Analytical review of the framework of the reuse of treated wastewater for agriculture under Algeria's 2030 water resources strategy.

ABSTRACT

Wastewater is produced by human activity and has a direct impact on the natural environment in which it is discharged, whether treated or not. Responsible management of increasing volumes of wastewater represents a real health and environmental challenge for all involved actors (local authorities, operators, etc.), worldwide. Effective treatment solutions exist, including the possible reuse of treated wastewater.

Water is a prerequisite for economic growth and prosperity. as well as the basis of ecosystems, vital for human health and well-being, for this, it has been strongly presented at the heart of the 2030 Agenda for Sustainable Development. through UN-Water integrated monitoring for achieving the Sustainable Development Goals (SDGs) 6. where cited that the availability and sustainable management of water and sanitation are closely linked to all other sustainable development goals.

In the light of this global view, the aim of this paper is to give an analytical review the status of wastewater treatment in Algeria as a main unconventional water resources for irrigating agricultural crops, as well as to reviewing the prospects for investment in the reuse of treated wastewater in irrigation under the Algeria's water resources strategy by 2030.

INTRODUCTION

The focus of UN-Water's World Water Day in 2017 was on the theme of wastewater as an untapped resource. furthermore, the required change is built into target 6.3 of the Sustainable Development Goals (SDGs), which commits governments to halve the proportion of untreated wastewater and increase substantially safe recycling and reuse by 2030.[1]

As mentioned in the Global Program for the assessment of water resources, in 2017, wastewater is still an untapped water resource. whereas wastewater is not only a source of pollution, but it can also often transform into a resource.

In the face of increasing water scarcity, mainly due to population growth, economic growth and changing consumption patterns exacerbated by climate change and land degradation, while climate change makes many freshwater sources less reliable, sewage is geographically close,

contains valuable energy and nutrients, and may be unique in that it increases with additional use.[2]

Faced with the difficult situations of water stress experienced during the 1990s and early 2000s, Algeria has made significant investments in the construction of hydraulic infrastructures to meet a growing demand for water. growth, in relation to development, of demography as well as of urbanization and of agricultural and industrial activities. In order to free itself from an exceed on the level of water stress in the near future. The ministry of water is looking for a pilot project, where all problems related to water management are integrated into one single plan of action.[3]

Economic evidence shows that for any national strategy in term of water exploitation to be successful it is necessary to develop a parallel system of investment planning and budgeting to ensure its success and attempt to targets.

according to the socio-economic priorities of the country, an approach based on the consultation, the communication and the participation of all the sectors and all the various institutional, private and associative actors. Algeria has also engaged since the beginning of 2000 in a policy of environmental protection and sustainable development by adopting an economic view of wastewater purification for irrigation.[4]

Implementing effective water recycling, safe reuse or disposal involves costs referred to as cost of action; their assessment includes costs of investing, as well as operating and maintenance of the required facilities.

The three types of actions needed for wastewater management are wastewater collection, wastewater treatment, recovery of resources from wastewater (such as water, nutrient, organic matter, biogas and energy) and safe reuse, as described below.

In the context of wastewater management, cost functions are a suitable tool to help analyze costs.[5]

Non-conventional water mobilization

Algeria has invested in the mobilization of unconventional water resources (desalination of seawater, demineralization of brackish water and reuse of treated wastewater).

At the end of 2016, we counted:[6]

• 10 seawater desalination plants, with a total capacity of 587.65 hm3 / year

• 21 monoblock desalination plants with a total capacity of 2.9 hm3 / year

• 14 brackish water demineralization stations with a total capacity of

33.73 hm3 / year

• 177 sewage treatment plants with a capacity of 38.77 hm3 / year for irrigation

POTENTIAL OF PURIFICATION STATIONS

Currently, the wastewaters in Algeria are treated by 171 wastewater treatment plants (WWTPs), However, the number of treatment plants in operation as of the end of February 2018, is 146 stations.[7] with a treatment capacity of 900 hm3/year. While 94% of the population is equipped with sanitation (including in the form of autonomous sanitation: lost wells, septic tanks, etc.), only 40% are connected to treatment plants.

