Blue Covenant: Planning strategies for water conservation

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Abstract. Safe, clean and ample freshwater is vital for the endurance of all living organism and the smooth performance of ecosystems, economies and communities. A decline in the quality and quantity of water is now a global concern as the population grows, agricultural and industrial activities expands, and climate change hovers to cause alterations to hydrological cycle. By 2050, an expected 40\% of the world’s population will live in severely water-stressed conditions. Due to the increasing demand in both rural and urban areas, it has led to disputes and tension over command and sharing over water resources. Hence, water scarcity is a complex issue, which deserves an urgent global attention. In this context, this paper attempts to understand the various factors affecting the water scarcity of area and the different water conservation strategies adopted in Cape Town and Israel. The outcome of the paper focussing on what are the factors /sectors to be considered while framing the planning strategies of water conservation an area.

1. Introduction
Water is indeed a vital resource, which is required to safeguard food security, maintain organic life, livestock, to conserve environment and biodiversity and industrial production. Scarcity of water refers to shortage of water resource to meet with the increasing water demand. It is even being stated in Composite water management index (CWMI) a report by NITI Ayog, which claims that 21 Indian cities will run out of groundwater by 2020, which will affect nearly 100 million people \textsuperscript{[1]}. Hence, water scarcity being a major issue, which needs to be dealt with at the earliest. Therefore, this study aims to understand the reasons for water scarcity through different summits, policies and case studies. This study will help in planning for an area concerning the available resources. The outcome of this study is to practice different methods, which can be followed to reduce the intensity of water scarcity and less dependency on the available resources.

2. Water Scarcity and its Factors
In 2019, World Economic Forum stated that within next 10 years based on potential impact the largest global risk would be water scarcity. Some factors inducing water scarcity are given below.

\begin{enumerate}
\item \textbf{Physical Factors}
Geology, which refers to the location of water storage, aquifers and ground water. Climate refers to the change in rainfall, snowfall and rates of evaporation and Water bodies refer to the change of watercourse, can dry up, pollution of water bodies.
\end{enumerate}
2.2. Human Factors
Pollution of water supplies by discharge of untreated raw sewage from industries and households, agriculture runoffs. Human littering. Overuse of Water.

2.3. Economic Factors
Population refers to increase in demand and supply. Urbanization refers to the impact on the physical environment.

3. International Concerns on Water Conservation and Policies

3.1. World Water Summits I
The World Water Summit I, which was held in New on 21-23 August 2018. It focused on Nature for Water- Solution to the Water Challenges. It will synergies between water security and economic prosperity, finance and technology to deliver clean and safe water solutions for both industries and utilities.

3.2. World Water Summits II
The World Water Summit II, which was held in Geneva on 7-8 February 2018. It focused on Leaving No One Behind. It provides a dynamic platform for bringing real projects and funders together in an engaging manner.

3.3. World Water Summits III
The World Water Summit III, which was held in New Delhi on 24-26 August 2019. It focused on water management locally and globally. It will initiate an interaction between both industries and utilities.

3.4. Salient Features of National Water Policy (2012)
Emphasis on need of a national water framework law. Ecological needs of the water resource should be determined that portion of the water resource flows to be kept aside to meet its ecological needs. Water, after meeting the needs of people for safe drinking, food security, sanitation, etc. should be considered as an economic good for promoting its efficient use and conservation. Adaptation of strategies based on climate change for management of the water resources structures. Setting up of a Water Regulatory Authority. Removal of large disparity in prerequisite for water supply. Water resources projects and services should be managed with community participation [2].
4. Case study on water conservation strategies - Cape Town

4.1. Cape Town
In 2015, Cape Town won a prominent International award recognizing their efforts and measures that they took for Water Conservation and Demand Management (WCWDM). Cape Town reduced successfully its water use by more than 50 percent during the drought in 2015 - 2018. 2019 was a recovery year for Cape Town after having successfully emerged from the severe drought.

4.2. Brief about Cape Town
Cape Town is known for being a port city in South Africa’s southwest coast. It is the capital of South Africa. The city is well known for its harbour. Cape Town’s topography consists of an extensive coastline, rugged mountain ranges, coastal plains, inland valleys and semi-desert fringes. It is spread in total area of 400.3 sq. km, total population of 37,40,026, total households are 10,68,572 and household size as 3.50 person. It has Mediterranean climate with mild winters and pleasant summers. Summers range from 15 to 27°C and winters range from 7 to 20°C. Moderate rainfall is about 788mm per year. The factors that induced water scarcity in Cape Town are its physical and economic factors. Lack of rainfall led to reduction of water in water bodies and the gradual increase in population and urbanization being the major reasons for increasing demand for water.

