IWRM TOOL - C3.03

Recycle and Reuse

Water reuse and recycling refers to the process of converting wastewater into water that can be reused for other purposes. It can supplement traditional water supply with an alternative source, which can help bridge the supply-demand gap. This Tool provides an overview of different categories of water recycling and reuse at different scales, their benefits, and barriers to implementation.

Rationale for Water Reuse and Recycling

Recycling and reuse is a strategy to improve water supply by managing wastewater. Wastewater is critical component of the water management cycle and consists of water that has already been used by users such as households and industries. Wastewater can be broadly be classified into black water, (from toilets and urinals) and greywater (from non-toilet uses such as showers, dishwashing, or laundry) (Raschid-Sally and Jayakody, 2008).

With the increasing global water scarcity, the resource value of wastewater is being increasing realised as an supplemental/alternative source of water. Water reuse and recycling can allow users to gain more benefits out of the same water while relieving stress from existing natural supplies to improve efficiency in water management. Furthermore, it establishes a circular system through which water can be used again for other purposes such as domestic, industrial, irrigation, heating and cooling, groundwater recharge, restoration of water bodies and wetlands as well as potable reuse (Figure 1).

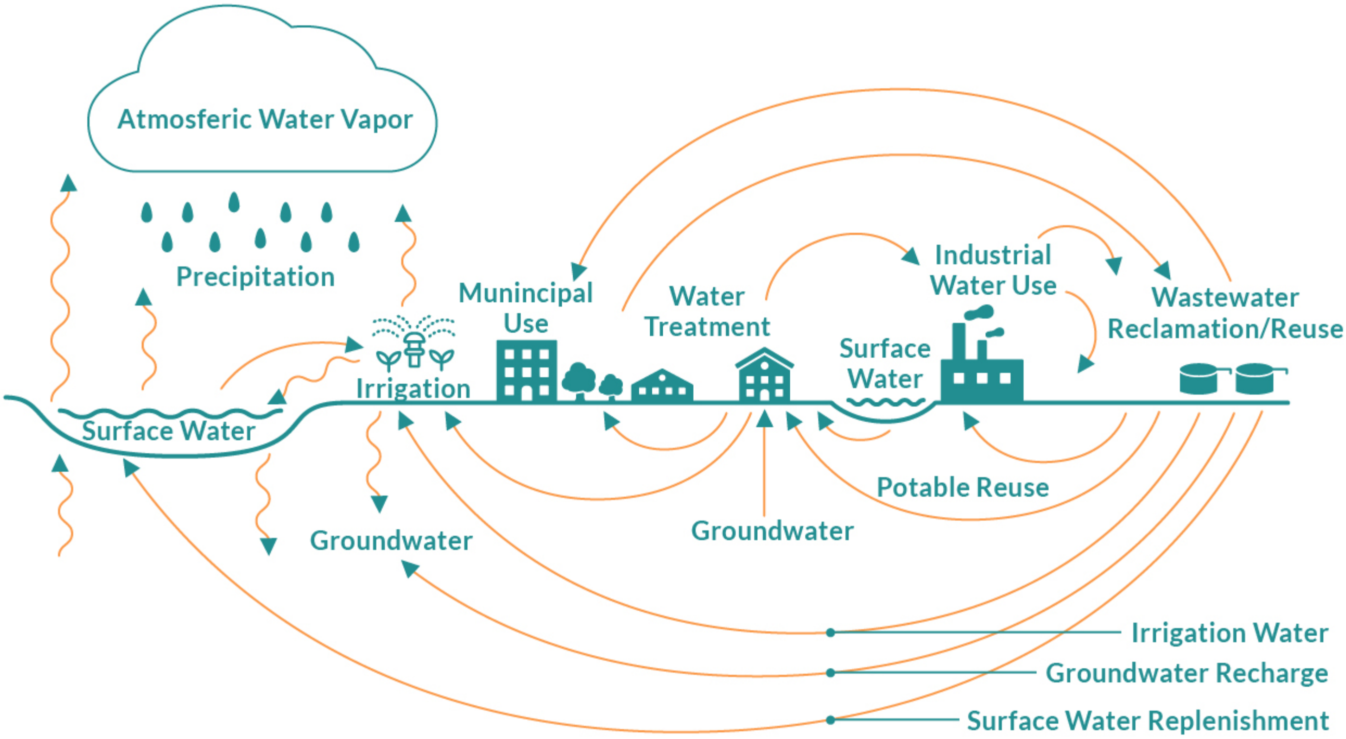

Figure 1. The role of water reuse and recycling for multiple uses in the hydrologic cycle (Adapted from Asano and Levine, 1997)

Leaving wastewater untreated causes poor sanitation, poses health risks to populations, pollution risks to ecosystems in addition to jeopardising economic growth and food security. Pollution deteriorates quality of water resources from which water is abstracted and supplied, leading to reduction in availability of appropriate quality of water or requiring more advanced and expensive treatment before supply. Planning for wastewater reuse and recycling requires a comprehensive understanding of the entire water system at various levels and must account for spatio-temporal, upstream-downstream and socio-economic interactions. These should be explicitly included in IWRM plans at national and basin level (Tool A3.01; Tool A3.02). To make the most of available water through recycling treatment processes, individual water users must adopt measures at company, institutional and household-levels.

Categories of Reuse and Associated Benefits

The general approach dominantly adopted for tackling wastewater is based on producing an effluent that is compliant with water quality discharge requirements which are often re-enforced through principles of polluters pay (Tool C4.04). However, to move towards water reuse and recycling water quality must be treated to specific standards which vary according to type of use. The end user and input water quality have a considerable impact on decisions regarding treatment approach and processes. Hence, the first step in designing water reuse and recycling schemes is linking wastewater type/quality with end uses of the water and its associated water quality requirements (Shoushtarian and Negahban-Azar, 2020). Some of the different uses for reused and recycled water are as follows:

- **Non-Potable Urban Uses:** Water run-off from rooftops or paved surfaces can be used for non-potable uses such as flushing by utilising technologies such as rainwater harvesting. In some cases, this may also support effective urban drainage and stormwater management (WWAP, 2017). Treated effluent from centralised or decentralised plants may be reused within urban settings or piped directly for other uses such as agriculture or industries. Dual supply systems consisting of different water quality for different uses can increase efficiency in water management. For example, having separate systems for domestic use (such as flushing) and for drinking water. In this process water quality must be ensured through monitoring system and replacement/maintenance of water conveyance pipes (Satterfield, 2009). In urban settings recycled and reused water can be used for irrigating public parks, sports grounds, and private gardens; cleaning streets, vehicles; fire protection; and toilet flushing. This increases water availability and contributes to managing urban pollution, stormwater drainage, and improving sanitation.
- **Agricultural Uses:** Recycled and reused water has widely been used for irrigation as it supplies added nutrients leading to additional benefits such as reducing the need for artificial fertilisers, causing an increase crop yields and income of farmers (GWP and IWMI, 2006). This can be done safely and simply following wastewater reuse guidelines for agriculture (WHO, 2006).
- **Industrial Uses:** Different industrial processes may require different qualities of water allowing implementation of dual supply systems that supply appropriate quality of water for each industrial process. Using recycled and reused water can reduce manufacturing costs while also controlling water discharge quality which can help industries meet environmental regulations (Visvanathan and Asano, 2001). Many industries implement decentralised systems to ensure that water can be used again within the same industry. Water can be used in industries for processes such as cooling and washing.
- **Environmental Uses:** Wastewater effluent can be treated and returned to aquifers, wetlands or rivers for restoration. This allows water to sustain essential ecosystem services while also allowing water to be re-abstracted by downstream users. Allowing reuse of water also reduces over-abstraction and stress on existing water supplies promoting conservation of aquatic ecosystems. This can be done through discharge permits, which takes into account the needs of the aquatic environment and water available for dilution (Tool C3.01).
- **Potable Uses:** Water reuse and recycling can also be used as potable water is not very common except for some countries such as Australia, Singapore and the United States. Refining water to high qualities may be technically and economically challenging (WWAP, 2017). This includes monitoring and identification of different contaminants as well as their separation. Different levels of sophisticated physical, chemical, and biological treatments may be required depending on the type of water being treated.