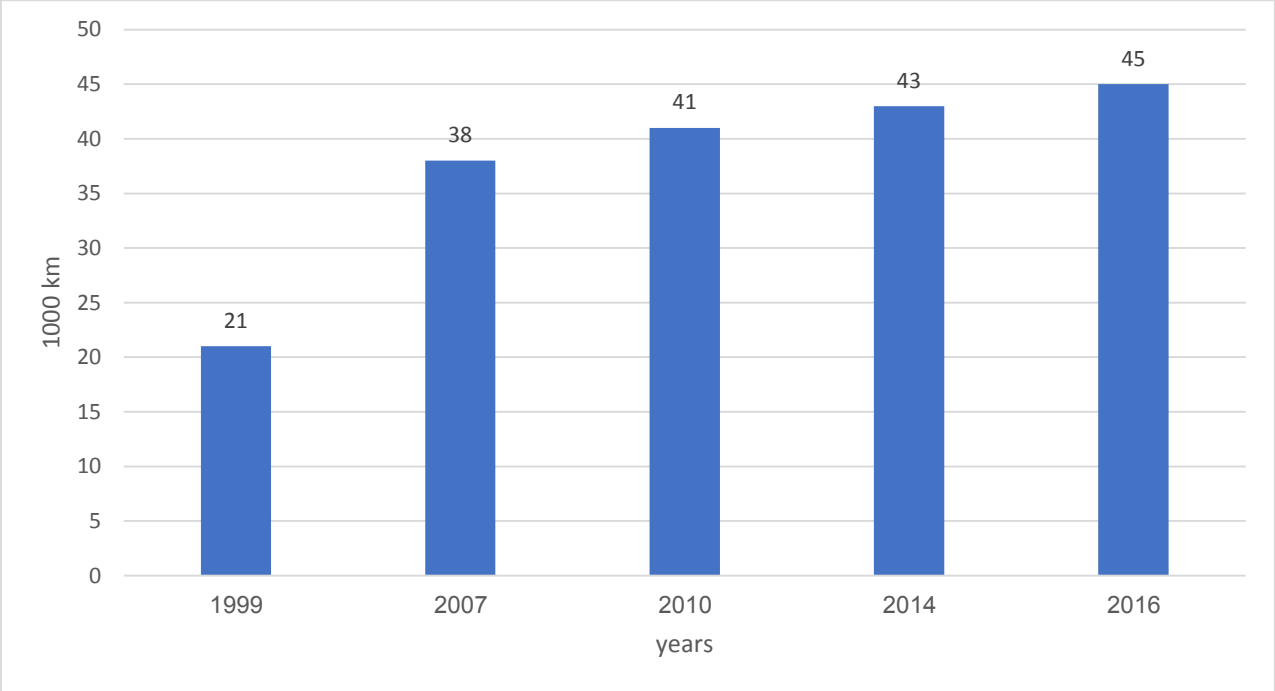
The declared objective of the authorities is to count 240 wastewater treatment plants (WWTP) in corresponding to a capacity of 1.2 billion m3 per year of treated water. The increasing use of this non-conventional water resource is an additional incentive to improve the treatment capacity of wastewater and increase the connection rate specific to the sewerage system. The priorities for the authorities concern the precise definition of the uses of this resource, the capacity of WWTPs and the purified water transport network to meet hydraulic needs and the acceptance by users to reuse treated wastewater.

