



Fragile Soil Index

Interpretation



Fragile Soils

- Fragile soils are those that are most vulnerable to degradation
 - easily degraded, low resistance
 - high susceptibility to erosion with low resilience
- Characteristics of fragile soils
 - Low organic matter contents
 - Low water-stable aggregates
 - Absence of structure
 - On sloping ground
 - In arid and semiarid regions
 - Have sparse plant cover
 - Low biodiversity

Indicators

- **Organic matter content**
 - Indicates the capacity of the soil to resist and/or recover from degradation processes
- **Aggregate stability/soil structure**
 - Indicates the capacity of the soil to resist degradation such as from accelerated erosion (by increasing the amount of infiltration).
- **Rooting/soil depth**
 - Shallow soils are more vulnerable to degradation because they have limited rooting depth and have a reduced capacity to generate new soil.

Indicators

- **Vegetation cover**
 - Uncovered soil is vulnerable to the processes of soil erosion, both by wind and water.
- **Slope**
 - Sloping ground is more vulnerable to the processes of water erosion, and to mass movement.
- **Aridity**
 - Lack of water is a main factor limiting biological processes and the capacity to recover. Susceptibility to degradation increases with aridity.

$$\text{FSI} = (0.1 \times \text{OM}) + (0.1 \times \text{AgS}) + (0.1 \times \text{RD}) + (0.2 \times \text{V}) + (0.2 \times \text{S}) + (0.3 \times \text{AI})$$

FSI = fragile soil index (0 to 1)

OM = organic matter (surface horizon)

AgS = aggregate stability or structure index (surface horizon)

RD = rooting depth

V = vegetative cover

S = slope

AI = aridity index

Indicator data are converted to relative values ranging from 0 to 1.

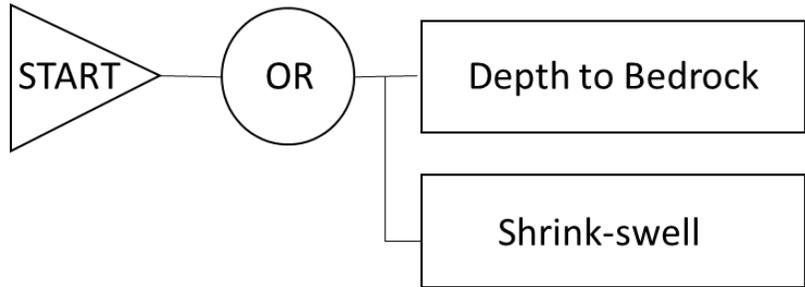
The standardized scores are then weighted.

Index values (FSI) range from 0 to 1 with one being the most fragile.

Overview of NASIS Interpretations

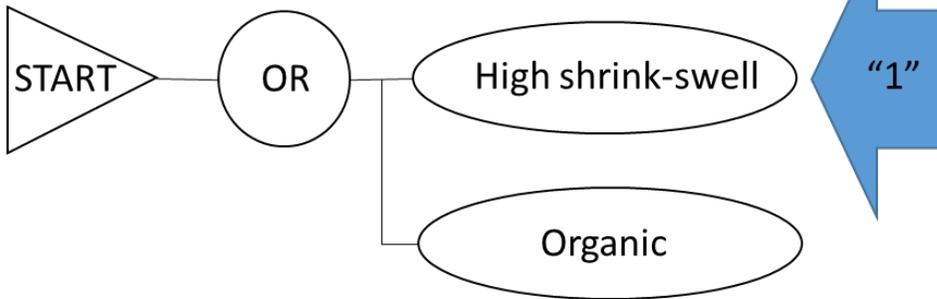
Dwellings with Basements

INTERPRETATION (primary rule)



