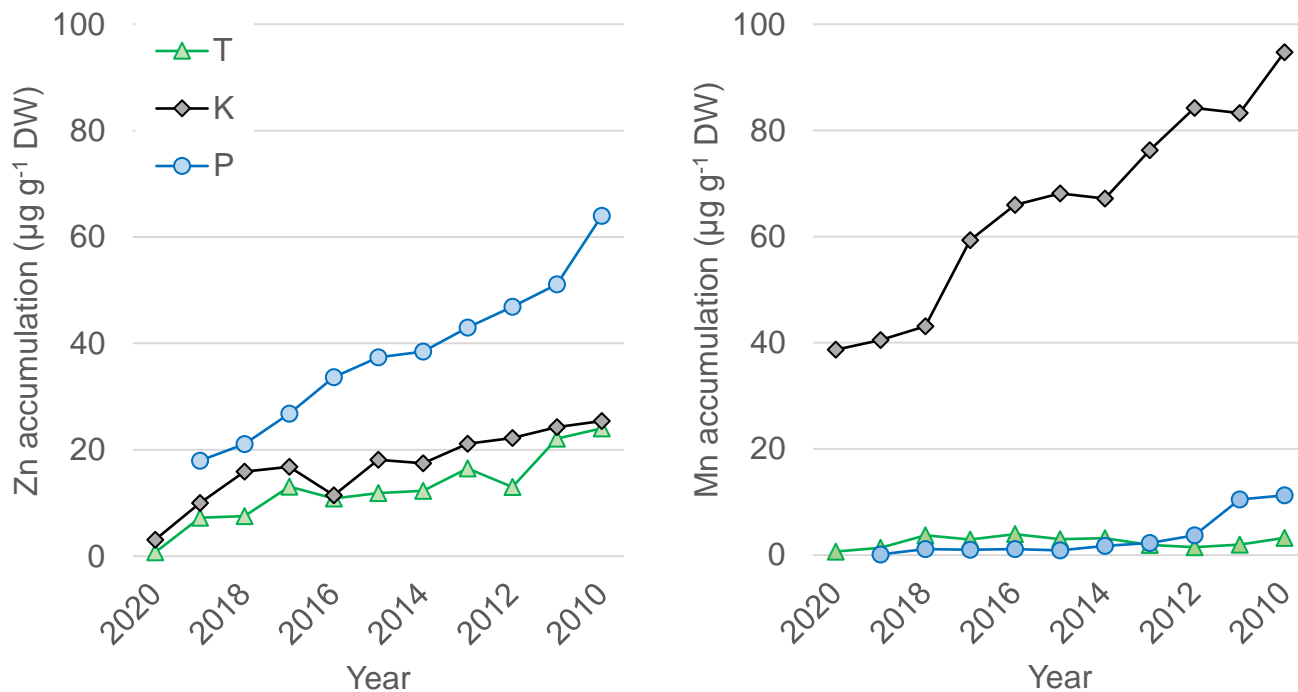


**Figure S1.** Photographs of typical birch leaves from reference site in Tychy (A), post-coal mine heap in Katowice (B) and post-smelter heap in Piekary Śląskie (C).



**Figure S2.** The accumulation of zinc or manganese in birch wood from a particular year of growth. Data are means ( $n = 10$ ). Abbreviations: T – reference site in Tychy; K – post-coal mine heap in Katowice; P – post-smelter heap in Piekary Śląskie.

**Table S1.** Site and soil characteristics.

<i>Site characteristics</i>			
	T	K	P
Location	Tychy	Katowice-Murcki	Piekary Śląskie
Altitude (m AMSL)	259	321	287
Temperature (°C) <sup>a</sup>	9.0	9.1	9.1
Precipitation (mm) <sup>a</sup>	817	807	910
Latitude	50.1043268	50.1895495	50.3681323
Longitude	18.9644241	19.0322035	18.9689818
Habitat	suburban area	post-coal mine spoil heap	post-smelter spoil heap
<i>Soil characteristics</i>			
pH (H <sub>2</sub> O)	6.09 ± 0.15 b	3.68 ± 0.06 c	7.33 ± 0.08 a
EC (µS cm <sup>-1</sup> )	160 ± 28 b	113 ± 10 b	800 ± 91 a
Total element content in the soil (µg g <sup>-1</sup> DW)			
Ca	2140 ± 440 b	160 ± 40 c	81070 ± 3420 a
Cd	0.52 ± 0.07 b	BDL	212.51 ± 34.90 a
Cu	7.2 ± 2.0 c	28.3 ± 0.9 b	961.5 ± 131.8 a
Fe	5160 ± 300 b	6160 ± 150 a	6890 ± 410 a
K	2340 ± 570 b	9560 ± 370 a	670 ± 110 c
Mg	1070 ± 210 b	910 ± 50 b	16920 ± 1920 a
Mn	350 ± 40 b	160 ± 10 c	3900 ± 190 a
Zn	25.0 ± 3.0 c	138.7 ± 26.8 b	25545.1 ± 4110.0 a

<sup>a</sup> – data from climate-data.org

Abbreviations: T – reference site in Tychy; K – post-coal mine heap in Katowice; P – post-smelter heap in Piekary Śląskie.

