Analysis of Rural-Urban Systems and Historic Climate Data in Mexico

Global Conference on Big Data for Official Statistics

October 2015, Abu Dhabi, UAE
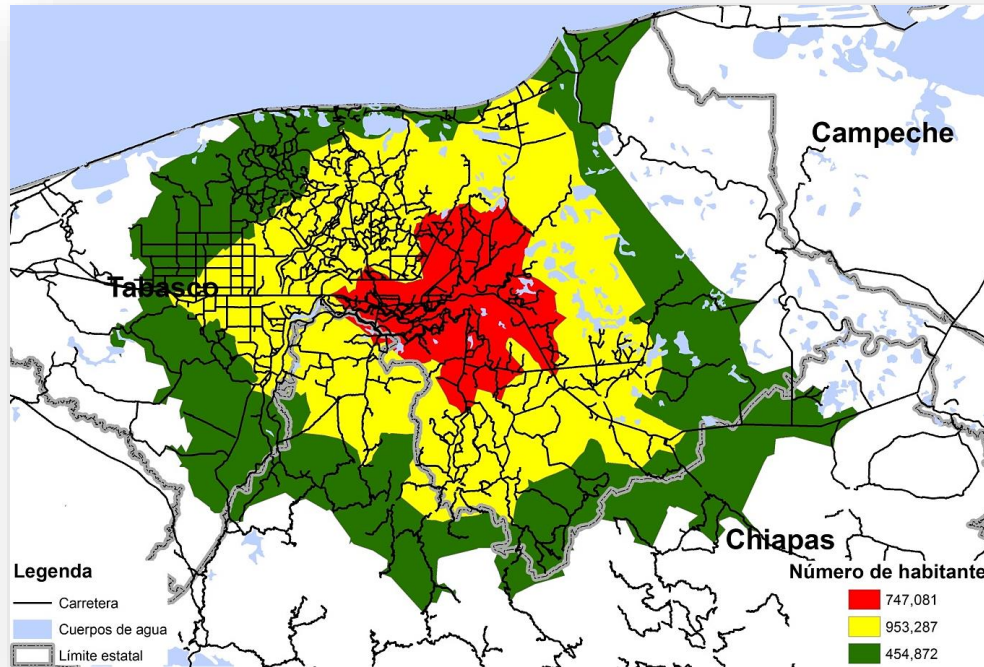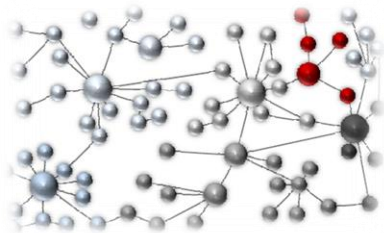
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RURAL-URBAN SYSTEMS

Rural-Urban Systems: Functional Picture of the Territory

| 0-30 min 747,081 inhabitants |
| 30-60 min 953,287 inhabitants |
| 60-90 min 454,874 inhabitants |

Urban-Rural Systems (SUR, in Spanish) are strategic systems that a different geographical levels, make possible the territorial cohesion improving its knowledge and social, economical and natural characterization
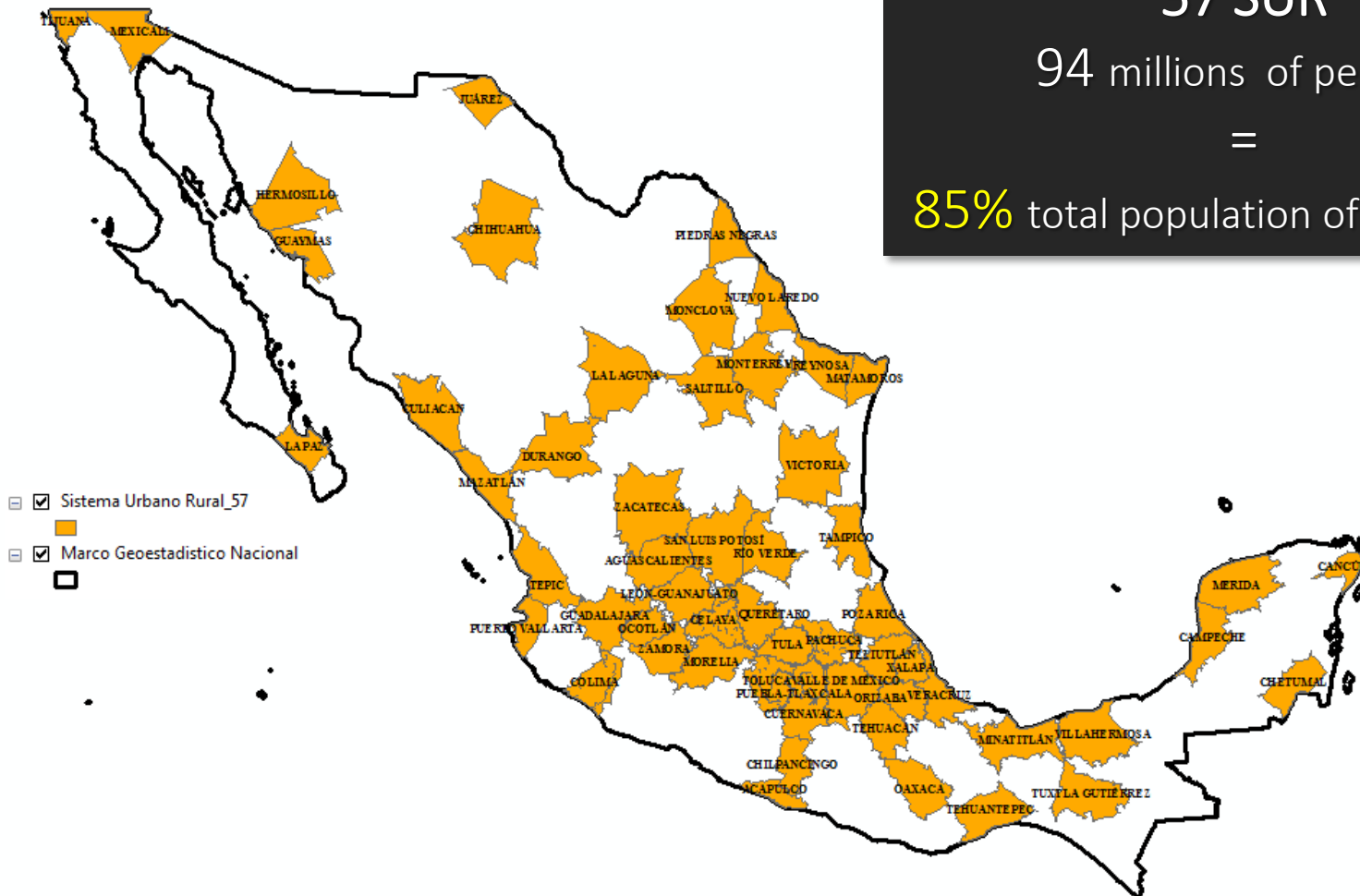
They are territorial areas organized by a schema based on human settlements dynamics and the interrelations between them and the environment

