

# Planning for Water Accessibility of Urban Poor Settlements: Case Study of Vijayawada City, Andhra Pradesh, India

Padala Kanaka Maha Lakshmi<sup>1</sup>, Adinarayanane Ramamurthy<sup>2</sup>

<sup>1</sup>Masters student from SPAV

<sup>2</sup>Associate Professor in SPAV

**Abstract:** Water is a central basic unit and vital for life. Access to a safe, affordable supply of water is universally recognized as a basic human need. For a large proportion of the world's population, to match water demand to its supply has become a big problem; it meant lack of provision of adequate water for domestic use especially in case of slums. It is thus very important to assess and evaluate their water resource availability, accessibility, capacity in using them properly. In order to achieve this, a more holistic approach needs to be adopted; efforts are being made to develop a water management tool known as the Water Poverty Index (WPI). The idea of WPI is to combine measures of water availability and access with measures of people's capacity to access water. Keeping the above said knowledge, the researcher has chosen the Vijayawada city, Andhra Pradesh, India, as study area for further investigation. The researcher analyzed the existing water supply distribution network in the study area, comprising of 111 notified slums, with three operational zones. The researcher has made an attempt to quantify the demand and supply of water supply and the study witnessed that there is a gap in demand and supply of water in slum pockets. In order to assess the water problems, WPI has been evolved for slum areas based on five slum specific key parameters, viz., Resources, Access, Capacity, Use and Environment. Out of 111 slums, 9 slums have been chosen to assess the slum water stress. Study reveals that resources and access are the two major constraint parameters which lead to water stress in slums. Based on the findings of the research study, the researcher has made an attempt to develop water accessibility mapping and recommended appropriate planning strategies, which can facilitate better water supply accessibility network in the system.

**Keywords:** Water Accessibility; Water Resources; Capacity; Water Poverty Index; Environment

## 1. Introduction

Urbanization represents a challenge for water management in the developed as well as in developing countries. And it leads to increase in the slum areas. The urban population in India grew to 377 million showing a growth rate of 2.76 percent per annum during 2001-2011. As the global population expands and the planet warms, demand for water is rising, while the quality and reliability of our water supply is declining. And because of these people who reside in slums will have the severe water problem. Water is a precious resource and vital for life. Access to a safe and affordable supply of drinking water is universally recognized as a basic human need for the present generation. Among the world population of 7.7 billion, 46 per cent of the population are poor. And as a whole, 70 percent population is having safe drinking water accessibility, 15 percent is having basic drinking water service, 5 percent is having limited drinking water service and 10 percent is having unimproved water sources away from the premises. Considering the proportion of slum households to the urban households; among Andhra Pradesh, Madhya Pradesh and Chhattisgarh states, Andhra Pradesh stands first in proportion of slum households to the urban households among all the states i.e. 35.7 percent. According to National India Water Stress Levels, more than half of the Indian population faces high (40 to 80 percent) to extremely high (more than 80 percent) water stress. Andhra Pradesh falls mostly in high water stress zone, and more than half part of Krishna District is in high zone.



**Figure 1:** Spatial location of slums in Vijayawada City  
Source: Compiled by the Authors, 2019

Vijayawada is the third largest city in the State of Andhra Pradesh, located in Krishna District, Andhra Pradesh has been chosen for further investigation. It constitutes about 3.91 percent of the total urban population of the state. Among 1.84 million of Krishna District urban population, 56.9 percent is shared by Vijayawada Municipal Corporation

(VMC). Entire city is divided into 59 wards and occupied with 111 notified slums in the city. The total population of city is 4.51 lakhs and having geographical area of 9.27 Sq.km.

## 2. Literature Survey

The observations from the literature study basically focus on the various research studies from different journals where as to study, analyze, review the parameters and develop the tool for the specific study and follow accordingly. The tool chosen to develop the study majorly focus on five parameters like Resources (R), Access (A), Capacity (C), Use (U), and Environment (E) to develop the water poverty index for the study area.

## 3. Research Methodology

Urban System concept has been employed in this investigation; in order have clear understanding about interactions with various sub systems of an urban system. In an urban system, all the subsystems, such as, physical, social, economy, ecology, environment, -infrastructure and institutions together functions as a whole. The water supply system lies under the physical sub system contains water supply, road network and its distribution etc., Water supply network is directly proportional to the population residing in study area and per capita water consumption in the system. The researcher has chosen the Vijayawada city, Andhra Pradesh, India, as study area for further investigation. The researcher analysed the existing water supply distribution network in the study area, comprising of 111 notified slums, with three operational zones. The researcher has made an attempt to quantify the demand and supply of water supply and the study witnessed that there is a gap in demand and supply of water in slum pockets. In order to assess the water problems, Water Poverty Index(WPI) has been evolved for slum areas based on five slum specific key parameters, viz., Resources, Access, Capacity, Use and Environment. Out of 111 slums, 9 slums have been chosen to assess the slum water stress. Study reveals that resources and access are the two major constraint parameters which lead to water stress in slums. Based on the findings of the research study, the researcher has made an attempt to develop water accessibility mapping and recommended appropriate planning strategies, which can facilitate better water supply accessibility network in the system.

