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URBAN WATER MANAGEMENT ISSUES IN MEGA CITY KARACHI

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ABSTRACT

Water is a dynamic and valuable resource for all living creatures on this planet. Its importance can never be denied by different sectors of economy. Water is fundamental need and has become an important arena of investigation in mega cities of both developing and developed countries. Main objective of this study is to monitor and assess the state of water related issues prevailed in different towns of Karachi. Primary data collection was performed through questionnaire. Displaying of acquired information through maps charts and graphs for quick understanding was carried out in ARC Map 10.6. Software.

The results revealed that core urban areas with substantial increase in population has created high water demand and supply gap which led to water crises. Water shortage in surveyed towns has been caused by the negligence of concerned authorities and mismanagement. It has not only allowed bottled water business to flourish and strengthened tanker mafia that consequently created unprecedented socio-economic, environmental and political problems for the inhabitants of the mega city Karachi.

Monitoring the state of vital resource of water is important for researchers, economist, urban planners and decision makers for future infrastructure development.

Keywords: Water crises, Urban sprawl, Mismanagement, Bottled water business, Arc Map 10.6.

INTRODUCTION

In Karachi level of Urban Growth is very fast and it is serving as hub of job opportunities for range of primary, secondary and tertiary activities. This city is at the risk of various environmental challenges. These are Natural as well as caused by man-nature interaction, Water scarcity is one of them. There is a dire need to notice and study this phenomenon in order to suggest some preventive measures for combating it. As projected by World Bank Pakistan falls among the top ten countries which are facing acute shortage of water. This pertinent issue is directly linked with food and energy crises by 2025 (World Bank, 2012). The most populous city of Pakistan is Karachi, its semi-arid climate conditions and unreliable rainfall make it susceptible to drought. Therefore, regular monitoring, of water is essential for satisfying the demand of inhabitants. Karachi being an industrial hub with more than ten thousands industrial units handles 95 % of the country's exports.

It is high time to work on the feasibility on the availability of surface and ground water at provincial and local scale. Strict measures are to be taken for governing the resource of groundwater which is being also over-exploited and contaminated; WRI report of 2013 quantified extreme water stress in Pakistan is mainly due to arid to semi- arid location. (Gassert *et al.*, 2013; IWMI, 2000). Pakistan is declared 2nd amongst highly water stressed countries of Asia in the report by United Nation's Economic and Social Commission for Asia and the Pacific. Government statistics in Environment Report of 2005 shows radical rise of Population as compared to per capita availability of water since 1951 (GoP, 2005).

In the 21st Century Urbanization is one of the most significant cause which has been affecting, natural resources, energy consumption, human well-being and overall economic development at global and regional scale (Brown *et al*., 2009; Elmqvist *et al*., 2013; ; Lederbogen *et al*., 2011; McDonald *et al*., 2013 ; Montgomery, 2008). As reported by United Nations Development Programme, urban areas are the home of almost 3.6 billion population. Rapid urban growth has been witnessed in the past few decades and it is estimated that by 2050 another 2.6 billion people will be living in the cities (UNDP, 2011). All these urban dwellers will need water for their survival, but unfortunately very few large cities are designed to consider implication of infrastructure for the better and reliable water sources (Padowski and Jawitz, 2013; Mc Donald *et al*., 2011).

Urbanization in Pakistan became drastically increased in past few decades and expected to reach about 178 million people till 2050, Karachi's population is going to be doubled. Urban growth has direct link with demand of fresh water have never been globally assessed to avoid water stress. Efficient management of water sources is therefore important for better future of the economy. A research on modelling global water stress in 20 mega cities was conducted by (Mcdonald *et al*; 2013) for computing the ground and surface water stress. Karachi ranked number 7 for the water stress (Padowski and Jawitz, 2013).

Table 1. Largest cities under water stress: The water sources are shown, as well as if they are stressed in our analysis. (WBM = Water Balance Model shows stress, WG = Water GAP model shows stress).