Expected benefits

- Coordination between government agencies and society sectors
- Identification of geographic vocations and potentials
- Promotion of public/private investment to generate local and regional development
- Identification of opportunity areas to improve infrastructure at the regional level
- Promotion of economic development and welfare
- Decreased inequality gaps

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Identification of SUR in Mexico

57 SUR

94 millions of persons

=

85% total population of the country

Legend:
- Sistema Urbano Rural_57
- Marco Geoestadistico Nacional

Map labels:
TIJUANA, MEXICALI, JUÁREZ, HERMOSILLO, GUAYMAS, CHIHUAHUA, PIEDRAS NEGRAS, NUEVO LAREDO, MONCLOVA, LA LAGUNA, MONTERREY, REYNOSA, MATAMOROS, SALTILLO, CULIACAN, LA PAZ, DURANGO, VICTORIA, MAZATLÁN, ZACATECAS, TAMPICO, SAN LUIS POTOSI, RÍO VERDE, AGUASCALIENTES, TEPIC, LEÓN-GUANAJUATO, MERIDA, CANCÚN, GUADALAJARA, OCOTLÁN, CELAYA, QUERÉTARO, POZA RICA, PUERTO VALLARTA, ZAMORA, TULA, PACHUCA, TEZIUTLÁN, CAMPECHE, MORELIA, XALAPA, COLIMA, TOLUCA, VALLE DE MÉXICO, PUEBLA-TLAXCALA, ORIZABA, VERACRUZ, CHETUMAL, CUERNAVACA, TEHUACAN, MINATITLÁN, VILLAHERMOSA, CHILPANCINGO, ACAPULCO, OAXACA, TEHUANTEPEC, TUXTLA GUTIÉRREZ

Urban-Rural Sub-Systems (SSUN)

Are composed of mid-sized cities not included in any SUR which also have influence on other small cities and towns. It's integrated by 134 cities of the National Urban System (SUN). They represent more tan 15 millions of inhabitants.
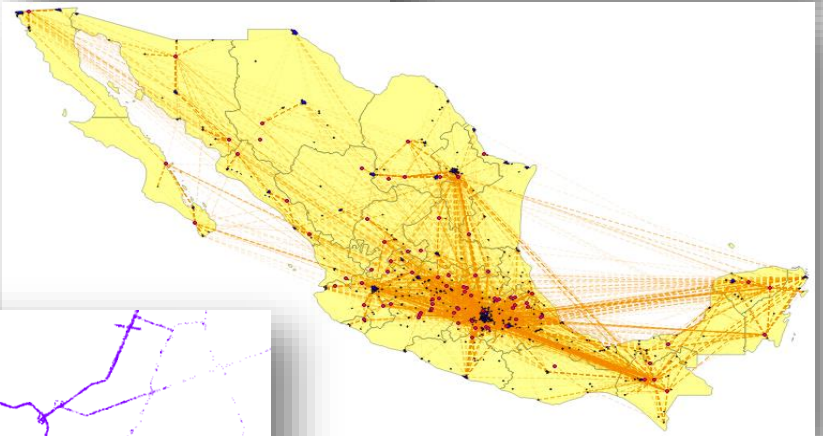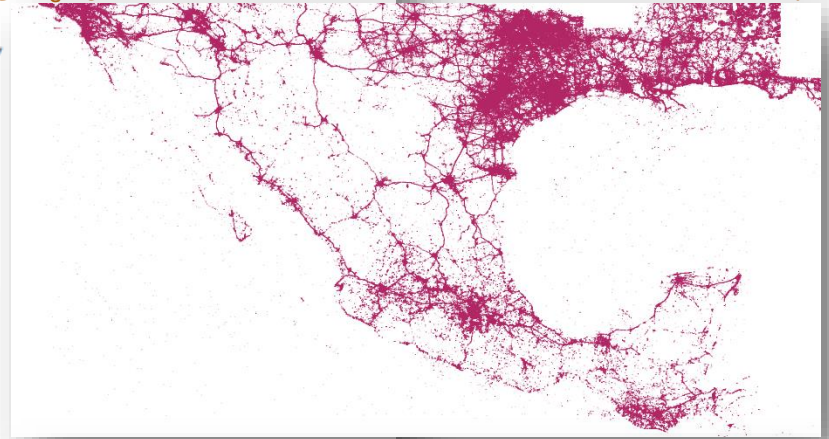
Urban-Rural Sub-System
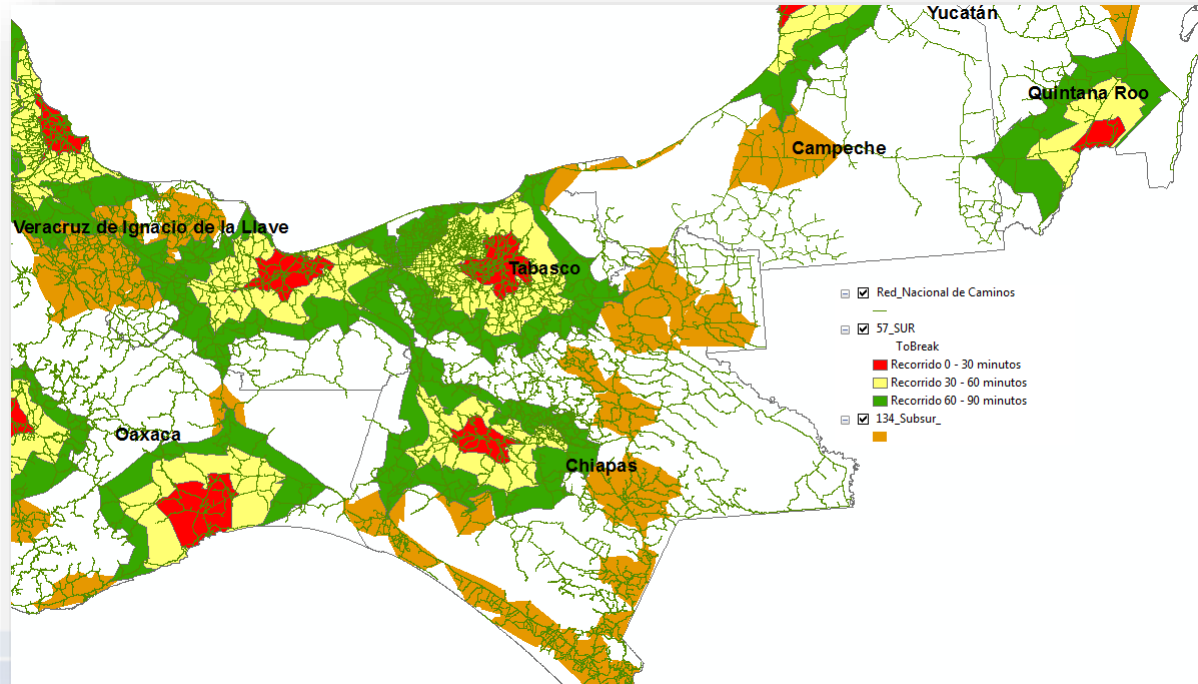
Analysis of origin-destiny mobility from Twitter data

- **Objective:** To make an analysis of the geographic footprints of people users to test the functional dependences between localities at national level.

