IWMI-TATA WATER POLICY RESEARCH PROGRAM

ANNUAL PARTNERS' MEET 2002

Wastewater and Welfare:

Pump Irrigation Economy of Peri-Urban Vadodara

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WASTEWATER AND WELFARE: PUMP IRRIGATION ECONOMY OF PERI-URBAN VADODARA

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List Of abbreviations

BOD	- Biological Oxygen Demand
COD	- Chemical Oxygen Demand
CS	- Cropping Sequence
DS	- Domestic Sewage
ECP	- Effluent Channel Project
ECPL	- Effluent Channel Project Limited
GIDC	- Gujarat Industrial Development Corporation
GPCB	- Gujarat Pollution Control Board
GWSSB	- Gujarat Water Supply and Sewerage Board
MGD	- Million Gallons per Day
MLD	- Million Litres per Day
PST	- Primary Settling Tank
RRA	- Rapid Rural Appraisal
STP	- Sewage Treatment Plant
VMC	- Vadodara Municipal Corporation
VUDA	- Vadodara Urban Development Authority
WW	- Wastewater

Wastewater and Welfare: Pump Irrigation Economy of Peri-Urban Vadodara

Vaibhav Bhamoriya

Abstract

Wastewater treatment is believed to be a very costly proposition. A masterplan for the city of Vadodara puts the costs at Rupees 3735 million for a perspective plan for twenty-five years. This study reveals (figures tentative) that wastewater flowing from the city sustains an agricultural economy worth Rupees 825 million annually over a hundred villages and 130 Kms of linear distance. It is time wastewater is recognized as a planning and design variable for area development, economic planning and resource management. Scientific analysis of health hazards needs to be done to ascertain the truth regarding many myths. The governing agencies should be exploring possibilities of treated Wastewater irrigation schemes in Semi-arid and Arid regions.

Introduction

Located in the plains between the rivers Narmada and Mahi and on the banks of river Vishwamitri, Vadodara city lies on the $22^{o}\ 17^{0}\ 59^{0}$ N latitude and $73^{0}\ 15^{0}\ 18^{0}$ E longitude with a gentle slope from north east to south west. The city has moderate climate with an average rainfall of 800mm[1] annually spread over 3 to 4 months. It is one of the key industrial cities of Gujarat. The present municipal area of Vadodara is 108 sq. Kms with a population of approximately 14 lakhs.

Vadodara has a large industrial complex in the Nandesari – Bajwa- Koyali area that helped the study of industrial wastewater also along with domestic sewage. The old town of Vadodara had a piped water supply system since 1894. Two years later the city acquired piped sewerage facilities as well. However, the first sewage treatment plant of the city was commissioned only in 1952 in the *Wadi* area and it had only primary treatment facility with a capacity of 18 MLD. A 27 MLD treatment plant at *Atladra* was set up in the late 60s followed by another passive treatment plant of 9 MLD capacities at *Tarsali*.

A master plan for sewerage for the city was prepared in 1985 but it could not be fully implemented. The sewerage in the city has been extended on priority basis from time to time based on the availability of fund. Though this has led to a vast sewerage system in the city it still leaves about 35 % percent of the city area uncovered. Presently the sewerage is divided into three zones.

The wastewater use in the peri-urban areas of the city is spread over a large tract of land along the rivers Vishwamitri and Dhadar that has water scarcity and salinity problems. This tract is technically a no-source zone of water. Nonetheless, this location is suited to wastewater use, as a large population in the area subsists on agriculture.

[1] *Source: Report on Master Planning of sewerage system, AIC Watson Consultants Limited, December 1999*

Waste-water Economy in Peri-urban Vadodara

As mentioned earlier, a part of the land in the area receives industrial wastewater and some areas receive domestic sewage. The industrial sewage is being managed through the Effluent Channel and the domestic sewage after some treatment is being channeled into the rivers Vishwamitri, Jambuva and to Dhadar as mentioned below:

1. *Industrial Effluent*: this is disposed of via the Effluent channel disposal facility of the ECPL, the first of its kind in Asia. The channel runs through 56 Kms. to dispose of the wastewater generated from the Nandesari industrial Estate and the Petrochemical and refining industries in downstream areas.

2. *Domestic Sewage*: this is sewage and wastewater collected by the Municipal Corporation flowing into the sewage facility. This also covers the areas not covered by the system as the wastewater generated in these areas also flow into the network of natural drains called Kaans which take it and discharge it into the rivers Vishwamitri and Jambuva. Thus the drainage from the area also goes into the same discharge as the drainage from the sewered areas after is released from the treatment plant.

The domestic sewage from the city flows as wastewater through the ruparel Kaans, Jambuva River and the Vishwamitri River onto the river Dhadar. These rivers are all inundation rivers for collecting and discharging the excess water from rains into the sea. These have however been made perennial by the wastewater flows from the city. The total flow length of these rivers would be something like 80 kilometers. Thus the total flow length of the wastewater flows adds upto something like 130 kilometers.

ECPL

The Industrial complex near Vadodara comprises some large, medium and numerous small industrial units. These units being very close to the Mahi River posed a threat to the river water as well as the underground freshwater through pollution with the industrial effluents. In order to take corrective measures the State Government entrusted the Gujarat Industrial Development Corporation (GIDC) with the responsibility of developing a project for disposal of these effluents at a safe point in the Gulf of Cambay. The effort was the first project of its kind in Asia – the Effluent Channel Project (ECP) that was completed and commissioned in 1983.

Today the ECP, a 55.6 km long masonry channel, receives 18 million gallons per day (MGD) of treated effluent at 9 intake points and through a no source zone of water and discharges the effluent into the gulf of Cambay. Total cost of the project in 1983 was Rs 13 crores, contributed by the industries on pro-rata basis.

The project meant initially for 9 industries now caters to 33 industries. This includes the common treatment plant discharge form the industries of upstream Nandesari industrial estate.