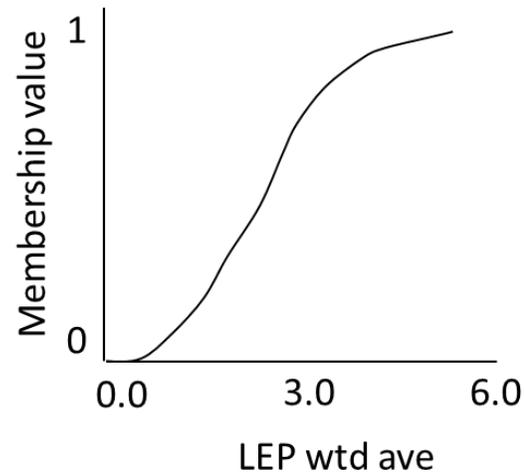
“Soil has limitations for dwellings with basements”

SUBRULE



EVALUATION

“high shrink-swell”



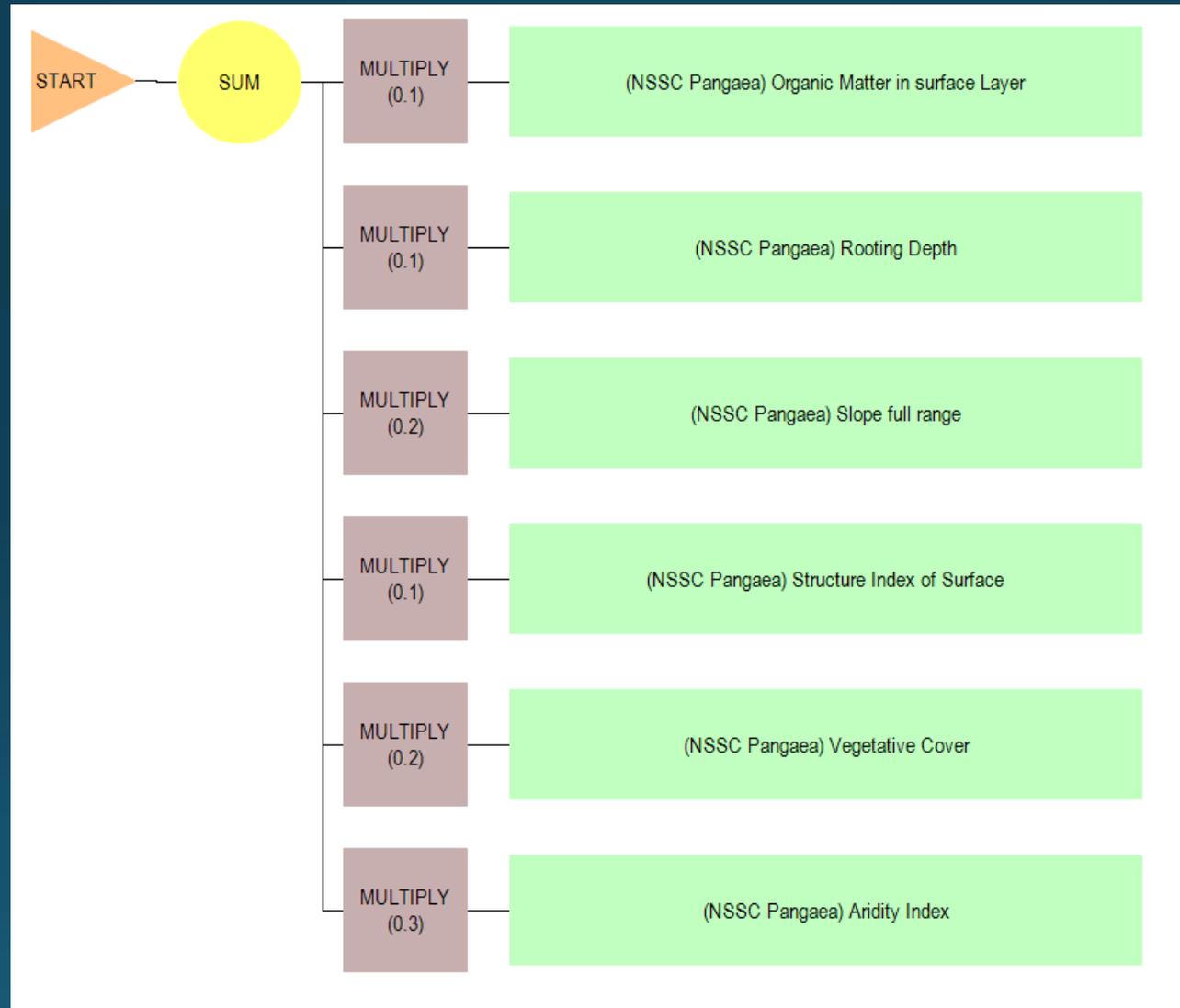
PROPERTY

“LEP weighted average, 25-150 cm depth or above restriction”

