Improved Hammond's Landform Classification and Method for Global 250-m Elevation Data

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World Landforms - Improved Hammond Method 2015

High Hills
Low Mountains
High Mountains
Moderate Hills
Scattered Moderate Hills
Scattered High Hills
Scattered Low Mountains
Scattered High Mountains
Irregular Plains with Low Hills
Irregular Plains with Moderate Relief
Tablelands with Moderate Relief
Tablelands with Considerable Relief
Tablelands with High Relief
Tablelands with Very High Relief
Flat or Nearly Flat Plains
Smooth Plains with some local relief
Surface Water

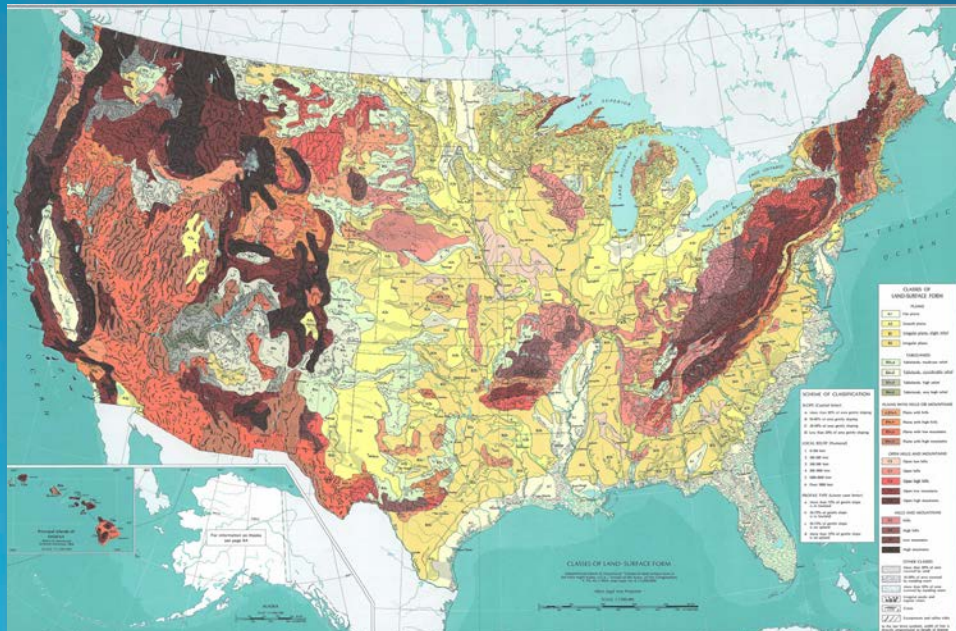*esriurl.com/landscape*

Why do we need a Global Landform Map?

Characterize and Define Ecosystems

Update Global ELU Map

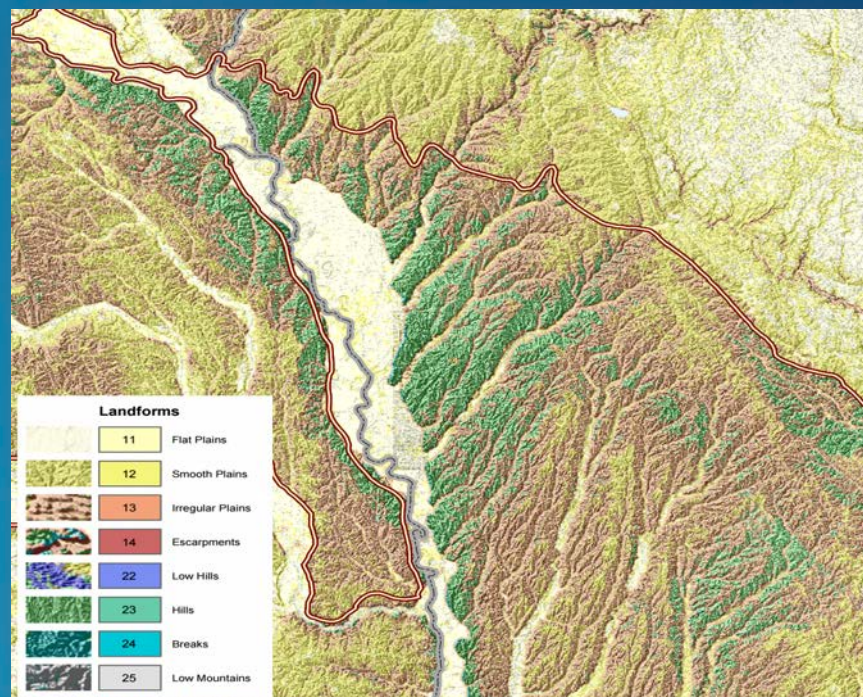Landform

Rock Type

Landcover

Bioclimate

Background

Classes of land surface form in the forty-eight States, USA, Hammond (1964)

