DISTRIBUTION OF DRINKING WATER IN THE GRAND-DUCHY OF LUXEMBOURG – THE CHALLENGE TO MIX WATER OF DIFFERENT CHEMICAL AND PHYSICAL PROPERTIES

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Summary
In Luxembourg, the consumption of drinking water is around 120,000 m^3 a day. Two thirds of this quantity is ensured by groundwater and one third by the treatment of surface water.
The groundwater, of a hardness of 22 to 30°fr, is obtained from approximately 300 sources and drillings fed largely by water from the aquifers of the "Sandstone of Luxembourg " and the "Buntsandstein".
The drinking water resulting from surface water possesses a hardness of 7 to 9°fr and requires complex treatment.
The final quality delivered to the consumers depends on the way the local distribution network functions. A too strong variation in the composition of the water distributed to the consumers can prevent the installations being regulated properly. Besides, it is important to verify if by mixture of waters we do not generate an aggressive water entailing the dissolution of protective coatings consisting partially of carbonate of calcium and, thus, the corrosion of metallic pipes as well as the degradation of the structures in concrete.

Résumé
Au Luxembourg, la consommation en eau potable se situe autour de 120'000 m3 par jour. Cette quantité est assurée pour les deux tiers par l'eau souterraine et pour un tiers par le traitement d'eau superficielle.
L'eau souterraine, d'une dureté de 22 à 30°fr, est captée par environ 300 sources et forages alimentés en majeure partie par les eaux des aquifères du "Grès du Luxembourg" et du "Buntsandstein".
L'eau potable provenant d'eau superficielle accuse une dureté de 7 à 9°fr et exige un traitement complexe.
La qualité finale livrée aux consommateurs dépend bien évidemment du mode de fonctionnement des réseaux de distribution locaux. Une trop forte variation de la composition de l'eau distribuée aux consommateurs empêche le bon réglage des installations. Par ailleurs il y a lieu de vérifier si par le mélange d'eaux on ne génère une eau agressive entraînant la dissolution des couches protectrices composées en partie de carbonate de calcium, et favorisant donc la corrosion des tuyaux métalliques ainsi que la degradation des structures en béton.

Zusammenfassung

In Luxemburg liegt der Verbrauch von Trinkwasser um die 120.000 m3 täglich. Diese Menge besteht zu zwei Drittel aus Grundwasser und zu einem Drittel aus Oberflächenwasser.

Grundwasser, mit einer Härte 22 bis 30°fr, wird aus ungefähr 300 Quellen, die größtenteils aus den Grundwasserleitern des „Luxemburger Sandsteins“ und des „Bundsandsteins“ gespeist werden, gewonnen .

Das aus oberflächlichem Wasser herkommende Trinkwasser besitzt eine Härte zwischen 7 und 9°fr, und bedarf einer komplexen Aufbereitung.

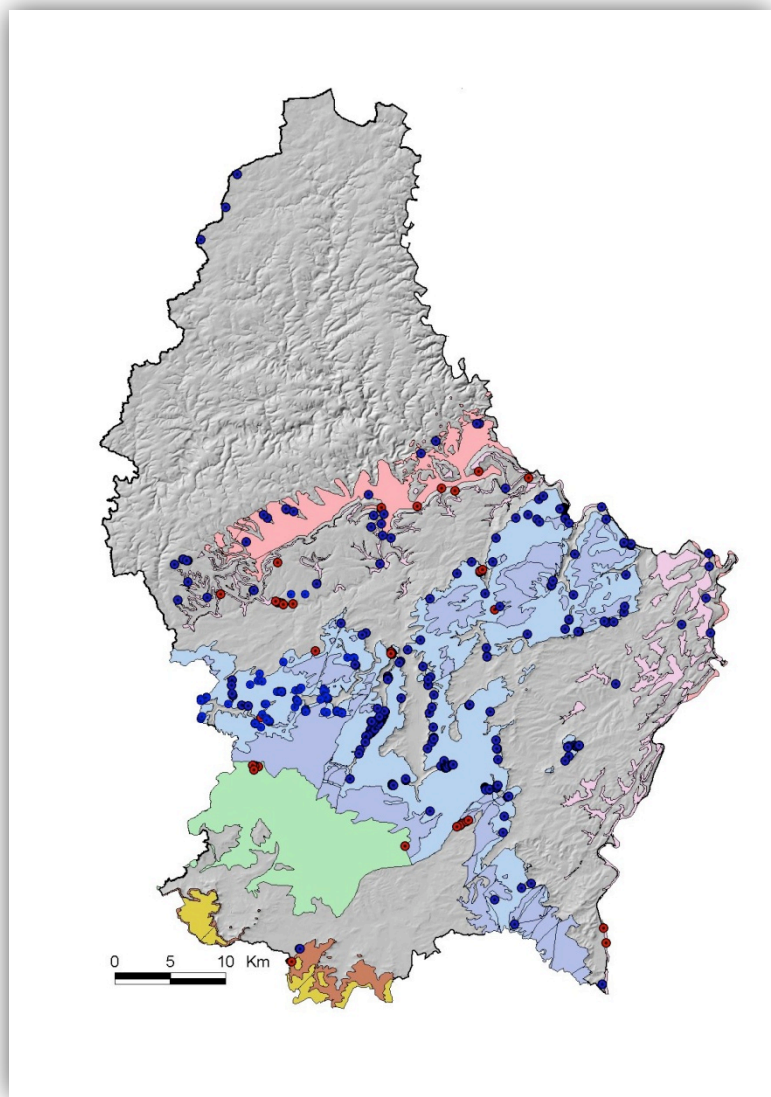
Die endgültige, den Verbrauchern gelieferte Qualität hängt natürlich von der Betriebsart der örtlichen Verteilernetze ab. Eine zu starke Variation der Zusammenstellung des Wassers, das den Verbrauchern verteilt wird, kann die optimale Einstellung der Einrichtungen beeinträchtigen. Auch muss überprüft werden, ob durch die Mischung von Gewässern kein aggressives Wasser entsteht, das die teilweise aus Kalziumkarbonat zusammengestellten Schutzschichten auflöst und somit die Korrosion der metallischen Rohre sowie die Beschädigung der Betonstrukturen beschleunigt.

