Public services for distribution of drinking water and liquid sanitation in urban zones in Morocco Relevance of introduction the performance indicators for preservation water resources.

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Summary. Because of the absence of regulations and specific national norms, the unilaterally applied indicators for performance evaluation of water distribution management services are insufficient. This does not pave the way for a clear visibility of water resources. The indicators are also so heterogeneous that they are not in equilibrium with the applied management patterns. In fact:

1- The performance (yield and Linear loss index) of drinking water networks presents a discrepancy between operators and lack of homogeneity in terms of parameters put in its equation. Hence , It these indicators lose efficiency and reliability;
2- Liquid sanitation service has to go beyond the quantitative evaluation target in order to consider the qualitative aspects of water.

To reach this aim, a reasonable enlargement of performance indicators is of paramount importance in order to better manage water resource which is becoming scarce and insufficient.

Keywords: Service - Distribution –Drinkable Water – Sanitation – Indicators – Performance – Water Resources

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I- INTRODUCTION

Drinking water and liquid sanitation public services constitute a communal prerogative (Loi organique 113-14, 2014)). Communes have the freedom to create and manage or delegate their management to public or private operators. In addition to their responsibility in relation to other townships, the operators are obliged to respect three fundamental principles while exercising their management. These principles are inscribed in the constitution of the Moroccan Kingdom namely, equal citizen access to services, continuous service supply and fair territory (Constitution du Royaume du Maroc, 2011).

These principles can only be truly guaranteed through two main axis for durable water resource management e.g., resource saving and its protection against pollution. Indicators are set up to evaluate the performance of these two management aspects which are still regarded as insufficient to figure out the reality.

This article comes within the scope of a national research entitled ‹‹ Public service management of water and liquid sanitation: performance measures between communal operators and private operators››

This work is supervised by Professor Abdelhamid Bouzidi, within the environmental science and development laboratory at the scientific and technical university of Settat, Morocco. This work is also supervised by Mr. Said Housni, head of the technical department at the Directorate of communal operators and Concession Services of the Ministry of the Interior, Morocco.

The objective is to analyze the suitability of performance indicators for the management of water resource, which is intended for urban distribution. This can be realized through a national assessment and review of some applied models worldwide. An indicator panel of water resource management will be suggested at the end of this report.

II- STATEMENT OF FACTS

The indicator assessment, ‹‹Performance of drinkable water distribution system›› which is applied in drinkable water distribution service without a legal basis, demonstrates an average value of 74.5% consolidated by the communal operators and private operators. (Ministère de l'Intérieur, 2016)). A deposit of 58 Mm^3[(1)]of drinking water is lost every year with regard to an optimal feasible distribution performance of 82%. The amendments made to this indicator between 2005 and 2015 are 4.3 points for private operators and 5.9 points for commune operators. Nevertheless, these values remain biased due to the absence of standardization of calculation methodology and performance indicators. In this respect, we notice that in the 2015 database, a 1 point improvement performance would help to gain 8 million m^3 of drinking water every year.

II.1. Multiplicity and interference of contributors: factors against good water resource mastery.

The institutional and functional schema of water in Morocco is characterized by a vast number of participants. The attributions are redundant and stand as an obstacle against a positive management of public water service. In fact, as outlined by the economic, social and environmental council (CESE, 2014): ‹‹ In a macroscopic view of the participants' role in the water sector in general, the multiplicity of the contributors, and the global scheme of interoperability become extremely complex, risk generator and inefficient». These interferences are manifested in two main levels:

1- Perimeter of urban planning [(2)] does not always coincide with perimeter of management. This leads incoherence in the establishment of directing schemes and causes, for the communes, a lack

[(1)]The total volume manipulated by the communal operators and private operators in 2015 is 774 Mm3 while that actually recorded and consumed by the users is of the order of 577 Mm3

[(2)] The Perimeter of urban planning is fixed by statutory way fixing the spatial extent and the rules of its urbanization. This perimeter covers inevitably the territory of the territorial community.

of visibility on the resource;

2- In the case of private operators' management, small townships are likely to be demographically and economically stifled by other big ones due to the absence of a strong institutional authority. The managers invest their money in projects which are highly profitable and where there is strong social pressure. Any interference is constraining especially when two operators intervene in the same perimeter.

