RECLAMATION
Managing Water in the West

Bureau of Reclamation Automated Modified Einstein Procedure (BORAMEP)
-Program for Computing Total Sediment Discharge

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Program Objective

- The primary objective of this investigation was to create a computer program that would automate the process of computing total sediment discharge using the MEP procedure.

- The program would be applicable to a wide range of flow and sediment conditions and provide information to identify areas where additional research might be needed.

- Re-evaluate the MEP within the new automated procedure.

How BORAMEP Works

(Bureau of Reclamation Automated Modified Einstein Procedure)

- Measured Channel Information

- Measured Suspended Sediment

- Measured Bed Material

- Calculate Total Load based on Measured plus Unmeasured
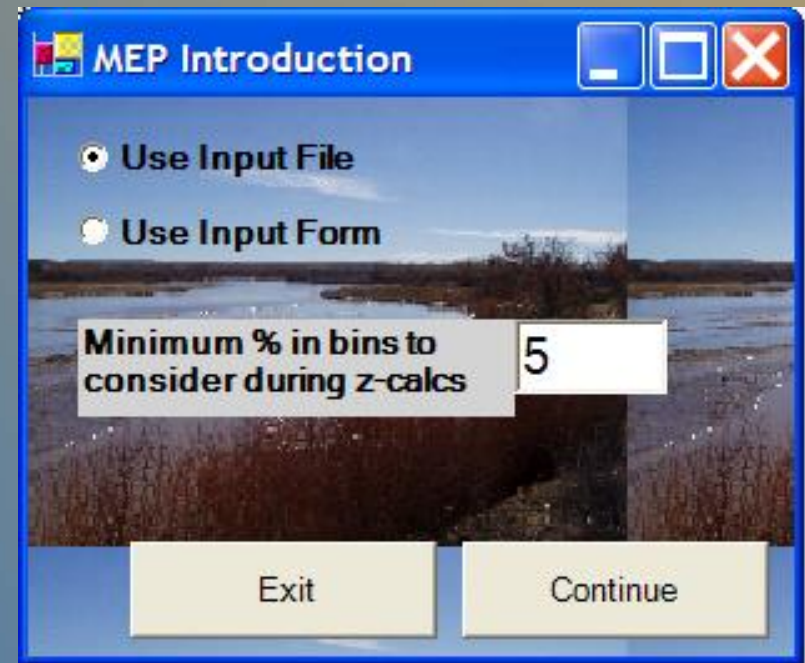
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BORAMEP Basics

- Input Format:
    1) a csv input file to Calculate total load for multiple samples at one time, or
    2) an input form to calculate total load for a single sample

- Output Format:
    – Results are outputted to txt files that can be used for additional analysis

BORAMEP Input form

BORAMEP Output

Filename.txt

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BORAMEP Example Problem output.txt                                                    2/3/2004

                                    OUTPUT
                                 08354900 - Sample13

METHOD OF COMPUTATION   MODIFIED EINSTEIN   DATE OF COMPUTATION 2/3/2004
DATE OF SAMPLE      3/3/1982         TIME OF SAMPLE        1200         TEMPERATURE        51.8     SLOPE OF ENERGY
GRADIENT        0.0008
D65 =      0.2350684
                  mm   D35 =       0.1994948
                                        mm
Velocity (ft/s) =    3.6      Width (ft) =         130      Depth (ft) =         1.6
Dn (ft) =          0.3      Ds (ft) =           1.6

    SIZE FRACTION      PERCENT OF MATERIAL IBQB     QPRIME        Z-VALUES        COMPUTATIONAL FACTORS      COMPUTED
    IN MILLIMETERS     SUSPENDED BED       T/D   SUBS(T/D) COMPUTED FITTED      F(J)       F(I)+1          TOTAL LOAD