Pumping station for spring water of the S.E.S in Koerich (L)

Drinking water in Luxembourg: where does it comes from, how is it distributed and who is responsible?

In Luxembourg, drinking water consumption averages around 120,000 m^3 per day. Two thirds of this amount is provided for by groundwater and one third by the treatment of surface water.

Groundwater is captured by about 300 springs and wells fed mainly by water from the sandstone aquifers of Luxembourg and the Buntsandstein. The sandstone of Luxembourg is a fine sand caught in a calcareous cement. It is the site of Luxembourg's largest aquifer, where groundwater flows primarily along fractures with high circulation rates. Marls and limestone from Elverange form the impermeable basis of this aquifer.



Geology of Luxembourg showing the main water bodies

Drinking water from surface water is produced at the Esch-sur-Sûre dam located in the north of the country. This production requires a complex treatment, carried out by SEBES (Syndicat des Eaux du Barrage d'Esch-sur-Sûre). The maximum capacity of the treatment plant is 80,000 m^3/day. Besides the treatment of surface water, SEBES also exploits groundwater captured by drilled wells at three different sites. (production per day = 30,000 m^3).

Arial view of the SEBES treatment plant near Esch-sur-Sûre

The water collected and treated, is distributed through reservoirs and pumping stations to the final consumers. The number of distribution facilities is estimated at 500.

