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Implementation of supra-local drinking water asset management policies: A study of the Rhône department (France).

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Abstract

France is divided into around one hundred administrative units, known as "departments", whose officials are responsible for allocating water service funding to the various municipalities within their jurisdiction. The AQUADEP project (2008-2012) looked at the characterisation, assessment, and monitoring of departmental drinking water policies in France. As part of this project, we examined the allocation of funding for pipe renewal in one such department, namely the Rhône.

To satisfy various objectives (reducing price disparity, improving network asset management, and reducing water losses) the authorities in the Rhône department had put in place a system whereby money was provided based on three criteria and four performance indicators. To analyse this system, we created our own set of indicators, based on objectives and available data. Our study showed that out of the three key objectives, only one had been (partially) realised - that of improving asset management. The reason for this was shown to be the incompatibility of the different objectives, and the fact that a single action (pipe renewal) was prioritised over all others.

Keywords

Asset management; drinking water networks; investment prioritisation; supra-local policies

INTRODUCTION

France is divided into a hundred and one regional administrative units, known as departments. These are essentially a stepping stone between central and municipal government. Within each department, there are several municipalities, responsible for drinking water supply systems in their respective areas. Some municipalities may choose to operate water services in partnership with neighbouring councils. Funding for water supply purposes can be allocated by the department in which a municipality is located.

AQUADEP was a research project carried out from 2008 to 2012, bringing together a team of geographers, sociologists, and engineers. As part of a wider program set out by the French Ministry for Ecology, AQUADEP was designed to characterise, assess, and monitor departmental policies relating to drinking water throughout France (Barbier 2012). One of the key parts of the project was an in-depth analysis and assessment of the information systems and indicators developed by French departments as part of their respective drinking water policies (Renaud *et al* 2012). Systems from three different departments were studied, including the Rhône department, which is one of only a handful to take an interest in the way in which assets are managed within the municipalities under its jurisdiction (Renaud and Large 2011).

Located in the East of France, the Rhône department is a fairly small but highly developed area, dominated by its main city of Lyon. Out of a total of 1.7 million inhabitants, around 1.3 million live within the Lyon Urban Area (LUA). The main objectives relating to drinking water management in the Rhône department are the following (Département du Rhône, 2010):

- Reducing disparities in water prices from one area to another
- Maintaining reliable water distribution

- Improving asset management
- Reducing water losses
- Protecting water resources.

In 2007, to meet these objectives, the Rhône authorities introduced a performance-orientated system of funding, based on indicators set out in national regulations (République Française 2007).

METHODOLOGY

Allocation of funding for pipe renewal

In the Rhône department, funding for pipe renewal is distributed based on three criteria. These take into account four key performance indicators defined in the French water regulations:

- Water price (average price for 120 m³, including tax)
- Asset knowledge and Management Index (AMI). The value of this indicator is between 0 and 100. Points are added in tens based on knowledge of the network and the implementation of a long-term pipe renewal program.
- Network Renewal Rate (RR). This is the quotient (as a percentage) of the annual average length of pipes renewed (excluding connections) over the last 5 years, divided by the total network length.
- Linear Loss Index (LLI) is the volume of water lost within a network per day and per kilometre (excluding connections).

The first criterion used to determine the level of funding provided to a WSS (Water Supply System) is its water price compared to the Departmental Average (DA), which is the average water price for all WSS's in the department (including LUA), weighted based on the number of subscribers (Table 1).

Table 1. Adjustment of levels of funding based on water prices.

	Price < DA	DA ≤ Price < DA + 25 %	Price > DA + 25 %
Level of funding	0 %	Standard rate	Standard rate + 10 %

The second criterion requires a minimum AMI score to be obtained (Table 2).

Table 2. AMI score required to obtain funding.

	AMI < 30	AMI ≥ 30
Level of funding	0 %	Applicable rate

The third criterion cross-references the linear loss index with the renewal rate (Table 5). In order to do this, the LLI is first calculated based on a set of benchmark values (Table 3). These values take into account whether the WSS is located in an urban, semi-urban, or rural area. WSS's are placed into these categories based on the Linear Consumption Index (LCI) which is the annual volume of water consumed by users per day and by kilometre (Table 4).

