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Drinking Water Reuse: One-Step Closer to Overpassing the "Yuck Factor"

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Abstract

Water shortage, because of either augmented domestication or climatic variability, has prompted nations to diminish stress on water supplies mostly via decreasing water demand. Nevertheless, this procedure entirely is not enough to ensure the quality of life that high-quality water services boost, particularly inside the case of augmented domestication. Intrinsically, the notion of water reuse (WR) has been reaching strength for the last few decades. Decision-makers require ready and reachable data concerning public attitudes toward WR to adopt convenient and sustainable resource management plans. Applying reclaimed infrastructure must concentrate firstly on usages with more important social acceptability, like street cleaning, car washing, irrigation of parks and athletic fields or toilet flushing. Acceptance of the usage of recycled water for other goals implementations, like food crop irrigation and watering of residential lawns may augment as public knowledge of the system expands. As inhabitants begin to be more usual with the techniques and global comprehension of the linked advantages of WR increases, officials, planners, and managers may encounter reduced objection to extra usages and attain bigger water savings via prolonged application of WR schedules. For potable WR, there is only one-step closer to overpassing the "yuck factor". However, great efforts remain to be accomplished in mater of hybrid water technologies to assure efficient pollutant removal. Finally, WR may be considered a safe tool to avoid water sources' contamination. In other words, treating wastewater at its source of generation before its expansion at the highest level of purity will avoid pollution expansion into nature: air, soil, and water. In this case and only in this case, the "yuck factor" will be overpassed.

Subject Areas

Hydrology

Keywords

Water Shortages, Water Reuse (WR), Wastewater Treatment, Potable Water, Yuck Factor

1. Introduction

The worldwide domestication tendency has conducted to a continuous augmentation of municipal societies. As an illustration, in Europe, the percentage of the municipal people is 73.4% of the total and is anticipated to augment to 81% by 2050 [1]. This direction is combined with water lack because of the supply-side effects of climatic fluctuations [2] and enhancing surviving qualities conducting to elevated stresses on water supplies [1]. For such cause, new European Union (EU) accounts emphasize the necessity to promote European stakeholders to primarily admit that "water is an essential but limited resource and needs to be carefully allocated and used", and subsequently to support and advocate circular and green economies [3] [4] [5] [6].

Transforming waste into supply is a fundamental bit of augmenting the performance of resources and advancing across a more circular economy [7]. In the background of the municipal water cycle, this moves firstly into employing treated wastewater (a waste) to supply (as a resource) a (more often than not) non-drinking water employment [8]. This may be applied at many levels, linked with the extent of centralization of the treatment used [9]. At the more centralized level, employing tertiary treatment in present wastewater treatment plants (WWTPs) may spread out non-drinking reuse choices, particularly in huge water users like agriculture or industry [10] [11] [12]. Outstanding cases of such large-scale reuse comprise situations in many countries [13]-[18]. Nevertheless, since centralized WWTPs are by convention near to the municipal centers they serve, they are not inevitably near sufficiently to agricultural or industrial activities and intrinsically the construction and operation of treated effluent transport systems may equal in costs even desalination [1] [19].

Following their type (*i.e. in situ* installation), decentralized techniques are moreover nearer to the circular economy notion. As a result, the loop between waste and resource may be closed regionally. In addition, wastewater begins to be not "just" a by-product of the municipal water system with some possibility for reuse, but a resource in itself, also diminishing (or removing) the barricade of transmission costs [1] [20].

Decentralized water recovering techniques are classified in a large set of choices and levels [21]. At the smallest level, in-house units treat water from the hand-basin, shower, and bath and give this water for employment in the toilet, washing machine and outside employments [22] [23]. The issue at this level is that the maintenance and operational costs are extremely elevated to let economically feasible schemes and intrinsically, this degree of recycling (known as greywater reuse [24]) frequently depends on supplementary mobilization, like drought situations or positive environmental behaviors of persons at the household degree [1] [21].

This paper discusses the main trends in water reuse (WR) technologies, implementations and status.