This effluent flow of the ECP has become a life saviour for the farmers on both sides of the flows. Paddy and tobacco, the major crops of the region, are dependent on assured and reliable supplies from the ECP. However trend beyond the village *Uber* towards the disposal point “J” appears to be different. The farmers in these areas stated that there was quality problem of the wastewater and hence, there was restricted use by them. The use of this water upstream of *Uber* is very widespread.

Domestic Sewage

The Domestic Sewage and its use in agriculture in peri urban areas is an even more interesting study. Though it is difficult to understand the complex nature of its use due to intermixing of variables and their overlap, it does represent a richer and accepted source of irrigation..

The wastewater from domestic sewage as a resource contains lot of organic material along with night soil. This night soil is a rich traditional input contributing to increase in agricultural production. However the growth of industries within city limits and the practice of illegal effluent discharge without proper treatment and illegal industries add to the quality problem for wastewater measurement, monitoring, treatment, and hence management.

Collection

The domestic sewage system in Vadodara as described in the master plan for the city sewage and storm water drainage is divided into three main zones. These three zones are similar to three micro catchments and collect wastewater and drain them into the common drainage channel – River Vishwamitri. These three zones are as follows.

Drainage zone I: The entire area south of meter gauge railway line and east of River Vishwamitri -- which is trapped by the Tarsali Sewage Treatment Plan.

Drainage zone II: The entire area north of the meter gauge railway line and East of the River Vishwamitri – which is trapped by the Wadi Sewage treatment plant.

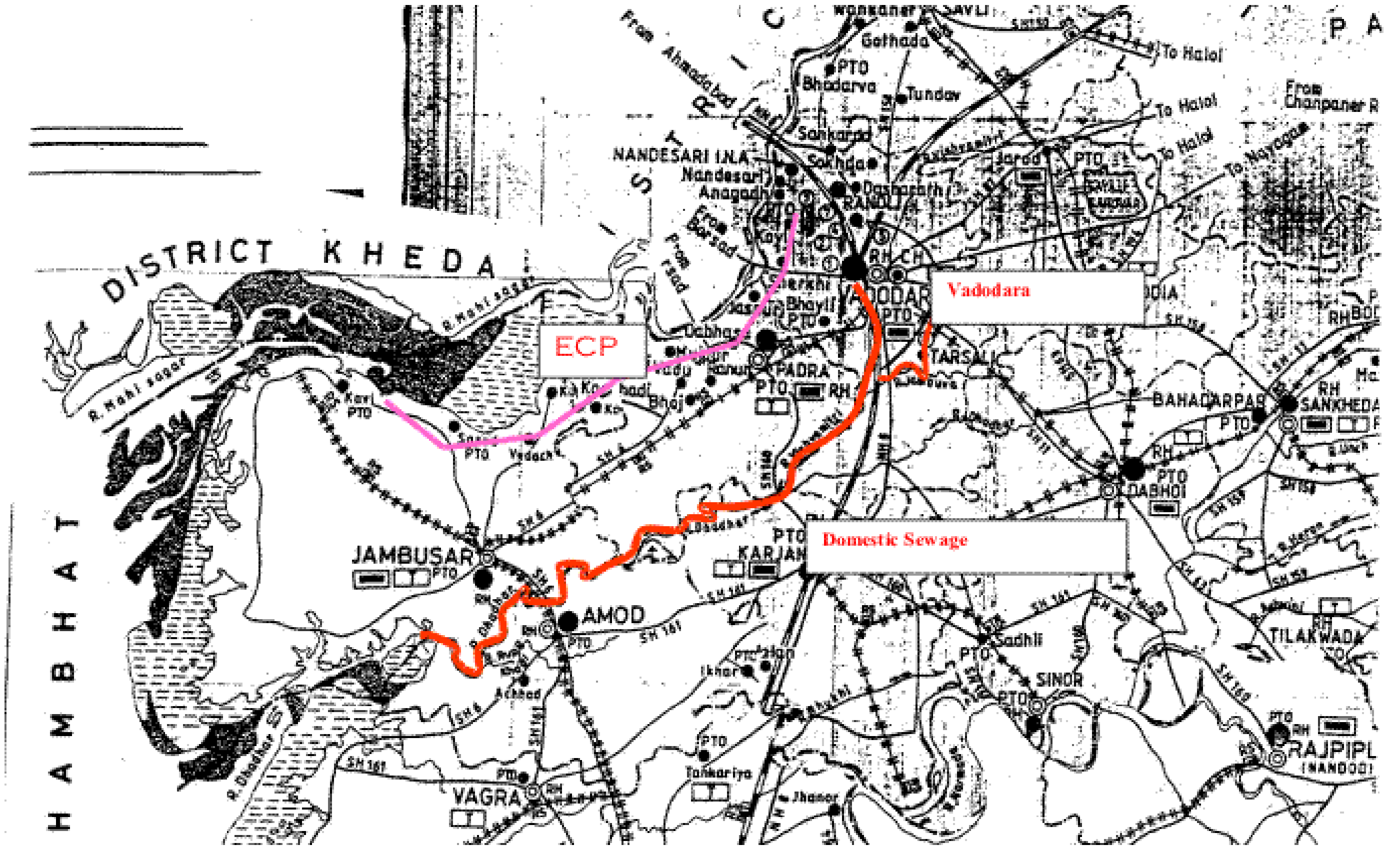
Drainage Zone III: The entire area west of River Vishwamitri – this is trapped by the Atladra Sewage Treatment plant (STP).

Treatment

At present none of the three STPs of the city is in working condition. The oldest STP at Gajrawadi has become irreparable and cannot be rehabilitated. This STP has trickling filter technology and presently receives about 85 MLD of sewage. As stated earlier this is directly passed into the *Ruparel Kaans* now.

Another plant at Atladra only has the Primary Settlement Tank (PST) in working condition that receives about 60 MLD sewage. Of this only 27 MLD sewage is treated and the rest is passed untreated into river Vishwamitri.

The Tarsali STP receives some industrial sewage as well along with domestic sewage. The plant that has a capacity of around 9 MLD receives around 40 MLD of sewage per day. It employs oxidation ditch technology, which has now become obsolete. The wastewater is first carried to Ruparel Kaans and then discharged into river Jambuva.



