Moderator's Note:

Dear Members,

Hello. I am filling in for Preeti Soni, as the Resource Person and Moderator, while the due process of selection to this position is going on. I look forward to your valuable contributions, as always.

Jyotsna Bapat

Environment

Water & Environmental Sanitation Network (WES-Net India)

Solution eXchange

Wider Choices Smarter Development

Solution Exchange for WES-Net India Consolidated Reply

Query: Treatment of wastewater for reuse, from APFAGMS, Hyderabad

Compiled by Jyotsna Bapat, Resource Person and Moderator; additional research provided by Ramya Gopalan, Research Associate
10 March 2006

Original Query: K.A.S. Mani, APFAGMS, Hyderabad

Posted: 24 February 2006

I am Dr K A S Mani, working with Andhra Pradesh Farmer Managed Groundwater Systems (APFAMGS) Project which is a network of over 650 villages working towards enabling the farmers to manage their groundwater systems in about 638 villages in seven drought prone districts of Andhra Pradesh. The development objective of the project is that farmers in Andhra Pradesh manage their groundwater systems based on annual recharge-draft conditions. Main activities include participatory hydrological monitoring, artificial recharge and sustainable agriculture inputs, capacity building and institutional development. One of the areas being explored by the communities is better management and treatment of waste water, so that it could be re-used for agricultural and other purposes.

It is a fact that 80% of all the water used for domestic needs, comes back as sewage water. Handling of sewage water is slowly emerging as a big issue in small towns, and even in villages, which have no adequate drainage facilities. Again wherever the untreated waste water goes it creates a trail of polluted streams contaminating source of good water as well. Apart from creating health and nuisance we also lose precious and scarce water that could be otherwise put to re-use in water scarce areas.

I will like to know from the members simple and cost effective experiences in the following, which would be useful to communities living in villages or small towns:-

- Various ways and means of treatment of domestic sewage involving the community using constructed wet land followed by recharge of ground aquifers with the treated water.
- Any experience wherein sewage water treatment could be turned into an economical proposition as well, by commercially exploiting the bye products of treatment such as vermi-compost, sludge, establishing nurseries, fish farms as well as selling the recovered water for secondary use.

Responses received with thanks from:

1. **V. Kurian Baby, Socio-Economic Unit Foundation (SEUF), Kerala**
2. **Dinesh Kumar, International Water Management Institute (IWMI), Anand**
3. **Vishwanath, Rainwater Club, Bangalore**
4. **R. Santhanam, Indian Society of Agribusiness Professionals (ISAP), New Delhi**
5. **Prabhjot Sodhi, UNDP GEF SGP, New Delhi**
6. **Padma S Vankar, IIT, Kanpur**
7. **Mihir Maitra, ICEF, New Delhi**

Further contributions are welcome!

Summary of Responses

Members' responses suggested a range of approaches; covering: from small household level waste treatment devices, middle range technologies suitable for settlement level requirements to plants for large and intensive treatment solutions. All of these can be further categorized and adapted to suit rural and urban contexts. Members, however, point out that while the concept of finding solutions for wastewater treatment and its eventual use as a value added product is valid, the known strategies can be effectively applied only after analyzing the chemical composition of the sewage, and examining local conditions

In the village context, the need to protect watersheds provides the primary motivation for installing (suitably designed and maintained) onsite treatment systems. Of the various treatment/disposal methods, one commonly used is the **soak pits/small dug holes -** for kitchen and domestic wastewater. The treated water coming out of the soak pit can be used effectively near the household for growing plants. Members also highlight the option of exercising **source control** - to reduce the generation of wastewater itself. Another approach suggested for sewage management was creating **source separating composting toilets** wherein urine is collected separately and faeces is composted. These processes together not only reduce water requirement and generation of black water in toilets, but also provide compost at no extra cost. An alternate suggestion involves the use of **gravel filter** - planted amidst crops to evapo-transpirate grey water thereby converting it to food. Plans for treating several household together can also be designed, where individual households using small lined canals connect to village **'nullah'** (drainage) which collects the waste and transports it to a convenient common treatment facility

For towns and peripheries of urban centers, suggestions were made to locate wastewater discharge points within the watershed; and it was stated that as far as possible, a balance should be maintained between groundwater recharge and its export - within each watershed. The main technologies currently being used include: a) **aerobic treatment systems;** b) **constructed wetlands;** c) **drip irrigation leach fields;** and d) **Gravel-less pipe leach fields.** Other technologies highlighted by members include **DEWATS** – Decentralized Wastewater Treatment System which is particularly applicable to small and medium enterprises - mostly using anaerobic treatment, multiple baffle tanks, root zone aeration systems and sand bed/gravel filters; and solutions which use **biotechnology** that stabilizes effluents with respect to pathogens and dissolved solids - 'bio converting' them into a safe mode.