- Input: Geo-referenced tweets from 2014 to 2015
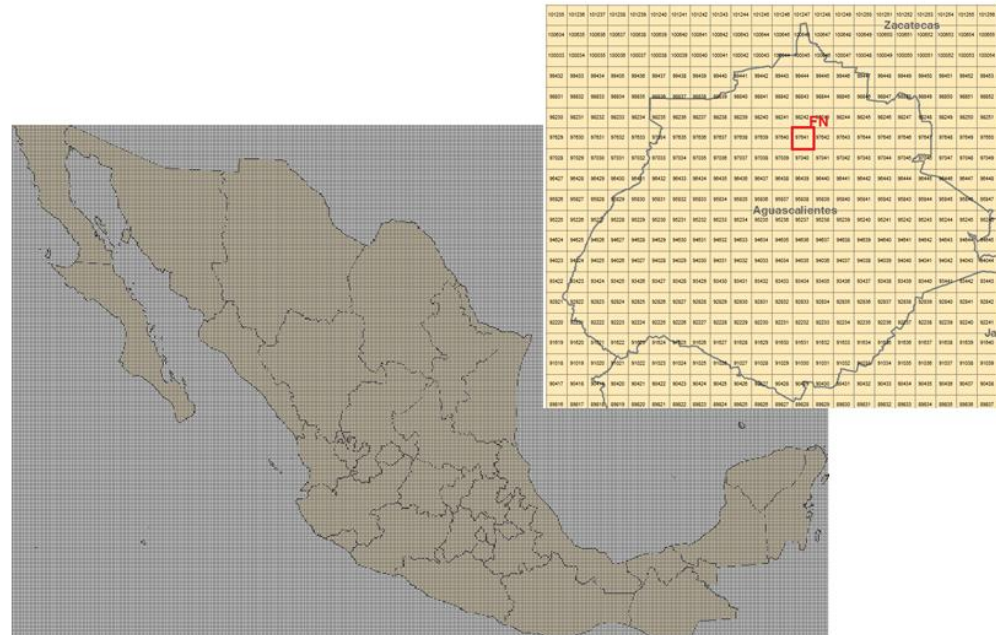
Tweet Structure


```json
{
    "text": "Todo listo para la presentación de #BigData en el @FSLmx",
    "created_at": "2014-02-21T17:00:50.000Z",
    "source": "<a href=\"http://android.com\" rel=\"nofollow\">Android</a>",
    "truncated": false,
    "mention": [],
    "retweet_count": 0,
    "hashtag": [],
    "location": {
        "lat": 19.39617897,
        "lon": -99.22636055
    },
    "place": {
        "id": "3ad512d283f67a11",
        "name": "Aguascalientes",
        "type": "city",
        "full_name": "Aguascalientes, Aguascalientes",
        "street_address": null,
        "country": "México",
        "country_code": "MX",
        "url": "https://api.twitter.com/1.1/geo/id/3ad512d283f67a11.json"
    },
    "link": [
        {
            "url": "http://t.co/AUNXLVSimQ",
            "display_url": "4sq.com/1p1LyUL",
            "expand_url": "http://4sq.com/1p1LyUL",
            "start": 28,
            "end": 50
        }
    ],
    "user": {
        "id": 205760874,
        "name": "Abel Coronado",
        "screen_name": "abxda",
        "location": "",
        "description": "Filósofo,Desarroll                    rendedor,
        "profile_image_url": "http://pbs.t                    e3d1a2895
        "profile_image_url_https": "https:                    5754d65e3
    }
}
```

HISTORIC CLIMATE CHANGE

Background

- The National Institute for Ecology and Climate Change in Mexico (INECC) joint with the Atmosphere Sciences Center took several standard Climate Change Sceneries:
  - CRRMCM5, GFDL_CM3, HADGEM2_ES, MPI_ESM_LR, ENSAMBLE REA
- They made a downsizing on those sceneries to an approximate resolution of 1Km.
  - 2 pathways (RCP): 4.5 and 8.5.
  - Three time scopes: 2015 – 2039, 2045-2069 y 2075 – 2099
  - Four climate monthly variables: (1) Minimum temperature, (2) Maximum temperature, (3) Mean temperature and (4) Precipitation (Rainfall).
- Reference or Base Climate Data
  - Same monthly variables using an 1961 – 2000 average

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Project Objective

- Use of Reference Climate Data to characterize:
  - Watersheds.
    - Estimate present and projected water availability.
  - Soils.
  - Kinds of vegetation
  - Land use
- Apply different scenarios to analyze possible changes for each case.

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Relevance

- Change sceneries imply an increase in vulnerability of the population and ecosystems.

- Increase – decrease in rainfall impacts on water availability.

- Temperate and cold vegetation area decrease (example Conifer forests)

- Vectors for tropical diseases will disperse to new areas – regions.

Initial Inputs

Descarga y procesamiento de escenarios climáticos

		4.5tmax	4.5tmed	4.5tmin	4.5prec	4.5Pcambio	8.5tmax	8.5tmed	8.5tmin	8.5prec	8.5Pcambio
CNRMCM5	2015	X	X	X	X	X	X	X	X	X	X
	2045	X	X	X	X	X	N	N	N	N	N
	2075	X	X	X	X	X	N	N	N	N	N
GFDL	2015	X	X	X	X	X	N	N	N	N	N
	2045	X	X	X	X	X	N	N	N	N	N
	2075	X	X	X	X	X	N	N	N	N	N
HADGEM2	2015	X	X	X	X	X	X	X	X	X	X
	2045	X	X	X	X	X	X	X	X	X	X
	2075	X	X	X	X	X	X	X	X	X	X
MPI	2015	X	X	X	X	X	X	X	X	X	X
	2045	X	X	X	X	X	X	X	X	X	X
	2075	X	X	X	X	X	X	X	X	N	N
REA	2015	X	X	X	X	X	X	X	X	X	X
	2045	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2075	X	X	X	X	X	X	X	X	X	X

5 Models - Sceneries
2 Pathways (RCP): 4.5 and 8.5
4 Variables + % Change in Precipitation
3 Periods (Short, Medium and long term)
12 months/variable

1800 raster files (32 million of pixels per file, 250mx250m each pixel)
Reference climate: 4 variables x 12 months
Variables: Annual temperatures (max, med, min), Total Annual Rainfall, Others: % Winter, summer rain, etc.

