CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

One cannot imagine life without water on the earth. Water is an essence and fundamental to life. Water improves the condition of life and smoothens the living of humankind. It is a known fact that 60 percent of human body is made up of water and 90 percent of blood contains water being vital for the proper functioning of the human body , necessitating the essentiality of fresh water.

Though water is a free gift from nature, but the rate at which the water is being extracted and water level depletes there is a possibility that it will soon become a rarity and scarce resource on the earth. “While water covers two-thirds of the earth’s surface, most of it is salty and not suitable for drinking. Only 2.7 percent of the available water is freshwater and only 1 percent of the available freshwater can be accessed for use from rivers, lakes, and groundwater” (Khambete, 2021).

Water crisis is rising at such an alarming rate that it doesn’t need introduction. As a millennium development goal, the United Nation has drawn the attention of the world towards the drinking water problem, data showed 748 million people had no access to improved drinking water, at international level (United Nation Organization, 2015). Ahead of World Water Day (March 22) on 18th March, 2021 the UN Water called a high-level meeting to expedite the action and doubling efforts on SDG 6 by 2030. The Sustainable Development Goal (SDG) 6 on “Water and Sanitation” in SDG report 2020 showed 2.2 billion population of the world deprived of safely managed drinking water, including 785 million lacking basic drinking water and this number will go further year by year.

India is following directions of the UN and rapidly formulating various policy frameworks to speed-up the action and efforts for sustainable drinking water. The Ministry of Drinking Water and Sanitation, now renamed, The Ministry of Jal Shakti, took water crisis very seriously and declared it a National Movement (28-09-2019) for water conservation. An alarming water crisis is deafening but still not realized that there is a need to put obligatory responsibility on stakeholders. “India’s water future is in danger if the current trend in its use continues (Piyush et al. 2011)”. At macro level, India is in a water- stressed state and the gap between demand and supply of water in India is worsening (Upali et al. 2008). According to World Resource Group estimates, if the

present pattern of demand remains unchanged then by 2030 only 50 percent of demand will be met (WRG, 2009). Availability of safe drinking water is a serious concern at local, national and international level as it is inevitable for living. “In 2010, the UN General Assembly explicitly recognized the human right to water and sanitation. Everyone has the right to sufficient, continuous, safe, acceptable, physically accessible and affordable water for personal and domestic use” (United Nations). So, providing drinking water is not only imperative but also recognized as the right to life in Article 21 of our constitution. There is increasing demand for water due to increasing population, increasing temperature, pollution in the water due to industrial effluents, slow rate of water recharge, inefficient use of water and other economic, social and political aspects posing concerns for policy makers.

Intensive ground water extraction on one hand and increasing pollutants on the other has made the situation worse in many states like Andhra Pradesh, Gujarat, Maharashtra, Karnataka and Tamil Nadu (Biswas et al., 2017). Further, mismanagement of available water resources makes drinking water a scarce resource. NASA report, 2009 placed the Indus basin at second most overstressed aquifer globally. Government is actively taking many initiatives to improve availability of drinking water despite natural, geographical, demographical, social, technological, institutional, infrastructural and man-made hurdles. To increase the efficiency in management and usage of drinking water, every stakeholder needs to participate, suggest, accept, and be accountable and liable for it.

As the international institutions are playing a pertinent role towards drinking water and related issues by highlighting and addressing the key facts at global level as discussed below by WHO: (WHO, 2022)

Key facts

> Over 2 billion people live in water-stressed countries, which is expected to be exacerbated in some regions as a result of climate change and population growth.
>
> Globally, at least 2 billion people use a drinking water source contaminated with feces. Microbial contamination of drinking-water as a result of contamination with feces poses the greatest risk to drinking-water safety.

> While the most important chemical risks in drinking water arise from arsenic, fluoride or nitrate, emerging contaminants such as pharmaceuticals, pesticides, per- and polyfluoroalkyl substances (PFASs) and microplastics generate public concern.
>
> Safe and sufficient water facilitates the practice of hygiene, which is a key measure to prevent not only diarrheal diseases, but acute respiratory infections and numerous neglected tropical diseases.
>
> Microbiologically contaminated drinking water can transmit diseases such as diarrhea, cholera, dysentery, typhoid, and polio and is estimated to cause 485000 diarrheal deaths each year.
>
> In 2020, 74 percent of the global population (5.8 billion people) used a safely managed drinking-water service – that is, one located on premises, available when needed, and free from contamination.

As per the WHO information sustainable development Goal target 6.1 focuses on universal and equitable access to safe and affordable drinking water. For this purpose, safely managed drinking services are tracked i.e., drinking water from improved water resources located on premises, available when needed and from chemical contamination, free from faecal and priority chemical contamination. About 2 billion people are left without safely managed services in the year 2020, which include 1.2 billion with basic services, located within 30 minutes round trip. Two hundred eighty-two (282) million are with limited services located more than 30 minutes round trip whereas Three hundred sixty-eight (368) million people are availing water source from unprotected wells and springs moreover the rest 122 million people collect untreated surface water from the lakes, ponds, river, and streams (World Health Organisation,2017). Comparatively people living in low-income, informal or illegal settlements have less access to improved sources of drinking water.

Water and health related problems are discussed below to know the seriousness of the water. Lack of sanitation and contamination of water cause waterborne diseases like cholera, diarrhea, dysentery, hepatitis A, typhoid and polio. The magnitude of health issues ironically gets augmented when even in hospitals, healthcare centers patient and health care staff are at risk of

infection and disease. Global data revealed that 15 percent of patients develop infection during the hospital stay which is high low-income countries.

> Inadequate management of urban, industrial and agricultural wastewater means the drinking-water of hundreds of millions of people is dangerously contaminated or chemically polluted. Natural presence of chemicals, particularly in groundwater, can also be of health significance, including arsenic and fluoride, while other chemicals, such as lead, may be elevated in drinking-water as a result of leaching from water supply components in contact with drinking-water (JMP, 2017).

The criticality of water concerns across the global are mounting worth every passing day calling for a collective resolution to redress as well as conserve drinking water in order that the coming generation are not left parching.

1.2 DRINKING WATER CONCERNS: GLOBAL SCENARIO

Water as an Economic Resource and a Subject is gaining the attention of all the stakeholders in all bounds. Furthermore, in the last one decade several summits, conferences, meetings and programmers were held with the aim to address the issues and challenges

World Health Assembly (WHA) has passed various resolution pertaining to safe drinking water, sanitation facilities, health and hygiene in a chronology, WHA 35.17 (1982), WHA 39.20 (1986), WHA42.25 (1989), WHA 44.28 (1991), WHA 45.31 (1992), WHA 51.28 (1998), and WHA 63.23 (2010) & resolution WHA 70.7 (2017). United Nations General Assembly associated human rights to water and sanitation in resolution 64/292 (2010). resolution 72/178 (2017) UN Human Rights Council Resolution 39/8 (2018) also loudly addressed the human rights dimension attached to the safe drinking water and sanitation subject matter at international level (WHA, 2019).

According to the global agencies and authorities without the adequate and safe water, sanitation and hygiene facilities, it is impossible to attain the SDG 3 (Sustainable Development Goal) (Ensuring healthy lives and promote health and wellbeing for all at all ages) and SDG 6 (Ensuring availability and sustainable management of water and sanitation for all). Drinking water also aims to include reducing the maternal and newborn mortality and accomplishing effective universal health coverage and also addressing SDG 1(End poverty in all its forms everywhere). The SDG 7,

11, 13 i.e., Ensure access to affordable, reliable sustainable and modern amenities for all: Make cities and human settlements inclusive, safe, resilient and sustainable: And take urgent action to combat climate and its impact, respectively are also dependent on the safe drinking water (WHA, 2019)

Moreover, the Joint Monitoring Project by WHO and UNICEF report highlights that one fourth health care facilities lack basic water services. Drinking water is very important in the healthcare sector and lay stress on the dignity of patients, women in labour and newborn babies. According to the Director General's report of Assembly-72, it is expected that quality, quantity and access, sanitation and freshwater are going to be affected.

1.3 INDIA- WATER WOES

> "India is among the world's most water stressed countries. Yet, it is believed that India does not so much face a water crisis as a water management crisis"
>
> by I Jsbrand H de Jong
>
> -Lead Water Resource Specialist Water Department

According the to the Jsbrand India's water problem is caused by the mismanagement of the water. Today, India is listed in water stressed countries not because of the water crisis but due to the inefficient management of the water resource.

Water borne diseases cost approximately USD 600 million a year in India. This is true for drought and flood affected areas, this has already one third of India's population has experienced this in a couple of previous years. As ground water across India is extracted at such a faster rate more than 60 percent of India's 718 districts are facing extreme water depletion. (JMP, 2017). India supplies groundwater at over 30 million access points, 85 percent of supplies in rural India and 48 percent is fed to urban areas.

