INFRASTRUCTURAL AND INSTITUTIONAL CAPABILITIES FOR CLIMATE SERVICES AND GLANCE AT WMO REGION VI

Mesut DEMIRCAN

MSc. in Physical Geography
Geodesy & Photogrametry Engineer
Turkish State Meteorological Service
Research Department
Climatology Division
e-mail: mdemircan@mgm.gov.tr

A. The Climate for Whose:

Climate products have different meanings for the users from every sector. For this reason, each user community tends to a different product. For example, scientists interest in such climate products which consist of climate variability from past to present, oscillation range and the extreme conditions, comparison of past, present and the future climate conditions. In this context, products; which shows oscillation and changes in climate, comparing with today's climate and long term normal as monthly and annual assessment in local and global scale with the standard time periods and what is the climate and climatic parameters from the beginning of the world, are used in scientific studies.

Public and sectorial user community show more interest in another class of climate products such as seasonal and monthly forecasts and the secondary climate products such as cooling and heating degree days, heat index and drought and so on and they use these products for planning their works. For example, 'What will happen' is very important than 'What happened' for the energy sector to plan future energy use and agricultural sector to plan stages of agricultural production. However, sectors such as insurance especially interest in records of extreme weather events when they occurred. And also long term climate data are demanded by sectorial user while planning and building industrial plants, solar and wind energy farms, dams, airports and so on. This issue can be seen also in recommendations of Fifteenth session of the Commission for Agricultural Meteorology (CAgM) "the Commission recommended the implementation of tools and services aimed at multiple stakeholders and for assisting with risk management. Tools and services should address long-term (strategic), seasonal (tactical) and short-term (operational) forecasting and the distinct differences between these services. Service delivery should assume a basic minimum access to ICT and should build up from the minimum in a progressive manner (paragraph 4.27 WMO-No. 1062)".

Scenarios of global and regional climate models are used mostly by scientists and decision-makers, governments, intergovernmental and international structures for one or more decadal planning (fig. 1).

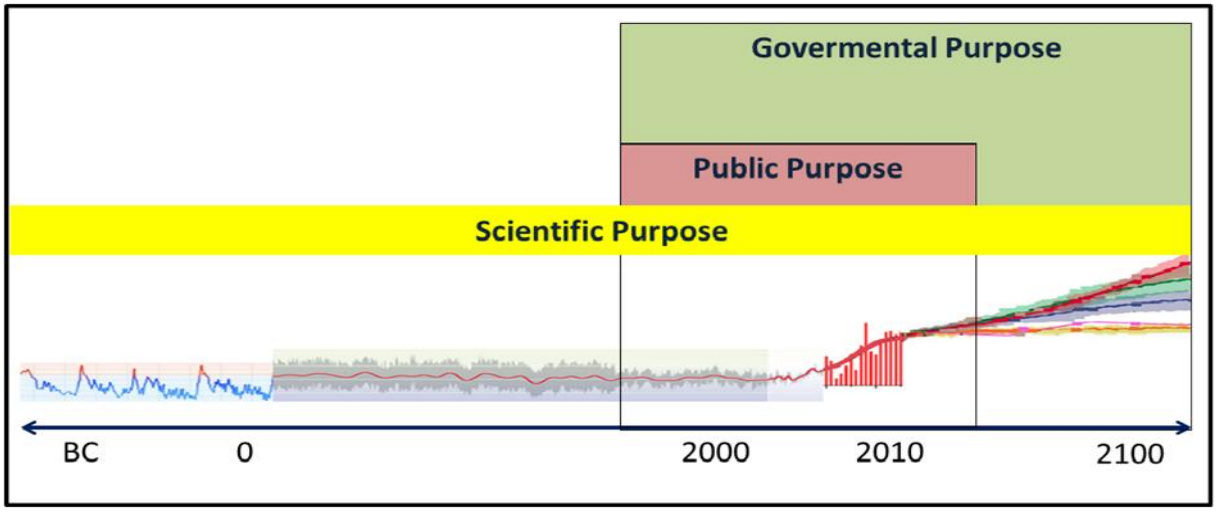


Figure.1 Users for climate monitoring products.

B. The Climate Products Features:

B.1 Standard Period:

In order to speak on climate, first of all, it is required to have observations of climate variables and series of observed climate variables. Reliable data sets are needed to make accurate climate analysis. If we make this analysis on a large scale such as countries, continents and the world, it needs to use the standard periods, and i.e. observations must have a common period.

