

## Review Article

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# Environmental health effects associated with recycling of sewage for potable purposes: a literature review

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## ABSTRACT

This literature review has been drafted to explore and emphasise the potential environmental health risks and benefits of recycling wastewater especially in areas affected by prolonged drought. With limited water resources, recycled treated sewage water can be used to augment the fresh water supply. This review will provide an understanding of the importance of water recycling and the environmental impacts recycling can have on the environment. A comparison is also provided to understand the environmental effects of untreated sewage on the environment and the potential benefits associated with the recycling. Public health aspect is also elaborated to highlight whether recycled treated sewage is a viable option to be considered for the use as potable water. Literature suggests that recycled treated water has a purifying effect on the environment and can be used for potable and non-potable purposes.

**Keywords:** Recycled water, Potable water, Wastewater

## INTRODUCTION

Water is a vital element of life with an arbitrary supply, exhibited by wet and dry periods, making it very precious.<sup>1</sup> Water use has increased considerably recently and is expected to rise by 50% in developing and 18% in developed countries by 2025.<sup>2</sup> Globally, fresh water demand is increasing with inadequate supply.<sup>3</sup> particularly for the communities that regularly experience times of drought.<sup>2</sup> This shortage is amongst the most significant issues faced by these communities and is exacerbated if a climate dependent, single source of water is used.<sup>4</sup> Resolutions to global water scarcity are instantly required however it is imperative to design sustainable and economical solutions which are safe for the community and the environment.<sup>5</sup> Climate change is projected to further effect the water quality and accessibility and the aquatic ecosystems.<sup>6</sup> Water reuse is

at times the only real solution available on local scale and a broader global scale.<sup>2</sup>

Wastewater reuse is accepted as a favourable strategy to manage water scarcity around the world.<sup>7</sup> Reclaimed wastewater is a water source which can supplement the water balance of an area.<sup>8</sup> Wastewater reuse holds an important is an important strategy to overcome the demands on limited available water resources.<sup>9</sup>

## METHODS

A focussed search was conducted with the search terms environment, environmental health, environmental risks, environmental benefits, recycled water, sewage water, recycled sewage, potable water and all associated terminologies through PubMed and Scopus database for available literature related to the topic.

Abstracts were reviewed and articles were selected for the use of this assessment. Search strategy was not filtered for language of the publication but all articles chosen are in English. The selected articles were separately acquired and further studied for exploration. The references included in the selected articles were also investigated for any further evidence to be included in this review and also to explore publications which were not included during in the initial database search. Grey literature was also included to gather more information on the topic. Various official websites like WHO websites were also taken into account for information and data.

## DISCUSSION

The environmental effects of the waste water or sewage recycling are manifold. Some of the effects explored in the available literature are discussed here.

### *Potable use of recycled water*

Recycled water has been used for non-potable purposes for a long time around the globe.<sup>10</sup> The use of reclaimed water for drinking purpose has gained a lot of attention over the years due to climate change, shortage of fresh water supplies and growth in population. The potable use of recycled water can be further classified as direct and indirect potable reuse.

#### *Direct potable reuse*

Direct potable reuse (DPR) is the addition of extensively treated wastewater under stringent quality standards directly into the council water supply system.

According to a paper from Leverenz, Tchobanoglou, and Asano it has been suggested that it is unavoidable to make direct potable reuse as part of the practice for water management. This paper has suggested that blending of potable water and treated water can be achieved which will further ensure a complete reuse of treated water using existing infrastructure for potable water distribution.<sup>11</sup>

A case study by Friedler, has highlighted that direct potable reuse creates a new water supply source that warrants a reliable supply between and throughout the years.<sup>8</sup> With increased benefits to communities suffering for water shortfall.<sup>12</sup>

Environmentally, with the increase in the available resource of potable water there would be decreased pressure on natural fresh water sources.<sup>13</sup> Direct potable reuse also provides an effective way of managing the nitrogen and other contaminants present in sewage and also create a new source of agricultural fertilization.<sup>14-17</sup>

### *Indirect potable reuse*

Indirect potable reuse (IPR) is the process of water recycling in which sewage is treated and released into groundwater for the purpose of drinking water augmentation.<sup>18</sup> Water purification is achieved by using environmental buffers such as rivers, dams, lakes or aquifers.<sup>19</sup>

A study by Rodriguez, has suggested that areas with limited water supply can use IPR as it is not weather dependent and quality recycled drinking potable water can be produced. The chemical and biological hazards found in wastewater are very high and contaminants have been found in low quantity in recycled water.<sup>4</sup>

Environmental health benefits of indirect sewage reuse emphasizes on refining the water quality, averting depletion and increased holding time and a natural purification of the sewage.<sup>20</sup>

Another study by Garcia, has identified that IPR benefits the environment in two ways. One by increase in the water resources accessibility and consistency and secondly through the improved ecological conditions and thus ecosystem.<sup>7</sup>

On the contrary Winpenny, has stressed on the loss of fertilizer properties of the recycled sewage. Nutrients in sewage possess fertilization properties that can replace other fertilizers.<sup>21</sup>

### *Chemical risks and benefits*

The foremost concern resulting from wastewater reuse is the environmental risk in urban or ecosystem. Reclaimed wastewater poses a definite risk as it holds chemicals, solids, heavy metals, pesticides, pathogens and other substances endangering the ecosystems and humans.<sup>22</sup> These pollutants are a result of human activity and can be released in the environment in dangerous concentrations, if not suitably treated.