Source: District Census report 1991, Census Department, Government of India, 1991.

Figure 1: Study Area for Wastewater reuse using pumps

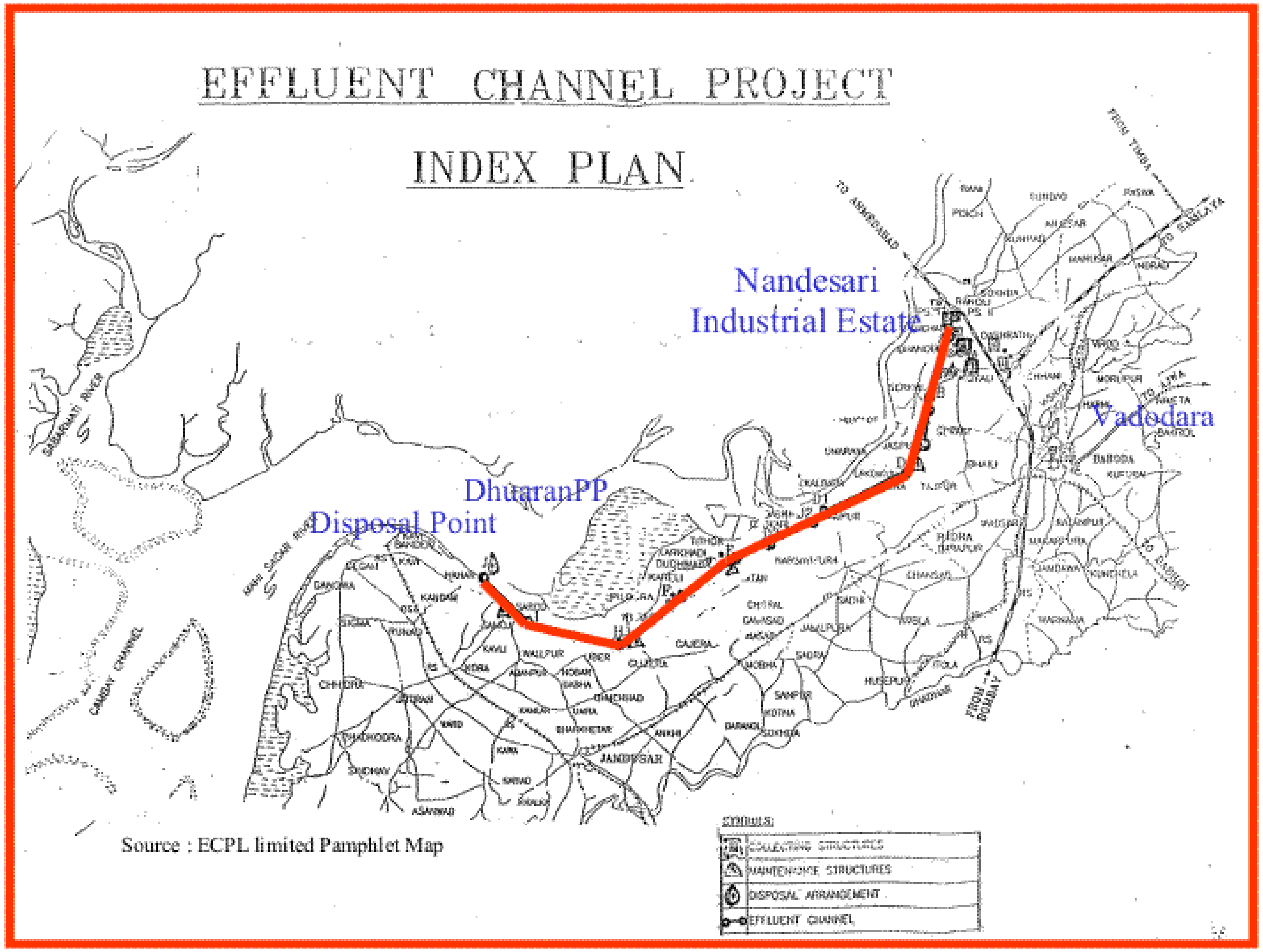


Figure 2: Study Area for Effluent Channel Project Wastewater Reuse

Disposal

The drainage form the first two zone is discharged into Ruparel kaans from where it flows into Jambuva River and finally passes on to river Vishwamitri. From Vishwamitri the sewage load moves on to river Dhadar and then finally into the Arabian Sea near the Gulf of Cambay. The sewage from the third zone is directly discharged into river Vishwamitri as this sewage treatment plant is situated on the banks of the river itself.

The Vadodara Masterplan – A powerhouse of potential

What we refer to, as the masterplan here is the plan for sewerage as developed by M/s. AIC Watson Consultants ltd. Requisitioned by the Vadodara Municipal Corporation. The plan takes into account sewerage requirements of the city for 25 years ahead. It divides Vadodara into three zones and then based on population data assumes 80% of water supply as the wastewater generated. It includes methodology for treatment of wastewater technology to be used and the costs for the project over a period of 25 years.

The cost estimates for the year 1998-99 on GWSSB rates work out to Rs 160 crores, which with engineering cost, physical contingency and cost contingency works out to Rs. 373.53 crores. The breakup is as follows:

Table 1: Cost Calculations for the Vadodara Masterplan

	Rs. In Millions
Basic Cost	1598.5
Engineering (10%)	159.8
Physical contingency (7.5%)	119.9
Subtotal	**1873.3**
Cost Contingency (@7%)	1857.0
Total	**3735.3**

(*Source: Report on Master Planning of sewerage system, AIC Watson Consultants Limited, December 1999.)*

An extension of such a masterplan becomes important when seen in the perspective of governance, economy and resource base. The extension comes as a natural following since it is the responsibility of the governing agency to take care of the environment and social aspect that requires ground level implementation of collecting and treating wastewater. The same logic can be extended when we consider the economy supported by the wastewater flows. It is only a question of matching of output and input in a situation of resource crunch in certain areas, especially where the water is scarce and also in areas where the farming community has learnt how to efficiently utilize and gain advantage from wastewater.

