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Impacts of Climate Change in the Developing World

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Abstract

Objective: To identify the adverse effect of urbanization on the land use pattern, surface water, groundwater and pollution due to solid waste in the study area by accompanying survey. **Method:** The environmental impact of urbanization process will be analyzed through the aspects such as urban population, urban land use, solid waste management, surface and ground water hydrology. The rate of urbanization can be predicted using Land Use Data. Using this predicted model, the demand for the water, quantity of solid waste generation, flood prediction, ground water recharge rate, changes in drainage pattern can be obtained. **Findings:** Leachate should be reduced. Mixing of rain water with water from dumping yard should be reduced. Disposal of carcasses near dumping yard should be prohibited. Disposal of sewage waste in open land should be prohibited. Disposal of sewage in channel water affects the domestic usage of channel water. Expansion of building construction towards the Ullur - Ariyamangalam should be retarded. Due to high wages for agriculture Coolies and poor selling price of paddy, the farmers are pushed to convert the farm land into plots. The farms should be protected. The unused pond should be renovated. Inflow and outflow channels should be deepened and widened. **Application:** Dust bin should be placed in every street for proper collection of solid waste. Drainage should be laid for the sub main streets too. Husk ash emission should be retarded.

Keywords: Ground Water, Land Use Pattern, Rainfall, Surface Water, Solid Waste Management, Urbanization

1. Introduction

Climate change is a long-term change in the earth's climate, especially a change due to an increase in the average atmospheric temperature. A number of studies have indicated that there is some relationship between urbanization and climate change.]Urbanization is the physical growth of urban areas as a result of global change. Urbanization occurs because people move from rural areas to urban areas[1]. This usually occurs when a country is still developing. Urbanization will slightly or considerably increase runoff volume, depending on the development rate. The environmental impact of urbanization process was analyzed through the aspects such as urban population, urban land use, solid waste management, surface and ground water hydrology.

1.1 Land Use Pattern:

The earth surface has been significantly altered due to the anthropogenic activities that had a reflective effect upon the natural environment. The adverse effect upon the environment resulted into the observable pattern in the land use over the period. The demographic pressure in the urban area created the scarcity of land. This leads to the construction of buildings over a large area in the rural area. The land use pattern change can affect the: Slope of the land, Erosion rate of the soil, Suitability of the soil, Change in vegetation cover, Change in Local Climate, Run Off Rate, Precipitation, Sedimentation, Drainage pattern, ground water recharge[2].

1.2 Surface Water:

Surface water flow generally occurs when soil is infiltrated to full capacity and the excess water from rain, melt water, or other sources flows over the land. The main changes of the physical pathways of the surface water system due to urbanization which include: Removal of natural vegetation drainage patterns, Loss of natural depressions which temporarily store surface water, Loss of rainfall absorbing capacity of soil, Creation of impervious areas (e.g., rooftops, roads, parking lots, sidewalks, driveways) and Provision of man-made drainage systems (e.g., storm

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sewers, channels, detention ponds). The surface plays an important role in irrigation, domestic usage, Ecosystem etc. Therefore the study of surface water assumes greater importance.

1.3 Ground Water:

Urbanization comes with an increase in non-porous surfaces such as parking lots, streets, driveways and buildings. As a result of the installation of non-porous surfaces, runoff water does not have as much of a chance to seep into underground aquifers and so it runs off into the streams. Increased water in the streams leads to increased stream flow, which in turn leads to increased sediment pollution. As a result, erosion is more pronounced and streams contain more silt and sediment. The demand for the drinking water is increasing day by day due to increase in population and sophistication in the life style of the people. To compensate the need, more number of bore wells are driven which leads to exploitation of the ground water table. This creates a negative effect in the quality and quantity of ground water. Hence the ground water potential and the quality should be studied[3].

1.4 Solid Waste Management:

Solid waste includes domestic, commercial and industrial wastes especially common as co-disposal of wastes. Solid waste management includes proper collection, transfer, recycling and disposal of solid wastes. In many cities the solid waste disposal is inefficient or non-existing. The effective method of handling the solid waste and possible methods of decreasing the production of the solid waste should be predicted[4].

