Impacts of demography on changes in water losses from drinking water networks

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Topic: NRW Assessment and Strategy Design

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Context and objectives

The great majority of the Gironde department (South west of France) is supplied with drinking water from deep groundwater with very high inertia. Some of these aquifers are overexploited as a result of withdrawals intended for more than 90% to supply drinking water. The management of these resources therefore requires a good knowledge of the water needs of the Water Supply Systems (WSS), including the losses of the distribution networks. In this context, the SMEGREG (public basin establishment which aims to help preserve and enhance the deep aquifers of Gironde) and INRAE (public research body) are leading a research collaboration to progress in the prospective estimation of water losses from WSS of Gironde under the influence of changes in urban density and demography. This study aims, on the one hand, to build a benchmark for evaluating the performance of services in terms of water losses as a function of urban density, and on the other hand to study the respective changes in the population, the length of the networks and the number of connections.

Benchmark to assess water losses from water supply systems

Since 2009, the dashboards related to deep water tables of Gironde drawn up by SMEGREG have used a benchmark established by Cemagref (former name of INRAE) which makes it possible to assess the linear index of losses according to the density of subscribers (Renaud *et al*, 2007). This benchmark, which has the advantage of overcoming the threshold effects of previous benchmarks, has the drawbacks of being based on old data and of having a validity limited to services for which the density of subscribers per km of network is below 45. A new reference system was therefore sought to attempt to remedy these limitations.

The data used are those from SISPEA (national French database related to WSS performance) for years 2009 to 2018. In 2018, 5,818 WSS provided information on the variables *L*, length of the network in km; *N*, number of service subscribers and *NRW*, annual volume of Non-Revenue Water in m^3 which are necessary for the calculation of $D = N / L$, subscriber density; $LLI = NRW / (L \times 365)$ Linear Losses Index and $SLI = NRW / (N \times 365)$, index of losses per subscriber (Alegre et al., 2017) (Lambert et al., 1999). After ruling out outliers or extreme data, 5,490 services made up the study database. The services thus selected were ordered by increasing subscriber density and then grouped into classes comprising the same number of services. For each class, the values of the indicators *D, LLI* and *SLI* are calculated by considering the cumulative values of the variables *L, N* and *NRW* of the services belonging to the class.

For $D \leqslant 60$, the linear regressions of *LLI* as a function of *D* passing through the origin are, each year, very well adjusted ($R^2 \geqslant 0.99$). Beyond ($D > 60$) *LLI* becomes independent of

D. From these results, the frame of reference represented by the figure below was constructed with the 2018 data. For *D*> 60, the constant values used are consistent with the statistical distribution of *LLI* (Figure 1).