4.3. Sources of Water
The Western Cape Water Supply System (WCWSS) Company has control over the water sources. Wemmershoek Dam & Upper Steenbraas Dam serve municipal and industrial sector. Theewaterskloof Dam is the largest dam with 41% of the water storage capacity available to Cape Town. Voelvlei Dam is the second largest capacity of dams in the WCWSS. Lower Steenbras Dam has a hydroelectric plant, which supplies Cape Town electricity supply during peak demand. Berg River Dam captures the winter rainfall and store it to supply during the dry summer months [3,6].

4.4. Water usage and Quality
Agriculture sector is the largest users of water at 63%. The major water is for irrigation of crops and water-intensive grazing of livestock. The second users are the Municipal sector; which uses 26% of water supply. Major uses include gardening, toilets, washing & personal hygiene. The third and lowest users are the Industrial sector; which uses 11% of water supply. The major water uses include manufacturing applications like processing of minerals & crops, textiles, chemical refinement, component and auto supplies. Mining and power applications like extraction, refining, and cooling. Water quality of Cape Town is improving accordingly [3,5].

4.5. Concerns
Economic sector faced decrease in visitors. Nurseries were restricted on municipal water usage, which led to reduction in demand for garden plants. Environment sector faced low water levels in dams.
Habitats and ecosystems were destroyed for agriculture land. Water pollution due to fertilizers, poorly treated sewage. Social sector faced concerns like increase of private access to groundwater via boreholes. Increase of fire risk due to dry weather so does environment and infrastructure. An estimate of 50,000 people suffered job losses and pushed below the poverty line [4].

4.6. Measures Taken
Government have installed water management devices in all households with taps. It allowed basic water allocation for non-paying users, but cut off supply in case of leaks or excessive use. Block tariffs were introduced where households using more water paid a higher rate than those using less. Introduction of water demand management efforts, including increased penalties for high volume users, an extensive communication campaign, and installations of Water Metering Devices in households. Phase 1: Preservation restrictions: Cape Town to cut its water use by 40%. Phase 2: Disaster Restrictions: when dam levels dropped to 13.5%. Day Zero was activated with strict water rationing to make water last at least 3 months before hitting 10%. The City would turn off supply to private taps and direct citizens to municipal water collection sites. Phase 3: Disaster Implementation: Collection sites would offer ground water and bottled water for drinking purposes only. Water supply focused only on domestic sector, which consumes 70% of the city's water [5,6].

4.7. Policy Recommendations
Long-term supply side augmentation and diversification. Proper information provided to people through messaging and communication. Permanent and complete changes in water usage. Actionable early warning system development. Sensitivity to different sections of society. Cooperation between different levels of government. Climate change mitigation policy. Incentivize water reduction while maintaining financial solvency of water utility providers [5,7].

4.8. Inference
There are three interlinked lessons to be learnt from the measures taken to promote efficient water use. First Lesson Learned is water governance should be inclusive. Second Lesson Learned is water governance requires coordination among all sectors. Third Lesson Learned is development needs were to be accounted for Government; as the regular service provision and new supply sources needs regular funding.

5. Case study on water conservation strategies - Israel.
Israel was battling its worst drought once but now has become a water-exporting country due to water conservation measures and technological advancements. Even after being 60% desert and lacking primary resources of water, Israel became the world’s leader in water conservation and reuse, recycling approximately 80% of its water.
5.1. **Brief about Israel**

Israel belongs to the Asian continent. Its western border is the Mediterranean Sea. Lebanon and Syria to its north, Jordan to its east, and the Red Sea and Egypt to its south. The topography of Israel is very diverse with snow-capped mountains in the north and desert conditions in the south. Long and narrow in shape, Israel is about 470 km long and 135 km across at its widest point. Its total area is 22,072 sq. km, of which 21,643 sq. km is land area. Israel has total area of 22,072 sq. km with total population of 91,36,000, total households are 24,11,700 and household size is 3.32 people. Israel has a Mediterranean climate. Summers is from April to September ranging from 22°C to 33°C. Winters is from October to March ranging from 6°C to 15°C. Rainfall is unevenly distributed. 2010 was the hottest and rainless year in the history of Israel. Since 1970s, Israel had been consuming water beyond the renewable rates. Israel government invested extensively in the development and upgradation of water infrastructure to provide affordable water supply. It was in 1998 and 1999, when Israel suffered the worst drought in 100 years. Following years had less than average rainfall resulting in the shortfall of 0.5 million m3 in Israel’s water balance each year. Israel faced acute water stress from 1998 to 2002, which is 5 years consecutively.

