Water Classroom 1-2 (version 2)

Where does my water come from?

Teaching plan for learning on water for middle school students

Under a project initiated by the Living Waters Museum, Centre for Water Research, IISER Pune and Research and supported by Transforming Education for Sustainable Futures, IIHS, Bangalore

1-2-1 Proposed plan

Lesson Plan number	WC-1-2
Topic	Where does my water come from?
Discipline	Geography, History, Civics
Time	60 minutes (can be divided into multiple sessions)
Prior learning	Print and give students the map of Pune and its topology *Refer to – Background content for facilitator/educator – section 1-2-2c*
Learning objectives	● Students *examine* different sources of water on the planet and *discover* the important water sources for their city ● Students *examine* their domestic water supply in the context of Pune city, from a geographical perspective ● Students *construct* and *present* their ideas about the path of water flow from various sources to their homes in front of an audience
Learning outcomes	1. Students are able to *identify* global and local sources of potable water

	2. Students are able to *illustrate* the flow of water from rain to different surface water bodies and groundwater 3. Students are able to *illustrate* a plausible path for the water supplied at their home from any source, *listing out* the important institutions and actors responsible for the supply.
Resources/materials	Drawing sheets, crayons/pencils/pens
Use of teaching time	**5-10 min** - Educator will discuss with students- --The sources of potable water on Earth and the sources of freshwater *Refer to – Background content for facilitator/educator – sections 1-2-2a-b.* --Does groundwater flow? --Does groundwater form a part of the water cycle? **10-15 min -** The educator will discuss how in Pune rainwater becomes the source of all kinds of water systems by showing this 2 min video- Start at 20 sec - play at speed 1.25X https://www.youtube.com/watch?v=w_YfL9mYb8Q&list=PL_Fnbk2-zebmJpEd2rkK9BOQrxrTbRkv-&index=4&t=3s **10-15 min -** Conduct activity - WC-1-2-Activity-I In this activity, each student will draw and trace the journey of water

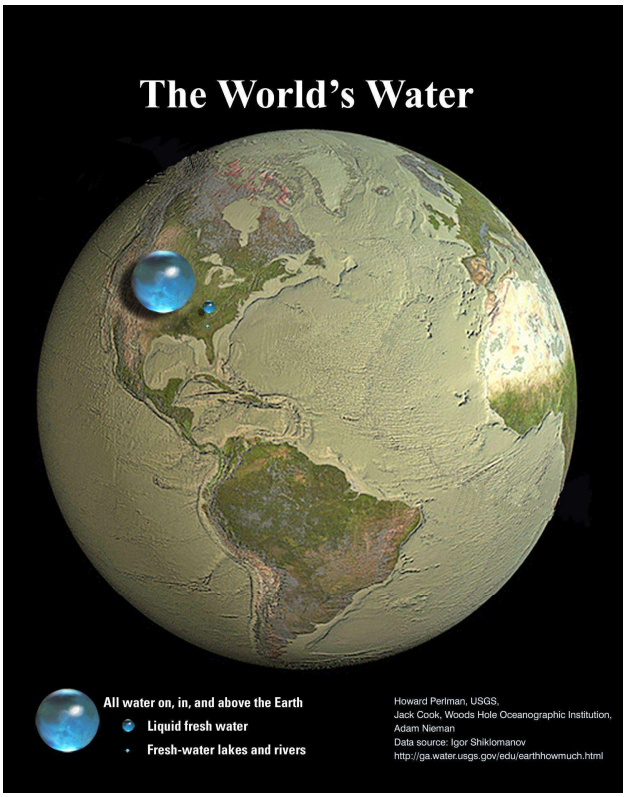
	from the rains to their homes. **10-15 min -** Selected students can display their drawings and discuss how they map the process of rainwater reaching Earth's surface, becoming surface runoff, becoming groundwater, and eventually reaching the taps in their homes. **5 min -** Optional The educator can introduce the students to the historical perspective of Pune's water system and distribute the additional reading/reference materials as homework readings. *Refer to – Background content for facilitator/educator – sections 1-2-3.*
Differentiation	WC-1-2-Activity-II could be used if students need to be challenged more. In this case the additional reading material should be handed out earlier. One can bring in aspects of water quality (not discussed here).
Additional activities	If the educator wishes to understand the effectiveness of the session and the extent of student understanding, they can conduct WC-1-2-Activity-I (trace the journey of water from the rains to one's home) in the beginning and repeat it at the end of the class. Students may explain how the before and after drawings they have made are different from each other, and what they learnt in the

