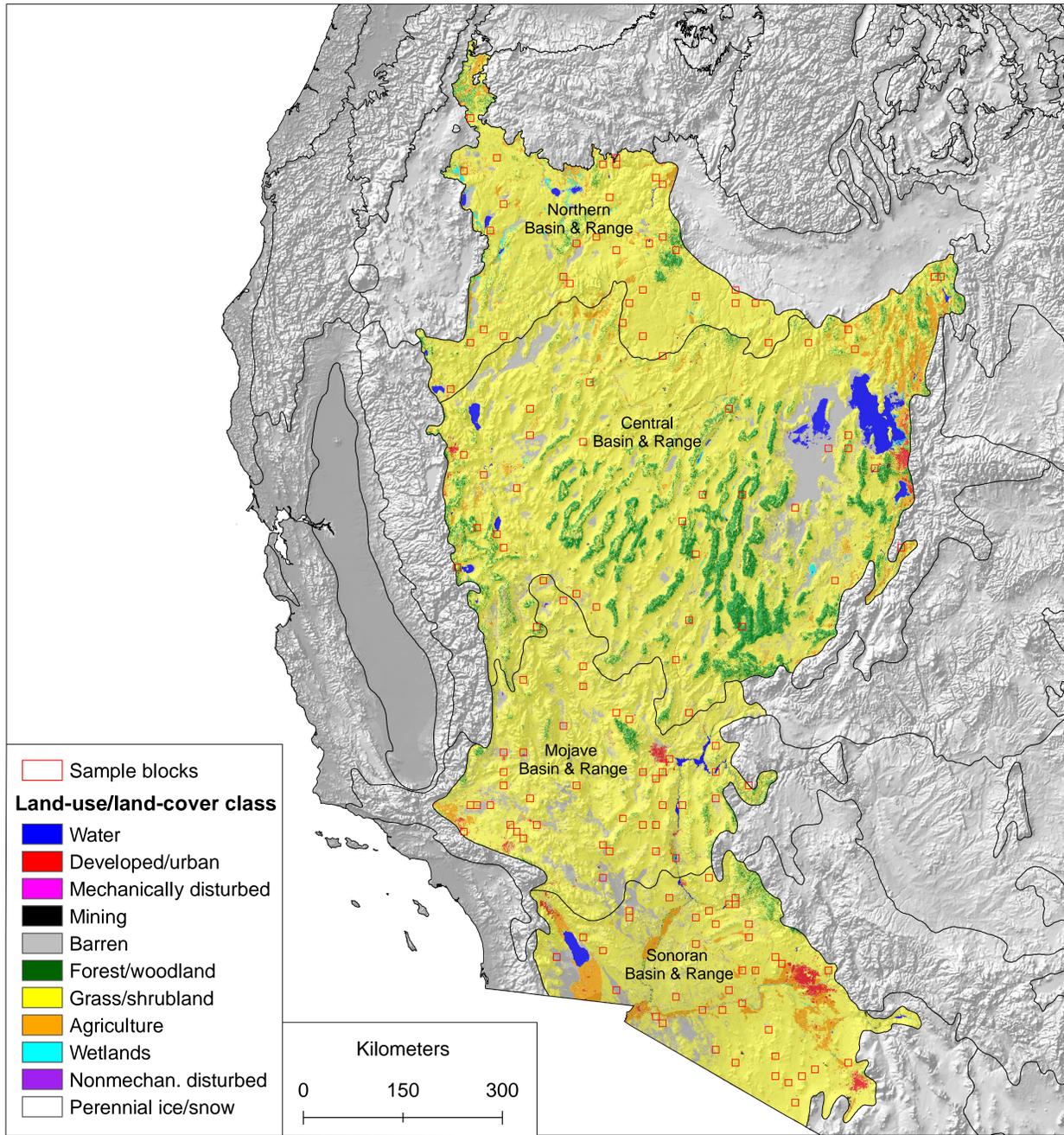


Abstract

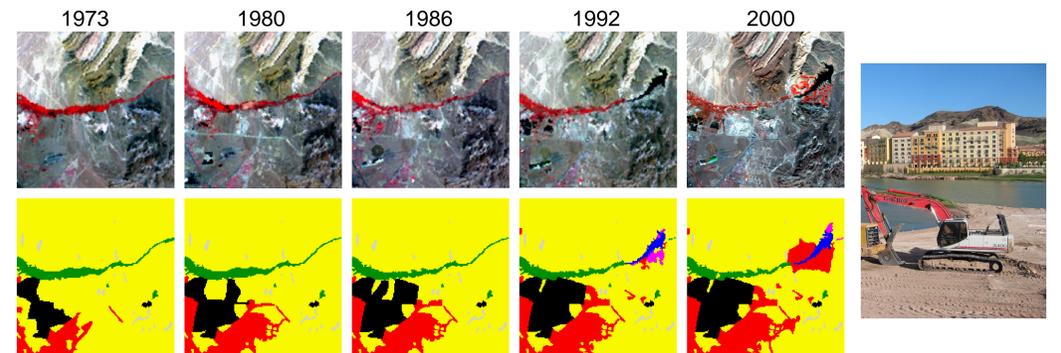
Few multi-temporal landscape-change data currently exist for the basin-and-range provinces of the United States. As part of the U.S. Geological Survey Land Cover Trends project, we present land-use/land-cover change estimates for each of the basin-and-range ecoregions (Northern, Central, Mojave, and Sonoran) between 1973 and 2000. Estimates for four ecoregions were calculated by utilizing a sampling strategy coupled with manual interpretation of Landsat imagery for five dates (1973, 1980, 1986, 1992, and 2000). Although harsh climate, infertile soils, and lack of viable natural resources have historically impeded anthropogenic land-use change across the region, varying influences from agriculture, mining, development, and fire have contributed to the loss of grasslands and shrublands across all of these ecoregions. Between 1973 and 2000, the footprint of change across the entire basin-and-range was 2.5 percent (17,830 km²). Additionally, 8,860 km² of the change was the direct loss of grasslands and shrublands. This loss of rangeland may have implications for future management of livestock and national carbon resources. The U.S. Global Change Research Program can use these rates of land change along with other Land Cover Trends metrics to assess progress in balancing carbon sources and sinks, while researchers in the LandCarbon Project can use Land Cover Trends data to help estimate land-use and land-cover change over time. Furthermore, in conjunction with models of terrestrial carbon stocks and fluxes, the LandCarbon Project can use Land Cover Trends data to project carbon storage potential under various scenarios into the future.

Keywords: Land-use change, land-cover change, ecoregion, carbon storage, rangeland, fire