According to Joint Monitoring Program report 2015, data showed 93 percent of rural households have access to improved sources of water supply. However, the reality check reveals that only 49 percent of rural population have access to improved drinking water (JMP, 2017). According to water org. time spent collecting water or seeking a safe place to go accounts for billions of dollars

in lost economic opportunities. There are 771 million people in the world who lack access to safe water, and of them, women and children are generally tasked with water collection. They spend hours, multiple times per day, waiting in long lines at community water kiosks or walking to distant sources like rivers and ponds to find it. This is time spent, and income not earned. An estimated $260 billion is lost globally each year due to lack of basic water and sanitation (JMP, 2017).This has resulted in fall in the enrollment and increase in drop out ratio, for instance 22 percent drop out has been reported in drought affected areas. Also, the opportunity cost of collecting water every day is estimated as 27 days of wage over a year's time period (JMP, 2017)

Clean water is the right of a child under the convention of human rights. Every child fulfills the right to clean water, and no one is left unturned, it is the aim of UNICEF's work in water. in India, specially, drought affected areas, where the responsibility of women and children's is to collect the water from far places.

Under the JJM, providing clean water to every child in India is the objective. The water matter is given a separate Ministry under the government of P.M Modi, the Ministry of Drinking Water and Sanitation was reformed and restructured under the Ministry of Jal Shakti and the work of Jal Jeevan Mission was placed under the Department of Drinking Water and Sanitation.

Since the inception to till date 2022. Under JJM, functional household tap connection (FHTC) has increased from 17 percent to 49 percent. Almost all the schools and preschools in India are well established with tap water. The new government focus agenda is safe drinking water and sanitation. The detailed discussion on the JJM is discussed in the water and governing Institution in India.

1.3.1 Gujarat Water Concern

Water resource of Gujarat accounts for only 2.28 percent with territorial boundary 6.39 percent. The intra- state water distribution puts further restriction on its water resource. The state has history of drought and recorded average of 80 cm annual rainfall. It has reported "Water riots" have been reported due to the shortage of water backed by mismanagement of water resource. People of Saurashtra and Kactchh in the Western and South Western Gujarat migrated to the Central and

South areas of the state, due to the water scarcity, also leading to the shift of domestic animals causing social, economic, and cultural disequilibrium (Himanshu, 2022).

In Gujarat water supply is very low with only 17 percent as compared to huge population in the state, facing water scarcity of approximately 75 percent. According to India Meteorological Department (IMD) Report of 2015, Gujarat experienced 12 major droughts from 1980 to 2001. The problems of continuous drought situation are due to lack of ground water recharge and geographical characteristics (Raju, 2005)

The ground water of 33 districts of Gujarat has recorded 30 meters of average depth in the year 1975 to 1980. The data of 2001-02 recorded the average depth of the ground water to 150-250 meters with an average rate of 3-5 meters annually, the continuation of which will transform Saurashtra and Kachchh into desert in two decades (Himanshu,2022).

Figure-1.1

News Paper Cutting

Source- The Hindu News

The above Fig 1.1 shows the water crisis in nutshell highlighting the quite essential water woes of Gujarat.

- 561 villages receive water through water tanks with daily trips of 1581
- Legislators demand for water tankers for the villages
- Gujarat has emerged as a dry state with worsening of situation
- Industrial water supply cut by 50 percent.
- Average rainfall recorded in 2018 was 73.87 with a short fall of
- 73.87 percent of average rain fall recorded in 2018 was 73.87 percent with a short fall of 26 percent.
- Rajkot was reported with only 20 minutes water was supplied in a day and in many other localities in the periphery water supplied through the tankers on alternative days (The Hindu News, 2019).

The alarming state of affairs of water woes in Gujarat immediate attention towards management of water and water resources to save the states' natural, socio-cultural, and economic ecosystem. Government of Gujarat has taken initiative in the form of institutionalizing bodies, agencies, and

committees at different levels of governance working on water administration and regulation as well as implantation and operation.

1.3.2 Institutional Structure of Water Sector in Gujarat

Under the discussion of institutional structure of water sector in Gujarat gives a brief outline of the state's water agencies, its jurisdiction and roles assigned to the agencies.

Administration and Regulation

Agency	Jurisdiction	Role
Department of Narmada, Water Resources, & Water Supplies	State Level	Regulatory oversight of the water sector in the State Oversight of State government owned corporations involved in the implementation and operation of water schemes.
Department of Urban Development	State Level	Oversight of urban local bodies, excluding corporations, in matters of financial, planning and management issues. Regulation of political and administrative appointments in the local authorities.
Municipal Corporations	Major Cities	Provision of retail water supply services for domestic and industrial purposes in the area of their jurisdiction
Municipalities & Nagar Palikas	Smaller Cities	Provision of retail water supply services for domestic and industrial purposes in the area of their jurisdiction
Gram Panchayats	Villages	Provision of retail water supply services for domestic and industrial purposes in the area of their jurisdiction
Gujarat Industrial Development Corporation	State Level	Provision of retail water supply services in industrial estates owned by GIDC.

Implementation and Operation

Agency	Jurisdiction	Role
Gujarat Water Supply and Sewerage Board (GWSSB)	State Level	Mainly Implementing water supply and sewerage schemes for urban local bodies. Operation of some schemes. Inspection of schemes where State government fund is provided.
Gujarat State Drinking Water Company Limited	-	Bulk transmission and bulk supply of drinking water to local bodies, GWSSB, and Industrial estates.
Sardar Sarovar Narmada Nigam Ltd.	State Level	Wholesale supply of water.
Department of Narmada, Water Resources, and Water Supplies	Smaller Cities	Operation and maintenance of some river schemes like the Ukai Dam.

The Table 1.1 shows the various agencies of the Gujarat state working under the jurisdiction of the state level, Major cities, smaller cities and villages. The functions are classified into a) administrative and regulatory and b) implementation and operational. Every agency assigned with important role.

1.4 ECONOMIC SIGNIFICANCE OF WATER

Every aspect of life is connected to water. The access to safe water may enable an individual to overcome many socio-economic problems which later on can be turned into potential opportunities, empowering people with time for school, work and contribute to improved health and a sustainable life: reflecting positively and progressively in sustained economic growth.

Gains in the form of improved health, averted health care costs and time saved are directly associated with the availability of improved and safe water in general and drinking water in

particular. It also has long term economic, social, and environmental benefits that make a difference to lives of billions of people. The co-relational sustainability of water and economic growth can be comprehended by economic theories.

1.4.1 The Economic Theories and Water

The following section briefly discuss the importance of the economic theories with respect to water and gives the economic significance to water as resource and good.

- **Diamond – Water Paradox**

Diamond Water paradox is very prominent subject called the "paradox of value" in economics, proposed by the Adam Smith, according to which the price of goods is decided upon the value of the goods. Goods has two types of value i.e., value in use and value in exchange (Smith, 1776). According to the concepts given by Adam Smith the theory contradicts in case of water. In other words, some non-essential goods have high value compared to some essential goods.

To address the paradox Adam Smith, David Ricardo and Karl Marx justified the value of water and diamond on the basis of value of labour used in production. Diamond is very difficult to extract and needs more labour, whereas water is easily available and requires less labour. The justification was argued on the ground that the production of any goods using large number of labours with less value doesn't fetch high Price, it doesn't justify and discarded by other thoughts of schools. Earlier water was a free good, now it is no more, this assert the reversal of diamond water paradox (Vinay, et al. 2020) as there is no substitute of water (Der, et al. 2006).

Then came marginalist with diminishing marginal utility of the good, the utility derived from the additional unit of goods always decreases. The justification for diamond and water was based on the marginal unit and not on the total available water and diamond. When additional diamond is offered, it has greater satisfaction compared to the satisfaction arrived from additional unit of water, because additional unit of water has less marginal utility than diamond. Furthermore, bringing this paradox to the Demand and Supply concepts states goods more in demand in comparison of supply get higher price (White, 2002).

Water is the lifesaving resource on the planet and has high value-in-use in terms of total utility. Water is a need of every individual, but every individual doesn't have the ability to pay for water. Three pertinent questions to the stakeholders, by the stakeholders and for the stakeholders stem out of this discussion: Should water be Priced? What should be the Price and How should it be Priced? These questions construct a narrative of water as a market and water as an economic good. (ICWE, 1992).

- **Scarcity Definition**

The scarcity definition given by Robbins, is one of the key concepts in economics. "Economics is the science which studies human behaviour as a relationship between ends and scarce means which have alternative uses". This implies that there are unlimited ends, scarce means, alternative uses of means, wants differs, in urgency and problem of choice. Scarcity occurs when the demand for a natural resource, product or service outstrips the supply, indicating that the existing amount of use of natural resources is unsustainable in the long term. In simple words, the demand for a good or service is greater than the availability of the good or service. The scarcity of drinking water will limit the choices available to the people who are integral part of the economy. It is estimated that by 2025, two-thirds of the world's population may face water shortages (JMP, 2017), posing the question of existence of entire ecosystem. This research deals with the relationship between the scarce water resources and access to the safe drinking water, from human behavioral perspective. There are three causes of scarcity in the economy: Demand scarcity arises when the demand for a resource is increasing due to increasing population or changes in preferences; Supply scarcity arises when supply or resource is low or out, due to weather, disasters, or resources depletion; Structural scarcity, arises due to the mismanagement or inequality of access to populations, often because of politics or location (UN,2021).

