Table S1. Soil diversity (pedodiversity) is expressed as taxonomic diversity at the level of soil order in the state of Iowa (IA) (USA).

Stocks		Area (2016)	Proportion (2016)
Soil Order	**General Characteristics and Constraints**	**(km²)**	**(%)**
	Slightly Weathered	**21,424.7**	**15.0**
Entisols	Embryonic soils with ochric epipedon	9195.7	6.4
Inceptisols	Young soils with ochric or umbric epipedon	12,080.7	8.5
Histosols	Organic soils with ≥ 20% of organic carbon	148.4	0.1
	Moderately Weathered	**121,376.2**	**85.0**
Alfisols	Clay-enriched B horizon with B.S. ≥ 35%	34,090.3	23.9
Mollisols	Carbon-enriched soils with B.S. ≥ 50%	86,991.2	60.9
Vertisols	Soils with swelling clays	294.7	0.2
Total		**142,801.0**	**100%**

Note: B.S. = base saturation. Entisols, Inceptisols, Alfisols, Mollisols, and Vertisols are mineral soils. Histosols are mostly organic soils.

Table S2. An overview of the accounting framework used by this study (adapted from Groshans et al. (2019) [26]) for the state of Iowa (IA) (USA).

OWNERSHIP (e.g., government, private, foreign, shared, single, etc.)

Time (e.g., information disclosure, etc.)	**STOCKS / SOURCE ATTRIBUTION**		**FLOWS / LAND USE, CHANGE**		**VALUE**
	Biophysical Accounts (Science-Based)	**Administrative Accounts (Boundary-Based)**	**Monetary Account(s)**	**Benefit(s)/ Damages**	**Total Value**
	Soil extent:	Administrative extent:	Ecosystem good(s) and service(s):	Sector:	Types of value (e.g., economic value, etc.):
	Composite (total) stock: Total soil carbon (TSC) = Soil organic carbon (SOC) + Soil inorganic carbon (SIC)				
Past (e.g., post-development disclosures) **Current** (e.g., status) **Future** (e.g., pre-development disclosures)	- Soil orders (Entisols, Inceptisols, Histosols, Alfisols, Mollisols, Vertisols)	- State (Iowa); - County (99 counties)	- Regulation (e.g., carbon sequestration); - Provisioning (e.g., food production)	Environment; Soil health - Carbon gain (sequestration); - Carbon loss	"Avoided" or "realized" social cost of carbon ($SC\text{-}CO_2$) emissions **(carbon footprint**, **CF)**: - \$46 per metric ton of CO_2 applicable for the year 2025 (2007 U.S. dollars with an average discount rate of 3% [27])
			Conflicts of Interest (COI)		
Soil Quality = Inherent Soil Quality (Soil Suitability) + Dynamic Soil Quality (Soil Health)					
Loss and Damage (L&D)					
Liability (Responsibility)					

Table S3. Area-normalized content (kg m^{-2}) and monetary values ($ m^{-2}) of soil organic carbon (SOC), soil inorganic carbon (SIC), and total soil carbon (TSC = SOC + SIC) by soil order using data developed by Guo et al. (2006) [29] for the upper 2-m of soil and an avoided social cost of carbon (SC-CO_2) of $46 per metric ton of CO_2, applicable for 2025 (2007 U.S. dollars with an average discount rate of 3% [27]).

Soil Order	SOC Content (kg m^{-2}) SOC Value ($ m^{-2})	SIC Content (kg m^{-2}) SIC Value ($ m^{-2})	TSC Content (kg m^{-2}) TSC Value ($ m^{-2})
	Minimum—Midpoint—Maximum Values		
Entisols	1.8—8.0—15.8 0.30—1.35—2.66	1.9—4.8—8.4 0.32—0.82—1.42	3.7—12.8—24.2 0.62—2.17—4.08
Inceptisols	2.8—8.9—17.4 0.47—1.50—2.93	2.5—5.1—8.4 0.42—0.86—1.42	5.3—14.0—25.8 0.89—2.36—4.35
Histosols	63.9—140.1—243.9 10.78—23.62—41.14	0.6—2.4—5.0 0.10—0.41—0.84	64.5—142.5—248.9 10.88—24.03—41.98
Alfisols	2.3—7.5—14.1 0.39—1.27—2.38	1.3—4.3—8.1 0.22—0.72—1.37	3.6—11.8—22.2 0.61—1.99—3.74
Mollisols	5.9—13.5—22.8 1.00—2.28—3.85	4.9–11.5–19.7 0.83—1.93—3.32	10.8—25.0—42.5 1.82—4.21—7.17
Vertisols	5.4—14.7—25.5 0.91—2.48—4.30	10.3—23.2—38.3 1.74—3.91—6.46	15.7—37.9—63.8 2.65—6.39—10.76

Note: Entisols, Inceptisols, Alfisols, Mollisols, and Vertisols are mineral soils. Histosols are mostly organic soils.

Table S4. Distribution of soil carbon regulating ecosystem services in the state of Iowa (IA) (USA) by soil order.

