WORLD BANK GROUP
Energy & Extractives

R2E2
ARMENIA RENEWABLE RESOURCES AND ENERGY EFFICIENCY FUND

# Final Meeting

# Yerevan. June 2017

## Task 5: Selection of Suitable Sites for PV development

ENERGIA effergy

irsolav

Energy Advisory

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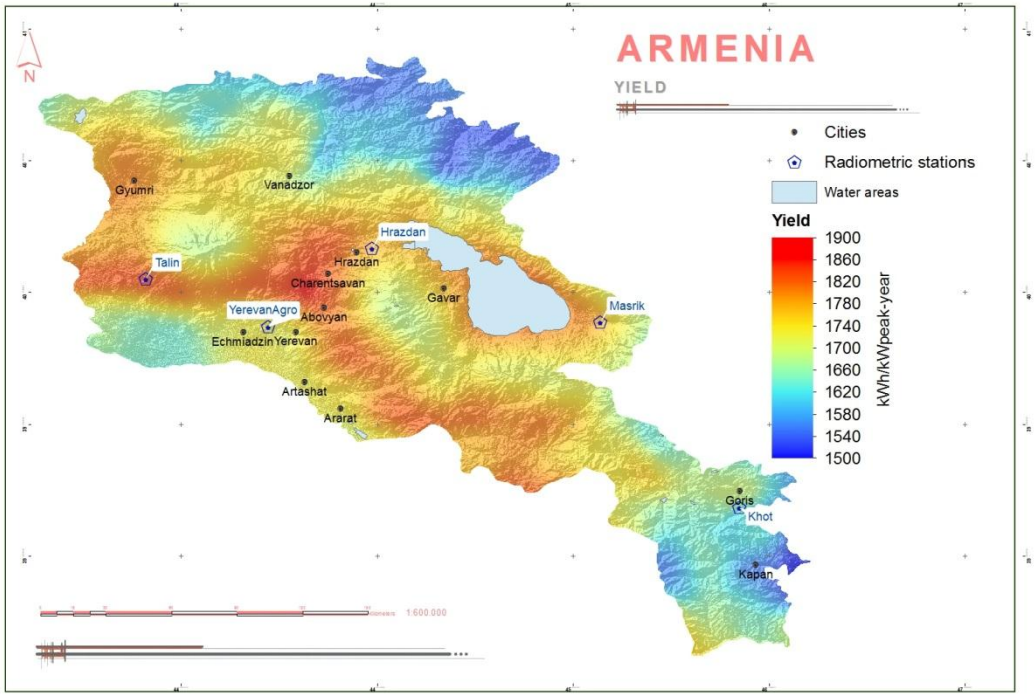
# 1 Methodology

# 1. Methodology

- GIS-based multicriteria decision methodology
- Parameters:
  - PV production
  - Electric lines network
  - Roads network
  - Slope of terrain
  - Protected areas
  - Population density
  - Rivers and water bodies
  - More…: airports, rail roads.
  - Needed area



# 1. Methodology

- GIS-based multicriteria decision methodology
- Parameters:
  - PV production
  - Electric lines network: 110-220kV
  - Roads network
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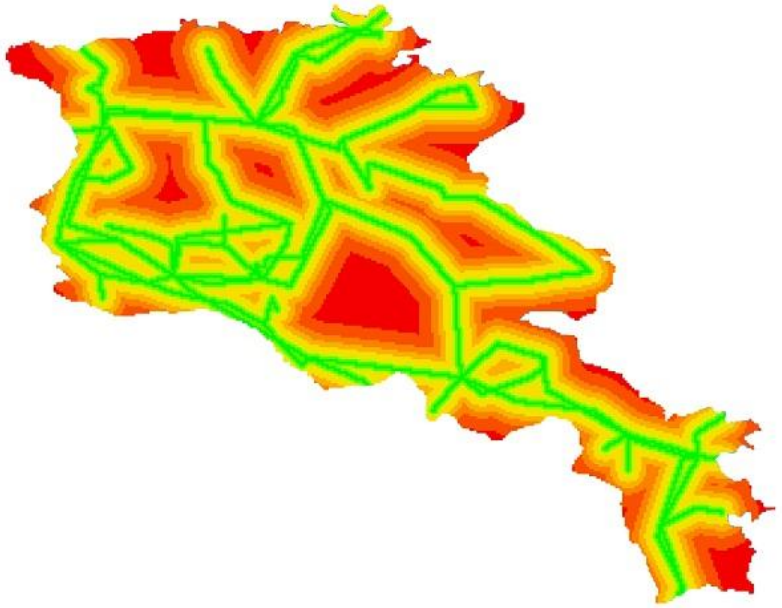
  - Protected areas
  - Population density
  - Rivers and water bodies
  - More…: airports, rail roads.
  - Needed area