S.No	Urban agglomeration	Country	Population (2010)	Sources
1	Tokyo	Japan	36,933,000	Surface (WG)
2	Delhi	India	21,935,000	Surface (WBM, WG), Ground
3	Mexico City	Mexico	20,142,000	Ground (stress), Surface
4	Shanghai	China	19,554,000	Surface (WBM, WG), Ground
5	Beijing	China	15,000,000	Ground (stress), Surface
6	Kolkata	India	14,283,000	Surface (WBM, WG), Ground
7	Karachi	Pakistan	13,500,000	Surface (WBM, WG), Ground
8	Los Angeles	United States	13,223,000	Surface (WBM, WG), Ground
9	Rio de Janeiro	Brazil	11,867,000	Surface (WG)
10	Moscow	Russia	11,472,000	Surface (WBM, WG), Ground
11	Istanbul	Turkey	10,953,000	Surface (WG), Ground
12	Shenzhen	China	10,222,000	Surface (WG)
13	Chongqing	China	9,732,000	Surface (WBM), Ground
14	Lima	Peru	8,950,000	Surface (WG), Ground (stress)
15	London	United Kingdom	8,923,000	Surface (WBM, WG), Ground
16	Wuhan	China	8,904,000	Surface (WBM, WG)
17	Tianjin	China	8,535,000	Surface (WBM, WG), Ground
18	Chennai	India	8,523,000	Surface (WG), Ground
19	Bangalore	India	8,275,000	Surface (WG), Ground
20	Hyderabad	India	7,578,000	Surface (WBM, WG), Ground

World largest cities under Water Stress; Source: Mc Donald *et al.*, 2013

Several researches had been conducted during past two decades revealed that with urban sprawl; the total water demand is simultaneously increases. Many researchers concluded that increase in total municipal water demand is determined not only by the increase in urban population, but also caused by economic development of urban population that uses municipal supply of water instead of other private local wells (Falkenmark and Widstrand, 1992; McDonald *et al*., 2011; Bartlett, 2003; Bhatia and Falkenmark, 1993).

In Karachi, financial restraints are one of the most important reason which hamper continuous provision of water supply on daily basis. There has been tremendous difference in water quota across the city, with some less developed areas, such as Orangi town which is the largest *Katchi Abadi* of Asia and home of more than 15 lac inhabitants receives just thirty per cent of its total water. In contrast, high income residents of the Defence Housing Authority, with half of the population than Orangi town receives 133 % of its quota.

Moreover, tanker mafia is also a serious concern in Karachi. Powerful groups in Karachi have strengthened their control over the water supply by operating around 200 illegal pumping stations that draw off water to sell in different corners of Karachi at inflated rates (Bhatia and Falkenmark, 1993).

Karachi's water supply system has extended noticeably over the past few decades. In 1984, it was providing 280 MGD of water to the city; two well-known water projects K-II and K-III completed in 1998 and 2006, increased additional 100 MGD to the system. In between this another 40 MGD of water added to the water supply in the year 2000 as mentioned by (McDonald *et al*., 2011). See fig.2 below for water demand trend projected in 2005.

Water supply system is infused with severe mismanagement. Unfortunately, there has been large-scale inadequacies such as water theft and negligence in regular maintenance of machinery observed. An official personnel shared that Karachi can attain around 648 MGD of water from *Keenjhar* Lake, but failed as the capacity of pipeline and canals that transport the water is not more than 583 MGD. Moreover, the old and famous *Dhabeji* pumping station, for instance, was set up in 1959 and most of its machines are not in working condition as have long passed their expiry dates.

Similarly, the poor maintenance of canal that carry water from Hub dam to Karachi create the water loss of almost 30 %. As a result many areas along the canal located in the western and central districts do not get regular supply and remained at the mercy of tanker mafia. New machinery is installed by the water board to pump more water for the residents of affected areas.