The goal is to bring these rates up to 100% nationally by 2030 to ensure the protection of water resources, the reduction of water-borne diseases and the avoidance of pollution of coastal marine waters.[8]

Furthermore, in Algeria the estimated quantity of sludge produced in 2017 will exceed 2.0 million tons per year. Since there production, the treatment and disposal of sewage sludge is become an economically and environmentally sensitive problem.[9]

Water infrastructure also includes sewerage and wastewater treatment plants. With regard to the wastewater infrastructure in Algeria, the collection network in 1999 is 21,000 km, and 45000 km in 2016 (with an extension estimated of 70,000 km in 2020), with a connection rate of 87%. [10]

Table 1 Evolution of the sanitation network



Source: MRE

Table 2

PURIFICATION infrastructures	2015	Forecast 2020
Linear network (km)	43.000	70.000
Connection rate	87%	94 %
Discarded volumes (Hm3 / year)	1.200	1.500
Number of WWTPs in operation	171	200
Theoretical purification capacity (hm3 / year)	900	1.300
Purification capacity in Millions Equivalent Habitant	12,4	18
% Capacity purification / discharges	75%	86%

Source: MRE

* Hydraulic statistics do not differentiate between rural and urban areas.

EXPLOITATON OF PURIFICATION STATIONS

The number of treatment plants in operation by the ONA, at the end of February 2018, is 146 stations, including:

• 71 activated sludge stations;

• 72 lagoon stations;

• 03 filters planted.

The total installed capacity of these 146 stations is 9,914,714 population equivalents, representing a nominal flow of 1,521,548 m3/d.

During the month of February, a volume of wastewater of more than 19 million cubic meters, were treated, an average daily flow of 692 923 m3 / d.

The average installed capacity utilization rate of the 146 WWTPs is 46%, with:

Rate < 25%, for 32 stations.

25 ≤ Rate <50, for 41 stations.

50 ≤ Rate <100, for 55 stations.

Rate ≥ 100, for 13 stations.

The remaining five stations are at a standstill.

REUSE OF PURE WASTEWATER

During the month of February 2018, a volume of 1.5 million cubic meters of water purified by 17 WWTPs was used to irrigate 11,062 hectares of agricultural land, a reuse, equivalent a rate of 40% of volume purified by the 17 STEPs concerned and a 9% of the total volume purified by all 146 WWTPs in operation by the ONA.

CONSUMPTION OF ELECTRICAL ENERGY

During the month of February 2018, 8,880,952 KWh of electrical energy were consumed, including:

5,985,319 KWh of active energy consumed by WWTPs, a ratio of 309 Wh / m 3.

2,895,634 KWh of active energy consumed by CTs, a ratio of 110 Wh / m3.

OPERATING COSTS OF SANITATION SYSTEMS

The direct operating costs of sanitation systems managed by ONA are estimated at about 594 million DA, broken down as follows:

Table 3 ***OPERATING COSTS OF SANITATION SYSTEMS***

Activity	Amount (DA)	Ratio (DA / m3)	% total
Collection	356634175	3,84	60
lifting	91097166	3,78	15
purification	**146056802**	**8,75**	**25**
Total cost	593788143	16,37	