II.2. Terminology ambiguity and performance indicator construction.

II.2.1. Drinkable water service

The glossary used and calculation parameters differ from one operator to another. This lack of conformity is manifested at the level of variable indicators calculation. Concerning independent public companies in particular (communal operators), the product specifications do not demonstrate any indicators that can measure performance. However, and as a consequence of the competition in the distribution sector together with the introduction of private operators in management, annual reports of public companies indicate that the technical and financial ratios are similar to performance indicators. Three prominent dissimilarity examples:

- ✓ The designation of "access to service" is discordant. The denomination access rates, the rate of connection coverage are used to give information about special network coverage. Still, this can mean for certain operators the availability of water in taps.
- ✓ Network performance is calculated according to different approaches. It is defined as being the volume of water sold and added to the volume of water mobilized (produced volumes and imported volumes). Because sold water is not defined beforehand, it creates a confusion concerning the volumes that are not changed but used with full knowledge of the facts (consumed volumes for free, used volumes for service requirements, etc). The majority of operators don't give enough precision to this subject.
- ✓ Linear loss index follows the same approach as performance without the presence of standardization reference rate. Although the technical performance systems (yield of network), which are run by communal operator and private operators, have improved by 80%, linear loss index is so high that it makes this result superfluous. (16.9 m³/day/km in 2015) (Figure n°4).
- ✓ Users' water consumption tendency is declining. It was the range of 7.5% from 2005 to 2015 (all operators and all customer segments are taken together). The tendency has gone from 115.8 to 107.1 l/inhabitant/day.(AKKA H and Bouzzidi A, 2017) (Figure n°1). Temporary evaluation indicators of consumption in the users' tap, which are absent in the current indicator set, are relevant in measuring when a drop or rise persists, and inevitably impacts the whole production-distribution process.

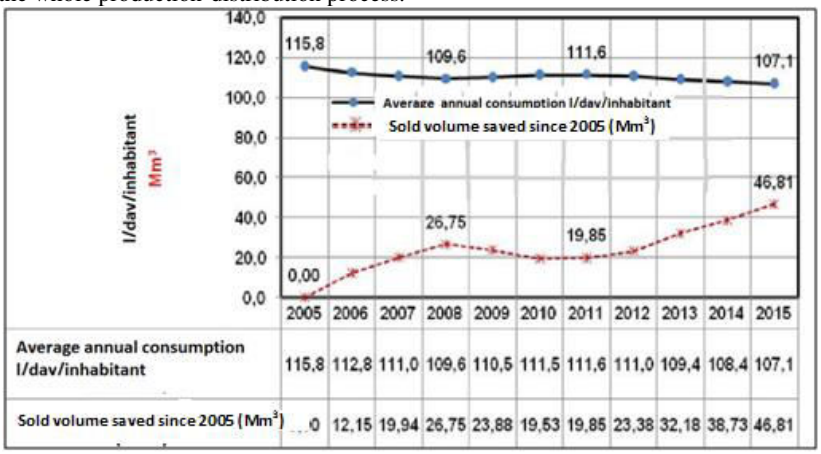


Figure n°1: Consumption dynamics per unit (Communal operators and private operators)

II.2.2. Liquid sanitation.

Wastewater, which is manipulated by communal operators and private operators, accounts for 510 Mm³ volume in 2015. This number represents approximately 70% of wastewater discharges at the national level. Treatment rate is at 80% for both communal operators and private operators. All this water is rejected either in the sea or in hydraulic public land (figure n°2). Only 37 Mm³, among 63 Mm³ is reused (Ministère de l'Intérieur, 2016)). The most known project is that of Marrakech city which recycles part of the used water for golf irrigation, the irrigation of palm grove and green municipal .places. It has to be underlines that the reuse of raw sewage has always been a common practice. In 2009, it was estimated that about 70 Mm³ of raw sewage was reused to irrigate an area of at least 7200 ha in the outskirts of some big cities like Marrakech, Meknes, Oujda, Fes etc)(CORDOM NICOLAS and AL, 2015). This shows that the reuse of used water is relatively accepted.