Methods and Tools

- Re-projection and resampling of raster data to 250 m resolution.
- Multiple processes and statistical and spatial analysis.
    - Derived data: averages, ratios, indexes.
    - Use of ancillary data: ie. Digital Elevation Mo
    - Statistics for:
        - Climate types.
        - Plant formations and vegetation types
        - Watersheds
    - Modelling, classification.
        - Decision trees
        - Maximum likelihood
        - Spatial Interpolation
- Free, Open Software
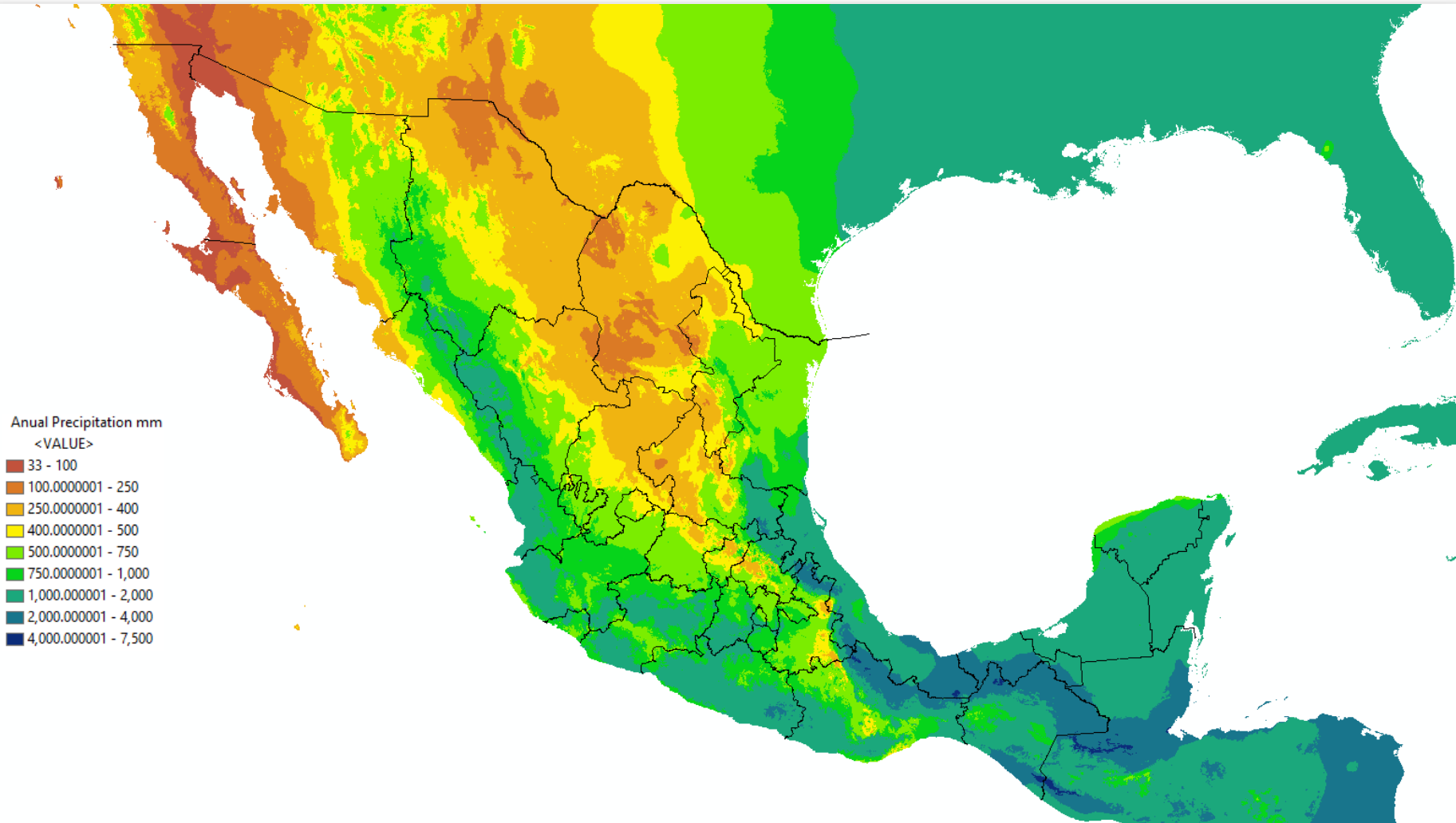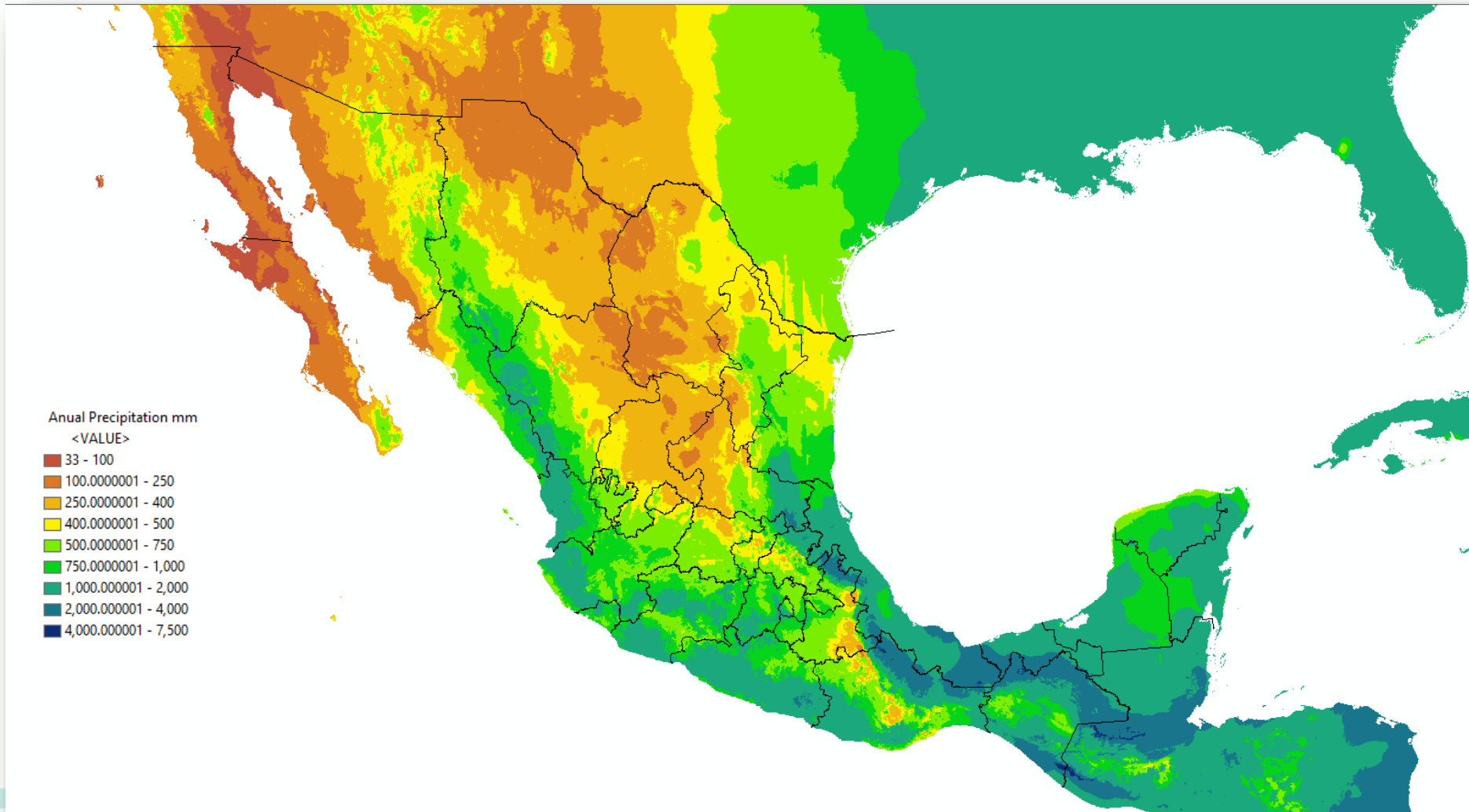   - R, GDAL, Quantum GIS

