International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Drinking Water Source in India: A Spatial Analysis

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Abstract:
The study's main focus is on analyzing the geographical distribution and trends of India's primary drinking water sources. This study is based on secondary data acquired from the NSS 76th cycle, July 2018–December 2018, NSS Report No-584, Drinking Water, Sanitation, Hygiene, and Housing Conditions in India. According to an examination of access to the primary sources of drinking water in India, tap water is available to nearly 44% of households, followed by handpump/tubewell (41%), other sources (8%), and bottled water (7%). Goa has the largest number of families, around 97%, that have access to tap water as their primary source of drinking water. In terms of Union Territories, Chandigarh ranks top with 100% tap water availability for all homes. As far as the urban India scenario is concerned, 65 percent of families in urban areas have access to clean drinking water from taps. Mizoram leads all states (almost 99 percent) in terms of tap water access to homes as the primary source of drinking water in urban India. Whereas Bihar (almost 20%) occupies the bottom rank among the states in the specific category.
A Composite Index based on many primary sources has been explored to determine the overall state of drinking water in India. In addition, the association between urbanization levels and composite indexes for distribution and patterns of primary sources of drinking water among Indian states and Union Territories will be investigated.

Keywords: Drinking water, Households, Spatial distribution.

Introduction:

By 2030, everyone should have equal and universal access to cheap, clean drinking water, according to Sustainable Development Goal 6.1 of the UN. Economic growth and productivity depend on the sustainable management of water resources, as well as the availability of clean water and proper sanitation. These factors also significantly increase the return on current investments in health and education. According to Article 11(1) of the International Covenant on Economic, Social, and Cultural Rights, access to drinking water and sanitary facilities are internationally recognized human rights. According to UN estimates, if present consumption rates continue, about one-third of the world's population may experience chronic water shortages by 2025. A sufficient supply of safe drinking water is essential for survival and a key factor in determining one's standard of living. A lack of access to clean drinking water can lead to a number of illnesses, such as cholera, trachoma, hepatitis A, and diarrhea. In 1987, the first National Water Policy (NWP) was developed. The National Water Policy of 2002 states that "adequate safe drinking water facilities should be provided to the entire population both in urban and rural areas," reflecting the importance placed on clean drinking water. In order to

evaluate the effectiveness of service delivery providers, the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) Directorate has established a list of nine service-level standards with regard to water supply services. Launched in 2019, the Jal Jeevan Mission, a division of the Jal Shakti Ministry, aims to provide every rural home with a daily supply of 55 liters of water through Functional home Tap Connections (FHTC) by 2024.

The goal of the Jal Jeevan Mission is to provide local infrastructure for source sustainability measures that are required. These efforts, which include managing domestic wastewater for reuse, rainwater collection, and groundwater recharging, are carried out in tandem with other government programs and schemes. The mission is centered on a community-based approach to water and comprises a significant information, education, and communication component. The primary source of drinking water for the home was determined to be the water source from which the majority of the water was acquired over the previous 365 days. Seventeen categories were used to gather data on the primary drinking water source for the household: (i) bottled water; (ii) piped water into the dwelling; (iii) piped water to the yard or plot; (iv) piped water from neighbors; (v) public tap/standpipe; (vi) tube well; (vii) hand pump; (viii) protected well; (ix) unprotected well; (x) public tanker truck; (xi) private tanker truck; (xii) protected spring, (xiii) unprotected spring, (xiv) collecting rainwater The surface water includes rivers, dams, streams, canals, lakes, and other bodies of water. The other surface water includes carts with tiny tanks or drums. The NSS gathered data on household members' access to their primary drinking water source from 17 distinct categories. Four main sources were used for the analysis in this study after 17 distinct main categories combined. The four main sources of drinking water that were used for this study are as follows: (i) Tap water (water that is piped into a home, into a yard or plot, from a neighbor, or from a public tap or standpipe); (ii) Tubewell/handpump; (iii) Bottled water; and (iv) Additional sources (surface water, tanker truck, well, rainwater, and spring).

Objective:

1. To investigate the patterns and geographic distribution of India's main sources of drinking water.
2. To research the main sources of drinking water's geographical distribution and patterns in India's cities.
3. To investigate the connection between India's degrees of urbanization and people's general access to the country's main sources of drinking water.

