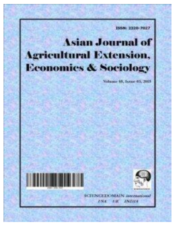

Asian Journal of Agricultural Extension, Economics & Sociology

33(3): 1-5, 2019; Article no.AJAEES.34983
ISSN: 2320-7027

Status of Sewage Water Generation in Karnataka, India

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJAEES/2019/v33i330179
Editor(s):
(1) Dr. Wang Guangjun, Pearl River Fisheries Research Institute, Chinese Academy of Fishery Sciences, China.
(2) Dr. Jurislav Babić, PhD, Associate Prof., Faculty of Food Technology, University of Osijek, Croatia.
Reviewers:
(1) Ningappa. M. Rolli, Bldea's Degree College, India.
(2) Saima Fazal, South China University of Technology, China.
Complete Peer review History: http://www.sdiarticle3.com/review-history/34983

Original Research Article

Received 28 October 2017
Accepted 29 January 2018
Published 26 June 2019

ABSTRACT

Water is vital to the existence of all living organisms, but this valuable resource is increasingly being threatened with increasing population growth and demand for high water quality for both domestic purposes and economic activities. A critical factor in the estimation of waste water generation is the population growth. The population of the Hubli-Dharwad twin cities is the second-largest in Karnataka, after Bangalore. The present study was based on secondary (time series) data. The population and sewage water flow in twin cities was found to have increased almost nearly about twelve times with the growth rate of 1.07 percent per annum. The projected future population and sewage water generation from twin cities for three decadal points of time showed an increasing trend. This poses a challenging task in future with respect to management. The farmers consider the resource as a boon which provides water for irrigation throughout the year and serves as a source of income and employment.

Keywords: Sewage water generation; population; flow.

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1. INTRODUCTION

Water plays the most pivotal role in existing of all living organism, but this valued resource is gradually being threatened with increasing population growth and need for high water quality for both domestic usages and economic activities. The food requirement of the growing population will be about 450 million tonnes in 2050 as against the present highest food grain production of around 266.57 million tonnes. Two-thirds of this is obtained from irrigated food grain production areas. Thus, irrigation water requirement of the country is likely to exert tremendous pressure on our water resources in the future.

Many countries worldwide are entering a period of severe water shortages. Increasing competition for water among urban centers, industry, and irrigated agriculture together with rapidly growing populations has put current agricultural and irrigation practices under severe pressure because agriculture is by far the largest user of water. Polluted water consists of Industrial effluents, sewage water, and the rainwater. The use of this water is a common practice in agriculture. In poor countries of the world, more than 80 percent of polluted water has been used for irrigation enabling 70 to 80 percent food and livelihood security in industrial urban and semi-urban areas.

In the semi-arid climate, where the summer temperature exceeds 35°C and the monsoon rains are erratic and unreliable, the waste water is an extremely valuable resource for farmers of urban and peri-urban areas and many extracts it from the Dallas and underground sewer pipes to irrigate their crops. This is considerably cheaper than digging a borehole. This practice is more accessible to farmers with lesser investment. The waste water also provides an irrigation source during the dry season, which enables farmers to sell their produce for three to five times the Kharif (monsoon) season prices [1], while its high nutrient load increases crop yields and also reduces the need for costly fertilizer input. This farming practice alleviates poverty for many urban and peri-urban farmers. Kiziloglu et al. [2] in Turkey where the increase in cauliflower and red cabbage yield with the application of untreated waste water by 29.05 and 28.57 percent, respectively as compared to fresh water. Samina and Mehmood [3] in Pakistan who reported that the impact of waste water irrigation on household income was considerable as waste water farmers earned approximately US$300/annum more than farmers using freshwater. It simultaneously places producers, consumers' products, and the environment at risk. The farmers are in close contact with the untreated waste water, containing pathogens and the high levels of anemia found amongst them can be attributed to water-borne parasitic diseases and worm infestation. The waste water also contains potentially injurious bio-medical waste (including disposable needles and syringes), which after tilling operations becomes half buried in the soils creating hazardous conditions for farmers during work in the fields. Unregulated and continuous irrigation with waste water leads to environmental problems such as sanitation, phytotoxicity (plant poisoning) and soil structure deterioration (soil clogging), which in India is commonly referred to as 'sewage sickness'.

