Ministry of Environment, Water and Forests
NATIONAL METEOROLOGICAL ADMINISTRATION

# *The Romanian agrometeorological services and products – current status and challenges in the context of climate change*


***Elena MATEESCU***
***National Meteorological Administration of Romania***


***WORKSHOP***
***Agrometeorologists for farmers in hotter, drier, wetter future***
***9-10 November 2016***
***Ljubljana, SLOVENIA***

***OUTLINE***

***1. Current and future climate changes***

***2.The National Meteorological Administration – the development of observation network infrastructure***

***3. Research project results:***

***3.1. National drought risk assessment / RO-RISK Project***
***3.2 Innovative Remote and Ground Sensors, Data and Tools into a decision support system for agriculture water management / IRIDA Project***

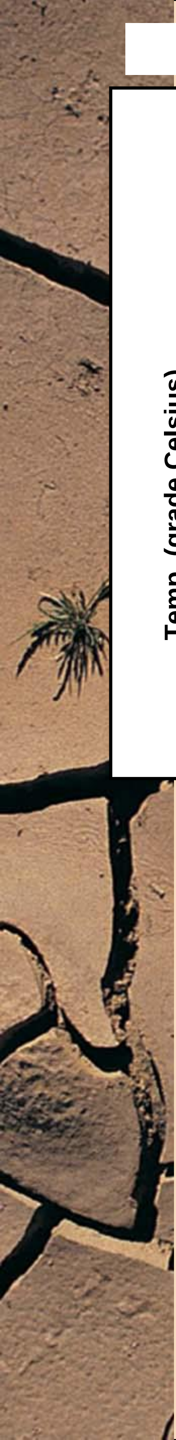
***Climate change is likely to shift the patterns of droughts and possibly increase the frequency and severity of extreme drought conditions in Romania.***

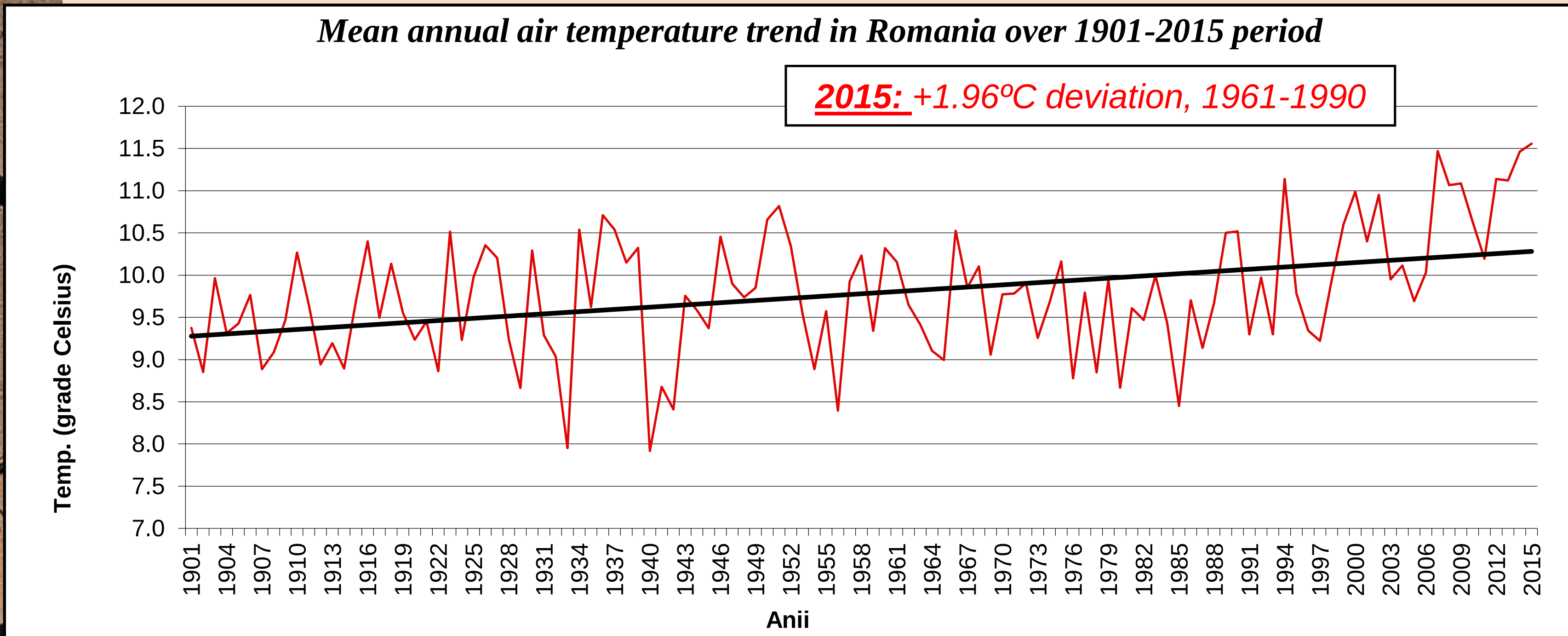
## REASON FOR CONCERNS???

## CLIMATIC CONDITION IN ROMANIA IN THE CONTEXT OF CC

- In Romania, the mean annual air temperature rose by 0,6°C in the last 100 years. The evolution by decades of the mean multiannual air temperature over the 1901-2015 period show that the increasing trend is obvious especially beginning with 1991, 2015 being the warmest year of the records.
- As regards precipitation, the 1901-2015 period highlighted a general decreasing trend in the annual precipitation amounts especially in the last 30 years and a parallel enhance of the precipitation deficit in the South, South-East and East of the country.
- Since 1901 until now, Romania has seen in every decade one to four extremely droughty/rainy years, an increasing number of droughts being more and more apparent especially after 1991.

**_OBSERVED SHIFTS IN THE COURSE OF THE MEAN ANNUAL AIR TEMPERATURE IN ROMANIA_**






*1961-1990 / 8.8ºC*
*1981-2010 / 9.3ºC*
***+0.5ºC***

*SUMMER*
***1961-1990: 18.5°C***
***1981-2010: 19.5°C, +1°C***

***1. 2012: 21.8°C, +2.4°C***
***2. 2007: 21.8°C +2.1°C***
***3. 2003 si 2015: 20.8°C, +1.3°C***

*ROMANIA*
*The warmest 16 years:*
***2015, 2007, 2014, 1994, 2012, 2013, 2009, 2008, 2000, 2002, 2010, 2001, 2011, 2004, 2006, 2003, 2005.***

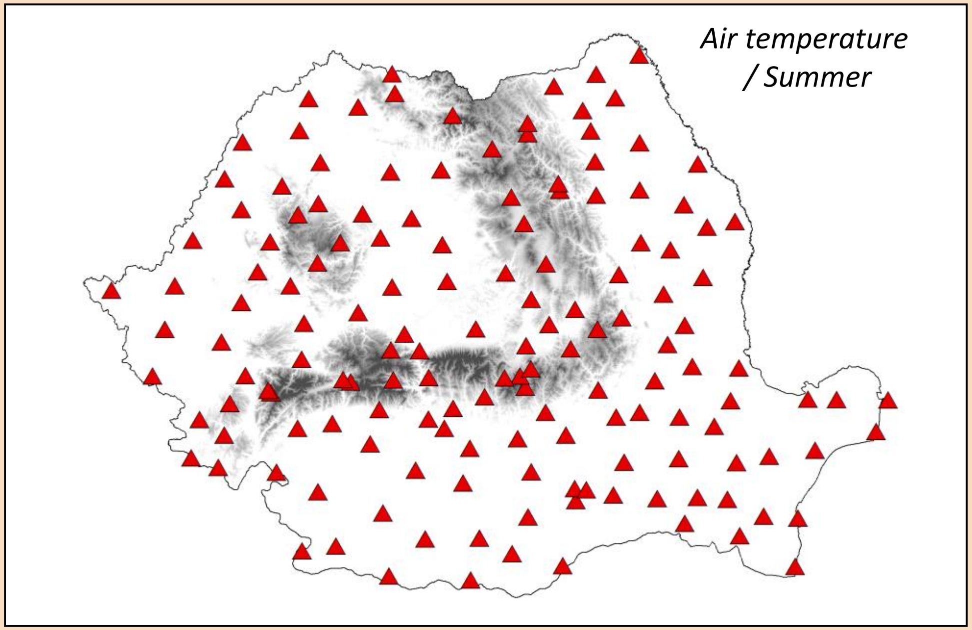
## *The warmest years in Romania*

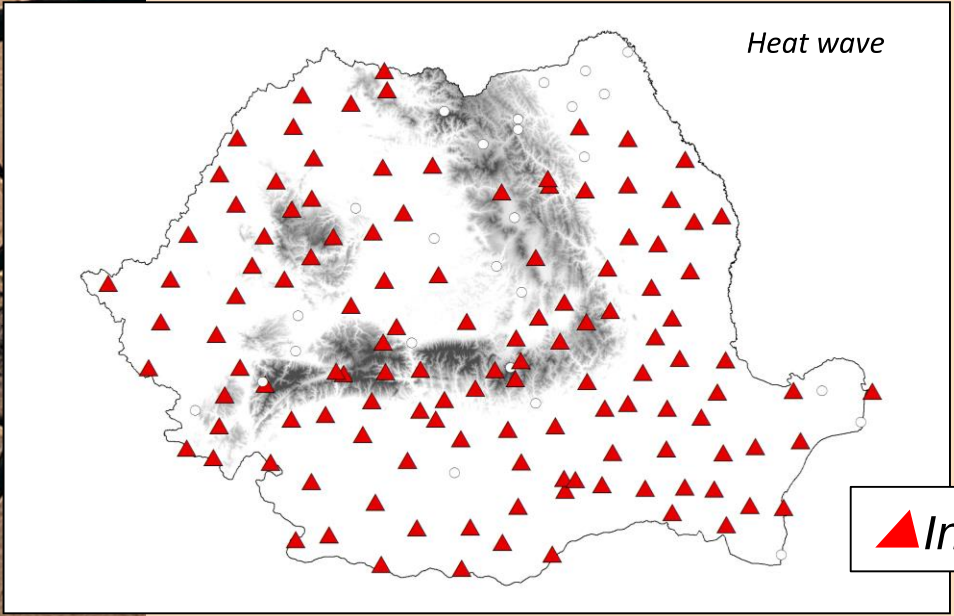
| The warmest years / 1901-2015 | | |
|---|---|---|
| | **Annual air temperature** | **Deviation** |
| **1. 2015** | **11.6°C** | **1.9600°C** |
| **2. 2007** | **11.5°C** | **1.8743°C** |
| **3. 2014** | **11.5°C** | **1.8644°C** |
| **4. 1994** | **11.1°C** | **1.5415°C** |
| **5. 2012** | **11.1°C** | **1.5413°C** |
| **6. 2013** | **11.1°C** | **1.5243°C** |
| **7. 2009** | **11.1°C** | **1.4874°C** |
| **8. 2008** | **11.1°C** | **1.4671°C** |
| **9. 2000** | **11.0°C** | **1.3920°C** |
| **10. 2002** | **11.0°C** | **1.3528°C** |

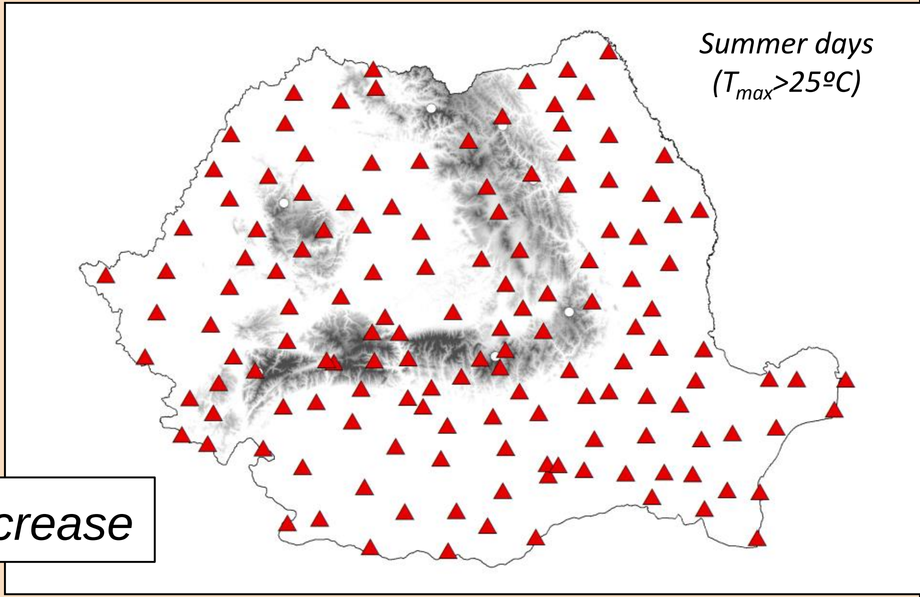
**The warmest 16 years in the range 2000-2015 period, except 1994: 2015, 2007, 2014, 1994, 2012, 2013, 2009, 2008, 2000, 2002, 2010, 2001, 2011, 2004, 2006, 2003, 2005**

***44.3℃ / 24.07.2007 in Calafat – absolute maximum monthly air temperature***

# *Air temperature trend in Romania / 1961-2015*

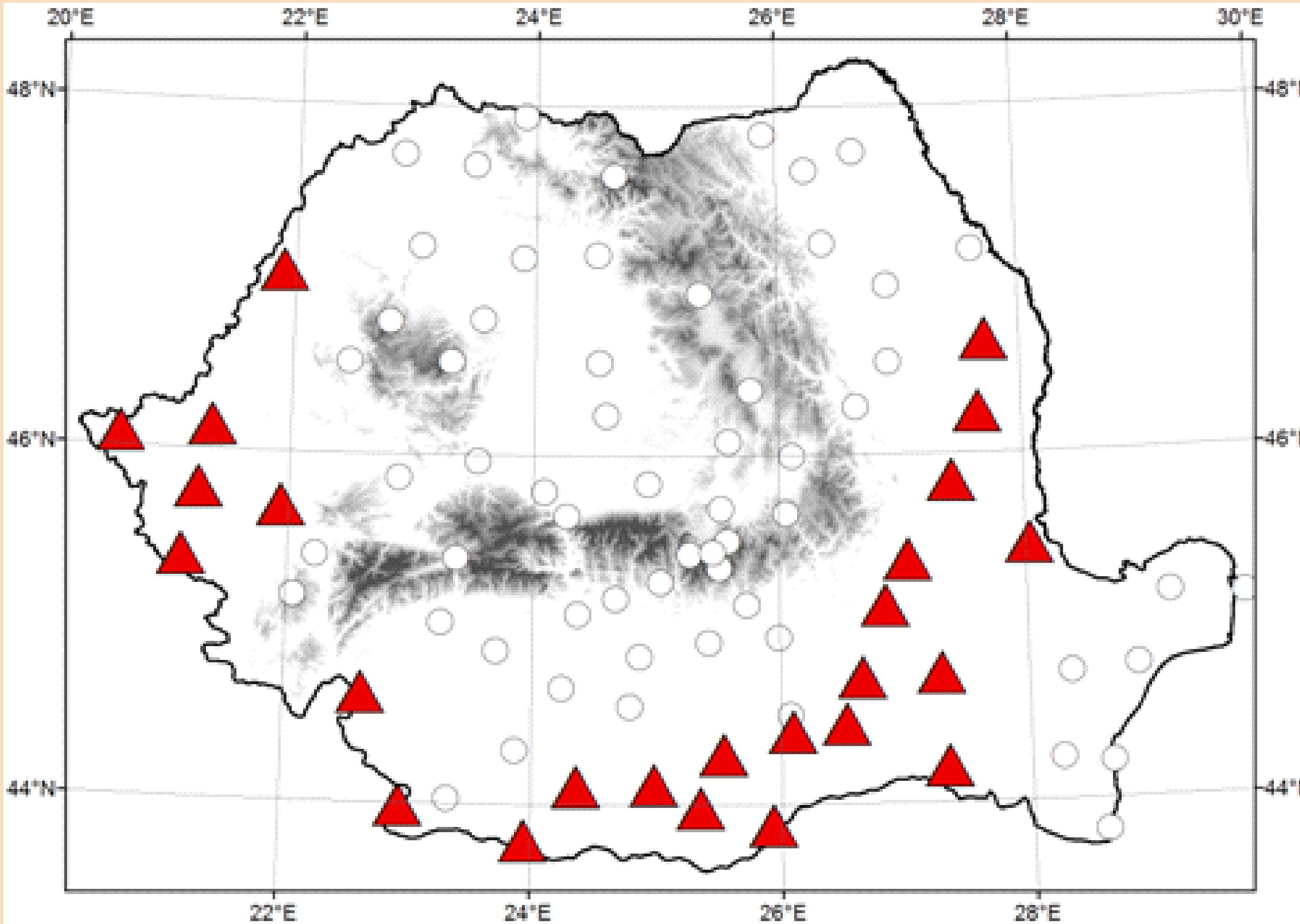



Increase

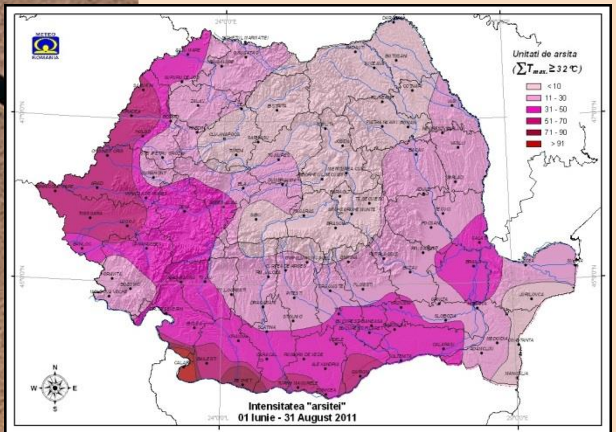
***Heat wave trend in Romania***
***(2 days consecutive with Tmax ≥37ºC)***



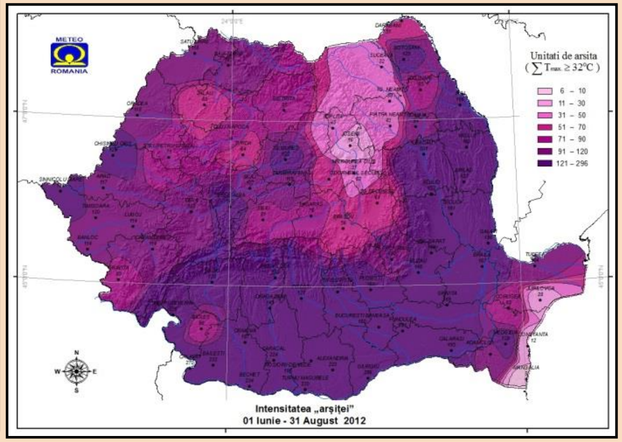

▲ *Increase*

# *Intensity of scorching heat in the summer season*

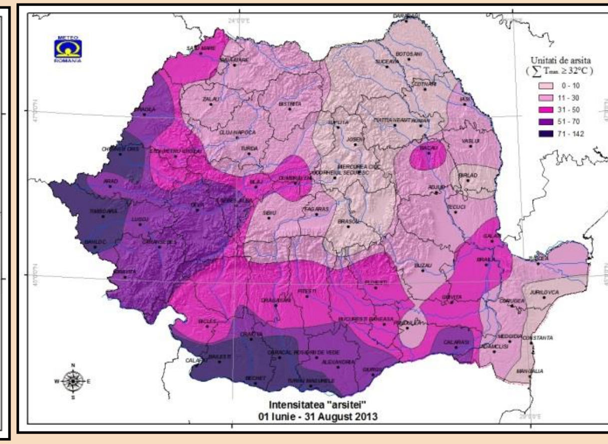
**2011**



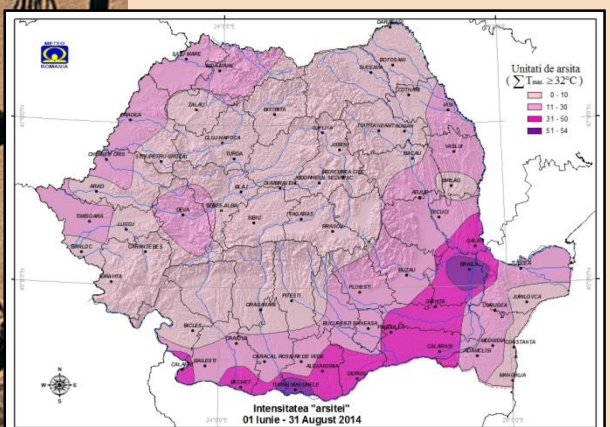

**2012**



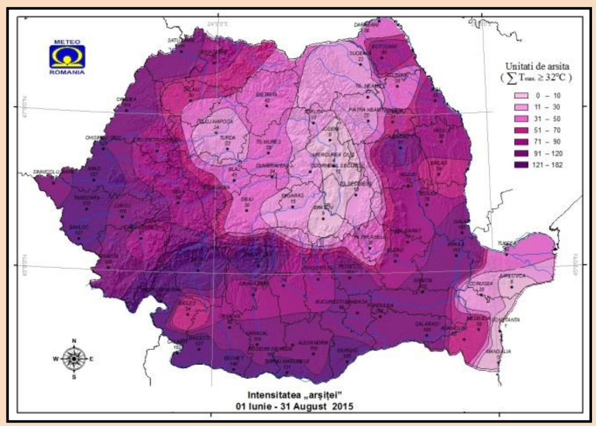

**2013**



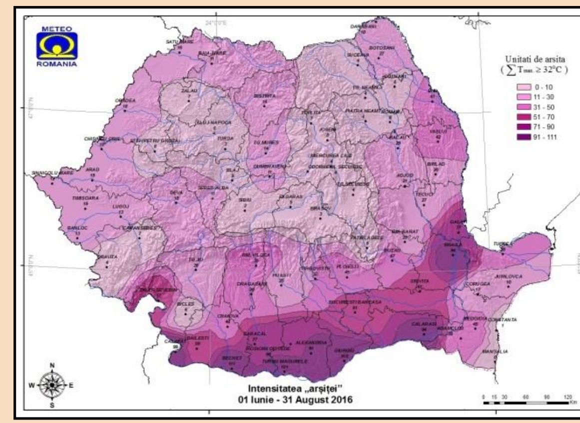

**2014**




**2015**




**2016**

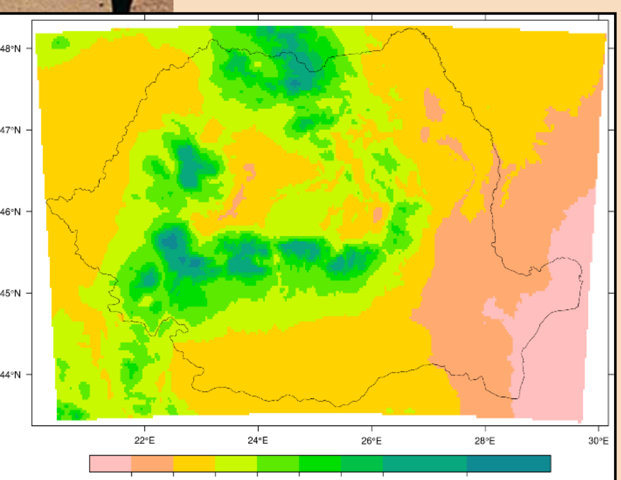



| | Units of scorching heat (∑Tmax≥32°C, VI-VIII) |
|---|---|
| 1961-1990 | 13 |
| 1971-2000 | 18 |
| 1981-2010 | 28 |

