Country Paper for Mauritius

Safe Use of Wastewater in Agriculture
3rd Regional Workshop,
Johannesburg, 26-28 September 2012

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20th September 2012

1. Wastewater Production and Treatment

The Republic of Mauritius lies in the Indian Ocean bearing a surface area of 1,864 km^2 with a population of 1,283,415. Over the past decades, Mauritius has witnessed a remarkable economic progress combining rapid development, growth and modernization with an overall outcome of raising the standards of living of Mauritians. As a consequence, the volume of wastewater generated from economic, domestic and commercial and industrial activities has been constantly increasing. The first sewer pipes were laid in the capital of Mauritius, Port Louis in the late 19th century. Since then and until the mid 20th century, development in that sector was very slow. The present Plaines Wilhems system was developed in the 60's and major improvements were brought to the Port Louis system in the late sixties and early seventies. The operation of these systems was regulated by the Port Louis Sewerage Act and the Plaines Wilhems Sewerage Ordinance of 1904 and 1959, respectively. To date, 29% of population of Mauritius is connected to sewer network and by year 2033 it is planned to connect 80% of the population (source: Wastewater Management Authority, 2012). The corresponding volume to be treated in 2012 is 39.1 Mm^3/year and with present works in progress the estimate volume will rise to about 79.9 Mm^3/year in 2033 (source: National Sewerage Master Plan) as depicted in Figure 1.

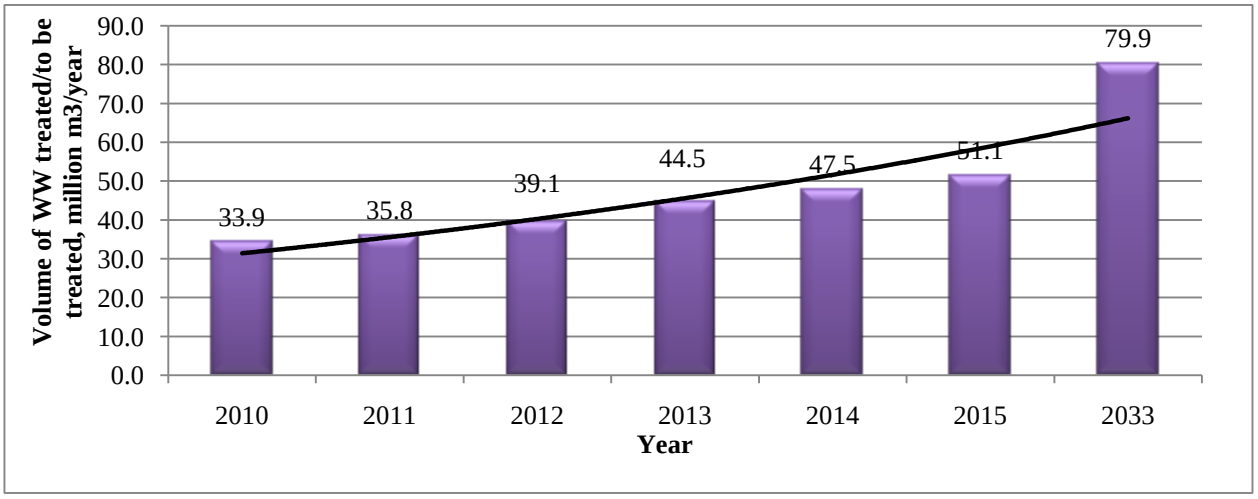

Figure1: Trend on the volume of wastewater treated in Mauritius

Based on the nature of usage downstream, the type of treatment normally practiced in Mauritius starts from preliminary to tertiary level as detailed in Table 1 below.

WWTP	Type of Treatment	Year Commissioned	Design Treatment Capacity, m^3/day	Actual Volume Treated, m^3/day
Baie du Tombeau	Preliminary	2002	48 000	28 000
St Martin	Tertiary	2005	69 000	40 000
Grand Baie	Tertiary	2006	5 500	2 000
Mt Jacquot	Primary	2007	48 000	32 000
TOTAL			**170 500**	**102 000**

Table 1: Major Wastewater Treatment Plants in Mauritius

Other treatment facilities include small wastewater treatment plants (six in total) which cater for specific areas and amounting to 2000 m^3/day. In addition, on site disposal such as leaching fields over the island amount to some 3000 m^3/day.