Table 3. Benchmark LLI values based on network type

	Rural	Semi-urban	Urban
Good	< 1.5	< 3	< 7
Acceptable	< 2.5	< 5	< 10
Average	< 4	< 8	< 15
Poor	≥ 4	≥ 8	≥ 15

Table 4. Type of network based on Linear Consumption Index (LCI)

Type of network	LCI
Rural	< 10
Semi-urban	< 30
Urban	≥ 30

Table 5. Standard level of funding based on LCI and RR

	0 % ≤ RR ≤ 1 %	1 % ≤ RR ≤ 1.5 %	RR > 1.5 %
LLI Good or Acceptable	25 %	15 %	0 %
LLI Average or Poor	35 %	25 %	15 %

Assessing the effectiveness of the funding system

In 2011, we collated available data to examine the effectiveness of the funding system implemented in 2007 in the Rhône department:

- Water prices from 41 out of 45 WSS's between 2006 and 2009.
- Information relating to work subsidised between 2008 and 2011.
- Technical information from WSS's who received funding between 2007 and 2009.

A significant limiting factor is the absence of technical information from WSS's who did not receive funding. This is exacerbated by the fact that subsidies were not allocated to the same WSS year on year.

The system of funding for pipe renewal in the Rhône department is driven by three key objectives:

- Reducing disparities in water prices
- Improving asset management for water services
- Reducing water losses

The reasons for applying certain criteria to certain objectives were not clearly defined. Also, there were no indicators to measure the effectiveness of the funding system. In view of this, we had to assume the reasons why the different criteria were selected. Our indicators were then based on these. Using available data, we were able to evaluate the fulfilment of objectives, and suggest possible improvements to the system.

RESULTS AND DISCUSSION

Reducing water price disparity

With the objective of reducing price disparity, one of the conditions of receiving funding in the Rhône department is that water prices charged by WSS's are above the departmental average. If the prices exceed this average by more than 25%, funding is increased to 10% above the standard rate (Table 1). The average price for a given year is calculated with the figures from two years previously. These are figures from all WSS's within the department (including ULA) weighted by the number of customers.

We assumed that the Rhône department's decisions were based on the following principles:

- If the department finances work carried out by WSS's with already high water prices, they will be able to limit their borrowing, and therefore avoid increasing their prices any further. For services with very high water prices, providing added bonuses has even greater effect.
- If the department does not provide funding to WSS's with low water prices, the cost of investment will result in them raising their prices, and discourage them from maintaining very

low prices.

- The system can encourage WSS's to review their pricing structures in order to receive funding. If this is the case, it will have the desired effect (reducing price disparities) for low-price WSS's, who will increase their rates to above the departmental average. However, for high-price WSS's, the effect will be the opposite, as they will increase their prices further to benefit from the 25% bonus.
- Using the departmental average as a benchmark rather than a fixed value allows funding thresholds to adapt dynamically, taking into account changes in economic conditions.

We created two indicators to measure "price disparities" between all WSS's in the department, based on the distribution of water prices during a given year.

The first, Rq , is the ratio between the third and first quartiles in the distribution of water prices: the level below which 75 % and 25% of WSS's respectively set their price. This indicator measures the differences between extremes, and is always greater than or equal to 1. The higher the value of this indicator, the more price disparity there is.

$$Rq = \frac{3^{rd} \text{ quartile}}{1^{st} \text{ quartile}}$$

The second indicator is the Coefficient of Variation (CV) for water price distribution. This is the ratio of the standard deviation (SD) to the average. The greater the value of CV, the more price disparity there is.

$$CV = \frac{SD}{Average}$$

For ease of comparison of the two indicators, we set them both at a scale of 100 for 2006 (Table 6):

$$IRq = \frac{Rq \times 100}{Rq(2006)} \quad ICV = \frac{CV \times 100}{CV(2006)}$$

Table 6. Water price disparity indicators for WSS's in the Rhône department between 2006 and 2009.