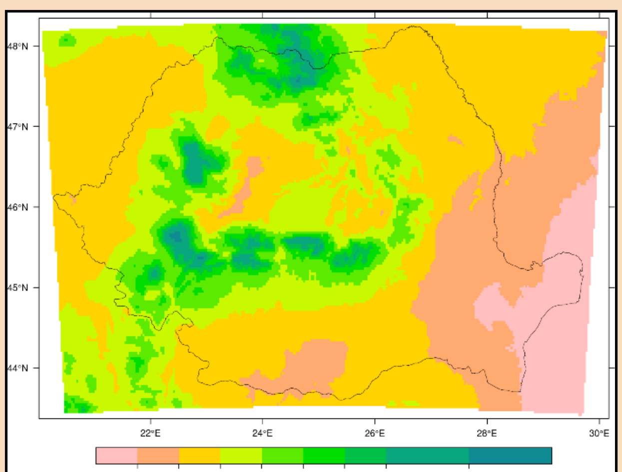
# *Annual rainfall / agricultural region – decreasing tendency*

| | 1961-1990 | 1981-2010 | |
|---|---|---|---|
| Dobrogea | 417.0 mm | 412.0 mm | ↓ |
| Moldova | 576.7 mm | 575.9 mm | ↓ |
| Muntenia | 598.2 mm | 575.7 mm | ↓ |
| Oltenia | 673.4 mm | 645.8 mm | ↓ |
| Crisana | 669.3 mm | 668.4 mm | ↓ |
| Transilvania | 681.5 mm | 680.0 mm | ↓ |
| Banat | 753.2 mm | 737.8 mm | ↓ |
| Maramures | 799.2 mm | 829.1 mm | ↑ |

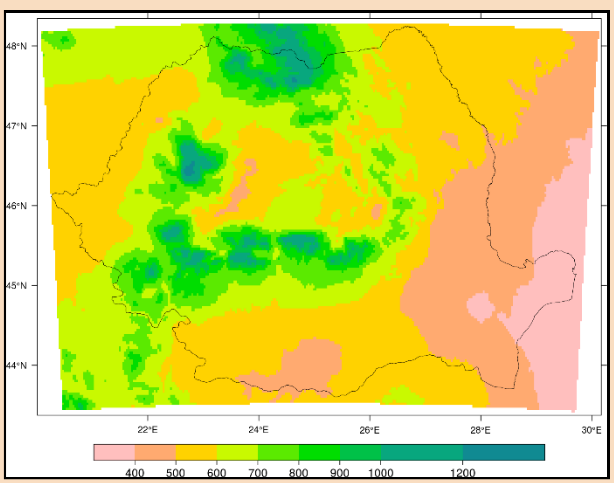
*1961-1990*




*1971-2000*




*1981-2010*



## *Droughty/rainy years in Romania /1901-2020*

| DECADE | XX-TH CENTURY | |
|---|---|---|
| | EXTREMELY DROUGHTY YEARS | EXTREMELY RAINY YEARS |
| 1901-1910 | 1907-1908 | 1910 |
| 1911-1920 | 1917-1918 | **1911, 1912, 1915, 1919** |
| 1921-1930 | 1923-1924, 1927-1928 | 1929 |
| 1931-1940 | 1934-1935 | 1937, 1939, 1940 |
| 1941-1950 | **1945-1946**, **1947-1948, 1949-1950** | 1941, 1944, 1947 |
| 1951-1960 | 1952-1953 | **1954, 1955, 1957, 1960** |
| 1961-1970 | 1962-1963, 1964-1965 | 1969, 1970 |
| 1971-1980 | 1973-1974, 1975-1976 | **1972, 1974, 1975, 1976** |
| 1981-1990 | **1982-1983, 1985-1986, 1987-1988** | 1981, 1990 |
| 1991-2000 | **1992-1993, 1997-1998, 1999-2000** | 1991, 1997 |
| | **XXI-ST CENTURY** | |
| 2001-2010 | **2000-2001, 2001-2002, 2002-2003, 2006-2007, 2008-2009** | **2005, 2006, 2008, 2010** |
| 2011-2020 | **2011-2012, 2014-2015, July-September 2016, …..** | |

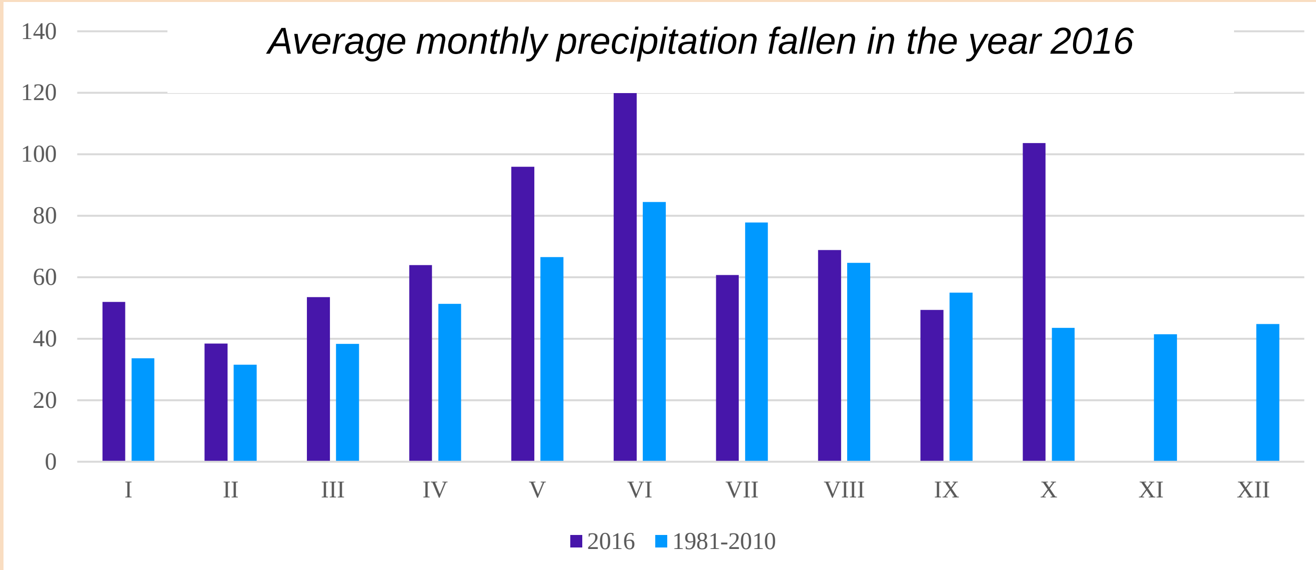
***Since 1901 until now, Romania has seen in every decade one to four extremely droughty/rainy years, an increasing number of droughts being more and more apparent after 1981***

*Mean air temperature / January –September 2016*

| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2016 | -0.9 | 5.7 | 1.7 | 2.7 | -1.2 | 1.4 | 0.8 | 0.2 | 1.5 | | | |
| 2015 | 1.6 | 1.1 | 0.9 | -0.5 | 0.6 | 0.3 | 2.0 | 1.9 | 2.6 | -0.5 | 2.4 | 2.9 |
| 2007 | 5.2 | 3.2 | 2.7 | 0.7 | 2.0 | 2.4 | 2.8 | 1.3 | -0.9 | 0.1 | -1.4 | -0.7 |
| 2014 | 2.3 | 2.9 | 3.5 | 0.6 | -0.7 | -0.8 | 0.0 | 0.3 | 0.7 | 0.5 | 1.1 | 1.6 |
| 1994 | 3.5 | 1.3 | 2.3 | 1.2 | 0.2 | -0.2 | 0.9 | 0.7 | 4.2 | -0.3 | -0.1 | 0.5 |
| 2012 | -0.4 | -5.7 | 0.2 | 1.8 | 0.6 | 2.2 | 3.5 | 1.7 | 2.7 | 1.9 | 2.2 | -1.3 |

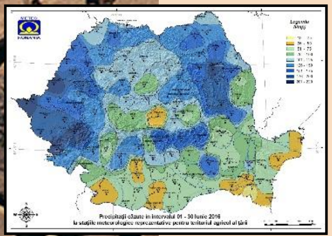
| | **Mean air temperature / the first 9 months of the 2016 year / deviation of 1981-2010 period** |
|---|---|
| **2007** | **2.10°C** |
| **1994** | **1.51°C** |
| **2016** | **1.27°C** |
| **2015** | **1.12°C** |
| **2014** | **0.92°C** |
| **2012** | **0.68°C** |

# *Monthly rainfall - 2016*

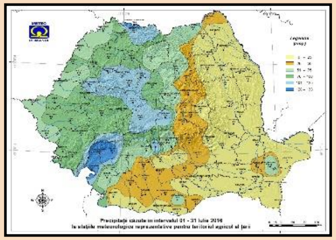



| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1981-2010** | 33.6 | 31.6 | 38.3 | 51.3 | 66.5 | 84.5 | 77.8 | 64.7 | 55.0 | 43.5 | 41.5 | 44.8 |
| **2016** | 52.0 | 38.4 | 53.5 | 64 | 95.9 | 128.3 | 60.7 | 68.8 | 49.4 | 103.6 | | |

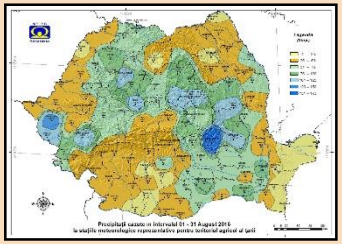
*June 2016*



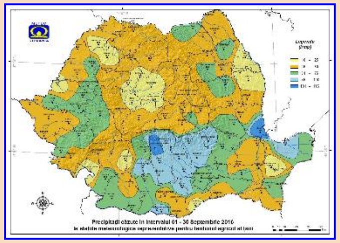
*July 2016*



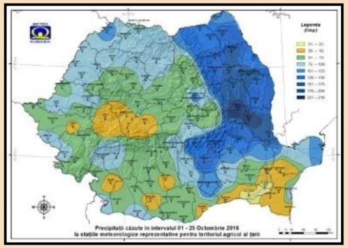
*August 2016*



*September 2016*



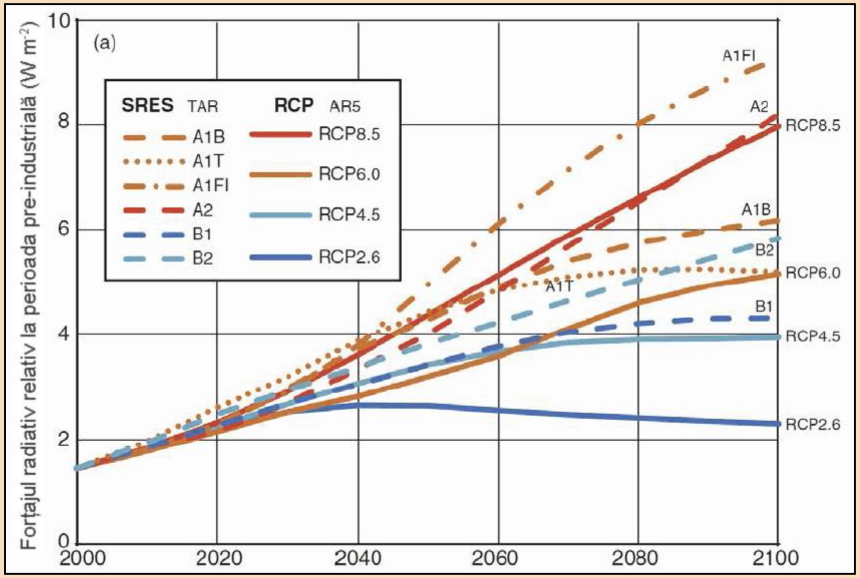
*October 2016*



# Data: EuroCORDEX numerical experiments

| Nr. | Centrul de modelare climatică regională/Regional modeling center | Model regional/ Regional model | Model global/Global model |
| --- | --- | --- | --- |
| 1 | CLMcom (Consorţiul CLMcom) | CCLM4-8-17 | MPI-ESM-LR |
| 3 | IPSL-INERIS (Laboratorul de Stiinţa Climei şi Mediului, IPSL, CEA/CNRS/UVSQ – Institutul Naţional al Mediului Industrial şi la Riscurilor, Halatte, Franţa) | WRF331F | IPSL-CM5A-MR |
| 4 | KNMI (Institutul Regal Olandez de Meteorologie) | RACMO22E | ICHEC-EC-EARTH |
| 6 | SMHI (Institutul Hidrometeorologic Suedez) | RCA4 | ICHEC-EC-EARTH |

## *Scenarios*

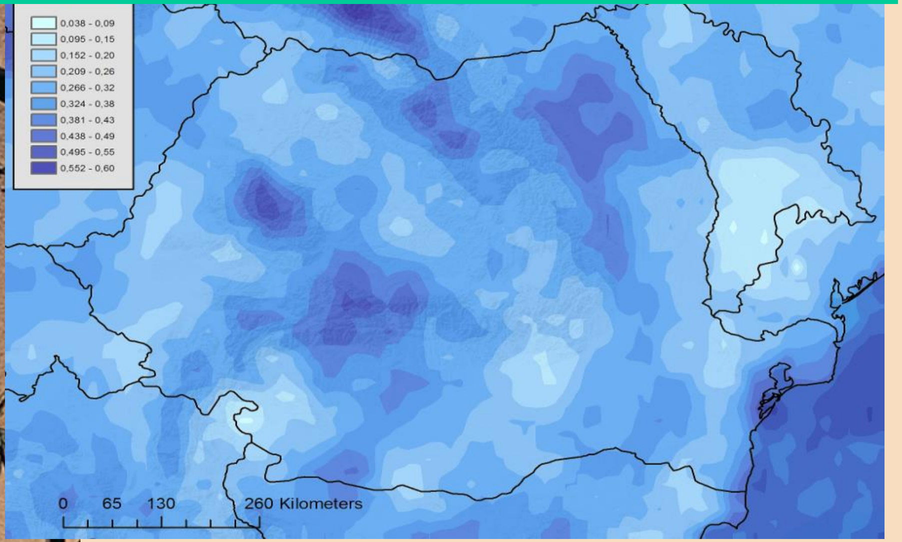



*Source: WG 1 AR5 IPCC*

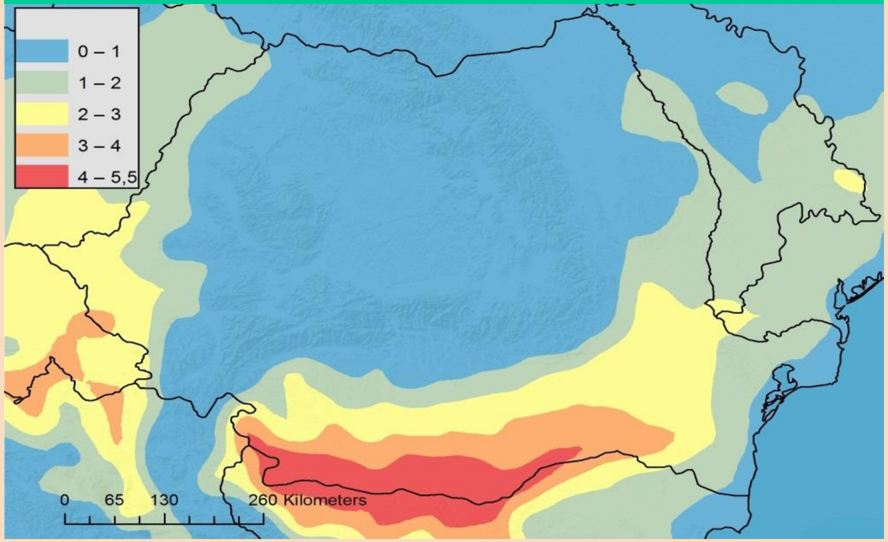
*Scenarios RCP 2.6, RCP 4.5 and RCP 8.5.*
*Spatial resolution of EuroCORDEX models is 0.125 deg. in latitude and longitude.*

# *CLIMATE CHANGES / 2021-2050 vs. 1971-2000*

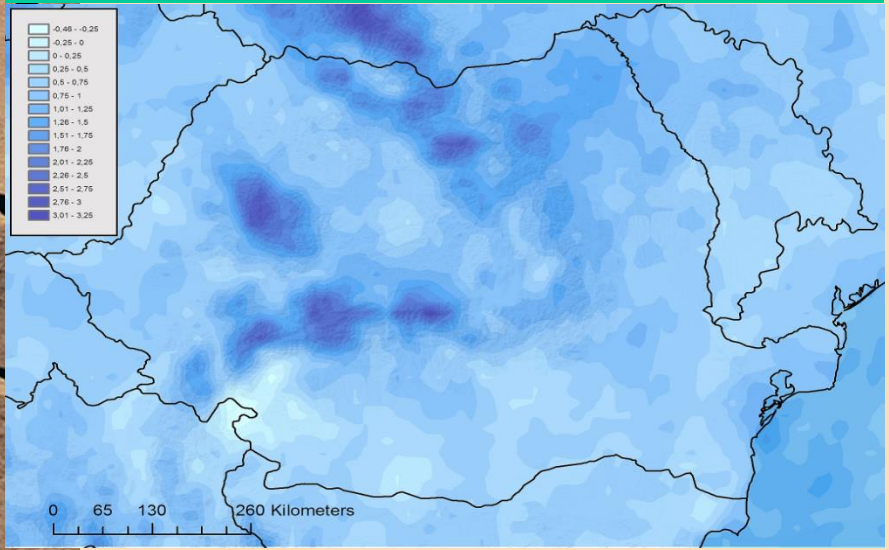
***Mean difference of 4-models ensemble for daily precipitation intensity (mm)***
*2021-2050 vs. 1971-2000*