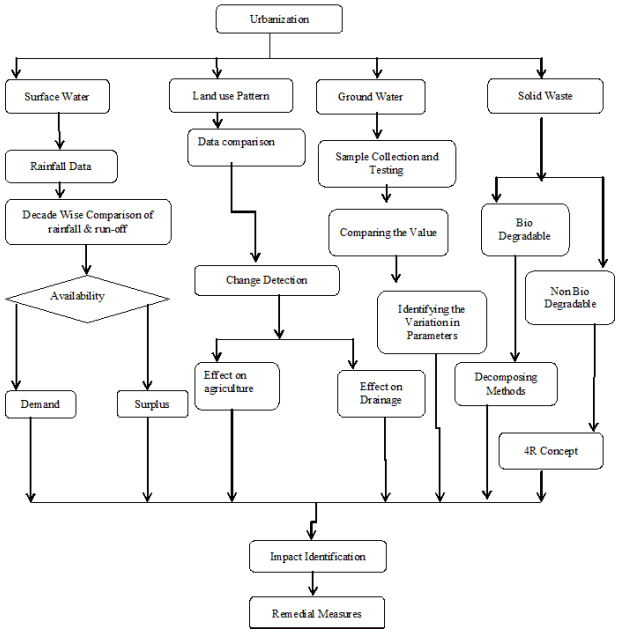
1.5 Study Area:

Tiruchirappalli, better called as Trichy, is the fourth largest city of Tamil Nadu and the transportation center of the State. Tiruchirappalli City Corporation consists of 65 wards and 4 zonal offices, namely, Srirangam, *Ariyamangalam*, Ponmalai and Abishekapuram. In this study, Ariyamangalam zone is focused. This zone has an area of 17.64 acre or 71400 m^2. Ariyamangalam is located at 10.7196°N and 78.68°E. It is located almost at the geographic center of the state of Tamil Nadu. The topology is almost flat with a few isolated hillocks rising above the surface, the highest of which is the Rock fort. Ariyamangalam experiences a subtropical climate. The mean relative humidity is about 58%, while the minimum and maximum temperatures are 40.2° C and 15° C, respectively. The average annual rainfall ranges from 357.7 mm to 364.9 mm. The mean annual evaporation ranges from 1200 mm to 1650 mm and the mean annual runoff ranges from 800 mm to 1850 mm. The average daily sunshine hour is 6.2 hours. The average daily wind speed is 19 km/h from 300° West-northwest[5]. Figure 1 shows the Location Map for Study Area.

2. Objectives:

- To identify the adverse effect of urbanization on the land use pattern, surface water, groundwater and pollution due to municipal solid waste in the study area by accompanying survey.
- To identify the quality variation of ground and surface water from the collected water sample in the study area.
- To determine the possible disposal methods for both degradable and non-degradable waste that creates an impact in the environment and hygiene of the society.

3. Methodology and Materials:



3.1 Data Collection:

Available data and information related to the assessment such us maps, statistical data, population, rainfall, water quality parameters, land use pattern map,

Table 1. Types and Source of Data

Types of Data	Year	Source of Data
Physical Data	1995-1996	Indian department of Remote Sensing and Geo-
1. Land Use Data	2004-2011	graphic Information System (GIS), Chennai.
2. Solid waste generation	2007-2011	Tamil Nadu Pollution Control Board, Tiruchirappalli.
3. Solid waste output per capita		Tamil Nadu Pollution Control Board, Tiruchirappalli.
Biological Data	2003 & 2008	Indian department of Remote Sensing and Geo-
Land use pattern map		graphic Information System (GIS), Chennai.
Social Data	1981-2001	Department of statistics, Tiruchirappalli.
1. Population		Department of survey, Tiruchirappalli
2. Administrative map		
Hydrological Data		Department of Meteorology, Chennai.
1. Rainfall	1990-2010	Tamilnadu Water supply And Drainage board,
2. Water quality parameters		Tiruchirappalli
a) Surface water	2003,	Public Works Department, Chennai.
b) Ground water	2008 & 2012	Department of Economics and Statistics, Chennai
3. Water consumption per capita	2001&2011	Public Works Department, Chennai.
4. Agricultural data	2009-2010	
5. Water resources data	1995&1996	
6. Culturable commanded area	2009-2010	
7. Gross commanded area	2009-2010	
8. Intensity of irrigation	1995 & 2005,	
9. Ground Water Level Data	2009-2010	
	2003 & 2008	

solid waste data and other related data was collected by the offices of local authorities and relevant professional institutions and our team. The types of data and their sources are shown in the Table 1.

