37. Re-use of wastewater

In many arid and semi-arid countries, wastewater is becoming an increasingly important source of irrigation water. The demands of growing urban communities for both food and water require the agricultural sector not only to increase food production but also to reduce its use of natural water resources. At the same time the volume of sewage effluent is increasing, and safe disposal can be difficult. The use of reclaimed wastewater for irrigation is the obvious solution, but few people have expertise in the full range of technology involved.

This Technical Brief considers situations where it may be appropriate to re-use wastewater for agriculture and introduces the different types of wastewater re-use scheme. It also provides a recommended guide to water quality for irrigation, and outlines, using diagrams, the necessary procedures for treating wastewater.

When to re-use wastewater

There are several questions to consider:

■ **What are the water requirements of the community?**

Many communities in most developing countries do not have reliable access to supplies of clean water. As the demand for water increases, making more efficient use of water becomes more important. Water re-use should be seriously considered before water availability is matched by water demand (Figure 1). Note that not all water needs to be treated to potable standards. Most wastewater re-use is informal and goes largely unrecognized by the public and by many professionals.

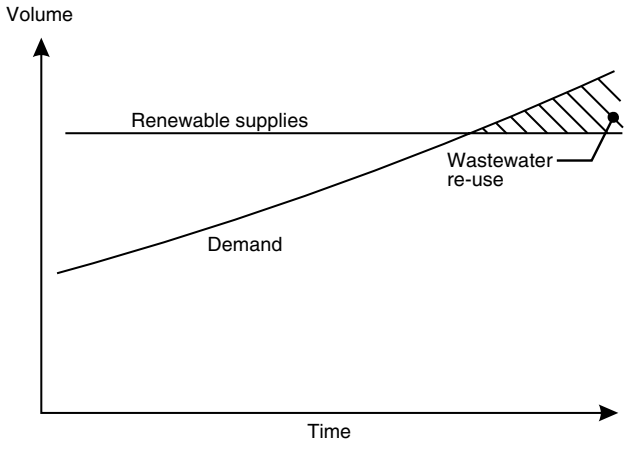

Figure 1. Water availability and demand

■ **Is the content of the wastewater harmful?**

Wastewater may contain chemicals which are harmful to the growth and development of plants. It may also contain bacteria and other organisms which are harmful to agricultural workers and to those who handle, cook, or eat the plants. Wastewater may even contain bacteria and other organisms which, when eaten by animals, may in turn infect the people who eat the contaminated meat. Figure 2 examines the health risks in relation to the level of contamination and the re-used wastewater control measures.

■ **What will the wastewater be used for?**

It is important to first consider which water uses are the major ones, and efforts should then be made to be more economical in these sectors. Industry and agriculture require large volumes of water, but the quality need not always be high. Water demands for irrigated agriculture are considerable. (For example, since 1949 agricultural water consumption in Israel has ranged from 71.3 to 83.3 per cent of the total water consumption.)

■ **Is it economical to re-use wastewater?**

The costs of treating the wastewater adequately as opposed to using conventional water resources should be carefully considered and the more economical option chosen.

Control measures	*Wastewater or excreta*	*Field or pond*	*Crop*	**Desirable sanitary barrier**	*Worker*	*Consumer*
	Level of contamination				*Level of risk*	
No protective measures	High	High	High		High	High
Crop restriction	High	High	High		High	Safe
Application measures	High	High	Safe		Safe	Safe
Human exposure control	High	High	High		Low	Low
Partial treatment in ponds	Low	Low	Low		Safe	Low
Partial treatment by conventional methods	Low	Low	Low		Low	Low
Partial treatment in ponds, plus crop restriction	Low	Low	Low		Safe	Safe
Partial treatment by conventional methods, plus crop restriction	Low	Low	Low		Low	Safe
Partial treatment, plus human exposure control	Low	Low	Low		Safe	Low
Crop restriction, plus human exposure control	High	High	High		Low	Safe
Full treatment	Safe	Safe	Safe		Safe	Safe

Figure 2. Wastewater re-use: Control methods and health risks

(Adapted from WHO Technical Report 778. Health guidelines for use of wastewater in agriculture and aquaculture.)

Types of wastewater re-use schemes

Wastewater re-use may be 'direct' or 'indirect'.

Direct re-use is the planned and deliberate use of treated wastewater for some beneficial purpose, including drinking.

