## APPENDIX 1

## Detailed methods for ES sampling, indicators selected and scale adaptation.

### Climate regulation

Temperature samples were recorded every 60 minutes over a period of 8 months (February to September 2012) using data loggers (iButton). Three devices per plot were hung from trees located at regular distances along a river transect perpendicular to the river channel. Three replicate plots were sampled in representative sites of each selected land use type. *Dry cereal crops* and *Fruit groves* were not surveyed but surrogate values from *Abandoned crops* and *Poplar groves* were used respectively, due to their similar cover and structure. Means of daily temperatures range (DTR=maximum temperature of day x − minimum temperature of day x) (Scheitlin and Dixon 2010) were used as an indicator. Average values by land use were calculated and used as ES values. Inverse values (1/DTR) were used to ease graphics comparisons; by doing so, higher indicator values mean higher supply of the ES (Hubbart et al. 2005; Hubbart 2011).

### Gas regulation

Annual $CO_2$ sequestration rates were obtained from a national database (Montero 2005, CITA 2008) which estimated the amounts of carbon stored by the above- and below-ground biomass of different plant species. This database calculates the species annual growth and transforms it into carbon equivalent tons per hectare, considering that Carbon stored = Biomass x 0.4735. Then carbon is transformed into $CO_2$ using their stoichiometric coefficients. Grass species are not supposed to store any $CO_2$, because they grow up, die and get decomposed annually, and thus their annual balance equals zero (CITA 2008).

### Soil Stability

The organic matter on topsoil (0-10 cm) was differentiated visually and its depth recorded with a measuring tape. Leaf litter was excluded. Three samples were taken along a river transect perpendicular to the river channel and three transects replicates were taken in each plot. Three plot replicates were sampled by land use except for urban soils. Soils were first surveyed in September 2010 and replicated in July 2011 and 2012.

**Nutrient regulation**

Soil samples (0.5 kg) were taken from the topsoil (0 – 15 cm). Three samples were taken along a river transect perpendicular to the river channel and three transects replicates were taken in each plot. Three plots replicates were sampled by land use except for urban soils. Soils were dried, sieved and milled prior to lab analyses. Total Nitrogen was measured using a macro elemental analyzer (Vario Macro Max CN) and results were expressed in concentration (ppm). Soils were first surveyed in September 2010 and replicated in July 2011 and July 2012.

**Habitat quality**

Habitat quality was evaluated using the Riparian Quality Index (González del Tánago et al. 2006). Three replicate plots per land use were sampled during the field campaigns between July 2010, July 2011 and July 2012.

**Raw materials**

Annual growth rates per plant species were obtained from a national database (Montero 2005, CITA 2008) which calculated the annual growth as tons of biomass tons per hectare, considering that Biomass = Correction factor x timber diameter. Grass species are not supposed to accumulate any biomass annually, because they grow up, die and get decomposed, and thus the annual balance equals zero (CITA 2008). Other woody species and woody formations were calculated individually by plant species.

**Food production**

Yield values for the crops growing within the study area were obtained from national databases statistics (Instituto Nacional de Estadística, updated on 30 October 2012) expressed as kilograms per hectare and multiplied by the crop caloric value (kilocalories per 100 grams). The ES value is expressed as kilocalories per hectare.

**Fishing**

Available fishing stretches for recreational use at the river Piedra were obtained from the fishing regulatory policy of 2012 for the Autonomous Community of Aragon (BOA 2012) and drawn using GIS tools (ArcGIS 10.0, ESRI). Fishing available stretches were computed for both riversides. Stretches were converted into polylines, their perimeters calculated and summarized into stretches available or unavailable for fishing. Polylines

were converted into polygons and intersected to the land use cover with a buffer of 10 m to add both the land use and municipality information of each stretch of the river. Then lengths were recalculated. Total length across river stretches of each land use type was used as an indicator at landscape scale. Average values by land use type across municipalities were used as an indicator at landscape scale. The length of the river across each land use type in relation to the total length of the river (i.e. including areas unavailable for recreational fishing) and in reference to a 1 hectare patch (a patch of 100 meters of side) was used as an indicator at patch scale (i.e. Fishing at land use $x$ = (Total length of land use $x$ / Total length of the river)*100).

