A Digital Surface Soil Erosion Hazard Rating for California Forest Management using gSSURGO and Digital Spatial Data

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Background:

The Surface Soil Erosion Hazard Rating was developed by California (CA) soil scientists in the late 1980's to estimate the hazard from soil erosion for timber harvesting operations in California. It is required by the CA Forest Practice Rules for approval of timber harvest plans. It has also been used by CA NRCS for conservation programs and planning. Before this project was completed, the rating was manually calculated using a representative slope and set of soil properties.

CalFire, under the authorities of the CA Board of Forestry, requested assistance from NRCS to develop a digital model for the Surface Soil Erosion Hazard Rating that could link to SSURGO data directly. This rating is required on California Environmental Quality Assessment (CEQA) reviews of forest management activities.

Tables from Instructions, California State Board of Forestry Technical Rule Addendum No. 1 Erosion Hazard Rating (EHR) System For Sheet And Rill Erosion (1989, Rev. 2001) were subjected to regression analysis, plotted and new tables were constructed to match values suitable for the SSURGO data structure.

Raster-based gSSURGO data was merged with a statewide 10m DEM with calculated slope gradients, and a raster dataset with Two-Year, One-Hour Rainfall Intensity. A layer for an area of interest (AOI) or defined project area, along with a user-entered percentage of protective vegetative cover to be left after disturbance, is used to calculate a numerical erosion hazard value for each 10-meter raster cell, which is converted to a rating class of Low, Moderate, High or Extreme Erosion Hazard. Analysis and display of the results across the AOI is then possible.

The model was field tested during Spring of 2014 and has been adopted by NRCS in CA for ranking EQIP forestry projects and deployed to field offices for use. CalFire is evaluating how the tool can be provided to their customers and incorporated into their regulatory process.

Scoring tables in the original document needed to be revised. New rating scores are based on plotting the values in the tables and computing a regression equation in Excel:

Board of Forestry Technical Rule Addendum No. 1

Soil textural classes and associated suggested ratings

Table 1

Broad Class	Texture	Rating
Coarse	Sands	30
	Loamy Sands	27
	Sandy Loam	23
	Fine Sandy Loam	20
Medium	Loams	17
	Silt Loams	14
	Silty Clay Loams	11
Fine	Clay Loams	8
	Clays	5
	Extremely Fine Clays	1

Texture	Revised EHR texture score
Clay	5
Clay loam	8
Coarse sand	30
Coarse sandy loam	23
Fine sand	30
Fine sandy loam	20
Loam	17
Loamy coarse sand	27
Loamy fine sand	27
Loamy sand	27
Loamy very fine sand	27
Sand	30
Sandy clay	5
Sandy clay loam	8
Silt	14
Silty clay	5
Silty clay loam	11
Silt loam	14
Sandy loam	23
Very fine sand	30
Very fine sandy loam	20

Soil textures and associated permeabilities and rating factors.

Table 2

Soil Texture	Permeability	Factor
Sands	Rapid	1
Loamy Sands		
Sandy Loam		
Fine Sandy Loam		
Loams	Moderate	2-3
Silt Loams		
Silty Clay Loams		
Clay Loams	Slow	4-5
Clays		
Extremely Fine Clays		

Permeability Class	Ksat (inches per hour)	Revised EHR Score
Rapid or Very rapid	>20	1
Moderately rapid	6 - 20	2
Moderate or Moderately slow	0.20 - 6	3
Slow	0.06 - 0.20	4
Very slow or Impermeable	< 0.06	5

The revised Permeability rating score is based on the minimum saturated hydraulic conductivity (Ksat) representative value in the upper 50 cm, excluding the organic surface litter horizon