Presently, some 48 hotels are known to be treating their wastewater (processes: Activated sludge process, rotational biological contactors and one of them use the constructed wetlands). Approximately 3.5 Mm^3 of treated wastewater is generated per year from these 48 hotels (WMA, 2012).

Main types of constraints to wastewater treatment:

A. Financial constraints
   - High construction **costs of treatment systems.**
   - High **Operation and Maintenance costs**, e.g. for electricity, equipment maintenance and investments in trained personnel.
   - High **price of treated wastewater** vs. lower freshwater prices for treatment.

B. Health and Environment risks – Monitoring
   - Environmental risks (mainly soil clogging, soil salinisation).
   - Risk occurrence linked to: Failure to meet quality standards at source (Treated effluent disposal).
   - It is noted that there has been a considerable decrease in waterborne, water-related and water-vector diseases over the past years nationwide. The statistics on waterborne diseases is a good indication of an improvement in environmental sanitation in Mauritius.(source: Independent environment audit on wastewater projects final report period Sept 2010-Aug 2011).

C. Technical constraints
   - Laying down of infrastructure due to topographical constraint.

2. Wastewater Use and Disposal

In Year 2006, the Irrigation Authority, responsible for irrigation development in Mauritius, signed an agreement with the Wastewater Management Authority for the reuse of treated water which has been treated to tertiary level using uv-light. An average volume of 40000 m^3/day tertiary treated effluent was being delivered by the St Martin Wastewater Treatment Plant into the Western Coast Canal System to irrigate about 600 hectares of sugar cane plantation downstream of the point of injection into the canals as illustrated in Figure 2. This flow was mixed in 1:1 ratio for dilution of the treated effluent with the raw upstream water from reservoirs.