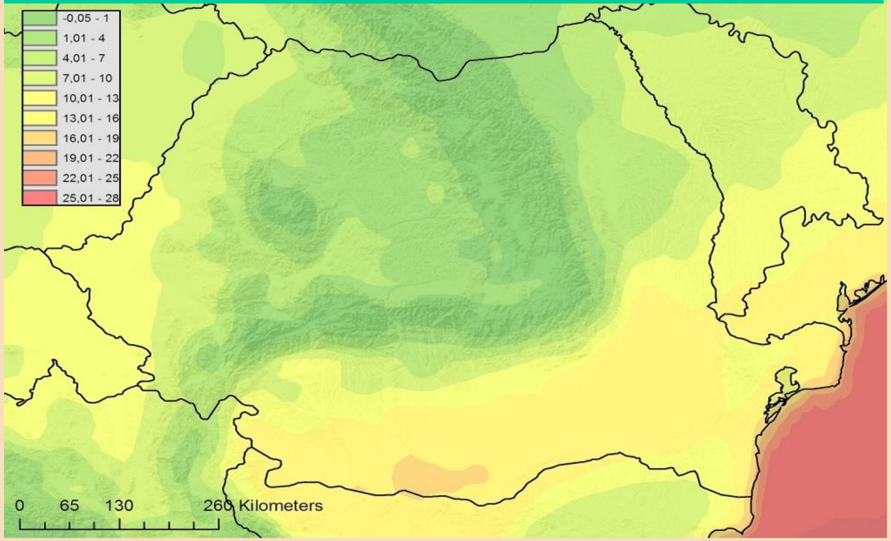

***Mean difference of 4-models ensemble for number of days with T. max greater than 35 deg.C***
*2021-2050 vs. 1971-2000*



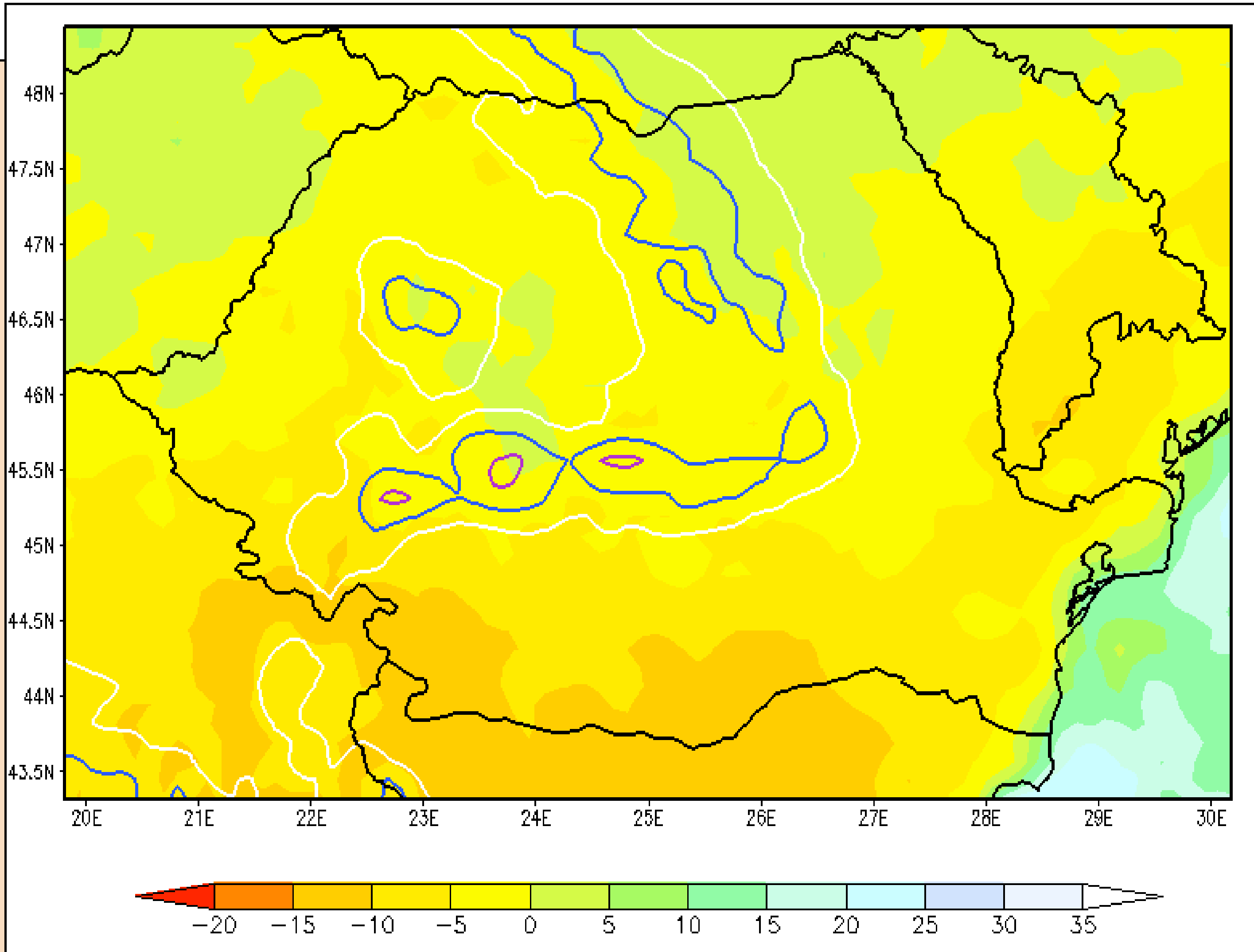

***Mean difference of 4-models ensemble for number of days with daily precipitation amount greater than 20 l/m²***
*2021-2050 vs. 1971-2000*




***Mean difference of 4-models ensemble for number of days with T. min greater than 20 deg.C***
*2021-2050 vs. 1971-2000*



*Rainfall in the summer season*
*2021-2050 vs. 1971-2000*




Differences in the average amount of summer rainfall (*%)* in the conditions of the scenario RCP 4.5
*2021-2050 vs.1971-2000*

***Climate change scenarios in Romania:***

*- Increasing probability of occurrence for droughty events due to raising temperature and decreasing precipitation especially during the summer season in the Southern, South-Eastern and Eastern regions;*

*- Increasing probability of occurrence for tropical nights, hot days, summer days;*

*- Local factors modulate the magnitude of the increasing probability of occurrence for natural hazards (e.g. topography).*

- ***EU Funding Period for 2007-2013 and 2014-2020 periods / Operational Sectoral Programme for Environment (POS-MEDIU)***
- *NMA project: The development of the national system of monitoring and warning of extreme weather phenomena for the protection of life and property materials (5 million Euro).*
- *In 2007-2013 programming period will be implemented the activities related of modernization of meteo and agrometeorological networks:*

***1. Meteorological network (1 million Euro) – 31 weather meteo stations (MWAS) in order to complete the automatic meteorological network and dedicated software for processing data in automatic flow / 31 December 2015***

***2. Agrometeorological network (200.000 Euro):***

- *Modernization of agromet network / 25 soil moisture portable systems / new systems implemented within 1 November 2015*
- *Windows Server /CISC x86 6-core*
- *National data base platform / type SQL Server 2008*
- *Modernization of applications in operational activity – dedicated software for agrometeorological data and indicators (national/regional level) / **31 December 2015***

*OMU PEAK, 2504 m*

***For the next 4 years (2016-2020), other objectives are foreseen:***

***-the acquisition of a new visualization system***

***-the modernization of the radar network***

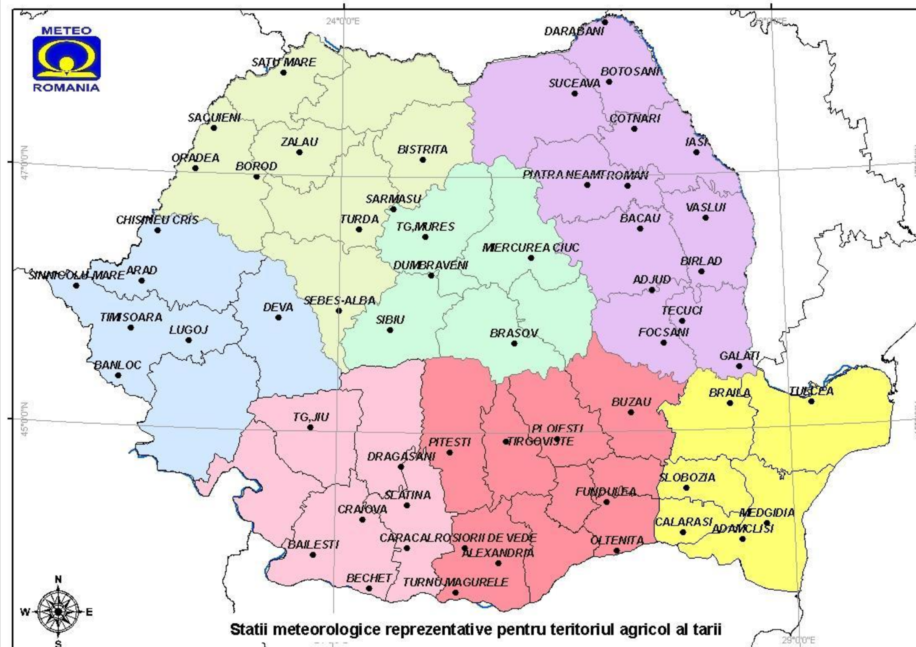
***-the modernization of the weather data communication system***

***-the improvement of the informatic security of the IT infrastructure of the whole meteorological system***

# www. meteoromania.ro
# NMA – Surface Observation Network

*Synoptic and climatological network*
*– 160 automatic stations*

*Agrometeorological network*
*– 55 automatic stations*

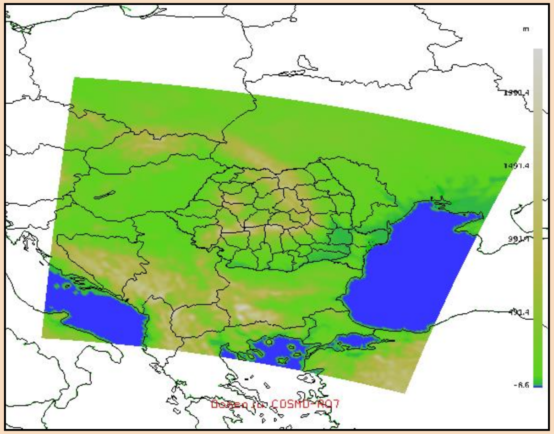

***- 7 Regional Meteorological Centres***

***- 160 weather meteorological stations***

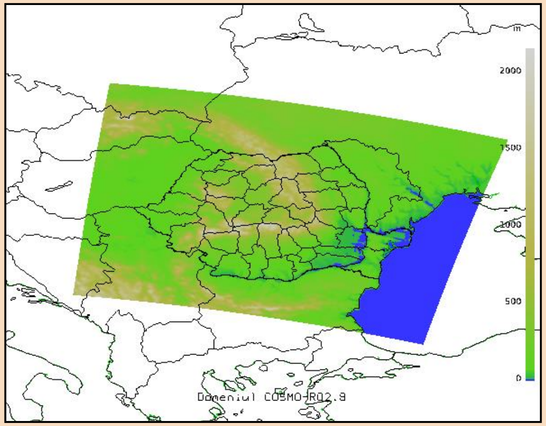
***- 55 weather stations integrating a special program of agrometeorological measurements – soil moisture and phenological data (winter wheat, maize, sunflower, rape, fruit trees and vineyards.***

# *Weather forecast*

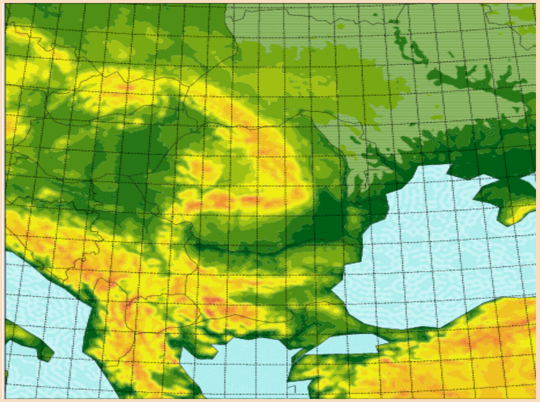
- ***NMA has kept its status as a member of the COSMO and ALADIN/LACE consortium.***
- ***The non-hydrostatic COSMO model is integrated operationally four times a day (00UTC, 06UTC, 12 UTC and 18UTC), at two horizontal resolutions (7 km and 2.8 km horizontal resolution). The model is implemented on a Cluster Linux IBM. For the 7 km-resolution, the model is integrated for 78 hours of forecast on a domain which covers Romanian territory. The initial and lateral and boundary conditions for the COSMO model integrated at 2.8 km horizontal resolution are obtained from the integration of the COSMO model at the 7 km resolution. The results are post-processed and used in the operational forecasting activity.***
- ***The ALADIN model version named "ALARO" (with specific moist parameterization package) run four times a day at 6.5 km resolution over a domain covering Romania and its surroundings.***



*COSMO - RO07*



*COSMO - RO2.8*



*ALARO – RO6.5*

## *Agrometeorological operational activity:*

***- ANM use the soil water balance model (SWBM) in order to identify periods of water stress which may have adverse effects on crop production. This identification help in adopting appropriate management practices to alleviate the constraint and increase the crop yields.***

-***The meteorological data (synoptic data and ETP data based on the FAO recommended Penman-Monteith method) are processing in order to obtain the outputs data for soil water model balance (SWBM).***

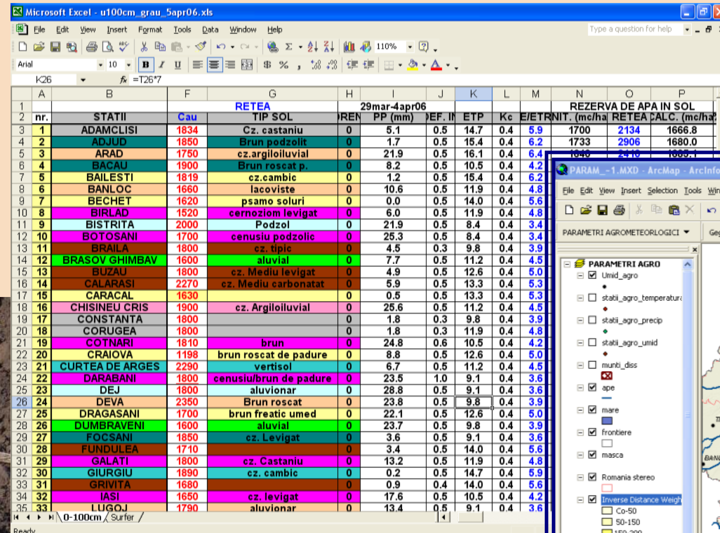
- ***The agrometeorological data (phenological data and in-situ soil measurements) represent specialized information coming from the network's weather stations with agrometeorological programme (55 stations), representative for areas of agricultural interest.***

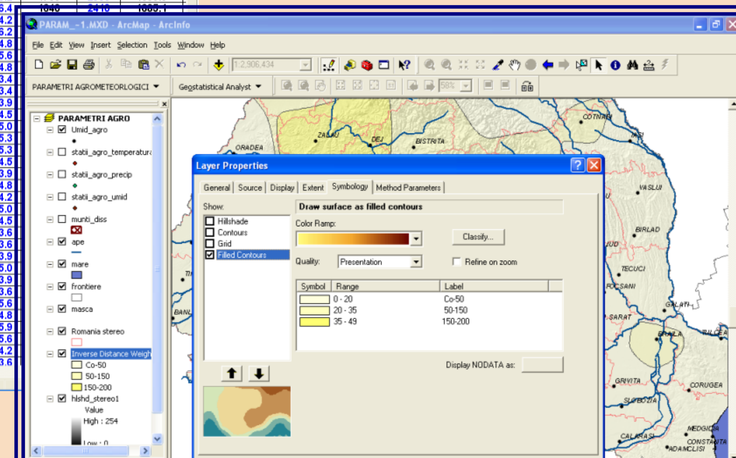
- ***The soil water balance model (SWBM) calculates the soil moisture reserve (mc/ha) and water deficit (mc/ha) in order to assess the available water resources for crops (watering time) – maps at national/regional level.***

- ***Agrometeorological Bulletin (diagnosis/forecasts) – weekly, monthly, seasonal, annual.***

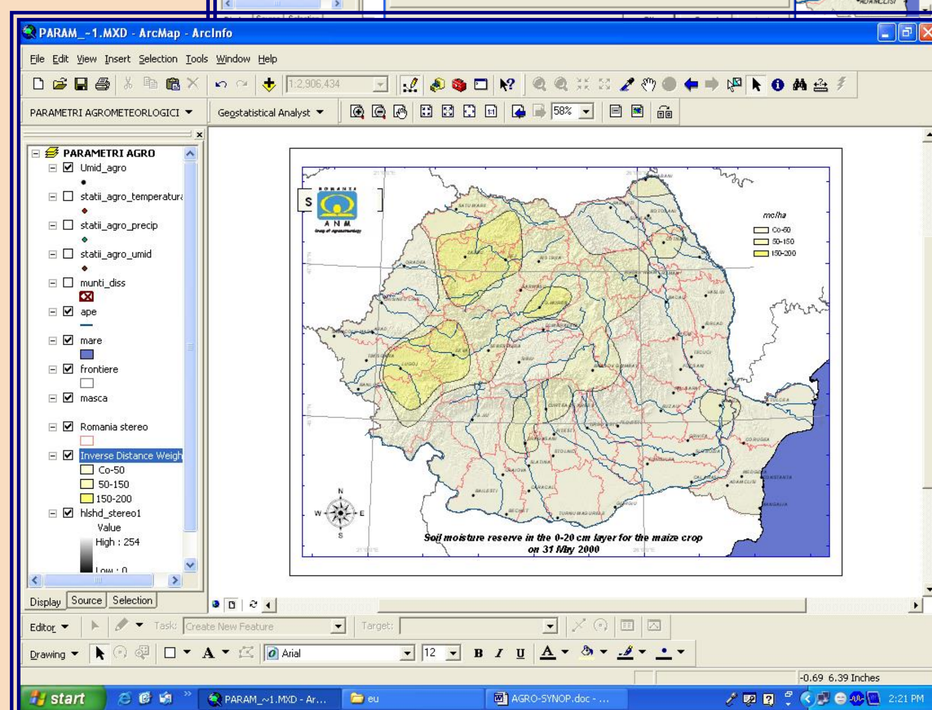
- ***Beneficiaries: Ministry of Environment, Water and Forests, Ministry of Agriculture and Rural Development, farmers, Agricultural Associations, public media, etc.***