Common conversions for the Central Basin and Range Ecoregion						Common conversions for the Northern Basin and Range Ecoregion										
Period	From class	To class	Area changed (km ²)	Margin of error (± km ²)	Standard error (km ²)	Period	From class	To class	Area changed (km ²)	Margin of error (± km ²)	Standard error (km ²)	Percent of ecoregion	Percent of all changes			
1973-1980	Grassland/Shrubland	Agriculture	352	353	240	0.1	50.5	1973-1980	Water	Mechanically Disturbed	255.6	340.4	230.6	0.2%	31.1%	
	Water	Grassland/Shrubland	101	148	101	0.0	14.5		Grassland/Shrubland	Agriculture	223.5	314.4	122.3	0.2%	27.4%	
	Grassland/Shrubland	Mining	62	51	34	0.0	8.9		Grassland/Shrubland	Nonmechan. Disturbed	192.2	279.4	189.4	0.2%	23.4%	
	Wetland	Water	39	57	38	0.0	5.5		Mechanically Disturbed	Water	59.3	84.3	57.1	0.1%	7.2%	
	Grassland/Shrubland	Wetland	37	55	37	0.0	5.3		Wetland	Grassland/Shrubland	43.8	49.9	33.8	0.0%	5.3%	
	Other	Other	106	n/a	n/a	0.0	15.2		Other	Other	46.0	n/a	n/a	0.0%	5.8%	
698						822.1						0.8%	100%			
1980-1986	Wetland	Water	600	874	594	0.2	51.6	1980-1986	Grassland/Shrubland	Nonmechan. Disturbed	1247.9	1058.0	716.8	1.1%	73.5%	
	Grassland/Shrubland	Water	202	234	159	0.1	17.3		Grassland/Shrubland	Agriculture	227.0	314.4	122.3	0.2%	14.0%	
	Agriculture	Water	108	158	107	0.0	9.3		Grassland/Shrubland	Water	94.8	95.9	65.0	0.1%	5.6%	
	Grassland/Shrubland	Agriculture	55	57	39	0.0	4.8		Grassland/Shrubland	Wetland	33.8	39.8	27.0	0.0%	2.0%	
	Grassland/Shrubland	Developed	51	46	31	0.0	4.4		Grassland/Shrubland	Mining	21.4	28.2	19.1	0.0%	1.3%	
	Other	Other	147	n/a	n/a	0.0	12.7		Grassland/Shrubland	Other	42.0	n/a	n/a	0.1%	3.1%	
1163						1697.0						1.6%	100%			
1986-1992	Agriculture	Grassland/Shrubland	399	320	218	0.1	31.8	1986-1992	Grassland/Shrubland	Nonmechan. Disturbed	2477.4	2523.0	1709.4	2.3%	58.6%	
	Grassland/Shrubland	Developed	243	193	131	0.1	19.4		Grassland/Shrubland	Nonmechan. Disturbed	1137.3	659.0	440.7	1.0%	26.9%	
	Water	Grassland/Shrubland	154	225	153	0.0	12.3		Grassland/Shrubland	Mechanically Disturbed	312.6	329.4	223.3	0.3%	7.4%	
	Wetland	Water	149	214	145	0.0	11.9		Nonmechan. Disturbed	Nonmechan. Disturbed	102.3	148.7	100.8	0.1%	2.4%	
	Grassland/Shrubland	Mining	126	117	79	0.0	10.1		Wetland	Grassland/Shrubland	69.7	67.7	45.9	0.1%	1.6%	
	Other	Other	182	n/a	n/a	0.1	14.5		Other	Other	120.4	n/a	n/a	0.1%	3.1%	
1254						4229.8						3.5%	100%			
1992-2000	Forest	Nonmechan. disturbed	1005	1471	1000	0.3	37.5	1992-2000	Nonmechan. Disturbed	Nonmechan. Disturbed	1388.8	2019.6	1368.3	1.3%	31.8%	
	Grassland/Shrubland	Nonmechan. disturbed	867	1269	862	0.3	32.4		Grassland/Shrubland	Nonmechan. Disturbed	1491.2	2020.3	1368.8	1.4%	33.5%	
	Grassland/Shrubland	Mining	328	252	171	0.1	12.2		Nonmechan. Disturbed	Forest	1146.8	1667.8	1129.9	1.0%	26.3%	
	Grassland/Shrubland	Developed	224	198	135	0.1	8.4		Mechanically Disturbed	Wetland	151.5	219.8	149.9	0.1%	3.5%	
	Grassland/Shrubland	Agriculture	85	124	84	0.0	3.2		Mechanically Disturbed	Grassland/Shrubland	143.8	127.1	86.1	0.1%	3.3%	
	Other	Other	170	n/a	n/a	0.0	6.4		Other	Other	22.0	n/a	n/a	0.2%	5.9%	
2678						4364.8						4.0%	100%			
Overall	1973-2000	Forest	1005	1471	1000	0.3	37.5	Overall	1973-2000	Grassland/Shrubland	Nonmechan. Disturbed	5006.9	4235.2	2869.4	4.6%	45.4%
	Grassland/Shrubland	Nonmechan. disturbed	867	1269	862	0.3	32.0		Grassland/Shrubland	Nonmechan. Disturbed	1491.2	2020.3	1368.8	1.4%	33.5%	
	Water	Water	640	922	633	0.2	11.0		Nonmechan. Disturbed	Grassland/Shrubland	1379.1	1195.9	810.2	0.3%	12.5%	
	Grassland/Shrubland	Developed	538	386	262	0.2	9.3		Nonmechan. Disturbed	Forest	1148.2	1667.7	1129.9	1.0%	10.4%	
	Wetland	Agriculture	527	413	281	0.2	9.1		Water	Mechanically Disturbed	568.2	660.9	447.8	0.5%	5.2%	
	Other	Other	2217	n/a	n/a	0.6	38.3		Other	Other	1433.5	n/a	n/a	1.3%	13.0%	
5793						11024.1						10.1%	100%			

