HYDROLOGY, CLIMATE AND SELECTED SOILS LITERATURE

SAGERS WASH - EAST UTAH DESERT AREA

ABSTRACT

Jackson, William L.; R. Gordon Bentley and Scott Fisher. 1984. Salinity status report: 1980-82. Results of Bureau of Land Management studies on public lands in the Upper Colorado River Basin. Technical Note 364. USDI, BLM, Denver Service Center, Division of Resource Systems. 54p.

The purpose of this report was to summarize the most important results and conclusions from eight BLM salinity studies completed 1980-82. In addition, specific techniques and alternatives were reviewed for managing salinity from diffuse overland sources.

Salt and sediment yields on ephemeral washes: Price River Basin, Utah

Rainfall, stream discharge, and water quality data were collected 1979 to 1981 on Wattis Branch, Soldier Creek and Coal Creek, all ephemeral washes in saline geologic settings in the Price Basin. Very few data existed previously depicting Total Dissolved Solids (TDS) and Total Solids (TS) concentrations in relation to complete storm hydrographs of ephemeral channels. Only a few runoff events were successfully monitored 1979-80, but in 1981 eighteen eventswere successfully monitored during late summer and early fall. (Tables 1,2,3). Particularly high TS and TDS occurred in runoff on all three watersheds during the first monitored storm following a long, dry period, suggesting a flushing of accumulated salts and sediments. The average salt: sediment (TDS/TS) ratios in the flows were generally representative of those found in watershed soils (2-3 percent), except early on the rising limb where a distinct maximum TDS/TS occurred. The rising limb maximum of TDS/TS suggests an initial flushing of concentrated in-channel salts, followed by a predominantly sediment controlled salinity transport mechanism. It is 77concluded that salts (possibly occurring as efflorescence crust) accumulate and concentrate over time on the channel surface, causing the peak on the rising limb of the hydrograph. For three small, moderately steep ephemeral washes on Mancos shale, the average annual salt discharge was 0.031 tons per acre.

Table 1. Wattis Drainage Storm Summary

	DATE						
	8/23/81	9/5/81	10/3/81	10/11/81	10/11/81	10/16/81	10/17/81
Runoff Volume (RO), m^3	6,868	3,138	3,239	10,256	3,0521	14,192	8,439
Time to Peak, hrs	0.7	3.3	0.25	1.3	0.25	2.2	1.3
Duration of Runoff, hrs	1.5	10.0	1.7	6.0	3.0	7.0	7.0
Peak Discharge, m^3/s	3.7	0.34	2.2	1.6	1.2	2.4	0.7
TDS Load, t	42.9	6.84	17.84	NA	4.94	19.57	11.74
TS Load, t	1,495	185	430	NA	206	547	1,675
Peak TDS, mg/l	60,000	7,000	25,000	NA	1,800	1,500	2,200
Paak TS, mg/l	680,00	100,000	310,000	NA	90,000	54,000	62,000
Averaga Salt: Solid Ratio. %	2.87	3.67	4.15	NA	2.41	3.58	7.05
Avaraga TDS, mg/l	7,682	2,177	5,495	NA	1,616	1,365	1,391
Average TS, mg/l	267,684	59,292	132,108	NA	67,158	38,414	19,699
Soil Loss, (USLE) t	NA	NA	NA	1,067	309	482	551
Precipitation (P), cm	NA	0.43	0.51	1.27	0.25	1.52	0.43
Runoff/Pracip. Ratio	NA	0.0560	0.0476	0.0601	0.0896	0.0698	0.146
Complatanass of Samples	C	MF	C	PT	C	C	C
Sampling Method	M	M	M	ISCO	M	ISCO	ISCO

Notes:

C = Completely sampled
PT = Partially sampled
MF = Initial part of storm event sampled
NA = Not available

1 m = 3.281 ft
1 t = 1.1 tons
1 mg = 3.53 x 10^{-5}
1 liter = 61.02 in^3

Table 2. Soldier Creek Storm Summary.

