

# Solar Power Plant Site Selection



Peregrine Edison-Lahm, Benjamin Harper, and John Townsend

## Previous Studies We Found

- Site selection study in Iran\* (fossil fuel)
  - Provided suitability ratings
- Solar siting in Andalusia\*\* and Tunisia \*\*\*
- And most of all:
  - Oregon statutes\*\*\*\*

| Feature          | Description        | Limitation or Buffer size |
|------------------|--------------------|---------------------------|
| Elevation        |                    | > 1800 m                  |
| Slope            |                    | > 10%                     |
| Fault            | Major & minor      | 1 Km                      |
|                  | Reverse            | 2 Km                      |
| Earthquake spots | 5.5-6 mb           | 1 Km                      |
|                  | > 6 mb             | 2 Km                      |
| City             | Shiraz             | 10 Km                     |
|                  | Center of district | 5 Km                      |
|                  | Other cities       | 3 Km                      |
| Village          |                    | 2 Km                      |
| Dam              |                    | 10 Km                     |
| Swamp            |                    | 1 Km                      |
| Sandy land       |                    | The whole area            |
| Mine             | Unimportant        | 1 Km                      |
|                  | Important          | 2 Km                      |
| Lake             |                    | 1 Km                      |
| Floodway         |                    | 2 Km                      |
| Marsh            |                    | 1 Km                      |
| Orchard          |                    | The whole area            |
| Forest           |                    | 1 Km                      |
| Protected areas  | National park      | 3 Km                      |
|                  | Wild life          | 2 Km                      |
|                  | Protected area     | 1 Km                      |

\* Carrion, et al, The electricity production capacity of photovoltaic power plants and the selection of solar energy sites in Andalusia (Spain)

\*\*\* Vandenberg et al, A GIS approach for the siting of solar thermal power plants application to Tunisia

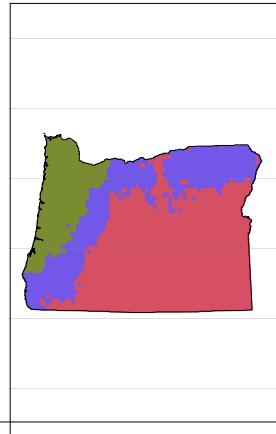
\*\*\*\* General Standards For Siting Facilities ORS 345-022-0000

# Find the Sunny Spots

- This is just some of the calculation

for solar radiance: The beam irradiance normal to the solar beam  $B0c$  [ $W.m^{-2}$ ], attenuated by the cloudless

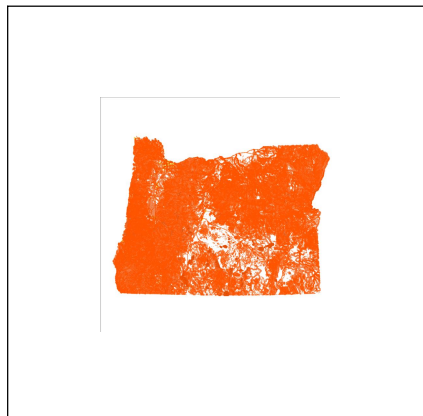
- atmosphere, is calculated as follows:
- $B0c = G0 \exp \{-0.8662 TLK m \delta R(m)\}$  (4)
- The term  $-0.8662 TLK$  is the air mass 2 Linke atmospheric turbidity factor [dimensionless]
- corrected by Kasten [24]. The parameter  $m$  in equation (4) is the relative optical air mass
- $[-]$  calculated using the formula [25]:
- $m = (p/p0) / (\sin h0)$
- $ref + 0.50572 (h0$
- $ref + 6.07995) - 1.6364)$  (5)
- where  $h0$
- $ref$  is the corrected solar altitude  $h0$  (an angle between the sun and horizon) in
- degrees by the atmospheric refraction component  $\Delta h0$
- $ref$ :
- $\Delta h0$
- $ref = 0.061359 (0.1594 + 1.123 h0 + 0.065656 h0$
- $2) / (1 + 28.9344 h0 + 277.3971 h0$
- $2)$
- $h0$
- $ref = h0 + \Delta h0$
- $ref ($
- ...So we were glad we found existing data (from NREL). In Oregon, its not hard to narrow it down...
- Jaroslav Hofierka, "Marcel.úrn"; "The solar radiation model for Open source GIS:
- implementation and applications