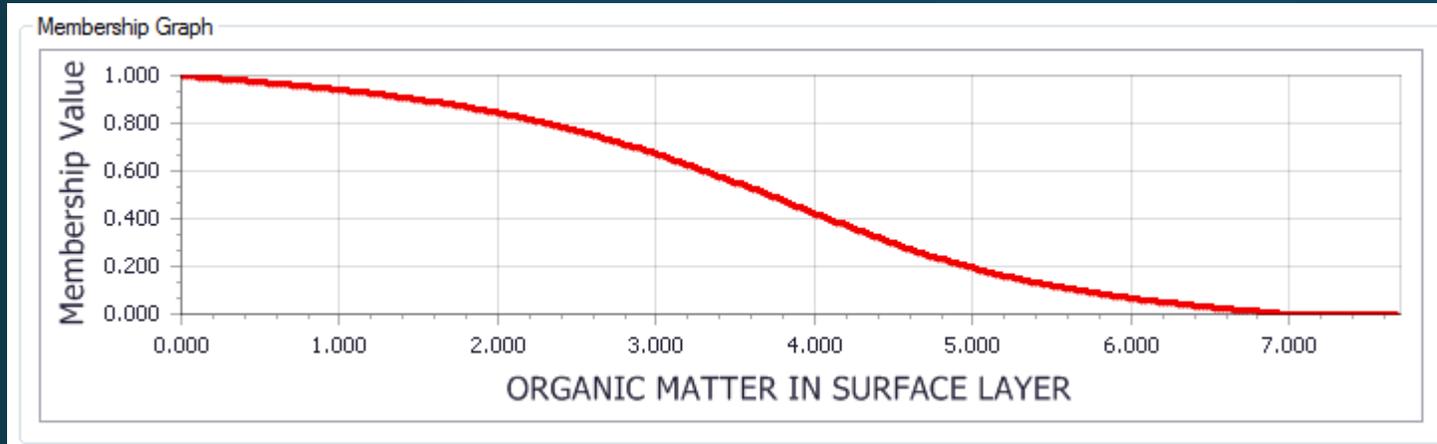
EXEC SQL
select lep_l low,
lep_r rv, lep_h high
FROM component
INNER join
chorizon...

“6.0”

Fragile Soil Index Interpretation



Organic Matter in surface layer



- Cornell soil health assessment (medium curve)
- Maximum inherent potential for organic matter

Table 1. Interpretative ratings for organic matter.		
Rating Class Name	Organic Matter Limits (%)	Scoring Curve Rating Class Upper Boundary
Extremely Low Organic Matter	< 1.3	1.000
Very Low Organic Matter	1.3 – 2.6	0.916
Low Organic Matter	2.6 – 3.9	0.750
Moderate Organic Matter	3.9 – 5.2	0.447
High Organic Matter	5.2 – 7.0	0.158
Very High Organic Matter	> 7.0	0.000