Database and Methodology:

The NSS 76th Round, which ran from July 2018 to December 2018, yielded the data used in this research (NSS Report No. 584, Drinking Water, Sanitation, Hygiene, and Housing Conditions in India). All states and Union territories have data gathered on their four main sources of drinking water. Simple percentages, co-efficient variations, simple correlation, and the creation of a composite index are used in the analysis. Data accuracy is ensured by using ArcGIS software.

Results:

Total India Scenario (Urban+Rural):

Table No. 1 shows the proportion of Indian families with access to main sources of drinking water, such as bottled water, tap water, hand pumps/tubewells, and other sources. It is observed that, of all Indian

homes, over 44% utilize tap water as their primary source of drinking water, followed by hand pumps and tubewells (41%), other sources (8%), and bottled water (7%).

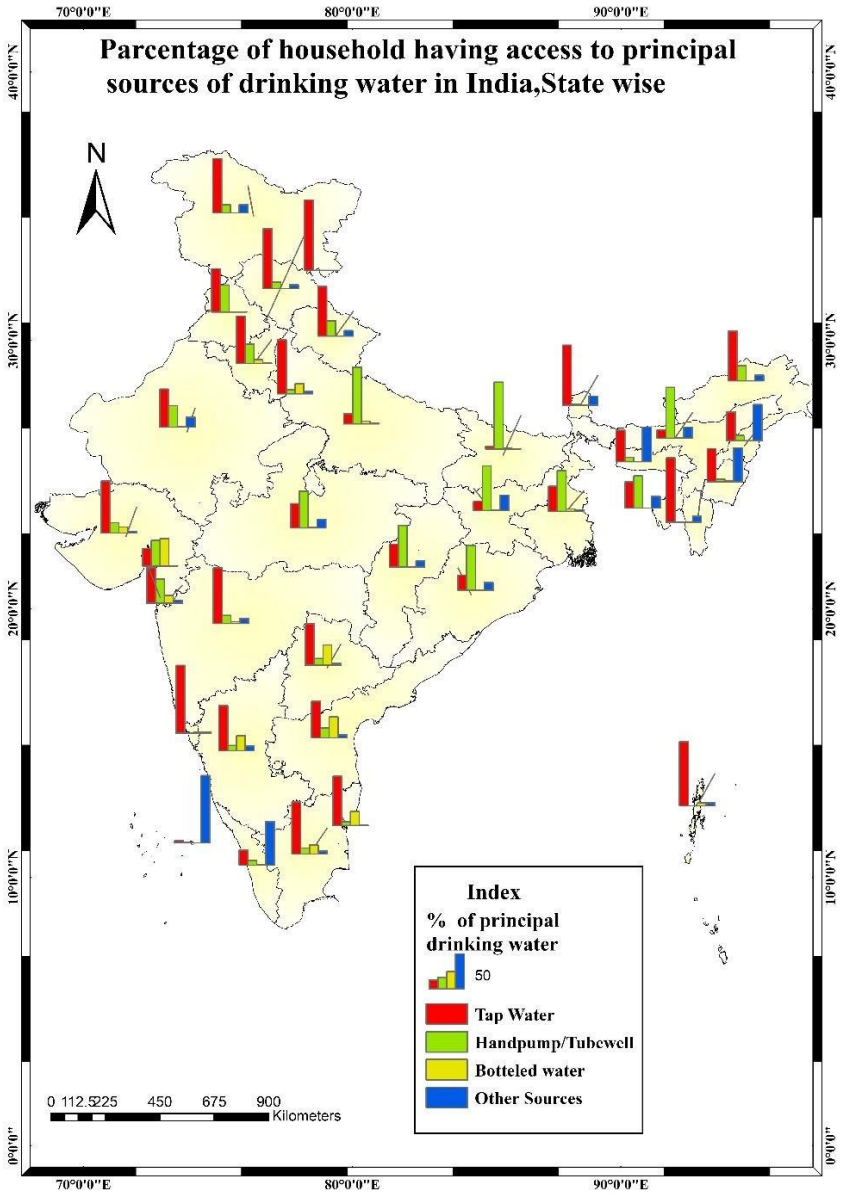
Table No 1: Percentage of household access to Principal sources of drinking water in India

