COMING TO TERMS WITH NATURE: WATER REUSE NEW PARADIGM TOWARDS INTEGRATED WATER RESOURCES MANAGEMENT

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Keywords: Water reuse, incidental, unintentional, natural recharge, artificial recharge, groundwater, surface water

Contents

Summary

Traditionally, water reuse is considered only as an activity where wastewater is intentionally treated to be used once again. Therefore, water reuse is understood as an artificial man made practice. Nevertheless, natural reuse also exists as part of the hydrological cycle, but is not acknowledged. This paper explains the reasons why natural reuse exists and proposes that it be acknowledged as a part of the hydrological

cycle. Cases concerning natural water reuse for human consumption and for agriculture are presented as well as the origin of the discharges that cause it. Because natural reuse is a fact of life, ways to better control its possible negative effects are discussed. It is concluded that recognizing natural water reuse will increase social acceptance of artificial water reuse while at the same time making both water planners and society more aware of the fact that artificial water reuse schemes require more considerations than wastewater treatment plants.

1. Introduction

Traditionally, water reuse is considered only as an activity where wastewater is intentionally treated to be used once again. Therefore, water reuse is understood as an artificial man made practice. Nevertheless, natural reuse also exists as part of the hydrological cycle, but is not acknowledged. Natural reuse exists because water supplies (both surface and groundwater) are not isolated in the environment but are linked with each other and with extractive and in-stream uses, exchanging water and compounds. Moreover, water supplies are linked and also exchange flows with the atmosphere, the ocean and the soil (see Figure 1). All these cross connections produce a natural unacknowledged reuse, which has been happening to such an extent and for so long now that there is increasing evidence that most water contained in water supplies has been previously used. And, although water is naturally reused, wastewater treatment is almost never performed for the purpose of water reuse but to protect human health and the environment.

