Sorting of wastewaters for urban and rural recycling and reuse

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Abstract. The drinking water of good quality, in enough quantity at right time start to be very scarce in the world. At the same time perfect drinking water is used to flushing toilet, cleansing of sewage pipes, washing of industry floors, firefighting, washing of cars and trucks etc. Also agriculture is suffering of lack of water for irrigation during dry periods and it is necessary to use drinking water or river/lake water of high quality to get rich harvest of good quality. In the future drinking water must just be used as food stuff and not wasted in the society. People must, since they are children, be trained to respect the drinking water and not waste a single drop. Also, storm water can be considered as a source of fresh water if it collected and recycled properly. Recycling/reuse of treated/reclaimed wastewater will help to mitigate part of the increasing water demands in the society and secondary water can be used in non-potable end paths such as agriculture, industry or even recharging water aquifers. Reclaimed/technical or recycled water for non-potable uses such as flushing toilets, irrigation and other uses will be very important in modern society in the future.

1 Introduction

During the summer 2019 there has been current fresh water stress at the south-eastern part of Sweden as well as other parts in Europe at the same time as flooding problems has occurred in other regions [1-4]. Drinking water of good quality, in enough quantity at right time should be a human right. Today we are not carefully with the drinking water use and protection as result of attitudes established already in 1960 s when urban and industrial discharges was said – it is just a drop in the ocean [4-8]. Today we know that the ocean are polluted and so is groundwater sources with pesticides and pharmaceutical. In order to fulfil the human need of clean water as a food stuff there is a need of strong regulation and restrictions for use and

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saving of drinking water and protection of its quality. In the future there will have water of
different quality delivered to the household and the industry and to farmlands in different
pipe systems. Sorting of the wastewater must start already at the sink in the household and at
the process machine in the industry for recycling/reuse on site [9-12]. Already there exist
pipe system leading treated wastewater to agricultural for irrigation. It is of highest
importance to identify and analyse existing options for recycling/reusing reclaimed/technical
wastewater as a resource and develop new methods for future use. This must also include
understanding of hinders and benefits for future implementation of such recycling and in
Kalmar/Sweden a project on this topic has been carried out ‘Sustainable water reuse in
Kalmar’ sponsored by VINNOVA foundation. The idea behind that project has been to
investigate projects and experiments covering the same idea of recycling/reusing treated
wastewater and explore end users. However, using wastewater for irrigation of agricultural
land is not anything totally new thinking and it has been practiced in many dry and poor
countries for many decades. It has also been practised in Europe and according to European
Commission: The Water reuse refers to the production of water through water treatment
processes which introduces a feedback loop in the water cycle. As such, water reuse is not an
additional water source but rather a product that needs to be tailored to the intended uses. It
differs to supply augmentation measures such as sea-water desalination, which in effect
includes a new input to the water cycle [10-19].

In order to fulfil the production demand health and environmental safety regulations/guidelines have been developed concerning the reuse/recycle of wastewater for both EU and on Global level [12-20]. There exist useful regulations/ guidelines for recycling/reusing wastewater of which some are shown here:

- World Health Organization (WHO): “Guidelines for the safe use of wastewater, excreta and greywater” (2006).
- United Nations Environment Programme (UNEP): “Guidelines for municipal wastewater reuse in the Mediterranean region” (2005).
- United Nations Water Decade Programme on Capacity Development (UNW-DPC): Proceedings on the UNWater project “Safe use of wastewater in agriculture” (2013).
- Cyprus: Law 106 (I) 2002 Water and Soil pollution control and associated regulations (KDP 772/2003, KDP 269/2005) (Issuing Institutions: Ministry of Agriculture, Natural resources and Environment, Water Development Department).
- Greece: CMD No 145116. Measures, limits and procedures for reuse of treated wastewater (Issuing Institutions: Ministry of Environment, Energy and Climate Change).
- Italy: DM 185/2003. Technical measures for reuse of wastewater (Issuing Institutions: Ministry of Environment, Ministry of Agriculture, and Ministry of Public Health).
- Portugal: NP 4434 2005. Reuse of reclaimed urban water for irrigation (Issuing Institutions: Portuguese Institute for Quality).
- Spain: RD 1620/2007. The legal framework for the reuse of treated wastewater (Issuing Institutions: Ministry of Environment, Ministry of Agriculture, Food and Fisheries, Ministry of Health).
- Canada: “Canadian guidelines for domestic reclaimed water for use in toilet and urinal flushing” (2010).
- China: China National Reclaimed Water Quality Standard; China National Standard GB/T 18920-2002, GB/T 19923-2005, GB/T 18921-2002, GB 20922-2007 and GB/T 19772-2005.
On the European levels studies have been initiated to identify the requirement of recycling wastewater as reclaimed water and these studies have come out with proposals for the first required regulations in end 2018 for irrigation purposes (Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL-on minimum requirements for water reuse, 2018/0169 (COD)).

