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Abstract

Water is one of the most critical resources worldwide. At urban level, clean water is not only used as drinking water, but for a wide range of uses. Due to human health and environmental risks, water reuse has strong limitations in the existing regulation of water and wastewater. A more efficient water reuse could be essential in the transition towards a circular economy. Differences in national and regional legislations lead to differences in the possibilities for cities to use existing knowledge. However, treated wastewater can be used for several purposes such as street cleaning, irrigation of parks and gardens, industrial purposes, etc. After all, different uses require different standards of water quality.

Actually, at European level, the Urban Agenda for the EU is willing find workable ideas focused on the topics of EU legislation, funding and knowledge sharing. One of these partnerships is the EU Partnership on Circular Economy. Cities play an essential role in the development of a circular economy and overall governance, enabling businesses, public procurement, consumption and resource management are the themes that would all have a bearing upon the development of circular economy concepts within cities. At present, the Municipality of Prato is the Italian representative in the EU Partnership on Circular Economy. The Urban Agenda project would enhance EU policies, strengthen the EU's understanding of urban issues, and would share best practice strategies. Within the partnership, the Municipality of Prato leads the debates regarding wastewater reuse.

This study aims to describe the role of Prato within the EU Partnership on Circular Economy, as well describing the recent evolution on EU legislation about reuse of treated wastewater. In particular, we will focus on recent published proposal for Regulation of the European Parliament and of the Council on minimum requirements for water reuse.

Keywords: Circular economy; Urban agenda; Wastewater reuse; Industrial symbiosis; Reclaimed water.

1. Introduction

In a developed economy with several industrial activities, many different by-products are generated. According principles of circularity the range of potential uses of by-products as second raw materials

can be various. Circular economy enables, in fact, the development of a brand new paradigm, where the model overcomes the concept of an economy that close the loop with waste (Ellen Macartur Foundation, 2015). Today, both the reasons for the sustainability and the environmental impact suggest a radical switch to the circular paradigm, with positive conditions leading to a full exploitation of the big potential of this new approach (Ghisellini et al., 2016). In order to stimulate the transition to circular economy, in 2015, the European Commission has adopted a "Circular Economy Package" (CEP), which includes revised legislative proposals. CEP consists of an action plan that establishes a concrete action programme, with measures covering from production and consumption to waste management and the potential market and reuse of secondary raw materials (European Commission, 2015). These actions aim at both promoting to close the loop in products' life cycle and bringing benefits for both the environment and the economy. One of the most important challenges that the circular economy has to face is the necessity, in the near future, of designing indicators capable to assess the level of efficiency in terms of reduction, reutilization, and recycling of waste generated in the linear economy model (Molina-Moreno et al., 2017). During the Dutch presidency of the European Union in 2016 the Pact of Amsterdam (PA) was adopted by EU Ministers responsible for Territorial Cohesion and/or Urban Matters. PA strives to involve Urban Authorities in achieving better regulation, better funding and better knowledge, considering cities as drivers of innovation. The Urban Agenda for the EU (UAEU) helps to ensure that these facts are acknowledged and reflected by EU legislation, funding and knowledge sharing. Among the UAEU, works the EU Partnership on Circular Economy (UEPCE). In facts, cities play an essential role in the development of a circular economy; they act as enablers of potential measures by which they can influence both the consumers and the businesses (Kirchherr et al., 2017). Moreover, overall governance, enabling businesses, public procurement, consumption and resource management are the themes that would all have a bearing upon the development of circular economy concepts within cities. The partnership consists of six urban authorities, namely the City of Oslo, The Hague, Prato, Porto, Kaunas and Flanders region. The Member States are Finland, Poland, Slovenia and Greece. The European Commission (in particular DG Regio, DG ENV, DG Clima, DG RTD, DG Grow), the Council of European Municipalities and Regions, Eurocities, Urbact, the European Investment Bank and the Association of Cities and Regions for sustainable Resource management are also partners. At present, the Municipality of Prato (MoP) is the Italian representative in the UEPCE. Within the partnership, MoP is leader in the debates regarding wastewater reuse.

