Addressing socio-economic and environmental impacts in sewer networks' rehabilitation decision making tools

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Introduction

Rehabilitation of sewer networks has to serve various objectives, both in terms of present general performance, and in terms of long term sustainability. Part of these stakes are external to the sewerage utility operation, such as social impacts of sewer failures, or social impacts of works. These external impacts are to some extend considered in real life decisions, and should therefore also be taken into account in decision support systems. CARE-S project (2003-05 EU 5th Framework Program), "Computer Aided Rehabilitation of Sewer systems", has developed a decision support environment and software prototype, including data management procedures, a set of performance indicators, models describing the condition and evolution of sewers, models describing the risks and consequences of failures, a database describing rehabilitation technologies with their characteristics, an assessment of socio-economic criteria, a long term planning tool, multi-criteria decision tools. The objective is to help utility managers to rehabilitate the right pipe, at the right time, with the right technology. Criteria concern on one hand impacts during rehabilitation works, criteria used for the selection of the best technique for rehabilitating the concerned pipe in a multi-criteria decision making procedure, on the other hand impacts during a failure, criteria used for the selection of pipes candidates for rehabilitation. We worked out criteria such as time loss due to traffic deviation, economic loss for trades due to accessibility problems during works but also criteria concerning ground water or surface water pollution damages risk during overflow or due to exfiltrations from the pipes. Concerning floods damages in cellars during overflow, valuation has taking into account methods used for river flooding damages concerning material goods (Werey & al., 2005)
A second project INDIGAU " Performance Indicators for urban sewer networks asset management" (financed by the ANR, French Research Agency, 2007-10) goes further on with the valuation of the impact criteria using methods coming from the environmental economics such as "Willingness to pay "or contingent ranking recently used for giving a value to intangible damages or impacts such as odours problems or loss of "sentimental affect" goods such as photographs during floods due to overflows of the networks (Larabi, 2009).
In our paper we will first present the impacts of failures or works identified in sewers management, the we will present the economic valuation methods and finally present two examples of criteria valuation: on one hand the valuation of loss of trade due to works using compensation data, belonging to indirect valuation methods, and on the other hand the valuation of dysfunction impacts on intangible goods using a "stated choice preferences" direct method.

1 – sewer networks management: how taking into account environmental and socio- economic impacts

1.1 Impacts definition

CARE-S project has developed a decision support environment and software prototype, including data management procedures, a set of performance indicators, models describing the condition and evolution of sewers, models describing the risks and consequences of failures, a database describing rehabilitation technologies with their characteristics, an assessment of socio-economic criteria, a long term planning tool, multi-criteria decision tools. The motto of the project was " how to rehabilitate the right pipe, at the right time, with the right technology".

So socio-economic criteria were developed (Werey & al., 2005) to take into account the impacts due to failures or to works on the network, this("indirect", or "external") costs have then be evaluated to feed the multi-criteria tools relying on both technical and socio-economic criteria:
- decision criteria for comparing a limited set of technologies when considering a given single pipe (impacts of rehabilitation works),
- decision criteria for comparing various rehabilitation projects, defined each at pipe level, given the related failures or failures hazards (impacts of failures).

So two set of impacts are to be taken into account:

Impacts of failures

10 criteria have been worked out concerning failures:
1: flooding damage to buildings and their contents, and business losses
2: flooding intangible damage
3: traffic disruption and trouble due to flooding
4: degradation of surface water quality and consequences on present or future water uses
5: degradation of groundwater quality and consequences on present or future water uses
6: waste water service interruption
7: traffic disruption and trouble, annoyances to life quality, due to soil depression
8: annoyances and damage from dry weather flooding in basements
9: annoyances and damage from dry weather flooding on the street
10: annoyances due to odours, insects, rodents
Our definition of failure is inspired by the French AFNOR standard on maintenance terminology NF EN 13306: termination of the ability of a pipe or of a network to perform a required function; a failure is a *defect* or a *performance deficiency* and is defined in reference to a required level of performance.

