Assessment of household water consumption during COVID-19 pandemic: a cross-sectional web-based study in India

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Abstract
The fatal novel COVID-19 creates precarious threats to humans through speedy diffusion. This virus not only disrupts human health but also makes multidirectional loss and slowdown of modern earth. Almost all countries strictly imposed lockdown and social distancing norms to prevent the infection of COVID-19 virus. In almost all parts of the world, people are using more water for washing, cleaning, bathing and hand washing practices. As a result, per capita water demand along with expenditure have been significantly increased. The principal objective of this study is to evaluate the household level water consumption status and to improve the water security with management for future. The current study has been conducted among the general population of India to assess household level water consumption through internet E-Surveys Google form from August 18 to September 8, 2020. Around 1850 respondents have sent their comments from different sites (rural and urban areas in various climatic regions) of Indian subcontinent. The results show the tremendous increase of water usage along with electrical consumption and expenditure during COVID-19 pandemic situation. Our results revels that 10%, 15% and 17% of higher water consumption per day in rural, urban and peri-urban residential respectively. We hypothesize that the reasons for the increasing water demand and household consumption per day may be found in changed behavioral routines through bathing, washing clothes, and hand washing practices. This web-based study also suggests that few alternative and dependable management techniques i.e. rain water harvesting can be installed to fight the crisis and for the sustainable future. Subsequently, research and development are highly required for long-term management of water resources or reuse of water.

Keywords  COVID-19 · Lockdown effects · Water consumption · Water security · Sustainable management

Introduction
Most of the countries in the world have been severely affected by the global pandemic of novel coronavirus disease (COVID-19). The Wuhan city in the Hubei Province of China is the probable place of origin of the fatal disease and due to its speedy transmission almost 216 countries have been brutally affected (Asyary and Veruswati 2020; Gupta et al. 2020). Considering the COVID-19 infected cases, India is on the 2nd position as of 6th September, 2020. World Health Organization (WHO) reported that the total number of active cases in the world is 26.76 million while India’s figure is 4.11 million as of 6th September, 2020. The rapid rate of diffusion of COVID-19 virus among people occurs through sneezing, coughing and from the droplets of infected patients. Common symptoms of this disease include fever, cough, breathing difficulties, pneumonia, and kidney failure (WHO 2020). As no vaccine has been discovered yet, few necessary preventive measures like social distancing, using hand sanitizer, and frequent washing of hands with soap and clean water are the only ways to restrict the virus from spreading. Due to COVID-19 outbreak, while the consequent lockdown phases have some positive impacts on environment like reduction in river water pollution (Patel et al. 2020; Chakraborty et al. 2021a, b; Khan et al. 2021) and air quality improvement (Chowdhuri et al. 2020, 2021; Chakraborty et al. 2021; Pal et al. 2021a), there have been negative impacts on socio-economic life as well (Ghosh et al. 2020; Mishra et al. 2020; Pal et al. 2021b). During the pandemic, household water consumption has increased significantly (Abu-Bakar et al. 2021; Kim et al. 2021; Lüdtke et al. 2021). According to WHO’s guideline, a proper way of cleaning our hands can prevent the transmission of coronavirus (SAR-COV-2). According to a report of United Nations
(2019), Economic and Social Council, world’s 60% population and in case of developing countries, only 30% of population has the facility to use soap and water for cleaning their hands. About 3 billion people do not have a proper facility to wash hands in their houses. Water crisis is a burning issue in developing countries like India where household-wise adequate availability of water is less. According to a report of the NSSO (2019), India’s 21.4% of the households and in cities 41% of the households have the facility of piped drinking water connection. In rural areas, 18% of the households have the provision of direct potable water (DDWS 2019).

