

Recommendations for online elicitation of swing weights from citizens in environmental decision-making

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SI 1. Case study related information

SI 1a. Description of the objectives

We present an English version of the text. These texts were then translated to French by a French science communication professional. Additional adjustments were made thereafter in the French version only, thus explaining some small differences in the text. The survey was carried out in French. The original text in French used for the survey is available on request.

Objective English text (before translation and further adjustments)
code

	The five management options (management 1–5) can be evaluated according to how well they protect the natural environment. Ideally, a new wastewater management system should lower the impact on air, water and soil quality.
Nut	For instance, it should decrease the discharge of nitrogen to the rivers and air . Wastewater contains different forms of nitrogen. It includes reactive forms such as nitrate and ammoniac. Today, these are not fully removed in the wastewater treatment plant. Excess nitrate in rivers can cause growth of algae. The algae use the oxygen, and in severe cases, other aquatic life such as fish may die. Ammoniac is toxic when breathed and very toxic for aquatic life. The gas contributes to air pollution events. The discharge of nitrogen from the wastewater facilities to the rivers and air is measured in grams of nitrogen per person per day. If there was no treatment at all, the discharge would be of 13 grams of nitrogen per person per day. Currently , every person discharges 4.7 grams of nitrogen each day to the river and the air via the wastewater treatment plant. This is the worst case . This discharge in the river Seine corresponds to twice as much as the threshold set by river quality experts to define a good quality river. In the best case , nitrogen discharge can be more than halved: per person, it is reduced to 1.8 grams of nitrogen per day. In this case, the water would be of good quality.
Mic	A second objective can be to decrease micropollutants in the rivers and soils . Micropollutants in wastewater stem for instance from pharmaceuticals, cosmetics, shampoo, perfume, cloth waterproofing chemicals, etc. Today, many micropollutants are not removed by the usual wastewater treatment plants (management 1). Micropollutants are extremely diverse (over 100'000 molecules). The European Water Framework Directive requires monitoring of only 52 of them. Micropollutants may cause a risk to aquatic and soil life, even at low concentration. Precise effects of micropollutants are not fully known. By precaution, to reduce micropollutants levels in discharged water, our Swiss neighbors have to upgrade all the wastewater treatment plant. Micropollutants spread on fields and discharged in water are measured by an index in unit per person per day. It allows relative comparison, despite the uncertain environmental impact.

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Currently, from every person, 13 units are spread on soils and discharged into rivers every day. In the **worst case**, from every person 16 units of micropollutants reach the rivers and soils every day. In the **best case**, only 9 units per person and day reach the river, which means that the risk to the environment is reduced.

Ghg A third objective can be to **decrease the emission of greenhouse gases**. Greenhouse gases contribute to climate change. They are emitted during wastewater management at the following steps, listed from the most to the least important: during the wastewater processing at the wastewater treatment plant, energy used for treatment, chemicals used for treatment, and transport of sludge. The emission of greenhouse gas is measured in grams of gas converted in CO₂ equivalents per person and per day.

Currently, 166 grams of CO₂ are emitted from each person from the wastewater system every day. This is the **worst case**. France has committed to divide by four his emissions according to the Paris Climate agreement. Thus, the aim would be to emit 42 grams of CO₂ per person per day or less. In the **best case**, the wastewater system can help avoiding other emissions (e.g. fertilizer synthesis, bio methane production). So, in the best case, the balance between the emission originating from the system and the avoided emissions becomes negative: -5 grams of CO₂ per person and per day. The target would be met.

The five management options (management 1–5) can also be evaluated according to how well they increase societal welfare.

Hea For instance, it [a management option] should **increase the possibility of swimming in rivers**. Wastewater contains pathogens, such as some strains of *E. coli*, that can cause, for example, diarrhea, nausea or vomiting. People may get in contact with contaminated water that reaches rivers from the wastewater system. The *E. coli* discharge into the river is estimated by the number of *E. coli* colonies that appear in a standard dish of 100 ml of river water. According to European rules, swimming in rivers is allowed if there are less than 900 *E. coli* colonies in 100 ml of river water.

Currently, we estimate that 17'100 colonies of *E. coli* appear in 100 ml of water from the river Seine. This is the **worst case**. It means that swimming in the Seine is not allowed because the health risk is high. In the **best case**, *E. coli* in the river Seine can be reduced to 8 colonies in 100 ml of river water. In this best case, there is low health risk and swimming in the Seine would be allowed.