2. Sewer-Mining: A Promising Water Reuse (WR) Solution

Sewer-mining is a low famous choice in the toolbox of decentralized wastewater recycling techniques at a middle (local-to-neighborhood) level [1]. It takes out wastewater from local sewers, treats it at the point of demand and supplies local non-potable uses (like municipal green irrigation) while returning treatment residuals back to the sewer system [25] for eventual treatment in the centralized WTTP. Therefore, such procedure avoids the necessity for both expensive conveyance systems from the end of pipe treatment installations and dual reticulation infrastructure.

This kind of engineering was introduced in Australia to supply non-drinking water for municipal employments, comprising, as an illustration, the irrigation of municipal green spaces, sport facilities and even domestic employments [26] [27] [28] [29] [30]. **Table 1** shows various effective implementations of sewer-mining in Australia with abilities extending from 100 to over 2000 m^3/d. In a general manner, the mean cost of reclaimed water is very near to drinking water costs [1].

Regardless of the presence of sewer-mining success stories in Australia, diverse defiances stay actually on the road of these implementations in Europe, comprising popular understanding, unsuitable regulatory frameworks, technical problems, and, significantly, economic restrictions [1].

The Makropoulos *et al.* [1] article was placed inside the circumstance of an outstanding debate among centralized and decentralized WR technologies and the examination of compromises among performance and financial applicability of reuse at various levels. Precisely, Makropoulos *et al.* [1] contended for a medium

Table 1. Sewer-mining applications in Australia [1].

Location	Technology	Capacity (m^3/d)	Use	Cost
[a]Flemington Racecourse, Melbourne, Australia	Dual membrane, UV[f]	100	Irrigation	Estimated unit capital cost 0.42 \$/m^3, operational cost 0.43 \$/m^3, prices 2006
[b]Darling Quarter, Sydney's CBD, Australia	Moving bed, biofilm reactor, RO[g], UV	170	Toilet flushing, irrigation, cooling towers	Unit capital cost 2.2 \$/m^3 operational cost 2.1 \$/m^3, prices 2011
[c]Riverside Rocks Park, Sydney, Australia	Reed beds, UV	360	Irrigation	Estimated unit capital cost 0.49 \$/m^3, prices 2006
[d]Pennant Hills, North Sydney, Australia	MBR[h], UV	1000	Golf field irrigation	Estimated unit capital cost 0.49 \$/m^3, prices 2008
[e]Sydney Olympic Park	SBR, nutrient	2191	Toilet flushing, irrigation	Cost 1.05 \$/m^3, prices 2009 (90% the price of potable)

[a][31]; [b][32]; [c][33]; [d][34]; [e][35]; [f]UV (Ultraviolet); [g]RO (Reverse Osmosis); [h]MBR (Membrane Bioreactor); [i]SBR (sequencing Batch Reactor).

level of a WR choice named "sewer-mining", which may be viewed as a reuse program at the neighborhood level. They proposed that sewer-mining 1) gives a realizable substitutional reuse choice if the location of the WWTP is difficult, 2) depends on efficient treatment techniques and 3) provides a favorable chance for Small Medium Enterprises (SME) to be implicated in the water industry, assuring environmental, social and financial advantages. To favor this reasoning, they mentioned a pilot sewer-mining usage in Athens, Greece. This pilot combined two subsystems: a packaged treatment unit and an information and communications technology (ICT) infrastructure. They discussed the pilot's global efficiency and deeply assessed the capacity of the sewer-mining concept to turn into a fundamental part of the circular economy puzzle for water.