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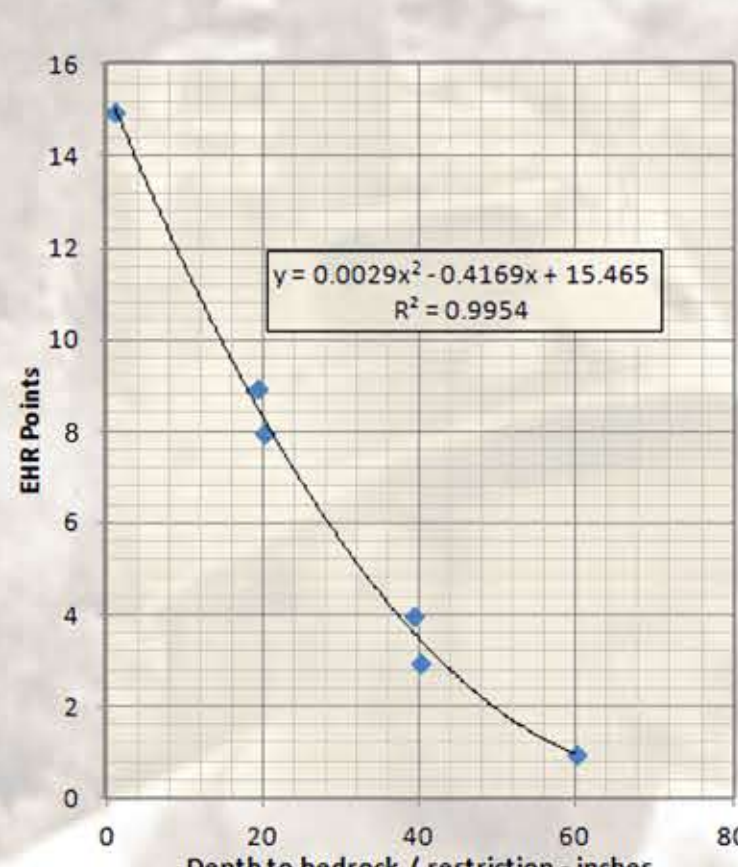
Depth to restrictive layer or bedrock.

	Shallow	Moderate	Deep
	1"-19"	20"-39"	40"-60"
Rating	15 - 9	8 - 4	3 - 1

Regression: $y = 0.0029x^2 - 0.4169x + 15.465$, $R^2 = 0.9954$

Depth to bedrock / restriction (inches)	Revised EHR Score
<=2	15
3 - 4	14
5 - 7	13
8 - 10	12
11 - 13	11
14 - 16	10
17 - 19	9
20 - 22	8
23 - 26	7
27 - 30	6
31 - 34	5
35 - 38	4
39 - 45	3
46 - 53	2
>= 54	1

Percent surface fragments greater than 2mm in size including rocks and stones.