Members' experiences of using the above methods bring several aspects to focus. In **Bhubaneshwar**, for instance, the sewage carrying drains running through the city have sufficient land available for construction of retention ponds which allows the sewage to undergo a natural rejuvenation process before its disposal. However, in small villages of **Andhra Pradesh** the same may not be applicable due to insufficiency of sewage, and different site conditions. In the use of **constructed wetlands,** one member's experience indicates that sub-surface and surface flow offers an affordable solution in areas having warm climate, high water table, low soil percolation, high suspended solids in wastewater, and sufficient un-shaded area. The **Kanpur** project records results of using different strategies to treat effluents from industries, and the effluents from domestic sources (given that the centralized treatment system is barely operational). Referring to some international experiences, members informed that while in **Israel** the collected and treated wastewater is bought by farmers, in **Australia,** the same is used for gardening, flushing of toilets, and other such purposes.

A number of **problems/constraints** noted by members with regard to centralized wastewater treatment are: 1) high costs of infrastructure and the substantial quantity of wastewater needed for it to be viable; 2) feasibility, but not necessarily commercial viability of the projects; 3) lack of willingness/inability of consumers to pay for treated wastewater; 4) difficulties in participatory monitoring; and 5) over-estimation (generally) of ground water availability since total outflows from aquifers are not captured in assessments.

Recommendations from members towards addressing these problems include:

- Combination of cost recovery, (profits from) commercial by-products, and 'polluter pays' principle to ensure higher economic returns;
- Preparation of annual wastewater management and reporting plan;
- Monitoring of water use by farmers.

Members' experiences covering both generic and specific issues regarding wastewater treatment are given in greater detail below.

Comparative Experiences

From R. Santhanam, Indian Society of Agribusiness Professionals (ISAP), New Delhi

DEWATS

DEWATS meaning Decentralized Wastewater Treatment System where the waste stream is not transported over long distances and compact systems with low foot prints are used. They use mostly anaerobic treatment, multiple baffle septic tanks for sewage, use of polishing ponds and aquatic plants with root zone aeration systems and sand bed /gravel filters. Essentially it offers demand based technical solutions to reduce water pollution in small and medium enterprises (SME). Experience indicates that DEWATS technical solutions are worked in accordance with the characteristics of hospitals, agro based industries, for communities etc. Some of its benefits include building of implementation capacities at various levels, reliable and long lasting applications, minimal maintenance, long lasting efficiency, establishment of multi stake holder networks etc. For details see DEWATS

Use of Biotechnology
Whereby effluents get stabilised in respect of pathogens and dissolved solids, including brackishness, heavy metal and other toxics which get "Bio converted" into a safe mode. The treated water gets stabilised with lower BOD and COD. The dissolved solids do not pollute the ground water. Experience suggests that when used for gardening or irrigation in farms including in peri urban areas, the pollutants actually seem to help plant life to flourish, without contamination of such residuals. The treated waste water also seems to have the property of improving existing ground water quality through the complex mechanism of soil biology. For more information see Biosanitiser

From Vishwanath, Rainwater Club, Bangalore

Source control
To reduce waste water generation and to use it up effectively near the household itself for growing plants What village households need in the village is water in the household and a toilet/bath facility. Building a storage tank of 2000 litres capacity to collect rainwater (otherwise waste water) close to 20,000 litres is harvested even from a small 30 square metre house. This water becomes available to the household for essentially non potable use or for cows/cattle.

Source separating composting toilet
Whereby urine is collected separately and faeces composted, which reduces water requirement for toilets, generates fertilisers and eliminates completely the generation of black water from toilets.

Gravel filter
Water from bathrooms/clothes wash/utensils wash are led to a gravel filter planted with canna/bananas/papaya even sugarcane. They evapotranspirate grey water and convert it to food. When done at a village scale, it helps clean up the catchment for rainwater to be collected and recharged if possible through small tanks.

