

## Water Scarcity in Gwadar: Challenges and Way Forward

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### Abstract

*Gwadar is the newest hub of trade for Pakistan, lying at the heart of the China-Pakistan Economic Corridor (CPEC). This newly developing port town, continues to struggle for its water needs and is facing water scarcity. Qualitative research work has been carried out using both the primary and the secondary sources of data by adopting descriptive and analytical approaches. In-depth interviews with a variety of stakeholders in Gwadar were conducted. In addition a inclusive fieldwork that involved visits to different dams in the outskirts of Gwadar were also carried out including visit to Shadi Kaur Dam which falls under the B Area of District Kech. Apart from that, visits to Sawad Dam, Akra Kaur Dam and Desalination Plant in Surbandar were also carried out to collect relevant data and assess the ground situation for the research work. Gwadar, despite being a seaport and having other rain-dependent water resources like dams, has faced water scarcity primarily because of mismanagement by the concerned authorities. The study concludes that Gwadar needs to optimally manage its water resources by utilizing modern means of Sustainable water resource policy along with better water management, to meet its growing water demands. This study defines a sustainable water resource as a flux of water that is managed to maintain the availability and quality of water to meet increasing water demand and achieve safe and environmentally sustainable future supplies.*

**Keywords:** Gwadar, Water scarcity, Seaport, Environment, Climate Change

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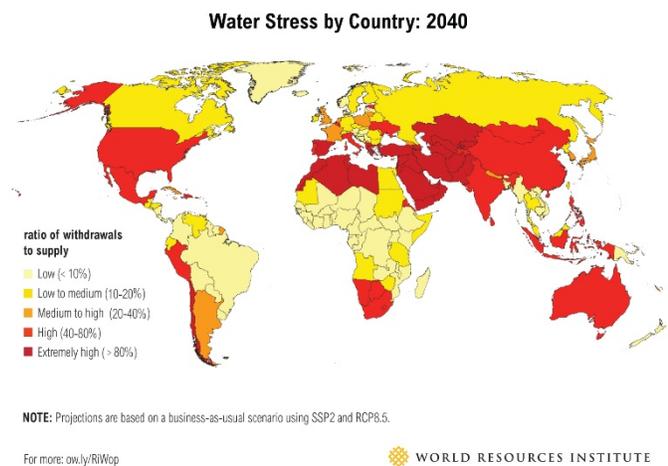
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## 1. Introduction

There are two types of water scarcity; physical water scarcity and economic water scarcity. Physical water scarcity is the one where a region has higher water demand and limited water resources to meet that demand, while economic water scarcity is the one where a region has a sufficient amount of water resources but lacks of infrastructure, or poor management fails to utilize those water resources. According to the Food and Agriculture Organization (FAO), about 1.6 billion people around the world face economic water scarcity (Pimm, 2023). So, Water Scarcity is fundamentally associated with 'water management'. Nature has provided multiple resources of water around the world and if they are managed properly, the issue of water scarcity can be addressed to an extent. In fact, at times, mismanagement at different levels can lead to issues like water scarcity which has been the case in many developing and under-developed states.

'Baseline water stress' is a measurement of how much water is withdrawn from streams, rivers and shallow aquifers by countries every year for different domestic, industrial and agricultural usage. The countries are marked out of a total of 5 in which the scores above 4 indicate that more than 80% of water available is withdrawn annually for the average water user (Reig et al., 2013). According to World Resources Institute research of 2013, Pakistan ranks 31<sup>st</sup> among the water-stressed countries with 4.31 baseline water stress score out of 5. The water stress in Pakistan is only expected to increase by 2040. Pakistan's water stress score in 2040 is expected to be 4.48 as per the World Resources Institute (Maddocks et al., 2015).



**Figure 1: Map showing the projection of Water Stress by Country 2040. World Resources Institute**

Balochistan is about 44% of the total land area of Pakistan and yet one of its' most arid parts. Water scarcity makes survival difficult in Balochistan. Vast arid lands covering miles and miles without any traces of living beings is how Balochistan is for most of its parts. Quetta and other potential urban centers face a serious problem of water scarcity, which is only increasing with the passage of time and needs potential solutions to overcome the crippling effects. Whereas, the masses in the rest of the province always have to struggle to fulfill their water needs to keep the wheels turning (Naz et al., 2020).