	Low	Moderate	High
	(-) 10 – 39%	40 – 70%	71 – 100%
Rating	10 - 6	5 - 3	2 - 1

Percent rock fragments	Revised EHR Score
<= 12	10
13 - 18	9
19 - 25	8
26 - 31	7
32 - 39	6
40 - 47	5
48 - 56	4
57 - 67	3
68 -81	2
>= 82	1
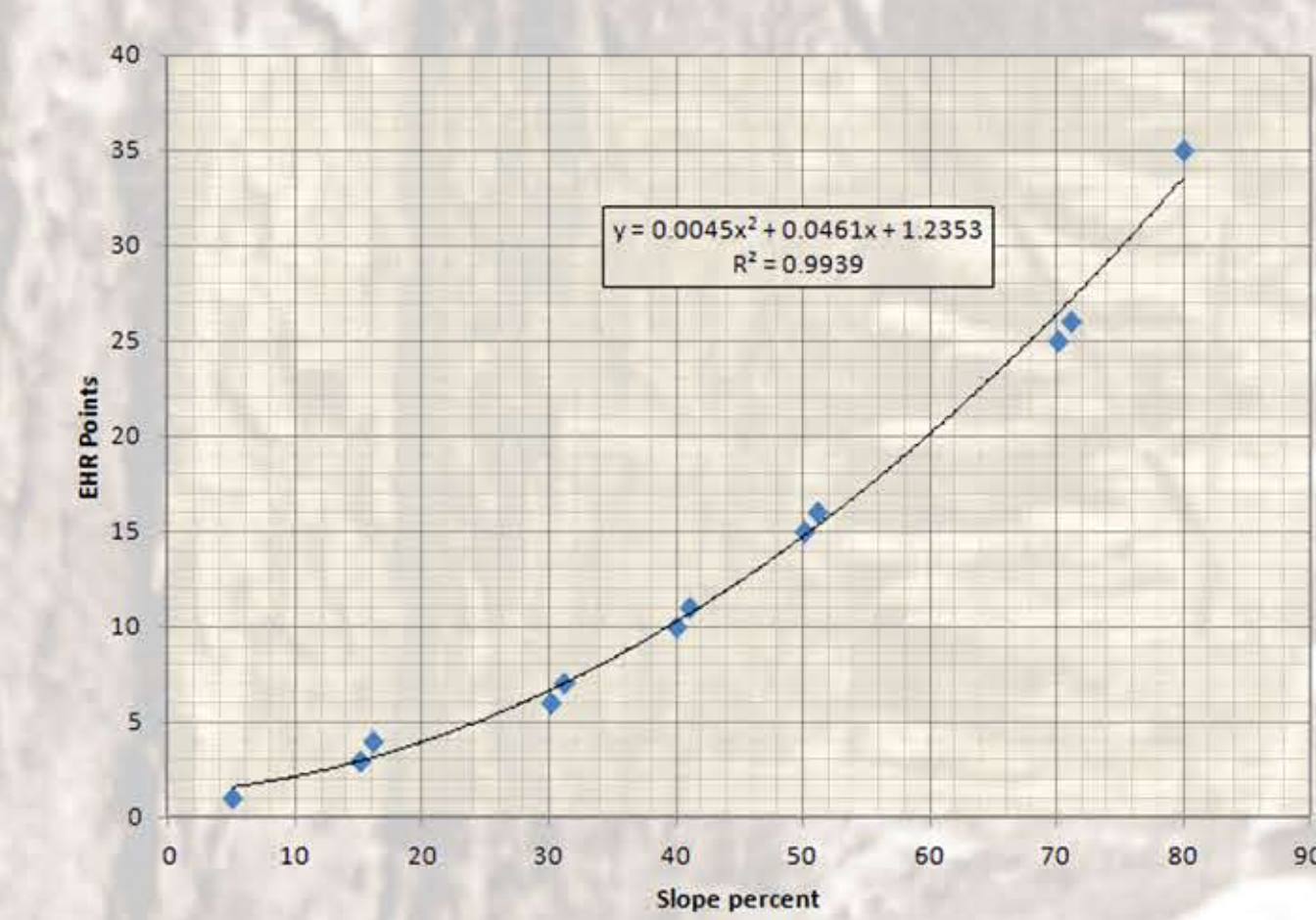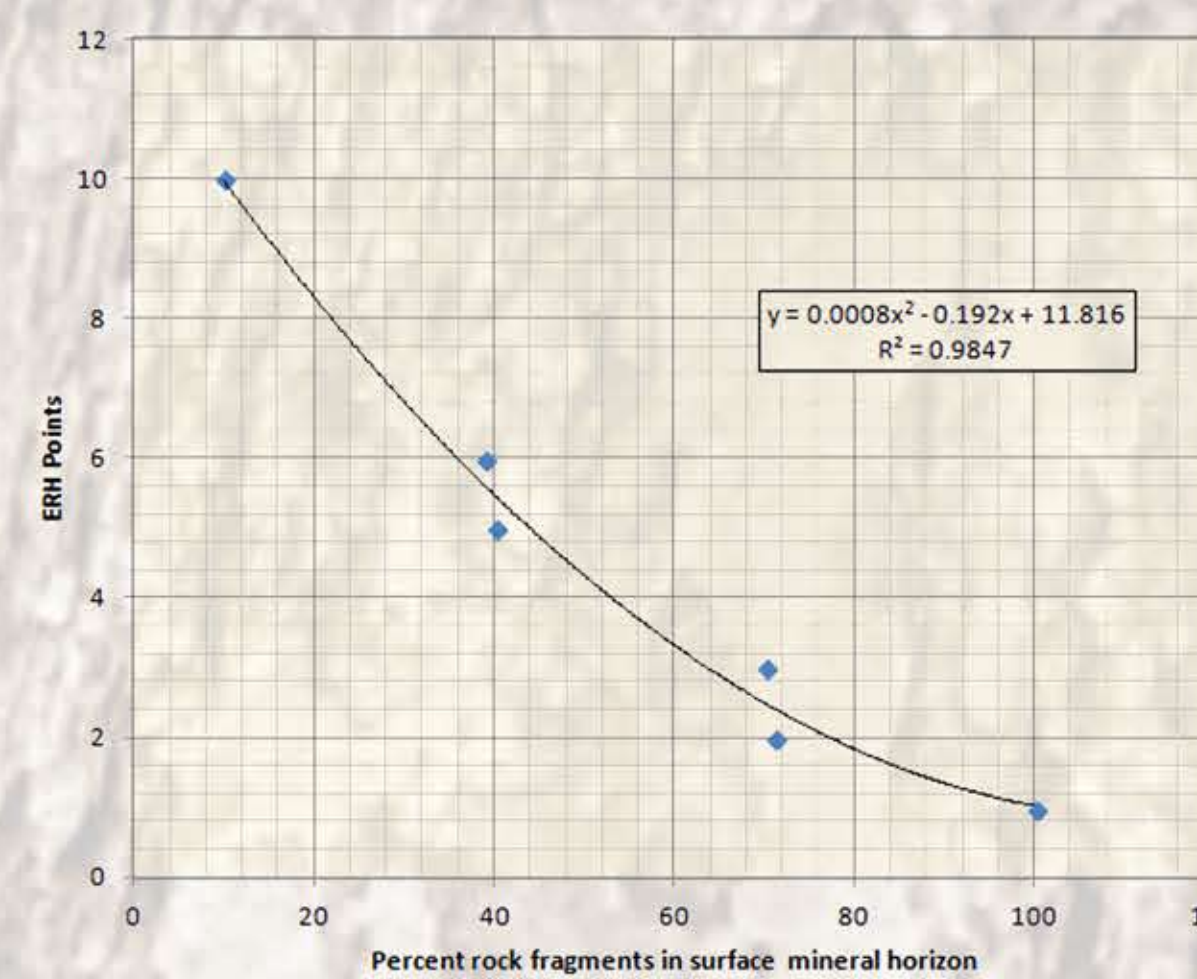
Regression: $y = 0.0008x^2 - 0.192x + 11.816$, $R^2 = 0.9847$