Figure 1 ***OPERATING COSTS OF SANITATION SYSTEMS***

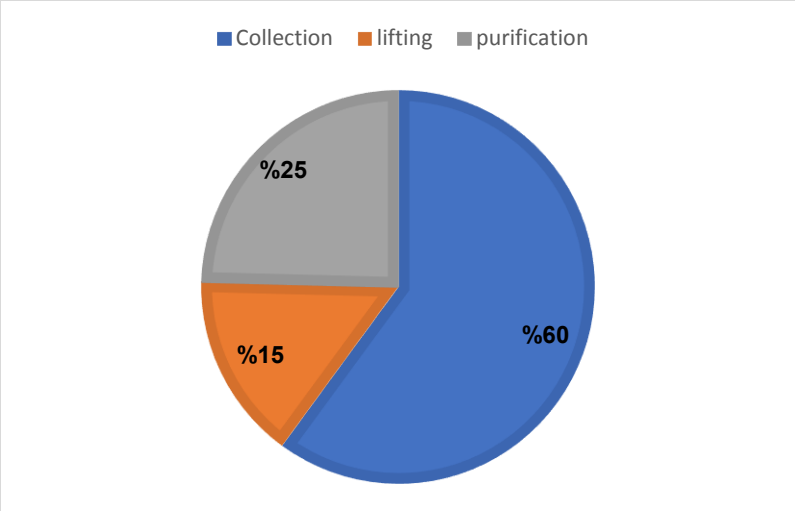
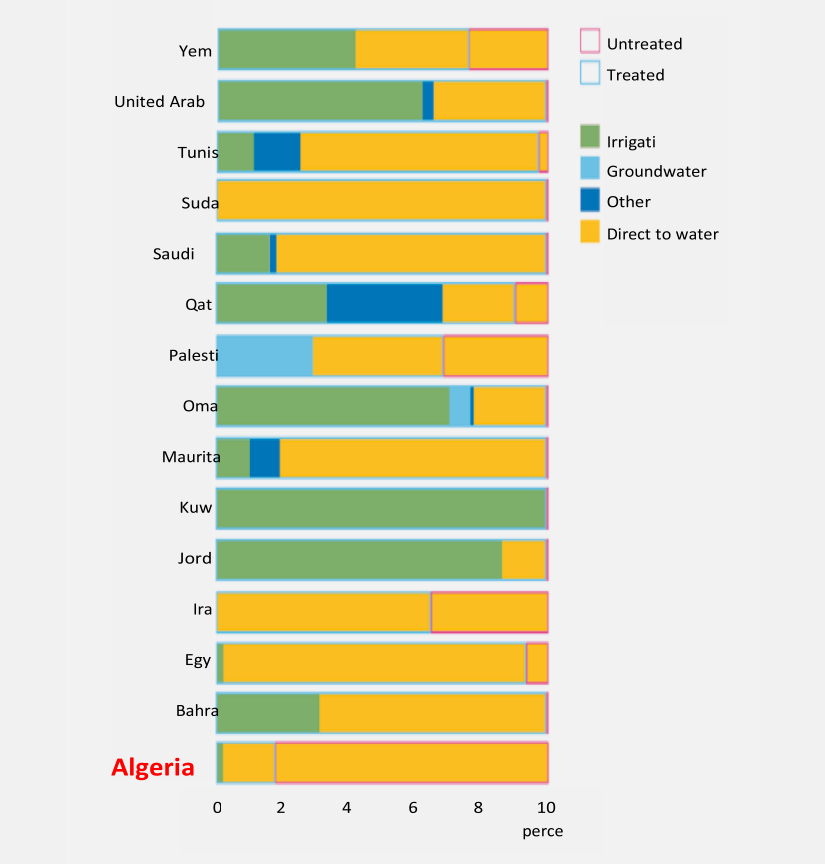


*Figure 2: **Monitoring of wastewater reuse in Arab States***



Source: Arab Countries Water Utilities Association (ACWUA), 2016

QUALITY OF WASTEWATER TREATED.

LEGAL FRAMEWORK OF WASTE WATER PURIFICATION IN ALGERIA.

Law n ° 05-12 of 04 August 2005 relative to water.[11]

• Executive Decree No. 07-149 of 20 May 2007 fixing the wastewater using concession arrangements to clean for irrigation and the specification deviation thereto.[12]

• Executive Decree No. 09-209 of 11 June 2009 laying down the procedure for granting the discharge permit wastewater other than domestic in a public sewerage system or a sewage treatment plant.[13]

• Executive Decree No. 10-23 of 12 January 2010, fixing the technical characteristics of wastewater treatment systems.[14]

• Order of March 30 , 2011 , fixing the list of harmful chemicals for the treatment and correction of water for human consumption.

- Order of March 30 , 2011 , fixing the list of workstations concerned by the medical follow-up of the persons exercising at the level of works and installations of exploitation of a public service of the water.