The plan concerns two major agencies: Vadodara Municipal Corporation (VMC) and the Vadodara Urban Development Authority (VUDA). It also concerns the Gujarat Pollution Control Board (GPCB), the authority responsible for controlling pollution in the rivers and the effluent from the treatment plants. The VMC and VUDA are the administrative authorities of the city in different areas and they are responsible for implementation and management of this master plan. The figures stated above do seem to suggest that collection and treatment of water is a costly affair as is widely believed. What remains to be seen is the economy it affects. This report tries to present this very aspect.

Objectives

The major objective of the study was to

- Estimate the size of wastewater economy in a peri-urban area of Vadodara.

The idea of this estimation was to analyze the cost (it is widely believed that treatment of waste is a costly exercise) of efficient waste discharge or reuse in agriculture vis-a-vis the benefits. There are instances of widespread use of wastewater for irrigation in developing nations especially in peri-urban areas. It was thought that the rampant use of wastewater in agriculture might be sustaining an economy large enough to justify the establishment of wastewater use as a variable in the decision making for establishing and design of water supply systems in the urban context. So far wastewater is never considered as a variable in any design or planning process.

Thus the study has tried to develop a roadmap for utilizing wastewater, as a resource to help in fulfilling water needs for irrigation purposes especially in the regions of low rainfall or no source zones.

Methodology

The methodology can be divided into different parts or stages. Firstly the entire route of the wastewater flows was tracked and marked. Then villages were selected. Care was also taken to try and capture as much variation as possible in this sampling. Transect visits were carried out to gain a preliminary understanding of the area before starting information collection. This preliminary understanding helped in deciding the mode of collection of information and the type of questions to be asked and also in deciding how to proceed.

The information was collected by methods of Rapid Rural Appraisal (RRA) and triangulation was done with participatory focused group discussions and in-depth interviews.

In the process of information collection the first step was to make a use inventory for the wastewater. This was followed by collection of information on cropping pattern data. During this exercise there were other interesting diversions, which led to some more information collection as well.

The model applied for calculations is an additive model as it was possible to check the representativeness of sample villages for strips of land. The additive model helped in removing the possibility of the problem of compounding of errors in a multiplicative model. This also helped in balancing error by algebraic addition of negative and positive errors. The methodology therefore was basically aimed at reducing error and sampling to establish representativeness.

Calculations for the Estimation

As stated in the methodology section, an additive model of the two subdivisions was used as given below

$$E = IW + DS$$

Here, E = Estimates at study level
IW = Estimates for the industrial wastewater Flow through the ECP
DS = Estimates for the Domestic Sewage Flow through the rivers

The sampled villages were chosen subjectively on the following criteria:
- Distance between the sample villages
- Representativeness of the variance within the region (flow command) regarding extent of use, cropping, wastewater use.
-

The Industrial Wastewater (E.C.P.)

The region extends from the start of the Effluent Channel at the first intake point at *Dhanora* works to the final disposal "J" point at *Nahar* close to *Sarod* village. This is a linear distance of 55.6 Kms. as shown in the schematic diagram.

Calculation for the Command Area

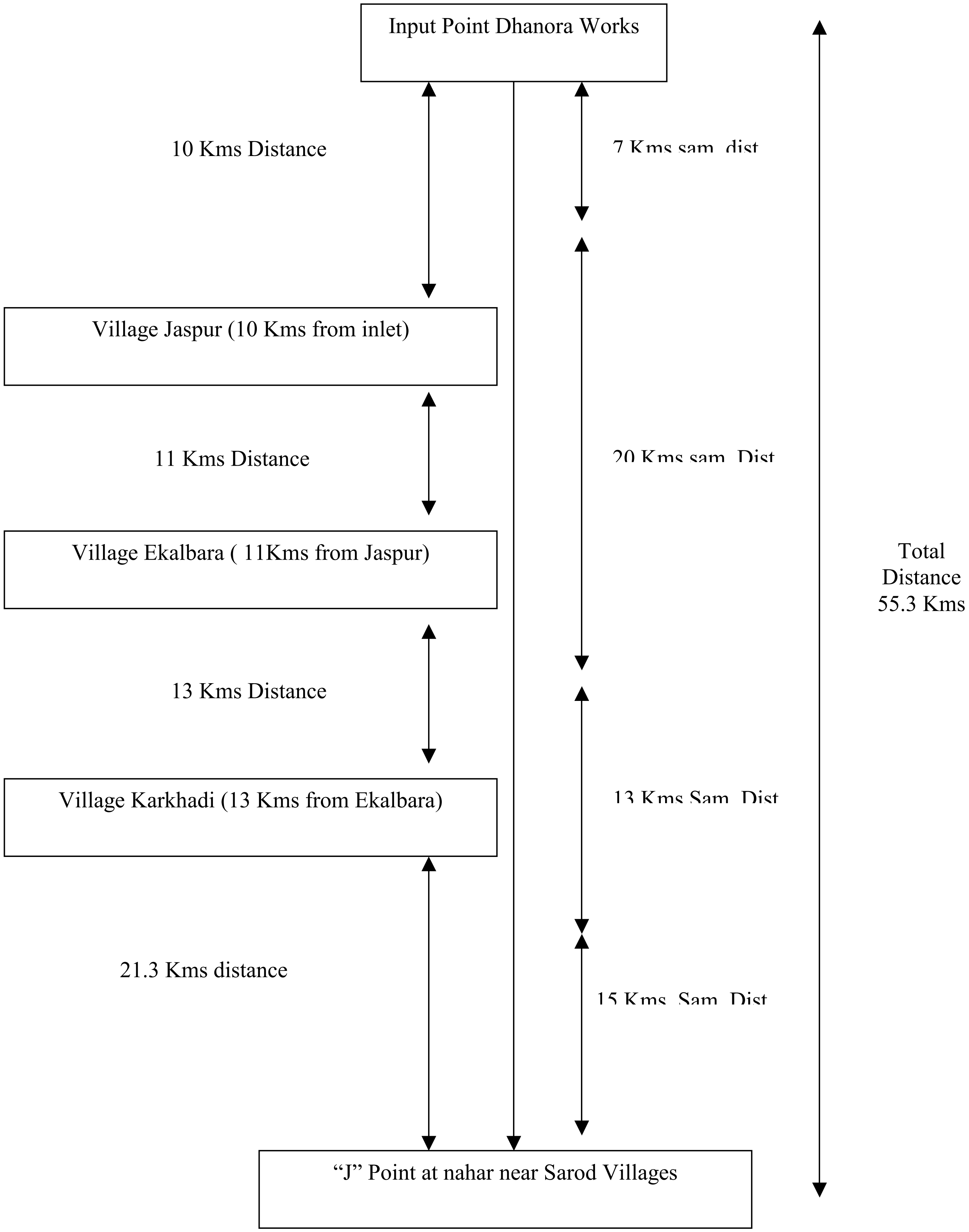
The Command area of the ECP can be divided into three distinct sub regions. This division is based on the extent of use as represented by the perpendicular distance from flow upto which the wastewater from the ECP is being used.