Water is of utmost necessity to all the living organisms on earth. Water is an important indicator of socio-economic development of almost every country in the world (Shit et al. 2019; Singh and Turkiya 2013). In any country, the quality of life of a community is directly influenced by availability of safe drinking water. With the increasing population, demand of water is rising which is creating a huge pressure on the water resources. On the other hand, climate change and environmental degradation adversely affect the global hydrological cycle and ground water storage particularly in confined aquifers. Areas suffering from scarcity of rainfall show less groundwater recharge leading to lesser availability of safe drinking water (Bera et al. 2021). According to NITI Aayog (2019), the comprehensive water management index (CWMI) report predicted that within 2030 the demand of water in India will be doubled resulting in acute water shortage and India will face around 6% loss in GDP. As far as the usage of water resources is concerned, India is highly dependent on groundwater resources. Every year, India extracts 249 BCM of groundwater, which is twice that of US (Khambete and Bhaduri 2020). Out of the withdrawn water resource, 221 BCM (89%) is used for irrigation and 25 BCM for domestic purposes (CGWB 2019). In the recent years, water scarcity is acute in arid and semiarid regions (Al-Khatib et al. 2003). As these regions do not have the availability of enough fresh water, inhabitants suffer due to water shortage for decades (Bera and Das 2021; Chowdhury et al. 2021). There are several water resources management techniques which need to be implemented in arid and semiarid regions for an immediate solution to the water demands (Grey and Sadoff 2007). In the last decade, mountainous regions are facing severe water crisis along with elementary water treatment facilities in case of water security concern (Sharma et al. 1996; Kreutzmann 2011; Rasul 2014). With limited water resources and supplies, the local inhabitants obtain their domestic water from different natural sources such as spring, stream, lake, etc. (Shit et al. 2019).

In India the per capita average annual fresh water availability has gone down from 5177 m$^3$ in 1951 to 1545 m$^3$ in 2011. It has been estimated that in 2050, it will drop down to 1140 m$^3$ (Kumar et al. 2005; Census 2011). To combat water security and to determine nature of water available in any region, socio-economic, demographic, and environmental aspects are very significant (Van Aalst et al. 2008). Almost in all developing countries of the world including India, the rural community continuously suffers due to the absence of clean drinking water as well as lack of multiple fresh water resources (Sharma et al. 1996).

A major section of the rural population spend a considerable amount of time in a day to arrange and fulfill their daily water needs (Singh and Turkiya 2013). Lack of availability of enough safe drinking water leads to increase in huge economic expenditure as well as diminishing health conditions which indirectly accelerate human poverty and economic distress (Howard et al. 2003). Factors affecting rural water security are household size, number of household contamination of water resources, and per capita water consumption (Scheffter 1990; Vörösmarty et al. 2010; Evengard et al. 2011). Depending on the quality of water index, out of 122 countries, India holds 120th position. A huge number of population (663 million people worldwide) use unsafe sources of water like unprotected well, spring and surface water bodies (Bandyopadhyay 2016). Community level awareness, response and basic knowledge about water resources conservation are the principal regulating factors which are required to improve the water security (Wilbanks and Kates 1999). Water security has always been an indicator of advanced economy for micro- to macro-level societal development and to ameliorate the country’s economic growth (Grey and Sadoff 2007; Basu et al. 2015). The household level water security is a serious issue to combat against the fast transmission of coronavirus (COVID-19). The water usage has rapidly increase at the household level due to frequent washing of hands, bathing and washing of cloths. As a result, the electricity consumption rate has increased leading to amplification of household expenditure. In most of the cases, non-governmental employees face serious economic trouble and the static groundwater storage capacity has reduced tremendously.

The main objective of the present study is to quantify water consumption rate before and during COVID-19 pandemic situation and to advocate the proper water management scheme for sustainability of humans. A perception-based interesting study, during COVID-19 critical circumstances, has been completed considering few limitations like actual water usage figure data and indirect interactions with people through digital platforms. The significance of the study is to highlight the rural and urban per capita water consumption and demand scenario as well as enumeration of increasing economic pressure due to excessive usage of water during COVID-19 global pandemic. This study also suggests some alternative sources of water in this time of dire need. The necessity of proper management of water to meet the augmenting demand has been put forward through
this study. Therefore, this study can significantly help to plan better water management schemes during serious situations.