Jajmau, Kanpur *(from Prabhjot Sodhi, UNDP GEF SGP, New Delhi)*
Where 350 odd leather factories localized are mainly responsible for polluting the river Ganges with Chrome (Cr) VI, the main pollutant of the tanneries. The tanneries discharge their toxic wastes laden with Cr VI into the sewage system. This effluent is carried through the main drainage system to the centralized treatment plant located in Jajmau. The treated water is then used for irrigation or released directly into the Ganges. However this centralized treatment plant is hardly operational and hence this remediation project examines alternate strategies has been piloted by UNDP GEF SGP and implemented by the Devender Vidyapith Shiksha Sansthan. For details of this project see A Pilot Experience under the UNDP GEF Small Grants Program on Chrome VI Remediation in the affected areas of Jajmau

Bhubaneshwar *(from Mihir Maitra, ICEF, New Delhi)*
This ICEF funded project called "Community based Water Resource Management with Emphasis on Natural Water Quality Improvement and Resource Recovery" is being implemented by Xavier Institute of Management in collaboration with Central Institute for Freshwater Aquaculture (CIFA), Bhubaneswar. In this project, the sewage is made to undergo natural rejuvenation process through engineered wetland system before disposal. An overflow weir is constructed on

the drains which act as the first siltation pond/tank followed by a series of 3 more ponds/tanks namely aeration pond, duck weed pond and fishery pond. Water quality is monitored regularly for BOD load etc. before disposal. More information can be collected from Community-based Water Resource Management with Emphasis on Natural Water Quality Improvement and Resource Recovery.

From Ramya Gopalan, Research Associate

Punjab
Two villages in Punjab, India have developed community-based wastewater treatment projects on constructed wetlands. The wetlands are said to reduce biological oxygen demand by up to 85 percent and coliforms by 95 percent.

Kharoudi Village, Punjab
In Kharodi village, Hoshiapur district of Punjab, NRI's along with the help of state government have helped develop an efficient system of sanitation and wastewater management through an underground sewerage system with a stabilization tank and activated sludge system. How this works is that the entire sewage of the village is made to flow into a large covered septic tank outside the village within which anaerobic bacterial are produced and thrive on the chemicals in the sewerage. This bacterium does not need oxygen but feeds only on solids thus cleaning the water up to 85 percent. From this tank, water flows into a smaller tank laid with perforated pipes, covered with nylon filters and three feet of rubble and further covered with three inches of sand and three inches of mud and finally taken into a pond for UV treatment of pathogens. A fountain in the middle of the pond provides aeration. The project includes the "Sewerage Water Treatment Plant" (SWTP), which enables villagers to reuse this water for fishery and irrigation of fields. For more information go to Kharoudi Village in Punjab – Model of Cleanliness

Calicut
Examines use of artificial wetland for wastewater treatment in an eco friendly manner wherein a demonstration unit is constructed at CWDRM campus for wastewater treatment flowing from the canteen. Wastewater is received by a tank which serves a s a skimming tank to remove oil particles. An inclined inlet and slotted baffles are attached to this tank. Water is passed through subsequent tanks and the final pre treated water is stored in tank with flow adjustment to regulate the flow into the constructed wetland which consists if a ferrocement tank having a membrane canvas inside. This wastewater is sprinkled over plants by perforated PVC pipes. This system is effective in sewage treatment and certain industrial effluents before being disgorged into water bodies. A vermi composting unit near the artificial wetland enables treatment of organic solid waste, converting it into manure. See Integrated Development Plan of Calicut City

Mysore
Mysore region accounts for about 60 percent of the 36,509 big and small tanks. Following this, the Rural Literacy and Health Programme's decentralized wastewater treatment plant in Mysore has been set up in collaboration with BORDA-India to help mitigate environmental degradation. Providing a wide range of waste water types that can be treated at an affordable price and fulfilment of discharge standards and environmental laws, the wastewater thus treated can be recycled for use in agriculture and the installed system has many tangible benefits. Other benefits also includes protection of soil and water from contamination, ensuring environmental hygiene and largely the adoption of a community-based approach to address health and hygiene-related issues. For additional information see Environmental Sound Technologies (ESTs) for Conservation and Management of Lakes - A Case Study of Mysore Region

International Experiences

Israel *(from Dinesh Kumar, International Water Management Institute (IWMI), Anand)*
Wastewater from 10 cities (DAN city association) is collected and treated in waste stabilization ponds and the treated and the same is recharged underground through sandy aquifers (soil aquifer treatment). The same water is pumped out before it gets mixed with the natural groundwater and is put into the national water system. Farmers use it and also pay for it. The price is around 30 cents per cubic metre and farmers earn much higher returns from every cubic metre of water used by growing citrus fruits, like avocado, oranges and high valued vegetables for exports.