Com Also, a wastewater system should **increase the chance of compliance by end-users (you)**. The more unusual the wastewater management is, the more you will need to adapt. For instance, to warrant a functioning system, you may need to use specific products for maintenance of pipes or adapt to new types of toilet bowl receiving urine and feces. The more adaptations required, the higher the chances of not using the toilets properly. This can be balanced by the severity of the system breakdown following non-compliance. If you don't have functioning toilets anymore following misuse, you most likely will not repeat the problematic behavior. The chance of compliance is measured by an index, estimated by experts. It considers how many changes are expected and the rate of compliance to the user manual after learning occurred.

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In the **worst case**, the chance of compliance index is 0 (the system implies many changes for the end-users that are difficult to adapt to, and the misuse lasts). In the **best case**, there is little change expected and no misuse, so the chance of compliance is 10.

The five management options (management 1–5) can also be evaluated according to how they use natural resources.

Pho	Some wastewater management options increase phosphorus recovery . Phosphorus is a nutrient that plants need to grow. Farmers apply phosphate fertilizers to crops and vegetables. They often use phosphorus that is mined in industrial mining plants. The phosphate rock reserves are rapidly decreasing worldwide. Some companies are considering to mine the deep ocean next. Meanwhile, most the phosphorus contained in our food ends up in our urine and feces. Dedicated treatment could recycle this phosphorus. Phosphorus recovery is measured in % of phosphorus initially contained in the wastewater. Currently , 41 % of the phosphorus in wastewater is recovered and brought to fields as sewage sludge. This is the worst case . It represents one fourth of the quantity of phosphorus lost by the soils feeding an inhabitant of the Grand Paris due to erosion. In the best case , 81 % is recovered from urine or feces and brought to fields as fertilizer or compost and/ or sludge. It represents half of the quantity of phosphorus lost by the soils due to erosion.
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Wat	Some wastewater management options can increase water saving . Most usual toilets today use 3 to 6 liters of water for each flush. Usually, this is most likely drinking water. Some toilets can strongly reduce water consumption for flushing toilets. Decreasing water consumption is very important worldwide, especially in arid regions. However, even in water rich countries such as France, reducing water consumption may be important. Paris region is facing more frequent droughts, particularly in autumn and spring. Heat waves are also occurring more often, and are even more severe in urban areas (urban heat island effect). Thus, another water use emerges: water is necessary for many cooling measures. Water consumption is measured in liters per person and per day. Currently , a person uses on average 26 liters of drinking water every day to flush the toilets. This is the worst case . This is about 20 % of the total drinking water used, which is on average 120 liters in Paris per person and day. In the best case , no water is used to flush the toilets (0 liters per person and day).
-----	--

The five management options (management 1–5) can also be evaluated according to their economic performance.

Job	Some wastewater management options can increase or decrease the number of local jobs . Engineers, technicians, managers, chemists, etc. work on the maintenance, repair and renewal of the sewer system and at the wastewater treatment plant. We measure the number of jobs per 100'000 inhabitants of the Paris region. Today , per 100'000 inhabitants in the Paris region, about 40 people work for the operation and maintenance of the wastewater system. This equals 0.06 % of a total of about 5'000'000 people working in the Paris region. This is the worst case . In the best
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case, this number is doubled; there are 80 jobs for the wastewater system per 100'000 inhabitants. This equals 0.12% of a total of about 5'000'000 people working in the Paris region.

Cost	Some wastewater management options can increase or decrease the costs . Today , a person in the Paris region pays about 125 € per year for wastewater collection and treatment. This cost comprises the investment and operation costs. Higher costs can become difficult to afford for inhabitants but it also means that the society invests more in the management of urine and feces. In the worst case , the wastewater system can cost 142 € per person and year. This equals 0.7% of the median annual income of a person in Ile-de-France, which is about 21'800 € per year (as many person in Paris earn less than 21'800 € per year as many earn more than 21'800 € per year). In the best case , the wastewater system costs 92 € per person per year. This equals 0.4 % of the average annual income of a person in Ile-de-France.
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SI 1b. Description of the alternatives

The alternatives were **not** presented in the survey. We add short descriptions hereafter for the unfamiliar reader who may want to know why/ how these alternatives impact the citizens' daily life.

