Wastewater Reuse (WWR) in Lebanon

What is WWR?

The aim of liquid wastewater treatment is to discharge treated water, with sufficiently satisfactory physico-chemical characteristics, in the environment with minimal negative impact on its watercourses. More specifically, the aim is to preserve the quality of the watercourses.

The reuse of treated wastewater implies a different vision of sanitation; not only can it be applied to meet this environmental objective (as well as that of public health), but also it can be reused for human activities. The most frequent uses of treated wastewater today are agricultural irrigation, watering green spaces, washing roads, recharging groundwater and cooling or processing water in industry.

Treated wastewater is increasingly perceived as an "unconventional" water resource.

This summary sheet focuses on Wastewater reuse (WWR) in agricultural practices in Lebanon. An agricultural WWR system is usually made of the following:

- Complementary treatment,
- Storage tanks,
- Pumping and filtration equipment,
- Irrigation network,
- Irrigation perimeter development.

Why WWR and for what ?

In a global context of climate change, increasing water demand (population growth, industrial development) and scarcity of water resources, prospects of treated wastewater reuse have increased. In 2019, the FAO estimated average annual renewable inland freshwater resources per capita worldwide at 5555 m3, compared with 7046 m3 in 2000. The first countries to be affected by this scarcity of resources are those currently experiencing water stress, such as most of countries in the Mediterranean basin.

Recourse to reuse can be a way of reducing the pressure on water resources, provided that reuse is seen as a substitution and not as an additional resource, and that the impact of failure to return water to the natural environment in the immediate vicinity of the plant is properly measured.

WWR as additional or substitute resources?

Treated wastewater can be considered as an additional resource, enabling, for example, the support of a new agricultural or industrial development project bringing economic benefits. However, on a watershed scale, this does not mean that water resources are better preserved, but rather that they are put to greater use.

A WWR strategy can claim to have an impact on the preservation of available water resources, but only if it is planned as a substitution for a resource that is initially in demand.

WWR, redirecting an existing flow for anthropogenic use

It is also important to be aware that the routing of water used for domestic purposes, and implemented by water and wastewater services, is interwoven into the great water cycle and is already diverting its natural course. The reuse of treated wastewater from a wastewater treatment plant involves routing this water to the site of the agricultural or industrial activity, rather than discharging it into the environment directly nearby (infiltration into the soil, or into a watercourse). Wastewater that is not reused is not "lost" but returned to the environment.

To avoid negative social and environmental impacts, a WWR strategy must also take into account its integration into the wider water cycle and be viewed from an Integrated Water Resources Management perspective.

Depending on the context, the impact may be:

- neutral e.g. wastewater discharge negligible in relation to the discharge of the watercourse that constitutes the receiving environment, reuse on a nearby agricultural site allowing infiltration into the watercourse's accompanying aquifer, etc.
- significant e.g. wastewater discharge constituting the low-water flow of the watercourse in the summer season, its elimination and thus depriving users of the resource downstream, a situation that is a source of social tension).

On the other hand, the positive impact of WWR appears systematic, in cases where it is intended as a replacement for discharge into the sea, enabling freshwater to be reinjected into the water cycle.

The "small water cycle", or "technical water cycle".
Water circulation resulting from human intervention for domestic uses, implemented by water utilities (abstraction, potabilization, distribution) and wastewater services (collection, treatment, discharge).

The "great water cycle"
The path taken by water as it passes through different states (solid, liquid, vapor) and ends up in different environmental media. The concerned scale is the "watershed", a territory that receives the water that flows naturally towards a single watercourse or groundwater table.
Various users (human and non-human) and pressures are exerted on the water resource at different levels of the watershed, notably by water and wastewater services and by agricultural activities.

Agricultural WWR, an opportunity to optimize yields?

The nutrients required for plant growth are naturally present in the soil, but additional inputs may be required to achieve the desired yields. Irrigation with treated wastewater, containing nitrogen, phosphorus and potassium, represents a fertilizing opportunity that can replace or at least complement synthetic fertilizers.

This implies appropriate fertilization management, taking into account the nutrients contained in the wastewater and in the soil and the specific needs of the crops, in order to maximize yields and limit excessive inputs that may prove toxic to the plant.

Agricultural WWR: how to manage health risks?

Viruses, parasites and bacteria contained in wastewater can contaminate irrigated crops. The main viral diseases associated with fecal contamination of fruit and vegetables are gastroenteritis and hepatitis A. Parasites are particularly resistant, in the form of eggs for helminths and cysts for protozoa. Some pathogenic bacteria are responsible for typhoid fever (Salmonella), gastrointestinal and urinary tract infections (Escherichia coli) or cholera (Vibrio cholerea).