Prato is one of the largest Italian industrial districts and one of the most important textile and clothing production centers in the world. Since the post-war period, textile waste management has represented one among the main drivers for textile district development: recovery and recycling of natural fibers from rags and used clothes were the basis for the Prato's yarn and textile industry. Prato has been always a model of innovation in this sector having historically based its industrial fortune on the reuse of waste from the textile process and on the reuse of second-hand clothing from all over the world. The local centralized water treatment plant also plays one role within the textile district. Created in 1981, GIDA was founded in order to manage treatment plants, sewage treatment plant and the industrial aqueduct network. The core of the centralised treatment system is the Baciacavallo treatment plant. Weekdays

the plant can treat up to 130,000 m³/d, breaking down up to 100,000 kg of COD per day and 4,500 kg of surfactants per day. It consists of stages for equalization, primary sedimentation, biological oxidation, sedimentation, flocculation and a final refinement with ozone to remove colour and surface residues. The sludge line consists of gravity thickening, mechanical dewatering by centrifugation and sludge incineration. This last stage uses a multi-level incinerator of 100 t/d, supplied with post combustion, a wet scrubber tower for fumes, dust collector and continuous emission analyser. The sludge resulting from the treatment process can reach 30,000 t/a with 75% moisture. ARCO is a university action-research centre founded in 2008 at PIN S.c.r.l. (Polo Universitario "Città di Prato") – University of Florence that integrates the expertise and skills into five strategic research units: local development, social economy, M&E and impact evaluation, inclusive development, sustainable food commodities. On circular economy, ARCO consults with the MoP and offers its scientific and technical support especially on the topic of the circularity of production processes. ARCO participates at meetings and workshops within the UEPCE, contributing at the discussion and proposing ideas and innovative solutions along the way. The MoP, together with GIDA, ARCO and other main stakeholders, takes a step forward in order to outline a future vision of sustainable city where water management is circular.

This study aims to describe the role of Prato within the Urban Agenda on Circular Economy, as well describing the recent evolution on EU legislation about reuse of treated wastewater. In particular, following the interest of Prato about water reuse action within the UEPCE, we will focus on recent published proposal for Regulation of the European Parliament and of the Council on minimum requirements for water reuse.

2. Methods

The paper is the result of involvement of the authors within the EUPCE. Main activities carried out: a) Desk-based analysis of reports and publications on CE as well as main European legislation on water; b) Conduction of semi-structured interviews with local representative stakeholders; c) Participation at all debates and meeting within the PCE. These methods has allowed diversifying the sources of information, in order to obtain a comprehensive and consistent picture of water reuse issues.

More, this paper analyse the recent proposal for a "Regulation of the European Parliament and of the Council on minimum requirements for water reuse" and the minimum requirements proposed have been compared with the current results of the analysis on the treated water in exit from GIDA treatment plant.

3. Results and Discussion

Water is one of the most critical resources worldwide, but also in parts of Europe. Clean water is not only used as drinking water, but for a wide range of uses within the city. Today, there are strong restrictions towards the use of cleaned water from wastewater treatment plants (thereinafter "reclaimed water"). However, reclaimed water can be used for several purposes such as street cleaning, irrigation of parks and gardens, industrial purposes, etc. After all, different uses require different standards of

quality, with the aim to safe both people and environment. Is should be noted that with term 'urban wastewater' European legislation defined as domestic wastewater or the mixture of domestic wastewater with industrial wastewater and/or run-off rain water. Most cities have one system for collecting urban wastewater, including wastewater from industrial and commercial activities, which results in the limitation for these cities to reuse water with current legislation. Although, water reuse encounters numerous barriers in the EU, this practice is commonly used in extra European countries (i.e. Israel, Australia, and Singapore). The following table 1 regroups relevant EU legislation on water:

Table 1. *Source: Authors*

Legislation	Brief description
Water Framework Directive. Directive 2000/60/EC	Since 2001 a Common Implementation Strategy has been in operation, bringing together national experts, stakeholders and the Commission involved.
Drinking Water Directive. Directive 1998/83/EC	Its objective is to protect human health from adverse effects of any contamination of water intended for human consumption by ensuring that it is wholesome and clean.
Bathing water quality. Directive 2006/7/EC	To monitor and assess the bathing water. The BWD also complements other environmental policies.
Groundwater. Directive 2006/118/EC	Developed in response to the requirements of Article 17 of the Water Framework Directive.
Urban Waste Water Treatment. Directive 91/271/EC	Article 12: "treated waste water shall be reused whenever appropriate. Disposal routes shall minimize the adverse effects on the environment."

In Europe, identified barriers in water reuse are among others: wastewater from industrial production activities has more regulatory limitations than urban wastewater; there is a lack of minimum quality requirements for water in its different uses and processes; reused water is less attractive than freshwater (EU Commission, 2018). Both southern member states such as Spain, Italy, Greece, Malta and Cyprus and northern member states like Belgium, Germany and the UK already have in place numerous initiatives regarding water reuse for irrigation, industrial uses and aquifer recharge (Alcalde-Sanz et al., 2017). Cyprus and Malta already reuse more than 90% and 60% of their wastewater respectively, while Greece, Italy and Spain reuse between 5 and 12% of their effluents, clearly indicating a huge potential for further uptake (EU Commission, 2018). In Italy the level of stringency of the existing water reuse standards has been reported to be an obstacle to the further uptake solutions, due to high administrative burden and associated costs for local authorities. The situation is likely to remain unchanged in the absence of EU action related to standards' harmonization and simplification. Italy has implemented the Directive 2000/60/EC by Legislative Decree 152/2006 "Norms Concerning the Environment", regrouping in a single legislative text the environmental laws previously contained in several decrees. Part III regulates "Soil protection and the fight against desertification, protection of water from pollution and management of water resources". Concerning drinking waters, Legislative Decree 31/2001 implements Directive 98/83/EC. The need to address the problem at EU level has been acknowledged in the 2012 Commission Communication "A Blueprint to Safeguard Europe's Water Resources", as

well as a number of actions to promote water reuse were included in the Communication from the Commission "Closing the loop – An EU action plan for the circular economy" in 2015, including an action to prepare a legislative proposal on minimum requirements for water reuse for irrigation and groundwater recharge. Furthermore, the European Parliament, in its September 2015 Resolution on the follow-up to the European Citizens' Initiative Right2Water and the Committee of the Regions, in its December 2016 opinion on "Effective water management system: an approach to innovative solutions" encouraged the Commission to draw up a legislative framework on water reuse (EU Commission, 2018).

Within the EUPCE, MoP (leading the action plan on water reuse) has proposed, at urban level, the use of treated industrial and civil waters (e.g. urban wastewater) for irrigation purposes, e.g. urban green-gardens, green areas, peri urban-agriculture. This action comes just before EU Commission announced the publishing of a proposal for "Regulation of the European Parliament and of the Council on minimum requirements for waterreuse". For this reason, together of other municipalities involved in the EUPCE, MoP has opened the debate over the new proposal, contributing at the general discussion about requirements and future application.

Reclamation plant operators shall ensure that reclaimed water destined to a specific use (e.g. crops irrigation) comply with Annex I and Annex II of the proposal. About the uses of reclaimed water the proposal outlines in Annex I different requirement for agricultural irrigation according different types of crops: Class A) food crops consumed raw; B) food crops where the edible part is not in direct contact with water or processed food; C) food crops where the edible part is not in direct contact with water or processed food (drip irrigation only); D) use of reclaimed water for industrial or energy purposes. The proposal would set minimum requirements, and any member state could still adopt or retain more stringent legislation for water reuse in its territory. To avoid unequal barriers, the proposal goes in the direction that no member state could ban imports of food products irrigated with reclaimed water in another member state. Member states competent authorities would be responsible for enforcing the permit and carrying out inspections as necessary.