	process. *Refer to – Background content for facilitator/educator – sections 1-2-2d.* WC-1-2-Activity- II (optional) Historical perspective can be shared as a homework sheet and educator and assess students on it separately. In the assessment – Students will list out some of the historical water supply structures/systems in Pune and the reasons for their construction as well as decline. This will need additional time.
Anticipated challenges and solutions	Students might ask probing questions about damaged pipelines, damaged aquifers due to mountain cutting and the topic might deviate towards government roles and responsibilities. This will be taken up in the topic - Who manages our waters? Students may not be clear about snow-fed and rain-fed rivers and which one is responsible for water reaching their cities and homes.
Keywords	Potable water, topology, Sahayadris, mountains, rivers, springs, surface water, groundwater, water cycle

1-2-2 Background content for facilitator/educator

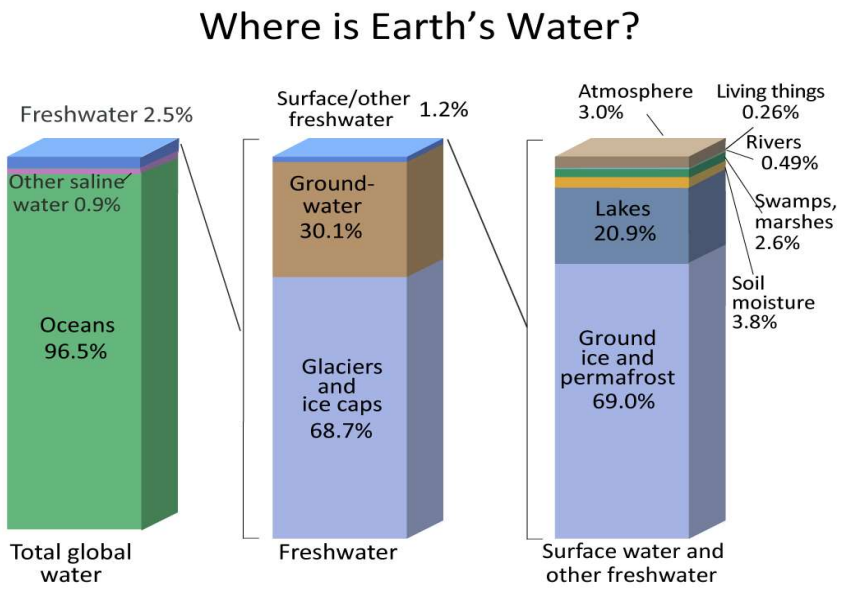
1-2-2a Sources of potable water on Earth

Water is present in many locations on Planet Earth, but not all water is potable. While the waters in our oceans sustain life, they cannot be directly used by humans and other animals who depend on freshwater.



Distribution of water.

Reference - https://www.usgs.gov/media/images/all-earths-water-a-single-sphere



Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources. (Numbers are rounded).

Reference: NCERT

1-2-2b Sources of freshwater

While there are several sources of freshwater, still not all of them are easily accessible. Freshwater can be present either as surface water or groundwater as explained below:

1. Surface water
    a. Directly accessible - This is water collected on Earth's surface in lakes, rivers, ponds, streams, reservoirs, etc.

Surface water as rivers (photo credit: Gayatri Kshirsagar).

    b. Not directly accessible - glaciers, icecaps, living things, swamps, marshes, atmosphere, soil moisture

Surface water as glaciers and ice caps (photo credit: Chhavi Mathur)

2. Groundwater - Groundwater is the water that soaks into the ground. The water moves down because of gravity, passing between particles of soil, sand, gravel, and rock until it reaches a depth where the ground is saturated with water. Water from underground is groundwater and is accessed through wells, handpumps, borewells, etc.

Groundwater (photo credit:Tushar Sarode/LWM).

Video by Tushar Sarode can be accessed at:
https://punyachepaani.livingwatersmuseum.org/story/pune-paradox/

How does groundwater become a part of surface water? What is a spring?