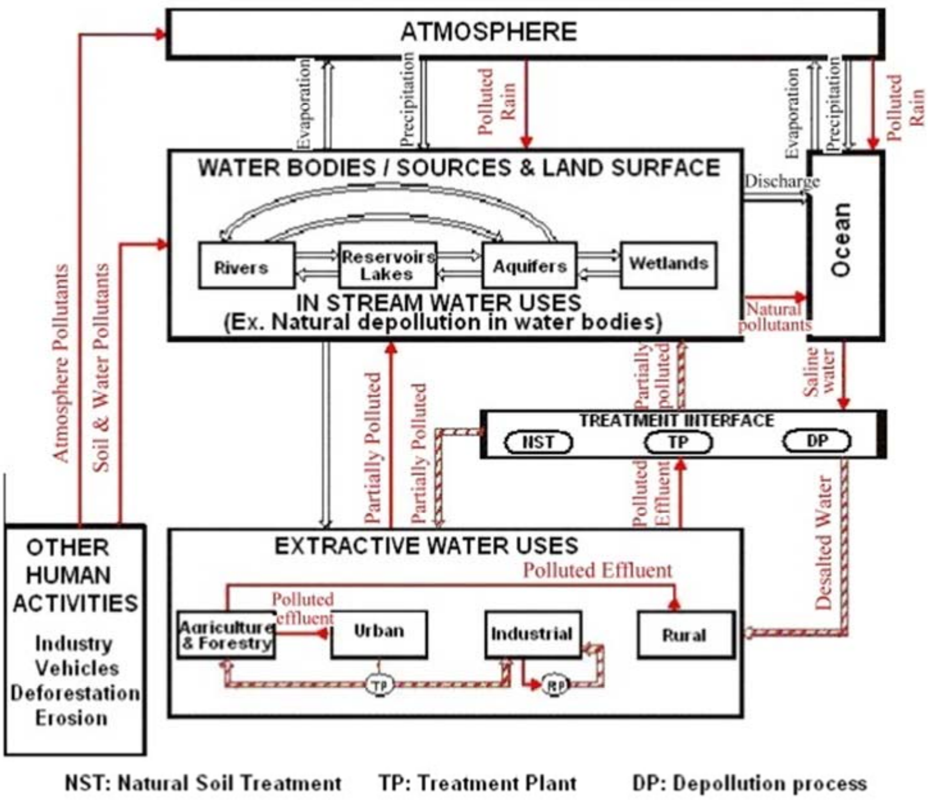

Figure 1: Natural water reuse as part of the hydrological cycle

It is not difficult to anticipate that the way we look at the hydrological cycle will change in the future. On the one hand, the world's water deficit will increase (by the year 2025 one third of the world population will live in countries with a water shortage, Appelgren 2004) while on the other, the use of water will be more intense (over the last 100 years water use intensity has increased by more than 6 times,Tuinhof and Heederik 2002). This will not only make wastewater treatment for reuse a common activity but also an important part of the hydrological cycle. This scenario stands in marked contrast with the increasing rejection of water reuse, particularly for human consumption, in some countries and makes it important for water planners to gain water reuse acceptance. Not only could recognizing natural water reuse modify the social perception of artificial water reuse by making water reuse in general a normal activity, it could also make both water planners and society more aware of the fact that artificial water reuse schemes need more considerations than wastewater treatment plants. Recognizing natural water reuse will contribute to a better understanding of information about the depolluting capability of nature not only in water bodies but also in soil and atmosphere and thus how to keep water sources as clean as we wish when required.

2. Towards an integral definition of water reuse

Fear of reusing water comes not from the water itself but from the compounds that water may contain. In that sense, the problem with "used water" is not the fact that it is used but that due to its use quality is changed. If this is true, it should be recognized that there are more "uses" than the officially recognized ones in producing discharges (municipal, industrial or agricultural). These uses/discharges can add noxious compounds to water and may also be the origin of the "evidence" that water bodies contain used water. Other uses given to water bodies are: (a) receptors of used water, (b) a means of getting rid of pollutants, (c) a "self depuration" procedure, (d) a source for diluting used water or (d) simply a sink of several materials. Such uses, intentional or not, should also be considered as sources of discharges. These uses/discharges are opposite to our desire of having good quality water supplies containing "first use water" or "non used water". Recognizing all these uses/discharges will enable us to recognize that more water bodies than ever imagined contain "used water" and, hence, its use is natural water reuse. Acknowledging natural water reuse will increase our knowledge of its advantages and drawbacks and will make us more aware of the global interactions between in-stream uses, extractive uses, discharges, water bodies, soil, atmosphere and land management. And this perhaps will permit the reconciliation of two antagonistic points of view frequently present in artificial reuse projects:

- That of the reuse experts that cannot understand why people prefer to drink water from "natural" water sources with evidence of used water rather than drink water coming from artificial reuse projects that have been known to produce water with a better quality.
- That of society that does not understand why water planners want people to drink artificially reused water if they can drink water from natural sources that they perceive to be more reliable because they assume these sources have never been used.

3. How to overcome people's fear of reused water

Studies concerning water reuse and social perception refer only to artificial reuse and are still very scarce (see Literature review of factors influencing public perceptions of water reuse) because it is a relatively new activity performed in only some parts of the world. Most of these studies come from developed countries and very specific and local water reuse projects. People consider that (artificial) water reuse is risky because: (1) the use of this water source is not natural; (2) it may be harmful to people; (3) there might be unknown future consequences; (4) their decision to use the water may be irreversible; and (5) the quality and safety of the water is not within their control (see Understanding public attitudes to technology). From different studies the main social objections to artificial water reuse are: (a) the disgust or "Yuck factor", (b) the perception of the risks of using recycled water; (c) the specific uses of the recycled water; (d) the sources of water to be recycled; (e) the issue of choice; (f) trust and knowledge; (g) attitudes toward the environment; (h) environmental justice issues; (i) the cost of recycled water; and (j) socio-demographic factors (Murni et al 2004). The fears mentioned above express a lack of knowledge of all the uses given to water bodies as well as of all the discharges sent directly or indirectly to them. Society's perceptions reflect the thinking of a society that has been taught that water reuse is a new activity and a merely human invention. Some of these perceptions might be different if people were more aware of natural reuse.