# MODULE / Soil moisture



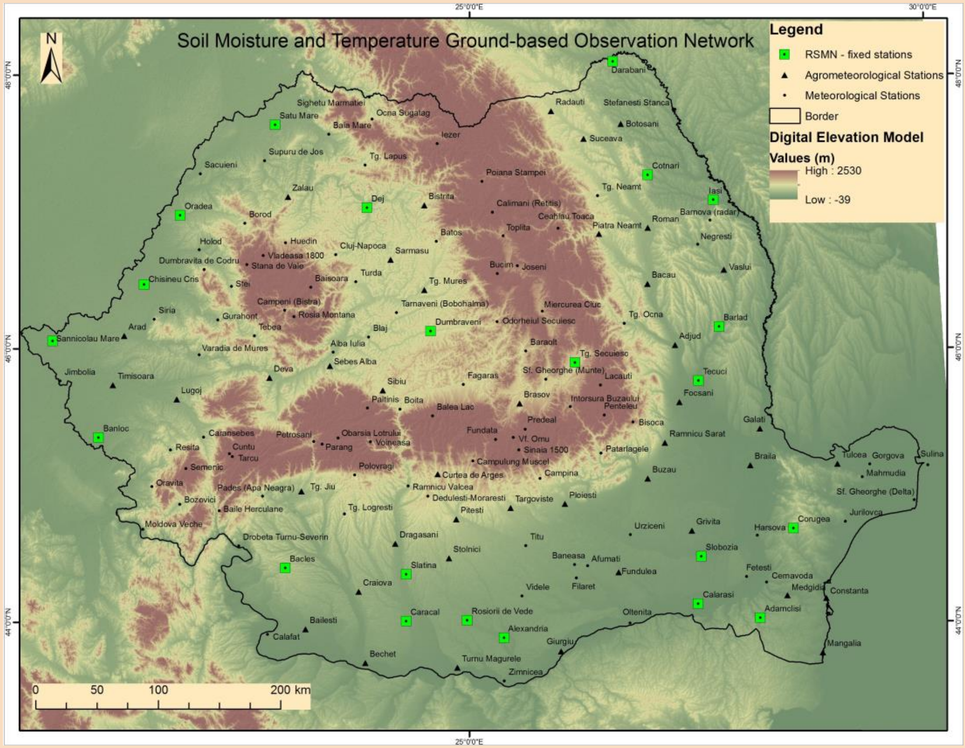








# RSMN: The Romanian Soil Moisture & Temperature Observation Network
# 55 NEW STATIONS

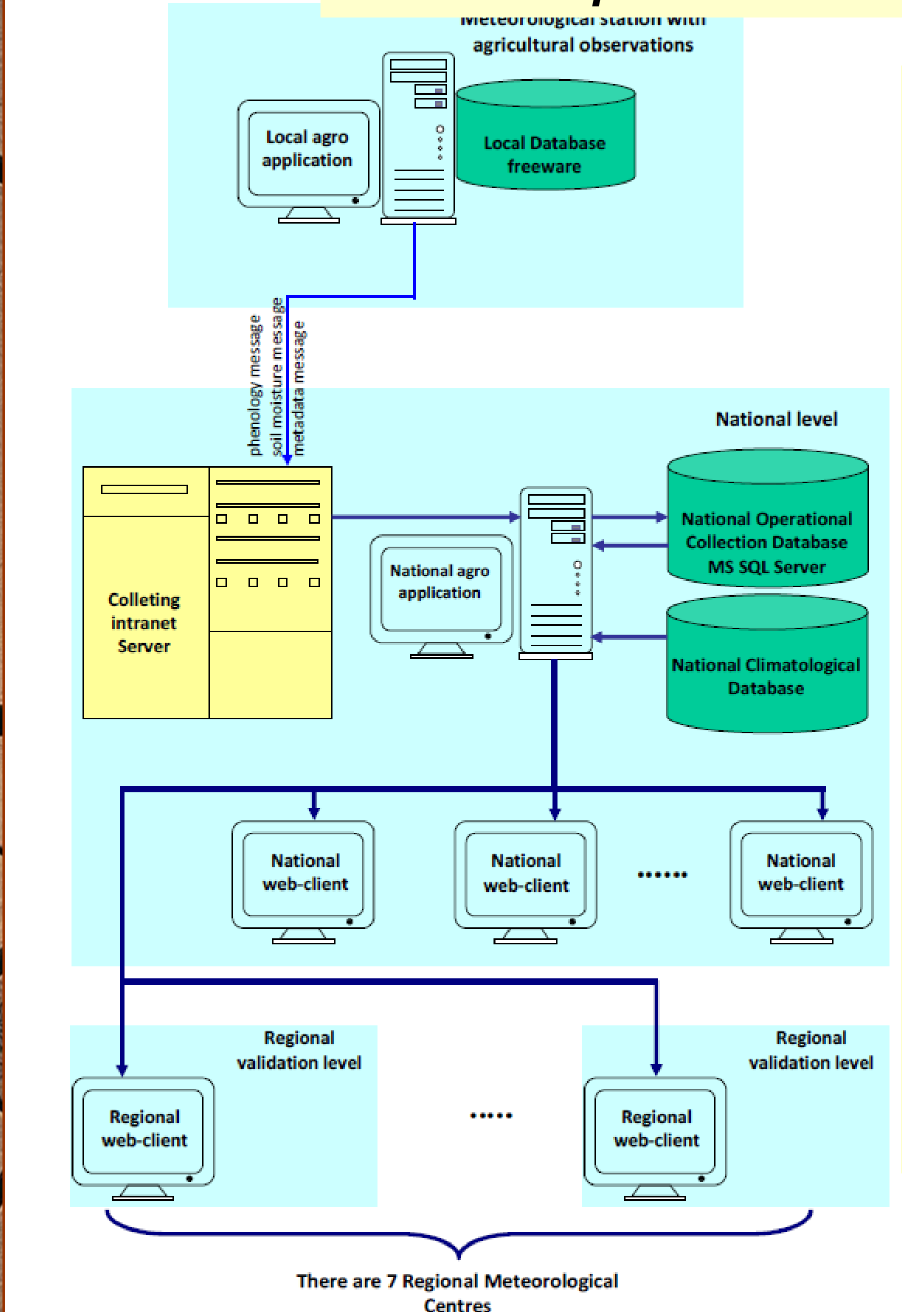
- *By ASSIMO project it will set a Continuous Soil Moisture & Temperature Ground-based Observation Network (RSMN) within the framework of NMA's weather station network, for achieving it's overall goal of stimulating the utilization of space-based Earth observations of soil moisture.*
- *RSMN is made up of a "static" component – the SM&T probes at 20 weather station locations and of a mobile component – 30 autonomous, easy to deploy SM stations.*




- While NMA is operating a network of 160 weather stations, soil moisture measured every 10 days at 55 stations for agro-meteorological applications.
- At 247,000 km2 – the areal extent of the country, the resulting average spacing of $67^2$ $km^2$ (calculated as the ratio of areal extent/number of sites) could be a good starting point provided that the measurements are more frequent and the topography and land cover less diverse.


**Assessment of Satellite Derived Soil Moisture Products over Romania**
**(ASSIMO)**
**Program for Research-Development-Innovation for Space Technology and Advanced Research – STAR**
**Romanian Space Agency (ROSA)**
**(http://assimo.meteoromania.ro/)**

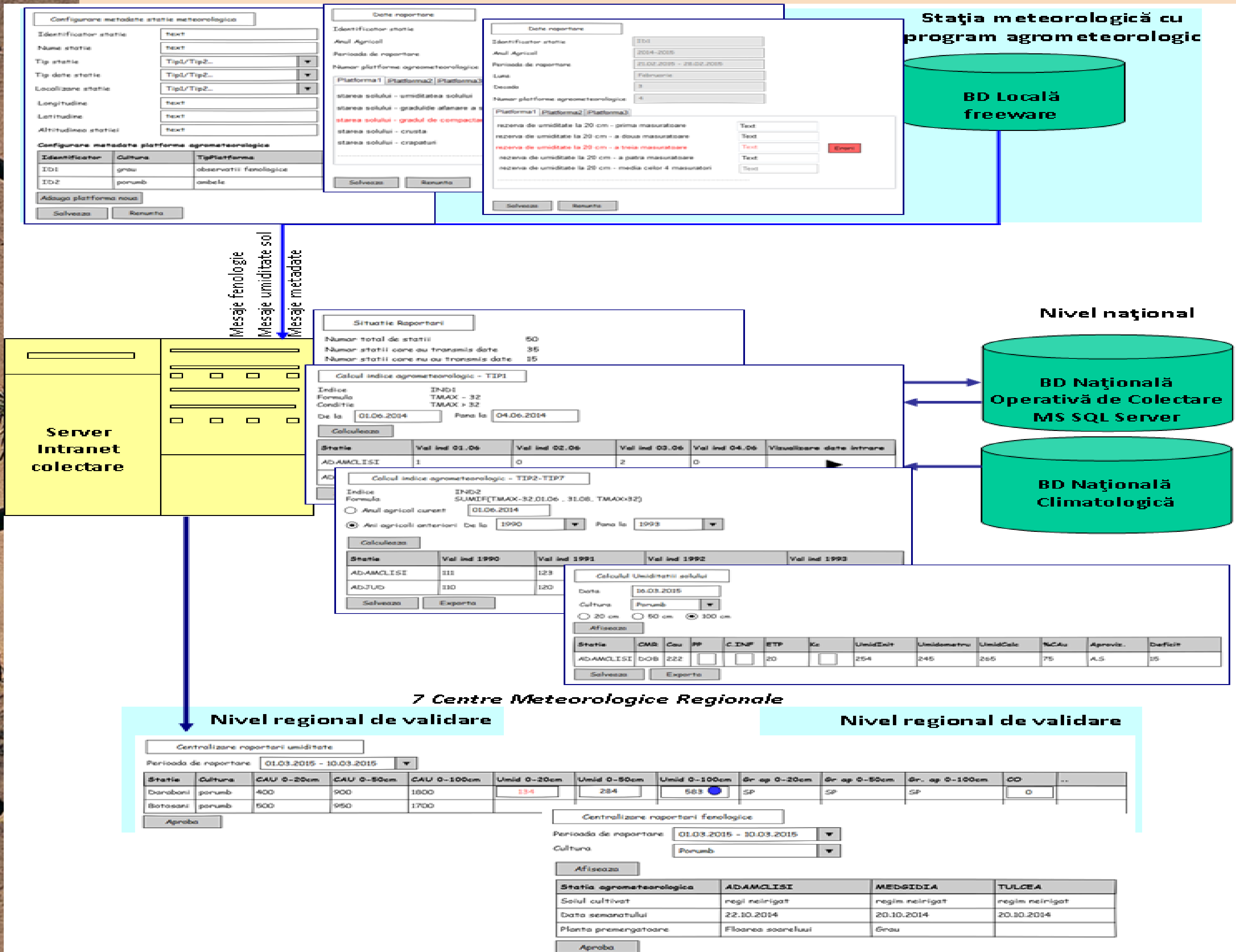
# The conceptual scheme of "SYSTEM SOFTWARE AGROMETEO"




► *Local level / agrometeorological station – metadata*

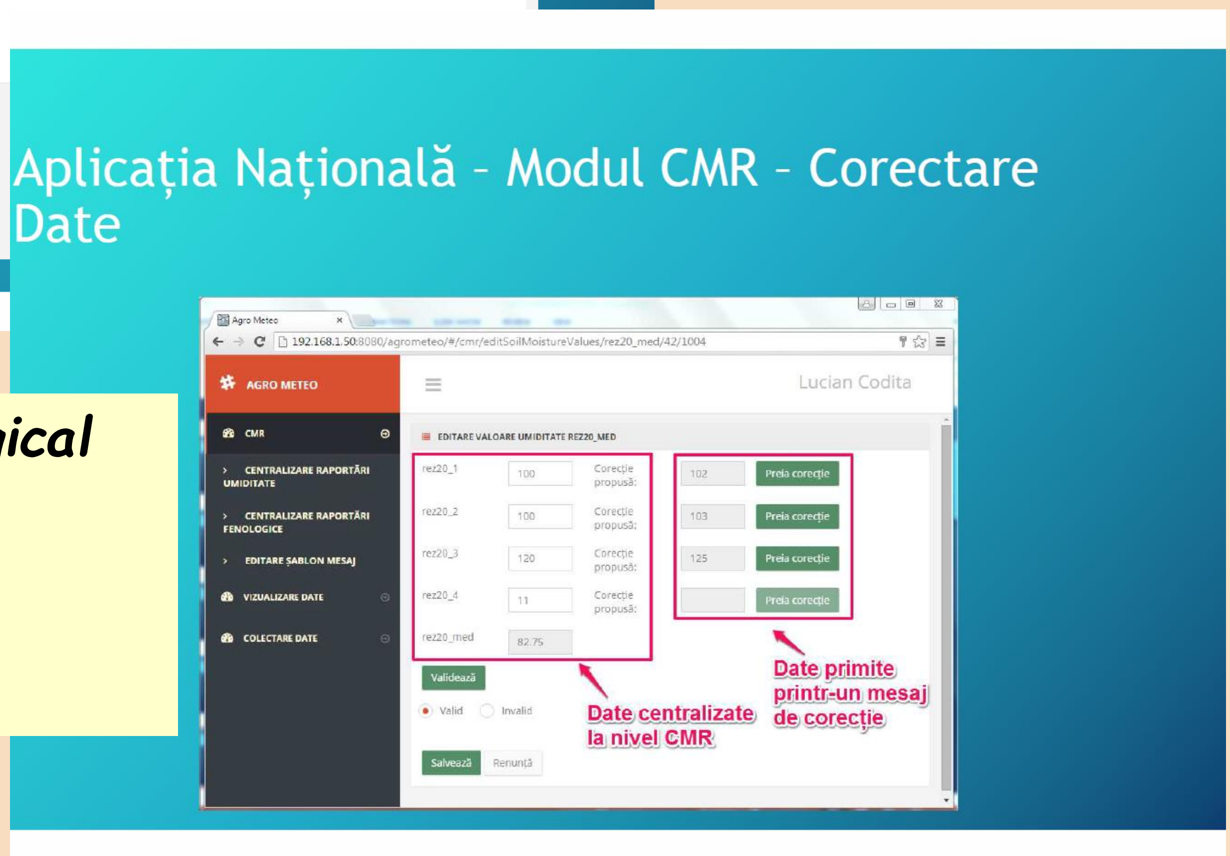
► *National level – web application*

► *Validation of data at regional level by 7 responsible with agrometeorological activity using a friendly web interface*


Staţia meteorologică cu program agrometeorologic
BD Locală freeware
Mesaje fenologie
Mesaje umiditate sol
Mesaje metadate
Nivel naţional
Server Intranet colectare
BD Naţională Operativă de Colectare MS SQL Server
BD Naţională Climatologică
7 Centre Meteorologice Regionale
Nivel regional de validare
Nivel regional de validare
Configurare metadate statie meteorologica
Configurare metadate platforme agrometeorologice
Date raportare
Situatie Raportari
Calcul indice agrometeorologic - TIP1
Calcul indice agrometeorologic - TIP2-TIP7
Calculul Umiditatii solului
Centralizare raportari umiditate
Centralizare raportari fenologice


► *National AGROMETEO Application is a web-application based on a module dedicated to agro-meteorological responsible from each Regional Meteorological Centre*

- ➢ *Consolidate phenological reports*
- ➢ *Data correction*
- ➢ *Data validation*
- ➢ *Save data*



# AGROMETEOROLOGICAL OPERATIONAL ACTIVITY

## CLIMATIC INDICATORS

| Index | Name | Index | Name |
|---|---|---|---|
| **FD** | Frost Days | **R5mm** | n° of days with RR $\geq$ 5mm |
| **TD** | Tropical Days | **CDD** | Consecutive Dry Days |
| **CTD** | Consecutive Tropical Days | **CWD** | Consecutive Wet Days |
| **GSL** | Growing Season Length | **PRCPTOT** | Total precipitation |
| **GDD** | Growing Degree Days | **SPI** | Standardized Precipitation Index |
| **WSDI** | Warm Spell Duration Index | **SPEI** | Standardized Precipitation-Evapotranspiration Index |
| **CSDI** | Cold Spell Duration Index | **AI** | Aridity Index |
| **PET** | Potential EvapoTranspiration | **PDSI** | Palmer Drought Severity Index |

## AGROMETEOROLOGICAL INDICATORS

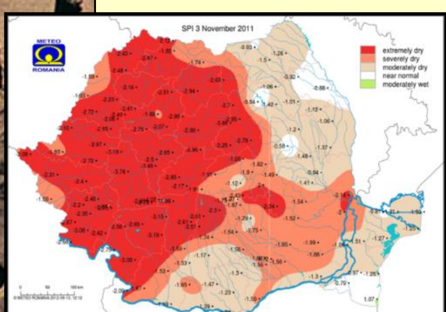
| Index | Name | Index | Name |
|---|---|---|---|
| SM | Soil Moisture | CW | Cold Wave ($\Sigma$Tminº$\leq$-10ºC, December- February) |
| HW | Heat Wave ($\Sigma$Tmax$\geq$32ºC, June-August) | DVI | Drought Vulnerability Index |

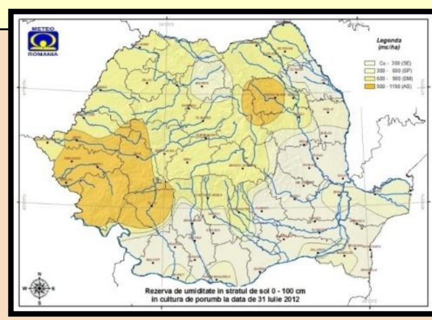
***AGROMETEOROLOGICAL OPERATIONAL ACTIVITY / 55 weather stations integrating a special program from 1971-present***

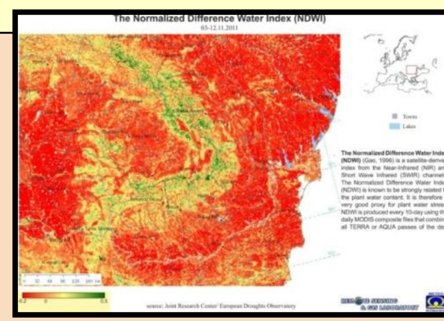
***– soil moisture and phenological data (winter wheat, maize, sunflower, rape, fruit trees and vineyards).***

***SOIL MOISTURE and CROP MONITORING IS BASED ON SPECIFIC INDICATORS / agrometeorological operational and research activities***

- ***climatic indicators***: *SPI, Aridity index, etc*
- ***agrometerological indicators***: *Soil moisture, heat waves, etc*
- ***satellite-derived products:*** *Normalized Difference Water Index (NDWI), Leaf area Index (LAI); Fraction of Absorbed Photosynthetic Solar Radiation (fAPAR)*

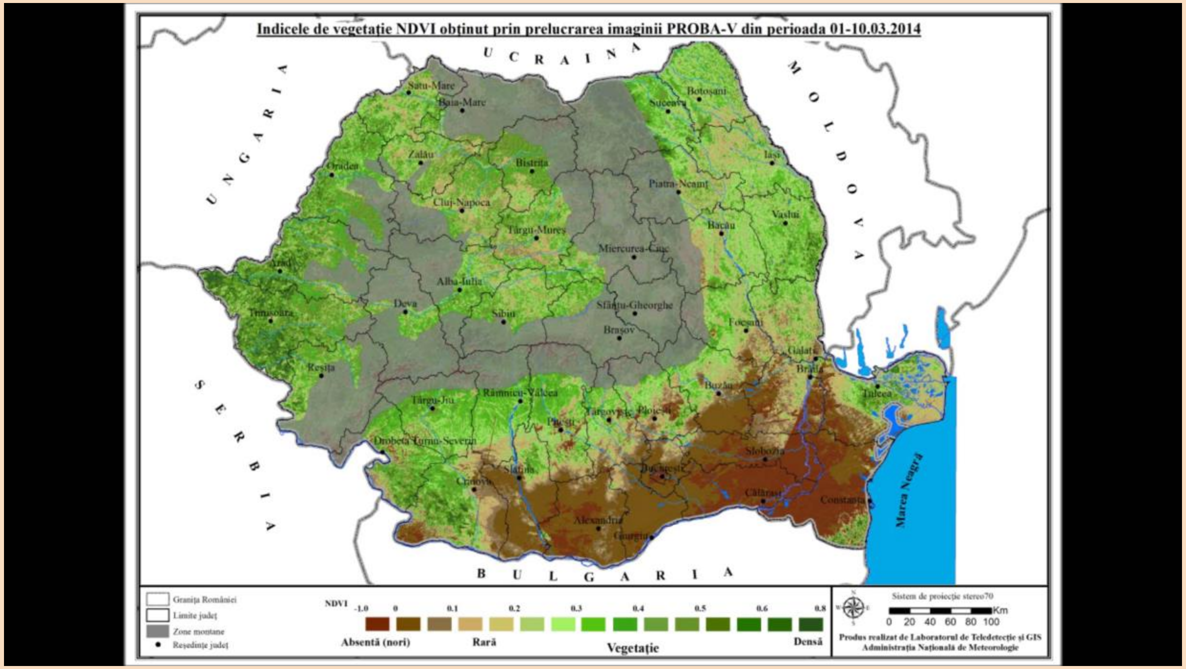



## *SATELLITE DERIVED INDICES*

| Index | Name | Index | Name |
|---|---|---|---|
| NDVI | Normalized Differences Vegetation Index | NDDI | Normalized Difference Drought Index |
| NDWI | Normalized Difference Water Index | FAPAR | Fraction of Absorbed Photosynthetically Active Radiation |
| LAI | Leaf Area Index | SMI | Soil Moisture Index |




**NDVI evolution over Romania for the period 01 March – 10 October 2014**
**(10 days synthesis)**

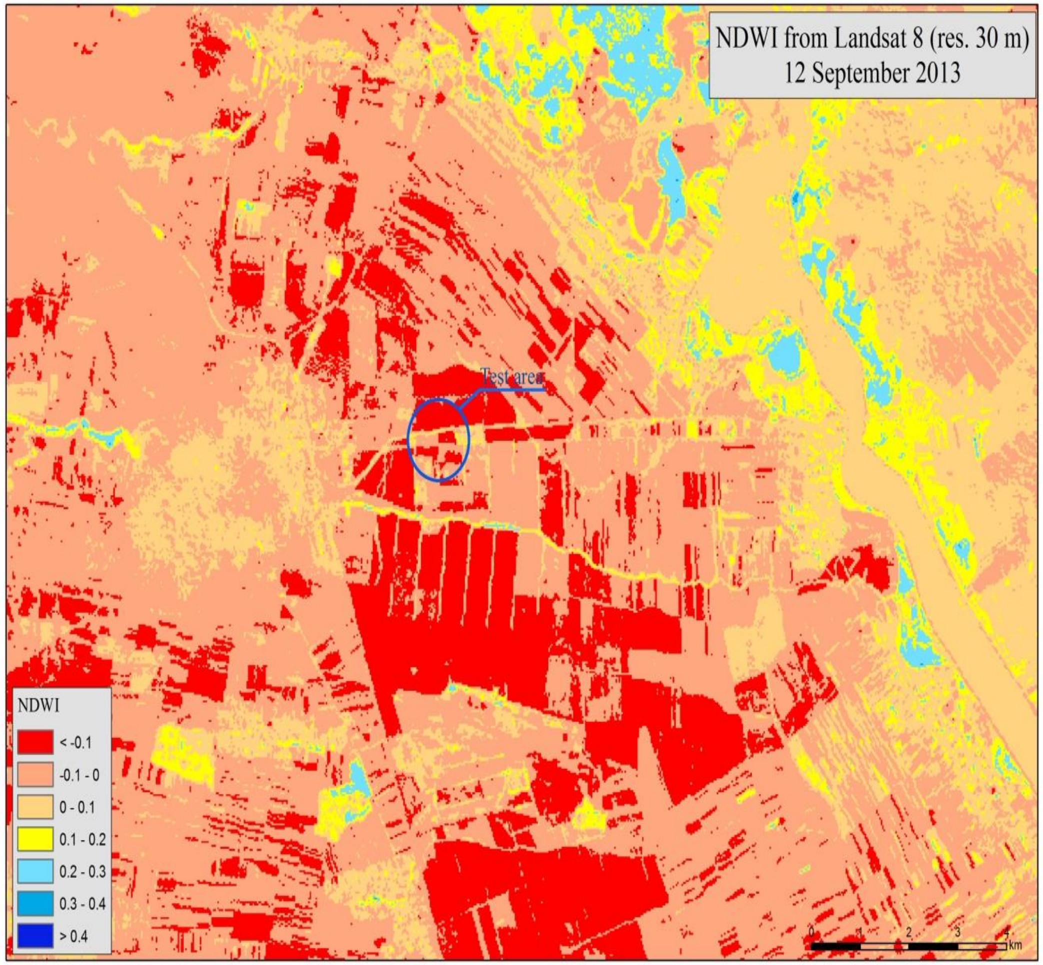
# *Vegetation indices: NDWI*

***The Normalized Difference Water Index (NDWI)*** *is a satellite-derived index from the Near-Infrared (NIR) and Short Wave Infrared (SWIR) reflectance channels:*