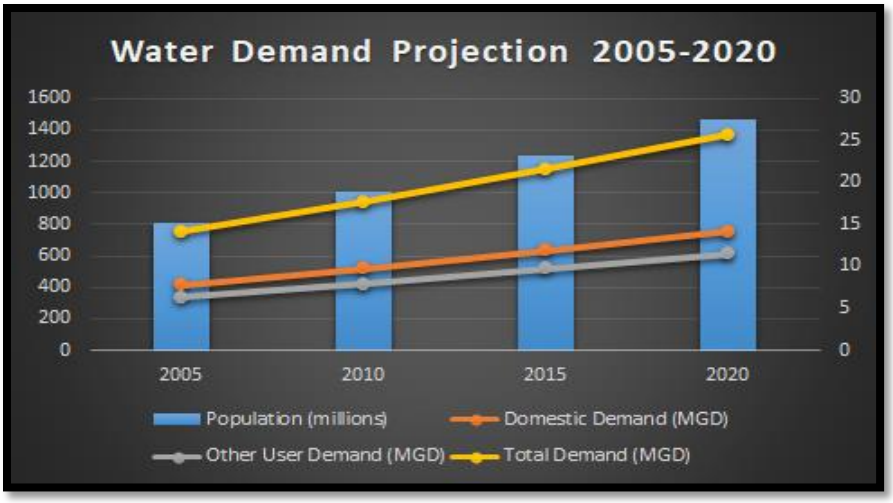

Fig. 2. Water Demand Projection 2005-2020.
Data Source: After CDGK Strategic Development Plan 2020

Research Objectives

- To investigate natural and human induced factors affecting water availability in mega city Karachi.
- To emphasize the use of modern state of art Technology of Geo-informatics in research field of natural resource management.
- To suggest workable solution for the existing problems of water quality and quantity

Study Area

To conduct this study, core urban areas of Karachi was selected. Located around eighty miles west of mighty River Indus with geographical limit between 24° 45' N to 25° 37' N and 66° 42' E to 67° 34' E.

MATERIALS AND METHODS

Field parameters

In this context field surveys of different towns of Karachi were arranged to collect firs hand information including filing of questionnaire, taking coordinates points using GPS device and photographs of the water sampling sites.

GIS Techniques

GIS has emerged as a powerful tool for data processing, integration and modelling, spatial and statistical analyses help to support stakeholders in decision-making.

Geographical data

Geographical data include map to show spatial distribution and density of any phenomenon.. Development of base map, location information (X-Y Coordinates), administrative boundary, cultural or physical feature etc.

Questionnaire for urban dwellers

The questionnaire was developed and executed through field visits of various towns of Karachi. Questionnaire are the formal method to collect information. There were questions to get information about status and challenges regarding water availability and water quality. There were more than 500 questionnaires circulated and filled amongst the residents of 18 sample locations (towns) of Karachi and were used for statistical analysis. The statistical data was further made eye catching and meaningful through maps using Arc Map 10.5 software. During the process of questionnaire filling, informal interviews from the inhabitants were also performed to get in-depth understanding and gravity of the issues and problems.

RESULTS AND DISCUSSION

Analysis Based on Water Quality Test (Physical Parameter) of selected areas

Research reports on tape water collected from different parts of Karachi confirmed the presence of bacteria in about sixty eight per cent of total samples. There were 40 water samples collected from 4 selected towns of Karachi to perform Physical analysis. Three parameters selected were pH, Total Dissolved Solids (TDS) and Electrical conductivity (EC) were measured by the authors.

According to the study conducted by (El Moujabber *et al*., 2006 and Stigter *et al*, 2006) these are the most important physical elements that help in determining level of salinity in water. Ground water near coastal areas of Karachi experience sea water intrusion and extreme variability of rainfall does not recharge properly thus, possess varying amount of salt concentrations. Measurement of capacity of water body to carry electric charges is called Electrical Conductivity. There is direct relationship between EC and TDS and are correlated quality parameters (Logeshkumaran *et al*., 2015 and Marandi *et al*., 2013). Concentrations of TDS creates the dissolved ions in a water reserve (Hem, 1985). TDS measurements is essential in groundwater quality analysis and it is calculated through the formula given below

TDS (ppm or mg/L) = k x EC (µs/cm or dS/m)

Where "k" is constant and its variations depict increase or decrease of ions in the water. (Siosemarde, 2010). Results revealed the fact that TDS value in 31 samples was ranging from 250-500ppm while, remaining 9 out of 40 samples were found hazardous with TDS above 700-1200 which is above the safe limits, see fig.3. Similarly results of Electrical Conductivity as show that there were higher than permissible limit in same 9 samples in which values of Total dissolved solids were high. As far as water's hydrogen power is concerned depicted in graph; pH values in all samples were found within the range of 6.5 till 8.3 which is considerably safe.