It is one of challenges in climate analyzes from the early and mid1800's to today which instrumental observations began in, both the lack of global distribution and adequate number of observation stations and continuously changing in measurement systems. There are useful studies to overcome from these difficulties to derive climate data base such as tree rings, isotope techniques etc. which are methods the paleo-climatology, and also data recovery efforts, satellite climatology, re-analysis products of forecasting models.

On the other hand, there are difficulties in using the standard periods due to the climate observations have not begun at same times in every country. Moreover, observation network may not be operated and observations may be interrupted because of the economic challenges, wars, and political turmoil and so on. However, the standard periods of 1961-1990, 1971-2000 or 1981-2010 can be used together with or separately according to most common period inside of countries.

In case of selecting one of these standard periods, it must be drawn attention of National Meteorological Services to the importance of preparing of a homogeneous data sets for selected period. Another tool for normal's data sets of the standard period may be database which derived from re-analyzed data sets or model outputs (fig. 2).

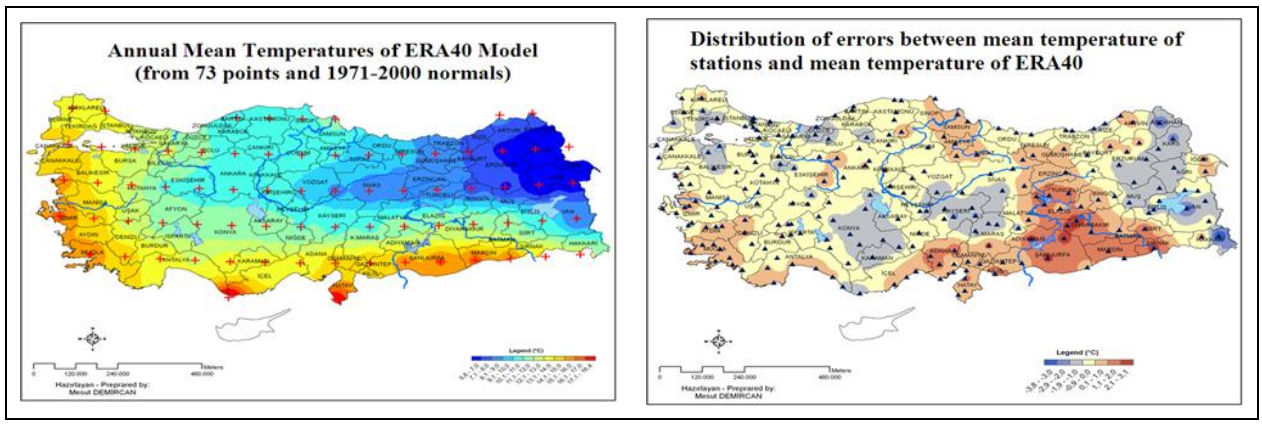


Figure2. 1971-2000 average temperature of ERA40 re-analysis data set of the European Centre for Medium-Term Weather Forecasts (ECMWF) which has created for the Turkey and differences between observations. ERA40 has been produced from different sources of meteorological observations by the ECMWF Integrated Forecast System (IFS) (which have 1,125° (~125km) resolution and topography ranging from50m to 2500m for Turkey)(Demircan, M. et al., 2011).

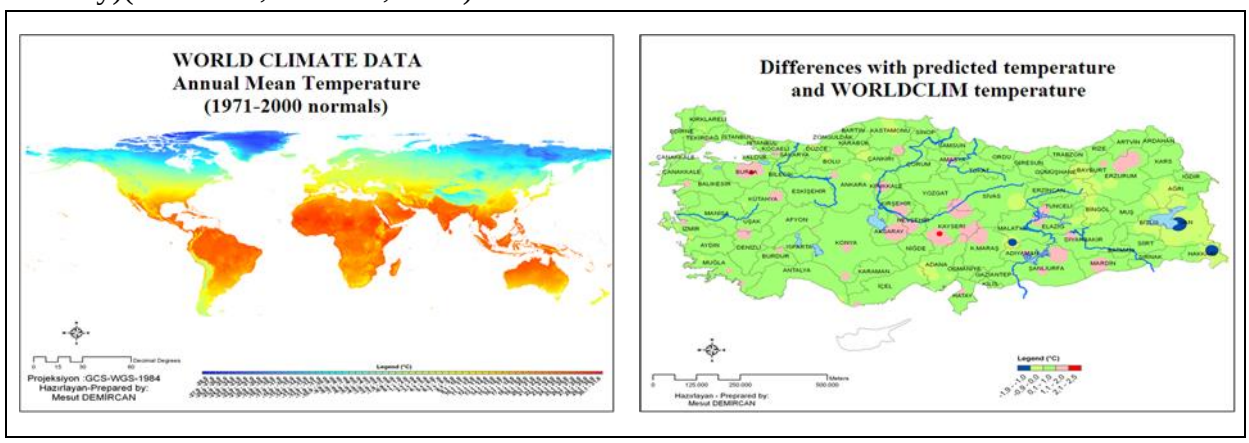


Figure3. 1971-2000 average temperature of Global Climate Data (WorldClim) and differences between predicted temperatures for Turkey(which have 30 arc second (~1km) resolution and topography ranging from 0–3730m for Turkey)(Global Climate Data; http://www.worldclim.org) (Demircan, M. et al., 2011).