In many urban areas, water scarcity is already a reality. This leaves many cities sorely unequipped for continued rapid population growth in the future (UNICEF, 2021). As the population increases, the percentage of people without access to clean water will increase as well.

- **Opportunity Cost**

The concept of opportunity cost is very relevant and significant for water resource. The cost of next best alternative forgone is known as opportunity cost. In case of water, the opportunity cost

of the water can be seen as a very important theory in taking decision while choosing alternative option over another. For instance, if the water is used for generating electricity as an option over the use of water in irrigation, the authority has to select the best option among the two. If the water is used for generating electricity, the opportunity cost to society would be the water sacrificed for irrigation.

The opportunity cost can be significant in pricing the water and deciding the cut-off point in the distribution of the water among the sectors, among the industries, and the residential or commercial use of water. The marginal opportunity cost of water is very complicated. It refers to the benefits given up by not allocating an additional unit of water to its most economically productive use. This can be explained with an example, the opportunity cost of the water wasted during the production can be calculated by the total value of the water wasted equals to the total value of the water sold in the market. Calculating the market value of wasted water is complex as the pricing of the water in the market is not decided by the market forces alone (Rouge, 2017)

Another example of the water pricing using opportunity cost can be significant contribution: the residents in the rural areas fetch water from far places at free of cost. The water obtained using the time and efforts for fetching it from far place is the opportunity cost of water. The cost here in the example is measured in terms of time and efforts sacrificed to obtain the good though it is free. The information provided by the water organization reveals that “Time spent on collecting water or seeking a safe place to go accounts for billions of dollars lost economic opportunities (water.org, 2021).

Opportunity cost concept give significance to the use of water to its best economical allocation to minimize the opportunity cost of the water as a scare resource. In case of free goods, the opportunity cost principle helps in measuring the cost.

- **Theory of Human Capital**

Human Capital is acquisition “of all useful skills and knowledge that is part of the deliberate investment” (Schultz) vital for economic and the political development of a nation. The formation of human capital is thus correlated with investment in humans, his/her development as a creative and valuable resource. Human capital development remains vital to support economic growth and

promote overall socio-economic well-being of the country. Consequently, availability of clean and safe drinking water is one of the crucial factors which will affect the formation of human capital. Thus, the investment in the drinking water infrastructure will support the worth of human capital.

1.4.2 Water: A Free Good or an Economic Good?

The price of the water makes it an economic good which helps in addressing its efficient use with, minimum wastage, water conservation. There arises a price Paradox: Providing water for irrigation and agricultural produce would deprive people of low-income group whereas, people with high income and high purchasing power can avail quality water (in quantity as well). The adversity unfolds itself cruelly when people with low purchasing power are forced to avail less quality water in less quantity.

The problem with the market comes with pricing of water used for irrigation which is used for agricultural produce to feed, deprives people with low income from water as a good, unfolding inequality in consumption of water, people with high purchasing power gets quality and quantity of water and people with low purchasing power gets less quality and quantity of water.

Water is a special economic goods which should not be left alone to the market able to decide its price. Rather, the price should be decided on the basis of objectives to be satisfied i.e., the recovery of the cost of providing the water and services, and to make the stakeholders realize that water as a scare resource to be put efficient use without wasting (Der, et al. 2006)

The key takeaways in practice by the water supply authorities like Municipal corporations include charging for water through water bills in urban areas. Water bills are very nominal (Deccan Herald, 2021), in some states (Punjab, Delhi) there are separate bills whereas, in other states, there is a combined bill with house tax as the case of Vadodara city. It has been observed that prices are charged at very nominal rates for water consumption, evident from the cross checking of the real house tax bill of the residents of the Vadodara city. In an informal conversation with municipal authority a mention was made regarding partial recovery of the cost of supplying drinking water from the residents of the Vadodara.

To make water as a special economic good (Der, et al. 2006) water meter plays a vital role. A lesson from America can serve good governance of water where to reduce the cost of water and

the purpose of efficient usage, the recent policy by the U.S Department of Energy on 1st October, 2022 directed the federal building to install water meters (United States, 2022).

1.4.3 Water and Economic Development

Almost all economic activities need water. Every sector directly or indirectly uses drinking water as in for health and industry, agriculture, and services sector.

Infrastructure is the center of economic development, so is water infrastructure. The primary sector primarily depends on the water resource. The progress and growth of agriculture sector is dependent on the availability and access to water resource. Water is key to agriculture sector and agriculture sector is responsible for the growth of other two sectors directly or indirectly due to the inter sectoral interdependence.

In Industries, contributing in production like brewery, carbonated beverages, dairy, sugar mills, refineries, textile manufacturing, pulp and paper mills, oil and gas, automotive and aircraft industry, pharma and chemical industry water is inevitable.

Similarly in service sector water supply being a part of social infrastructure plays an important role in the economic development. Safe and sufficient water supply and Human Development Index are closely related as the life expectancy index is directly related to the health aspect of the Human Development Index. If the water is not safe for drinking, how can the country have good and healthy representative life Index. The growth of service sector is directly dependent on the quality of human capital and quantity of labour in the country. The short term and long term of the human capital is related to the quality of water in the county. If the water quality is not proper or poor the impact on the health of the people will not be constructive.

Thus, it becomes very important to maintain the quality of water and maintain the standard to safeguard all the sectors and the human resource of the country. For instance, water quality and quantity become poor for irrigation requirement then the agricultural product can be dangerous and harmful to human consumption (Centers for Disease Control and Prevention, 2016). This is an incidence of indirect health hazard to human health. In the light of safety and number of reported cases of health hazards due to unsafe water the Bureau of Indian Standard has laid down certain

minimum standards. One has to be very cautious to direct health hazards not only in short period of time but also for long term impact of unsafe water.

“There are two incontrovertible facts: one, that water is the key determinant for health security and economic growth. And two, water wars are not inevitable but will happen only if we do not manage our resources prudently” (Narain,2021).

It became very vital to discuss the health hazard and permissible limits of the of the drinking water. The researcher has briefly discussed the health hazards of unsafe drinking water with respect to various types of dissolved metals. The objective of discussing the drinking water and health hazard is to bring into the notice of the stake holders of drinking water how serious the problem of drinking water is and why drinking water infrastructure needs attention.

1.5 DRINKING WATER AND HEALTH HAZARDS: AN OVERVIEW

This section of the research study gives the brief details on the health hazards caused by unsafe water. Researcher highlights the minimum and maximum permissible limits of the dissolved solids which makes water unsafe for human consumption.

WHO (World Health Organization) in its report has detailed the impact of unsafe drinking water and related risks.

> “Some 829 000 people are estimated to die each year from diarrhea as a result of unsafe drinking-water, sanitation, and hand hygiene. Yet diarrhea is largely preventable, and the deaths of 297 000 children aged under 5 years could be avoided each year if these risk factors were addressed. Where water is not readily available, people may decide handwashing is not a priority, thereby adding to the likelihood of diarrhea and other diseases.
>
> Diarrhea is the most widely known disease linked to contaminated food and water but there are other hazards. In 2017, over 220 million people required preventative treatment for schistosomiasis – an acute and chronic disease caused by parasitic worms contracted through exposure to infected water” (World Health Organization,2017).

In many parts of the world, insects that live or breed in water carry and transmit diseases such as Malaria dengue. Some of these insects, known as vectors, breed in clean, rather than dirty water, and household drinking water containers can serve as breeding grounds. The simple intervention of covering water storage containers can reduce vector breeding and may also reduce faecal contamination of water at the household level. WHO produces a series of water quality guidelines, including on drinking-water, safe use of wastewater, and recreated water quality

Water quality can be defined in terms of Biological, Physical and Chemical properties. There are many publications available on drinking water and its effect on health, in this chapter the researcher has followed the BIS (Bureau of Indian Standards) guidelines for the information on drinking water parameters and health effects.

The BIS (Bureau of Indian Standards), Indian Standard for Drinking Water - Specification IS 10500: 1991 (1991) had published the guidelines for drinking water highlights. The Table below reflects on BIS Guideline value with the maximum permissible limit for each parameter including effect on general health.