Region A comprises the first 7 Kms from the intake point at the *Dhanora* works upto 3 Kms before the village Jaspur and a stretch of about 13 Kms, upto 6.5 Kms on either side of village *Karkhadi.* This region is characterized by moderate use of the wastewater for irrigation purposes. The use here is limited to about 500 meters on either side of the channel. Also in this region about 85% of the area on an average is under wastewater irrigation.

Region B characterizes large-scale use of wastewater for irrigating the fields. This region extends for about 20 Kms starting about three Kms upstream of *Jaspur* village to about 6.5 Kms beyond village *Ekalbara*. Here the use of wastewater for irrigation extends upto as far as 1 km on either side of the channel. Also what is especially noticeable in this region is the fact that about 95 % of the area on an average within these limits is using wastewater irrigation.

Region C extends beyond the village *Piludra* upto the disposal point. This is a linear distance of about 15 Kms where the use of wastewater is very limited and the farmers have their fingers crossed when they use it. The use is almost negligible due to the problem of reliability of quality because of indiscriminate and illegal discharge of untreated effluents by tankers as stated earlier.

Fig. 3 Schematic representation of the ECP command area for Calculations



Here the use is restricted to about only 100 meters on either side of the channel and this too is being used by only 60% of the fields within these limits. It seems that only the farmers who find this source very cheap and easily available are using it. Those who had other options available have shifted to those.

Table 2: Calculation for the Command Area of ECP wastewater flows

Region	**Linear Distance**	**Perpendicular Extent of use**	**Areal Coverage of wastewater**	**Area**	**Area on both banks**
A	20	0.5	0.85	8.5	17
B	20	1.0	0.95	19	38
C	15	0.1	0.60	0.9	1.8
			Total Area	**28.4**	**56.8 Sq. Kms.**

Area in hectares = 5680
Area in Bighas = 22720

Calculations for the Agriculture production

The whole of the region till village *Karkhadi* excluding the region it represents upstream is a major region, which grows paddy as wastewater is amenable to paddy and the farmers also know paddy cultivation. Cotton does not find much favour here. Paddy cultivation during the monsoon season is followed by cultivation of either wheat or tobacco that in turn is followed by *Bajra*, Maize or *Sundiya* (a local variety of fodder crop). The following table gives the cropping position at the time of the survey during the late monsoon season in 2001 (month of September). [All figures in Bighas]

Table 3: Position of Cropping with WW irrigation during late monsoon (September 2001) in three villages surveyed along ECP area

Village	**Paddy**	**Wheat**	*Cotton*	**Tobacco**	***Tuvar***	**Castor**	*Total*
Jaspur	300	400		200	150		**1150**
Ekalbara	300	400		100	50		**850**
Karkhadi			200	100		100	**400**
Total	**600**	**800**	**200**	**400**	**200**	**100**	**2300**

Cropping sequences with the areal representation that they have in this region are also given below:

CS1: Paddy –Wheat – Bajra: 30 %
CS2: Paddy- Wheat – Maize: 20 %
CS3: Paddy – Tobacco – Bajra: 25 %
CS4: Paddy – Tobacco – Maize: 15 %
CS5: Tuvar – Wheat: 10 %

The region beyond village Karkhadi and including the area upstream is characterized by the growth of cotton, tobacco, castor and Bajra. Different cropping sequences of this area with the areal representations are as follows:

CS6: Cotton - Wheat: 30%
CS7: Castor - Wheat – Bajra: 20 %
CS8: Cotton – Tobacco – Bajra: 50 %

Thus we get the following calculations for the area and these are derived in the same manner as those for the command areas.

Table 4: Calculations for Production and Sales Worth of Agriculture in ECP command area

Crop	Area	Avg. Productivity	Avg. Price	Production	Sales Worth
Unit →	*bighas*	*Kgs / bigha*	*Rs. / Kgs.*	*Kilograms*	*Rupees*
Paddy	11034	1300	7.00	14344200	100409400
Wheat	9926	800	4.80	7940800	38115840
Tobacco	6861	250	14.00	1715250	24013500
Cotton	4112	200	13.50	822400	11102400
Bajra	10341	408	4.60	4219128	19407988
Castor	1028	200	10.00	205600	2056000
Maize	4291	300	5.00	1287300	6436500
Tuvar	1226	250	18.00	306500	5517000
			Total	**30841178**	**207058628**

Total Sales Worth: Rupees 207.058 million

We see that in the ECP command area alone agricultural production worth Rs 207.058 Million is obtained annually with the help of the wastewater flows.

The Domestic Sewage

The domestic sewage as it flows through the inundational rivers covers a distance of over eighty kilometers before it meets the sea. A schematic diagram shows the flow of domestic sewage on the next page.