Sl.No	NAME OF STATE/UT	Tap Water	Tubewell/Hand Pump	Bottled Water	Other Sources
*	All India	43.9	41.2	6.8	8.2
1	Andhra Pradesh	51.8	14.1	29.8	4.2
2	Arunachal Pradesh	70.8	21.6	0	7.9
3	Assam	11.8	72.2	0.3	15.8
4	Bihar	3.7	94.9	1.2	0.2
5	Chhattisgarh	32.4	58.9	0	8.8
6	Delhi	76.7	5.7	14.1	3.5
7	Goa	96.5	0.6	1.8	1.2
8	Gujrat	74	14.8	8.6	2.7
9	Haryana	67.1	27.4	5.1	0.3
10	Himanchal Pradesh	85.1	9.4	0.1	5.4
11	Jammu and Kashmir	76.9	11.5	0	11.7
12	Jharkhand	13.3	63.6	1.1	21.9
13	Karnataka	64.1	7.6	21.3	7
14	Kerala	21.5	6.5	0.5	61.7
15	Madhya Pradesh	34.6	52.4	0.6	12.2
16	Maharashtra	79	11.4	2.5	7.1
17	Manipur	46.8	3.6	1.7	47.9
18	Meghalaya	44.9	6.1	0	49.2
19	Mizoram	91.4	0	0	8.5
20	Nagaland	41	7.5	0	51.5
21	Odisha	21.7	63.7	0	11
22	Punjab	61.5	38.4	0.1	0.1
23	Rajasthan	54.1	30.6	1.1	14.1
24	Sikkim	85.4	1.6	0	13.1
25	Tamil Nadu	74	8.6	12.8	4.6
26	Telangana	59.1	9.5	28.7	2.7
27	Tripura	37.4	45.9	0.1	16.6
28	Uttarakhand	70.4	21.8	0	7.9
29	Uttar Pradesh	14.3	80.6	3.7	1.3
30	West Bengal	35.7	58.3	3.5	2.5
31	A & N Island	91.3	0	4.1	4.5
32	Chandigarh	100	0	0	0

33	Dadra Nagar Haveli	50.6	34.1	11	4.3
34	Daman and Diu	24.7	36.4	38.8	0
35	Lakshadweep	3.1	1.1	0	95.8
36	Puducherry	69.9	5.4	20	0.6
	Average	53.79	25.71	5.90	14.10
	Standard Deviation	27.85	26.47	9.94	21.03
	CV	51.77	102.95	168.47	149.14

The regional distribution of families with access to sources of drinking water, including bottled, tap, hand pump/tubewell, and other sources, is shown in the above table. Goa has the greatest number of households (about 97%) that have access to tap water as their primary source of drinking water out of all the states. However, with only 4% of families having access to tap water, the state of Bihar comes in last. Chandigarh is the top state in the Union Territories, where every home has access to tap water. Similarly, only 3% of homes in Lakshadweep have access to tap water, placing it at the bottom of the list. States with higher percentages of household tap water availability include Mizoram (91%), Sikkim (85%), and Himachal Pradesh (85%). Conversely, fewer families have access to tap water in Kerala (22%) and Jharkhand (13%), Uttar Pradesh (14%), and Jharkhand (13%). Bihar ranks top (almost 95%) among 28 states and 7 Union territories in terms of household access to hand pumps and tubewells as their primary source of drinking water. Mizoram makes up the smallest percentage—that is, 0%. About the availability of hand pumps and tubewells in India. The Andaman and Nicobar Islands and Chandigarh are examples of Union Territories where residents lack access to hand pumps or tubewells. However, when it came to household access to hand pumps and tubewells, Daman and Diu (36%) took first place. While a lower percentage of households in states like Goa (1%), Sikkim (2%), Manipur (2%), Meghalaya (6%), and Kerala (7%) have access to tubewells or hand pumps as their primary source of drinking water, states like Uttar Pradesh (81%), Assam (72%), Jharkhand (64%), and Odisha (64%) have higher percentages of households with this access.

