



**Bharat Lal**  
Additional Secretary  
&  
Mission Director

**National Jal Jeevan Mission**  
Government of India, Ministry of Jal Shakti  
Department of Drinking Water and Sanitation

**No. 11048/4/2020- Water-DDWS**

Dated the 13<sup>th</sup> April, 2020

**Advisory in compliance of Hon'ble Supreme Court's order dated 03.04.2020 in  
WP (PIL) No.10808/2020**

**Madam/ Sir,**

Please find enclosed a copy of the Writ petition(PIL number 10808 of 2020), order of Hon'ble Supreme Court dated 3/4/2020 in the writ petition and an advisory note of National Jal Jeevan Mission, detailing the requirements and suggested course of action for compliance of orders of the Hon'ble Court.

2. It may be seen that the Hon'ble Court in its order has directed the respondents to treat the petition as a representation and act upon the prayers made therein appropriately. In the list of prayers, *inter alia*, it has been prayed to ensure clean water to the citizens, including those residing in shelter homes or are undergoing quarantine/ treatment during the period of pandemic COVID- 19 conditions.

3. As per Ministry of Finance, Dept. of Expenditure OM 55(5)/ PF-II/ 2011 dated 6.9.2016, and subsequent modifications issued, flexi fund under JJM can be used to meet the requirement arisen due to calamity. Thus, provision of flexi fund upto 25% of the annual allocation is already existing in the Jal Jeevan Mission. It is reiterated that the flexi-funds under the Jal Jeevan Mission can be utilized for mitigating drinking water requirements during calamities and wherever needed. It is also to be ensured that potable water supply as an essential service has to be maintained and necessary arrangements for manpower, chemicals, water testing, operation and maintenance, etc. to be made. In case, people involved in running the water supply systems get infected, alternate arrangement has to be in place so as there is no breakdown in the service.

4. The State Government may utilize such funds for compliance of directions of Hon'ble Court and largely for giving relief to the people during the period of lockdown. Further, you are also requested to comply with relevant instructions issued by the Ministry of Home affairs, Govt from time to time, to combat the COVID-19 pandemic by following the prescribed protocols.

With warm regards

Yours Sincerely,

  
13/4/2020  
(Bharat Lal)

**Enclosure:** As above

To

**Chief Secretary/ Administrator/ Advisor to Lieutenant Governors**  
All States/ UTs.

**Copy for information and necessary action to:**

1. Additional Chief Secretary/ Principal Secretary/ Secretary, In-charge Rural Water Supply Department, All States/ UTs.
2. Chief Engineer, Rural Water Supply Department, All States/ UTs.

**Copy for information to:**

1. Home Secretary
2. Secretary, D/o Health and Family Welfare
3. Secretary, M/o Housing and Urban Affairs

**Advisory for ensuring safe drinking water during lock down and effective management of pandemic caused by Corona Virus**

COVID-19 has taken pandemic proportions in many countries and in view of the seriousness of the matter, Govt of India and State Governments have taken several pre-emptive measures to contain this disease in the country. Frequent washing of hands with frothing soaps is recognized as most efficient and effective measure in the listed preventive measures for controlling the spread of the virus. Thus, there is an urgent need to ensure that safe potable water is available to all citizens particularly in the rural areas where facility of medical sanitizers may not be available.

Public Health Engineering Departments/ Boards/ Nigams of the State Governments need to accord top priority for taking measures to augment supply in areas where water supply may be deficient as of now and special care may be given to vulnerable sections of the society like people residing in relief camps, places of quarantine, hospitals, old age homes, poor strata of society, slums, etc. It will be appropriate to integrate the identified needs of potable water in the micro-plans of the districts being formulated to combat the spread of COVID-19 disease.

Further, wherever chemical treatment for enhancing the safety of potable water is required, appropriate purifying chemicals like Chlorine tablets, bleaching powder, Sodium hypochlorite solution, Alum, etc. as may be needed, should be used. State Governments may assess the requirements of water purifying chemicals and availability of the same. In case the supply of the same is deficient, to meet the immediate requirement, then suitable intervention for their procurement from elsewhere sources may be resorted to. The purifying chemicals are among the essential commodities and therefore it may be ensured that these are part of the running supply chain.

In addition, sufficient field test kits may be made available to the villagers trained in their use and they may be advised to do periodic testing of water supplied and alert all concerned in the event of any contamination.

Arrangements for round the clock vigil may be made to ensure functionality of water supply systems from source to delivery points.

Personal safety measures like masks, sanitisers, etc. may be provided to the officials of PHED, particularly who are managing the operation and maintenance of the water supply systems in the field. Alternate arrangement should be in place to replace the staff managing water supply, in case they get infected.

It is possible that demand during this period may go up and if people have to fetch water from the public stand post, supply hours may be required to be increased to ensure social distancing.

Further, existing grievance redressal mechanism may be strengthened so that any interruption in water supply can be immediately brought to the notice of all the concerned and timely action can be ensured to reinstate the supply.

The principles of social distancing and relevant instructions issued by the Ministry of Home affairs, GoI to combat the COVID -19 pandemic may be complied with, by following the prescribed protocols.

\*\*\*\*

The Registrar General (Judicial),

Supreme Court of India,

Tilak Marg, Delhi

**Subject: URGENT MATTER- PIL on provision of CLEAN WATER and other reliefs mentioned in the petition to fight against COVID19.**

Respected Sir,

Listing of the urgent PIL is requested before the Supreme Court Justice(s), to plead for directions regarding provision of clean water and sanitation to 166 million Indians who continue to lack access along with other prayers mentioned in the petition. Unfortunately, despite access to Water being one of the crucial aspect in fighting COVID Pandemic, no steps have been taken by the Centre or State Government to ensure clean and sufficient water supply to all people within India.

We are deeply disturbed by the plight of marginalised and destitute Indian population who will be facing a massive Pandemic in the coming days. We have come to realise that the Government of India and State governments have not taken any effective measures for securing the right to water and sanitation for all persons living in India. There have been disturbing reports on the lack of PPE for sanitation workers and scientific reports stating how important water and sanitation is in fight against COVID19.

Through this petition we are praying the Hon'ble Supreme Court to:

- Impose urgent positive duty upon state and non-state actors to ensure that the right to water remains available and cost-free at all times during the disaster.
- Ensure that urgent steps are taken in making clean water and sanitary conditions available to all persons in India.
- Direct State governments and Central agencies to stop all activities of manual scavenging, rehabilitate manual scavengers and provide PPE to the Sanitation worker in the wake of COVID 19 pandemic.
- Direct State governments and Central agencies to ensure open defecation is prohibited in the entire country in the wake of COVID 19 pandemic.

Regards  
Rohit Samhotra  
Advocate  
P-2057/2015

**IN THE SUPREME COURT OF INDIA**

CIVIL ORIGINAL JURISDICTION  
**WRIT PETITION (C) NO. \_\_\_\_\_ OF 2020 (P.I.L)**  
**PUBLIC INTEREST LITIGATION**  
**(UNDER ARTICLE 32 OF THE CONSTITUTION OF INDIA)**

IN THE MATTER OF:

POSITION OF PARTY:

Between

In this Court

Rohit Samhotra and Another

....Petitioners

AND

Union of India and Ors.

....Respondents

**I N D E X**

S.No.	Particulars	Page no.
1.	Civil Writ Petition	1-14
2.	Annexure P-1 (Statement issued by 10 eminent UN Experts)	15-16
3.	Annexure P-2 (Guidance issued by WHO)	17-22
4.	Annexure P-2A	23-24

	(Advisory issued by Centers for Disease Control and Prevention, USA)	
5.	Annexure P-3 (FAQs on prevention of COVID-19 by Indian Centre for Medical Research has stated in its COVID-19)	25-26
6.	Annexure P-4 (Review article on use of Sanitizer)	27-39
7.	Annexure P-5 (Article on water scarcity)	40-50
8.	Annexure P-5A (Visual data simulation of ground water)	51
9.	Annexure P-5B (General water stress)	52
10.	Annexure P-5C (Report published by Ministry of Statistics & Programme Implementation)	53-55
11.	Annexure P-6 (Resolution no. 64/292 passed by United Nations, General Assembly)	56-58
12.	Annexure P-7 (Study on sewage water)	59-64
13.	Annexure P-8 (Study published online on Lancet Journal)	65-66

**IN THE SUPREME COURT OF INDIA**  
**ORIGINAL JURISDICTION**  
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**PUBLIC INTEREST LITIGATION**  
**(UNDER ARTICLE 32 OF THE CONSTITUTION OF INDIA)**

IN THE MATTER OF:

POSITION OF PARTY:

Between

In this Court

1. Rohit Samhotra,  
H.no. 624,  
Sector 16D,  
Chandigarh  
160015

...Petitioner no. 1

2. Ritumbra Manuvie,  
H.no.360, Sector-19,  
Faridabad  
121002

...Petitioner no. 2

**AND**

1. Union of India,  
Through Secretary,  
Ministry of Home Affairs,  
Jai Singh Marg,  
Hanuman Road Area,

Connaught Place,  
New Delhi  
110001  
jscpg-mha@nic.in

...Respondent no. 1

2. Ministry of Health & Family Welfare  
Through Secretary,  
Near Udyog Bhawan Metro Station,  
Maulana Azad Rd,  
New Delhi,  
Delhi 110011  
secyhfw@nic.in

...Respondent no. 2

3. Ministry of Water and Sanitation  
Through Secretary,  
C Wing, 4th Floor,  
Pt. Deendayal Antyodaya Bhawan,  
CGO Complex, Lodhi Road,  
New Delhi 110003  
param.iyer@gov.in, secydws@nic.in

...Respondent no. 3

PUBLIC INTEREST LITIGATION UNDER ARTICLE 32 READ  
WITH ARTICLE 142 OF THE CONSTITUTION OF INDIA.

To,

THE HON'BLE CHIEF JUSTICE AND HIS COMPANION JUSTICES OF  
THE SUPREME COURT OF INDIA.

THE HUMBLE PETITION OF THE PETITIONERS AS  
ABOVENAMED.

MOST RESPECTFULLY SHOWETH,

1. That the petitioners herein are filing the instant writ petition in public interest under Article 32 read with Article 142 of the Constitution of India for the enforcement of rights under Article 14 and 21 of the persons seeking a writ directing the respondents for the prayers mentioned in this petition in the view of COVID-19 pandemic.

2. That on 23<sup>rd</sup> March 2020 a group of 10 eminent UN Experts have stated that governments must ensure access to continuous and sufficient water to their populations in order to effectively fight the COVID-19 pandemic. They further asserted that as washing hands with soap and clean water is vital in the fight against COVID-19, the global struggle against the pandemic has little chance to succeed if personal hygiene, the main measure to prevent contagion, is unavailable to the citizenry, especially to those living with intersectional vulnerabilities in urban and rural slums. The copy of the statement issued is annexed as **Annexure P-1**.

3. That World Health Organization has established that thoroughly and frequently washing hands with soap and water are the only '*gold standard*' for prevention of and contamination

from COVID-19. Similar, guidelines have been shared by medical experts across the world, who have repeatedly said that while alcohol-based hand-sanitizers can be effective it does not guarantee the removal of all bacteria and viruses and can in fact cause the microbes to develop immunity and mutate into a more resistant variety. The copy of guidance issued by WHO is annexed as **Annexure P-2**. The copy of advisory issued by Centers for Disease Control and Prevention, USA is annexed as **Annexure 2A**.

4. That Indian Centre for Medical Research has stated in its COVID-19 prevention FAQs that thoroughly washing hands with soap and water for 20 seconds is most useful. They have further stated that alcohol-based hand-sanitizers are also effective, however, they have not stated any guideline on the composition or use of the sanitizers. The copy of FAQs for Patients with Hypertension, Diabetes and Heart Diseases in view of Coronavirus/COVID-19 Pandemic is annexed as **Annexure 3**.

5. That the global medical advice is to use a hand-sanitizer which constitute 60% alcohol for a minimum of 20 seconds (before evaporation of alcohol) to ensure neutralization of COVID-19. However, the validity of this claim is unfound, as the study that the guideline refers to while comparing the various

forms of hand-hygiene says that a minimum of 6ml of hand-sanitizer rubbed for 60 second is required to remove viral and bacterial microbes. The copy of review article is annexed as **Annexure P-4.**

6. That the above mentioned article further concludes that such high-level of alcohol-based hand-sanitization can cause problems of flammability amongst those involved in food-preparation, causing grave injuries. This is problematic especially for women in rural areas whose lives is on additional risk due to open-stove cooking across India.

7. That further, it is not known how the hand-sanitization bottles which are highly-flammable will be safely disposed. Indian Land-fills are already struggling with massive plastic pollution and these bottles will only add to the environmental burden through which yet another problem will be created in long-term.

8. That the provision of clean water is the most appropriate and key measure in fighting COVID-19 pandemic. However, it is humbly submitted that there are grave inconsistencies in the access to clean water, which can be summarised as follows:

**a** Down to Earth has reported on 23 March 2018 that approximately 166 million people in India still do not have

access to clean water and approx. 541 Million people lack access to proper sanitation, with scarcity felt more acutely in urban slums and rural areas for drinking water and sanitation respectively. These figures were also cross-checked with the NITI Ayog Report of 2018 titled Composite Water Management Index, published on 12<sup>th</sup> June 2018.

**a** As per the several scientific studies conducted by reputed institutes, the most vulnerable areas for water depletion are Punjab, Haryana, Rajasthan, Gujarat and Delhi. The copy of an article summarising that India is running out of water is annexed as **Annexure P-5**. These estimations are further cross-checked with Aquaduct data supported by the World Resource Institute. The copy of visual data simulation of ground water, and general water stress are annexed as **Annexure P-5 (A&B)** respectively. After conducting a survey on Drinking Water, Sanitation, Hygiene and Housing condition in India, a report was published by Press Information Bureau, Government of India, Ministry of Statistics & Programme Implementation. The copy of report is annexed as **Annexure P-5 (C)**.

**b** Every year approximately 37.7 million people in India are affected by waterborne diseases due to contamination of

water by bacteria (E coli, Shigella, Vibrio cholerae), viruses (Hepatitis A, polio virus, rota virus) and parasites (E. histolytica, Giardia, hook worm). And the NITI Ayog report has shown that approximately 2,00,000 people in India die every year due to water borne diseases.

9. That the Human Right to Water and Sanitation (HRWS) was recognised as a human right by the United Nations, General Assembly on 28 July 2010 through resolution no. 64/292. The copy of Resolution is annexed as **Annexure P-6**.

10. That the Hon'ble Supreme Court has emphasised the importance of the Right to access to safe and clean water in **Bandhua Mukti Morcha vs. Union of India** [1984 AIR 802, 1984 SCR (2) 67]. The Hon'ble Supreme Court in **Subhash Kumar v State of Bihar** [1991 AIR 420, 1991 SCR (1) 5] held that Right to life is a fundamental right under Article 21 of the Constitution and it includes the right of enjoyment of pollution free water and air for full enjoyment of life. In **State of Karnataka vs State of Andhra Pradesh** [AIR 2001 SC 1560], this Hon'ble Court held that the right to water is a right to life, and thus a fundamental right. In **Narmada Bachao Andolan vs Union of India** [(2000) 10 S.C.C. 664] (2000), it was again reiterated that '*water is the basic need for the survival of human beings and is part of the right to life and human rights*'.

11. That the principle of Roman Law '*salus populi est suprema lex*'(welfare of the people is paramount law) is the abiding faith in Indian Constitution and the '*State is assigned a positive role to help people realize their rights and needs*'. Apart from the interpretation of Article 21 by the Hon'ble Supreme Court, Directive Principles of State Policy also lay down guiding principles of Governance for the State as to best sub serve needs of its people.

12. That however, despite the Central government's planning with respect to countering COVID-19 pandemic, **no guidelines have been issued to ensure clean water and sanitary facilities.**

**a** Ministry of Health and Family Welfare, which has focused on provision of hand-sanitizers as a quick fix but not on provision of clean water and Sanitation facilities;

**b** Or the Department of Water and Sanitation, has not issued any notification on provision of clean water and sanitation facilities during the Pandemic;

**c** Or the Ministry of Home Affairs, has not issued any notification with regards to continued availability of clean and safe water and sanitation for 1.35 billion Indians;

d Or the Prime Minister Office– has not issued any notification on availability of clean water or Sanitation facilities;

e Or the Swatch Bharat Mission have not issued any specific guidelines to ensure supply of clean water and sanitation facilities.

13. That it is also submitted that a recent study in Netherlands has found SARS-Covid-2 RNA remains in the sample testing of sewage water. The copy of the study is annexed as **Annexure P-7**. And hence, maintenance of clean water and sanitization for all people inside Indian Territory becomes highly crucial for tackling the COVID-19 outbreak.

14. That the necessity of tackling water and sanitation crisis in light of COVID-19 has also been highlighted by the WHO, Times Magazine (especially in context of India) and various Humanitarian actors across the globe who have terms '*hand hygiene as a luxury of the privileged class who can lock themselves up in self-isolation and can spend money stock-piling hand-sanitizers*'.

15. That a recent study '***Prolonged presence of SARS-CoV-2 viral RNA in faecal samples***' published online on Lancet Journal suggests that the possibility of extended duration of viral

shedding in faeces, for nearly 5 weeks after the patients' respiratory samples tested negative for SARS-CoV-2 RNA. In such circumstances, community educational workshops to prohibit open defecation, especially, in villages would be indispensable. The directives of government and mandatory guidelines would be extremely important to prohibit open defecation in villages. The copy of study is annexed as **Annexure P-8**.

16. That it is further humbly submitted that the Sanitation work who are at the front-line of fighting COVID-19 Pandemic, continue to work in abysmal condition without PPE. These people are also at an elevated risk due to continued practise of manual scavenging in several states in India. On 16 February 2020, *The Hindu* has reported that despite the 2013 legislation on Prohibition of Employment as Manual Scavengers and Their Rehabilitation Act, there are at least 48,345 manual scavengers, across India with the highest number of Manual Scavenger employed in the State of Uttar Pradesh while relying upon a national survey conducted in 18 States.

**PRAYER: -**

17. In the given circumstances and given the existing inconsistencies of the current government's response to COVID-19 pandemic it is prayed as follows: -

- (A) Impose urgent positive duty upon state and non-state actors to ensure that the right to water remains available and cost-free at all times during the COVID-19 pandemic situation. Also to maintain healthy hand hygiene, along with social distancing as the most effective known measure to prevent contracting COVID-19.
- (B) Ensure that urgent steps are taken in making clean water and sanitary conditions available to all persons within India, including the provision of clean drinking water and appropriate sanitation measures in all detention centres, camps, prisons, hospitals and buildings otherwise established to isolate COVID-19 patients.
- (C) Direct all State governments and Central agencies to make urgent provisions through the use of civil-society actors to create make-shift water camps across all migratory routes and ensure that those migrating to villages from the cities have access to water for drinking and washing hands throughout their journey.
- (D) Direct State governments and Central agencies to take all appropriate measures to provide mass-information on the educational workshops at community level to prohibit open defecation especially in villages. Also, to issue the directives and mandatory guidelines to prohibit open defecation in villages.

- (E) Direct State Governments, especially the government of Uttar Pradesh to immediately stop all activities of manual scavenging, rehabilitate manual scavengers and provide PPE to the Sanitation worker.
- (F) To pass such other orders and further orders as may be deemed necessary on the facts and in the circumstances of the case.

FILED BY:

PETITIONER NO.1 IN PERSON

ROHIT SAMHOTRA

Advocate

P-2057/2015

(Also representing petitioner no. 2)



UNITED NATIONS  
HUMAN RIGHTS  
OFFICE OF THE HIGH COMMISSIONER

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## COVID-19 will not be stopped without providing safe water to people living in vulnerability – UN experts

[Spanish version](#)

GENEVA (23 March 2020) – As washing hands with soap and clean water is vital in the fight against COVID-19, governments worldwide must provide continuous access to sufficient water to their populations living in the most vulnerable conditions, UN experts\* said.

“The global struggle against the pandemic has little chance to succeed if personal hygiene, the main measure to prevent contagion, is unavailable to the 2.2 billion persons who have no access to safe water services,” the experts said.

“We call on governments to immediately prohibit water cuts to those who cannot pay water bills. It is also essential that they provide water free of cost for the duration of the crisis to people in poverty and those affected by the upcoming economic hardship. Public and private service providers must be enforced to comply with these fundamental measures.

“For the most privileged, washing hands with soap and clean water - the main defence against the virus - is a simple gesture. But for some groups around the world it is a luxury they cannot afford.”

The UN experts welcomed the measures announced by some governments to mitigate the impact of the loss of jobs likely to result from the pandemic and called for policies to ensure the continuous access to water and sanitation.

“People living in informal settlements, those who are homeless, rural populations, women, children, older persons, people with disabilities, migrants, refugees and all other groups vulnerable to the effects of the pandemic need to have continuous access to sufficient and affordable water. Only this will allow them to comply with the recommendations of health institutions to keep strict hygiene measures,” the UN experts said.

They expressed concerns that economically vulnerable people will become victims of a vicious cycle. “Limited access to water makes them more likely to get infected. Infection leads to illness and isolation measures, making it difficult for people without social security to continue earning a living. Their vulnerability increases, which results in even more limited access to water. Governments need to implement measures to break this cycle.

“Throughout our mandates, we keep insisting on the need to ensure that ‘no one is left behind.’ Governments must pay special attention to marginalised groups who are rarely at the centre of public policies related to water and sanitation. In relation to COVID-19, this message is even more critical,” they said.

ENDS

\* **The UN experts:** the Special Rapporteur on the human rights to safe drinking [water and sanitation](#), Mr Léo Heller; the Independent expert on the promotion of a democratic and equitable [international order](#), Mr Livingstone Sewanyana; the Special Rapporteur on the rights of [persons with disabilities](#), Ms Catalina Devandas-Aguilar; the Special Rapporteur on the [right to development](#), Mr Saad Alfarargi; the

*Special Rapporteur on the issue of human rights obligations relating to the enjoyment of a safe, clean, healthy and sustainable [environment](#), David R. Boyd; the Special Rapporteur on the right of everyone to the enjoyment of the highest attainable standard of physical and mental [health](#), Mr Dainius Puras; the Special Rapporteur on [adequate housing](#) as a component of the right to an adequate standard of living; Ms Leilani Farha; the Special Rapporteur on the human rights of [migrants](#), Mr Felipe González Morales; the Independent Expert on the enjoyment of all human rights by [older persons](#), Ms Rosa Kornfeld-Matte; and the the Independent Expert on human rights and [international solidarity](#), Mr Mr. Obiora C. Okafor; and the Independent Expert on the effects of [foreign debt](#) and other related international financial obligations of States on the full enjoyment of all human rights, particularly economic, social and cultural rights, Mr Juan Pablo Bohoslavsky.*

Follow the Special Rapporteur on [Twitter](#) and [Facebook](#)

*Special Rapporteurs and Independent Experts are part of what is known as the [Special Procedures](#) of the Human Rights Council. Special Procedures, the largest body of independent experts in the UN Human Rights system, is the general name of the Council's independent fact-finding and monitoring mechanisms that address either specific country situations or thematic issues in all parts of the world. Special Procedures experts work on a voluntary basis; they are not UN staff and do not receive a salary for their work. They are independent from any government or organization and serve in their individual capacity.*

For more information and **media requests**, please contact: Mr. Jon Izagirre García (+41 22 917 9715 / [jizagirre@ohchr.org](mailto:jizagirre@ohchr.org))

For media inquiries related to other UN independent experts, please contact Xabier Celaya (+ 41 22 917 9445 / [xcelaya@ohchr.org](mailto:xcelaya@ohchr.org))

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CONTACT US

# Water, sanitation, hygiene, and waste management for the COVID-19 virus

Interim guidance  
19 March 2020

## Background

This interim guidance supplements the infection prevention and control (IPC) documents by summarizing WHO guidance on water, sanitation and health care waste relevant to viruses, including coronaviruses. It is intended for water and sanitation practitioners and providers and health care providers who want to know more about water, sanitation and hygiene (WASH) risks and practices.

The provision of safe water, sanitation, and hygienic conditions is essential to protecting human health during all infectious disease outbreaks, including the COVID-19 outbreak. Ensuring good and consistently applied WASH and waste management practices in communities, homes, schools, marketplaces, and health care facilities will help prevent human-to-human transmission of the COVID-19 virus.

The most important information concerning WASH and the COVID-19 virus is summarized here.

- Frequent and proper hand hygiene is one of the most important measures that can be used to prevent infection with the COVID-19 virus. WASH practitioners should work to enable more frequent and regular hand hygiene by improving facilities and using proven behavior-change techniques.
- WHO guidance on the safe management of drinking-water and sanitation services applies to the COVID-19 outbreak. Extra measures are not needed. Disinfection will facilitate more rapid die-off of the COVID-19 virus.
- Many co-benefits will be realized by safely managing water and sanitation services and applying good hygiene practices.

Currently, there is no evidence about the survival of the COVID-19 virus in drinking-water or sewage. The morphology and chemical structure of the COVID-19 virus are similar to those of other human coronaviruses for which there are data about both survival in the environment and effective inactivation measures. This document draws upon the evidence base and WHO guidance on how to protect against viruses in sewage and drinking-water. This document will be updated as new information becomes available.

## 1. COVID-19 transmission

There are two main routes of transmission of the COVID-19 virus: respiratory and contact. Respiratory droplets are generated when an infected person coughs or sneezes. Any person who is in close contact with someone who has respiratory symptoms (sneezing, coughing) is at risk of being exposed to potentially infective respiratory droplets.<sup>1</sup> Droplets may also land on surfaces where the virus could remain viable; thus, the immediate environment of an infected individual can serve as a source of transmission (contact transmission).

Approximately 2–10% of cases of confirmed COVID-19 disease present with diarrhoea,<sup>2,4</sup> and two studies detected COVID-19 viral RNA fragments in the faecal matter of COVID-19 patients.<sup>5,6</sup> However, only one study has cultured the COVID-19 virus from a single stool specimen.<sup>7</sup> There have been no reports of faecal–oral transmission of the COVID-19 virus.

## 2. Persistence of the COVID-19 virus in drinking-water, faeces and sewage and on surfaces.

Although persistence in drinking-water is possible, there is no evidence from surrogate human coronaviruses that they are present in surface or groundwater sources or transmitted through contaminated drinking water. The COVID-19 virus is an enveloped virus, with a fragile outer membrane. Generally, enveloped viruses are less stable in the environment and are more susceptible to oxidants, such as chlorine. While there is no evidence to date about survival of the COVID-19 virus in water or sewage, the virus is likely to become inactivated significantly faster than non-enveloped human enteric viruses with known waterborne transmission (such as adenoviruses, norovirus, rotavirus and hepatitis A). For example, one study found that a surrogate human coronavirus survived only 2 days in dechlorinated tap water and in hospital wastewater at 20°C.<sup>8</sup> Other studies concur, noting that the human coronaviruses transmissible gastroenteritis coronavirus and mouse hepatitis virus demonstrated a 99.9% die-off in from 2 days<sup>9</sup> at 23°C to 2 weeks<sup>10</sup> at 25°C. Heat, high or low pH, sunlight, and common disinfectants (such as chlorine) all facilitate die off.

It is not certain how long the virus that causes COVID-19 survives on surfaces, but it seems likely to behave like other coronaviruses. A recent review of the survival of human

coronaviruses on surfaces found large variability, ranging from 2 hours to 9 days.<sup>11</sup> The survival time depends on a number of factors, including the type of surface, temperature, relative humidity, and specific strain of the virus. The same review also found that effective inactivation could be achieved within 1 minute using common disinfectants, such as 70% ethanol or sodium hypochlorite (for details, see Cleaning practices).

### 3. Keeping water supplies safe

The COVID-19 virus has not been detected in drinking-water supplies, and based on current evidence, the risk to water supplies is low.<sup>12</sup> Laboratory studies of surrogate coronaviruses that took place in well-controlled environments indicated that the virus could remain infectious in water contaminated with faeces for days to weeks.<sup>10</sup> A number of measures can be taken to improve water safety, starting with protecting the source water; treating water at the point of distribution, collection, or consumption; and ensuring that treated water is safely stored at home in regularly cleaned and covered containers.

Conventional, centralized water treatment methods that use filtration and disinfection should inactivate the COVID-19 virus. Other human coronaviruses have been shown to be sensitive to chlorination and disinfection with ultraviolet (UV) light.<sup>13</sup> As enveloped viruses are surrounded by a lipid host cell membrane, which is not robust, the COVID-19 virus is likely to be more sensitive to chlorine and other oxidant disinfection processes than many other viruses, such as coxsackieviruses, which have a protein coat. For effective centralized disinfection, there should be a residual concentration of free chlorine of  $\geq 0.5$  mg/L after at least 30 minutes of contact time at pH  $< 8.0$ .<sup>12</sup> A chlorine residual should be maintained throughout the distribution system.

In places where centralized water treatment and safe piped water supplies are not available, a number of household water treatment technologies are effective in removing or destroying viruses, including boiling or using high-performing ultrafiltration or nanomembrane filters, solar irradiation and, in non-turbid waters, UV irradiation and appropriately dosed free chlorine.