In order to evaluate if the minimum requirement expressed in the EU proposal are feasible, we compare the requirements with the results of reclaimed water exiting from GIDA plant. It should be noted that GIDA treats urban wastewater as a mix of domestic wastewater with industrial wastewater (coming from textile industries of Prato district), meeting the requirements of Italian legislation. The considered analyses are the official ones carried out by GIDA (through the internal accredited laboratory as well as by an external accredited laboratory) from 2014 to 2017 considering E.coli, BOD_5, Total Suspended Solids (TSS) and Turbidity.

Table 2 shows the average of the results of the analyses, in correspondence with the minimum requirements established by the proposal as well the limits required by the Italian DM 185/2003 on "Legislation about use of reclaimed water"[1].

Table 2. *Source: Authors*

	Quality class A (limits)	**Quality class B (limits)**	**Quality class C (limits)**	**Quality class D (limits)**	**Italian law DM 185/2003 (limits)**	**GIDA (average of analyses)**
E. coli (cfu/100 ml)	≤ 10	≤ 100	≤ 1000	≤ 10000	100	2.48
BOD_5 (mg/l)	≤ 10	According Council Directive 91/271/EEC			20	< 5
TSS (mg/l)	≤ 10	According Council Directive 91/271/EEC			10	1.14
Turbidity (NTU)	≤ 5	-	-	-	-	0.8

Both with the average and with absolute values, GIDA meets Annex I requirements for classes A, B, C and D. Meeting the requirements, GIDA could became a reclamation plant operator according the proposal.

The proposal, along with laying down minimum requirements for water quality, obliges to carry out monitoring and specific risk management tasks for the safe use of reclaimed water (Annex II). The proposed approach for the risk management is similar to the HACCP one, based on the following steps: 1) Describe the water reuse system; 2) Identify potential hazards (e.g. chemical, biological, physical); 3) Identify the environments, populations and individual risks; 4) Conduct a risk assessment covering both environmental risks and risks to human an animal health[2]; 5) Consider, when appropriate, additional requirements for water quality when ones stricter than those specified in Annex I are needed; 6) Identify preventive measures; 7) Ensure that adequate quality control system and procedures are in place; 8) Ensure an effective environmental monitoring system; 9) Ensure that an appropriate system is in place to manage incidents and emergencies. The water reuse risk management plan is based on the key risk management and it has to be set by the reclamation plant operator. Frequency of analyses depends by classes defined by the proposal and the water destination. In our opinion, although risk management procedure is well defined, it is important to stress more about the responsibility of food

[1] DM 185/2003 is not expressly repealed by Legislative Decree 152/2006 but in fact substitute with the provisions of Articles 78, 108 and 131 of the LD.

[2] The requirements and obligations to be taken into account in the risk assessment need to consider among others: i) the requirement to reduce and prevent water pollution from nitrates in accordance with Council Directive (CD) 91/676/EEC2; ii) the obligation for drinking water protected areas to meet the requirements of CD 98/83/EC3; iii) the requirement to prevent groundwater pollution in accordance with Directive 2006/118/EC; iv) the requirement to meet the environmental quality standards for priority substances and certain other pollutants laid down in Directive 2008/105/EC; v) the requirement to meet the bathing water quality standards laid down in Directive 2006/7/EC; vi) the requirements concerning the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture under CD 86/278/EEC8; vii) the requirements regarding hygiene of foodstuffs as laid down in Regulation (EC) No 852/2004 on guidance document on addressing microbiological risks in fresh fruits and vegetables at primary production through good hygiene.

