

Table S1 supplemental. Proposed allocation criteria

Allocation criteria	Objective Function	Sensitive receptors	Note
Individual exposition to the $i$ -th pollutant in the $k$ -th cell [ $\mu\text{g} \cdot \text{m}^{-3} \cdot \text{h}$ ]	<p><b>Exposition<sub>i,k</sub></b> = max (<math>C_{i,k} \times t</math>)</p> <p>Where  <math>C_{i,k}</math>: Concentration of the <math>i</math>-th pollutant [<math>\mu\text{g} \cdot \text{m}^{-3}</math>] in the <math>k</math>-th cell  <math>t</math>: outdoor exposure time [h]*</p> <p>* Population outdoor exposure time: summer 3h 40'; winter 1h 50'. Vegetation outdoor exposure time: summer and winter 24h (ISPRA, 2010)</p>	Population Vegetation	Quantifies the exposure of an individual to a specific outdoor pollutant (Kao and Hsieh, 2006; Langstaff et al., 1967; Larsen et al., 1967; Negri and Sozzi, 1988; Noll et al., 1977; Tseng and Chang, 2001)
Overall exposition to the $i$ -th pollutant in the $k$ -th cell [ $\mu\text{g} \cdot \text{m}^{-3} \cdot \text{h} \cdot \text{n}$ ]	<p><b>Overall Exposition<sub>i,k</sub></b> = max (<math>\text{Exposition}_{i,k} \times \text{Pop}_k</math>)</p> <p>Where  <math>\text{Exposition}_{i,k}</math>: Individual exposition to the <math>i</math>-th pollutant in the <math>k</math>-th cell [<math>\mu\text{g} \cdot \text{m}^{-3} \cdot \text{h}</math>]  <math>\text{Pop}_k</math>: population residential in the <math>k</math>-th cell of the study area [n.]</p>	Population	Quantifies the overall exposure of all individuals present in a given cell (Kao and Hsieh, 2006; Langstaff et al., 1967; Tseng and Chang, 2001)
Overall risk to all the pollutants in the $k$ -th cell [ $\mu\text{g} \cdot \text{m}^{-3} \cdot \text{h}$ ]	<p><b>Risk<sub>k</sub></b> = max (<math>(\alpha_{a,k} \times \text{Exposition}_{a,k}) + (\alpha_{b,k} \times \text{Exposition}_{b,k}) + (\alpha_{n,k} \times \text{Exposition}_{n,k})</math>)</p> $\alpha_{a \text{ to } n,k} = \frac{C_{a \text{ to } n,k}}{X_{a \text{ to } n}}$ <p>Where  <math>\text{Exposition}_{a \text{ to } n,k}</math>: Exposition to the <math>a</math> to <math>n</math> th pollutant in the <math>k</math>-th cell [<math>\mu\text{g} \cdot \text{m}^{-3} \cdot \text{h}</math>]  <math>C_{a \text{ to } n,k}</math>: Concentration the <math>a</math> to <math>n</math> th pollutant in the <math>k</math>-th cell [<math>\mu\text{g} \cdot \text{m}^{-3}</math>]  <math>X_{a \text{ to } n}</math>: Legal limit of the <math>a</math> to <math>n</math> th pollutant [<math>\mu\text{g} \cdot \text{m}^{-3}</math>]</p>	Population Vegetation	Quantifies the individual risk as the contribution of all the considered pollutants
Correlation between simulated and measured data of the $i$ -th pollutant in the $k$ -th cell	<p><b>Corr<sub>i,k</sub></b> = max (<math>\frac{(C_{o,j} - \bar{C}_{o,j})(C_{p,i} - \bar{C}_{p,i})}{\sigma_o \sigma_p}</math>)</p> <p>Where  <math>C_{o,k}</math>: Concentration of the <math>j</math>-th pollutant measured by the <math>j</math>-th fixed air quality monitoring stations [<math>\mu\text{g} \cdot \text{m}^{-3}</math>]  <math>C_{p,i}</math>: Concentration of the <math>i</math>-th pollutant estimated in the <math>k</math>-th cell of the study area [<math>\mu\text{g} \cdot \text{m}^{-3}</math>]  <math>\sigma</math> = Standard deviations for the measured and estimated concentration values [<math>\mu\text{g} \cdot \text{m}^{-3}</math>]</p>	Population	Identifies areas with a good match between the measured data from fixed air quality monitoring stations and concentration data estimated (Elkamel et al., 2008; Saisana et al., 2001; Sajani et al., 2004)