Different approaches to managing the health risks associated with agricultural WWR

The guidelines proposed by the FAO and WHO traditionally define threshold values for various indicators of water contamination (concentration of certain microorganisms). Different threshold values are defined according to the type of crop to be irrigated. These recommendations are intended to be adapted to local contexts, to inspire national regulations and standards.

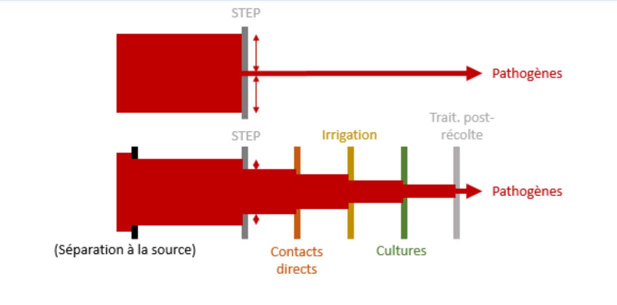
The aim is to protect both consumers and farmers who come into contact with irrigation water.

The 2006 WHO Guidelines offer a new vision for the safe use of wastewater, excreta and water, based on a multi-barrier approach.

It defines levels of pollution reduction that can be achieved through different "barriers" to prevent the risk of contamination. The wastewater treatment system is considered to be one of these "barriers", the others being the type of irrigation (sprinkler, drip, irrigation frequency), the type of crop (fruit trees, vegetables, cereals, etc.) and preparation method (raw, peeled, cooked).

This vision seeks to match the realities on the ground. In many contexts, high levels of treatment are not always technically or financially coherent, while wastewater that has not undergone high levels of treatment is already commonly reused.

However, this approach is currently difficult to apply and translate into regulations and standards. Research is underway to make it more operational.



Multi barrier approach, INRAE

Wastewater treatment systems can eliminate some of these pathogens through mainly tertiary disinfection (chlorination, ozonation, fine filtration, activated carbon, etc.). These types of treatments may nevertheless prove not to be the technically or economically relevant option in certain contexts.

In fact, the risk of contamination from waterbone pathogens can also be controlled through simple measure such as: choosing the type of crop consumed (raw or cooked), controlling irrigation before harvesting (e.g. stopping irrigation before harvesting) ensuring pathogens are eliminated before consumption (by allowing a time interval between the last irrigation and consumption), and food preparation measures (e.g. washing, cooking and peeling).

The Lebanese context

A delicate water context and substantial irrigation water requirements

Although Lebanon is one of the least water-stressed countries in the Middle East, water availability for its inhabitants is currently around 1,000 m3/capita/year, which is below the threshold for water stress as defined by the WHO (1,700 m3/capita/year). The country's hydrological balance (difference between needs and renewable resources) could reach a deficit of 1.7 billion m3 per year by 2040, compared with around 300 million m3 today. In 2022, average annual renewable freshwater resources per capita are estimated at 657 m3 (FAO), compared with 1077 m3 in 2000.

In 2019, the FAO estimated that annual freshwater withdrawals for agriculture will amount to 38% of total freshwater withdrawals in Lebanon, compared with 13% for domestic uses. In this context, where agriculture represents the main anthropogenic pressure on water resources, reuse in the agricultural sector could be an alternative for restoring the balance between resources and needs. Indeed, the "Roadmap to recovery of the water sector in lebanon" published by the Ministry of Energy and Water (MoEW) in May 2022, highlights the reuse of treated wastewater as one of the main non-conventional resources to be developed, particularly for agricultural irrigation.

WWR in Lebanon

In 2015, an EU project (ACCBAT) in partnership with the Italian University Cooperation, the Lebanese Ministry of Agriculture, LARI (Lebanese Agricultural Research Institute) and the municipality of Ablah designed and implemented a reuse system fed by treated effluent from the Ablah wastewater treatment plant. After a tertiary disinfection treatment, the treated water is stored in an artificial hillside lake (1500 CM), then pumped to irrigate 20 ha of vines, replacing the need for individual wells and benefiting 37 winegrowers.

Operational from 2015 to 2017, the system then ceased to function due to a complaint filed by a resident whose house had allegedly been affected by the nearby collection reservoir. The aim of the study is to propose a rehabilitation plan for the existing abandoned wastewater utilization system.
This is the only wastewater treatment plant currently equipped with a reuse system.

Nevertheless, informal reuse of wastewater is already practiced throughout the country. Many wastewater treatment plants are located in water-stressed agricultural areas, and farmers living close to these plants are already exploiting the effluent (particularly in the Bekaa).