Anticipated Challenges

- Varied sources and types of data.
- Variability of outcomes in Climate Change Sceneries.
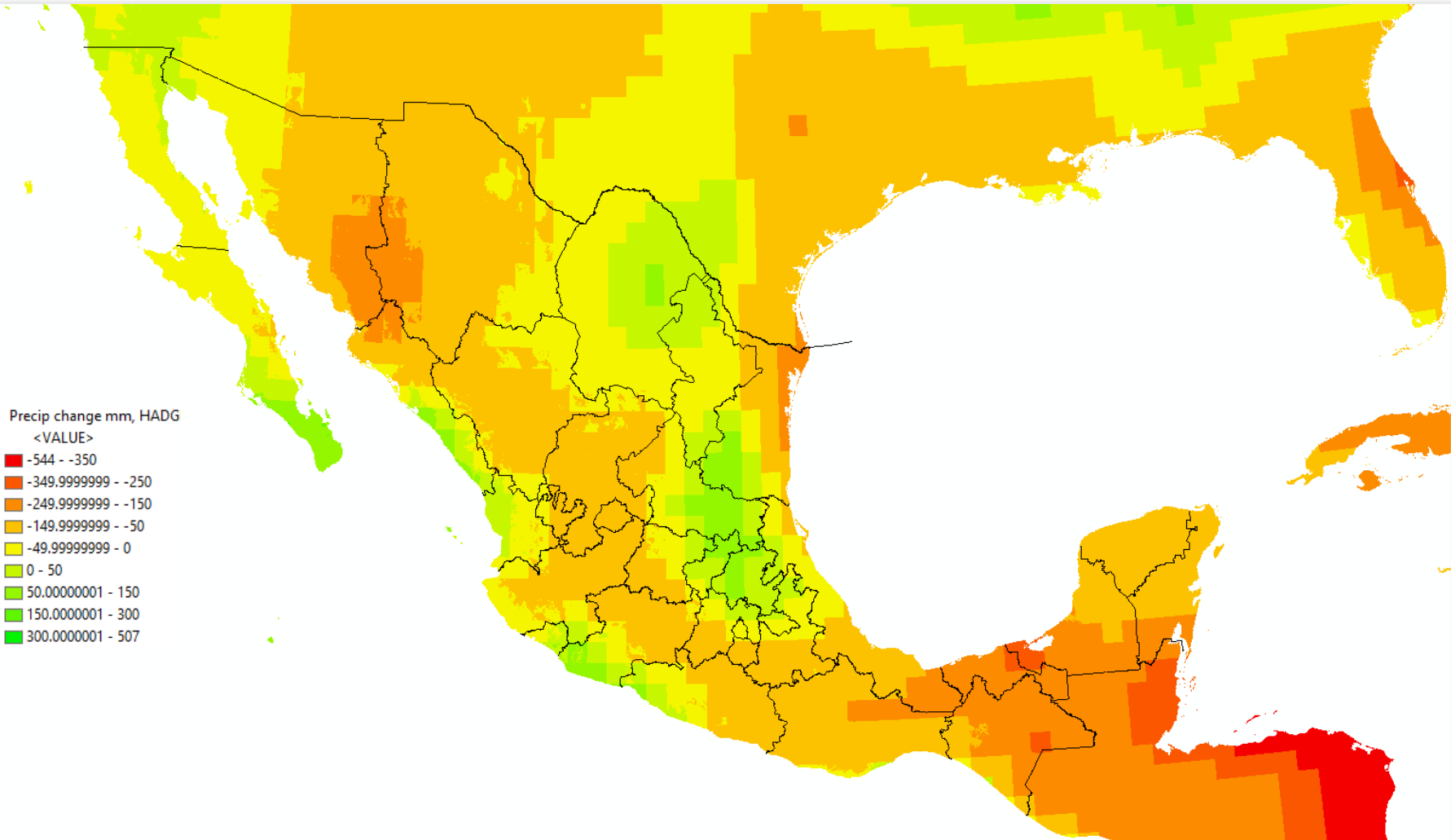- Complexity in analysis.
- Training.

Annual Precipitation (average 1961-2000)

Anual Precipitation mm
<VALUE>
- 33 - 100
- 100.0000001 - 250
- 250.0000001 - 400
- 400.0000001 - 500
- 500.0000001 - 750
- 750.0000001 - 1,000
- 1,000.000001 - 2,000
- 2,000.000001 - 4,000
- 4,000.000001 - 7,500

HADGEM2 RCP85. 2075-2099. Precipitation (mm).