	2006	2007	2008	2009
1st quartile	1.63 €	1.69 €	1.58 €	1.72 €
3rd quartile	2.49 €	2.45 €	2.55 €	2.58 €
Median	2.03 €	2.10 €	1.96 €	2.07 €
Rq	1.52	1.45	1.61	1.50
IRq	100.0	95.0	105.8	98.6
Standard deviation	0.55 €	0.58 €	0.62 €	0.62 €
Average	2.09 €	2.14 €	2.08 €	2.13 €
CV	0.26	0.27	0.30	0.29
ICV	100.0	102.7	112.4	110.6

The first thing that stands out here is that the choice of indicator impacts the way in which price disparities are shown. For example, we can see in Figure 1 that between 2006 and 2007, Rq shows a reduction in disparity, whereas CV shows an increase over the same period.

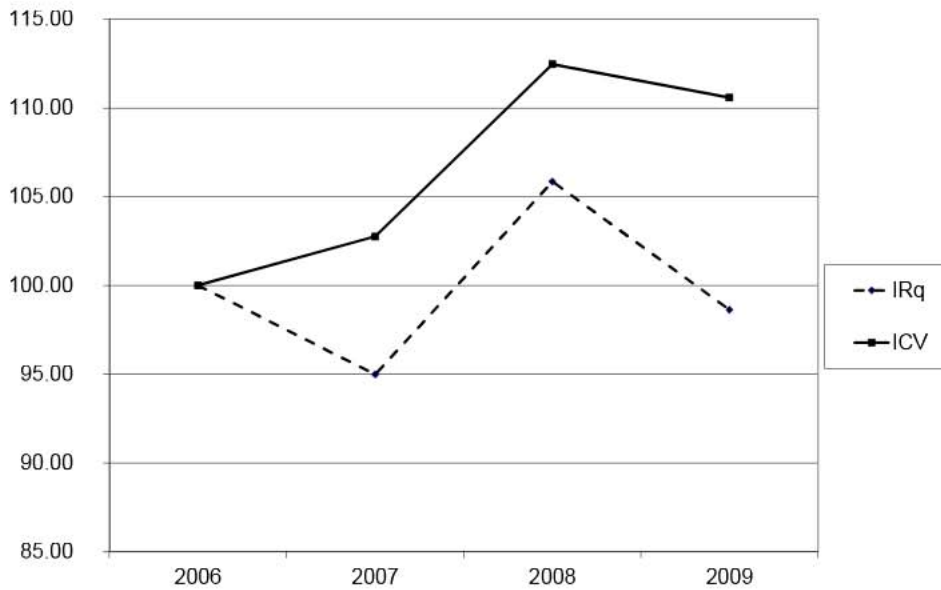


Figure 1. Evolution of water price disparity indicators

The second important point is that regardless of the indicator used, the current system does not lead to a reduction in water price disparity. To analyse this in more depth, we compared the evolution of average prices charged by subsidised and non-subsidised WSS's between 2008 and 2009 (Table 7). This showed that far from increasing as anticipated, the water price charged by non-subsidised WSS's actually reduced. The same was true in the case of subsidised WSS's, whose high prices increased even further. The effect was therefore to create more, rather than less, price disparity.

Table 7. Weighted average prices for subsidised and non-subsidised WSS's in 2008 and 2009.

	2008	2009	Evolution
Subsidised WSS's (18)	2.37 €	2.45 €	+ 0.08 €
Non-subsidised WSS's (19)	1.67 €	1.61 €	- 0.06 €
Ensemble (37)	2.13 €	2.15 €	+ 0.03 €

There are several possible explanations for the current system's failure to reduce price disparities:

- The current system only takes into account investment, whereas over 50% of the price of water is down to operating costs and taxes, changes in which can offset any benefits obtained through outside intervention.
- By aiming to both reduce price disparities and encourage pipe renewal, the system encourages high-price WSS's to carry out work without covering the full cost. The remainder of the cost is then met directly by the WSS, thus pushing up water prices further.
- Low-price WSS's are not encouraged to invest any money, meaning that their prices remain more or less stable. They may even drop further once debts are paid off.