Table 1.2

Drinking Water - Specification IS 10500: 1991

BIS Guideline Value (Maximum Allowable) Mg/L	General & Health Effect
TOTAL DISSOLVED SOLIDS 2000	Undesirable taste; gastrointestinal irritations, corrosion or incrustation.
PH 6.5-8.5	Affects mucous membrane; bitter taste; corrosion; affects aquatic life.
ALKALINITY 600	Boiled rice turns yellowish.
HARDNESS 600	Poor lathering with soap; deterioration of the quality of clothes; scale forming; skin irritation; boiled meat and food become poor in quality.
CALCIUM 200	Poor lathering and deterioration of the quality of clothes; incrustation in pipes; scale formation.
MAGNESIUM 100	Poor lathering and deterioration of clothes; with sulfate laxative.
IRON 1.0	Poor or sometimes bitter taste, color and turbidity; staining of clothes materials; iron bacteria causing slime.
MANGANESE 0.3	Poor taste, color and turbidity; staining; black slime.
ALUMINUM 0.2	Neurological disorders; Alzheimer's disease.
COPPER 1.5	Liver damage; mucosal irritation, renal damage and depression; restricts growth of aquatic plants.

NITRATE 100	Blue baby disease (methemoglobinemia); algal growth.
SULFATE 400	Taste affected; laxative effect; gastrointestinal irritation.
CHLORIDE 1000	Taste affected; corrosive.
FLUORIDE 1.5	Dental and skeletal fluorosis; non-skeletal.
PHOSPHATE	Algal growth.
ARSENIC 0.05	Toxic; bioaccumulation; central nervous system affected; carcinogenic.
MERCURY 0.001	Highly toxic; causes 'Minamata' disease-neurological impairment and renal disturbances; mutagenic.
CADMIUM 0.01	Highly toxic; causes 'itai-itai' disease-painful rheumatic condition; cardiovascular system affected; gastrointestinal upsets and hypertension.
LEAD 0.05	Causes plumbism-tiredness, lassitude, abdominal discomfort, irritability, anemia; bioaccumulation; impaired neurological and motor development, and damage to kidneys.
CHROMIUM 0.05	Carcinogenic; ulcerations, respiratory problems, and skin complaints.
PESTICIDE 0.001	Affects central nervous system Detergent - Undesirable foaming

Source: Indian Standard for Drinking Water - Specification IS 10500: 1991

The above parameters reveal the essentiality of being aware of the harmful effect of consuming water below the established standards or consuming the unconsumable water. The greatest challenge before the consumer is its inability to identify and map the consumable water on every single parameter and standard. The common practice to identify the consumability of water is through colour, odor and taste.

Due to limited knowledge, awareness, tools and technique it is difficult for the population at large go for use lab tests assessing its parameters to be as per the standard. Moreover, population at large doesn’t know the exact permissible limits of the dissolved solids in drinkable water. The urban population is dependent on the Municipal Corporations for the safety standards, but the rural population is following the traditional method for defining consumability of drinkable from the colour, odor and taste.

As per EPA (Environmental Protection Agency,2017) of United States, the harmful effects of each parameter are more likely to attack the infant, young children, pregnant women, older people, and people with low immune systems. The rapid development of industries, especially fertilizer, pesticides and other chemicals getting close to water sources increases the chances of contamination.

The Bureau of Indian Standard timely provides the drinking water specifications to update the required permissible limits and the methods of test, for health safety of the people. the following is the second revision given by BIS in the year 2012, IS:10500-2012, Drinking Water Specification (Second Revision).

Table 1.3

IS: 10500-2012 Drinking Water Specification (Second Revision)

Sr.no	Test parameter	Requirement (acceptable limit)	Permissible limit in the absence of alternate source	Method of test (Indian standard is:3025 methods of sampling and test for water and wastewater)
1.	Odor	Agreeable	Agreeable	IS:3025 Part 5
2.	Taste	Agreeable	Agreeable	IS:3025 Part 8
3.	pH value	6.5 – 8.5	No relaxation	IS:3025 Part 11
4.	Turbidity, NTU, Max	1	5	IS:3025 Part 10
5.	Total dissolved solids (TDS), mg/l, Max	500	2000	IS:3025 Part 16
6.	Total alkalinity as CaCO3, mg/l, Max	200	600	IS:3025 Part 23
7.	Total hardness as CaCO3, mg/l, Max	200	600	IS:3025 Part 21

8.	Calcium as Ca, mg/l, max	75	200	IS:3025 Part 40
9.	Magnesium as Mg, mg/l, Max	30	100	IS:3025 Part 46
10.	Chloride as Cl, mg/l, Max	250	1000	IS:3025 Part 32
11.	Residual Free Chlorine, mg/l, Min*	0.2	1	IS:3025 Part 26
12.	Sulphate as SO4, mg/l, max	200	400	IS:3025 Part 24
13.	Nitrate Nitrogen as NO3, mg/l, Max	45	No relaxation	IS:3025 Part 34
14.	Fluoride as F, mg/l, Max	1.0	1.5	IS:3025 Part 60
15.	Total Iron as Fe, mg/l, Max	0.3	No relaxation	IS:3025 Part 53
16.	Coliform MPN/100 ml	Shall not be detectable in any 100 ml sample		Indian Standard IS:1622, Methods of Sampling and Microbiological Examination of water.
17.	Faecal Coliform, Presence/Absence	Shall not be detectable in any 100 ml sample		
18.	E. coli, Presence / Absence	Shall not be detectable in any 100 ml sample		

*Source- Eureka Forbes *Applicable only when water is chlorinated*

"Water is lifesaving, yet it is also a carrier of pathogens and toxic chemicals which when consumed cause diseases and deaths. Diarrheal diseases, cholera, typhoid, polio, hepatitis A and E are water borne diseases. Water is necessary for personal hygiene, allows for hand hygiene which are key factors in preventing the spread of respiratory diseases and trachoma yet to be eliminated in India (Ofrin, 2021)".

The second revision on the various tested parameters of the water gives the updated minimum and maximum permissible limits which decides safety of water. The updated drinking water specification helps us to keep check on the consumption of safe drinking water.

After the brief overview of the water parameters and its health risk, the next section discusses about the water governing institution in detail.

1.6 WATER AND GOVERNING INSTITUTION IN INDIA

With the passage of time water as an economic resource is gaining importance in economic discussions at international, national, and local levels. With the increasing demands of water and mismanagement of water resources, various emergent issues, disputes, and challenges at international, national, and local levels need to be addressed. For this the country needs a sound governing institution to deal with all the matters related to water. This part of the discussion details the brief history of water governing institution in India.

Brief History

Water was the only concern, and the subject came under the Irrigation and Power in 1855 by the Department of the Public works, which was not given significant importance till the famine of 1858. In the year 1863 irrigation subject was placed under the irrigation expert, with the designation of Inspector General of Irrigation, under the administrative control of secretary of the Public Works Department. In the year 1919, Indian Government Act irrigation became the provincial subject and the matter related to water of inter- provincial Rivers was limited. Later in the year 1923 the Public Works Department was merged with the Department of Industry got renamed as the Department of Industries and Labour looking into the subject matter of Irrigation and Power. In 1927 Central Board of Irrigation was formulated and after a decade in 1937 Department of Industry and Labour was demerged into Department of Communication and Department of Labour. Irrigation and Power was assigned to the Department of Labour. Before the New Ministry of National Resource and Scientific Research in 1951 came into existence, the Department of Works, Mines and Power viewed the subject matter related to Irrigation and Power.

The Ministry of Irrigation and Power was established in the year 1952 dedicated to Irrigation subjects and a Flood Control Board was constituted. Irrigation Commission was set up in 1969 for irrigation development for the future. To expedite the irrigation and command area development projects and other agriculture support inputs, a dedicated Department of Irrigation was set up in November 1974 under the Ministry of Agriculture and Irrigation. In 1980 the Department of

Irrigation was later developed and expanded to the Ministry Level. In January 1985, the irrigation ministry was again merged under the Ministry of Irrigation and Power, later in the September, government reorganized the ministry, demerged it from Power and the Irrigation was reconstructed as a new Ministry of Water Resource.

The Ministry of Jal Shakti came into the existence under the leadership of the Modi government in the year 2019 by merging two departments, department of drinking water and sanitation (Ministry of Drinking water and sanitation set up in 2011), and department of water resources, river development and ganga rejuvenation (Ministry of Water Resource renamed in the year 2014) under the Jal Shakti

It is a known fact, water resources are one of the key resources, which is undervalued and underpriced. As the development is increasing it puts more pressure on the water resources. Rapid Industrial development increases the pollution in the water and causes contamination of water resources on one hand and on the other the agriculture sector puts the pressure on demand for water for irrigation purposes. To achieve sustainability in the water resource and attain the SDG-6, the Ministry of Jal Shakti undertakes all the matters related to water resources under its purview. The ministry of Jal shakti is the main institution which has its subordinate departments and the role which are explained in the following section.

Table 1.4

Water governing Authority in India

Ministry of Jal Shakti

National level	Department of water resources, river development and ganga rejuvenation	Department of drinking water and sanitation
State level	Water Board / Public Health Engineering Department	
Urban	Municipal Corporation/Water Board / Public Health Engineering Department	
Rural	Gram Panchayats/ Water Board / Public Health Engineering Department	

Source Jalshakti.gov.in

The brief information on water governing authority and its various departments, sub departments are explained in the following section.