Calculations for estimating the command area

The calculation for the Command area is based on determining an average perpendicular distance for use of the water resources for irrigation. The average distance is determined as given in Annexure no.1. This distance is 1045 meters from the river flow (wastewater flow). This whole region is characterized as no source zone hence the percentage area within this perpendicular fan coverage is very high, close to 85%. This is a subjective judgment arrived at from the discussions in the villages with the groups of farmers. The use is high due to wastewater being the cheapest source for irrigating the fields up to an economic distance. There are few tube wells within this fan area, which supply irrigation water to the fields of their owners as well as to the nearby fields where their supply shall be cheaper than the supply from the river.

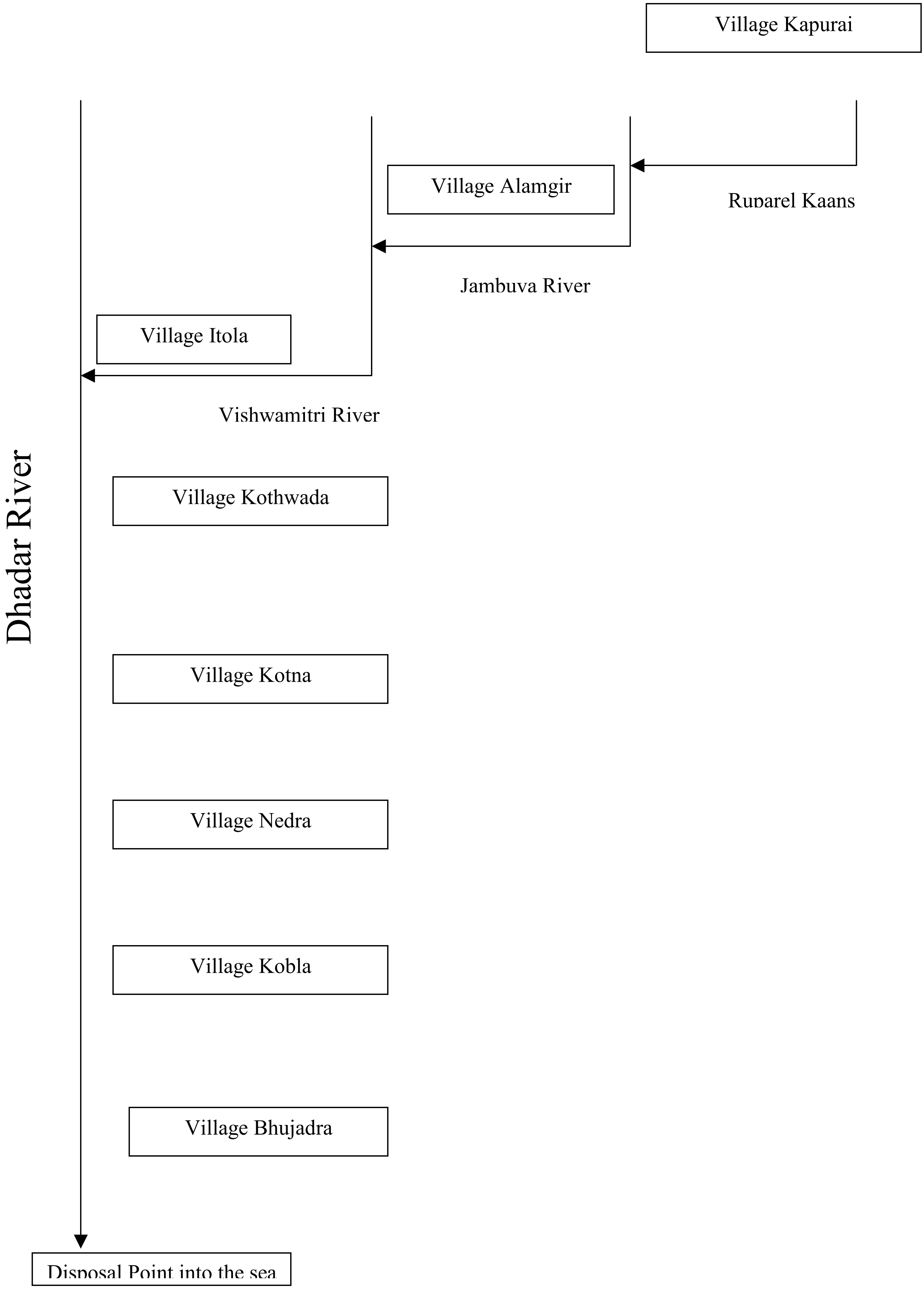


Fig.2 Schematic representation of the Domestic Sewage command area for Calculations

Thus the total length of run of wastewater flows is as follows:

TL = L (JR) + L (VR) + L (DR)

Where, TL = Total Length of Run of Wastewater flows
L (JR) =Length of run with Jambuva River (7 Kms.)
L (VR) = Length of run with the Vishwamitri River (19 Kms.)
L (DR) = Length of run with the Dhadar river (56 Kms.)

Total Linear Distance = 7 + 19+ 56 = ***82 Kms***

Total command area = 2[82 x 1.045 x 0.85] = 2 [72.8365] Sq. Kms.
= 145.673 Sq. Kms.
= 14567.3 Hectares = 58269.2 Bighas

Calculations for the Agricultural production

The whole region is dominated by the cropping sequence based on cotton and crops like wheat, Bajra, *Tuvar,* maize with some instances of paddy and sugarcane. The cropping sequence of the area is as follows:

CS1: Cotton – Wheat –Bajra (35%)
CS2: Cotton – Wheat – Maize (25%)
CS3: Cotton – Jowar - Bajra (combined for CS3 and 4 = 5%)
CS4: Cotton – Jowar – Maize
CS5: *Tuvar* – Wheat – Maize (20%)
CS6: *Tuvar* – Wheat – Bajra (10%)
CS7: *Tuvar* – Jowar – Maize (combined for CS 7 and 8 = 5%)
CS8: *Tuvar* – Jowar – Bajra

Thus we get the following calculations for the area which are derived in the same manner as the calculations for the command areas.