## 4. Application of Tools and Techniques

### 4.1 Survey Research

Secondary data collection has been done to obtain the data related to existing water supply network in the study area, spatial location of slums etc. And primary survey has been done to collect the data regarding problems related to water supply, their income levels, availability of resources and access etc.

### 4.2 Statistical Techniques

Stratified random sampling approach has been adopted for

conducting the household survey at slum level. By taking 95% confidence level with  $\pm 5\%$  precision, sampling size for primary survey has been obtained.

### 4.3 GIS Technique

GIS Technique has been adopted for representation of data through maps. It has been used for generating maps like spatial location of slums, location of water sources, water supply distribution network etc..

### 4.4 Water Poverty Index (WPI)

The purpose of the Water Poverty Index is to express an interdisciplinary measure which links household welfare with water availability and indicates the degree to which water scarcity impacts on human populations. The primary focus of the index is on poor people, who suffer most from inadequate access to water. It is combination of physical, social, economic and environmental information associated with water scarcity. Water Poverty Index is an analytical tool that gives the relationship between water and the poverty. For calculating the Water Poverty Index, five major indicators were selected and those are: (i) **Resources**, (ii) **Access**, (iii) **Capacity**, (iv) **Use** and (v) **Environment**. Formula to calculate WPI is given by:

$$WPI = \frac{\sum_{i=1}^N (w_i X_i)}{\sum_{i=1}^N (w_i)}$$

$$WPI = \frac{W_R * R + W_A * A + W_C * C + W_U * U + W_E * E}{W_R + W_A + W_C + W_U + W_E}$$

$$WPI = \frac{0.2 * R + 0.2 * A + 0.2 * C + 0.2 * U + 0.2 * E}{0.2 + 0.2 + 0.2 + 0.2 + 0.2}$$

It is the weighted average of the five components Resources (R), Access (A), Capacity (C), Use (U), and Environment (E). 'W' is the weighting factor for each component. Each of the components is first standardized so that it falls in the range of 0 to 100; thus the resulting WPI value is also between 0 and 100.

## 5. Results and Discussion

### 5.1 Water Supply Distribution Network

Vijayawada Municipal Corporation is supplying water to the entire city dividing it into the three circles with three sources: Surface Source, Ground Water Source and Infiltration galleries, with total installed capacity of 212.75 MLD and the working capacity is 206 MLD in the existing system. Based on the secondary data obtained, it has been observed that slums are the major areas with lack of water supply in the system. This is due to various influential factors like; accessibility, reliability, distances from the households and their income levels.

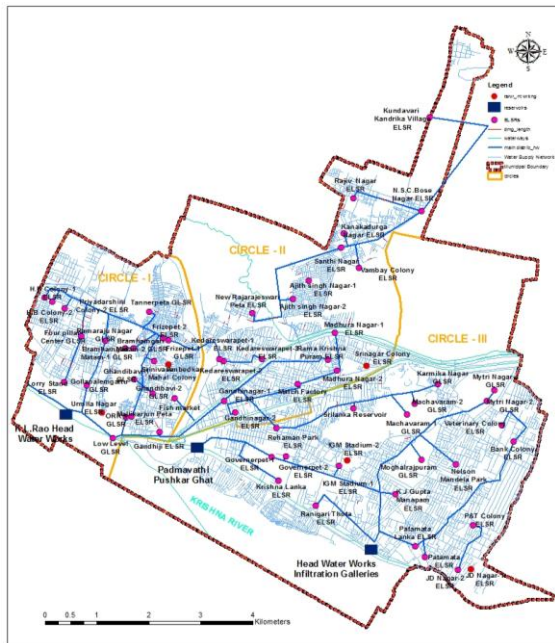


Fig No 2: Existing water supply distribution network of Study Area

Source: Compiled by the Authors,

2019

Fig 2: shows the existing water supply distribution in the city. Considering the Service Level Benchmarks for water supply as 135 Lpcd, for the slum population of 4.51 lakh, water supply should be 68 MLD. But the present water supply is 35 MLD only that means they are getting only 50-60 Lpcd. The gap identified was 33 MLD. This is because of

the breakages mainly in slum areas, government response to water supply problems in slums, water supply hours(2 to 4 hrs per day), distance from water resource and slum household (>300m). To understand all these problems in a detailed manner, Water Poverty Index has been used. This Water Poverty Index relates water accessibility problems with their income levels, level of water accessibility and availability of resources etc.