$$\text{OM score} = (a + cx + ex^2)/(1 + bx + dx^2 + fx^3)$$

$$a = 1.0002993; b = -0.14767395; c = -0.21024973;$$

$$d = -0.0081101367; e = 0.009697; f = 0.0073572721;$$

$$x = \text{OM } (\%)$$

Structure in surface layer

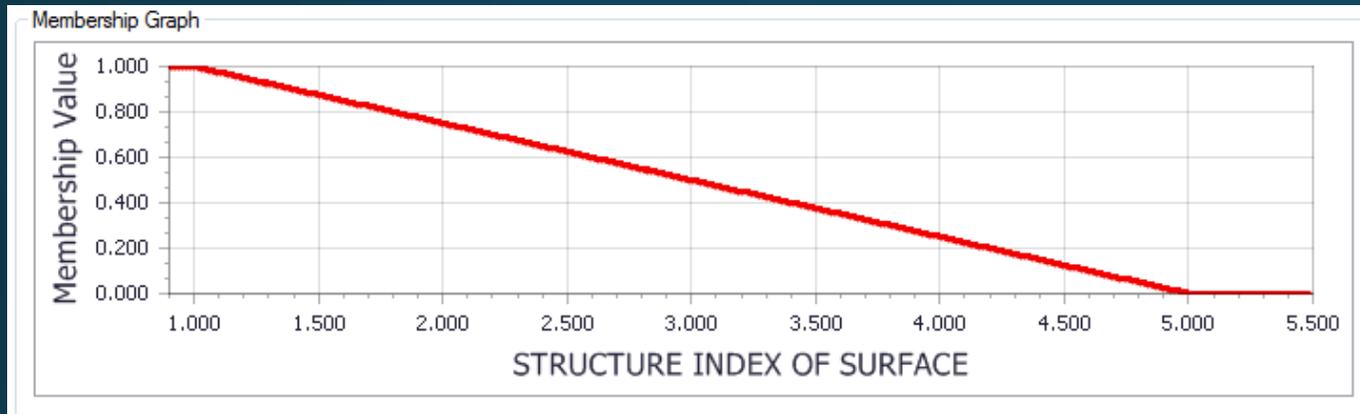


Table 3. Criteria for structure class placement in the soil quality morphological index.

Structure class Criteria

- 1 All structures with common or many stress surfaces irrespective of other features, massive, platy with firm or stronger horizontal rupture resistance, all weak structure except granular, moderate very coarse prismatic, all columnar.
- 2 All structures with few stress surfaces irrespective of other features, weak granular; moderate very coarse and coarse blocky; coarse and medium prismatic; platy with friable horizontal rupture resistance; strong very coarse and coarse prismatic.
- 3 No stress surfaces; moderate medium blocky; very fine, fine and medium prismatic; platy with very friable horizontal rupture resistance; strong very coarse and coarse blocky.
- 4 No stress surfaces, moderate granular, moderate very fine and fine blocky; strong fine.
- 5 No stress surfaces, strong granular, strong very fine through medium blocky and very fine prismatic.

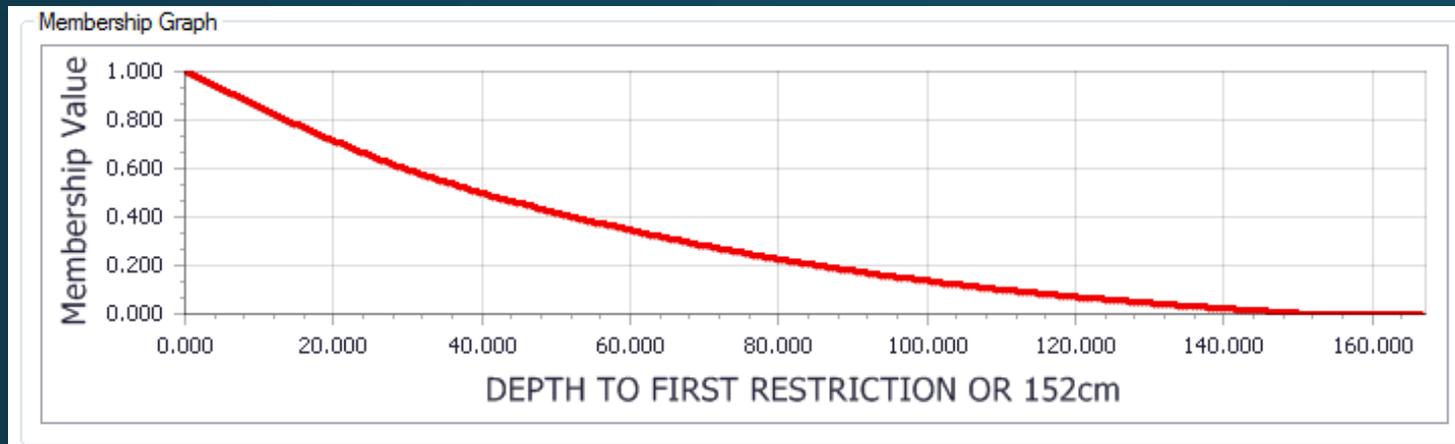
Table 2. Interpretative ratings for soil structure.