Direct potable re-use is not popular and is limited to a few places including Windhoek in Namibia and Denver in the United States. It is generally unacceptable to the public because of both the expense and the attitudes of the community. Studies have shown that people will drink wastewater from an indirect source unless there is evidence to suggest that it is unsafe to do so. People will not, however, drink water from a direct source unless it is proven to be safe.

Indirect re-use refers to water that is taken from a river, lake, or aquifer which has received sewage or sewage effluent.

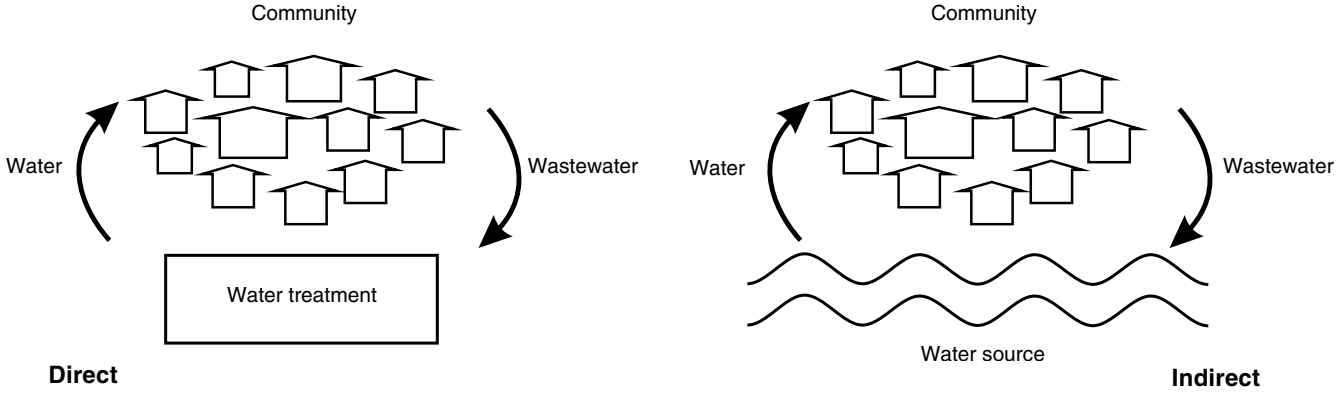

Figure 3. Direct and indirect wastewater schemes

Category	*Re-use conditions*	*Exposed group*	*Intestinal nematodes[b] (arithmetic mean no. of eggs per litre[c])*	*Faecal coliforms (geometric mean no. per 100 ml[c])*	*Wastewater treatment expected to achieve the required microbiological quality*
A	Irrigation of crops likely to be eaten uncooked, sports fields, public parks[d]	Workers, consumers, public	⩽1	⩽1000[d]	A series of stabilization ponds designed to achieve the microbiological quality indicated, or equivalent treatment
B	Irrigation of cereal crops, industrial crops, fodder crops, pasture, and trees[e]	Workers	⩽1	No standard recommended	Retention in stabilization ponds for 8 to 10 days or equivalent helminth and faecal coliform removal
C	Localized irrigation of crops in category B if exposure to workers and the public does not occur	None	Not applicable	Not applicable	Pre-treatment as required by the irrigation technology, but not less than primary sedimentation

[a] In specific cases, local epidemiological, sociocultural, and environmental factors should be taken into account, and the guidelines modified accordingly.

[b] *Ascaris* and *Trichuris* species and hookworms.

[c] During the irrigation period.

[d] A more stringent guideline (⩽200 faecal coliforms per 100 ml) is appropriate for public lawns, such as hotel lawns, with which the public may come into direct contact.

[e] In the case of fruit trees, irrigation should cease two weeks before fruit is picked, and no fruit should be picked off the ground. Sprinkler irrigation should not be used.

(Adapted from WHO Technical Report 778. Health guidelines for use of wastewater in agriculture and aquaculture.)

Figure 4. Recommended quality of water for irrigation[a]