Anual Precipitation mm
<VALUE>
- 33 - 100
- 100.0000001 - 250
- 250.0000001 - 400
- 400.0000001 - 500
- 500.0000001 - 750
- 750.0000001 - 1,000
- 1,000.000001 - 2,000
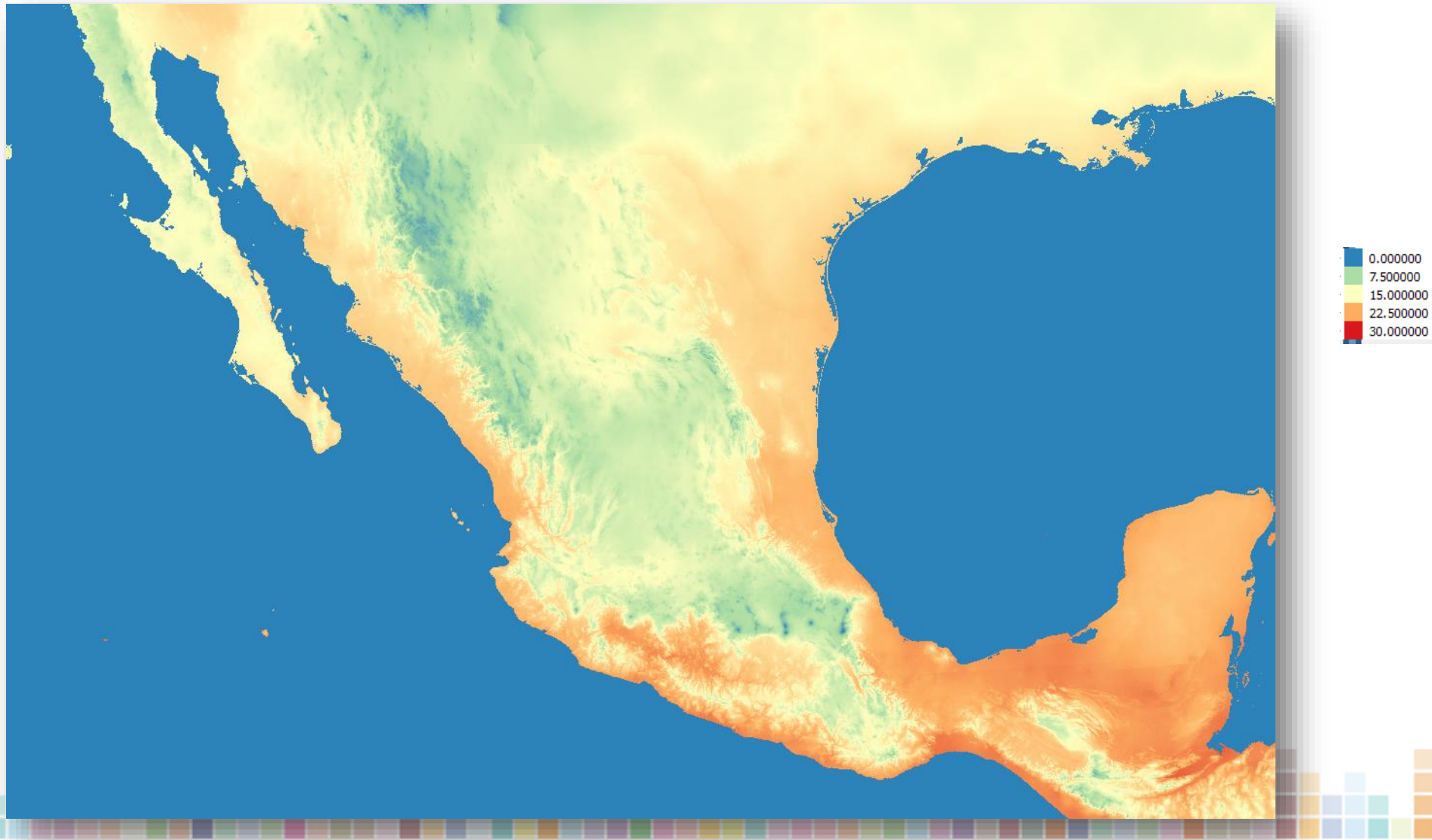- 2,000.000001 - 4,000
- 4,000.000001 - 7,500

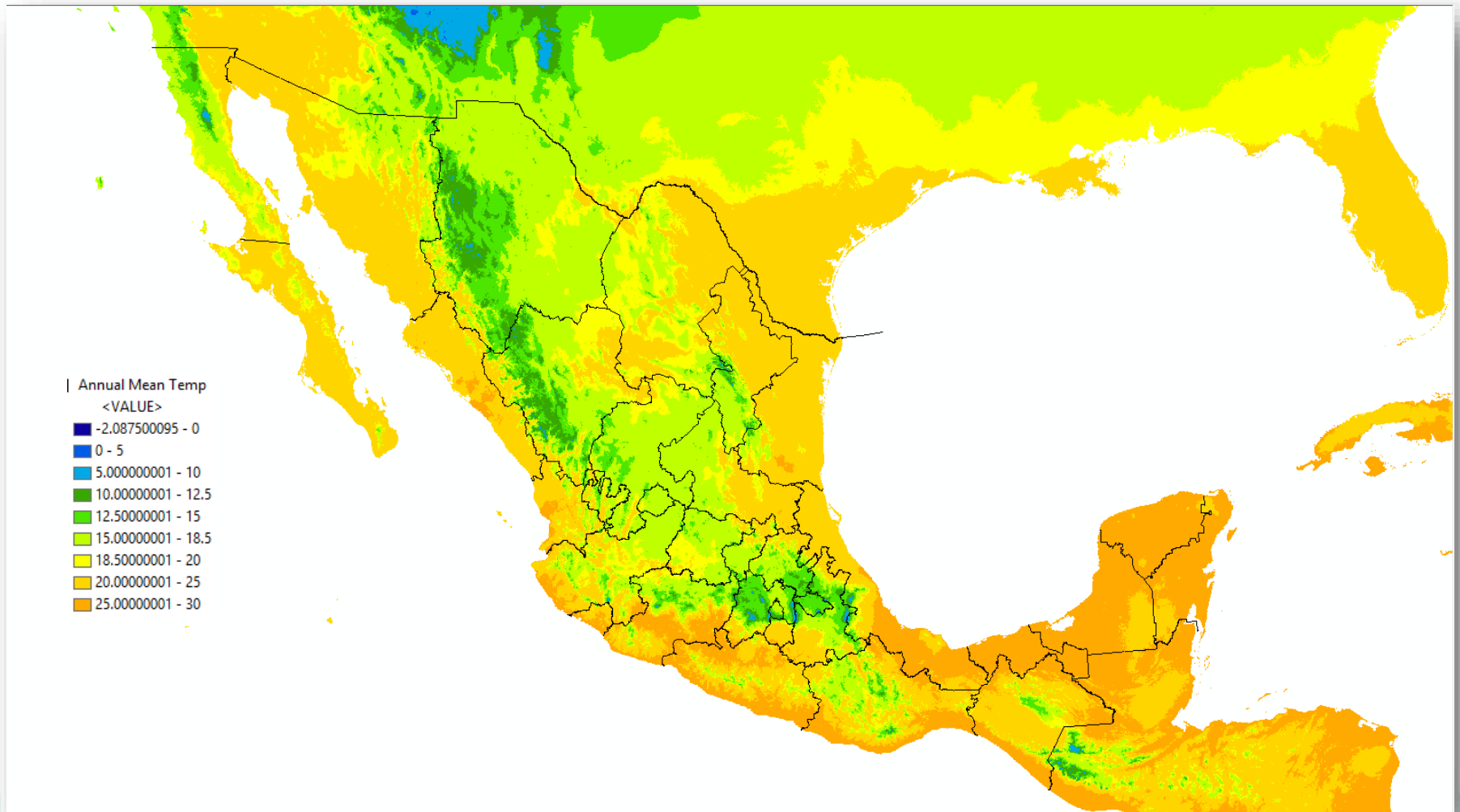# Change in rainfall (mm) HADGEM2 RCP85. 2075-2099 VS 1961-2000 AVERAGE (mm).