Rating Class Name	Soil Structure Limits (class)	Scoring Curve Rating Class Upper Boundary
Poor structure	1	1.000
Weakly structured	2	0.990
Moderately structured	3	0.750
Well structured	4	0.250
Highly structured	5	0.000

Structure Class Score

$$1 = 1; 2 = 0.75; 3 = 0.5; 4 = 0.25; 5 = 0$$

Rooting Depth



- Response of crop yield to erosion is generally convex (Bakker et al., 2004)
- Based on a depth to a root restrictive layer or 150 cm.
- Depths > 150 cm are assigned a score of zero

Table 3. Interpretative ratings for rooting depth.

Rating Class Name†	Rooting Depth† Limits (cm)	Scoring Curve Rating Class Upper Boundary
No Soil		1.000
Very Shallow	< 25	0.990
Shallow	25 - 50	0.743
Moderately Deep	50 -100	0.500
Deep	100 - 150	0.140
Very Deep	> 150	0.000

†Soil Survey Division Staff (1993)

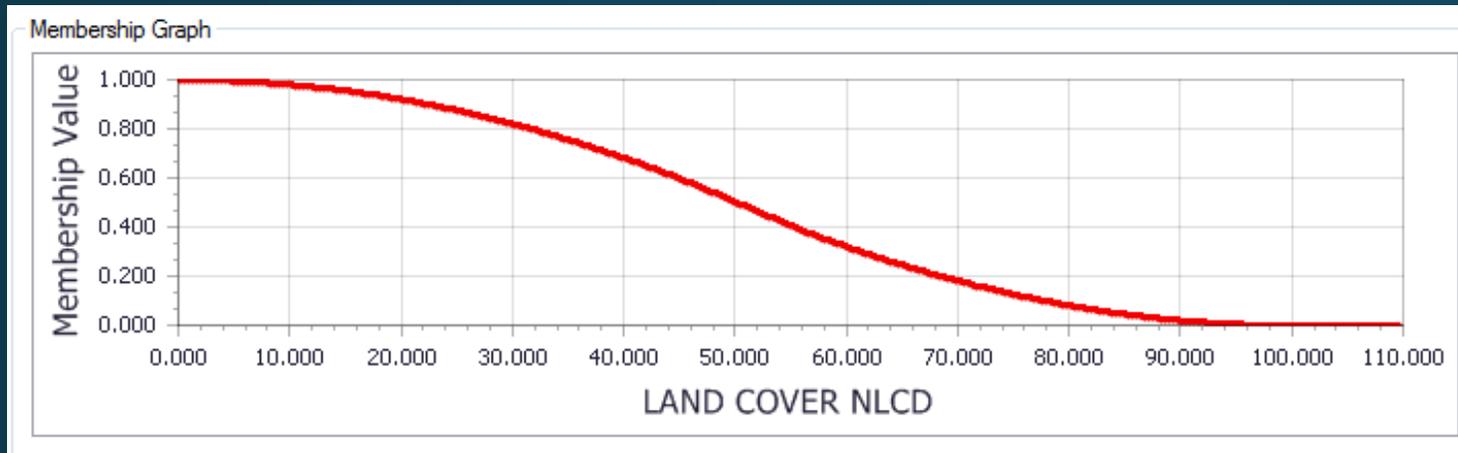
$$RD = a + bx + cx1.5 + dx3$$

$$a = 1.0000338; b = -0.019773028; c = 0.0011661322;$$

$$d = -5.1038528e-08;$$

$$x = \text{rooting depth (cm)}$$

Vegetative Cover



- Earth-cover-kind 1 and 2 for a component are used
- Assigned a cover percent to earth-cover-kind choices
- Not well populated

Table 4. Interpretative ratings for vegetative cover.