	DATE					
	10/3/81	10/4/81	10/11/81	10/13/81	10/15/81	10/16/81
Runoff Volume, m^3	5,883	101	10,949	4,826	12,478	19,765
Time to Peak, hrs	2.3	0.6	1.0	1.0	1.0	3.5
Ouration of Runoff, hrs	4.6	2.0	4.5	3.5	4.7	10.0
Peak Discharge, m^3/s	1.7	.045	3.1	10.5	2.6	2.1
TDS Load, t	9.10	.18	8.77	6.02	14.47	NA
TS Load, t	384.90	.87	174.72	63.61	452.27	NA
Peak TDS, mg.1	9,000	3,000	1,200	2,000	1,900	NA
Peak TS, mg/1	85,000	16,000	17,500	14,000	61,000	NA
Average TDS, mg/1	1,564	1,776	808	1,244	1,154	NA
Average TS, mg/1	65,531	8,621	15,853	13,414	38,414	NA
Average Salt: Solid Ratio, %	2.36	20.83	5.02	9.47	3.20	NA
Soil Loss, (USLE) t	NA	NA	24.8	16.5	74.6	32.8
Precipitation (P), cm	1.00	0.51	0.66	0.38	1.02	1.65
Runoff/Precip. Ratio	0.182	0.006	0.512	0.392	0.378	0.370
Comments: Method of Sampling	C M	C M	C ISCO	C ISCO	C ISCO	MF ISCO

Table 3. Coal Creek Storm Summary.

	DATE				
	10/3/81	10/4/81	10/12/81	10/13/81	10/16/81
Runoff Volume, m^3	113	20	1,062	1,039	2,020
Time to Peak, hrs	0.5	0.4	0.3	2.3	1.3
Ouration of Runoff, hrs	1.5	1.3	1.6	6.0	7.00
Peak Oischarge, m^3/s	0.055	0.012	03.10	0.240	0.290
TDS Load, t	0.39	.004	.223	.2737	.419
TS Load, t	26.21	.06	6.09	9.65	15.20
Peak TDS, mg.1	410	210	250	410	260
Peak TS, mg/1	19,800	3,400	19,000	16,000	12,200
Average TDS, mg/1	380	181	218	262	207
Average TS, mg/1	3,000	2,783	5,715	9,218	5,709
Average Salt: Solid Ratio, %	13.0	7.0	3.80	2.83	2.75
Soil Loss, (USLE) t	NA	NA	10.5	2.2	12.7
Precipitation (P), cm	0.510	1.02	1.65	.76	1.91
Runoff/Precip. Ratio	0.021	0.0018	0.061	0.129	0.0998
Comments: Method of Sampling	C M	C M	C ISCO	C ISCO	C ISCO

Notes:
C = Complete hydrograph sampled
MF = Initial strom event record are not available
NA = Not available
M = Manual
ISCO = Automatic pumping sampler

1 m = 3.281 ft
1 t = 1.1 tons
1 mg = 2.2×10^{-6} lb
1 liter = 0.2642 gal

Salt yields at three small basins: Badger Wash, Colorado

A gaging station with continuous discharge and periodic electrical conductivity sampling capability was operated 1977-82 on each of the following watersheds in the Badger Wash Experimental Area: Prairie Dog Reservoir, Middle Basin, and West Twin Basin. Beginning in 1982 samples were analyzed for suspended sediment concentration. Historic runoff from the 1966 to 1973 period was then used to extend the average Total Dissolved Solids (TDS) data to estimate a longer-term average annual salt yield from each basin.

Because of the infrequency of runoff events and the short period of gaging, only rough estimates of TDS yield and TDS to Total Solids ratios were developed. Still, the overall average annual salt discharge of 0.05 tons/acre/year further substantiates the rough estimates of salt yield and TDS/TS ratios developed in the Price River Basin for small, moderately steep ephemeral washes on Mancos shale.

Individual basin average salt discharges for Prairie Dog, Middle and West Twin were 0.063, 0.058, and 0.023 tons/acre/year respectively. The mean TDS/TS ratio based on 4 samples was 3.8 percent.