Keeping afore said facts in view, the present study aims at analyzing the impact of waste water use for irrigation in Dharwad district with an objective to assess the trend of sewage water generation in Hubli-Dharwad twin city and to compare the impact of utilization of sewage water and fresh water for irrigation on cropping pattern, yield and income.

2. METHODOLOGY

The Hubli-Dharwad Municipal Corporation is the second largest corporation in Karnataka state which is partially provided with the underground drainage system. About 60 million liters of sewage is being generated every day in these twin cities. The untreated sewage water is being utilized by the farmers in nearby villages along the sewage discharge canals for the past 30-35 years. This might have affected crop yields, soil health, and underground water quality.

A critical factor in the estimation of waste water generation is the population growth. The population of the twin cities is the second-largest in Karnataka, after Bangalore. The present study was based on secondary (time series) data. Hubli-Dharwad Municipal Corporation and Karnataka State Pollution Control Board served as secondary sources of data. Secondary data was collected on the extent of population growth over the decades. The secondary data for the period 1901 to 2011 on the population of Hubli-Dharwad city were collected for calculation of waste water generation. The estimated per capita sewage water generation of 113.40 liters per day by Municipal Corporation was assumed for the study.

The data collected were presented in tabular form to facilitate easy comparisons. The results were summarized with the aid of statistical tools like Compound growth rate analysis, Trend line analysis, and Tabular analysis (averages, percentages *etc.*) to draw valid and meaningful conclusions.

3. RESULTS AND DISCUSSION

In consistence with the objectives of the study, the necessary data collected from different sources were analyzed and interpreted. The results of such analysis are presented and discussed in this chapter under the following headings.

3.1 Trend in Population and Sewage Water Growth in the Municipal Corporation Limit and Their Projections

3.1.1 Trend in population growth and sewage water generation

A critical and most important of the factors that contributed towards sewage water generation is the population growth. Compound growth rates were computed to comprehend the annual growth in population and resultant sewage water flow in Hubli-Dharwad cities under Municipal Corporation limit for the period from 1901 to 2011.

The results revealed that the population was found to have increased almost nearly about twelve times from 80,142 to 9,43,788 during the period from 1901 to 2011 with the growth rate in population by 1.07 percent per annum (Table 1. and Fig. 1). Similarly, sewage water flow was also increased from 9.09 million liters per day to 107.03 million liters per day with an annual growth rate of 1.07 percent. The increasing trend in population is mainly due to rapid urbanization and industrialization which created ample employment opportunities, resulted in a huge influx of people into the city from neighboring areas. The above results were in line with findings of Bhardwaj [4] who found 121 liters per day per capita in urban centers of India.

3.1.2 Projections of future population and sewage flow in Hubli-Dharwad cities

The projections on decadal population changes and sewage water flows were depicted in Table 2. and Fig. 2. As per the projections based on trend line analysis, the extent of population and sewage water for three decadal points of time in future years (2021, 2031 and 2041) showed an increasing trend. The size of the population in twin cities of Hubli-Dharwad together will be 11.46 lakh during 2021 and expected to increase to 13.54 lakh during 2031 and a largest predicted population size of 15.81 lakh during 2041. The corresponding sewage water to be generated also showed an increasing trend over the

Table 1. Trend in population and sewage water growth in the municipal corporation limit

Sl. No.	Year	Population	Sewage water flow (MLD)
1	1901	80142	9.09
2	1911	91031	10.32
3	1921	100992	11.45
4	1931	124398	14.11
5	1941	143504	16.27
6	1951	196180	22.25
7	1961	248561	28.19
8	1971	379166	42.99
9	1981	527108	59.77
10	1991	648298	73.52
11	2001	786195	89.15
12	2011	943788	107.03
	CGR	**1.07**	**1.07**

Table 2. Projections of population and sewage water generation in the municipal corporation limit

Sl. No.	Year	Population	Sewage flow (MLD)
1	2021	1145772	129.93
2	2031	1354016	153.55
3	2041	1580840	179.27