The disgust or "Yuck" factor is the objection most frequently cited in literature. It basically consists of the mental association between the water to be reused with concepts that are culturally disgusting such as urine, faecal feces and, in general, all kind of wastes (Hamilton and Greenfield 1991). This barrier is difficult but not impossible to cross, although the way to do it is still not clear. Projects to artificially reuse water for direct human consumption (those where municipal wastewater is treated to achieve drinking quality and then diluted with "first use water" prior to being directly injected to the distribution network) are few. Currently there are only two, and, curiously, both in developing countries. The only one planned in the United States some decades ago was socially rejected after a newspaper announced it as "from toilet to tap". The first direct (and artificial) water reuse project began to operate in 1968 in Windhoek, Namibia. Several epidemiological and toxicological studies have shown that there are no measurable health risks (Van der Merwe 2000). Besides this, government and experts are considered credible people because whenever the treatment plant does not meet the imposed standards, higher than those for drinking water, the supply is stopped. Information about the quality of the reclaimed water is published every day through newspapers. The second project is an "almost direct" water reuse project and it is much more recent (from 2002). It is known as NEWater and takes place in Singapore. NEWater project consists of an advanced wastewater treatment plant with membranes that produce reclaimed water that is mixed with the water contained in a natural reservoir. Water from this reservoir is used to supply 1% of the population. The inhabitants of this country are very conscious of the lack of water, their international dependency on the resource (50% of the water is imported from Malaysia) and the very high cost of desalinating water (Seah 2002). For these reasons as well as intense communication and public participation campaigns, the project is well accepted (Collins 2003). Schemes for indirectly reusing water for human consumption (where water is treated to a very high level prior to being injected into an aquifer where it remains for several months to be diluted and naturally treated) can be found in several developed countries, such as the United Sates, The Netherlands and Germany. Injecting the reused water into soil and extracting it later mixed with water previously stored in the aquifer makes it more acceptable to society because they have the feeling it comes from a natural source. In both cases, the strategy of the indirect and direct reuse experts has been to emphasize that the reused water is not used water and that is why the terms reclaimed water or new water are employed.

The second barrier, "perceptions of risk associated with using recycled water", is complex because what safe means differs for experts and lay people. Experts express safety in a probabilistic way such that a risk of 1 in 1 million may be safe enough while lay people want to perceive how safe is safe in absolute terms. For them the 1 in 1 million might be risky if the one is a family member. In any case, if risks of consuming water from "natural sources" were measured to evaluate natural reuse effects, artificial water reuse would be more easily accepted if it improves a present situation.

Society's trust and knowledge has evolved with time. When the first water reuse projects begun to operate three decades ago, there was no social rejection because people thought that experts and the government made the right decisions. Nowadays society is less confident for several reasons (Murni et al 2004). One of them is that experts from different disciplines have different opinions on how convenient and safe water reuse is, and even if lay persons do not fully understand the disagreement between experts they perceive that the knowledge is not as strong as it should be to accept the practice. Recognizing natural water reuse should make water reuse a more familiar activity, not only for society but also for experts from different fields. Acknowledging natural water reuse should help overcome the fear of the unknown. The effects of drinking (naturally) reused water would be known and the feeling of being able to control water quality through artificial reuse would be acquired.

Besides the issues mentioned, it would be interesting to know if water reuse perception varies between developed and developing countries, what the different perceptions among experts of different disciplines are and what people would think about artificial reuse if natural reuse were recognized.

4. What we know about natural water reuse

Actually, we know very little about natural water reuse, simply because it is not an accepted concept. Available information is dispersed in literature, which often links it with pollution problems. Nevertheless, some recent works have begun to talk about "non intentional", "non planned" or "incidental" water reuse. These cases, in general, describe situations where used water is mixed with (or becomes) part of the water supply. Most of these cases deal with groundwater, not just because it constitutes an important source of water but also because depollution through the passage of used water on soil makes it difficult to reject it as used water. In surface water bodies pollution and even used water discharges are easily detected. Natural water reuse has been reported for human consumption and agricultural irrigation. Sometime, when acknowledge reuse of polluted water is considered as the use of a non conventional source, see Unconventional Sources of Water Supply.

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Biographical Sketch

Blanca Elena Jimenez Cisneros is a Mexican with a *Bachelor's degree in Environmental Engineering and* Master and a PhD degree in Wastewater treatment from the Institut National de Sciences Appliquées, Toulouse, France. She works since 1985 at The National Autonomous University (UNAM) where she is senior researcher. In 1992 founded the graduate program in Environmental Engineering in Morelos and in 1994 launched the prestigious Group of Wastewater Treatment and Reuse at the UNAM.
Dr Jiménez has published more than 180 international papers and has 4 patents. She has published the book: "The Environmental Pollution in Mexico. Causes, Effects and Technology": She has been the responsible for more than 117 research projects for several public and private institutions. Due to her professional reputation Dr. Jiménez has been invited to lecture more 100 conferences in several countries. She has been awarded several prizes like Sor Juana Inés de la Cruz (as best female researcher in the engineering field) 2003, the Environment and Ecology Award "Miguel Alemán Valdés" (2001), Award for Scientific Research in the area of Technology Research, granted by the Mexican Academy of Sciences, (1997) and the Ciba Award for Technological Innovation in Ecology (1993). She is the chairperson of the Water Reuse Specialty Group in the International Water Association. She was President of the Mexican Association of Environmental Engineers, the Mexican Federation of Sanitary Engineering and Environmental Sciences (the oldest environmental professionals association in the country), she belongs to the Executive Committee of the International Water Association.