Parameter	2016 Total	Degree of Weathering and Soil Development					
		Slight			Moderate		
		Entisols	Inceptisols	Histosols	Alfisols	Mollisols	Vertisols
2016 Area (km^2)	**142,801.0**	**9195.7**	**12,080.7**	**148.4**	**34,090.3**	**86,991.2**	**294.7**
Soil organic carbon (SOC):							
Minimum (kg)	6.5×10^{11}	1.7×10^{10}	3.4×10^{10}	9.5×10^{9}	7.8×10^{10}	5.1×10^{11}	1.6×10^{9}
Midpoint (kg)	1.6×10^{12}	7.4×10^{10}	1.1×10^{11}	2.1×10^{10}	2.6×10^{11}	1.2×10^{12}	4.3×10^{9}
Maximum (kg)	2.9×10^{12}	1.5×10^{11}	2.1×10^{11}	3.6×10^{10}	4.8×10^{11}	2.0×10^{12}	7.5×10^{9}
Minimum (SC-CO_2, $, USD)	1.1×10^{11}	2.8×10^{9}	5.7×10^{9}	1.6×10^{9}	1.3×10^{10}	8.7×10^{10}	2.7×10^{8}
Midpoint (SC-CO_2, $, USD)	2.8×10^{11}	1.2×10^{10}	1.8×10^{10}	3.5×10^{9}	4.3×10^{10}	2.0×10^{11}	7.3×10^{8}
Maximum (SC-CO_2, $, USD)	4.8×10^{11}	2.4×10^{10}	3.5×10^{10}	6.1×10^{9}	8.1×10^{10}	3.3×10^{11}	1.3×10^{9}
Soil inorganic carbon (SIC):							
Minimum (kg)	5.2×10^{11}	1.7×10^{10}	3.0×10^{10}	8.9×10^{7}	4.4×10^{10}	4.3×10^{11}	3.0×10^{9}
Midpoint (kg)	4.7×10^{11}	4.4×10^{10}	4.7×10^{10}	2.2×10^{10}	4.0×10^{10}	1.1×10^{11}	2.1×10^{11}
Maximum (kg)	2.2×10^{12}	7.7×10^{10}	1.0×10^{11}	7.4×10^{8}	2.8×10^{11}	1.7×10^{12}	1.1×10^{10}
Minimum (SC-CO_2, $, USD)	8.8×10^{10}	2.9×10^{9}	5.1×10^{9}	1.5×10^{7}	7.5×10^{9}	7.2×10^{10}	5.1×10^{8}
Midpoint (SC-CO_2, $, USD)	2.1×10^{11}	7.5×10^{9}	1.0×10^{10}	6.1×10^{7}	2.5×10^{10}	1.7×10^{11}	1.2×10^{9}
Maximum (SC-CO_2, $, USD)	3.7×10^{11}	1.3×10^{10}	1.7×10^{10}	1.2×10^{8}	4.7×10^{10}	2.9×10^{11}	1.9×10^{9}
Total soil carbon (TSC):							
Minimum (kg)	1.2×10^{12}	3.4×10^{10}	6.4×10^{10}	9.6×10^{9}	1.2×10^{11}	9.4×10^{11}	4.6×10^{9}
Midpoint (kg)	2.1×10^{12}	1.2×10^{11}	1.5×10^{11}	4.3×10^{10}	3.0×10^{11}	1.3×10^{12}	2.2×10^{11}
Maximum (kg)	5.0×10^{12}	2.2×10^{11}	3.1×10^{11}	3.7×10^{10}	7.6×10^{11}	3.7×10^{12}	1.9×10^{10}
Minimum (SC-CO_2, $, USD)	2.0×10^{11}	5.7×10^{9}	1.1×10^{10}	1.6×10^{9}	2.1×10^{10}	1.6×10^{11}	7.8×10^{8}
Midpoint (SC-CO_2, $, USD)	4.9×10^{11}	2.0×10^{10}	2.9×10^{10}	3.6×10^{9}	6.8×10^{10}	3.7×10^{11}	1.9×10^{9}
Maximum (SC-CO_2, $, USD)	8.5×10^{11}	3.8×10^{10}	5.3×10^{10}	6.2×10^{9}	1.3×10^{11}	6.2×10^{11}	3.2×10^{9}

Table S5. Anthropogenic land degradation status and potential land for nature-based solutions in the state of Iowa (IA) in the contiguous United States of America (USA) in 2016. Percent changes in area from 2001 to 2016 are shown in parentheses. Reported values have been rounded; therefore, calculated sums and percentages may exhibit minor discrepancies. This table shows the anthropogenic land degradation status in 2016 but most likely does not account for historical anthropogenic land degradation as well as most of the inherent land degradation.

County	Total Area (km^2)	Carbon Index (CI)	Anthropogenically Degraded Land	Proportion from Total	Types of Anthropogenic Degradation			Potential Land for Nature-Based Solutions
					Barren	Developed	Agriculture	
			(km^2)	(%)	(km^2)	(km^2)	(km^2)	(km^2)
Adair	1464	33 (15)	1411 (−0.1)	96	0.4 (−0.4)	65 (+0.5)	1345 (−0.1)	4 (+7.9)
Adams	1088	33 (16)	1006 (−0.1)	92	0.3 (−4.6)	44 (+0.3)	962 (−0.1)	5 (+11.8)
Allamakee	1598	18 (10)	975 (0)	61	0.8 (+0.7)	68 (+1.5)	907 (−0.2)	32 (+6.4)
Appanoose	1270	24 (13)	924 (−0.9)	73	2.0 (+298.6)	62 (+0.9)	860 (−1.2)	15 (+106.2)