Andhra Pradesh ranks #1 in India when it comes to household access to bottled water; over 30% of households use bottled water as their primary source of drinking water. However, states like Uttarakhand, Mizoram, Nagaland, Odisha, Sikkim, Meghalaya, Jammu & Kashmir, and Arunachal Pradesh lack access to bottled water as their main supply of drinking water. Daman and Diu have the largest percentage of households (39%) who use bottled water as their primary source of drinking water among the Union Territories. In contrast, the primary source of drinking water in Chandigarh and Lakshadweep is bottled water.



With regard to alternative water sources, Kerla has the largest proportion of households (almost 62 percent) that rely on these sources as their primary supply of drinking water. Punjab, on the other hand, comes in last among the states that mostly obtain their drinking water from external sources (0.1%). When it comes to the Union Territories, Lakshadweep leads with 96% of them using alternative sources of drinking water. The primary drinking water source for Chandigarh, Daman, and Diu is unobtainable from other sources. The same data shows that when it comes to tap water, the regional variance is less than when it comes to tube wells and hand pumps; in the case of tap water, the value of the coefficient of variation is 51.77 percent. Bottled water (168.47 percent), other sources (149.14 percent), and tubewell/handpump (102.95%) exhibit greater geographical variances.

Urban India Scenario:

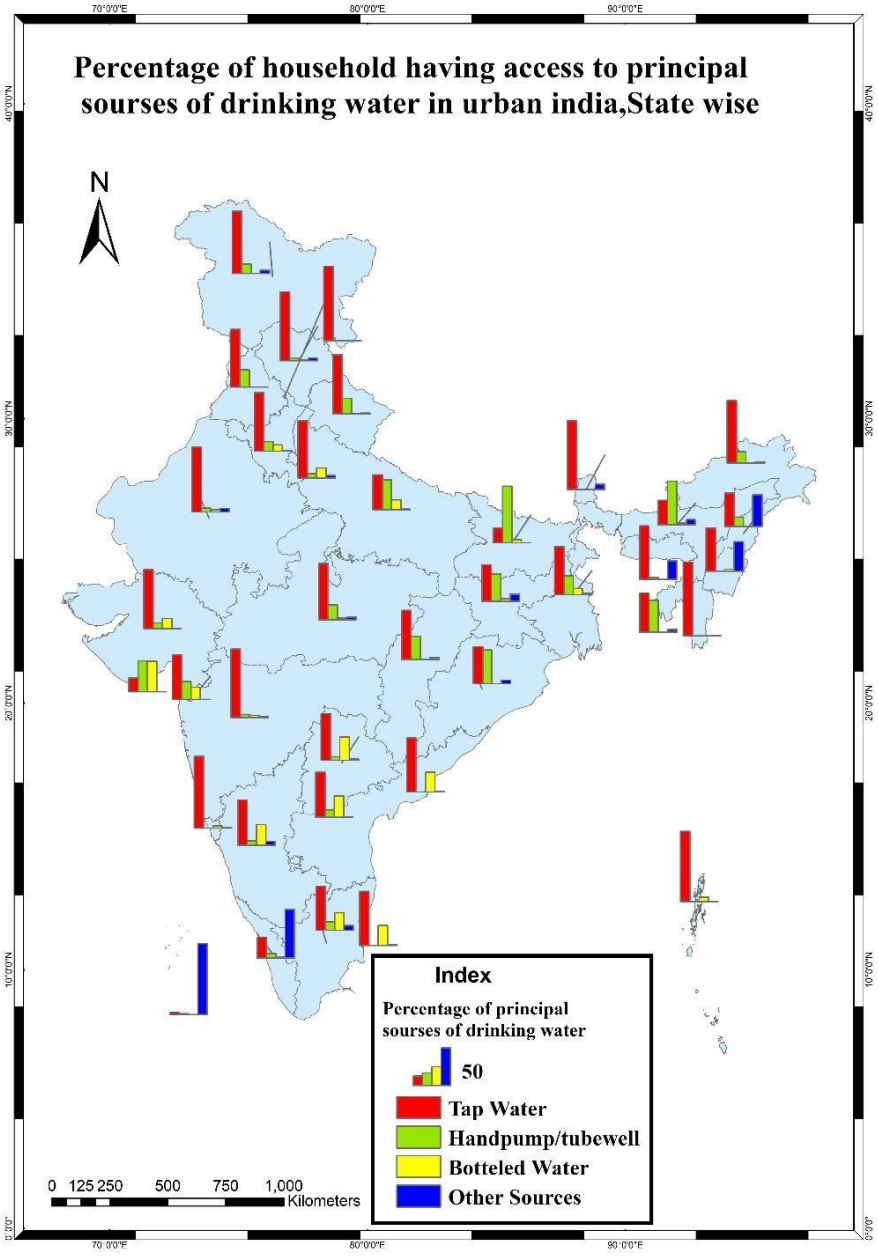
Regarding the current state of urban India, 65 percent of households have access to tap water as their main supply of clean drinking water. Mizoram holds the top spot among all states (almost 99 percent) in