- 1900-1954 based on genetic geomorphology

- Regional Based (Hammond, 1954)
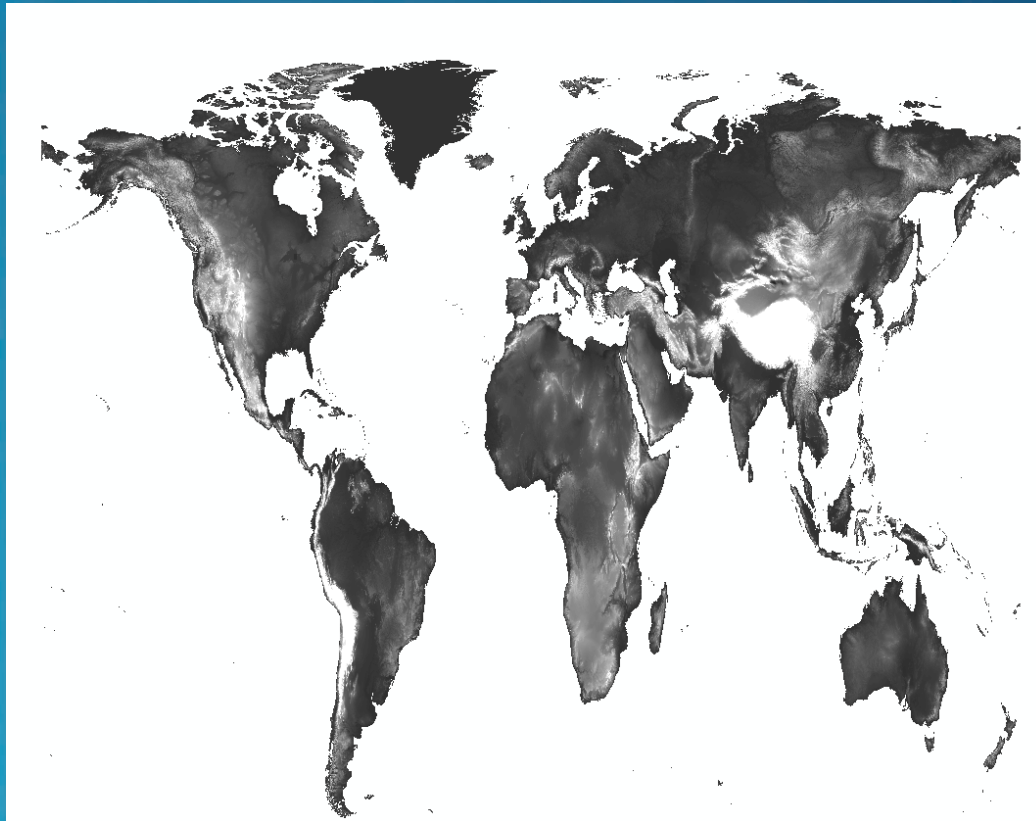
- Slope + Local Relief + Profile

Automating Hammond's Classification in GIS

- **Dikau et al., 1991, New Mexico**
- **Brabyn 1998, New Zealand**
- **True 2002, Midwest, US**
- **Gallant et al., 2005, Alaska**
- **Morgan and Lesh 2005, Maryland**

Landforms

	11	Flat Plains
	12	Smooth Plains
	13	Irregular Plains
	14	Escarpments
	22	Low Hills
	23	Hills
	24	Breaks
	25	Low Mountains