4. Results and Discussions

4.1 Land Use Pattern Change:

Table 2. Land use Pattern Change

Land use pattern	1995-1996 (hec.)	2005-2006 (hec.)
Forest lands	234	234
Non available for cultivation	14183	14193
Other uncultivable land	2984	3078
Fallow land	7536	6923
Cropped area	9051	9560
Total geographical area	33988	33988

From the Table 2 it is clear that there is a slight increase in non available area for cultivation, other cultivable land and cropped area. Consequently, there is a decrease in fallow land. The conversion has been taken place in the fallow land. The change in land use pattern affects the run off due to increase in impermeable surface above the soil[6]. The change in run-off has been shown in the below table which has been determined using SCS Curve Number method.

Table 3. Land use & Runoff Change Rate

Month	1995 land use & 1995 rainfall-runoff%	2005 land use & 1995 rainfall-runoff%	1995 land use & 2005 rainfall-runoff%	2005 land use & 2005 rainfall-runoff%
May	2.12	2.22	0.54	0.58
June	0.96	1.01		
July	1.02	1.05	0.97	1.38
Aug	0.88	0.92	0.6	0.97
Sep	1.26	1.29		
Oct	0.31	0.38	2.54	2.63
Nov	2.1	2.2	2.34	2.41
Dec			1.6	1.68
April	1.39	1.42	0.94	0.97

The Table 3 shows that there is an increase in run-off for the 2005-2006 year's land use pattern compared to that of 1995-96. This is mainly due to increase in impermeable surface over soil. This causes adverse effect on percolation of water into ground water table.

Table 4. Survey Questionnaire

S. No	Questions	Yes	No	Smaller	Larger	Don't know
1	Is Water harvesting scheme implemented?					
2	Is this area traffic prone?					
3	Are the water drains provided?					
4	Does the drainage get mixed with river water?					
5	Are there any changes in size of the drains?					
6	Are the drains cleaned regularly?					
7	Is the waste disposed properly?					
8	What kind of waste is generated?	Plastic	Bottle	Coconut shell	Vegetables	
9	Is the air polluted?					
10	Is the surface water source enough?					
11	Is there stagnation of surface water?					
12	Do you use surface water?					
13	Are the agriculture lands available?					
14	What are the changes under gone by the agricultural land?					
15	Is there good yield?					
16	Is the ground water used?					
17	Is Ground water available at required depth?					
18	Is there any change in taste of ground water?					
19	Is there any change in color of ground water?					
20	Is there any change in odor of ground water?					
21	Is the ground water potable?					
22	Is there any change in color of the tooth?					
23	Are there any springs present?					
24	What has been the major source of income?	Industries	Agriculture	Self-employment	Govt. employee	
25	Are there any major impacts of diseases?					
26	Are there any effects due to industries?					

4.2 Survey Questionerie:

Survey questions used for the study is given in Table 4.

4.2.1 Ariyamangalam Zonal Office Back Side:

Figure 2 shows the Ariyamangalam Zonal Office back side's chart for deriving the below result.

Land Use:

- Basically, it is a residential area for Coolie people. The whole barren lands are already converted into residential buildings and lathe workshops, workshops that indulge in selling recyclable wastes from dumping yard.

Solid Waste:

- There are no proper dust bins in this area. Collection of waste does also not exist. Therefore wastes are disposed in the sides of the roads only. The wastes are incinerated by local people and it causes air pollution.

Domestic Water usage:

- There is no disruption in domestic water.

Drainage:

- Open drainage has been constructed properly in the main areas only but there are no facilities for drainage in the interior. There is lack of maintenance and cleaning of blockages. During rainy season water

stagnates. These all are will create the generation of mosquitoes which troubles the community.

Figure 1. Location Map for Study Area.

Pollution:

- Air pollution is majorly due to burning of waste in local sites by local community. Presence of solid waste dumping yard in nearby place will significantly create undesirable smell.

4.2.2 Ambigapuram:

Land use:

- It is a residential area for government staffs. The barren lands are converted into residential buildings.

Solid Waste:

- There are no proper dust bins in this area. Collection of waste does also not exist. Therefore wastes are disposed in the neighbourhood plots. The wastes are incinerated by local people and it will cause air pollution.