Gwadar as the newly developing port town, continues to struggle with its water needs. Despite its ever-growing status of potential trade and tourist hub of the future, Gwadar has still a long way to go, to come at par with other metropolitan seaports of the world (Syed et al., 2017). This rapidly expanding port city has growing demands of water which are not being met or managed through the existing resources of water. Hence,

newer resources, methods, and technologies are needed to be utilized to uncap its full potential.

### **1.1 Aims/Objectives**

This paper aims at studying the water scarcity in Gwadar and suggest a viable policy solution to the problem. The problem of water scarcity concerns not just the human beings but almost every living being in the concerned areas and its surroundings. Therefore, finding a solution of water scarcity is important for the habitat to survive. By keeping in view, the geoeconomic constraints of the region, the main objective of the paper is to give viable policy recommendations for the city of Gwadar to resolve its water crisis.

### **2. Methodology**

This paper has followed qualitative research using both the primary and the secondary sources of data by adopting descriptive and analytical approaches. Primary data was collected through in-depth interviews using an interview guide. The interview guide consisted of 15 interview questions and numerous follow-up questions. All the Interviews were conducted in person and penned down. The data was analyzed according to requirements and relevance to the research objectives. An ethical and interview-informed consent form was shared with participants before conducting in-depth interviews, giving an idea about what the study will include. So that participants can make an informed decision about whether or not to participate in the study.

A field visits to different dams in the outskirts of Gwadar were also carried out including visit to Shadi Kaur Dam which falls under the B Area of District Kech. Apart from that, visits to Sawad Dam, Akra Kaur Dam and Desalination Plant in Surbandar were also carried out to collect relevant data and assess the ground situation for the research work. Interviews were conducted with the officials of:

- Gwadar Development Authority (GDA)
- Gwadar Industrial Estate Development Authority (GIEDA)
- Gwadar Port Authority (GPA)
- Public Health Engineering (PHE)
- Agriculture Department
- Frontier Works Organization (FWO)
- Irrigation Department
- DIG Office

### **3. Gwadar - An Overview**

Gwadar is a developing port city on the western shores of Pakistan. It is about 0-300 m above sea-level and the oceanic influence keeps the temperature moderate throughout the year (GDA, 2022b). Average rainfall in Gwadar varies in different months. January gets the highest rainfall about 16 mm in a month while there is no rainfall in months like September at all (WA, 2023).

Gwadar is located in the south west of Pakistan. Iranian border is about 70 km west of Gwadar. The Arabian Sea provides access to the Gulf and Middle Eastern countries. It is the district headquarters comprising three more tehsils, which also happen

to be the port towns. The town of Jiwani in the extreme west, while Pasni and Ormara in the east are part of the Gwadar district. The total population of Gwadar district is 2,35,000 and it covers an area of 15210 sq km with about 600 km long coastline (Maqsood, 2021).

The total population of the city of Gwadar is 90,762 as per the 2017 census of Pakistan. According to the blueprint of Gwadar Master Plan, its population is expected to rise to 2 million people by 2050 as Gwadar is set to become the third largest city of Pakistan by then. However, that promised future has a long way to go. Some plans are needed to be fast-tracked and execution of all those plans is needed on war footings (Imran et al., 2021)

### 3.1 Water Resources in Gwadar

Gwadar has quite a few potential water resources available to it, some natural and some rain-dependent, which it can utilize to overcome the issue of water scarcity. Gwadar, before work was started to turn it into a major port used to get water through the Akra Kaur Dam. Since then, some other new dams have been built generally in the north of Gwadar to meet its future demands, or are under construction. Thus, dams and water reservoirs are one of major water resources in Gwadar. These dams are either rain dependent or being filled through streams and torrents coming from the north. Although the rainfall is scanty but the streams coming from the north and north-west, even from Iran, make them a feasible option to overcome the water scarcity issue, provided there is no prolonged drought, which keeps happening (Anees, 2018).