Table 5: Calculations for Production and Sales Worth of Agriculture in Domestic Sewage command area

Crop	**Area**	**Avg. Productivity**	**Avg. Price**	**Production**	**Sales Worth**
Unit →	*bighas*	*Kgs / bigha*	*Rs. / Kgs.*	*Kilograms*	*Rupees*
Cotton	37875	391	21	14809125	310991625
Tuvar	20394	245	13.8	4996530	68952114
Wheat	36709	700	6.4	25696300	164456320
Jowar	4078	400	4.50	1631200	7340400
Bajra	17480	575	4.90	10051000	49249900
Maize	11653	300	5.00	3495900	17479500
			Total	60680055	618469859

Total Sales Worth: Rupees 618.469 million

Results Summary

The results obtained from the study are presented here. The total command area works out to a large figure and is many times larger than those under any other small-scale irrigation schemes. It is, therefore, concluded that the size of economy sustained by wastewater flows is also very large and especially when compared against the cost of treatment and reuse. This opens up new issues that need to be thought over and worked on to realize a potential so far unutilized or under-utilized.

Table 6: Summary results for Agriculture Economy sustained on Wastewater flows

Effluent Channel Projects		**Domestic Sewage Flows**	
Net Command Area	56.8 Sq. Kms	**Net Command Area**	145.673 Sq. Kms
Gross Command Area	140.485 Sq. Kms	**Gross Command Area**	320.45 Sq.Kms
Water Market*	78,964,480	**Water Market***	202,493,440
Agricultural Production	Rs. 207,058,628	**Agricultural Production**	Rs. 618,469,859
Grand Total	Rs. 825,528,487		

This (825 million rupees) by no means is a small amount as can be seen. Why is it that these schemes come up in an unorganized manner and why there is less thought to replicate this with an organized model? These issues are discussed further.

Implications

There are many interesting implications emerging out of the information that we get from this study. However, most of them are raw and need to be authenticated and set t right scientifically before we start taking actual steps any further.

Costs and Benefits

The Benefit (Economy Sustained Value) and cost calculations show a marked excess of the positive contribution over the costs but these figures are tentative and do not include the costs of implementing, maintaining, managing and operating any irrigation or Wastewater use scheme.

Table 7: comparison and Costs and economy sustained for Wastewater

Treatment plants	Wastewater Irrigation agriculture
Cost of Masterplan for Vadodara	Annual Economy sustained by Wastewater
3735.3 Million rupees	825.528 Million rupees

At this rate the payback period would appear to be close to five years only while the Masterplan envisages costs for the next 25 years.

Sustenance of Livelihoods

The availability of wastewater as a cheap source of irrigation has led to large-scale agricultural sustenance in the region. A total of over 100 villages are sustaining a significant fraction of their agriculture on wastewater Irrigation. These villages lying in a no-source zone were dependent on rainfall till wastewater irrigation was discovered and developed. These villages today also have been able to achieve food security by overcoming the uncertainty of rainfall by shifting to wastewater irrigation.

Reliability and Assured Supply

Wastewater presents a unique picture of reliable and assured supplies as the industries or domestic areas do not suffer from seasonalities of wastewater production. The supply is assured and the domestic supply does not suffer from wide fluctuations on quality parameters of wastewater. With the establishment of ECP –Common Effluent Treatment Plant the fluctuations in industrial effluent quality has also reduced significantly.

This has also led to successive changes in farming practices along with cropping patterns and sequences. This has also led to an increase in Gross Cropped Area and Net Cropped Area due to a shift from rain-fed farming to irrigated agriculture with assured supplies.

Productivity and Inputs

There are claims about productivity increase and there are claims of no such rise being observed. Accompanying these are claims about reduction in requirement of fertilizers and other inputs against counter claims of no difference. It is necessary to ascertain scientifically whether such benefits can really be obtained from the use of wastewater for irrigation.

Water Markets

The wastewater in the ECP Command area is being used for irrigating fields and crops in a no source zone. It is, therefore, self-postulating that an important water market economy has been created and is being sustained by the wastewater flows. The cropping sequence also suggests the use of water in this region as is calculated in the following table

Table 8: Water Use and Markets on the ECP command area

Crop	**Area (Bigha)**	**No. of irrigation required for crop**	**Hours of irrigation required for one Bigha**	**Cost of Water / Hour of irrigation**	**Total Value of Water used**
Paddy	11034	6	8	40	21185280
Wheat	9926	6	8	40	19057920
Tobacco	6861	6	8	40	13173120
Cotton	4112	6	8	40	7895040
Bajra	10341	3	8	40	9927360
Castor	1028	5	8	40	1644800
Maize	4291	3	8	40	4119360
Tuvar	1226	5	8	40	1961600
Total	**48819**				78964480

The total market value appears to be close to rupees 78.96 m

The total market value appears to be close to Rs 78.96 million. However, these figures are very tentative and do not take into account the irrigation done by rainfall (however less it might be). It still signifies a high potential towards water markets within the agricultural sector itself.

Similar to the wastewater markets in the ECP command area here are the calculations for the domestic sewage command area. However these figures are again tentative and not exact but what the table points out is that there exists a huge water market potential in this area considering the low and erratic rainfall here.

Table 9: Water Use and Markets on the DS command area

Crop	Area (Bigha)	No. of irrigation Required for crop	Hours of irrigation Required for one Bigha	Cost of Water / Hour of irrigation	Total Value of Water used
Cotton	37875	6	8	40	72720000
Tuvar	20394	6	8	40	39156480
Wheat	36709	5	8	40	58734400
Jowar	4078	3	8	40	3914880
Bajra	17480	3	8	40	16780800
Maize	11653	3	8	40	11186880
Total	**128189**				**202493440**

Planning and Irrigation Scheme

Given the widespread use of wastewater for irrigation in an unorganized manner and the vast potential that it has to contribute to economy, we cannot deny the prospects of wastewater as an important irrigation source especially in arid and semi-arid zones. Also given the huge benefits to the economy from wastewater irrigation, it would make sense to plan and implement such schemes without incurring a negative net present value (NPV) or financial loss. It would only enhance the economy and agriculture of the region that it would serve.