B.2 Climate Products Features:

Temperature and precipitation are most common climate products prepared by NMHS. NHMS also prepares wind, sunshine duration, radiation, snow and other climate variables products according to demands of stakeholders. Seasonal and monthly forecasts and secondary climate products such as extreme events, cooling and heating degree days, heat index and drought and so on are also prepared according to capacity of NHMS. Table, report, data, graphic, map and bulletin formats are used as climate products formats with one or more and separately or together.

While analyzing of a climate parameter; must be evaluated together with the normal period, the normal value, deviation of the normal value, the lowest and the highest value. For example, while analyzing temperatures of a month or a year, it can be seen normal trend in temperature but also it can consist of extreme cold or heat at same time. If we produce only

temperature normal product we do not make a true assessment for temperature. Nevertheless, that appears in recent years, a month can be seen wet after heavy rains which fall down in one or two days with above normal. In today's general findings, while temperature and precipitation do not show an excessive increase in their normal, they show an increase in their extreme events (fig. 4).

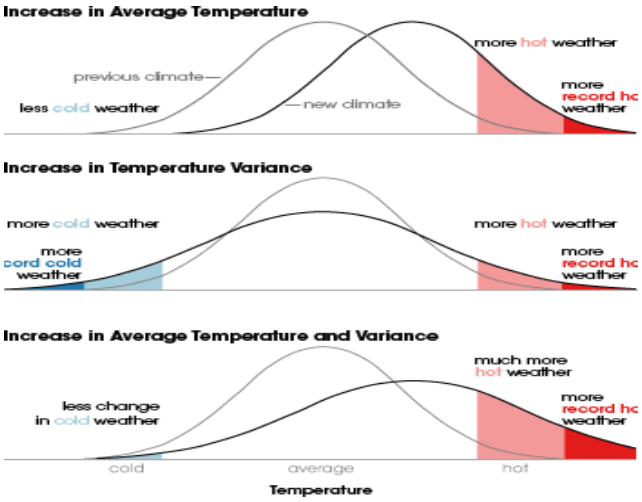


Figure4. Increase in average temperature, temperature variance and together (http://hot-topic.co.nz/when-the-rain-comes/)

B3. Sectoral Climate Products:

In generally stakeholders (i.e.; users, governments and climate related all sectors) follow up NHMS's standard climate products and they take into account in their works. Especially they interest in seasonal and monthly forecasts and the secondary climate products or specialized climate products. Unfortunately, they could not use directly in their works in sometimes due to time interval and format of climate products. Stakeholders demand time interval for climate products nearly one or two decade connected with current time i.e. 1990 – 2015 or 1985 – 2014 and this is different from climate products standard normal i.e. last climate normal is 1981 – 2010. Generally observation point's information is not enough for stakeholders and they want to spatial information which is basically produced by interpolation or comprehensively produced by modelling. Stakeholders demand digital format such as shape (one of GIS formats) to insert products directly their works.

Specialized climate products are based on threshold values for climatological parameters. These threshold values related with sectoral use and critic values for their purpose. Thresholds especially are important for future sectoral planning to combat with climate change in adaptation and mitigation plans (fig. 5, 6).