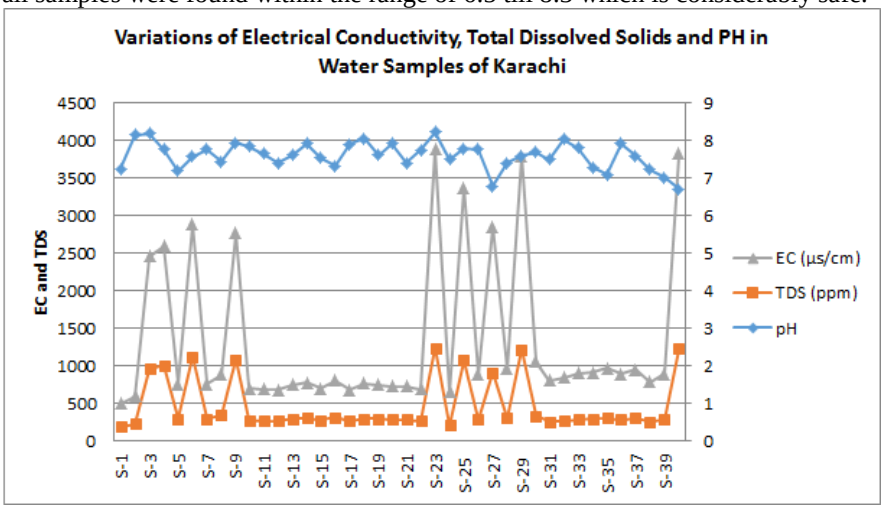

Fig.3. Variation in pH, EC and TDS in water samples of selected towns

Analysis based on questionnaire

Mega cities of the developing countries have always been suffering from challenges pertaining to management of resources. Exponential population growth coupled with climate uncertainty hampers the sustainability of urban environment. IPCC reported that by the year 2050, runoff of Indus Basin may decline by twenty seven per cent, which would further stress both rural and urban water supplies. A serious, consistent and multidimensional approach would require to address this matter in holistic way.

More than 500 questionnaires were filled and made digital to obtain relevant statistical data to be analysed. Results are presented by maps charts and graphs for further interpretation and better understanding.

On the pertinent issue of water supply duration, majority of the respondents (i.e. 220) were supplied water for less than 2 hours. 95 respondents told that they get water for only 2 to 5 hours, 42 of them get water for 5 to 8 hours, 39 respondents reported 8 to 12 hours of water supply. Remaining 62 respondents received nonstop water supply in a day, while 6 respondents complained of no piped water supply at all. In response to weekly water supply frequency in days, 97 respondents get water regularly, 66 respondents reported that they get water supply more than once a day. Most number of respondents i.e. 117 reported to receive water supply once in two days, 52 respondents

get water once in three days while 86 of them get the supply once a week. 9 respondents get water supply only once a month.

When the respondents were asked if they treat water in any way to make it safe for drinking, 77 % responded in affirmation. 84 % respondents boils water before drinking while only 16 % use alum or straining through cloth method. Only 34 % respondents use water filters installed at their homes.

Overall quality of water in Karachi, as reported by the participants, was good with 91 % reporting clear water and 9 % respondents complained about brackish and salty water. 84 % of the respondents have clear water supply while the remaining has turbid or cloudy water supply. 13 % respondents complained of smell in water and the other 87 % have clean water supply with no smell.

In terms of satisfaction level of the citizens, there is almost an equal proportion. 55 % of the people were satisfied with the water supply and quality while 45 % were dissatisfied.

Majority of the people are suffering from diarrhoea (65 cases) while 25 cases of intestinal disorders were recorded. Other water related diseases reported by the respondents are cholera (8), hepatitis (9), typhoid (2) and throat infection (1). 391 respondents did not report any kind of illnesses. See Fig. 7.

Only 26 per cent people launched complaint about issues of water quality and service. The response from the authorities was not very efficient with only 25 percent complaints getting prompt response while 32 percent received a delayed response and 43 percent of the registered complaints went in vain.