Figure 2: Map of Gwadar

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Desalination is another potentially major water resource available to Gwadar. Many coastal towns and metropolitans around the world are using desalination as a major water resource where other natural water resources are not easily available. The process of desalination is costly compared to other natural water resources. It requires a lot of energy and can adversely affect the marine life as well (Ahmed et al., 2023). The option of having different energy resources can help to overcome the water scarcity issue. A nuclear power project in Gwadar can perhaps be the best option as it can resolve the energy crisis of the city, indeed of the entire area and can also provide cheaper energy for desalination.

Another major water resource available to Gwadar is to use the recycled water. As the town grows in future and its water requirement increase, this can become an important water resource at least for the non-domestic purposes. Usage of recycled water is a sustainable water solution available, which the world is rapidly adopting. The city

of Gwadar can also tap that resource and utilize it for its future water needs by educating masses about its relevance and hygiene.

### **3.2 Groundwater in Gwadar**

Ground water in Gwadar is almost non-existent, the total dissolved solids (TDS) of groundwater available is quite high, reaching about as much as 45,000 milligrams per liter or parts per million (ppm), which is chemically unfit for consumption as per international standards (Shahabuddin, Personal Communication, November 21, 2021).

The maximum TDS recommended in the drinking water is 900ppm and anything above 1200ppm is considered to be the worst or unacceptable as per the World Health Organization (Vanjari, 2023). The ground water quality in Gwadar is worst as per the international standards.

### **3.3 Water Requirement of Gwadar**

The existing water demand of the town is about 7.5mgd. However, the water requirement for Gwadar City for 2025 is estimated to be 17.5mgd. In order to meet the ever-growing demand of the town an alternative water supply system is needed for which the government decided to connect a few more dams to the Gwadar's central water tank which then supplies water to the Gwadar town. Gwadar in future is expected to grow, the increase in population will not only increase the domestic demand for water but other sectors like industry and agriculture will also need water (Notezai, 2017). Considering that and the future potential of Gwadar, a single water resource is not enough to fulfill its requirements, instead multiple resources would be needed to be utilized.

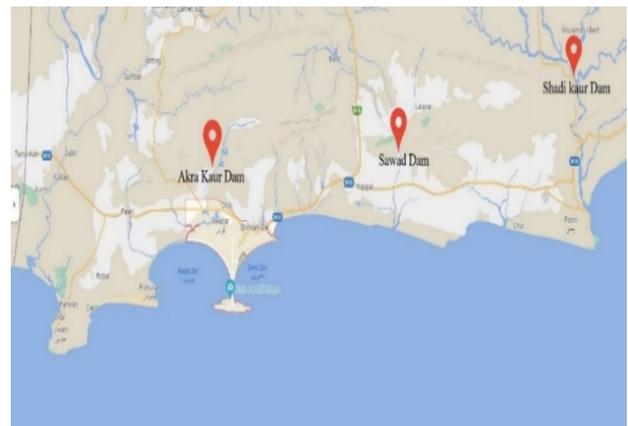
### **3.4 Dams**

North of Gwadar, quite a few dams are existing and being looked after by the Irrigation Department to meet the water requirements of the city in particular and the district in general. Among them:

- Sawad Dam has the highest capacity of about 45,000 acre/ft.
- Akra Kaur Dam has the capacity of about 9,000 acre/ft.
- Shadi Kaur Dam which was completed in 2018 has the capacity of 37,000 acre/ft.

Apart from these operational dams there are a few which are under construction:

- Shehzanik Dam with the capacity of 47,000 acre/ft is expected to be completed within 2-3 years and is recently in tendering process.
- Shinzai Dam, a provincial government project, is expected to be completed in a one-year time with the capacity of 18,000 acre/ft.



**Figure 3: Map indicating the location of already existing Dams supplying water to Gwadar city**

- Sur Dam in Surbandar is also part of the 100 dams project initiated by the federal government.
- Dusi Dam which is also being built by the federal government has the capacity of 16,000 acre/ft.

In Gwadar, some smaller dams are meeting the needs of nearby villages which include:

- Makola Dam,
- Roombru Dam,
- Kalmank Dam,
- Belar Dam,
- Kulanch Dam, and
- Kanero Dam.

These smaller dams have the capacity to meet the requirements of 10-15 villages in the vicinity. While two more dams are under feasibility study which include:

- Suka Kaur Dam, and
- Solaar Dam.