HYDRO-AGRICULTURAL DEVELOPMENT PROGRAM 2015 -2019

Investment efforts in hydro-agricultural development will be pursued under the next five-year plan 2015-2019. The target for the 2015 - 2019 program is to move from an irrigated area of **1,136,000 ha (2013)** to an irrigated area of **2,136,000 ha (2019)** , an increase of "01 million ha" which represents more than 25% of the UAA. To do this, the water resources sector proposes to carry out the following program:

- Development and rehabilitation of large irrigation schemes, in the four hydrographic regions of the north of the country, over an area of
- 232,000 ha. The areas equipped could reach more than **462,000 ha (currently 230,000 ha)**
- Realization of **219 hill reservoirs**, to mobilize
- **60 Million m3 and irrigation of 15,000 ha** through 25 wilayas
- The development of small and medium scale irrigation (PMH) by the construction of hillside dams or boreholes, including for Saharan agriculture, would increase agricultural yields in the medium term and boost the local agricultural economy by 1,674. 000 ha.

The programming of these projects of perimeters was stopped on the principle falling within the main orientations of the CWP:

- The availability of the resource (downstream development of dams in operation).
- The maturation of projects (availability of studies ODA perimeters).

- The reallocation of the resources of the dams or the desalination plants are put into service.

By prioritizing:

- Works of redevelopment and rehabilitation of the perimeters in operation.
- The completion of the perimeters launched in the first tranche and put into operation during the five-year period 2010-2014.
- The development of upstream systems Hauts Plateaux (Beni Haroun - High Plains Sétifiennes) by respecting the phasing of commissioning mobilization works.

4. EXPECTED IMPACTS OF REALIZATION OF IRRIGATION PROGRAMS

On a physical level, the evolution of areas equipped with large irrigation perimeters is as follows:

Années	1962	1999	2004	2009	2015	2019
Superficie équipée (ha)	105.500	156.250	195.400	219.052	230.000	462.000

In terms of irrigated agricultural production in large irrigation schemes in the country's high plains and small and medium irrigation schemes in hill and mountain areas, agricultural production will experience high and sustainable growth rates. This will significantly reduce the import bill and ensure reasonable food security.

On the socioeconomic level, the development of irrigated agriculture will make it possible to sustain jobs in the rural areas (an irrigated hectare generates on average 3 jobs) and to improve incomes (an irrigated hectare generates on average an added value more than 120,000 DA) and consequently to contribute to stabilize the rural world and to rebalance Algerian society.

The reuse of treated wastewater “REUE ” is a voluntary and planned action that aims to produce additional quantities of water for different uses.

Today the national strategy for sustainable development in Algeria is particularly materialized through a strategic plan that brings together three dimensions namely: Social, Economic and Environmental.[15]

uses of the treated wastewater

The main uses of the treated wastewater are:

• **Agricultural uses: -** Irrigation - the most answered, allowing to exploit the fertilizing material contained in these waters thus achieving a saving of fertilizer;

• **Municipal uses**: watering green spaces, washing the streets, feeding water bodies, fighting fires, watering golf courses, public works sites, watering for compaction of the basic layers of roads and highways.

• **Industrial uses** : cooling;

• **Improvement of resources** : recharge of aquifers for the fight against the drawdown of aquifers and the protection against the intrusion of salted bezels at the seaside.

Current potential

Of the 130 wastewater treatment plants operated by ONA through the 44 wilayas, 17 are concerned with the reuse of treated wastewater in **agriculture**.

The volume reused in late August 2016 is estimated at 14.6 million m^3 for those 17 STEPS concerned with received; to irrigate more than 11 076 ha of agricultural land, it is:

· Kouinine (El Oued) and Ouargla,

· Guelma, Souk Ahras

· Tlemcen, mascara and lagoons of: Ghriss, Bouhanifia, Hacine, Wadi Taria, Froha, Khalouia, Tizi and Mohamadia,

· Boumerdes.

