Drinking water choices
Tap, bottled, filtered

Fig. 2. Conceptual model showing the integrated health impact assessment (HIA) and life cycle assessment (LCA) of drinking water consumption choices.

Fig. 3 shows the combined health and environmental impacts of the four drinking water source scenarios, highlighting the large environmental benefits and modest health trade-offs of moving from the current drinking water source share in Barcelona to tap water.

4. Discussion

Our study, based on a novel integration of health impact and life cycle assessment applied to the city of Barcelona, resulted in several key findings. First, meeting drinking water needs for the city of Barcelona with bottled water resulted in high ecosystem and resource damages compared to tap water. Second, current drinking water source choices result in 103.9 DALYs (that equals on average 40 min if borne equally by all Barcelona residents). The scenario where all the population in Barcelona consume tap water yielded the lowest impact on ecosystems, resources and health, while the scenario where the entire population drinks bottled water yielded the highest impacts of water production. Relative to S2 (all drink tap water), S3 (all drink bottled water) led to approximately 1400 times more species lost/year and 3500 times more resource use (in $). At the local scale, S3 led to lowest bladder cancer burden in the Barcelona population (2.4 DALYs), and S2 led to the highest (341.8 DALYs).

The higher environmental impact of bottled water was attributed to the high input of materials (i.e. packaging) and energy needed for bottled water production as compared to tap water. Indeed, raw materials and energy required for bottle manufacturing accounted for the majority of the impact of bottled water use (up to 90% of the impact in all indicators), consistent with previous studies (Garfí et al., 2016; Lagioia et al., 2012; Papong et al., 2014). Regarding tap water, the production of drinking water in the Llobregat area had the highest potential environmental impacts (from 2 up to 30 times higher compared to the other water supply areas). Since water of Ter reservoirs have better quality compared to Llobregat river, the corresponding drinking water

Table 3
Estimated average total THM exposure (μg/L) by water supply area for each drinking water consumption scenario.

Water supply area	Llobregat	Llobregat + Ter	Ter	Barcelona City
Scenario 1: Current	15.4	26.1	27.6	24.4
Scenario 2: All tap water	31.1	46.3	40.1	42.7
Scenario 3: All bottled water	12.7	18.8	16.3	17.3
Scenario 4: All filtered tap water	14.6	21.7	18.7	20.0

Table 4
Environmental impacts of drinking water production in the study area, from the life cycle assessment.

	Ecosystems	Resources
	(Species/year)	($)
Per 1 l of drinking water produced in:		
Drinking water treatment plants		
Sant Joan Despí	2.25E-12	5.93E-05
Abrera	3.59E-13	4.35E-06
Desalination plant	6.32E-12	8.06E-05
Cardedeu	1.56E-13	1.71E-06
Bottled water	1.45E-09	8.52E-02
Per 1 l of drinking water in supply areas:		
Llobregat area	2.43E-12	4.62E-05
Llobregat + Ter area	9.92E-13	2.47E-05
Ter area	1.56E-13	1.71E-06
In the drinking water consumption scenarios:		
S1: Current	0.852	5.00E+07
S2: All tap water	1.01E-03	2.37E+04
S3: All bottled water	1.43	8.39E+07
S4: All filtered tap	1.01E-03	2.37E+04