

IMPACT OF URBANIZATION ON THE WATER RESOURCES AND THEIR MANAGEMENT IN PONDICHERRY

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ABSTRACT

The city of Pondicherry, which constitutes 68.3% of the land area and 75.3% of the population of the four-town conglomerate of the Union Territory of Pondicherry – the other three constituents being Karikal, Mahe, and Yanam; each being a land-locked 'island' in the states of Tamil Nadu, Kerala, and Andhra Pradesh – is much better endowed in terms of water resources than other regions on the east coast of the Indian peninsula. The city typifies the present trend of rapid urbanization occurring all over India with its attendant benefits and problems. Among the exceedingly pressing problem is the growing decline in the availability and quality of water.

In this paper the authors describe results of several surveys which have led to the first-ever extensive documentation of the water quality in some of the heavily industrialized pockets of the city, as also base-level data on the extent of salinization of the coastal wells.

In the paper, the authors have also identified water management strategies relevant to the city by which the present trend of declining water availability and quality can be reversed.

1.0 INTRODUCTION

The Union Territory (UT) of Pondicherry has unique geography. Its four constituent towns are situated as land-locked islands (Figure 1) in the States of Andhra Pradesh (Yanam), Kerala (Mahe), and Tamil Nadu (Pondicherry and Karaikal). The capital, Pondicherry, is not a contiguous territory either – its pockets are interspersed with the Tamil Nadu territory (Figure 1) and there are situations when one door of a house is in Pondicherry and another door in Tamil Nadu.

Whereas Goa, Daman and Deu were colonized by the Portuguese and most of the rest of India by the British, the UT of Pondicherry was under French occupation. The territory achieved independence in 1954, its colonizers departing under much less vitiated atmosphere than the British or the Portuguese did. The territory, especially Pondicherry, continues to nurture educational and cultural institutions set up by the French. From the point of view of water resources development and management, the Pondicherry city harbours several relics of the French technology most of which, sadly, are in disuse and disrepair.