-
- Alt.1 **Management 1 “As usual”**. It is the status quo alternative. All buildings are connected to a centralized system. The urine, feces and greywater are transported in sewers to the wastewater treatment plant.
-
- Alt.2 **Management 2 “Concentrated urine”**. Urine source separation toilets are installed in new buildings. Two sewer systems exist: one for urine only and another for feces and greywater. The urine pipes lead to a local urine treatment plant, where disinfection and concentration of the urine occur. It produces a concentrated liquid fertilizer. The feces and greywater pipes lead to a wastewater treatment plant as usually done today.
-
- Alt.3 **Management 3 “Stored urine”**. Urine source separation toilets are installed in new buildings. Urine pipes lead to a urine tank in the basement of each building. When the tanks are full, trucks collect the urine and transport it to a storing facility. During storage, natural disinfection of the urine occurs. After a few months, urine is then spread on fields, as a fertilizer. A sewer system remains for feces and greywater, as today.
-
- Alt.4 **Management 4 “Vacuum”**. Vacuum toilets are installed in new buildings. There are two sewer systems: a vacuumed one for mixed urine and feces, and another one as today for greywater. The vacuumed pipes (containing urine, faeces and very little water) lead to a local wastewater treatment plant. The greywater is discharged to the usual wastewater treatment process, at the same local wastewater treatment plant.
-
- Alt.5 **Management 5 “Compost”**. Dry toilets are installed in new buildings. The toilet is connected to a vertical chute. Urine and feces fall in a composting unit in the basement of each building. Most liquids evaporate during the composting process and the remaining leaching liquids are diverted to the greywater, which is collected in separate pipes. The compost is used in agriculture. The greywater pipes lead to nearby constructed wetlands, where microorganisms “treat” it.

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SI 1c. Prediction matrix. It displays how each alternative (columns estim_alt1 to estim_alt5) fulfils each objective (rows). Nut = Low release of nitrogen to the rivers & air; Mic = Low release of micropollutants in the rivers and soils; Ghg = Low greenhouse gas emission; Hea = High recreation and swimming in rivers; Com = High chance of compliance by end-users; Pho = High phosphorus recovery; Wat = High water saving; Job = High number of local jobs; Cost = Low cost. For the meaning of the units, please refer to the full objective description in SI 1a. The predictions (or how each alternative fulfils the objectives) were obtained through modelling of the system, as described in Esculier et al. (in prep.)

obj_name	unit	worst	best	estim_alt1	estim_alt2	estim_alt3	estim_alt4	estim_alt5
Nut	gN/p/d	4.7	1.8	4.7	1.8	1.9	2.5	4
Mic	unit/p/y	16	9	13	9	13	16	15
Ghg	gCO2eq/p/d	166	-5	166	37	17	51	-5
Hea	CFU/100mL	17100	8	17100	17100	17100	3800	8
Com	index	5	9	9	7	6	9	5
Pho	%	41	81	41	59	59	77	81
Wat	L/p/d	26	0	26	16	16	6	0
Job	jobs/100.000							
Job	inhab	41	80	41	43	52	53	80
Cost	€/p/y	142	92	125	142	134	125	92

Esculier, F., Aubert, A.H., Lienert, J., Larsen, T.A., in prep. Selection and assessment of criteria to evaluate scenarios of urine and faeces urban management.

SI 2. Online swing weight elicitation survey

SI 2a. Main steps

The screenshot shows a web browser window displaying a survey titled "Le futur des urine et matièr...". The survey content is in French and discusses the impact of wastewater management on society. The text is as follows:

Améliorer le bien-être de la société suppose que le système de gestion des eaux usées devrait diminuer son impact négatif sur les utilisateurs finaux (nous tous). Cet objectif général est défini par 2 sous-objectifs :

- **Augmenter les possibilités de baignade en rivière.**
Les eaux usées contiennent des pathogènes, tels que *E. coli*, qui peut causer, par exemple, des diarrhées, nausées ou vomissements. Lors de baignade en rivière ou pêche, des personnes pourraient être en contact avec des eaux contaminées issues du système des eaux usées et qui auraient atteint les rivières.
Le déversement d'*E. coli* dans une rivière est estimé en comptant le nombre de colonies d'*E. coli* dans 100 mL d'eau. Selon la réglementation européenne, la baignade en rivière est autorisée en-dessous de 900 colonies de *E. coli* dans 100 mL d'eau.
Actuellement, on estime que 17 100 colonies d'*E. coli* sont présentes par 100 mL d'eau de la Seine. C'est le **pire** des cas. Cela implique que se baigner dans la Seine soit interdit, le risque sanitaire étant élevé.
Dans le **meilleur** des cas, la quantité d'*E. coli* dans la Seine pourrait être réduite à 8 colonies par 100 mL d'eau. Dans ce cas, le risque sanitaire serait faible et la baignade pourrait être autorisée dans la Seine.

- **Augmenter la probabilité d'usage correct par les utilisateurs finaux (c'est-à-dire vous).**
Plus un système de gestion des eaux usées est inhabituel, plus vous aurez besoin de vous adapter. Par exemple, pour garantir le fonctionnement du système, vous devrez peut-être

Annotations on the right side of the screenshot:

- Objective name
- Definition
- Potential impact
- Status Quo
- Worst case
- Best case

Fig SI.2a.1. Step learning about the objectives. Screenshot of the online swing weight elicitation developed with Qualtrics (platform for survey, (www.qualtrics.com, retrieved on 19.07.2018)). The objectives are described in SI 1a, above.