**Study area**

The present study has been conducted based on an online survey in different states of India. The latitudinal and longitudinal extension of India is 8° 4′ N to 37° 6′ N latitude and 68° 7′ E to 97° 25′ E longitude respectively. Based on geographical area, India is the seventh largest (3,287,263 km²) country in the world. India is the 3rd most severely COVID infected country in the world after America and Brazil. Up to 6th September, 2020, around 4,113,811 people have been infected by coronavirus and 70,626 deaths have already occurred. In India, the highest number of infected people is from Maharashtra (883,862) followed by Andhra Pradesh (487,331) and Tamil Nadu (457,697). North Eastern states of India and Jammu Kashmir are relatively less infected. India is the second most populated country in the world. According to the census of 2011, population density of India is 500/km². Based on age structure, around 28.6% population stands within the range of 0–14 years while about 63.6% population is within the range of 15–64 years and the remaining 5.3% is above the age of 65 years. According to Trewartha’s classification, India can be divided into 7 climatic regions (Fig. 1). However, for convenience of discussion, study area has been divided into four broad climatic zones, which are moist, arid, semi-arid and hilly regions. Moist regions of India include the states of West...
Bengal, Orissa, Andhra Pradesh, Uttar Pradesh, Kerala and Goa. Some parts of Rajasthan and Gujarat lie within arid regions while Haryana, Karnataka, Tamil Nadu, eastern parts of Gujarat and Rajasthan are semi-arid regions. Jammu Kashmir, Himachal Pradesh and North Eastern states are hilly regions included within mountainous climate of India. Hydro-geological formation of India is diverse wherever from oldest Archean to recent alluvium types of subsurface lithological formations can be found. In general, the groundwater condition in major part of India is good and is suitable for drinking, agricultural and industrial activities.

Web-based survey and data analysis

Maintaining the strict norms of social distancing along with other lockdown regulations, direct interaction with households is a relatively hazardous task and is simultaneously a risky job in big country like India during COVID-19 global pandemic. A cross-sectional web-based (online) survey was conducted among the general population of India to assess household level water consumption through bathing and washing of clothes and hands from August 18 to September 8, 2020. The survey has been conducted through Internet E-Surveys Google form on a virtual social platform. The survey included a brief overview of the study context, purpose, procedures, confidentiality agreement, and consent. For the survey, an online questionnaire was arranged and kept active for 20 days on the google platform. Link of the questionnaire form was sent to people through various social platforms and e-mails. Within the span of these 20 days, respondents from various climatic regions and states of India had submitted their feedback through the questionnaire answer form. The data has been gathered from 28 states and some union territories of India. As there is a huge regional diversity with multiple languages and dialects in India, English was chosen as the medium of communication. Around 1850 people sent their feedback from different parts of India through this platform. Different relevant questions have been framed related to domestic water sources and consumption and systematically arranged on the google form for the convenience of the respondents (Table 1). Questions regarding water consumption in the pre and during the COVID-19 period were also placed in the form. Similarly, parameters related to daily water consumption for washing hands, clothes, and for bathing, etc. were given on the google form. The data collected were encoded and entered into a computer using Microsoft Excel 2016 version and exported to SPSS. All statistical analyses were performed using the SPSS software version 20. Descriptive statistics such as frequency, percentages, confidence interval, mean, and standard deviation were calculated and presented in the tables. The confidence interval (CI) is a range of values that’s likely to include a population value with a certain degree of confidence. It is often expressed as a % (percentage) whereby a population mean lies between an upper and lower interval.

Results and discussion

Water use for washing hands

Humans are the main medium of SARS-COV-2 virus transmission. The virus spreads when a person comes in contact with a Covid infected person. Therefore, to avert the escalation of this virus, maintaining effective hand hygiene is one of the vital preventive measures. The behavioural changes caused by COVID-19 such as home-schooling, work-form-home, hygiene practices, etc. can alter the local daily amount and pattern of water usage. Changing the habit and behaviour of washing hands is way more tough and complex than the availability and arrangement of required water facilities and soap (Cooper 2020). Through repeated hand washing, people can keep themselves safe to some extent. Enough quantity of water is essential to follow a routine of washing hands repeatedly.

For this study, person-wise hand washing data from different climatic regions have been collected and studied. The study shows that in arid regions, where people used to wash hands 6 times on an average, the frequency has reached to 11–12 times during the COVID situation (Fig. 2). In arid regions, maximum frequency of washing hands practiced by 7.69% people during pre COVID-19 situation was 12–16 times a day. But in COVID-19 situation around 19.23% people are following the routine of washing hands 12–16 times a day while 23.07% people are washing their hands 16–20 times a day. The minimum frequency of washing hands is 1–4 times a day but it has decreased considerably (34.61%) in COVID-19 situation. In semi-arid, hilly and moist regions the drop in the frequency of hand washing is 29.5%, 20.69% and 34.65% respectively. Similar to arid regions, the maximum frequency of washing hands in semi-arid, hilly and moist regions have increased to 22.12%, 17.24% and 21.26% respectively.