At present, Gwadar is being supplied water through some of the dams enlisted above. Sawad Dam is the biggest among them which was connected to Gwadar in 2021. Among others, Akra Kaur Dam which previously used to be the main source of water for Gwadar is supplying water to Jiwani and adjoining areas while Shadi Kaur Dam is supplying water to Pasni. Both of these are also connected to Gwadar for the future needs. For now, the officials from Irrigation Department maintain that Sawad Dam is providing sufficient amount of water to meet the needs of Gwadar (Daily Times, 2023).

Public Health Engineering (PHE) Department which oversees the water supply to the city of Gwadar estimated the official requirement of the Gwadar town to be 18 lac gallons per day in 2019-2020. While only the Sawad Dam is providing about 20-24 lac gallons at the moment, which is more than the estimated demand and has the capacity to provide 30 lac gallons per day, if needed. This is one of the reasons that at the moment only Sawad dam is streaming water to Gwadar while rest of the dams are either on standby or are providing water to the surrounding towns (Khan Gulab, Personal Communication, November 21, 2021).

### **3.5 Necessary Facilities for Freshwater Supply and Distribution System**

The water requirement of Gwadar for 2025 was estimated to be 17.5mgd and to meet that requirement federal government initiated “Necessary Facilities for Freshwater Supply and Distribution System”. This project was initiated in 2016 and is funded by the federal government to resolve the water crisis in Gwadar (CPEC, 2021).

Necessary Facilities for Freshwater Supply and Distribution System is divided into three phases:

- The first phase targeted connecting Sawad Dam to Gwadar.
- The second phase targeted to connect Shadi Kaur Dam with Sawad Dam.

- The final phase intended the installment of new pipelines within the city as the old ones have become obsolete (CPEC, 2021).

Hence, the work on “Necessary Facilities for Freshwater Supply and Distribution System” has started. Gwadar’s existing demand is being fulfilled through Sawad Dam now, as work on connecting Gwadar to Sawad Dam has been completed. The work on connecting Shadi Kaur Dam to Sawad Dam has also been finished. However, that has not been made operational by the authorities for Gwadar and remains on standby for future or emergency needs. In the meantime, Shadi Kaur Dam which is about 200 km east of Gwadar continues to supply water to the town of Pasni. While the Akra Kaur Dam is now supplying water to the town of Jiwani (Khan Gulab, personal communication, November 21, 2021).

#### **4. Problems and Challenges**

##### **4.1 Future Potential of Gwadar and Energy Constraints**

Gwadar is lying at the heart of China Pakistan Economic Corridor (CPEC) and is projected as a future trade hub in the region. Pakistan needs to take many steps to bring Gwadar at par with the rest of the modern seaports around the world. Gwadar, as of yet, has not been connected to the national grid of Pakistan, and given the vast distances, it will not be practical even in the future. So far, Gwadar and the Kech (Mekran) Division is getting electricity from Iran since 2002. However, this strategic utility cannot be dependent on Iran forever. The existing powerhouses of Panjgur and especially Pasni, require to be upgraded and plans for a nuclear power plant in next 10-15 years ought to be made keeping the growth of Gwadar in perspective.

Gwadar since 2005 has an LPG plant which provides gas for mostly domestic use. Given the scarcity of natural gas in Pakistan, it will not be possible to provide natural gas to Gwadar. LNG may be planned in due course of time. If and when the US sanctions are lifted off Iran, then Gwadar could hope to get natural gas from Iran. Gwadar being a port city has an advantage of using sea water for Gwadar’s daily requirements but to desalinate that, the energy requirement is hard to be met with the present sources of energy. To tap that option of desalination, Gwadar needs to be provided with the cheaper source of energy, which can be solar or nuclear or both.

##### **4.2 Desalination in Gwadar**

Desalination is another important water resource available to Gwadar, like any other port city. On the east of Gwadar town lies a small peninsula – Surbandar, which at the moment has a small desalination plant operated by Frontier Works Organization (FWO). This desalination plant is meeting different requirements including the water needs of Surbandar. The 0.2mgd desalination plant operational in Surbandar is also providing water to different military units in the town of Gwadar (Rehman, 2018). However, this desalination plant is unfortunately not observing the best of the desalinating practices. Since it is collecting water from the shores and have not gone deep into the sea, it makes it difficult to fetch enough water, and mostly the proportion of unwarranted suspended particles is much higher.