terms of families' access to tap water as their primary source of drinking water. In contrast, Bihar, with about 20 percent of the total, comes in last among the states listed above. In Chandigarh, one of the union territories, every home in urban India has access to tap water. Conversely, Lakshadweep (almost 3 percent) ranks bottom among union territories where tap water is the primary source of drinking water. Urban India's states with higher percentages of tap water access to homes are Goa (97 percent), Sikkim (93 percent), Himachal Pradesh (92 percent), and Maharashtra (92 percent).

Sl. No.	State/UT	Tap Water	Hand/Tube Well Water	Bottled Water	Others Sources
*	**All India**	**65**	**17.1**	**12.2**	**5.7**
1	Andhra Pradesh	60.2	10.2	28.6	1.1
2	Arunachal Pradesh	83.7	15	0.0	1.5
3	Assam	32.7	58.5	2.0	6.7
4	Bihar	19.9	75.8	4.4	0.0
5	Chhattisgarh	65.9	31.3	0.1	2.7
6	Delhi	77.2	5.7	13.6	3.4
7	Goa	96.7	0.0	2.9	0.4
8	Gujarat	78.8	7.5	13.3	0.4
9	Haryana	78.4	12.8	8.2	0.6
10	Himachal Pradesh	92.1	3.5	0.9	3.5
11	J & K	83.4	12.5	0.0	4.2
12	Jharkhand	49.2	37	3.9	9.9
13	Karnataka	60.9	6.3	27.6	5.3
14	Kerala	27.8	6.2	0.9	65.1
15	Madhya Pradesh	75.1	19.8	2.0	3.3
16	Maharashtra	91.7	4.1	2.9	1.4
17	Manipur	58	0.1	2.6	39.4
18	Meghalaya	72	2.7	0.2	25.2
19	Mizoram	99.1	0.0	0.0	0.9
20	Nagaland	45.1	12.5	0.0	42.5
21	Odisha	49.9	45.3	0.0	4.8
22	Punjab	77.1	22.9	0.0	0.0
23	Rajasthan	87	5.1	3.0	4.8
24	Sikkim	92.7	0.0	0.0	7.3
25	Tamil Nadu	59	11.3	23.4	6.2
26	Telangana	62.4	4.6	31.4	1.6
27	Tripura	52.9	43.2	0.0	3.9
28	Uttarakhand	78.8	20.6	0.0	0.6
29	Uttar Pradesh	46.4	40.1	13.0	0.6
30	West Bengal	64.6	25.3	8.1	1.9
31	A & N Islands	94	0.0	6.0	0.0

32	Chandigarh	100	0.0	0.0	0.0
33	D & N Haveli	59.7	23.9	16.4	0.0
34	Daman & Diu	18.2	41.4	40.4	0.0
35	Lakshadweep	3.4	1.2	0.0	95.3
36	Puducherry	72.4	0.0	26.5	1.1
	Average	65.73	16.84	7.84	9.6
	S D	24.28	18.73	11.05	20.27
	C V	36.94	111.19	141.01	211.24