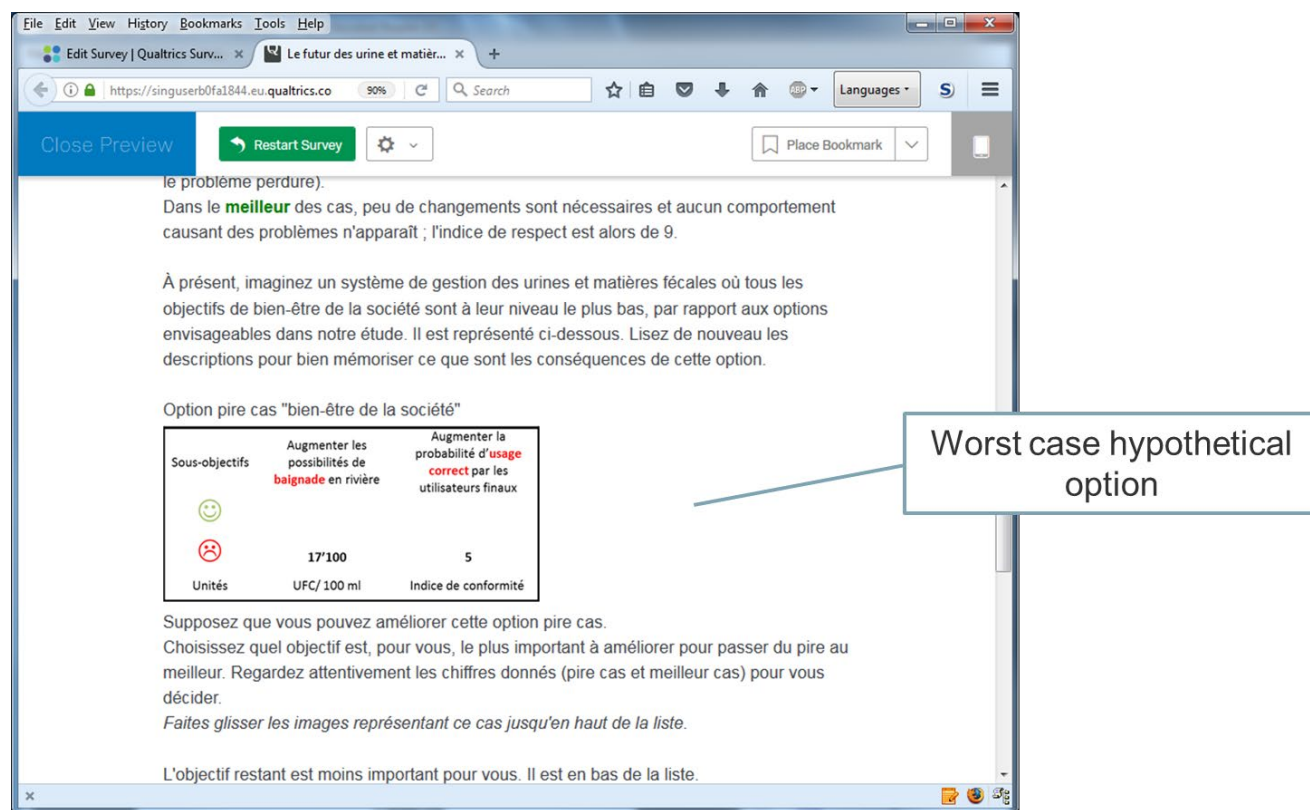


Fig SI.2a.2. Step learning about the worst case hypothetical option. Screenshot of the online swing weight elicitation developed with Qualtrics (www.qualtrics.com, retrieved on 19.07.2018).