Audubon	1144	33 (16)	1129 (0)	99	0.5 (−18.2)	49 (+0.7)	1080 (0)	2 (−5.5)
Benton	1845	34 (10)	1710 (+0.4)	93	0.2 (−5.0)	105 (+2.3)	1606 (+0.3)	33 (−18.6)
Black Hawk	1424	33 (17)	1304 (+0.4)	92	0.7 (+0.5)	170 (+11.3)	1134 (−1.0)	22 (−18.5)
Boone	1472	34 (23)	1305 (0)	89	1.2 (+37.8)	87 (+4.6)	1217 (−0.3)	17 (−0.6)
Bremer	1119	35 (17)	993 (+0.1)	89	0.3 (+10.2)	70 (+4.9)	923 (−0.3)	22 (−4.0)
Buchanan	1473	34 (20)	1385 (0)	94	0.4 (−3.4)	85 (+2.7)	1299 (−0.1)	15 (−0.2)
Buena Vista	1482	39 (18)	1445 (−0.1)	98	1.2 (−1.9)	80 (+2.5)	1364 (−0.2)	9 (+1.1)
Butler	1491	34 (17)	1378 (+0.1)	92	0.4 (+7.3)	74 (+2.1)	1304 (0)	26 (−6.0)
Calhoun	1473	40 (20)	1450 (−0.1)	98	0.4 (−2.5)	75 (+7.3)	1374 (−0.4)	7 (−5.6)
Carroll	1471	34 (20)	1445 (0)	98	0.8 (−8.4)	84 (+2.2)	1360 (−0.1)	7 (−5.9)
Cass	1455	36 (17)	1421 (0)	98	0.3 (−10.0)	74 (+2.2)	1347 (−0.1)	5 (−9.3)
Cedar	1492	32 (16)	1359 (+0.2)	91	0.2 (−19.0)	78 (+2.3)	1281 (0)	15 (−11.6)
Cerro Gordo	1456	34 (16)	1379 (+0.2)	95	1.1 (+12.6)	116 (+5.0)	1263 (−0.2)	32 (−10.0)
Cherokee	1484	39 (19)	1413 (−0.1)	95	0.8 (−8.8)	72 (+1.4)	1340 (−0.2)	23 (+2.6)
Chickasaw	1298	34 (18)	1181 (+0.1)	91	0.3 (−17.6)	66 (+1.7)	1115 (+0.1)	38 (−4.6)
Clarke	1108	27 (12)	882 (−0.6)	80	0.1 (+16.3)	48 (+2.3)	834 (−0.8)	5 (+98.5)
Clay	1465	39 (15)	1374 (0)	94	0.6 (+10.6)	74 (+2.0)	1299 (−0.2)	23 (−2.5)
Clayton	1995	18 (16)	1368 (−0.1)	69	1.0 (+0.6)	88 (+0.9)	1280 (−0.1)	49 (+7.5)
Clinton	1787	26 (10)	1595 (+0.6)	89	0.6 (−6.7)	121 (+4.0)	1473 (+0.3)	24 (−28.4)
Crawford	1842	30 (13)	1781 (+0.3)	97	0.5 (−2.7)	88 (+1.7)	1692 (+0.2)	26 (−14.0)
Dallas	1492	33 (16)	1321 (0)	89	2.3 (−1.3)	133 (+31.3)	1186 (−2.6)	16 (+1.5)
Davis	1288	23 (10)	982 (−0.5)	76	0.2 (−2.2)	53 (+0.5)	929 (−0.6)	7 (+77.5)
Decatur	1359	23 (17)	1032 (−0.8)	76	0.2 (+6.6)	58 (+0.6)	974 (−0.8)	8 (+75.3)
Delaware	1488	28 (23)	1321 (+0.1)	89	1.1 (+15.2)	76 (+1.9)	1243 (−0.1)	32 (−0.2)
Des Moines	1063	26 (17)	806 (0)	76	0.6 (−4.7)	108 (+4.1)	698 (−0.6)	20 (−1.9)
Dickinson	972	38 (20)	854 (+0.6)	88	0.8 (+9.4)	63 (+5.3)	790 (+0.2)	71 (−7.5)
Dubuque	1408	18 (18)	1177 (+0.1)	84	1.6 (−12.5)	127 (+10.0)	1048 (−0.9)	31 (+0.8)
Emmet	1017	37 (17)	960 (+0.1)	94	1.1 (−0.6)	47 (+0.8)	912 (+0.1)	17 (−8.2)
Fayette	1819	28 (20)	1629 (0)	90	0.5 (−2.5)	95 (+1.4)	1534 (−0.1)	41 (+0.1)
Floyd	1283	34 (20)	1185 (+0.2)	92	0.3 (−18.5)	72 (+2.2)	1112 (0)	38 (−4.9)
Franklin	1501	37 (17)	1449 (0)	97	0.6 (−2.3)	75 (+1.8)	1373 (0)	14 (−5.5)
Fremont	1315	36 (17)	1150 (+0.1)	87	6.3 (+1987.5)	63 (+0.6)	1081 (−0.5)	33 (+9.7)
Greene	1465	37 (20)	1394 (0)	95	0.5 (+5.2)	67 (+1.8)	1327 (−0.1)	12 (−3.6)
Grundy	1298	40 (15)	1281 (0)	99	0.2 (−3.9)	64 (+2.6)	1216 (−0.1)	8 (−2.7)
Guthrie	1517	31 (16)	1328 (0)	88	0.5 (−26.7)	70 (+1.6)	1258 (−0.1)	11 (+1.8)
Hamilton	1486	36 (23)	1423 (+0.1)	96	0.5 (−6.5)	80 (+3.0)	1342 (−0.1)	14 (−7.6)
Hancock	1470	38 (22)	1428 (0)	97	0.6 (+2.0)	74 (+1.4)	1354 (0)	14 (−13.1)
Hardin	1462	36 (19)	1372 (0)	94	0.5 (−4.9)	83 (+3.0)	1289 (−0.1)	18 (−3.8)
Harrison	1790	30 (16)	1530 (+0.8)	85	4.3 (+1287.5)	85 (+0.6)	1441 (+0.6)	85 (−6.9)
Henry	1115	26 (12)	895 (−0.2)	80	2.1 (+418.5)	70 (+1.4)	823 (−0.5)	16 (+24.2)
Howard	1221	32 (16)	1122 (+0.8)	92	0.3 (−6.0)	54 (+2.1)	1067 (+0.8)	42 (−18.2)
Humboldt	1117	38 (20)	1083 (0)	97	1.0 (+21.8)	52 (+1.3)	1029 (−0.1)	7 (−6.3)