Domestic Water usage:

- There is no trouble on domestic water.

Drainage:

- Open drainage has been constructed properly but there is lack of maintenance and cleaning of blockages. During rainy season water stagnates in the area this will creates the generation of mosquitoes which troubles the community.

Pollution:

- Burning of waste by local community is major cause of air pollution in the area. Due to the presence of solid waste dumping yard, undesirable smell is mildly created.

Figure 3 shows the Ambigapuram's chart for deriving the above result.

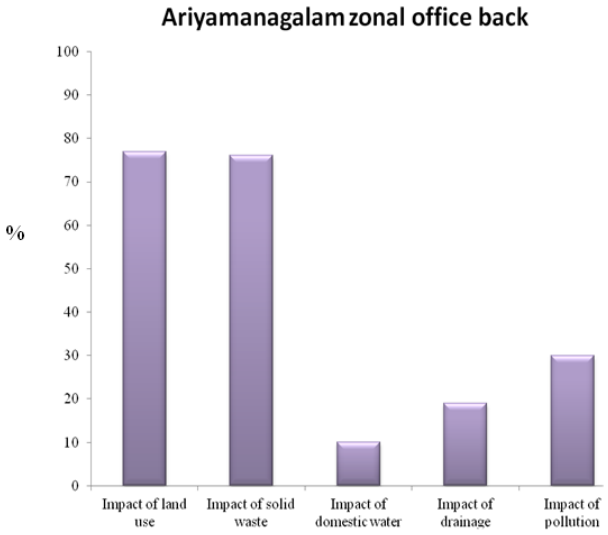


Figure 2. Ariyamangalam Zonal Office Back Side.

4.2.3 Ullur Ariyamangalam:

By using the Figure 4, following results have been made.

Land use:

- This place is a village area that cultivates rice and dal at once in a year. But, all the cultivable lands are converted into residential building. This is mainly due to hike in land rate, poor income in agriculture, and high wages for Coolie's due to introduction of 100 days' work scheme.

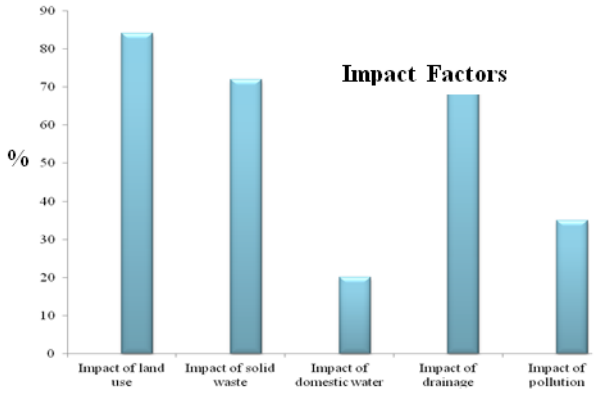


Figure 3. Ambigapuram.

Solid Waste:

- Waste is properly collected but that does not dispose properly owing to absence of dust bins.

Domestic Water usage:

- Even though the pond is available this is not under usage, no scarcity of water. If the pond is reconstructed then it is much helpful for the locality. The size of the channel has been decreased and route has been blocked because of the encroachment.

Drainage:

- Drainage has been good in few areas. The sewage drainage is currently disposed into the unused pond.

Pollution:

- Disposal of sewage into pond will increase mosquitoes and also creates undesirable smell.

4.2.4 SIT:

Land use:

- Basically, this is a residential area of coolies, company workers and government staffs. The barren lands are converted into residential buildings and rice mills.

Solid Waste:

- Waste are properly collected and disposed.

Domestic Water Usage:

- No problem.

Drainage:

- Open type drainage has been constructed and maintained in proper manner.

Pollution:

- It is mainly due to fly ashes from rice mills. The fly ash settles in the drying clothes, in all exposed materials. So, this will affect the local people by wheezing, asthma and other respiratory problem.

The above results are drawn from the Figure 5.