Challenges and Opportunities

Generally, a high level of technical management, monitoring, financing, and regulatory institutions are needed for recycling and reuse to be both safe and effective. Hence capacity building (Tools B4) must go in tandem with the development of water recycling and reuse. Here are some key considerations regarding the challenges and opportunities related to reusing and recycling water:

- **Regulatory:** Reusing wastewater without adequate treatments raises potential health and environmental risks such as diarrhoea, contamination of groundwater, and build-up of chemical pollutants in the soil. Setting appropriate guidelines and standards according to water usage must be set to ensure effectiveness of water recycling and reuse (Morris et al., 2021). Furthermore, it is important to ensure compliance to quantity and quality standards of water returned to water bodies to ensure that it will not pose ecological or health risks to downstream users. Along with standard regulations a robust monitoring system should be put in place to guarantee the quality of water (Tool C2.05).
- **Technical and Economical:** Compared to desalination water recycling and reuse technology are cost-effective and less energy intensive. Furthermore, partial treatment of effluent can be done at a fraction of the cost of full-scale advanced treatment. They still have clear benefits and yield favourable benefit-cost ratios that would be affordable to many communities. In some cases, decentralised treatments may prove more cost-effective than centralised systems (UNESCAP, UN-Habitat and Asian Institute of Technology, 2015). Partial treatment of water may be useful for non-potable uses such as heating and cooling in industrial processes. Some less sophisticated techniques for grey water reuse are being developed, such as guideline ratios for safe mixing of wastewater and fresh water, which can make this tool suitable for less developed areas. Furthermore, methods have been developed to extract nutrients from wastewater and sewage that can be turned into fertilizer and biogas. The feasibility of these technologies must be judged based on sound economic assessments (Tool D1.01). Financial incentives (Tools C4) can help promote reuse and recycling in cases where water users can choose among different water sources. Volumetric charges can encourage wastewater reuse and discourage discharge into natural waterways while subsidies for equipment can speed the pace at which communities can begin using wastewater.
- **Institutional:** Wastewater is a responsibility and concern for multiple sectors at a household, municipality, basin, and global level. The implementation of such practices can be supported multi-stakeholder engagement (Tools B3.05) and cooperation among agencies and sectors such as health, water utilities, environmental organizations (World Bank, 2012). They can share the risks and benefits of water recycling by preserving ecosystems, diversifying water sources, tackling scarcity, and preventing health hazards.
- **Social:** A different and creative mindset is required for dealing with human waste and wastewater. Wastewater and accompanied sewage are primarily viewed as a waste disposal problem but with increasing water demands and depleting resources, there is a need for a shift to view them as economic and environmental opportunities. This shift in perspective to view wastewater and sewage as a resource can support sanitation, clean ecosystems, and ease pressure on over abstracted water resources. Community perspectives can be driving forces or key barriers to implementation of water recycling and reuse. Social and behavioural changes (Tools C5) supports a switch in perspectives and can improve acceptance and implementation of wastewater treatment. In some cases, users maybe resistant to the installation of infrastructure or treatment facilities unless they have some confidence that they will have access to benefits of using wastewater in terms of both quantity and quality (Bahri, 2009). This includes the psychological barrier such as “yuck factor” commonly associated with wastewater treatment and reuse making public outreach and awareness key to success (Tortajada, 2019).

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