Ida	1114	36 (17)	1094 (+0.7)	98	0.2 (−2.2)	51 (+2.3)	1043 (+0.6)	13 (−37.0)
Iowa	1507	27 (15)	1257 (+2.7)	83	0.3 (+29.2)	74 (+1.1)	1183 (+2.8)	92 (−26.7)
Jackson	1628	16 (9)	1166 (+0.7)	72	0.5 (+3.7)	75 (+2.5)	1091 (+0.6)	44 (−16.5)
Jasper	1859	31 (16)	1728 (+0.2)	93	0.4 (+7.8)	110 (+2.8)	1618 (0)	24 (−13.6)
Jefferson	1119	24 (11)	891 (−0.2)	80	0.9 (+686.6)	62 (+4.9)	827 (−0.6)	19 (+7.7)
Johnson	1568	28 (15)	1280 (+0.9)	82	0.9 (−8.5)	166 (+12.8)	1114 (−0.6)	53 (−15.6)
Jones	1477	26 (14)	1242 (+0.2)	84	0.5 (−9.6)	75 (+3.3)	1167 (0)	24 (−1.6)
Keokuk	1486	26 (15)	1238 (+2.3)	83	0.3 (+2.2)	69 (+0.4)	1168 (+2.5)	84 (−25.1)
Kossuth	2509	40 (23)	2439 (0)	97	2.0 (−1.8)	114 (+1.1)	2323 (−0.1)	18 (−5.3)
Lee	1329	21 (12)	924 (−0.2)	70	1.2 (+51.2)	92 (+6.5)	831 (−0.9)	19 (+15.7)
Linn	1799	28 (24)	1522 (+0.6)	85	0.6 (−27.5)	238 (+11.8)	1283 (−1.2)	35 (−16.9)
Louisa	1020	26 (15)	754 (+0.4)	74	0.4 (+12.2)	49 (+1.7)	705 (+0.3)	60 (−5.2)
Lucas	1109	25 (12)	796 (−0.8)	72	0.1 (+88.4)	49 (+0.7)	748 (−0.9)	10 (+59.0)
Lyon	1509	34 (15)	1431 (+0.1)	95	1.7 (−1.7)	70 (+1.7)	1359 (0)	54 (−3.6)
Madison	1405	30 (16)	1176 (−0.2)	84	0.8 (+18.3)	62 (+2.0)	1113 (−0.3)	10 (+12.0)
Mahaska	1455	30 (16)	1285 (+0.5)	88	0.8 (+6.1)	85 (+2.8)	1199 (+0.3)	35 (−12.9)
Marion	1348	25 (12)	1045 (−0.2)	78	4.3 (+120.0)	87 (+4.0)	954 (−0.8)	26 (+20.2)
Marshall	1472	35 (18)	1383 (+0.1)	94	0.5 (+3.8)	95 (+3.5)	1287 (−0.2)	17 (−5.3)
Mills	1124	34 (17)	1003 (+0.3)	89	2.6 (+658.8)	60 (+3.7)	941 (−0.2)	38 (+2.2)
Mitchell	1207	32 (12)	1127 (+0.1)	93	0.5 (−0.9)	61 (+3.4)	1066 (0)	30 (−5.5)
Monona	1785	31 (15)	1527 (+0.7)	86	3.4 (+1136.2)	83 (+0.3)	1441 (+0.5)	77 (−6.6)
Monroe	1094	24 (15)	735 (−1.0)	67	0.2 (−55.6)	47 (+3.4)	688 (−1.3)	15 (+53.7)
Montgomery	1090	35 (14)	1026 (+0.1)	94	0.2 (+24.3)	55 (+1.0)	971 (+0.1)	14 (−11.3)
Muscatine	1117	27 (15)	888 (+0.7)	80	0.6 (−1.1)	86 (+5.3)	801 (+0.2)	51 (−10.9)
O'Brien	1480	43 (20)	1438 (0)	97	0.7 (+14.9)	78 (+2.9)	1360 (−0.2)	22 (−1.1)
Osceola	1029	38 (17)	995 (0)	97	0.8 (+1.9)	52 (+5.0)	943 (−0.3)	20 (−2.5)
Page	1375	38 (15)	1272 (0)	93	0.3 (+33.5)	69 (+0.8)	1203 (0)	18 (−4.3)
Palo Alto	1453	37 (24)	1404 (−0.1)	97	1.4 (+12.0)	67 (+2.1)	1335 (−0.2)	14 (−4.1)
Plymouth	2213	31 (17)	1955 (+1.7)	88	1.1 (+9.7)	112 (+4.6)	1842 (+1.5)	199 (−14.1)
Pocahontas	1491	41 (24)	1464 (0)	98	1.3 (+20.5)	69 (+1.1)	1394 (−0.1)	10 (−7.0)
Polk	1376	34 (18)	1197 (+0.3)	87	4.0 (+17.7)	370 (+25.4)	823 (−8.0)	26 (+1.9)
Pottawattamie	2449	33 (16)	2267 (+0.3)	93	4.1 (+314.5)	190 (+6.4)	2073 (−0.4)	68 (−3.3)
Poweshiek	1509	31 (14)	1421 (+0.7)	94	0.2 (−10.1)	80 (+1.6)	1341 (+0.7)	30 (−26.7)
Ringgold	1377	29 (13)	1196 (−0.4)	87	0.3 (−1.7)	55 (+0.6)	1141 (−0.5)	7 (+48.6)
Sac	1482	39 (19)	1450 (0)	98	0.8 (−18.7)	77 (+5.4)	1373 (−0.3)	9 (−7.0)
Scott	1111	31 (16)	986 (+0.6)	89	0.6 (−37.2)	147 (+13.5)	839 (−1.3)	16 (−20.0)
Shelby	1527	28 (17)	1504 (+0.2)	98	0.3 (+0.6)	70 (+1.3)	1434 (+0.1)	11 (−21.8)
Sioux	1973	37 (21)	1904 (+0.2)	96	2.6 (−5.3)	123 (+5.2)	1778 (−0.1)	43 (−8.8)
Story	1474	36 (20)	1394 (+0.1)	95	0.4 (+2.0)	134 (+10.8)	1260 (−0.9)	16 (−9.2)
Tama	1853	34 (21)	1640 (+0.5)	89	0.3 (+5.3)	89 (+2.6)	1551 (+0.3)	41 (−12.7)
Taylor	1372	29 (12)	1203 (−0.1)	88	0.1 (0)	57 (+0.2)	1146 (−0.1)	11 (+11.1)
Union	1082	33 (13)	958 (−0.2)	88	0.3 (−3.7)	54 (+1.0)	903 (−0.3)	5 (+61.9)
Van Buren	1239	20 (11)	828 (−0.5)	67	0.7 (+30.1)	52 (+0.1)	776 (−0.5)	14 (+13.6)
Wapello	1101	24 (11)	839 (−0.2)	76	1.3 (+132.8)	81 (+6.4)	757 (−1.0)	12 (+30.2)
Warren	1415	30 (15)	1126 (−0.2)	80	1.5 (+101.8)	91 (+8.1)	1033 (−0.9)	18 (+13.1)
Washington	1464	27 (16)	1226 (+0.2)	84	0.7 (+51.4)	79 (+2.2)	1146 (0)	57 (−3.2)
Wayne	1356	27 (13)	1153 (−0.3)	85	0.4 (+1858.3)	54 (+0.2)	1099 (−0.4)	7 (+140.6)
Webster	1809	38 (19)	1669 (0)	92	1.2 (−16.9)	101 (+6.0)	1567 (−0.3)	19 (−4.7)
Winnebago	1032	37 (24)	981 (+0.3)	95	0.6 (+8.1)	53 (+1.2)	928 (+0.3)	17 (−18.7)
Winneshiek	1761	20 (11)	1456 (+0.8)	83	0.6 (−1.9)	86 (+1.6)	1370 (+0.7)	63 (−15.8)
Woodbury	2207	25 (14)	1957 (+3.1)	89	2.3 (+147.0)	155 (+5.0)	1800 (+2.9)	153 (−27.0)
Worth	1026	34 (16)	965 (+0.2)	94	0.2 (+3.8)	49 (+3.4)	915 (0)	21 (−8.9)
Wright	1491	37 (21)	1433 (+0.1)	96	0.9 (−24.5)	73 (+2.4)	1359 (0)	20 (−9.3)
Total	**142,801**	**n/a**	**126,573 (+0.2)**	**89**	**95 (+42.8)**	**8386 (+4.9)**	**118,092 (−0.1)**	**2837 (-8.9)**