Impacts during rehabilitation works

In this case the following 5 criteria have been worked out:
1: noise
2: dust
3: service interruption
4: traffic disturbance and business losses

1.2 Link between dysfunctions and impacts

The failure impacts are linked with one or more different defects and dysfunctions and presented in table 1

Table 1 failures impacts considered in defining decision making criteria for selecting priority pipes for rehabilitation (Werey & al,2005)

DEFECTS AND MISFUNCTIONS					
	wet weather flooding (with probability)	blockages (with probability) in dry weather situation	structural pipe collapses (with probability)	combined sewer overflows	exfiltration
are they considered as failures ?	choice of end-user according to probabilities of reaching given levels	all of them	all of them	choice of end-user according to a set of parameters	any
presence of water in basements	1, 2	8			
presence of water on soil surface	1, 2, 3	9			
presence of water on buildings ground floor	1, 2				
pollution discharge to surface receiving waters				4	
pollution of groundwater (defined through “groundwater vulnerability” WP3)					5
no discharge possible to sewer		6			
soil depression			7		
odours, insects, rodents		10	10		

The impacts have been evaluated taking into account the different probabilities of failures or dysfunction occurrences and the effect of the natural or socio-economic environment of the pipe.

The criteria taken into account represent impacts on the natural environment (groundwater, surface water..) but also to the urban environment (damage to buildings, traffic disruptions…) and to the users disturbance by service interruption or flood damages as to economic activity.

1.3 Typologies considered for describing the pipe environment

For describing and possibly quantifying various components of vulnerability, we may consider an endless detailed description of population, buildings, river quality and morphology… Not only is there a limitation in available and manageable information, but moreover the decision maker has to be proposed a “reasonable” trade-off between detailed description and quantification on one hand, time and resources for processing on the other hand. This is true for hydraulic modelling as well as for socio-economic parameters. The paragraphs below show the way we chose to describe various dimensions of the pipe and network environment.

land uses

Dealing with vulnerability leads to taking into account different land use types, as they include for instance different population densities, different commercial activities… A CARE-S common typology corresponding to the typology addressed by standard EN752 for recommending levels of flood protection :

- rural
- urban housing
- city centre
- industrial area
- shopping area.

The decision-maker must also be able to define “special areas or buildings”, in a case-by-case way, for especially sensitive or special places (hospitals…)..

roads and traffic

Roads and the corresponding traffic are described by several parameters:

daily traffic flow: number of vehicles per day

number of lanes: absolute number for a street section

public transport through 5 classes

0 No public transport

1 Bus traffic with low frequency
2 Bus traffic with heavy frequency
3 Tram traffic
4 Tram + bus traffic
5 Heavy vehicles traffic: presence or not

groundwater types and uses

These are classified according to potential vulnerability:

- protected area for drinkable water production
- drinkable water production
- private domestic wells
- other sensitive water uses
- other water uses
- no water use
- no groundwater

receiving surface water types and uses

These are classified according to potential vulnerability:

- protected area for drinkable water production
- bathing area
- shell fisheries
- drinkable water production downstream
- fishing
- ecological area (protected / non protected)
- other sensitive water uses
- other water uses

2- How making an economic valuation of these impacts

In literature, several papers present works using economic valuation methods coming from environmental economics to evaluate externalities liked with a given environmental problem. Such methods were developed within cost-benefit approaches. In care-s and INDIGAU projects we use multi criteria decision tools, so “monetarising” criteria is not compulsory but we consider that it is a good way to give a value to a criteria, less subjective that a notation method.
These methods are generally based on the measurement of the variation of the individuals welfare variation due to a qualitative modification of the environment.
There are two methods developed in environmental economics: indirect methods based on revealed preferences and direct methods dealing with expressed preferences. Works exist making economic valuation of the impact of a pollution but very few concern sewerage networks or equipments.
In a general way, effects are similar (water pollutions, air pollution, noise, mortality, morbidity) and approaches used in other contexts (waste, noise pollution) can be used as example for a monetary valuation of sewer defects impacts.

2.1 Indirect methods

Revealed preferences methods suppose “Willingness to pay “ of agents can be established by observing their behaviour transactions concerning trade possessions trade goods. The objective is to reconstitute the characteristics of “'unobservable “ behaviours using “ empiric proofs”. They are revealed approaches.

the most common methods are: the travel cost method, the hedonist prices method, the protection cost method and the accounted costs method.

2.1.1 Travel cost method

This method has been developed for giving a value to leisure demand by economic agents (Clarwson& Knecht, 1967).the idea was that the spendings The spendings granted by the households to go to natural, tourist or leisure sites and the entry cost establish a revelation of the value they give to the existence of the site.

So this method can give a value of the impact in case of pollution and concerning sewer dysfunction such as pollution discharge to surface receiving water, when it concern surface water having recreation uses.