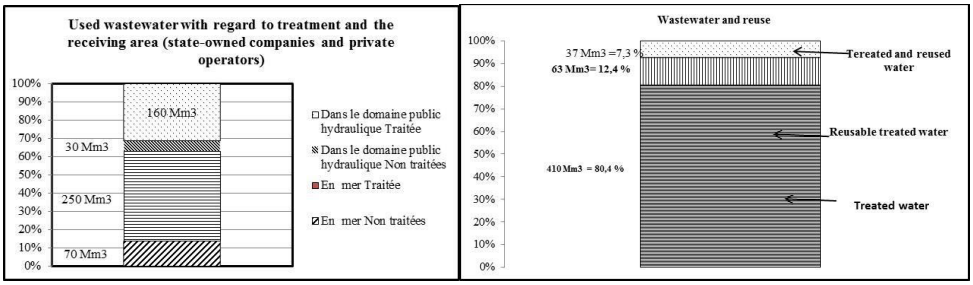


Figure n°2: Waste water rejected according to the treatment and the receiving environment (Communal operators and private operators)

II.3. Absence of national norms:

II.3.1. Resorting to benchmarking for indicator qualification.

In 2006, water and sanitation management laboratory of (ENGREF) established a frame of reference concerning linear loss index depending on the covered area (rural or urban) (table n°1). The correlation is done by taking into account subscribers' size per kilometer network (DREAL-CERA, 2013). In this frame of reference, the consolidation of the last five year results qualifies the performance of communal operators and private operators as poor. Obviously, the values exceed the reference in the urban area of GEA. The national average is 20.8m³/day/km. By applying this ratio on the total network length of communal operators and private operators' area, we are surprised by the big amount of water lost; either 556 500m³ per day[(3)] (with regard to an optimal LIL average of 3,3 m³/day/km). In order to line up with the diagram norms in figure n°3, these loses have to be brought back to 104 940 m³/ year**.**

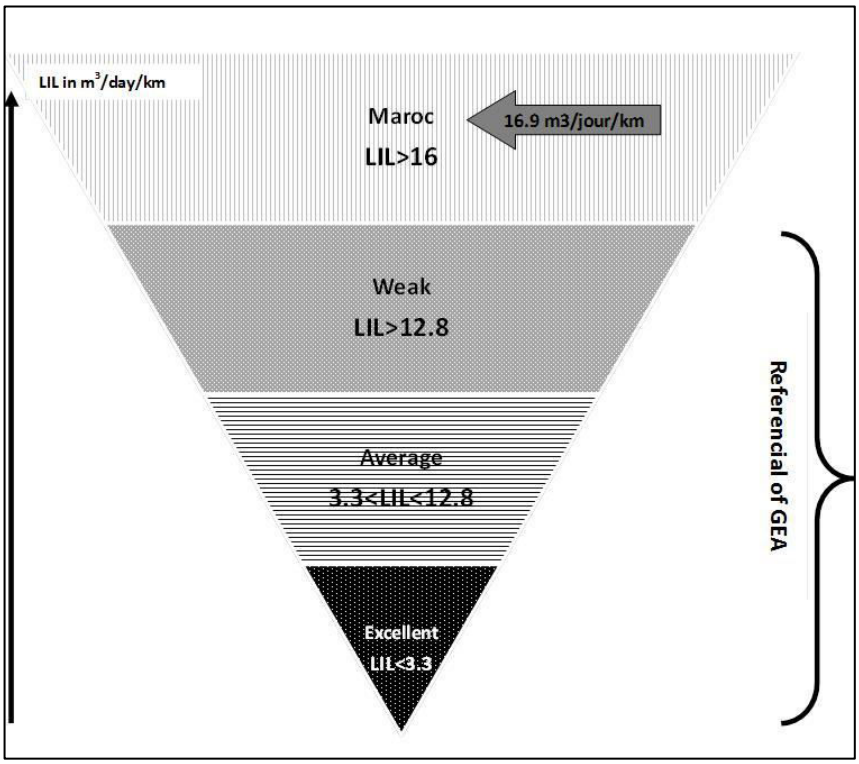
N.B: The mathematical correspondence between production and LLI is not obvious. When it's about estimated or measured variables, the bias are numerous. The marked difference in the values of volume loss using the two indicators shows the suitability of the consistency of the two equation indicators.