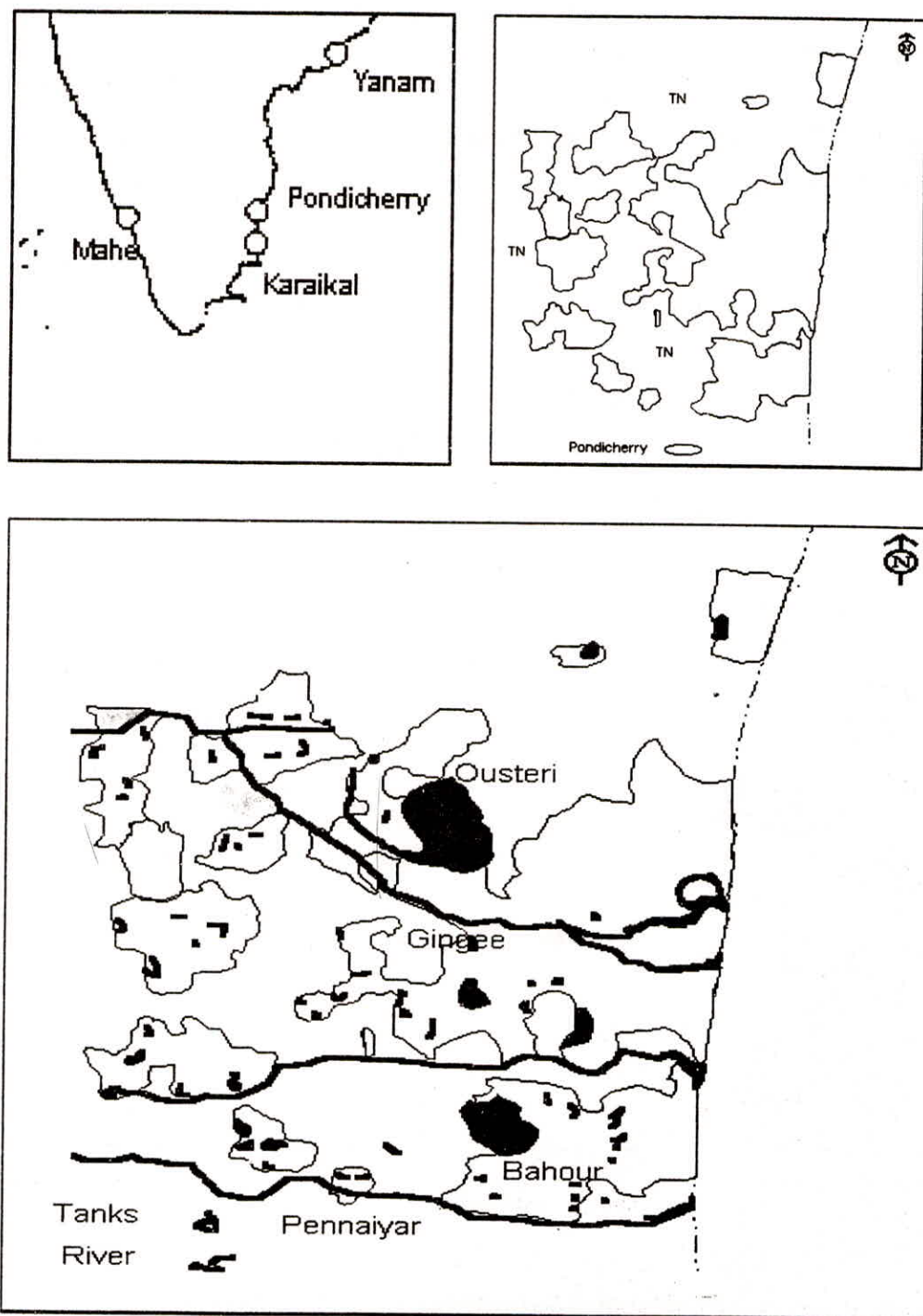


Fig. 1 : Location of Pondicherry Union territory and the water resources of Pondicherry region

The present day Pondicherry is a rapidly burgeoning city with an increasing influx of new settlers as well as a large 'floating populations'. Both types of people are putting ever increasing pressure on the city's resources and its environment. The availability and the quality of water is one of the most worrisome of the resultant problems. In this paper the focus is on the city of Pondicherry and wherever Pondicherry is mentioned it implies the city; when the name is used to indicate the union territory, it is mentioned as "UT of Pondicherry".

2.0 METEOROLOGY AND WATER RESOURCES

Pondicherry is situated close to Chennai (140 Km South) on the east coast of the Indian peninsula. The region has less severe weather – in terms of ambient temperatures (Figure 2) and humidity – than Chennai. Pondicherry also receives more rainfall than Chennai does. The bulk of the precipitation occurs during the North-East monsoon (about 800 mm), and about half this amount during the South-West monsoon (Figure 3). Pondicherry also receives some rainfall during summer and winter (Figure 3). In some years the city has rainy days occurring in all but one or two months (Table 1).