2.1.2 Hedonist prices methods

The objective of this method was to appreciate the value that individuals grant to the change of a component of the environment, given the localisation of their habitation considering that they would accept to pay their habitation more to avoid environment problems. This method was used to evaluate air pollution and noise effect near airports, and also concerning nuisances due to solid waste treatment plants (Chèze, 2007). It needs many data so that the other characteristics of habitations are sufficiently represented.

Concerning sewer's dysfunctions this method could be a way to evaluate the impact of odours.

2.1.3 Protection costs method

This method bases on the consumer choice theory, and more specifically on the observation of the production function of households. We can calculate, indirectly, the cost of the pollution impact by taking into account the spendings made by households to protect themselves from an environment degradation . This methodology has been used for noises impacts due to airports by evaluating the costs of Double glazing, it has also been applied for the valuation of the cost of the contamination of ground water in Pennsylvania (Abdalla & al., 1992).

Concerning sewer dysfunctions, protection costs due to double glazing could be imagined during works with a long duration.

2.1.4 Accounted costs method

This method relies on the data analysis of compensations that have been given similar cases. For instance concerning the realisation a new tramway lines, prealable compensation procedures exists to take into account the loss of trade for the activities in the street concerned by the new line. We used such data to make a typology of the different activities, we will present his valuation in the third part.

2.2 Direct methods

The idea is here to create an hypothetical market to observe directly the value of goods for which there exists no market. The specificity is that the value will be given by the individuals during interviews. We will focus on the two principal methods, “contingent valuation” and “choice modelling” approaches.

2.2.1 Contingent valuation

This method bases on the agents expression of their “Willingness to pay “ , using a contingent market, that is to say an hypothetical market were environmental goods can be sold and bought. It is widely used for environmental impacts valuation. It has been used by the American Water Resources Council and is promoted by the water framework directive (2000).

The methodology uses a questionnaire making the agent give the value he is ready to pay to avoid or to reduce a given impact. It can give an answer ex-ante to the impact of a environmental policy This methodology has been applied to value benefits of river floods protection (Deronzier & Chegrani, 2005), also in 2003 concerning annoyances due to a waste water treatment plant (CMV2, 2003).

2.2.2 Choice modelling

The Choice modelling is one of the stated preferences. The difference comes from the fact that contingent evaluation gives a value at a global level, were as choice modelling decomposed the good to be evaluated in several attributes, an one of this attribute is a cost to pay to reduce the impact. So the agent doesn't have to give the value of his willingness to pay, given the discribed situation as in the precedent method, but to classify different scenario reducing more or less the impact and costing more or less.

This approach has been used by Adamowicz et al. (1994) for valuing recreative preferences on two Canadian rivers Alberta. Dachary-Bernard (1994) used the same approach to analyse landscape economical value in the Monts d'Arrée (France).

This methodology has been applied to value intangible damages due to floods or odours coming from dysfunctions on the network, his work is presented in part 4..

3 – Valuation of the impact of works on loss of trade

Loss of trade means that because of the works, trades suffer from economic losses. This is linked essentially to the duration of the works, the location of the street, its accessibility, the technique put into place…People can decide to delay their purchases another day because the shop is in a works area and there are difficulties to access it by car or by bus for traffic jam reasons, or because the pavement is uneven and it is difficult to walk on it… People can also decide to go to another shop and come back to the "works concerned shop" once the works are finished, or maybe never come back…
Goods delivery may also be disturbed. In specific cases, if the goods are not in place at a given time of the day, they will not be sold: newspaper, bread….
Parking possibilities and public transportation facilities will of course have be significant in the consumers' attitude, we will focus here on the question of accessibility of the shops at the street level.
In literature, loss of trade is studied as a social cost mainly for situations of service interruptions (essentially concerning water delivery for sensitive activities) or during big public works such as new tramway laying.

3.1 methodology

One example of monetary valuation is given by Angot (2001) when using a technique with trench opening on the pavement. takes into account the fact that parking and access to shops can be disturbed. One possibility for valuation is to consider the tax that shops are paying to the municipality to occupy the public area of the pavement in front of their shop or trade. Another way is to take into account the loss for the parking manager, in this case, the cost of losing parking space can be calculated as follows:

$$C_p = C_l \cdot 10h \qquad (1)$$

with

C_p	cost of consumption of parking place (€/m^2/day)
C_l	hourly cost of lending the parking place (€/m^2/h)
10h	operating duration in hours of a ticket machine per day.