Slope Factor.

Slope	5 - 15%	16 - 30%	31 - 40%	41 - 50%	51 -70%	71- 80% (+)
Rating	1 - 3	4 - 6	7 - 10	11 - 15	16 - 25	26 - 35

Regression: $y = 0.0045x^2 + 0.0461x + 1.2353$, $R^2 = 0.9939$

Two-year, one hour rainfall intensity (0.01")

	Low	Moderate	High	Extreme
	(-) 30 -39	40 - 50	60 - 69	70 - 80 (+)
Rating	1 - 3	4 - 7	8 - 11	12 - 15

2 yr.- 1 hr. rainfall intensity (0.01 inch)	Revised EHR Score
<=30	1
31 - 34	2
35 - 40	3
41 - 44	4
45 - 48	5
49 - 52	6
53 - 56	7
57 - 59	8
60 - 62	9
63 - 65	10
66 - 68	11
69 - 71	12
72 - 74	13
75 - 77	14
>= 78	15

Regression: $y = 0.0025x^2 + 0.0008x - 0.8403$, $R^2 = 0.9877$
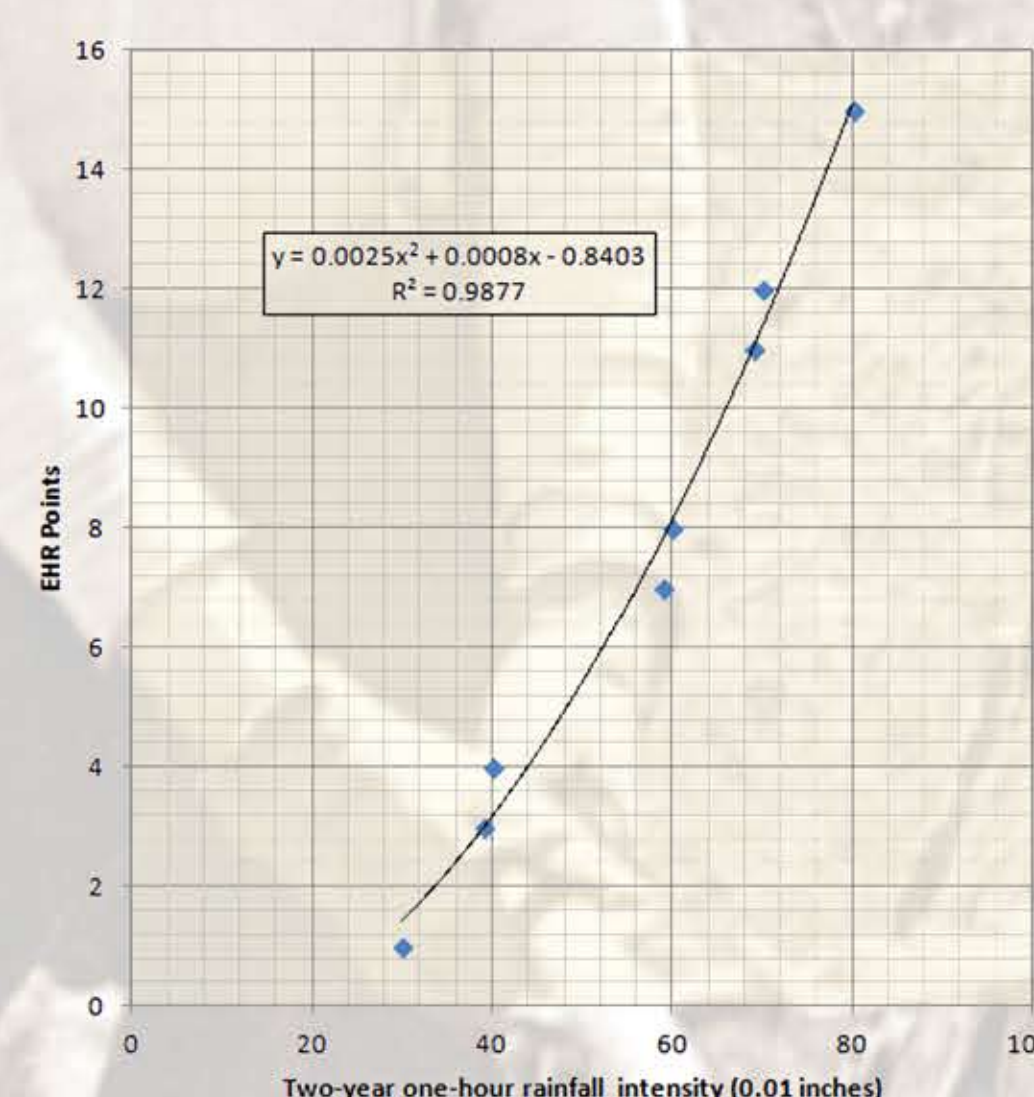
Protective vegetative cover remaining after disturbance.