business operator that use reclaimed water within his productions (i.e. crops irrigation or water as food ingredient). Further indications for food operators could be necessary to push them to take into specific account the hazards linked to the use of reclaimed water (in order to further add eventually control points and analyses in the HACCP plan). It should be noted that, if the reclamation plant operator knows the destination of treated water could be easier for him to set the treatments according the requirements. In fact, a collaboration among reclaimed plant operator and food operators could create positive industrial symbiosis. At city level, this kind of collaboration can advance social relationships among the involved local actors, including surrounding neighborhoods. These activities involve a form of brokering to bring companies together in new positive collaborations (e.g. industrial symbiosis), finding innovative solutions to use resources, and thus to increase revenues while reducing waste.

4. Conclusions

This paper aims to outline the role of the MoP within the EUPCE, as well describing the recent evolution on EU legislation about reuse of treated wastewater. About the proposal on minimum requirements for water reuse, its adoption at European level is an opportunity to solve the problem of water scarcity and at the meantime to address productions at circularity. Following circular approach, cities of the future will be more resilient, inclusive and livable. Also Sustainable Development Goals (SDG), and in particular SDG6 (“Ensure availability and sustainable management of water and sanitation for all”) and SDG11 (“Make cities and human settlements inclusive, safe, resilient and sustainable”), call for the promotion of sustainable urban water management for safer, more inclusive and resilient cities. Within the EUPCE, the MoP will continue to promote water reuse, following the legislation change and contributing at the debate at European level.

References

Alcalde-Sanz, L., Gawlik, B.M., 2017. Minimum quality requirements for water reuse in agricultural irrigation and aquifer recharge. Towards a legal instrument on water reuse at EU level. Publications Office of the European Union. Luxemburg.

Chertow M. R., 2000. Industrial symbiosis: literature and taxonomy. Annual review of energy and the environment, 25(1), pp. 313-337.

Directive 2000/60/EC. Water Framework Directive.

Directive 1998/83/EC. Drinking Water Directive.

Directive 2006/7/EC. Bathing water quality.

Directive 2006/118/EC. Groundwater.

Directive 91/271/EC. Urban Waste Water Treatment.

Ellen MacArthur Foundation, 2015. Growth within: a circular economy vision for a competitive Europe.

European Commission, 2018. Proposal for a Regulation of the European Parliament and of the Council on minimum requirements for water reuse.

European Commission, 2018. Annexes to the Proposal for a Regulation of the European Parliament and of the Council on minimum requirements for water reuse.

European Commission, 2018. Working document Impact Assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council on minimum requirements for water reuse.

European Commission, 2015. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Closing the loop - An EU action plan for the Circular Economy. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52015DC0614 (accessed 09.03.2018).

European Commission, 2012. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: A Blueprint to Safeguard Europe's Water Resources.

European Commission – DG ENV, 2015. Optimising water reuse in the EU.

European Commission - DG Internal Policies of the Union, 2006. Economic and Scientific Policy Status of Implementation of EU Environmental Laws in Italy.

Ghisellini P., Cialani C., Ulgiati S., 2016. A Review on Circular Economy: the Expected Transition to a Balanced Interplay of Environmental and Economic Systems, Journal of Cleaner Production, 114, 11-32.

Kirchherr J., Reike D., Hekkert M., 2017. Conceptualizing the circular economy: An analysis of 114 definitions Resources, Conservation & Recycling 127, 221–232.

Italian Legislative Decree 152/2006 “Norms Concerning the Environment”.

Italian Ministerial Decree n. 185/2003. Regolamento recante norme tecniche per il riutilizzo delle acque reflue.

Molina-Moreno, V., Leyva-Díaz, J. C., Llorens-Montes, F. J, Cortés-García, F. J., 2017. Design of Indicators of Circular Economy as Instruments for the Evaluation of Sustainability and Efficiency in Wastewater from Pig Farming Industry, Water, 2-3.

Disclaimer

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