The 1.2mgd desalination plant is also working in Gwadar Port Authority (GPA) and during the water crisis they initially gave a water connection to the public as well

which was withdrawn later on. Now that desalination plant is solely being used by the port authority and the Chinese working in Gwadar (Daily Times, 2022).

Some of the desalination plants in Gwadar are lying abandoned and the national exchequer is bearing the cost of the mismanagement of authorities. For instance, the 0.2mgd desalination plant in Sanghar Housing on the Koh-e-Batil is not yet made operational. The 0.2mgd desalination plant with Gwadar Industrial Estate Development Authority (GIEDA) is lying idle as well. Reason of it being lying idle was the lack of skilled labour in the initial years, which kept the project pending. Now, the equipment bought years ago, is said to have been outdated as well.

Although one desalination plant of 2.0mgd was made operational in 2017 by Balochistan Development Authority (BDA), but now, that has also stopped working and has a National Accountability Bureau (NAB) case over it. The one lying idle with GIEDA also has a NAB case over it. NAB in Pakistan is an accountability watchdog, it is pursuing cases of corruption in different public sector departments. Public sector authorities believe that the plants bought years ago are so obsolete that installing and running them is going to be very costly now. Those who try to run it with increased cost get NAB cases slapped on them. While those who denied to run them in the initial years also got the NAB cases over corruption (Gichki Rizwanullah, Personal Communication, November 21, 2021). How serious the allegations of corruption are could only be ascertained once the cases are completed. However, this shows the gross mismanagement that the port city has witnessed either on part of local management or the central and provincial planners.

Gwadar Development Authority (GDA) is also working on 5.0mgd water desalination plant in Gwadar to ensure that Gwadar's water needs are not only dependent on dams (CPEC, 2018). Installation of this desalination plant has been allocated to contractor and its installation will be commencing soon (MoPD, 2017). This is going to be the biggest desalination plant in Pakistan, tendering of which had its own problems as investors had to follow old traditional procurement rules, instead of modern easier ways. Since the practices like e-procurement are followed by the rest of the provinces of Pakistan but not Balochistan. Apart from this, in July 2021, another desalination plant of 1.2mgd has also been approved for the old city area of Gwadar, where most of the native fishermen of Gwadar live. As per the official documents, the civil work of this project was expected to be completed in twelve-months' time, which has not been completed yet (CPEC, 2021).

### **4.3 Sewage Treatment Plants**

Another important water resource available to Gwadar is the use of recycled water. The world is rapidly adopting that sustainable water resource and Gwadar can utilize it as well.

To give a greener look to the town, the administration in Gwadar has planted a few trees by the road side, which should be encouraged, but then again, comes the water question. If the needs of the domestic use are not being met, there is no way to grow trees. The administration has found a solution to that but on a lower level. The patches of greenery found in Gwadar city are because of the water recycled through different small

recycling plants. Gwadar has one Sewage Treatment Plant (STP) which provides about 0.2mgd treated water which is utilized for greenbelts in the city, while another one with the same capacity is planned as well. Apart from that, Gwadar has almost no water recycling projects for the domestic or any other use, as that needs a specified sewage system which is yet to be finalized especially in the old Town areas where most of the native population lives.

Recycled water can also meet the industrial requirements of the town which is expected to start and then grow in the coming years. This along with desalination can resolve Gwadar's water scarcity issue to a great deal but unfortunately very little has been planned on those lines, and the progress on it is a testimony to this fact. The masses ought to be educated on the usage of recycled water as well as saving water which can resolve water scarcity issue to a great extent.

#### **4.4 Water Requirement for Agriculture Sector**

Agriculture in Gwadar is almost zero. There are fields outside Gwadar which are being utilized by the people for their agricultural needs. Especially in the north of Gwadar the areas of Dasht are cultivated through Mirani Dam, River Dasht and other smaller streams (Britannica, 2018). However, no agriculture of notable value exists in the tehsil of Gwadar. In fact, the construction of Mirani Dam has been a game-changer in the region of Mekran as it increased the production of all major crops in its command area of 33,200 acres. That has resultantly changed the lifestyle of people in the vicinity as it had a positive socio-economic impact (Ahmed et al., 2019).