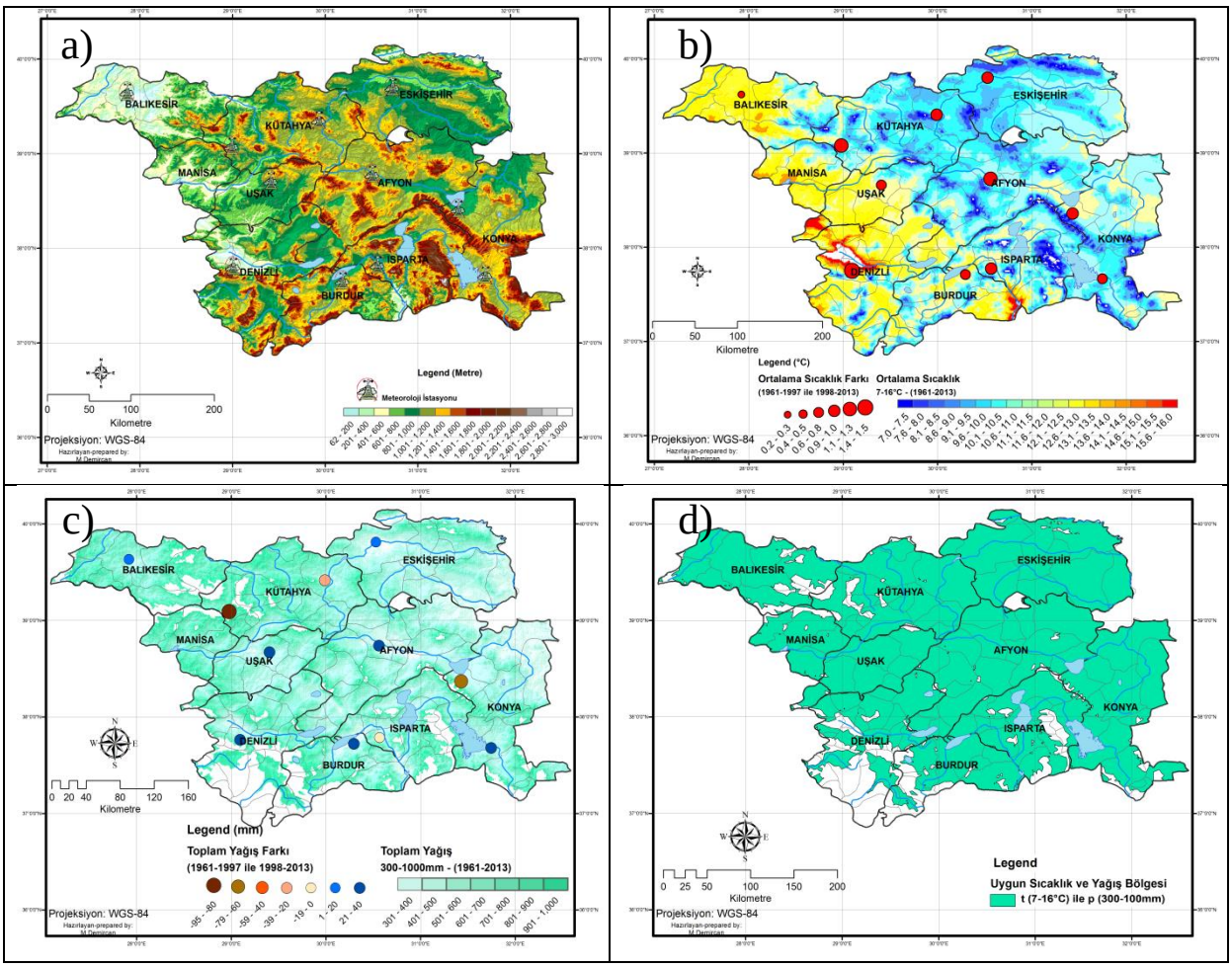
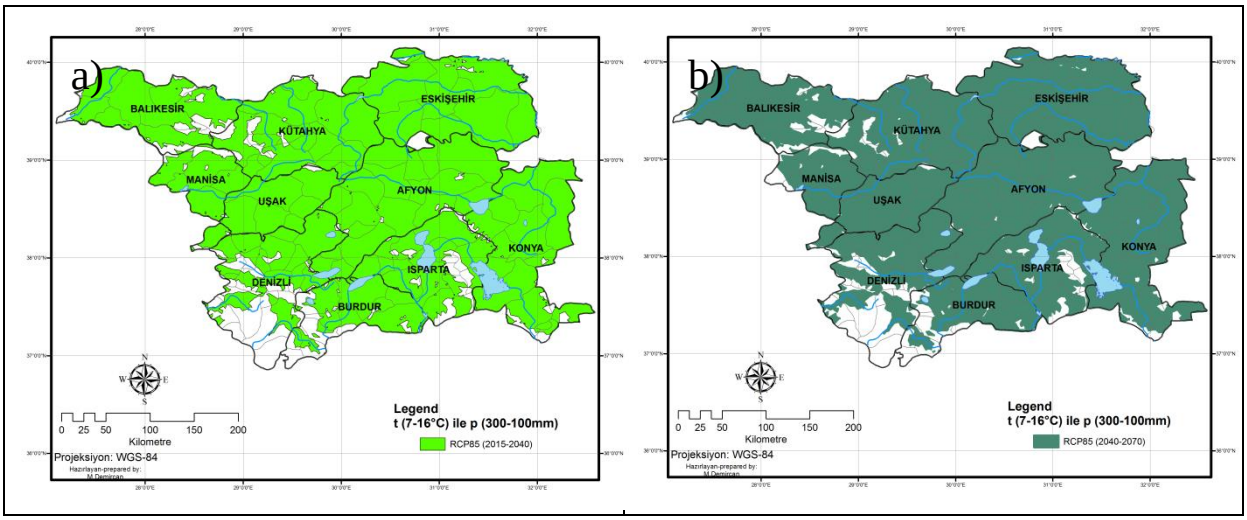