3. Choosing Potential Urban Water Reuse (WR) Implementations

In countries such as Canada, the public perception and government regulations are favorable to reclaimed water employment. Reclaimed water may be employed in different usages that can possess diverse efficiency in economic, environmental and social fields for changing stakeholders, showing decision on WR choice is compound [36]. Researchers [37] suggested a multi-criteria multi-decision-makers framework integrating multicriteria decision analysis (MCDA) and game theory for chosing a sustainable WR implementation (**Figure 1**). The suggested framework is implemented to the City of Penticton, BC, Canada. The assessment criteria comprised were environmental: fresh water saving, energy use [38], and carbon emissions; economic: annualized life cycle cost; and social: government policy, public perception, and human health risk for three stakeholders: municipality, citizens, and farm operators. The game theory is used to

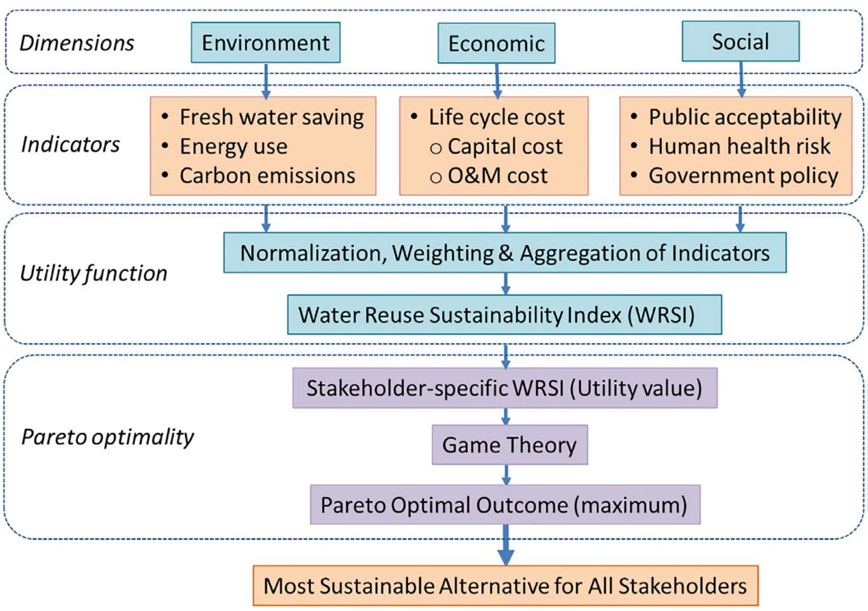

Figure 1. Suggesed multi-criteria multi-decision makers framework for WR selection [37].

eight WR choices taking into account a cooperative game (Figure 2). The finding illustrates that lawn, golf course and public park irrigation and toilet flushing with an equal sharing of urban advantages among the municipality and inhabitants is the optimal solution. Through employing the solution, the municipality may possess a supplementary saving of around \$35/household/year and the inhabitants must spend an extra amount of about \$100/household/year for dual plumbing of toilet and lawn for reclaimed water use. The supplementary expenditure for the inhabitants is within Canada's public desire to pay an extra charge for reclaimed water use. The scenario analysis proves that the weights of sustainability criteria are crucial in decision-making. Plus, the sensitivity analysis illustrates that the change in the quantity of reclaimed water accessibility may touch WR sustainability efficiency. The suggested framework may moreover be employed in various usages via modifying the number of evaluation criteria and stakeholders as needed.

4. Public Perception of Water Reuse (WR)—On the Other Side of the Evidence

Throughout the last decades, considerable investigations have tried to understand what motivates public echos to WR, employing diverse methods [39]. Smith *et al.* [40] exhibited post-millennium evidence and reasoning about public responses to WR and underlined the new comprehensions and mutations in value that have happened in the domain. They focused on four broads, and highly interrelated, strands of thinking: 1) work focused on defining the span of parameters that touch public reactions to the notion of WR, and largely searching for relationships among diverse parameters; 2) more particular methods embedded in the socio-psychological modeling mechanisms; 3) work with a special attention on comprehending the impacts of trust, risk perceptions and affective (emotional) reactions; and 4) work employing social constructivist perspectives and socio-technical systems theory to frame responses to WR. Some of the most important advancements in reasoning in this domain stem from the increasingly sophisticated understanding of the "yuck factor" and the contribution

