Reuse Options of Reclaimed Waste Water in Chennai City

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ABSTRACT:
In the present research work Sholinganallur taluk which comes under the zone of Chennai city expansion area was taken for management of wastewater effectively. Overlay operation in GIS tool was performed by selected decentralized wastewater treatment site map on reclassified landuse map. A 1000 m buffer map was created around each decentralized wastewater treatment sites to suggest various reuse options. The landuse map within the buffer zone comprises of detailed classification of ward number and its boundary. The settlement area which falls in the buffer zones includes number of households and population density, educational institutions like schools, colleges, industrial buildings like IT buildings, manufacturing buildings, government offices, shopping complex, hospitals, hotels, restaurants, etc., public areas like parks, pavement area etc. and crop land, forest area, salt pan, sand bar etc. Reuse of treated wastewater is broadly categorized into two purposes namely potable and non potable purposes. Treated waste water for potable purpose such as for drinking and recharge of ground water require higher standard of water quality. Whereas the non potable reuse such as domestic purpose like gardening, toilet flushing, car washing, industrial reuse, recreational, agriculture, landscape irrigation, wetland applications etc requires low standard of treated waste water quality. The reuse options considered in the present study are the urban, Industrial, recreational, groundwater respectively.

Keywords: *GIS, Overlay analysis, Decentralisation, Wastewater*

I. INTRODUCTION

Asano etal (1996) described that wastewater reclamation and reuse is a type of wastewater treatment system and its quality is attained after treatment process. Application of wastewater for various level of reuse purpose purely depends on the characteristics of wastewater attained after treatment. Asano and Levine (1996) clearly stated that the level of wastewater treatment required for a particular purpose purely depends on the quality of the end-use. Rose (1999) recommended that sustainable manner of wastewater treatment must be given attention in domestic and industrial wastes. Nhapi et al (2002) stated that, wastewater reuse is an approach to turn the useful component of wastewater into a resource. Great care must be exercised when reusing the reclaimed wastewater which may contain chemical and biological substances that may create some harmful effects on public health. MetCalf & Eddy (2005) included rainwater and storm-water collected by urban sewer system was also considered as wastewater. Raw wastewater contain organic matters, toxic compounds and nutrients which results in eutrophication and release of harmful gases. Massoud et al (2009) defined the wastewater reclamation as a treatment process which treats wastewater to predetermined levels of water quality, further facilitating its reuse. Water reuse includes the use of treated waste water for all beneficial purpose, including agricultural, irrigation, industrial cooling and other non potable or potable applications. Pinkham et al (2004) discussed that integrated wastewater planning improves upon conventional wastewater facility planning by representing whole system costs and benefits of wastewater management systems. Vigneswaran and Sundaravadivel (2004) explained that the reuse of treated wastewater for specific direct or indirect reuse purpose is mainly depends on the standard of treated wastewater attained after treatment. Parkinson and Tayler (2003) pointed out that the view of conventional or centralized wastewater treatment systems involve advanced collection and treatment processes that collect, treat and discharge large quantities of wastewater. GTZ (2009) and Werner et al (2010) developed, EcoSAN which promotes the extraction of water, energy and nutrient resources found in wastewater for beneficial reuse locally in agriculture and to increase sustainability of wastewater management. centralized systems for wastewater collection and disposal require disproportionately large investments which are unaffordable to the majority of the peri-urban poor people (Seidenstat et al 2003 and USEPA 2004). Fraganol et al (2001) suggested that decentralized wastewater treatment system is an effective technique in planning and decision-making, design of physical infrastructure and management arrangements for operations and maintenance.

II. STUDY AREA

Shollinganallur Taluk comes under the administrative boundary of Kancheepuram district. The study area is located between latitudes 12 15' 20"N and 12 58' 12"N and longitudes 80 9'12" and 80 16'9"E, covering a total area of 118 km^2. The physiographic units present in the study area (Figure 1) are alluvial plain, hard rock areas and coastal plain. The present population of Shollinganallur Taluk as per 2011 Census is 3,33,534.