•We also found data from FEMA and Oregon Geospatial Data Clearing House

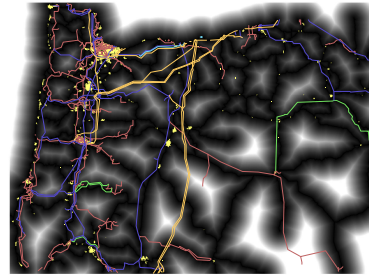
# Create and Exclusionary Zone: Buffer and Eliminate

- Streams (1/2 mile)
- Other water bodies (1 mile)
- Highway (1/4 mile)
- Roads (1/4 mile)
- Slope > 2 %
- National Parks, State Parks, Forest Land...
- Learn to love your erase tool.



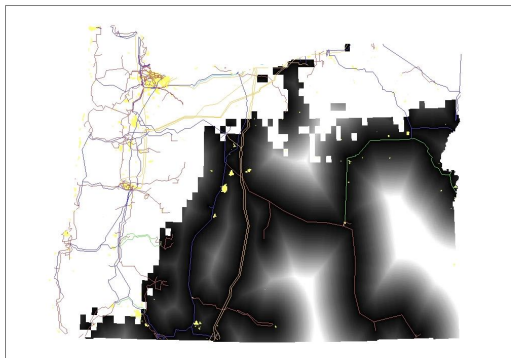
## Derive Euclidian Distance:

- Slope
- Aspect
- Distance to from roads
  - You want it close (cost) but not too close (danger?)
- Distance from cities
  - See above!



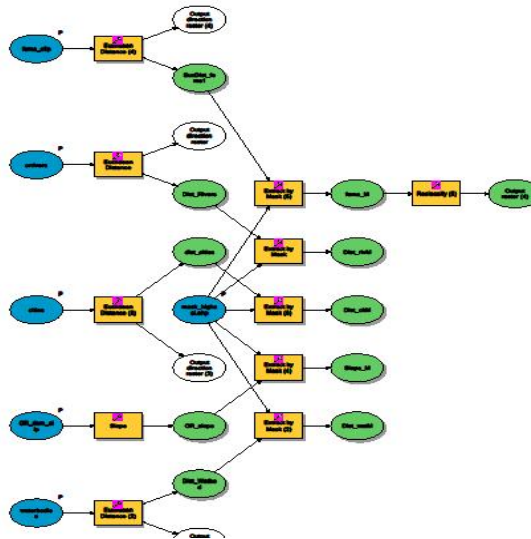
Distance from Highways  
With cities and power lines

## Eliminate All But the Sunny Spots



Euclidian Distance to Power Lines  
With power Lines and Cities

## The Model So Far



## Reclassify According To Desirability

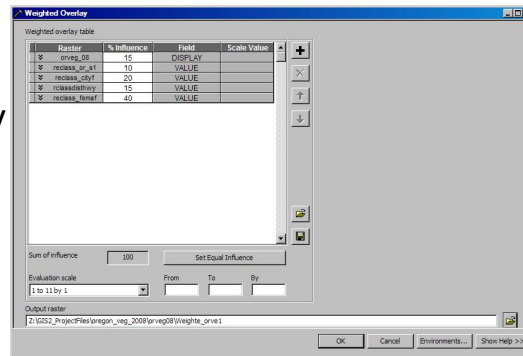
(normalize data for comparison)

Using 10 desirability levels for: remaining land use, highways, distance to city, slope, and distance to power grid.