Groundwater can be exposed through human activities such as digging wells and borewells. Naturally, groundwater comes to the surface as springs. A spring is where water emerges from the ground, sometimes as just a trickle, maybe only after a rain, and sometimes in a continuous flow, in a place where water moving underground finds an opening to the land surface and rises up.
https://www.usgs.gov/special-topics/water-science-school/science/springs-and-water-cycle

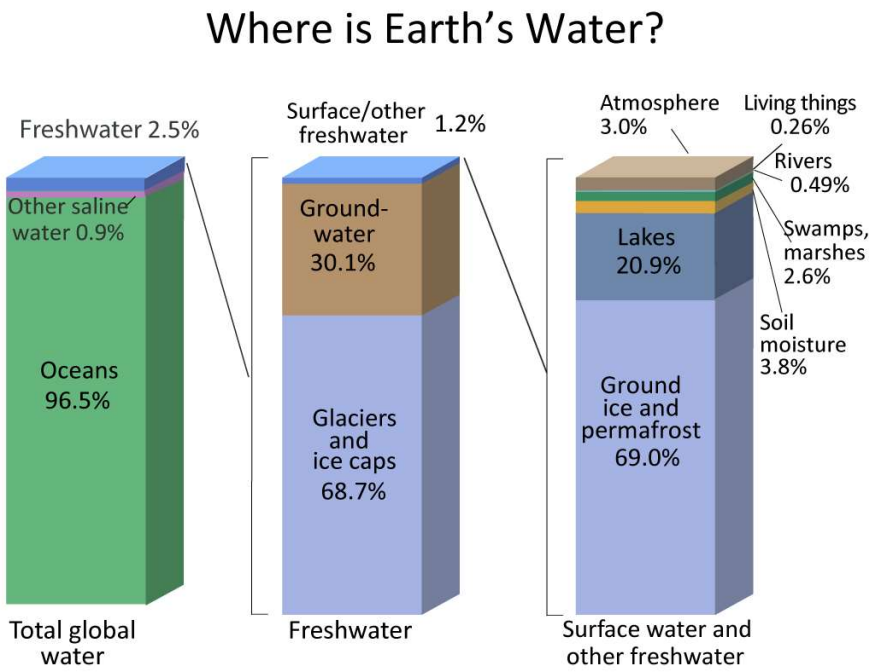
Springs can be found at the ghats of Vitthal mandir and Omkareshwar ghat along Mutha river in Pune. (Photo credit: Akshay Shete/LWM)

Video about a spring in Pune: Save Bavdhan Spring - https://www.youtube.com/watch?v=6X3MHrN6NPk

Video about surface water and groundwater in Pune – https://www.youtube.com/watch?v=w_YfL9mYb8Q&list=PL_Fnbk2-zebmJpEd2rkK9BOQrxrTbRkv-&index=4
(Video by Prajakta Divekar and Rahul Iyer (Science Media Centre, IISER Pune)

3. Water in the atmosphere forms clouds and rain/precipitation which return to us as surface water and groundwater. This will be discussed in more detail under the water cycle when we discuss Water and Climate.