Figure5. Region topography and station place (a) and Possible areas where poppy can be grown are shown depending on temperature (b, temperature in range of 7-16°C), rainfall (c, precipitation in range of 300-1000 mm) and topography. Intersections of two layers, according to the long-term climatological parameters are determined as Poppy's life region (d). Dots show differences between time series mean 1961 – 1997 and 1997 – 2013 for temperature and precipitation (Yildirim et.al, 2015)



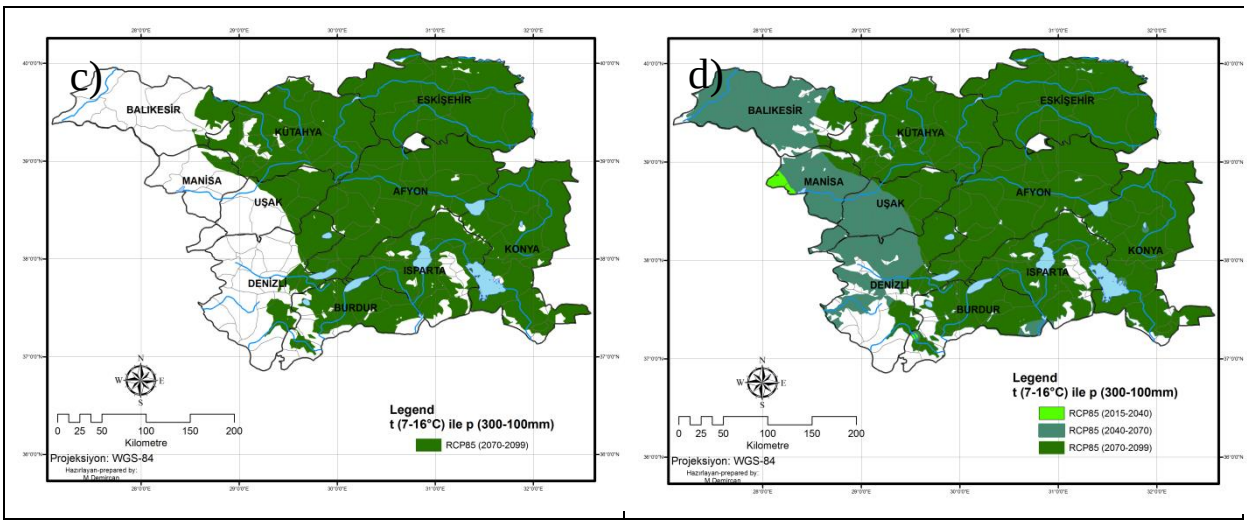


Figure6. Using temperature and precipitation projections for 2015-2040, 2040-2070 and 2070-2099 periods, possible changes are shown in poppy cultivation areas for the future. HadGEM-2ES RCP8.5 period for 2015-2040 (a), period for 2041-2070 (b), period for 2071-2099 (c), intersections of all layers (d) (Yildirim et.al., 2015)

C. The Institutional Location of Climate Services:

Climate services are categorised according to types of climate products. These are basic (Cat 1), essential (Cat 2), full (Cat 3) and advanced (Cat 4) according to (GFCS, 2014). Types of climate products can be seen in (fig.7). Most of national climate service providers are take place in basic to essential category and approximately one third in full to advanced category (fig.8).