Note: Anthropogenically degraded land was calculated as a sum of degraded land from agriculture (hay/pasture, and cultivated crops), from development (developed, open space; developed, low intensity; developed, medium intensity; developed, high intensity), and barren land. Developed land includes categories: developed, open space; developed, low intensity; developed, medium intensity; developed, high intensity. Agriculture includes categories: hay/pasture; and cultivated crops. Potential land for nature-based solutions (NBS) is limited to barren land, shrub/scrub, and herbaceous land cover classes, to provide potential land

areas without impacting current land uses. Average carbon index (CI, the standard deviation is given in parentheses) of mineral soils for each county in Iowa was obtained from Al-Kaisi et al., 2012 [36]. Change in the area was calculated as follows: ((2016 Area – 2001 Area) / 2001 Area) × 100%.

Table S6. Developed land and potential for realized social costs of carbon (C) due to complete loss of total soil carbon (TSC) of developed land by soil order in the state of Iowa (IA) (USA) prior and through 2016.

Parameter	Total	Degree of Weathering and Soil Development					
		Slight			Moderate		
		Entisols	Inceptisols	Histosols	Alfisols	Mollisols	Vertisols
Developed, open space (km²)	5038.9	350.7	408.5	2.3	1082.3	3185.3	9.9
Total soil carbon (TSC):							
Minimum (kg)	4.2×10^{10}	1.3×10^{9}	2.2×10^{9}	1.5×10^{8}	3.9×10^{9}	3.4×10^{10}	1.5×10^{8}
Midpoint (kg)	1.0×10^{11}	4.5×10^{9}	5.7×10^{9}	3.3×10^{8}	1.3×10^{10}	8.0×10^{10}	3.7×10^{8}
Maximum (kg)	1.8×10^{11}	8.5×10^{9}	1.1×10^{10}	5.7×10^{8}	2.4×10^{10}	1.4×10^{11}	6.3×10^{8}
Minimum (SC-CO_2, $, USD)	7.1×10^{9}	2.2×10^{8}	3.6×10^{8}	2.5×10^{7}	6.6×10^{8}	5.8×10^{9}	2.6×10^{7}
Midpoint (SC-CO_2, $, USD)	1.7×10^{10}	7.6×10^{8}	9.6×10^{8}	5.5×10^{7}	2.2×10^{9}	1.3×10^{10}	6.3×10^{7}
Maximum (SC-CO_2, $, USD)	3.0×10^{10}	1.4×10^{9}	1.8×10^{9}	9.6×10^{7}	4.0×10^{9}	2.3×10^{10}	1.1×10^{8}
Developed, medium intensity (km²)	686.4	85.7	51.2	0.2	110.6	438.4	0.3
Total soil carbon (TSC):							
Minimum (kg)	5.7×10^{9}	3.2×10^{8}	2.7×10^{8}	1.3×10^{7}	4.0×10^{8}	4.7×10^{9}	4.7×10^{6}
Midpoint (kg)	1.4×10^{10}	1.1×10^{9}	7.2×10^{8}	2.9×10^{7}	1.3×10^{9}	1.1×10^{10}	1.1×10^{7}
Maximum (kg)	2.5×10^{10}	2.1×10^{9}	1.3×10^{9}	5.0×10^{7}	2.5×10^{9}	1.9×10^{10}	1.9×10^{7}
Minimum (SC-CO_2, $, USD)	9.7×10^{8}	5.3×10^{7}	4.6×10^{7}	2.2×10^{6}	6.7×10^{7}	8.0×10^{8}	7.9×10^{5}
Midpoint (SC-CO_2, $, USD)	2.4×10^{9}	1.9×10^{8}	1.2×10^{8}	4.8×10^{6}	2.2×10^{8}	1.8×10^{9}	1.9×10^{6}
Maximum (SC-CO_2, $, USD)	4.1×10^{9}	3.5×10^{8}	2.2×10^{8}	8.5×10^{6}	4.1×10^{8}	3.1×10^{9}	3.2×10^{6}
Developed, low intensity (km²)	2475.9	187.9	165.8	1.0	614.9	1504.9	1.4
Total soil carbon (TSC):							
Minimum (kg)	2.0×10^{10}	7.0×10^{8}	8.8×10^{8}	6.2×10^{7}	2.2×10^{9}	1.6×10^{10}	2.3×10^{7}
Midpoint (kg)	5.0×10^{10}	2.4×10^{9}	2.3×10^{9}	1.4×10^{8}	7.3×10^{9}	3.8×10^{10}	5.5×10^{7}
Maximum (kg)	8.7×10^{10}	4.5×10^{9}	4.3×10^{9}	2.4×10^{8}	1.4×10^{10}	6.4×10^{10}	9.2×10^{7}
Minimum (SC-CO_2, $, USD)	3.4×10^{9}	1.2×10^{8}	1.5×10^{8}	1.0×10^{7}	3.8×10^{8}	2.7×10^{9}	3.8×10^{6}
Midpoint (SC-CO_2, $, USD)	8.4×10^{9}	4.1×10^{8}	3.9×10^{8}	2.3×10^{7}	1.2×10^{9}	6.3×10^{9}	9.2×10^{6}
Maximum (SC-CO_2, $, USD)	1.5×10^{10}	7.7×10^{8}	7.2×10^{8}	4.0×10^{7}	2.3×10^{9}	1.1×10^{10}	1.6×10^{7}
Developed, high intensity (km²)	184.8	34.3	9.7	0.0	22.5	118.2	0.05
Total soil carbon (TSC):							
Minimum (kg)	1.5×10^{9}	1.3×10^{8}	5.1×10^{7}	2.4×10^{6}	8.1×10^{7}	1.3×10^{9}	7.8×10^{5}
Midpoint (kg)	3.8×10^{9}	4.4×10^{8}	1.4×10^{8}	5.4×10^{6}	2.7×10^{8}	3.0×10^{9}	1.9×10^{6}
Maximum (kg)	6.6×10^{9}	8.3×10^{8}	2.5×10^{8}	9.4×10^{6}	5.0×10^{8}	5.0×10^{9}	3.2×10^{6}
Minimum (SC-CO_2, $, USD)	2.6×10^{8}	2.1×10^{7}	8.6×10^{6}	4.1×10^{5}	1.4×10^{7}	2.2×10^{8}	1.3×10^{5}
Midpoint (SC-CO_2, $, USD)	6.4×10^{8}	7.5×10^{7}	2.3×10^{7}	9.1×10^{5}	4.5×10^{7}	5.0×10^{8}	3.2×10^{5}
Maximum (SC-CO_2, $, USD)	1.1×10^{9}	1.4×10^{8}	4.2×10^{7}	1.6×10^{6}	8.4×10^{7}	8.5×10^{8}	5.3×10^{5}
Total area (km²)	8385.9	658.6	635.2	3.5	1830.3	5246.7	11.7
Total soil carbon (TSC):							
Minimum (kg)	6.9×10^{10}	2.4×10^{9}	3.4×10^{9}	2.3×10^{8}	6.6×10^{9}	5.7×10^{10}	1.8×10^{8}
Midpoint (kg)	1.7×10^{11}	8.4×10^{9}	8.9×10^{9}	5.0×10^{8}	2.2×10^{10}	1.3×10^{11}	4.4×10^{8}
Maximum (kg)	3.0×10^{11}	1.6×10^{10}	1.6×10^{10}	8.7×10^{8}	4.1×10^{10}	2.2×10^{11}	7.4×10^{8}
Minimum (SC-CO_2, $, USD)	1.2×10^{10}	4.1×10^{8}	5.7×10^{8}	3.8×10^{7}	1.1×10^{9}	9.5×10^{9}	3.1×10^{7}
Midpoint (SC-CO_2, $, USD)	2.9×10^{10}	1.4×10^{9}	1.5×10^{9}	8.4×10^{7}	3.6×10^{9}	2.2×10^{10}	7.4×10^{7}
Maximum (SC-CO_2, $, USD)	5.0×10^{10}	2.7×10^{9}	2.8×10^{9}	1.5×10^{8}	6.8×10^{9}	3.8×10^{10}	1.3×10^{8}

Table S7. Increases in developed land and potential for realized social costs of carbon (C) due to complete loss of total soil carbon (TSC) of developed land by soil order in the state of Iowa (IA) (USA) from 2001 to 2016.