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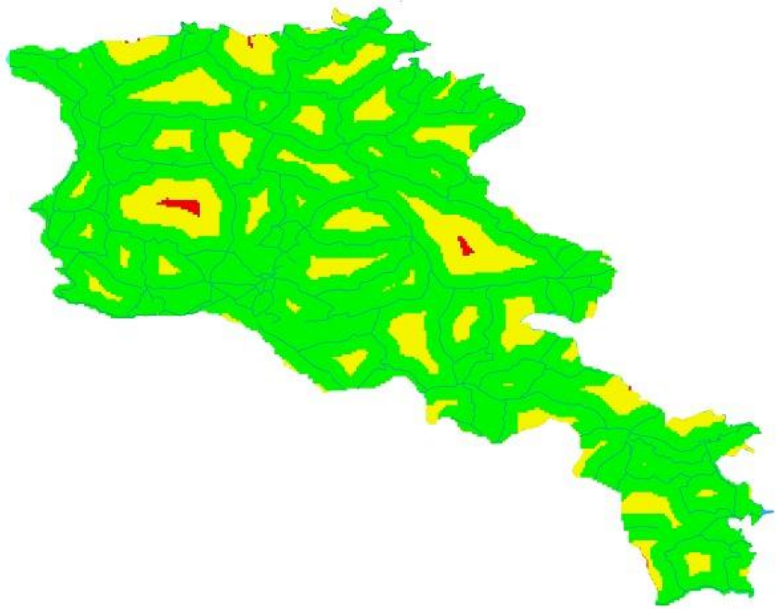
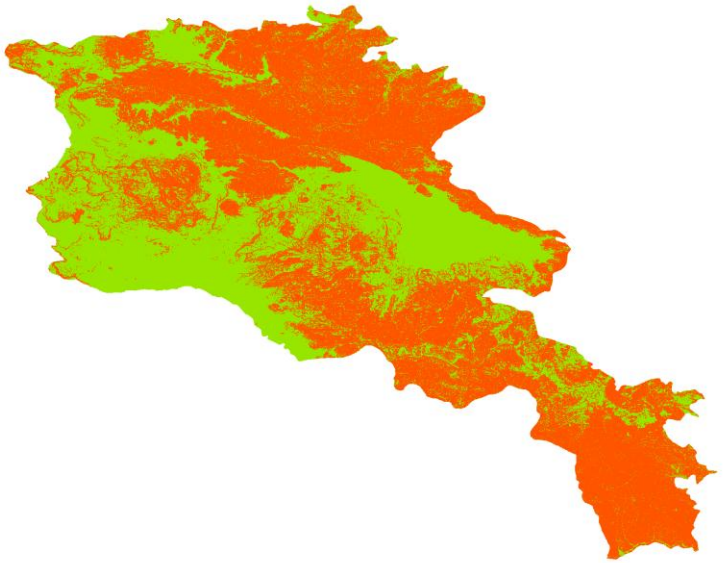


# 1. Methodology

- GIS-based multicriteria decision methodology
- Parameters:
  - PV production
  - Electric lines network
  - Roads network
  - Slope of terrain: 12%
  - Protected areas
  - Population density
  - Rivers and water bodies
  - More…: airports, rail roads.
  - Needed area