### 4. Safely managing wastewater and faecal waste

There is no evidence that the COVID-19 virus has been transmitted via sewerage systems with or without wastewater treatment. Further, there is no evidence that sewage or wastewater treatment workers contracted the severe acute respiratory syndrome (SARS), which is caused by another type of coronavirus that caused a large outbreak of acute respiratory illness in 2003. As part of an integrated public health policy, wastewater carried in sewerage systems should be treated in well-designed and well-managed centralized wastewater treatment works. Each stage of treatment (as well as retention time and dilution) results in a further reduction of the potential risk. A waste stabilization pond (an oxidation pond or lagoon) is generally considered a practical and simple wastewater treatment technology particularly well suited to destroying pathogens, as relatively long retention times (20 days or longer) combined with sunlight, elevated pH levels, biological activity, and other factors serve to accelerate pathogen destruction. A final disinfection step may be considered if existing wastewater treatment plants are not optimized to remove viruses. Best practices for protecting the health of workers at sanitation treatment facilities should

be followed. Workers should wear appropriate personal protective equipment (PPE), which includes protective outerwear, gloves, boots, goggles or a face shield, and a mask; they should perform hand hygiene frequently; and they should avoid touching eyes, nose, and mouth with unwashed hands.

## WASH in health care settings

Existing recommendations for water, sanitation and hygiene measures in health care settings are important for providing adequate care for patients and protecting patients, staff, and caregivers from infection risks.<sup>14</sup> The following actions are particularly important: (i) managing excreta (faeces and urine) safely, including ensuring that no one comes into contact with it and that it is treated and disposed of correctly; (ii) engaging in frequent hand hygiene using appropriate techniques; (iii) implementing regular cleaning and disinfection practices; and (iv) safely managing health care waste. Other important measures include providing sufficient safe drinking-water to staff, caregivers, and patients; ensuring that personal hygiene can be maintained, including hand hygiene, for patients, staff and caregivers; regularly laundering bedsheets and patients' clothing; providing adequate and accessible toilets (including separate facilities for confirmed and suspected cases of COVID-19 infection); and segregating and safely disposing of health care waste. For details on these recommendations, please refer to Essential environmental health standards in health care.<sup>14</sup>

### 1. Hand hygiene practices

Hand hygiene is extremely important. Cleaning hands with soap and water or an alcohol-based hand rub should be performed according to the instructions known as “My 5 moments for hand hygiene”.<sup>15</sup> If hands are not visibly dirty, the preferred method is to perform hand hygiene with an alcohol-based hand rub for 20–30 seconds using the appropriate technique.<sup>16</sup> When hands are visibly dirty, they should be washed with soap and water for 40–60 seconds using the appropriate technique.<sup>17</sup> Hand hygiene should be performed at all five moments, including before putting on PPE and after removing it, when changing gloves, after any contact with a patient with suspected or confirmed COVID-19 infection or their waste, after contact with any respiratory secretions, before eating, and after using the toilet.<sup>18</sup> If an alcohol-based hand rub and soap are not available, then using chlorinated water (0.05%) for handwashing is an option, but it is not ideal because frequent use may lead to dermatitis, which could increase the risk of infection and asthma and because prepared dilutions might be inaccurate.<sup>19</sup> However, if other options are not available or feasible, using chlorinated water for handwashing is an option.

Functional hand hygiene facilities should be present for all health care workers at all points of care and in areas where PPE is put on or taken off. In addition, functional hand hygiene facilities should be available for all patients, family members, and visitors, and should be available within 5 m of toilets, as well as in waiting and dining rooms and other public areas.

## 2. Sanitation and plumbing

People with suspected or confirmed COVID-19 disease should be provided with their own flush toilet or latrine that has a door that closes to separate it from the patient's room. Flush toilets should operate properly and have functioning drain traps. When possible, the toilet should be flushed with the lid down to prevent droplet splatter and aerosol clouds. If it is not possible to provide separate toilets, the toilet should be cleaned and disinfected at least twice daily by a trained cleaner wearing PPE (gown, gloves, boots, mask, and a face shield or goggles). Further, and consistent with existing guidance, staff and health care workers should have toilet facilities that are separate from those used by all patients.

WHO recommends the use of standard, well-maintained plumbing, such as sealed bathroom drains, and backflow valves on sprayers and faucets to prevent aerosolized faecal matter from entering the plumbing or ventilation system,<sup>20</sup> together with standard wastewater treatment.<sup>21</sup> Faulty plumbing and a poorly designed air ventilation system were implicated as contributing factors to the spread of the aerosolized SARS coronavirus in a high-rise apartment building in Hong Kong in 2003.<sup>22</sup> Similar concerns have been raised about the spread of the COVID-19 virus from faulty toilets in high-rise apartment buildings.<sup>23</sup> If health care facilities are connected to sewers, a risk assessment should be conducted to confirm that wastewater is contained within the system (that is, the system does not leak) before its arrival at a functioning treatment or disposal site, or both. Risks pertaining to the adequacy of the collection system or to treatment and disposal methods should be assessed following a safety planning approach,<sup>24</sup> with critical control points prioritized for mitigation.

For smaller health care facilities in low-resource settings, if space and local conditions allow, pit latrines may be the preferred option. Standard precautions should be taken to prevent contamination of the environment by excreta. These precautions include ensuring that at least 1.5 m exists between the bottom of the pit and the groundwater table (more space should be allowed in coarse sands, gravels, and fissured formations) and that the latrines are located at least 30 m horizontally from any groundwater source (including both shallow wells and boreholes).<sup>21</sup> If there is a high groundwater table or a lack of space to dig pits, excreta should be retained in impermeable storage containers and left for as long as feasible to allow for a reduction in virus levels before moving it off-site for additional treatment or safe disposal, or both. A two-tank system with parallel tanks would help facilitate inactivation by maximizing retention times, as one tank could be used until full, then allowed to sit while the next tank is being filled. Particular care should be taken to avoid splashing and the release of droplets while cleaning or emptying tanks.

### 3. Toilets and the handling of faeces

It is critical to conduct hand hygiene when there is suspected or direct contact with faeces (if hands are dirty, then soap and water are preferred to the use of an alcohol-based hand rub). If the patient is unable to use a latrine, excreta should be collected in either a diaper or a clean bedpan and immediately and carefully disposed of into a separate toilet or latrine used only by suspected or confirmed cases of COVID-19. In all health care settings, including those with suspected or confirmed COVID-19 cases, faeces must be treated as a biohazard and handled as little as possible. Anyone handling

faeces should follow WHO contact and droplet precautions<sup>18</sup> and use PPE to prevent exposure, including long-sleeved gowns, gloves, boots, masks, and goggles or a face shield. If diapers are used, they should be disposed of as infectious waste as they would be in all situations. Workers should be properly trained in how to put on, use, and remove PPE so that these protective barriers are not breached.<sup>25</sup> If PPE is not available or the supply is limited, hand hygiene should be regularly practiced, and workers should keep at least 1 m distance from any suspected or confirmed cases.

If a bedpan is used, after disposing of excreta from it, the bedpan should be cleaned with a neutral detergent and water, disinfected with a 0.5% chlorine solution, and then rinsed with clean water; the rinse water should be disposed of in a drain or a toilet or latrine. Other effective disinfectants include commercially available quaternary ammonium compounds, such as cetylpyridinium chloride, used according to manufacturer's instructions, and peracetic or peroxyacetic acid at concentrations of 500–2000 mg/L.<sup>26</sup>

Chlorine is ineffective for disinfecting media containing large amounts of solid and dissolved organic matter. Therefore, there is limited benefit to adding chlorine solution to fresh excreta and it is possible that this may introduce risks associated with splashing.

### 4. Emptying latrines and holding tanks, and transporting excreta off-site.

There is no reason to empty latrines and holding tanks of excreta from suspected or confirmed COVID-19 cases unless they are at capacity. In general, the best practices for safely managing excreta should be followed. Latrines or holding tanks should be designed to meet patient demand, considering potential sudden increases in cases, and there should be a regular schedule for emptying them based on the wastewater volumes generated. PPE (long-sleeved gown, gloves, boots, masks, and goggles or a face shield) should be worn at all times when handling or transporting excreta offsite, and great care should be taken to avoid splashing. For crews, this includes pumping out tanks or unloading pumper trucks. After handling the waste and once there is no risk of further exposure, individuals should safely remove their PPE and perform hand hygiene before entering the transport vehicle. Soiled PPE should be put in a sealed bag for later safe laundering (see Cleaning practices). Where there is no off-site treatment, in-situ treatment can be done using lime. Such treatment involves using a 10% lime slurry added at 1-part lime slurry per 10 parts of waste.

### 5. Cleaning practices

Recommended cleaning and disinfection procedures for health care facilities should be followed consistently and correctly.<sup>19</sup> Laundry should be done and surfaces in all environments in which COVID-19 patients receive care (treatment units, community care centres) should be cleaned at least once a day and when a patient is discharged.<sup>27</sup> Many disinfectants are active against enveloped viruses, such as the COVID-19 virus, including commonly used hospital disinfectants. Currently, WHO recommends using:

- 70% ethyl alcohol to disinfect small areas between uses, such as reusable dedicated equipment (for example, thermometers);
- sodium hypochlorite at 0.5% (equivalent to 5000 ppm) for disinfecting surfaces.

All individuals dealing with soiled bedding, towels, and clothes from patients with COVID-19 infection should wear appropriate PPE before touching soiled items, including heavy duty gloves, a mask, eye protection (goggles or a face shield), a long-sleeved gown, an apron if the gown is not fluid resistant, and boots or closed shoes. They should perform hand hygiene after exposure to blood or body fluids and after removing PPE. Soiled linen should be placed in clearly labelled, leak-proof bags or containers, after carefully removing any solid excrement and putting it in a covered bucket to be disposed of in a toilet or latrine. Machine washing with warm water at 60–90°C (140–194°F) with laundry detergent is recommended. The laundry can then be dried according to routine procedures. If machine washing is not possible, linens can be soaked in hot water and soap in a large drum using a stick to stir and being careful to avoid splashing. The drum should then be emptied, and the linens soaked in 0.05% chlorine for approximately 30 minutes. Finally, the laundry should be rinsed with clean water and the linens allowed to dry fully in sunlight.

If excreta are on surfaces (such as linens or the floor), the excreta should be carefully removed with towels and immediately safely disposed of in a toilet or latrine. If the towels are single use, they should be treated as infectious waste; if they are reusable, they should be treated as soiled linens. The area should then be cleaned and disinfected (with, for example, 0.5% free chlorine solution), following published guidance on cleaning and disinfection procedures for spilled body fluids.<sup>27</sup>

#### **6. Safely disposing of greywater or water from washing PPE, surfaces and floors.**

Current WHO recommendations are to clean utility gloves or heavy duty, reusable plastic aprons with soap and water and then decontaminate them with 0.5% sodium hypochlorite solution after each use. Single-use gloves (nitrile or latex) and gowns should be discarded after each use and not reused; hand hygiene should be performed after PPE is removed. If greywater includes disinfectant used in prior cleaning, it does not need to be chlorinated or treated again. However, it is important that such water is disposed of in drains connected to a septic system or sewer or in a soakaway pit. If greywater is disposed of in a soakaway pit, the pit should be fenced off within the health facility grounds to prevent tampering and to avoid possible exposure in the case of overflow.

#### **7. Safe management of health care waste**

Best practices for safely managing health care waste should be followed, including assigning responsibility and sufficient human and material resources to dispose of such waste safely. There is no evidence that direct, unprotected human contact during the handling of health care waste has resulted in the transmission of the COVID-19 virus. All health care waste produced during the care of COVID 19 patients should be collected safely in designated containers and bags, treated, and then safely disposed of or treated, or both, preferably on-site. If waste is moved off-site, it is critical to understand where and how it will be treated and destroyed. All who handle health care waste should wear appropriate PPE (boots, apron, long-sleeved gown, thick gloves, mask, and goggles or a face shield) and perform hand hygiene after removing it. For more information refer to the WHO guidance, Safe management of wastes from health-care activities.<sup>28</sup>

## **Considerations for WASH practices in homes and communities.**

Upholding best WASH practices in the home and community is also important for preventing the spread of COVID-19 and when caring for patients at home. Regular and correct hand hygiene is of particular importance.

### **1. Hand hygiene**

Hand hygiene in non-health care settings is one of the most important measures that can prevent COVID 19 infection. In homes, schools and crowded public spaces – such as markets, places of worship, and train or bus stations – regular handwashing should occur before preparing food, before and after eating, after using the toilet or changing a child’s diaper, and after touching animals. Functioning handwashing facilities with water and soap should be available within 5 m of toilets.

### **2. Treatment and handling requirements for excreta.**

Best WASH practices, particularly handwashing with soap and clean water, should be strictly applied and maintained because these provide an important additional barrier to COVID-19 transmission and to the transmission of infectious diseases in general.<sup>17</sup> Consideration should be given to safely managing human excreta throughout the entire sanitation chain, starting with ensuring access to regularly cleaned, accessible, and functioning toilets or latrines and to the safe containment, conveyance, treatment, and eventual disposal of sewage.

When there are suspected or confirmed cases of COVID-19 in the home setting, immediate action must be taken to protect caregivers and other family members from the risk of contact with respiratory secretions and excreta that may contain the COVID-19 virus. Frequently touched surfaces throughout the patient’s care area should be cleaned regularly, such as beside tables, bed frames and other bedroom furniture. Bathrooms should be cleaned and disinfected at least once a day. Regular household soap or detergent should be used for cleaning first and then, after rinsing, regular household disinfectant containing 0.5% sodium hypochlorite (that is, equivalent to 5000 ppm or 1-part household bleach with 5% sodium hypochlorite to 9 parts water) should be applied. PPE should be worn while cleaning, including mask, goggles, a fluid-resistant apron, and gloves,<sup>29</sup> and hand hygiene with an alcohol-based hand rub or soap and water should be performed after removing PPE.

## **References**

1. Coronavirus disease (COVID-19) advice for the public. Geneva: World Health Organization; 2020 (<https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public>, accessed 3 March 2020).
2. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet*. 2020;395:497–506. doi:10.1016/S0140-6736(20)30183-5.

3. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *Lancet*. 2020;395:507–13. doi:10.1016/S0140-6736(20)30211-7.
4. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *JAMA*. 2020. Feb 7. doi:10.1001/jama.2020.1585.
5. Xiao E, Tang M, Zheng Y, Li C, He J, Hong H, et al. Evidence for gastrointestinal infection of SARS-CoV. medRxiv. doi:10.1101/2020.02.17.20023721.
6. Holshue ML, DeBolt C, Lindquist S, Lofy KH, Wiesman J, Bruce H et al. for the Washington State 2019-nCoV Case Investigation Team. First case of 2019 novel coronavirus in the United States. *N Engl J Med*. 2020. Jan 31. doi:10.1056/NEJMoa2001191.
7. Zhang Y, Chen C, Zhu S et al. [Isolation of 2019-nCoV from a stool specimen of a laboratory-confirmed case of the coronavirus disease 2019 (COVID-19)]. *China CDC Weekly*. 2020;2(8):123-4. (In Chinese.)
8. Wang XW, Li JS, Zhen B, Kong QX, Song N, Xiao WJ et al. Study on the resistance of severe acute respiratory syndrome-associated coronavirus. *J Virol Methods*. 2005;126:171–7. doi:10.1016/j.jviromet.2005.02.005.
9. Gundy P, Gerba CP, Pepper IL. Survival of coronaviruses in water and wastewater. *Food Environ Virol*. 2009;1:10-14. doi:10.1007/s12560-008-9001-6.
10. Casanova L, Rutalal WA, Weber DJ, Sobsey MD. Survival of surrogate coronaviruses in water. *Water Res*. 2009;43(7):1893–8. doi:10.1016/j.watres.2009.02.002.
11. Kampf G, Todt D, Pfaender S, Steinmann E. Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. *J Hosp Infect*. 2020;104(3):246–51. doi:10.1016/j.jhin.2020.01.022.
12. Guidelines for drinking-water quality, fourth edition, incorporating the first addendum. Geneva: World Health Organization; 2017 (<http://apps.who.int/iris/bitstream/10665/254637/1/9789241549950-eng.pdf>, accessed 3 March 2020).
13. SARS-CoV-2 – water and sanitation. Adelaide: Water Research Australia; 2020 ([http://www.waterra.com.au/r9544/media/system/attrib/file/2199/WaterRA\\_FS\\_Coronavirus\\_V10.pdf](http://www.waterra.com.au/r9544/media/system/attrib/file/2199/WaterRA_FS_Coronavirus_V10.pdf), accessed 3 March 2020).
14. Essential environmental health standards in health care. Geneva: World Health Organization; 2008 ([https://apps.who.int/iris/bitstream/handle/10665/43767/9789241547239\\_eng.pdf?sequence=1&isAllowed=y](https://apps.who.int/iris/bitstream/handle/10665/43767/9789241547239_eng.pdf?sequence=1&isAllowed=y), accessed 3 March 2020).
15. My 5 moments for hand hygiene. In: WHO/Infection prevention and control [website]. Geneva: World Health Organization; 2020 (<https://www.who.int/infection-prevention/campaigns/clean-hands/5moments/en/>, accessed 3 March 2020).
16. Siddharta A, Pfaender S, Vielle NJ, Dijkman R, Friesland M, Becker B, et al. Virucidal activity of World Health Organization-recommended formulations against enveloped viruses, including Zika, Ebola, and emerging coronaviruses. *J Infect Dis*. 2017;215(6):902–6. doi:10.1093/infdis/jix046.
17. WHO guidelines on hand hygiene in health care settings. Geneva: World Health Organization; 2009 ([https://apps.who.int/iris/bitstream/handle/10665/44102/9789241597906\\_eng.pdf?sequence=1&isAllowed=y](https://apps.who.int/iris/bitstream/handle/10665/44102/9789241597906_eng.pdf?sequence=1&isAllowed=y), accessed 3 March 2020).
18. Infection prevention and control during health care when novel coronavirus (nCoV) infection is suspected: interim guidance, 25 January 2020. Geneva: World Health Organization ([https://www.who.int/publications-detail/infection-prevention-and-control-during-health-care-when-novel-coronavirus-\(ncov\)-infection-is-suspected-20200125](https://www.who.int/publications-detail/infection-prevention-and-control-during-health-care-when-novel-coronavirus-(ncov)-infection-is-suspected-20200125), accessed 3 March 2020).
19. Q&A on infection prevention and control for health care workers caring for patients with suspected or confirmed 2019-nCoV. In: WHO/Newsroom [website]. Geneva: World Health Organization; 2020 (<https://www.who.int/news-room/q-a-detail/q-a-on-infection-prevention-and-control-for-health-care-workers-caring-for-patients-with-suspected-or-confirmed-2019-ncov>, accessed 3 March 2020).
20. Health aspects of plumbing. Geneva: World Health Organization; 2006. (<https://apps.who.int/iris/handle/10665/43423>, accessed 3 March 2020).
21. Guidelines on sanitation and health. Geneva: World Health Organization; 2018 (<https://apps.who.int/iris/bitstream/handle/10665/274939/9789241514705-eng.pdf?ua=1>, accessed 3 March 2020).
22. Yu ITS, Li Y, Wong TW, Tam W, Chan A, Lee JHW, et al. Evidence of airborne transmission of the severe acute respiratory syndrome virus. *N Engl J Med*. 2004;350(17): 1731-9. doi:10.1056/NEJMoa032867.
23. Regan H. How can the coronavirus spread through bathroom pipes? Experts are investigating in Hong Kong. CNN. 12 February 2020 (<https://edition.cnn.com/2020/02/12/asia/hong-kong-coronavirus-pipes-intl-hnk/index.html>).
24. Sanitation safety planning: manual for safe use and disposal of wastewater, greywater and excreta. Geneva: World Health Organization; 2015. (<https://apps.who.int/iris/handle/10665/171753>, accessed 3 March 2020).
25. How to put on and take off personal protective equipment. Geneva: World Health Organization; 2008 (<https://apps.who.int/iris/handle/10665/70066>, accessed 3 March 2020).
26. Chemical disinfectants: guideline for disinfection and sterilization in healthcare facilities (2008). In: CDC/Infection Control [website]. Atlanta: US Centers for Disease Control and Prevention; 2019. (<https://www.cdc.gov/infectioncontrol/guidelines/disinfection/disinfection-methods/chemical.html>, accessed 3 March 2020).

27. Best practices for environmental cleaning in healthcare facilities in resource-limited settings. Atlanta: US Centers for Disease Control and Prevention; 2019  
(<https://www.cdc.gov/hai/pdfs/resource-limited/environmental-cleaning-508.pdf>, accessed 3 March 2020).
28. Safe management of wastes from health-care activities: a summary. Geneva: World Health Organization; 2017  
(<https://apps.who.int/iris/handle/10665/259491>, accessed 3 March 2020).
29. Home care for patients with suspected novel coronavirus (COVID-19) infection presenting with mild symptoms, and management of their contacts: interim guidance, 4 February 2020.  
([https://www.who.int/publications-detail/home-care-for-patients-with-suspected-novel-coronavirus-\(ncov\)-infection-presenting-with-mild-symptoms-and-management-of-contacts](https://www.who.int/publications-detail/home-care-for-patients-with-suspected-novel-coronavirus-(ncov)-infection-presenting-with-mild-symptoms-and-management-of-contacts), accessed 3 March 2020).

US Centers for Disease Control and Prevention, United States of America; David Berendes, US Centers for Disease Control and Prevention, United States of America; Lisa Casanova, Georgia State University, United States of America; David Cunliffe, SA Health, Australia; Rick Gelting, US Centers for Disease Control and Prevention, United States of America; Dr Thomas Handzel, US Centers for Disease Control and Prevention, United States of America; Paul Hunter, University of East Anglia, United Kingdom; Ana Maria de Roda Husman, National Institute for Public Health and the Environment, the Netherlands; Peter Maes, Médecins Sans Frontières, Belgium; Molly Patrick, US Centers for Disease Control and Prevention, United States of America; Mark Sobsey, University of North Carolina-Chapel Hill, United States of America.

WHO continues to monitor the situation closely for any changes that may affect this interim guidance. Should any factors change, WHO will issue a further update. Otherwise, this interim guidance document will expire 2 years after the date of publication.

## Contributors

This interim guidance was written by staff from WHO and UNICEF. In addition, a number of experts and WASH practitioners contributed. They include Matt Arduino,

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## Handwashing: Clean Hands Save Lives

# Show Me the Science – When & How to Use Hand Sanitizer in Community Settings

Note: For hand hygiene guidance in healthcare settings, please visit the [Clean Hands Count webpage](#).

CDC recommends washing hands with soap and water whenever possible because handwashing reduces the amounts of all types of germs and chemicals on hands. But if soap and water are not available, using a hand sanitizer with at least 60% alcohol can help you avoid getting sick and spreading germs to others. The guidance for effective handwashing and use of hand sanitizer in community settings was developed based on data from a number of studies.

Alcohol-based hand sanitizers can quickly reduce the number of microbes on hands in some situations, but sanitizers do *not* eliminate all types of germs.

**Why?** Soap and water are more effective than hand sanitizers at removing certain kinds of germs, like *Cryptosporidium*, *norovirus*, and *Clostridium difficile*<sup>1-5</sup>. Although alcohol-based hand sanitizers can inactivate many types of microbes very effectively when used correctly<sup>1-15</sup>, people may not use a large enough volume of the sanitizers or may wipe it off before it has dried<sup>14</sup>.

Hand sanitizers may not be as effective when hands are visibly dirty or greasy.

**Why?** Many studies show that hand sanitizers work well in clinical settings like hospitals, where hands come into contact with germs but generally are not heavily soiled or greasy<sup>16</sup>. Some data also show that hand sanitizers may work well against certain types of germs on slightly soiled hands<sup>17,18</sup>. However, hands may become very greasy or soiled in community settings, such as after people handle food, play sports, work in the garden, or go camping or fishing. When hands are heavily soiled or greasy, hand sanitizers may not work well<sup>3,7,16</sup>. Handwashing with soap and water is recommended in such circumstances.

Hand sanitizers might not remove harmful chemicals, like pesticides and heavy metals, from hands.

**Why?** Although few studies have been conducted, hand sanitizers probably cannot remove or inactivate many types of harmful chemicals. In one study, people who reported using hand sanitizer to clean hands had increased levels of pesticides in their bodies<sup>19</sup>. If hands have touched harmful chemicals, wash carefully with soap and water (or as directed by a poison control center).

If soap and water are not available, use an alcohol-based hand sanitizer that contains at least 60% alcohol.

**Why?** Many studies have found that sanitizers with an alcohol concentration between 60–95% are more effective at killing germs than those with a lower alcohol concentration or non-alcohol-based hand sanitizers<sup>16,20</sup>. Hand sanitizers without 60-95% alcohol 1) may not work equally well for many types of germs; and 2) merely reduce the growth of germs rather than kill them outright.

When using hand sanitizer, apply the product to the palm of one hand (read the label

to learn the correct amount) and rub the product all over the surfaces of your hands until your hands are dry.

**Why?** The steps for hand sanitizer use are based on a simplified procedure recommended by CDC <sup>21</sup>. Instructing people to cover all surfaces of both hands with hand sanitizer has been found to provide similar disinfection effectiveness as providing detailed steps for rubbing-in hand sanitizer <sup>22</sup>.

## Swallowing alcohol-based hand sanitizers can cause alcohol poisoning.

**Why?** Ethyl alcohol (ethanol)-based hand sanitizers are safe when used as directed, <sup>23</sup> but they can cause alcohol poisoning if a person swallows more than a couple of mouthfuls <sup>24</sup>.

From 2011 – 2015, U.S. poison control centers received nearly 85,000 calls about hand sanitizer exposures among children <sup>25</sup>. Children may be particularly likely to swallow hand sanitizers that are scented, brightly colored, or attractively packaged. Hand sanitizers should be stored out of the reach of young children and should be used with adult supervision. Child-resistant caps could also help reduce hand sanitizer-related poisonings among young children <sup>24</sup>. Older children and adults might purposefully swallow hand sanitizers to become drunk <sup>26</sup>.

## References

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Page last reviewed: March 3, 2020



## FAQs for Patients with Hypertension, Diabetes and Heart Diseases in view of Coronavirus/COVID-19 Pandemic

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### Are patients with heart disease, diabetes or hypertension at increased risk to get coronavirus infection?

No, people with hypertension, diabetes or heart diseases are at no greater risk of getting the infection than anyone else.

### Among people with above diseases is there an increased risk of severe illness or complications once infected?

The majority (80%) of people diagnosed with COVID-19 will have mild symptoms of a respiratory infection (fever, sore throat, cough) and make full recovery. Some of the people with diabetes, hypertension and heart diseases including Heart Failure (weak heart) may develop more severe symptoms and complications. Therefore extra care is advised for these patients.

### Are people with diabetes more prone to Covid-19 ?

In general, you know that people with uncontrolled diabetes are at increased risk of all infections. People with diabetes are not at higher risk for acquiring the infection, but some individuals are prone to more severe disease and poorer outcomes once infected. Hence, follow your diet and exercise routine (to the extent possible), take your medications regularly and test your sugar levels frequently so as to keep your diabetes under control.

When diabetic patients become sick, they may require frequent monitoring of blood glucose and adjustment of drugs including insulin, small frequent meals and adequate fluids.

### Some tips for those with diabetes, hypertension and heart disease:

#### Take your medicines regularly - It is very important

Make sure that you take all medications prescribed regularly as before even if you are mildly symptomatic. Don't stop any medication unless advised by your doctor. Continue with your blood pressure, diabetes and heart disease medications in case you are unable to visit your doctor. Medications to control cholesterol (statins) should be continued.

#### What about reports about BP medications increasing severity of COVID-19 ?

After review of available information the consensus of various scientific societies and expert group of cardiologists is that currently there is no evidence that the two group of drugs- ACE inhibitors (eg. Ramipril, Enalapril and so on ) and angiotensin receptor blockers (ARBs) (eg. Losartan, Telmisartan and so on) increase the susceptibility or severity of COVID-19. These drugs are very effective for heart failure by supporting your heart function, and controlling high blood pressure. It maybe be harmful to stop these medications by yourself. This can worsen your heart condition.

#### What can I take pain or fever?

Some type of pain killers(called NSAIDs) like Ibuprofen is found to worsen the

COVID-19. Such drugs are known to be harmful to heart failure patients and may increase your risk of kidney damage. Avoid NSAIDs or take them only when prescribed by your doctor.

Paracetamol is one of the safest pain killers to use if needed.

### **Control blood pressure (BP), blood sugar and do regular physical activity**

It is also important to control your risk factor levels – Avoid smoking and alcohol, have your BP and blood sugar levels under control and have some form of regular physical activity (However, please modify your out-door activities according to the norms of social-distancing.). Follow the diet and salt restriction as advised. If you are a non-vegetarian, you can continue to be so. Increasing the fibre and protein content of the diet and more vegetables and fruits in diet is advisable.