The distribution of water prices in 2008 and 2009 (Figure 1) is consistent with these conclusions. Prices below 1.50 € did not increase, and prices above that level did not rise in accordance with the thresholds used to allocate funding.

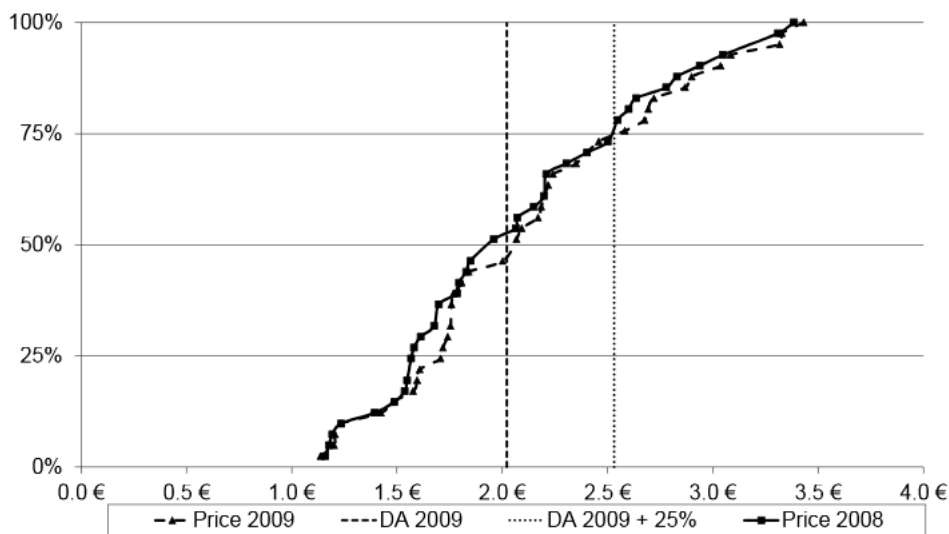


Figure 2. Water price distribution in 2008 and 2009

Improving asset management and reducing water losses

The aims of improving asset management and reducing losses are simultaneously targeted using a system of pipe renewal incentives, based on two key criteria. The first condition for receiving funding is to obtain a minimum AMI score (Table 2). The second criterion adjusts the standard rate of subsidy based on the combined values of the LLI and Renewal Rate (RR) (Table 5).

Although they are not expressly stated, the principles behind this system would appear to be the following:

- Having up-to-date plans and a renewal program (included in master plan) are essential elements for effective asset management.
- Effect asset management is defined by a high renewal rate and reduced water losses. It is therefore necessary to invest in networks with high water losses and low renewal rates (remedial system).
- Municipalities need to be encouraged to keep their renewal rate at least 1%
- Pipe renewal is the preferred method of reducing water losses.

To analyse whether or not the goal of improving asset management was achieved, we created three indicators (Table 8):

- The Length of Pipes Renewed (LPR) for the year
- The Annual Renewal Rate (ARR) for subsidised municipalities
- The number of Services Subsidised Annually (SSA)

Table 8. Asset management indicators from 2008 to 2011 inclusive

	2008	2009	2010	2011
SSA	14	15	17	18
LPR (km)	36	53	56	63
ARR	0.56 %	0.82 %	0.76 %	0.82 %

We found that there was a net increase in the number of WSS's receiving funding, and in the length of pipes renewed by these services. Also, while pipe renewal increased significantly between 2008 and 2009, it then stabilised at close to the desired level of 1% (Figure 3).