*NDWI index is a good indicator of water content of leaves and is used for detecting and monitoring the humidity of the vegetation cover.*

*Because it is influenced by plants dehydration and wilting, NDWI may be a better indicator for drought monitoring than NDVI.*

*By providing near real-time data related to plant water stress, the water management can be improve, particularly by irrigating agricultural areas affected by drought, according to water needs.*



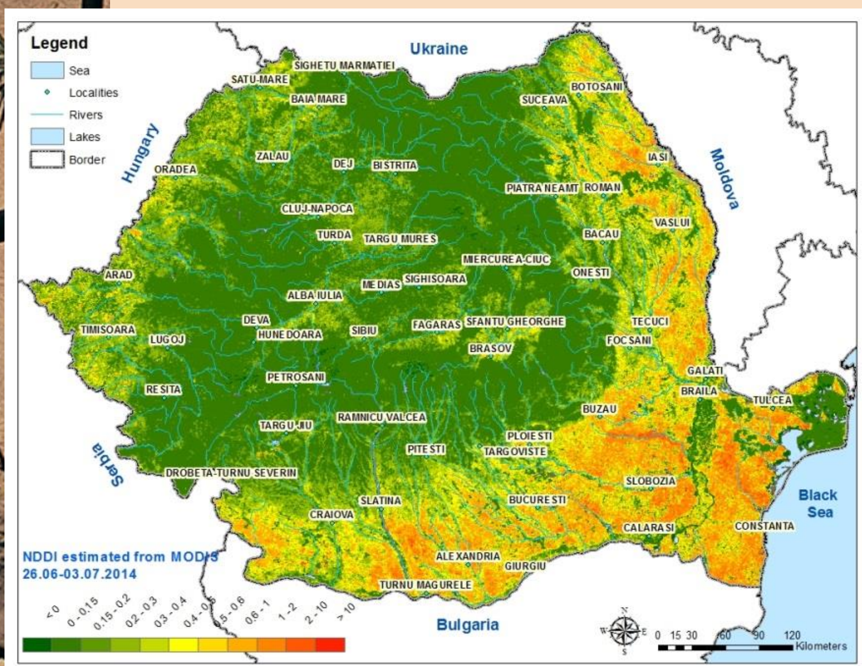

***LANDSAT 8 - NDWI evolution over Caracal area (South of Romania) (May – September 2013)***

# *Vegetation indices: NDDI*

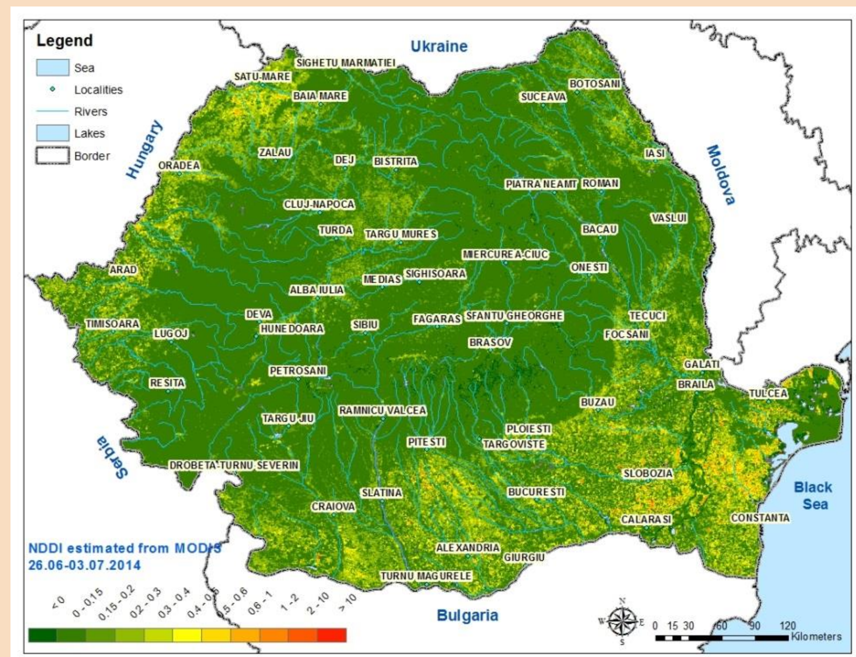
- **The Normalized Difference Drought Index (NDDI):**

$$NDDI = (NDVI - NDWI) / (NDVI + NDWI)$$

- *NDDI had a stronger response to summer drought conditions than a simple difference between NDVI and NDWI, and is therefore a more sensitive indicator of drought.*
- *This index can be an optimal complement to in-situ based indicators or for other indicators based on remote sensing data.*




***NDDI: 26.06-3.07.2007 droughty year***




***NDDI: 26.06-3.07.2014***

**The NDDI obtained from MODIS - MOD09A1 products (8-days composite)**

UNIUNEA EUROPEANĂ
Fondul Social European

GUVERNUL ROMÂNIEI

POCA
Programul Operațional Capacitate Administrativă
Competența face diferența!

Instrumente Structurale
2014-2020

”National Risk Assessment – RO RISK – (SIPOCA code: 30, co-financed under EFS through Operational Programme Administrative Capacity) under coordination of General Inspectorate for Emergency Situations

9 HAZARDS – natural, technological and biological

***Ministry of Environment, Water and Forests – Coordinator for the analysis of the flood and drought hazards National Meteorological Administration, National Institute of Hydrology and Water Management, Institute of Geography of Romanian Academy - DROUGHT***

***DROUGHT METEOROLOGICAL HAZARD***

4 scenarios at national level:

- Scenario 1: 2011-2012 year, with a return period of 3 events in 10 years
- Scenario 2: 2006-2007 year, with a return period of 3 events in 25 years (4 events in 100 years)
- Scenario 3: Annual Maximum Consecutive Dry Days (CDD), with daily mean rainfall <1 mm (CDD), with a return period of 1 event in 100 years
- Scenario 4. PDSI Index / 2071-2100 vs. 1971-2100, with a return period of 1 event in 100 years

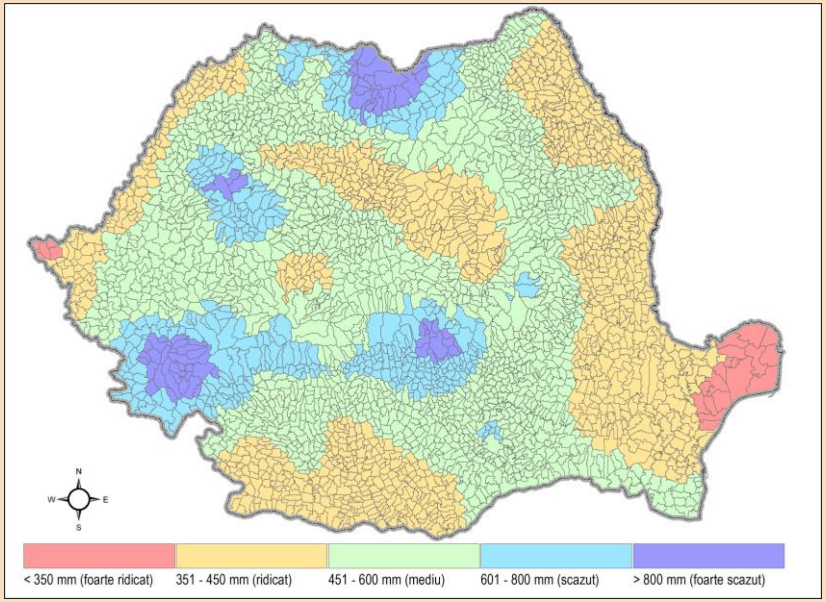
3 scenarios at regional level:

- Scenario 1: Oltenia / SPEI index, with a return period of 1 event in 10 and 100 years
- Scenario 2: Moldova / SPEI index, with a return period of 1 event in 100 years

| Scenario | The number of stations for which the condition as the rainfall to be less than 350 mm /year | Probability | Return period | Probability Scale |
|---|---|---|---|---|
| 2011- 2012 | 7 | 0,30 | 3 events in 10 years | Category 5 - HIGH |

The probabilities were calculated on the basis of a distribution *Gen. Pareto,* fitted to the string of observations with the number of stations for which the condition as the rainfall to be less than 350 mm/year has been met, over 1961-2015 period

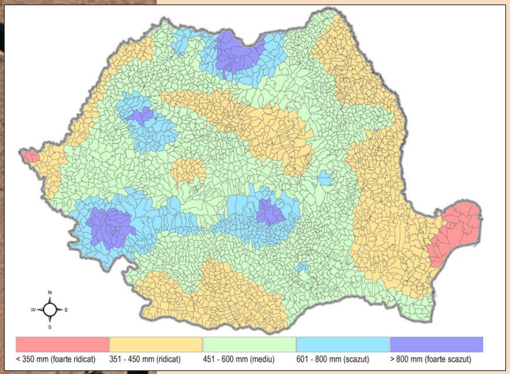
| Risk classes | Risk drought level | Rainfall amounts / year and significance |
|---|---|---|
| 1 | Very low | >800 mm |
| 2 | Low | 601-800 mm |
| 3 | Medium | 451-600 mm |
| 4 | High | 351-450 mm |
| 5 | Very high | <350 mm |



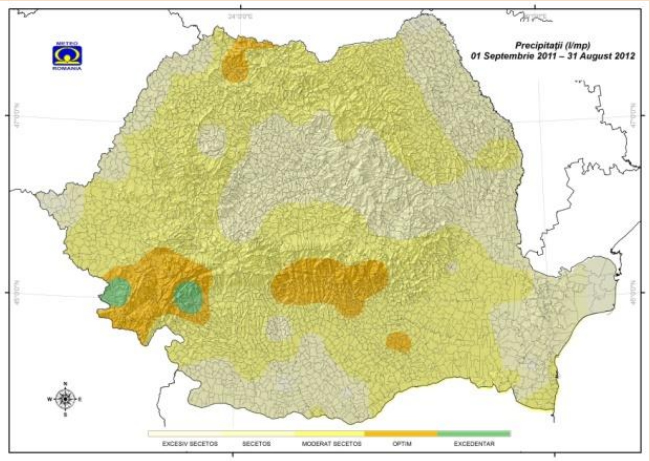

Scenario 1: 2011-2012 year, with a return period of 3 events in 10 years

# HISTORICAL CONDITIONS OF THE YEARS 2011-2012

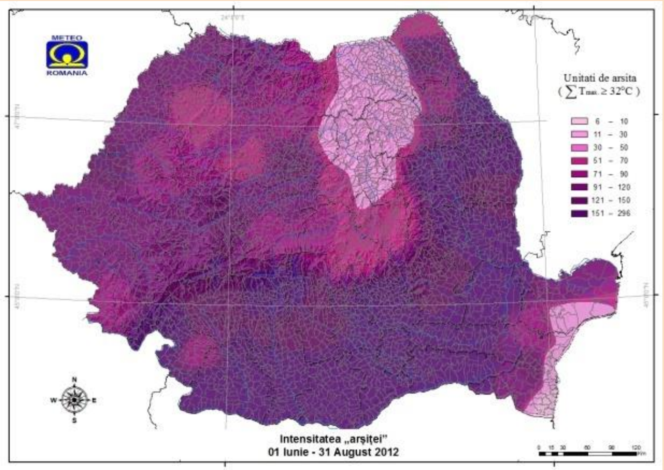
*SCENARIO 2011-2012*



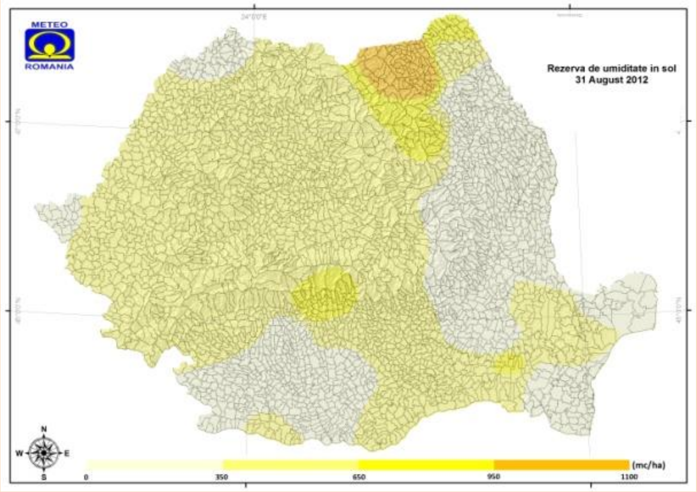

***Annual rainfall / 2011-2012***



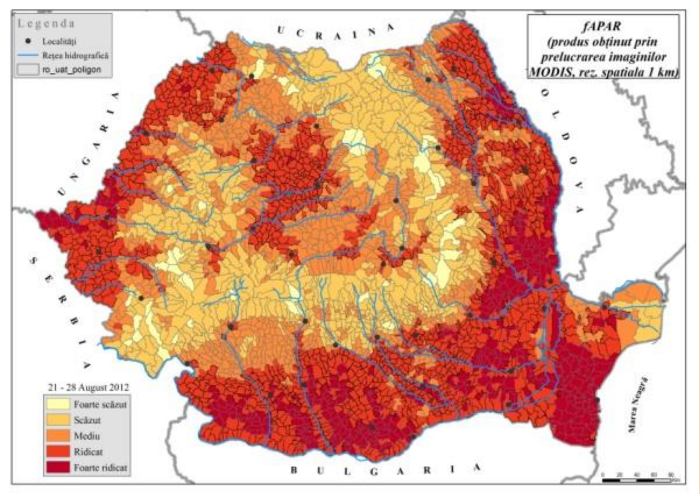

***Intensity of scorching heat /summer 2012***



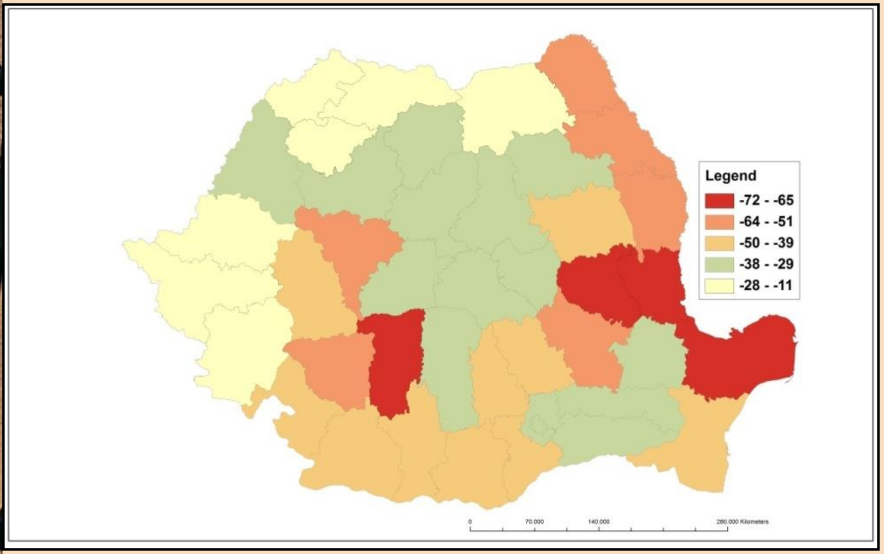

***Soil moisture, 31 August 2012***



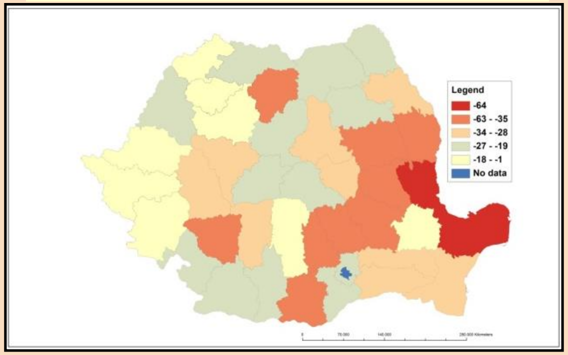

***fAPAR, 21-28 August 2012***



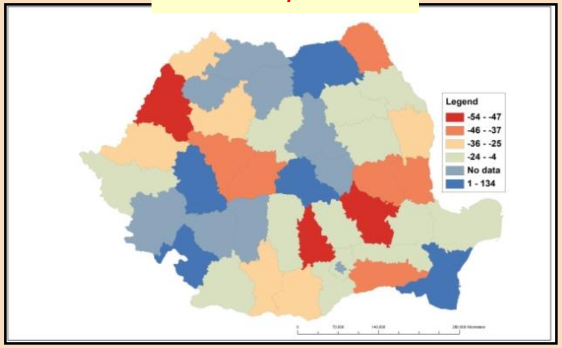
## *Loss of production from grain / 2011- 2012 were over 50% losses (%)*