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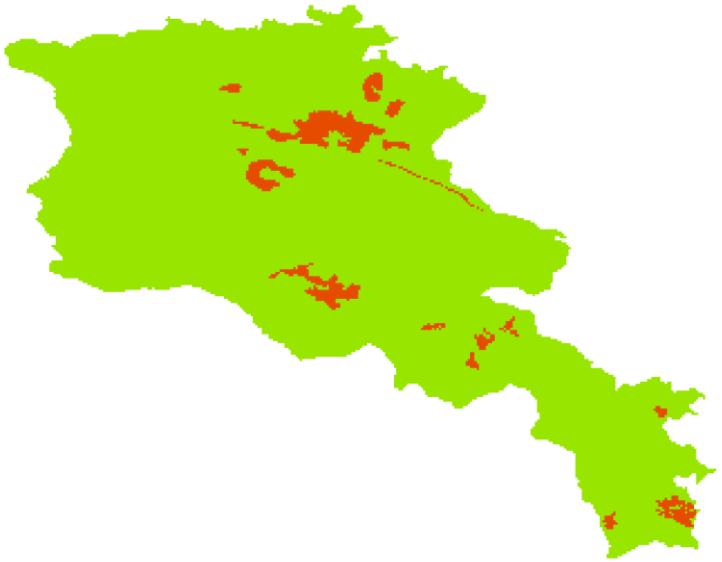

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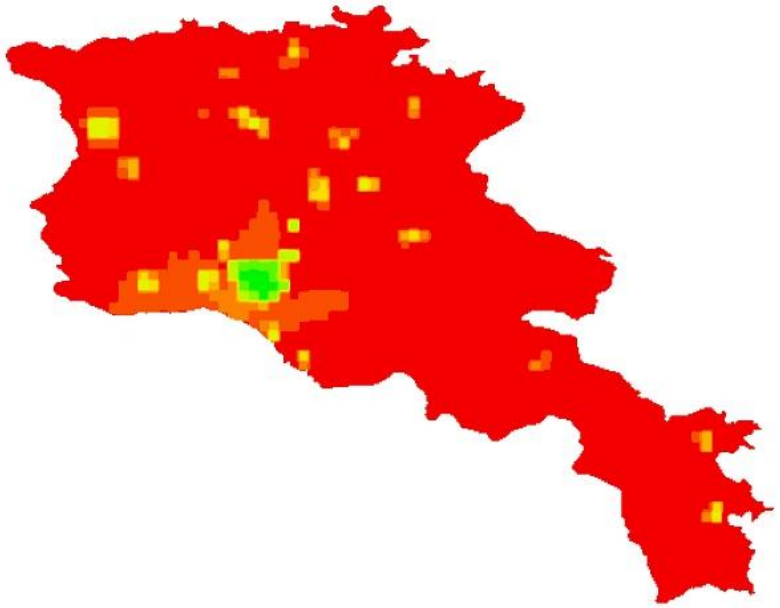

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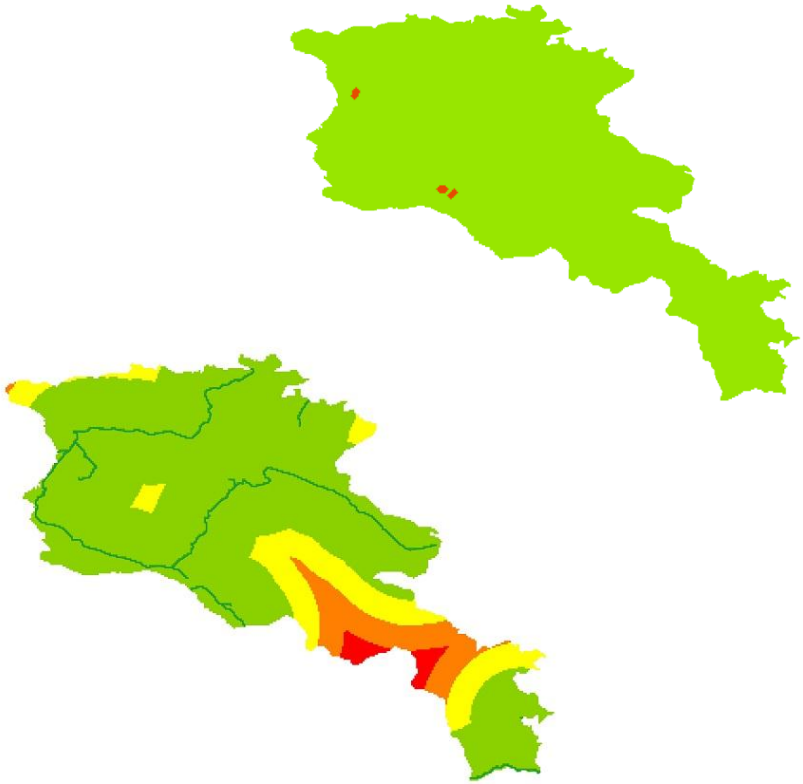