From Ramya Gopalan, Research Associate

Mexico
Experience enumerates advantages and disadvantages of using urban wastewater for crop production in Mexico's water-scarce Guanajuato river basin where wastewater irrigation is a critical component of intensive water recycling practices. The study shows that 140-hectare site downstream of Guanajuato, irrigated with raw sewage serves as a defacto water treatment facility with significant retention of contaminants also representing a significant monetary benefit to both society and these water users. Further, experience indicates that the continued application of wastewater to this land is a more economical form of wastewater treatment than building a wastewater treatment plant although benefits maybe offset by the potential for negative health and environment effects. But in this context where treatment plant is expensive, benefits maybe magnified under certain precise conditions. For further details see IWMI

Pakistan
In Pakistan, near the town of Haroonabad in the Southern Punjab region experience regarding current wastewater practices and the related irrigation, health and environmental issues indicates that the primary benefits are financial gains for local farmers who cultivate high value crops, and increase crop productivity without the need to purchase additional fertilizer. However also revealing that accumulation of heavy metals in the wastewater-irrigated soils, indicates that land will become unprofitable unless it is properly managed, using reclamation and other measures. Thus wastewater irrigation offers benefits that can help many rural water-short areas in Pakistan increase their agricultural productivity and profitability however with the context specific evaluation of negative impacts and sustainability issues. For further details see IWMI

Castor, Senegal
Experience of a community based wastewater treatment system shows the use of water hyacinth in waste water treatment. The local NGO, ENDA-Tiers Monde, has built a wastewater collection and treatment system serving most of the community's inhabitants. Project has been successful in gaining support from community members, creating employment opportunities and treating wastewater to a standard high enough to use it directly for the production of food such as banana, apple, papaya, pepper, corn and a various other vegetables. A number of tree species are also grown and biomass formed is composted and marketed for use in local gardens

Bangladesh
Example of a duck-weed based pisci culture wherein duckweed, another aquatic macrophyte whose nutritional value is similar to soybeans has proved to be efficient at the centre of a wastewater treatment system. Experience indicates that if grown on domestic wastewater free of heavy metals, it can be used as animal fodder and green fertilizer. PRISM-Bangladesh, an NGO based in Dhaka has developed a successful duckweed cropping system for domestic wastewater treatment and production of fish protein.

Related Resources

Recommended Organizations

From R. Santhanam, Indian Society of Agribusiness Professionals (ISAP), New Delhi

FEDINA-Borda Dewats Coordination, Bangalore
Contact Person: Mr. Pedro Kraemer, Coordinator
Email: borda.India@vsnl.net; borda-india@dishnetdsl.net

> *This organisation funded by Bremen Overseas Research and Development Association is recommended for the DEWATS technology in the treatment of wastewater*

Samruddhi, New Delhi
Contact Person: Mr.Gopal Sane
Email: samrudhhi100@yahoo.co.in

> *This organization is recommended for enquiries regarding supplies, technical advice, and engineering the pilot study plant using the Biosanitiser technology*

India-Canada Environment Facility (ICEF) *(from Mihir Maitra, ICEF, New Delhi)*
http://www.icefindia.org/SP_XIM.htm

> *Information on ICEF funded project Community-based Water Resource Management with Emphasis on Natural Water Quality Improvement and Resource Recovery (XIM)*

From Ramya Gopalan, Research Associate

Praj Industries, Pune
http://www.praj.net/wastewatersystems.htm#9

> *Is recommended for its expertise in fermentation and distillation, complementing its expertise in wastewater treatment solutions particularly for these industries*

IWMI, Srilanka
http://www.iwmi.cgiar.org/respages/Wastewater/

> *Recommended for two recently completed research projects, in Mexico & Pakistan which studies the socio-economic, institutional and health aspects of irrigating with wastewater*

Recommended Contacts

Vishwanath, Rainwater Club, Bangalore

> *For information regarding implementation of source control of waste water generation & use of source separating composting toilet for efficient management of waste generated*

From R. Santhanam, Indian Society of Agribusiness Professionals (ISAP), New Delhi

Dr. Uday Bhawalkar, Bhawalkar Vermitech Pvt Ltd (BVPL) and Bhawalkar Ecological Research Institute (BERI), Pune
http://www.biosanitiser.com/index.asp