A similar observation has been made in village and urban areas. As compared to pre-COVID situation, in rural, urban and peri-urban areas, the maximum frequency of washing hands (16–20 times a day) has increased to 22.62%, 20.59% and 17.64% respectively. On the other hand, compared to pre COVID-19 situation minimum frequency of washing hands (1–4 times a day) has decreased by 28.57%, 34.3% and 35.3% respectively (Table 2). Thus, in all the above cases it can be seen that there is a decline in minimum frequency and an augment in maximum frequency of washing hands during the COVID-19 period. As a consequence of this, usage of water for washing hands...
has also increased noticeably. A proper way of cleaning our hands involves washing both sides of our palm using soap and water for 20 s. Washing hands for 20 s, once in a day requires a minimum of 2 L of water. So, if a family has 5 members and every member washes their hands ten times a day, 100 L of water will be required (Bhowmick 2020; Rohilla 2020). This scenario is a luxurious one for India’s rural community. So, in this COVID-19 situation much more amount of water is utilized than during the normal conditions. Therefore, availability of huge quantity of water for each and every household is of paramount importance.

**Water use for bathing**

Regular bathing is one of the effective ways to prevent the spread of corona virus since it helps to keep ourselves clean and to some extent restricts the disease from spreading. So, in this situation, daily bathing of at least one time is very necessary for our safety. People who need to go outside in

### Table 1  Demographic characteristic and house level water consumption status of the participants

| Variables                        | n    | %    | 95% confidence interval (CI) |
|----------------------------------|------|------|-----------------------------|
| **Gender**                       |      |      |                             |
| Male                             | 1012 | 54.70| 62.1–68.2                   |
| Female                           | 838  | 45.30| 33.2–39.4                   |
| **Education**                    |      |      |                             |
| No schooling                     | 102  | 5.51 | 4.1–6.1                     |
| Primary level                    | 124  | 6.70 | 4.5–6.3                     |
| SSC                              | 234  | 12.65| 8.7–12.4                    |
| HSSC                             | 474  | 25.62| 18.9–20.3                   |
| Graduate                         | 560  | 30.27| 25.6–27.1                   |
| Post-graduate/higher             | 356  | 19.24| 17.6–19.2                   |
| **Occupation**                   |      |      |                             |
| Student                          | 430  | 23.24| 17.3–18.5                   |
| Un-employed                      | 140  | 7.57 | 5.5–7.1                     |
| Business                         | 364  | 19.68| 14.5–17.2                   |
| Housewife                        | 128  | 6.92 | 5.6–7.2                     |
| Service/employed                 | 642  | 33.72| 28.5–32.4                   |
| Others                           | 146  | 7.89 | 5.6–6.1                     |
| **Residence**                    |      |      |                             |
| Urban                            | 624  | 33.73| 29.4–33.5                   |
| Peri-urban                       | 676  | 36.54| 30.8–34.1                   |
| Rural                            | 550  | 29.73| 25.6–28.5                   |
| **Sources of water**             |      |      |                             |
| Electric motorized pump          | 764  | 41.29| 12.4–18.2                   |
| Govt. tube well                  | 426  | 23.03| 19.2–23.5                   |
| Private tube well                | 330  | 17.84| 15.2–19.8                   |
| Water tanker                     | 107  | 5.78 | 4.8–7.1                     |
| Well                             | 119  | 6.43 | 5.1–7.4                     |
| Piped water supply               | 104  | 5.62 | 4.6–6.8                     |

SSC secondary school Certificate, HSSC Higher secondary school Certificate
public places for regular household requirements or avail
public transport should bath after coming back to home.
Like many other countries, in India too, people are bath-
ing more than once in a day. This study shows that around
26.92% of the people bathed 2 times a day before COVID-19
outbreak but during the COVID-19 period around 53.85%
of the people are following this practice in arid regions.
In semi-arid regions a similar observation has been made,
where compared to pre COVID-19 period, bathing practice
of more than once in a day during the COVID period has
increased to 31.97%. In hilly regions, the increase in bath-
ing frequency is 34.45% and in moist region it is 22.83%
(Fig. 3). Hence, in India, a rise in bathing rate has taken
place among the inhabitants from all the climatic regions
for safety proposes.