5.2. **Sources of Water**

River Jordan is the only river. The Mountain Aquifer also known as Yorkon- Taninim is a limestone aquifer. The aquifer faces the problem of a gradual salinization process, derived from the presence of a saline water body with a salinity level. Sea of Galilee or Lake Tiberius is the only natural freshwater lake in Israel and also the lowest freshwater lake in the world. The Coastal Aquifer, which is a sandstone aquifer. This aquifer is a secondary source of water [8] [10].

5.3. **Water usage and Quality**

Agriculture sector is the largest users of water at 58 percent. The major water uses is for the irrigation of crops. The second users are the Municipal sector, which uses 36% of water supply. The third and lowest users is the Industrial sector, which uses 6% of water supply. The quality of water in Israel varies from very low salinity water to more than 1500mg/l. Chloride and nitrate concentration is found in 50% of the well water, which ranges from 10mg/l to 200mg/l of chlorides [10].

5.4. **Concerns**

Economic sector faced water pricing with different prices for people and places. Adverse impact on tourism and recreation. Under environment sector, over the past 30 years, water that fed Dead Sea was diverted to Sea of Galilee to provide water supply to Israel. Ecosystem instability, deterioration of water quality, receding shorelines and damage to nature and landscape assets. The effects of global climate change is steadily reducing the annual rainfall Israel gets, which means that the country will be increasingly dependent on technology to create water sources. Creating water from desalination solves the urgent problem of water stress though it requires polluting energy. The use of desalination and wastewater treatment has given life to streams in Israel.

5.5. **Measures Taken**

Public water conservation campaigns coupled with technical and economic measures are being applied. In agriculture, of low volume irrigation systems and automation has increased the average efficiency to 90% as compared to 64% for furrow irrigation. The average requirement of water per unit of land area has decreased from 8,700 cum/ha to under an informal settlements making up 3.6% of conservation reigns, including watering at night and planting of drought-resistant plants. Restricting the land use activities above the groundwater resources to protect the underground resources, Water conservation maps. Regular monitoring of water resources which includes water table levels, salinity (chlorides), pollution (nitrates) data and water recharge are regularly reported and monitored. The data
helps in influencing the development process, permissible emission of pollutants and the planning [11,12].

5.6. Policy Recommendation
Economic policies and pricing was followed where total metering system were introduced. Re-use of sewage effluents was encouraged by replacing fresh water with treated wastewater effluents to the farming community. Improved efficiency of water usage by continued policies concentrating on the norms, allocations, and block rates for all the sector, research, development and implementation of agronomic techniques and large-scale implementation of the technological means to improve the efficient water use and to reduce the water consumption in all sectors. Agricultural Sector Water Allocations System was followed where the research community together with farmers’ community introduce new irrigation technologies, changes of cropping patterns and move away from crops with product value/unit of water is low. Virtual water policy was introduced were they imported water intensive products instead of using their own water to produce those goods. Introduction of water markets where they sell their temporary or permanent allocations to others by transferring the actual transaction through the national water carrier, opening the sector for market like operation. The water commissioner is done for years already by trading fresh water with treated sewage effluents [9] [11].

5.7. Inference
Israel has achieved water supply security even after being one among the countries facing most water scarcity in the world. The nine key lessons that can be learned from Israel are: - First Lesson Learned is enforcement of strong water allocation and control during acute water scarcity. Second Lesson Learned is to provide public awareness towards value of water, pricing of water and demand management. Third Lesson Learned is introducing a national conveyance water system which helps to optimize water management. Israel created a nationwide water conveyance infrastructure which connects 95% of the marginal brackish, desalinated, natural water resources and recycled effluent. Fourth Lesson Learned is timely data of water, comprehensive and probabilistic. It provides sufficient volumes of water to compensate for seasonal or annual fluctuations in demand. Fifth Lesson Learned is huge efforts have been put by every country on water reforms. Sixth Lesson Learned is investment massively in new water infrastructure is not enough. It should be done in a financially sustainable manner through convenient institutional reforms. Seventh Lesson Learned is the desalination BOT guaranteed by the government might not be replicable. However, it allowed Israel to achieve surprisingly low prices of the desalinated water. The eight Lesson Learned is, reuse of wastewater is the best sustainable water management. Ninth Lesson Learned is corporatization of water and sanitation services are long processes. It needs sound regulation and heavy-handed supervision to get successful.
Figure 4. Map showing overall water scarcity and water depletion