**Table S2.** Element accumulation in bark and wood of studied birch populations.

	T	K	P
Element accumulation in bark ( $\mu\text{g g}^{-1}$ DW)			
Ca	4915 $\pm$ 52 b	563 $\pm$ 63 c	7542 $\pm$ 420 a
Cd	BDL	BDL	3.02 $\pm$ 0.36 a
Cu	BDL	BDL	BDL
Fe	74.29 $\pm$ 0.91 a	24.28 $\pm$ 1.12 b	26.92 $\pm$ 2.48 b
K	462 $\pm$ 18 a	46 $\pm$ 4 c	265 $\pm$ 12 b
Mg	166 $\pm$ 13 b	148 $\pm$ 15 b	696 $\pm$ 27 a
Mn	38.8 $\pm$ 2.4 b	257.5 $\pm$ 14.4 a	15.9 $\pm$ 1.5 c
Zn	113.5 $\pm$ 5.5 b	92.3 $\pm$ 6.2 b	230.5 $\pm$ 12.4 a
Element accumulation in wood ( $\mu\text{g g}^{-1}$ DW)			
Ca	382 $\pm$ 40 b	188 $\pm$ 35 c	923 $\pm$ 91 a
Cd	BDL	BDL	4.44 $\pm$ 0.57 a
Cu	BDL	BDL	BDL
Fe	50.28 $\pm$ 4.98 a	25.26 $\pm$ 3.39 b	14.62 $\pm$ 5.52 b
K	BDL	BDL	BDL
Mg	100 $\pm$ 18 b	129 $\pm$ 9 b	335 $\pm$ 35 a
Mn	3.7 $\pm$ 0.5 b	96.0 $\pm$ 2.8 a	1.0 $\pm$ 0.2 b
Zn	12.0 $\pm$ 0.8 c	25.5 $\pm$ 1.9 b	45.6 $\pm$ 3.1 a

Abbreviations: T – reference site in Tychy; K – post-coal mine heap in Katowice; P – post-smelter heap in Piekary Śląskie. BDL – below detection limit. Data are means  $\pm$  SE (n = 10).