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  - Electric lines network
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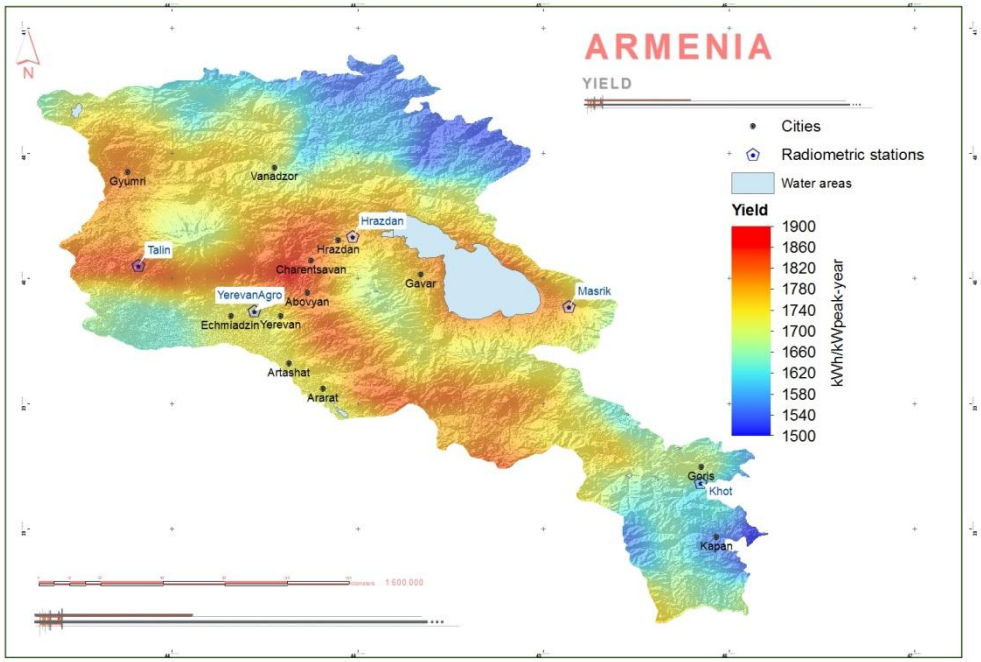
  - Rivers and water bodies
  - More…: airports, rail roads.
  - Needed area: 1.2Ha for PV utility scale of 1MWp