### **What should I do if I get symptoms suggestive of COVID-19?**

In case you get fever, cough, muscle pain without shortness of breath, call your doctor and seek advice on phone. You need to stay at home (at least for 14 days) and avoid close contact with other family members and maintain hand hygiene and correctly wear a medical mask.

If there is shortness of breath or worsening symptoms like excessive fatigue call/visit your doctor (further advice will depend on advise of your physician)

### **What should you do to prevent COVID-19?**

Covid-19 is spread by coughs and sneezes, through what are called droplets ( tiny amount saliva or other secretions expressed through cough/sneezing or even after a hearty laugh) and through touch . When you touch an object that has the virus particles on it, the virus may

get onto your hands and when you touch your face, you may get infected. Virus particles can persist upto 3 days and therefore it is important to maintain hygiene of your surroundings. Wash the rooms , tables and other surfaces with floor cleaners or even simple soap solution and sanitize your hands with hand sanitizers or by washing when you touch unknown or suspicious surfaces.

### **What are the important steps you can do to prevent acquiring or spreading infection**

#### **1. Social distancing – Very important .**

- A. Avoid contact with someone who shows symptoms of possible COVID-19 - anyone having a cold or cough or fever.
- B. Avoid non-essential travel and use of public transport.
- C. Avoid public places, crowds and large family get togethers. Keep in touch with friends and relatives using phone, internet, and social media.
- D. Avoid routine visits to hospitals / Labs. for minor problems, contact hospital or HF clinic by phone or helpline number if possible. If you are regularly checking INR and adjusting blood thinning medicines, please contact the doctor over phone if possible and try and avoid a hospital as much as possible.

#### **2. Hand hygiene**

- A. Avoid handshakes and touching face with hands
- B. Wash your hands with soap and water frequently – do this for at least 20-30 seconds and systematically to clean all parts of the hand
- C. Alcohol based hand-sanitisers are also useful.
- D. Avoid touching possibly contaminated areas/objects – Public toilet doors, door handles etc.

## Review

# Outbreaks Where Food Workers Have Been Implicated in the Spread of Foodborne Disease. Part 10. Alcohol-Based Antiseptics for Hand Disinfection and a Comparison of Their Effectiveness with Soaps

EWEN C. D. TODD,<sup>1\*</sup> BARRY S. MICHAELS,<sup>2</sup> JOHN HOLAH,<sup>3</sup> DEBRA SMITH,<sup>3</sup> JUDY D. GREIG,<sup>4</sup> AND CHARLES A. BARTLESON<sup>5</sup>

<sup>1</sup>Department of Advertising, Public Relations and Retailing, Michigan State University, East Lansing, Michigan 48824, USA; <sup>2</sup>The B. Michaels Group Inc., 487 West River Road, Palatka, Florida 32177, USA; <sup>3</sup>Campden BRI, Chipping Campden, Gloucestershire GL55 6LD, UK; <sup>4</sup>Public Health Agency of Canada, Laboratory for Foodborne Zoonoses, 160 Research Lane, Unit 206, Guelph, Ontario, Canada N1G 5B2; and <sup>5</sup>6100 Troon Lane S.E., Olympia, Washington 98501, USA

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## ABSTRACT

Alcohol compounds are increasingly used as a substitute for hand washing in health care environments and some public places because these compounds are easy to use and do not require water or hand drying materials. However, the effectiveness of these compounds depends on how much soil (bioburden) is present on the hands. Workers in health care environments and other public places must wash their hands before using antiseptics and/or wearing gloves. However, alcohol-based antiseptics, also called rubs and sanitizers, can be very effective for rapidly destroying some pathogens by the action of the aqueous alcohol solution without the need for water or drying with towels. Alcohol-based compounds seem to be the most effective treatment against gram-negative bacteria on lightly soiled hands, but antimicrobial soaps are as good or better when hands are more heavily contaminated. Instant sanitizers have no residual effect, unlike some antimicrobial soaps that retain antimicrobial activity after the hygienic action has been completed, e.g., after hand washing. Many alcohol-based hand rubs have antimicrobial agents added to them, but each formulation must be evaluated against the target pathogens in the environment of concern before being considered for use. Wipes also are widely used for quick cleanups of hands, other body parts, and surfaces. These wipes often contain alcohol and/or antimicrobial compounds and are used for personal hygiene where water is limited. However, antiseptics and wipes are not panaceas for every situation and are less effective in the presence of more than a light soil load and against most enteric viruses.

This is the 10th article in a series on food workers and foodborne illness. In the first three articles, the authors described the types of outbreaks identified during a review of 816 published and unpublished reports and how workers contributed to these outbreaks (49, 130, 131), and the next three articles provided information on infective doses, pathogen carriage, sources of contamination, pathogen excretion by infected persons, and transmission and survival of pathogens in food environments (132–134). In the seventh and eighth papers, the authors discussed physical barriers to contamination and the pros and cons of glove use (136, 137). In the ninth article, hand hygiene for removing as much soil (bioburden) from fingers and other parts of hands as possible, the effectiveness of various soaps (with and without antimicrobial compounds), and the need for drying hands to remove loose microorganisms from the skin surface were discussed (138). The present article provides a discussion of the increasing use of antiseptics and sanitary wipes in the health care and food industries and the

effectiveness of various soaps and antiseptics or sanitizers under different conditions.

## DEFINITIONS

Weber et al. (147) defined germicides as biocidal agents, such as antiseptics, disinfectants, and preservatives, that inactivate microorganisms. Antiseptics are antimicrobial substances that are applied to the skin or mucous membranes to reduce the microbial flora. Disinfectants are substances that are applied to inanimate objects to destroy harmful microorganisms, although disinfectants may not kill bacterial spores. Preservatives (antimicrobials) are incorporated into soaps and other antiseptics to prevent microbial growth.

Hand disinfection can be defined as the application of a chemical agent with antimicrobial activity to the hands. Reduction of the resident flora depends on the ability of the topical antimicrobial product to produce an immediate and persistent residual effect (104). The terms “hand antiseptic” or “alcohol-based hand rub” (ABHR) are more often used than “hand sanitizer,” especially in Europe (121, 145). In

\* Author for correspondence. Tel: 517-355-8371; Fax: 517-432-2589; E-mail: todde@msu.edu.

the 2005 version of the U.S. Food and Drug Administration (FDA) Food Code (144), the term “hand sanitizer” was changed to “hand antiseptic” to eliminate confusion with the term “sanitizer” (a defined term in the Food Code) and to more closely reflect the terminology used in the FDA monograph for health care concerning antiseptic drug products for over-the-counter human use (143).

The term “sanitizer” is typically used to describe a substance used to control bacterial contamination of inert objects or articles, equipment and utensils, and other food contact surfaces, usually a strong chemical solution such as sodium hypochlorite or a quaternary ammonium compound. The Food Code definition of “sanitizer” requires a minimum microbial reduction of 5 log units, which is equal to a 99.999% reduction. Most antimicrobial hand agents typically achieve a much smaller reduction and so are not consistent with the definition of “sanitizer” in the Food Code.

A hand antiseptic solution used as a hand dip should be kept clean and at a strength equivalent to at least 100 mg/liter chlorine. An antimicrobial soap with an E2 designation requires activity equivalent to 50 ppm of chlorine. However, because “sanitizer” and “antiseptic” are used interchangeably in the literature with possibly different meanings it is not always easy to separate the two, and both are used in this article.

Four types of hand disinfection were described by Smith (121) based on hospital requirements. Hygienic hand disinfectants are alcohol-based agents used to rapidly kill transient organisms on the hands (i.e., within 15 to 30 s) but may have an additional antimicrobial effect on resident microflora. Hygienic hand disinfectants with residual activity differ from alcohol-based agents because repeated use of hexachlorophene, iodophors, alcoholic chlorhexidine, and chlorhexidine leads to longer residual activity. These agents can destroy both the existing transient bacteria and other bacteria (e.g., *Staphylococcus aureus*) that may subsequently contaminate the hands. Surgical hand disinfectants are agents that remain active against both transient and resident organisms for 2 to 4 h (e.g., povidone-iodine and chlorhexidine) and are less commonly used in food facilities.

Basic hand disinfection includes use of the agents described below, which are designed to continually reduce the density of resident organisms and are particularly useful for food, pharmaceutical, and health care workers. The effectiveness of these agents is based on application frequency, with repeated use giving a greater reduction in hand flora than that obtained with a single treatment. Hand disinfection agents approved for use in the food industry are limited because compounds that are potentially toxic to consumers or affect the taste or appearance of the food are not permitted. However, these agents must have sufficient activity against a wide range of microorganisms. Most of the compounds that meet these criteria are liquid soaps. Powdered soaps containing borax (sodium borate decahydrate) are available for heavy duty hand cleaning, to use as laundry detergents, or to remove grease under cold washing conditions and may be effective in hard water but are rarely

used in the food industry for hand washing. Some of the agents most frequently used are listed below and mentioned briefly elsewhere in this article, especially when they are used in combination with alcohol. Alcohol-based compounds used as antiseptics are discussed in more detail in the following sections.

**Chlorhexidine.** This hand disinfectant is effective against gram-positive cocci and to a lesser extent gram-negative bacteria and fungi at 4% concentrations or at 0.5 to 2% (wt/vol) alcohol, e.g., 0.5% in 70% isopropanol. Chlorhexidine gluconate (CHG) is commonly used in health care facilities.

**Quaternary ammonium compounds (“quats”).** These products, typically used for cleaning equipment in food operations, are bacteriostatic and fungistatic. Benzalkonium chloride (BAC) is the quaternary ammonium compound most often used in health care settings.

**Iodophors.** These compounds (e.g., 7.5 to 10% povidone) are effective against both gram-positive and gram-negative bacteria and some spore-forming bacteria.

**Triclosan.** Triclosan is widely used at concentrations of 0.2 to 2% and exhibits bacteriostatic activity against gram-positive bacteria and to a lesser extent on other bacteria and fungi.

**Ozone.** The use of 4 ppm of ozonated water in combination with 0.2% BAC and 83% ethanol is an effective method of hand disinfection. However, Michaels and coworkers (85, 86) found that there was no significant difference between hands washed with water containing 3 ppm of ozone combined with bland soap (without antimicrobial compounds) or soap containing 0.2% BAC and hands washed with nonozonated water. Therefore, the combination of ozone and alcohol appears to be more important for disinfection than combination of soap with ozonated water.

## ALCOHOL INSTANT HAND ANTISEPTICS, SANITIZERS, AND RUBS

### Effectiveness of alcohol for disinfecting hands.

Although alcohol has been used as an antiseptic since ancient times, the first systematic in vitro studies of the germicidal activity of ethyl alcohol against pure cultures of bacteria were performed by Koch in the early 1880s, and in the 1890s and early 1900s alcohol was proposed for use as a skin antiseptic (22). Early investigators discovered that preparations containing 50 to 70% alcohol were more effective than those containing 95% alcohol, and isopropyl alcohol reduced bacterial counts on contaminated hands when used as a hand rub (22). Using more quantitative methods, Price (112) found that 65.5% alcohol was effective for reducing the number of bacteria on the skin. He subsequently recommended the use of a 3-min wash with 70% alcohol as a preoperative hand scrub and that

70% alcohol should be used for disinfecting contaminated hands.

ABHRs have become commercially available and have been in common use since the 1970s; they appear to be more effective than many nonalcoholic products when hands are relatively clean (106). ABHRs were more widely used in Europe than in North America until the early 2000s. Despite the proven efficacy of alcohol-based products, delayed acceptance of ABHRs by some hospitals was attributed to a concern that repeated use would lead to excessive drying of the skin, but with the addition of 1 to 3% glycerol or other emollients skin drying has not been a problem (22), and most antiseptic brands contain a moisturizer to minimize irritation to the skin. Most alcohol-based antiseptics contain ethanol and/or isopropanol. The alcohol strips away oils on the skin and works immediately to kill bacteria and most viruses by modifying their protein structure, but the alcohol should remain on the skin for at least 30 s. Unfortunately, proteins and fats on soiled hands, often encountered in food production and preparation scenarios, decrease the effectiveness of alcohol as an antiseptic.

In health care settings, ABHRs are much more efficient for reducing the bacterial load on hands than is washing with antiseptic soap. Girou et al. (48) found that after hand rubbing, the median percent reduction in bacterial contamination was significantly higher than that achieved with hand washing in 23 health care workers in intensive care units (83 versus 58%,  $P = 0.012$ ). In another study, Karabay et al. (65) found that rubbing with ABHRs was more efficient than washing with an antimicrobial soap for 35 nurses (54 and 27%, respectively;  $P < 0.01$ ); compliance also was better in the hand rubbing group than in the hand washing group (72.5 and 15.4%, respectively;  $P < 0.001$ ). Ehrenkranz and Alfonso (41) found that transmission of gram-negative bacteria can occur from patients to catheters unless an alcohol rinse is used with soap and water. Mackintosh and Hoffman (77) found that when hands contaminated with *Escherichia coli*, *Streptococcus pyogenes*, *Staphylococcus saprophyticus*, *Pseudomonas aeruginosa*, *Klebsiella aerogenes*, and *Serratia marcescens* were exposed to 0.3 ml of alcohol sanitizer containing either 80% ethanol or 70% isopropanol, bacterial transfer to fabric was slightly lower than that after a soap-and-water wash. However, when the volume of the alcohol in the rubs was raised to 0.5 ml with 70% isopropanol, a 14,000-fold reduction in transfer occurred compared with a 9,800-fold reduction after using a thorough soap-and-water wash, which is a nonsignificant difference.

Antiseptic effectiveness will differ based on (i) alcohol type, (ii) alcohol concentration, (iii) quantity used on hands, and (iv) exposure period. Use of small amounts of antiseptic containing low alcohol concentrations combined with short drying times will markedly decrease efficacy, especially when organic matter (dirt, grease, or food) and/or viruses are present. Differences in procedures, levels of grease or food debris, and specific requirements must be noted when comparing the requirements between food service and health care settings. Alcohol-based antiseptics should be

combined with regular hand washing regimens and should not replace hand washing and drying or use of fingernail brushes (71, 74, 87, 88, 145).

**Types of alcohol-based agents.** The majority of alcohol-based hand antiseptics or sanitizers contain isopropanol, ethanol, n-propanol, or a combination of two of these (23). Those containing 60 to 95% alcohol denature proteins most effectively because water is needed for the process. These agents are effective against enveloped viruses but not against spores, oocysts, and nonenveloped viruses, e.g., norovirus, rotavirus, hepatitis A virus, and poliovirus. The alcohol-based gels or liquids can cause a 3.5-log reduction of bacteria on hands after a 30-s application and a 4- to 5-log reduction after 1 min; however, the time required for virus inactivation often is longer than the alcohol remains active on the hands. There is no residual effect with these products compared with CHG, quaternary ammonium compounds, octenidine, or triclosan, which are often added to the alcohols (23, 88, 111). However, the use of alcohol hand antiseptics with and without antimicrobial additives was equally effective for reducing hospital-associated infections (62, 87). Thus, the incorporation of antimicrobials with residual activity, such as CHG, into gels is considered unnecessary for health care workers and has been viewed with caution and concern because of the potential for development of antimicrobial resistance and dermatitis and the unknown long-term effects of residual biocides on skin flora. There is also the possibility of a false sense of security for users who believe that a "long lasting" formula offers ongoing barrier protection (83, 111); antibiotic-resistant bacteria have been isolated from the surfaces of dispensers of soap containing CHG (25).

Newer formulations with combinations of alcohols and other agents are being developed against pathogens resistant to disinfection. A formulation containing less ethanol (55%) in combination with 10% propan-1-ol, 5.9% propan-1,2-diol, 5.7% butan-1,3-diol, and 0.7% phosphoric acid has a broad spectrum of virucidal activity (67). In quantitative suspension tests, with and without protein load, this formulation reduced the infectivity titer of nine enveloped viruses (influenza A and B viruses, herpes simplex 1 and 2 viruses, bovine coronavirus, respiratory syncytial virus, vaccinia virus, hepatitis B virus, and bovine viral diarrhea virus) and four nonenveloped viruses (hepatitis A virus, poliovirus, rotavirus, and feline calicivirus) by  $>10^3$  units within 30 s. In comparative testing, only 95% ethanol had similar levels of activity. In fingerpad tests, the poliovirus type 1 (Sabin) titer decreased 3.04 log units after 30 s compared with 1.32 log units with 60% propan-2-ol. Testing against feline calicivirus produced a 2.38-log reduction with the test formulation, whereas 70% ethanol and 70% propan-1-ol produced 0.68- and 0.70-log reductions, respectively. In a recent WHO study (124), two formulations, one based on ethanol and the other based on isopropyl alcohol, were compared for their activity against both enveloped and nonenveloped viruses. Formulation I contained 80% (vol/vol) ethanol, 1.45% (vol/vol) glycerol, and 0.125% (vol/vol) hydrogen peroxide, whereas formu-

lation II contained 75% (vol/vol) isopropyl alcohol, 1.45% (vol/vol) glycerol, and 0.125% (vol/vol) hydrogen peroxide. Both formulations had activity against enveloped viruses. Formulation I also reduced the titers of adenovirus and murine norovirus (a surrogate for human norovirus) by >4 log units within 30 s but failed to inactivate poliovirus by 4 log units within short exposure times, indicating insufficient activity against enteroviruses. Steinmann et al. (124) strongly recommended formulation I rather than products with recognized microbiological activity for settings with frequent nosocomial viral infections. Because of its broader spectrum against viral pathogens, formulation I also should be used in outbreak situations involving known and unknown viruses.

Recently introduced alcohol foam antiseptics that can be spread over the surface of the hand are better than gel products and have been associated with higher compliance and increased efficacy as compared with gels in health care settings in the United States and the United Kingdom (8, 82). In comparative studies with standard test methods (European Standard EN 1500), both alcohol liquid and alcohol foam products had significantly higher efficacy (>1 log) than did gel products (37, 68, 82, 110). Gel and foam products are now used in remote high-traffic areas away from hand washing sinks, e.g., at bed sides, in food service facilities, at deli counters, in areas catering to at-risk patients, and at grocery store check-out counters. However, Boyce and Pittet (23) revealed the economic implications associated with extensive use of these products; the total budget for hand hygiene supplies in a hospital was about \$1 per patient-day, but costs for alcohol-based products and foam products were 1.6 to 2.0 times higher and 4.5 times higher, respectively, than those for soap.

### ANTIMICROBIAL WIPES

**Moistened wipes.** Before the widespread use of alcohol gels and foams, disinfectant wipes were popular for removing transient organisms from hands. Premoistened cleansing tissues are still used as baby wipes, adult incontinence wipes, hand and face wipes, feminine wipes, cosmetic wipes, and household cleaning wipes. Antiseptic wipes are available for general hand and face cleansing and specific uses such as antiacne treatment. These products can loosen soil, facilitating the removal of dirt, grease, and microorganisms from skin.

One recent concern is that sporadic cases of *Campylobacter* infection in infants have been linked to grocery store shopping carts. Infections have been acquired by infants who have either touched the contaminated shopping cart or been touched by the contaminated hands of caretakers who have handled packaged retail meats, which are known to harbor external contamination (45). Thus, wipes have been advocated for removal of pathogens and are widely available to customers for in-stores use, but no peer-reviewed studies have been published addressing wipe effectiveness on carts.

The use of wipes in the food industry is more questionable. Smith (121) argued that wipe use may

increase the risk of foreign body contamination of food from wipes themselves (or pieces of them); unless wipes are needed to remove visible dirt, alcohol gels and foams were suggested as better alternatives. In the past, wipes were most often treated with aqueous alcohol solutions containing surface-active detergents, fragrance, and humectants to maintain a moist state. Because of the lotions present in these wipes, friction is reduced, which is beneficial when wiping sensitive or irritated skin. However, because finger and palm friction is important for reducing microbial loads, these wipes also must include antimicrobial compounds. Alcohol-impregnated paper hand wipes were effective for surface sanitization (63, 127), and have been advocated as an alternative to hand washing in hospitals in place of or as an alternative to soap and water (29). Various alcohol concentrations have been studied for their effectiveness in wipes, e.g., 80% ethanol and 15% glycerol for removal of *P. aeruginosa* and *S. aureus* from the hands of nurses on ward rounds (126) and 70% isopropyl alcohol for removal of *Campylobacter* spp. on hands (32). Larson et al. (73) advocated a minimum of 60% alcohol, whereas Butz et al. (29) reported that alcoholic wipes with 30% alcohol could reduce viable counts comparable to those achieved with nonmedicated soap after repeated use. This lower alcohol concentration may be an advantage because wipes containing 30% alcohol are less irritating to skin than are those with triclosan and chlorhexidine. However, because of skin irritation and dryness (19, 57, 104) newer hand antiseptics and moist wipe products are being formulated as alcohol-free (39, 84). Antimicrobial moist wipes typically contain quaternary ammonium compounds such as BAC and benzethonium chloride and povidone iodine and triclosan products; most produce immediate effects through contact but some have cumulative and residual effects (10, 34, 39, 84, 95). Inactive ingredients found in wipes include moisturizers, wetting agents, surfactants, detergents, emulsifiers, and emollients. Examples of prework creams, moisturizers, emollients, and conditioning creams were provided by Smith (121).

In special cases in which hand washing sinks are not available, such as catering in remote locations, workers may use chemically treated towelettes for hand washing, but little work has been done to determine their efficacy. Butz et al. (29) and Ayliffe (10) found that dry tissue wiping combined with an antimicrobial moist wipe without rinsing is at least equivalent to or better than a soap-and-water wash and rinse. Michaels et al. (84) conducted an experiment in which hands contaminated with  $10^8$  CFU/ml *E. coli* in tryptone soya broth were wiped with dry tissue paper after a 2-min drying period and then wiped with a moist tissue containing 0.1% BAC. When the hands were exposed to a series of 10 contamination and wipe cycles, the residual effect of the BAC was noticeable; reductions increased from the 1st to the 10th decontamination step (1.09- to 1.4-log reduction per hand), equivalent to 96.1% decontamination. Edmonds et al. (40) evaluated the SaniTwice three-step process, which comprises a sanitizer hand wipe followed by paper towel drying and reapplication of the sanitizer. In a comparison study, the SaniTwice wipe and a nonantimicrobial hand

washing procedure both achieved microbial reductions of about 2.6 to 2.9 log units when hands were contaminated with  $10^9$  CFU of *E. coli* in beef broth. Based on limited experimental work, the SaniTwice alcohol-based method seems to be more effective than the BAC wipe. However, the need for two stages (dry wipe and moist wipe) or three stages (moist wipe or alcohol alone, dry paper, and moist wipe or alcohol alone) may inhibit the use of these methods, or some of the stages may be ignored. Nevertheless, because wipe methods tested have been more effective than soap and water, they should be considered feasible, practical hand hygiene interventions for remote food service situations or where water availability is limited.

### COMPARISON OF THE EFFECTIVENESS OF SOAPS AND ALCOHOL-BASED ANTISEPTICS AND SANITIZERS

A telephone survey of 40 consumers in Colorado revealed that in the home most people (78%) used a liquid hand cleaner typically containing an antibacterial ingredient (63%), but these respondents did not know the identity of the active agent (26). A written survey of 60 students yielded similar results (73 and 67%, respectively). In general, these students thought that regular hand soaps and even ABHRs were not as effective as antibacterial soaps in removing bacteria from the hands, and only 2% of the telephone survey respondents had gel rubs in their homes compared with 15% of the students. At the same time that this survey was conducted, 90 students in food preparation classes were volunteers in an experiment to estimate the bacterial load on hands before and after cleaning by different methods (26). Regular, antibacterial, and alcohol gel hand cleaners reduced bacterial populations by means of 0.4, 0.7, and 1.4 log units, respectively, indicating that alcohol gels significantly reduced bacteria on hands compared with liquid hand soap and antibacterial soap ( $P \leq 0.05$ ). Gruendemann and Bjerke (53) published a full discussion on the value of alcohol gels in health care settings. However, it is not always clear from the literature whether experimental results are applicable to resident species of skin flora and/or transients, and caution should be used when comparing efficacy data.

Montville et al. (96) compared interventions by considering the results as distributions. Data from other publications and from their own experiments were translated into appropriate discrete or probability distribution functions. Soap with an antimicrobial agent was more effective than regular soap. Hot air drying increased the amount of bacterial contamination on hands, whereas paper towel drying slightly decreased contamination. There was little difference in efficacy between alcohol and alcohol-free antiseptics. Ring wearing slightly decreased the efficacy of hand washing. The experimental data validated the simulated combined effect of certain hand washing procedures based on distributions derived from reported studies. The conventional hand washing system caused a small increase in contamination on hands compared with the touch-free system, i.e., where faucets are operated by

elbows, feet, or automatic movement sensors. Sensitivity analysis revealed that the primary factors influencing final bacterial counts on the hand were sanitizer, soap, and drying method.

We evaluated 38 separate studies of hand hygiene interventions for their effectiveness for removal of various microorganisms, mainly members of the *Enterobacteriaceae* and *S. aureus* combined with soils and applied to hands (7, 11, 12, 16, 31, 32, 36, 76, 78, 86, 89–91, 94, 101, 102, 105, 107, 109, 115, 122, 125) and enteric viruses, such as rotavirus, adenovirus, rhinovirus, poliovirus, and hepatitis A virus (7, 20, 80, 119, 120). Most of the interventions in these studies used standard methods of 15 to 20 s of washing and 10 s of rinsing. Hand hygiene experiments in the health care field have mostly used light soil conditions, such as tryptone soy broth with or without 5% serum and phosphate-buffered saline, because they are standard laboratory materials easily applied to skin, but these conditions do not accurately represent conditions encountered in many settings in clinical practice and almost all food preparation environments. In these studies, the overall efficacy of hand hygiene methods depended on many factors such as soil type, antimicrobial soap strength, e.g., bland (no antimicrobial compound), E1 (low strength antimicrobial compound), or E2 (strong antimicrobial compound at 50 ppm), and the type of alcohol antiseptic (sanitizer). For information on bland, E1, and E2 soaps, see Todd et al. (138). As expected, light soil was more easily removed than were heavy soils (ground beef, chicken juice, fecal material, and organic soils), and the contaminating organisms on lightly soiled hands were inactivated by antimicrobials at significantly higher levels. Enteric bacteria were fairly easy to remove (1.1- to 3.5-log reduction for light soil and 0.7- to 2.4-log reduction for heavy soil), but viruses were more difficult to remove because they are more resistant to physiochemical inactivation than are most non-spore-forming bacteria. Alcohol-based compounds were most effective against gram-negative bacteria on lightly soiled hands, but a soap with an antimicrobial agent seemed to be as effective, if not more so, when hands were more heavily soiled. Unfortunately, there is very little published work available on alcohol antiseptic efficacy against bacteria or viruses embedded in heavy soils, conditions more likely to be encountered by food workers.

Enteric bacterial loads on hands can be high when toilet paper is improperly used or not used at all after defecation, and hand washing will not remove all of the enteric organisms present. A combination of hand washing with plain soap and rubbing with an ABHR will enhance the hygiene process, making the procedure more effective than either approach alone, unless larger quantities of antiseptic (up to 6 ml) are employed (87). Larmer et al. (69) evaluated the effectiveness of different types of soaps in 24 separate hand hygiene studies. These authors concluded that there were no significant differences in effectiveness between ABHRs and medicated and/or plain soap. However, greater efficiency was achieved with hand rubs with 70% alcohol or 70% alcohol with CHG than with rubs with 30% alcohol. Larmer et al. also noted that all of the studies had some

methodological limitations, e.g., no assessor blinding or difficulty creating experimental conditions in institutions. However, they recommended that hands be washed with soap and water when visibly soiled, and when soap is used regularly hand moisturizers should be used liberally. All ABHRs used should contain an emollient and 0.5% CHG. The U.S. Food Code (145) specified that food workers must maintain clean hands by washing with an appropriate cleaning compound, e.g., soap and water. Ojarjarvi (101) tested five types of liquid soap for 1 year and found little difference in their effectiveness. However, the type of antiseptic did affect the preference for the cleaning agent, especially among workers with dermatological problems who do not like alcohol or emulsion-type soaps and may prefer plain water.

In Europe, hygienic hand washing (biocidal) soaps are evaluated based on EN 1499 (43) and hand rubs are evaluated based on EN 1500 (44). In both of these methods, the soap or hand rub being tested is compared with a reference product using 15 volunteers per test. The reference soap for EN 1499 is a defined nonbiocidal product, and the reference rub for EN 1500 is isopropan-2-ol. In these tests, hygienic hand washing soaps are approved when they perform significantly better than the nonbiocidal soap, and hand rubs are approved when they perform the same as or better than isopropan-2-ol. Testing at Campden BRI (Chipping Campden, UK) involved assessing six hygienic hand washing soaps and six hand rubs according to EN 1499 and EN 1500, respectively. All hygienic hand washing soaps passed the EN 1499 tests, with an overall mean 3.18-log reduction compared with a 2.79-log reduction for the nonbiocidal soap. However, only two of the six hand rubs passed the EN 1500 tests, with an overall 3.19-log reduction compared with a 3.81-log reduction for the isopropan-2-ol. Approval of hand rub agents in the European Union is thus more difficult to obtain than approval of biocidal soaps.

