INTEGRATED USE OF WATER

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ABSTRACT

Integrated use of water can happen in many ways: (1) the systematic consideration of groundwater and surface water, both in quantity and quality (2) the interactions between water, land and the environment (3) the interrelationships between water and the social and economic development. Furthermore, the analysis may be carried at different levels: (a) the normative level – what ought to be done (b) the strategic level – what can be done and (c) operational level – what will be done.

This paper examines how the above principles may be applied to the water resources in Mauritius. A few examples are discussed to show what could be the possible effects of such strategies on the long term policies for the country.

Customarily, public water supplies provide water of potable quality to serve all the usual uses, including non-potable purposes (street cleaning). When the latter are supplied with reclaimed water, it is as if a "new" source has been discovered, and it becomes possible to maintain the highest quality for public consumption and to extend potable water to an increased population.

It is hoped that EACH country will try to assess the re-use of wastewater within the country, by requesting funds for the preparation of the Waste Water Reuse Master Plan and train engineers and other technical staff on the above.

If this is properly co-ordinated, the country can say that it is meeting one of the UN MDGs.

Key words: water, integrated use, re-use, strategy

1. INTRODUCTION

1.1 Uses of Water

There are four main uses for water in Mauritius, namely:
Domestic
Industrial
Irrigation
Hydropower

Of course, domestic use relates to potable water and applies to others users as well such as tourists and workers in industry and elsewhere. Industrial use does not necessarily have the same water quality requirements. Cooling water need not be so pure as potable water, while water used for dyeing – even when obtained from the CWA network – may need a prior removal of ferrous/ferric ions. Similarly, different plants have differing tolerances to the salts present in water. Hydropower has existed for quite a long time in Mauritius and presents the advantage of its tailrace water being re-used in most cases.

1.2 Integrated use

While the above uses of water can and do, very often, occur piece meal, integrated use involves a holistic approach of how best to use the available resources in the country. As such, it is interesting to examine the following aspects:

- the use of ground water compared to the use of surface water.
- the interactions of water, land use and the environment impacts.

- how water affects the social and economic development of the country.

Having carried out such an analysis, the implementation of integrated use of water would imply

- formulating policies to explain what ought to be done
- looking at constraints which limit what can be done, and
- what is being presently carried out or what will be done

2. WATER SCARCITY

It is right to ask what can be done in times of water scarcity. Water abundance is certainly something of the past. There are times when rains seems plentiful, but these are short lived periods and we have to make up with managing our scarce water resources so as to try to satisfy each and every need. The several approaches tried in most countries include the following:

- Save water
- Demand management
- Check our meters
- Better Use
- Re-use

2.1 Save Water.

The first reaction is of course is how to save water if it is needed. However, there are many ways in which this resource is lost or wasted. Thus, the distribution network very often contains leaking pipes which should be repaired. Sometimes, water runs on the roads several days before repairs are carried out. In Rodrigues, all pipes are laid on the ground. Thus, the inspector who walks along the pipeline every day can immediately report the leak and even tell which components are needed.

Similarly, the home user can detect leaks in the home and have them repaired. These actions may seem negligible, but when accumulated over time or aggregated over the country, do quantify a significant proportion of water savings. There are, conversely, some practices which are not warranted, such as opening the tap while shaving, or keeping the water running while the toothbrush is being activated on the teeth. On a larger scale, we often find cars which are spotlessly clean every day. How much water has been used unnecessarily in so doing, reflects the possible savings.

2.2 Demand Management.

This term refers to curbing the demand, if necessary and possible. How this may be done depends on government policy and on water availability. For example, in times of drought in Mauritius, supply of water to the irrigation sector is reduced, gradually at first and sometimes, completely – simply because the water storage is barely enough for potable use, alone.

2.3. Meter Checks.

One of the sources of errors in balancing water availability against water use is the meter, either at the production end or at the consumer. A regular check, both in terms of flow and regular calibration or renewal after a given time, will ensure a better knowledge of water being produced and used.

2.4 Better use

How can we make better use of water may be seen from the imagination of people who are really short of water. Some possibilities include

- Collecting rainwater from roof top to wash the car
- Using kitchen water for garden watering
- Using tailrace water from hydroturbines

2.4.1 Rainwater harvesting.

In fact, this is practiced by many people in Rodrigues. It used to be carried out by everybody because it was practically the only source of water (it was similar in Agaléga, 20 years ago). Since then, a suitable network has been implemented and people in Rodrigues pay only Rs. 22 (half of a Euro) annually for their water supply. So fewer and fewer people practice this now.

However, it is still possible to collect rainwater for several uses, such as car washing, etc.

2.4.2 Use kitchen water for garden watering.

What happens to water which is used in the kitchen for washing? Many people are accustomed to a first rinse with soapy water, before a final rinse with clean water from the tap. Unfortunately, this practice is not widespread. But water used for washing vegetables, etc is still useable for gardening. Needless to say, very few people practice this.

2.4.3 Use tailrace water from hydroturbines.

Once the CEB has generated electricity, the water coming out of the turbines may be used. At Tamarind Falls, the tailrace water is used for irrigation of the western coast. Will this practice continue with the development of integrated resort schemes in the west?

At Réduit power station, the tailrace water goes back to the river, which further downstream feeds the Pailles treatment works for the Port Louis water supply.

At La Marie, the CWA receives water under pressure from Mare aux Vacoas. This is used to generate electricity for its internal use and for pumping. In this way, the CWA is contributing to using less energy from the CEB. Of course, the outgoing water at La Marie is treated for potable water supply.

2.4.4 Treated water for irrigation

Apart from re-using tailrace water from turbines, another possible source of water is using treated waste water. Though advocated as long back as 1973 in Mauritius, it is only recently that a few schemes have been implemented so as to enable waste water to be treated and used for irrigation.

3. PARADIGM SHIFTS IN THINKING ABOUT WATER

3.1 Price increase with scarcity

It is quite common on islands which are regularly visited by cyclones to suffer severe damages to agriculture. Most often, then after a cyclone, due to a SCARCITY of vegetables, their prices INCREASE.

In a similar vein, we could rightly ask whether the price of water should INCREASE when there is SCARCITY during drought periods.

3.2 Price of water

The price of water as supplied by the National distributor (Central Water Authority in Mauritius) is often considered to be expensive. In Mauritius, the price is Rs. 6 per cubic metre. There are many persons who do buy regularly, albeit a small quantity, bottled water at Rs. 10 /litre. However, this is equivalent to paying Rs. 10,000 per cubic metre.

Those people who have no option but to use desalinated water pay something of the order of Rs. 30 per cubic metre.

At this juncture, we might well ask at which price would we be willing to BUY bottled water in a DESERT, or at which price would we be willing to SELL water in the same surroundings.

3.3 Irrigation water requirement

A common figure used in Mauritius is that irrigation uses some 7,000 cubic metres annually per hectare to give an EXTRA yield of 30 tonnes of cane.

However, this volume of 7,000 cubic metres, if processed by CWA, would be suffice to supply 20 families generously with water for 1 year.

3.4 Re-use of treated water for irrigation

As explained earlier, recently treated waste water has started to be used for irrigation. The previous section has just shown that the extra yield arising from this irrigation is minimal. In fact, the cost of treatment EXCEEDS the revenue

With some further treatment, the same water could be injected into the POTABLE water network. It should earn more money or at least be probably be more beneficial nationally.

4. RE-USE FOR POTABLE AND NON-POTABLE PURPOSES

4.1 Re-use for non-potable purposes

Whether wastewater is being reused in industrialised or developing countries, it must be treated. The extent of the treatment depends upon the use the treated waste water will be put to. Higher-level uses, such as irrigation of vegetables to be consumed without processing, require a higher level of treatment than lower-level uses, such as pasture irrigation. In urban reuse, where there is a high potential for human exposure to reclaimed water used for landscape irrigation, toilet flushing, and industrial purposes, the water must be adequately disinfected and a chlorine residual must be maintained in the distribution system.

Many urban residential, commercial, and industrial uses can be satisfied with water of less than potable quality: irrigation of lawns, parks, and roadway borders; air conditioning and industrial cooling towers; industrial processing; toilet and urinal flushing; construction; cleaning and maintenance, including vehicle washing; scenic waters and fountains, and environmental and recreational purposes. Customarily, public water supplies provide water of potable quality to serve all these purposes. When reclaimed water is substituted for potable water formerly used for non potable purposes it is as if a “new” source has been discovered, and it becomes possible to maintain the highest quality for public consumption and to extend potable water to an increased population.

Alternative uses of the sewage effluent are not necessarily in competition for this water resource. The following could possibly be practised before using the water for irrigation:

- Fish farming for local consumption and/or export.
- Crocodile farming. This could be part of a tourist attraction and would not necessarily need to be geared for production.

These activities could be used as part of the tourist attraction if a nature park is created. Interest in "eco-tourism" is on the rise, and opportunities exist to educate local and foreign tourists in conjunction with such initiatives.

4.2 Re-use for potable purposes

For those people thinking about the use of waste water (treated, of course) for potable use, it would be judicious to think what Mother Nature does with the WATER CYCLE. All waters, including WASTE WATER is evaporated into clouds and sent back again to Earth. The key is the proper treatment of the waste water.

It may be interesting to note that the Goreangab Water Reclamation Works in Namibia supplies WINDHOEK with 23,000 cubic metres of POTABLE water every day. This amounts to 36 % of the Windhoek consumption. This re-use has been in operation since 1969.

"Experience since 1969 has proved beyond doubt that the reclamation of purified domestic effluent can be seen as a safe and acceptable supplement to POTABLE water supply".

No doubt, this long experience is proof enough that given the proper treatment, it is possible to re-use waste water in the potable water network.

4.3 Practical implications

Figure 1 shows how a distribution network which is fed 100,000 cubic metres of water loses 25 % through the network, thus bringing 75,000 cubic metres to the town. If it is possible to recover 85% of this volume, 64,000 cubic metres will be sent to a treatment plant working at 90 % efficiency. Thus 57,000 cubic metres will have been reclaimed.

Thus, next time a volume of 100,000 cubic metres is required for the network, only 43,000 cubic metres (LESS than HALF the initial amount) are required from the conventional source. This implies that at least TWICE as many people may be served.

5. FUTURE OF HYDROPWER

5.1 Present status of hydropower in Mauritius

The present electricity production in Mauritius is of the order of 1,700 GWh annually, out of which some 95 GWh is produced by hydrogenation, i.e. around 6 %. The present use of water may be summarised as below in Table 1.

Table 1: Water Use in Mauritius

Sector	**Mm^3/yr**	**%**
Potable	209	21 %
Agricultural	468	48 %
Hydropower	305	31 %

It may be seen that quite a large volume of water is used for hydrogenation. Some of it is re-used, but more than half does not, being sent to the sea.

One question to be asked at this stage is whether the water that is used for hydrogenation should continue to do so or can it be diverted for potable use or other uses for that matter?

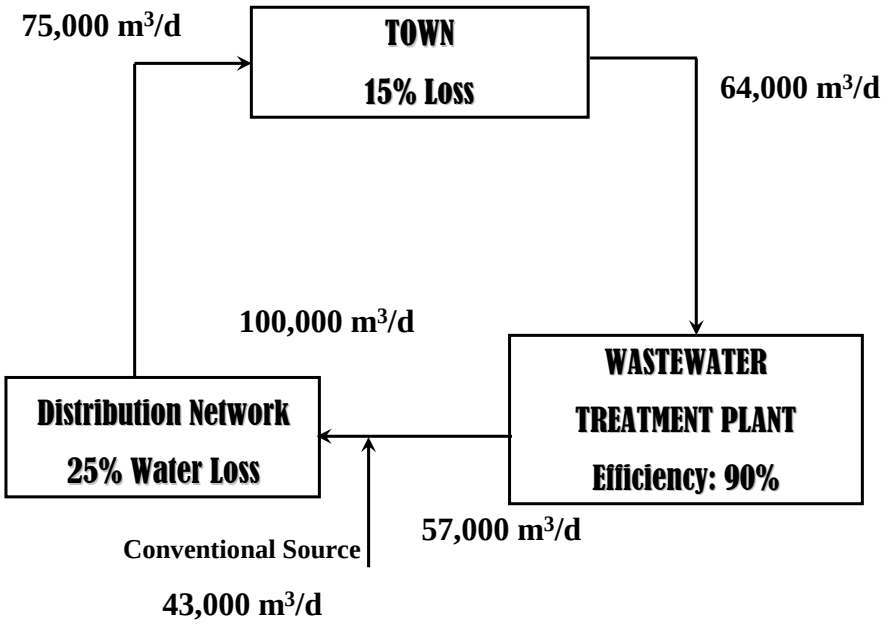

Figure 1: Reclamation of wastewater

5.2 Cost of electricity production

Figures obtained from the Central Electricity Board (CEB) indicate that production costs are as follows:

- Hydropower Rs. 0.35 /kWh
- Thermal power Rs. 1.01 to Rs. 3.27/kWh

There are two cases where the CEB could find itself with NO water for hydropower:

(1) the CWA starts charging the CEB (presently free) at a "prohibitive rate" for the use of water for hydrogenation

(2) NO extra water is available for hydrogenation, as all available water is being sent to other uses.