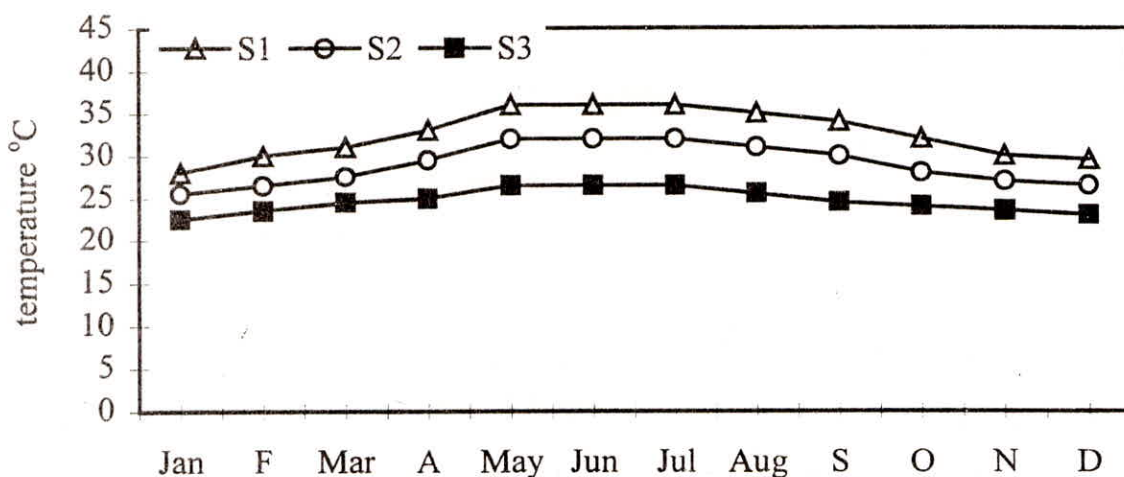
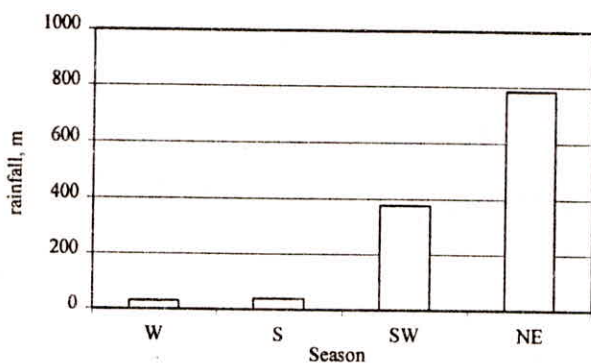


Fig. 2 : Annual patterns of the minimum (S1), average (S2) and maximum (S3) temperature in Pondicherry

Table 1 : Rainfall over Pondicherry, 1975 – 97

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
1975	2	-	19	-	26	50	190	197	110	163	428	53
1976	-	-	-	4	-	9	60	123	55	216	500	175
1977	16	6	-	2	63	38	25	199	92	570	561	31
1978	3	-	-	2	9	18	106	78	343	249	578	470
1979	-	31	15	-	77	16	2	34	237	355	544	142
1980	-	-	-	0.5	7	13	124	72	91	137	281	69
1981	4	-	-	-	120	8	114	77	119	332	132	188
1982	5	-	-	5	7	82	101	30	75	91	292	154
1983	-	-	-	-	17	6	72	176	118	299	320	531
1984	42	272	36	28	-	18	198	78	117	64	321	107
1985	187	-	-	-	30	261	81	167	216	313	655	117
1986	104	25	43	-	2	30	5	107	27	117	210	133
1987	6	-	45	-	-	64	-	35	165	252	208	378
1988	32	-	6	21	58	6	54	215	84	6	464	NA
1989	15	-	-	-	80	-	94	20	77	88	517	NA
1990	54	30	4	-	12	94	55	237	193	546	211	24
1991	57	7	-	-	-	131	26	103	161	400	299	20
1992	5	-	-	-	20	46	46	45	169	99	449	75
1993	-	8	31	-	46	100	59	90	165	336	458	384
1994	-	65	-	-	5	27	92	142	32	249	376	235
1995	41	-	-	5	174	18	113	144	113	192	150	16
1996	-	-	-	-	83	229	25	253	326	202	301	736
1997	12	-	-	-	19	51	142	265	97	112	711	-

Two rivers which have most of their run in Tamil Nadu, flow through Pondicherry as well : Gingee (or Sankaraparani) and Pennaiyar. These are seasonal; and run dry whenever rains cease.