Five to 6 ml of alcohol antiseptic will reduce viral loads by 2.4 log units in the presence of light soil and by 1.1 log units in the presence of heavy soil (20, 22, 80). However, this amount of alcohol is not practical to use in food worker environments; it is two to six times the amount commonly utilized by workers using alcohol antiseptics. Viruses are most practically removed by the vigorous friction that occurs during hand washing and drying (120). A typical example is norovirus, which requires aggressive hand washing and sodium hypochlorite solutions (1,000 ppm) for surface sanitizing (54). Rinsing hands under running water (2.0-log reduction) and use of alcohol antiseptic followed by vigorous wiping with a paper towel provide the necessary conditions for virus removal (120). In recognition of this problem of cleaning before use of an alcohol antiseptic, the U.S. Food Code (145) requires that hands of food workers be washed before use of ABHRs.

In fingernail studies, overall lower levels of *E. coli* were removed from artificial versus natural nails, and a significant improvement ( $P \leq 0.05$ ) over all other methods, including a soap wash followed by an alcohol hand sanitizer, was achieved when a fingernail brush was used (87). Courtenay et al. (33) argued that the National

Restaurant Association ServSafe program hand washing methods are more effective than a warm water or cold water rinse ( $<1$  versus 1.4 and 2.1 log CFU/ml *E. coli* on hands, respectively, from 3.6 log CFU/ml on unwashed hands) and more effective than the use of an ethanol-based sanitizer alone (2.9 to 3.4 log CFU/ml remained on hands when ethanol-based sanitizers were used instead of hand washing). The ServSafe procedure calls for wetting hands in warm water, soaping to a good lather, scrubbing hands and arms, cleaning fingernails, and then rinsing and drying with a single-use paper towel. When vinyl food service gloves were worn during the hand washing treatments, gloves retained more bacteria than when only hands were rinsed or washed.

## CONTAMINATION OF ANTISEPTICS

**Contamination from bar soaps, soap dispensers, and reservoirs.** Studies performed by soap manufacturers have indicated that bar soaps do not easily transmit bacteria to users (14, 59); however, there is considerable evidence that soap bars stored in wet dishes are easily and commonly contaminated during use (24, 27, 64, 81). In survey studies of bar soap contamination compared with liquid soaps, *S. aureus* and *Enterobacteriaceae* of human origin typically have been isolated in  $>96\%$  of samples tested (24, 60, 64, 81). This is one reason why bar soaps are not mentioned for hand washing in food operations in the 2005 and 2009 U.S. FDA Food Code editions in contrast to the 2001 version (142, 144, 145), and liquid soaps are the current standard for soaps used in health care and food environments (116). However, bar soaps still are used in many other settings, including the home, and these bars should be replaced frequently.

Contamination also can occur at hand washing stations that dispense liquid soaps (92). More than 40 outbreaks or infections have been documented as associated with contaminated antiseptics (147), resulting in systemic infections, skin abscesses, and conjunctivitis in patients and workers. The most frequently implicated soaps were those containing chlorhexidine and BAC. Both outbreaks and sporadic failures of antiseptics are typically due to user error rather than microbial contamination during production. Common errors include the use of overdiluted solutions, the use of outdated products, the use of tap water to dilute the germicide, the refilling of small-volume dispensers from large-volume stock containers, and use of an inappropriate product. Prior cleaning is necessary to remove proteinaceous material and biofilms so that the germicide can achieve adequate microbial inactivation. In a case-control study to determine the source of *S. marcescens* in a hospital, hands of health care workers were 54 times more likely to be contaminated with the organisms after hand washing with an *S. marcescens*-contaminated soap pump ( $P < 0.001$ ) (118). In hospital environments, patients have been infected through handling of contaminated soap, resulting in eye damage, bacteremia, and even death (51, 79, 117, 139). The most frequent contaminating microorganisms were *Pseudomonas* and/or *Burkholderia* spp., although *S. aureus*,

*S. marcescens*, and other opportunistic pathogens have been isolated from these soaps. Soaps causing such infections range from bland soaps to those containing antimicrobial ingredients such as CHG, hexachlorophene, polyvinylpyrrolidone-iodine, and triclosan.

Soaps can become contaminated either before or during use. Intrinsic sources are production and packaging areas, where contaminated raw ingredients or the manufacturing process itself leads to bacteria being present in the soaps (1, 17, 35, 61, 92, 128). Contamination of ingredients or water used in processing can lead to formation of biofilms in distribution pipes, and these biofilms can be difficult to eradicate (1, 92). In a manufacturing plant producing iodophor products (1), the antiseptic became contaminated with a variety of gram-negative water bacteria, which colonized product distribution lines, affecting the manufacture and quality of the formulated iodophors and causing infections in several patients who used the antiseptic. *Pseudomonas* (*Burkholderia*) *cepacia* was able to survive for 68 weeks in a 1% iodine solution. Biofilm formation occurred in the distribution lines, and periodically the organisms would slough off into the product.

Manufacturers of iodophors and other health care professionals should be aware that pipes or other surfaces colonized with bacteria may be a source of contamination. Anderson et al. (2) recommended scheduled bacteriologic quality control checks of process water and finished product, maintenance of resin beds and filters, and sanitization of water and product distribution pipes (e.g., 60°C water for 1 h). Risk of contamination is minimized when manufacturing is configured around well-designed proprietary production processes and risk management protocols are incorporated within quality control and quality assurance programs (e.g., ISO 9001). Good manufacturing practices and hazard analysis critical control point plans should be considered when designing soap production systems, and assumptions should not be made that a few bacteria are of no consequence.

Extrinsic contamination occurs when contaminating microorganisms are introduced into soap containers during use by individuals with soiled hands. Design and function of soap and antiseptic dispensers, such as pump-top bottles and wall-mounted self-contained delivery mechanisms, are critical to reducing cross-contamination and infection rates. Devices delivering drugs or simple soap can be contaminated by hand contact, leading to infections in health care environments (9, 47, 66, 97, 141). In these scenarios, pseudomonads and other gram-negative bacteria can metabolize ingredients in soaps or lotions and predominate over staphylococci, yeasts, and molds (128). However, the outer surfaces of soap containers can easily be contaminated by hands before and after washing (25, 81), and the potential for cross-contamination between users should be considered another risk factor. Dispensers can be either open or closed. Reservoir systems fall into the open category, where soap is either poured into a reservoir or a bottle is positioned in a fixed reservoir. Bag-in-the-box or sealed cartridge systems have soap fully enclosed within the cabinet. Piston pump-top bottles are another form of an

open system metering device. These pump-top bottle systems allow air ingress through the neck of the pump plunger and are thus considered open systems in the soap industry (92). McBride (81) and Brooks et al. (25) described how dispensers become contaminated with opportunistic pathogens. Soap residues were found on the underside of the dispenser, near the dispenser orifice, and in crevices around the dispensing button, which were heavily contaminated (25). The soap within the prefilled disposable bags appeared to be uncontaminated, but the dispensers were covered with *Klebsiella pneumoniae*, *Acinetobacter* spp., *Pseudomonas* spp., and methicillin-resistant *S. aureus* (MRSA). The nozzles and pumps on many collapsible bag systems do not work well, which leads to leaking soap. Sticky soap bottle surfaces attract organic soil and can become reservoirs for microbes capable of growing on and in soap films (13, 25, 128). Thus, hand washing stations must be monitored for proper settings and maintenance of soap dispensers and the amount of time simple soaps are used.

In addition to dispenser mechanism cross-contamination, soap reservoir systems have caused outbreaks in health care setting after dispensers have been refilled (15). After discovering that these reservoirs were problematic, health care regulatory agencies requested that the reservoir and dispenser nozzles be sanitized before refilling (46, 75, 123). These strict directives were seemingly forgotten or ignored, resulting in recent hospital-associated outbreaks (52, 139). One of these outbreaks involved an antimicrobial soap from a reservoir-type dispenser that staff refilled or topped off without sanitizing the reservoir (52). Reservoir systems situated in locations with possibly high insect populations, such as around food processing facilities, can become contaminated through contact by these pests (83). Weber et al. (147) recommend the following practices (germicides include both antiseptics and disinfectants): (i) use only approved antiseptics and disinfectants; (ii) use all germicides at their recommended use dilution and do not overdilute products; (iii) use sterile water to dilute antiseptics; (iv) use all germicides for the recommended contact times; (v) do not use germicides labeled only as antiseptics for the disinfection of medical devices or surface disinfection; (vi) follow the recommended procedures in the preparation of products to prevent extrinsic contamination; (vii) continue to use small-volume dispensers that are refilled from large-volume stock containers until they are entirely empty and then rinse dispensers with tap water and air dry before refilling; and (viii) store stock solutions of germicides as indicated on the product label.

Theft also may be an important risk factor in the contamination of reservoirs and dispensers, although this factor is not widely documented or discussed. Pilfering of product, i.e., taking small quantities out of a large container for personal use, can introduce contaminants into that container, and other soap product tampering situations have been identified in various food environments (83, 113). Thus, soap dispenser design should include a locking mechanism and reserves should be kept in sealed cabinets to prevent pilfering and/or intentional product contamination. Most standard soap and paper towel dispensers available

through hygiene equipment suppliers include standard locking security devices, and these must be sophisticated enough to prevent tampering but not so complex as to be a barrier to restocking or to limit the availability of soaps for hand washing.

**Contamination of hands and clothing at hygiene stations and automated hand washing machines.** Michaels et al. (93) surveyed microbial contamination on contact surfaces associated with hand washing stations in restrooms and processing areas. Indicator organisms (coliforms, *E. coli*, and *S. aureus*) were found on many of the sampled surfaces, revealing that an individual can be contaminated from organisms deposited by a previous user on hygiene contact surfaces, e.g., water faucet handles, sink counter tops, door handles, and soap dispenser buttons (zig-zag cross-contamination). An ideal hand washing station includes faucets that operate automatically or through use of a knee, foot, or elbow. In restrooms and many food preparation facilities, these types of faucets are not available, increasing the risk of cross-contamination through use of contaminated faucet handles. When a wet hand turns the faucet off, contamination deposited by one user is picked up by the next user. Paper towels for turning off faucets and opening restroom doors is a little-used option that can prevent recontamination of hands after washing. In health care facilities, surfaces contacted during hand drying have led to cross-contamination (50, 55, 56, 58). Another issue is the risk from sprays. During both manual and automated hand washing, users may become contaminated from water droplets dispersed from the water flow of taps or nozzles and the action of the hands during hand washing (J. Holah, personal observation). Such droplets can be described as either ballistic, i.e., they travel in the direction of the originating motive force (e.g., the bounceback of large water droplets from the sink surfaces) or aerosol (smaller droplets), whose movement is directed by local air currents. The degree of cross-contamination to the clothing and skin of the user from this transfer vector is unknown but is likely to be affected by the water pressure at the taps, the shallowness of the sink, the vigorousness of the hand rubbing, and the degree of contamination picked up from the hand or sink surface. Transfer of contamination to uniforms or clothing of food workers at a height on the uniform that may come into contact with foodstuffs during food preparation (e.g., around the waist and stomach area) would be of most concern. Managers of food preparation operations should be encouraged to check for water droplet transfer, i.e., how wet the uniform is in this area, and modify the hand washing station accordingly.

In the 13th century, Muslim engineer Al-Jazari in northern Mesopotamia (present-day Iraq) designed an automated hand washing device with humanoid servants (150). By pulling a plug on the tail of an artificial peacock, water was released from the bird's beak. As the wash water accumulated in a basin below the rinsed hands, a float rose and actuated a servant to appear from behind a door under the peacock and offer soap. When more water was used, a second float at a higher level was activated and a second

servant appeared with a towel. When the base valve was released and the water drained away, the servants disappeared and the doors closed. Actual use of this device was not recorded, but a long time elapsed before automated hand washing machines were considered for industrial use.

In the 20th century, hand washing machines and automatic sinks were investigated as a way to improve hand washing effectiveness and compliance, but deficiencies were found (146, 149). Reports from users of early hand washing machines indicated contaminated water was a problem (100), and features of a then-available unit included a "self-cleaning monitor to eliminate bacterial colonization during operation," indicating a possible problem. Negative attitudes concerning the use of these machines have been reported (70), and manual hand washing was noted to be superior in many instances (140, 149). In one case, hands were more effectively washed with an automatic sink, but this sink was used less often than a regular sink for hand washing, therefore decreasing compliance (70). In one instance, cross-contamination of the hands after the use of a hand washing machine resulted in an outbreak, and an observational study revealed that hand washing compliance improved from 22 to 38% when the hand washing machines were in use (149). However, 4 months after the hand washing machines were installed, an outbreak of MRSA infection occurred in the intensive care unit. As part of evaluating the outbreak, the machines were found to be positive for cultures of methicillin-resistant *Staphylococcus epidermidis*, *Achromobacter* spp., and *Streptococcus viridans*. The design of the hand washing machines made contamination of sleeves and already washed hands possible. The effectiveness of these devices also is dependent on water pressure (146) or use of alcoholic disinfectants (98, 99). Some units are designed for glove washing. These devices have been useful as compliance intervention devices (72, 149). Some automated cleansing systems have been associated with reducing variability in hand washing effectiveness (103) and therefore suited for the testing of antimicrobial soap products (98, 148).

Recent changes have made hand washing machines more sophisticated. One model is available in three different versions: countertop, wall mounted, and free standing but portable (5, 18). When washing hands, the user wearing a radio frequency identification badge is identified by the machine's reader, which scans that person's unique tag number that is associated with a name in a back-end database. The device records the date, time, and beginning and end of the wash cycle and then sends that information to the database. The touchless wash cycle automatically starts when the hands are inserted into two rotating cylinders, which deliver a fully automated 10- to 12-s cycle of hand washing, sanitizing, and rinsing designed to clean the hands from fingertips to wrists. The claim is that by using a CHG sanitizing solution the single cycle is able to remove >99.98% of pathogens and can continue to kill bacteria for up to 6 h. When the automated hand cleansing system was set for a total cycle length of 15 s using 5 ml of 2% CHG against feline calicivirus on hands (Standard Test Method for Determining the Virus-Eliminating Effectiveness of

Liquid Hygienic Handwash and Handrub Agents Using the Fingerpads of Adult Volunteers, ASTM E 1838.02), a mean 3.97-log reduction (99.99%) and as high as a 4.25-log reduction (99.994%) was achieved (4). The system uses up to 75% less water than manual hand washing and discharges 75% less wastewater. The use of this system also further boosts compliance by ensuring a pleasant, uniform hand washing from fingertip to wrist with 20 to 40 high-pressure, low-volume water jets in a consistent wash-and-sanitize cycle. Time will tell whether this type of hand washing device will become sufficiently widespread to become the norm.

For food workers, boots also must be cleaned or disposable overshoes must be worn. As for automatic hand washing devices, boot washers tend not to be used. Unless these washers are well designed and maintained, the disinfectant quality is not sufficient to inactivate contaminants, as occurred in Wales in 2005 when a meat processing establishment was responsible for 157 cases of *E. coli* O157:H7 infection (108).

#### NONDISINFECTION ISSUES ASSOCIATED WITH ALCOHOL-BASED COMPOUNDS

**Flammability.** Alcohols are flammable, and flash points of alcohol-based hand rubs range from 21 to 24°C, depending on the type and concentration of alcohol present (114). Thus, ABHRs should be stored away from high temperatures or flames. Even removal of a polyester gown can create enough static electricity to generate an audible static spark, which can be sufficient to ignite unevaporated alcohol on the hands of a health care worker (28). Queensland Health provided details on how alcohol-based products should be displayed and stored, e.g., in small quantities, not near any electrical outlet, and out of reach of children (114).

**Abuse of the alcohol content.** Another issue for alcohol-based antiseptics is they could be consumed to access the alcohol, and ethanol-based hand antiseptics are considered a safety issue in prison communities (38) or hospital and/or health care settings where alcohol-addicted individuals are confined. In one anecdotal report from the United Kingdom (Campden BRI), the alcohol was removed from alcohol-based products and then mixed with orange juice before consumption. One individual was admitted to a hospital after consuming rubbing alcohol but then ingested ethanol-based hand antiseptic while in the hospital (42, 129). The media have reported accidental and intentional consumption of alcohol-based antiseptics by children and teens, highlighting public awareness of the alcohol content of these products and the potential for misuse (3). Blanchet et al. (21) reported intoxication of a hospitalized patient who on two separate days ingested two 100-ml bottles of a topical antiseptic solution containing isopropyl alcohol and propanol-1. This case points out the need to limit access to alcohol-containing antiseptic solutions in wards where alcoholic and psychotic patients are hospitalized. In 2009, Health Canada delayed the delivery of ABHRs to some First Nations communities affected by H1N1 influenza virus

because of concerns that these products might be consumed for their alcohol content (30). Thefts of ABHRs had been reported previously in some of these communities, where large numbers of people suffer from alcohol addiction.

**Religious concerns.** Another issue associated with these alcohol-based gels is the potential conflict with religious beliefs. In the United Kingdom, town councils, schools, and businesses have been purchasing alcohol-based gels to reduce the spread of the H1N1 influenza virus, but some Muslims are refusing to use these gels because the Koran forbids the use of alcohol (6). To accommodate these individuals, some council chiefs issued nonalcohol gels, which have little effect on the virus (121). However, the Muslim Council of Britain stated that people should follow medical advice and use the alcohol-based hand gels, pointing out that Islamic teachings allow Muslims to use alcohol for medicinal purposes. The Muslim Council of Britain stated that

consumption of all intoxicants including alcohol is totally forbidden in Islam, and according to some Schools, alcohol itself is considered impure. External application of synthetic alcohol gel, however is considered permissible within the remit of infection control because (a) it is not an intoxicant and (b) the alcohol used in the gels is synthetic, i.e. not derived from fermented fruit. Alcohol gel is widely used throughout Islamic countries in health care settings. Any controversy, therefore, is likely to be in perception rather than principle within Islam. Any confusion in this respect may be avoided if references to and labelling of alcohol gel bottles emphasized the disinfection properties rather than its alcohol content—use of the term ethanol to describe the contents was to be encouraged.

#### CONCLUSION

In previous articles, a composite list of problems uncovered during investigations of foodborne disease outbreaks involving food workers and potential interventions to improve hygiene and prevent spread of foodborne disease from food workers were provided (49, 130–134). The major concerns identified included (i) hand washing, (ii) sanitation of food contact surfaces, (iii) facility-wide hygiene education and training, (iv) incentives for workers to report their illnesses, (v) surveillance of the work force by management, and (vi) regular professional screening of employees for illness, including nasal and stool samples obtained from staff returning from overseas travel.

Hand hygiene is a key factor in the transmission of foodborne disease and one of the least costly interventions to implement. Use of hand antiseptics and/or sanitizers, including ABHRs, has been increasing in recent years, especially during the 2009 H1N1 pandemic. Public health messaging focused on hand washing or the use of antiseptics as a major method to control the spread of the virus when combined with vaccination, resulting in record sales for manufacturers of these hand hygiene products. The risk of cross-contamination from person-to-person and from hands to food or vice versa can be reduced by using wash stations with hands-free faucets and easy-to-use paper towel dispensing systems.

Alcohol instant hand antiseptic use has been advocated in conjunction with hand washing and drying, although experimental data indicate no significant increase in efficacy when both hand washing and alcohol antiseptics are used sequentially (87). Most of these recommendations are incorporated into Chapter 2 and Annex 3 of the 2009 U.S. FDA Food Code (145). Although alcohol-based antiseptics are convenient and can be installed at many locations where hand hygiene is required, these agents have their limitations when heavy soil is involved, and they must be combined with a hand washing regimen. They are effective against some but not all viruses, and the type of alcohol preparation used makes a difference, e.g., ethanol versus isopropyl alcohol at different concentrations (124). The correct amount of antiseptic with an effective level of alcohol, e.g., 70%, must be used followed by an appropriate drying time. Alcohol-based antiseptics should be combined with regular hand washing schedules and should not replace hand washing and drying or the use of fingernail brushes.

Economic implications may play a role in the use of alcohol-based products because the daily cost can be up to 4.5 times higher than that of soap and water. ABHRs can be flammable and may be abused for their alcohol content. Religious prohibitions and social customs also can complicate hand hygiene practices, but every society recognizes the need for clean hands when preparing food.

Training alone will not improve hand hygiene and other important food safety practices substantially; manager commitment is required, and programs should be designed to encourage compliance through rewards and penalties. Employees come from diverse cultural backgrounds, sometimes with different concepts of the principles of contamination and sanitation. The issue of hand hygiene compliance is addressed in a subsequent article (135).

## REFERENCES

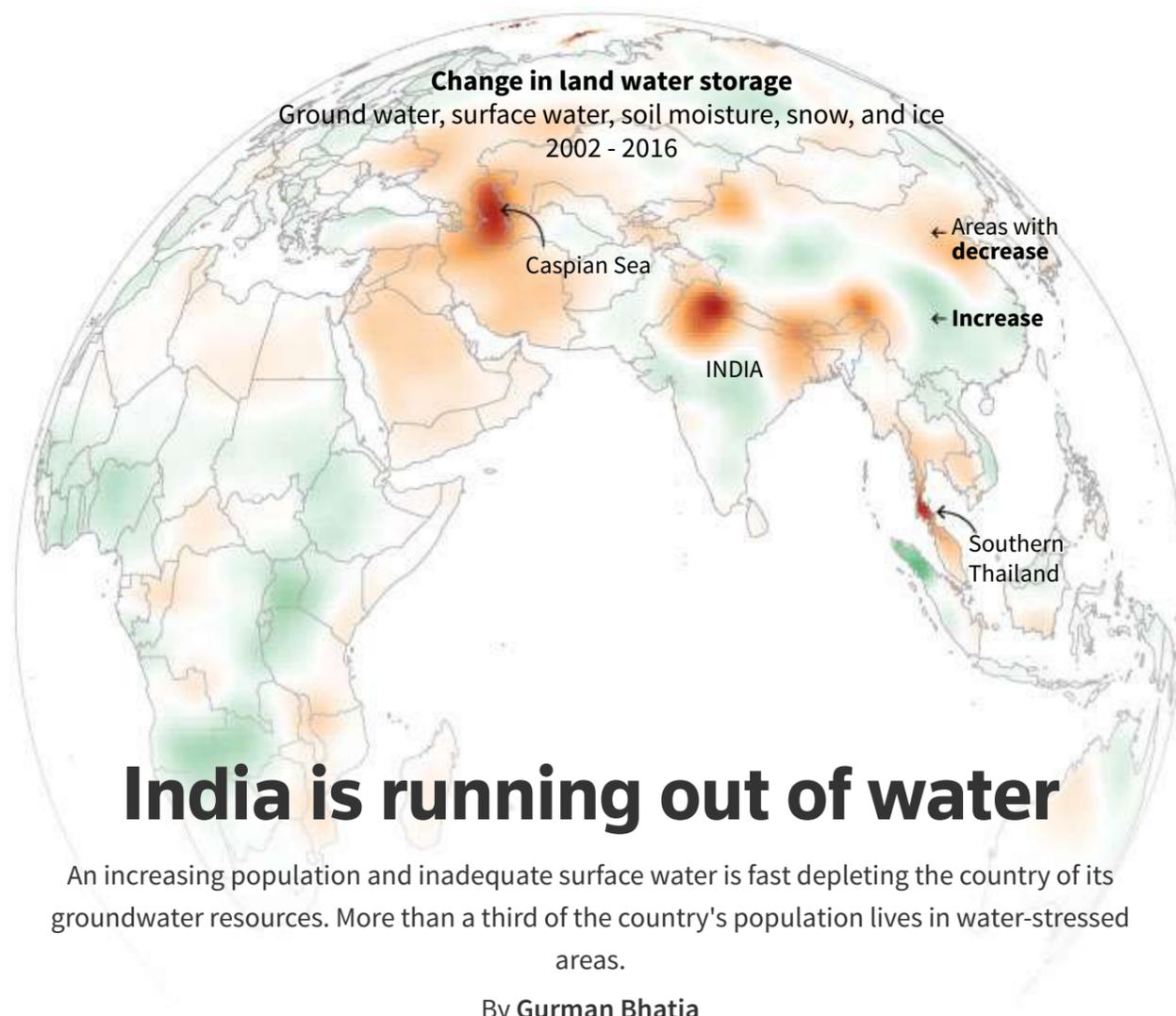
- Anderson, R. L., R. W. Vess, J. H. Carr, W. W. Bond, A. L. Panlilio, and M. S. Favero. 1991. Investigations of intrinsic *Pseudomonas cepacia* contamination in commercially manufactured povidone-iodine. *Infect. Control Hosp. Epidemiol.* 12:297–302.
- Anderson, R. L., R. W. Vess, A. L. Panlilio, and M. S. Favero. 1990. Survival of *Pseudomonas cepacia* in commercially manufactured povidone-iodine. *Appl. Environ. Microbiol.* 56:3598–3600.
- Anonymous. 2007. Getting drunk off hand sanitizers. *Chicago Tribune* Web edition, 22 May. Available at: [http://featuresblogs.chicagotribune.com/features\\_julieshealthclub/2007/05/getting\\_drunk\\_o.html](http://featuresblogs.chicagotribune.com/features_julieshealthclub/2007/05/getting_drunk_o.html). Accessed 27 July 2009.
- Anonymous. 2008. Resurgent Health and Medical's handwashing systems removed 99.994% of norovirus in laboratory studies. *Business Wire*, 21 August. Available at: [http://www.businesswire.com/portal/site/home/permalink?ndmViewId=news\\_view&newsId=20080821005454&newsLang=en](http://www.businesswire.com/portal/site/home/permalink?ndmViewId=news_view&newsId=20080821005454&newsLang=en). Accessed 12 March 2010.
- Anonymous. 2008. Automated handwashing system boosts hand hygiene compliance. *Infection Control Today*, 19 May. Available at: <http://www.infectioncontrolday.com/articles/automated-handwashing-systems.html>. Accessed 12 March 2010.
- Anonymous. 2009. Muslims refuse to use alcohol-based hand gels over religious beliefs. *Daily Mail* on-line. Available at: <http://www.dailymail.co.uk/news/article-1202192/Muslims-refuse-use-alcohol-based-hand-gels-religious-beliefs.html>. Accessed 27 August 2009.
- Ansari, S. A., S. A. Sattar, V. S. Springthorpe, G. A. Wells, and W. Tostowaryk. 1989. In vivo protocol for testing efficacy of hand-washing agents against viruses and bacteria: experiments with

- rotavirus and *Escherichia coli*. *Appl. Environ. Microbiol.* 55:3113–3118.
- Aragon, D., M. L. Sole, and S. Brown. 2005. Outcomes of an infection prevention project focusing on hand hygiene and isolation practices. *AACN Clin. Issues* 16:121–132.
  - Archibald, L. K., A. Corl, B. Shah, M. Schulte, M. J. Arduino, S. Agüero, D. J. Fisher, B. W. Stechenberg, S. N. Banerjee, and W. R. Jarvis. 1997. *Serratia marcescens* outbreak associated with extrinsic contamination of 1% chlorxylenol soap. *Infect. Control Hosp. Epidemiol.* 18:704–709.
  - Ayliffe, G. A. J. 1984. Surgical scrub and skin disinfection. *Infect. Control* 5:23–27.
  - Ayliffe, G. A., J. R. Babb, J. G. Davies, and H. A. Lilly. 1988. Hand disinfection: a comparison of various agents in laboratory and ward studies. *J. Hosp. Infect.* 11:226–243.
  - Ayliffe, G. A., J. R. Babb, and A. H. Quoraishi. 1978. A test for "hygienic" hand disinfection. *J. Clin. Pathol.* 31:923–928.
  - Ayliffe, G. A., D. F. Barrowcliff, and E. J. Lowbury. 1969. Contamination of disinfectants. *Br. Med. J.* 1:505.
  - Bannan, E. A., and L. F. Judge. 1965. Bacteriological studies relating to handwashing. 1. The inability of soap bars to transmit bacteria. *Am. J. Public Health Nations Health* 55:915–922.
  - Barry, M. A., D. E. Craven, T. A. Goularte, and D. A. Lichtenberg. 1984. *Serratia marcescens* contamination of antiseptic soap containing triclosan: implications for nosocomial infection. *Infect. Control* 5:427–430.
  - Bartzokas, C. A., J. E. Corkill, and T. Makin. 1987. Evaluation of the skin disinfecting activity and cumulative effect of chlorhexidine and triclosan handwash preparations on hands artificially contaminated with *Serratia marcescens*. *Infect. Control* 8:163–167.
  - Bassett, D. C. J., K. J. Stokes, and W. R. G. Thomas. 1970. Wound infection due to *Pseudomonas multivorans*, a water-borne contaminant of disinfectant solutions. *Lancet* i:1188.
  - Batchelor, B. 2007. RFID debuts as hand-washing compliance officer. *RFID Journal*. Available at: <http://www.rfidjournal.com/article/view/3425/>. Accessed 12 March 2010.
  - Bently, P. H., and R. Ponsford. 1993. Recent advances in the chemistry of anti-infective agents. Publ. no. 119. Royal Society of Chemistry, Cambridge.
  - Bidawid, S., J. M. Farber, and S. A. Sattar. 2000. Contamination of foods by food handlers: experiments on hepatitis A virus transfer to food and its interruption. *Appl. Environ. Microbiol.* 66:2759–2763.
  - Blanchet, B., A. Charachon, S. Lukat, E. Huet, and A. Astier. 2007. A case of mixed intoxication with isopropyl alcohol and propanol-1 after ingestion of a topical antiseptic solution. *Clin. Toxicol. (Philadelphia)* 45:701–704.
  - Boyce, J. M. 2000. Using alcohol for hand antiseptics: dispelling old myths. *Infect. Control Hosp. Epidemiol.* 21:438–441.
  - Boyce, J. M., and D. Pittet. 2002. Guideline for hand hygiene in healthcare settings: recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. *Morb. Mortal. Wkly. Rep.* 51:1–45.
  - Brook, S. J., and L. Brook. 1993. Contamination of bar soaps in a household setting. *Microbios* 76:55–57.
  - Brooks, S. E., M. A. Walczak, R. Hameed, and P. Coonan. 2002. Chlorhexidine resistance in antibiotic-resistant bacteria isolated from the surfaces of dispensers of soap containing chlorhexidine. *Infect. Control Hosp. Epidemiol.* 23:692–695.
  - Brown, J. M., J. S. Avens, P. A. Kandall, D. R. Hyatt, and M. B. Stone. 2007. Survey of consumer attitudes and the effectiveness of hand cleansers in the home. *Food Prot. Trends* 27:603–611.
  - Bruun, F. N., G. J. McGarrity, W. S. Blakemore, and L. L. Coriell. 1976. Epidemiology of *Pseudomonas aeruginosa* infections: determination by pyocin typing. *J. Clin. Microbiol.* 3:264–271.
  - Bryant, K. A., J. Pearce, and B. Stover. 2002. Flash fire associated with the use of alcohol-based antiseptic agent. *Am. J. Infect. Control* 30:256–257.