Table 1. Comparative analysis between two case studies: Cape Town and Israel

| Parameters | Cape Town | Israel | Remarks |
|------------|-----------|--------|---------|
| Topography | Desert condition. | Rough mountain ranges and semi-desert fringes | It helps to understand the spatial organization of activities and the land use |
| Population Growth | 2011 = 19.90% rise, 2018 = 15.28% rise. The population is increasing. | 2011 = 29.31% rise, 2018 = 18.44% rise. The population is increasing. | The impacts of the increasing number of people, their daily activities and the increasing demands for resources eventually affects the environment. |
| Climate | Mediterranean Climate. | Mediterranean Climate. | Study of climate reveals if there is any change in climate. It helps in determining how climate is likely to change in the coming years. |
| Sources of Water | Less water resources. Rely on reuse and recycle of water | Completely rely on dams. | Alternate source should be introduced instead of relying on the existing primary resources. Due to the increasing need of water. |
| Water usage | Agriculture is the largest user of water resource. | Agriculture is the largest user of water resource. | Water is a central component in a sustainable and healthy built environment and planning for efficient water use is an essentially important activity. |
| Water Quality | Varies from very low to high salinity water. | Achieved awards for excellent water quality. | Monitoring water quality helps to determine progress in cleaning of waterways. It helps reveal the composition and health of water bodies over days, weeks, months, and years. |

6. Analysis

Water scarcity was the major concern for both Cape Town and Israel and the major factor that induced it was climate change and their lack of availability of fresh water. Decrease in annual rainfall led to huge water stress. But both Cape Town and Israel successfully overcame the major concern with small and large-scale measures. Every small action taken to conserve water can make a difference. These small changes in attitude towards water and efficient usage of water made Israel an example globally.

7. Formulation of Strategies

The following strategies are based on various parameters derived from the study, which can be used globally to conserve water and efficient water usage. The strategies are as follows.

Sources of Water – Water needs to be managed as a community resource held by the state, under public trust doctrine. Periodic inspections of sources of water should be done and strict actions should be taken against people responsible for pollution. Regular monitoring of water resources. Traditional systems and source of water supply should be conserved as a build heritage for future generation.

Water usage – Water should be returned to the water cycle with minimum impact on the environment by proper wastewater treatment or directly reused. Community-based water management should be institutionalized and strengthened. Water using activities need to be regulated keeping in mind the local geo-climatic and hydrological situation. Recycle and reusing treated wastewater effluent for various applications, like watering of sports fields, irrigation, for certain industrial uses etc. Integrated Watershed development activities with groundwater perspectives need to be taken comprehensively.
Planting of drought-resistant plants (Teff, Sorghum, Sunflower) and watering at night. Optimizing cropping plants and crop rotation. Methods like aligning cropping pattern with existing natural resources, automated irrigation operation, drip, sprinkler, etc. should be encouraged and incentivized. Water from the industry can be recycled and reused for other applications, such as cooling towers, cleaning, and irrigation, or other uses.

Water supply - Urban water supply and sewage treatment should be integrated and executed simultaneously. Water supply bills should include sewerage charges. An effective management with skilled practitioners who work within, across institutions, and among multiple stakeholders collaboratively should introduce measure for efficient water use.

8. Conclusion
Water scarcity is a global concern from which we cannot get rid of. It will only worsen as the days unfold. Thus, it is not possible to address this issue solely by local, regional or even national policies. So, before it gets too late, everyone should take steps forward in conserving water and using water efficiently and wisely. Hence looking at the present condition it is indeed very important to start planning based on water conservation and management practices. Conservation not just starts from a country but it primarily starts from the most basic unit which is a house. When every house starts with the practices for conservation of water and efficient water usage; it is then we can overcome water scarcity regionally, nationally and globally. The water available today is not enough for our future generations to enjoy.

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