Other valuation made by AWWARF (2002) or CSIRO (Speers, Burn et al., 2002) used for water supply disruption take into account the decrease in turnover concerning the economic activity and propose results within a typology of economic sectors.
We identified also a method used in France in relation with big urban projects such as tramway works; because of the duration of the works and the area of the working site, works like laying a new tramway line often lead to compensation requests. The loss of trade during works is due essentially to accessibility problems of the shop itself or of the works area.
In France, several towns have decided to construct new tramway lines, and have put into place a conciliatory compensation procedure. The compensation risk is taken into account in the project cost valuation. So more and more information is provided to shopkeepers, craftsmen and freelancers concerning their possibility of asking for compensation, which is possible if they are directly concerned by the works.
The calculation of the compensation is given in equation 2 and used by chartered accountants:

$$\text{Compensation}_w = (\text{TTO}_w - \text{RTO}_w) \cdot \text{CM} - \Delta SC_w \qquad (2)$$

with

w	period concerned by the works
TTO	average theoretical turnover during the 2 years before the works for the corresponding period w
RTO	real turn over during the period w
CM	gross income ratio for the victim or the national average for the economic sector concerned
ΔSC	variation of staff costs on period w

The first part represents the loss of contribution margin and the second one the saving in fixed costs concerning the staff. The gross income ratio is calculated on the 2-years-period before works and compared to the value of the national gross income ratio in the same activity sector. Depending on the activity, seasonal factors can be introduced.
In regard to this valuation method,, a survey has been made in Strasbourg for works corresponding to one tramway line. The average duration of these works was 15 months. 93 requests have been examined on which we had the information of the compensation value. We classified them into a 14 activities typology presented in table 2..

Table 2 activities typology in the sample (Werey, 2005)

categories	**Detail**
FOOD PRODUCTS	Butchery, Bakery, coffee, tea houses, chocolate shops, health food shops
HEALTH CARE	Doctor, Dentist
PETROL SUPPLY	wholesaler to service station
CULTURE & LEISURE	Travel agency, Music and instruments shop, Gymnastic centre Cinema
EQUIPMENT FOR THE HOUSE	Furniture shop
EQUIPMENT FOR THE PERSON	Florist, Sport wear shop, Clothing shop, Shoes shop, Jewellery
MEDICAL EQUIPMENT	Pharmacy, Optician, Biological products
BOOKSHOP	
RESTAURANT	Restaurant,, Fast food, Cake-shop, Tea-room
HEALTH, BEAUTY and HYGIENE	Hairdresser, Beauty centre
SERVICES TO PERSONS	School of motoring, Insurance office, Dry cleaning
SERVICE STATION	
SUPERMARKET	
TOBACCONIST	

In our analysis, we focused on the valuation of 28 of them on which we got detailed information of the calculation steps. With this reduced sample we defined for each activity sector the ratio (average loss of trade/theoretical turn over) on the works period with the loss of trade given by the difference (loss of contribution margin – economy on staff costs), that gives an idea of the relative loss of each activity sector and in this way of the sensitivity of the economic activities. These results are presented in table 3.

Table 3: reduced sample – loss trade/turn over (Werey & al., 2005)

Activity categories	Number of requests	%(Loss of trade)/theoretical turn over
ALIMENTARY PRODUCTS	**4**	**14**
HEALTH CARE	1	4
FUEL DELIVERY	1	2
CULTURE & LEISURE	1	2
EQUIPMENT FOR THE HOUSE	1	4
EQUIPMENT FOR THE PERSON	3	**26**
MEDICAL EQUIPMENT	3	1
BOOKSHOP	0	/
RESTAURANT	**6**	**22**
HEALTH, BEAUTY and HYGIENE	1	19
SERVICES TO PERSONS	0	/
SERVICE STATION	1	**28**
SUPERMARKET	2	4
TOBACCONIST	**4**	7
total	28	

We can see that the most sensitive activities concern food products, equipment for the persons, restaurant and service station.