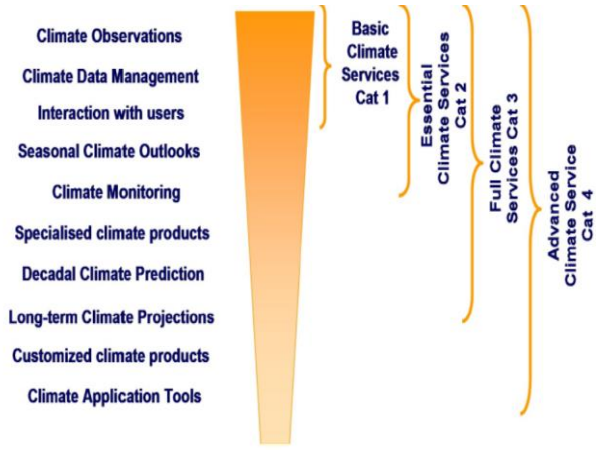


Figure7. Types of climate products and services by category of national climate service provider (GFCS, 2014)

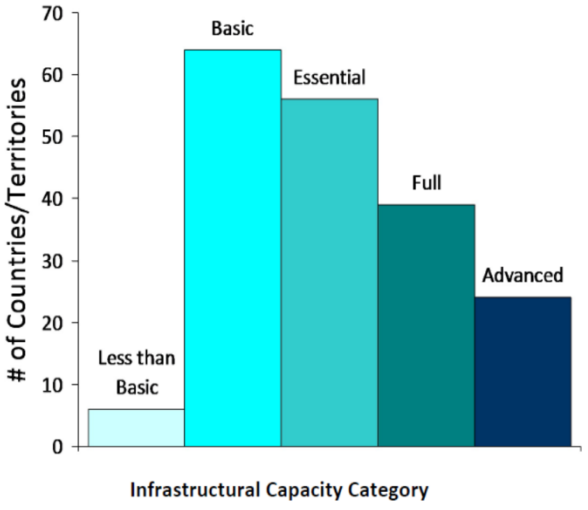


Figure8. Profile of national climate service providers as a function of category, October 2010 (GFCS, 2014)

Climate has a relation and intersection with other branch of science such as meteorology, hydrology and agriculture and so on. Climatology uses meteorological data and

produces climate products such as precipitation, drought, extreme events, heat wave and monthly-seasonal forecast. At same time these products are produced by different services in NHMS. Climate services take place as roof structure such as department in some institutions or as a division under department. For example if the climate service has a department statue other branches such as observation, data management, monitoring and prediction take place as a division even agro-climatology/meteorology or hydro-climatology/meteorology. As a result of this these, all proses from observation to monitoring products and forecast products are prepared by climatological logic. In other circumstance if the climate service is a division in a department with other division hydrometeorology, agro-meteorology and so on, products are distributed to divisions for example precipitation prepared by hydrometeorology and drought monitoring prepared by agro-meteorology. In these case products may not be prepared in climatological logic.

D. Climate Products Training and Tools:

Training of climate services personnel, it has got great importance for national and global climate observations and climate monitoring products. In this regard, WMO Regional Training Centers (WMO RTC) can be used to provide training for climate service of NHMSs. Through this training, climate monitoring products can gain a standard format in all NHMSs. In this process, WMO must take an active role both training of RTC trainer, supplying of training document to RTC and providing financial support to trainees in developing or least developed countries (fig.9).

Figure9. Training course on Climate Applications was held in 7 June 2010 in WMO RTC Alanya Facility, Antalya, Turkey by TSMS.

WMO has prepared some guide and technical documents, these are

1. Guide to Climatological Practices, WMO-No. 100, 2011 (http://www.wmo.int/pages/prog/wcp/ccl/guide/documents/WMO_100_en.pdf)
2. Compendium of Lectures Notes in Climatology for Class III and Class IV Personnel, WMO-No. 726, 1992 (https://drive.google.com/file/d/0BwdvoC9AeWjURk5MT0dUVDF4eW8/edit)

3. Introduction to Climate Change: Lecture Notes for Meteorologists, WMO-No. 926, 2002 (http://www.wmo.int/pages/prog/dra/etrp/documents/926E.pdf)
4. On the Statistical Analysis of Series of Observations, WMO-No. 415, 1990
Documents are old as seen from publications date except Guide to Climatological Practices and they needs to update according to development in science and computer technology.

Today, there are many tools that climate monitoring products can be made with them. Especially, programs that produced under the name of Geographic Information Systems (GIS), are more skilful to make simple climate monitoring products as well as detailed product through modelling. WMO must take an active role supplying of program and it's training and training tools to developing or least developed countries. There is large number of GIS and mapping programs and model that leads to produce maps in many different formats. So it needs identification of the standard format for digital maps (fig.10).