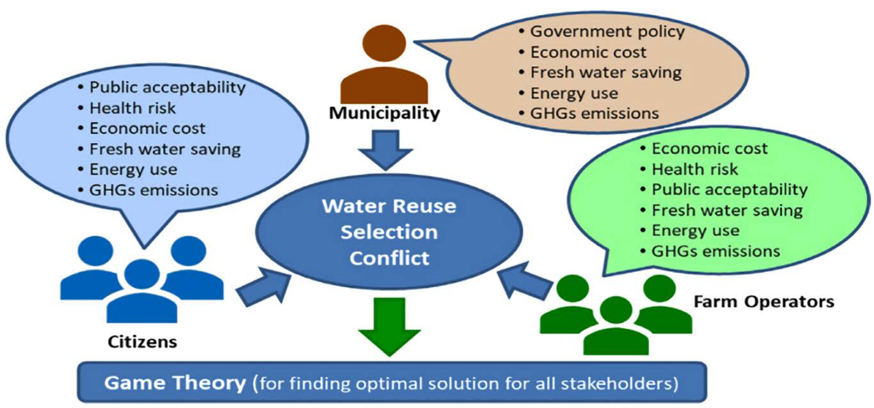

Figure 2. Game theory for finding optimal solution for all stakeholders [37].

of such pre-cognitive affective reactions. These are deeply entrenched within individuals but are also related to larger societal methods and social representations. Work in this domain proposes that replies to reuse are located inside a global mechanism of technological "legitimation". These rising discernments have to aid catalyze some fresh reasoning about methods to public engagement for WR.

Garcia-Cuerva *et al.* [41] mentioned the findings of a thorough investigation that was performed to assess the possible acceptability of recovered water use. Globally, 2800 respondents over the U.S. took part in the investigation. Findings show that a small fraction of the population is worried concerning water lacks, the plurality of the population exercises some degree of water conservation, and an important portion of the population encourages the employment of recovered water. Climate, demographic parameters, and financial incentives have experimented for impact on attitudes and behaviors concerning water, comprising awareness, conservation, and support for WR. The shortage of water situations does not possess a statistically crucial influence on the number of reclaimed water supporters. Financial incentives touch the desire of respondents to participate in WR programs, and a diminution in the monthly water bills augmented the probability that respondents would participate in a recovered water program. Support for the employment of recovered water for diverse usages ranked positively, on average, except for the implementation of WR for food crop irrigation and the use of reclaimed water at respondents' own residences.

Mukherjee and Jensen [42] examined the interaction among regulation, public acceptance, and technology adoption for drinking reuse. They used a Process Tracing procedure to assess two country cases, the US and Australia, both of which possess know-how in the succeeded adoption of drinking reuse as well as cases of public objection and abandonment of particular projects. The examples propose that local, collaborative, transparent risk-based regulation participates in elevated acceptance of reuse among the public and government officials and supports the take-up of the technology (**Figure 3**).

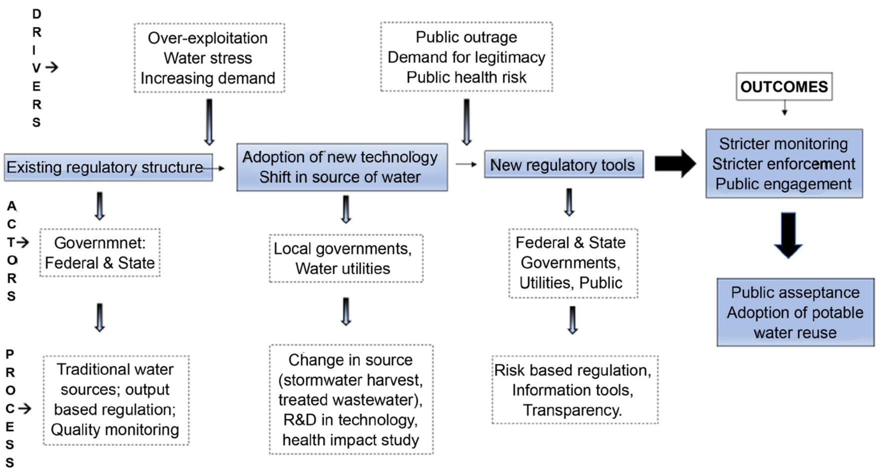

Figure 3. Causal mechanism (revised) illustrating evolution of WR regulatory regime [42].