Rating Class Name	Vegetative Cover Limits (%)	Rating Class Upper Boundary
Low Vegetative Cover	< 30	1.000
Moderate Vegetative Cover	30 - 60	0.820
Mod.-High Vegetative Cover	60 - 80	0.320
High Vegetative Cover	> 80	0.080

$$\text{Veg Cover Score} = (a + cx + ex^2)/(1 + bx + dx^2)$$

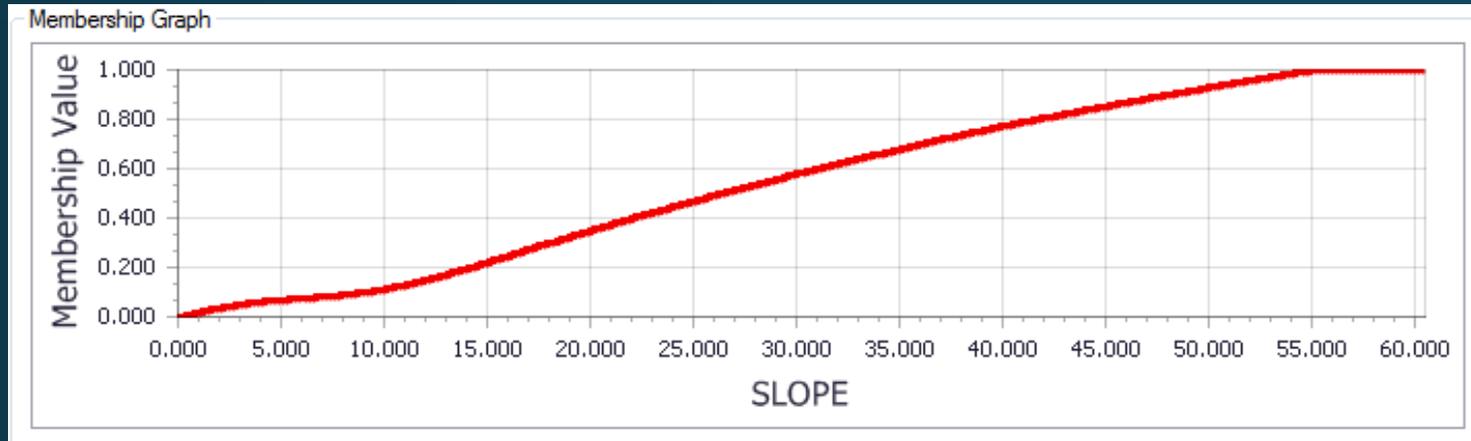
$$a = 0.99966629; b = -0.018080619;$$

$$c = -0.019063775; d = 0.00018014742;$$

$$e = 0.000090710991;$$

$$x = \text{veg cover (\%)}$$

Slope



- Scoring curve for slope was based on a study by Lui et al. (1994)
- Slopes greater than 55% are assigned a score of one. Scores for level slopes are zero.

Rating Class Name†	Slope Limits (%)†	Scoring Curve Rating Class Upper Boundary
Very Steep	> 45	1.000
Steep	28 - 45	0.850
Moderately Steep	16 - 28	0.550
Strongly Sloping	8 - 16	0.250
Gently Sloping	3 - 8	0.095
Nearly Level	< 3	0.050

†Soil Survey Division Staff (1993)

