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Useful waste water

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Abstract
Securing Water, food and energy is an important and vital issue not only for India but also for the world. The effects of agricultural growth, industrialization and urbanization has affected most of the river basins in India and elsewhere and brought on moderate to severe water shortages. Current and future fresh water demand needs to be met by enhancing water use efficiency and demands waste water management. Thus, wastewater/low quality water management after essential treatment is the 'need of the times'.
What is wastewater? Wastewater or sewage is the by-product of many uses of water. There are the household uses such as bathing, washing utensils, clothes and flushing the toilet. Industries use water for many purposes including the different processes, products and cleaning. After the water has been used it flows to the wastewater treatment plant which provides a high quality end product.
Why treat wastewater? We need to remove the wastewater pollutants to protect the environment and protect public health. When water is used by our society, the water becomes contaminated with pollutants. If left untreated, these pollutants would negatively affect our water environment. For example, the depletion of oxygen in lakes, rivers, and streams due to the pollutants in them and results in dead fish and/or foul odours. Waterborne diseases can be eliminated through proper wastewater treatment as many pollutants could exhibit toxic effects on aquatic life and the public.
How do we collect the wastewater? The sewer or collection system is designed so that it flows to a centralized treatment location. The collection system is comprised of smaller sewers. As more homes and companies are connected along the system, the pipes become larger in diameter. Where gravity systems are not practical, pumping stations are often included to lift the wastewater. In many states, there are some very old collection systems - the late 1800s! Materials of construction and methods of construction have changed significantly over the years. Many systems experience problems during rainy season with inflow and infiltration. This is when water should flow into a storm water system and not into the sanitary sewer system. The "combined sewers" carry street waste as well as wastewater. Older sewer pipes may have leaking joints or cracks that allow the water to enter the system.
Ignoring wastewater management leads to chemical contamination and microbial pollution. The industrial and commercial effluents are often mixed with domestic wastewater.
Wastewater contains a number of pollutants and contaminants, including: • plant nutrients (nitrogen, phosphorus, potassium); • pathogenic microorganisms (viruses, bacteria and protozoa); • heavy metals (e.g. cadmium, chromium, copper, mercury, nickel, lead and zinc); • organic pollutants (e.g. polychlorinated biphenyls, polyaromatic hydrocarbons, pesticides); and biodegradable organics (BOD, COD); and • micro-pollutants (e.g. medicines, cosmetics, cleaning agents). All of these can cause health and environmental problems and when improperly or untreated wastewater is released into the environment.

Keywords: securing water, industrialization, wastewater

Introduction
At the beginning of the 21st century, the world faces a water quality crisis resulting from continuous population growth, urbanization, land use, industrialization, food production practices, increased living standards, poor water use practices and lack of wastewater management strategies. This has a direct impact on the biological diversity of aquatic ecosystems, disrupting the fundamental integrity of our life support systems. It is essential that wastewater management be considered as part of an integrated, full life cycle, ecosystem-based management system that operates across all three dimensions of sustainable development (social, economic and environmental), geographical borders, and includes both freshwater and marine waters.
The World Water Forum meeting in March 2012 echoed the problems and the need to bring wastewater to the fore in world water politics and described the existing situation: The "…MDG targets on improved sanitation have focused resources on increasing service coverage in terms of access to improved toilet facilities, but with far less attention paid towards ensuring that waste streams are adequately collected and treated prior to discharge into the environment. Worldwide wastewater treatment is failing. … As a result, the majority of wastewaters, septage and faecal sludges are discharged without any form of treatment into the environment … spreading disease to humans and damaging key ecosystems such as coral reefs and fisheries. Dirty water is a key factor in the rise of de-oxygenated dead zones that have been emerging in the seas and oceans across the globe. This is becoming increasingly a global problem– but already most cities lack adequate wastewater management due to aging, absent or inadequate sewage infrastructure". According to the fourth World Water Development Report, presently only 20% of globally produced wastewater receives proper treatment. Environmental conditions arising from inadequate or non-existing wastewater management pose significant threats to human health, well-being and economic activity.

Wastewater is water whose physical, chemical or biological properties have been changed as a result of certain substances which render it unsafe for drinking. The day to day activities of man is mainly water dependent and therefore discharge 'waste' into water. Some of the substances include body wastes (faeces and urine), hair shampoo, hair, food scraps, fat, washing powder, fabric conditioners, toilet paper, chemicals, detergent, household cleaners, dirt, micro-organisms (germs) which can make people ill and damage the environment. It is known that much of water supplied ends up as wastewater which makes its treatment very important. Wastewater treatment is the process and technology that is used to remove most of the contaminants that are found in waste water to ensure a sound environment and good public health. Wastewater Management therefore means handling wastewater to protect the environment to ensure public health, economic, social and political soundness.