This wastewater is often only partially treated, and its quality is often poorly monitored and controlled, a situation that creates health risks. The risk is all the greater in the context of the cholera epidemic suffered by Lebanon between November 2022 and February 2023. In addition to the health consequences of this pollution, the contamination of plant products (fruit and vegetables) makes them unfit for export as they no longer meet international standards.

Obstacles to the development of WWR in Lebanon

Limited development of wastewater treatment, which restricts WWR possibilities

Before even considering the reuse of treated wastewater, it is important to point out that the production of treated wastewater is still limited in Lebanon, due to a lack of infrastructure and, above all, to the malfunctioning of existing plants.

Only 60% of users are connected to a sewerage network, and less than 10% of wastewater is currently treated. Numerous wastewater treatment plant projects are struggling to materialize, while not all existing infrastructures are operational. Lebanon remains below the regional average in terms of volume of treated wastewater, estimated at 46% for countries in the Middle East and North Africa.

Every year, Lebanon produces 250 million m3 of domestic wastewater and 60 million m3 of industrial wastewater. In addition, it is estimated that 1.5 million Lebanese who do not benefit from a sanitation service discharge their wastewater untreated into the environment, including 700,000m3 directly into a watercourse.

These difficulties are exacerbated by the energy crisis (availability and cost of fuel for operating facilities) and the financial crisis. In a situation of widespread financial crisis, wastewater treatment plants are suffering from a low collection rate from users, which means that they are unable to cover the costs of operating and maintaining their infrastructures (supply of materials and reagents needed for treatment processes) and paying their staff. This situation implies a lack of qualified WE personnel, and the need to prioritize operational tasks, leaving aside the development of strategic dimensions such as WWR.

Regulations and standards yet to be developed

Furthermore, there are no national regulations or standards for controlling the quality of wastewater leaving treatment plants, either for discharge into the environment or for reuse. Plant managers (companies, Water Establishments, municipalities, CDR) refer to different standards; and their technical and financial capacities do not allow them to ensure this control on a continuous basis.

An attempt to unify standards is underway under the auspices of LIBNOR (the Lebanese standardization institution) and IWMI through the ReWater MENA project, then CWANA, in order to implement systematic and reliable quality control of treated wastewater, without any concrete application for the moment.

Currently, FAO recommendations tend to be taken into consideration, although there is no regulatory obligation to refer to them.

An experiment on leafy vegetables, which are eaten raw, showed that irrigation was possible with only secondary treatment (without disinfection), by applying the "multiple barriers" recommended by the WHO, in particular by stopping irrigation two days before harvesting.

As with any infrastructure project, the implementation of a reuse system requires a management and economic model to ensure its long-term operation.

Responsibilities to be defined

Different players may be involved in the management of WASH systems. Regarding the tertiary treatment system that may be required, the authority in charge of the sanitation service is responsible for it. Lebanese regulations entrust this responsibility to the Water Establishment. Although WWTPs are not highly developed only some of them are already equipped with tertiary treatment.

Despite the difficulties encountered by the Water Establishments in managing domestic water and wastewater services, the Lebanese water code stipulates that they are also responsible for irrigation systems.

The water code recognizes the existence of associations of irrigators. Associations of irrigators already exist, in particular for the management of irrigation from mountain springs in the Bekaa. Farmers pay the association's irrigation committee, which is responsible for canal maintenance. Their official status is defined by a sophisticated mode of organization and operation, with formalized governance adapted to the management of modern irrigation systems. Existing associations of irrigators, which have a simpler, more empirical mode of operation, may find it difficult to recognize and comply with these rules.

Business models to be co-constructed locally

The investment required for such an infrastructure project, even more when presented with a view to preserving water resources, is likely to benefit from funding from various donors, however operation and maintenance is costly, which requires the construction of an economic model.

In the context of the current crisis, the willingness and ability of users to pay for a public service appears to be an issue. As the collection rate for water and wastewater services is declining, the financial situation of the WEs is worsened, further hampering their ability to manage the services, and thus the confidence of users in the service.

If free water is to be made available to farmers, another resource must be found to provide the service manager with the revenue needed to ensure its smooth operation.

Some projects and experiments underway in Lebanon

The ReWater MENA project: towards better regulated and more widespread WWR

In 2018, the International Water Management Institute (IWMI) set up a 4-year project helping to expand the safe reuse of treated wastewater in the Middle East and North Africa (MENA), funded by the Swedish International Cooperation Agency (SIDA). The project addresses the potential and obstacles to reuse in the region and analyzes reuse practices for agricultural irrigation that minimize health risks.