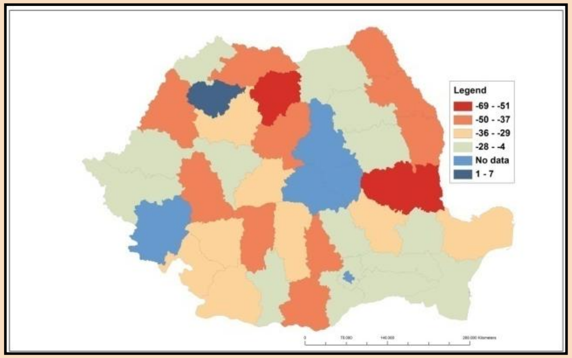

*Winter wheat*



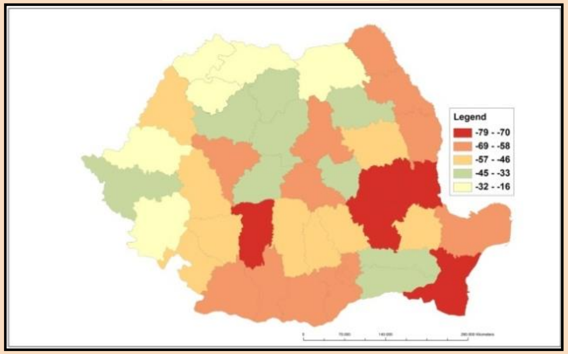

*Rape*

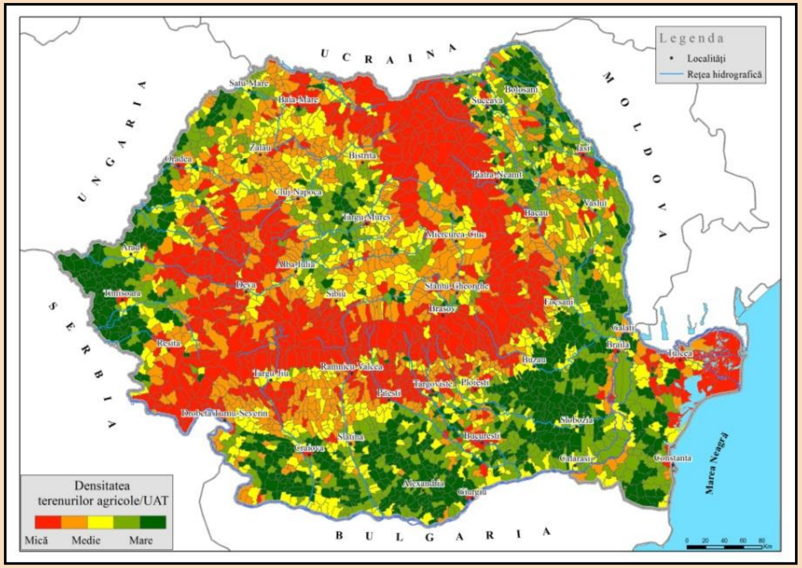



*Sunflower*

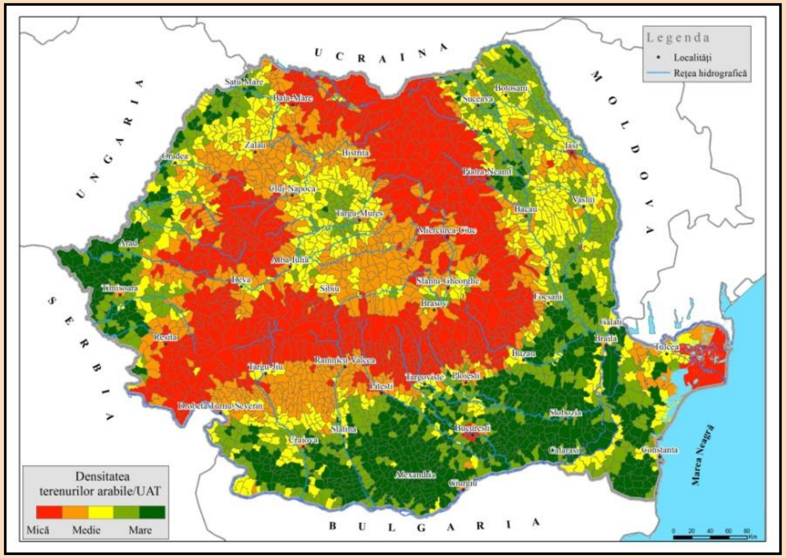



*Maize*



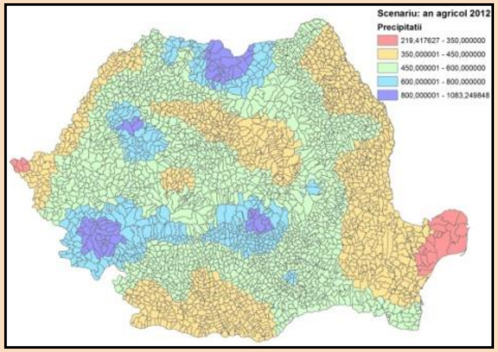



The density of agricultural land at the level of LAU

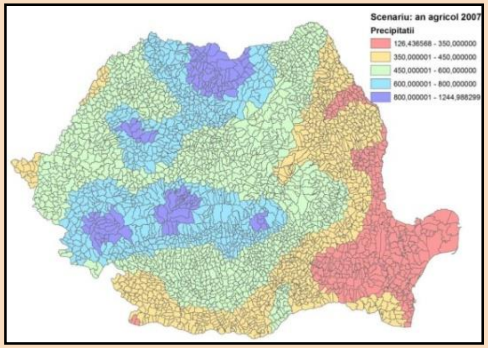



The density of arable land at the level of LAU

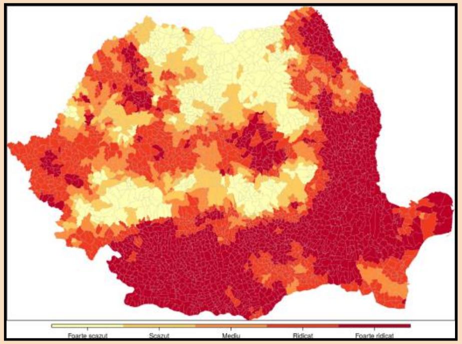
***Scenario 2011-2012 / Category 5 / HIGH***



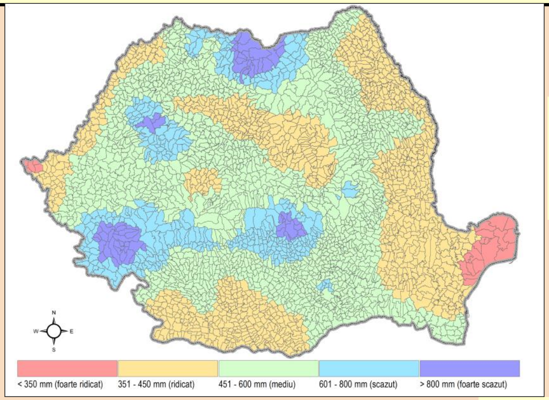

***Scenario 2006-2007 / Category 4 / MEDIUM-HIGH***




***ScenariO CDD / Category 3 / MEDIUM***

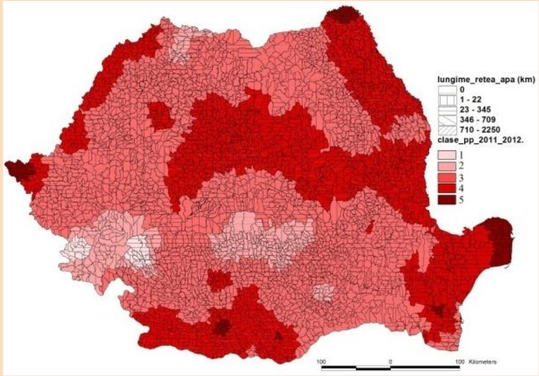


**_PHYSICAL IMPACT / Scenario 2011-2012,_** with a return period of 3 events in 10 years

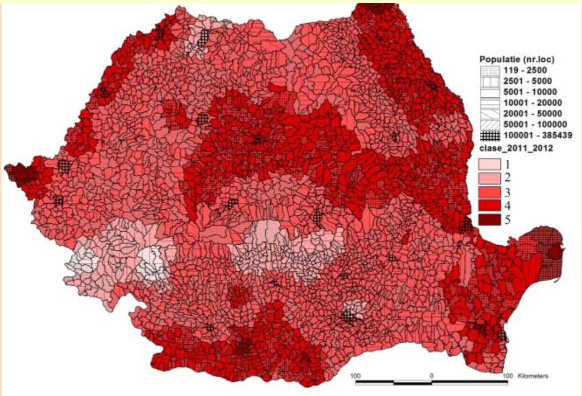



***Scenario 2011-2012 / Category 5 - HIGH***

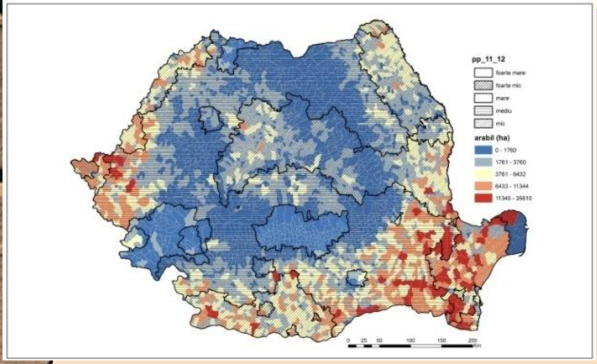
The length of water supply network (km)

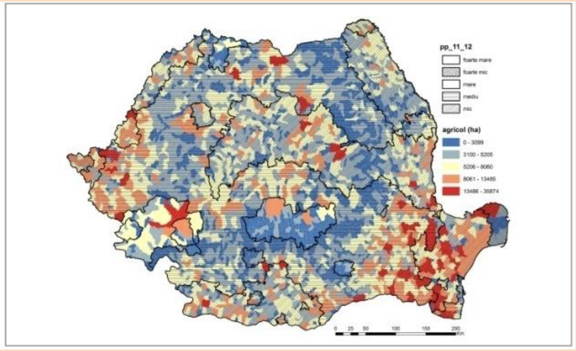


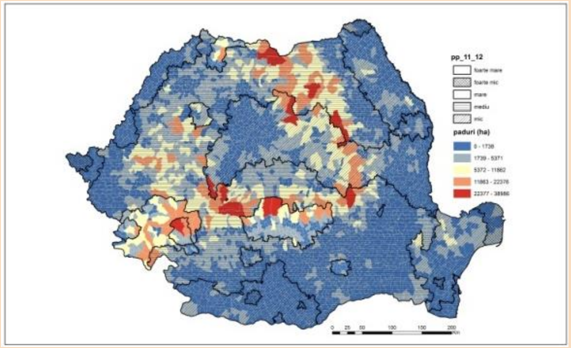

The people without access to basic services (no. inhabitants)



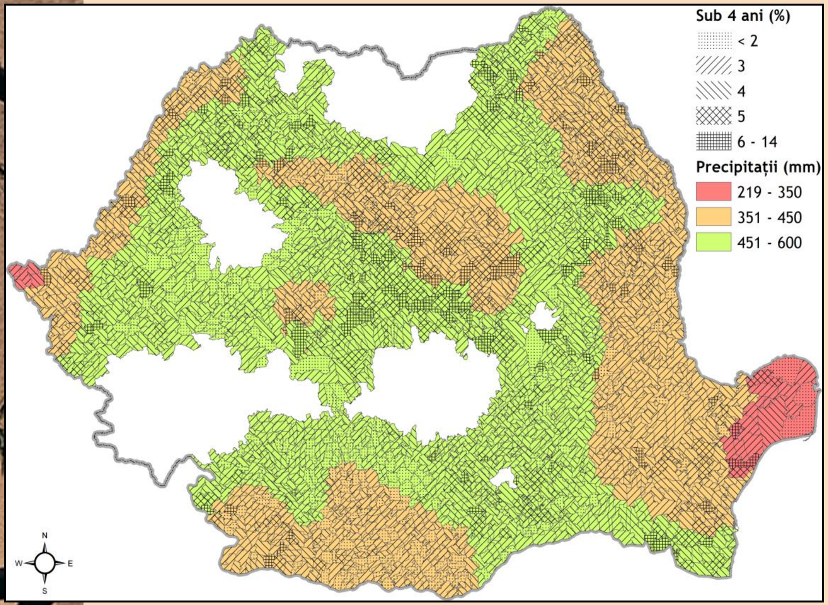

*THE AFFECTED AREA – arable, agriculture and forests (ha)*

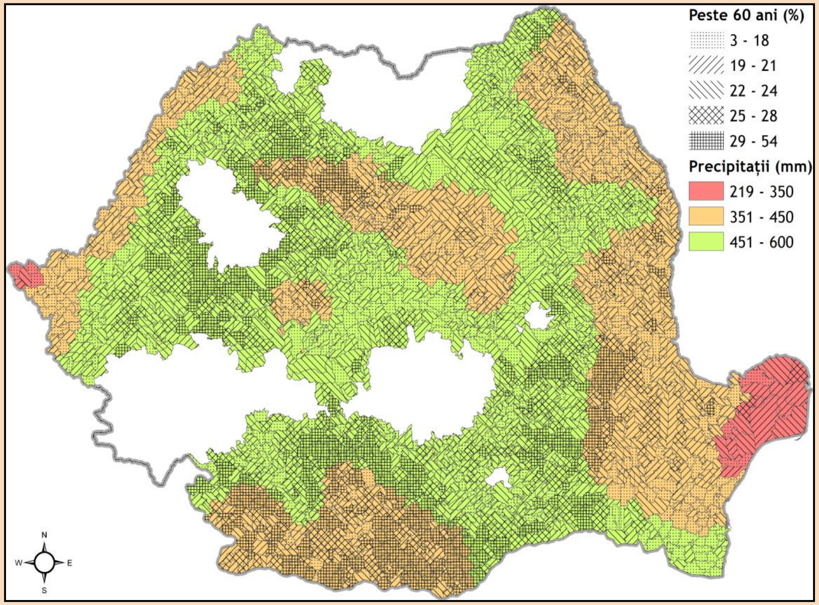


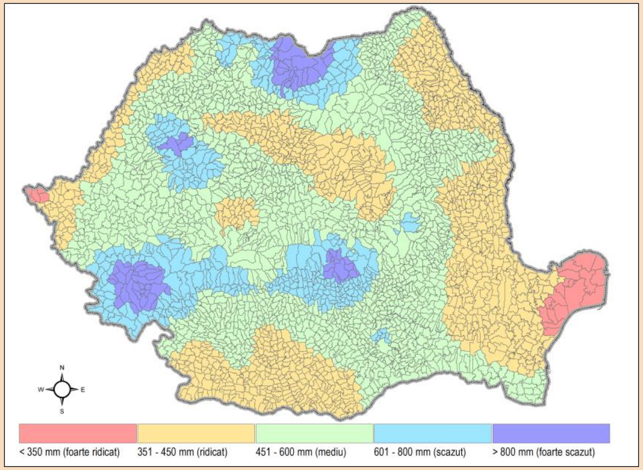



*EXPOSURE TO DROUGHT HAZARD: Scenario 2011-2012*
*Population <4 and >60 years (% of the total population)*



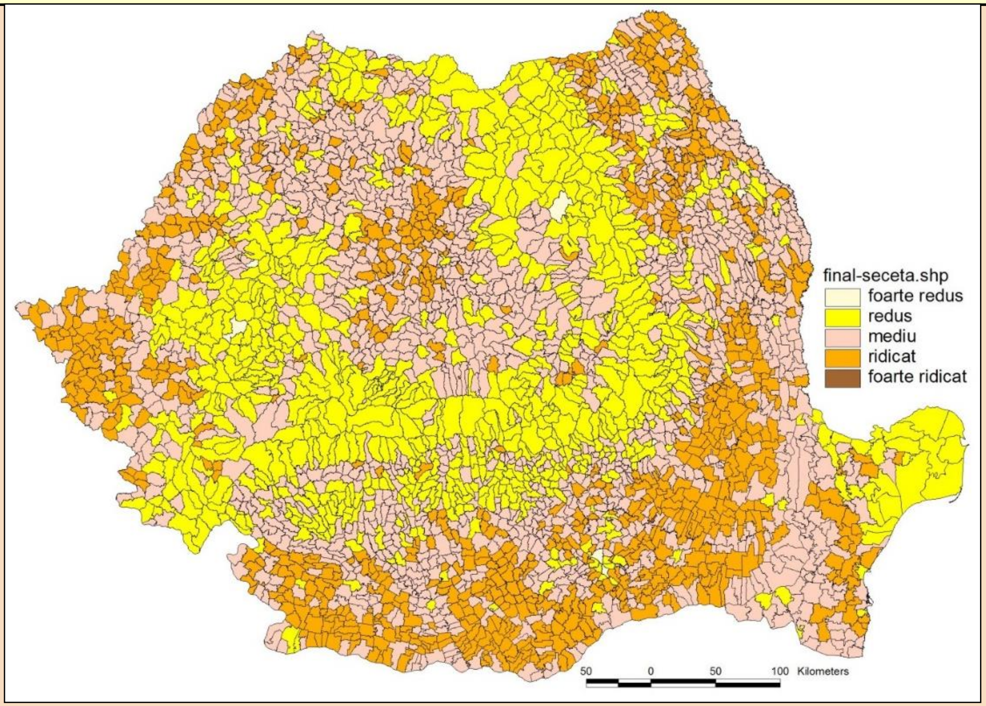



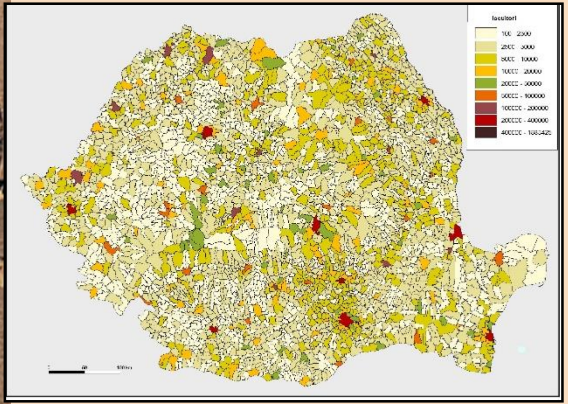

*Scenario 2011-2012 /*
*Category 5 - HIGH*

***Index of socio-economic vulnerabilityto drought***

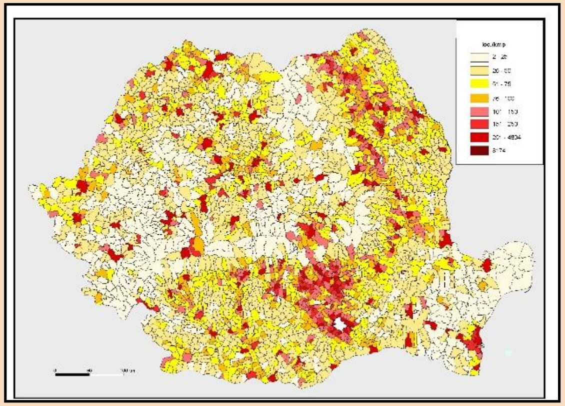
- ***Sensibility (SENSIB)***
- ***Coping capacity (CAPACIT)***
- ***Adaptative capacity (ADAPT)***



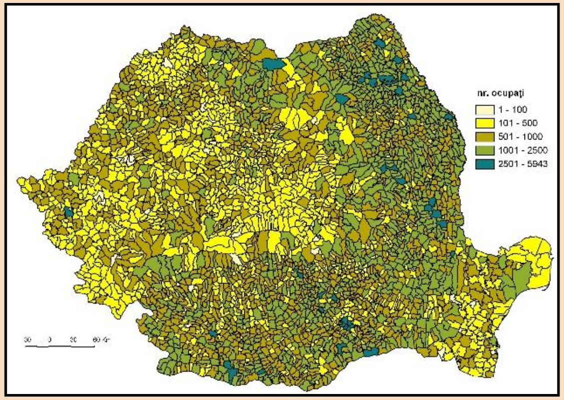

*DEMOGRAPHIC SIZE*



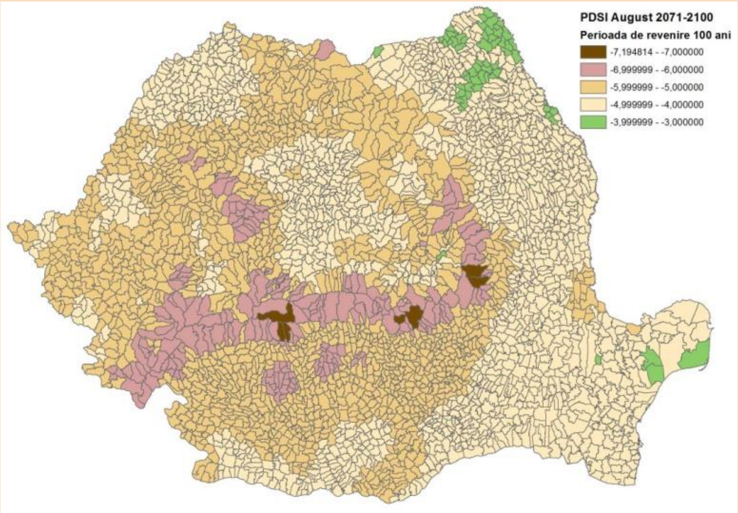

*POPULATION DENSITY*

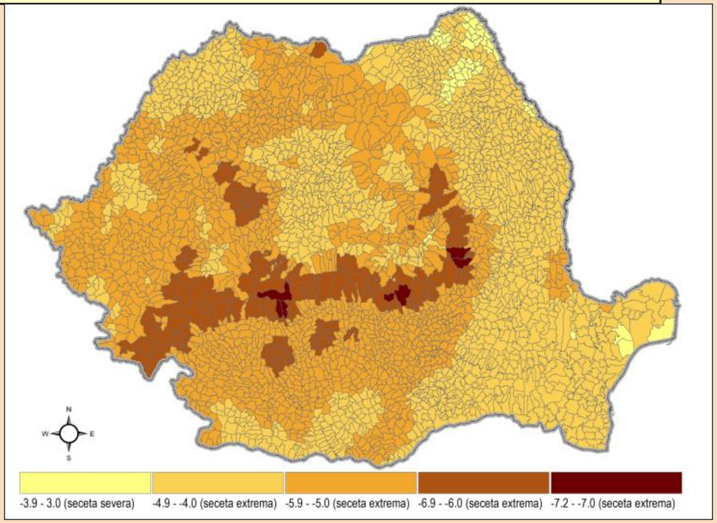



*POPULATION IN AGRICULTURE FIELD*



# The aridity trend in Romania / 2071-2100, 100 years return period




***PDSI Index / 2071-2100***
***100 years return period***

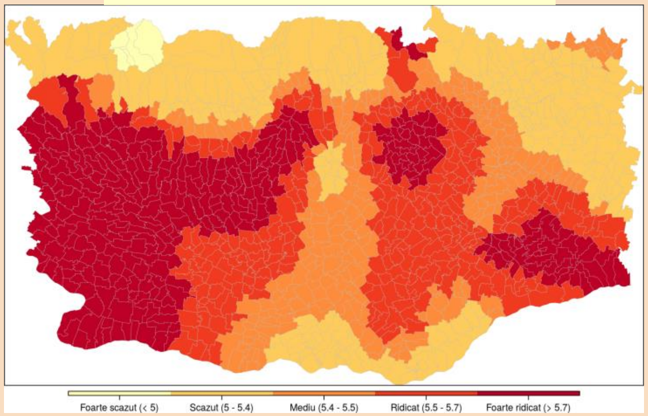
***DROUGHT HAZARD BASED OF THE PDSI INDEX ANALYSIS / 2071-2100,***
***100 YEARS RETURN PERIOD***

| Classes | Risk drought | Drought significance | PDSI Index |
|---|---|---|---|
| **1** | Very low | Poor drought | -0,50 - -0,99 |
| **2** | Low | Early stage drought | -1,00 - -1,99 |
| **3** | Medium | Moderate drought | -2,00 - -2,99 |
| **4** | High | Severe drought | -3,00 - -3,99 |
| **5** | Very high | Extreme drought | ≤-4,0 |