About 17% of families in urban India get their primary drinking water from hand pumps or tubewells. It is noted that the largest percentage of households in urban India have access to a hand pump or tubewell as their primary source of drinking water, with Bihar having the greatest percentage at over 76%. India's urban residents lack access to tubewells or hand pumps in states like Goa, Mizoram, and Sikkim. When it comes to the union territories, Daman and Diu (41%) come in top when it comes to using hand pumps or tube wells as their primary source of drinking water. Yet, the main supply of drinking water for the urban Indian states of Puducherry, Chandigarh, and Andaman & Nicobar Island is not a hand pump or tube well. In urban India, a greater percentage of families in states like Assam (58%), Odisha (45%), Tripura (43%) and Uttar Pradesh (40%) have access to hand pumps or tube wells as their primary source of drinking water. In India, approximately 12% of urban families consume bottled water. When it comes to the availability of bottled water as the primary source of drinking water in urban India, Telengana (31%) comes in top among the states. The primary supply of drinking water for states like Arunachal Pradesh, Mizoram, Nagaland, Odisha, Punjab, Sikkim, Tripura, and Uttarakhand is not bottled water. In urban India, bottled water is the primary source of drinking water for a greater number of families in Andhra Pradesh (28%) compared to Karnataka (27%) and Tamil Nadu (23%). It is observed that Daman and Diu (40%) use the most bottled water of any union territory in metropolitan India. Chandigarh and Lakshadweep, on the other hand, lack access to bottled water, which is the main supply of drinking water for homes in urban India.



In urban India, about 8% of families have access to additional sources of drinking water. In metropolitan India, Kerla has the greatest percentage of households (65%) with access to drinking water sources other than tap, tubewell/hand pump, and bottled water. In metropolitan India, the two states of Chhattisgarh and Punjab lack access to alternative sources of drinking water. Urban India's states with the highest percentage of households utilizing alternative sources of drinking water as their primary source include Nagaland (42 percent), Manipur (39 percent), and Meghalaya (25 percent) Lakshadweep has the largest percentage of families in metropolitan India adopting alternative sources of drinking water (95 percent) among the union territories. The homes in metropolitan India in union territories like Chandigarh, Andaman and Nicobar Island, Dadra and Nagar Haveli, and Daman and Diu lack access to alternative sources of drinking water. Compared to other major sources of drinking water in urban India, tap water is noted to exhibit less regional variation. Tap water has the lowest coefficient of variation, with a value of 36.9%.

State/UT	Tap	Z-Score	Hand pump/Tubewell	Z-Score	Bottled Water	Z-Score	Other Sources	Z-Score	Composite Index
All India	**65**		**17.1**		**12.2**		**5.7**		
Andhra Pradesh	60.2	0.22	10.2	-0.35	28.6	1.87	1.1	-0.41	**1.33**
Arunachal Pradesh	83.7	0.74	15	-0.09	0.0	-0.70	1.5	-0.39	**-0.36**
Assam	32.7	-1.36	58.5	2.22	2.0	-0.53	6.7	-0.14	**0.19**
Bihar	19.9	-1.88	75.8	3.14	4.4	-0.31	0.0	-0.47	**0.48**
Chhattisgarh	65.9	0.007	31.3	0.77	0.1	-0.70	2.7	-0.34	**-0.26**
Delhi	77.2	0.47	5.7	-0.59	13.6	0.52	3.4	-0.30	**0.1**
Goa	96.7	1.27	0.0	-0.89	2.9	-0.45	0.4	-0.45	**-0.52**
Gujarat	78.8	0.53	7.5	-0.49	13.3	0.49	0.4	-0.45	**0.08**
Haryana	78.4	0.52	12.8	-0.21	8.2	0.03	0.6	-0.44	**-0.1**
Himachal Pradesh	92.1	1.08	3.5	-0.71	0.9	-0.62	3.5	-0.30	**-0.55**
J & K	83.4	0.72	12.5	-0.23	0.0	-0.70	4.2	-0.26	**-0.47**
Jharkhand	49.2	-0.68	37	1.07	3.9	-0.35	9.9	0.01	**0.05**
Karnataka	60.9	-0.19	6.3	-0.56	27.6	1.79	5.3	-0.21	**0.83**
Kerala	27.8	-0.01	6.2	-0.56	0.9	-0.62	65.1	2.73	**2.37**
Madhya Pradesh	75.1	0.38	19.8	0.15	2.0	-0.53	3.3	-0.31	**-0.31**
Maharashtra	91.7	1.06	4.1	-0.68	2.9	-0.45	1.4	-0.40	**-0.47**
Manipur	58	-0.31	0.1	-0.89	2.6	-0.47	39.4	1.47	**-0.2**
Meghalaya	72	0.25	2.7	-0.75	0.2	-0.69	25.2	0.76	**-0.43**
Mizoram	99.1	1.37	0.0	-0.89	0.0	-0.70	0.9	-0.42	**-0.64**
Nagaland	45.1	-0.84	12.5	-0.23	0.0	-0.70	42.5	1.62	**-0.15**
Odisha	49.9	-0.65	45.3	1.51	0.0	-0.70	4.8	-0.23	**-0.07**
Punjab	77.1	0.46	22.9	0.32	0.0	-0.70	0.0	-0.47	**-0.39**
Rajasthan	87	0.87	5.1	-0.62	3.0	0.43	4.8	-0.23	**0.45**
Sikkim	92.7	1.11	0.0	-0.89	0.0	-0.70	7.3	-0.11	**-0.59**
Tamil Nadu	59	-0.27	11.3	-0.29	23.4	1.40	6.2	-0.16	**0.68**
Telangana	62.4	-0.13	4.6	-0.65	31.4	2.13	1.6	-0.39	**0.96**
Tripura	52.9	-0.52	43.2	1.40	0.0	-0.70	3.9	-0.28	**-0.1**
Uttarakhand	78.8	0.53	20.6	0.20	0.0	-0.70	0.6	-0.44	**-0.41**
Uttar Pradesh	46.4	0.79	40.1	1.24	13.0	0.46	0.6	-0.44	**2.05**
West Bengal	64.6	-0.04	25.3	0.45	8.1	0.02	1.9	-0.37	**0.06**
A & N Islands	94	1.16	0.0	-0.89	6.0	-0.16	0.0	-0.47	**0.58**
Chandigarh	100	1.41	0.0	-0.89	0.0	-0.77	0.0	-0.47	**-0.72**
D & N Haveli	59.7	-0.24	23.9	0.37	16.4	0.77	0.0	-0.47	**0.83**