1.6.1 Department of Water Resources, River Development and Ganga Rejuvenation

The work assigned to the Department of Water Resources, River Development and Ganga Rejuvenation is:

A. General

- Conservation, development, and management of national water resources by planning and coordination of water at national level in relation to different users and interlinking of rivers.
- Council for national water resources
- General Policy

a. Technical assistance, research and development training and all matters relating to irrigation, including multi-purpose, minor, medium, major, and emergency irrigation works

b. Hydraulic structures for navigation and hydropower

c. Tube wells and groundwater exploration and exploitation

d. Protection and preservation of groundwater resources.

e. Conjunctive use of surface and groundwater,

f. Irrigation for agricultural purposes,

g. Water management,

h. Command area development

i. management of reservoirs and reservoir sedimentation

j. Flood (control) management, drainage, drought proofing, water logging

- Inter-state rivers and river valleys regulation and development. Awards of tribunals through schemes, river boards.
- Framing Water laws, legislation.
- Water quality assessment.
- Cadre control and management of the Central Water Engineering Services (Group-A)
- Conservation, development, management, and abatement of pollution of rivers.

B. International Aspects

- International organizations, commissions and conferences relating to water resources development and management, drainage, and flood control.
- International Water Law.
- Issues related to rivers common to India and neighboring countries; the Joint Rivers Commission with Bangladesh, the Indus Waters Treaty 1960; the Permanent Indus Commission.
- Bilateral and external assistance and cooperation programmers towards water resources development.

Presently, the following attached & subordinate offices are working under the control of the Department of Water Resources, RD & GR:

Attached Offices

- Central Water Commission (CWC)
- Central Soil & Materials Research Station (CSMRS)

Subordinate Offices

- Central Ground Water Board (CGWB)
- Central Ground Water Authority (CGWA)
- Central Water & Power Research Station (CWPRS)
- Bansagar Control Board (BCB)
- Ganga Flood Control Commission (GFCC)
- Farakka Barrage Project (FBP)
- Farakka Barrage Project Control Board
- Sardar Sarovar Construction Advisory Committee
- Upper Yamuna River Board (UYRB)
- National Water Information Centre (NWIC)

Statutory Bodies are working under the control of the Department of Water Resources, RD & GR

- Tungabhadra Board (TB)
- Betwa River Board (BRB)
- Brahmaputra Board (BB)

- Godavari River Management Board (GRMB)
- Krishna River Management Board (KRMB)

Corporate Bodies are working under the control of the Department of Water Resources, RD & GR:

- Narmada Control Authority (NCA)
- Cauvery Water Management Authority

Registered Societies/ Autonomous Bodies are working under the control of the Department of Water Resources, RD & GR:

- National Water Development Agency (NWDA)
- National Institute of Hydrology (NIH)
- North Eastern Regional Institute of Water and Land Management (NERIWALM)
- National Mission for Clean Ganga (NMCG)
- National River Conservation Directorate
- National Water Informatics Centre (NWIC).
- Polavaram Project Authority (PPA)

Public Sector Undertakings are working under the control of the Department of Water Resources, RD & GR:

- National Projects Construction Corporation Limited (NPCC Ltd.)
- Water & Power Consultancy Services Limited (WAPCOS Ltd.)

The ministry of water resource, river development and ganga rejuvenation work on a broad area and handle every subject matter related to water resources on International, National and State level. It has a rich department to address almost every subject matter on water like international conflicts on water, inter- state water conflict, groundwater recharge, rivers and dam's projects, canals and irrigation, hydro projects and many more. The ministry and its departments are well equipped with various agencies, NGO, tribunals, corporate bodies, registered society, autonomous bodies, departments, attached offices, subordinate offices and statutory bodies.

1.6.2 Department of Drinking Water and Sanitation

Unlike the department of water resources, river development and ganga rejuvenation, the department of drinking water and sanitation undertakes the national mission designed and framed by the ministry of Jal Shakti. At present, Swachh Bharat Mission and Jal Jeevan Mission are the key working areas of the department. The focal area of the department is to provide safe drinking water and hygiene to all. In the following section SBM and JJM are discussed in detail.

Swachh Bharat Mission (SBM)

Clean India Mission was launched on 2nd October 2014, by Prime Minister Narendra Modi as a tribute to Gandhiji. It was announced on 15th August 2014 addressing the audience at National Capital, Rajghat, New Delhi where every Indian was requested to join the campaign of *Swachh Bharat.* This mission is carried out in Phases, Phase -I Under the Phase 1 of Swachh Bharat Mission, Villages, States and UTs in India declared themselves "open-defecation free" (ODF) by 2nd October 2019 and Phase-II aimed at sustainable open defecation free behavior.

> "Friends, the way the Swachh Bharat Mission reached every nook and corner of the country in the form of a Jan Andolan is a case study for many prestigious universities

across the world. I think that in the 21st century, this kind of movement for behavioral change has not happened in any other country until now. India is certainly changing. Behaviors and habits are changing."

- Prime Minister Narendra Modi at Motihari, Bihar, 10th April 2018

Jal Jeevan Mission (JJM)

This is a flagship program announced on 15th, August 2019 by PM Narendra Modi. The vision of the Jal Jeevan Mission is to ensure "every rural household has drinking water supply in adequate quantity of prescribed quality on regular and long-term basis at affordable service delivery charges leading to improvement in living standard of rural communities' '. The following are the mission agenda of JJM;

- States/ UTs in planning of participatory rural water supply strategy for ensuring potable drinking water security on a long-term basis to every rural household and public institution, viz. GP building, school, Anganwadi center, Health center, wellness center, etc.
- States/ UTs for creation of water supply infrastructure so that every rural household has functional tap connection (FHTC) by 2024 and water in adequate quantity of prescribed quality is made available on a regular basis.
- States/ UTs to plan for their drinking water security.
- GPs/ Rural communities to plan, implement, manage, own, operate, and maintain their own in-village water supply systems.
- States/ UTs to develop robust intuitions having focus on service delivery and financial sustainability of the sector by promoting utility approach.
- Capacity building of the stakeholders and creating awareness in the community on the significance of water for improvement in quality of life.
- In making provision and mobilization of financial assistance to states/ UTs for implementation of the mission.

Objectives of Jal Jeevan Mission

The broad objectives of the Jal Jeevan Mission are given to achieve the vision of the JJM.

- To provide FHTC (functional household tap connection) to every household.
- To prioritize provision of FHTC in quality affected areas, villages in drought prone and desert areas, Sansad Adarsh Gram Yojana (SAGY) village, etc.
- To provide functional tap connection to school, Anganwadi centers, GP buildings, Health Centers, Wellness centers and Community Buildings.
- To monitor functionality of tap connections.
- To promote and ensure voluntary ownership among local community by way of contribution in cash, kind and/ or labour and voluntary labour (S*hramdaan*)
- To assist in ensuring sustainability of the water supply system i.e., water source, water supply infrastructure, and funds for regular O&M.
- To empower and develop human resources in the sector such that the demand of construction, plumbing, electrical, water quality management, water treatment, catchment protection, O&M etc., are taken care of in short and long term.
- To bring awareness on various aspects and significance of safe drinking water and involvement of stakeholders in manner that make water everyone's business.

Components Under JJM

- Development of in-village piped water supply infrastructure to provide tap water connection to every rural household
- Wherever necessary, bulk water transfer, treatment plants and distribution network to cater to every rural household.
- Technological interventions for removal of contaminants where water quality is an issue.
- Retrofitting of completed and ongoing schemes to provide FHTCs at minimum service level of 55 lpcd (liters per capita per day).

- Greywater management.

- Support activities, i.e., IEC, HRD, training, development of utilities, water quality laboratories, water quality testing & surveillance, R&D, knowledge centre, capacity building of communities, etc.

- Any other unforeseen challenges/ issues emerging due to natural disasters/ calamities which affect the goal of FHTC to every household by 2024, as per guidelines of the Ministry of Finance on Flexi Funds.

Achievements of JJM

Rural HHs with tap water supply as on 15/08/2019 to till date 15/08/2022 shows the achievement of Jal Jeevan Mission over a short period of time. The data is analyzed to conclude the achievement of JJM.

Table 1.5

Percentage of Change in Water Supply since 15/08/2019

Category	Percentage of change	No. of States/UTs
AA	99 % and above	7
A	75% -99%	3
B	60% -75%	7
C	30% -60%	11
D	Less than 30%	5
C	Over all 51.61%	33

Source: Compiled by the researcher through secondary data (** Annexure) JJM -IMIS

Notes:

AA- 99 % and above changes in water supply

A- 75% -99% changes in water supply

B- 60% -75% changes in water supply

C- 30% -60% changes in water supply

D- Less than 30% changes in water supply

The Table 1.5 shows the achievement of the Jal Jeevan Mission since the launch of the program. The data shows that there is an overall change in the percentage of Tap water supply over all India is 51.61 percent. The state wise performance gives a clearer picture of the achievement and shows the effectiveness of the state government's active participation towards it.