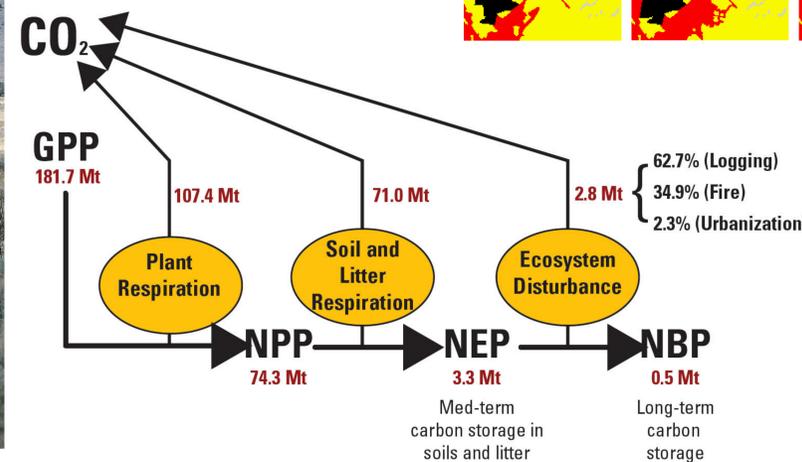
Common conversions for the Mojave Basin and Range Ecoregion						Common conversions for the Sonoran Basin and Range Ecoregion									
Period	From class	To class	Area changed (km ²)	Margin of error (± km ²)	Standard error (km ²)	Period	From class	To class	Area changed (km ²)	Margin of error (± km ²)	Standard error (km ²)	Percent of ecoregion	Percent of all changes		
1973-1980	Grassland/Shrubland	Developed	314	241	164	0.2	46.5	1973-1980	Grassland/Shrubland	Water	617	608	414	0.5	40.0
	Grassland/Shrubland	Mining	90	94	64	0.1	13.3		Water	Wetland	204	381	260	0.2	17.1
	Mechanically disturbed	Developed	52	56	38	0.0	7.7		Agriculture	Agriculture	257	188	128	0.2	16.6
	Wetland	Water	34	50	34	0.0	5.1		Grassland/Shrubland	Forest	90	120	82	0.1	5.8
	Barren	Grassland/Shrubland	34	49	34	0.0	5.0		Grassland/Shrubland	Mechanically disturbed	80	61	0.1	5.2	
	Other	Other	151	n/a	n/a	0.1	22.4		Other	Other	236	n/a	n/a	0.2	15.3
675						1544						1.3	100%		
1980-1986	Grassland/Shrubland	Developed	202	192	131	0.2	33.3	1980-1986	Water	Grassland/Shrubland	457	738	503	0.6	41.5
	Grassland/Shrubland	Mechanically disturbed	115	132	90	0.1	19.0		Water	Wetland	344	496	338	0.3	21.7
	Grassland/Shrubland	Mining	110	103	70	0.1	18.1		Grassland/Shrubland	Agriculture	147	112	76	0.1	9.3
	Barren	Mining	49	70	48	0.0	8.0		Grassland/Shrubland	Developed	96	75	51	0.1	6.1
	Mechanically disturbed	Developed	38	35	24	0.0	6.2		Agriculture	Grassland/Shrubland	90	108	74	0.1	5.7
	Other	Other	92	n/a	n/a	0.1	15.3		Other	Grassland/Shrubland	249	n/a	n/a	0.2	15.7
605						1583						1.4	100%		
1986-1992	Grassland/Shrubland	Developed	751	851	580	0.6	45.2	1986-1992	Wetland	Grassland/Shrubland	158	227	155	0.1	28.3
	Grassland/Shrubland	Mechanically disturbed	435	421	287	0.3	26.2		Water	Grassland/Shrubland	147	160	109	0.1	26.4
	Water	Wetland	125	180	123	0.1	7.5		Grassland/Shrubland	Developed	91	63	43	0.1	16.3
	Grassland/Shrubland	Mining	110	97	66	0.1	6.4		Agriculture	Grassland/Shrubland	49	44	30	0.0	8.7
	Grassland/Shrubland	Nonmechanically disturb	82	118	80	0.1	4.9		Grassland/Shrubland	Wetland	47	67	46	0.0	8.4
	Other	Other	158	n/a	n/a	0.1	9.5		Other	Other	67	n/a	n/a	0.1	12.0
1660						558						0.5	100%		
1992-2000	Forest	Mechanically disturbed	324	467	318	0.2	38.5	1992-2000	Grassland/Shrubland	Agriculture	245	264	180	0.2	24.9
	Grassland/Shrubland	Developed	160	183	124	0.1	19.1		Grassland/Shrubland	Grassland/Shrubland	207	161	110	0.2	21.0
	Mechanically disturbed	Developed	89	80	54	0.1	10.5		Grassland/Shrubland	Developed	99	68	0.1	13.7	
	Nonmechan. disturbed	Grassland/Shrubland	82	118	80	0.1	9.7		Forest	Nonmechan. disturbed	113	163	111	0.1	11.5
	Grassland/Shrubland	Mechanically disturbed	77	58	40	0.1	9.1		Wetland	Grassland/Shrubland	89	128	87	0.1	9.0
	Other	Other	110	n/a	n/a	0.1	13.1		Other	Other	195	n/a	n/a	0.2	19.8
841						985						0.8	100%		
Overall	1973-2000	Grassland/Shrubland	1426	1191	811	1.1	37.7	Overall	1973-2000	Water	833	809	551	0.7	17.8
	Grassland/Shrubland	Mechanically disturbed	651	591	403	0.5	17.2		Water	Grassland/Shrubland	462	620	422	0.6	14.4
	Grassland/Shrubland	Mining	345	245	167	0.3	9.1		Grassland/Shrubland	Agriculture	651	427	291	0.6	13.9
	Forest	Mechanically disturbed	340	488	332	0.3	9.0		Agriculture	Grassland/Shrubland	360	241	164	0.3	7.7
	Mechanically disturbed	Developed	205	138	94	0.2	5.4		Water	Wetland	358	514	350	0.3	7.7
	Other	Other	814	n/a	n/a	0.6	21.5		Other	Other	1786	n/a	n/a	1.5	39.2
3781						4671						4.0	100%		