All the respondents unanimously believe that the provision of regular and clean water is the responsibility of the City Government. Failure of government is giving rise to the business of bottled water and RO plants which are showing rapid growth in recent past. Out of 500 respondents, 273 were found purchasing bottled water, 73 percent have monthly expenditure of 2000 Rupees and less, while the remaining people pay more than two thousand with 4 percent paying more than 4500 Rupees and they all considered it a burden on their routine monthly budget.

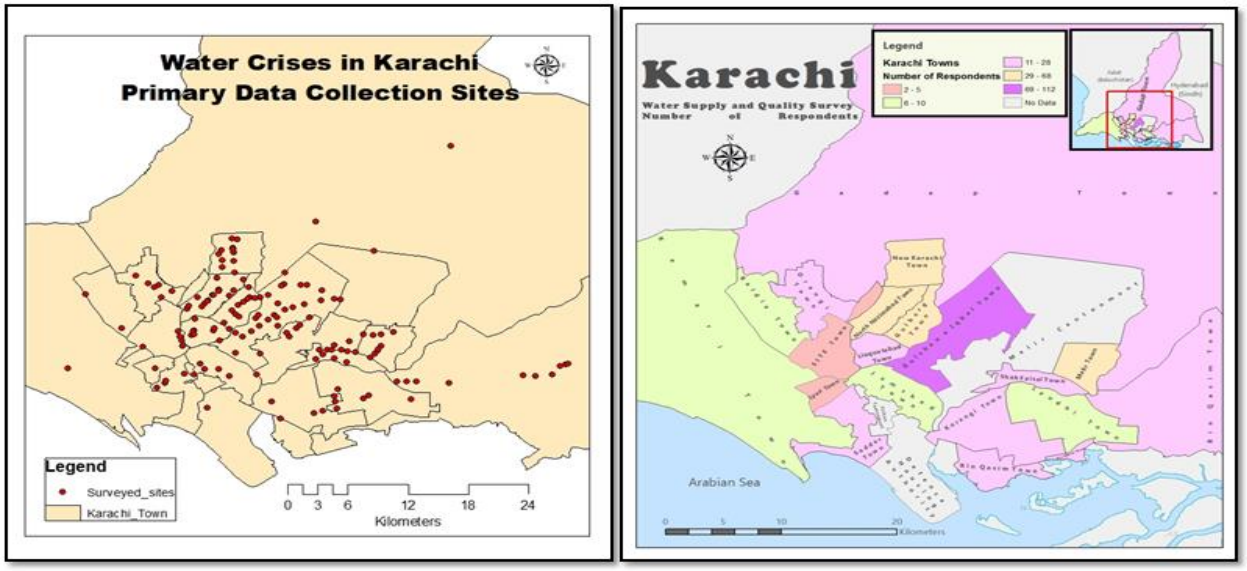

Fig .4. Locations and concentrations of questionnaire respondents.

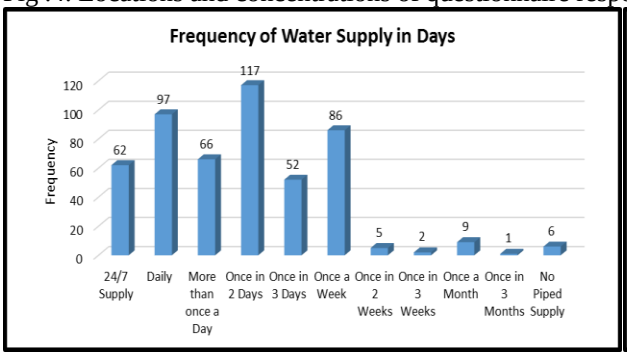

Fig. 5 a. Frequency of Water Supply.

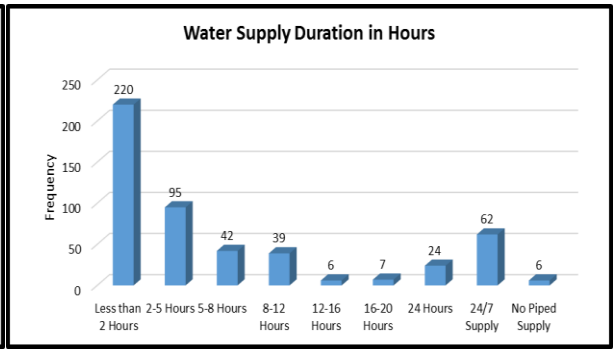

Fig. 5 b. Duration of Water Supply in hours.