In rural areas in India, bathing rate of more than once in a
day during pre COVID-19 period was only 20.83% but dur-
ing COVID-19 situation (Table 3). Therefore, with the increase
in bathing frequency usage of water has also increased. In
a developing country like India, people need minimum 15
L of water for bathing once in a day (Kalbermatten et al.
1982; Gleick 1996; Singh and Turkiya 2013). So, in a family
of 4 members, if all the members follow a routine of bath-
ing twice in a day, then 120 L of water will be used only
for bathing purpose. Thus, during this COVID-19 outbreak,
usage of water has increased noticeably. In rural areas and
in few pockets of urban regions, there is a practice of mass
bathing in pond and rivers, where repeated bathing gives
rise to waterborne diseases (Kulshrestha and Sharma 2006;
Jani et al. 2018; Roy Chowdhury et al. 2019). So, to main-
tain a better hygiene, availability of enough fresh water is
of utmost necessity.

**Water use for washing cloth**

Due to COVID-19 lockdown, certain numbers of people
are going out on a regular basis for emergency services.

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**Fig. 2 Hand washing frequency in different climatic regions of India**

**Table 2 Hand washing frequency of respondents in different regions of India**

| Hand washing frequency (n = 1850) respondents (in %) | Village region (n = 550) | Urban (n = 624) | Peri-urban (n = 676) |
|-----------------------------------------------------|-------------------------|----------------|---------------------|
| Pre-COVID | During COVID | Pre-COVID | During COVID | Pre-COVID | During COVID |
| 1–4 times a day | 32.74 | 4.17 | 36.27 | 1.97 | 38.24 | 2.94 |
| 4–8 times a day | 44.05 | 17.86 | 38.24 | 31.37 | 47.06 | 32.36 |
| 8–12 times a day | 19.64 | 36.9 | 19.61 | 35.29 | 11.76 | 26.47 |
| 12–16 times a day | 3.57 | 18.45 | 5.88 | 10.78 | 2.94 | 20.59 |
| 16–20 times a day | 0 | 6.55 | 0 | 7.84 | 0 | 8.82 |
| > 20 times a day | 0 | 16.07 | 0 | 12.75 | 0 | 8.82 |
Presently, in India, unlock phase-4 processes have started and some factories and offices have resumed their work. People are using masks and gloves for their protection while going outdoor. According to scientists, corona virus can thrive for 72 h on fabrics. So, to prevent this virus from spreading through masks and clothes these fabrics need to be washed after returning home. In this situation, every family member consumes more water for washing clothes.

In arid regions, during the pre COVID-19 period around 80.77% of the population washed clothes everyday but during COVID-19 around 92.31% of the population are following this routine for cleaning their clothes. In semi-arid regions, people are washing their clothes once in a week but it has decreased by 3.28% while the practice of every day washing has increased by 13.93% (Fig. 4). A similar kind of practice has been noticed in the hilly regions as well. In moist regions, there is a sharp rise in the practice of washing clothes where in the pre COVID period 55.12% people used to follow the routine of daily washing of clothes while during COVID situation 82.68% people are following the same practice.

In rural areas of India people who cleaned their clothes once in a week has reduced by 5.35% and daily washing practice has increased by 20.83% (Table 4). This practice of washing clothes daily has increased in urban and peri-urban regions by about 15.69% and 17.65% respectively.

In arid regions, around 11.54% people used 4 to 14 buckets (Capacity of each bucket is 18 L) of water during pre COVID period while around 46.15% people are using the same quantity of water in the COVID situation (Fig. 5). In case of semi-arid, hilly and moist regions, usage of water in COVID situation compared to pre COVID period has increased by 22.94%, 13.79% and 22.83% respectively. This additional use of water is 1.26% more in rural areas of India (23.81%) than in urban regions (22.55%) (Table 5). Therefore, due to the outbreak of COVID-19, the frequency of washing clothes and usage of water have increased significantly (in every region of India). Therefore, a huge amount of water is required to maintain better hygiene and proper water resources management techniques should be implemented for a sustainable management of water resources.
Sources of domestic water

The population explosion along with the execution of different developmental activities give rise to severe water crisis except monsoon months in India. To fulfill the multi-dimensional demands of water resources, sustainable reuse of water and technological development are the principal research components in the modern era. Protecting source water can help to improve water quality and lower the costs of water treatment for urban suppliers whereas for rural areas it can provide access to safe drinking water. Certain sections of society such as marginalised groups, persons with disabilities, poor households and women often experience inequality in terms of water accessibility for their livelihood (World Bank 2016). During a pandemic, these groups are less likely to take preventive measures due to difficulties.
because of the inequalities. Therefore, there are more possibilities of these sections getting exposed to infections easily. It should be ensured that hurdles faced by these groups are considered and tackled productively in interventions.