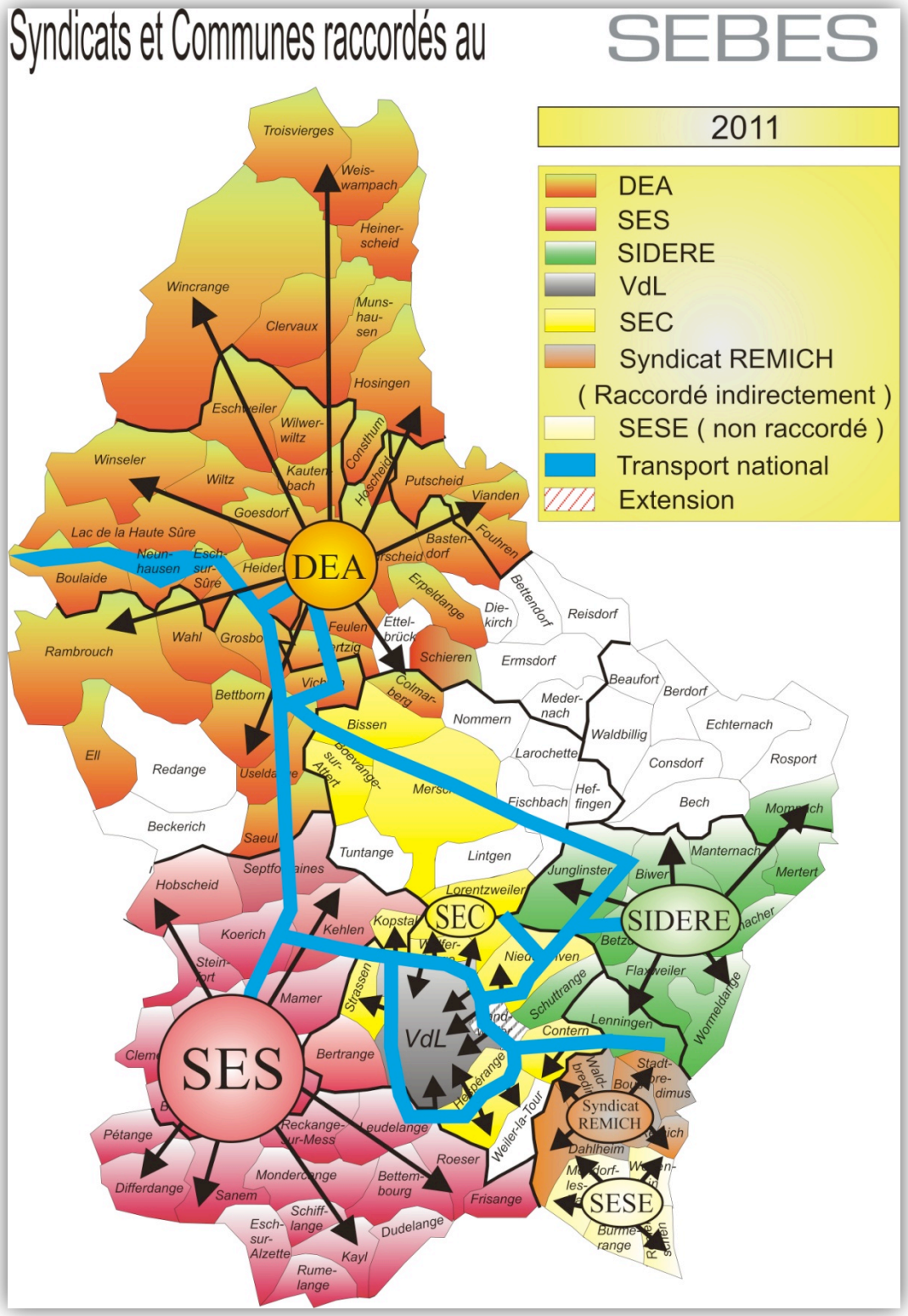
National regulations relating to drinking water ('Règlement grand-ducal du 7 octobre 2002 relatif à la qualité des eaux destinées à la consommation humaine') place much responsibility on municipalities with respect to their inhabitants. The municipality is obliged to monitor the quality of distributed water and look after the supply infrastructures. At least once a year, the municipalities must inform consumers of the quality of distributed water.
They also have an advisory function with respect to consumers. In addition, municipalities are required to prepare a technical report on the supply infrastructures

with an analysis of critical points in the network. These audits cover the whole distribution network and are intended to pinpoint the weaknesses in the system and address them, thus ensuring an optimal supply and restore consumer confidence regarding the drinking water quality.

1866	First water distribution facility in the city of Luxembourg
1908	Syndicat des Eaux du Sud (SES)
1929	Distribution d'Eau des Ardennes (DEA)
1936	Syndicat des Eaux du Sud-Est (SESE)
1949	Syndicat pour la Distribution d'Eau dans les Communes de Bous, Remich et Waldbredimus (SER)
1962	Syndicat des Eaux du Barrage d'Esch-sur-Sûre (SEBES)
1995	Syndicat Intercommunal pour la Distribution d'Eau de la Région de l'Est (SIDERE)
2005	Syndicat des Eaux du Centre (SEC)

History of the water distribution in Luxembourg

Depending on their drinking-water supply facilities, municipalities fall into three categories:
- Municipalities that operate their own sources or wells for their drinking water supply;
- Municipalities that are members of municipalities associations or water syndicates that provide drinking water to municipalities. The latter then distribute the water to consumers;
- Municipalities that have their own catchments and are also fed by a water syndicate to meet their needs.



The distribution network for drinking water in the G. D. of Luxembourg

Risk analyses

The national regulation of 7 October 2002 on the quality of water intended for human consumption implementing the European Directive 98/83/EC, aims to ensure the safety and cleanliness of water intended for human consumption and to protect human health and the adverse effects of contamination potential of these waters.

In detail, this disposition contains various provisions that are not expressly prescribed by the European Directive, but that serve the purpose, that is to say, to ensure good quality drinking water. The requirements concern mainly the development, the operation and the maintenance of infrastructure for supplying drinking water.

Indeed, rather than correcting the pollution of drinking water by further treatment , such as chlorination, it is best to make every effort to ensure that no contamination can occur, thus applying the principle of prevention.
Network operators of drinking water are required to conduct an examination and diagnosis of technical infrastructures and draft a report analysing the risks of contaminating the water supply.
The objective of this diagnosis is to propose an intervention policy to local officials and their technical services to guide them in good management of the quality of service offered to consumers.