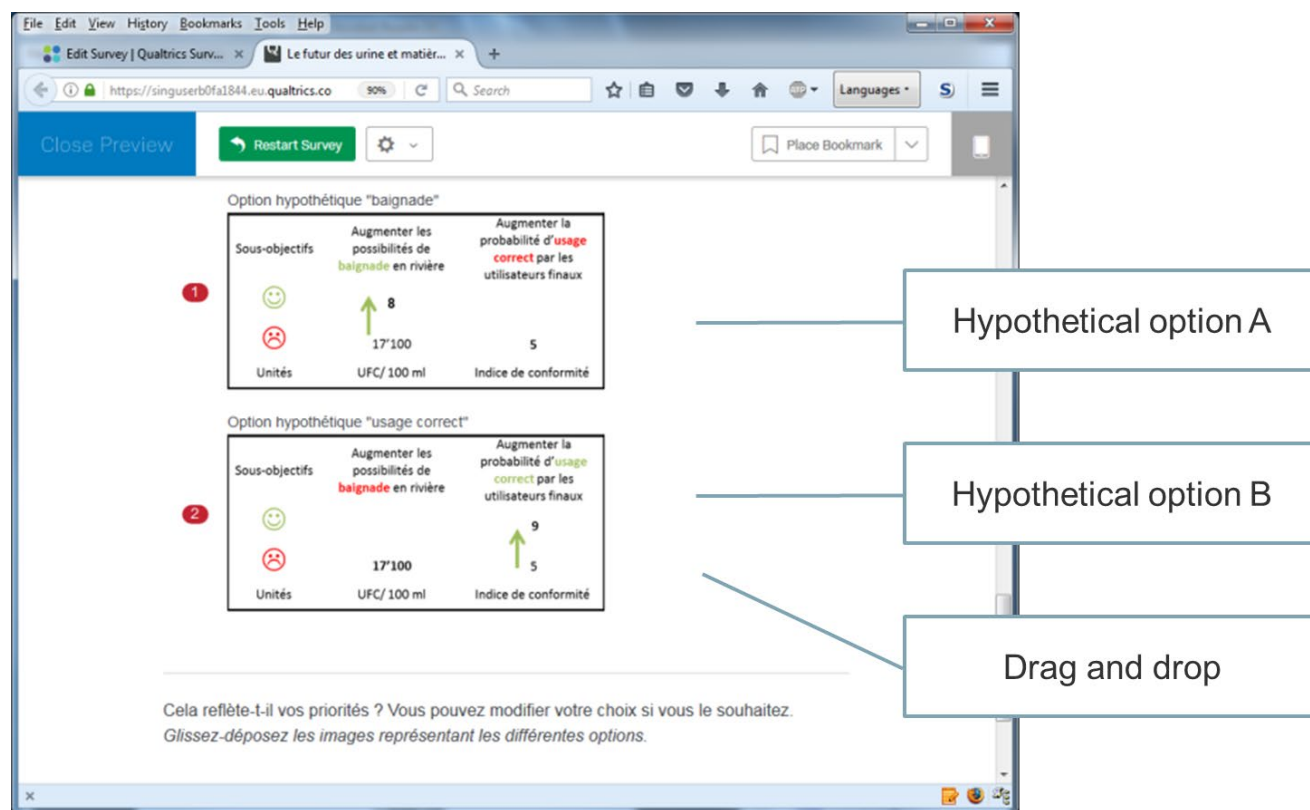


Fig SI.2a.3. Step ranking of hypothetical options. Drag and drop the vignettes of the hypothetical options (with only one objective at its best level) in order of preference, with the most preferred at the top, and the least preferred at the bottom. Screenshot of the online swing weight elicitation developed with Qualtrics (www.qualtrics.com, retrieved on 19.07.2018).

The screenshot shows a Qualtrics survey titled 'Le futur des urine et matière...' with a 'Close Preview' button and a 'Restart Survey' button. The survey is in a 'Draft' state. The main content area displays three hypothetical options for ranking, each with a slider for scoring from 0 to 100. The top option is 'baignade', the middle is 'usage correct', and the bottom is 'Bien-être de la société'.

Important (autant que la pire option)	Plutôt important	Modérément important (moitié moins que la meilleure option)	Très important	Important (autant que la meilleure option)						
0	10	20	30	40	50	60	70	80	90	100
Option hypothétique "baignade"										
Sous-objectifs										
Augmenter les possibilités de baignade en rivière										
Augmenter la probabilité d'usage correct par les utilisateurs finaux										
Unités										
UFC/100 ml										
Indice de conformité										
17/100										
5										
Option hypothétique "usage correct"										
Sous-objectifs										
Augmenter les possibilités de baignade en rivière										
Augmenter la probabilité d'usage correct par les utilisateurs finaux										
Unités										
UFC/100 ml										
Indice de conformité										
17/100										
5										
Option pire cas "Bien-être de la société"										
Sous-objectifs										
Augmenter les possibilités de baignade en rivière										
Augmenter la probabilité d'usage correct par les utilisateurs finaux										
Unités										
UFC/100 ml										
Indice de conformité										
17/100										
5										

Hypothetical option ranked 1st.

Hypothetical option ranked 2nd.

Scoring on the slider

Worst case option

Fig SI.2a.4. Step rating the ordered hypothetical options. The most preferred one on top of the list received the default rating value of 100. The worst case hypothetical option at the bottom of the list received the default value of 0. Screenshot of the online swing weight elicitation developed with Qualtrics (www.qualtrics.com, retrieved on 19.07.2018).

**SI 2b. Logic of the coding of the swing survey using Qualtrics (survey platform
(www.qualtrics.com, retrieved on 19.07.2018))**

Within each branch of the objectives hierarchy (presented in Fig. 1 of the main text) (example given for the branch “high environmental protection (EnvPro)” containing 3 objectives: Objective A to Objective C)

Ranking task (drag and drop of vignettes for Objective A, Objective B, Objective C)

Then branch if...