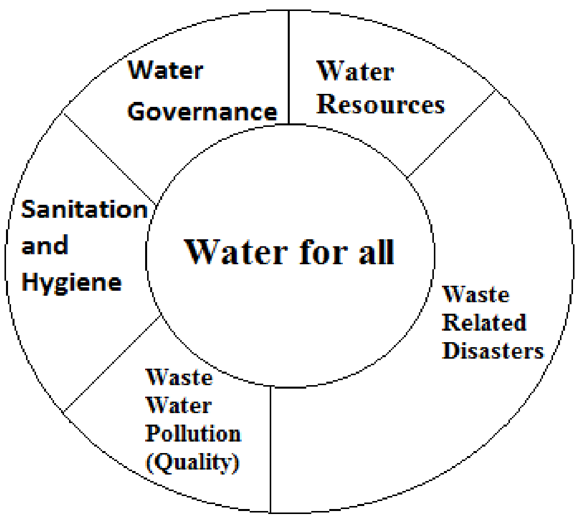

Fig 1

History of Wastewater Treatment

Wastewater treatment is a fairly new practice although drainage systems were built long before the nineteenth century. Before this time, "night soil" was placed in buckets along streets and workers emptied them into "honey-wagon" tanks. This was sent to rural areas and disposed off over agricultural lands. In the nineteenth century, flush toilets led to an increase in the volume of waste for these agricultural lands. Due to this transporting challenge, cities began to use drainage and storm sewers to send wastewater into water bodies against the recommendation of Edwin Chadwick in 1842 that "rain to the river and sewage to the soil" should be the correct method. The discharge of waste into water bodies has led to gross pollution and health problems.

In 1842, an English engineer named Lindley built the first "modern" sewerage system for wastewater carriage in Hamburg, Germany. The improvement of the Lindley system is basically in improved materials and the inclusion of manholes and sewers - the Lindley principles are still upheld today. Treatment of wastewater became apparent only after the assimilative capacity of the water bodies was exceeded and health problems became intolerable. Between the late 1800s and early 1900s, various options were tried until in 1920, the processes we have today were tried. Centralized wastewater systems were designed and encouraged.

Wastewater is commonly known as sewage. Wastewater treatment is a very vital and essential part of making sure that we live in a pleasant and healthy environment. Wastewater contains pathogens and organic matter which allows the pathogens to multiply quickly as well as absorbs oxygen from the water. It also contains nutrients, but in natural water body can be very damaging.

Common Waste Water Terms

Waste water is water containing wastes from residential, commercial, and industrial processes. Municipal wastewater contains sewage, gray water (water from sinks and showers) and industrial wastewater. Large industries also generate wastewater.

Water treatment is any process that makes water more acceptable for drinking, industry, irrigation, river flow maintenance, water recreation or any other uses.

Sewage treatment is the process of removing contaminants from household sewage. It includes physical, chemical, and biological processes to remove these contaminants and produce environmentally safe treated wastewater.

Wastewater treatment is a process to convert wastewater into an effluent that can be either returned to the water cycle with minimal environmental issues or reused.

Some of the most common wastewater terms are:

Aerobic: A process that requires dissolved oxygen to operate properly.

Anaerobic: A process that can operate or needs to operate without oxygen being present.

Biochemical Oxygen Demand (BOD5): A test that measures the organic strength of a sample of wastewater. It provides information on the organic load or how much "food" there will be for organisms.

Total Suspended Solids (TSS): Data from a test that measures by weight how much particulate material is contained in wastewater samples by filtering the sample through a special fibre glass filter.

Parts per million (ppm) or milligrams per litre (mg/L): These are the results of analyses such as TSS or BOD5.

Clarifier or settling tank: Tanks designed for the physical separation of wastewater into floatable solids and settle able solids.

Disinfection: Killing disease-causing organisms present in the water.

Dissolved Oxygen (DO): An electronic meter that tests and measures the dissolved oxygen of the sample. Too much oxygen can mean that money is wasted through excess energy consumption to provide the oxygen.

Effluent: The liquid stream which is discharged from a wastewater treatment plant or discharge from a unit process or operation.