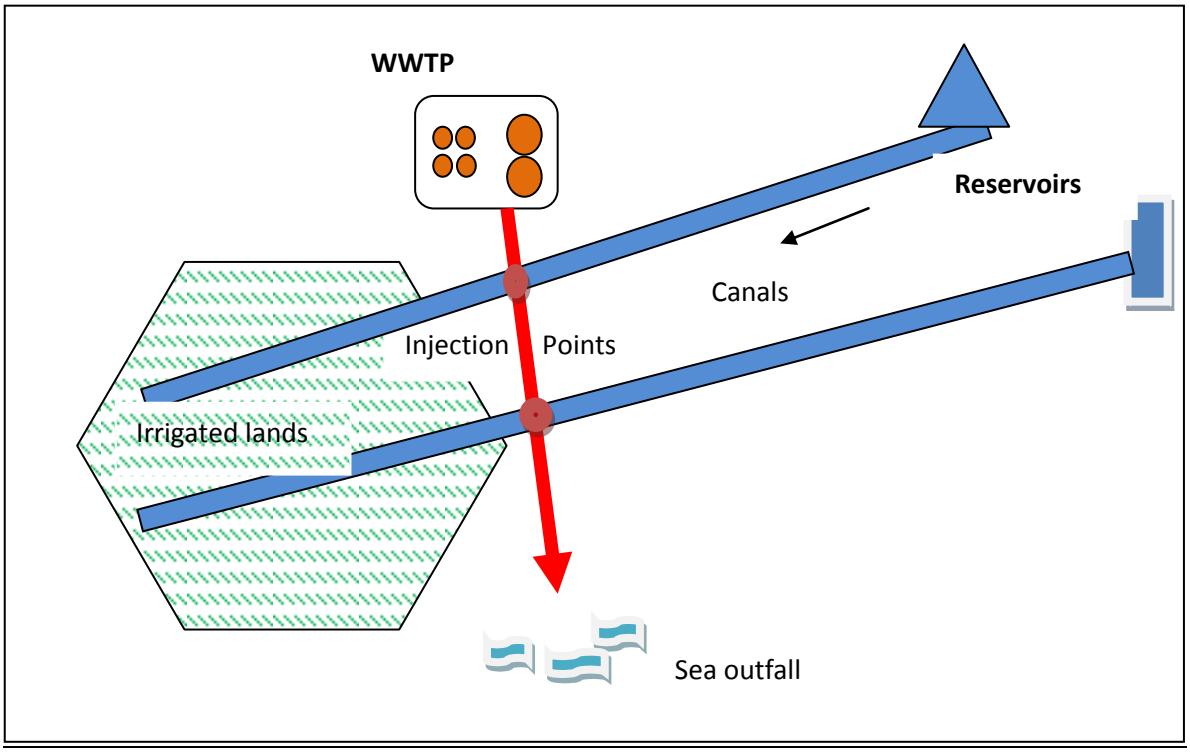

Figure 2: Schema depicting reuse of tertiary treated wastewater for irrigation

The price of treated water charged to farmers downstream of the injection points was 80 cents/m^3 as compared to seven cents/m^3 for raw water from reservoirs charged to other farmers upstream of the injection points. This lead to the unwillingness of farmers to pay the 80 cents/m^3. This situation continued and the Irrigation Authority had no alternative than not to renew the contract after expiry of the agreement after 3 years that is in 2009. Because of pronounced drought from October 2011 till April 2012, the Government reconsidered the reuse of the treated effluent for irrigation purposes. The price of this tertiary treated effluent has been fixed at 70 cents/m^3 and the farmers have again shown their disagreement. The pricing structure is being reviewed by the Ministry of Energy and Public Utilities.

3. Policies and Institutional Set-up for Wastewater Management and Irrigation

a) The Ministry of Environment and Sustainable Development (MOE & SD)

This Ministry is responsible to formulate and enforce Environmental Laws relating to re-use/disposal of wastewater such as:

- Standards for the sewage and industrial effluent discharges to land, surface water and oceans
- Standards of effluent for use in Irrigation Regulations (Gov. Notice No.46 of 2003.)

b) The Wastewater Management Authority (WMA)

The Wastewater Management Authority plays a vital role in the protection of the environment and in ensuring the country's sustainable development by the provision of appropriate water pollution standards, wastewater control systems and management services to the entire population of Mauritius.

The Authority operates under two legal instruments which regulate the relationship between WMA and the Ministry of Energy and Public Utilities. These instruments are:

(1)Convention de Maîtrise d'Ouvrage Deleguée (for the construction of new works)
(2)Contrat de Délégation (for the Operation & Maintenance of the Public Wastewater Systems).

Under the Convention de Maîtrise d'Ouvrage Deleguée, the Government of Mauritius entrusted to WMA the overall responsibility for the implementation of all projects under the National Sewerage Program (NSP).

The adoption of the National Sewerage Master Plan (NSMP) embodies Government's commitment to the improvement of the environment and to promote sustainable development. The NSMP provides a complete scheme for the development of wastewater sector in Mauritius and targets above 80% population connection to the sewerage system by the year 2033. The overall objective of the National Environmental Policy is to "foster harmony between quality of life, environmental protection and sustainable development for the present and future generations. The Government has adopted this policy and recognises that a high quality environment is essential for the sustained development of the country's economy and for the health and welfare of its people. The Wastewater Management Authority (WMA) has been entrusted the responsibility pertaining to all matters relating to the collection, treatment and disposal of wastewater. The mission of the WMA is in line with the government policy which puts emphasis on sustainable development concepts such as Maurice Ile Durable and Green Mauritius, overarching guidelines for improvement in water supply and sanitation in developing and transition countries set in the Millennium Development Goals.

c) The Irrigation Authority

The Irrigation Authority (IA) was established as a parastatal body by the provisions of the Irrigation Authority Act No.39 of 1978. It was created under the aegis of the Ministry of Agriculture and Natural Resources (now Ministry of Agro-Industry and Food Security) with the following objects:

- to study the development of irrigation;
- to implement and manage irrigation projects in every irrigation area and to do all other acts incidental thereto, and;
- to undertake research into the optimum use of water.

Since its creation, IA has implemented 20 projects island wise covering 3968 hectares belonging to some 5000 small planters. These projects are ensuring an incremental yield of about 22 tons/hectare and 7500 tons food crop production on some 750 hectares.