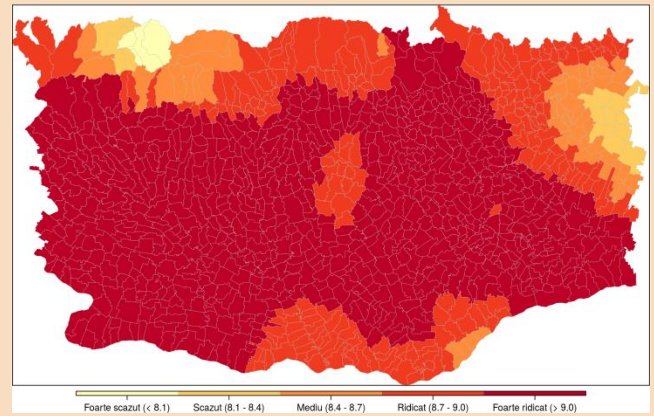
Scenario 1: Oltenia / SPEI index, with a return period of 1 event in 10 and 100 years

| Scenario | Probability Scale | Probability of occurrence |
|---|---|---|
| **SPEI, 10 years return** | 4 Medium-High | 1 event in 10 years return period |
| **SPEI, 100 years return** | 3 Medium | 1 events in 100 years return period |

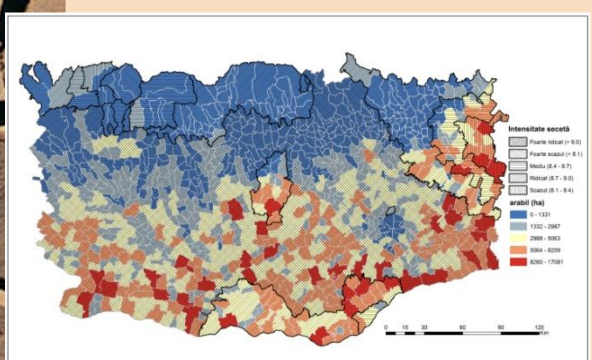
*10 years return*

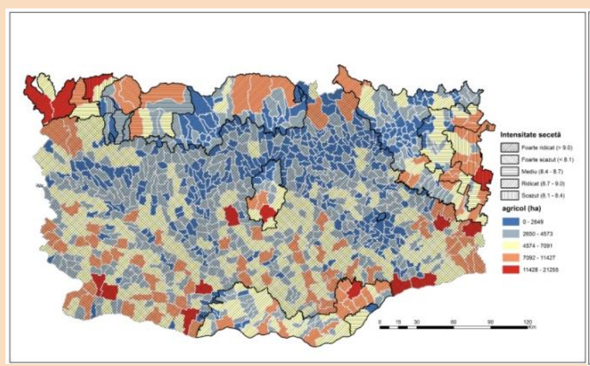


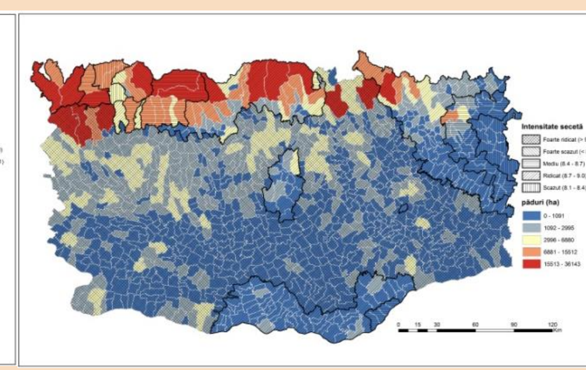

*100 years return*



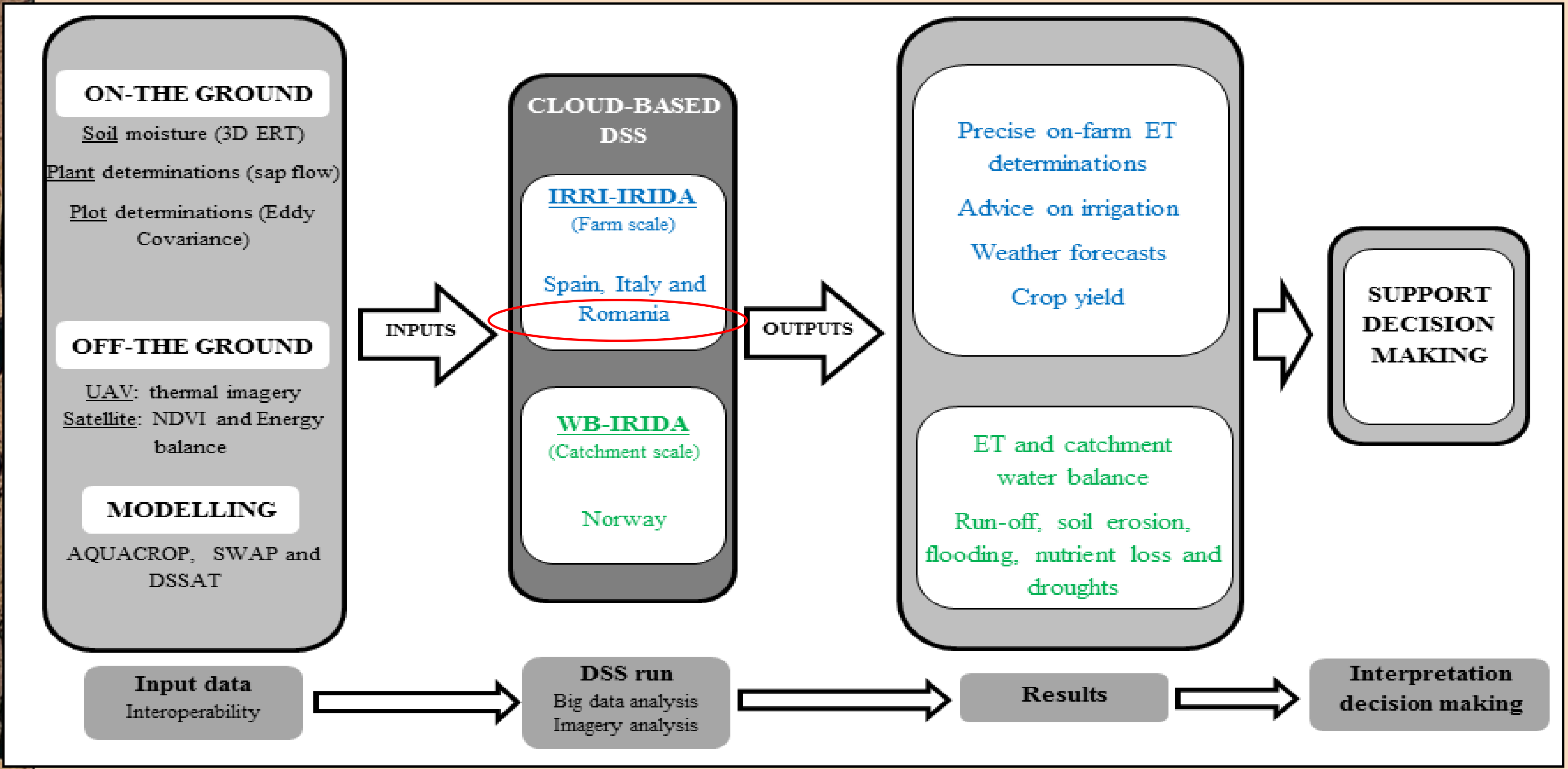

*THE AFFECTED AREA – arable, agriculture and forests (ha)*







# IRIDA - Work flow and approach



# *IRIDA Project*
# *D 1.3.Remote sensing data used to estimate evapotranspiration*

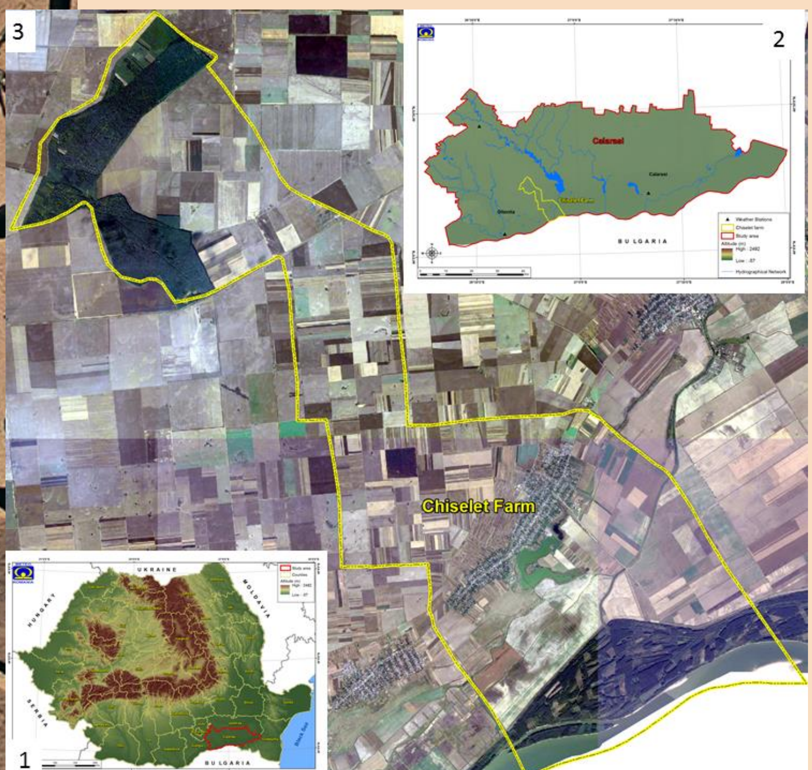
- *In agriculture, an accurate quantification of ET is important for effective and efficient irrigation management.*
- *In order to monitor the vegetation statement, the medium and high resolution satellite images can be used to obtain the dedicated vegetation indexes and daily evapotranspiration. These indexes are good indicators of drought and they are used also by the scientific community (European Drought Observatory).*
- *The LANDSAT 5 TM data: 7 spectral bands, with 30 m spatial resolution (thermal band (6) has 120 m spatial resolution).*
- *Landsat 7 ETM+ data: the main features are: a panchromatic band with 15 m spatial resolution (band 8); visible bands in the spectrum of blue, green, red, near-infrared (NIR), and mid-infrared (MIR) with 30 m spatial resolution (bands 1-5, 7); a thermal infrared channel with 60 m spatial resolution (band 6).*
- *Landsat 8 OLI data: the main features are: a panchromatic band with 15 m spatial resolution (band 8); visible bands in the spectrum of blue, green, red, near-infrared (NIR), and mid-infrared (MIR) with 30 m spatial resolution (bands 1-9); two thermal infrared channels with 100 m spatial resolution (bands 10 and 11).*

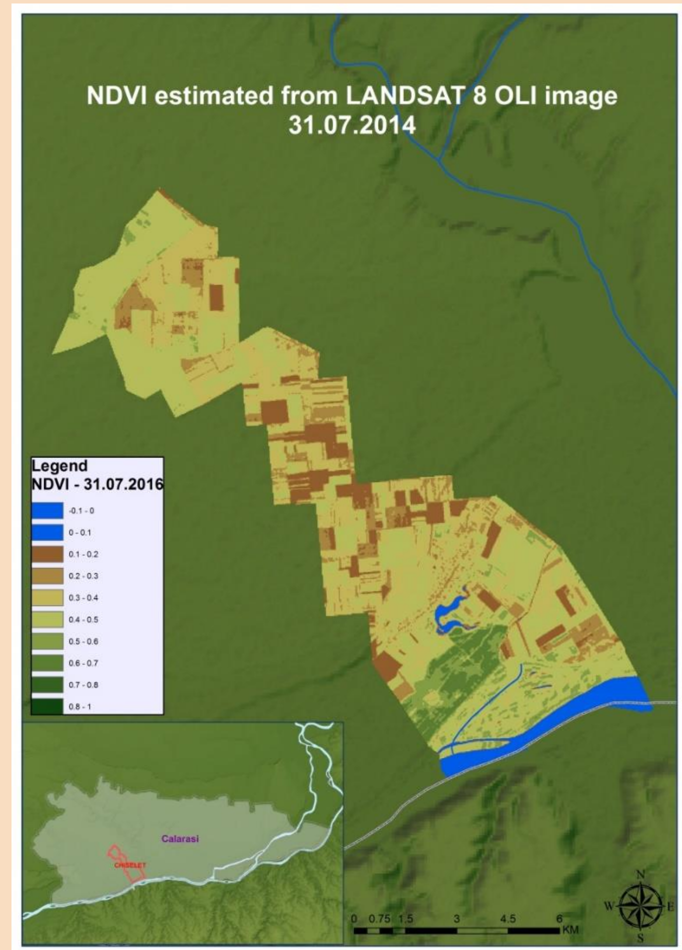
# D1.3.Remote sensing data used to estimate evapotranspiration

***ROMANIAN DEMO AREA***

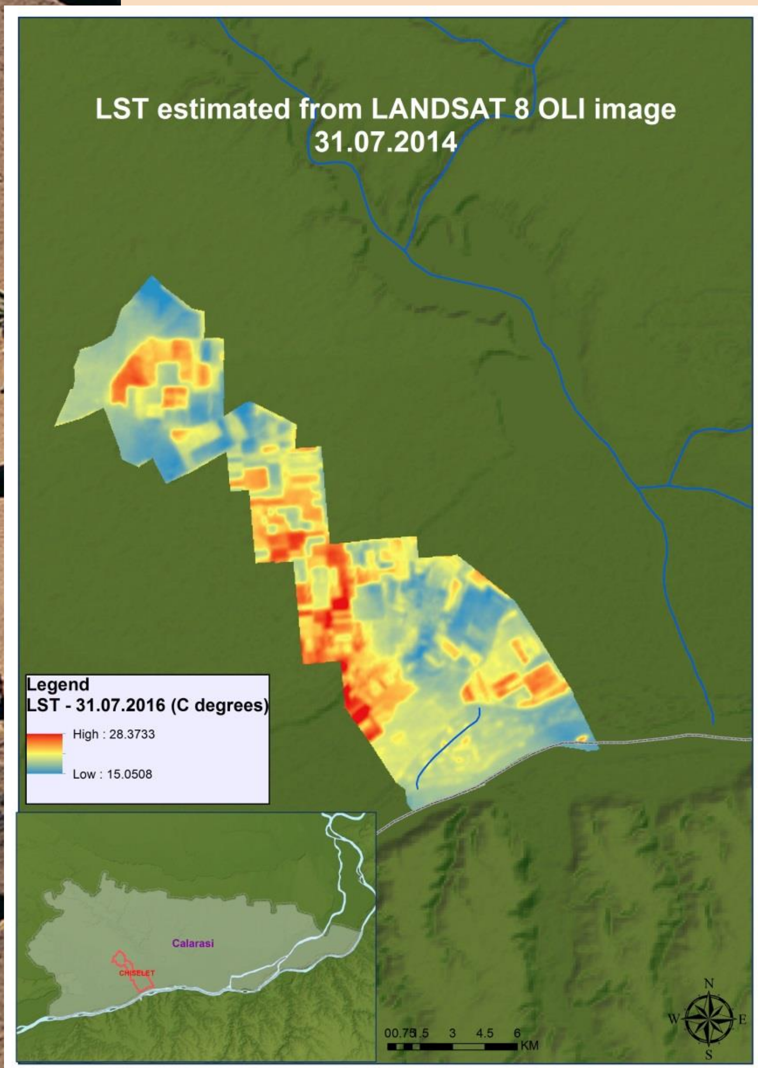
- *Calarasi County / Chiselet farm*
- *Total area: 6.000 ha*
- *Cereal crops: winter wheat, barley, rape, maize, sun-flower*
- *Irrigated area: 300 ha*

*NDVI is an indicator of presence, density and health of vegetation compared to a pixel; the positive values are colored in shades of green to dark green and negative values are colored in shades from yellow to brown, indicating a lack of vegetation or bad health. Blue color indicates water bodies.*

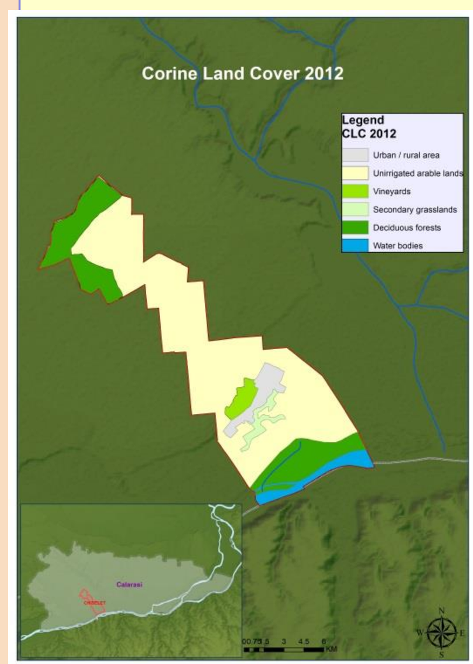


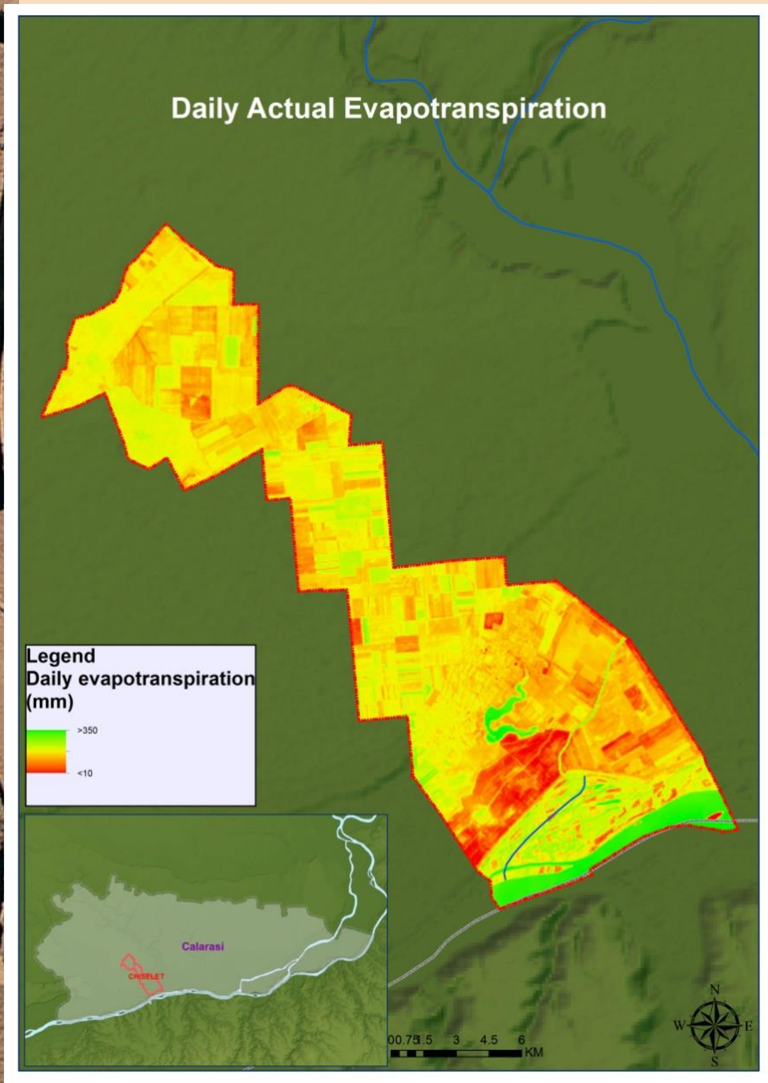
# *D1.3.Remote sensing data used to estimate evapotranspiration*