    0.001   0.002       26         0      -9999   1194.025 -9999    0.014      1.195      -9999            1426.875
    0.002   0.004        8         0      -9999    367.392 -9999    0.024      1.202      -9999             441.449
    0.004   0.016       12         0      -9999    551.088 -9999    0.058      1.224      -9999             674.267
    0.016   0.0625      19         1       0.124   872.556 -9999    0.183      1.325       3462.438        1156.338
    0.0625  0.125       12         5       2.905   551.088  0.403   0.427      1.667        261.631         918.442
    0.125   0.25        18        76     124.886   826.632  0.82    0.712      2.566         36.808        2121.047
    0.25    0.5          5        18      83.66    229.62   0.943   1.024      5.113          9.578         801.308
    0.5     1            0         0      -9999      0      -9999    1.295     -9999        -9999               0
    1       2            0         0      -9999      0      -9999    1.547     -9999        -9999               0
    2       4            0         0      -9999      0      -9999    1.809     -9999        -9999               0

    TOTAL                                                                                                7539.725
```

BORAMEP Output

out.sum

***		Discharge	Conc	Suspended	Total Load	Total Sand Load	Computed total load by size fraction (tons/day)									
Location	Date	(cfs)	(PPM)	Sample (tons/day)	(tons/day)	(>0.625mm)(tons/day)	0.001 - 0.002	0.002 - 0.004	0.004 - 0.016	0.016 - 0.0625	0.0625 - 0.125	0.125 - 0.25	0.25 - 0.5	0.5 - 1	1 - 2	2 - 4
08330000 - Sample1	5/8/1969	4570	3200	39484.8	50657.05994	40208.01529	3176.13	397.34	1195.78	5679.80	15187.20	15023.96	8325.34	1521.26	150.26	0.00
08330000 - Sample6	2/16/1971	865	1220	2849.31	4951.973145	4170.111843	202.55	29.00	87.78	462.53	1157.49	2205.42	766.14	41.06	0.00	0.00
08330000 - Sample8	3/19/1973	1130	2780	8481.78	12188.42117	8454.852104	861.36	172.53	434.20	2265.49	3554.80	3906.49	894.96	98.61	0.00	0.00
08330000 - Sample9	7/30/1973	3270	2570	22690.53	29587.74107	23188.06555	1837.71	230.46	931.30	3400.20	4889.50	9134.69	5484.51	3415.82	263.55	0.00
08330000 - Sample10	1/22/1979	964	912	2373.754	3515.774938	1710.101048	1181.80	169.34	195.70	258.83	124.42	801.50	649.09	132.43	2.66	0.00
08330000 - Sample11	12/3/1979	1680	1620	7348.32	10846.80438	10537.60057	150.59	0.00	77.08	81.53	182.56	9508.40	0.00	846.65	0.00	0.00
08354900 - Sample13	3/3/1982	777	2560	5370.624	7539.725311	3840.796692	1426.88	441.45	674.27	1156.34	918.44	2121.05	801.31	0.00	0.00	0.00

out.err

Date	Discharge (cfs)	Error Code	Error Message		
7/7/1969	317	-9999	Only 1 z-value was calculated, Not enough data to compute valid Z-fit curve		
9/2/1969	788	-9999	Not enough data to compute valid Z values		
9/30/1969	558	-9999	Unable to compute total load due to missing data values		
10/5/1970	-9999	-9999	Unable to compute total load due to missing data values		
7/27/1971	5460	-9999	Not enough data to compute valid Z values		
4/5/1996	437	-9999	Fitted z-values generated a negative exponent, Not continuing…		

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Where We Are and Where We're Going…

- Re-analyze original Colby and Hembree (1955)
  - Niobrara River near Cody Nebraska

- Comparison with Williams and Rosgen (1989)
  - Measured total sediment loads for 93 U.S. streams

- Collaboration with USGS on a Translate Program
  - Used to generate BORAMEP input files from USGS records obtained using the USGS NWIS website

- Finalize BORAMEP Program and Manual
  - Update error codes and data checking