1-2-2c Water on Earth and in my city



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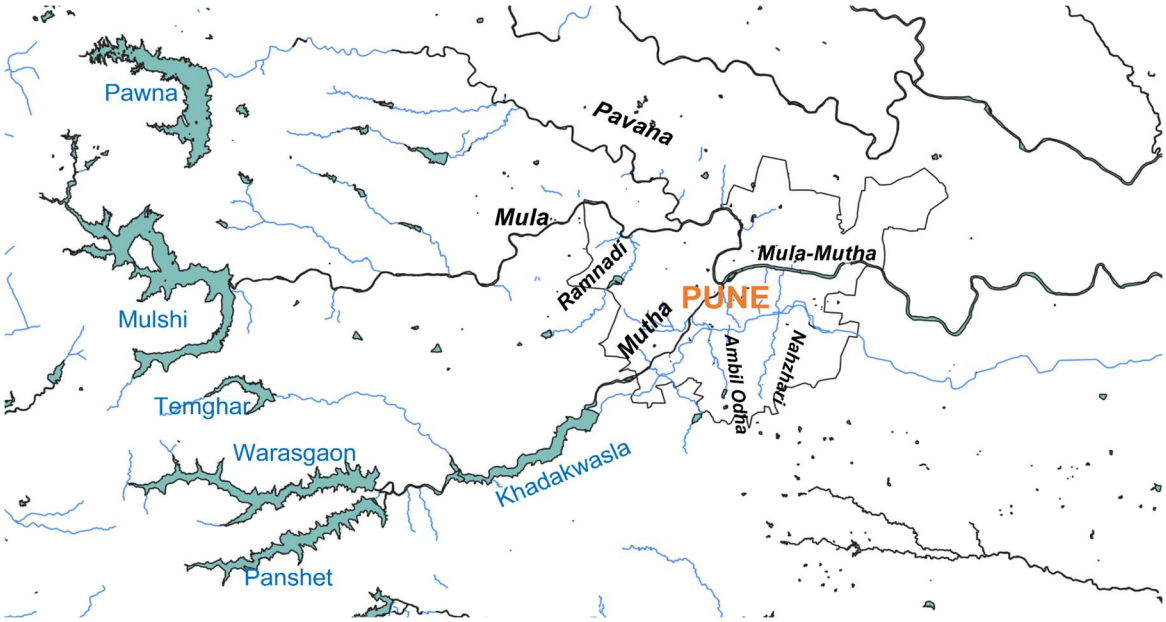
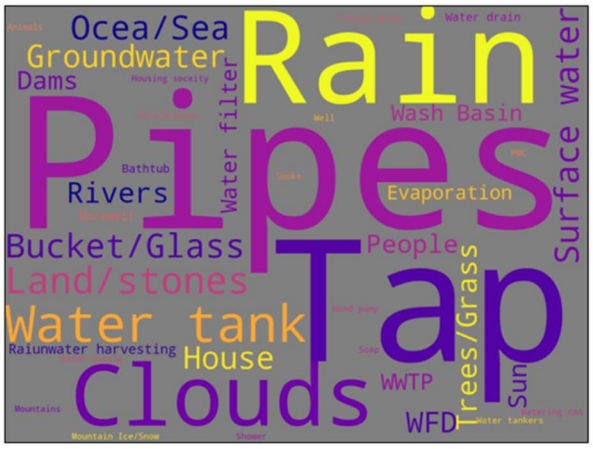


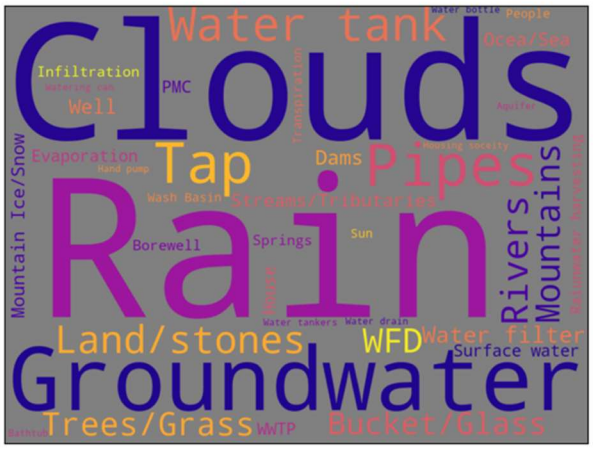
Map of Pune with its *rivers, streams* and dams (Image credit: Chhavi Mathur)

1-2-2d Pilot study

While we were testing this teaching plan in July 2022, we found that the student drawings done before and after the session depicting ‘where does my water come from?’ showed more focus on the natural elements after the session than before.

Before the session





After the session

Water Classrooms WC-1-2-ACTIVITY – I

Student Name: Class: Date:

1. Think about where the water that you use for bathing, drinking, and washing comes from? Try tracing it back to its source - if possible all the way back to the rains (or snow).
2. Draw and trace this path of water that reaches you on a plain sheet of paper.

Water Classrooms WC-1-2-ACTIVITY -II

Student Name: **Class:** **Date:**

1. Think about where the water that you use for bathing, drinking, and washing comes from if you were living as (choose of the below):
    b. Option 1 - in a house with only ground floor in Pune city centre
    c. Option 2 - in an apartment building with 15 floors
    d. Option 3 - on top of a hill or in a fort
    e. Option 4 - with no government approved water supply
    f. Option 5 - in a temple with a local water source
2. Draw and trace this path of water from the rain (or snow) that reaches you on a plain sheet of paper.

1-2-3 Additional reading/reference material – WC-1-2 - Where does my water come from?