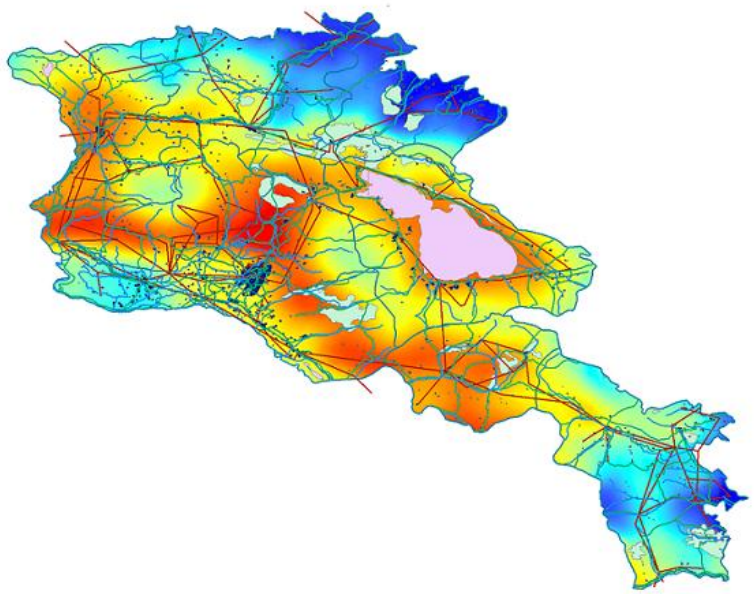
# 1. Methodology: Step 1

- **PV production**
- GTI, Temperature, Wind
- PV utility scale 1MWp
  - Fixed structure photovoltaic with optimum tilt.
  - Factor 1.8 for the relation of horizontal distance between rows of modules and height.
  - Factor 1.2 for the relation between the power of the inverter and the peak power.
  - Transformation center is considered.
  - 2.5% average dirt losses.



# 1. Methodology: Step 2

- **Restricted (discriminatory) areas**
  - Cities
  - Lakes, rivers
  - Roads
  - Airports
  - Protected Areas
  - Areas with slope terrain > 12%



# 1. Methodology: Step 3

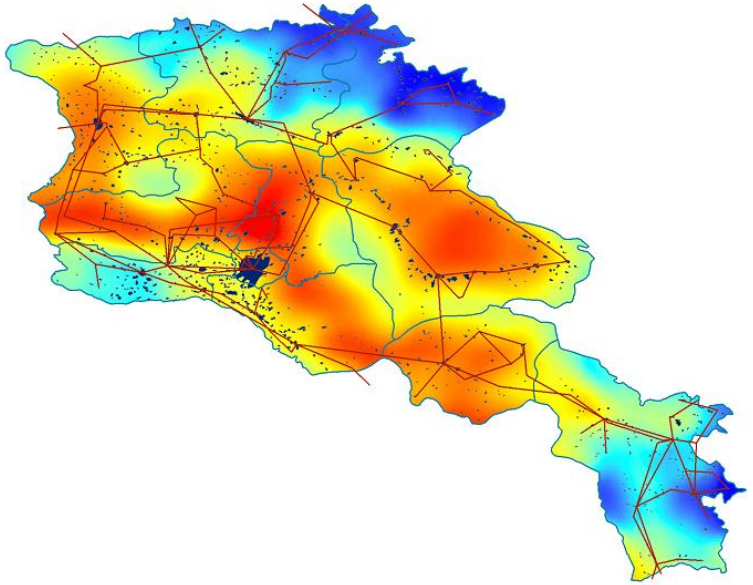
- **Economic impact**

  - Independent assessment of parameters that produce economic impact in the initial phase of the project:
    - Distance to electrical infrastructures
    - Distance to roads
    - Slope terrain

  - Smart calculation of weighting factors for each parameter. **Trade-off**
    - **Optimal PV yield**
    - **Costs minimization**
    - **Maximization of PV project profits**

# 1. Methodology: Step 3

- **Economic impact**
  - Distance to electrical infrastructures
    - 140,000 $/km
  - Distance to roads
    - 220,000 $/km