Hyderabad has already taken the lead and after establishing two STPs, half of the treated wastewater has been diverted into a dry canal to give the shape of an irrigation Scheme. Such efforts can be replicated after careful scientific study on Health and Environmental hazards.

Health Hazards

There are numerous doubts on this front. Heavy metal concentration, high N-P-K concentration, high bacterial and organic content, high BOD and COD all seem to impose health hazards. Much, however, needs to be ascertained scientifically as so far no instance of any epidemic or any endemic health problem has been reported and ascribed to wastewater use. Farmers have been using wastewater for thirty years with no problem and consumers have not reported anything adverse. However, the effect, like climate change, could take a long time to manifest. Research initiatives are required to ascertain with accuracy the status on health hazards direct and indirect to direct and indirect users and consumers.

What this study wants further

It is now required to firm up the estimates by going at the individual user level and performing an extensive survey to reevaluate the wastewater economy. Also it is envisaged to take a hard look at some of the issues discussed here. The health hazards need a closer look with empirical information rather than theoretical constructs. The next stage would try to develop better estimates at the same calculations and then work some other estimates as well also try to develop simulations of management and operating costs for an irrigation scheme of treated wastewater.

Ways Forward – What needs to be done at the macro level

→ Identify and establish wastewater as a planning and design variable for area development, economic planning and resource management
→ Ascertain scientifically and with accuracy the truth about health hazards associated with wastewater use and consumption of produce
→ Scientific push by proper research to treatment technology and suitable farming practices
→ Proper monitoring and measurement techniques and methods to achieve effectiveness especially in industrial Sewage scenario
→ Develop the right way for application of agricultural inputs for wastewater irrigation
→ Plan and develop irrigation schemes with use of treated wastewater
→ Spread of knowledge and awareness about hazards, truth and benefits of wastewater use in irrigation.

Implications for State Policy

➔ Promote ECP style projects with better management
➔ Establish wastewater as a Planning and design variable for area development, economic planning and resource management
➔ Promote research on Wastewater issues
➔ Try to replicate Hyderabad type wastewater irrigation schemes at suitable locations
➔ Enhance Sewage and treatment facilities at all residential locations to tap on this resource.

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Annexes

Annexure 1: Distance of irrigation form the wastewater source (Domestic sewage)

Village	Distance in Feet	Distance in Meters
Alamgir	3000	914.4
Kothwada	1640	500
Itola	4000	1219.2
Nedra	4921	1500
Kotna	2000	609.6
Kobla	3500	1066.8
Bhujadra	4921	1500

Average Distance = 1045 metres

Std. Deviation = 397.6 metres

Annexure 2: Productivity of Paddy in the ECP region

Village	Productivity (Kgs Per bigha)	Prices 1999-00	Prices 2000-01
Ekalbara	1500	3.5	4
Jaspur	1500	3.5	4

Average productivity = 1500 Kgs per bigha

Average Price (ECP) = Rs. 3.75 per KG

Annexure 3: Productivity of Cotton in the region

Village	Productivity (Kgs per bigha)	Prices 1998-99	Prices 1999-00	Prices 2000-01
Kothwada	500	20	17	20
Alamgir	400	22	21.5	21
Itola	550	22.5	23	21
Nedra	400	19	20	20
Kotna	40		15	20
Kobla	250	25	20	17
Bhujadra	600	22.5	25	30
Karkhadi	200		14	13

Average productivity (D.S.) = 391 Kgs per Bigha

Average productivity (ECP) = 200 Kgs per Bigha

Average Price (D.S.) = RS. 21.075 per Kg

Average Price (ECP) = Rs. 13.5 per Kg

Annexure 4: Productivity of Wheat in the region

Village	Productivity (Kgs per bigha)	Prices 1998-99	Prices 1999-00	Prices 2000-01
Kapurai	800		7.25	7.25
Kothwada	600	5.5	6	6
Jaspur	800		4.5	5.5
Ekalbara	800	4	4.5	5.5

Average productivity (D.S.) = 700 Kgs per Bigha

Average productivity (ECP) = 800 Kgs per Bigha

Average Price (D.S.) = Rs. 6.4 per Kg

Average Price (ECP) = Rs. 4.8 per kg

Annexure 5: Productivity of Bajra in the region

Village	Productivity (Kgs per bigha)	Prices 1998-99	Prices 1999-00	Prices 2000-01
Kothwada	400	4	5	5
Bhujadra	750	5.5	6	4
jaspur	400	4	4.75	4.5
Ekalbara	450	4	4.75	4.5
Karkhadi	375	4.5	5.5	5

Average productivity (D.S.) = 575 Kgs per Bigha

Average Price (D.S.) = 408 Kgs per Bigha

Average productivity (E.C.P.) = Rs. 4.91 per Kg

Average Price (E.C.P.) = Rs. 4.61 per Kg

Annexure 6: Productivity of Tuvar in the region

Village	Productivity (Kgs per bigha)	Prices 1998-99	Prices 1999-00	Prices 2000-01
Alamgir	250	13.5	12.5	16
Itola	300	12	13	16
Nedra	250	15	15	15
Kotna	250		10	15
Kobla	125	15	13	10
Bhujadra	300	12	14	18
jaspur	250		16	20
ekalbara	250		16	20

Average productivity (D.S.) = 245 Kgs Per Bigha

Average productivity (ECP) = 250 Kgs per Bigha

Average Price (D.S.) = Rs. 13.82 per Kg

Average Price (ECP) = Rs. 18 per Kg

Annexure 7: Productivity of Tobbacco in the region

Village	Producitivity (Kgs per bigha)	Prices 199-00	Prices 2000-01
Jaspur	250	12.5	17.5
ekalbara	250	12.5	17.5
Karkhadi	250		10

Average productivity (ECP) = 250 Kgs per Bigha

Average Price (ECP) = Rs. 14 per Kg

Annexure 8: Productivity of Castor in the region

Village	Producitivity (Kgs per bigha)	Prices 2000-01
Karkhadi	200	10

Average productivity (ECP) = 200 Kgs per Bigha

Average Price (ECP) = Rs. 10 per Kg

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