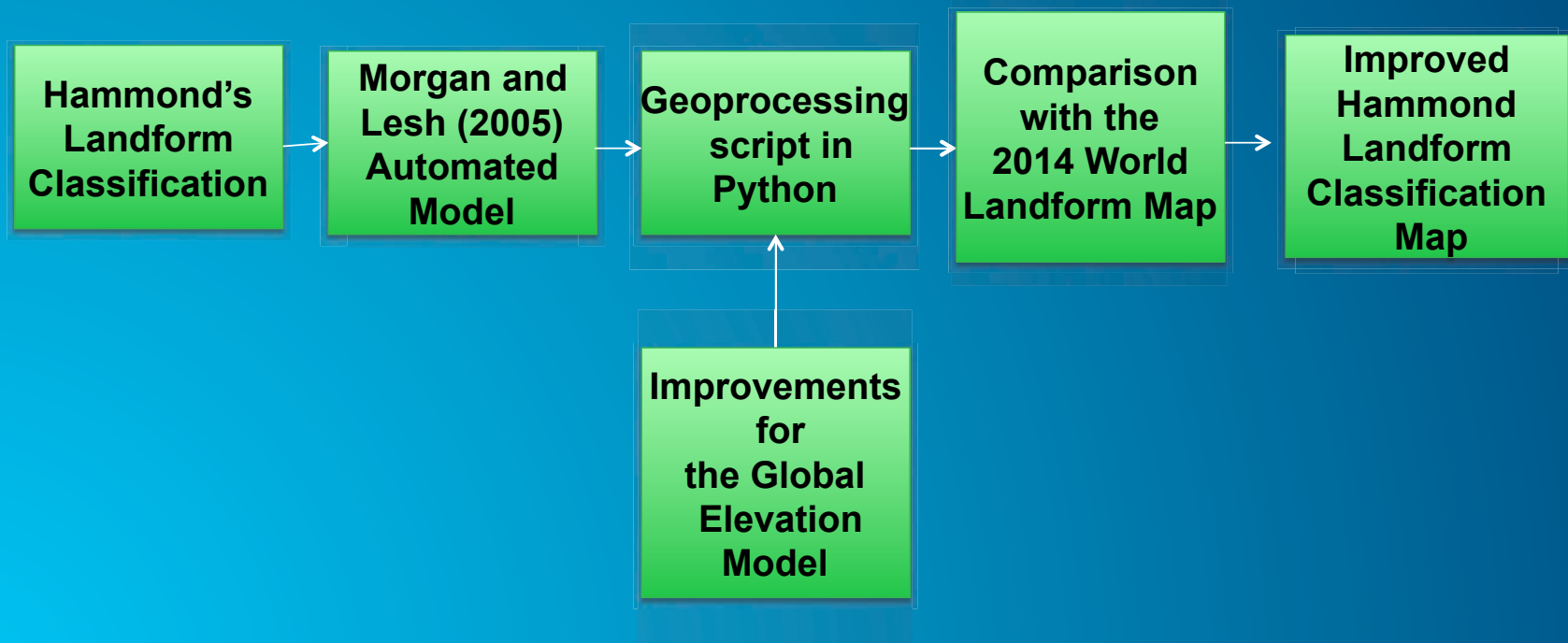*30-meter Midwest Landform Classes,*
True, MoRAP (2002)