People cultivate Wheat, Barley, Dates and Sorghum in the region. Travelling by road from Turbat to Gwadar gives a pleasant greener look which is otherwise very rare in the whole region of Southern Balochistan - which is arid, barren and dry for most of its parts (Ziring et al., 2023). Gwadar's environment, however, is suitable for any fruit or plant that is found in coastal areas around the world including Aloe Vera, Palm, Coconut, Falsa etc. The problem lies in almost no subsurface water being available.

So, to overcome the lack of suitable ground water and to promote agriculture in Gwadar, desalination or other water-advanced mechanisms for agriculture are required. Gwadar has potential of Agriculture as large tracts of land are available for agriculture.

#### **4.5 Water Requirement for Industrial Sector**

Gwadar's future water need will grow when industrial estate is developed. At the moment Gwadar Industrial Estate lies devoid of both water and industry. Officials from Gwadar Industrial Estate Development Authority (GIEDA) are of the opinion that the provincial and federal governments keep inquiring about the water requirements for industrial estate, but they cannot possibly provide them with the estimates when there is not a single industry working. This is a paradox in itself and speaks volumes about the mismanagement of the city.

The officials from Gwadar Development Authority, however believe that the pace of work has increased in the last four years after the change in senior management. Dams continue to be the basic source of water in Gwadar however, there are plans to introduce desalination into the system as well. However, there are hardly any plans of using recycled water, which can be an effective resource of water especially for the industrial

needs. As the city grows in future, its industrial requirement will grow as well. The traditional resources of water like dams and desalination might not be enough to overcome that challenge and authorities will have to look for the alternatives. Planning on this front is not up to the mark, the proactive approach needed for Gwadar's potential growth is lacking, which can be observed on multiple levels.

#### 4.6 Obsolete Infrastructure

The water supply system and its infrastructure in Gwadar has become quite obsolete, which has been one of the main reasons of water scarcity in the town. For instance, the pipelines that supplies water to the city of Gwadar are decades' old which were designed to meet the needs of the old Town only. As the Town has grown and is growing ever since, the previous water infrastructure has become obsolete. It cannot bear the high pressure of water supplied through it, which resultantly leads to water crisis. On one hand, the existent pipeline is becoming obsolete, but on the other hand, some other places in the town have no water pipeline at all, from the very beginning. Although, the old pipes are now being replaced by the newer broader pipes in the city, which is expected to resolve the water problem of the city.

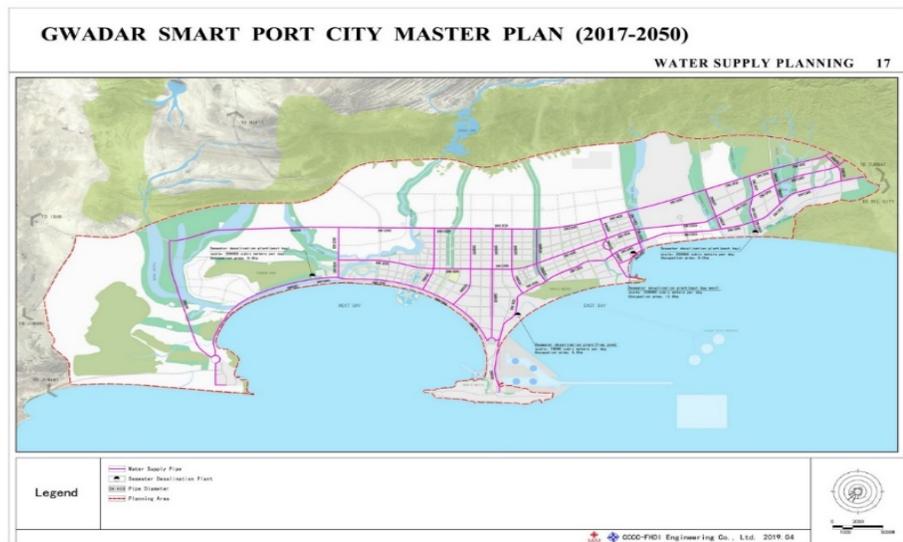


Figure 4: Map showing Gwadar smart port city master plan (2017-2050)

The map above shows the water supply planning of Gwadar as planned in the master plan of the city for 2050 (GDA, 2022a).