5.2 Water Poverty Index (WPI)

Survey research technique has been employed in this research study and household survey has been conducted by using pretested survey schedule. Primary data collection has been carried out for the selected slum areas in the Vijayawada city. Sub components under each parameter includes; (i) Resources: Water Quantity, Percentage of people not having sufficiency, Alternative Sources, Reliability. (ii) Access: percentage of people not having Individual House Hold tap, Percentage of people travelling more than 200 meters to carry water, percentage of people spending more than thirty minutes to carry water. (iii) Capacity: Percentage of people spending more than five percent of their income on water related illness. (iv) Use: Percentage variation in consumption of water. (v) Environment: Percentage of people having water with Total Dissolved Solids more than 300 mg/lit, Percentage of people reporting household level water treatment, percentage of people reporting water related illness. The data collected through primary data were analysed, compiled related to the above components and presented below in Table 1:

Table 1: Water Poverty Index and associated specific parameters

Circle	S. No.	Slum Name	Quantity (% variation in quantity)	% not having Sufficiency	Alternative Sources	Reliability	Not Having IHH Connections	Travelling more than 200m	Travelling more than 30min	Spending more than 5% of income on water related illness	% Variation in water Consumption	% having TDS>300 mg/lit	% reporting HH level treatment	% of HH reporting water related illness
			R1	R2	R3	R4	A1	A2	A3	C1	U1	E1	E2	E3
I	1	Kothapet	74	100	100	84	100	30	100	60	40	0	30	40
	2	RTC Workshop	56	100	0	80	100	20	100	48	39	0	28	45
	3	Chinatala Malapalli	31	100	0	83	100	40	81	62	45	0	30	58
II	4	Heart Pet	46	100	0	75	100	10	60	40	50		29	50
	5	Devi Nagar	32	100	100	82	100	25	54	52	64	0	30	30
	6	Vambay Colony	40	100	0	77	100	11	36	30	71	0	30	34
III	7	Arul Nagar	49	100	0	81	100	8	65	32	70	0	30	36
	8	Maruthi Nagar	55	90	100		100	7	40	41	59	0	20	30
	9	Bramarambapuram	36	89	100	79	100	13	51	54	56	0	26	40

Source: Compiled by the Authors based on the Primary Survey, 2019

The Table 1 demonstrates that no slum household has individual water supply connection, all the slum areas in the city are supplied with the Vijayawada Municipal Corporation. Ninety percent of the people are not having the

sufficient water supply. Only thirty percent of the people have alternative resources, for the other seventy percent people there are no alternative sources. And forty percent of the people are travelling more than 200 meters from their household to the water source and more than eighty percent of the people are spending more than thirty minutes to carry water. Around sixty percent of the people are spending their income on water related illness. Variation in water consumption varies from forty to seventy percent. Almost all the people are supplied with the quality water having total dissolved solids less than 300 mg/lit except some times in the rainy season.

### 5.3 Design of Water Poverty Index (WPI)

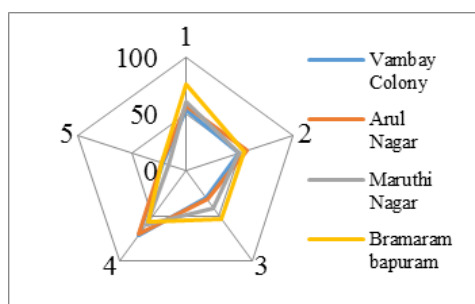
Based on the above data obtained from the primary survey, the sub-components related to each parameter are averaged and obtained parameter value. And then Water Poverty Index has been calculated for the selected slums in the city and tabulated in the below given Table 2:

**Table 2:** Resultant of Water Poverty Index for selected slums in the study area

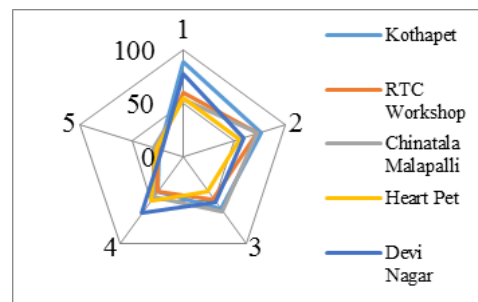
S.No.	Slum Name	R	A	C	U	E	WPI
1	Kothapet	89	76	60	40	23	57.6
2	RTC Workshop	60	73	48	39	24	48.8
3	Chinatala Malapalli	54	73	62	45	29	52.6
4	Heart Pet	55	56	40	50	26	45.4
5	Devi Nagar	78	59	52	64	20	54.6
6	Vambay Colony	54	49	30	71	21	45
7	Arul Nagar	57	57	32	70	22	47.6
8	Maruthi Nagar	61	49	41	59	16	45.2
9	Bramarambapuram	76	54	54	56	22	52.4

Source: Compiled by the Authors, based on the Primary Survey, 2019

The Table 2 debits that the slums Kothapet, Devi Nagar, Chintala Malapalli and Bramarambapuram slums have high WPI values more than fifty. And for other slums also WPI is more than forty. Among the five parameters access and resources are the major parameters that lead to have high WPI which debits that the areas have more water problems.