Daman & Diu	18.2	-1.95	41.4	0.31	40.4	2.94	0.0	-0.47	**0.83**
Lakshadweep	3.4	-2.56	1.2	-0.83	0.0	-0.70	95.3	4.22	**0.13**
Puducherry	72.4	0.27	0.0	-0.89	26.5	1.68	1.1	-0.41	**0.65**
Average	**65.73**		**16.84**		**7.84**		**9.6**		
S D	**24.28**		**18.73**		**11.05**		**20.27**		

It is discovered that there is a 0.039 level link between tap water and urbanization. The table demonstrates that the availability of both tap and bottled water improves with increasing urbanization levels. Urbanization and hand pumps/tube wells have a considerable yet unfavorable relationship. There is a 0.039 level relationship between the levels of urbanization and the Composite Index.

Conclusion:

The state-by-state analysis, which includes both urban and rural families for all four categories combined, reveals that about 85% of Indian households obtain their primary drinking water from hand pumps or tubewells and tap water. Compared to other states, the southern states—Andhra Pradesh, Telengana, Karnataka, and Tamil Nadu—have more availability to bottled water. This is because these states have a high rate of urbanization. Apart from tap, hand pump/tubewell, and bottled water for families, Kerala is the only state with access to over sixty percent of alternative sources of drinking water (well, tanker truck, spring, rainwater, surface water). Kerala has less annually replenishable groundwater available than its neighboring states. The state's long-term needs require the recharging of potential resources through the preservation of wetlands. When it comes to drinking water, 65 percent of households in urban India have access to tap water. Nearly all families in Goa and Mizoram have access to tap water. However, when it comes to tap water connections to Indian urban families, Bihar has the poorest conditions. This survey found that urban families mostly consume bottled water. States with high levels of urbanization have easier access to tap water as their main supply of drinking water.

At the 0.039 level, it is determined that there is a substantial correlation between the states and union territories of India's levels of urbanization and the composite Index of access to major sources of drinking water. According to the study, tap and bottled water accessibility improves with increasing urbanization. The department of drinking water supply is in charge of supplying and maintaining the water supply to homes, just like it is everywhere else in the world. Depending on each state's level of development, different investments have been made for basic amenities including the water supply. Compared to underdeveloped states, states with high per capita income have been able to invest more. In actuality, this has caused a very high level of inequality in the availability of facilities for drinking water across the nation. The goal of the policies and programs pertaining to drinking water access should be to sufficiently support the necessities for the nation's or state's economic development.

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