Regulatory framework in Algeria

- **The law n ° 05-12 of August 4, 2005** , on the water, established the right to use treated wastewater for irrigation purposes (OJ No 60, 2005)
- **The decree n ° 07-149 of 20 May 2007** establishes the concession arrangements for the use of treated wastewater for irrigation purposes and the specifications deviation thereto.
- **The interministerial decrees of January 02, 2012** that implement the provisions of **Article 2 of Executive Decree No. 07-149** , published in January 2012 by the Ministry of Water Resources. (OJ No 41) These decrees fix:
- The specifications of treated wastewater used for irrigation purposes, in particular with regard to microbiological parameters and physicochemical parameters
- The list of crops that can be irrigated with treated wastewater.
- **Algerian Standard N ° 17683** "Reuse of treated wastewater for agricultural, municipal and industrial purposes - Physico-chemical and biological specifications" is available at the Algerian Institute of Standardization IANOR;[16]

Conclusion

The use of treated wastewater for irrigation is only in its infancy. With a wastewater production estimated at 1.2 billion m3 / year and a treatment capacity of 0.8 billion m3, Algeria currently reuses only 0.1 billion m3 / year. This is due to three factors. The first is in the stringent conditions imposed by the regulations on the use of treated wastewater, conditions which are not yet fulfilled by many treatment plants. The second factor is the lack of irrigable land downstream of the treatment plants. The third is the prohibitive cost of bringing irrigable land upstream of the treatment plants.

Algeria has, in the last few years, made large investments in water treatment plants. In total 146 installations have been built and 17 are under construction. 90% of the households are connected to the sewage system. The problem is that still no more than 40% of the sewage water is treated. Most existing plants are classical active sludge facilities.

The investment in irrigation is considered much more profitable than if the water resource is available at any time, in the case of the use of an unconventional water, especially purified, it may be possible taking into account the capacity of existing treatment plants remains for farmers to submit to this new reality of the regulated use of unconventional waters, as this can provide them with a regularity of availability, able to manage sewage treatment plants through the concession and, in particular, periodically carry out the necessary monitoring and analyzes.

the resolution of the water issue, for the benefit of the population and the service of agriculture, requires:

- the continuation and reinforcement of construction work on dams, hill dams and sewage treatment plants as well as seawater desalination plants.
- the launch of studies for three other major operations aimed at transferring water from the southern Albian aquifer to about ten states (wilayas) in the Highlands.
- The development of more efficient irrigation technologies will significantly reduce the dependence of rainfall on agriculture and livestock production in an increasingly arid country.

The Mobilization of non-conventional water resources (desalination and wastewater reuse) in Algeria is a strategic component of water policy. The development of unconventional resources and the management of water demand will increase more the energy consumption of the water sector. This consumption would reach nearly 12% of the country's consumption and must be integrated in the country's energy forecasts.

BIBLIOGRAPHY

[1] United Nations,2015, "Transforming our World: The 2030 Agenda for Sustainable Development" URL (last checked February 2018):

https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf

[2] Kjellén, M. (2018). Wastewater governance and the local, regional and global environments. *Water Alternatives, 11*(2), 219-237.

[3]

[4] Odd dz

[5] Hernández-Sancho, Francesc, Birguy Lamizana-Diallo, Javier Mateo-Sagasta, and Manzoor Qadir. *Economic valuation of wastewater: the cost of action and the cost of no action*. United Nations Environment Programme (UNEP), 2015.

[6] Mre 2017

[7] www.Ona.dz 2018

[8] www.Ona.dz 2018

[9] Djafari D, Semcha A, Zentar R, Mekerta B, Touzi A, Hannache H, Elharti M, Zarrouk A. Characterization and valorization of sludge of wastewater treatment plant (WWTPs) into cement industry. Journal of Materials and Environmental Sciences. 2017;8(4):1350-8.

[10]

[11] http://mree.gov.dz/wp-content/uploads/2016/10/F2005060.pdf

[12] http://mree.numidiait.com/wp-content/uploads/2016/10/test.pdf

[13] http://mree.numidiait.com/wp-content/uploads/2016/10/F2009036.pdf

[14] http://mree.numidiait.com/wp-content/uploads/2016/10/F2010004.pdf

[15] Odd algeria

[16] http://www.ianor.dz/Site_IANOR/index.php