Influent: Wastewater flowing into a reservoir, basin or treatment plant. It is wastewater which is yet to enter in a wastewater treatment plant or liquid waste that is yet to be treated.
Sludge is the semi-solid slurry from a wastewater treatment plant.
Wastewater Treatment Plant is a plant with a series of designed unit operations and processes that aims at reducing certain constituents of wastewater to acceptable levels

Definition of concepts and terminology
Storm Water Runoff is water from streets, open yards etc after a rainfall which run through drains or sewers.
Industrial wastewater is liquid waste from industries, factories and production units.
Domestic waste water is also known as municipal wastewater i.e. wastewater from residences (homes), business buildings (e.g. hotels) and institutions (e.g. schools, colleges and university). It can be categorized into grey water and black water.
Grey water (sullage) is liquid waste from washrooms, laundries and kitchens which does not contain human or animal excreta.
Black water is wastewater generated in toilets. Black water may also contain some flush water besides urine and faeces (excreta). Urine and faeces together is sometimes referred to as night soil.
Sewage is the term used for black water if it ends up in a sewerage system.
Septage is the term used for black water if it ends up in a septic tank.
Sewerage system is the arrangement of pipes laid for conveying sewage.

On-Site System: This is wastewater disposal method which takes place at the point of waste production like within individual houses without transportation. On- site methods include dry methods (pit latrines, composting toilets), water saving methods (pour-flush latrine and aqua privy with soakage pits and methods with high water rise flush toilet with septic tanks and soakage pit, which are not emptied).

Off-Site System: In this system, wastewater is transported to a place away from the point of production. Off- site methods are bucket latrines, pour-flush toilets with vault and tanker removal and conventional sewerage system.
Conventional sewerage systems can be combined sewers (where wastewater is carried with storm water) or separated sewers.
Septic Tank is an on-site system designed to hold black water for sufficiently long period to allow sedimentation. It is usually a water tight single storey tank.
Faecal sludge is all sludge collected and transported from on-site sanitation systems by vacuum trucks for disposal or treatment.

Unit Operation: This involves removal of contaminants by physical forces.

Unit Process: This involves biological and/or chemical removal of contaminants.

Characteristics of Wastewater
Depending on its source, wastewater has peculiar characteristics. The basic principle according to Kamala and however is waste prevention by good housekeeping practices that will ultimately result in volume reduction and strength reduction

Faecal sludge treatment and disposal
Sewage sludge contains organic and inorganic solids that were found in the waste water. The generated sludge is usually in the form of a liquid or semisolid. Sludge is treated by means of a variety of processes that can be used in various combinations. Thickening, conditioning, dewatering and drying are primarily used to remove moisture from sludge, while digestion, composting, incineration, wet-air oxidation and vertical tube reactors are used to treat or stabilize the organic material in the sludge.

Industrial wastewater treatment
Industrial wastewater with characteristics of municipal or domestic wastewater can be discharged together. Industrial wastewater may require pre-treatment if it has to be discharged with domestic wastewater. In general, the type of plant to be installed depends on the characteristics of the wastewater produced from the industry depending on their major contaminant e.g. heavy metals, dye, etc. Industrial wastewater is treated the same way as domestic or municipal sewage—preliminary, primary, secondary and advanced treatment levels.

Wastewater reuse in agriculture
Irrigation with wastewater is an effective form of wastewater disposal, but, only after treatment it can be used for agricultural or landscape irrigation or for aquaculture.
In many industrialized countries, primary treatment is required for wastewater irrigation and used to irrigate crops that are not consumed by humans or to irrigate orchards, vineyards, and some processed food crops (FAO, 2006).
Nutrients in municipal wastewater and treated effluents are a particular advantage as supplemental fertilizers. Success in using this treated wastewater for crop production will largely depend on adopting appropriate strategies for optimizing crop yields and quality, maintaining soil productivity and safeguarding the environment. Wastewater effluent can be blended with conventional water for agriculture.