According to world health organization (WHO 2020), daily per capita of 125 L of fresh water is the minimum requirement and people of developing and under developing countries are not getting the minimum standard. Subsequently, they are using unhealthy, polluted and contaminated water to fulfill their basic demands. In India, a large scale withdrawal of groundwater is being continued to meet the huge demand of different sectors. In case of rural India, people are using groundwater as well as surface water while hilly and mountainous people are collecting fresh water from the natural springs and lakes. This perception study brings a general scenario of different sources of domestic water particularly for diverse climatic regions of India.

In arid regions, around 38% people use water from electric motorized pump for domestic purposes while government and public tube wells serve as source of water for around 30.77% and 3.85% people (Fig. 6). A very small percentage of the population (7.69%) uses water from dug wells. In semi-arid, hilly and moist regions, about 45.9%, 58.62% and 37.79% people respectively are using government and private tube wells. Inhabitants of moist regions use relatively more quantity of water from dug wells than the inhabitants of hilly and semi-arid regions. In hilly regions, people benefit more by piped water supply than other regions of India. As a source of water, water tanks have also been used mostly by people of arid regions.

| Water used for washing clothes | Village region (n=550) | Urban (n=624) | Peri-urban (n=676) |
|-------------------------------|-----------------------|--------------|-------------------|
|                               | Pre-COVID | During COVID | Pre-COVID | During COVID | Pre-COVID | During COVID |
| <2 Buckets                    | 27.98     | 9.52         | 27.45     | 10.78         | 35.29     | 14.71         |
| 2–4 Buckets                   | 48.21     | 42.86        | 46.08     | 40.2          | 38.24     | 38.23         |
| 4–6 Buckets                   | 14.29     | 25           | 13.73     | 18.63         | 17.65     | 17.65         |
| 6–8 Buckets                   | 2.38      | 10.12        | 5.88      | 16.67         | 0         | 14.71         |
| 8–10 Buckets                  | 4.17      | 5.95         | 5.88      | 8.82          | 8.82      | 8.82          |
| 10–12 Buckets                 | 2.87      | 3.57         | 0.98      | 1.96          | 0         | 2.94          |
| 12–14 Buckets                 | 0         | 0.6          | 0         | 1.96          | 0         | 2.94          |
| >14 Buckets                   | 0         | 2.38         | 0         | 0.98          | 0         | 0             |

**Fig. 6** Source of domestic water in different climatic regions of India
It is evident from the study that majority of the population (37.5%, 45.1%, and 41.18%) of rural, urban and peri-urban regions of India use water from electric motorized pump for domestic purposes (Table 6). But in villages people mostly use dug wells as a source of drinking water. In urban and peri-urban regions people tend to use more piped water than in rural regions. From the above results it is perceptible that in almost every region, people use more water from electric motor pump and government tube wells. Therefore, the frequency of using pump during COVID-19 has increased noticeably. Meanwhile, it leads to an increase in consumption of electricity along with the payment of extra electric bills. In this situation, when livelihood is suffering seriously due to corona virus outbreak, the extra pressure of spending more money on electric bills has created difficulty for common people. Hence, considering each and every dimension, rain water harvesting and parallel techniques can be introduced as the best alternatives during the crisis period and for long term sustainable management.

Management and recommendation

Atmospheric water harvesting and amelioration of water security

Atmospheric water which is available in every climatic region occurs as a huge renewable water source. But, unfortunately, this has been ignored. This source of water can be utilized in its liquid form for our daily uses with the help of few technologies (Tu et al. 2018; Beysens and Milimouk 2000). This water obtained from atmospheric vapor is plain in quality and is usable for drinking and other domestic purpose. Globally 1/7 million people die due to poor water quality, poor sanitation and poor hygiene (Macedonio et al. 2012). Through the process of water harvesting from air, people in arid and semi-arid regions can use this water as a substitute (Fessehaye et al. 2014). For less precipitated regions of the world, different kinds of surface water bodies (like rivers, lakes, springs, ponds etc.) are not enough to meet the needs of inhabitants and thus require availability of more fresh water for socio-economic development (Schemenauer and Cereceda 1991; Olivier and de Rautenbach 2002; Abdul-wahab and Lea 2008; Guan et al. 2014). The average amount of water obtained from precipitation is about 4000 BCM, in which utilizable water is only 28.1% (1123 BCM), whereas around 17.3% (690 BCM) is surface water and 10.8% (433 BCM) is groundwater (NITI Aayog 2018). If a country like India treats the atmospheric water as drinking water, around 10% pressure will be reduced from groundwater (Das 2018).