[(3)]The length of the total drinking water network (communal operators and private operators) is of the order of 31 800 km

Table n° I: GEA frame of reference for loss index (RNAUD, 2009)

Type of area	Rural	Intermédiate	Urban
Criterion	D≤20	20<D≤40	40<D
Excellent	LIL<0.7	LIL<1.5	LIL<3.3
Average	0.7≤LIL≤2.5	1.5≤LIL≤5.2	3.3≤LIL≤12.8
Weak	2.5<LIL	5.2<LIL	12.8<LIL

D = density of subscribers / linear of the network in km excluding connections), LIL = Linear index of loss (loss index) in m^3 / day / km.



Figuren° 3: LIL in Morocco and norms of GEA

This signifies that drinkable water is wasted five times more that it is authorized for an efficient network in terms of losses.

II.3.2. The case of Maghreb countries and Jordan

Drinkable water system in Tunisia (SONEDE, 2016) is characterized by a linear index of loss that is 50% less than that wasted in Morocco (8.7 versus 16.9m³/day/km in 2015). The average yield of network is also higher (figure n°4). The indicators of water resource management in Tunisia

particularly cover all the economic aspects of water. There are twelve established indicators. The consumption ratios, which give information on users' behavior, are also established (SONEDE, 2016)

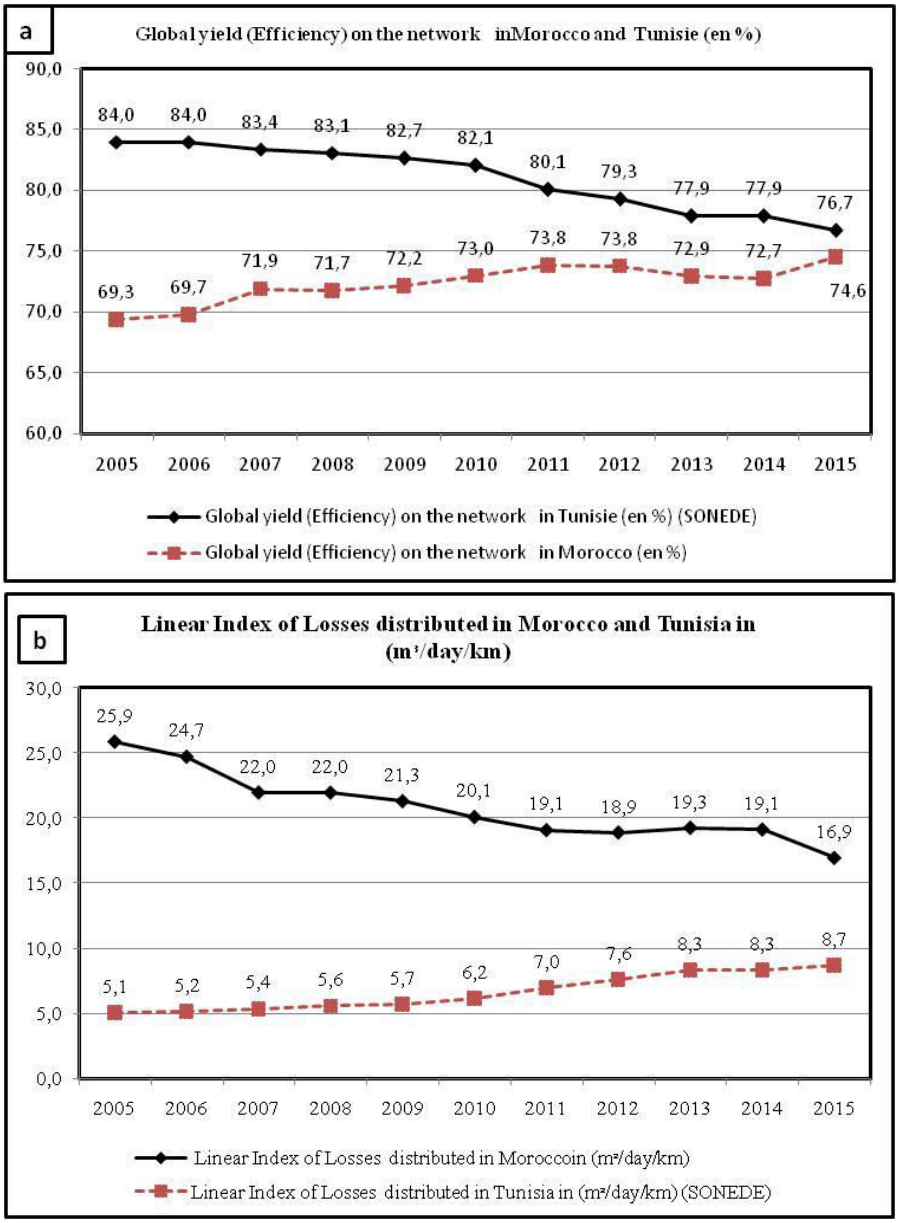


Figure n° 4: Yield (a) and LIL (b) of water distribution network in Morocco and Tunisia

In Algeria, individual demand for drinking water was at 120 l/inhabitant in 2011 and the estimated performance was at 55% in 2010 (BENBLIDIA, 2011).
Jordan, another country in the MENA region, uncalculated drinkable water volumes or non-revenue

water constituted in 2015, 51.3 % of the total distributed volume. (JORDAN WATER SECTOR, 2015).
The reuse in Tunisia, however, is more developed that in Morocco. If the latter reuses 7% of wastewater manipulated by communal operators and private operators, Tunisia will succeed in reusing 26%, which is equivalent to 60 mm³ (figure n°5). As for liquid sanitation, the current indicators in Morocco cover quantitative aspects. Used, collected and treated volumes of water as well as the number of STEP are the only indicators that appear in management reports. We also note the total absence of information concerning sludge management.

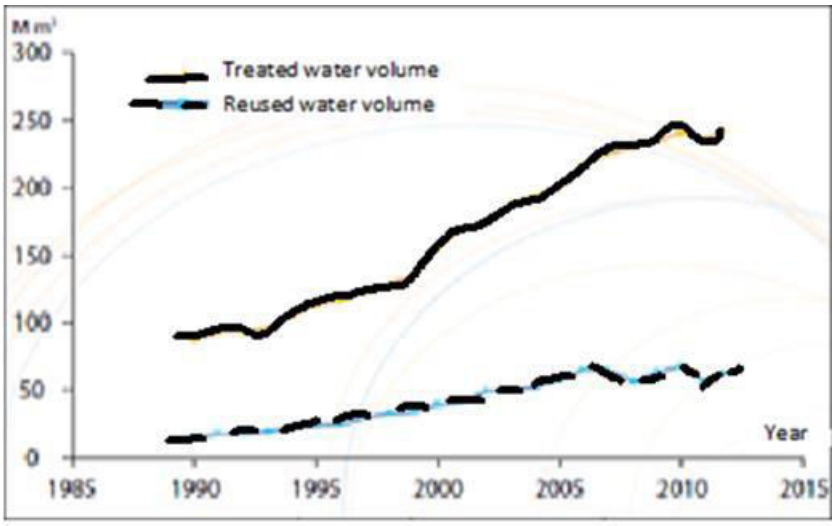


Figure N° 5: used water volume treated and reused in Tunisia (2013) (ONAS, 2013)

II.4. Urban rain water.