29. Butz, A. M., B. E. Laughon, D. L. Gullette, and E. L. Larson. 1990. Alcohol-impregnated wipes as an alternative in hand hygiene. *Am. J. Infect. Control* 18:70–76.
30. Canadian Broadcasting Corporation. 2009. Alcohol-based sanitizers for flu-hit First Nations delayed over substance abuse fears. 23 June. Available at: <http://www.cbc.ca/canada/manitoba/story/2009/06/23/first-nations-swine-flu.html>. Accessed 22 July 2009.
31. Cardoso, C. L., H. H. Pereira, J. C. Zequim, and M. Guilhermetti. 1999. Effectiveness of hand-cleansing agents for removing *Acinetobacter baumannii* strain from contaminated hands. *Am. J. Infect. Control* 27:327–331.
32. Coates, D., D. N. Hutchinson, and F. J. Bolton. 1987. Survival of thermophilic campylobacters on fingertips and their elimination by washing and disinfection. *Epidemiol. Infect.* 99:265–274.
33. Courtenay, M., L. Ramirez, B. Cox, I. Han, X. Jiang, and P. Dawson. 2005. Effects of various hand hygiene regimes on removal and/or destruction of *Escherichia coli* on hands. *Food Service Technol.* 5:77–84.
34. Cremieux, A., M. E. Reverdy, J. L. Pons, C. Savage, J. Chevalier, J. Fleurette, and M. Mosse. 1989. Standardized method for evaluation of hand disinfection by surgical scrub formulations. *Appl. Environ. Microbiol.* 55:2944–2948.
35. Curry, A. S., J. G. Graf, and G. N. McEwen (ed.). 1993. Microbiology guidelines. Cosmetic Toiletry and Fragrance Association Publishers, Washington, DC.
36. de Wit, J. C., and E. H. Kampelmacher. 1982. Microbiological aspects of washing hands in slaughter-houses. *Zentralbl. Bakteriol. (Orig. B)* 176:553–561.
37. Dharan, S., S. Hugonnet, H. Sax, and D. Pittet. 2003. Comparison of waterless hand antisepsis agents at short application times: raising the flag of concern. *Infect. Control Hosp. Epidemiol.* 24:160–164.
38. Doyon, S., and C. Welsh. 2007. Intoxication of a prison inmate with an ethyl alcohol based hand sanitizer. *N. Engl. J. Med.* 356:529–530.
39. Dyer, D. L., K. B. Gerenraich, and P. S. Wadhams. 1998. Testing a new alcohol-free hand sanitizer to combat infection. *AORN J.* 68:239–241, 243–244, 247–251.
40. Edmonds, S. L., C. A. Bondi, R. McCormack, D. R. Macinga, J. W. Arbogast, J. Mann, and M. J. Dolan. 2009. SaniTwice™: a hand hygiene solution for food handlers when water is unavailable, T2-08. Abstr. 96th Annu. Meet. IAFP 2009. International Association for Food Protection, Des Moines, IA.
41. Ehrenkranz, N. J., and B. C. Alfonso. 1991. Failure of bland soap handwash to prevent hand transfer of patient bacteria to urethral catheters. *Infect. Control Hosp. Epidemiol.* 12:654–662.
42. Emadi, A., and L. Coberly. 2007. Intoxication of a hospitalized patient with an isopropanol-based hand sanitizer. *N. Engl. J. Med.* 356:530–531.
43. European Committee for Standardization. 1997. Chemical disinfectants and antiseptics—hygienic handwash—test method and requirements (phase 2, step 2). European standard EN 1499. Central Secretariat, European Committee for Standardization, Brussels.
44. European Committee for Standardization. 1997. Chemical disinfectants and antiseptics—hygienic handrub—test method and requirements (phase2/step2). European standard EN 1500. Central Secretariat, European Committee for Standardization, Brussels.
45. Fullerton, K. E., L. A. Ingram, T. F. Jones, B. J. Anderson, P. V. McCarthy, S. Hurd, B. Shiferaw, D. Vugia, N. Haubert, T. Hayes, S. Wedel, E. Scallan, O. Henao, and F. J. Angulo. 2007. Sporadic *Campylobacter* infection in infants: a population-based surveillance case-control study. *Pediatr. Infect. Dis. J.* 26:19–24.
46. Garner, J. S., and M. S. Favero. 1986. CDC guideline for handwashing and hospital environmental control, 1985. *Infect. Control* 7:231–243.
47. Gilani, S. J., M. Gonzalez, I. Hussain, A. Y. Finlay, and G. K. Patel. 2005. *Staphylococcus aureus* re-colonisation in atopic dermatitis: beyond the skin. *Clin. Exp. Dermatol.* 30:10–13.
48. Girou, E., S. Loyeau, P. Legrand, F. Oppein, and C. Brun-Buisson. 2002. Efficacy of handrubbing with alcohol based solution versus standard handwashing with antiseptic soap: randomised clinical trial. *Br. Med. J.* 325:362.
49. Greig, J. D., E. C. D. Todd, C. A. Bartleson, and B. S. Michaels. 2007. Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 1. Description of the problem, methods, and agents involved. *J. Food Prot.* 70:1752–1761.
50. Griffith, C. J., R. Malik, R. A. Cooper, N. Looker, and B. Michaels. 2003. Environmental surfaces and the potential for contamination during handwashing. *Am. J. Infect. Control* 31:93–96.
51. Grigo, J. 1976. Micro-organisms in drugs and cosmetics—occurrence, harms and consequences in hygienic manufacturing. *Zentralbl. Bakteriol.* 162:233–287.
52. Grohskopf, L. A., V. R. Roth, D. R. Feikin, M. J. Arduino, L. A. Carson, J. I. Tokars, S. C. Holt, B. J. Jensen, R. E. Hoffman, and W. R. Jarvis. 2001. *Serratia liquefaciens* bloodstream infections from contamination of epoetin alfa at a hemodialysis center. *N. Engl. J. Med.* 344:1491–1497.
53. Gruendemann, B. J., and N. B. Bjerke. 2001. Is it time for brushless scrubbing with an alcohol-based agent? *AORN J.* 74:859–873. Available at: [http://findarticles.com/p/articles/mi\\_m0FSL/is\\_6\\_74/ai\\_81218976/pg\\_7](http://findarticles.com/p/articles/mi_m0FSL/is_6_74/ai_81218976/pg_7). Accessed 13 November 2009.
54. Gulati, B. R., P. B. Allwood, C. W. Hedberg, and S. M. Goyal. 2001. Efficacy of commonly used disinfectants for the inactivation of calicivirus on strawberry, lettuce, and a food-contact surface. *J. Food Prot.* 64:1430–1434.
55. Harrison, W. A., C. J. Griffith, T. Ayers, and B. Michaels. 2003. Bacterial transfer and cross-contamination potential associated with paper-towel dispensing. *Am. J. Infect. Control* 31:387–391.
56. Harrison, W. A., C. J. Griffith, and B. Michaels. 2003. A technique to determine contamination exposure routes and the economic efficiency of folded paper towel dispensing systems. *Am. J. Infect. Control* 31:104–108.
57. Harvey, S. C. 1980. Antiseptics and disinfectants; fungicides; ectoparasiticides, p. 964–987. In A. G. Gilman, L. S. Goodman, and A. Gilman (ed.), Goodman and Gilman's the pharmacological basis of therapeutics, 6th ed. Macmillan Publishing, New York.
58. Hattula, J. L., and P. E. Stevens. 1997. A descriptive study of the handwashing environment in a long-term care facility. *Clin. Nurs. Res.* 6:363–374.
59. Heinze, J. E., and F. Yackovich. 1988. Washing with contaminated bar soap is unlikely to transfer bacteria. *Epidemiol. Infect.* 101:135–142.
60. Heiss, F. 1969. Hygienic studies of the use of soap bars in communal sanitary facilities. *Arch. Hyg. Bakteriol.* 153:427–432.
61. Hutchinson, J., W. Runge, M. Mulvey, G. Norris, M. Yetman, N. Valkova, R. Villenur, and F. Lepine. 2004. *Burkholderia cepacia* infections associated with intrinsically contaminated ultrasound gel: the role of microbial degradation of parabens. *Infect. Control Hosp. Epidemiol.* 25:291–296.
62. Johnson, P. D., R. Martin, L. J. Burrell, E. A. Grabsch, S. W. Kirska, J. O'Keefe, B. C. Mayall, D. Edmonds, W. Barr, C. Bolger, H. Naidoo, and M. L. Grayson. 2005. Efficacy of an alcohol/chlorhexidine hand hygiene program in a hospital with high rates of nosocomial methicillin-resistant *Staphylococcus aureus* (MRSA) infection. *Med. J. Aust.* 183:509–514.
63. Jones, M. V., G. B. Rowe, B. Jackson, and N. J. Pritchard. 1986. The use of alcoholic paper wipes for routine hand cleansing: results of trials in two hospitals. *J. Hosp. Infect.* 8:268–274.
64. Kabara, J. J., and M. B. Brady. 1984. Contamination of bar soaps under "in-use" conditions. *J. Environ. Pathol. Toxicol. Oncol.* 5:1–14.
65. Karabay, O., I. Sencan, I. Sahin, H. Alpteker, A. Ozcan, and S. Oksuz. 2005. Compliance and efficacy of hand rubbing during in-hospital practice. *Med. Princ. Pract.* 14:313–317.
66. Kiracofe, G. A. 1997. Contaminated dispensers increase risk of infection. *Mil. Med.* 162:632.
67. Kramer, A., A. S. Galabov, S. A. Sattar, L. Döhner, A. Pivert, C. Payan, M. H. Wolff, A. Yilmaz, and J. Steinmann. 2006. Virucidal activity of a new hand disinfectant with reduced ethanol content:

- comparison with other alcohol-based formulations. *J. Hosp. Infect.* 62:98–106.
68. Kramer, A., P. Rudolph, G. Kampf, and D. Pittet. 2002. Limited efficacy of alcohol-based hand gels. *Lancet* 359:1498–1490.
  69. Larmer, P. J., T. M. Tillson, F. M. Scown, P. M. Grant, and J. Exton. 2008. Evidence-based recommendations for hand hygiene for health care workers in New Zealand. *N. Z. Med. J.* 121:69–81.
  70. Larson, E., A. McGeer, Z. A. Quraishi, D. Krenzschek, B. J. Parsons, J. Holdford, and W. J. Hierholzer. 1991. Effect of an automated sink on handwashing practices and attitudes in high-risk units. *Infect. Control Hosp. Epidemiol.* 12:422–428.
  71. Larson, E. L. 1995. APIC guideline for handwashing and hand antiseptics in health care settings. APIC Guidelines Committee. *Am. J. Infect. Control* 23:251–269.
  72. Larson, E. L., J. L. Bryan, L. M. Adler, and C. Blane. 1997. A multifaceted approach to changing handwashing behavior. *Am. J. Infect. Control* 25:3–10.
  73. Larson, E. L., P. I. Eke, and B. E. Laughon. 1986. Efficacy of alcohol based hand rinses under frequent-use conditions. *Antimicrob. Agents Chemother.* 30:542–544.
  74. Lin, C. M., F. M. Wu, H.-K. Kim, M. P. Doyle, B. S. Michaels, and L. K. Williams. 2003. A comparison of handwashing techniques to remove *Escherichia coli* and calicivirus under natural or artificial fingernails. *J. Food Prot.* 66:2296–2301.
  75. Lowbury, E. J. L., G. A. Ayliffe, A. M. Geddes, and J. D. Williams. 1975. Control of hospital infections: a practical handbook. Chapman & Hall, London.
  76. Lowbury, E. J. L., H. A. Lilly, and J. P. Bull. 1964. Disinfection of hands: removal of transient organisms. *Br. Med. J.* 2:230–233.
  77. Mackintosh, C. A., and P. N. Hoffman. 1984. An extended model for transfer of micro-organisms via the hands; differences between organisms and the effect of alcohol disinfection. *J. Hyg. (Lond.)* 92: 345–355.
  78. Madeline, P., and F. Tournade. 1980. Hand drying by means of disposable products and with hot air. *Prev. Bucco Dent.* 4:24–25.
  79. Mayall, G. C. 1999. Hospital epidemiology and infection control, 2nd ed. Lippincott Williams & Wilkins, Philadelphia.
  80. Mbithi, J. N., V. S. Springthorpe, and S. A. Sattar. 1993. Comparative in vivo efficiencies of hand-washing agents against hepatitis A virus (HM-175) and poliovirus type 1 (Sabin). *Appl. Environ. Microbiol.* 59:3463–3469.
  81. McBride, M. E. 1984. Microbial flora of in-use soap products. *Appl. Environ. Microbiol.* 48:338–341.
  82. Michaels, B. Cutan® foam alcohol hand sanitiser: alcohol foam hand sanitiser having improved efficacy and significantly enhanced hand hygiene compliance capability. On file with the NHS (National Health Service) Rapid Review Panel, London, and the Deb Group, Ltd., Denby, Derbyshire, UK.
  83. Michaels, B. Alcohol-based hand rub with and without chlorhexidine gluconate (CHG): reduction of healthcare associated infections (HAIs). Unpublished data.
  84. Michaels, B., T. Ayers, and D. Paulson. Efficacy of tissue wipes containing BAC for decontaminating hands. Unpublished data.
  85. Michaels, B., T. Ayers, and D. Paulson. Ozonated water test controls. Unpublished data.
  86. Michaels, B., J. Budd, T. Ayers, C. Beausoleil, and D. Paulson. 2001. Evaluation of the combined effects of selective handwashing temperatures and antimicrobial soaps on microbial reduction efficacy and skin irritation. *J. Food Prot.* 64(Suppl. A):92.
  87. Michaels, B., V. Gangar, C.-M. Lin, and M. Doyle. 2003. Use limitations of alcoholic instant hand sanitizer as part of a food service hand hygiene program. *Food Service Technol.* 3:71–80.
  88. Michaels, B., V. Gangar, C.-M. Lin, and M. Doyle. 2003. Use of alcoholic instant hand sanitizer in food service as part of a hand hygiene program: efficacy and limitations for use, p. 262–272. In Proceedings of the 4th International Conference on Culinary Arts and Sciences Global and National Perspectives, Örebro, Sweden.
  89. Michaels, B., V. Gangar, E. Meyers, H. Johnson, and M. Curiale. 2000. The significance of hand drying after handwashing. *J. Food Prot.* 63(Suppl. A):106.
  90. Michaels, B., V. Gangar, A. Schultz, M. Arenas, M. Curiale, T. Ayers, and D. Paulson. 2001. Handwashing water temperature effects on the reduction of resident and transient (*Serratia marcescens*) flora when using bland soap. *Dairy Food Environ. Sanit.* 21:997–1007.
  91. Michaels, B., V. Gangar, A. Schultz, M. Arenas, M. Curiale, T. Ayers, and D. Paulson. 2002. Water temperature as a factor in handwashing efficacy. *Food Service Technol.* 2:139–149.
  92. Michaels, B., and C. Griffith. Simple soaps and NHS infection control challenges: a literature review of potential sources of microbiological contamination of hand cleansing products and recommendations for risk reduction. Unpublished data.
  93. Michaels, B., B. Smith, and M. Pierson. 2001. Pathogenic and indicator bacteria associated with handwashing and drying contact surfaces. *J. Food Prot.* 64(Suppl. A):95.
  94. Michaud, R. N., M. B. McGrath, and W. A. Goss. 1972. Improved experimental model for measuring skin degerming activity on the human hand. *Antimicrob. Agents Chemother.* 2:8–15.
  95. Minakuchi, K., Y. Yamamoto, and K. Matsunaga. 1993. The antiseptic of a quick drying rubbing type povidone-iodine alcoholic disinfectant solution. *Postgrad. Med. J.* 69(Suppl. 3):23–26.
  96. Montville, R., Y. Chen, and D. W. Schaffner. 2002. Risk assessment of hand washing efficacy using literature and experimental data. *Int. J. Food Microbiol.* 73:305–313.
  97. Morse, L. J., H. L. Williams, F. P. Gren, E. E. Eldridge, and J. R. Rotta. 1967. Septicemia due to *Klebsiella pneumoniae* originating from a hand-cream dispenser. *N. Engl. J. Med.* 277:472.
  98. Namura, S., S. Nishijima, and Y. Asada. 1994. An evaluation of the residual activity of antiseptic handrub lotions: an “in use” setting study. *J. Dermatol.* 21:481–485.
  99. Nishijima, S., S. Namura, K. Mitsuya, and Y. Asada. 1993. An evaluation, using computerized image analysis, of antimicrobial efficacy of an automatic hand washing machine with ultrasonic wave spraying. *J. Dermatol.* 20:654–656.
  100. Oda, B. October 1996. Personal communication through B. S. Michaels (barrymichaels@gbso.net).
  101. Ojajarvi, J. 1981. The importance of soap selection for routine hand hygiene in hospital. *J. Hyg. (Lond.)* 86:275–283.
  102. Paulson, D. S. 1992. Evaluation of three handwashing modalities commonly employed in the food processing industry. *Dairy Food Environ. Sanit.* 9:615–619.
  103. Paulson, D. S. 1993. Efficacy evaluation of a 4% chlorhexidine gluconate as a full-body shower wash. *Am. J. Infect. Control* 21: 205–209.
  104. Paulson, D. S. 1994. Comparative evaluation of five surgical hand scrub preparations. *AORN J.* 60:246–256.
  105. Paulson, D. S. 1994. A comparative evaluation of different hand cleansers. *Dairy Food Environ. Sanit.* 14:524–528.
  106. Paulson, D. S. 2005. Importance of vertebrate viruses for choosing hand antiseptics with virucidal efficacy. *Am. J. Infect. Control* 33: 435–436.
  107. Paulson, D. S., E. J. Fender, M. J. Dolan, and R. A. Williams. 1999. A close look at alcohol gel as an antimicrobial sanitizing agent. *Am. J. Infect. Control* 27:332–338.
  108. Pennington, H. 2009. The public inquiry into the September 2005 outbreak of *E. coli* O157 in South Wales. HMSO, Cardiff, UK. Available at: <http://wales.gov.uk/ecolidocs/3008707/reporten.pdf?skip=1&lang=en>. Accessed 3 December 2009.
  109. Pether, J. V. S., and R. J. Gilbert. 1971. The survival of *Salmonella* on finger-tips and transfer of the organisms to food. *J. Hyg. (Camb.)* 69:673–681.
  110. Pietsch, H. 2001. Hand antiseptics: rubs versus scrubs, alcoholic solutions versus alcoholic gels. *J. Hosp. Infect.* 48:S33–S36.
  111. Pollack, R. 2003. Topical antimicrobial drug products for over-the-counter human use; health-care antiseptic drug products; reopening of the administrative record. 21 CFR Part 333, docket no. 75N-183H. Proposed rule. *Fed. Regist.* 68:32003.
  112. Price, P. B. 1938. The bacteriology of the normal skin; a new quantitative test applied to a study of the bacterial flora and the disinfectant action of mechanical cleansing. *J. Infect. Dis.* 63:301–308.
  113. Prince, G. (gale@galeprince.com). 2005. Personal communication.

114. Queensland Health. 2007. Queensland Health policy for hand hygiene: clean hands are life savers. Queensland Health, Brisbane. Available at: [http://www.health.qld.gov.au/chrsp/ffc\\_guidelines/appendix\\_A.pdf](http://www.health.qld.gov.au/chrsp/ffc_guidelines/appendix_A.pdf). Accessed 21 November 2009.
115. Rotter, M. L. 1984. Hygienic hand disinfection. *Infect. Control* 5: 18–22.
116. Rotter, M. L., and G. A. J. Ayliffe. 1991. Practical guide on rationale and testing procedures for disinfection of hands. World Health Organization, Geneva.
117. Ryan, M. P., J. T. Pembroke, and C. C. Adley. 2006. *Ralstonia pickettii*: a persistent gram-negative nosocomial infectious organism. *J. Hosp. Infect.* 62:278–284.
118. Sartor, C., V. Jacomo, C. Duvivier, H. Tissot-Dupont, R. Sambuc, and M. Drancourt. 2000. Nosocomial *Serratia marcescens* infections associated with extrinsic contamination of a liquid nonmedicated soap. *Infect. Control Hosp. Epidemiol.* 21:196–199.
119. Sattar, S. A., M. Abebe, A. J. Bueti, H. Jampani, J. Newman, and S. Hua. 2000. Activity of an alcohol-based hand gel against human adeno-, rhino-, and rotaviruses using the fingerpad method. *Infect. Control Hosp. Epidemiol.* 21:516–519.
120. Schurmann, W., and H. J. Eggers. 1985. An experimental study on the epidemiology of enteroviruses: water and soap washing of poliovirus 1-contaminated hands, its effectiveness and kinetics. *Med. Microbiol. Immunol. (Berl.)* 174:221–236.
121. Smith, D. L. 2009. Hand hygiene: guidance for best practice. Guideline 62. Campden BRI, Chipping Campden, UK.
122. Sprunt, K., W. Redman, and G. Leidy. 1973. Antibacterial effectiveness of routine hand washing. *Pediatrics* 52:264–271.
123. Steere, A. C., and G. F. Mallison. 1975. Handwashing practices for the prevention of nosocomial infections. *Ann. Intern. Med.* 83:683–690.
124. Steinmann, J., B. Becker, B. Bischoff, D. Paulmann, M. Friesland, T. Pietschmann, J. Steinmann, and E. Steinmann. 2010. Virucidal activity of 2 alcohol-based formulations proposed as hand rubs by the World Health Organization. *Am. J. Infect. Control* 38:66–68.
125. Stiles, M., and A. Z. Sheena. 1987. Efficacy of germicidal hand wash agents in use in a meat processing plant. *J. Food Prot.* 50:289–295.
126. Takahashi, S., Y. Terao, and Y. Nagano. 1987. The effectiveness of ethanol gauze for hand disinfection in surgical wards. *J. Hosp. Infect.* 10:40–46.
127. Tebutt, G. M. 1988. Laboratory evaluation of disposable and reusable disinfectant cloths for cleaning food contact surfaces. *Epidemiol. Infect.* 101:367–375.
128. Tenenbaum, S. 1967. Pseudomonads in cosmetics. *J. Soc. Cosmet. Chem.* 18:797–807.
129. Thanarajasingam, G., D. A. Diedrich, and P. S. Mueller. 2007. Intentional ingestion of ethanol-based hand sanitizer by a hospitalized patient with alcoholism. *Mayo Clinic Proc.* 82:1288–1289. Available at: <http://www.mayoclinicproceedings.com/content/82/10/1288.full.pdf+html>. Accessed 27 July 2009. DOI: 10.4065/82.10.1288.
130. Todd, E. C. D., J. D. Greig, C. A. Bartleson, and B. S. Michaels. 2007. Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 2. Description of outbreaks by size, severity, and settings. *J. Food Prot.* 70:1975–1993.
131. Todd, E. C. D., J. D. Greig, C. A. Bartleson, and B. S. Michaels. 2007. Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 3. Factors contributing to outbreaks and description of outbreak categories. *J. Food Prot.* 70:2199–2217.
132. Todd, E. C. D., J. D. Greig, C. A. Bartleson, and B. S. Michaels. 2008. Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 4. Infective doses and pathogen carriage. *J. Food Prot.* 71:2339–2373.
133. Todd, E. C. D., J. D. Greig, C. A. Bartleson, and B. S. Michaels. 2008. Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 5. Sources of contamination and pathogen excretion from infected persons. *J. Food Prot.* 71:2582–2595.
134. Todd, E. C. D., J. D. Greig, C. A. Bartleson, and B. S. Michaels. 2009. Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 6. Transmission and survival of pathogens in the food processing and preparation environment. *J. Food Prot.* 72:202–219.
135. Todd, E. C. D., J. D. Greig, B. S. Michaels, C. A. Bartleson, D. Smith, and J. Holah. Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 11. Use of antiseptics and sanitizers in community settings and issues of hand hygiene compliance in health care and food industries. *J. Food Prot.*, in press.
136. Todd, E. C. D., B. S. Michaels, J. D. Greig, D. Smith, and C. A. Bartleson. 2010. Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 8. Gloves as barriers to prevent contamination of food by workers. *J. Food Prot.* 73:1762–1773.
137. Todd, E. C. D., B. S. Michaels, J. D. Greig, D. Smith, J. Holah, and C. A. Bartleson. 2010. Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 7. Barriers to reduce contamination of food by workers. *J. Food Prot.* 73:1552–1565.
138. Todd, E. C. D., B. S. Michaels, D. Smith, J. D. Greig, and C. A. Bartleson. 2010. Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 9. Washing and drying of hands to reduce microbial contamination. *J. Food Prot.* 73:1937–1955.
139. Tresoldi, A. T., L. G. O. Cardoso, P. Trabasso, M. C. S. Carvalho, S. R. P. Dantes, M. L. Leichsenring, R. Fagnani, and M. L. Moretti. 2005. Outbreak of nosocomial bacteraemia due to *Burkholderia cepacia* associated soap, 1134-04-171. Presented at the 15th European Congress of Clinical Microbiology and Infectious Diseases, Copenhagen, Denmark, 2 to 5 April 2005.
140. Turner, J. G., D. K. Gauthier, J. R. Roby, E. Larson, and J. J. Gauthier. 1994. Use of image analysis to measure handwashing effectiveness. *Am. J. Infect. Control* 22:218–223.
141. Uchio, E., H. Ishiko, K. Aoki, and S. Ohno. 2002. Adenovirus detected by polymerase chain reaction in multidose eyedrop bottles used by patients with adenoviral keratoconjunctivitis. *Am. J. Ophthalmol.* 134:618–619.
142. U.S. Food and Drug Administration. 2001. 2001 Food Code. Available at: <http://www.fda.gov/Food/FoodSafety/RetailFoodProtection/FoodCode/FoodCode2001/default.htm>. Accessed 16 November 2009.
143. U.S. Food and Drug Administration, Center for Drug Evaluation and Research. 2005. Approved drug products with therapeutic equivalence evaluations (the Orange Book). Available at: <http://www.fda.gov/downloads/Drugs/DevelopmentApprovalProcess/UCM071436.pdf>. Accessed 30 September 2010.
144. U.S. Food and Drug Administration, Center for Food Safety and Applied Nutrition. 2005. 2005 FDA Food code. Available at: <http://www.fda.gov/Food/FoodSafety/RetailFoodProtection/FoodCode/FoodCode2005/default.htm>. Accessed 30 September 2010.
145. U.S. Food and Drug Administration, Center for Food Safety and Applied Nutrition. 2009. FDA Food Code. Available at: <http://www.fda.gov/Food/FoodSafety/RetailFoodProtection/FoodCode/FoodCode2009/>. Accessed 11 December 2009.
146. Vesley, D., D. R. Lillquist, and C. T. Le. 1985. Evaluation of nongermicidal handwashing protocols for removal of transient microbial flora. *Appl. Environ. Microbiol.* 49:1067–1071.
147. Weber, D. J., W. A. Rutala, and E. E. Sickbert-Bennett. 2007. Outbreaks associated with contaminated antiseptics and disinfectants. *Antimicrob. Agents Chemother.* 51:4217–4224.
148. Wolf, R., and M. Friedman. 1996. Measurement of the skin-cleaning effects of soaps. *Int. J. Dermatol.* 35:598–600.
149. Wurtz, R., G. Moye, and B. Jovanovic. 1994. Handwashing machines, handwashing compliance, and potential for cross-contamination. *Am. J. Infect. Control* 22:228–230.
150. Wye, M. 2009. Handwashing device with automated servants. Shining history—medieval Islamic civilization. Available at: <http://www.shininghistory.com/2009/07/handwashing-device-with-automated.html>. Accessed 12 March 2010.