Sewage water is a known source of many beneficial nutrients but it also contains a substantial quantity of heavy metals and many pathogens.<sup>23</sup> The impact of sewage waste on ecosystems is well recognized. The organic and inorganic nutrients in the sewage can result in eutrophication and algae increased growth which can affect fish and is a known global environmental issue.<sup>24</sup>

Evolving pollutants such as organic waste water derived compounds that consist of pharmaceuticals, endocrine disrupting compounds (EDC) are also considered to be stressors to the ecological environment and can have significant effect on fish reproductive and developmental capabilities.<sup>25,26</sup>

### ***Adverse health effects of using recycled water***

In multiple projects across the globe various treatment techniques and ways of introducing the recycled sewage as potable water have been used but there has been no reported additional health risks associated with the recycled water use.<sup>19</sup>

An ecological study in Namibia, explored the association of diarrhoea and the source of water used by the community and found that type of potable water used is not associated with diarrhoea.<sup>19</sup>

Another cohort study examined the association of the use of treated recycled water and birth outcomes and found no association and the adverse effects were similar for groups using different percentage of recycled water as potable water.<sup>27</sup>

In Singapore, a study on recycled water use concluded that there is no carcinogenic or estrogenic effects.<sup>28</sup> It has also been observed that appropriate treatment of sewage can also efficiently remove endocrine disrupting compounds.<sup>29</sup>

### ***Carbon footprint***

Water supply through sewage treatment and reuse not only lessen the shortage of water resources but also benefits the climate.<sup>30</sup> Waste water treatment plants directly or indirectly emit carbon dioxide and nitrous oxide which are major greenhouse gas produced during the process into the environment. Sewage itself is the sixth largest source of nitrous oxide emission in the world and is also responsible for a high carbon emission into the environment.<sup>31</sup> Nitrous oxide from the treatment units represents 26% of the carbon footprint of the water recycle.<sup>31</sup> Sewage treatment results in the reduction in the emission of carbon and nitrogen into the environment.<sup>32</sup>

### ***Sludge production***

The sludge produced as a result of the sewage treatment and recycling possesses high concentrations of various chemicals and contaminants with negative effects on the environment. Sludge produced is used for soil improvement. The chemicals present in the sludge increase in concentration after repeated use and further pose adverse effects on the environment.<sup>33</sup>

### ***Acceptability and perception***

Public opinion and acceptance is a major obstruction for the use of recycled potable water.<sup>13</sup> In the past, water recycling projects have been rejected by the public and recycled water was left to be used in emergency situations only.<sup>34</sup> It has been found that people are willing to support water recycling projects but are more hesitant in supporting the potable use. Through studies, It has also

been noticed that people are more supportive of the waste water recycling and reuse after extended dry periods.<sup>35,36</sup>

One study identified the potential factors that can increase the public participation and acceptance to the water recycling for potable uses.<sup>37</sup> These factors include motivation and strong commitment by the organizations, increased public involvement through better communication, availability of fair and transparent information to all stakeholders, establishing trust on water authorities and fair decision on the projects.

Participation of the community is crucial for any recycling project to be successful and to increase knowledge and trust.<sup>38</sup>

### ***Management and decision making***

Although recycling of wastewater carries many benefits but the decision making for the projects is very critical and many factors must be considered which will affect the sustainability and success of these projects. These issues may be related to the availability of the recycled water at the required time and in required quantities considering the variability in the demand and supply. Environmental and health risks are also important considerations for the authorities due to the presence of chemicals in the recycled sewage. And most importantly, public awareness and concerns need to be addressed before any projects that involve potable use of recycled water.<sup>7</sup>

## **CONCLUSION**

Through the search of the literature, this paper has highlighted the important environmental risks and benefits associated with recycling treated sewage for potable use. Recycling the wastewater has purifying effect on the environment. Treated water can be used as potable water either directly or indirectly. Indirect potable use is being practiced in many parts of the world with a lot of success but there is still reluctance in the direct potable use of the recycled water. Climate change, depleting water resources and population growth are the major factors which are making potable use of recycled sewage inevitable. Limited knowledge and research on the prolonged effects of recycled water use on human health is required in order to increase the understanding of any adverse effects of prolonged use. It is evident that community perception is one of the major driving factors for decision making for the authorities and later the success of any future projects for the potable use of recycled sewage.

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