The problem of urban rain water continues to create differences between territorial community and operators. In fact, there is an important rain water flow; thus, it necessitates investment to be collected. In addition, the last is not recovered by applied tariff model. Their reuse is still low. The lack of regulatory and financial incentives seems to be a determining factor in the negligence noted in this regard.

III- The relevance of introducing performance indicatorstomanagingdrinking water and sanitation services in Morocco.

III.1. Particularities of Morocco

The following specifications have to be taken into account while adopting the performance indicator approach in public service management of drinking water distribution and sanitation in Morocco.

1- Direct management by the communes: a lot of townships in Morocco themselves manage water services and/or sanitation. When there is lack of means, communes cannot assume the maintenance of performance indicators in a detailed and precise manner.

2- Urbanization degrees of management perimeter: in a rural area, the density of individuals connections is very small. Diameters of canalizations are reduced and the network is wide in space. Concentrating on connection runaways will have no sense. The dysfunction frequency indicator of public fountains is more significant than dysfunction detection frequency in the pipe system. The latter is generally installed in places where road traffic is infrequent; hence, it does not provoke breakage (even if installation conditions aren't always optimal).
3- Traditional systems of drinking water: Including indicators for traditional systems of drinkable water is so required. A lot of villages are provided with water through schemes which are composed of well, a small tank and some public fountain. These systems have always existed since the PAGER program started and still function in areas where there are active users associations.
4- Information and communication: The transparency need and participation in public life are emerging dynamics in Moroccan society. This dynamic has to be taken into consideration while monitoring the dashboard. It is about designing indicators that translate users' expectations with regard to these two aspects. Information campaign or joint bulletin attached to the invoice including details about the services as well as comparisons with neighboring communities etc. the recent law 31 -13 about access to information supports this suggestion.
5- Utilities of information and communication between actors: the implementation of indicators is not solely about setting variables. The discussions about setting up performance indicators are always arduous. This is mainly due to the different possibilities of perceiving an indicator and also of the conflicting actors' objectives. Consensus, assessment and clamping are of paramount importance in this process. The phase of normalization is there only the crowning.

III.2. Admonition and suggested indicators panel

III.2.1. Drinkable water distribution service:

1- The necessity to review mathematical construction efficiency (yield).

a- Productivity is an environmental and economic indicator before being an indicator of the network state. For some authors, it is primarily an indicator of the waste of the resources (GUERIN SHNEIDER, 2001). For others, only the net return (performance indicator of the distribution network) reflects the use of a resource with or without waste (IGD. Fondation d'entreprises, 2004.)
b- A number of specialists touch upon the necessity of supplementing the production with other indicators ((IGD. Fondation d'entreprises, 2004.)) ((GUERIN SHNEIDER, 2001)). In addition to that, the interpretation is always difficult. The difficulty resides in the extent to which the management perimeter is qualified; urban, semi urban or rural. In the case of Morocco, frequent construction of villages and suburban districts in cities makes this idea reasonable. The indicators, the density of subscribers and Linear Consumption Index have to be included in the matrix in order to be able to judge whether it is a rural, urban or intermediate perimeter ((Renaud, 2009)). The employment of output as an exclusive indicator of the system condition in France was discussed and questioned (long ago) ((GUERIN SHNEIDER, 2001)). Furthermore, we notice that IWA didn't include the network efficiency (yield) as an indicator in its report about performance of water distribution services. (IWA, 2003).
c- Water public service operators demonstrate the performance on their management dashboard. In fact, the network efficiency intervenes in the economic calculation: the yield indeed intervenes in the economic calculation: the more the yield is low, the more the volume produced for a given consumption will have to be important, and the more the proportional loads in the produced volume will be raised. This approach has been particularly theorized in England together with the "economic level of the leaks" (GUERIN SHNEIDER, 2001). The comparison helps to guide the choices between different technical solutions (realization or non realization of leakage research, system rehabilitation or construction of new production infrastructure…). In Morocco however, it would be very difficult to ignore the indicator of yield of the network, given its simplicity and popularity to all actors. It is however necessary to see to it to separate between yield in the production (adduction) and yield in the distribution, and not to neglect the index of the losses in network.
d- The examination of the common Yield on the network calculation formula draws the following