Types of Waste Water

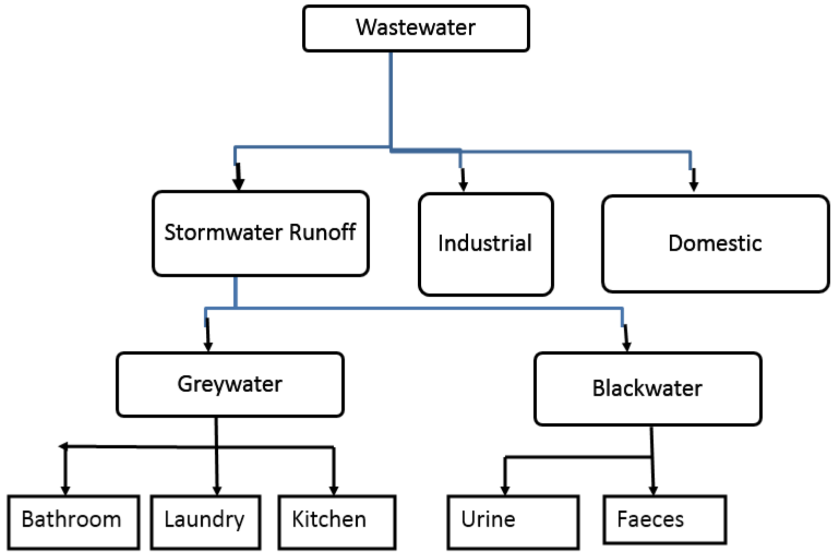

Fig 2

Challenges of Wastewater Management

Wastewater management though not technically difficult can sometimes be faced with socio-economic challenges. They include:

Infrastructure

Usually wastewater infrastructure is not the priority of most countries and therefore very little investment is made. It is however very important to consider this as almost all the water produced ends up as wastewater.

Pollution of water sources

The effects of the wastewater effluents on the receiving water body quality (lakes or ponds or rivers) is enormous, as it changes the aquatic environment and interrupts with the aquatic ecosystem. What we eat contains carbonaceous matter, nutrients, trace elements and salts as aqua bodies, plants and animals contain traces of urine and faeces as also medications (drugs), chemicals and in recent times hormones (contraceptives) which have been discharged.

Choice of appropriate technology

Because the economy of most developing countries is donor driven, funds for wastewater plants are mainly from donors. The management of the operations and maintenance of parts become quite challenging as the technical expertise; power requirements etc are not sustainable.

Sludge Production

Treatment of wastewater results in the production of sewage sludge for which a reliable disposal method is needed. If it must be used in agriculture, then the presence of heavy metals in wastewater, may lead to accumulation of heavy metals in soils thereby contamination of yields.

Reuse

Effluents which meet discharge standards could be used for agricultural purposes such as aquaculture or for irrigation of farmlands. But, if wastewater treatment plants are not managed and continuously monitored to ensure good effluent quality, reuse becomes risky.

Effective Collection System

Effective collection systems are a key for good wastewater management where off-site centralised treatment is chosen. However, throughout the world most places have either no collection systems or systems that are dysfunctional. There are a number of reasons for this:

- The failure to plan and install collection networks (sewerage);
- Old or decaying networks;
- Installation of inappropriate systems;
- Inappropriate sizing of systems (in relation to the wastewater flows or concentrations);
- Inadequate resilience to storm events;
- Ineffective operation and inadequate maintenance;
- Ineffective regulation and control of connections which severely limit the ability to check the accurate level of wastewater discharged to the environment. Decaying infrastructure also adds to the problem since broken pipes allow infiltration of water into the sewer network and/or ex-filtration of wastewater into the groundwater when the water table is low, causing groundwater pollution and potential cross-contamination of drinking-water supplies.

The need of the present times is the importance of good wastewater management and the urgent need to address this on a global basis.

Suggestions / Possibilities

The different technologies are not always designed together. They are often an attempt to retrofit or added to an existing system or is an individual component design. This also results in sewers running below or above capacity and treatment plants receiving too little or too much wastewater.

- Thus, developing an overall wastewater management plan, where all wastewater components should be undertaken based on appropriate boundaries is of extreme importance.
- An appropriate administrative unit is needed to ensure effective design and operation.
- The systems must be flexible to accommodate new populations and sources, and allow communities to have access to an improved level of service. Optimizing the re-

use of wastewater which is rich in recoverable materials is effective. [The 2006 WHO Guidelines also offer a range of treatment and non-treatment options.]

- Recognition of wastewater and its critical role in sustainable development needs to be more fully recognized within the overall water cycle, as one of the greatest untapped opportunities to enhance sustainable development. This is applicable in big cities and in rural areas.
- In terms of serving the poorest first, there is still a long way to go, both for basic water supply and sanitation.
- Wastewater management should consider the sustainable management of wastewater from source to re-entry into the environment ('reuse/disposal' in the sanitation service chain).
- Many of today's poorly thought-out and badly managed systems overload natural processes that purify water and maintain soil structure. Thus, it is clearly important to design wastewater management systems that "work with rather than against natural ecosystem processes". This has to be done before designing infrastructure/artificial systems and choosing a sustainable wastewater management approach.