| Rowid | VALUE * | COUNT    |
|-------|---------|----------|
| 0     |         | 29224877 |
| 1     |         | 19854784 |

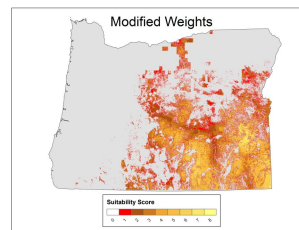
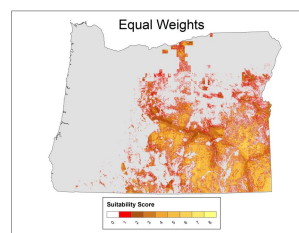
## Perform a weighted overlay with a cranky ArcGIS

- Slope
- Land Use
- Distance to highway
- Distance to cities
- Distance to grid

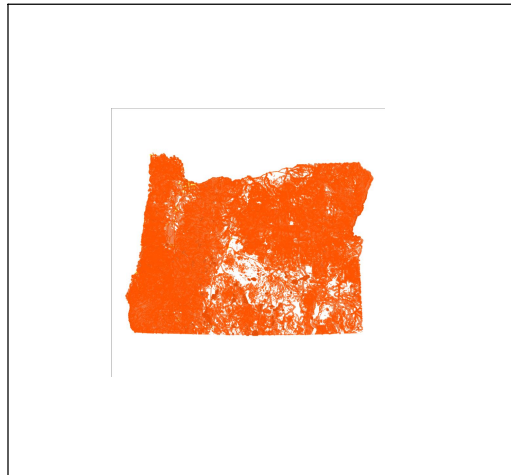


## Equal Weight vs. Modified Weight

- With sites closer to Electric Grid being more desirable the bottom map shows a clustered pattern near the grid.

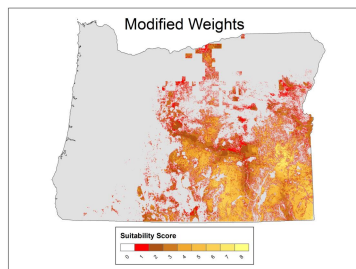
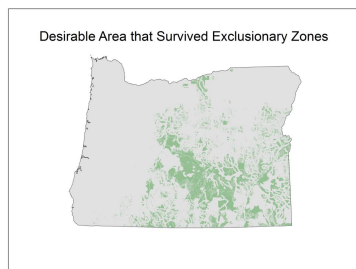