Exceedance the legal limits of the $i$ th pollutant in the $k$ -th cell [n.]	<p><b>Exd<sub>i,k</sub></b> = max (<math>(C_{i,k} - X_i) \times \delta</math>)</p> <p>Where  <math>C_{i,k}</math>: Concentration of the <math>i</math> th pollutant in the <math>k</math>-th cell [<math>\mu\text{g} \cdot \text{m}^{-3}</math>]  <math>X_i</math>: Legal limit of the <math>i</math> th pollutant [<math>\mu\text{g} \cdot \text{m}^{-3}</math>]  <math>\delta = \begin{cases} 1 &amp; \text{if } (C_{i,k} - X_i) &gt; 0 \\ 0 &amp; \text{if } (C_{i,k} - X_i) &lt; 0 \end{cases}</math></p>	Population Vegetation	Identifies the probability of exceeding the legal limits for a specific pollutant (Elkamel et al., 2008; Lee et al., 1978; Mazzeo and Venegas, 2010; Modak and Lohani, 1985; Negri and Sozzi, 1988; Saisana et al., 2001; Sarigiannis and Saisana, 2008; Trujillo-Ventura and Hugh Ellis, 1991; Tseng and Chang, 2001; Venegas and Mazzeo, 2003)
Maximum concentration value of the $i$ th pollutant in the $k$ -th cell [ $\mu\text{g} \cdot \text{m}^{-3}$ ]	<p><b>Max<sub>i,k</sub></b> = max (<math>C_{i,k}</math>)</p> <p>Where  <math>C_{i,k}</math>: Concentration of the <math>i</math> th pollutant in the <math>k</math>-th cell [<math>\mu\text{g} \cdot \text{m}^{-3}</math>]</p>	Population Vegetation	Identifies the probability of measuring an elevated concentration value for a specific pollutant (Corti and Senatore, 2000; Munshi and Patil, 1982; Tseng and Chang, 2001)

Minimum Index of Agreement (IOA) for the $i$ -th pollutant in the $k$ -th cell	$IOA_{i,k} = \frac{(Cs_{i,k} - Co_j)^2}{Co_j^2}$ <p>Where  <math>Cs_{i,k}</math>: estimated concentration value in the <math>k</math>-th cell [<math>\mu\text{g} \cdot \text{m}^{-3}</math>]  <math>Co_j</math>: observed value by the <math>j</math>-th air quality monitoring station [<math>\mu\text{g} \cdot \text{m}^{-3}</math>]</p>	Population	Assess how the values simulated by the model deviate from the values measured by the fixed air monitoring stations
Minimum Index of Agreement normalize with the Resident Population (IOAP <sub>r</sub> ) for the $i$ -th pollutant in the $k$ -th cell	$IOAP_{r,i,k} = \frac{1}{\left( \frac{(Cs_{i,k} - Co_j)^2}{Co_j^2} \times Pr_i \right)}$ <p>Where  <math>Cs_{i,k}</math>: estimated concentration value in the <math>k</math>-th cell [<math>\mu\text{g} \cdot \text{m}^{-3}</math>]  <math>Co_j</math>: observed value by the <math>j</math>-th air quality monitoring station [<math>\mu\text{g} \cdot \text{m}^{-3}</math>]  <math>Pr_i</math>: relative population for the <math>k</math>-th cell obtained as the ratio between the resident population in the <math>k</math>-th cell and the total population of the study area (Mazzeo and Venegas, 2010)</p>	Population	Assess how the values simulated by the model deviate from the values measured by the fixed air monitoring stations, considering also the presence of resident population.