Parameter	Total	Degree of Weathering and Soil Development					
		Slight			Moderate		
		Entisols	Inceptisols	Histosols	Alfisols	Mollisols	Vertisols
Developed, open space (km²)	85.8	5.1	13.6	0.0	21.2	45.9	0.0
Total soil carbon (TSC):							
Minimum (kg)	6.6×10^8	1.9×10^7	7.2×10^7	1.0×10^6	7.6×10^7	5.0×10^8	0.0
Midpoint (kg)	1.7×10^9	6.5×10^7	1.9×10^8	0.0	2.5×10^8	1.1×10^9	0.0
Maximum (kg)	2.9×10^9	1.2×10^8	3.5×10^8	4.6×10^6	4.7×10^8	2.0×10^9	0.0
Minimum (SC-CO_2, $, USD)	1.1×10^8	3.2×10^6	1.2×10^7	1.8×10^5	1.3×10^7	8.4×10^7	0.0
Midpoint (SC-CO_2, $, USD)	2.8×10^8	1.1×10^7	3.2×10^7	3.9×10^5	4.2×10^7	1.9×10^8	0.0
Maximum (SC-CO_2, $, USD)	4.9×10^8	2.1×10^7	5.9×10^7	6.8×10^5	7.9×10^7	3.3×10^8	0.0
Developed, medium intensity (km²)	153.4	16.6	18.9	0.0	22.3	95.5	0.0
Total soil carbon (TSC):							
Minimum (kg)	1.3×10^9	6.2×10^7	1.0×10^8	1.6×10^6	8.0×10^7	1.0×10^9	0.0
Midpoint (kg)	3.1×10^9	2.1×10^8	2.6×10^8	0.0	2.6×10^8	2.4×10^9	0.0
Maximum (kg)	5.4×10^9	4.0×10^8	4.9×10^8	6.0×10^6	5.0×10^8	4.1×10^9	0.0
Minimum (SC-CO_2, $, USD)	2.1×10^8	1.0×10^7	1.7×10^7	2.6×10^5	1.4×10^7	1.7×10^8	0.0
Midpoint (SC-CO_2, $, USD)	5.3×10^8	3.6×10^7	4.5×10^7	5.8×10^5	4.4×10^7	4.0×10^8	0.0
Maximum (SC-CO_2, $, USD)	9.2×10^8	6.8×10^7	8.2×10^7	1.0×10^6	8.3×10^7	6.8×10^8	0.0
Developed, low intensity (km²)	104.0	6.8	16.6	0.0	21.7	58.8	0.0
Total soil carbon (TSC):							
Minimum (kg)	8.3×10^8	2.5×10^7	8.8×10^7	2.0×10^6	7.8×10^7	6.3×10^8	0.0
Midpoint (kg)	2.0×10^9	8.7×10^7	2.3×10^8	0.0	2.6×10^8	1.5×10^9	0.0
Maximum (kg)	3.6×10^9	1.6×10^8	4.3×10^8	7.6×10^6	4.8×10^8	2.5×10^9	0.0
Minimum (SC-CO_2, $, USD)	1.4×10^8	4.2×10^6	1.5×10^7	3.3×10^5	1.3×10^7	1.1×10^8	0.0
Midpoint (SC-CO_2, $, USD)	3.5×10^8	1.5×10^7	3.9×10^7	7.4×10^5	4.3×10^7	2.5×10^8	0.0
Maximum (SC-CO_2, $, USD)	6.0×10^8	2.8×10^7	7.2×10^7	1.3×10^6	8.1×10^7	4.2×10^8	0.0
Developed, high intensity (km²)	52.2	8.6	4.4	0.0	6.4	32.8	0.0
Total soil carbon (TSC):							
Minimum (kg)	4.3×10^8	3.2×10^7	2.3×10^7	1.2×10^6	2.3×10^7	3.5×10^8	0.0
Midpoint (kg)	1.1×10^9	1.1×10^8	6.2×10^7	0.0	7.6×10^7	8.2×10^8	0.0
Maximum (kg)	1.9×10^9	2.1×10^8	1.1×10^8	4.7×10^6	1.4×10^8	1.4×10^9	0.0
Minimum (SC-CO_2, $, USD)	7.3×10^7	5.3×10^6	3.9×10^6	2.1×10^5	3.9×10^6	6.0×10^7	0.0
Midpoint (SC-CO_2, $, USD)	1.8×10^8	1.9×10^7	1.0×10^7	4.5×10^5	1.3×10^7	1.4×10^8	0.0
Maximum (SC-CO_2, $, USD)	3.1×10^8	3.5×10^7	1.9×10^7	7.9×10^5	2.4×10^7	2.3×10^8	0.0
Total area (km²)	395.4	37.1	53.5	0.0	71.6	232.9	0.0
Total soil carbon (TSC):							
Minimum (kg)	3.2×10^9	1.4×10^8	2.8×10^8	5.8×10^6	2.6×10^8	2.5×10^9	0.0
Midpoint (kg)	7.9×10^9	4.8×10^8	7.5×10^8	0.0	8.5×10^8	5.8×10^9	0.0
Maximum (kg)	1.4×10^{10}	9.0×10^8	1.4×10^9	2.2×10^7	1.6×10^9	9.9×10^9	0.0
Minimum (SC-CO_2, $, USD)	5.4×10^8	2.3×10^7	4.8×10^7	9.8×10^5	4.4×10^7	4.2×10^8	0.0
Midpoint (SC-CO_2, $, USD)	1.3×10^9	8.1×10^7	1.3×10^8	2.2×10^6	1.4×10^8	9.8×10^8	0.0
Maximum (SC-CO_2, $, USD)	2.3×10^9	1.5×10^8	2.3×10^8	3.8×10^6	2.7×10^8	1.7×10^9	0.0

(a) Hay/Pasture **(b)** Cultivated crops **(c)** Developed **(d)** Barren land

Figure S1. High-resolution aerial photos showing examples of land classes (LULC) which were used to determine anthropogenically degraded land (LD) in the state of Iowa (IA) (USA) by assuming that degraded lands are represented by the land classes (LULC) for agriculture (hay/pasture, and cultivated crops), development (developed, open space; developed, low intensity; developed, medium intensity; developed, high intensity) and barren lands. Representative examples were located using a land cover map of the contiguous United States of America (USA) for 2016 (based on data from the Multi-Resolution Land Characteristics Consortium (MRLC) with detailed descriptions of the land classes [30]).

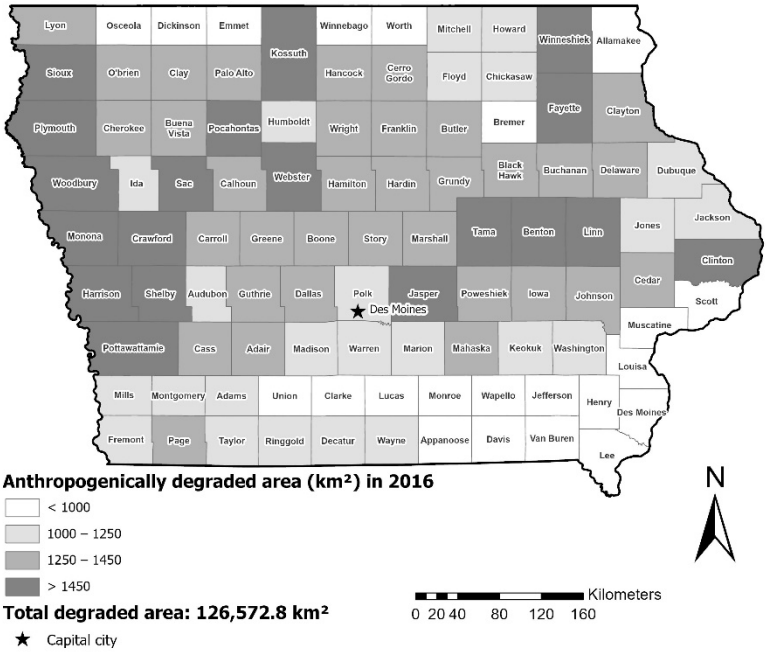

Figure S2. Anthropogenic land degradation status is presented as the total degraded land area (km^2) in the state of Iowa (IA) (USA) in 2016. Anthropogenically degraded land was calculated as a sum of degraded land from agriculture (hay/pasture, and cultivated crops), from development (developed, open space; developed, low intensity; developed, medium intensity; developed, high intensity), and barren land.