On the whole sample we looked at the relative average compensation cost per sector activity, that gives an idea of the scale of the cost for the utility, showing for instance that for a supermarket the ratio previously presented can be low but that the compensation amount will be high because of the size of the activity. The analysis of the global sample is presented on table 4

Table 4: whole sample – compensation scale (Werey & al., 2005)

Activity categories	Number of requests	Loss of trade scale
FOOD PRODUCTS	6	30
CONSULTING	5	13
FUEL DELIVERY	1	37
CULTURE & LEISURE	4	**71**
EQUIPMENT FOR THE HOUSE	2	**64**
EQUIPMENT FOR THE PERSON	**20**	40
MEDICAL EQUIPMENT	5	47
BOOKSHOP	4	55
RESTAURANT	**24**	31
HEALTH, BEAUTY and HYGIENE	6	53
SERVICES TO PERSONS	4	39
SERVICE STATION	1	31
SUPERMARKET	3	**100**
TOBACCONIST	8	30
total	93	

Here we can see that the activities culture-leisure, equipment for the house, supermarket represent the highest compensations.
These results have been integrated in the proposed valuation as following:

3.2 LossOfTradeW criteria calculation

For dig techniques

In this case the working area is whole length of intervention LossOfTradeW is given in equation 3

$$LossOfTradeW_{dig} = L \cdot d \cdot r \cdot p \cdot E_{dig} \qquad (3)$$

with

L	length of the works (m)
d	duration of the works (days)
r	if “need to later reopening of laterals” or “digging for reconnecting laterals” r=1,2 if no “need to later reopening of laterals” or “digging for reconnecting” laterals r=1
p	in case of “digging requirements: pit damage”, p=1,1 if no pit damage p=1
E_{dig}	loss of trade factor presented in table .5

Table 5: E_{dig} loss of trade factor for dig technique (Werey & al., 2005)

			Noise							
			Y				N			
			Dust							
		number of lanes	Y		N		Y		N	
Land use	rural = 1	pedestrian street = 0	50	50	40	40	40	40	30	30
		1	50	50	40	40	40	40	30	30
		2	20	20	15	15	15	15	10	10
	urban housing = 2	pedestrian street = 0	30	30	20	20	20	20	10	10
		1	30	30	20	20	20	20	10	10
		2	15	15	10	10	10	10	5	5
	City center = 3	pedestrian street = 0	120	120	110	110	110	110	100	100
		1	120	120	110	110	110	110	100	100
		2	70	70	60	60	60	60	50	50
	industrial area = 4	pedestrian street = 0		0		0		0		0
		1	130	130	120	120	120	120	110	110
		2	130	130	120	120	120	120	110	110
	shopping area = 5	pedestrian street = 0	120	120	110	110	110	110	100	100
		1	150	150	130	130	130	130	120	120
		2	80	80	70	70	70	70	60	60
	special area = 6	pedestrian street = 0		0		0		0		0
		1		0		0		0		0
		2		0		0		0		0

Trenchless techniques

Equation 4 gives the valuation of LossOfTradeW

$$LossOfTradeW_{trenchless} = a_{l,s,n} \cdot d \cdot (p + s) \cdot r \cdot E_{trenchless} \quad (4)$$

with

$a_{l,s,n}$	trip time factor given in table .6
l	number of lanes (0,1, 2)
ws	location size (< 100,100-300,300-800)
wn	number of working locations coefficient (1,2) (if variable we consider=2)

table 6 $a_{l,s,n}$trip time factor (Werey &al., 2005)

			Number of lanes l	
	Location size ws	location nb wn	$l=1$	$l=2$
trip time factor $a_{l,s,n}$	<100	1	**1,3**	**1,1**
		2	**1,5**	**1,3**
	100-300	1	**1,5**	**1,3**
		2	**1,8**	**1,5**
	300-800	1	**1,8**	**1,5**
		2	**2**	**1,8**

r if "need to later reopening of laterals" or "digging for reconnecting" laterals
r=1,2
if no "need to later reopening of laterals" or "digging for reconnecting" laterals r=1

p in case of pit damage,
p=1,1
if no pit damage p=1

s in case of surface damage s=0,05
if not s=0

$E_{trenchless}$ loss of trade factor

$E_{trenchless} = 1/3.E_{dig}$

Concerning this impact in the case of failure, the valuation is included in the criteria 1: “flooding damage to buildings and their contents, and business losses” and relies of results coming from river flooding impacts valuations linked with the characteristics of the buildings.

4 – valuation of the impact of dysfunction on intangible goods

The function of a sewer network is to collect , waste water and/or rain water and to forward them to the treatment plant. Networks are generally dimensioned for collecting rain water up to events of 10 years frequency. So the risk of flooding exist when rain events are more important. Our purpose are flooding events due to dysfunction of he sewer system.