Rainwater harvesting and improve the water security for long-term future use

Rainwater harvesting involves collection, storage and reproduction of rainwater and to recover from run-off loss. Rainwater can be considered as the most easily accessible and least polluted source of water. Though intensity of precipitation, so as to collect and store that water for further use, remains high mainly in monsoon in many regions of India, but a wisely planned management of rainwater harvesting can be extremely helpful during other seasons. Regular practice of rainwater harvesting is the best alternative to fight against any situation of water scarcity or sudden unprecedented rise in water usage. Surface run off harvesting and roof top rainwater harvesting are two methods which are associated to rainwater harvesting. The stored rainwater, especially in arid and semi-arid regions with limited rainfall, serves as one of the dependable sources of water during prolonged dry periods. The collected water must be filtered for drinking and domestic purposes. There are different water harvesting techniques which gather water from a catchment area where the rain water has been stored and then it is channeled to the sites of water requirement. In rooftop rainwater harvesting, the harvested water can be stored in a subsurface ground water reservoir to meet household needs through storage tanks. The most suitable kinds of rooftop surfaces for rainwater harvesting are corrugated iron sheets, tiles and asbestos sheets. In almost all climatic regions of India, through different feasible techniques, rainwater harvesting can be practiced to meet various necessities. Around 650,000 L of rainwater can be captured and recharged from a 100 m² rooftop to meet drinking and domestic water requirement of a family of 4 members for 160 days (Deshmukh 2006). By applying more such rainwater harvesting techniques, stored water can be treated and used. Thus, the pressure on groundwater resources will be definitely reduce which will help daily domestic activities to some extent.

| Sources of water       | Village region (n=550) | Urban region (n=624) | Peri-urban region (n=676) |
|-----------------------|------------------------|----------------------|--------------------------|
| Electric motorized pump | 37.5                   | 45.1                 | 41.18                    |
| Govt. Tube well       | 23.21                  | 22.55                | 23.53                    |
| Private Tube well     | 25                     | 11.77                | 17.65                    |
| Water tanker          | 4.76                   | 9.8                  | 2.94                     |
| Well                  | 8.93                   | 4.9                  | 5.88                     |
| Piped water supply    | 0.6                    | 5.88                 | 8.82                     |
Conclusions

Water is a vital requirement for life and socio-economic development. It is one of the natural resources that is getting utilized in a noticeable extent during the COVID outbreak. To prevent the virus from spreading, cleaning and sanitizing ourselves and our daily used accessories are of utmost importance. The study clearly concluded that the usage of water for different purposes have been doubled. Therefore, this sudden increase in demand is creating a tremendous pressure on the water resources. The online survey indicates that the inhabitants of every climatic region of India irrespective of rural or urban areas are using water on a large scale compared to the previous years. The uncontrolled use of water will definitely hamper the water security for the essential basis of our life. But to keep ourselves safe from the rapidly spreading disease, water needs to be used more with respect to preceding years. So, a proper management and arrangement of alternative sources of water is very much important to meet the growing demand. Hence, new techniques such as storing atmospheric water and rainwater harvesting mainly rooftop harvesting are required to maintain a balance between water supply and usage. The online survey based study reflected that the situation during COVID-19 global pandemic is very alarming. The relevant management techniques have been recommended for not only COVID-19 pandemic but also for long-term sustainable water crisis management. In case of future pandemic situations, to prevent or deal with such conditions effectively, enhancing and bolstering water resources management is imperative so that water is available where and when it is required. This will ensure an access to adequate quantity of water, preserving its acceptable quality. Citizens’ and communities’ roles in water management must be recognised, and steps to allow them to participate in decision-making should be taken. To efficiently fight future pandemic situations, ensuring adequate supply of good quality water, good water governance is needed. To buttress good water management and governance, knowledge and capacity building for institutions are essential. Application of new data tools like water accounting can help to support urban planning and decision making.

Data availability The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of interests The authors declare that they have no competing interests.

Ethics approval and consent to participate Not applicable.

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