	Low	Moderate	High
	0 - 40%	41 -80%	81 - 100%
Rating	15 - 8%	7 - 4%	4 - 1%

Percent vegetative cover	Revised EHR Score
0 - 1	15
2 - 6	14
7 - 12	13
13 - 17	12
18 - 23	11
24 - 29	10
30 - 36	9
37 - 42	8
43 - 50	7
51 - 58	6
59 - 67	5
68 - 77	4
78 - 89	3
90 - 98	2
>= 99	1

Regression: $y = 0.0007x^2 - 0.2005x + 14.825$, $R^2 = 0.9865$
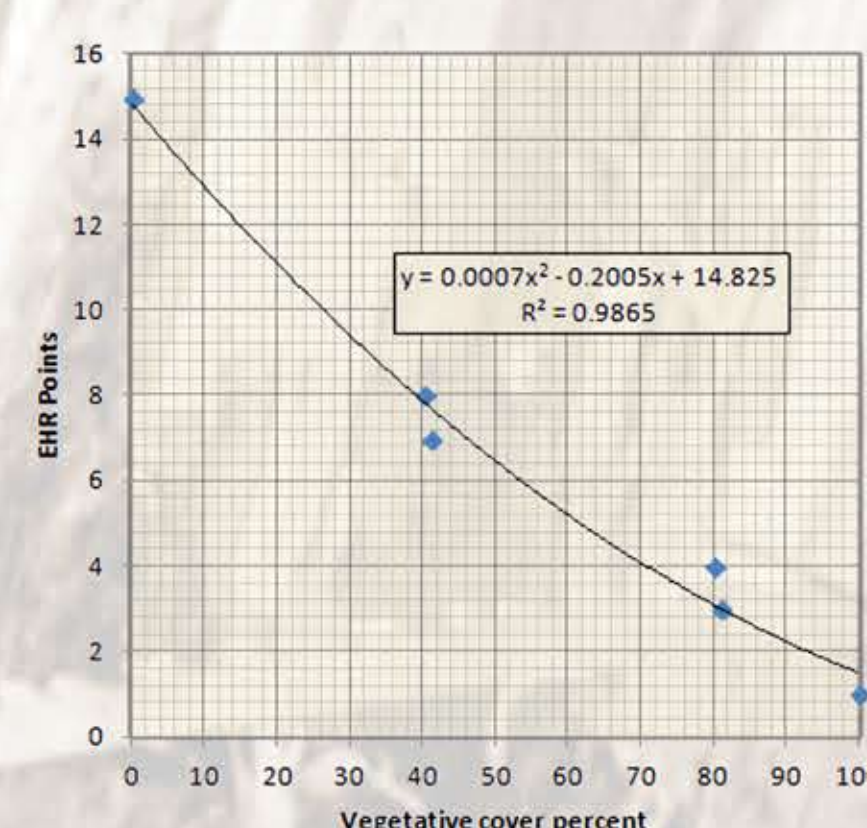
Model Data Input Preparation:

EHR_Scores_CA Raster. Statewide EHR raster layer, (10x10m cells) consisting of the summed revised EHR score values from: four gSSURGO raster factors (i.e. Texture, Permeability Class, Depth to Bedrock Restriction, Percent Rock Fragments), NED Slope Percent raster values, 2-Year, 1-Hour Rainfall Intensity raster values.