**Table S3.** The correlation matrix of variables used in the PCA.

	LEF	NPQ <sub>T</sub>	Φ <sub>II</sub>	Φ <sub>NO</sub>	Φ <sub>NPQ</sub>	PS1AC	Thick	E	A	ci	Chl	Flav	Anth	Ca	Mg	Mn	Zn	TRW
LEF	<b>1.00</b>	-0.20	0.11	0.18	-0.28	0.17	-0.58	0.61	0.32	0.04	0.31	-0.59	-0.46	0.15	-0.42	-0.31	-0.07	-0.12
NPQ <sub>T</sub>	<b>-0.20</b>	<b>1.00</b>	-0.68	-0.61	0.94	-0.14	0.45	-0.06	-0.11	0.07	-0.27	0.44	0.31	-0.31	-0.05	0.59	-0.25	0.52
Φ <sub>II</sub>	<b>0.11</b>	<b>-0.68</b>	<b>1.00</b>	-0.08	-0.79	0.37	-0.56	0.19	0.36	-0.24	0.31	-0.30	-0.39	0.28	-0.10	-0.44	0.09	-0.28
Φ <sub>NO</sub>	<b>0.18</b>	<b>-0.61</b>	<b>-0.08</b>	<b>1.00</b>	-0.47	-0.22	-0.05	-0.11	-0.19	0.10	0.01	-0.21	0.01	0.17	0.16	-0.26	0.22	-0.30
Φ <sub>NPQ</sub>	<b>-0.28</b>	<b>0.94</b>	<b>-0.79</b>	<b>-0.47</b>	<b>1.00</b>	-0.20	0.60	-0.19	-0.27	0.19	-0.36	0.53	0.41	-0.37	0.07	0.62	-0.20	0.48
PS1 AC	<b>0.17</b>	<b>-0.14</b>	<b>0.37</b>	<b>-0.22</b>	<b>-0.20</b>	<b>1.00</b>	-0.31	0.35	0.44	-0.23	0.42	-0.36	-0.51	-0.13	-0.25	-0.14	-0.14	0.03
Thick	<b>-0.58</b>	<b>0.45</b>	<b>-0.56</b>	<b>-0.05</b>	<b>0.60</b>	<b>-0.31</b>	<b>1.00</b>	-0.52	-0.48	0.21	-0.40	0.71	0.57	-0.28	0.27	0.68	-0.06	0.43
E	<b>0.61</b>	<b>-0.06</b>	<b>0.19</b>	<b>-0.11</b>	<b>-0.19</b>	<b>0.35</b>	<b>-0.52</b>	<b>1.00</b>	0.85	-0.42	0.49	-0.66	-0.61	-0.06	-0.64	-0.07	-0.40	0.24
A	<b>0.32</b>	<b>-0.11</b>	<b>0.36</b>	<b>-0.19</b>	<b>-0.27</b>	<b>0.44</b>	<b>-0.48</b>	<b>0.85</b>	<b>1.00</b>	-0.66	0.58	-0.55	-0.63	-0.02	-0.59	-0.07	-0.43	0.25
ci	<b>0.04</b>	<b>0.07</b>	<b>-0.24</b>	<b>0.10</b>	<b>0.19</b>	<b>-0.23</b>	<b>0.21</b>	<b>-0.42</b>	<b>-0.66</b>	<b>1.00</b>	-0.58	0.42	0.60	0.08	0.69	-0.12	0.44	-0.43
Chl	<b>0.31</b>	<b>-0.27</b>	<b>0.31</b>	<b>0.01</b>	<b>-0.36</b>	<b>0.42</b>	<b>-0.40</b>	<b>0.49</b>	<b>0.58</b>	<b>-0.58</b>	<b>1.00</b>	-0.50	-0.79	-0.11	-0.58	-0.07	-0.44	0.24
Flav	<b>-0.59</b>	<b>0.44</b>	<b>-0.30</b>	<b>-0.21</b>	<b>0.53</b>	<b>-0.36</b>	<b>0.71</b>	<b>-0.66</b>	<b>-0.55</b>	<b>0.42</b>	<b>-0.50</b>	<b>1.00</b>	0.74	-0.18	0.49	0.52	0.12	0.22
Anth	<b>-0.46</b>	<b>0.31</b>	<b>-0.39</b>	<b>0.01</b>	<b>0.41</b>	<b>-0.51</b>	<b>0.57</b>	<b>-0.61</b>	<b>-0.63</b>	<b>0.60</b>	<b>-0.79</b>	<b>0.74</b>	<b>1.00</b>	0.07	0.67	0.27	0.37	-0.07
Ca	<b>0.15</b>	<b>-0.31</b>	<b>0.28</b>	<b>0.17</b>	<b>-0.37</b>	<b>-0.13</b>	<b>-0.28</b>	<b>-0.06</b>	<b>-0.02</b>	<b>0.08</b>	<b>-0.11</b>	<b>-0.18</b>	<b>0.07</b>	<b>1.00</b>	0.32	-0.51	0.77	-0.58
Mg	<b>-0.42</b>	<b>-0.05</b>	<b>-0.10</b>	<b>0.16</b>	<b>0.07</b>	<b>-0.25</b>	<b>0.27</b>	<b>-0.64</b>	<b>-0.59</b>	<b>0.69</b>	<b>-0.58</b>	<b>0.49</b>	<b>0.67</b>	<b>0.32</b>	<b>1.00</b>	-0.12	0.58	-0.47
Mn	<b>-0.31</b>	<b>0.59</b>	<b>-0.44</b>	<b>-0.26</b>	<b>0.62</b>	<b>-0.14</b>	<b>0.68</b>	<b>-0.07</b>	<b>-0.07</b>	<b>-0.12</b>	<b>-0.07</b>	<b>0.52</b>	<b>0.27</b>	<b>-0.51</b>	<b>-0.12</b>	<b>1.00</b>	-0.50	0.89
Zn	<b>-0.07</b>	<b>-0.25</b>	<b>0.09</b>	<b>0.22</b>	<b>-0.20</b>	<b>-0.14</b>	<b>-0.06</b>	<b>-0.40</b>	<b>-0.43</b>	<b>0.44</b>	<b>-0.44</b>	<b>0.12</b>	<b>0.37</b>	<b>0.77</b>	<b>0.58</b>	<b>-0.50</b>	<b>1.00</b>	-0.75
TRW	<b>-0.12</b>	<b>0.52</b>	<b>-0.28</b>	<b>-0.30</b>	<b>0.48</b>	<b>0.03</b>	<b>0.43</b>	<b>0.24</b>	<b>0.25</b>	<b>-0.43</b>	<b>0.24</b>	<b>0.22</b>	<b>-0.07</b>	<b>-0.58</b>	<b>-0.47</b>	<b>0.89</b>	<b>-0.75</b>	<b>1.00</b>

Gradient:

> 0.75
0.75 > 0.5
0.5 > 0.25
0.25 > -0.25
-0.25 > -0.5
-0.5 > -0.75
-0.75 >

Abbreviations: LEF – linear electron flow; NPQ<sub>T</sub> – non-photochemical quenching; Φ<sub>II</sub> – realized steady-state efficiency of PSII; Φ<sub>NO</sub> – non-regulatory energy dissipation; Φ<sub>NPQ</sub> – non-photochemical quenching; PS1 AC – PSI active centres; Thick – leaf thickness; E – transpiration rate; A – photosynthetic rate; ci – intracellular CO<sub>2</sub> content; Chl – chlorophyll content; Flav – flavonol content; Anth – anthocyanin content; Ca – calcium content in leaves; Mg – magnesium content in leaves; Mn – manganese content in leaves; Zn – zinc content in leaves; TRW – tree ring width.