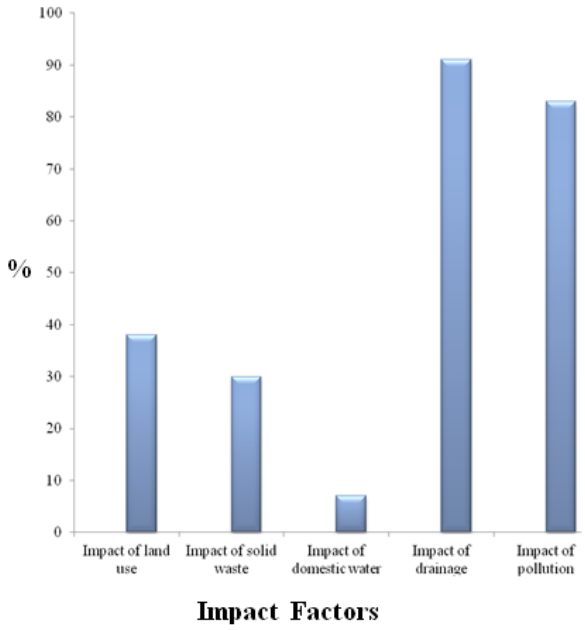


Figure 4. Ullur Ariyamangalam.

4.2.5 Flyover Left:

Figure 6 shows the Flyover Left's impact factor. Using the chart, the following results have been calibrated.

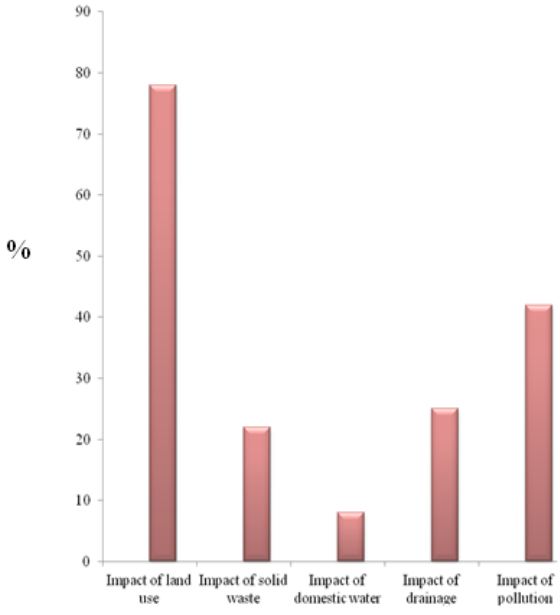


Figure 5. SIT

Land use:

- Fundamentally it is the residential area for Coolie and factory workers. The barren lands are converted into buildings in the adjacent of the roadside. The area away from roadside did not paying attention by the people for building.

Solid Waste:

- No proper dust bins are there but waste is properly collected. Wastes are disposed in the road sides.

Domestic Water usage:

- No problem.

Drainage:

- Open drainage has been constructed and maintained properly in the main areas but maintenance is poor in the inner part.

Pollution:

- No pollution

4.2.6 Gandhi Nagar:

Figure 7 shows the Gandhi Nagar's chart which is useful to derive the below result.

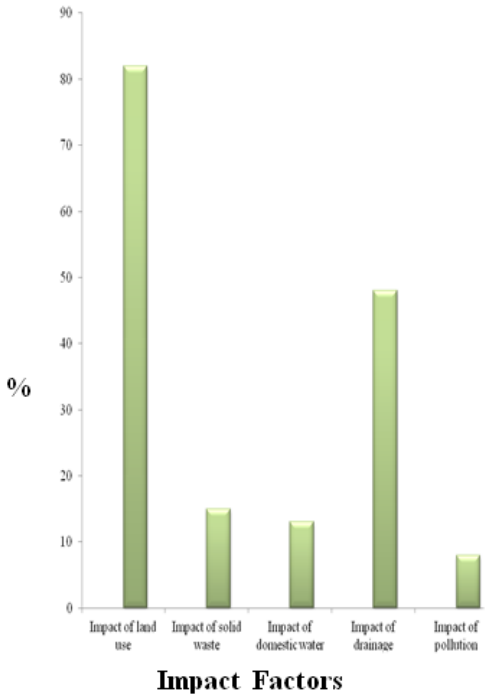


Figure 6. Flyover Left.

Land use:

- Half part of the barren land is converted into residential colonies, other parts are under conversion in slow process. It is a residential area for Coolie people.

Solid Waste:

- No proper dust bins and no proper collection. Therefore wastes are disposed in the road sides. The wastes are incinerated by local people and it causes air pollution.

Domestic Water usage:

1. There is a scarcity of domestic water. People are not wealthy for boring ground water.

Drainage:

- No drainage has been constructed. The drainage is disposed in the nearby channel.