5. Water Reuse (WR) Perspectives

For specialists implied with the planning and delivery of WR programs, and other debatable environmental techniques, the fundamental penetration to be earned from the Smith *et al.* [40] four connected strands of reasoning is that "standard" public engagement activities, like the easy provision of information linked to programs, may not (on their own) attain any relevant modifications in public attitudes. That does not imply, nevertheless, that such awareness-raising and information provision activities are minor or trivial. Smith *et al.* [40] mentioned that there is probably a necessity for a more thorough reflection about public engagement procedures. A large span of activities undertaken/supported by a large extent of players is finaly what supports a larger social shift for the sake of legitimizing WR [43].

For academia, the results and understandings that have been gathered these few years propose many extremely crucial conceivable orientations for the next labor about comprehending public replies towards WR [40]. Plus, such paths of research are not restricted to WR but are pertinent over a large domain of environmental techniques. Labor remains required to grasp if/how legitimation procedures, carried by the narrative building and additional forms of institutional work, can be reinforced in various situations. The "social representation" of recycled water will naturally be molded by a large span of contextual parameters and social players. Plus, there is obvious possibility for research to expand a better comprehension of how the "yuck factor" pre-cognitive affective reactions influence responses to reuse, and how these might be influenced by various forms of social narrative. Indeed, there is a requirement for more cross-disciplinary efforts that bring deep psychological comprehensions at the scale of the individual together with understandings from a societal scale that place WR within socio-technical and social constructivist perspectives. These efforts will let the field to advance away from the opinion that deeply entrenched emotional reactions are fixed, and enhance comprehensions of how they may probably be shifted through long-term societal legitimation and narrative building processes [44].

6. Conclusions

The main points drawn from this work may be given as:

1) Sewer-mining may be a weighty "game changer" in augmenting wastewater recycling within the augmenting municipal territory. Sewer-mining units, combing advanced compact treatment techniques with information and communications technology (ICT), present a set of advantages and offer a chance for more Small Medium Enterprises (SMEs) to enter the global water market, not only as technology furnishers but also as operators and service suppliers [1]. Such SMEs will be eligible to supply water to cover non-drinking demands (e.g. irrigation, cooling towers, car washing, etc.) via employing compact sewer-mining units at the location of demand.

2) The scenario examination illustrated that the significances of sustainability

parameters and dimensions may touch optimality and therefore the ultimate decision. The sensitivity analysis proved that the variation in reclaimed water accessibility might influence the WR sustainability efficiency and the decisions at a certain level. Consequently, the location specific data must be employed as far as usable. The game theory is more efficacious than traditional optimization techniques for solving a problem with multiples take-holders. The suggested framework may be employed in diverse usages by modifying the number of evaluation criteria and stakeholders as necessitated [37].

3) Finally, since more and more reuse plans are executed, next fieldwork will persist to gain from achievements to join labor founded on hypothetical reuse scenarios (comprising behavioral intentions studies) with empirical understandings from the real-world programs. Significantly, investigations founded on real-world programs have to concentrate on those that have produced positive and/or ambivalent reactions, not just those that have encountered objection. In the end, it is evident that much of the labor in this field has profited from strong engagement with other related literature (risk perception, behavioral psychology, socio-technical theory, etc.) and next investigation must persist to encourage cross-fertilization, specifically about the defying side of comprehending affective reactions [40].

4) To handle augmenting water demands, municipal water resources may be varied via WR schedules as a likely settlement to water lacks. Decision-makers require ready and reachable data concerning public attitudes toward WR to adopt convenient and sustainable resource management plans. Applying reclaimed infrastructure must concentrate firstly on usages with more important social acceptability, like street cleaning, car washing, irrigation of parks and athletic fields or toilet flushing. Acceptance of the usage of recycled water for other goals implementations, like food crop irrigation and watering of residential lawns, may augment as public knowledge of the system expands. As inhabitants begin to be more usual with the techniques and global comprehension of the linked advantages of WR increases, officials, planners, and managers may encounter reduced objection to extra usages and attain bigger water savings via prolonged application of WR schedules [41].