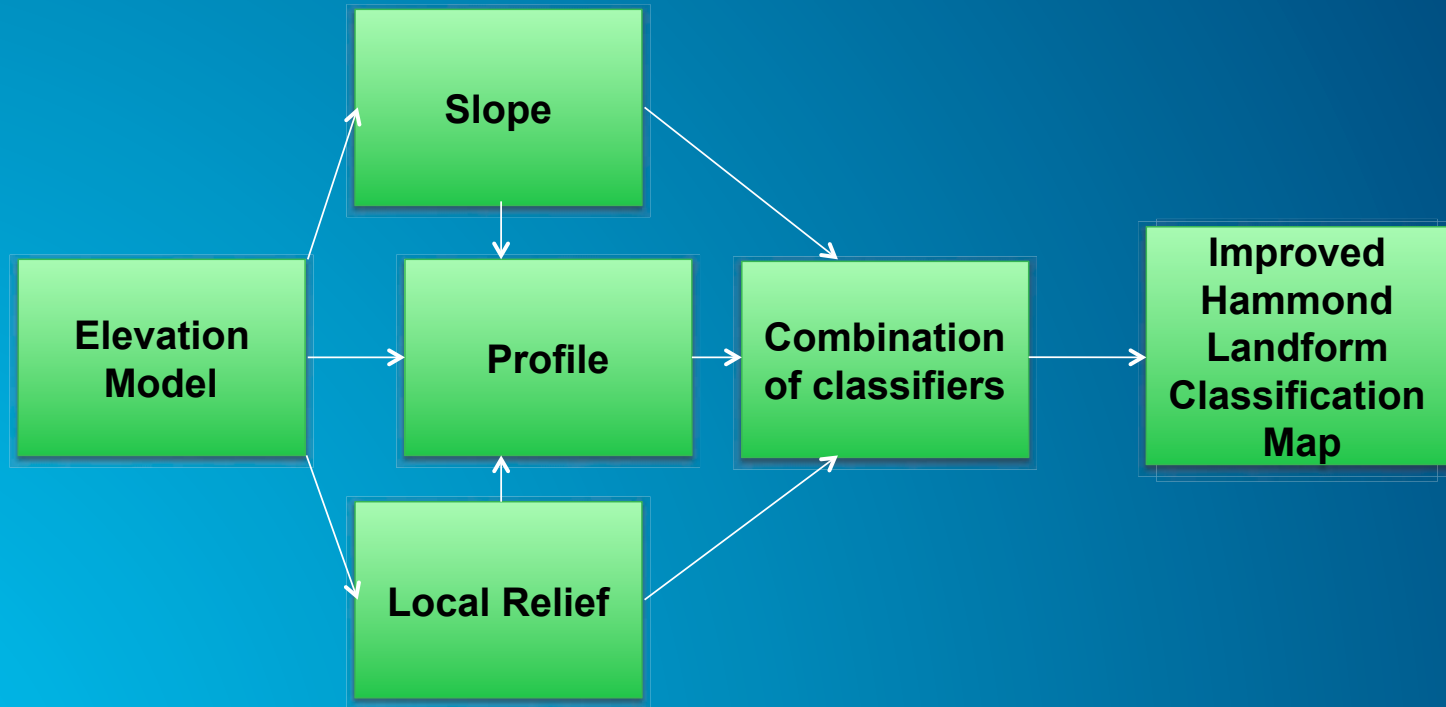**GMTED 2010 / 250-meter**

World Landforms MoRAP Method-2014

- **Missing Major Landform Class**

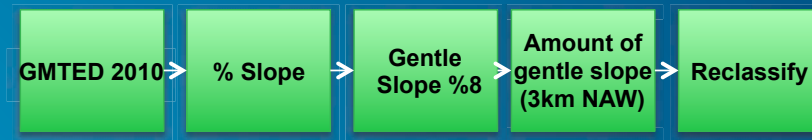- **Too Many Plains Cells**

- **Faceted or Fragmented**

ArcGIS Online, Living Atlas

Conceptual Methodology

Conceptual Summary

Gentle Slope

Amount of gentle slope
within the 3-km window

GMTED 2010 → % Slope → Gentle Slope %8 → Amount of gentle slope (3km NAW) → Reclassify

Percent of Neighborhood Over 8% Slope	Gentle Slope Class Code
0 - 20%	400
21% -50%	300
51% - 80%	200
>81%	100

Local Relief

Amount of elevation change within a circular 6-km window
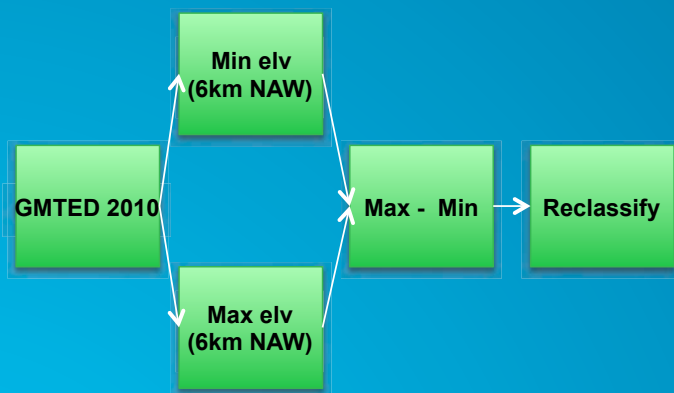
Change in Elevation	Relief Class Code
0 – 30 meter	10
>30m to 90m	20
>90m to 150m	30
>150m to 300m	40
>300m to 900m	50
>900m	60