Landscape Change Results

Overall spatial change for all of the basin-and-range ecoregions (Northern, Central, Mojave, and Sonoran), that is the area that changed at least one time between 1973 and 2000, was 2.5% (17,830 km²) with 0.7% (5,183 km²) of the region experiencing change in more than one time period. Multiple changes in individual pixels were generally associated with disturbance events and subsequent vegetation re-growth (e.g. fire). We found that change increased steadily in the first three time intervals from an average of 535 km² per year between 1973 and 1980 to 1,285 km² per year between 1986 and 1992. We estimated a small decline in the rate of change between 1992 and 2000, to an average change of 944 km² per year.

Grasslands/shrublands, frequently used for livestock grazing, constituted the vast majority of the study area. Overall, grassland/shrublands experienced the greatest net loss over the study period, decreasing from an estimated 83.8% (587,020 km²) in 1973 to 82.3% (578,160 km²) in 2000, a decline of 8,860 km² (13,164 km² lost and 4,300 km² gained). The most common LULC conversions across the basin-and-range ecoregions were indicative of the changes associated with natural disturbances (i.e. fire), and grass/shrubland loss to development, agriculture, and mining. Conversions of grass/shrubland and forest to nonmechanical disturbance totaled 7,114 km² and were the largest land-cover conversions over the 27-year study period. Between 1973 and 2000, common conversions from grass/shrubland to development, agriculture, and mining accounted for 2,332 km², 1,653 km², and 1,029 km² respectively.



Land Cover Trends & Carbon Dynamics

Land change is a first order driver of climate change and carbon budget research (Feddema et al. 2005; Houghton et al. 1999). Both the National Research Council and the U.S. Climate Change Science Plan identify land change as a core research area (NRC 2001; CCSP 2003). Trends data have been incorporated into carbon (C) storage assessments for the State of California, along with a number of other ecoregions (Liu J. et al., 2009). Although logging induced C ecosystem emissions were more of a factor than fire related emissions in California for 1951-2000, fire and rangeland conversions play a more central role in C flux across the basin and range provinces. As we begin to expand carbon storage assessments to the basin and range ecoregions, we expect urbanization and mining to serve as minor contributors to the state's C flux, while fire will likely prove to be the major C ecosystem emission source. We also expect the basin and range provinces to behave differently than the case study from California due to the prevalence of forested land across California compared to the grass/shrub dominated landscape in the high deserts. However, we also acknowledge that the cumulative potential Net Ecosystem Production (NEP) increase over the past 50 years may have more than offset all the direct carbon losses from fire disturbances and rangeland conversions during the same period, much like the case in California where vegetation growth and C storage escalated due to higher atmospheric CO₂.