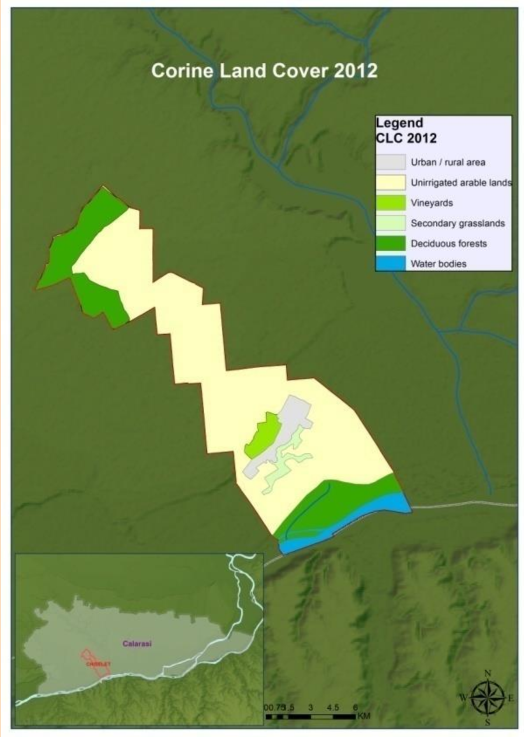

*Land surface temperature (LST) is one of the key parameters in the physics of land surface processes from local through global scales.*
*The high values are colored in shades of red to orange green and low values are colored in shades from blue to yellow.*
*Comparing with CLC 2012, the high temperature values are recorded over the arable lands.*



# *D 1.3.Remote sensing data used to estimate evapotranspiration*




***Daily actual evapotranspiration estimated using SEBAL model***
***Demo Area / Chiselet farm***



# WP2: Plant and soil water status determinations

***D2.2. Procedures for determining representative location within a field when measuring soil and plant water status***

- ***Agrometerological data:*** *Soil moisture measurements and phenological crops data (data since 1971-now)*
- ***Cereal crops:*** *winter wheat , barley, rape, maize, sun-flower*

# WP3: Big-data analysis and DSS development

***D3.1. Report on routines and algorithm for big-data analysis and images processing***
***NMA – a Report of the Demo area conditions including historical climatic data analysis and satellite-derived products / end of 2016***

***D3.2. IRIDA DSS available in cloud server with demo facilities available***
***NMA - Demo Area / meteorological warnings and forecasts for short (24 h and 3 days) and medium term (5-10 days) and seasonal (1-3 months) based of the ECMFW data and NWP run by NMA (COSMO and ALARO)***

***D.3.3. Smartphone Apps for Android and iOS***
***NMA- design a specialized module based of the meteo forecasts/warnings***


# *CONCLUSIONS (1)*

- ***A high variability of the mean water supply regime for the both crops in the different phenological phases with regional differentiations.***

- ***The south, south-eastern and eastern regions are the most affected by extreme and strong pedological drought in Romania, especially during the summer time for maize crop.***

-***The mean regime with extreme and strong drought for maize is wide, encompassing the whole of the country's south-east in July, expanding in August over the south of the country also and sparsely in the west.***

- ***As regards the general trend, there are differences between the two crops and between the different phenological phases.***

- ***For winter wheat :***

***a)*** *a significant upward trend over the almost entire country (September) and restricted areas for May and June (central, north and southwest parts)*

***b)*** *a significant upward shift around 1994 towards satisfactory or even optimum water supply conditions around 1994 for September.*

- *Hydric stress due to pedological drought was consistently increasing in the past 30 years, both in duration and intensity, inducing negative effects on crop development and production in Romania.*

# D3.2. A Decision Support System in agriculture

## *Drought forecasts and warnings*

| Agromet station | Jan. | Febr. | Marc. | May | Jun. | Jul. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CALARASI | | | | | | | | | | | |

| Agromet station | Drought Risk level | Scenario / Estimation (ECWMF) / updated weekly for the next 2 weeks or 1 month) |
|---|---|---|
| CALARASI | Very low | |
| | Medium | |
| | High | |
| | Extreme | |

# *WP4: Validation and agronomical and environmental impact assessment*

*D4.1 Agronomic validation of the IRIDA protocol for scheduling precise full and deficit irrigation based on plant and soil water status information.*
*D4.2 Agronomic validation of the IRIDA protocol for scheduling precise full irrigation based on crop modelling and weather forecasts.*
*D4.3 Environmental assessment of the IRIDA protocols based on water balance predictions for mitigating impacts of extreme weather in mixed agro-forestry systems.*

*NMA / D. 4.2.**Climatic scenarios:***

*- observed shifts (historical climatic data / 1961-now) of the air temperature, rainfall and extreme phenomena (e.g. heat waves, heavy rainfall)*

*- CC scenarios: CMIP5 and EURO-CORDEX numerical experiments (RCP 2.6, RCP 4.5, RCP 8.5)*

*- 2021-2050 vs.1970-2000*

*- End Users' interface and application to exploit solution intelligence: i.e. **Digital weather risk atlas** as web based tool providing visualizations of historical climatic data and indicators for the demo area*

# IRIDA – Economic and Environmental Impacts

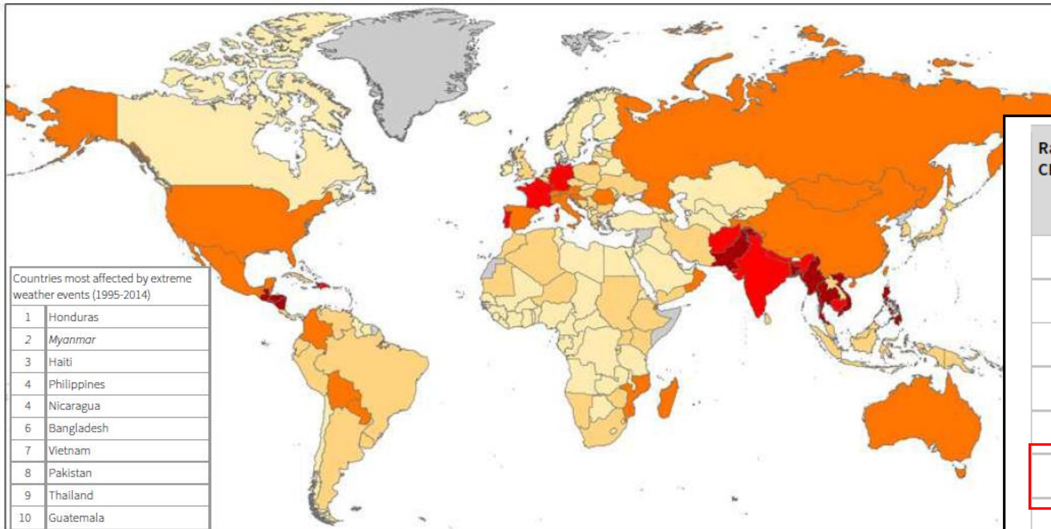
| Country | Agro-ecosystem | Current and expected water applications after applying the IRIDA protocols. | Economic impacts due to water savings, and environmental impacts. |
|---|---|---|---|
| **Romania** | • **Cereals crops** (winter wheat, barley, rape and maize).<br>• Irrigated area is 2.900 ha | • Current: 3.650 to 5.500 (m$^3$/ha)<br>• Expected after IRIDA: 3.250 to (4.950 m$^3$/ha) | • -216 to 270 €/ha (considering water prices of 0.36 €/m$^3$).<br>• -12% fertilizers use |

# *WP5: Dissemination and market exploitation*

*D5.1 Project web page fully operative and functional*
*D5.2 Report on potential targeted market for IRIDA DSS exploitation and commercialization plan including pricing strategies*
*D5.3 Report on the open-day carry out at the 4 demo sites in Spain, Italy, Romania and Norway with a list of first potential customers*
*D5.4 After project life plan including identification of R&D project calls of interest*

*NMA – Scientific conferences and SCI Journals*
*- National and international level*
*- A business model among practitioners/farmers in the Demo area and other areas vulnerable to CC in Romania to extent the project results*

# RISK CLIMATIC INDEX (CRI) / 1995-2014




*Cursive: Countries where more than 90% of the losses/deaths occurred in one year/event*

**Climate Risk Index: Ranking 1995 – 2014**

1 - 10 | 11 - 20 | 21 - 50 | 51 - 100 | > 100 | No data

**Figure 1: World Map of the Global Climate Risk Index 1995–2014**

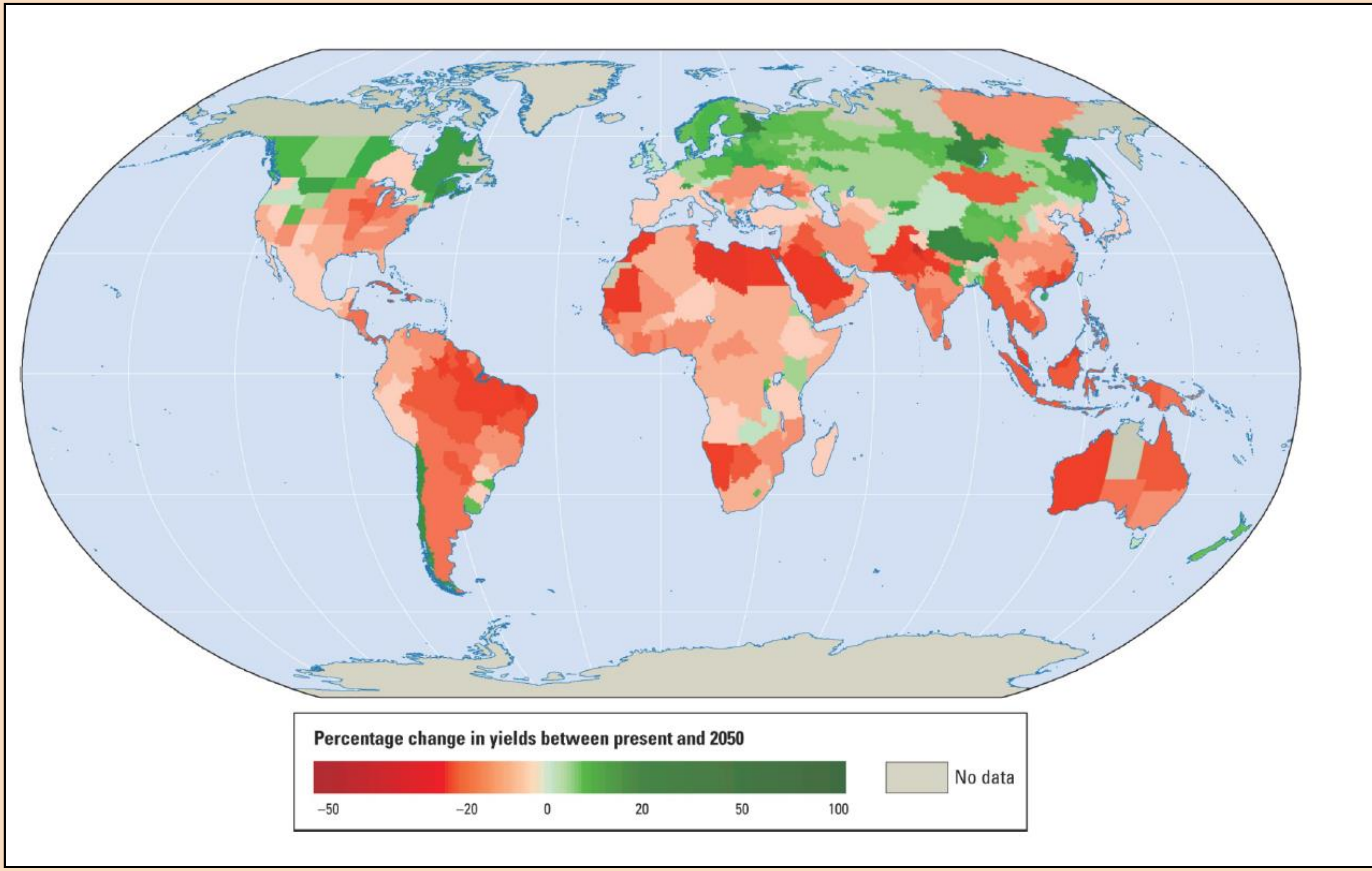
Source: Germanwatch and Munich Re NatCatSERVICE

*The most affected 15 countries in Europa / 1995-2014*

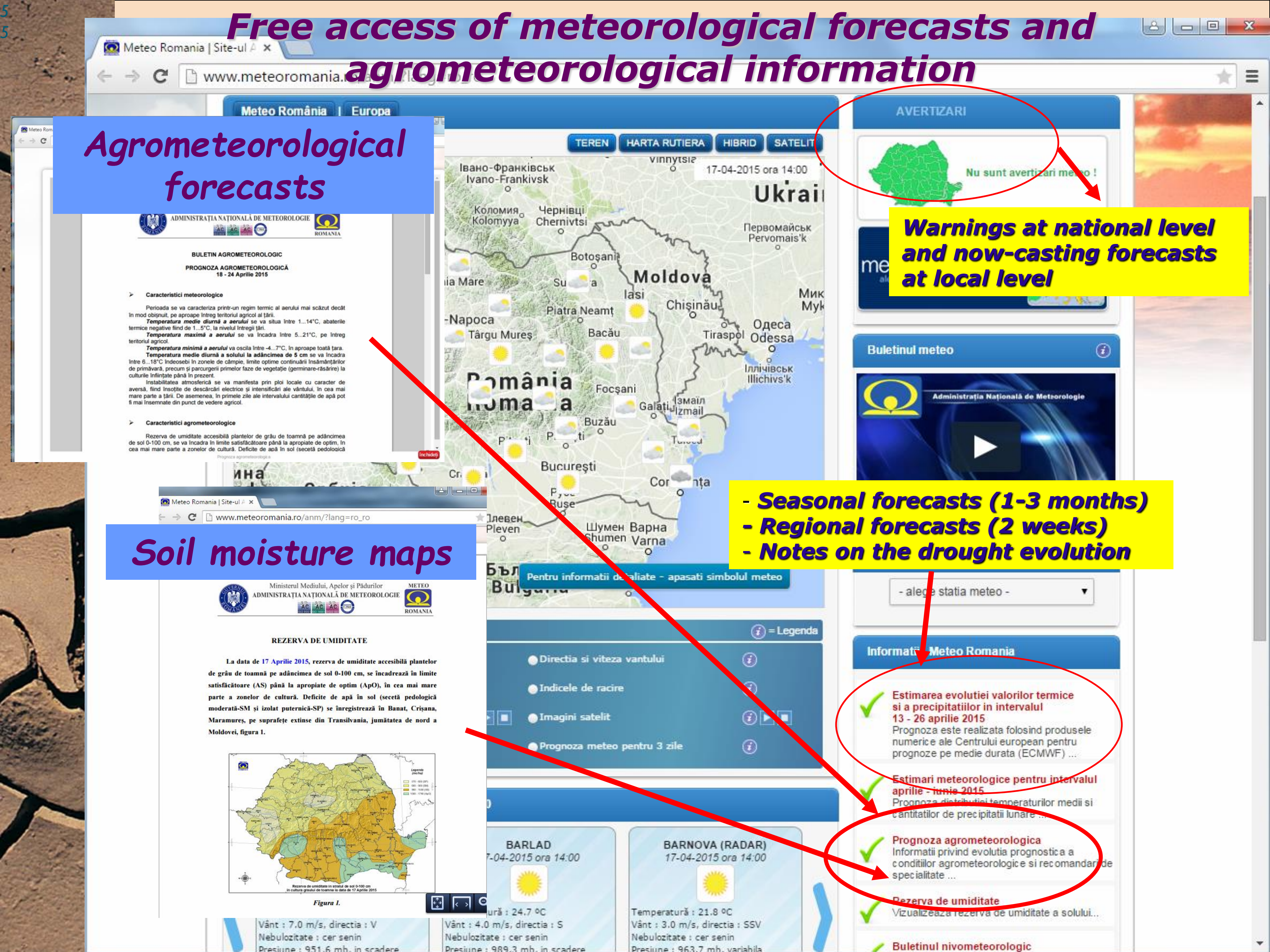
| Ranking CRI | Country | CRI score | Death toll | Deaths per 100 000 in-habitants | Absolute losses (in million US$ PPP) | Losses per unit GDP |
|---|---|---|---|---|---|---|
| 18 | Germany | 41.50 | 476.20 | 0.5816 | 3 446.096 | 0.120 |
| 19 | France | 41.83 | 958.65 | 1.5786 | 1 928.116 | 0.095 |
| 19 | Portugal | 41.83 | 143.85 | 1.3846 | 365.557 | 0.149 |
| 21 | Russia | 44.33 | 2 951.30 | 2.0376 | 2 171.603 | 0.068 |
| 24 | Italy | 45.33 | 999.80 | 1.7236 | 1 446.682 | 0.077 |
| 28 | Romania | 46.67 | 58.15 | 0.2713 | 1 144.896 | 0.328 |
| 30 | Croatia | 49.50 | 35.35 | 0.8120 | 158.361 | 0.204 |
| 33 | Spain | 50.00 | 702.85 | 1.6264 | 864.599 | 0.067 |
| 35 | Switzerland | 51.17 | 55.40 | 0.7429 | 401.563 | 0.114 |
| 36 | Slovenia | 52.50 | 12.05 | 0.5999 | 123.461 | 0.258 |
| 49 | Austria | 59.50 | 25.45 | 0.3111 | 485.587 | 0.159 |
| 58 | United Kingdom | 65.17 | 155.00 | 0.2559 | 1 469.249 | 0.077 |
| 60 | Hungary | 67.33 | 34.90 | 0.3449 | 216.070 | 0.107 |
| 61 | Poland | 68.17 | 53.80 | 0.1406 | 899.529 | 0.139 |
| 62 | Belgium | 69.00 | 86.15 | 0.8178 | 148.179 | 0.039 |

*(Source: The Global Climate Risk Index – 2016 / Germanwatch, www. germanwatch.org/en/cri*
*German Federal Ministry for Economic Cooperation and Development - BMZ*

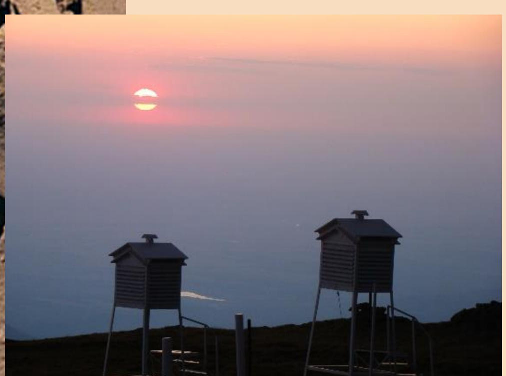
*Drought events, heat waves, floods, … / decreasing in the agricultural production at global level*
*-20 ….-50% in 2050 vs. 2015*




*CC impacts on agricultural production in 2050 vs. 2015*
*(Source: The Global Risk Report, World Economic Forum – 2016, 11th Edition)*


Free access of meteorological forecasts and agrometeorological information
Agrometeorological forecasts
Soil moisture maps
Warnings at national level and now-casting forecasts at local level
- Seasonal forecasts (1-3 months)
- Regional forecasts (2 weeks)
- Notes on the drought evolution
Meteo Romania | Site-ul
www.meteoromania.ro/anm/?lang=ro_ro
Meteo România | Europa
TEREN
HARTA RUTIERA
HIBRID
SATELIT
AVERTIZARI
Nu sunt avertizari meteo !
Buletinul meteo
Administrația Națională de Meteorologie
- alege statia meteo -
Informatii Meteo Romania
Estimarea evolutiei valorilor termice si a precipitatiilor in intervalul 13 - 26 aprilie 2015
Prognoza este realizata folosind produsele numerice ale Centrului european pentru prognoze pe medie durata (ECMWF) ...
Estimari meteorologice pentru intervalul aprilie - iunie 2015
Prognoza distributiei temperaturilor medii si cantitatilor de precipitatii lunare ...
Prognoza agrometeorologica
Informatii privind evolutia prognostica a conditiilor agrometeorologice si recomandari de specialitate ...
Rezerva de umiditate
Vizualizeaza rezerva de umiditate a solului...
Buletinul nivometeorologic
Pentru informatii detaliate - apasati simbolul meteo
= Legenda
Directia si viteza vantului
Indicele de racire
Imagini satelit
Prognoza meteo pentru 3 zile
BARLAD
17-04-2015 ora 14:00
BARNOVA (RADAR)
17-04-2015 ora 14:00
Temperatură : 21.8 ºC
Vânt : 3.0 m/s, directia : SSV
Nebulozitate : cer senin
ADMINISTRAȚIA NAȚIONALĂ DE METEOROLOGIE
BULETIN AGROMETEOROLOGIC
PROGNOZA AGROMETEOROLOGICĂ
18 - 24 Aprilie 2015
Caracteristici meteorologice
Caracteristici agrometeorologice
Ministerul Mediului, Apelor și Pădurilor
ADMINISTRAȚIA NAȚIONALĂ DE METEOROLOGIE
REZERVA DE UMIDITATE
La data de 17 Aprilie 2015, rezerva de umiditate accesibilă plantelor de grâu de toamnă pe adâncimea de sol 0-100 cm, se încadrează în limite satisfăcătoare (AS) până la apropiate de optim (ApO), în cea mai mare parte a zonelor de cultură. Deficite de apă în sol (secetă pedologică moderată-SM și izolat puternică-SP) se înregistrează în Banat, Crișana, Maramureș, pe suprafețe extinse din Transilvania, jumătatea de nord a Moldovei, figura 1.
Figura 1.





Thank you for your attention!

elena.mateescu@meteoromania.ro