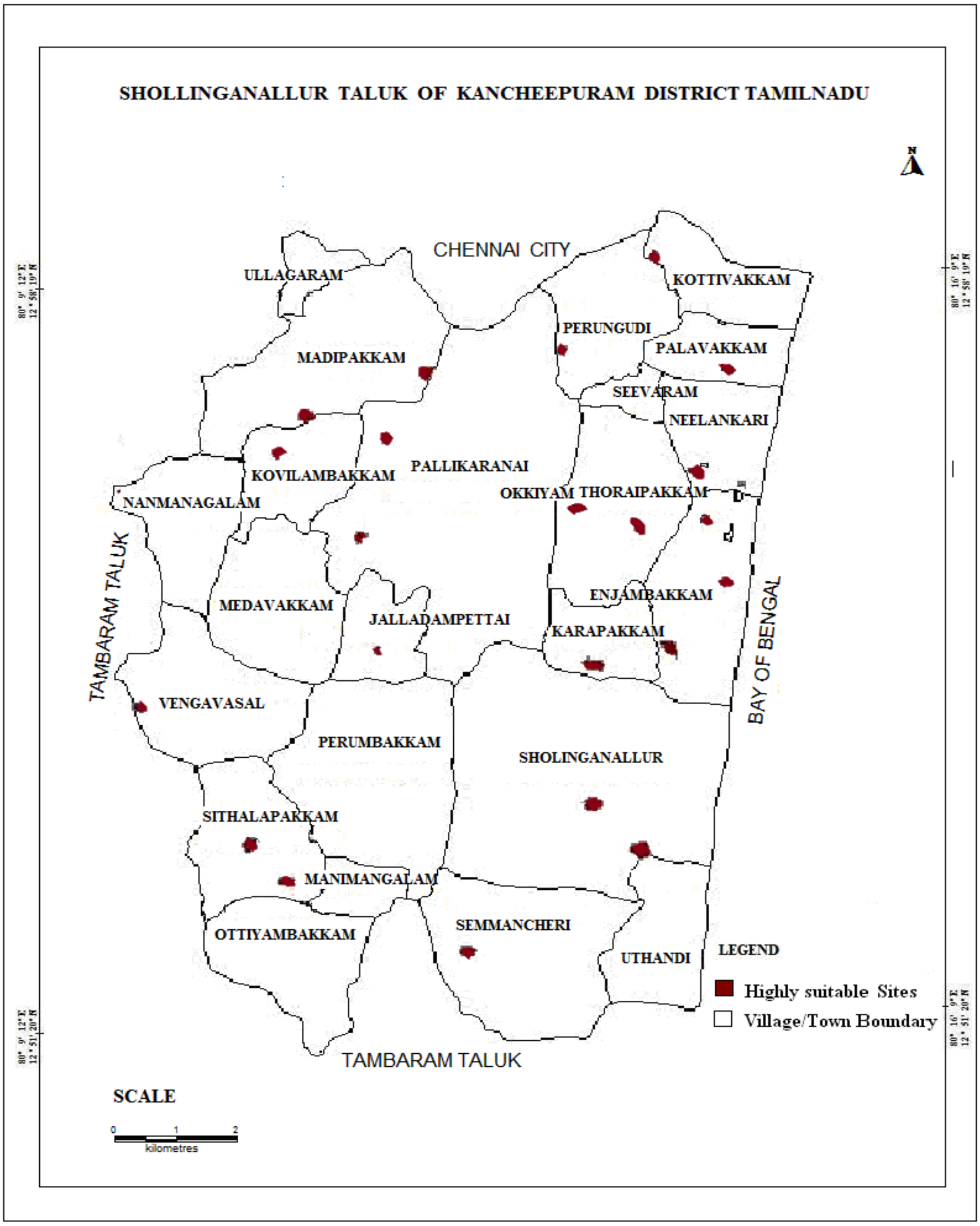

Figure 1. Study Area Map

III. METHODOLOGY

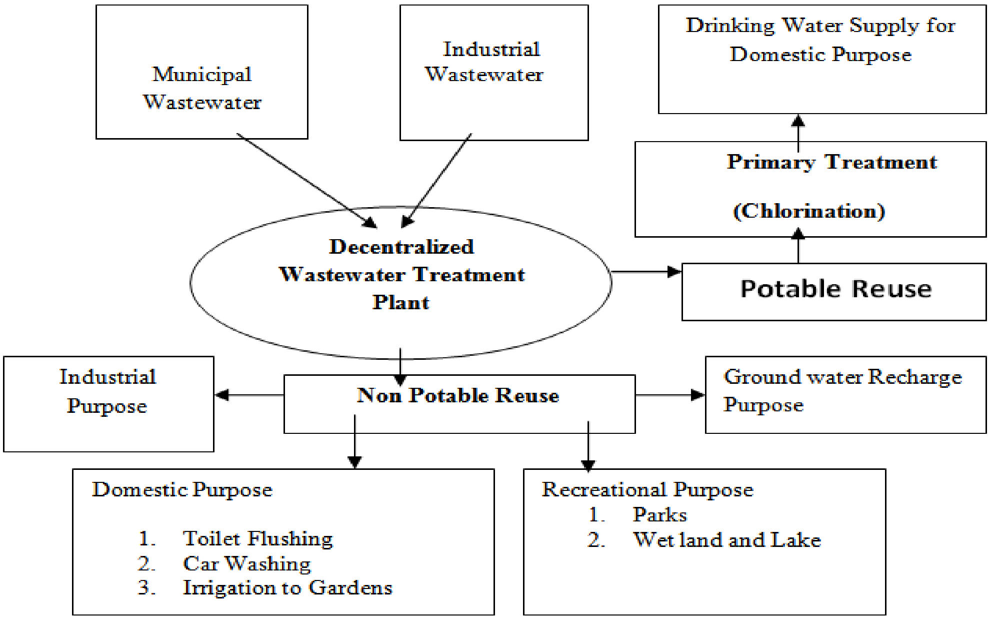

Figure 2 Methodology Flow chart of reclaimed water for various reuse options

IV. Results and Discussion

The buffer zone of 1000 m created around each decentralized wastewater treatment sites is presented in Figure 3. Each decentralized wastewater treatment site was analysed for possible reuse options. The percentage of various landuse types which is covered by the buffer zone of each decentralized wastewater treatment site are listed in Table 1.

Urban reuse

The daily consumption of water by a single person is listed in Table 2. From the table 2 it is observed that 59.3% of water consumed for drinking, bathing, washing clothes, cooking and dish washing purpose daily and 40.7% of water consumed for vehicle washing, floor cleaning, gardening and toilet flushing purpose. Therefore it is understood that the consumption of 59.7% of water depends on fresh water, whereas 40.7% does not depends on fresh water. Thus usage of 40.7% fresh water could be replaced by treated waste water. The effective reuse of treated wastewater from the treatment plants was suggested by redirecting the treated water for urban settlements by means of dual water supply system for gardening, toilet flushing, car washing and floor washing purposes. The percentage of reuse treated waste water for municipal purpose was calculated and presented in Table 3 below. The total volume of wastewater generated in study area for the present scenario is 47 MLD and 30 years projected future scenario is 69 MLD. Out of 24 suggested decentralized treatment plant sites, 14 sites are located in the urban settlements where the capacity of each treatment plant assumed to treat a quantity of 3 MLD of wastewater. The total capacity of wastewater to be treated by urban decentralized treatment plants is 42 MLD. From the Table 3 the quantity of treated wastewater to be reused for municipal purpose is 31.8 MLD. This results an effective replacement of 46.5% of fresh water or ground water.

Industrial reuse

The total number of industries present around the proposed decentralized treatment plant sites within the buffer zone of 1 km is about 336, which is shown in Table 3. The industrial categories considered are the hospitals, IT buildings, Government offices, schools, colleges, small scale private industrial companies, hotels, restaurants, shopping complex etc. An approximate total number of population working in these industrial sector was found to be about 2, 34,975. The projected population for 30 years is 4, 22,955. It is estimated that about 18% of treated wastewater could be consumed for toilet flushing and 10% will be marketed to the small scale manufacturing industries located near by the decentralized wastewater treatment sites.