If Branch EnvPro, Objective A is equal to 1 → Set embedded data EnvPro1 = description of Objective A.

If Branch EnvPro, Objective A is equal to 2 → Set embedded data EnvPro2 = description of Objective A.

If Branch EnvPro, Objective A is equal to 3 → Set embedded data EnvPro3 = description of Objective A.

If Branch EnvPro, Objective B is equal to 1 → Set embedded data EnvPro1 = description of Objective B.

If Branch EnvPro, Objective B is equal to 2 → Set embedded data EnvPro2 = description of Objective B.

If Branch EnvPro, Objective B is equal to 3 → Set embedded data EnvPro3 = description of Objective B.

If Branch EnvPro, Objective C is equal to 1 → Set embedded data EnvPro1 = description of Objective C.

If Branch EnvPro, Objective C is equal to 2 → Set embedded data EnvPro2 = description of Objective C.

If Branch EnvPro, Objective C is equal to 3 → Set embedded data EnvPro3 = description of Objective C.

Scoring (scales in a table) EnvPro1 (default value=100), EnvPro2, EnvPro3, EnvProNullOption (default value=0).

At the upper level of the objectives hierarchy. Given our hierarchy of objectives (presented in Fig. 1 of the main text), we needed to code 24 cases, corresponding to all the possible combinations of highest ranked objectives from each branch ($3 \times 2 \times 2 \times 2$). Below, one example of the logic is shown.

Then branch if...

If Branch EnvPro Objective A is equal to 1

And Branch SocWel Objective D is equal to 1

And Branch ResUse Objective F is equal to 1

And Branch EcoPer Objective H is equal to 1

→ Show block Importance of objective upper level case 1

Ranking task (drag and drop of vignettes for Objective A, Objective D, Objective F, Objective H)

Then branch if... [same logic as above, defining UpObj1, UpObj2, UpObj3 and UpObj4]

Required 16 code lines (4×4) [If → Set embedded data]

Show block scoring upper level case 1: UpObj1 (default value=100), UpObj2, UpObj3, UpObj4, and Up1NullOption (default value=0).

SI 3. Population description

SI 3a. Population statistics of the region Île-de-France

Data from the French Institute of statistics INSEE from 1^{er} January 2014 (<https://www.insee.fr/fr/accueil>, retrieved on 25.07.18)

Distribution per

Gender:	Women	51.7%
	Men	48.3%
Age (rescaled to cover the population from 18 to 74 years old (y.o.)):		
	18-19 y.o.	3.4%
	20-39 y.o.	41.1%
	40-59 y.o.	37.9%
	60-74 y.o.	17.6%
Socio-professional category :		
	csp+ (1, 2, 3 et 4)	33.5%
	csp- (5 et 6)	28 %
	without professional activity	38.5% among which
	retired	19.6%
	others	17.4%

csp +: categorie 1,2,3,4 (farmers, [Entrepreneurs], [Executives and higher intellectual professions], [Intermediate professions])

csp -: categorie 5 et 6 ([Employees], [Workers])

others : Other persons without professional activity (Unemployed persons who have never worked, Military contingent, Students, Students, Persons under 60 years old without professional activity (except retired))

SI 3b. Statistics of the respondents who answered the online swing survey

Distribution per

Gender:	Women	57.7%
	Men	42.3%
Pearson's Chi-squared with official statistical data (Insee): X-squared=0.51, df=1, p-value=0.48		
There is no statistically significant difference between the gender distributions.		

Age:

18-19 y.o.	2.0 %
20-39 y.o.	45.3%
40-59 y.o.	34.9%
60-74 y.o.	17.8%

Pearson's Chi-squared with official statistical data (INSEE): X-squared=0.68, df=3, p-value=0.88

There is **no** statistically significant difference between the age distributions.

Socio-professional category (csp) :

csp+ (1, 2, 3 et 4)	38.6%
csp- (5 et 6)	21.2%
without professional activity	30.2%
retired	15.1%
others	15.1%

Pearson's Chi-squared with official statistical data (INSEE): X-squared=1.27, df=3, p-value=0.74

There is **no** statistically significant difference between the csp distributions.

SI 3c. Statistics of the respondents who answered the online direct rating survey

Distribution per

Gender:	Women	52.1%
	Men	47.9%

Pearson's Chi-squared official statistical data (INSEE): X-squared=9.7e-31, df=1, p-value=1

There is **no** statistically significant difference between the gender distributions.