The percentage of change shows the present improvement of the tap water supply in comparison to the past situation as on 15/08/ 2019. For instance, the water supply status of Gujarat households as on date 15/08/2019 showed 65.16 percent of the households with water supply. During the JJM, 23.41 percent of households were provided water supply which has reached to the total rural household accounts for 91.77 percent with water supply, at present. Thus, the change in water supply in rural areas of Gujarat is in A category. Likewise, there are 7 state/UTs coming under the AA category with 99 percent and above change, 3 states/ UTs are falling under A category with 75percent -99 percent change,7 states /UTs falling under B category with 60 percent -75 percent change. 11 states /UTs falling under C category with 30 percent -60 percent change. 5 states /UTs falling under D category with less than 30 percent change and overall performance of India is falling under C category.

Table 1.6

State Under Different Category

Percentage of Change	States and UT's
AA	A & N Islands, DNH and D&D, Goa, Haryana, Puducherry, Punjab, Telangana
A	Bihar, Gujarat, Himachal Pradesh
B	Andhra Pradesh, Arunachal Pradesh, Maharashtra, Manipur, Mizoram, Sikkim, Uttarakhand
C	Assam, J&K, Karnataka, Kerala, Ladakh, Madhya Pradesh, Meghalaya, Nagaland, Odisha, Tripura, Tamil Nadu
D	Chhattisgarh, Jharkhand, Rajasthan, Uttar Pradesh, West Bengal

Source: Compiled by the researcher through secondary data(* Annexure JJM - IMIS)*

The above Table shows the category of the States and UTs falling under the different categories, starting with AA category, A & N Islands, DNH and D&D, Goa, Haryana, Puducherry, Punjab, Telangana followed by the three states Bihar, Gujarat, and Himachal Pradesh in the category A. under category B, Andhra Pradesh, Arunachal Pradesh, Maharashtra, Manipur, Mizoram, Sikkim, and Uttarakhand, are mainly from the seven sisters excluding Uttarakhand and Maharashtra. In category C, Assam, J&K, Karnataka, Kerala, Ladakh, Madhya Pradesh, Meghalaya, Nagaland, Odisha, Tripura, and Tamil Nadu are included and in the last category, D includes 5 state, Chhattisgarh, Jharkhand, Rajasthan, Uttar Pradesh, and West Bengal.

Thus, the overall performance of the JJM shows significant achievement in the study period and showed the 51.61 percent changes in the present water supply in rural households. It is also very early to comment and conclude on the achievement of JJM in the short span of time.

1.7 AN OVERVIEW OF WATER POLICIES IN INDIA

After independence the First National Water Policy was given in the year 1987 by the Ministry of Water Resource to address the water related Issues and looking at the rapid development, water resources were in demand and the need for the future. Rapid Industrial development and agriculture increased the demand for water. Being a precious resource, water related policy was indeed needed, not for present but for present too. This section details the need and other related areas of Water Policy in a chronology.

At present there are three National Water Policies namely, National Water Policy 1987, National Water Policy 2002, and National Water Policy 2012. (Proposed Water Policy of 2019).

1.7.1 National Water Policy 1987

The first water policy of India came into existence in September 1987 by National Water Research Council, under the then Ministry of Water Resource, presently Ministry of Jal Shakti.

Need for Water Policy

In the early 1980s the importance of water was not given much significant importance. Later in the 1980s the increasing need of water usage had drawn the attention of the policy makers in the water to address the following.

- To give attention to the prime natural resource.
- To address scarce resources and indivisible nature.
- To address flood and drought.
- To address common approaches and guidelines towards multipurpose projects.
- To address the growth process of the country and expansion of economic growth.
- To address the objective of the international drinking water supply and sanitation decade programme (1981-91).
- To address the water quality.
- To prepare the development planning of the country to enter the 21 centuries.

Prerequisite for the water resource planning needed a well-developed Information system which is prime condition for successful water management and planning. For having developed information system, the following are the aspects carefully considered and developed.

- Standardized national information system
- Network of data and database
- Integrating and strengthening
- Central and state level agencies
- Quality of data and processing capabilities
- Water availability and actual water uses
- Comprehensive and reliable

Maximizing Availability

- Conservation and availability regenerated by maximum retention and minimum losses
- Resource planning for hydrological units
- Establishing organization for planned development and management of river basin as holistic approach by every state
- Water availability to water short areas by transferring from river basins.

Water policy 1987 also includes many other subjects like maintenance and maximization, safety structure, ground water development water allocation priorities, Irrigation, water rates,

participation of farmers and other agencies, water quality, water zoning, conservation, flood control and management, land erosion by sea water or river drought management, science and technology, training are the other important parameters discussed.

Under the drinking water subject matter the policy states that “Drinking water needs of human beings and animals should be the first charge on any available water” (Water Policy 1987). This shows how drinking water is attaining a significant role in the present scenario.

On the similar lines of water policy 1987 the National Water Policy 2002 highlights is discussed as follows.

1.7.2 Water policy 2002

In 2002, the National Water Policy was revised by the National Water Resource Council on 1st April 2002. The policy focuses on artificial recharge of groundwater, water conservation in house and traditional water conservation methods with rooftop conservation, desalination of water in the coastal region to get freshwater, using low-temperature technique.

The objective of the policy is to identify the present situation, to draw the framework for laws and institutions and for management planning under the umbrella of national interest.

Salient features of the policy are discussed below:

- Water is the prime natural resource, planning, development, and management of water resources to be governed by national interest.
- Strengthening the information systems at central and state level.
- National resources should be maximized by bringing the resource to be utilizable.
- Introduction of non- conventional methods in practice for water conservation, harvesting.
- Water resource development.
- Transfer of water resources from one place to another.
- Development of water resource projects.
- Allocation of water, first priority given to drinking water followed by irrigation, hydropower, ecology, agroindustry, and non-agriculture industry.

- Exploitation of ground water regulation, recharge of ground water. Prevention of over exploitation of ground water prevention.
- Water charges to be implemented for recovery of operational and maintenance cost initially and portion of capital cost.
- To encourage public private partnership in water management and development.
- Monitoring of groundwater and surface water continuously.
- Efficiency of water utilization and consumption to be practiced by educating, regulations, incentives, and penalties.
- Special attention to drought prone areas.
- Training and research for water resource development.
- The need was felt for further revision in policy of 2002. The policy was revised, framed in accordance and a new national water policy 2012 came into exercise. The changing needs of the present and perspective of water planning and resource allocation.

The reason for the revision of the policy was the changing needs and challenging perspective of water resources planning, change in water allocation priorities etc.

1.7.3 Water policy 2012

The objective of the policy 2012 is to take cognizance of the existing situation, to propose a framework for the creation of a system of laws and institutions and to prepare a plan of action with a unified national perspective.

Salient feature of the policy in addition to the existing policies the following are the key areas discussed.

- Introduce a proposal to levy water tariff, based on quota (level of consumption).
- Establish responsibility for water tariff collection and distribution from the people (commercial and residential).
- Governance, planning and management of water managed in an integrated way under the state.
- Introduction of the private sector in management of basic necessity.

Perspective of the earlier policy 1987 and 2002 were broad and it discussed parameters at national level whereas the 2012 policy is an integrated perspective including local regional, state, and national.

Policy 2012 lays impetus on all the integration of water related information systems along with well-established systems, online updating and transfer of information to facilitate the data management for decision making and planning. Whereas earlier policies focused on standardization of the National Information System (NIS).

Present policy 2012 focuses on comprehensive legislation for optimum development of interstate river and river valleys. It also empowers the basin authority with power plan, manage and regulate the water utilization in basins.

Since the adoption of National Water Policy 2012, many issues including water scarcity have emerged in the water sector. With an objective to address the present-day challenges in water sector, amendment of National Water Policy 2012 has been envisioned by the Department of Water Resources, River Development and Ganga Rejuvenation, Ministry of Jal Shakti and a drafting committee has been established on 5th November 2019 to revise the National Water Policy.

These are a few areas where the government has already proposed bills in the parliament in the New Water Policy 2019 are as follows.

- The Inter-State River Water Disputes (Amendment) Bill, 2019 was introduced in Lok Sabha on 25.07.2019 and was subsequently passed by Lok Sabha.

- The Ministry of Jal Shakti has prepared a draft National Water Framework Bill and draft River Basin Management Bill, 2018, which have been circulated to States / UTs for comments.

- Dam Safety Bill, 2019 was prepared and introduced in Lok Sabha on 29th July, 2019. The bill was subsequently passed by the Lok Sabha.

The proposed National Water Policy has been sent to all States/ UTs for proper action. As per existing information, 16 States/UT have expressed and adopted their State Water Policies.