W : Winter (Jan & Feb) S: Summer (March - may)
 SW: South west monsoon(Jul - Sept) NE:North east monsoon (Oct- Dec)
Figure 3 Rainfall in Pondicherry across different seasons (10
 Year average: 1975- 84)

2.1 Surface water

The bulk of the surface water resources of Pondicherry is provided by 'tanks' and ponds. As many as 86 larger 'tanks' (natural depressions made more voluminous by selective dredging and bunding) and ponds, and 140 smaller ones, dot the Pondicherry landscape (Figure 1). The largest of these is the Oussudu lake. The lake has been identified by IUCN (International Union for Conservation of Nature) as one of the most important wetlands of Asia (Scott 1989). It is a major wintering site for migratory birds and plays a crucial role in recharging the aquifers at Muthirapalayam water works which supply drinking water to Pondicherry.

2.2 Ground water

Pondicherry region is covered by alluvial and sedimentary formations. Ground water occurs both under confined and unconfined conditions in the sedimentary formations. The shallow alluvial aquifers, the deep Cuddalore sandstone aquifers and Vanur – Ramanathapuram aquifers constitute the three major potential water-bearing systems of this region. Ground water from these aquifers is developed by means of shallow and deep tube wells. The major source of recharge are the precipitation, flow from the agricultural lands, and seepage from existing tanks and ponds.

3.0 WATER RESOURCES ASSESSMENT

The Public Works Department, Pondicherry, in consultation with Water and Power Consultancy Services Ltd., New Delhi, has assessed the availability and utilisation of water for the present and the foreseeable future upto 2006 A.D. as follows:-

The 1996 situation :

	Surface water	Ground water	Total
Water Availability	35.00 mm ³	150.00 mm ³	185.00 mm ³
Water required	35.00 mm ³	151.50 mm ³	186.50 mm ³
Water balance	0.00 mm ³	(-) 1.50 mm ³	(-)1.50 mm ³

The 2006 forecast :

	Surface water	Ground water	Total
Water availability	75.00 mm ³	150.50 mm ³	225.50 mm ³
Water required	75.00 mm ³	167.00 mm ³	242.00 mm ³
Water balance	0.00 mm ³	(-)16.50 mm ³	(-) 16.50 mm ³

Being in the middle of the 1996-2006 time-span we see that the surface water availability has not increased from the 1996 estimate (of 35 mm³) but the demand has. And for groundwater, which already was in deficit in its demand – supply equation, the size of the deficit is widening.

The causes and the possible remedies

For centuries the plentiful rainfall over Pondicherry, coupled with its elaborate system of tanks and ponds (called *eris* in Tamil) to capture the bounty, had ensured that Pondicherry remained a water-surplus oasis in the midst of draught-prone Tamil Nadu. Even today, with so much more demand for water than ever before, Pondicherry can remain water surplus. The reasons for why it is not so lie in the manner in which water and land is being managed in Pondicherry.

The negligence of *eris*, mentioned earlier, has harmed the water resources in two ways. Firstly it has reduced the ability of the city to capture and store rainwater thereby hindering groundwater recharge. Secondary it has propelled gross overuse of groundwater, multiplying the stress on the aquifers.

The only possible way in which this trend can be reversed is to restore the *eris* and even create new ones.

4.0 WATER QUALITY

We present here the gist of several surveys which illustrate the shape of things.

4.1 Quality of groundwater

Aquifers near the coast

Fortyfive dug-wells and bore-wells were studied for their water quality, covering the entire Pondicherry coastline (Table 2). The majority fails to comply with the drinking water quality guidelines set by Bureau of Indian Standards. The variable most often exceeding the limits is salinity, indicating the increasing ingress of salt water.

Aquifers in a typical industrial area

One of the industrialized regions of Pondicherry is comprised of the twin villages of Pillaiyarkuppam and Kirumampakkam. Extensive studies on the groundwater quality revealed the following (Abbasi & Vinithan 1997, 1999):

- 1) In 100% of the samples, total dissolved solids (TDS) levels exceeded the permissible limits for drinking water.
- 2) Hardness surpassed the permissible limits for drinking water in 72% of samples.