# India is running out of water

An increasing population and inadequate surface water is fast depleting the country of its groundwater resources. More than a third of the country's population lives in water-stressed areas.

By Gurman Bhatia

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Groundwater has been declining at an alarming rate in India, which is expected to surpass China as the world's most populous country in less than a decade.

More than a third of India's population lives in water-stressed areas and this number is set to grow due to depleting groundwater and rising urbanisation.

India is one of 17 countries facing extremely high water stress, according to a recent report by the World Resources Institute.

India's water stress has increased in the last few decades as borewells were dug to extract more and more groundwater for water-guzzling crops such as rice and sugarcane.

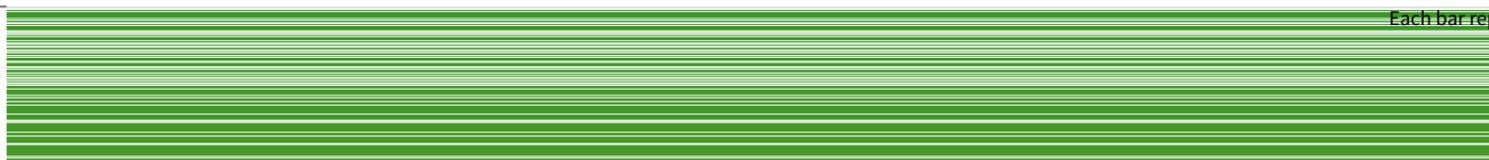
Ideally, surface water should be stored during monsoon season and used throughout the year instead of groundwater. India has built many large dams in the last few decades, but still there are hundreds of incomplete dams and successive federal governments have spent billions of dollars over the years to complete them. But several are still unfinished due to bureaucratic sloth, corruption, opposition to land acquisition and lack of coordination within the government.

Government data released in July 2019 shows that in 2017, 109 districts out of the 684 for which data was available, used more groundwater than what was replenished by both natural and artificial processes, a measurement known as groundwater "recharge".

## DISTRICT-WISE POPULATION AND GROUNDWATER UTILISATION IN INDIA (2017)

Colour represents percentage of the groundwater recharge utilised

0 percent of recharge utilised



As you scroll down,  
more groundwater is  
being exploited

Height represents the  
population of a district

10

20

30

Darjeeling

Sonitpur

Purulia

Raigad

Thane

Chandrapur

Araria

East Singhbhum

Coochbehar

Vizianagaram

East Godavari

Palghar

West Champaran

Rohtas

Dhubri

Visakhapatnam

Howrah

Kanniyakumari

Aurangabad

Giridih

Surat

Bhagalpur

Nagaon

Palamau

Yeotmal

Gwalior

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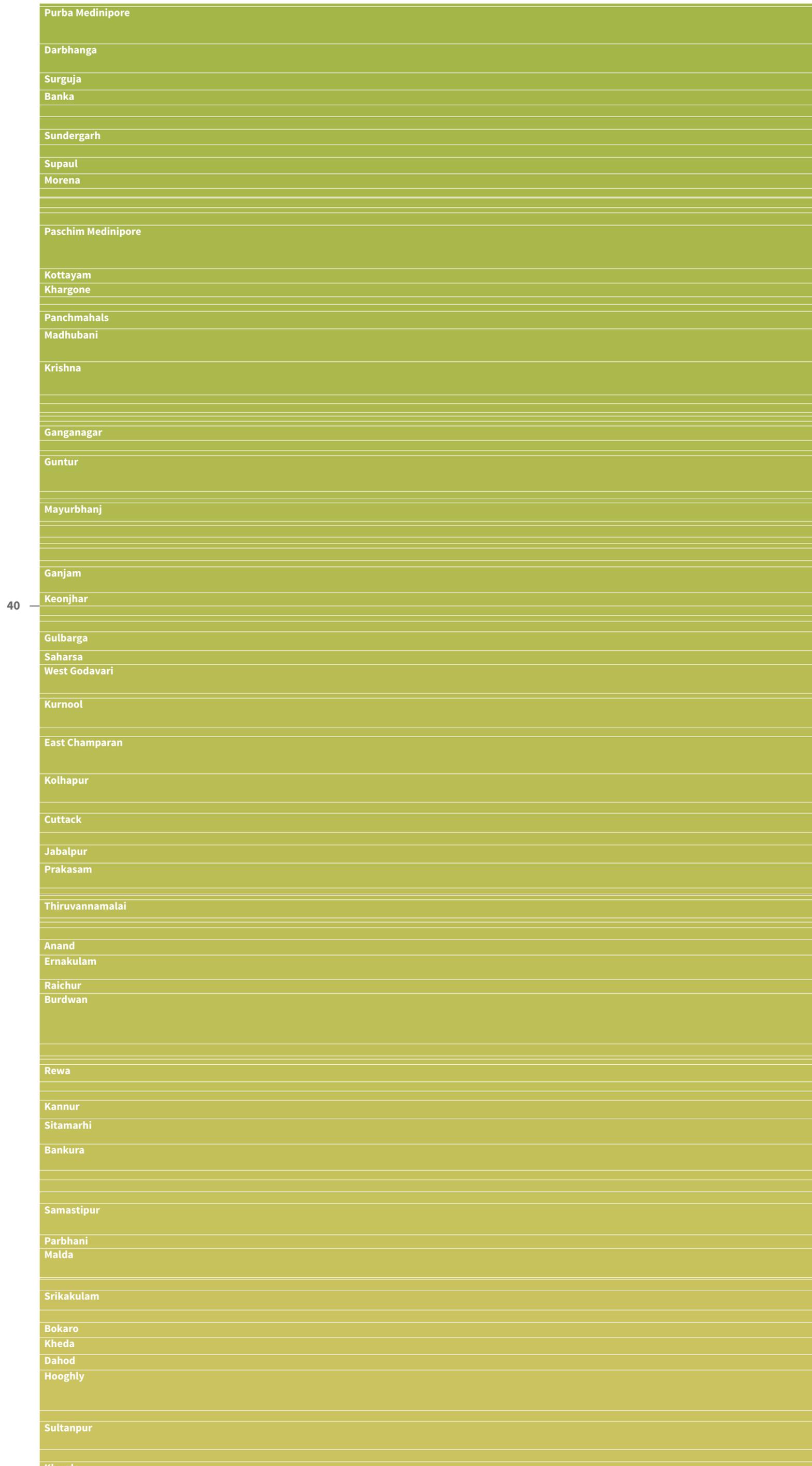
Alappuzha

Birbhum

Several sparsely populated,  
rural districts in the country  
have safe levels.

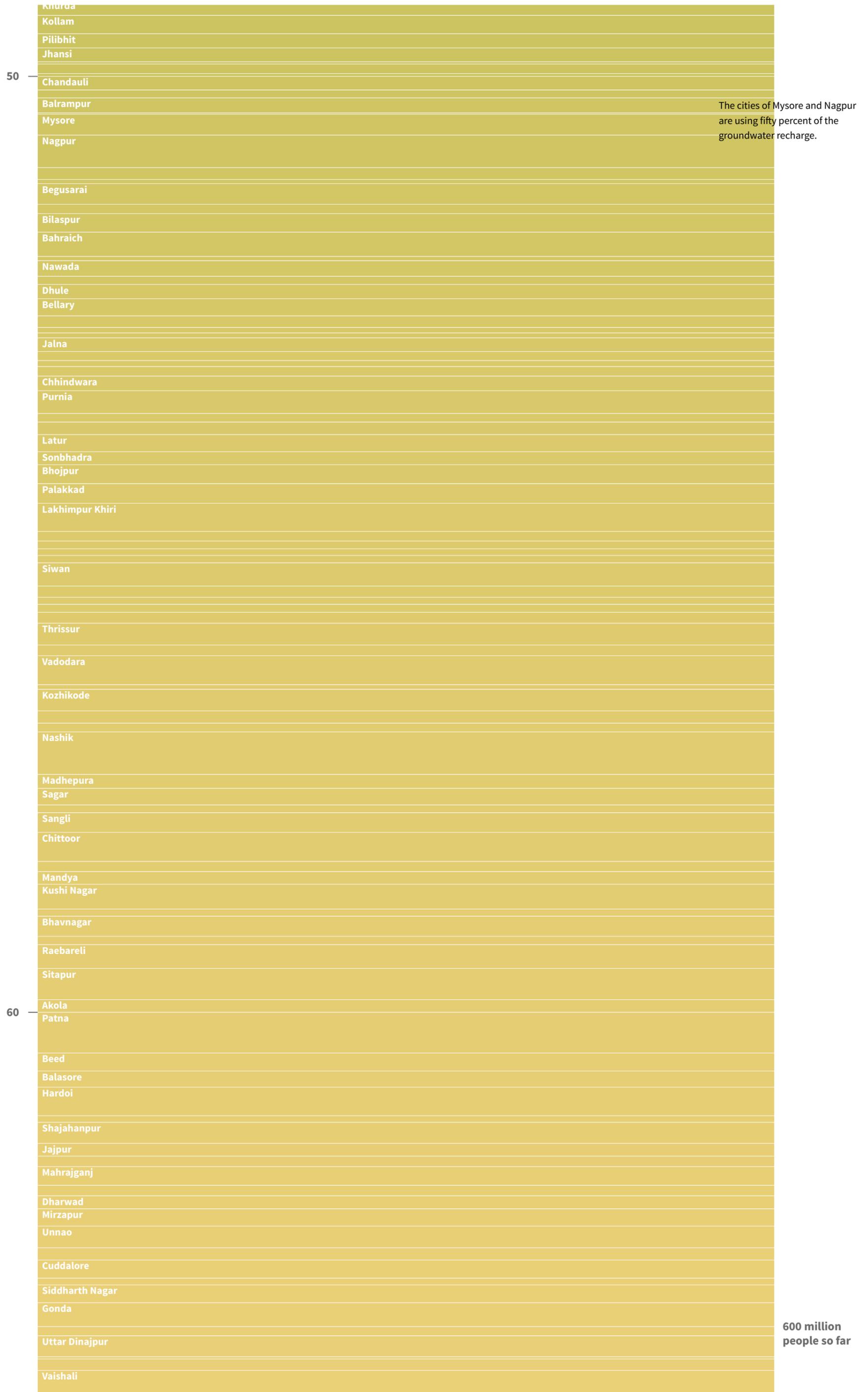
Thane district in the western  
state of Maharashtra is most  
populated but groundwater  
level is still safe due to large  
dams in the district.

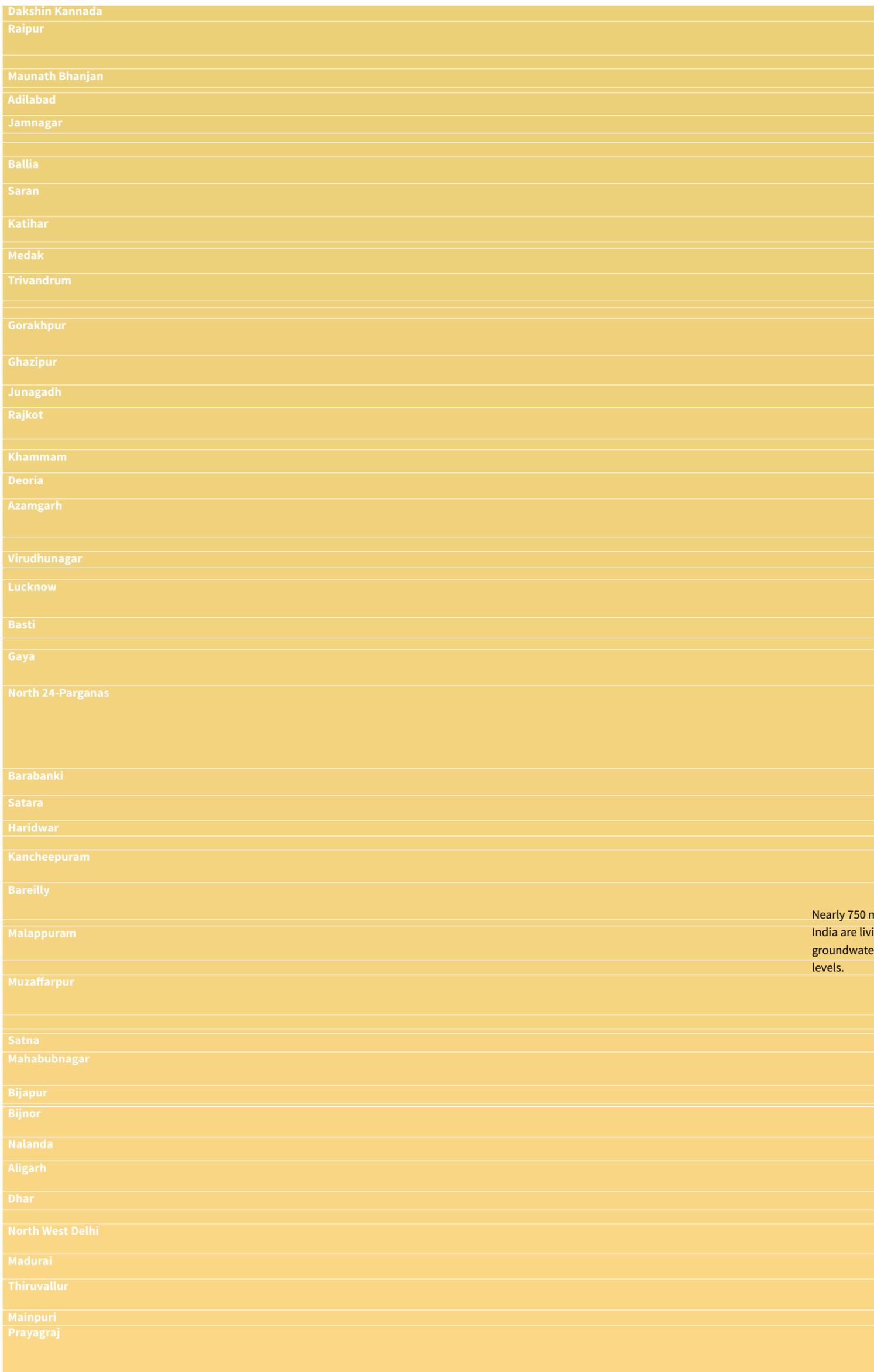
200 million  
people so far



40

400 million people so far

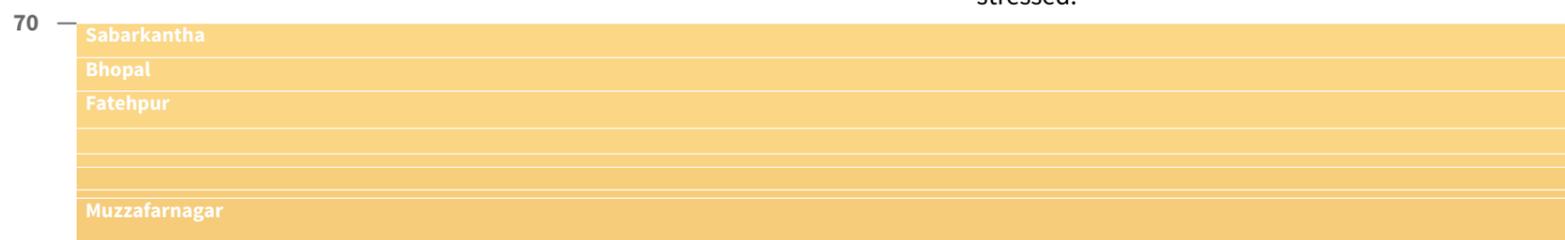


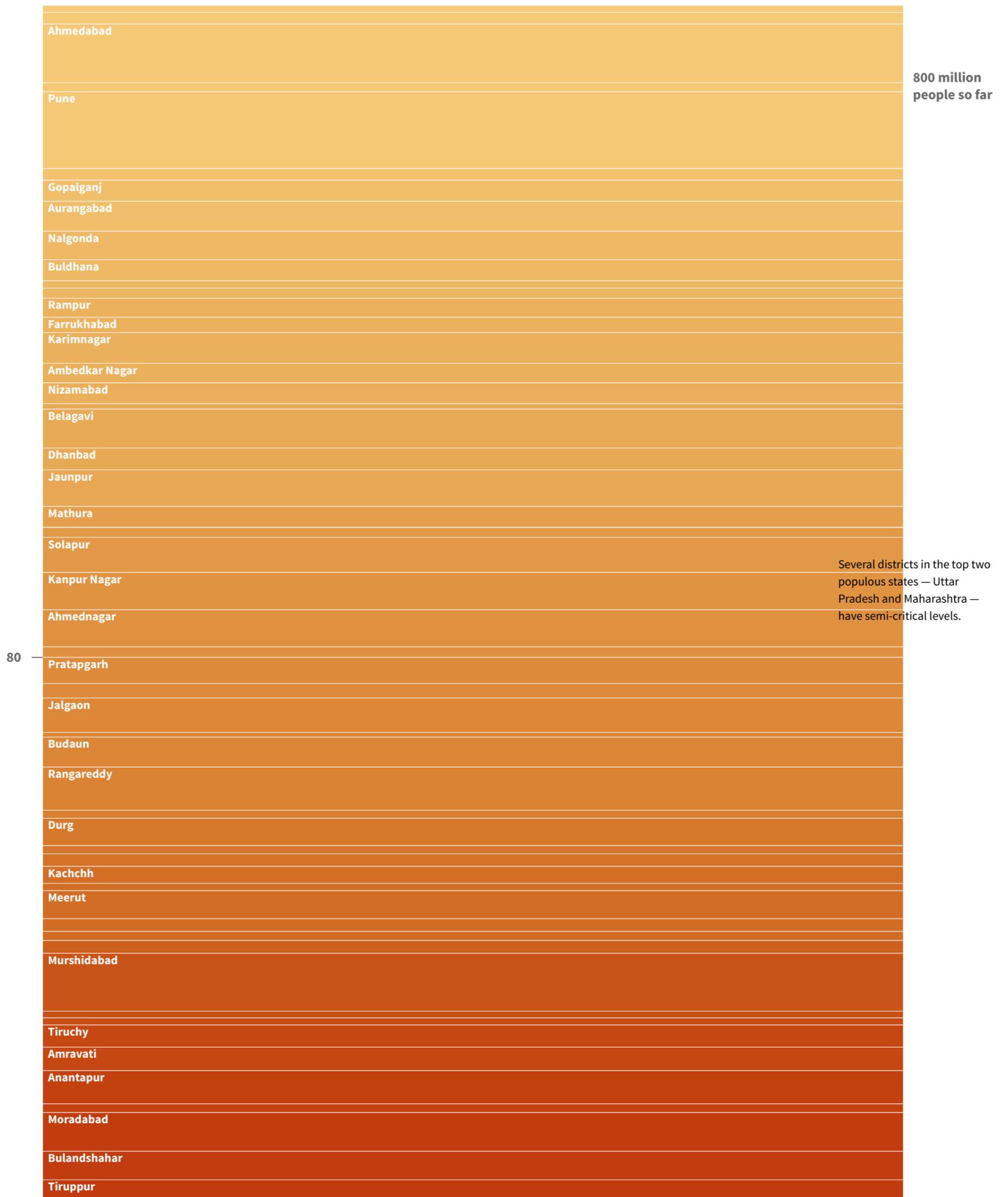


Nearly 750 million people in India are living in regions where groundwater usage is at safe levels.

**SEMI-CRITICAL DISTRICTS**

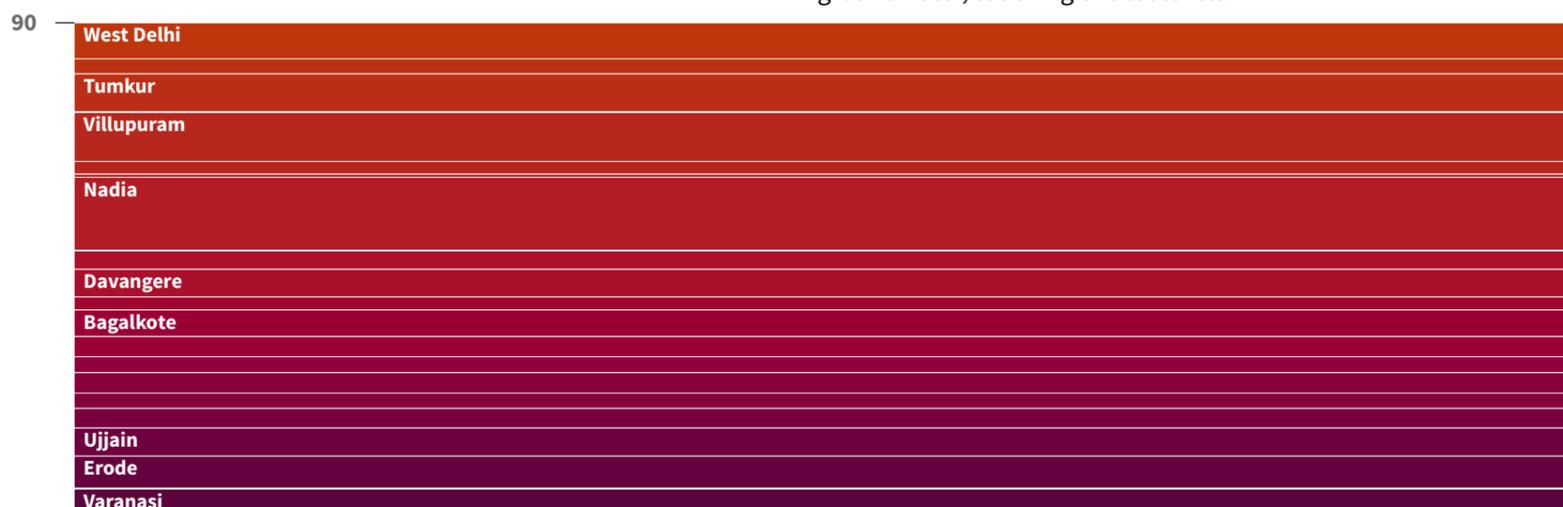
Districts that have groundwater utilisation over 70 percent are water-stressed.





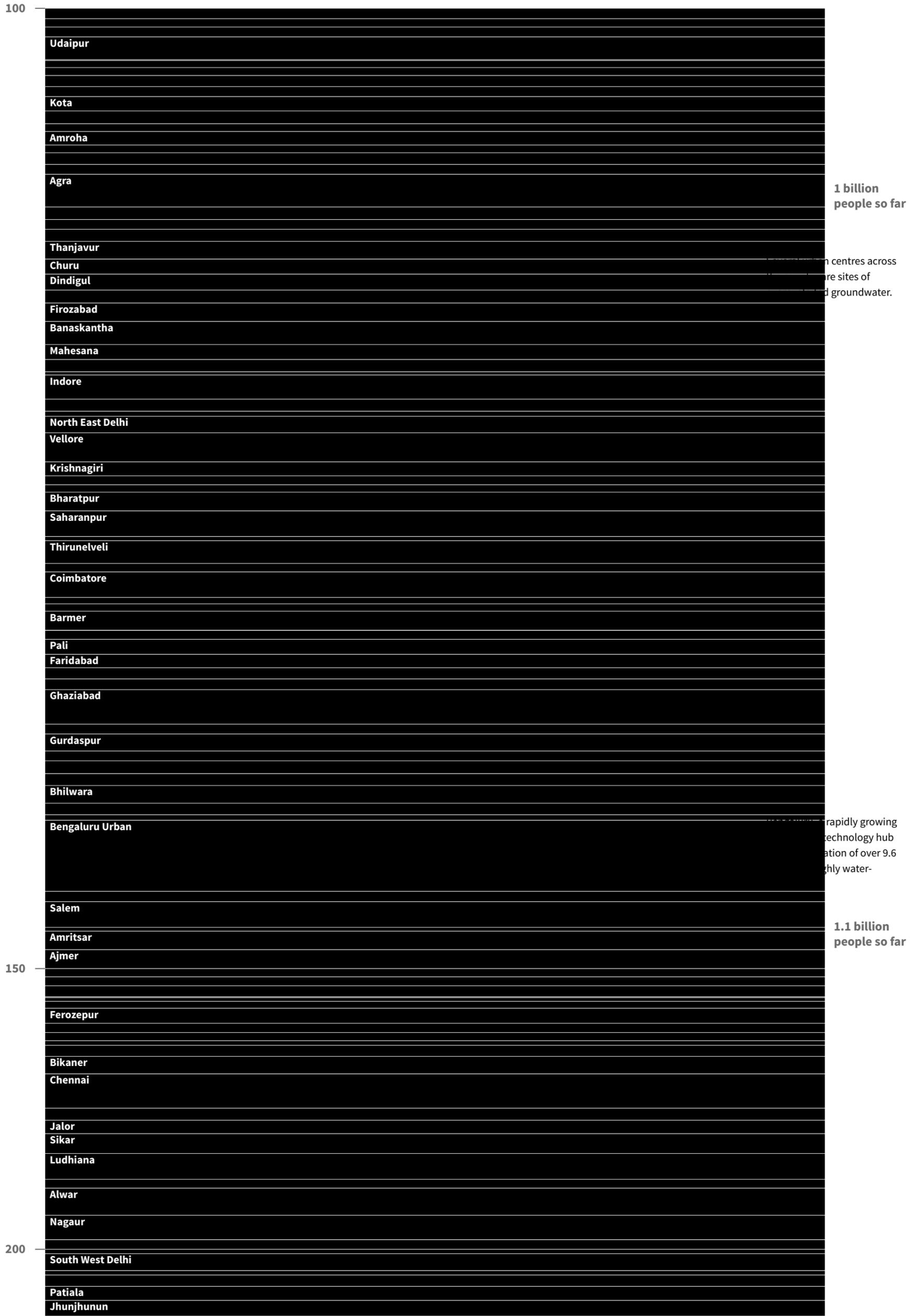
### CRITICAL DISTRICTS

As areas become more urban, the high demand increases the dependence on groundwater, touching critical levels.



### OVEREXPLOITED DISTRICTS

When the withdrawal volume exceeds the water replenished in a region, one ends up in the overexploited zone.

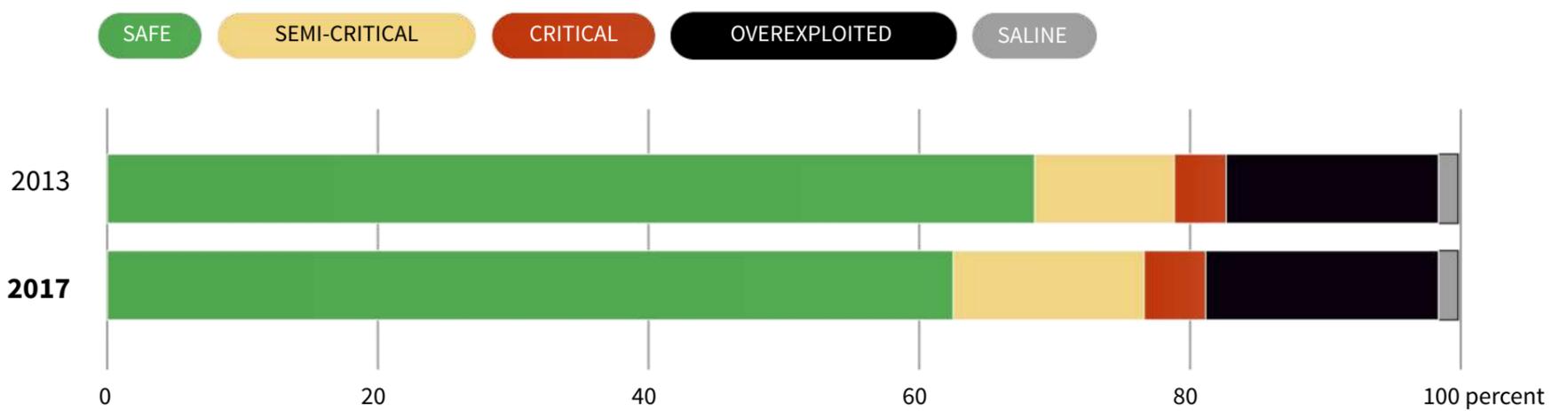




Data published by the Central Ground Water Board in India suggests that when city and village blocks were compared to the last review done in 2013, fewer blocks recorded safe levels in 2017. The percentage of overexploited blocks increased.

While 388 blocks improved, 504 deteriorated. 4,835 blocks saw no change.