**Sports**

Tracks of post-signed and user-designed paths were downloaded from both the local tourist office website and wikilocs (http://senderos.turismodearagon.com and www.wikiloc.com, respectively; date of reference: 12 October 2012) following Trabucchi et al. (2013b). Tracks around the study area were unified using GIS tools (QGIS, Quantum GIS Development Team), and overlapped to the study area viewshed. Then the viewshed of the shapefile obtained was calculated and intersected to the land use cover. Finally the extent of each land use that can be seen from the open-to-public used paths was calculated. Average values per hectare of each land use were used at patch scale. Values at municipality and landscape scale were obtained directly from the GIS attribute table in hectares.

**Recreation**

The number of areas for social amenity per land use and municipality were counted *in situ* in all the municipalities in August 2012. The average number of rest areas per hectare of land use was estimated as the total number of rest areas of each land use in the study area divided by the total number of hectares that each particular land use covers within the study area.

**Education**

The number of notice boards with information about the ecosystem of the study area was counted *in situ* per land use and municipality in August 2012. To calculate the average number of notice boards per hectare of land use, the total number of notice

boards of each land use was divided by the total number of hectares that each particular land use occupies within the study area.

**Social relationships**

The number of local associations related to the use of nature (either for conservation or for agriculture) per municipality within the study area was counted in August 2012. Downscaling to patch scale was estimated as follows,

$$Assoc_X = \frac{\sum_{i=1}^{n}(\frac{A_i}{S_i} * X_i)}{n}$$

where $Assoc_X$ is the average number of local associations related to the use of nature at land use $x$; $A$ is the number of local associations at municipality $i$; $S$ are hectares of municipality $i$ within the study area; $X$ are hectares of land use $x$ within the study area at municipality $i$; and $n$ is the number of municipalities.

| Land use | Cover (ha) | | | Total |
|---|---|---|---|---|
| | Mun1 | Mun2 | Mun3 | |
| A | 1.91 | 0.00 | 3.31 | 5.22 |
| B | 11.78 | 0.00 | 10.89 | 22.67 |
| C | 2.77 | 6.50 | 0.00 | 9.27 |
| D | 11.41 | 32.04 | 0.22 | 43.67 |

**iii) Landscape scale**

ES values

| Land use | Landscape |
|---|---|
| A | 0.79 |
| B | 2.95 |
| C | 2.04 |
| D | 14.85 |

**ii) Municipality scale**

ES values

| Land use | Mun1 | Mun2 | Mun3 | Average |
|---|---|---|---|---|
| A | 0.29 | 0.00 | 0.50 | 0.26 |
| B | 1.53 | 0.00 | 1.42 | 0.98 |
| C | 0.61 | 1.43 | 0.00 | 0.68 |
| D | 3.88 | 10.89 | 0.07 | 4.95 |

**i) Patch scale**

ES values

| Land use | Patch 1 | Patch 2 | Patch 3 | Average |
|---|---|---|---|---|
| A | 0.24 ±0.09 | 0.23 ±0.03 | 0.15 ±0.08 | 0.15 ±0.09 |
| B | 0.16 ±0.06 | 0.12 ±0.06 | 0.15 ±0.02 | 0.13 ±0.06 |
| C | 0.26 ±0.03 | 0.21 ±0.04 | 0.18 ±0.08 | 0.22 ±0.05 |
| D | 0.34 ±0.03 | 0.34 ±0.05 | 0.31 ±0.07 | 0.34 ±0.05 |

$$(1) \quad \sum_{i=1}^{n} \frac{(Average\ ES\ value\ at\ the\ patch\ x\ Cover\ of\ land\ use\ A\ at\ municipality_i)}{n\ municipalities}$$

$$(2) \quad Average\ ES\ value\ at\ the\ patch\ x\ \sum_{i=1}^{n} Cover\ of\ land\ use\ A\ at\ municipality_i$$

$$(3) \quad \frac{\sum_{i=1}^{n}(ES\ value\ at\ municipality_i / Cover\ of\ land\ use\ A\ at\ municipality_i)}{n\ municipalities}$$