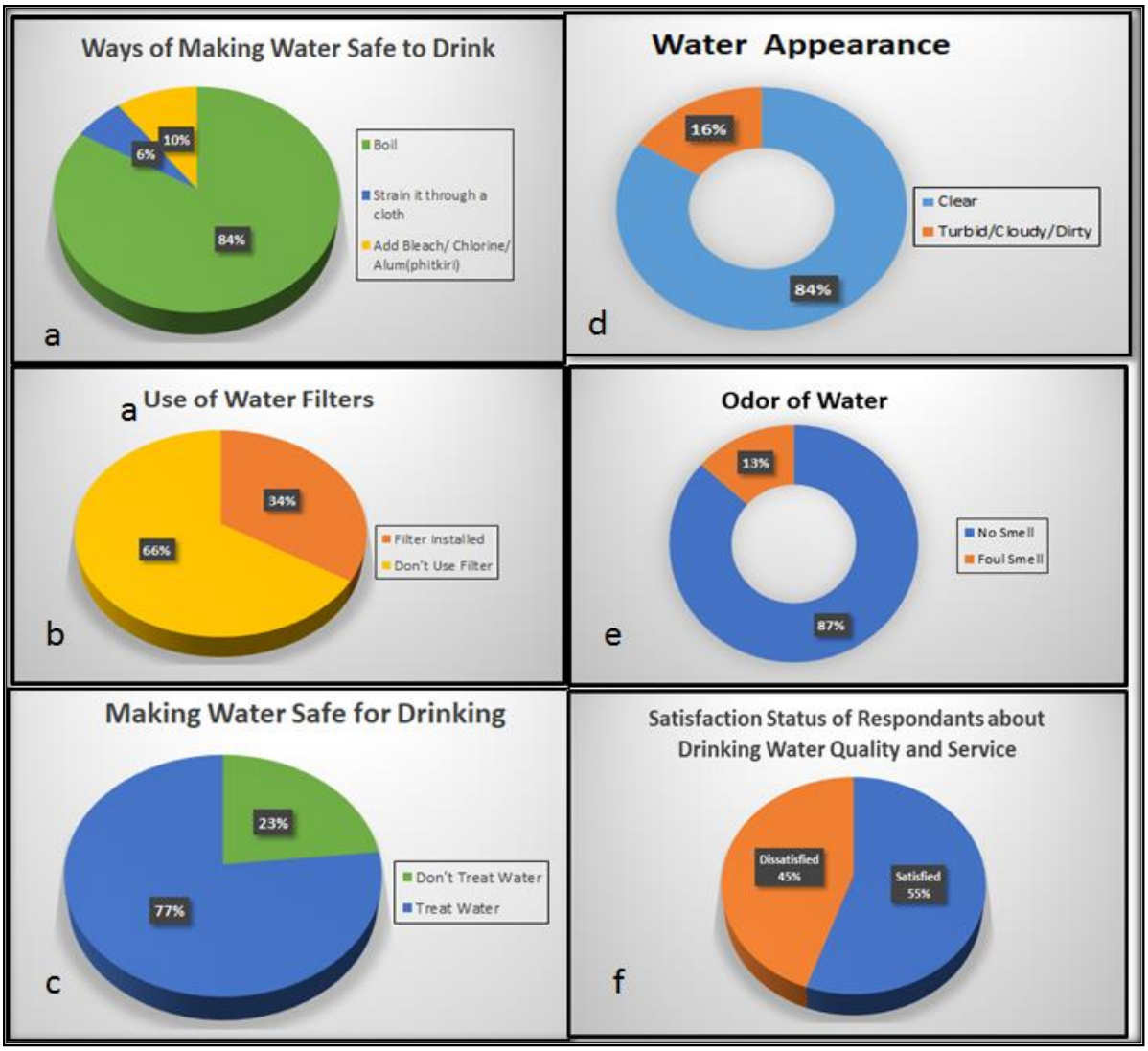

Fig. 6. Analysis of water quality and quantity.