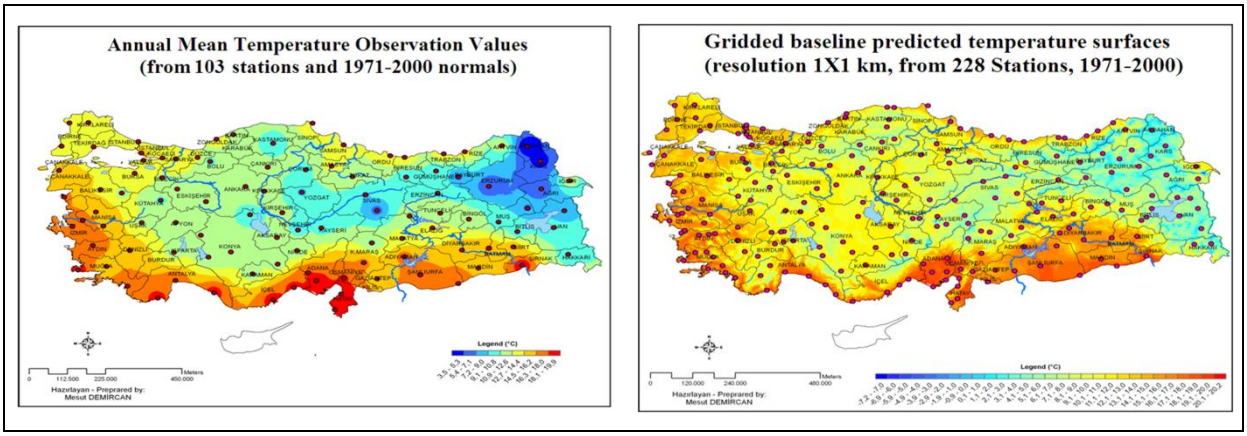


Figure10. Turkey temperature and modelling temperature map is produced by ArcGIS (Demircan, M. et al., 2011).

E. Recommendations for Climate Products:

1. National and global assessments must be done with comparing standard normal, and must be consisted extreme values since the beginning of the observation .
2. To be used products and analysis by national and global users, presentation should be made with at least one UN official language as well as the national language. The second language should be preferably in English.
3. Monthly and yearly analysis should be made containing at least temperature, rainfall and extreme events with extreme values. Essential climate variables which are recommended by WMO may also be useful to the entire analysis. Standard properties of climate products must be prepared by WMO CCl such as determining normal, calculate anomaly method, and area distribution method so on.
4. Climate products must be supported by secondary products such as climatic indices, heating and cooling degree days, heat index and drought monitoring.
5. Monthly and annual climate monitoring products and reports must be shared immediately with the Regional Climate Centers (RCC).

6. Monthly and seasonal climate forecasts should be done by climate service or RCC products can be used directly or with increasing the resolution of products. RCC and international forecast centers must be take active role in their region to support national climate services and to help them to improve national climate forecast products.
7. Regional climate models must be operated to downscale climate change scenarios by RCC leadership for own region and must be shared with the member countries. RCC should assist the member countries efforts to increase the resolution for their own regions.
8. Climate monitoring products must be serviced in digital map formats such as raster, netcdf or shape formats as well as picture format to users. So users can use easily in their own works.
9. It must be developed a common language between among climate services and users for climate monitoring products. CMPs must be promoted according to requirements of users such as mentioned in CAgM's report "As for regional climate change and variability impacts, the Commission acknowledged the need to standardize and adopt climate impact assessments at a regional level in order to identify common issues and find common solutions and comparable results e.g., impact of high temperatures on emergence and growth cereal crops (paragraph 4.74 WMO-No. 1062)".
10. Threshold values of climatological parameters for specialized climate products must be determined with sectoral representative together.

E. Glance at WMO REGION VI:

RA VI RCC-Network was formally designated as a WMO RCC-Network in May 2013.

There are 50 member countries in the WMO VI. Regional Association, which are mostly in Europe. Internet sites of these countries were examined. It cannot be reached website of 3 countries which are Albania, Lebanon and Syria. During the research, Google translator was used if countries have a website with only their own language.

E.1 RCC Implementation in WMO RAVI (Europe):

The RCC implementation in Europe (RA VI) was decided to be in the form of an RCC-Network, comprising of centres which provide regional level services according to their individual strengths, while making use of as many national level data and products as possible. Three RCC-Network Nodes have been established, which conducted their demonstration phase during the period 2009-13:

RCC-Network Node on Data Services (lead: The Netherlands)

RCC-Network Node on Climate Monitoring (lead: Germany)

RCC-Network Node on Long-range Forecasting (lead: Russia and France)

Each of these nodes is supported by a consortium of NMHSs of RA VI Member countries. RA VI RCC-Network is currently being coordinated by Germany. The network

approach has been chosen to ensure incorporation of as much competence and know-how as possible of the 50 RA VI Members (fig. 11, 12).