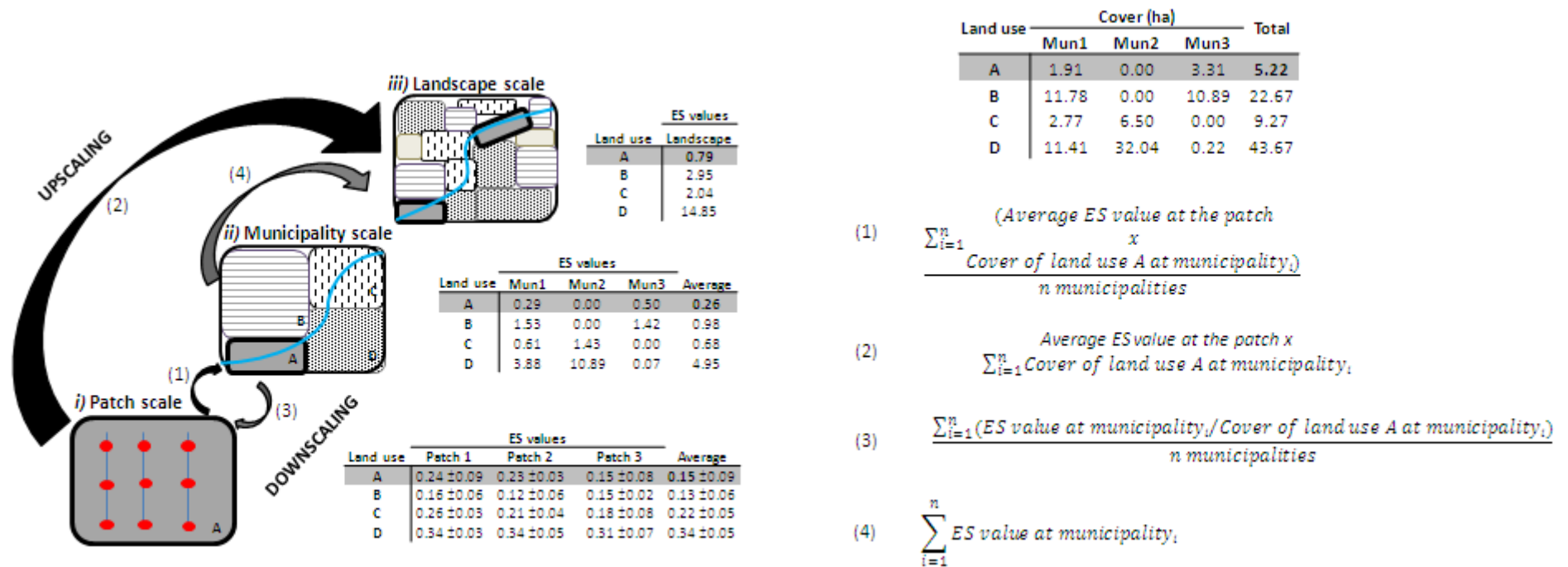$$(4) \quad \sum_{i=1}^{n} ES\ value\ at\ municipality_i$$

**Figure S1. ES scaling methods.** The figure represents the scaling techniques used to obtain the values of ES provision by land use types (land use A, as an example) at three spatial scales (patch, municipality, and landscape). Assessment of regulating, supporting and provisioning services (black arrows, case 1) starts at the patch scale, and assessment of cultural services (greys arrows, case 2) starts at the municipality scale. In case 1 (e.g. Nutrient regulation), we sampled three patches per land use type (figure *i)* shows patch 1 of land use A) collecting 9 soil samples (red dots) per patch to analyze total nitrogen content as a proxy of the ES. We averaged values within each patch and across the three patches of land use A to obtain a unique value of the ES at the patch scale. To scale up to municipality (small black arrow, equation (1)), we used the average value of land use A at the patch scale (i.e. 0.15) and multiplied it by the cover of land use A at municipality 1 (Mun1, see Land cover table on the right; i.e. 0.15x1.91=0.29). We did the same with each municipality and averaged values to obtain a single value of ES provision by land use A at the municipality scale (i.e. 0.26). We started from the patch scale again to scale up to landscape (large black arrow, equation (2)). We used the average value of the ES for land use A and multiplied it by the total cover of land use A in the landscape (i.e. the sum of the cover of land use A across the three municipalities; 0.15x5.22=0.78). In case 2 (e.g. Education), we counted the number of educational sites within land use A in each municipality (figure *ii)* shows municipality 1). We scaled down to the patch (small grey arrow, equation (3)) dividing the ES value of each municipality by the cover of land use A in that municipality (e.g. for municipality 1, 0.29/ 1.91=0.15). We averaged these values across the three municipalities to obtain a single value of ES provision by land use A at the patch scale (i.e. (0.15+0.00+0.15)/3=0.1). To scale up to the landscape (large grey arrow, equation (4)), we summed the ES values at land use A across the three municipalities (i.e. 0.29+0.00+0.50=0.79).