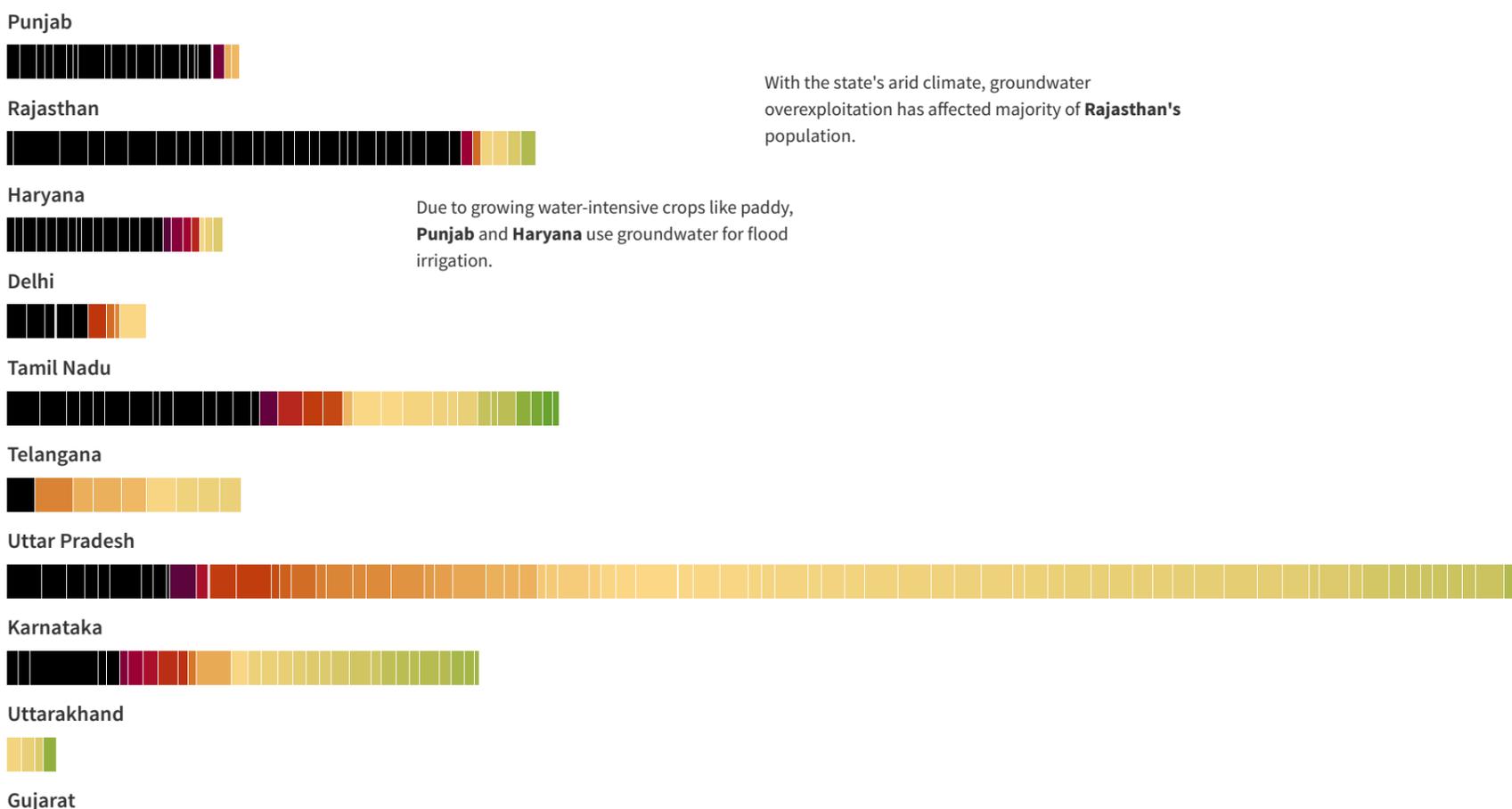
### DECREASE OF SAFE BLOCKS BETWEEN 2013 AND 2017

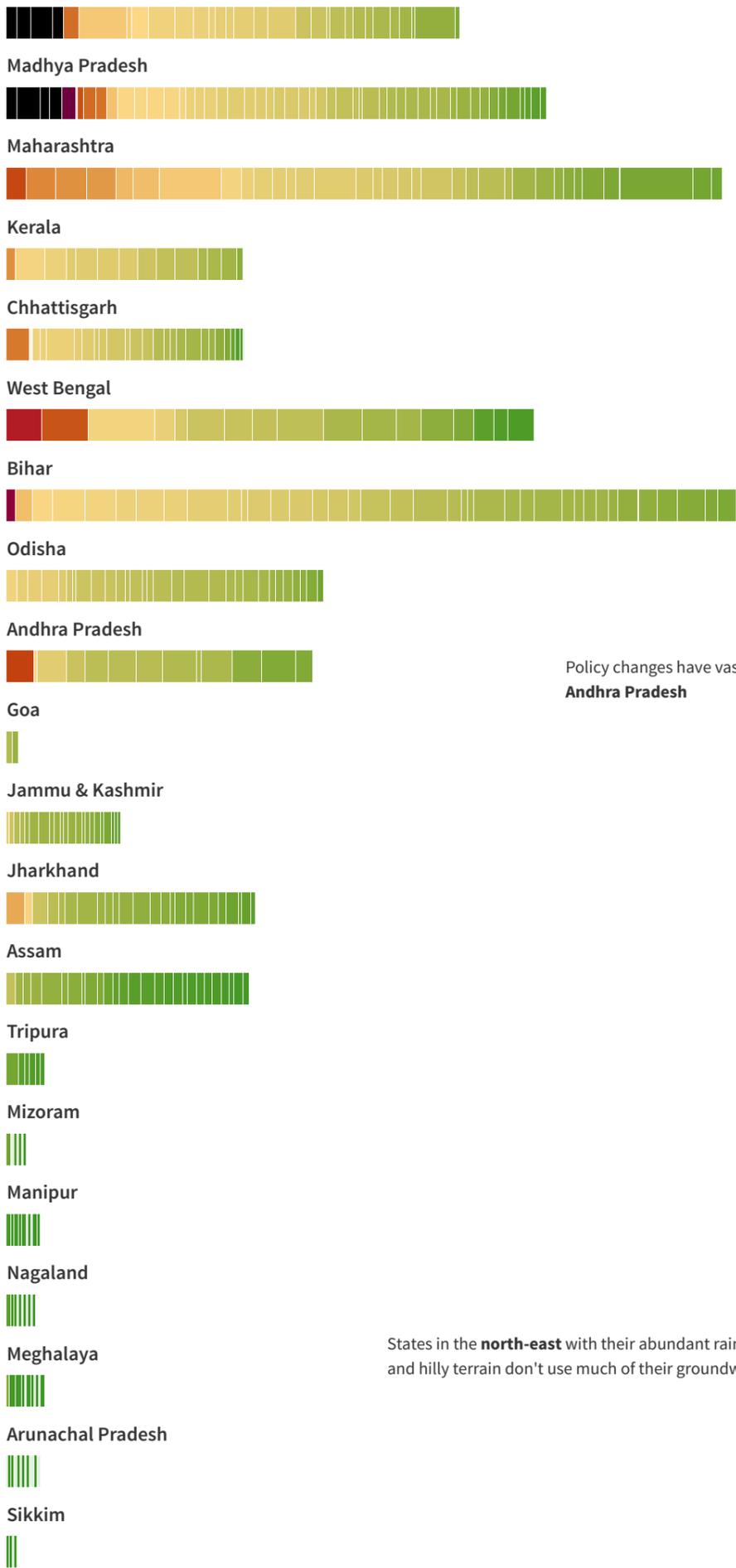


Most of the problematic areas are concentrated in a few states. While Rajasthan suffers because of being a land-locked desert, districts in Punjab and Haryana are overexploited due to their heavy use of groundwater for irrigation. Several other water-stressed districts are rapidly growing urban centres where groundwater ends up being the fallback to meet increasing demand amidst the lack of adequate sources.

### POPULATION AND GROUNDWATER UTILISATION IN INDIA BY STATE (2017)

Each block represents a district with available data. Width represents population.



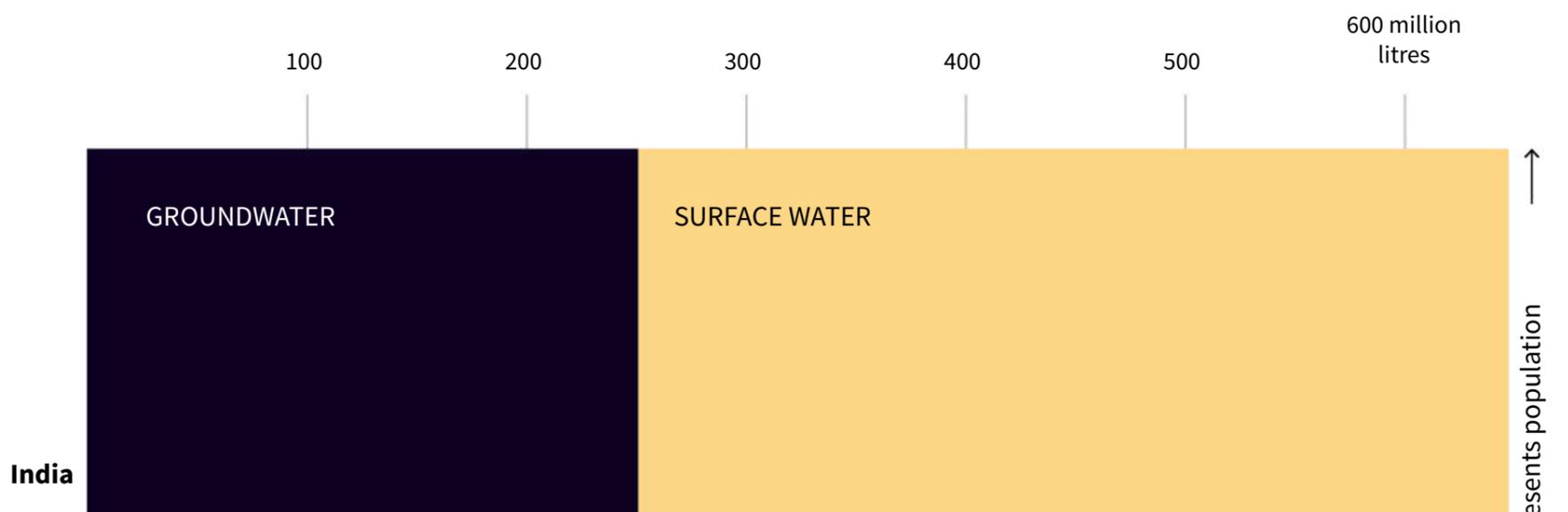


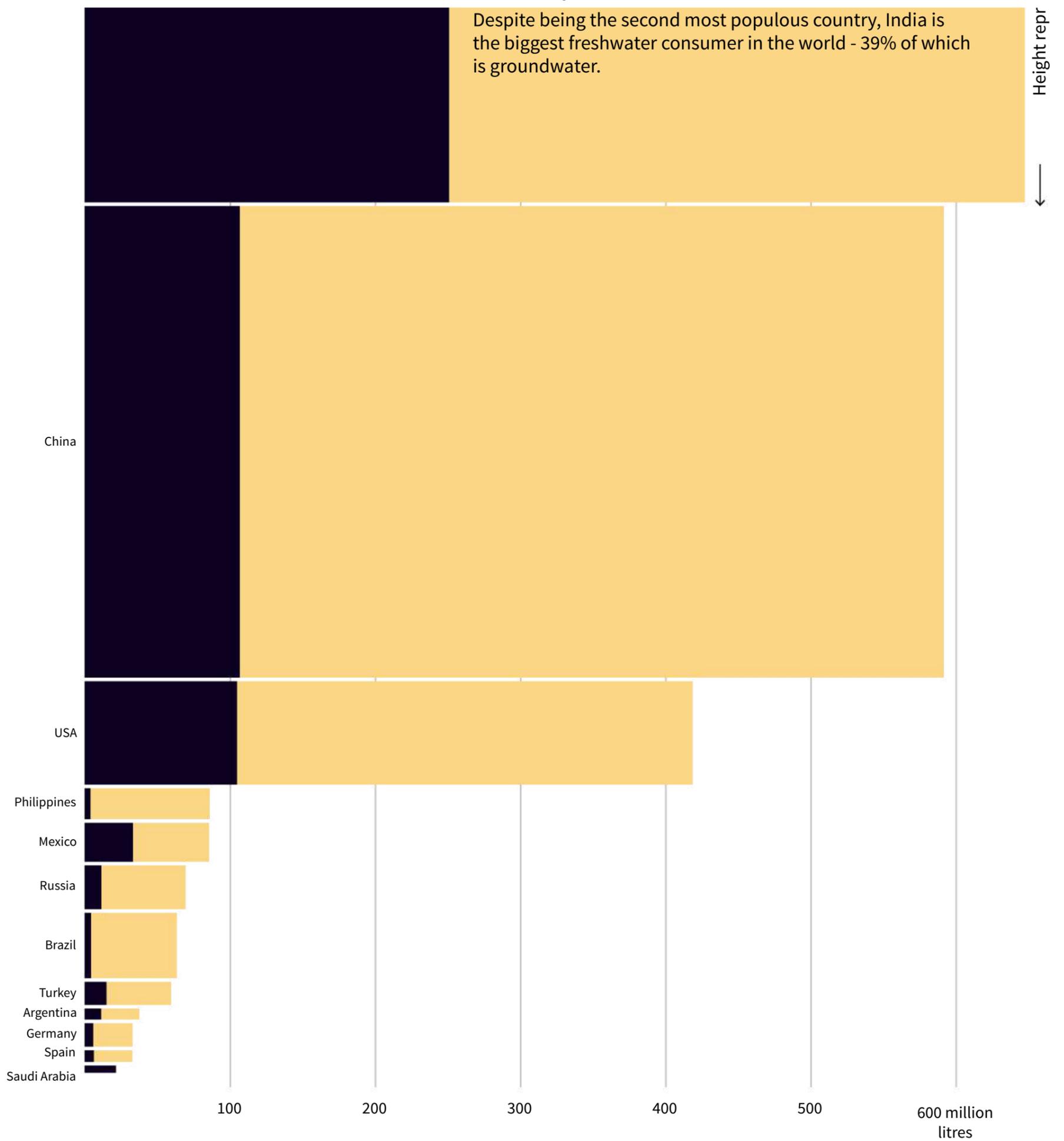
Policy changes have vastly improved the usage in **Andhra Pradesh**

States in the **north-east** with their abundant rainfall and hilly terrain don't use much of their groundwater.

India's groundwater usage exceeds that of China and the United States combined. They, like many other countries, instead depend on surface water for their daily fresh water requirements.

### ANNUAL FRESHWATER WITHDRAWAL BY TYPE AND COUNTRY

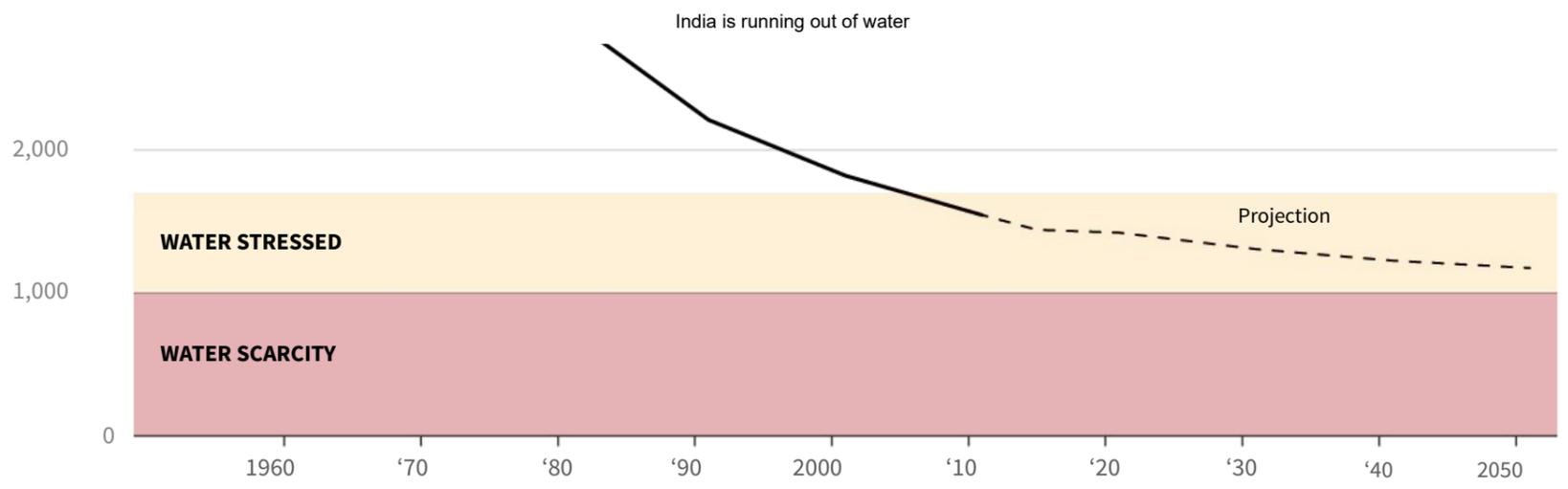




Per capita water availability has fallen to 1,545 cubic metres in 2011 from 5,177 cubic metres in 1950. Less than 1,700 cubic metres water availability is considered a water-stressed condition, whereas below 1,000 cubic metres is considered as a water scarcity condition. Availability in the South Asian country is forecast to drop below 1,300 by 2041.

**PER CAPITA WATER AVAILABILITY IN INDIA (M<sup>3</sup>/YEAR)**



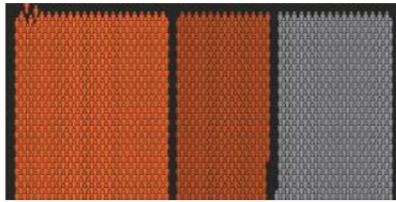


Note: Figures for West Bengal districts are from 2013.

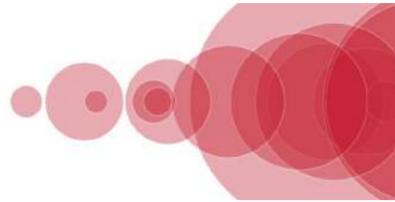
Sources: Central Ground Water Board of India; EnviStats 2018; Census of India (2011); (Rodell M. et al.) Emerging trends in global freshwater availability (2018); AQUASTAT Database (2010-2018), Food and Agriculture Organization of the United Nations.

By Gurman Bhatia. Additional work by Manas Sharma and Simon Scarr. Editing by Rajendra Jadhav. | REUTERS GRAPHICS

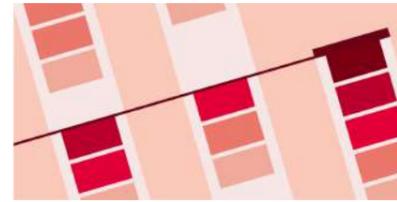
### MORE FROM REUTERS GRAPHICS



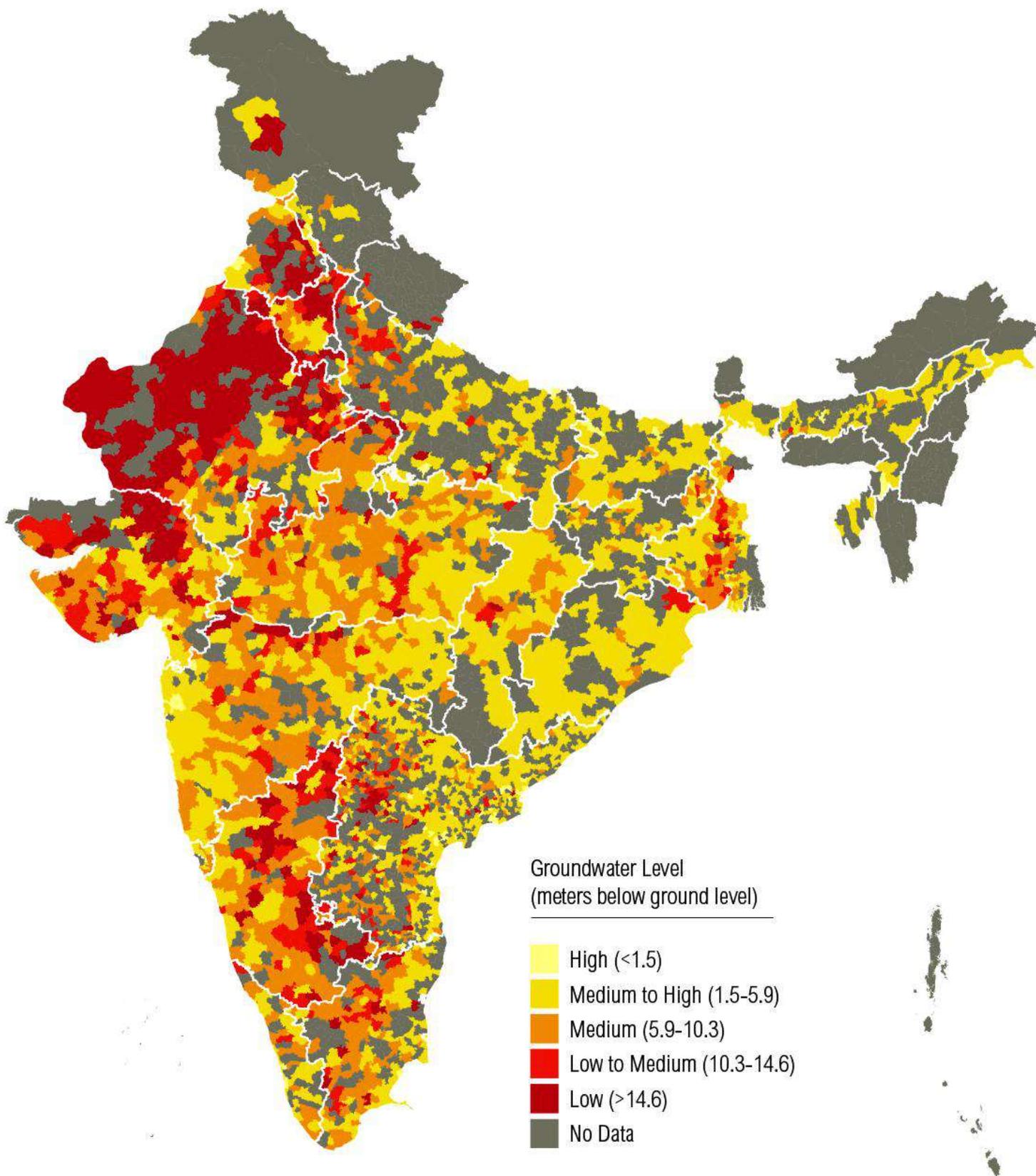
[A deluge of death in northern Italy.](#)

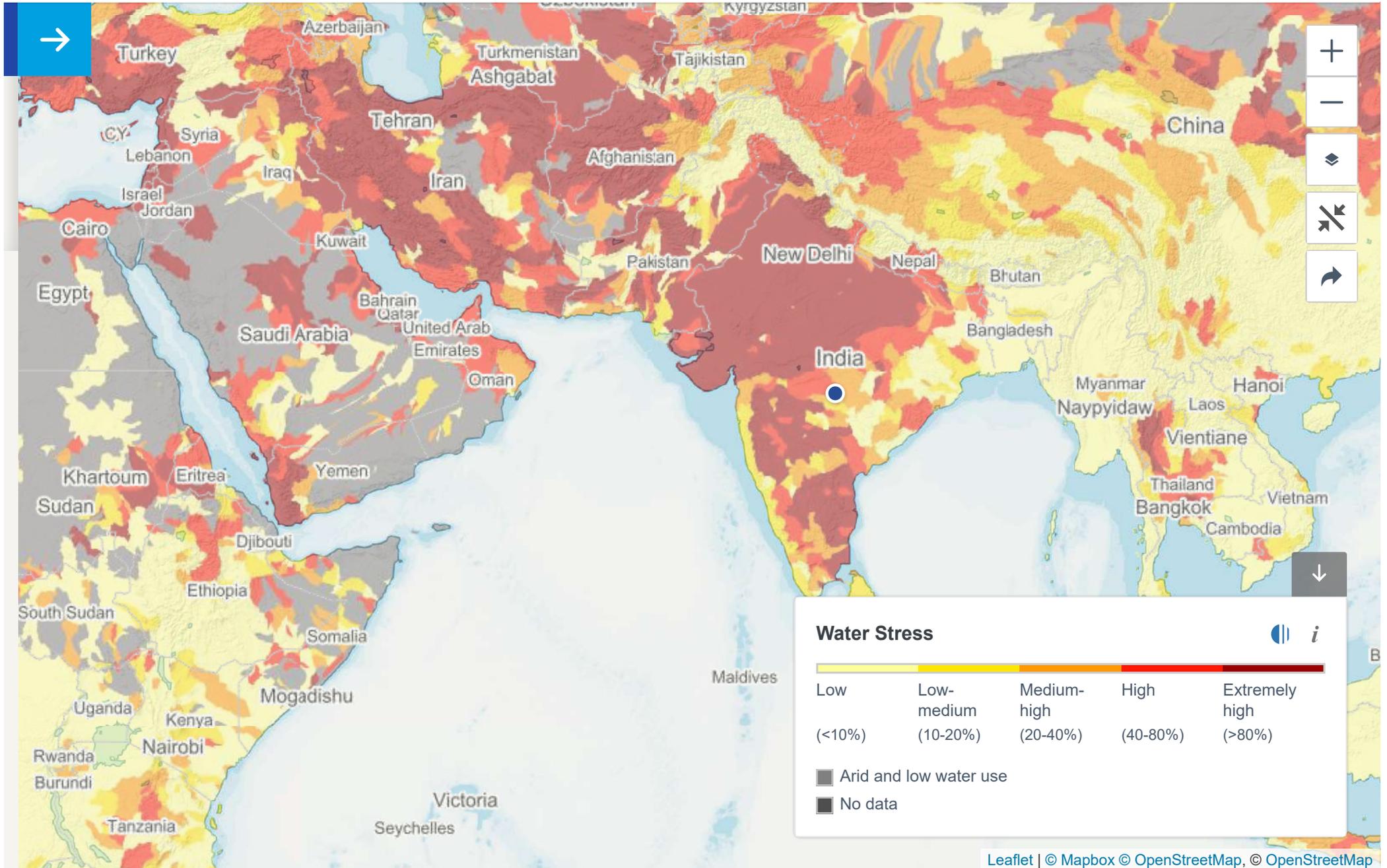


[Coronavirus testing: Which countries are leading?](#)



[State by state, COVID-19 grinds U.S. to a halt](#)





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**Press Information Bureau  
Government of India  
Ministry of Statistics & Programme Implementation**

23 NOV 2019 5:13PM by PIB Delhi

**NSS report no.584: Drinking Water, Sanitation, Hygiene and Housing condition in India, NSS 76th round (July – December 2018)**

1. The National Statistical Office (NSO), Ministry of Statistics and Programme Implementation has conducted a survey on Drinking Water, Sanitation, Hygiene and Housing Condition as a part of 76<sup>th</sup> round of National Sample Survey (NSS). Prior to this, surveys on the same subject were carried out by NSO during 65<sup>th</sup> round (July 2008 - June 2009) and 69<sup>th</sup> round (July - December, 2012).

2. The main objective of the survey was to collect information on facilities of drinking water, sanitation along with housing facilities available to the households and the micro environment surrounding the houses which are important determinants of overall quality of living condition of the people. The important aspects on which the information was collected in the survey are: type of the dwelling unit (viz. independent house, flat etc.), tenurial status of the dwelling unit (viz. owned, hired, no dwelling etc.), structure of the dwelling unit (viz. pucca, semi-pucca, katcha), condition of the structure (viz. good, satisfactory, bad), floor area of the dwelling unit, age of the house owned by the household, facilities available to the households in respect of drinking water, bathroom, latrine etc. and micro environment surrounding the house like drainage system of the house, system of disposal of household waste water, system of disposal of household garbage, problems of flies and mosquitoes etc.

3. The present survey was spread across the country and for the central sample, data were collected from 1,06,838 households (63,736 in rural areas and 43,102 in urban areas) from 5,378 sample villages in rural areas and 3,614 sample UFS blocks in urban areas, following a scientific survey methodology. This report is based on the central sample data collected through the survey on Drinking Water, Sanitation, Hygiene and Housing Condition during NSS 76<sup>th</sup> round. Some important findings of the survey, based on the response of the households, are being presented in the following paragraphs:

### 3.1 Drinking water facility

- a. The major source of drinking water was *hand pump* for the households in the rural areas and *pipied water into dwelling* in the urban areas. About 42.9% of the households in the rural areas used *hand pump* as the principal source of drinking water and about 40.9% of the households in the urban areas used *pipied water into dwelling* as the principal source of drinking water.
- b. About 48.6% of the households in the rural and about 57.5% in the urban areas had exclusive access to principal source of drinking water.
- o (c) About 87.6% of the households in the rural and about 90.9% in the urban areas had sufficient drinking water throughout the year from the principal source.
- d. About 58.2% of the households in the rural and about 80.7% in the urban areas had drinking water facilities within the household premises.
- e. About 94.5% of the households in the rural and about 97.4% in the urban areas used 'improved source of drinking water' viz. bottled water, pipied water into dwelling, pipied water to yard/plot, pipied water from

neighbour, public tap/standpipe, tube well, hand pump, protected well, public tanker truck, private tanker truck, protected spring and rainwater collection.

f. About 51.4% of the households in the rural and about 72.0% in the urban areas used improved source of drinking water, sufficiently available throughout the year located in the premises.