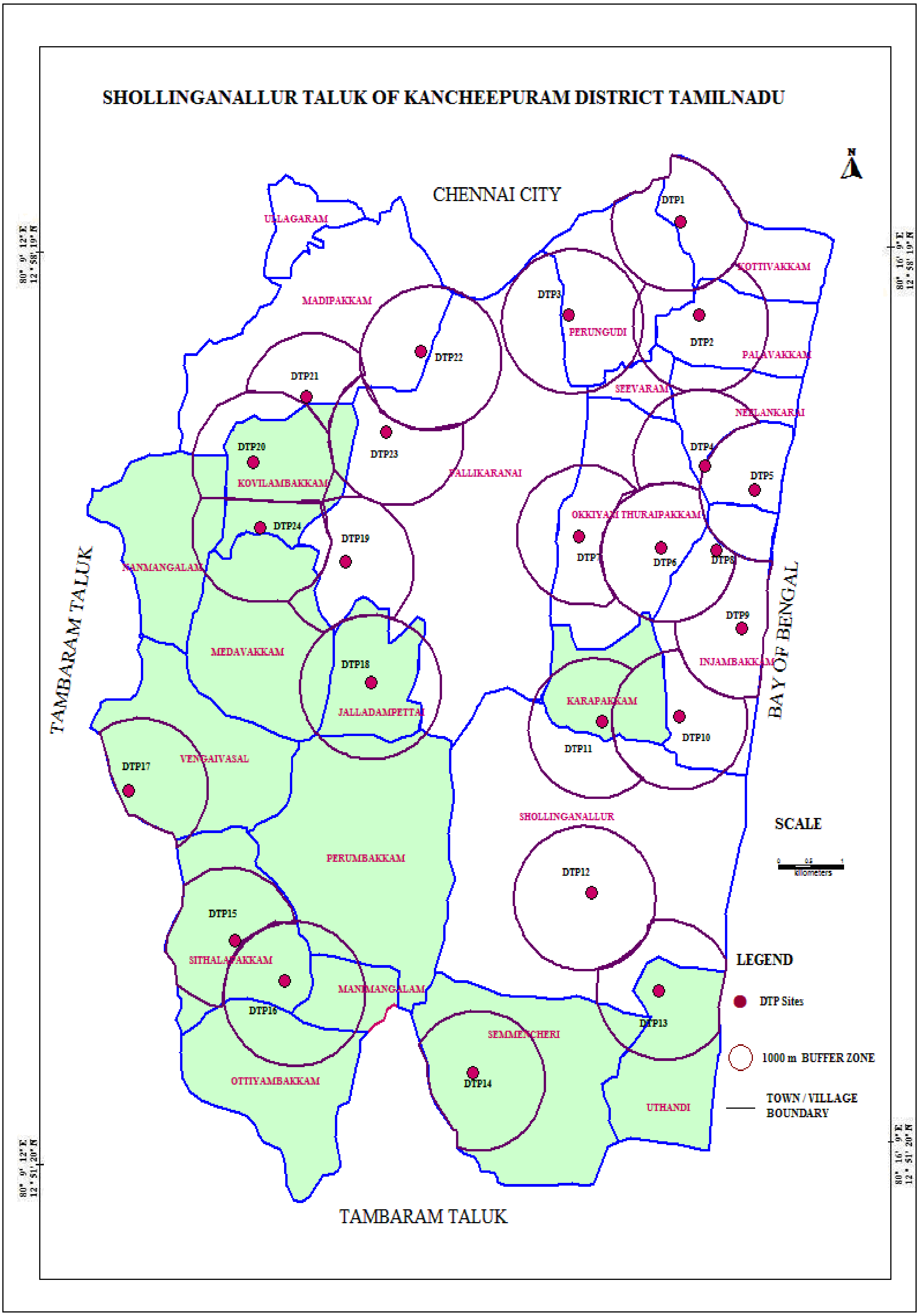

Figure 3 Buffer Zone Map

Table 2 Water Consumption for Different Category

SI. No.	Category of Water Consumption	Quantity of water Consumed (Litre/person /day)	Percentage
1	Drinking	5	3.7
2	Bathing	30	22.3
3	Washing Clothes	30	22.3
4	Cooking	5	3.7
5	Dish Washing	10	7.3
6	House Cleaning / Floor Washing	5	3.7
7	Car Washing	5	3.7
8	Toilet Flushing	30	22.3
9	Gardening	15	11.0
	Total	**135**	**100**

Source: CPHEEO 2003

Recreational reuse

From the above Table 3 it is observed that 1.151 km^2 area come under recreational purpose such as pavement gardens, public parks. Approximately 1 liter of water per day can be used to irrigate 1sq feet of the pavement area. It is estimated that about 18% of treated waste water can be used for public gardens, parks and road way plants.