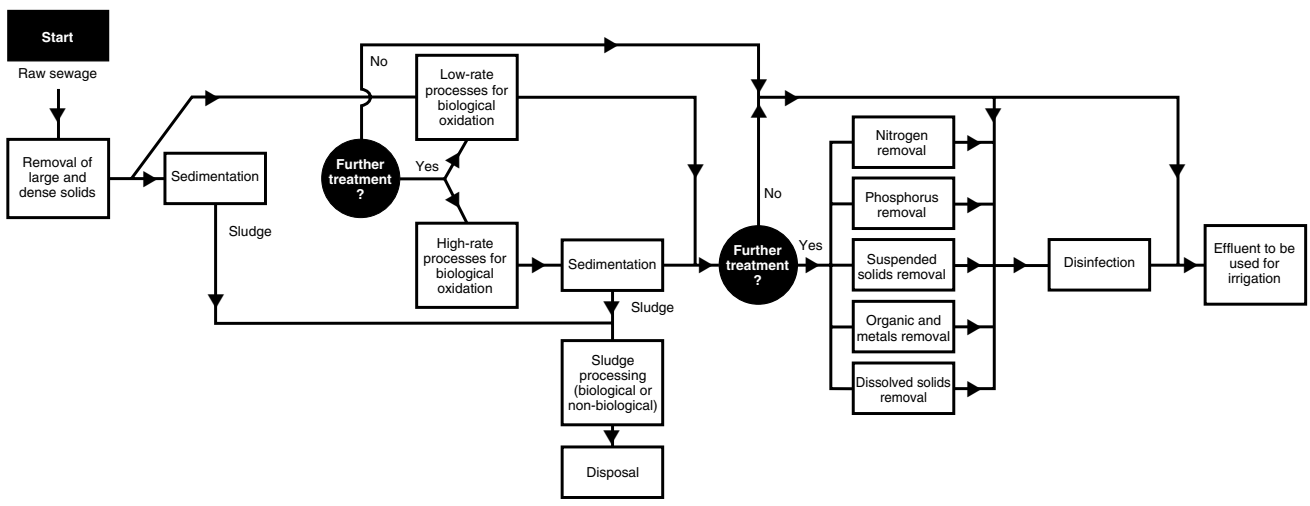

Figure 5. Procedure for treating wastewater

Further points to consider

- Studies in South America, Asia, and the Middle East have shown that farmers prefer to grow produce in the following order of priority:

1. Vegetables (to earn a regular income);
2. Fruit (to earn a regular income or foreign exchange);
3. Cereal crops (of lower value);
4. Fodder crops (of low value);
5. Other crops for which there is a demand (herbs, spices, flowers, etc.)

- The re-use of wastewater for irrigation has been most successful near cities, where wastewater is easily available and where there is a market for agricultural produce.

- The storage of treated wastewater may be necessary, because supply may not match demand (Figure 6).

- Re-use requires:
  - careful planning;
  - adequate and suitable treatment;
  - careful monitoring;
  - appropriate legislation; and
  - the implementation of legislation and quality standards.

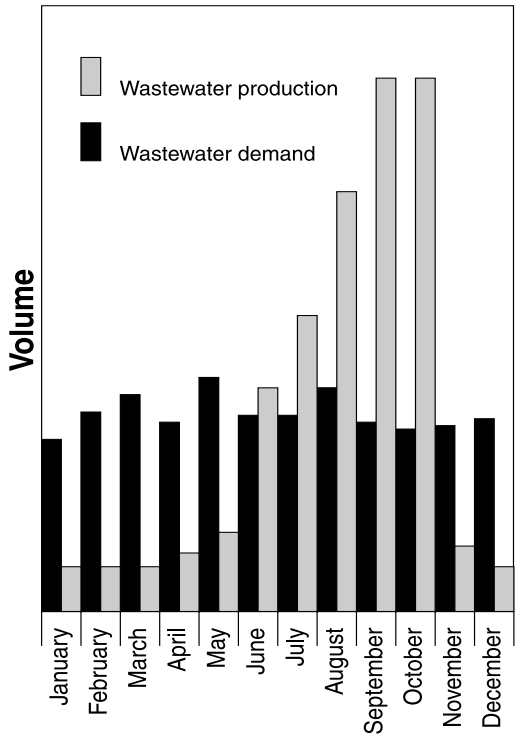

Figure 6.
Example of wastewater production and demand during one year

Conclusions

- Re-use can help to maximize the use of limited water resources.
- Wastewater re-use can contribute to national development.
- Environmental damage caused by re-use should be minimized.
- Health risks associated with re-use should be minimized.
- Collaboration between users, authorities, and the public is needed.
- Exchange of experiences is very important.
- Government support and encouragement is needed.

Further reading

Mara, D., and Cairncross, S., *Guidelines for the Safe Use of Wastewater and Excreta in Agriculture and Aquaculture,* WHO, Geneva,1989.
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World Health Organization, *Health Guidelines for the Use of Wastewater in Agriculture and Aquaculture,* Report of WHO Scientific Group, Technical Report Series No. 778. Geneva, 1989.

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