4.1 Causes and consequences of flooding

Damages can concern different goods: tangible that is to say material goods on one hand, theses are goods whose monetary value is established by the insurance companies, intangible goods on the other hand which are hard to value. Intangible goods gather for instance:

- degradation of personal effects with high affective value such as photographs
- stress due to the fair of a new flood to come, much more existing in relation with river floods
- odours coming from the sewers…

…

4.2 Objectives

Intangible goods lead to subjective costs for individuals. In order to take into account the welfare of individuals, we wanted to evaluate the amounts people would be ready to pay to avoid these damages.

The method we used is choice modelling because essentially of the decomposition in attributes which is interesting here, because we have several intangibles. The method relies on the fact that by presenting several combination of these attributes, individuals, here sewer consumers, are invited to reveal there preferences.

4.3 methodology

We defined our attributes and their levels and built so fictive amelioration programs. Attributes and levels are given in the following table 7.

table 7 attributes and levels (Larabi,2009)

Attribute	level
Reduction of flooding risk by	1- 0 % 2- 50% 3- 80%
Reduction of the water level by..	1- 0 cm 2- 10 cm 3- 15 cm
Reduction of odours by	1- 0 % 2- 50% 3- 80%
Contribution	1- 10 euros 2- 25 euros 3- 50 euros

These scenario were compared with the statue-quo (paying nothing and doing nothing) situation by using choice cards.
People had to class the different programs, from the best to the worst.

We have 4 attributes and 3 levels for each, that means 81 possible programs. Using the orthogonal design function within he SAS software we could reduce the number of cards, keeping a significant result. So 18 programs in 6 cards were proposed during to enquiry to each person. It is necessary that the number of cards is few to keep a good attention of people on all the cards.
So people had to classify 6 choice cards like the following one in table 8:

table 8 one of the six choice cards (Larabi, 2009)

1	Program A	Program B	Program C	Program D Statue quo
Reduction of flooding risk of	80%	0%	50%	0%
Reduction of the water level of..	15cm	10cm	0cm	0
Reduction of odours of	0%	50%	80%	0%
Contribution	50€	25€	10€	0€
Classement				

4.3 sample

The survey has been done on 200 habitants from 5 municipalities of 28 of the Urban Community of Strasbourg by a consultancy specialised in inquiries linked with environment impact valuation, within the INDIGAU project during may 2009. The people concerned by the survey are or have been concerned by .odours or flooding events

4.4 analysis of the survey data

The analysis was made with a Random Utility Model (Hanley et al., 2001). the utility is an index giving the importance of each attribute.
Random utility models assume, as neoclassical economic theory, that the decision-maker has a perfect discrimination capability. In this context, however, the analyst is supposed to have incomplete information and, therefore, uncertainty must be taken into account. Manski (1997) identifies four different sources of uncertainty: unobserved alternative attributes, unobserved individual attributes (called ``unobserved taste variations'' by Manski, 1997), measurement errors and proxy, or instrumental, variables.

The utility is modeled as a random variable in order to reflect this uncertainty. Similarly to the neoclassical economic theory, the alternative with the highest utility is supposed to be chosen.

4.5 results: willingness to pay

The Multinomial Logit Parameter Estimates showed that only 2 attributes were significant: Reduction of flooding risk and reduction of odours.
The willingness to pay value correspond to the marginal rate of substitution between the level of the considered attribute and the monetary attribute, the results are given in the following table 9

table 9 willingness to pay results (Larabi,2009)

Attributes :	**Willingness to pay (€/an)**
RI 50%	**60€**
RI 80%	**99€**
RO 50%	**-16€**

Thus people are ready to pay 60 euros per year to reduce of 50% the risk of flooding, 99 euros to reduce this same risk of 80 %.
Concerning the odours the negative results means that people are ready to support the impact but to be paid 16 euros per year

Conclusion

Our purpose in this paper was to show how environmental impacts can be taken in decision tools for sewer rehabilitation work programs. Environment is considered on the natural point of view but also on the human activity point of view. Environment economics methods seem to be well adapted to give trends and values but they are heavy to put in place because needing many data coming from different services or company of the network territory or needing he realisation of enquiry. Many evaluation still exist but not concerning sewer networks, the most nearly works concern evaluation of damages by rivers (Euleterio, 2008).

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