Ruchi Mahajan, Spatial Decision
Email: info@spatialdesisions.com

Environmental solutions specialist, recommended for experience regarding development of community-based wastewater treatment projects on constructed wetlands

From Prabhjot Sodhi, UNDP GEF SGP, New Delhi

Dr Padma Vankar, IIT Kanpur
and
KN Singh, Devender Vidyapith Shiksha Sansthan

Recommended for their involvement in the UNDG GEF SGP program enabling use of a central wastewater treatment plan, providing water for irrigation in the district of Jajmau

S.K.Satpathy, Xavier Institute of Management *(from Mihir Maitra, ICEF, New Delhi)*

Recommended as the implementing agency for Community based Water Resource Management project emphasizing natural water quality improvement in Bhubaneshwar

Recommended Documentation

From, R. Santhanam, Indian Society of Agribusiness Professionals (ISAP), New Delhi

Decentralised Wastewater Treatment Systems (DEWATS)
http://www.borda-net.org/conrat/Dewats_Mai05_72.pdf (Size: 485 KB)

Examines in detail DEWATS, technical approach offering demand based technical solutions to reduce water pollution by SME's in densely populated areas

Biosanitiser – A Resource for Ecosanitation
Dr Uday S. Bhawalkar, Bhawalkar Ecological Research Institute (BERI), Pune
http://www.wastetohealth.com/biosanitizer_ecosanitation_resource.htm

Explains the technology by which biosanitiser granules convert polluted water into clean water, which also becomes a resource for ecosanitation

Sanitation Connection – Wastewater Treatment Technology
http://www.sanicon.net/titles/topicintro.php3?topicId=6

Covers waste stabilization ponds (WSP), wastewater storage & treatment reservoirs (WSTR), constructed wetlands (CW) chemically enhanced primary treatment (CEPT),& upflow anaerobic sludge blanket reactors (UASBs)

A Pilot Experience under the UNDP GEF Small Grants Program on Chrome VI Remediation in the affected areas of Jajmau. (UP) *(from Prabhjot Sodhi, UNDP GEF SGP, New Delhi)*
http://www.solutionexchange-un.net.in/environment/cr/res10030601.pdf (Size: 184 KB)

This pilot study seeks to learn, document, find alternative strategies for wastewater treatment and to consider possible alternatives and choices for the community.

Community-based Water Resource Management with Emphasis on Natural Water Quality Improvement and Resource Recovery *(from Mihir Maitra, ICEF, New Delhi)*
http://www.icefindia.org/SP_XIM_details.htm

Examines renovation of silted and weedinfested wetlands and converting them to duck weed-fish ponds for natural water quality improvement in Bhubaneshwar

Additional documentation identified by Ramya Gopalan, Research Associate

Integrated Development Plan of Calicut City
MATURE Program, Tifac,
http://www.tifac.org.in/mature/progupcal1.php

This project of Calicut aims at improving its quality of life by the physical implementation in areas of wastewater treatment, application of GIS, modeling of drainage etc.

Kharoudi Village in Punjab – Model of Cleanliness
Shipra Saxena (consultant), Department of Drinking Water Supply, Ministry of Rural Development
http://ddws.nic.in/casestudy_kharoudi.pdf (Size: 654 KB)

Describes experience of this village as a model that understood necessity of clean drinking water, sanitation, solid and liquid waste management and hygiene

Treatment Options
H.P. State Environment Prevention & Pollution Control Board
http://hppcb.nic.in/treatment.htm

Provides a table of major contaminants in waste water and the unit operation, processes, or methods applicable for the removal of these contaminants

Groundwater Treatment Technologies
Central Pollution Control Board
http://www.cpcb.nic.in/groundwater/ch140703.htm

Provides different treatment technologies differentiating between organic contaminants, inorganic compounds and biological methods used in the treatment of groundwater

Environmental Sound Technologies (ESTs) for Conservation and Management of Lakes - A Case Study of Mysore Region
Venkataramaiah Jagannatha, Paper 4, Section 8 - Sustainable Water Resources Management, Policies and Protocols, Centre for Ecological Sciences, Indian Institute of Science, 2000
http://144.16.93.203/energy/water/proceed/section8/paper4/section8paper4.htm

Furnishes comparative list of conventional macro wastewater treatment methods with their effective capability in countering pollution along with their efficiency and cost

Solar Photocatalytic Treatment of Phenolic Wastewater
Pichiah Saravanan et al, CHEMCON '05, New Delhi
http://www.iitg.ernet.in/engfac/chemeng/public_html/psaha_files/cc05sara.pdf (Size: 133 KB)

The scope of the present study is to find an inexpensive TiO2 catalyst with good photocatalytic activity in order to reduce the operating cost of the wastewater treatment.