Source of freshwater for Pune - a historical narrative

The Sahayadri hills lie to the west of Pune. As monsoon arrives in Pune around June, it brings plenty of rain to these hills. The water either runs off the surface of the hills to reach small streams or seeps into the ground. Many of these streams form tributaries to the rivers that flow through Pune - Mutha, Mula, Mula-Mutha, Ramnadi, Pavana/ Pawna, Indrayani.

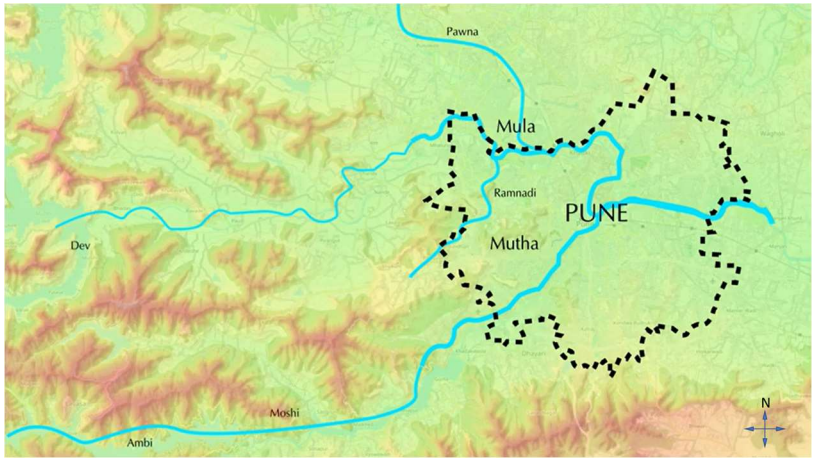


Image credit: Rahul Iyer, Science Media Centre and LWM, IISER Pune

https://www.youtube.com/watch?v=w_YfL9mYb8Q&list=PL_Fnbk2-zebmJpEd2rkK9BOQrxrTbRkv-&index=4&t=3s

This water - surface and underground - is potable water. People living in and around Pune have either used the waters from the streams and river or built structures to capture and manipulate these waters for thousands of years. Pune's water and their management have also played a critical role in the city's development from a hamlet to a big city. The historical evolution of Pune's water heritage is given below.
Also at link - https://punyachepaani.livingwatersmuseum.org/story/from-podhis-to-pipes/

1. **Podhi - Early historic - circa 200 BCE to 500 CE** -
These rock-cut cisterns were dug to collect surface and groundwater in the residential areas (*viharas*) of the Buddhist and Jain monasteries on Sahayadris between the Konkan coast and the Deccan, for drinking, bathing as well as for ritualistic purposes.

Podhi at Bhaje caves (photo credit: Saili Palande-Datar/LWM).

2. ***Barav - 900 CE to 1400 CE -***

Baravs or stepped ponds or wells were built in forts or outside villages often adjacent to temples and collected rainwater and underground water eg. from springs. They offered a space for community gatherings and resting spaces for travelers and pilgrims. The niches in the wall would house sculpture of deities and the waters were used often for ritualistic purposes. Sometimes the water from one *barav* would be sufficient for a village.

Barav at Loni Bhapkar (photo credit: Manas Marathe/LWM).

3. ***Taakya - 1100 CE to 1400 CE -***

Taakyas or *taakis* are complexes of rock-hewn cisterns first excavated in Yadava forts. Ganga-Jamuna taakya in Shivneri fort has an outer chamber used for fetching water and a chamber that lies largely in the rock-bed which keeps waters cool and clean. *Taakyas* were both utilitarian as well as spaces to socialize.

Ganga-Jamuna taakya (photo credit: Manas Marathe/LWM).

4. **Rivers - 1100 CE to 1300 CE** -
Mula and Mutha rivers are seasonal and often flood during the monsoons. Yadavas built

ghats along River Mutha. The confluence of Mula and Mutha was regarded as sacred.

Confluence of Mula and Mutha rivers in Pune and the ghats next to them where many rituals take place (photo credit: Gayatri Kshirsagar).

"Flowing since ages, the Mula & Mutha rivers bring with them the riches and the wisdom of the great old Sahayadris to the plains of Maharashtra. Supposed to be as old as the Sahyadri mountains, some 6,00,00,000 years they are older than the Himalayas and the Ganges. They have seen it all from the prehistoric times to the formation of modern cities.