### 3.2 Bathroom and sanitation facility:

- a. About 50.3% of the households in the rural and about 75.0% in the urban areas had exclusive access to bathroom.
- b. About 56.6% of the households in rural and about 91.2% in urban areas had access to bathroom. Among the households which had access to bathroom, about 48.4% in the rural areas and about 74.8% in the urban areas used bathroom attached to the dwelling unit.
- (c) About 71.3% of the households in the rural and about 96.2% in the urban areas had access to latrine. It may be noted that there may be respondent bias in the reporting of access to latrine as question on benefits received by the households from government schemes was asked prior to the question on access of households to latrine.
- d. The major type of latrine used by the households was flush/pour-flush to septic tank in both rural and urban areas. About 50.9% of the households in rural and 48.9% in urban areas used flush/pour-flush to septic tank type of latrine.
- e. Among the households which had access to latrine, about 94.7% of the males and 95.7% of the females in the rural areas used latrine regularly while about 98.0% of the males and 98.1% of the females in the urban areas used latrine regularly.
- f. Among the households which had access to latrine, about 93.8% of the males and 94.6% of the females in the rural areas regularly used *Improved Latrine* while about 97.2% of both males and females in the urban areas regularly used *Improved Latrine*. The latrine of any of the types (i) flush/pour-flush to piped sewer system, (ii) flush/pour-flush to septic tank, (iii) flush/pour-flush to twin leach pit, (iv) flush/pour-flush to single pit, (v) ventilated improved pit latrine, (vi) pit latrine with slab and (vii) composting latrine was considered as *Improved Latrine*.
- g. Among the households which had access to latrine, about 85.8% of the males and 86.4% of the females in the rural areas regularly used *Improved Latrine* which was for exclusive use of the household while the corresponding figure was about 82.4% for males and 84.7% for females in the urban areas.
- h. Among the households which had access to latrine, about 3.5% of the household members in the rural areas and about 1.7% of the household members in the urban areas never used latrine.
- a. Among the households using latrine, about 4.5% of the households in the rural areas and about 2.1% of the households in the urban areas reported that water was not available in or around the latrine used.
- j. About 48.0% of the households in the rural areas and about 86.1% of the households in the urban areas had bathroom and latrine both within household premises.

### 3.3 Tenurial status and household characteristics:

- a. About 96.0% of the households in the rural and about 63.8% in the urban areas had their own dwelling unit.
- b. Among the households living in houses (i.e. households with dwelling units), about 96.7% of the households in the rural and about 91.5% in the urban areas used the house for residential purpose only.
- (c) Among the households living in houses, about 89.0% of the households in the rural and about 56.4% in the urban areas had independent house.

- d. Among the households living in houses, about 76.7% of the households in the rural and about 96.0% in the urban areas had the house of pucca structure.
- e. Among the households living in houses, average floor area of the dwelling unit was about 46.6 sq. m. in the rural and about 46.1 sq. m. in the urban areas.

### 3.4 Electricity for domestic use:

- a. Among the households living in houses, about 93.9% of the households in the rural and about 99.1% in the urban areas had electricity for domestic use.

### 3.5 Micro environment:

- a. Among the households living in houses, about 48.3% of the households in the rural and about 86.6% in the urban areas used LPG as fuel for cooking.
- b. Among the households living in houses, about 61.1% of the households in the rural and about 92.0% in the urban areas had drainage system in the house for disposal of waste water/liquid waste.
- c. Among the households living in houses, about 48.1% of the households in the rural areas disposed off household waste water without treatment to open low land areas/streets. In the urban areas, about 71.1% of the households disposed off household waste water without treatment to drainage system.
- d. Among the households living in houses, about 72.4% of the households in the rural areas disposed off household garbage either in household's individual dumping spot or in a common place other than community dumping spot. In the urban areas, about 70.3% of the households disposed off household garbage either in community dumping spot or in a common place other than community dumping spot.
- e. Among the households living in houses, about 80.4% of the households in the rural areas had no arrangement for collection of household garbage. In the urban areas, panchayat/municipality/corporation made arrangement for collection of household garbage for about 74.1% of the households.
- f. Among the households living in houses, about 87.1% of the households in the rural and about 95.7% in the urban areas had the house with direct opening to approach road/lane/constructed path.

4. The report on “**Drinking Water, Sanitation, Hygiene and Housing Condition**” and unit level data are both available on [www.mospi.gov.in](http://www.mospi.gov.in).

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VRRK/VJ/NK



# General Assembly

Distr.: General  
3 August 2010

Sixty-fourth session  
Agenda item 48

## Resolution adopted by the General Assembly on 28 July 2010

[without reference to a Main Committee (A/64/L.63/Rev.1 and Add.1)]

### 64/292. The human right to water and sanitation

*The General Assembly,*

*Recalling* its resolutions 54/175 of 17 December 1999 on the right to development, 55/196 of 20 December 2000, by which it proclaimed 2003 the International Year of Freshwater, 58/217 of 23 December 2003, by which it proclaimed the International Decade for Action, “Water for Life”, 2005–2015, 59/228 of 22 December 2004, 61/192 of 20 December 2006, by which it proclaimed 2008 the International Year of Sanitation, and 64/198 of 21 December 2009 regarding the midterm comprehensive review of the implementation of the International Decade for Action, “Water for Life”; Agenda 21 of June 1992;<sup>1</sup> the Habitat Agenda of 1996;<sup>2</sup> the Mar del Plata Action Plan of 1977 adopted by the United Nations Water Conference;<sup>3</sup> and the Rio Declaration on Environment and Development of June 1992,<sup>4</sup>

*Recalling also* the Universal Declaration of Human Rights,<sup>5</sup> the International Covenant on Economic, Social and Cultural Rights,<sup>6</sup> the International Covenant on Civil and Political Rights,<sup>6</sup> the International Convention on the Elimination of All Forms of Racial Discrimination,<sup>7</sup> the Convention on the Elimination of All Forms of Discrimination against Women,<sup>8</sup> the Convention on the Rights of the Child,<sup>9</sup> the

<sup>1</sup> *Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3–14 June 1992*, vol. I, *Resolutions Adopted by the Conference* (United Nations publication, Sales No. E.93.I.8 and corrigendum), resolution 1, annex II.

<sup>2</sup> *Report of the United Nations Conference on Human Settlements (Habitat II), Istanbul, 3–14 June 1996* (United Nations publication, Sales No. E.97.IV.6), chap. I, resolution 1, annex II.

<sup>3</sup> *Report of the United Nations Water Conference, Mar del Plata, 14–25 March 1977* (United Nations publication, Sales No. E.77.II.A.12), chap. I.

<sup>4</sup> *Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3–14 June 1992*, vol. I, *Resolutions Adopted by the Conference* (United Nations publication, Sales No. E.93.I.8 and corrigendum), resolution 1, annex I.

<sup>5</sup> Resolution 217 A (III).

<sup>6</sup> See resolution 2200 A (XXI), annex.

<sup>7</sup> United Nations, *Treaty Series*, vol. 660, No. 9464.

<sup>8</sup> *Ibid.*, vol. 1249, No. 20378.

<sup>9</sup> *Ibid.*, vol. 1577, No. 27531.



Convention on the Rights of Persons with Disabilities<sup>10</sup> and the Geneva Convention relative to the Protection of Civilian Persons in Time of War, of 12 August 1949,<sup>11</sup>

*Recalling further* all previous resolutions of the Human Rights Council on human rights and access to safe drinking water and sanitation, including Council resolutions 7/22 of 28 March 2008<sup>12</sup> and 12/8 of 1 October 2009,<sup>13</sup> related to the human right to safe and clean drinking water and sanitation, general comment No. 15 (2002) of the Committee on Economic, Social and Cultural Rights, on the right to water (articles 11 and 12 of the International Covenant on Economic, Social and Cultural Rights)<sup>14</sup> and the report of the United Nations High Commissioner for Human Rights on the scope and content of the relevant human rights obligations related to equitable access to safe drinking water and sanitation under international human rights instruments,<sup>15</sup> as well as the report of the independent expert on the issue of human rights obligations related to access to safe drinking water and sanitation,<sup>16</sup>

*Deeply concerned* that approximately 884 million people lack access to safe drinking water and that more than 2.6 billion do not have access to basic sanitation, and alarmed that approximately 1.5 million children under 5 years of age die and 443 million school days are lost each year as a result of water- and sanitation-related diseases,

*Acknowledging* the importance of equitable access to safe and clean drinking water and sanitation as an integral component of the realization of all human rights,

*Reaffirming* the responsibility of States for the promotion and protection of all human rights, which are universal, indivisible, interdependent and interrelated, and must be treated globally, in a fair and equal manner, on the same footing and with the same emphasis,

*Bearing in mind* the commitment made by the international community to fully achieve the Millennium Development Goals, and stressing, in that context, the resolve of Heads of State and Government, as expressed in the United Nations Millennium Declaration,<sup>17</sup> to halve, by 2015, the proportion of people who are unable to reach or afford safe drinking water and, as agreed in the Plan of Implementation of the World Summit on Sustainable Development (“Johannesburg Plan of Implementation”),<sup>18</sup> to halve the proportion of people without access to basic sanitation,

1. *Recognizes* the right to safe and clean drinking water and sanitation as a human right that is essential for the full enjoyment of life and all human rights;

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<sup>10</sup> Resolution 61/106, annex I.

<sup>11</sup> United Nations, *Treaty Series*, vol. 75, No. 973.

<sup>12</sup> See *Official Records of the General Assembly, Sixty-third Session, Supplement No. 53 (A/63/53)*, chap. II.

<sup>13</sup> See A/HRC/12/50 and Corr.1, part one, chap. I.

<sup>14</sup> See *Official Records of the Economic and Social Council, 2003, Supplement No. 2 (E/2003/22)*, annex IV.

<sup>15</sup> A/HRC/6/3.

<sup>16</sup> A/HRC/12/24.

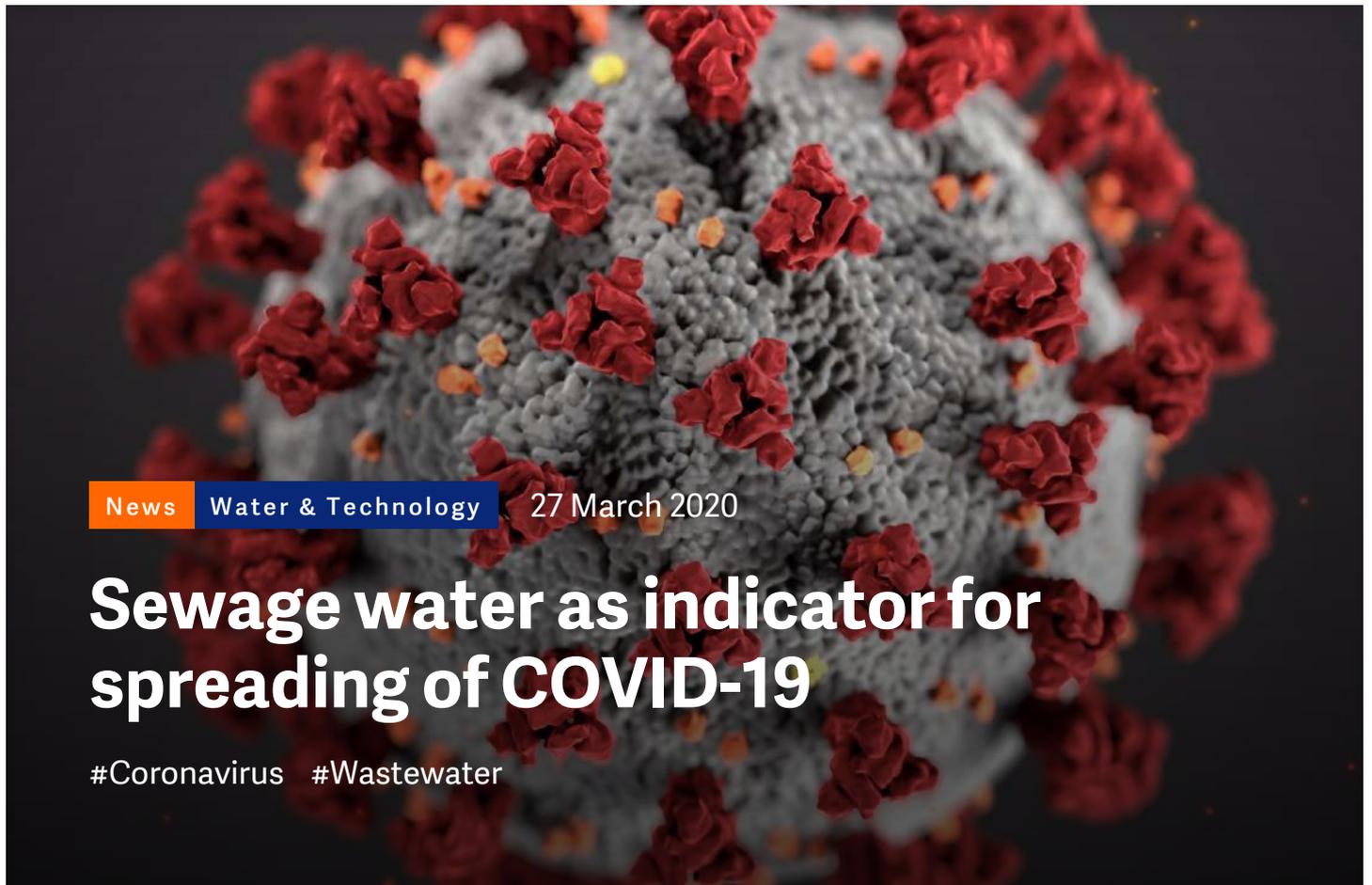
<sup>17</sup> See resolution 55/2.

<sup>18</sup> See *Report of the World Summit on Sustainable Development, Johannesburg, South Africa, 26 August–4 September 2002* (United Nations publication, Sales No. E.03.II.A.1 and corrigendum), chap. I, resolution 2, annex.

2. *Calls upon* States and international organizations to provide financial resources, capacity-building and technology transfer, through international assistance and cooperation, in particular to developing countries, in order to scale up efforts to provide safe, clean, accessible and affordable drinking water and sanitation for all;

3. *Welcomes* the decision by the Human Rights Council to request that the independent expert on human rights obligations related to access to safe drinking water and sanitation submit an annual report to the General Assembly,<sup>13</sup> and encourages her to continue working on all aspects of her mandate and, in consultation with all relevant United Nations agencies, funds and programmes, to include in her report to the Assembly, at its sixty-sixth session, the principal challenges related to the realization of the human right to safe and clean drinking water and sanitation and their impact on the achievement of the Millennium Development Goals.

*108th plenary meeting  
28 July 2010*



News

Water &amp; Technology

27 March 2020

# Sewage water as indicator for spreading of COVID-19

#Coronavirus #Wastewater

Photo by CDC on Unsplash

Microbiologists at research institute KWR conducted a series of RNA-analyses at municipal waste water treatment plants (WWTP) in the Netherlands. The analyses showed the presence of RNA gene fragments of the COVID-19 virus in the influent water.

According to KWR the screening of the COVID-19 virus at municipal waste water plants can be used to signal new outbreaks in advance and play an important role to follow the evolution of the pandemic.

Gene fragments of COVID-19 detected at Dutch WWTP.

## Additional research

RNA-analysis is a method to measure the presence of viruses through capturing virus particles and detect specific gene fragments. The method does not discriminate between inactive and infectious particles. The KWR microbiologists say they have not yet been able to quantify the presence of these fragments. Their first findings indicate that the concentration of the virus at the WWTP is low.

Currently researchers are examining all samples multiple times and are looking at the reproducibility of the results. Furthermore, they double check and focus on fragments of multiple genes, to strengthen their results about the presence of the virus.

KWR employees taking samples of sewage water as part of a European study to determine the presence of cocaine and party drugs. (photo: KWR)

## No real surprise

The detection of COVID-19 in the sewage water at the Dutch WWTP does not really come as a surprise. Sewage water contains many viruses and the detection of the new coronavirus from human faeces was to be expected.

Study results released by Chinese microbiologists in 2005 showed that SARS-CoV RNA had been detected in the sewage water of Chinese hospitals where SARS-patients were treated.

## Early warning of new outbreaks

KWR suggests the use of the RNA-analyses of sewage water as a tool to measure the virus circulation in cities or smaller municipalities. The concentration level of the virus can be an indicator for the number of virus infections in the population and can signal in advance a new outbreak, for instance when a lock down is lifted.

Similarly, these analyses can help monitor the effect of measures put in place to mitigate the spreading of the pandemic, according to KWR.

On Monday 30 March, KWR will broadcast a webinar titled: COVID-19: Significance and impact of the pandemic for the water sector. Two professors, Rosina Girones, Research Group Leader at the University of Barcelona, and Gertjan Medema, Principle Microbiologist at KWR, will discuss the new findings during this webinar.

Afterwards, a recorded version of the webinar will be published on the [KWR-website](#) and [Watershare website](#).

This news item was originally published on the website of [KWR Water](#)

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## Prolonged presence of SARS-CoV-2 viral RNA in faecal samples

We present severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) real-time RT-PCR results of all respiratory and faecal samples from patients with coronavirus disease 2019 (COVID-19) at the Fifth Affiliated Hospital of Sun Yat-sen University, Zhuhai, China, throughout the course of their illness and obligated quarantine period. Real-time RT-PCR was used to detect COVID-19 following the recommended protocol (appendix p 1). Patients with suspected SARS-CoV-2 were confirmed after two sequential positive respiratory tract sample results. Respiratory and faecal samples were collected every 1–2 days (depending on the availability of faecal samples) until two sequential negative results were obtained. We reviewed patients' demographic information, underlying diseases, clinical indices, and treatments from their official medical records. The study

was approved by the Medical Ethical Committee of The Fifth Affiliated Hospital of Sun Yat-sen University (approval number K162-1) and informed consent was obtained from participants. Notably, patients who met discharge criteria were allowed to stay in hospital for extended observation and health care.

Between Jan 16 and March 15, 2020, we enrolled 98 patients. Both respiratory and faecal samples were collected from 74 (76%) patients. Faecal samples from 33 (45%) of 74 patients were negative for SARS-CoV-2 RNA, while their respiratory swabs remained positive for a mean of 15.4 days (SD 6.7) from first symptom onset. Of the 41 (55%) of 74 patients with faecal samples that were positive for SARS-CoV-2 RNA, respiratory samples remained positive for SARS-CoV-2 RNA for a mean of 16.7 days (SD 6.7) and faecal samples remained positive for a mean of 27.9 days (10.7) after first symptom onset (ie, for a mean of 11.2 days [9.2] longer than for respiratory samples). The full disease course of the 41 patients with faecal

samples that were positive for SARS-CoV-2 RNA is shown in the figure. Notably, patient 1 had positive faecal samples for 33 days continuously after the respiratory samples became negative, and patient 4 tested positive for SARS-CoV-2 RNA in their faecal sample for 47 days after first symptom onset (appendix pp 4–5).

A summary of clinical symptoms and medical treatments is shown in the appendix (pp 2–3, 6–8). The presence of gastrointestinal symptoms was not associated with faecal sample viral RNA positivity ( $p=0.45$ ); disease severity was not associated with extended duration of faecal sample viral RNA positivity ( $p=0.60$ ); however, antiviral treatment was positively associated with the presence of viral RNA in faecal samples ( $p=0.025$ ; appendix pp 2–3). These associations should be interpreted with caution because of the possibility of confounding. Additionally, the Ct values of all three targeted genes (*RdRp*, *N*, *E*) in the first faecal sample that was positive for viral RNA were negatively associated with the duration of faecal viral RNA positivity (*RdRp* gene  $r=-0.34$ ; *N* gene



Lancet Gastroenterol Hepatol  
2020

Published Online  
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See Online for appendix

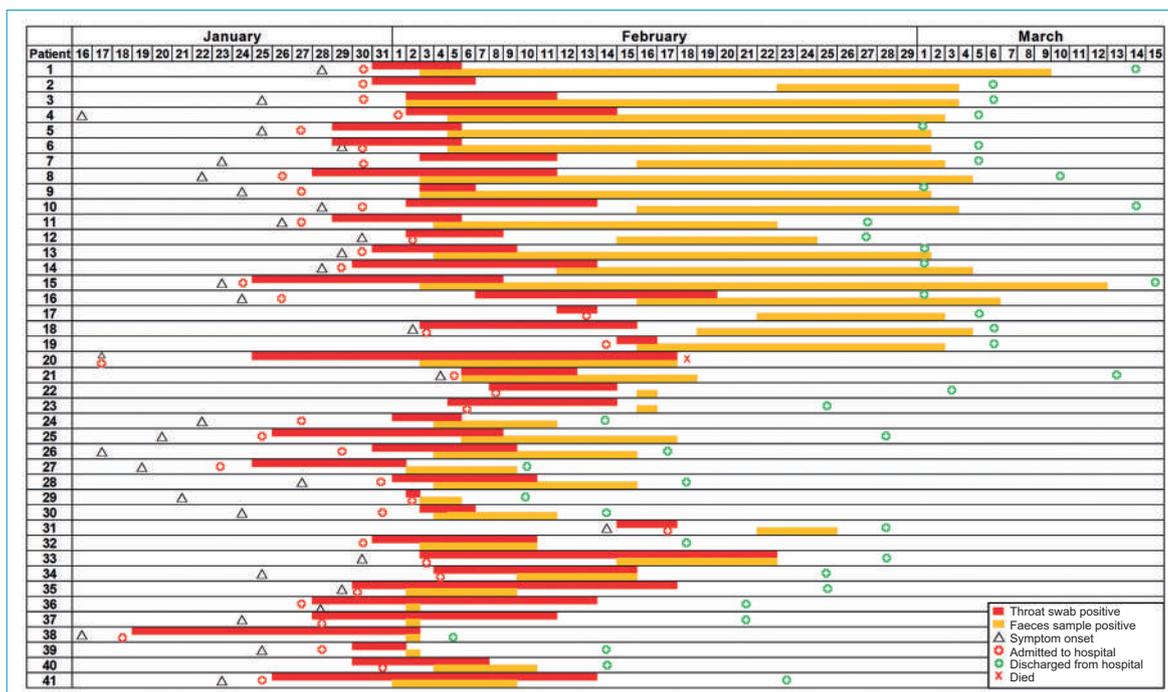


Figure: Timeline of results from throat swabs and faecal samples through the course of disease for 41 patients with SARS-CoV-2 RNA positive faecal samples, January to March, 2020

$r = -0.02$ ; and  $E$  gene  $r = -0.16$ ), whereas the correlation of the  $C_t$  values with duration of faecal sample positivity was only significant for  $RdRp$  ( $p = 0.033$ ;  $N$  gene  $p = 0.91$ ;  $E$  gene  $p = 0.33$ ).

Our data suggest the possibility of extended duration of viral shedding in faeces, for nearly 5 weeks after the patients' respiratory samples tested negative for SARS-CoV-2 RNA. Although knowledge about the viability of SARS-CoV-2 is limited,<sup>1</sup> the virus could remain viable in the environment for days, which could lead to faecal-oral transmission, as seen with severe acute respiratory virus CoV and Middle East respiratory syndrome CoV.<sup>2</sup> Therefore, routine stool sample testing with real-time RT-PCR is highly recommended after the clearance of viral RNA in a patient's respiratory samples. Strict precautions to prevent transmission should be taken for patients who are in hospital or self-quarantined if their faecal samples test positive.

As with any new infectious disease, case definition evolves rapidly as knowledge of the disease accrues. Our data suggest that faecal sample positivity for SARS-CoV-2 RNA normally lags behind that of respiratory tract samples; therefore, we do not suggest the addition of testing of faecal samples to the existing diagnostic procedures for COVID-19. However, the decision on when to discontinue precautions to prevent transmission in patients who have recovered from COVID-19 is crucial for management of medical resources. We would suggest the addition of faecal testing for SARS-CoV-2.<sup>3</sup> Presently, the decision to discharge a patient is made if they show no relevant

symptoms and at least two sequential negative results by real-time RT-PCR of sputum or respiratory tract samples collected more than 24 h apart. Here, we observed that for over half of patients, their faecal samples remained positive for SARS-CoV-2 RNA for a mean of 11.2 days after respiratory tract samples became negative for SARS-CoV-2 RNA, implying that the virus is actively replicating in the patient's gastrointestinal tract and that faecal-oral transmission could occur after viral clearance in the respiratory tract.

Determining whether a virus is viable using nucleic acid detection is difficult; further research using fresh stool samples at later timepoints in patients with extended duration of faecal sample positivity is required to define transmission potential. Additionally, we found patients normally had no or very mild symptoms after respiratory tract sample results became negative (data not shown); however, asymptomatic transmission has been reported.<sup>4</sup> No cases of transmission via the faecal-oral route have yet been reported for SARS-CoV-2, which might suggest that infection via this route is unlikely in quarantine facilities, in hospital, or while under self-isolation. However, potential faecal-oral transmission might pose an increased risk in contained living premises such as hostels, dormitories, trains, buses, and cruise ships.

Respiratory transmission is still the primary route for SARS-CoV-2 and evidence is not yet sufficient to develop practical measures for the group of patients with negative respiratory tract sample results but positive faecal samples. Further research into the

viability and infectivity of SARS-CoV-2 in faeces is required.

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Yongjian Wu, Cheng Guo, Lantian Tang, Zhongsi Hong, Jianhui Zhou, Xin Dong, Huan Yin, Qiang Xiao, Yanping Tang, Xiujuan Qu, Liangjian Kuang, Xiaomin Fang, Nischay Mishra, Jiahai Lu, Hong Shan, Guanmin Jiang, Xi Huang  
[huangxi1312@163.com](mailto:huangxi1312@163.com)

Center for Infection and Immunity, Fifth Affiliated Hospital, Sun Yat-sen University, Zhuhai, Guangdong Province, 519000, China (YW, LT, ZH, JZ, XD, HY, QX, YT, XQ, LK, XF, GJ, XH); Center for Infection and Immunity, Mailman School of Public Health, Columbia University, New York, NY, USA (CG, NM); School of Public Health, Sun Yat-sen University, Guangzhou, Guangdong Province, China (JL); and Guangdong Provincial Engineering Research Center of Molecular Imaging, Guangdong Provincial Key Laboratory of Biomedical Imaging, and Department of Interventional Medicine, Fifth Affiliated Hospital, Sun Yat-sen University, Zhuhai, Guangdong Province, China (HS)

- Goh GK-M, Dunker AK, Foster JA, Uversky VN. Rigidity of the outer shell predicted by a protein intrinsic disorder model sheds light on the COVID-19 (Wuhan-2019-nCoV) infectivity. *Biomolecules* 2020; **10**: e331.
- Yeo C, Kaushal S, Yeo D. Enteric involvement of coronaviruses: is faecal-oral transmission of SARS-CoV-2 possible? *Lancet Gastroenterol Hepatol* 2020; published online Feb 19. [https://doi.org/10.1016/S2468-1253\(20\)30048-0](https://doi.org/10.1016/S2468-1253(20)30048-0).
- Munster VJ, Koopmans M, van Doremalen N, van Riel D, de Wit E. A novel coronavirus emerging in China - key questions for impact assessment. *N Engl J Med* 2020; **382**: 692-94.
- Bai Y, Yao L, Wei T, et al. Presumed asymptomatic carrier transmission of COVID-19. *JAMA* 2020; published online Feb 21. DOI:10.1001/jama.2020.2565.

ITEM NO.21

SECTION PIL-W

S U P R E M E C O U R T O F I N D I A  
R E C O R D O F P R O C E E D I N G S

WRIT PETITION (CIVIL) Diary No(s). 10808/2020

ROHIT SAMHOTRA & ANR.

Petitioner(s)

VERSUS

UNION OF INDIA & ORS.

Respondent(s)

Date : 03-04-2020 This petition was called on for hearing today.

CORAM :

HON'BLE MR. JUSTICE L. NAGESWARA RAO  
HON'BLE MR. JUSTICE DEEPAK GUPTA

For Petitioner(s) Petitioner-in-person

For Respondent(s) Mr. Tushar Mehta, SG

UPON hearing the counsel the Court made the following  
O R D E R

The Court convened through Video Conferencing.

This Writ Petition may be treated as a representation to the Union of India. A copy of this Writ Petition be sent to the Respondents. Suitable action may be taken by the Respondents regarding the suggestions made by the Petitioners.

Writ Petition is disposed of with the above directions.

Pending application(s), if any, shall also stand disposed of.

Signature Not Verified

  
Digitally signed by  
GEETA AHUJA  
Date: 2020.04.03  
20:50:15  
Reason: I am the  
COURT MASTER (SH)

(ANAND PRAKASH)  
BRANCH OFFICER