#### 4.7 Public Protests over Water Scarcity

Gwadar became a port in 2005 and if people are on roads in 2022 protesting for very basic demand like water, then this needs serious consideration by the government. People in Gwadar have been protesting for the basic necessities in the past as well. However, the recent spike in protests drew more attention which were led by one Maulana Hidayat ur Rehman, member of Jamaat e Islami Pakistan and the founder of "Gwadar ko Haq Do" movement.

There have been contrasting opinions from the officials about the people protesting for water in Gwadar. One of the officials stated that, the water which used to be provided to the people of Gwadar on fortnightly basis or in 20 days is now being provided on weekly basis, but people are still protesting and the only rationale behind

that was the change in the habits of the people of Gwadar otherwise there was no shortage of water.

While on the other hand, another official said that there have been reports of contaminated water - yellowish in color coming through the supply lines. This contaminated water ran through the taps when the region faced extreme drought and the Akra Kaur Dam, which was the only dam supplying water to the town ran short of water. This forced masses to come out on streets. (Ali Arslan, Personal Communication, November 19, 2021). Droughts in Gwadar and the region are often prolonged, some extending to 8-10 years, which dries up the dams. However, water in multiple dams connected to the town is supposed to be enough in normal days unless the region faces another spell of extreme drought.

#### **4.8 Water Filtration Plants**

The most serious point of water management in Gwadar is that there is no public water filtration plant. The old central water tank (Aaf Tanki) of the town had one water filtration plant which lies idle at the moment, with taps either broken or stolen. The need of the potable water is increasing with the increasing influx of the people but the planning division has not worked out on water filtration plants in the city.

People of Gwadar are getting potable water through the cans and gallon-containers supplied throughout the city via donkey-carts and auto-rickshaws.

This is such a contrast that one witnesses while visiting Gwadar. On the one hand, there are plans for making Gwadar a modern port city, but on the other hand, people are being supplied potable water on donkey carts. The fact that with all the modern infrastructure being designed and built in the backdrop, the government has not thought about the provision of something as basic as potable water is strange. The Chinese, on the other hand, working in Gwadar were also getting their water imported from China via shipments on fortnightly basis until the near past.

#### **4.9 Private Filtration Plants**

One wonders, if Gwadar actually has a water scarcity problem, then where do these donkey-carts and rickshaw drivers get water to supply to the whole of the town? They get it from the private filtration plants working within the city. This clearly shows that the water problem of Gwadar is not really about the physical water scarcity, but about the economic water scarcity. If a private owner can establish a filtration plant and earn through it then the government can definitely establish a few in the town for the betterment of the people. However, not much has been done on those lines so far.

### **5. Recommendations - Way Forward for Gwadar**

- To tap on different water resources available, Gwadar needs energy, which it lacks at the moment to a great extent. With the sufficient amount of energy available, Gwadar can use alternative sources of water like desalination to meet its growing water demands.
- For Gwadar to progress and reach its maximum potential, it will have to explore its industrial potential and that needs energy requirements like electricity and natural gas. The earlier it gets them, the earlier it will emerge on the international

metropolitan world. Once the city gets on the track of industrial development it will be easier for authorities to plan and execute its civic necessities accordingly, which includes water as well.