Table 3 Quantity of Wastewater Reuse

DTP Site Number	Number of House holds	Present Population	Projected Population	Quantity of reclaimed Water for Municipal Reuse (Mld)	Number of Industries
1	3100	12400	23375	1.25	27
2	3800	15200	28285	1.53	14
3	4220	16880	31411	1.70	28
4	2123	8492	15802	1.0	17
5	1340	5360	9974	0.52	6
6	4060	16240	30220	1.63	31
7	1450	5800	10793	0.58	10
9	650	2600	4838	0.26	4
10	380	1520	2829	0.15	6
11	3020	12080	22479	1.2	23
12	2300	9200	17120	1.02	21
13	2359	9436	17559	1.01	34

14	933	3732	6945	0.38	7
15	1245	4980	9267	0.50	15
16	760	3040	5657	0.31	6
17	836	3344	6223	0.33	11
18	1210	4840	9007	0.48	9
19	1965	7860	14626	0.79	12
20	2570	10280	19130	1.03	16
21	984	3936	7324	0.40	12
22	3256	13024	24235	1.31	15
23	1800	7200	13398	0.72	7
24	627	2508	4667	0.25	5
Total	**44988**	**179952**	**334867**	**31.87**	**336**

Groundwater reuse

Indirect reuse provides treated wastewater by discharging it into surface water bodies or groundwater aquifer prior to reuse such as in groundwater recharge. Groundwater aquifers provide natural mechanism for treatment, storage and subsurface transmission of treated waste water (Asano et al 1996). About 7.5 % of the treated wastewater can be recharged through soil aquifer treatment method. It is a one such method where the unsaturated soil acts as natural filter media. The selection of possible locations for application of soil aquifer treatment was considered based on the evaluation of decentralized treatment plants sites by analysing various factors such as aquifer quality, water table depth, soil salinity and soil texture.

Table 1 Percentage of Landuse Classification in Buffer Zone

DTP Site Number	Buffer Area (Km^2)	Settlement Area (Km^2)	Industrial Area (Km^2)	Recreational Area (Km^2)	Other Area (Km^2)
1	0.48	0.29	0.11	0.05	0.03
2	0.79	0.52	0.15	0.08	0.04
3	1.03	0.87	0.01	0.09	0.06
4	0.40	0.32	0.01	0.06	0.01
5	1.31	1.1	0.01	0.10	0.10
6	0.72	0.58	0.01	0.11	0.02
7	0.25	0.18	0.02	0.01	0.04
9	0.48	0.15	0.01	0.02	0.3
10	0.79	0.37	0.0	0.02	0.39
11	0.71	0.53	0.02	0.10	0.06
12	0.40	0.12	0.04	0.03	0.21
13	1.31	0.33	0.10	0.21	0.67
14	0.72	0.32	0.05	0.15	0.30
15	0.25	0.05	0.02	0.01	0.17
16	0.48	0.22	0.10	0.02	0.16
17	0.79	0.20	0.03	0.02	0.54
18	1.03	0.23	0.01	0.03	0.76
19	0.40	0.15	0.04	0.02	0.19

20	1.31	0.86	0.13	0.20	0.12
21	0.72	0.44	0.06	0.10	0.19
22	0.25	0.12	0.01	0.01	0.11
23	0.48	0.24	0.02	0.03	0.19
24	0.79	0.36	0.06	0.04	0.33
Total	**15.89**	**8.55**	**1.12**	**1.151**	**5.09**

V. CONCLUSION

The effective reuse of treated wastewater from the treatment plants was suggested by redirecting the treated waste water for urban settlements by means of dual water supply system for gardening, toilet flushing, car washing and floor washing purposes. This results an effective use of 46.5% of treated wastewater instead of the usage of fresh water supply as surface water and groundwater. The treated wastewater of about 10% and above can be marketed to the industries located near by the decentralized plants for non potable purpose. Further 18% of water can be used for public gardens, parks and road way plants situated along the road ways. About 7.5 % of the treated wastewater can be recharged through Soil Aquifer Treatment Method.

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