1.8 ACCESS TO DRINKING WATER IN INDIA

In India, one of the challenges faced is regarding access to safe drinking water. It Goes without saying that, with increasing population, the per capita availability of water is going downhill day by day. Due to increasing population, urbanization, industrialization, water pollution the finite water resources of the country are under pressure and are shrinking. "One in every five households have access to piped water connections in the country. Rural areas continue to lag behind in terms of access to piped water as compared to urban areas (NSSO, 2019)". "With population growth over the years and increasing demand for water, today India is facing many challenges in the water sector. Water scarcity is already visible with the current population size of 1.3 billion which is projected to be increased to 1.6 billion by 2050. Along with this, with rising pollution levels and climate change, the water cycle is expected to undergo significant change all across the world. India consists of 16 percent of the world's population but with only 4 percent of the world's water resources. The total annual water available from precipitation in India is about 4,000 cubic km. Surface water and replenishable groundwater contribute to 1,869 cubic km but only 60 percent of this can be put to beneficial uses which means only 1,122 cubic km is a utilizable water resource in India (Prabhu, 2021)".

"As high as 48.6 percent rural households and 28 percent of urban households have to survive without access to an improved source (devoid of contamination/ safety) of drinking water throughout the year. Also, 11.3 percent of households do not get sufficient drinking water from their primary sources throughout the year (Khambete, 2021)". The NFHS survey of 2019-20 shows that, "access to drinking water from improved sources has increased in the 22 states surveyed as compared to NFHS survey of 2015-16, rural areas still continue to lag behind as compared to urban in terms of safe drinking water" (NFHS, 2015).

1.8.1 Different Sources of Drinking Water

The different sources of drinking water in India are associated with groundwater i.e., handpumps, borewells, tube wells, dug wells, and also from surface water sources like rivers, ponds, lakes, streams etc. According to the National Sample Survey Organization (NSSO) 76th round shows that, for 43 percent of the rural population groundwater is the most reliable source of drinking water. The NSSO Report also mentions that, around 58.3 percent of households still rely on hand

pumps, tube wells, public taps, piped water from neighbours, protected or unprotected wells, and private or public taps for their water. The brief of highlights of Gujarat on drinking water

It is the duty of the state government to provide safe drinking water. The concern over safe drinking water has gained significant attention at global, national, state and local level due to paradigm shift in water management as the perception that "freshwater is a free and abundant resource has changed to that of water being an economic goods in scarce supply, threatened by pollution and warranting efficient use" (Gujarat infrastructure development Board, 2022). The next section discusses about the status of water as an economic good or free good.

Considering the above discussion, the researcher has laid down the Objectives, Rational and Significance of the research study in the following discussion.

1.9 OBJECTIVE OF THE STUDY

The overview of the study is to conduct descriptive study using inductive method and to survey the schools of the Vadodara city to Identify the problems of drinking water infrastructure and analyze the cost of the drinking water infrastructure. In this study, educational institutions mean government schools and private schools. Government schools include all those schools which are directly funded by the government. The following were the major objectives of the research study.

1.9.1 Primary Objective:

- The primary objective of the research study is to identify the Drinking water infrastructure and operational and maintenance cost (O & M) of factors in the selected educational buildings of Vadodara City of Gujarat state.

1.9.2 Secondary Objectives:

- To identify the dependence of educational institute on municipal supply or private supply of drinking water
- To identify the educational institution lacking drinking water infrastructure.
- To compare the drinking water infrastructure at selected public owned and private owned educational buildings.

- To identify the role of the private sector in supplying drinking water in the selected educational building.

1.9.3 Hypotheses

To address the research objectives following hypothesis are tested using Bivariate analysis and applying t-test, chi-square, and correlation.

$H0_1$: There is no significant difference between the number of housekeeping staff and the type of school.

$H0_2$: There is no significant correlation between Number of labour and the size of the tanks.

$H0_3$: There is no significant difference between number of taps and types of schools.

$H0_4$: There is no significant difference between the number of purifiers and the types of schools.

$H0_5$: Cooler attached RO system and type of schools are not independent.

$H0_6$: Cleaning of water tanks and types of schools are not Independent.

$H0_7$ There is no significant association between number of labours used for cleaning and the type of school.

1.9.4 Rationale of the Study

Water shortages are witnessed across the globe and the reasons underlying are insufficient rain due to global warming and climate change, lack of water harvesting and many more. In view of the above problems, Gujarat state is also facing the heat of water crises in general and Vadodara in particular.

Due to insufficient rain, due to climate change and lack of water harvesting, Vadodara is heading towards a serious drinking water problem. According to the study conducted by Gujarat Ecological Society the quality of groundwater in the Vadodara city is deteriorating due to continuous increase

in dissolved solids, salinity, and fluoride content in it (TOI, 13th July 2015). Gujarat Ecological Society conducted 141 ground water sample surveys of Vadodara city.

> The Acting Director of Gujarat Ecological Society, Ms.Deepa Gavali said that "in the urban area 80 to 100 percent of drinking water demand is met through groundwater, leading to unsustainable development of groundwater. With increasing high rise building dependence on groundwater has increased. A large part of the city is settled on pockets of saline water." (Connect Gujarat Desk, 2021)

As we all are aware that children spend a large part of their day at school and therefore availability and access to safe drinking water becomes an important aspect to dwell upon.

Children spend a large portion of their day at and student's class focus and academic performance improves due to adequate water intake.

Therefore, pupils of Vadodara city who are also spending a large portion of their day at their school must be provided with quality drinking water, not only the fact that the students engage in the physical activities is tiring and dehydrating which needs healthy drinking water at schools. Thus, the study proposes to identify and evaluate (O & M) the drinking water infrastructure of drinking water in the selected educational building.

1.9.5. Significance of the Study

This inductive study helps in drawing the attention of the stakeholders towards the drinking water infrastructure in the schools. It forms the basis for conducting the future research in the area of drinking water infrastructure of the schools at national levels and state levels. Study gives new parameters of identifying the hygiene factors in context to drinking water infrastructure. It helps in addressing future of the present generation and next generations basic need of the school going students i.e., drinking water. It also draws the attention of the policy makers towards the health of the Young India, Fit India- who are going to be future India.

Research study helps in viewing the role of public and private in supplying drinking water and developing an efficient public-private partnership model. It helps in proposing adequate

operational & maintenance costs for providing improved drinking water at educational buildings. This helps in achieving the goals of Millennium Development Goal at micro level. The policy frame can be made for those schools lacking proper drinking water. Outcome of the proposed study helps in framing the policy to improving the drinking water facilities. Further, it improves the health and wealth of youth.

This research proposes to suggest the operational and maintenance cost of drinking water infrastructure in the selected educational buildings of Vadodara city of Gujarat state.

1.10 A BRIEF PROFILE OF VADODARA

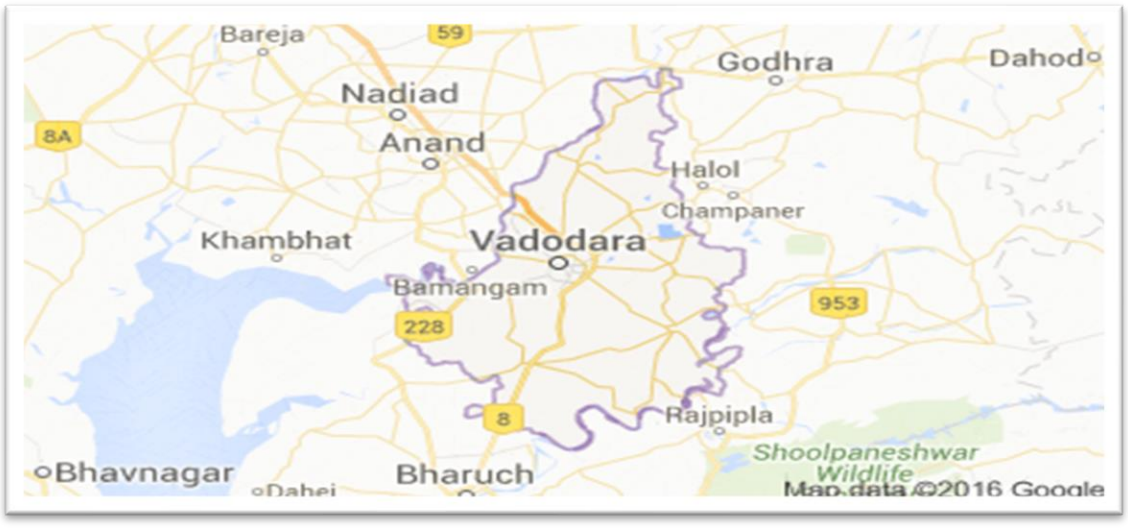
Vadodara (Baroda) is a well-known city in Gujarat. It is located on the banks of the Vishwamitri river, southeast of Ahmedabad, 139 km from state capital, Gandhinagar. Both, the railway line, and national highway connecting Delhi and Mumbai pass through Vadodara.