The main activities of the Irrigation Authority are:

(a) to identify irrigable lands, determine potential sources of water and carry out feasibility studies for new irrigation projects;
(b) to investigate plan, design, construct and supervise implementation of irrigation projects;
(c) to operate and maintain irrigation projects and to do all acts incidental thereto;
(d) to conduct and co-ordinate field research and investigation on the optimum use of water for irrigation;
(e) to formulate policies relating to irrigated agriculture;
(f) to monitor and evaluate ongoing irrigation projects;
(g) to modernize and upgrade old schemes so as to improve service to the small planters;
(h) to train small planters on different methods of irrigation and use of irrigation equipment;
(i) to provide support to Water Users' Associations and Cooperative Societies for the proper running of irrigation operations;
(j) to provide incentive to planters.

In early 2000's the Irrigation Authority played an instrumental role in the establishing of the standards for water quality for irrigation proclaimed under the Environment Protection Act 2002. During 2006-2009, the Irrigation Authority monitored the efficient use of tertiary treated water delivered by the Wastewater Management Authority into the Western Canal System as illustrated in Figure 2.

To date, almost 70% of the total irrigable lands (28000 hectares) are being irrigated and the remaining 30% is being earmarked for irrigation by year 2030, subject to availability of water for irrigation.

Presently, agriculture is using 48% share of water mobilized in Mauritius.

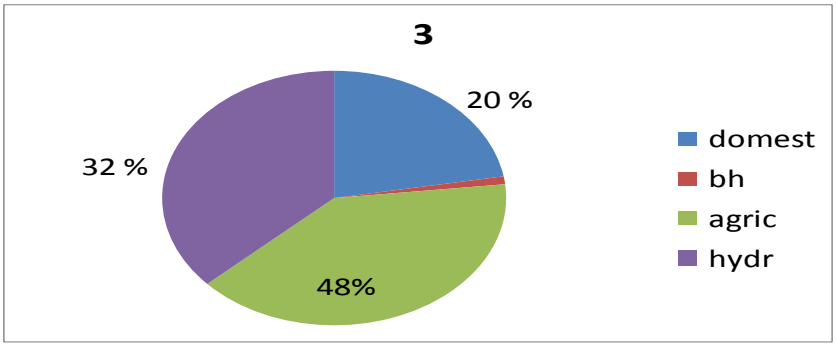

Figure 3: Pie chart showing water utilisation

With proper Government policy on price of treated effluent for irrigation, the pressure on competitive demand of water can be reduced hence assuring further irrigation development in Mauritius.

d) The Syndic

The farmers grouped into a Syndic are the users of the water for irrigation. At operational level, the Syndic liaises with the Central Water Authority and the Water Resources Unit for the release of water from the reservoirs. This close collaboration is required to enable proper dilution at the injection points. In parallel, the laboratory of the Waste Water Authority carries out 24 hours analysis and monitoring of the treated effluent and any discrepancies are immediately notified to the users. In case of water quality not being to standards set by the Environment Protection Act 2002, the treated effluent is discharged into the sea.

As sugar cane is irrigated from the tertiary treated effluent there is no quality control on the wastewater-irrigated produce (sugar).

e) Agricultural Research and Extension Unit (AREU)

AREU has prepared guidelines for use of treated waste water for food crop production, methods of irrigation and precautionary measures by workers in field where wastewater is used. Treated effluent is restricted to irrigation of industrial crops (e.g. sugar cane) and for crops and fruit trees that are processed or cooked for human consumption.

4. Research /Practice on Different Aspects of Wastewater

The Wastewater Management Authority actively participates in various projects and studies such as Independent environment audit on wastewater projects, climate change, Maurice Ile Durable, lagoonal monitoring in the region of Port-Louis, Integrated Coastal Zone Management which also involve the wastewater aspects.

