References**
7. Foresight as a Strategic Long-Term Planning Tool for Developing Countries. (2014). [EBook] UNDP. Available at:


