"Water is too precious a resource to be used only once before returning to nature."
This is what Sandberg (1992) said about the inseparable link between people and water.

IAGU

Using wastewater for irrigation in Senegal

Though seemingly trivial, this statement is pertinent as we realise how difficult it is to satisfy all water needs, encompassing domestic needs, agricultural activities, residential and recreational needs. This competition is especially tough in dry climates of the Sahelian zone, such as in Burkina Faso, Mauretania and Senegal – the three countries on which we are focusing our attention. Here, water is the major stumbling block to developing agricultural activities, and domestic needs win out over agricultural activities in the competition for water.

The Use of Wastewater

The Example of Dakar, Nouakchott and Ouagadougou for Urban Agriculture

Urban agriculture is a dynamic sector, characterised by the proximity of production and consumption sites. Its performance is ultimately limited by the difficulty of accessing water. One strategy to offset the water deficit is to re-use wastewater. Such a practice has to be examined closely for its advantages and disadvantages in relation to the issue of urban and periurban agriculture. In this article, we make a plea for judicious use and re-use of water, subject to appropriate treatment methods.

If **properly handled**, wastewater can **fulfil many needs**

DEVELOPMENT OF URBAN AGRICULTURE

Urbanisation is rapidly growing, with 43% of the total population in Senegal living in cities; 35% in Mauretania; and 25% in Burkina Faso. Population growth has turned urban zones into a large market capable of absorbing the local production of urban agriculture while minimising transport, storage, and preservation costs. At the same time as secondary towns have developed, the need for horticultural products has increased, leading to further development of urban agriculture.

Due to the high demand in urban centres for foodstuffs such as fruits and vegetables, but also because of high un- and under-employment, the surface area set aside for growing vegetables in Senegal has increased from 8,000 hectares in 1986 to 12,050 ha in 1997. Likewise, vegetable exports have progressed from 4,500 tonnes in 1994/95 to 5,857 t in 1995/96. In Mauretania, the fruit and vegetable yield reached 65,000 tonnes in 1997, of which 18% came from the city of Nouakchott.

Due to poor access to water and nutrient inputs, alternative strategies have developed to re-utilise wastewater and to recycle solid waste. Solid waste and wastewater are re-used in urban horticultural areas, namely for soil enrichment and to overcome water constraints. For example, at Dakar's main waste disposal site near the village of Mbeubeuss, a group of people reclaim waste material called *terrou*. The *terrou* develops from waste material deposited over a number of years, and is used by farmers as a kind of fertiliser. The re-use of wastes in agriculture can provide a means of enhancing fertility in soils usually low in organic matter, as an alternative to chemical fertilisers.

In the three countries, the main constraints hampering the increase of urban agriculture are:
- *conflicts* between the authorities and the market gardeners (Zallé 1999). Urban agriculture is seen to be conflicting with urban politics, which is why it suffers from inopportune administrative decisions and a lack of specific legislation on UA (e.g. no legal basis or appropriate supervision) and interest;
- *economic and technical problems* (regarding food preservation, processing, commercialisation, etc.) leading to decreased productivity and income; and
- *difficult access* to water sources and inputs.

WASTEWATER - FROM DISREGARD TO RECOGNITION

In the cities of Senegal, Burkina Faso and Mauretania, agricultural activities, such as horticulture, take advantage of existing hydrological networks, including shallows and valleys liable to flooding. The widespread opinion was that wastewater was not only worthless, but also dangerous. For this reason, producers in Dakar built dams to prevent wastewater from invading their plots of land. However, since a number of farmers noticed the higher yield from fields 'irrigated' by wastewater leaking out of a ruptured sewer, nowadays, urban farmers incre-

Ndèye Fatou Diop Gueye *and* **Moussa Sy**
African Institute for Urban Planning (Institut Africain de Gestion Urbaine, IAGU), Senegal
✉ *iagu@cyg.sn / iagurrps@enda.sn*

asingly appreciate the use of wastewater. If properly handled, wastewater can fulfil many needs.

The benefits of wastewater use in urban agriculture

A principal reason for using wastewater in urban agriculture is the lack of adequate water sources. Dakar, for example, already has a daily drinking-water deficit of 100,000 to 162,000 m^3. Besides the increasing scarcity of water resources, another argument for using wastewater is its nutrient content, something appreciated by the users, since artificial fertilisers are expensive. This aspect makes it further difficult to convince farmers of the health risks involved: in the farmers' perception, diseases are the result of supernatural spirits and cannot be explained in rational terms.

In the urban zones of Dakar, Ouagadougou, and Nouakchott, fruits and vegetables are watered with wastewater. Wastewater is readily available and also plentiful; e.g. Dakar currently produces 100,000 m^3 of wastewater a day (Niang 1999). This will continue to rise to ever greater quantities as the population continues to grow. The presence of water containing fertilising constituents guarantees considerable gains in productivity. For example, 70% of market gardeners in Dakar who get their water from *céanes*[1], say that they use close to 20 m^3 of water a day, while 86% of the market gardeners who use untreated wastewater affirm that they do not use more than 4 m^3 of water a day (ibid.). Analyses performed on wastewater in Dakar report high values of BOD_5 (Biological Oxygen Demand) attesting to a marked presence of organic matter, and high concentrations of nitrogen and phosphorus (essential nutrients for proper plant development).

The harmful aspects of wastewater use in urban agriculture

The utilisation of wastewater will remain a reality in urban agriculture. Nevertheless, using wastewater can cause problems to the health of the general population and the environment if used without prior treatment. The figures found in Dakar (see Table 1) indicate that wastewater may cause significant harm when used for irrigation in market gardening. The high concentration of suspended matter in wastewater leads to the clogging of the interstitial spaces in the soil. Worse, the high contamination of the water by Faecal Coliforms and Streptococci has a negative effect on the microbiological quality of the water, and on human health. The World Health Organisation (WHO) standards indicate that the water should not contain a concentration of Faecal Coliforms in excess of 1,000/100 ml and a concentration of intestinal nematode eggs in excess of 1/1000 ml (see page 25). However, Table 1 shows that these concentrations are much higher in Dakar (Niang 1999).

Parasitological analyses by Niang (1999) on common vegetables including lettuce, parsley and carrots have shown contamination by parasites (amoebas, etc.), which can transmit diseases such as diarrhoea, abdominal pain and parasitic infections, to people if the vegetables are consumed raw or poorly cleaned (see Table 2). *Ankylostoma*, ascarid and *Trichocephalus* worm species are intestinal nematodes that have a considerable latent period and do not require an intermediate host in order to spread to humans. The presence of eggs and larvae shows how much the vegetables in question are contaminated.

Table 1: Urban agriculture in Dakar: Characteristics of wastewater and drinking water

Parameters	Wastewater	Drinking water
pH	*8*	*7.7*
Conductivity (ms)	*1,900*	*1,100*
Residual dry matter (mg/l)	*900*	*800*
Chloride ions (mg/l)	*400*	*200*
Suspended matter (mg/l)	*1,200*	*0*
BOD_5 (mgO_2/l)	*500*	*2*
NH_4^+ (ngN/l)	*127*	*1*
PO_4^{-3} (ngP/l)	*16*	*2*
Faecal Coliforms (Number/100 ml)	*2.8×10^7*	*0*
Faecal Streptococci (Number/100 ml)	*1.8×10^7*	*0*

(Source: Niang 1999)

Table 2: Concentration of parasites found on vegetables per 100 m of rinsing water

Parasites	Lettuce	Parsley	Carrots
Amibe minuta (cysts)	*13*	*6*	*0*
Amibe hystolitica (cysts)	*9*	*14*	*0*
Anguillules (larvae)	*0*	*20*	*0*
Ankylostoma spp	*2 larvae*	*3 eggs*	*0*
Ascarids (eggs)	*40*	*0*	*0*
Budding yeast	*Many*	*17*	*0*
Nemathelminths	*0*	*7*	*11*
Platyhelminths	*0*	*4*	*4*
Trichomonas (eggs)	*13*	*12*	*3*
Trichocephalus spp (eggs)	*4*	*0*	*0*

(Source: Niang 1999)

Ms. Inés Beernaerts

Water sampling for laboratory analysispicture (La Fulani)

Domestic animals - that constitute intermediate hosts - often drink water used for rinsing contaminated vegetables, as well as eating the vegetable peels. Since these animals are then consumed by people, the cycle of contamination is quickly established.

Research undertaken in Ouagadougou in 1997, looked at the sanitary impact of wastewater re-use. It shows that the children of market gardeners up to the age of 4 had a higher rate of mortality from diarrhoea and parasitic infections than those of the same age group of the general population. During an epidemic in 1987, 400 cases of typhoid and paratyphoid A and B fever occurred in the region of Dakar. The epidemiological analyses showed that this epidemic was caused by the use of wastewater by the market gardeners to water their vegetables (Seck 1998: 14)

Socio-cultural acceptance of wastewater use despite recognised sanitary impact

Notwithstanding the negative health impacts made evident by different studies on this question, producers resist the idea of a possibility of health risks linked to the re-use of untreated water. In Ouagadougou, the market gardeners are not able to understand that invisible pathogens can contaminate them, their family, or those who eat their vegetables (Cissé 1997: 191). Consumers in Dakar have the same perception as market gardeners in Ouagadougou, on the risks involved in watering produce with wastewater. Results from a study by Seck (1998) show that 40% of individuals asked do not recognise any risk in consuming vegetables produced with wastewater.

These examples show the adherence to, or acceptance of, wastewater re-use, but also show how little success any attempt towards banning wastewater use would have. The following illustrates this last point: market gardeners in Dakar are aware of the rules on using untreated wastewater - it is prohibited for the cultivation of vegetables, but not for fruit trees. To get around this, farmers normally grow the more profitable vegetables when water is available from the *céanes*[1], and then mix vegetables and fruit trees when using wastewater. The fruit trees will then at least guarantee them some income in case of intervention by the health service authorities.

Producers are reluctant to give up wastewater use. Their knowledge of the cause and effects of diseases remains limited, which is important to consider when elaborating strategies concerning the practice of wastewater use.

CONCLUSION

The expansion of urban agriculture in Burkina Faso, Mauretania and Senegal is hindered by diverse constraints, of which the availability of water remains the main one. Wastewater has as a result become an important source for supplying water for irrigation purposes or as an additional water source. The health risks, however, call for urgent reflection and action.

Simply banning the use of wastewater is not an appropriate solution. Its use has to be accompanied by appropriate measures to achieve better quality standards like:

- purification of wastewater before use;
- modification of the irrigation method of sprinkling;
- irrigation via trenching systems, avoiding direct contact;
- restriction of crop production and marketing in terms of raw consumption;
- adoption of more hygienic techniques for spreading manure (such as underground spreading); and
- raising farmers' awareness about health risks (e.g, wearing boots and gloves).

Wastewater use has advantages, provided the necessary precautions are taken to protect the environment and public health. Judicious use of wastewater does not necessarily allow for reduced pollution of natural sites or for increased agricultural productivity.

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Note

1 A céane is a hole dug in the ground and widened according to its depth. In peat shallows, it is close to the surface between 0.5 and 2 m. In sandy soil, its depth increases to 5, sometimes 6 m. Beyond this depth, a well must be constructed.