Pollution:

- Septic tank wastes from various locations are disposed in the open barren lands where the local community settled. The usage of channel water to the people causes itches, skin problems. Domestic water usage of channel by local community is minimized due to drainage disposal in it.

4.2.7 IWMUST:

Land use:

- The barren lands are converted into residential buildings. Coolie and company workers are living in this area.

Solid Waste:

- Waste are not properly collected and also not properly disposed.

Domestic Water usage:

- Corporation water is only used. Ground water is not used for drinking purpose since there is an undesirable change in taste due to leachate percolation into ground water table in the nearby area of dumping yard.

Drainage:

- Open drainage has been constructed well but not maintained well. During rainy season the leachate water from dumping yard mixes with rain water and it drain into residential place and create problems.

Pollution:

- Carcasses of livestock are thrown by local people near the dumping yard which creates bad smell. The presence of solid waste dumping yard too smells badly.

The above results are drawn from the Figure 8.

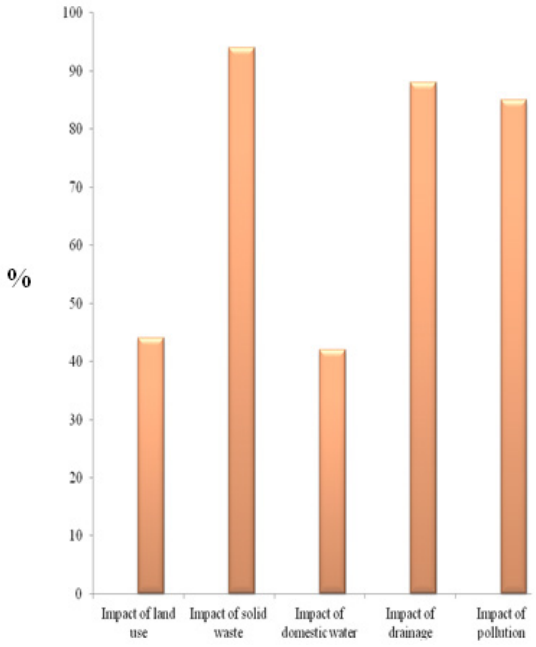


Figure 7. Gandhi Nagar.

4.2.7 Survey Equations:

By using the survey result and chart, the Dominant Eigen value Equations are formed for the study area. Depends upon the magnitude of the impacts, equations are formed and separated.

1. Ariyamangalam Zonal Office Back
   77A+76B+10C+19D+30E= 172.15
2. Ambigapuram
   84A+72B+20C+77D+35E= 217.957
3. Ullur Ariyamangalam
   38A+30B+7C+91D+83E= 180.498
4. SIT
   78A+22B+8C+25D+42E= 128.824
5. Membalam Left
   82A+15B+13C+48D+8E= 127.072
6. Ghandhi Nagar
   44A+94B+42C+88D+85E=250.652
7. IWMUST
   83A+18B+43C+10D+93E= 169.716

Ariyamangalam (Average)

69.42A+46.714B+20.42C+51.14D+53.71E= 196.38

Where,

A = Impact on Land use pattern
B = Impact on Solid Waste
C = Impact on Domestic Water
D = Impact on Drainage
E = Impact on Pollution

By using the survey result and equations, the Dominant Eigen value is found out. Land use pattern is majorly affected by the urbanization in the study area. Pollution is also another problem in the study area. There is a minor effect only on Domestic water by the urbanization.

4.3 Solid Waste Generation:

The Table 5 indicates the increase in solid waste generation, accompanied by increase in solid waste collection. The percentage of collection has been increasing every decade but still the percentage is not with very high efficiency. It is important to note that the decade wise generation rate increases gradually which is mainly due to increase in urban population.

Table 5. Solid Waste Generation Rate

Year	Solid waste generation (tones/day)	Solid waste collection (tones/day)	Collection percentage	Decade wise solid waste generation rate increase in %
1990	60	35	58.33	-
2000	75	50	66.66	25
2011	95	70	73.68	26.67

4.4 Water Sampling:

Groundwater data is usually obtained from bores installed for data collection, but might also be obtained from springs or seeps; water supply bores sumps and drains[7]. If applicable, wetlands, lakes and streams should also be sampled to better define groundwater interaction with the surface environment. The water samples were collected from open and boreholes in the study area. One

and half litre of water samples were collected polythene bottles from various wells during the month of February 2012. Totally five samples were collected from 5 locations, for analysis various physical and biological parameters. The water samples are collected by following standard procedure which will gives the standard result about the water quality parameters. The figure 10 shows the water sampling test result collected from the Tamilnadu Water supply and Drainage Board for South Ukkadai.