5) For potable WR, there is only one-step closer to overpassing the "yuck factor". However, great efforts remain to be accomplished in terms of hybrid water technologies to assure efficient contamination removal. Finally, WR may be considered a safe tool to avoid water sources' contamination. In other words, treating wastewater at its source of generation before its expansion (in the WWTP) at the highest level of purity (to get drinking water) will avoid pollution expansion into nature: air, soil, and water. In this case and only in this case, the "yuck factor" will be overpassed.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Makropoulos, C., Rozos, E., Tsoukalas, I., Plevri, A., Karakatsanis, G., Karagiannidis, L., Makri, E., Lioumis, C., Noutsopoulos, C., Mamais, D., Rippis, C. and Lytras, E. (2018) Sewer-Mining: A Water Reuse Option Supporting Circular Economy, Public Service Provision and Entrepreneurship. *Journal of Environmental Management*, **216**, 285-298. https://doi.org/10.1016/j.jenvman.2017.07.026

[2] Klein, R.J.T., Midgley, G.F., Preston, B.L., Alam, M., Berkhout, F.G.H., Dow, K. and Shaw, M.R. (2014) Adaptation Opportunities, Constraints, and Limits. In Climate Change 2014: Impacts, Adaptation, and Vulnerability. In: *Contribution to Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, UK.

[3] Ghernaout, D. (2017) Environmental Principles in the Holy Koran and the Sayings of the Prophet Muhammad. *American Journal of Environmental Protection*, **6**, 75-79. https://doi.org/10.11648/j.ajep.20170603.13

[4] (EUWA) (2014) EU Water Alliance, Main Priorities for Water under the Juncker Commission (2014-2019), September 2014.

[5] Ghernaout, D., Ghernaout, B. and Naceur, M.W. (2011) Embodying the Chemical Water Treatment in the Green Chemistry—A Review. *Desalination*, **271**, 1-10. https://doi.org/10.1016/j.desal.2011.01.032

[6] Ghernaout, D., Moulay, S., AitMessaoudene, N., Aichouni, M., Naceur, M.W. and Boucherit, A. (2014) Coagulation and Chlorination of NOM and Algae in Water Treatment: A Review. *International Journal of Environmental Monitoring and Analysis*, **2**, 23-34. https://doi.org/10.11648/j.ijema.s.2014020601.14

[7] (EC) European Commission (2015) European Commission-Fact Sheet: Circular Economy Package: Questions & Answers, MEMO-15-6204, Brussels.

[8] Ghernaout, D. (2019) Reviviscence of Biological Wastewater Treatment—A Review. *Applied Engineering*, **3**, 46-55.

[9] Libralato, G., Volpi Ghirardini, A. and Avezzù, F. (2012) Tocentralise or to Decentralise: An Overview of the Most Recent Trends in Wastewater Treatment Management. *Journal of Environmental Management*, **94**, 61-68. https://doi.org/10.1016/j.jenvman.2011.07.010

[10] Ghernaout, D. (2017) Water Reuse (WR): The Ultimate and Vital Solution for Water Supply Issues. *International Journal of Sustainable Development Research*, **3**, 36-46. https://doi.org/10.11648/j.ijsdr.20170304.12

[11] Ghernaout, D. and Naceur, M.W. (2011) Ferrate(VI): *In Situ* Generation and Water Treatment—A Review. *Desalination and Water Treatment*, **30**, 319-332. https://doi.org/10.5004/dwt.2011.2217

[12] Ghernaout, D. and Ghernaout, B. (2012) On the Concept of the Future Drinking Water Treatment Plant: Algae Harvesting from the Algal Biomass for Biodiesel Production—A Review. *Desalination and Water Treatment*, **49**, 1-18. https://doi.org/10.1080/19443994.2012.708191

[13] Mujeriego, R., Compte, J., Cazurra, T. and Gullón, M. (2008) The Water Reclamation and Reuse Project of El Prat de Llobregat, Barcelona, Spain. *Water Science & Technology*, **57**, 567-574. https://doi.org/10.2166/wst.2008.177

[14] Ghernaout, D. (2018) Magnetic Field Generation in the Water Treatment Perspectives: An Overview. *International Journal of Advanced and Applied Sciences*, **5**, 193-203. https://doi.org/10.21833/ijaas.2018.01.025

[15] Jimenez, B. and Asano, T. (2008) Water Reclamation and Reuse around the World.