2 The different applications of reclaimed/recycled wastewater

Many different pathways for recycling/reusing wastewater have been identified but most of these are for non-potable uses such as:

1. Agricultural irrigation

Agriculture is accounting for more than 33% of total fresh water use in Europe (EEA, 2012). The reclaim of wastewater recycling for agricultural irrigation in Europe is for instant used for rice, corn, grass and horticulture irrigations [2, 5-8, 17-19]. Water from rivers and lakes are commonly used for agriculture irrigation and during summer the river waters are heavily polluted by waste water, stormwater and sometimes with combined sewer overflow discharges.

2. Industrial applications

In Europe, industrial and energy sectors stand for 40% of the total fresh water use. In Central Europe, cost savings is the driving force for water recycling while ecological concerns play vital role for saving water in Western Europe. Reclaimed wastewater has been used in different operations such as processing water, cooling water, washing of equipment, washing aggregate and making concrete, soil.

Industrial stormwater can be used and is defined as water resulting from natural precipitation and generated at an industrial site via an industrial activity. Industrial activities
can be divided into the following main categories: 1) heavy manufacturing facilities; 2) medium manufacturing facilities; 3) mines, oil and gas facilities; 4) hazardous waste treatment storage and disposal facilities; 5) landfills, disposal facilities; 6) recycling facilities; 7) steam electric generating facilities; 8) selected transportation facilities; 9) domestic sewage treatment works; 10) construction activities; 11) other industrial facilities exposed to stormwater. Stormwater quality vary in time and space. The potential direct use of stormwater includes: re-circulation of stormwater for different industrial processes, washing, irrigation, cooling, drinking water and recreational used. Cleaning of industrial wastewater might be difficult because generated at multiple sources in the form of mixed pollutants, low volumes but high pollutant concentration.

3. Urban applications

In urban applications domestic toilet flushing, firefighting and urban green space irrigation are dominating. Other applications that are having slow but steady increase is the planned indirect potable reuse applications utilizing intermediate natural processes such as infiltration basins, river bank filtration, dune filtration, and aquifer storage and recovery. Important pollutants in urban runoff are sediment/habitat alteration; oxygen-demanding substances (organic matter); nutrients (phosphorous, nitrogen); toxic substances (heavy metals, oil and grease); bacteria; floatable; multiple impacts of several of these pollutants acting in concert, aesthetical. Classes of persistent organic pollutants (POPs) must be controlled in recycling and reuse as CFC, HCFC, Haloner; PHC –Petroleum; Hydro Carbons; PAH –Polyaromatic Hydro Carbons; Pesticides (most common); Glyfosat, DDT, Fenoxi acids; Insecticides(insects); Herbicides (weeds); Fungicides (fungis); Nematodicides (small worms);

4. Environmental services and recreation

Reclaimed wastewater can be also used for restoring and enhancing natural habitats such as wetlands or marshes as well as recharging aquifers (to protect groundwater from saline intrusion). This method can also be used for storing water during winter months which can help to stand the demands during summer. Reclaimed wastewater was also used for: golf course irrigation, recreational impoundments with/without public access (such as fishing, boating, bathing), aesthetic impoundments without public access and snowmaking.

3 Conclusions

Climate change and population growth are among many challenges facing the sustainability, quantity and the quality of our precious resource the fresh water. Fresh water sustains life and is accounting for less than 1% of the total stocks on Earth and Himalaya is the largest freshwater source and serve around 40% of the world population with water. To maintain this valuable resource, innovative methods and techniques must be implemented. The goal must be to develop potential of recycling reclaimed wastewater from treatment plants as a resource instead for discharging in the environment and losing the opportunity of sustainability of water. Recycling options from global and local sources must be better identified such as recycling/reusing the reclaimed wastewater for irrigation, industrial uses, urban applications and environmental recreation. Recycling or reusing reclaimed wastewater also brings many challenges and complex questions regarding purification of contaminants and the extent that must be removed. Identifying programmes for analyses considering local conditions, needs, scientific knowledge, regulations and requirements should be also taking
in accounts. The recycling/reusing of reclaimed wastewater requires the planning of advanced strategies covering multiple measures and considering public health and environmental risks. Therefore, the combinations control of reclaimed wastewater source, proposed and used treatment processes, flow schemes and technical requirements should be analyzed for the recycling and reusing of this reclaimed wastewater.

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