Age:

18-19 y.o.	3.1 %
20-39 y.o.	42.7%
40-59 y.o.	34.8%
60-74 y.o.	19.4%

Pearson's Chi-squared official statistical data (INSEE): X-squared=0.26, df=3, p-value=0.97

There is **no** statistically significant difference between the age distributions.

Socio-professional category (csp) :

csp+ (1, 2, 3 et 4)	40.9%
csp- (5 et 6)	31.7%
without professional activity	27.4%
retired	14.7%
others	12.9%

Pearson's Chi-squared official statistical data (INSEE): X-squared=2.4, df=3, p-value=0.5

There is **no** statistically significant difference between the csp distributions.

SI 3d. Statistics comparing the population of the online swing and direct rating surveys

Gender: Pearson's Chi-squared test with Yates' continuity correction:
X-squared=4.2e-1, df=1, p-value=0.51
There is **no** statistically significant difference between the gender distributions.

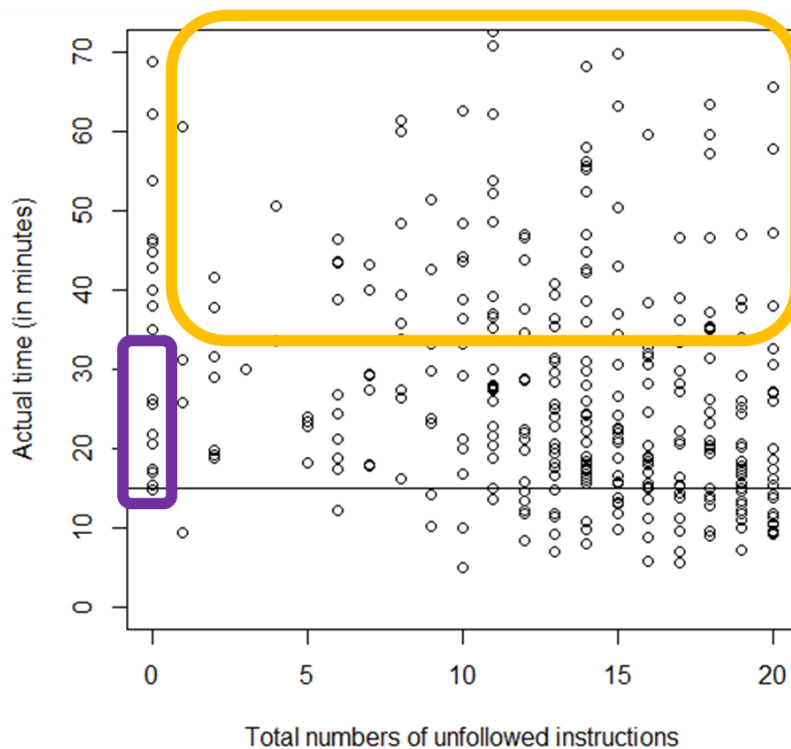
Age: Pearson's Chi-squared test
X-squared=3.8e-1, df=3, p-value=0.95
There is **no** statistically significant difference between the age distributions.

Socio-professional category (csp) : Pearson's Chi-squared test
X-squared=1.8, df=3, p-value=6.2e-1
There is **no** statistically significant difference between the CSP distributions.

SI 4. Additional results

SI 4a. Actual time needed to answer the survey against number of unfollowed instructions.

We observed (plot below) that the actual time needed to answer the survey did not correlate with the number of unfollowed instructions. In addition, we set a cut-off line of 15 minutes as minimum required time. No respondents from the valid swing sub-sample were faster than 15 minutes. It is also the reasonable time needed to read all the text (description of the objectives, and the instructions).



Expected: faster →
more unfollowed
instructions

Some following
instructions were
fast!

Some not following
instructions were
slow!

Cut-off: 15 minutes

SI 4b. Raw results for process compliance in the swing survey (N=298). Number (and percentage of participants) who followed the instructions of the survey for the elicitation of weights. B1-B4: weight elicitation within each branch of the objectives hierarchy (B1 with three objectives, and B2-B4 with two objectives; Fig. 2 of main text). Up: elicitation of weights for the upper level-objectives (four upper-level objectives: the most preferred ones from each branch). The instructions were “*preferred = 100*”: “the most preferred hypothetical option should receive 100 points”. “*worst = 0*”: “the worst-case hypothetical option should receive 0 point”. “*points = ranks*”: “point allocation (rating) should be consistent with the order of preference (ranking)”. “*all 3 instructions*”: following all three instructions listed before. “*all 3 cumulative*”: the respondent followed all the three instructions listed before cumulatively across the swing weight elicitation process.