In: *Water Reuse*: *An International Survey on Current Practice*, *Issues and Needs*, Chapter 1, IWAP, London, 3-26.

[16] Ghernaout, D. (2017) Water Treatment Chlorination: An Updated Mechanistic Insight Review. *Chemistry Research Journal*, **2**, 125-138.

[17] Ghernaout, D. (2018) Disinfection and DBPs Removal in Drinking Water Treatment: A Perspective for a Green Technology. *International Journal of Advanced and Applied Sciences*, **5**, 108-117. https://doi.org/10.21833/ijaas.2018.02.018

[18] Ghernaout, D., Aichouni, M. and Alghamdi, A. (2018) Applying Big Data (BD) in Water Treatment Industry: A New Era of Advance. *International Journal of Advanced and Applied Sciences*, **5**, 89-97. https://doi.org/10.21833/ijaas.2018.03.013

[19] Ghernaout, D. (2013) The Best Available Technology of Water/Wastewater Treatment and Seawater Desalination: Simulation of the Open Sky Seawater Distillation. *Green and Sustainable Chemistry*, **3**, 68-88. https://doi.org/10.4236/gsc.2013.32012

[20] Ghernaout, D. (2018) Increasing Trends towards Drinking Water Reclamation from Treated Wastewater. *World Journal of Applied Chemistry*, **3**, 1-9. https://doi.org/10.11648/j.wjac.20180301.11

[21] Rozos, E. and Makropoulos, C. (2012) Assessing the Combined Benefits of Water Recycling Technologies by Modelling the Total Urban Water Cycle. *Urban Water Journal*, **9**, 1-10. https://doi.org/10.1080/1573062X.2011.630096

[22] Dixon, A.M., Butler, D. and Fewkes, A. (1999) Water Saving Potential of Domestic Water Reuse Systems Using Greywater and Rainwater in Combination. *Water Science & Technology*, **39**, 25-32. https://doi.org/10.2166/wst.1999.0218

[23] Leggett, D.J., Brown, R., Brewer, D., Stanfield, G. and Holliday, E. (2001) Rainwater and Greywater Use in Buildings: Best Practice Guidance. CIRIA Publication C539, London.

[24] Li, F., Wichmann, K. and Otterpohl, R. (2009) Review of the Technological Approaches for Grey Water Treatment and Reuses. *Science of The Total Environment*, **407**, 3439-3449. https://doi.org/10.1016/j.scitotenv.2009.02.004

[25] Butler, R. and MacCormick, T. (1996) Opportunities for Decentralized Treatment, Sewer Mining and Effluent Re-Use. *Desalination*, **106**, 273-283. https://doi.org/10.1016/S0011-9164(96)00119-1

[26] AEDCS (2005) Australian Environmental Directory Case Studies, Technology Profile: Sewer Mining for Water Reuse. Canberra, Australia.

[27] Sydney Water (2013) Sewer Mining How to Set up a Sewer Mining Scheme. Sydney, Australia.

[28] Chanan, A. and Woods, P. (2006) Introducing Total Water Cycle Management in Sydney: A Kogarah Council Initiative. *Desalination*, **187**, 11-16. https://doi.org/10.1016/j.desal.2005.04.063

[29] Fisher, C. (2012) Sewer Mining to Supplement Blackwater Flow in a Commercial High-Rise. USEPA 2012: Guidelines for Water Reuse, E8-E10.