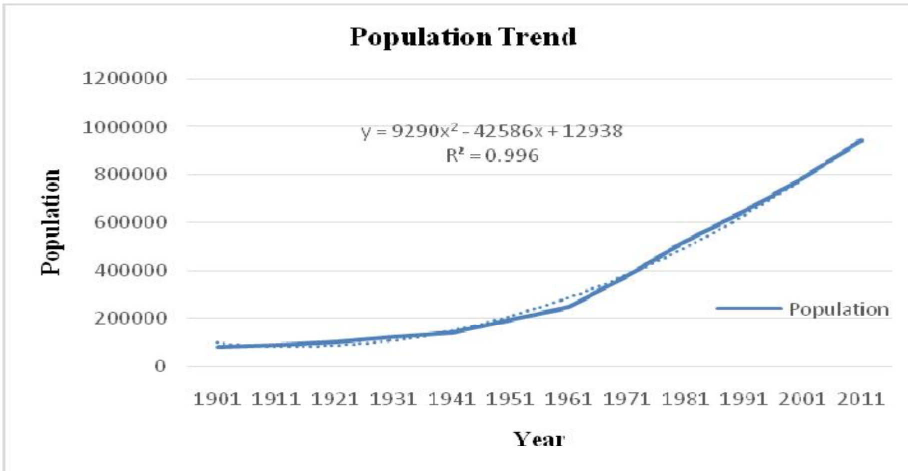

Fig. 1. Population trend in Hubli-Dharwad cities

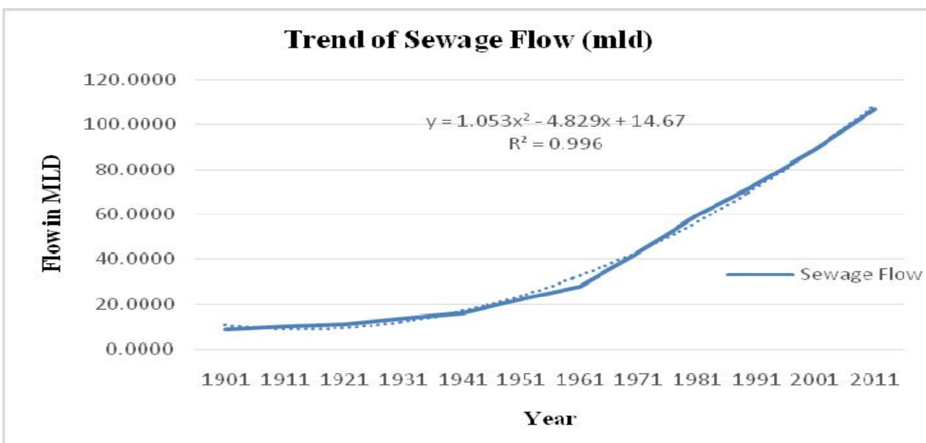

Fig. 2. Trend of sewage flow (mld) in Hubli-Dharwad cities

predicted periods as this depended largely on increase in the population growth. The predicted sewage water flows were 129.93 MLD, 153.55 MLD, and 179.27 MLD during 2021, 2031 and 2041 respectively. This increasing trend was due to the rapid urbanization and industrialization as stated earlier which induces increased human economic activities. The above results were in line with findings of Bhardwaj (2005) where the researcher predicted the increased generation of sewage water in Class-I and Class-II towns in India by 2051.

4. CONCLUSION

The population in twin cities was found to have increased almost nearly about twelve times from 80,142 to 9,43,788 with the growth rate in population by 1.07 percent per annum. Similarly, sewage water flow was also increased from 9.09 million liters to 107.03 million liters per day and showed an annual growth rate of 1.07 percent. The projected future population and sewage water generation from twin cities for three decadal points of time showed an increasing trend. This poses a challenging task in future with respect to management. The farmers consider the resource as a boon which provides water for irrigation throughout the year and serves as a source of income and employment.

5. POLICY IMPLICATIONS

There was an increasing trend in sewage water generation/growth over a time (1.07% per annum) with urbanization and hence, there is an urgent need to plan strategies and provide thrust to the development of socially acceptable, economically viable and cost-effective waste water treatment systems to check for possible ill-effects on the environment, health and ground water.

Use of sewage water by farmers is extensively practiced in peri-urban areas resulting in an increased crop yields (10% to 30%) and returns over fresh-water irrigation. Farmers found to adopt direct handling of this nutrients rich but highly contaminated water. In order to fix responsibility, an additional tax could be imposed by the municipal corporations. The collected tax could be used to build water treatment plants for management and safeguard the overall health of the community.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle3.com/review-history/34983