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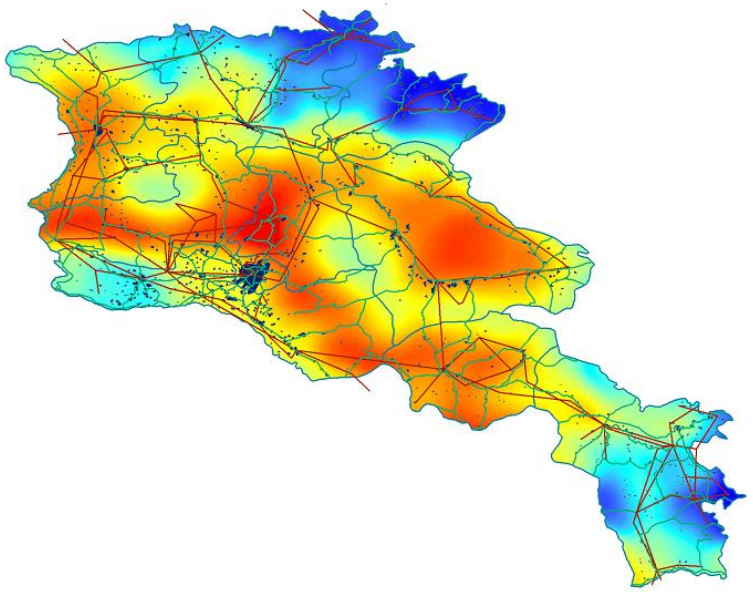
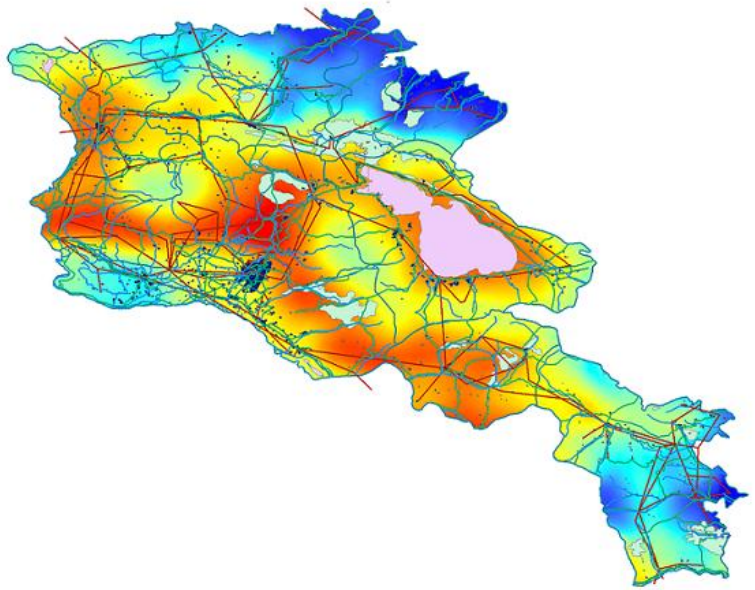


# 1. Methodology: Step 4

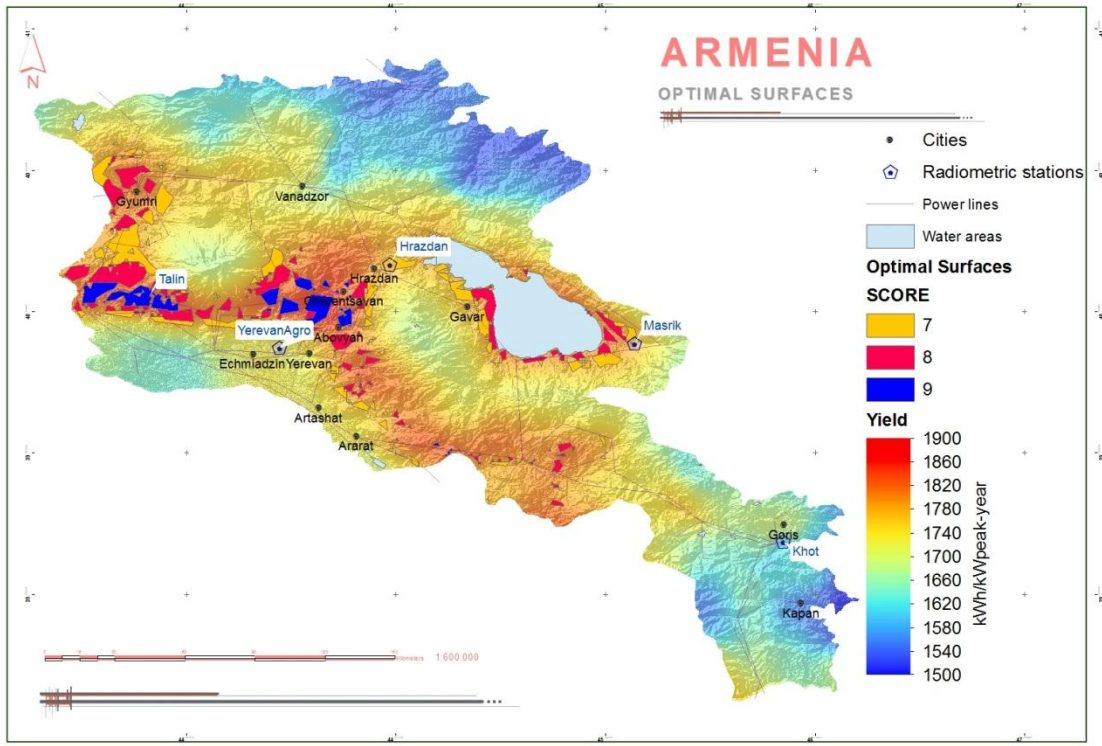
- **Combination in GIS**
  - Ranking of suitable regions
  - Visual inspection
- **Final selection of sites**