The authors emphasized that neither the research design nor the quantity and precision of data collected warranted any extrapolation to conclusions of the original 20 year Badger Wash effects of grazing study by Lusby with regard to sediment yield, livestock grazing, and salinity. However it was suggested that there is an important, though inconclusive relationship between salt and sediment yields. Where soils are more saline and less vegetated, there may be less opportunity to influence sediment yield and salt yields through grazing management. Since BLM showed in its first 1978 salinity progress report that Badger Wash soils are slightly to moderately saline, and that those soils are better vegetated than the highly saline soils common to the Mancos shale regions west of west of Badger Wash, salt management opportunities through grazing management alone may be more feasible at Badger Wash, than in the Eastern Utah mancos shale regions.

Soil geomorphology, soil salinity and vegetation: Woodside, Utah

The Woodside salinity research site in Emery County consisted of 5550 acres 12 miles south of Woodside and 13 miles northwest of the town of Green River, Utah. Three broad geomorphic units were recognized by a contract soil survey designed to improve a SCS Order 3. The units were as follows:

1. A low relief shale pediment and recent alluvial surface in the western third.

2. A remanent old pediment surface developed from Mesa Verde sandstone colluvium.

3. Dissected Mancos shale uplands.

Eleven different soil series in 22 mapping units were recognized by the more detailed soil survey performed for Woodside. Eleven plant communities were recognized for the study area, distributed from elevation of 4500 - 5100 feet.

Rainfall simulation study of water, sediment, and salt yields on three soil - landform units on Mancos Shale.

A Bureau of Land Management large-plot rainfall simulator patterned after one developed by M.E. Holland at CSU was used in the summer of 1981 to quantify relative yields of water, sediment and salt from three soil-landform units common in the Mancos shale regions of E- central Utah. The study site was the location of the previous detailed geomorphology, soil-salinity and vegetation study site located 12 miles south of Woodside, Utah.

Plots measuring 20 feet by 20 feet were located on 1.) a low-relief shale pediment on a gray, crusted, fine loamy shale - derived soil (Soil A), and 2.) the same shale pediment on a light brown, cracked, fine, loamy aeolian soil (soil D). A larger third plot encompassing a 2000 square feet microbasin was located on steep, dissected, raw shale babland. All plots had less than 20 percent vegetation cover, which is typical of the Mancos shale region. Two simulated rainfall runs of 35 - 40 minute storm were applied to each plot.

No runoff was generated from soil D. Electrical conductivity (EC) of runoff (which served as an index to TDS concentration) increased an average of 35 umhos/cm on soil A compared to EC of applied rain water.

This contrasts to an increase of 2400 umhos/cm over that in the rainfall on the dissected raw shale microbasin.

The study suggested that a similar rainfall-runoff event would produce considerably more salt and sediment from raw shale badlands than from lower-relief gray fine loamy shale bottomland. The authors believe that the high sediment and salt concentrations in runoff from the dissected Mancos shale badland unit are due to the dominance of rilling as an erosion mechanism, and the continued downcutting through salt-rich Mancos shales.

The surprisingly low concentrations of sediment and salt from the gray, crusted pediment unit (soil A) appears due to: 1.) the erosion protection of the surface soil crusts and mild slopes; and 2.) less saline surface soils. Erosion rates on soil A were insufficient to expose deeper, more saline soils, and capillary processes were apparently insufficient to replenish surface salt concentrations to gray pediment soil.

Management of salinity in Mancos regions will require careful analysis of salinity sources as function of soil - landform characteristics, because of the highly variable runoff and erosion attributes of different soil units.

Rainfall simulation study of the effects of trampling on runoff and water quality of Mancos shale rangeland.

In the summer of 1981 a small drop-former type of rainfall simulator (plot size 9 feet square) was used by Simmons, Li and Associates for BLM to index the relative effects of vegetative cover and livestock trampling on water, sediment and salt yields of a gray, crusted, fine textured Mancos shale-derived soil near Woodside, Utah. The soil was the same as soil A of the preceding rainfall simulation study, and was described by Schafer (1981) in the contract soil survey referred to earlier, performed 12 miles south of Woodside on 5550 acres. A total of 360 runoff events were simulated on 180 plots. The experimental design involved three vegetative conditions, four levels of livestock trampling, two antecedent moisture conditions and 15 replications.