$$\text{Slope score} = (a + cx + ex^2 + gx^3)/(1 + bx + dx^2 + fx^3)$$

$$a = -0.00097169878; b = -0.085569059;$$

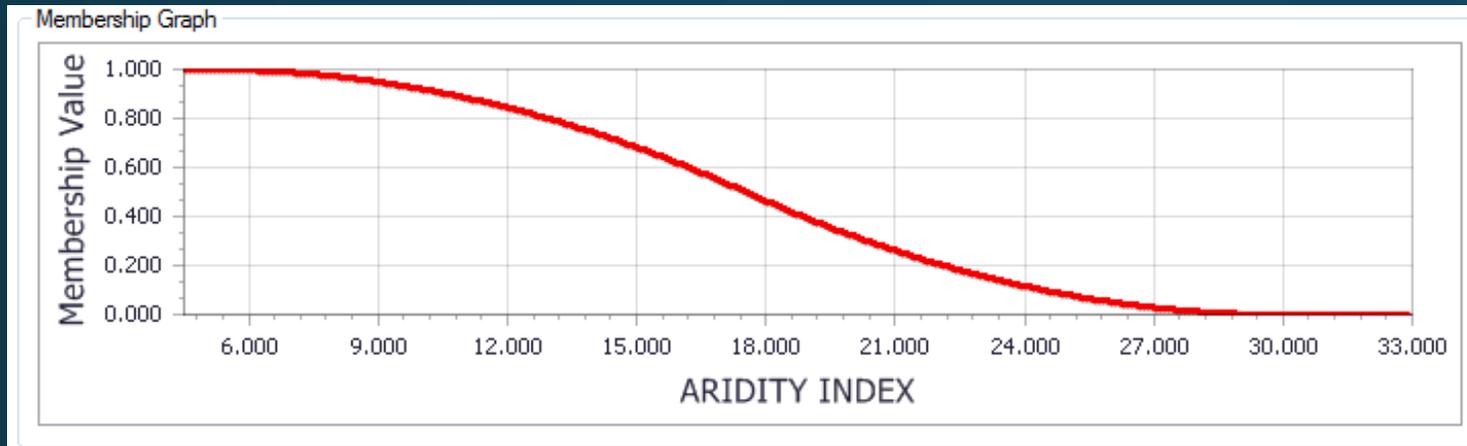
$$c = 0.022525266; d = 0.0068975356;$$

$$e = -0.0036133219; f = 8.00000689E-05;$$

$$g = 0.00024152235;$$

$$x = \text{slope gradient (\%)}$$

Aridity Index



- $A_m = P/(T + 10)$
 P (mm) = annual precipitation
 T (°C) = MAAT
 De Martonne (1926)

Rating Class Name†	Aridity Index Limits†	Scoring Curve Rating Class Upper Boundary
Very dry	< 5	1.000
Dry	5 - 15	0.999
Semi-dry	15 - 20	0.683
Mildly Wet	20 - 30	0.320
Wet and Very Wet	> 30	0.000