Before After

Rehabilitation of a spring water catchment

These new provisions are important to ensure better compliance with drinking water standards in force. In most cases, failure to meet the parametric values is due to inadequate maintenance of supply infrastructure. Thus, of the 260 spring water catchments under operation in Luxembourg, 75% have exceeded 60-year lifetime limit recommended by the water management administration.

Indeed, these works are often in disrepair, allowing the infiltration of polluted surface water. The new regulation means greater accountability, by requiring providers to submit their infrastructure to a quality audit to reveal weaknesses and deficiencies. Municipalities that have carried out this technical audit are also rewarded with a quality label for their efforts in the field of quality management of drinking water.

Burstlining of a cast iron pipe

Besides the detailed description of the supply infrastructure, the technical report is completed by a relative risk analysis that must:

- Identify and discuss all aspects of communal infrastructure supply and its mode of operation that present a risk to the quality of water distributed;

- Define preventive and corrective measures and a quality assurance program to be implemented to avoid the risk of non-compliance, such as:
    - Health protection of the public network against backflow,

- A sampling plan focused on areas at risk for impaired quality of drinking water,
- A cleaning and disinfection program for the network,
- A plan for the upkeep and maintenance of network equipment,
- A blueprint for the renewal of the network including a financial strategy to ensure the availability of financial budgets required;

- Define an action plan and local regulations, including an emergency procedure for makers and consumers of water and that will be implemented in case of interruption of the arrival of water or to protect consumers from the effects of contamination of the water supply and to restore the original quality of the water.

Pipe works

Maintenance and rehabilitation

Even if national regulations oblige municipalities and water distributors to improve maintenance of the water distribution network, reality sometimes looks quite different. Required budgets may not be granted, or simply political willingness to invest in infrastructures may not be present.
However, as the main complaints from customers concern taste, odour or colour of drinking water, many efforts are done to improve the quality of water.
Thus, to reduce the taste of chlorine, catchment areas are protected, catchments are rehabilitated and water treatments (membrane filtration, U.V.) are improved, to reduce the amounts of chemicals in the water.
Also leakages are reduced, not just to prevent the loss of water and money, but also to avoid the infiltration of contaminated water into pipes with low pressure. Criteria for replacing corroded pipes are mainly age and frequency of leakage or other road works that can be an opportunity to replace an old network.
More and more, pipes are cleaned mechanically to reduce deposits originating from corrosion or bio-film. New materials and coatings, as well as the use of cathodic protection help to prolong the service life of pipes.
As municipalities are asked to implement the real costs to the water price, customers are getting even more sensitive about the water quality. On the other hand, required budgets may be granted more easily.

Detecting and repairing leakage

Miscibility (IWW 2006)

A major challenge is the mixture of water sources with high hardness (d ° f between 20 and 30) with surface water from the Esch-sur-Sûre lake without creating aggressive drinking water. We will briefly consider the example of the Syndicat des Eaux du Sud (SES) supplying drinking water to the south and southwest of Luxembourg country.

The SES exploits 60 catchments in the sandstone of Luxembourg as well as 2 deep wells, with a total production of 25,000 m^3/day. On average, the SES distributes 40,000 m^3/day to its member-municipalities as well as industries directly connected to its network. However, in periods of high demand, consumption can exceed 60,000 m^3/day.
The missing quantities are provided by SEBES, treating surface water from the Esch-sur-Sûre lake, thus providing a fairly soft water.

In 2006, the IWW (Rheinisch-Westfälisches Institut für Wasser / Mülheim an der Ruhr) undertook a study analysing the miscibility of these different waters.
The result was that the mixed water will start dissolving calcite when the amount of surface water (SEBES) exceeds 20%. At 33% surface water, the calcite dissolving capacity is about 5 mg/l. The maximum of 8 mg/l is reached when surface water represents 50 to 70% of the mixed water. So it can be assumed that on most days, the maximum capacity to dissolve calcite is between 5 and 9 mg/l.
To reduce the water's aggressiveness, it was suggested to de-acidify the hard water by intensive contact with air in the main reservoir where mixing occurs. This can be done by means of cascades, jet pumps, static mixers and similar simple devices.
It was also recommended to introduce the surface water as evenly as possible throughout the day in the main reservoir to narrow the range of variation.

'Rebierg' water reservoir

Conclusions

As in most European countries, maintenance and rehabilitation of water distribution networks and infrastructures is a major challenge.
Recent regulations can help to improve the situation by making politicians aware and freeing up the requested budgets.
A major challenge remains the mixing of hard spring water with soft surface water without creating an aggressive type of water.

Main water reservoir of the S.E.S at 'Rebierg' (32.000 m3)