Area of Interest (AOI) polygon shapefile layer. This can be a NRCS Planned Land Unit layer, Timber Harvest Plan layer, or any build-your-own polygon layer which defines your Area of Interest to compute EHR scores.
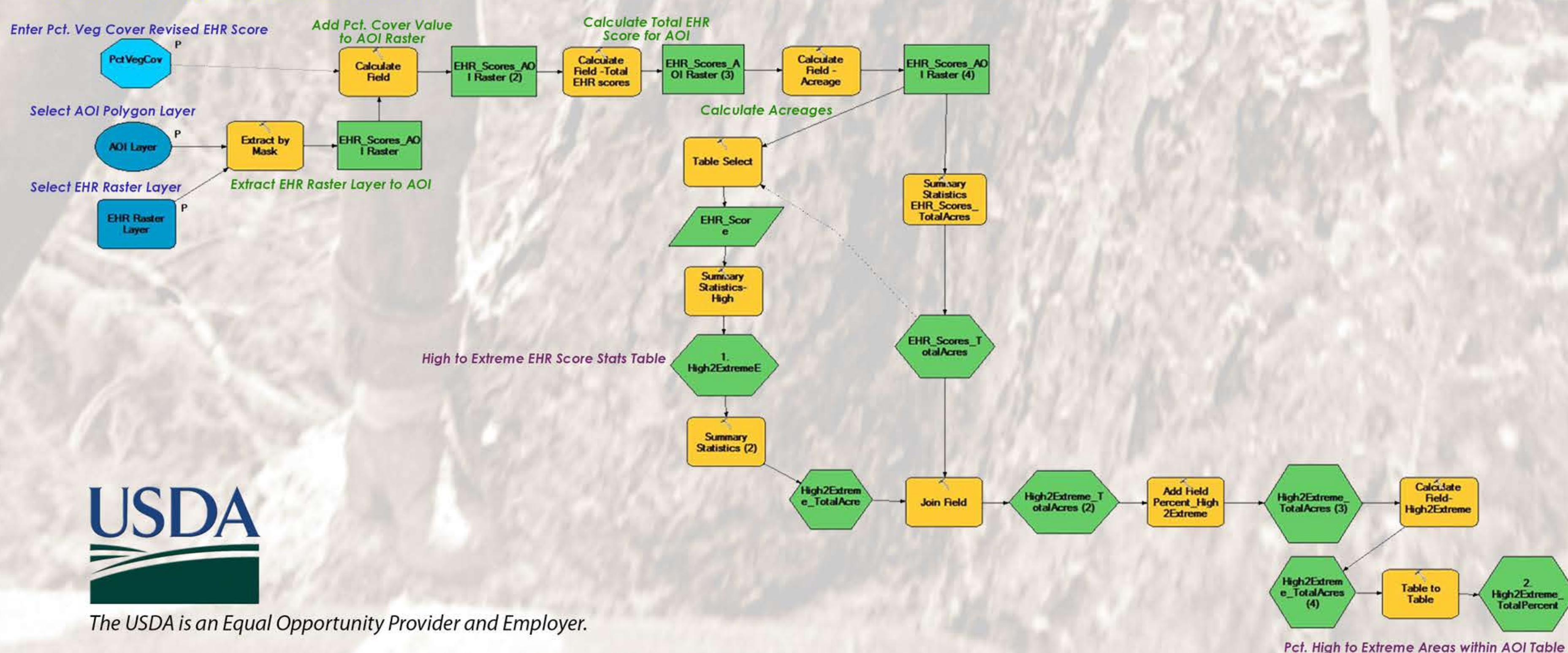
Required User-Defined Input:

Percent Vegetative Cover Revised EHR Score
Enter this score value from the table in the user guide.

EHR_Scores_AOI Raster - Depicts the EHR Overall Rating Classes for each 10x10m cell within the AOI polygon.

Forestry Surface Soil Erosion Hazard Rating Model - EHR Ranking Scores for AOI Poygon

EHR_Scores_AOI Raster
EHR_Score_Total

- <= 50 (LOW)
- 50 - 65 (MODERATE)
- 66 - 75 (HIGH)
- > 75 (EXTREME)

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