Theoretical assessment of the potential for WWR in Lebanon

In this context, the "WRR potential" in Lebanon was estimated by correlating the capacities of each existing and planned wastewater treatment plant on Lebanese territory, with estimates of irrigable agricultural land in the vicinity. The study revealed that 48 plants would have an interesting reuse potential (at the time the study was carried out, in 2020). Projecting a situation where existing treatment plants are fully functional and operating at full capacity, this reuse potential would justify equipping up to 82 plants.

Work in progress to develop national standards

As outlined in Lebanon's National Water Sector Strategy updated in 2020, the formulation of official water reuse standards will be essential to harness the long-term potential of water reuse. In 2019, the project has therefore brought together various Lebanese ministries (Energy and Water, Agriculture, Environment), LARI and LIBNOR, to begin work on defining treated water reuse standards based on the recommendations issued by the FAO in 2010.

Following the completion of the ReWater MENA project in September 2022, a new project entitled From Fragility to Resilience in Central and West Asia and North Africa (F2R-CWANA) is now underway. Led by the Consultative Group for International Agriculture Research (CGIAR), it aims to promote adaptation and mitigation to climate change, and builds on the results of the ReWater MENA project in Lebanon.

Local experiment

Following the study of the potential for WWR, Zahlé and Ablah wastewater treatment plants were targeted for pre-feasibility studies with a view to setting up (or re-commissioning in the case of Ablah) a WWR system.

In addition to the technical aspects, these studies showed the great importance of the social dimension of a WWR project. The needs and dynamics of the various groups potentially using the future system were carefully analyzed, and participatory workshops were held to collectively examine different scenarios directly with the beneficiaries.

Although the projects met with the approval of the potential beneficiaries, they were not implemented. The difficulties, accentuated in the context of the financial crisis, of envisaging a management and financing model that would enable these projects to be managed and, ultimately, the irrigation infrastructures to be managed, represents a brake on their implementation.

Bibliography

Nouvelle Stratégie Sectorielle pour le Secteur de l'Eau, MoWE, janvier 2023

Stratégie Nationale pour l'assainissement (résolution N°35 du 17 décembre 2021), MoEW

Ressources renouvelables d'eau douce intérieures par habitant (mètres cubes) | Data (banquemondiale.org)

Analysis of Water Reuse Potential for Irrigation in Lebanon, 2022 Karim Eid-Sabbagh, Salim Roukoz, Marie-Hélène Nassif, Naga Velpuri and Javier Mateo-Sagasta,

Water reuse in the Middle East and North Africa A sourcebook. Javier Mateo-Sagasta (IWMI) Mohamed Al-Hamdi (FAO) Khaled AbuZeid (AWC)

Rehabilitation and Extension project for Ablah Water Reuse System, Bekaa Lebanon. Marie-Helene Nassif, Antoine Slim, Linda Khalil, Javier Mateo-Sagasta, November 2022

Co-design of a water reuse project around Zahleh WWTP, Lebanon: Methodological learnings and implementation challenges. Marie-Helene Nassif, Antoine Slim, Linda Khalil, Javier Mateo-Sagasta November 2022

Assessment of treated wastewater for agriculture in Lebanon, FAO, 2016

Setting the ground to Water Reuse Policies and Projects in Lebanon - ReWater MENA (iwmi.org)

Overview - ReWater MENA (iwmi.org)

Arthur Deboos, Réutilisation des eaux usées traitées en Méditerranée et impacts sur les territoires, Mars 2018

FME, « Processus méditerranéen / Priorité GDE », rapport objectif-cible n°2, février 2012, p. 1

Le secteur de l'eau au Liban, Direction Générale du Trésor, Novembre 2022

Treated municipal wastewater reuse for eggplant irrigation. Australian Journal of Crop Science AJCS M. T. Abi Saab, C. Daou, I. Bashour, A. Maacaron, S. Fahed, D. Romanos, Y. Khairallah, N. Lebbous, C. Hajjar, R. Abi Saad, C. Ojeil, M. H. Sellami, S. Roukoz, M. Salman (2021)

Table grapes irrigation with treated municipal wastewater in a Mediterranean environment. Water and Environment 35 M. T. Abi Saab, H. Makhlouf, J. Zaghrini, S. Fahed, D. Romanos, Y. Khairallah, C. Hajjar, R. Abi Saad, M. H. Sellami, M. Todorovic (2020).

Assessing the performance of constructed wetland for water quality management of a Southern Mediterranean river. Water and Environment Journal M. T. Abi Saab, D. Jammoul, H. Makhlouf, S. Fahed, N. Lebbous, C. Hajjar, R. Abi Saad, M. Younes, M. Hajj, M. Todorovic (2018).