**Figure 3:** (a) WPI values of slums



**Figure 3:** (b) WPI values of slums

Source: Compiled by the Authors, based on the Primary Survey, 2019.

The researcher has made an attempt to analyse the WPI of various slum pockets in the study area and presented in Figure 3(a) and 3(b) respectively. From the Figure 3(a) and 3(b), it has been observed that out of all the parameters used to measure water poverty, the parameters related to resource, access and capacity are predominant that effects the settlement. Further, it is inferred that due to less availability of water, as per the need and requirement of the household, people are depending on alternative source of water i.e. either they purchase or they depend on bore water, ground water. The main source of water is municipal water supply; water access has been defined in terms of individual household water supply connections. If slum households are not having access to individual tap connections, then they are depending on community water taps as their main source of water. This research study indicate the basic fact that due to water poverty issue, the poor and those deprived of access to basic services are getting more marginalized. The people depending on community taps are paying more than those households having individual water connections due to their water insufficiency and the subsequent dependency on the alternative sources of water, which is accelerated in the system.

### 6. Conclusion

In an urban system, as the future population is growing in a fast manner, it is inevitable to utilize the existing water sources in a judicious and sustainable manner. All the water supply pipes with breakings should be replaced by the new pipes to avoid distribution waste and on the other hand, to curtail all the non-revenue water to greater extent in the system. More than half of the connections in the city are non-metered connections, and they are not paying tax for water supply. By making all the connections metered, the tax will be collected from every one, so that provision of community taps especially in slum areas can be improved in the system. Further, it is recommended that through new pipe line and new reservoirs all the non revenue water can be reduced, and water can be stored in new slum specific service reservoirs. These specific service reservoirs are the vital sources are within their premises and they can easily avail the water supply service in the system. Finally, this research study concludes that the equitable water supply distribution in slums and remaining parts of the city is very much essential and there is urgent need for optimal planning for water supply to eradicate water poverty and to promote sustainable water supply system.

## 7. Future Scope

Scope of the study is to improve the existing water supply system and focus on the future supply by managing the resources, increasing the accessibility in slum areas especially by overcoming the existing pull factors influencing in the region.

## References

- [1] Census of India.( 2011) *Data Products Available from The Registrar General and Census Commissioner*. New Delhi: Ministry of Home Affairs, Government of India,.
- [2] F. molle, P. Mollinga. (2003)"Water poverty indicators: conceptual problems and policy issues." *Water policy*,: 529\*544.
- [3] India Habitat III (2016). *India Habitat III National report*. New Delhi: Ministry of Housing and Urban Poverty Alleviation,.
- [4] Ministry of housing and urban poverty alleviation, Slum free city, vijaywada. Vijaywada(2013):, GOI,.
- [5] Rajiv Awas Yojana Report (2014)
- [6] Salamah, E. (2000). Redefining the Water Poverty Index. *Water International* , 107-114.
- [7] Sullivan, Caroline.( 2002) "Calculating water poverty index." *World development*,: 1195-1210.
- [8] UN. (2018). *UN World Water Report - Nature based solutions for water*. New York: UN Water.
- [9] UN-Habitat.( 2003) *THE CHALLENGE OF SLUMS - GLOBAL REPORT ON HUMAN SETTLEMENTS*. Nairobi: United Nations Human Settlements Programme, 2003.
- [10] VMC. (2013)"Slum Free City Plan of Action for Vijayawada Municipal Corporation." *Slum Free City Plan of Action for Vijayawada Municipal Corporation*. Vijayawada, Andhra Pradesh.

## Author Profile



**Padala Kanaka Maha Lakshmi** born in Eluru, Andhra Pradesh received Master's degree in Urban and Regional Planning from SPAV in 2019. She completed bachelors in Civil Engineering from IIT, Nuzvid. In 2015. As a part of her thesis she is

interested to publish the paper. Now she started her career as an urban planner after completion of post-graduation in urban and regional planning.



**Dr. Adinarayanane** (Associate Professor, Planning) acquired Ph.D., degree in Urban Studies and Planning from School of Architecture and Planning, Anna University, Chennai. He holds Ph.D., in simulation and modeling of Energy Efficient Sustainable Development

of Metropolitan city for quantitative urban analysis through System Dynamics. He completed post-graduation in Urban and Rural Planning from IITR, Uttarakhand State.