[30] Xie, M., Nghiem, L.D., Price, W.E. and Elimelech, M. (2013) A Forward Osmosis-Membrane Distillation Hybrid Process for Direct Sewer Mining: System Performance and Limitations. *Environmental Science & Technology*, **47**, 13486-13493. https://doi.org/10.1021/es404056e

[31] Waste Technologies of Australia Pty Ltd. (2006) Flemington Racecourse Multiple Water Reuse (MWR) Sewer Mining, Demonstration Project, Report No. 3722R. https://www.clearwatervic.com.au/user-data/research-projects/swf-files/40-sewer-m

ining-technology-trial-at-flemington-racecourse_final_evaluation_report.pdf

[32] (ISF) Institute for Sustainable Futures (2013) Darling Quarter Case Study: Successful Sewage Recycling within a High Profile Commercial Building.

[33] McFallan, S. and Logan, I. (2008) Barriers and Drivers of New Public-Private Infrastructure: Sewer Mining, Report No. 6 [CIBE-2007-032A]. Brisbane, Australia.

[34] (WERF) Water Environment Research Foundation (2008) Case Study: Pennant Hills Golf Club when to Consider Distributed Systems in an Urban and Suburban Context.

[35] Listowski, A. (2009) Recycled Water at Sydney Olympic Park. Sydney Olympic Park Authority.

[36] Ghernaout, D., Alshammari, Y., Alghamdi, A., Aichouni, M., Touahmia, M. and Ait Messaoudene, N. (2018) Water Reuse: Extenuating Membrane Fouling in Membrane Processes. *International Journal of Environmental Chemistry*, **2**, 1-12. https://doi.org/10.11648/j.ajche.20180602.12

[37] Chhipi-Shrestha, G., Rodriguez, M. and Sadiq, R. (2019) Selection of Sustainable Municipal Water Reuse Applications by Multi-Stakeholders Using Game Theory. *Science of The Total Environment*, **650**, 2512-2526. https://doi.org/10.1016/j.scitotenv.2018.09.359

[38] Ghernaout, D., Alghamdi, A., Touahmia, M., Aichouni, M. and Ait Messaoudene, N. (2018) Nanotechnology Phenomena in the Light of the Solar Energy. *Journal of Energy, Environmental & Chemical Engineering*, **3**, 1-8. https://doi.org/10.11648/j.jeece.20180301.11

[39] Ghernaout, D., Alshammari, Y. and Alghamdi, A. (2018) Improving Energetically Operational Procedures in Wastewater Treatment Plants. *International Journal of Advanced and Applied Sciences*, **5**, 64-72. https://doi.org/10.21833/ijaas.2018.09.010

[40] Smith, H.M., Brouwer, S., Jeffrey, P. and Frijns, J. (2018) Public Responses to Water Reuse—Understanding the Evidence. *Journal of Environmental Management*, **207**, 43-50. https://doi.org/10.1016/j.jenvman.2017.11.021

[41] Garcia-Cuerva, L., Berglund, E.Z. and Binder, A.R. (2016) Public Perceptions of Water Shortages, Conservation Behaviors, and Support for Water Reuse in the U.S. *Resources, Conservation and Recycling*, **113**, 106-115. https://doi.org/10.1016/j.resconrec.2016.06.006

[42] Mukherjee, M. and Jensen, O. (2020) Making Water Reuse Safe: A Comparative Analysis of the Development of Regulation and Technology Uptake in the US and Australia. *Safety Science*, **121**, 5-14. https://doi.org/10.1016/j.ssci.2019.08.039

[43] Al Arni, S., Amous, J. and Ghernaout, D. (2019) On the Perspective of Applying of a New Method for Wastewater Treatment Technology: Modification of the Third Traditional Stage with Two Units, One by Cultivating Microalgae and Another by Solar Vaporization. *International Journal of Environmental Sciences & Natural Resources*, **16**, Article ID: 555934. https://doi.org/10.19080/IJESNR.2019.16.555934

[44] Ghernaout, D., Elboughdiri, N. and Al Arni, S. (2019) Water Reuse (WR): Dares, Restrictions, and Trends. *Applied Engineering*, **3**, 159-170.