The total area of Vadodara is 7546 sq. km. The 41lakh population of Vadodara is divided into Urban and rural areas. Urban Vadodara holds 4 municipalities and rural Vadodara consists of 8 Taluka Panchayats and 540 Gram Panchayats. The sex ratio of Vadodara is 934 with literacy rate 78.92

It is a beautiful city, as it was the capital of Gaekwad state till 1947. There are many historical buildings and monuments in the city. It is also the home of the Maharaja Sayajirao University of Baroda and Bank of Baroda. Major industries include petrochemicals, engineering, chemicals, pharmaceuticals, plastics are situated in Vadodara.

Figure-1.2

Map of Vadodara



Source-Census India

Economy

The cities across the country have witnessed significant change over the past 10-15 years on the back of high GDP growth in the economy, infrastructure development and the evolution of the services sector in the country, Vadodara is one of those. The economy here is mainly based on Fertilizers, Cotton textiles, Machine tools, Pharmaceuticals, chemicals, Biotechnology,

Engineering, Tobacco, Fisheries, glass, and Dairy. Agriculture also plays an important role in the economy of Vadodara. Crops like Tobacco, Groundnut, wheat, Grams, Jowar, Oilseeds, and Sugarcane. Vadodara is a leading producer of pulses, fruits, and flowers in the state of Gujarat.

Located in Vadodara are over 35percent India's power transmission and distribution equipment manufacturers and an estimated 800 ancillaries supporting the big player in power sector manufacturing and engineering industry. Vadodara is also home to Vadodara Stock Exchange (VSE).

1.10.1 Water Supply in Vadodara

According to VMC it has installed 2040-270 MLD release / daily 10250 MLD source of water supply with the city limit of 20 Kms. It covers the 75 percent of the population for the supply of VMC water. The data of liters per capita consumption per day lpcd is estimated to be 180 lpcd. The duration of the time is estimated at .75 hours. (Vadodara Municipal Corporation, 2022).

According to the census 2011 the population of the Vadodara was 1741791 with 20.33 Kms approx. Population estimated for the current year is 2240522 approx. Vadodara is located at the 35.5 meters above sea level.

The main work of the VMC is to provide the drinking water to the resident of the Vadodara city, in some special cases where the drinking water gets contaminated or shortage of the drinking water, the fire brigade plays an important role by supplying water tanks for providing free distribution of drinking water to the affected areas.

The VMC also provides water tank services for the purpose of marriage, domestic purpose and construction purpose. These are available on chargeable basis which are classified into two types.

a) Charges without pump b) Charges with pump

In former case, tanker without pump for the purpose of marriage is charged with ₹200, for domestic use ₹ 100 and for construction ₹ 400. In later case, tanker pump for the purpose of marriage is charged with ₹ 300, for domestic use ₹ 250 and for construction ₹ 500. The cost of water tank cost is ₹ 250 per tanker.

The water tanks with both the types, with pump or without pumps are provided at 50 percent discounted rate for the purpose of Temples, public purpose, rally, mosque etc. the municipal

corporation also charges on the basis of waiting charges and outside the city limits, outside the VMC limits ₹1500 for 4 hours with additional charges above the 4 hours will be charged ₹ 400 per hour.

Water supply in Vadodara city is taken care by three agencies, GWSSB, GWIL & WASMO (Water Supply, 2022).

***GWSSB (*Gujarat Water Sewerage and Supply Board)**

Gujarat Water Sewerage and Supply Board was established in 1979, it renders the water supply to urban, rural, and private individual and perform duties and functions such as performed by Gujarat Public Health Engineering.

***GWIL (*Ground water Infrastructure Limited)**

Ground water Infrastructure Limited takes care the infrastructure related to water supply. The main objective of GWIL is to provide infrastructural facilities in the Gujarat like, cannels, construct water reservoir, setting up of water sub-stations, maintaining equipment, plants and machineries, and management.

***WASMO (*Water and Sanitation Management Organization)**

Water and Sanitation Management Organization is taking care of water supply in the rural areas. The demand for decentralization of water is fulfilled by establishing WASMO which only takes care the water supply to rural areas of Gujarat.

Need for Drinking Water Infrastructure in Schools

In our day-to-day life, one needs to drink considerable amounts of water for survival and staying healthy. But this drinking water needs to be safe and potable i.e., appropriate for human consumption. The water has to be drinkable and safe.

The available drinkable water must appear clear to the naked eye and be free of bad smells, tastes and colours and be of ideal temperature. Apart from this, it has to be safe and free from pollutants, carcinogens, pathogenic micro-organisms, and any other factors which can cause health hazard. (WHO, 2017). Thus, the water availability is not the only question, but the comprehensive drinking water infrastructure is the need of the present and future generation in the schools.

1.11. SCHOOL EDUCATION IN GUJARAT: A SNAPSHOT

According to the census of 2011 published by the government of Gujarat, the population of Gujarat has increased by 19.28 percent in 2001- 2011 to 1991-2001. The density of Gujarat is 798 per sq. mile with population of 6.04 crore which is spread over 196244 sq. km.

The government of Gujarat has set up schools in every area of the state. 11958 institutes impart education at primary, secondary and senior secondary level. Among the total schools in the state, 541 schools are exclusively for girls and 287 exclusively for boys (Embibe, 2021).

Gujarat school education is divided into four different stages, starting with early childhood development to child attaining adolescence, namely the classification is as follows (Gujarat Industrial Development Board, 2022).

- Primary School (I to IV class)
- Upper Primary (V to VI class)
- Secondary (VII to IX class)
- Higher education or higher secondary (XI to XII)

1.11.1 Education and Institutional Framework

The Department of Education provides overall directions, and the implementation of the policies are undertaken by various offices set up under this department of, The Ministry of Education. The primary secretary directs the overall management and development activities in the education sector. The Commissionerate of the schools is headed by the education department. The responsibility of control and management is assigned to this department ensuring that no single child is left out of the education system. all district education offices come under the Commissionerate of schools. The grants to the government and grant -in - aid schools are provided by this office (Commissionerate of School, 2022).

School Education with approximately million students enrolled in the primary classes with GER (gross enrollment ratio) is near 100 percent. On the other hand, 2.77 million are enrolled in secondary and higher secondary education. The private and government both are playing a bigger

role in ensuring that no single student at global, National, Statistical, and local levels due to paradigm shift is left out of the education system (Commissionerate of School, 2022).

The drinking water status in schools have become very important and given attention not because it may get a chance of various contamination. But, because the single case of contamination, in school's drinking water, may cost big loss at a single point of time: At times, if contaminated water is not identified at right time, it may cause more serious lifelong health hazards (see Table 4.1).

Thus, drinking water availability in the schools need more attention and likewise the drinking water infrastructure becomes all the more important in the context of safety and security of the drinking water in schools, where children spend significant time. The researcher has identified the drinking water availability in educational institutes as an important area of research and an attempt has been made to analyze the Cost of the drinking water availability with respect to its infrastructure in the selected schools of Vadodara city.

CHAPTER SCHEME

CHAPTER 1: INTRODUCTION

This chapter covers the introduction of water at international and national level, its health hazards, departments and institutions, policies and programs related to drinking water. The last portion of the chapter discuss the objective, rationale, significance of the research and brief profile of Vadodara

CHAPTER 2: REVIEW OF LITERATURE

The researcher has undertaken the review of research studies at broader sense to under the problematic area related to water and how those problems can be related to the present study. Section 2.1 Water resource/ conservation/ reuse/grey water discuss the broad areas related to water problems, 2.2 Economic aspect on water discuss the cost, pricing, subsidy, funding, budget, 2.3 Behavior approach towards water/ others related area discuss the willingness to pay and accept 2.4 Drinking water details the existing body of knowledge related to present research area. 2.5 Drinking water in schools/ contamination related to existing body of knowledge specifically

related to present research area. 2.6 Vadodara and water contamination discuss the research related to the Vadodara city and present research

CHAPTER 3: RESEARCH METHODOLOGY

This chapter covers the detail of various methods and tools used for achieving the objective of the research and the limitation of the study.

CHAPTER 4: STUDY ON DRINKING WATER INFRASTRUCTURE OF SCHOOLS

This chapter discusses findings from the survey of drinking water infrastructure of schools & details the cost analysis of the drinking water on the basis of the major factors contributing towards drinking water infrastructure. It also analysis the teachers and students' perception on parameters of drinking water facilities.

CHAPTER 5: ANALYSIS OF PACKAGED DRINKING WATER SUPPLY

This chapter discusses findings from the survey of packaged drinking water supplier. This chapter details the cost analysis of the drinking water from the packaged drinking water suppliers.

CHAPTER 6: SUGGESTIONS, CONCLUSION AND RECOMMENDATIONS

Based on the findings, the researcher suggests a cost subsidy model for drinking water infrastructure and JJM (Jal Jeevan Mission) at the national level with the aim of meeting the SDG-6 targets by WHO and UNICEF at the international level.

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