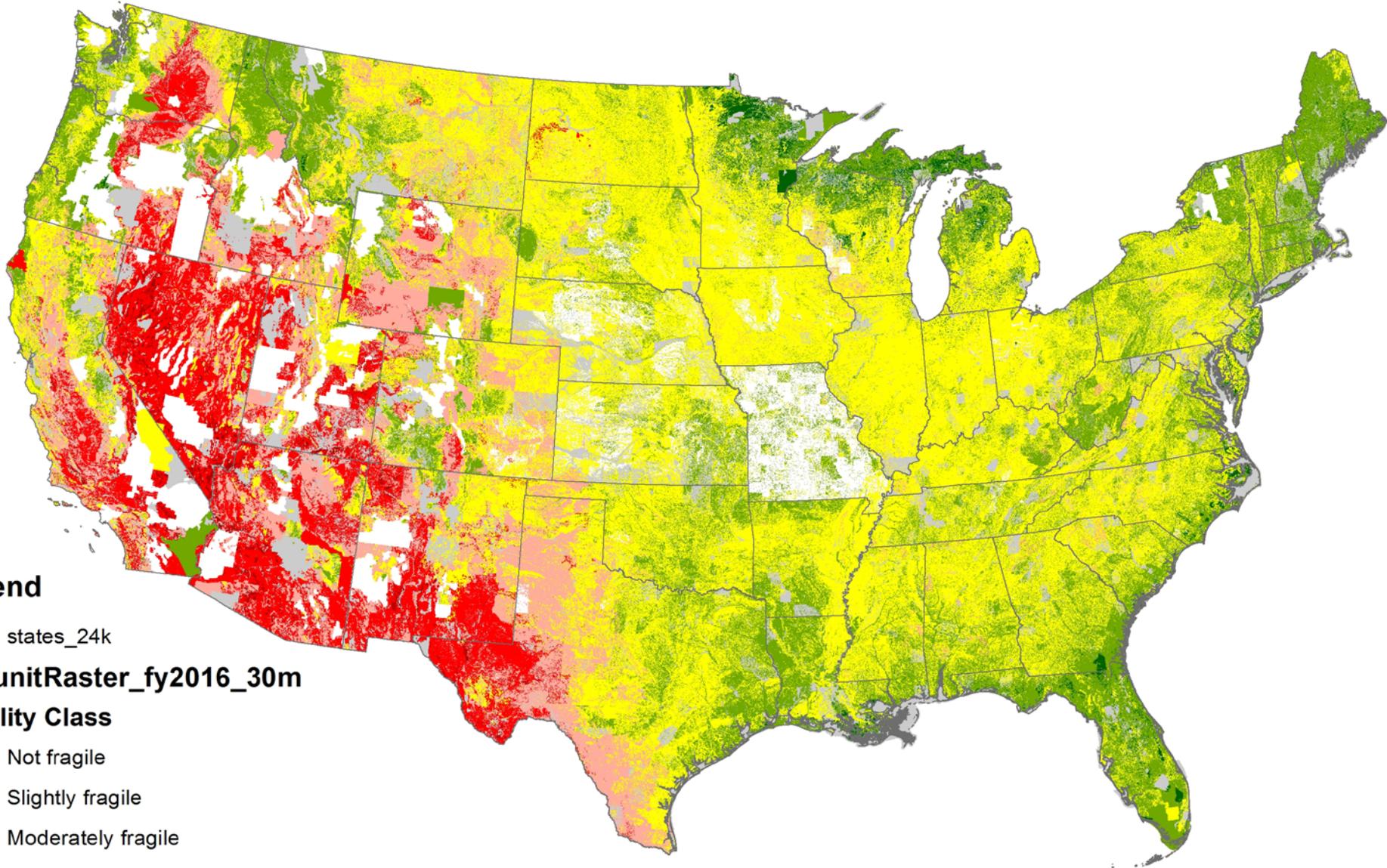
† De Martonne (1926), Lunga et al., 2011

$$A_m \text{ Score} = (a + cx + ex^2)/(1 + bx + dx^2)$$

$a = 0.99992575$; $b = -0.069544299$;
 $c = -0.065093715$; $d = 0.0019192058$;
 $e = 0.0010584767$;
 $x = A_m$

Table 7. Interpretation

Soil fragility Index Rating	Fragility Class	Description
≤ 0.009	Not fragile	Nearly level soils that are deep or very deep; have OM contents greater than 5.7% and are highly structured in the surface layer; and have > 85% vegetative cover; and have a wet (or very wet) aridity index rating.
0.010 – 0.209	Slightly fragile	Has one of the following: Very steep slopes or is very shallow or has poor soil quality or has low vegetative cover or has a semi-dry to mildly-wet aridity index rating.
0.210 – 0.409	Moderately fragile	Poor soil quality under low vegetative cover; poor soil quality on gentle slopes to very steep slopes; poor soil quality on shallow soils; poor soil quality in semi-dry to mildly-wet conditions; very dry conditions on moderately steep slopes; moderately steep or steeper slopes with low vegetative cover with good soil quality under wet conditions; good quality deep soils under 100% veg cover on steep slopes under semi-dry conditions.
0.410 – 0.609	Fragile	Poor soil quality with low vegetative cover on moderately steep or steeper slopes under wet condition; very dry conditions on steep or very steep soils
0.610 – 0.809	Very fragile	Poor soil quality in very shallow soils with low vegetative cover on steep slopes under mildly wet to wet conditions;
0.810 – 1.000	Extremely fragile	Poor soil quality in shallow soils with low vegetative cover on steep slopes under very dry conditions;



Legend

- states_24k
- MapunitRaster_fy2016_30m**
- Fragility Class**
- Not fragile
- Slightly fragile
- Moderately fragile
- Fragile
- Very fragile
- Extremely fragile
- Null, water