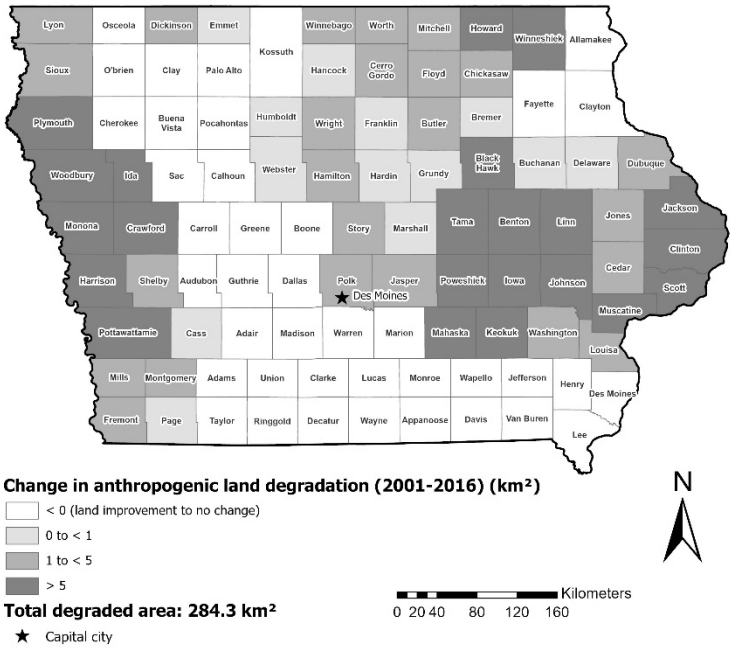

Figure S3. Change in anthropogenic land degradation status is presented as the total degraded land area (km²) over time (2001–2016) by county in the state of Iowa (IA) (USA). Anthropogenically degraded land was calculated as a sum of degraded land from agriculture (hay/pasture, and cultivated crops), from development (developed, open space; developed, low intensity; developed, medium intensity; developed, high intensity), and barren land.

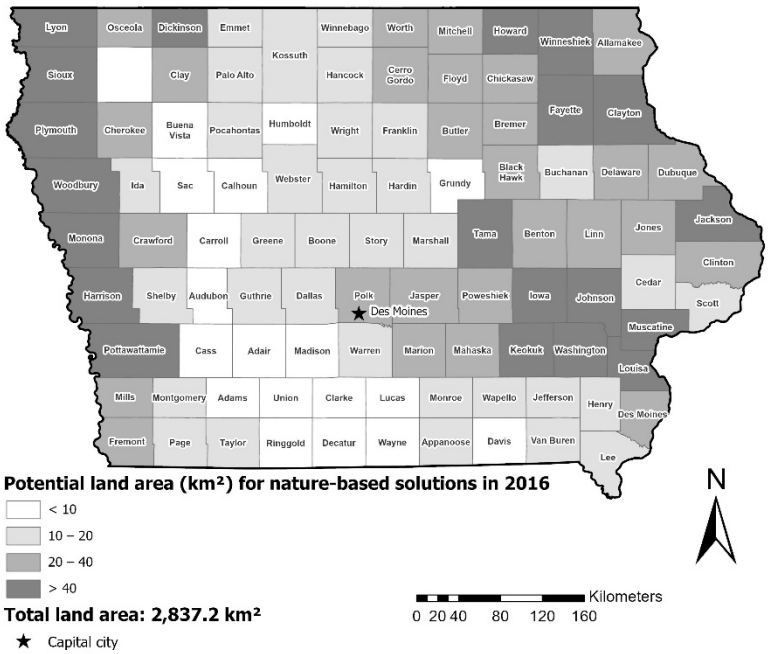

Figure S4. The status of potential land for nature-based solutions (NBS) is presented as the proportion of potential NBS land over the total land area (%) by county in the state of Iowa (IA) (USA). Potential land for NBS is limited to barren land, shrub/scrub, and herbaceous land cover classes, to provide potential land areas without impacting current land uses.

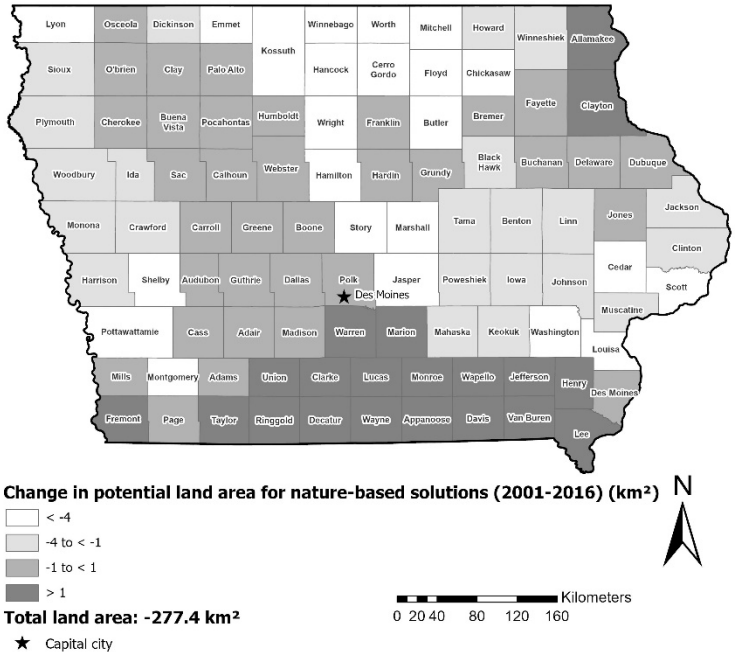

Figure S5. Change in the status of potential land area for nature-based solutions (NBS) (km^2) over time (2001-2016) by county in the state of Iowa (IA) (USA). Potential land for NBS is limited to barren land, shrub/scrub, and herbaceous land cover classes, to provide potential land areas without impacting current land uses.