5.3 Extra production cost of electricity

If the present CEB production cost for the newest equipment is Rs. 3.27/kWh, any further generation will be at least at this cost. To replace the 95 GWh of hydropower by thermal generation would represent a total cost increase of Rs. (3.27 – 0.35) x 95 GWh = Rs. 277 million

On the assumption of 1.1 million persons in Mauritius, this comes to Rs 250 per person per year and thus Rs 0.69 per person per day

6. WATER SCARCITY IN MAURITIUS

6.1 Water forecasts

The water consumption is Mauritius is ever increasing and the forecast is that by year 2020, the water deficit will grow to 250,000 m3/day, which is equivalent to 91Mm^3/yr

6.2 Options for providing potable water

The best known options for meeting this water challenge is, of course, dam construction and groundwater exploitation.

As regards dam construction, it is doubtful whether there are any there large dam sites, enough to provide 91 Mm^3/yr. The Midlands dam, which was constructed a few years ago, cost Rs. 1.4 billion and produces some 40 Mm^3/yr.

Should boreholes be used? It would seem that most boreholes have already reached their capacity, as relates to the groundwater potential. Apart from a prohibitive pumping cost, there might not be enough water underground.

6.3 Cost of providing extra water

As at the present time, the cost of providing water, by CWA, through a borehole does come to Rs. 6 to7 per cubic metre.

The average CWA selling price is also Rs. 6.1/m^3. In fact, the CWA makes very little profit out of distributing water.

Thus, in order to meet the coming deficit of 250,000 m^3/day, the extra cost could be AT LEAST of the order of Rs 6.1 x 250,000 = Rs. 1,525,000 /day

Again, assuming our 1.1 million persons in Mauritius, this represents Rs. 1.39 per person per day

6.4 Cost Comparison

It is fitting to make a cost comparison. Should there be a water scarcity of 250,000 m^3/d (91 Mm^3/yr), the

Extra Cost of producing Water by	CWA is	Rs. 1.39 /p/d
OR		
Extra Cost of producing Thermal Electricity by	CEB is	Rs. 0.69 /p/d

Is it important that Rs. 0.69 is spent by CEB, or that Rs. 1.39 is spent by CWA?

In the end product, MAURITIUS as a nation will foot the bill. The common sense ECONOMIC approach is to spend LESS for the country : Rs. 0.69 per person per day rather than Rs. 1.39 per person per day.

Of course, this was an EXTREME example; CEB uses 305 Mm^3/yr; CWA would need 91 Mm^3/yr by 2020. Not ALL hydropower would be foregone, and it is also IMPOSSIBILE to harness water in some places.

It is not so simple either, in the sense that the water saved from hydropower would need some treatment and conveyance, which would add to he costs. Nevertheless, the point is made: it would cost

less to the country to stop producing hydropower, rather than try by all means to harness new sources of water.

6. CONCLUSION: INTEGRATING WATER USES

As explained above, integrated use of water is considering how groundwater and surface water may be better used for the social and economic development of the country, due regard being paid to interactions between water, land and the environment. A proper examination of the country's use of resources will enable moving from what is being done to what can be done for an optimal use.

This paper examined how the above principles were applied rightly and less strictly to the water resources in Mauritius. The few examples discussed above have highlighted the possible effects of such strategies on the long term policies for the country. Thus, it should be possible to re-examine the use of water (e.g. hydropower) which more economical in other sectors, or to consider using reclaimed water as an additional "new" source of water. This makes it possible to maintain the highest quality for public consumption and to extend potable water to an increased population.

It is therefore hoped that EACH country will try to assess the re-use of wastewater (broad sense of the term) within the country, by requesting funds for the preparation of the Integrated (Waste Water Reuse) Master Plan and train engineers and other technical staff on the above. This action would entail, of course, re-examining the use of water in other sectors as well.

If this is properly co-ordinated, the country can say that it is meeting one of the UN MDGs.

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