The Irrigation Authority, AREU and MSIRI with the support of Ministry of Agro Industry and Food Security is giving full support to farmers in the use of treated wastewater
There is presently a research cum pilot project on **the reuse of sewage sludge into compost**. This study is conducted in conjunction with the Mauritius Sugar Industry Research Institute (MSIRI). The compost so obtained will be applied to sugarcane plantations. A similar exercise is being executed by the AREU but the **application of the compost will be on agricultural farms**. The University of Mauritius has been engaged on major projects related to the environment. Thus, the management of industrial wastewater, solid waste and ground water has been studied fairly extensively at the Faculty of Engineering of the University of Mauritius.
(http://www.un.org/esa/agenda21/natlinfo/countr/mauritiu/SANITATIONMAURITUS04F.pdf)

PARAMETERS	**Unit**	**Range (Treated effluent)**	**Standards of effluent for use in Irrigation (EPA 2002, G.N 46 of 2003)**
BOD5	mg/l	not detected-9.9	40
CHLORIDE	mg/l	28-70	250
COD	mg/l	10-50	120
DETERGENTS	mg/l	0.05-0.20	5
NITRATE	mg/l	1.7-6.9	20
OIL&GREASE	mg/l	not detected-8	10
pH	No unit	5.30-8.20	5-9
SULPHATE	mg/l	21-100	500
TDS	mg/l	260-410	2000
TSS	mg/l	1-13	45
CADMIUM	mg/l	not detected	0.01
COPPER	mg/l	not detected	0.2
IRON	mg/l	not detected-0.24	5
LEAD	mg/l	not detected	2
MANGANESE	mg/l	not detected-<0.05	0.20
NICKEL	mg/l	not detected-<0.05	0.20
ZINC	mg/l	not detected-<0.05	2
FAECAL COLIFORM	MPN/100ml	1-220	1000

Table 2: Results of Analysis of Effluent Quality for St. Martin WWTP for period April 2012-July 2012
(Source: Wastewater Management Authority, 2012)

Municipal Reuse Applications

In the case of Mauritius, it is obvious that significant applications of municipal re-use may possibly be considered if we consider the National Sewerage Programme Phase II under which a mega wastewater projects are being implemented.

The Mauritius Sugar Research Institute has carried out some research works of the reuse of treated effluent from the St. Martin WWTP mixed in a ratio of 1:1 with water from Canal La Ferme and Canal Magenta prior to distribution to sugarcane planters. Results of analysis for parameters faecal coliform, pH and conductivity to be found on link www.**msiri.mu**/Userfiles/file/Talk_**Irrigation**_2008.pdf.

5. Status and need for the knowledge and skills on the safe use of wastewater

As reuse of treated effluent is quite new in Mauritius (2006), there has been no systematic and scientific approach to assessing crop response to parameters present in the effluents. The Wastewater Management Authority needs to build capacity in the field of safe use of wastewater since it is the institution which provides the treated effluent and to determine the appropriate treatment technology to put in place.

Another aspect is about reviewing and updating legislation (emerging concern e.g pharmaceuticals, enteric viruses, dioxins, furans- any new test parameters to be added in the regulations). There is need for capacity development in the field of understanding and research on the relation between certain parameters in treated effluent used for irrigation and crop yield. It is of concern that a number of studies from Bangladesh and West Bengal (India) have reported increased concentrations in soils and crops because of irrigation with elements like Arsenic.

The increase in soil concentrations may or may not finally result in a reduction of soil quality and crop yields. Assessment of risks to crop production is difficult because of the limited information on current and future soil concentrations and the lack of reliable plant toxicity data. These gaps need to be addressed urgently.

It is recommended to initiate an integrated programme to quantify the scale of the problem in combination with the development of a water/soil/crop quality monitoring system for land degradation in agro-ecosystems. This should not only include Arsenic, but a range of physical, chemical (nutrients and contaminants) and biological parameters. Further, management options to prevent and mitigate contamination need to be explored.

The skills/training needs required as capacity development has to be properly identified by the Irrigation Authority jointly with other institutions conducting research like the MSIRI, the AREU of the Ministry of Agro-Industry and Food security and with the Wastewater Management Authority on issues of the type of treatment technology/practices that are more appropriate to produce a safe irrigation water, the monitoring systems/mechanisms to put in place as well as regulatory frameworks.

Competitive water demand in Mauritius from different sectors (potable water, industries, and hotels) is exercising extreme and unsustainable pressure on water availability for agriculture compelling tapping into reuse of treated effluent for irrigation. It is imperative that the Irrigation Authority in collaboration with MSIRI and AREU start as soon as possible with the help of FAO/UNEP/IWMI to gear its efforts towards a scientific approach to understand the advantages or drawbacks which the reuse of treated effluent may represent to crops, yields and to the soils in both short and long terms.