Where,

OW = Open Well

BW = Bore Well

The results (Table 6.) suggest that the ground water is safe for drinking and commercial usage but the channel water is unfit for drinking since the presence of high level of ammonia. This channel water is fit for agricultural purpose.

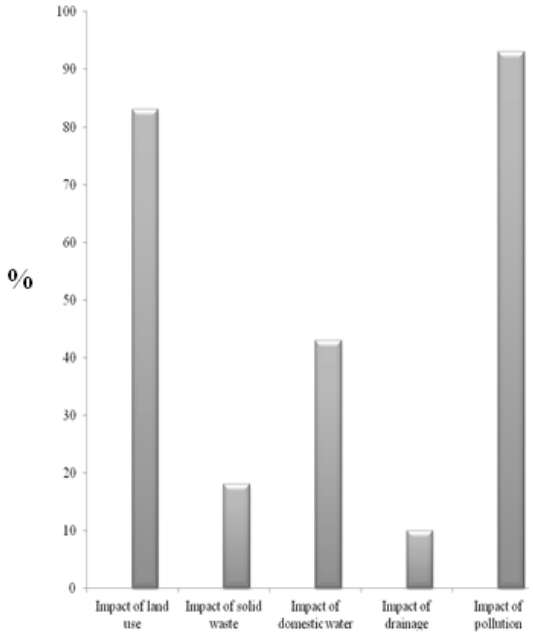


Figure 8. GIWMUST.

Table 6. Impact on Water Quality Parameters

S.No	Parameters	No	Yes	Major	Medium	Minor
1	Turbidity					
2	TDS mg/l			Anthoniyar Nagar (ow)	South Ukkadai (BW)	
3	Electrical Conductivity			Anthoniyar Nagar (ow)	South Ukkadai (BW)	
4	P^H					
5	Phe. Alkalinity as $CaCO_3$					
6	Alkalinity as $CaCO_3$ Total					
7	Total Hardness as $CaCO_3$			Anthoniyar Nagar (ow)		
8	Calcium			Anthoniyar Nagar (ow)		
9	Magnesium			Anthoniyar Nagar (ow)		
10	Iron					
11	Manganese					
12	Free Ammonia				Anthoniyar Nagar (Channel),MGR Nagar (Channel)	
13	Nitrite(NO_2)				MGR Nagar (Channel)	Anthoniyar Nagar(ow)
14	Nittrate(NO_3)			Anthoniyar Nagar (ow)		
15	Chloride			Anthoniyar Nagar (ow)		
16	Fluoride					
17	Sulphate					
18	Phosphate			Anthoniyar Nagar (Channel),MGR Nagar (Channel)	MGR Nagar(BW)	
19	Sodium			Anthoniyar Nagar (ow), South Ukkadai (BW)		
20	Pottassium			Anthoniyar Nagar (ow), South Ukkadai (BW)		

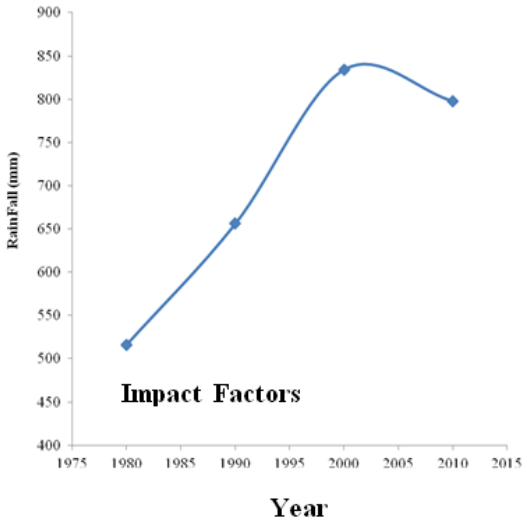


Figure 9. Decade vs. Rainfall.

5.5 Rainfall Data Analysis:

Rain fall amount for four decades (1980, 1990, 2000 and 2010) are compared with each other. The amount of rainfall is decreased in 2010 when compared to 2000. But the survey result shows that there is no demand for surface water in the study area which is depicted in the Figure 9.