Key limitations were the small plot (3 foot by 3 foot) nature of the data, data only reflecting one soil-vegetation complex, and trampling intensities higher than actual utilization conditions.

Runoff from trampled plots had higher concentrations of sediment and salt than from the untrampled plots (7197 to 9324 ppm for sediment and 331 to 577 umhos/cm for EC). However increased trampling also increase infiltration and surface depression storage, resulting in decreased volumes of runoff from the plots, thus the physical and geometric surface effects of trampling produced a potential net decrease on total plot salt and sediment discharge at the 35 and 60 percent trampling intensities.

The results of trampling on infiltration rate and runoff were completely opposed to those found by the U.S. Geological Survey in 20 years of livestock-hydrology effects research at Badger Wash.

Long-term sediment accumulation in retention basins in Mancos shale badlands.

The purpose of this study was to quantify long-term yields of sediment (and, by inference, salt) from unvegetated, steep dissected Mancos shale badlands, 12.8 miles to the west of the Utah communities of Castle Dale and Huntington. Twelve small basins created by BLM gully plug installation in the early 1970s were selected ranging in size from 0.2 to 3.2 acres in drainage area.

Results of the sediment accumulation survey are provided in Table 1.

Table 1. Watershed characteristics and sediment yields, Huntington sediment basin survey.

Plug No.	Drainage Area (m)	Plug Age (yrs)	Total Relief (m)	Weighted Watershed Slope (%)	Weighted Channel Slope (%)	Weighted Channel Slope (%)	Volume Sediment (m)	Sediment Yield (t/ha/yr)	Sediment Yield (t/ac/yr)
1	3,720	7	37	47	18	14	13	7.81	3.45
2	6,970	7	42	41	12	12	35	11.22	4.95
3	13,000	7	62	54	23	21	49	8.37	3.69
4	7,150	7	41	45	19	18	29	9.11	4.02
5	2,410	6	32	55	33	32	9	10.04	4.42
6	2,230	6	30	53	18	18	10	11.90	5.25
7	2,690	6	37	59	25	25	15	14.76	6.51
8	1,000	6	27	58	33	32	1.0	2.67	1.18
9	820	6	16	34	22	18	1.3	3.97	1.75
10	1,610	6	16	36	23	20	1.9	3.10	1.37
11	1,300	6	10	18	10	10	0.7	1.49	0.66
12	910	7	7	20	13	12	3.9	9.49	4.19
	3,650	6.4	30	43	21	19	14	7.81	3.45
S	3,660	0.5	16	14	7.4	7.3	16	4.15	1.83

X = mean, S = standard deviation

The data reveal that sediment accumulations behind the gully plugs average 3.45 tons/acre/year, and the highest accumulation was from the steepest basin. However sediment accumulations did not correlate well with measured watershed characteristics.

By applying a 3 percent salt content to sediments the authors estimated the average annual salt yield from the Mancos Shale badlands to the gully plugs was 0.10 tons/acre, which compares favorably to salinity yield estimations form other Mancos shale regions. In general, very rough estimates of long term soil erosion rates in Mancos shale range from 1 ton/acre/year on less steep moderately vegetated sites to 3.4 to 15 tons/acre/year on steep unvegetated dissected Mancos shale badlands. Salinity yields are roughly 3 percent of sediment yields.

Baseflow salt yield on small streams in the Price River Basin.

Concurrent with the study of salt and sediment yields on ephemeral washes in the Price River basin, described in an earlier abstract, weekly monitoring of discharge and salinity was also conducted at 5 intermittent stream sites and 13 perennial stream sites in the Price River basin. The purpose of the monitoring study was to determine average water quality as indexed by Electrical Conductivity (EC) of baseflows, and to contrast the relative importance of salt loading from baseflows with that from storm runoff.

The study results indicate that baseflows from ground water sources and irrigation return flows in the Price River basin contribute over three times the annual salt yield to the Price River at Woodside, than does the surface runoff from short duration summer convectional storms.