## (Desirable Area)

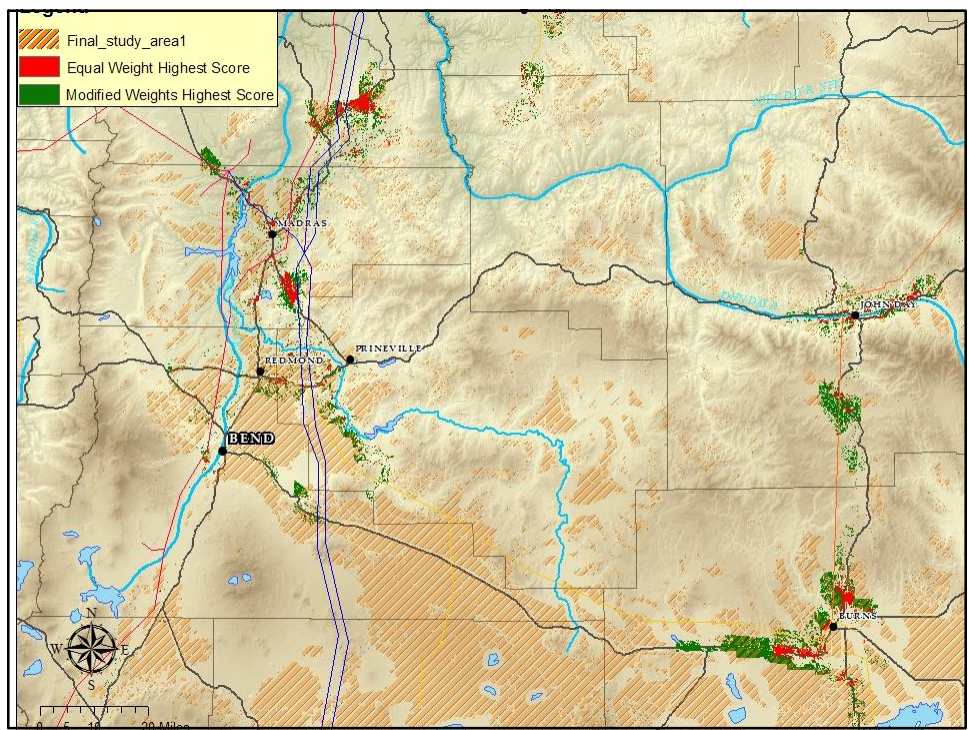


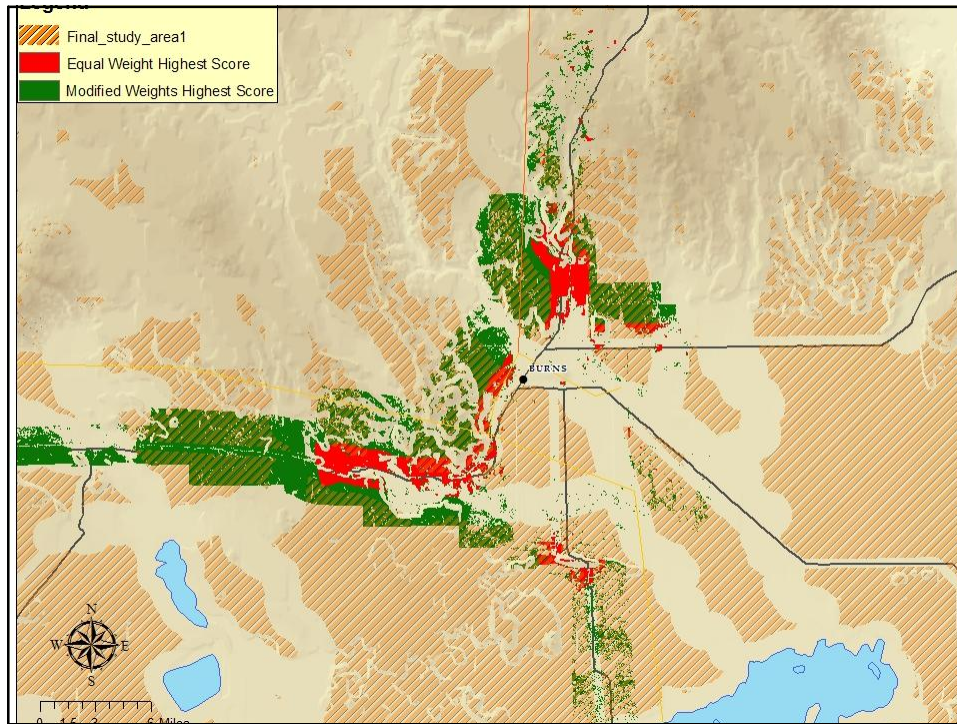
(Desirable Area is in white.)

## The Problem of Combining Large Datasets



- At this point we hoped to either mask the extent of the weighted overlay to the desirable area
- Or - After the overlay, mask the result to the desirable area.
- Problem... neither worked in ArcMap





## Conclusions

- Be careful of how big your layers get.
- “Carve” the state down more as you go, or choose a smaller scale to start with.
- Our results would be the first step in a larger process. The next step would be to study the ORS solar power siting statutes along with our suitable areas.

## Ideas for Further Study

- Narrow study area to a city and focus on rooftops.
- Focus study on to how to supply just one city with power.