Profile

Amount of gentle slope in uplands
and lowlands within the 6-km window
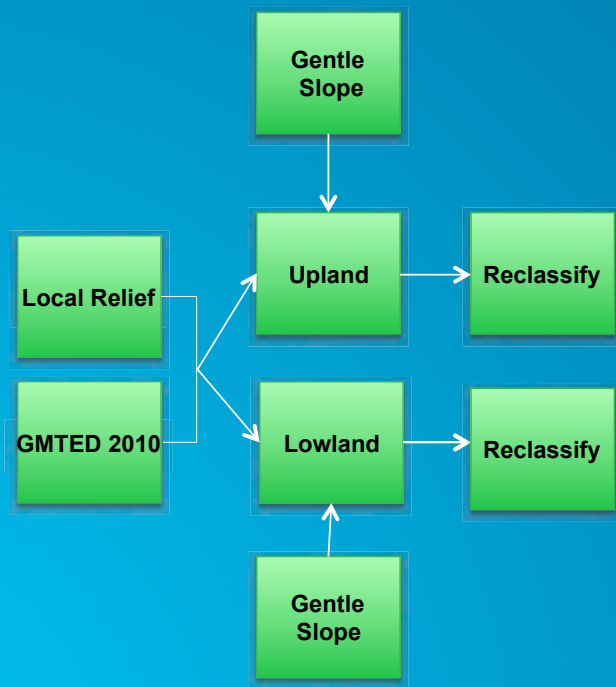
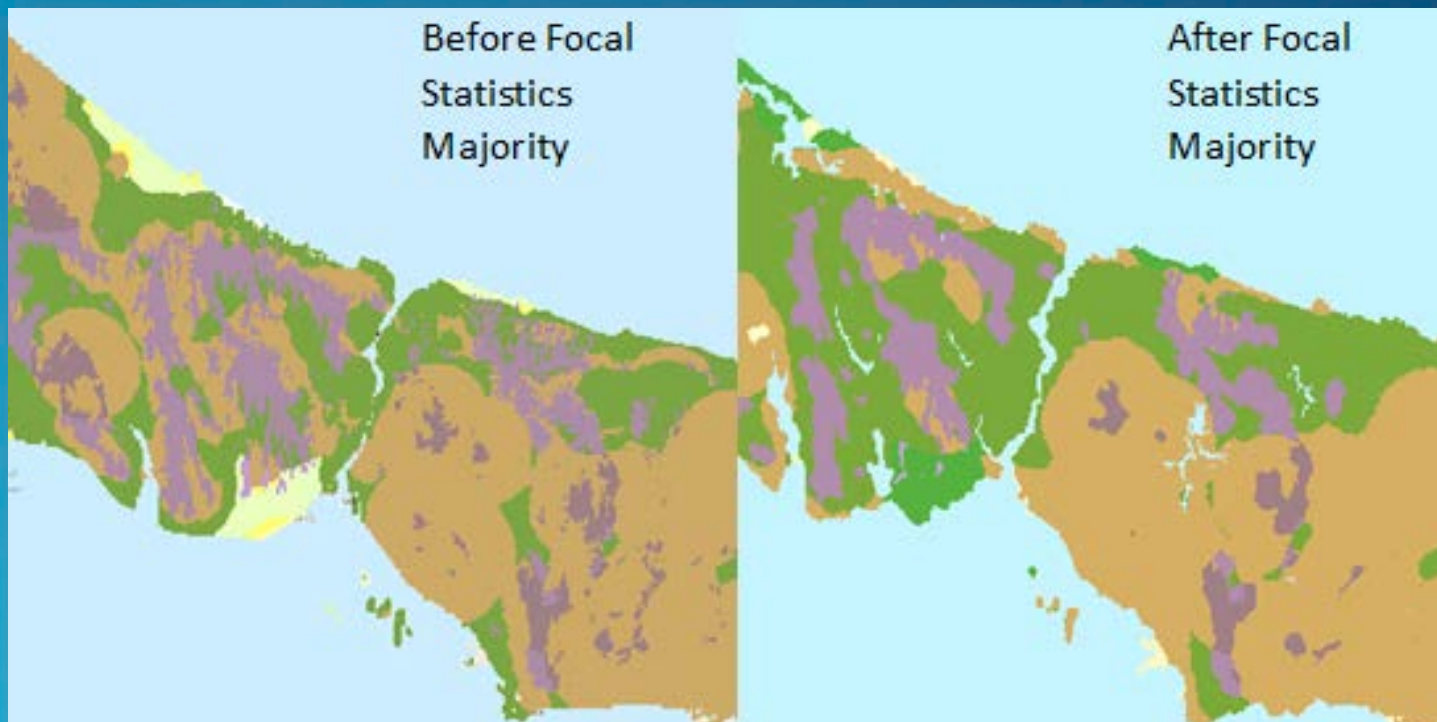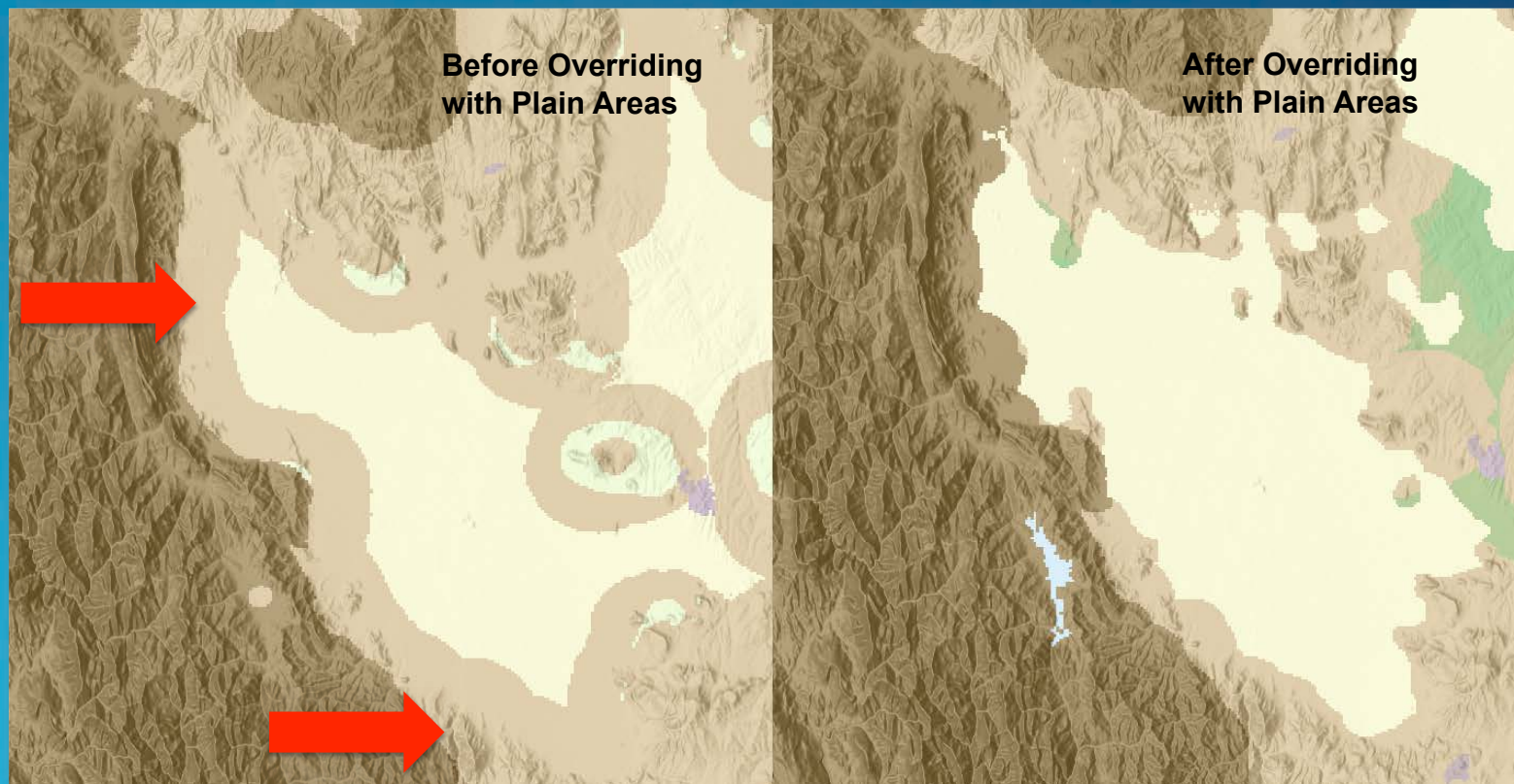| Percent of gentle slope within the uplands and lowlands	Profile Class Code
Less than 50% gentle slope is in upland or lowland	0
More than 75% of gentle slope is in lowland	1
50%-75% of gentle slope is in lowland	2
50-75% of gentle slope is in upland	3
More than 75% of gentle slope is in upland	4