*Table 2. Water quality of coastal wells at Pondicherry.
All values except pH (units) and EC (m μ) are in mg / litre. Hardness has
been expressed as my CaCo₃/l*

Sl. No.	Location	pH	EC	Acidity	Alkalinity	Chloride	TDS	Hardness
1.	Abhishakapakkam	6.9	1146.7	32	264.1	171.9	283.6	334.6
2.	Andiyarpalayam	7.0	881.7	29	203.3	123.7	617.2	238.3
3.	Ariyankuppam	6.8	2235	44.8	644.8	694.7	1146.3	880.7
4.	Auromodel City	6.2	200	34.3	97.1	138	227.6	36.3
5.	Bahour	6.5	316.7	38.4	104.8	242.9	399.1	113.2
6.	Bomiyarpalayam 1	6.0	343.3	21.7	521.9	162	267.2	122.5
7.	Bomiyarpalayam 2	6.6	1168.7	23.7	103.3	183	818.1	232.7
8.	C.Kalapet 1	6.0	116.7	49.7	190.8	108	178.2	31.4
9.	C.Kalapet 2	6.6	328.7	13.6	63.3	29.7	230.1	69
10.	C.M.Chavadi	6.9	852.3	10.8	67.3	126	596.6	272
11.	Echankadu	7.1	2193.3	24.7	186.7	607.3	1535.3	422.3
12.	Kakayanthopu	7.5	914.7	19.7	243.3	134.7	640.3	222
13.	Kanniyakoil	6.8	1103.3	27.2	158.4	125	206.3	182.04
14.	Karikalampakkam	7.1	963.4	36.8	361.2	107	176.6	221.4
15.	Keerapalayam	7.6	2115	16.8	637.2	589.8	973.2	780.1
16.	Kottakuppam	6.7	871	10.4	83.3	244.3	609.7	333
17.	Kottamedu	7.9	246.7	23.8	74.5	66	108.9	21.5
18.	Kuilapalayam	6.1	206.7	12.6	467	52	85.7	36.3
19.	Kurichikuppam 1	7.6	1183	35	472.6	231.9	382.6	294
20.	Kurichikuppam 2	7.3	1020	9.7	173.3	156	714	284.3
21.	Manapet	7.9	1871.7	11	193.3	335.7	1310.2	344
22.	Murthykuppam	6.8	216.7	4.8	34.2	105.9	174.7	93.5
23.	Nallavadu	7.4	5106.7	94.4	628.1	1769.4	2919.5	1180.8

24.	P.Kalapet 1	6.6	453.3	11.9	250	120	197.9	96
25.	P.Kalapet 2	6.8	480.3	16	40.7	58	336.2	72.7
26.	P.Muddaliar Chavadi 1	6.0	303.3	30.1	89.5	124	204.5	79.4
27.	P.Muddaliar Chavadi 2	6.7	1196	9.9	50	31	837.2	72.7
28.	Pannithitu 1	6.8	1060	12.8	131.8	241.9	399.1	312.1
29.	Pannithitu 2	7.3	2014.7	16.7	173.3	512.3	1410.3	416.7
30.	Pillaichavady 1	6.3	363.3	50.4	210.7	116	191.2	106.8
31.	Pillaichavady 2	6.4	309.3	12	56.7	18.7	216.5	61.7
32.	Pondy Town	7.7	637	8.3	163.3	68	445.9	134.7
33.	Pudukuppam 1	6.6	1660	36.8	457.6	185.9	306.7	861
34.	Pudukuppam 2	7.2	1772	23.3	213.3	451.7	1240.4	527.7
35.	Pillaiyarkuppam 1	6.8	1463.3	22.4	140.4	291.9	481.6	450.2
36.	Pillaiyarkuppam 2	7.2	3655	22.7	193.3	1514.7	2558.5	889.
37.	Purnangkuppam	6.6	2360	22.4	351	313.9	517.9	553.5
38.	Tandirakuppam	6.1	423.3	40.9	38.8	98	194.6	134.5
39.	Uppalam	7.3	1683	35.7	947.1	361.9	597.1	388.1
40.	Veerampatinam	6.9	1160	65.6	509.6	504.8	832.9	462.5

- 3) Several other parameters – sulphate, phosphorous, total dissolved solids (TDS) etc – were above limits in *majority* of cases.
- 4) Most alarmingly, there were excessively high levels of heavy metal in the groundwater samples : mercury was found in concentrations 150 to 1100 times higher than the permissible limit for drinking water. Arsenic and cadmium were two of the other toxic elements occurring above permissible limits (Figure 4).