observations:

$$R = \frac{Consumed\ Volume}{At\ the\ head\ of\ network\ volume} x100$$

- An additional distortion of the yield that manifests itself in the processing of the volumes produced by the operator: a surface resource requires more treatment compared to an underground resource. The quantities rejected in the first case are obviously larger. The overall yield would be affected without any change in consumption.
- The supplementary distortion of production is manifested at the level of the processed volumes which are produced by the operator: a surface quantity necessitate further treatment as opposed to ground water resources.
- Distinguishing between technical yield and commercial yield.
- Some authors prefer to use net yield which eventually intervenes with uncounted consumed quantities, diverted volumes and service volumes. However, this raises the difficulty of uncounted and diverted volumes. This feature renders the principle of net output in contradiction with the principles of measurability and verifiability. For this reason, some authors prefer and encourage the appellation "primary yield instead of net yield". In order to preserve water resources, the authors suggest adopting production performance (yield) (COUSQUER et Al., 2005)

2- Linear index of losses

$$LIL = \frac{volume\ put\ in\ distribution - \ consumed\ volume\ by\ ordinary\ users}{Network\ length\ (individual\ connection\ off)\ _x 365}$$

This indicator is better that the yield so as to translate the network state. It strongly depends on the linear density of connections (number of connections per km of network) and of uncounted authorized volumes that are to be consumed: numerous connections multiply the losses in the downstream of these and the authorized consumed volumes sidestep real loses in the network.

a) A lot of authors recommend analyzing the following indicators simultaneously: a- primary yield- b- number of leaks-c- replacement rate-d- leakage finding rate.
b) When the network comprises a part in a rural area, the indicator will be divided into two sub-indicators (rural and urban). A rural network is generally dispersed and extended. LIL is necessarily low in comparison with urban areas.

3- Resource protection index.

This indicator gives information on the development of actions taken in order to protect water resources against major factors of pollution. This has a percentage explanation. It is calculated through a scale-variant from 0 to 100%

No action	study launch	defined perimeter	signed regulatory order	implementation and completed jobs	existence of periodic follow-up procedures
0%	**20%**	**40%**	**60%**	**80%**	**100%.**

The indicator "water resource protection index" is rarely or never used by the operators in Morocco. The reason seems to be linked with the fact that water resource management, belongs the water department prerogative. The indicator's utility is recommended for operators who produce at least part of the distributed water

4- Charged consumption unit (sold) (1/day/inhabitant) (consumer segment)

$$\text{CCUc} = \frac{\text{annual charged volume (sold)}}{\text{Served population x 365}}$$ Per liter/day/inhabitant (The index "c" refers to the considered category

This indicator serves to know the effective consumption tendency of users. It is preferable to divide the population in terms of consumer segments because the trend can be low for one category and high for another. In order not to have biased results, it is not recommended to consider service consumption and that of agents because it is not charged. Everything that is cost-free encourages excess.
The aim is to appreciate water consumption variation of the consumer and to study her tendency with regard to awareness campaigns and pricing system. Eventually, the allocations used for the design of the networks equipments' can be revised.