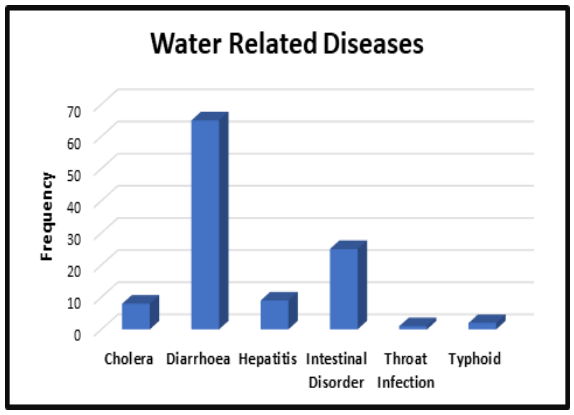

Fig. 7. Water related diseases reported by respondents.

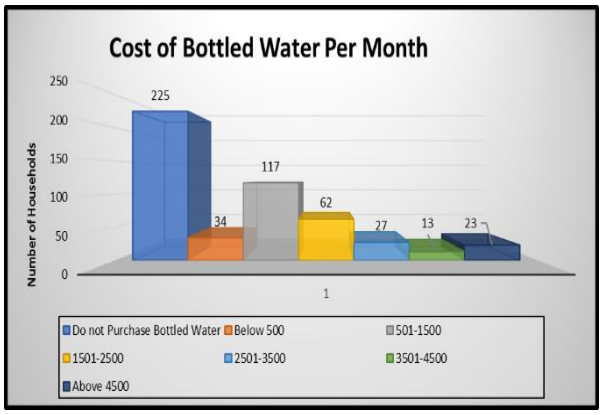

Fig. 8. Monthly Expenses of Bottled Water.

Almost all respondents were having same opinion about the provision of drinking water supply that it is the responsibility of city government. After being disappointed from them and as a result of water crises in Karachi in term of quality and quantity bottle water business is growing rapidly and city dwellers are compelled to purchase it.