4.2 Quality of surface water

We have conducted a very elaborate study of the largest of the water bodies of Pondicherry – the Oussudu lake (also called Ousteri). The findings, which have been detailed elsewhere (Chari 1998, Chari & Abbasi 2000) reveal that :

- a) The lake is very rapidly inclining towards eutrophication.

- b) The tilt has become alarmingly acute in the last three years after a decision was taken to stop periodic release of water – which used to be done earlier, and which apparently flushed out excess nutrients.
- c) The entire lake is now choked with submerged weeds and islands of *Ipomea carnia*. This has adversely affected the richness and diversity of fish fauna to an alarming extent.
- d) If the trend is not reversed quickly, the lake may silt up completely within the next few years.

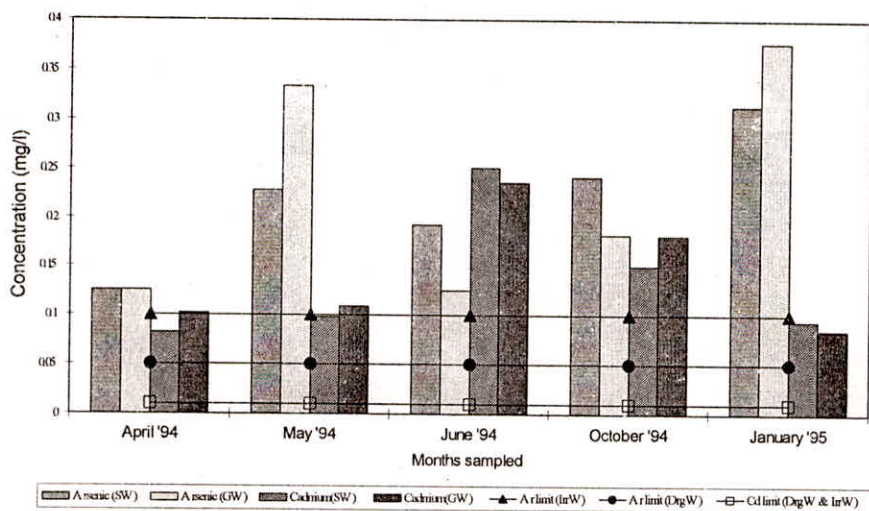


Figure 4 : Arsenic, Cadmium content of surface and ground water samples

5.0 SUMMARY AND CONCLUSIONS

- i. Pondicherry is blessed with more moderate climate and plentiful rainfall than most areas of the larger state (Tamil Nadu) of which Pondicherry is an enclave.
- ii. Pondicherry has also been bestowed with a very large network of *eris* –tanks and ponds – which capture rainwater and make it available directly as well as in the form of recharged groundwater.
- iii. Pondicherry is also unique in the sense that eventhough it is a small city, it happens to be a capital city, the seat of the Government of Pondicherry. This should theoretically, make it much easier for the governmental agencies to monitor the natural resources of the region and for them and the end-users to come together in solving problems.
- iv. Yet Pondicherry is suffering from the same 'ills that have palgued other cities and towns in India - shortage of water and pollution of what is available.

- v. In order to reverse the trend of declining water availability and quality the authors propose the following measures:
- a. restoration of the *eris* by involving end-users in the way it used to be in the past;
 - b. strict control over extraction of groundwater, especially for irrigation and industry;
 - c. strict control over release of liquid or solid industrial wastes, on land or in public sewers;
 - d. a continuous programme of public awareness and involvement in water conservation, harvesting, and prevention of pollution.

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