Imagined as a royal Maratha queen, the Mutha is a blend of beauty and riches as she flows through the heart of the city. Her composed stance exudes determination and fierceness, reminiscent of the great Maratha period. While the Mula river is imagined as a forest maiden as she curves along the (old) city borders – a little far from the city aspirations." - source: *https://punyachepaani.livingwatersmuseum.org/story/river-mula-mutha/*
Also use this link to learn about Pune's rivers today, and the heritage and ecology around them.

5. **Wells - 1600 CE to 1700 CE -**

Under the early administration of Peshwas, many people moved to Kasbe Pune - the initial settlement in Pune around Mutha river and Nagzari stream. They dug wells (*kups)* to harness the underground waters for drinking, bathing and washing. Many of these wells were used up to the 19th century. Wells in Kasbe Poona were of two kinds - Aad is generally with small diameter and vihir is larger and with steps. Wells access

underground water

Source: Indian Jottings by Edward Elwin

6. **Springs - 1700 to 1800 CE**

Springs can be found at the ghats of Vitthal mandir and Omkareshawar ghat along Mutha river in Pune. (Photo credit: Akshay Shete/LWM)

A spring is where water flowing under the ground finds an opening to the land and emerges on the surface. Sometimes it is a small flow that appears after rainfall and at other times it is a continuous flow. Springs often feed rivers, lakes, wells with groundwater and contribute to the water cycle.

7. ***Talav* – 1700 CE - 2000 CE -**
Several lakes (talavs) were built during Peshwa period for reasons beyond utility and rituals such as recreation, aesthetics and disaster management. Parvati lake, built by Balaji Bajirao soon after 1752 flooding of the Ambil Odha (stream) flowing to the east of Kasba peth, marks one of the early disaster management measures of Pune. The lake bloomed with lotus flowers and provided a great spot for boating. An island garden was built with an open temple, to which Saras cranes were brought by Sawai Madhavrao Peshwa, thus, giving it the name “Sarasbaug”. In 1968, Parvati talav was filled in and converted into a garden.


Left: Sarasbaug and Parvati talav (source: Wikicommons). Right: Pashan lake was built along Ramnadi by the British to provide water to their soldiers (photo credit: Arul Vasan/LWM).

In the British era, Pashan lake was built to provide water to British soldiers in suburbs like Pashan and Sutarwadi. Today this lake receives an inflow of wastewater (including untreated sewage) from all settlements upstream of Pashan Lake (along Ram nadi) and is covered with water hyacinth.

8. Aqueducts and hauds - 1750 CE to 1900 CE

A qanat tunnel (soure: Wikicommons)

Aqueducts or *Nahars* in Pune, built under Shivaji's rule, were inspired from *qanats* built in the Middle East. A system of cisterns/ reservoirs (*Haud*), dipping wells (*Ooswas*), and underground man-made aqueducts (Nal/ Nahar) constituted this network. The system was first built around 1750 and was fully functional until the middle of the 20th century. The artificially built underground channels, popularly known as aqueducts carried water from its source (Katraj lake south of Pune) to core parts of the city making water available to many neighbourhood before being dispensed into the river.
Source - Gokhale and Deo, 2016

***9. Pyaavs and paanpoyis* - 1800 CE till today**


A pyaav (left) and a paanpoi (right) in Pune cantonment. (Photo credit: Swapna Joshi/LWM)

The public drinking water fountains from colonial (British) period are locally called as *pyaavs.*There are only two-three such *pyaavs* in Pune which were patronized in the memory of deceased souls.They are testimonials of a legacy of hydrophilanthropy that took root in many Indian cities during the 20th century.

Similar in their motive of providing drinking water like the elaborate *pyaavs*, there exists a practice of installing *paanpois*. Backed by community support, such drinking water dispensing units are a good source of drinking water on streets. *Paanpois* are simple in form but highly utilitarian in nature.
Source:https://punyachepaani.livingwatersmuseum.org/story/pyaavs-and-paanpois/

***10. Bhishtis* - 1800 CE till today**

A Bhishti carrying a water-filled mashaq. (Photo source: Amit Tandon/LWM)

The *Bhishtis* are a traditional community of Water carriers who supply water in leather-skin bags called Mashaqs. Every British army contingent had a group of *Bhistis* who provided drinking water to every soldier in the battalion. Now few from this community can be spotted supplying water for washing shop floors and fulfilling the water needs of the pavement dwellers for drinking and bathing in parts of Bombay. More and more of the areas served by *Bhishtis* are taken over by the water tankers, plastic water containers and metal pots.
Source: https://www.livingwatersmuseum.org/bhishti-the-water-carriers
https://confluence.mumbaiwaternarratives.in/water-livelihoods/exhibit03.php

11. Reservoirs, canals, pipes and taps - 1700 CE till today

Pune.