Wastewater Treatment: Biological and Chemical Processes
Henze.M et al, Water Treatment Books
http://www.watertreatmentbooks.com/book12.asp

Detailed presentation of theories behind modern wastewater treatment processes presenting up-to-date description of characteristics, theories of biological processes etc

Wastewater Engineering: Treatment and Reuse
Metcalf & Eddy et al, Tata Mc Graw Hill, 2002
http://www.firstandsecond.com/store/books/info/bookinfo.asp?txtSearch=2167364

Describes technological and regulatory changes that have occurred over last ten years in this discipline, including improved techniques for the characterization of wastewaters

Environmental Standards – Experience with Wastewater Disposal Requirements in UK
Tata Consulting Engineers Ltd (TCE), TCE World July 2004
http://www.tce.co.in/downloads/publications/wastewater5.pdf (Size: 213 KB)

Provides experience in designing wastewater treatment works as per UK regulations giving an insight to the environmental standards followed in developed countries.

Responses in Full

V. Kurian Baby, Socio-Economic Unit Foundation (SEUF), Kerala

As you are aware, in villages, properly designed and maintained **onsite treatment systems** could treat wastewater cost effectively to a large extent and protect the watershed from pollutant overloads. There are various treatment/disposal systems, the selection of which shall be location-specific. Most commonly used methods are sullage, soak pits and kitchen gardens/homestead farms. If supplemented by household sanitation coverage would answer to a large extent the issues of grey and black water. In some States (Karnataka), direct re-charge of boreholes using flood water (using sedimentation and filtration process) and usage of discarded bore wells for ground water re-charge are being practiced. An essential pre-requisite for adoption of a feasible option or technical choice however, is the waste water characterization and analysis of pollutant distribution. Even well meaning efforts in ground water re-charge may lead to irreparable damage by way of ground water pollution.

In towns and peripheries of urban centres with in a watershed, it could be ideal to **plan for wastewater discharge locations within the watershed in which the wastewater is generated.** This is due to the fact that there is a balance that must occur between groundwater recharge and groundwater export within each watershed.

Major technologies used are; (a) aerobic treatment system; (b) **constructed wetlands**; (c) drip irrigation leach field; (d) Gravel-less pipe leach fields etc. The first two options are relatively cost effective. **Constructed wetlands, using sub-surface and surface flow could offer an affordable solution in areas having warm climate, high water table, low soil percolation, high suspended solids in waste water and enough unshaded area**. Sub-surface dual-cell discharge is common for small residential applications. As far as I know, sewage treatment systems are apparently not a commercially viable proposition, however **high economic rate of return** make the programmes tremendously feasible. If we can work out a mix of cost recovery, commercial bye products and polluter pays, even commercial viability could be proved. **Annual Waste Water Management and Reporting Plan** could also be made an integral part of the watershed-based planning.

Dinesh Kumar, International Water Management Institute (IWMI), Anand

I work with IWMI, India office in Anand. Responding to your query on wastewater treatment, there are no simple solutions for wastewater problems. They are expensive and are only viable when the amount of wastewater to be treated is quite substantial and is available with a high degree of reliability, and at low collection costs. This means, in small towns and villages (with no proper sewerage system), the entire process of collection of wastewater would be a messy and tedious process.

What is intriguing is that if all waste water generated in one year is collected and treated from a typical village (with a population of 2000 people) the total collection is only 20000 m^3 of water sufficient to irrigate 2-3 ha of land.

Many big cities in water scarce countries plan wastewater treatment systems. Australia and Israel are the two I can think of. In Israel, wastewater from 10 cities (DAN city association) is collected and treated in waste stabilization ponds and the treated and the same is recharged underground through sandy aquifers (soil aquifer treatment). The same water is pumped out before it gets mixed with the natural groundwater and is put into the national water system. Farmers use it and also pay for it. The price is around 30 cents per cubic metre and farmers earn much higher returns from every cubic metre of water used by growing citrus fruits, like avocado, oranges and high valued vegetables for exports. In Australian towns, they use the treated wastewater for gardening, toilets etc.

But, in India farmers may not be willing to pay for treated wastewater. If government decides to invest in treatment given the larger benefits to the society (social and economic), the cost of setting up recharge infrastructure and monitoring systems will be very high.