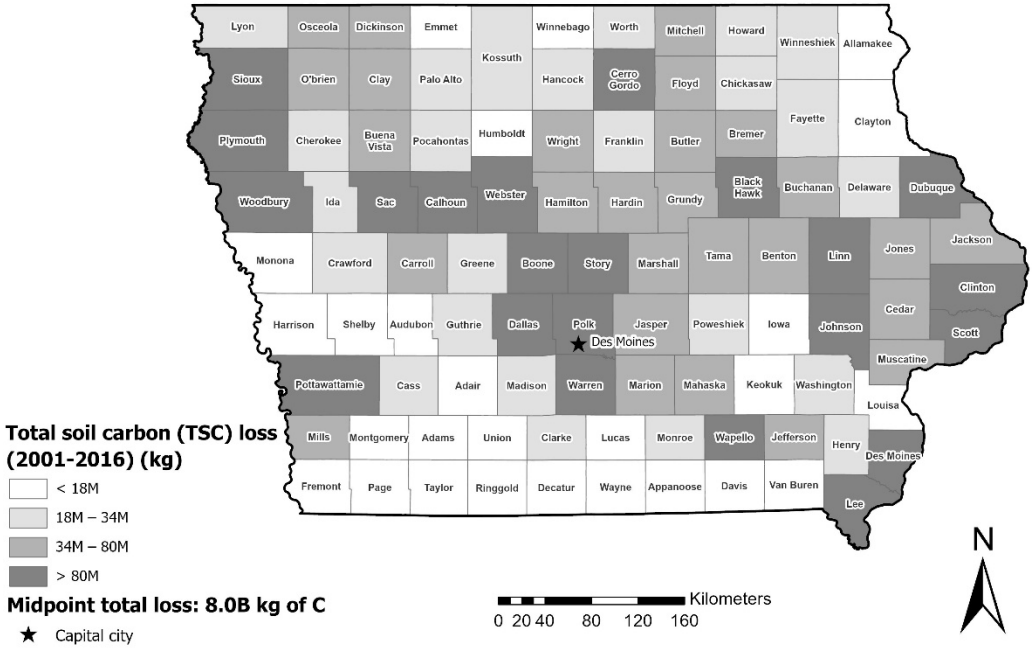

Figure S6. Damage to soil quality because of soil carbon (C) loss with associated emissions from more recent land developments between 2001 and 2016 in Iowa (IA) (USA). Note: M = million = 10^6, B = billion = 10^9.

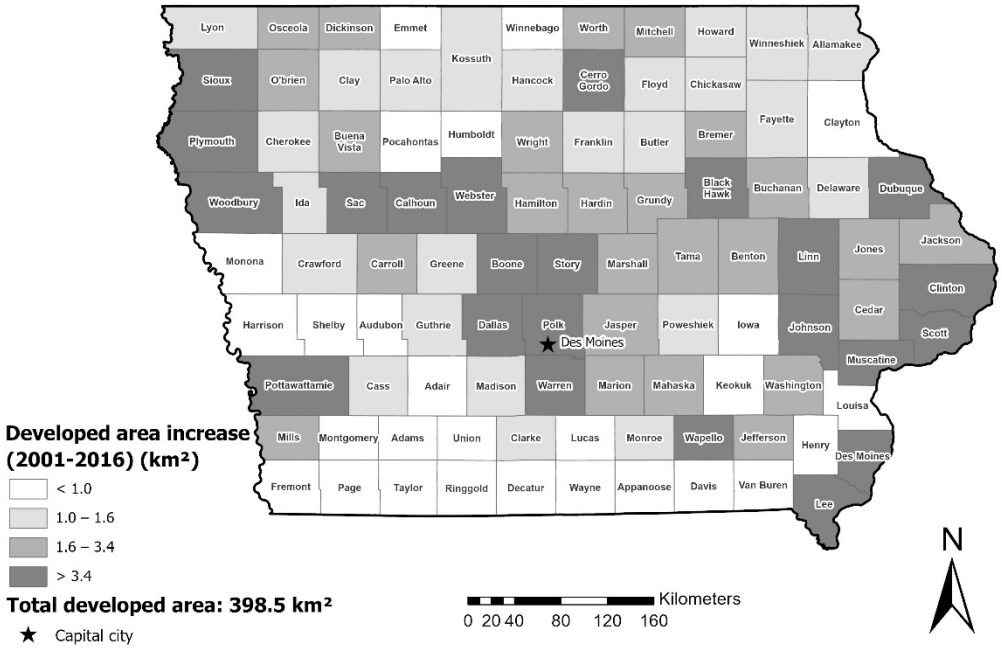

Figure S7. Damages to soil quality because of loss of land for potential soil carbon (C) sequestration from land developments that occurred between 2001 and 2016 for Iowa (IA) (USA).

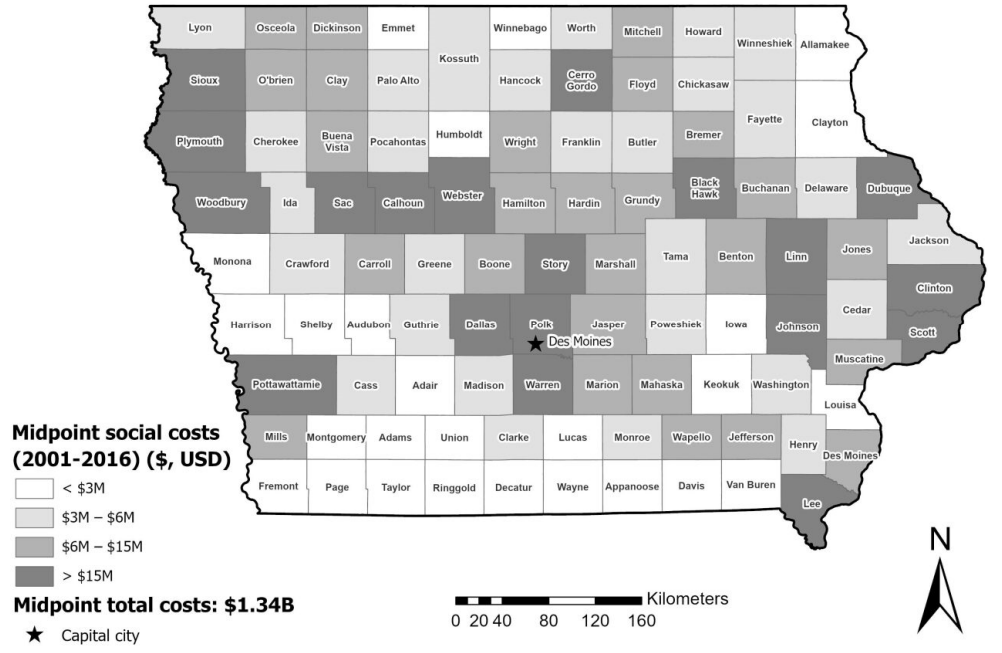

Figure S8. Damage to soil quality (SQ) from emissions can be measured as "realized" social costs of soil carbon (C) (SC-CO_2) from recent land developments in the state of Iowa (IA) (USA) from 2001 to 2016. Note: M = million = 10^6, B = billion = 10^9.