Minimum Annual Temperature (mean1961-2000)
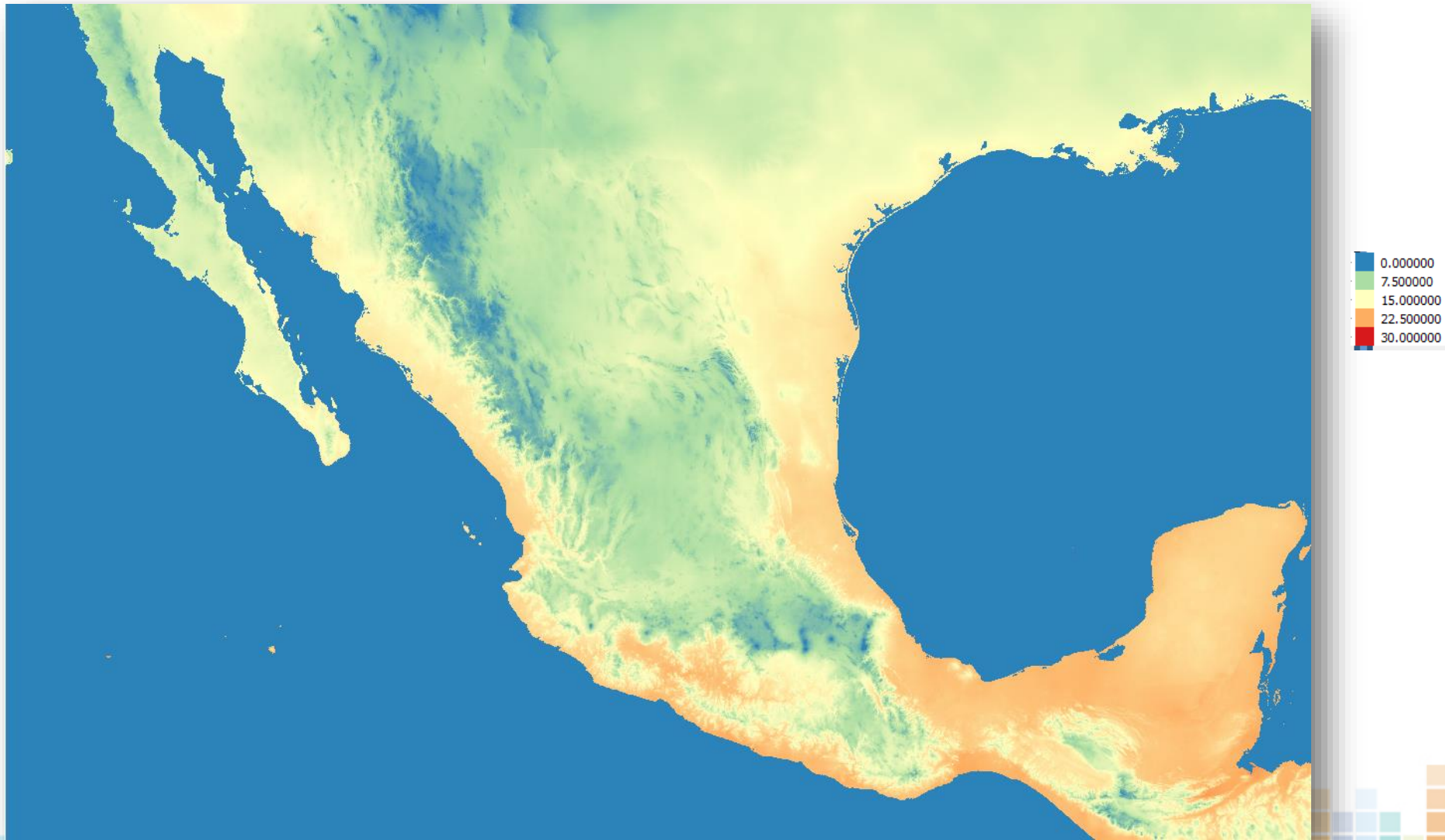
MPI-ESM-LR Model. RCP85.
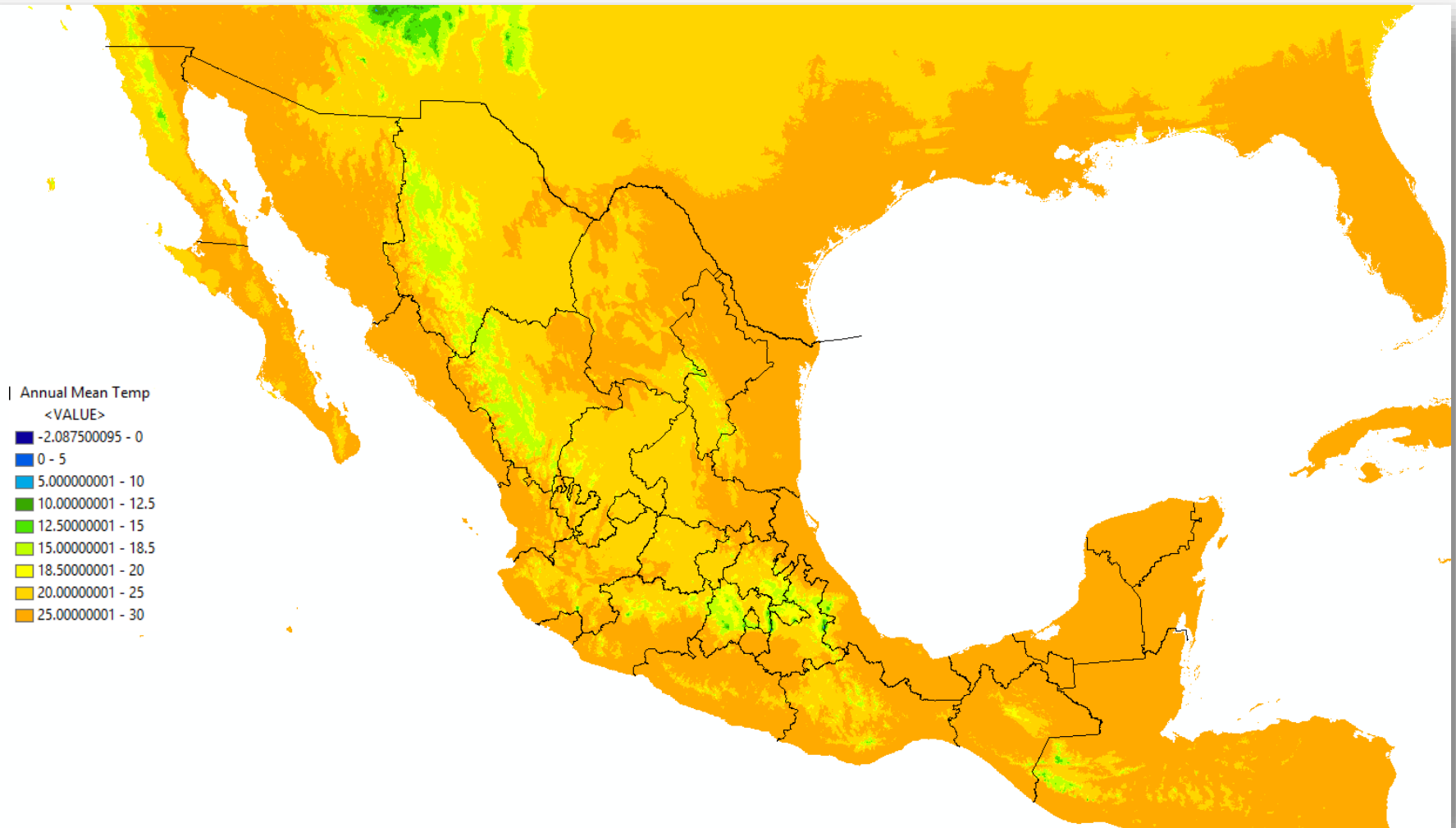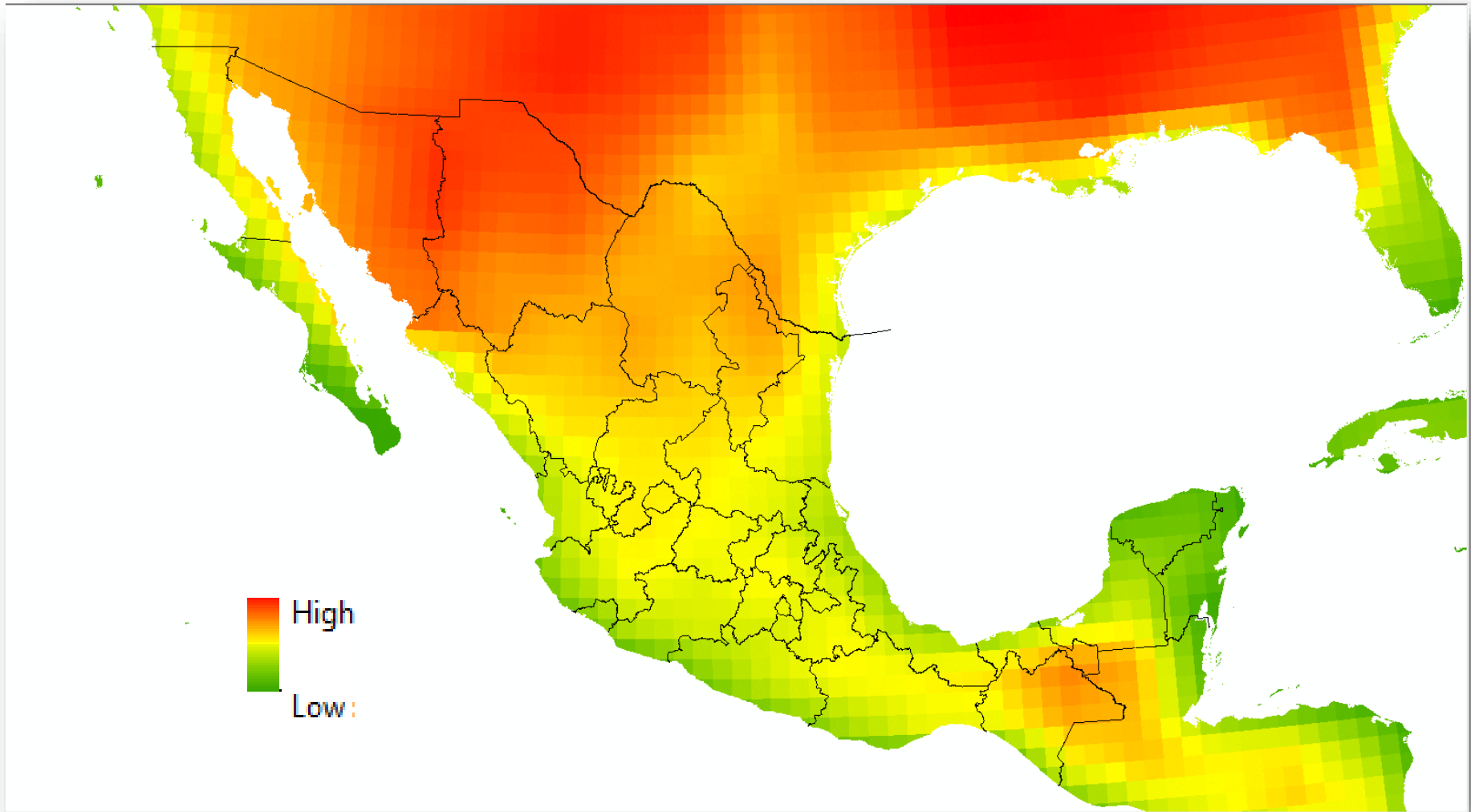# Projection 2075-2099. Minimum Annual Temperature

	0.000000
	7.500000
	15.000000
	22.500000
	30.000000

Annual Mean Temperature (1961-2000)

HADGEM RCP85. 2075-2099.
Annual Mean Temperature

Annual Mean Temp
<VALUE>
- ■ -2.087500095 - 0
- ■ 0 - 5
- ■ 5.000000001 - 10
- ■ 10.00000001 - 12.5
- ■ 12.50000001 - 15
- ■ 15.00000001 - 18.5
- ■ 18.50000001 - 20
- ■ 20.00000001 - 25
- ■ 25.00000001 - 30

Change in Annual Mean Temperature, HADGEM 8.5 2075 vs 1961 - 2000

Expected results; Statistical and Geospatial Data

- Potential climate type distribution.
  - Area covered by each climate type
  - Temperature and rainfall statistics (annual, monthly), indexes, etc.
- Vegetation Distribution Sceneries.
  - Area covered by vegetation type, plant formation.
  - Some possible outcomes:
  - Examples: Decrease in conifer forests, increase in tropical forests and desert scrubland.
- Watersheds: water availability sceneries and other water statistics.

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