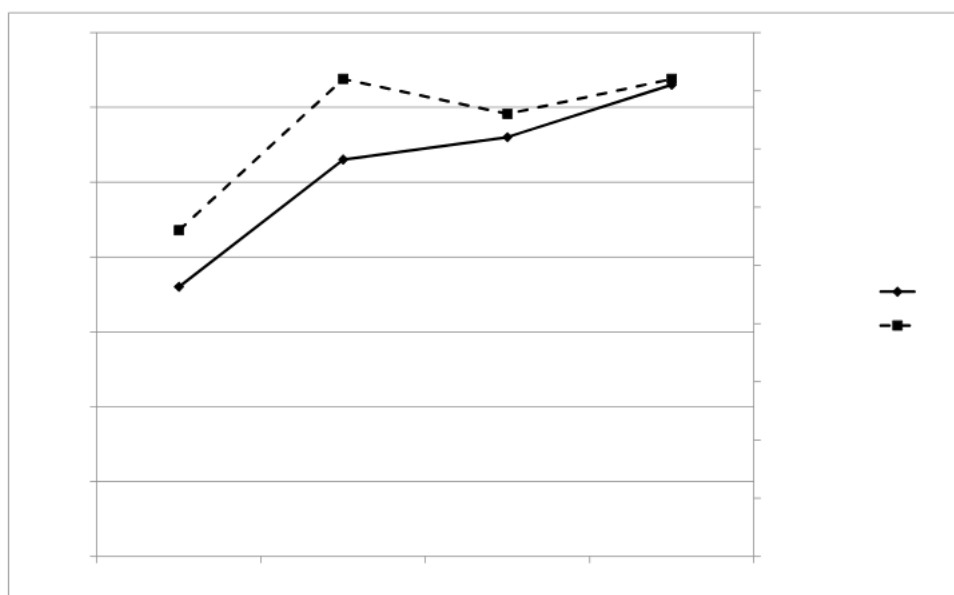


Figure 3. Evolution of LPR and RR from 2008 to 2011

It would appear that the current system is effective in encouraging the renewal of pipes for those WSS's who are eligible to receive funding.

To analyse whether or not the goal of reducing water losses was fulfilled, we used two performance indicators: the Linear Loss Index (LLI) (Alegre *et al*, 2006) and the Customer Leakage Index (CLI) (Renaud 2010). These indicators were calculated from 2007 to 2009 for ten WSS's who received funding from the Rhône department (Table 9).

Table 9. Loss indicators between 2007 and 2009

	2007	2008	2009
LLI (m³/km/day)	1.7	1.9	2.1
CLI (m³/customer/day)	0.11	0.12	0.13

These indicators show an increase in the level of losses between 2007 and 2009 (Figure 4). The funding system did not, therefore (within the period studied) attain its objective of reducing water losses.

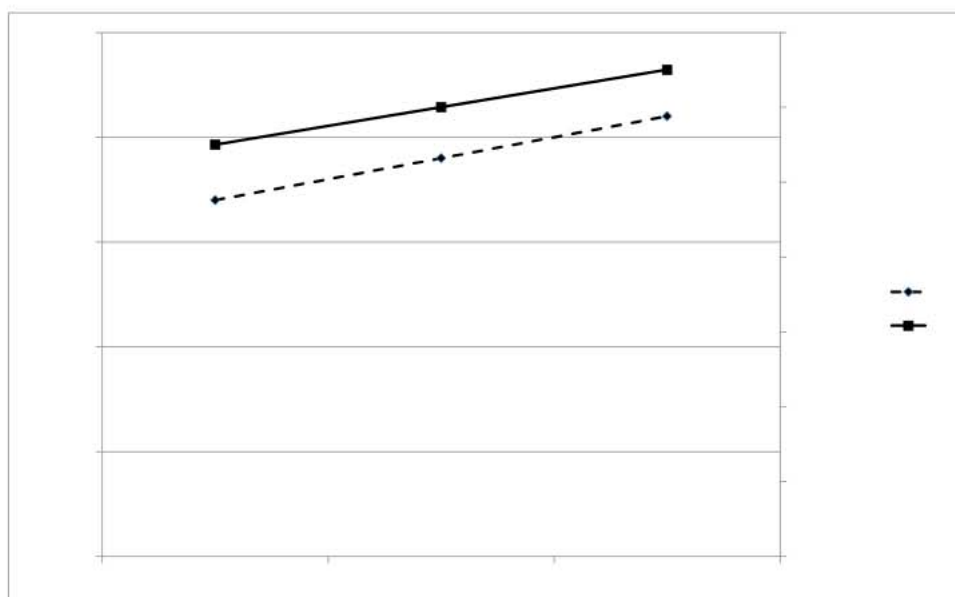


Figure 4. Evolution of LLI and CLI from 2007 to 2009.