Monitoring and managing groundwater in hard rock areas though participatory monitoring etc. is difficult. Further, its merits are not clear. Is there any record/documents related to water inflow and outflow particularly in hard rock areas? I think these are extremely important questions; more important than the water level fluctuations. As you know, the flow of groundwater in these hard rock areas is quite complex. What percentage of the annually replenished groundwater could be abstracted depends on the entire water use programming. When water level rises very high after monsoon rains, the groundwater outflows into surface streams would be quite significant because there is no pumping. The total outflows from the aquifer are often not captured in the resource assessments. The resource availability gets over-estimated.

We must start with monitoring water use by farmers—I hope this is part of the programme you have.

Vishwanath, Rainwater Club, Bangalore

Interesting question and here is some experience that I have.
Why generate waste water in the first place? Why not use source control to reduce waste water generation and to use it up effectively near the household itself for growing plants? What village households need in the villages where I work is water in the household and a toilet/bath facility. If we build a storage tank of say 2000 litres capacity and collect rainwater (otherwise waste water) we harvest close to 20,000 litres even from a small 30 square metre house. This water becomes available to the household for essentially non potable use or for cows/cattle.

Secondly a source separating composting toilet, whereby urine is collected separately and faeces composted, reduces water requirement for toilets, generates fertilisers and eliminates completely the generation of black water from toilets.

Water from bathrooms/clothes wash/utensils wash are led to a gravel filter planted with canna/bananas/papaya even sugarcane. They evapotranspirate grey water and convert it to food.

If done at a village scale, it helps clean up the catchment for rainwater to be collected and recharged if possible through small tanks. Fitting all forms of water in a village and managing it seems to be the key or atleast the first step to sustainability.

R. Santhanam, Indian Society of Agribusiness Professionals (ISAP), New Delhi

I just joined this group. Dr. Mani's Query made interesting reading as well as the response of Mr. Dinesh Kumar, who gave valuable inputs.

I am giving below information on two technologies available in India.

Dewats

I have attended a "Dewats" symposium organised by CSE at New Delhi. Dewats stands for decentralised waste water treatment system where the waste stream is not transported over long distances and compact systems with low foot prints are used. They use mostly anaerobic treatment, multiple baffle septic tanks (said to have been developed first in China) for sewage, use of polishing ponds and aquatic plants with root zone aeration systems and sand bed /gravel filters.

Details can be had from:
Mr. Pedro Kraemer
Coordinator
FEDINA-Borda Dewats Coordination
#220, 4th 'A' Cross, 3rd Block,
HRBR Layout, Kalyan Nagar,
Bangalore 560043
Tel: +91 80 25431772
Tel/Fax:+91 80 25431773
E mail: borda.India@vsnl.net
borda-india@dishnetdsl.net

This organisation is funded by Bremen Overseas Research and Development Association.

Biosanitiser

Another technology is the Biosanitiser, an invention by a Pune based scientist, Dr. Uday Bhwalkar. Use is made of biotechnology, whereby effluents get stabilised in respect of pathogens and dissolved solids, including brackishness, heavy metal and other toxics which get "Bio converted" into a safe mode. The treated water gets stabilised with lower BOD and COD. The dissolved solids do not pollute the ground water. When used for gardening or irrigation in farms including in peri urban areas, the pollutants actually seem to help plant life to flourish, without contamination of such residuals. The treated waste water also seems to have the property of improving existing ground water quality through the complex mechanism of soil biology. This means nitrates and other pollutants in the existing ground water get treated and the water becomes 'sweet'.

Both domestic sewage and industrial effluents are rendered fit for irrigation and / or use for ground water recharge. The process consists of a series of flow through tanks, in which some are open to the sky and sunlight. A scum is formed and floats on the open top on which vegetation grows. The retention time and flow through rates are comparable to other complex systems. This technology uses very little energy and makes use of natural eco systems. The Biosanitiser itself is described as a natural enzyme in a stabilised carrier, but the scientist has not disclosed the composition. Basic technology was developed in association with IIT Mumbai. It carries a U.S and Indian patent jointly held with IIT and Dr. Uday Bhawalkar besides other scientists. However, Dr. Uday Bhawalkar seems to have individually developed the Biosanitiser after these patents, which was based on earthworm based biofilters. Dr. Uday Bhawalkar is also well known in USA, internationally and in India for his earlier research work on deep burrowing earth worms and effects on soil biology. Latest applications do not require earthworms, and only the Biosanitiser, an enzymatic biocatalyst, which acts through aqueous media.