	B1	B2	B3	B4	Up
Preferred=100	150 (50.3%)	153 (51.3%)	158 (53.0%)	161 (54.0%)	179 (60.1%)
Worst=0	70 (23.5%)	51 (17.1%)	58 (19.5%)	67 (22.5%)	99 (33.2%)
Points=ranks	116 (38.9%)	144 (48.3%)	177 (59.4%)	185 (62.1%)	162 (54.4%)
All 3 instructions	33 (11.1%)	28 (9.40%)	27 (9.06%)	37 (12.4%)	43 (14.4%)
All 3 cumulative	33 (11.1%)	18 (6.04%)	17 (5.70%)	16 (5.37%)	14 (4.69%)

SI 4c. Raw results for the relation between the median weight obtained from swing (N=36) and “invalid” swing (N=262) and the rank. We described the shape of the non-linear curve representing the *median* weights as a function of the rank. In the main text, we described the shape of the non-linear curve representing the *mean* weights as a function of the rank. The results with the median lead to similar conclusions as with the mean.

For valid swing, the relation is concave (collapsed, as for the mean), however less steep than with the mean.

Residuals:

Min	1Q	Median	3Q	Max
-0.005117	-0.001964	0.001058	0.002087	0.003859

Intercept	0.185	***	with signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1	
First order coef.	-0.018	***		
Second order coef.	0.001	*		

Residual standard error:

F-statistic: 364.7 on 2 and 6 DF, p-value: 5.431e-07 (<.001)

For invalid swing, the relation is slightly convex (as for the mean), and less steep than with the mean.

Residuals:

Min	1Q	Median	3Q	Max
-0.0022405	-0.0018809	0.0001978	0.0011098	0.0026778

Intercept	0.149	***	with signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1	
First order coef.	-0.004	*		
Second order coef.	-0.001	**		

Residual standard error:

F-statistic: 736.1 on 2 and 6 DF, p-value: 6.687e-08 (<.001)

SI 5. Additional original text

SI 5a. Knowledge test questions. The correct answers are underlined.

1. De fortes concentrations en nutriments (des éléments chimiques nécessaires aux êtres vivants pour survivre et grandir, par exemple l'azote sous forme de nitrates) peuvent causer une féminisation des poissons. Vrai ou faux ? Vrai / **Faux** / Je ne sais pas

2. Les sources de micropolluants incluent les pesticides, les produits pharmaceutiques et les produits d'hygiène corporelle (par exemple les cosmétiques). Vrai ou faux ? **Vrai** / Faux / Je ne sais pas

3. Parmi le phosphore aujourd'hui extrait des eaux usées en usine de traitement, quelle proportion provient de l'urine? Cochez la case correspondant à la bonne réponse. 10% / 30% / **50%** / 70% / 90% / Je ne sais pas

4. Combien paye, chaque année, une personne de l'agglomération parisienne pour la collecte et le traitement des eaux usées ? Cochez la case correspondant à la bonne réponse. 1€ / 10 € / **100 €** / 1000 € / Je ne sais pas

5. Qu'est-ce qui pourrait changer pour les utilisateurs si le type de toilettes changeait ? Plusieurs réponses sont possibles. Rien, des toilettes sont seulement des toilettes / **Le nettoyage des nouvelles toilettes pourrait être différent** / **Il faudrait un espace dédié au sous-sol des bâtiments** / **Il serait possible de produire de la nourriture fertilisée par de l'urine humaine** / Il serait possible de jeter tous les déchets dans les toilettes / Je ne sais pas.

6. Quels types de maladies sont généralement liées au contact direct avec des eaux usées? Cochez la case correspondant à la bonne réponse Les maladies cardiovasculaires / Les maladies respiratoires / **Les maladies gastro-intestinales** / Les cancers / Je ne sais pas

7. Quelle quantité d'eau est utilisée habituellement lorsqu'on tire une chasse d'eau ? Cochez la case correspondant à la bonne réponse. Moins d'1 litre / 1 à 2 litres / **3 à 6 litres** / 7 à 10 litres / Plus de 10 litres / Je ne sais pas

8. Parmi les métiers suivants, lesquels participent au système de traitement des eaux usées (des canalisations qui sortent de chez vous, à celles qui déverse l'eau traitée dans la rivière)? Plusieurs réponses sont possibles. Secrétaire / Chimiste / Technicien de laboratoire / Égoutier / Opérateur d'usine de traitement des eaux usées / Je ne sais pas

9. Parmi les gaz émis par le système de traitement des eaux usées, le(s)quel(s) contribue(nt) au changement climatique? Plusieurs réponses sont possibles. Les gaz odorants qui se dégagent de l'urine / Les gaz émis lors de la production d'énergie pour le traitement des eaux usées / Les gaz émis lors de la production des produits chimiques utilisés dans le traitement des eaux usées / Les gaz émis lors du transport des boues / Les gaz émis lors du traitement des eaux usées à l'usine / Je ne sais pas