5. Conclusion:

The following are the conclusions derived from the survey results interpreted with the government data.

5.1. Zonal Office Back and Ambigapuram:

- Dustbin should be placed in every street. Solid waste

TAMIL NADU WATER SUPPLY AND DRAINAGE BOARD
DISTRICT WATER TESTING LABORATORY,OLD POST OFFICE ROAD
CONTONMENT TRICHY- 1 PHONE : 2400868

From
D.Benzamary
Junior Water Analyst,
District Water Testing Laboratory,
Trichy.

To
G.Yamuna,Student,
BE- Final Year,
Deparment of Civil Engineering,
Anna University of Technology,
Trichy.

Lr.No.7907/JWA/LAB/TRY/2011/Dt.20/02/2012

Sir,

SUB: Examination of Water Sample-Report Submitted-Reg
REF: Lr.No.Nil/dt.17/02/2012
The result of analysis for the given sample sent in the reference is enclosed.

HABITATION	Ariyamangalam	TYPE OF SOURCE	BW
LOCATION	South Ukkadai	TYPE OF SCHEME	HP
PANCHAYAT	Trichy City corporation	EXISTING&NEW	Existing
UNION	Trichy City corporation	DATE OF COLLECTION	17/02/2012
VILLAGE	Ariyamangalam	COLLECTED BY	G.Yamuna Student
DISTRICT	Trichy	INVOICE NO & DATE	6822.dt 17/02/2012

PHYSICAL EXAMINATION	(A)	(B)	49490
Appearance			C&C
Colour (Pt.Co.Scale)	5	25	
Odour	Unobjectionable		None
Turbidity NT Units	2.5	10	1
Total Dissolved Solids mg/l	500	2000	2485
Electrical Conductivity(Micromho/Cm)			3550
CHEMICAL EXAMINATION			
pH	7.0-8.5	6.5-9.2	7.2
Phe.Alkalinity as CaCO3			0
Alkalinity as CaCO3 Total	200	600	496
Total Hardness as CaCO3	200	600	455
Calcium as Ca	75	200	113
Magnesium as Mg	30	150	41
Iron as Fe	0.1	1	0.00
Manganese as Mn	0.05	0.5	0.00
Free Ammonia as NH3			0.00
Nitrite as NO2			0.00
Nitrate as NO3	45	100	47
Chloride as Cl	200	1000	780
Fluoride as F	1	1.5	0.2
Sulphate as SO4	200	400	78
Phosphate as PO4			0.00
Tidy's Test 4 hs as O			0.64
Sodium as Na			520
Potassium as K			48
Feacal Coliform per 100ml	Nil	Nil	NT

Results of Chemical Examination are expressed in mg/l
(A) CPHEEO Standards - Acceptable limit
(B) CPHEEO Standards - Cause for rejection when exceeds
C&C -Colourless & clear TNTC-Too numerous to count
NT-Not tested

D.Benzamary 20/2/12
Junior Water Analyst,
District water testing Laboratory,
Trichy.

Figure 10. Test Result for South Ukkadai (BW).

should be collected properly by corporation. This will reduce the air pollution caused when the uncollected wastes are burnt.

- Drainage should be laid for the sub main streets too and it should be properly maintained.

5.2 IWMUST Area:

Leachate should be reduced. Mixing of rain water with water from dumping yard should be reduced. Disposal of carcasses near dumping yard should be prohibited.

5.3 Flyover Left:

Drainage should be provided in the inner part which is away from road.

5.4 Gandhi Nagar:

Disposal of sewage waste in open land should be prohibited. Drainage should be constructed in the area. The area suffers with drinking water problem. Disposal of sewage in channel water affects the domestic usage of channel water.

5.5 SIT:

Husk ash emission should be retarded. Expansion of building construction towards the Ulur Ariyamangalam should be retarded.

5.6 Ullur Ariyamangalam:

Due to high wages for agriculture Coolies and poor selling price of paddy, the farmers are pushed to convert the farm land into plots. The farms should be protected. The unused pond should be renovated. Inflow and outflow channels should be deepened and widened. Solid waste collection bins should be placed. Since the sewage waste is disposed in channel water it should be used only for agricultural purpose.

6. References

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