Khadakwasla dam newar (Source: Wikicommons)

"Seri-Parvatiche Dharan" or "Bel Dharan" - Pune's first dam was built across Ambil Odha by Dadoji Konddev to promote irrigation and resettle Poona in the 18th century.

When the British took over Poona city they built the Poona cantonment and Kirkee cantonment. In order to supplement the clean water supply to Poona cantonment in 1840s, an embankment or a bund was built over the Mula-Mutha river with financial assistance of a Parsi merchant, Jamsetjee Jeejeebhoy. Around the same time, Bhushi dam was built to supply water for steam engines that connected Bombay and Poona.

In 1866, James George Fife R.E. proposed to the British government his plan to build the Khadakwasla dam. This project commenced in 1869, the dam was built and the water from the reservoir was channeled through two canals that ran along the Mutha river - Left bank canal brought water to Pune city, Kirkee cantonemnet and surrounding areas;

Right bank canal irrigated the fields in Pune district and served a few towns like Daund and Baramati. This was considered the most promising water-works undertaken in the Deccan at that time. The first network of piped water systems was constructed in the early 1900s that served a population of more than 100,000.

From 1950s, other dams at Panshet and Varasgaon were constructed as storage reservoirs to supplement the supply from the Khadakwasla reservoir. Pawna reservoir now caters to the increasing water demand of the industrial and IT hub near Pune.

12. Overhead tanks, home water storage - Today

Women washing clothes using stored water (photo credit: Chhavi Mathur).

With water supply limited to a few hours in a day or in multiple days, many households and/or communities store water in overhead tanks. For efficiency these tanks are kept in elevated spaces and often filled using electric motors. These need to be kept covered and could be a source of diseases if not maintained well.

Water may be stored in tanks within homes which are often made out of plastic or metal. Very often women and children are responsible for ensuring water availability at home and need to compromise more time and effort than other members of the family.

13. Water tankers - Today

Photo credit: Chhavi Mathur/LWM

With rapid urbanization, water from dams does not reach all parts of Pune and traditional sources such as the *Bhishtis, pyaavs,* etc. are not as functional as they once used to be. This has

led to a greater dependence on groundwater extraction and distribution through water tankers. This form of water distribution is unorganised and difficult to monitor and regulate, leading to more issues in the city's water management.

14. Desalination - Today

Desalination is an advanced technological method to remove minerals from seawater to produce potable water. Due to the energy consumed during desalination, this water is generally more costly than fresh water from surface water or groundwater, water recycling and water conservation. Many of the ships and submarines use this technology for sustainable water supply. Chennai has multiple desalination plants that convert seawater from Bay of Bengal to potable water that supplements other freshwater sources for the city like the Veerannam lake and Krishna river. Largest desalination plants can be found off the coast of the Mediterranean sea.

References -

https://www.usgs.gov/media/images/distribution-water-and-above-earth-0
https://punyachepaani.livingwatersmuseum.org/story/river-mula-mutha/
https://www.youtube.com/watch?v=w_YfL9mYb8Q&list=PL_Fnbk2-zebmJpEd2rkK9BOQrxrTbRkv-&index=4&t=3s
https://www.youtube.com/watch?v=mZ7bgkFgqJQ
https://punyachepaani.livingwatersmuseum.org/story/from-podhis-to-pipes/
https://www.livingwatersmuseum.org/mutha-river-and-ghats-of-pune
https://punyachepaani.livingwatersmuseum.org/story/pyaavs-and-paanpois/
Gokhale, P. & Prof. Deo S. (2016). Digital Reconstruction and Visualisation of Peshwa period water system of Pune. Heritage: Journal of Multidisciplinary Studies in Archaeology 4 : 2016 [ISSN 2347–5463]