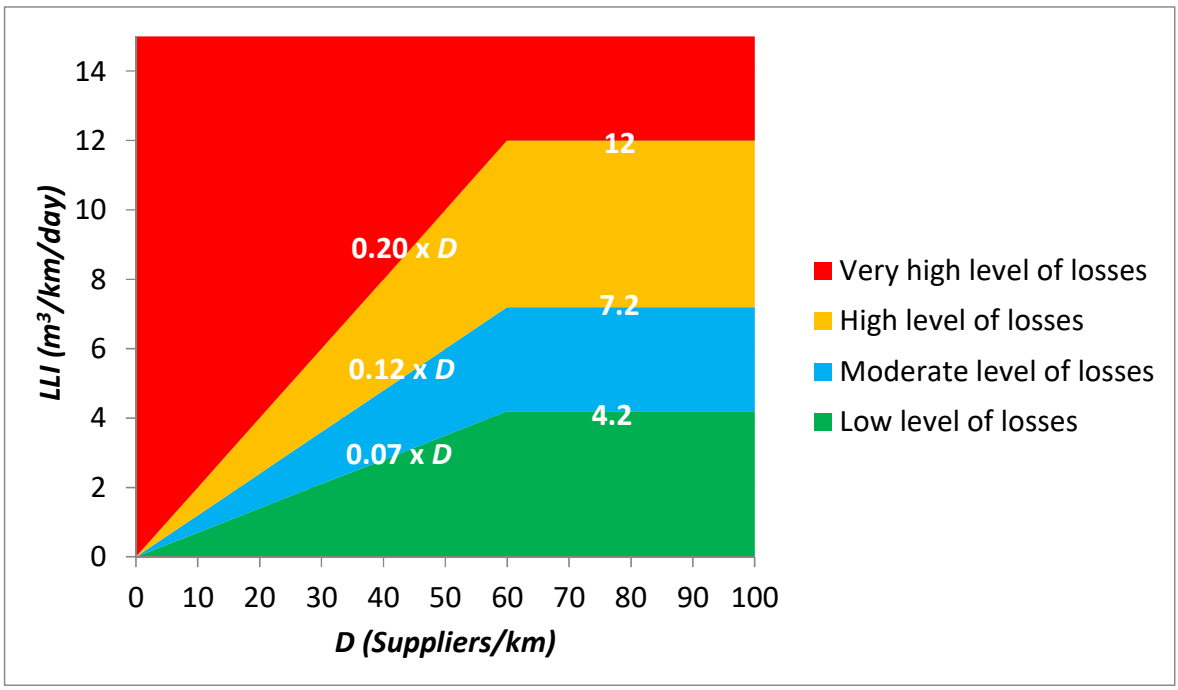

Figure 1 *LLI* reference system as a function of *D*

Changes in population, length of networks and number of connections

The SISPEA and INSEE (French institute of statistics) data from 2011 to 2017 were used to calculate for each WSS in Gironde the annual growth ratios of population (*AG-Pop*), network length (*AG-L*) and the number of subscribers (*AG-N*). As shown by Figure 2, while the evolution of the number of subscribers is comparable to that of the population, that of the network length is generally much less. Additional research, based on network GIS and INSEE data at the finest scale, is underway to deepen these results.

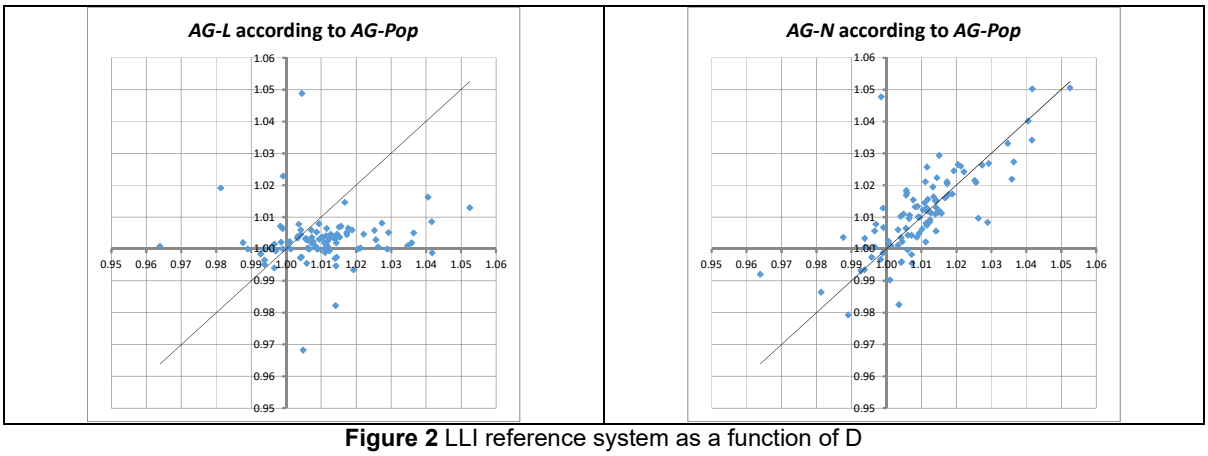

Figure 2 LLI reference system as a function of D

Conclusion and perspectives

Demographic changes are commonly taken into account to predict drinking water consumption but rarely to estimate changes in water losses. The aim of the work that has been carried out is to help fill this gap.

Thanks to the existence of a national database, it was possible to confirm the strong link that exists between Linear Losses Index and subscriber density. So, it has been possible to propose an updated national benchmark, the validity of which has been extended to very urban services. It has also been shown thanks to a statistical approach that, under the effect of denser housing, the length of water networks increases significantly less quickly than the population.

Completed by investigations on a finer scale, these results should make it possible to develop a method for estimating the evolution of losses which takes into account the combined effects of urban densification and population growth in addition to those linked to water supply networks management.

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