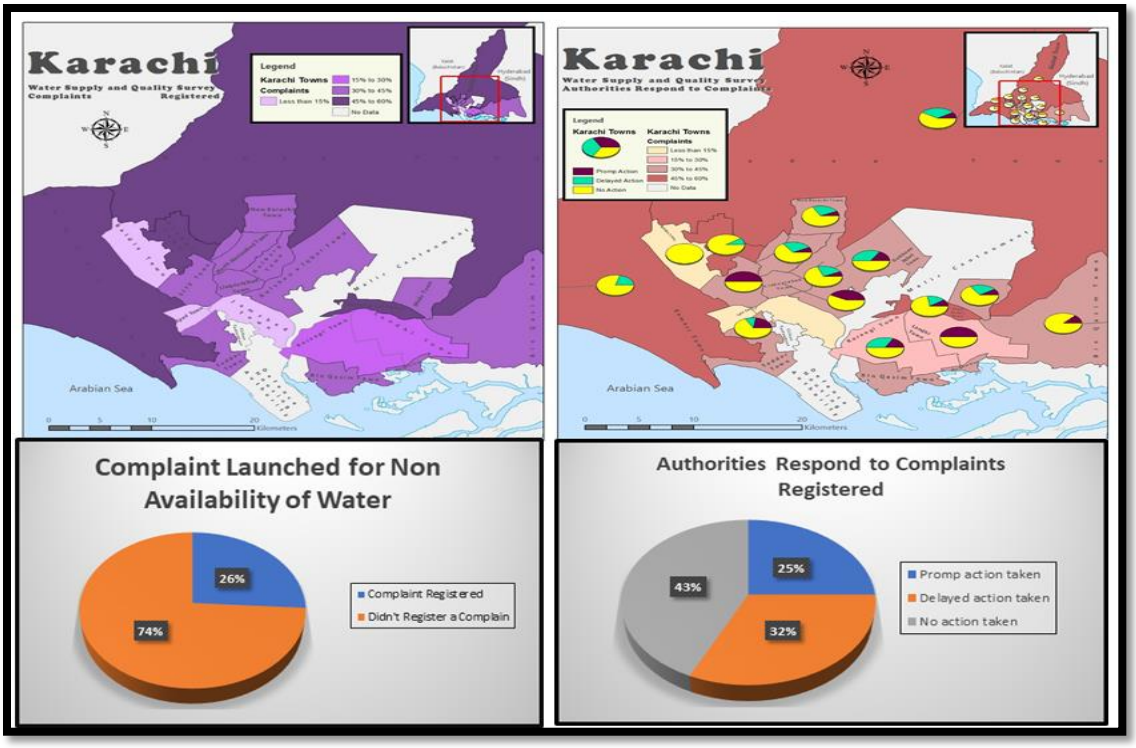

Fig. 9. Complaints launched by residents and authorities response.

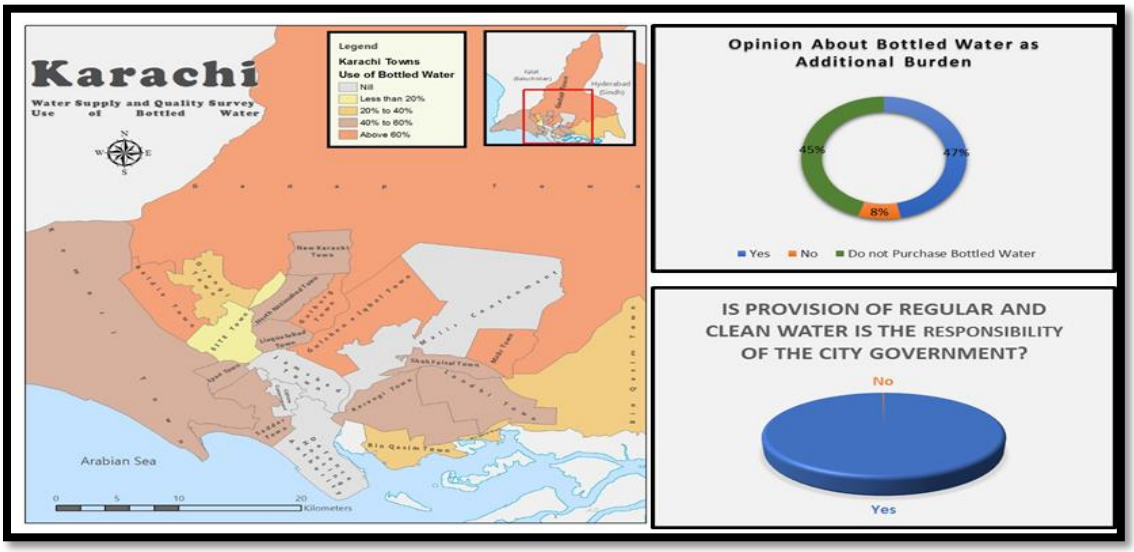

Fig.10. Use of Bottled water in different towns.

CONCLUSION AND RECOMMENDATIONS

It is concluded that sustainability of urban environment is at the stake due to mismanagement of water resources. Government has been failed in the Provision of clean and continuous supply of water to the citizens of mega city; though it is their prime responsibility.

According to Water-Aid project, 2016-17, In Karachi almost eighty per cent of the water is transmitted by 10,000 km long pipeline while, the remaining is supplied through tankers, which also has become an uncontrollable mafia in Karachi. Leakage in the old and rusty iron pipes is said to be one of the major cause of water loss. Unfortunately, there is financial constrain for upgrading the aging system. KWSB is supplying water at very low price that is ranging between Rs200 to Rs500 per month. It is therefore, recommended to install water meters in each unit of consumer to avoid any misuse and exploitation. It will surely help in revenue generation for the up gradation

of pipeline transmission system. Despite the rising water demand no investment is made for the installation of new pipeline since past three decades. Karachi's alarmingly increasing population is becoming very difficult to govern. Thus, regular monitoring and maintenance along with strict check and balance of non-stop and clean water provision is imperative to control the growing socio-economic concerns of the inhabitants.

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