# 2 Results

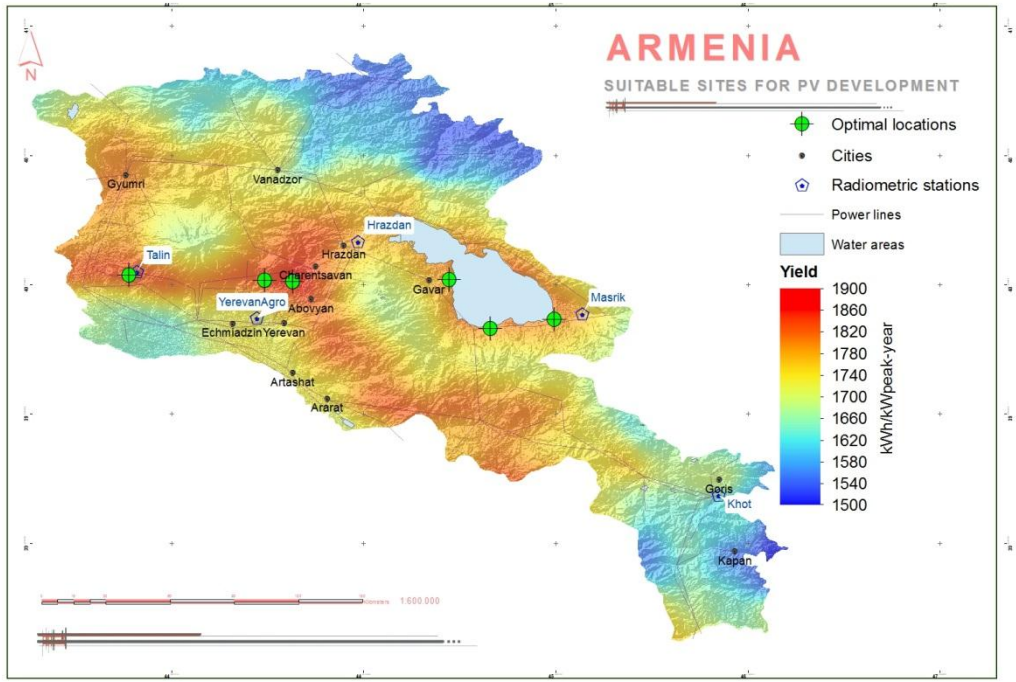
# 2. Results: Best regions

- **Belt rounding south face of Aragats mount**: radiation conditions are excellent, as well as available infrastructures.
- **Lake Sevan**: this region is second ranked, mainly due to its large distance to big population areas.



# 2. Results: Best sites

| Name | Latitude (deg) | Longitude (deg) |
|---|---|---|
| PV_site_1 | 40.3719 | 43.8601 |
| PV_site_2 | 40.3493 | 44.4307 |
| PV_site_3 | 40.3516 | 45.2056 |
| PV_site_4 | 40.3449 | 44.5462 |
| PV_site_5 | 40.1855 | 45.6460 |
| PV_site_6 | 40.1461 | 45.3770 |



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