- Pakistan's National Water Policy introduced in 2018 is more about what should the state be doing, but it fails to address the question of how should the state ensure implementation of all those points. Lack of planning and research is evident which should be tackled on priority basis. A properly planned mechanism should be designed to resolve the issues of civic amenities for the public.
- A futuristic planning is required to resolve the water problem of Gwadar by research and innovation. A research center in University of Gwadar exclusively on water management ought to be created which should undertake research.
- Desalination is normally the most utilized source of water in coastal areas but with research and innovation it should be ensured that future desalination is sustainable and cost-effective, especially regarding the overall environment along with the biodiversity and marine life. The world is advancing with newer cost-effective desalination methods, Gwadar should follow them as well.
- Sewage system in Gwadar should be designed on modern lines and connected with the water re-cycling plants. At the moment, Gwadar lacks infrastructure to run water recycling plants. Recycled water should be utilized at least for the non-domestic needs of Gwadar as it is one of the sustainable water resources and can resolve water scarcity issue to certain extent.
- Gwadar's water scarcity issue is more of an economic water scarcity issue and proper management is the key to resolving Gwadar's problems. At the moment it lags in quality management which is giving birth to the avoidable problems. To resolve civic issues of Gwadar a serious inter-linked management mechanism comprising of different departments should be adopted.
- Media platforms and educational programs should be utilized for informing and making a positive perception of people towards wastewater reuse and conservation of water. Public knowledge should be developed through different means of engagement and media. Once the public is well aware about the hygiene of recycled water then it can be adopted as another major resource of water. Similarly, the conservation of water can resolve water scarcity problem to a large extent as well.
- Gwadar has a unique option of utilizing nuclear power plants for its water needs which many other port cities lack. Usage of Nuclear power plant to resolve the energy and water needs of Gwadar can give a real boost to the emerging port city. A nuclear power plant in Gwadar can meet its energy needs and through desalination resolve the water crisis.
- To meet the future energy requirements of the city and its surroundings, a cost-effective study of solar energy should be carried out to assess its feasibility for Gwadar and its adjoining towns. The more energy resources are available in Gwadar the easier it will be for the planners to manage its civic amenities. Studies undertaken in 2001 did not support wind turbines for generating electricity.
- With the ever advancement in technology, Artificial Intelligence has become a key prospect for the future. Desalination and Water recycling can progress in many ways

with the utilization of Artificial Intelligence. Scientific Research on those lines can help not only Gwadar but many port cities around the world.

## **6. Conclusion**

Water scarcity in Gwadar is an example of economic water scarcity. The water scarcity in Gwadar is directly associated with the water management. Surrounded by the sea and multiple dams, Gwadar, definitely has reasonable water resources available but the lack of infrastructure in Gwadar has been the biggest issue in resolving water crisis of the city.

The water management policies in the developed world have been proactive while those in Gwadar have mostly been reactive. Singapore is planning for 2050 while Muscat is planning for 2040 already while Gwadar is still seeking to fulfill its contemporary demand. The authorities in Gwadar didn't really take the matter of resolving water crisis in the old Town of Gwadar very seriously until the public took to the streets. Similarly, with all the plans of turning Gwadar into a future industrial and economic hub, the energy constraints in the city are baffling. Very little has been planned and executed, which again shows the lack of proper and effective planning.

In 2022, Gwadar is still dependent upon Iran's electricity. Regional electricity grid ought to be planned and installed. The short-term policies of providing solar panels to the limited households cannot be the solution. This is not going to help Gwadar's needs. While short term policies are important there is a need for more comprehensive measures to tackle both energy and water crisis in Gwadar, as both are interlinked. The more energy options Gwadar have, the easier it will be to adopt modern technologies to resolve its water crisis.

The newer and modern infrastructure, desalination by modern means, saving and recycling water as much as possible, water reservoirs and to add up to all this a better management is a formula of resolving water problem in Gwadar. Work on some of these aspects has been started, however, Gwadar is still a long way to go in utilizing modern technologies for water management. While the world is moving ahead from the reverse osmosis desalination plants, Gwadar's first one is still under construction. Similarly, recycling of water has to become a key feature in Gwadar's water management, it is an environment friendly practice which can resolve much of water related issues. To resolve the water crisis in Gwadar, the authorities need to adopt a holistic and futuristic approach, only then the newly evolving port-city can develop and creep closer to the port cities around the globe.

## **7. Directions for Future Research**

Gwadar, despite of ample amount of seawater and other water resources available like dams, has faced water scarcity primarily because of the mismanagement of authorities. This paper suggests that future researchers should aim at carrying out a comparative study of water scarcity in Gwadar with other developed port cities of the world and may seek examples from them, how they have evolved over the years to manage the water scarcity and what they offer to learn from for finding adoptable and workable solutions of the water problem for the nature to remain productive, as it should be.

### **Ethical Consideration**

The authors declare that this submission follows the policies of AJSS as outlined in the Guide for Authors and in the Ethical Statement. Full consent was obtained from the participants prior to the study and all procedures were carried out in accordance with approved ethical standards.

### **Informed Consent**

Respondents were interviewed based on informed consent. A fully informed, considered, and freely given decision about whether or not to participate in the study, without the exercise of any pressure or coercion.

### **Declaration of Interest Statement**

The authors declare that we have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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