Gentle Slope (hundreds) + **Local Relief (tens)** + **Profile (ones)**
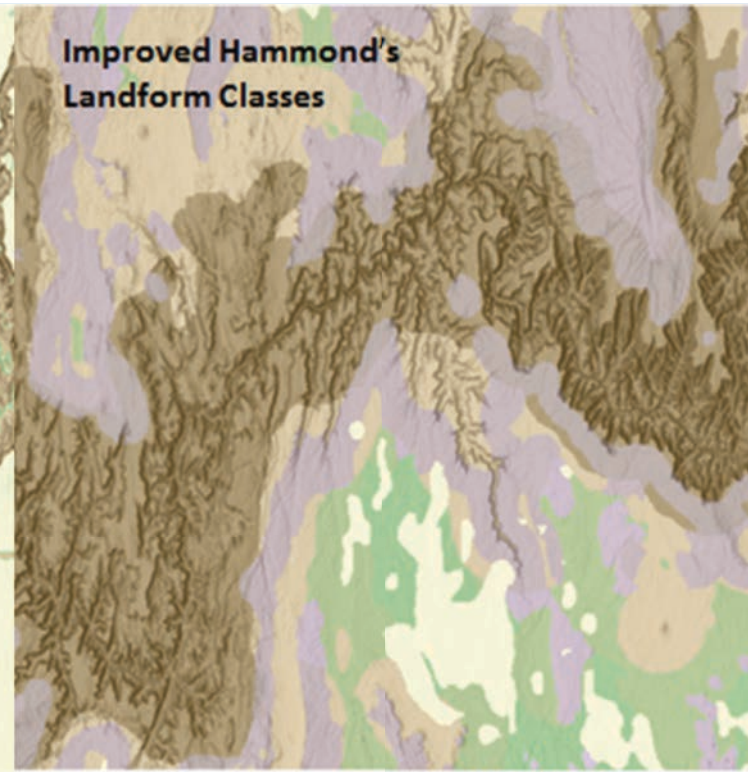
Data Filtering - Resampling

Before Focal Statistics Majority | After Focal Statistics Majority

Plains

Before Overriding
with Plain Areas

After Overriding
with Plain Areas

**Original Landform Classes
from Sayre et al., 2014)**

**Improved Hammond's
Landform Classes**

- Breaks/Foothills
- Flat Plains
- High Mountains/Deep Canyons
- Hills
- Low Hills
- Low Mountains
- Smooth Plains

- High Hills
- Low Mountains
- High Mountains
- Moderate Hills
- Scattered Moderate Hills
- Scattered High Hills
- Scattered Low Mountains

- Scattered High Mountains
- Irregular Plains with Low Hills
- Irregular Plains with Moderate Relief
- Tablelands with Moderate Relief
- Tablelands with Considerable Relief
- Tablelands with High Relief
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- Flat or Nearly Flat Plains
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Result

- **16 landform classes, including tablelands**
- **Intuitive empirical expression of regional landform classes**
- **To our knowledge, this is the first successful automated global implementation of Hammond's landform classification.**
- **Better results than earlier works.**
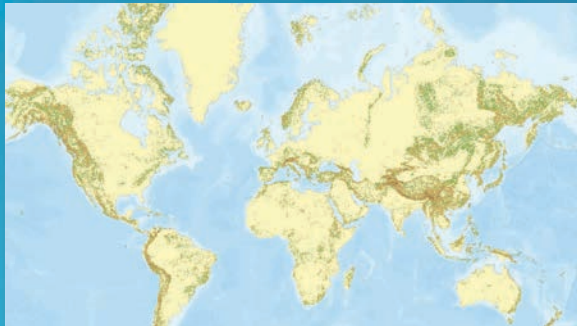
Thank You.
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Understanding our world.