Suggestions / Possibilities in India

In developing countries like India, the problems associated with wastewater reuse arise from its lack of treatment. The challenge thus is to find such low-cost, low-tech, user friendly methods, which on one hand avoid threatening our substantial wastewater dependent livelihoods and on the other hand protect degradation of our valuable natural resources.

The use of constructed wetlands is now being recognized as an efficient technology for wastewater treatment as compared to the conventional treatment systems. Constructed wetlands need lesser material for construction, driven by natural energy of sun, wind, soil, microorganisms, plants and animals; are easily operated, have no sludge disposal problems and can be maintained even by untrained personnel.

But, for planned, strategic, safe and sustainable use of wastewaters there is a need for policy decisions and properly planned programs which have low-cost decentralized waste water treatment technologies, bio-filters, efficient microbial strains, and organic / inorganic amendments, appropriate crops/ cropping systems, cultivation of remunerative non-edible crops and modern sewage water application methods.

India's fragile and finite water resources are depleting while the multi-sectoral demands for water from sustained economic growth (over 8%) is driving the increased demand for water due to population growth and agricultural use. The high degree of variability in the availability of water resources throughout the country as also climate change and extreme climate variability are factors which will affect the society. The higher usage of water in the domestic and industries is likely to continue as the pace of economic development grows.

Wastewater has been described as both "a resource and a problem" (Hanjra *et al.,* 2012), with respect to maximizing the resource potential and minimizing the problems. Some of the challenges in relation to the use of reclaimed water for irrigation is the presence of toxic chemicals (from industrial sources of effluent) and the presence of pathogenic microorganisms). Irrigation with even treated wastewater can lead to excess nutrients, pathogens, heavy metals and salts building up on the irrigated land unless proper care is taken. The separation of industrial and domestic wastewater will facilitate the likelihood of safe reuse from a toxic chemical waste. Showed that in India there were financial benefits associated with wastewater farming compared to freshwater agriculture, but only where domestic wastewater was not mixed with industrial sewage. Wastewater can be treated to minimise the risks from pathogenic microorganisms.

Some of the suggested government initiatives are

Setting-up an Energy Fund: In the Union Budget 2010-11, the government announced the setting up of the NCEF for all funding research and innovative projects within clean technologies.

Initiating Waste Management Programs: Government has set up JNNURM program to fund cities for developing urban infrastructure and services.

Budget Expansion: Plan outlay for the Ministry of New and Renewable Energy has increased by 61%, from Rs. 99M in 2009- 10 to Rs. 160M in 2010-11

Encouraging Public-Private Partnerships (PPP): Through economic incentives, both the central and state governments are promoting PPPs for the development of infrastructure for environmental services

Conclusion

Wastewater is and will always be with us because we cannot survive without water. When supplied water is used for the numerous human activities, it becomes contaminated or its characteristics is changed and therefore become wastewater. Wastewater can and must be treated to ensure a safe environment and foster public health. There are conventional and non-conventional methods of wastewater treatment and the choice of a particular method should be based on factors such as characteristics of wastewater whether it from a municipality or industry (chemical, textile, pharmaceutical etc.), technical expertise for operation and maintenance, cost implications, power requirements among others.

Wastewater can act as a drought-resistant source of water (especially for agriculture or industry); source of nutrients for agriculture; soil conditioner and a source of energy/heat. It is necessary to gain public acceptance and maximize benefits of reuse while minimizing negative impacts, health risks of reuse which need to be assessed, managed and monitored on a regular basis. The scale of reuse can range from individual households practicing ecological sanitation (where urine is separated from faecal matter at source and then diluted and applied directly to plants, while the faecal matter is stored [composted] until it is safe for land application) to major urban irrigation systems or biogas production. As Qadir *et al.* (2010) point out, many farmers and consumers are unaware of the potential negative health impacts of wastewater and suggest that public programmes informing farmers as well as consumers about health impacts will be a valuable public health measure. Perception of water quality and also control over irrigation choices may play an important role in the acceptability of the use of wastewater in agricultural irrigation.

The world is undergoing significant demographic and social changes, with urbanization and migration being two of the most important issues, here managing wastewater rand the increasing influences on the production of wastewater in a changing world is a necessity. Although, this is problematic, due to collection and treatment, it will pave the way for an exciting opportunity for decentralised collection and treatment and will be more economically attractive. On the negative side, if urban areas are allowed to encourage discharge of wastewater from small scale manufacturing enterprises, medical industries and unplanned settlements etc., it will seriously affect local populations, their access to fragile water supplies and subsequently their health. We will irreversibly damage the natural environment and miss cost effective opportunities to improve health if we fail to seize the opportunities that better wastewater management can bring.

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