Maximum concentration gradient for the $i$ -th pollutant in the $k$ -th cell	$Grad_{i,k} = \max \left( \sum (C_{i,k} - C_{i,k+1}) \right)$ <p>Where  <math>C_{i,j}</math>: Concentration of the <math>i</math>-th pollutant at the <math>k</math>-th cell [<math>\mu\text{g} \cdot \text{m}^{-3}</math>]  <math>C_{i,k+1}</math>: Concentration of the <math>i</math>-th pollutant at the cells near the <math>k</math>-th cell [<math>\mu\text{g} \cdot \text{m}^{-3}</math>]</p>	Population	Assesses how changing the concentration field at a specific point compared to neighboring points (Kanakoglou et al., 2005; Kumar et al., 2009; Langstaff et al., 1967; Ott and Thorn, 1976)
Maximum Air Quality Index in the $k$ -th cell	$AQI = \max (a_{i,k})$ $a_{a \text{ to } n,k} = \frac{C_{a \text{ to } n,k}}{X_{a \text{ to } n}}$ <p>Where  <math>C_{i,k}</math>: Concentration of the <math>i</math>-th pollutant in the <math>k</math>-th cell [<math>\mu\text{g} \cdot \text{m}^{-3}</math>]  <math>X_i</math>: Limit defined by the law for the <math>i</math>-th pollutant [<math>\mu\text{g} \cdot \text{m}^{-3}</math>]</p>	Population	Assesses the contribution of all the pollutant at the same time (Arpa, 2008; Modak and Lohani, 1985; Ott and Thorn, 1976)
Minimum concentration difference in the $k$ -th cell	$Diff_{i,k} = \min \left( \sum (C_{i,k} - \bar{C}_i) \right)$ <p>Where  <math>C_{i,j}</math>: Concentration of the <math>i</math>-th pollutant at the <math>k</math>-th cell [<math>\mu\text{g} \cdot \text{m}^{-3}</math>]  <math>\bar{C}_i</math>: mean concentration of the <math>i</math>-th pollutant on the whole study area [<math>\mu\text{g} \cdot \text{m}^{-3}</math>]</p>	Population	Assesses how changing the concentration field at a specific point compared to whole study area (Kumar et al., 2009; Trujillo-Ventura and Hugh Ellis, 1991)
Maximum pollutant deposition in the $k$ -th cell	$Dep_k = \max (D_k^{SO_x} + D_k^{NO_2} + D_k^{O_3}) \times \delta$ <p>Where  <math>D_k</math> = Wet and dry deposition of <math>SO_x</math>, <math>NO_2</math> and <math>O_3</math> in the <math>k</math>-th cell [<math>\text{cm/s} \cdot \mu\text{g} \cdot \text{m}^{-3}</math>]  <math>\delta = \begin{cases} 1 &amp; \text{if there is vegetation} \\ 0 &amp; \text{if there is not vegetation} \end{cases}</math></p>	Vegetation	Assess the total deposition of the selected pollutants (ARPAV, 2006)
Maximum PM <sub>10</sub> deposition in the $k$ -th cell	$Dep_k = \max (D_k^{PM_{10}}) \times \delta$ <p>Where  <math>D_k^{PM_{10}}</math> = Wet and dry deposition of PM<sub>10</sub> in the <math>k</math>-th cell [<math>\text{cm/s} \cdot \mu\text{g} \cdot \text{m}^{-3}</math>]  <math>\delta = \begin{cases} 1 &amp; \text{if there is vegetation} \\ 0 &amp; \text{if there is not vegetation} \end{cases}</math></p>	Vegetation	Assess the total deposition of the selected pollutants (ARPAV, 2006)
Maximum damage index in the $k$ -th cell	$Damage_k = \max (Erosion_k + 2.5 \text{ blackening}_k) \times \delta$ $Erosion_k = [\alpha_1 R + \alpha_2 RH^+ + \alpha_3 R \delta_j^C + \alpha_4 (D_k^{SO_2} + D_k^{HNO_3} + D_k^{PM_{10}})] \times \delta^{ARC}$ $Blackening_k = CPTS_k$ <p>Where  <math>\alpha_1, \alpha_2, \alpha_3, \alpha_4 = 18.8, 0.016, 1.88, 0.0018</math></p>	Physical cultural heritage	Assess the total damage due to erosion blackening pollutants (ARPAV, 2006; ISPRA, 2011; Lipfert, 1989)

	<p> <math>R</math> = precipitations [mm of rain]  <math>H^+</math> = Hydrogen ion concentration in the rain [<math>\mu\text{g} \cdot \text{m}^{-3}</math>]  <math>D_k^{\text{SO}_2}</math>, <math>D_k^{\text{HNO}_3}</math>, <math>D_k^{\text{PM}_{10}}</math> = Total deposition of <math>\text{SO}_2</math>, <math>\text{HNO}_3</math> and <math>\text{PM}_{10}</math> in the <math>k</math>-th cell [<math>\text{cm/s} \times \mu\text{g} \cdot \text{m}^{-3}</math>]  <math>\text{CPTS}_k</math> = Concentration of total suspended particulate in the <math>k</math>-th cell [<math>\mu\text{g} \cdot \text{m}^{-3}</math>]   <math>\delta^C \begin{cases} 1 \text{ if the } k - \text{th cell is near the coast (within 5 km)} \\ 0 \text{ if the } k - \text{th cell is not near the coast (within 5 km)} \end{cases}</math>   <math>\delta^{\text{ARC}} \begin{cases} 1 \text{ if there is cultural heritage} \\ 0 \text{ if there is not cultural heritage} \end{cases}</math> </p>		
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