His web site: http://www.biosanitiser.com/index.asp

In its present state, the technology is proven in several locations and commercialised. For enquiries on Biosanitiser supplies and technical advice, and engineering the pilot study plant, please contact:

Mr.Gopal Sane
Samrudhhi
A-4/245, Konark Apartments
Pocket A-4,Kalkaji Extension,
New Delhi - 110 019
Tel: +91 11 26093248
E mail: samrudhhi100@yahoo.co.in

Prabhjot Sodhi, UNDP GEF SGP, New Delhi

Firstly, I would like to share the details on the pilot experiment that we in the SGP have initiated.
Kanpur - A small industrial town has roughly 5500 industries with 75 medium and large industries such as fertilizers, detergents, chemicals and paints. Out of these, the 350 odd leather factories localized in one area called Jajmau along the river Ganges are mainly responsible for river pollution. Chrome (Cr) VI, the main pollutant of the tanneries, remediation project piloted by UNDP GEF SGP, implemented by the Devender Vidyapith Shiksha Sansthan. The tanneries discharge their toxic wastes laden with Cr VI into the sewage system. This effluent is carried through the main drainage system to the centralized treatment plant located in Jajmau. The treated water is then used for farming irrigation or released directly into the Ganges. Please see link for details of this project.

For further queries, the persons to contact are both Dr Padma Vankar and Mr KN Singh NGO Director. Please, directly get in touch with them or you are also most welcome to let us know for any future queries. Hope this meets your details.

Padma S Vankar, IIT, Kanpur

I am a principal research scientist in the Facility for Ecological and Analytical Testing (FEAT) in IIT Kanpur. Mr. Mani your concern of finding solution to your sewage water treatment and its eventual use as a value added product is very valid. Since sewage content is rich in nitrogen and phosphorus, it is ideal for fertilizer and can be definitely used for vermiculture and as food for fish in fishponds. A chemical analysis is needed to determine the chemical composition of the sewage before a solution can be recommended. We are talking of the best method that can be used from known strategies for its effective utilization and not some exotic techniques. Treatment plans can be designed that can range from individual household to a whole village. While a small dug hole with a bed of coagulants can used to pass the waste water to deposit the solids and then the water can be used for kitchen garden at a household level. For a couple of houses a Nullah or a drainage pipe can be put in place, to collect the water for say ten households and can also be treated thus. For a village or a higher volumes of sewage a higher scale of treatment facility can be created. Thus the volume and composition of the sewage needs to be specified for the option to be planned.

Mihir Maitra, ICEF, New Delhi

I would suggest you to enquire in to one ICEF funded project in Bhubaneswar called "Community based Water Resource Management with Emphasis on Natural Water Quality Improvement and Resource Recovery". This project is being implemented by Xavier Institute of Management (Contact person: Mr. S.K.Satpathy) in collaboration with Central Institute for Freshwater Aquaculture (CIFA), Bhubaneswar. In this project, the Sewage from Bhubaneswar city is made to undergo natural rejuvenation process through engineered wetland system before disposal. A overflow weir is constructed on the drains which acts as the first siltation pond/tank. This is followed by a series of 3 more ponds/tanks namely aeration pond, duck weed pond and fishery pond. Water quality is monitored regularly for BOD load etc. before disposal. There are three sites like this and one will be extended soon to Puri. More information can be collected from XIM/ICEF.

The advantage of Bhubaneswar is that it already had sewage carrying drains running through the town with sufficient land available along both its side for construction of the retention ponds of required size. The fishes being grown in the last pond are the property of the local communities associated with the project. The fish being grown have been declared safe for human consumption by CIFA.

In the context of small villages in Andhra Pradesh perhaps such large flow and site conditions would not be available commonly. Hence one plausible strategy would be to use the collected sewage (community level) for recharging the prelatic aquifer through a number of small recharge pits after necessary filtration and treatments. Needless to mention that expert advice would be required to adopt standard design for the pit and the filter materials to be used apart from extensive quality monitoring.

Many thanks to all who contributed to this query!

If you have further information to share on this topic, please send it to Solution Exchange for WES-Net at se-wes@solutionexchange-un.net.in with the subject heading "RE: [se-wes] Query: Treatment of Waste Water for Reuse, from APFAGMS, Hyderabad, (Experiences). Additional Response".