III.2.2. Liquid sanitation service: Widening indicator matrix of resource management performance

In Morocco, the regulations as far as the standardization of used water rejection is concerned relate certain specific activities to limited values of rejection. (Domestic used water and industrial activities of sugar, cement, surface treatment, paper pulp, paper and cardboard). In the same respect, a decree related to individual sanitation system was promulgated in 2006 listing the sanitation systems that belonged to this group. Joint application texts should specify the technical arrangements of these systems construction.
In 2015, a new law about water was promulgated (law 36-15) amending the law 10-95 which has arranged a whole section to liquid sanitation, treatment and reject (article 106 to 110). This legal framework is waiting to be completed by executive acts for an appropriate start-up of performance measurement mechanisms.
Nevertheless, at the present stage, it would be possible, through contractual or conventional means, to insert specific indicators for the preservation of the water resource against water pollution. The two aspects to be evaluated are the liquid discharges and the fate of the treatment products. The proposed indicators are:

- *Ratio of the volume of used and treated water (in %): RUT*

$$RUT = \frac{Volume\ of\ used\ and\ teater}{Voulme\ of\ used\ and\ collected\ water}\ x\ 100$$

- *Performance of Treatment (in %)*

$$PT =. = \frac{Polluant\ load\ at\ station\ exit}{Poluant\ load\ at\ station\ inlet}\ x\ 100$$

This indicator is the denomination of being in compliance with sewage discharges which refers to regulatory limits of rejected, used and treated water.

- *Ratio of Water volume that is treated and Reused (in %):*it portrays the percentage of used water volumes valued with respect to collected volumes by the system.

$$RWR =. = \frac{Treated\ and\ reused\ water\ volume}{Used\ and\ collected\ water\ volume}\ x\ 100$$

- *Ratio of treated sludge:*

$$RTS =. = \frac{Treated\ sludge\ quantity}{collected\ sludge\ quantity}\ x\ 100$$

- *Ratio of Reused Sludge (in %)*

$$RRS =. = \frac{Reused\ sludge\ quantity}{collected\ sludge\ quantity}\ x\ 100$$

IV- Conclusion

The performance indicators, which are generated by drinkable water and sanitation public service operators, are generally of internal type. They pave the way for exploitation management objectives. Moreover, their discrepancy and heterogeneity complicate their efficiency. Because of the lack of standardization, at the national level, these indicators do not allow a macroscopic visibility of the public service. At the regulatory level, the governing law 13-14 which is related to communes stated the necessity for local public services to establish performance indicators (article n°12). This text should constitute the basis for engagement in this process.
In the meantime, the suggested indicators in this research paper can be introduced as evaluative and analytical tools for water and liquid sanitation services. This can be done through contracts and agreement established with the operators. For the latter, the three-year revision constitutes an appropriate occasion for them to be introduced in the system. As for the communal operators, board of directors is in a position to adapt performance indicators in the management of public water and sanitation services. However, a cushion system has to be realized in the presence of operators. This approach will provide scope for testing the indicators and appropriating them by service providers.

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LIST OF ABBREVIATIONS

AFD	: Agence Française de développement
AFEID	: Association Française pour l'Eau l'Irrigation et le Drainage
CEMAGREF	: Centre du Machinisme Agricole du Génie Rural, des Eaux et Forêt France (IRSTEA)
CERA	: Cellule Economique Rhône-Alpes
COSTEA	: Comité Scientifique et Technique Eau Agricole
DREAL	: Direction régionale de l'environnement, de l'Aménagement et du Logement. Rhône-Alpes
DRSC	: Direction des Régies et des Services Concédés
ENGREF	: Ecole Nationale du Génie Rural, des Eaux et des Forets
FNCCR	: Fédération nationale des collectivités concédantes et régies, France
IGD	: Institut de la Gestion Déléguée, France
IRSTEA	: Institut national de Recherche en Sciences et Technologies pour l'Environnement et l'agriculture. (Old naming: CEMAGREF)
IWA	: International Water association
MENA	: Meadle East and North Africa
ONAS	: Office national d'Assainissement, Tunisie
PAGER	: Programme d'Alimentation Globale en eau Rurale
SAGE	: Schéma d'Aménagement et de Gestion des Eaux, France
SISPEA	: système d'information des services publics d'eau et d'assainissement
SONEDE	: Société nationale d'Exploitation et de Distribution des eaux, Tunisie
STEP	: Station d'Epuration