Discussion

It would appear that the Rhône department's funding system, based on three criteria (water price, AMI, and a combination of LLI and RR) fails to fulfil two out of its three objectives, namely reducing water price disparities and reducing water losses.

With regard to the objective of reducing price disparity, it is important to take into account the large number of complex factors in play, and the fact that water prices are affected by a range of different things. Because of this, a sectoral approach (only involving pipe renewal) with low levels of funding (15% to 45% for eligible WSS's) will not produce any appreciable results. Indeed, in certain cases, notably - as we have shown - where high-price WSS's are encouraged to borrow more money, such a system may have negative effects.

For reducing water losses, the system uses the third criteria, centred on the LLI and RR, with the main aim being to help the most problematic WSS's: i.e. those with high loss levels and low renewal rates. This would appear to be a logical approach; however, any potential benefits are offset by the other two criteria. Because WSS's with water prices below the departmental average and an AMI score below 30 are ineligible to receive funding, many of the WSS's most in need of assistance are excluded.

Another shortcoming in the system is to base everything on pipe renewal. In reality, renewal can be used for a variety of objectives other than simply reducing leaks (Le Gaufre *et al* 2005) By the same token, pipe renewal is not the only means by which leaks can be reduced (Farley *et al* 2008).

In essence, the system is effective in so much as it encourages pipe renewal. However, the WSS's receiving funding are often the same, year after year. These WSS's have high water prices, which do not tend to be reduced as a result of work carried out. In addition to this, the more work that is carried out on a network, the less potential there is for reducing water losses.

Questions can also be raised about the relevance of using a "Renewal Rate" indicator with a fixed benchmark of 1% for all WSS's as a way of improving asset management. In reality, the optimum renewal rate for a given WSS is largely dependent on network construction history, as well as a range of other factors that influence the ageing and service life of water pipes (Renaud *et al* 2012) (Herz *et al* 2004).

CONCLUSION

The system used by the Rhône department to allocate subsidies for pipe renewal is based on clear objectives, applying criteria that take into account some of the performance indicators required by French water regulations. Thanks to this distinct framework, we were able to examine in depth their existing water funding operation, and carry out an evaluation based on available data.

It became apparent that using a single instrument (pipe renewal) to address all three of the key objectives (reducing price disparities, improving asset management, and reducing water losses) had mixed results.

One of the most significant issues was the use of water prices in determining eligibility to receive funding. This policy excluded a large number of water services who could have benefited a great deal from improvements to their asset management and reductions in water losses.

Pipe renewal is just one type of action that can be taken to achieve the required objectives. It would be advantageous for the Rhône department's water policy to start taking into account other possible means of improvement. To reduce water losses, pressure regulation and sectorisation, and active leakage control could be useful. From the point of view of improving asset management, it is important to take into account connections, and encourage the use of water main rehabilitation techniques.

Our suggestions on to how to improve the system are as follows:

- Simplify funding eligibility criteria to include only indicators of knowledge (existence of a master plan, asset knowledge) and finance studies aimed at improving this knowledge.
- Use water prices only to determine the level of funding rather than whether or not funding is allocated. Introduce a system of bonuses for high water prices and penalties for low prices.
- Provide funding for pipe renewal only where work is really required (service outages, reduced water quality, continuous leaks), rather than relying on renewal rates.
- Finance more work and studies aimed at reducing water losses, namely sectorisation and pressure regulation. When allocating funding, use an indicator that is simpler to interpret than LLI (e.g. Customer Leakage Index), and focus more on indications that WSS's are actively working to limit losses (e.g. leakage control rate).

To run an effective funding system, it is necessary to clearly define performance indicators at the planning stage. In order to do this correctly, data need to be collected from all WSS's (not only those receiving funding).

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