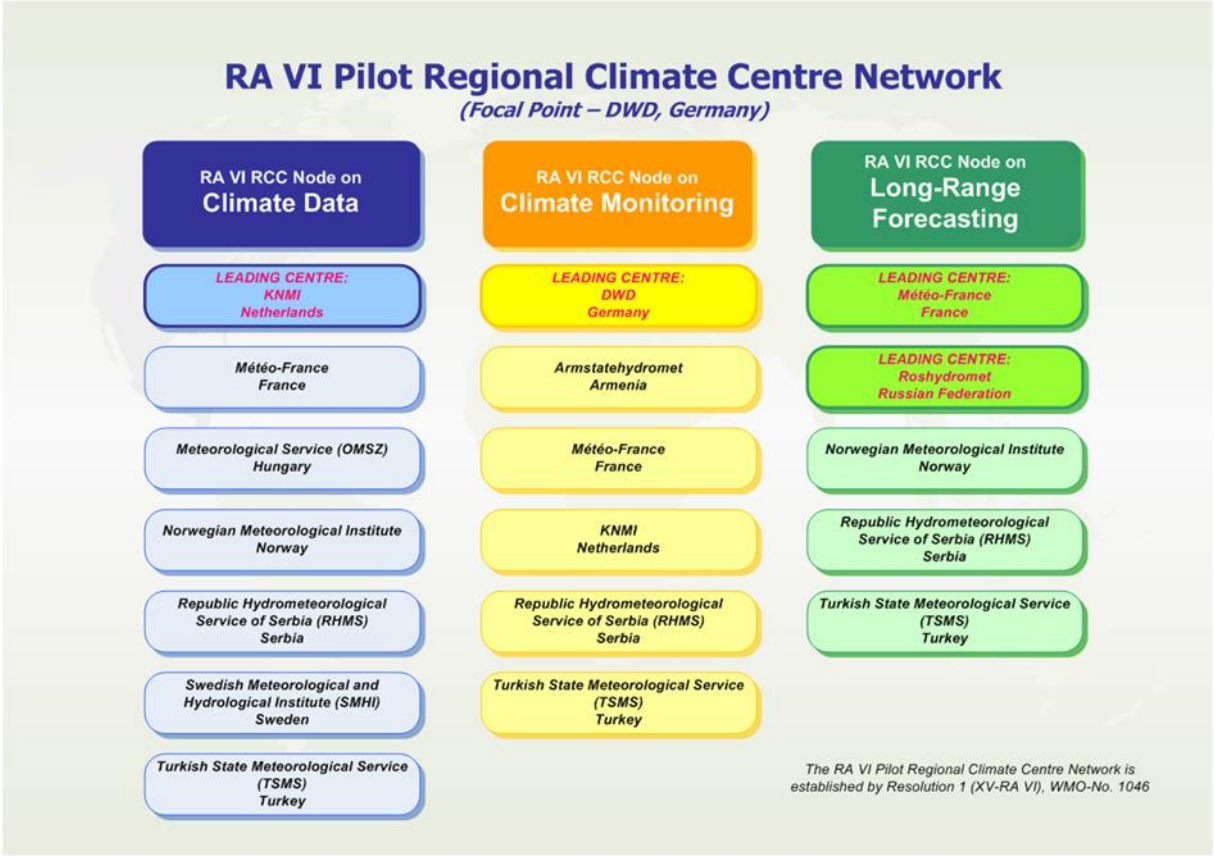


Figure11. WMO RA VI RCC-Network

The RA VI RCC-Network has successfully completed its demonstration phase and has been recommended by WMO Commission for Climatology (CCl) and Commission for Basic Systems (CBS) in September 2012 to be designated as a WMO RCC-Network. The recommendation was accepted by WMO Executive Council in May 2013, and RA VI RCC-Network was formally designated as a WMO RCC-Network.

(http://www.wmo.int/pages/prog/dra/eur/RAVI_RCC_Network.php ; http://www.rccra6.org/ ; Domain: All countries of RA VI)

The RCC Node on Climate Data provides operational data services to support climate services on long-range forecasting, climate modelling and climate monitoring by developing quality controlled regional data sets and providing database, archiving and data rescue services. The RCC Node on Climate Monitoring provides operational services for monitoring the climate system by i.e. climate diagnostics, historical reference climatologies at regional and sub-regional levels, and implementing a regional climate watch. The RCC Node on Long-range Forecasting provides operational services related to seasonal to inter-annual forecasts by interpretation of products from Global Producing Centres (GPCs), generating relevant regional and sub-regional products, and consensus statements on regional and sub-regional forecasts.

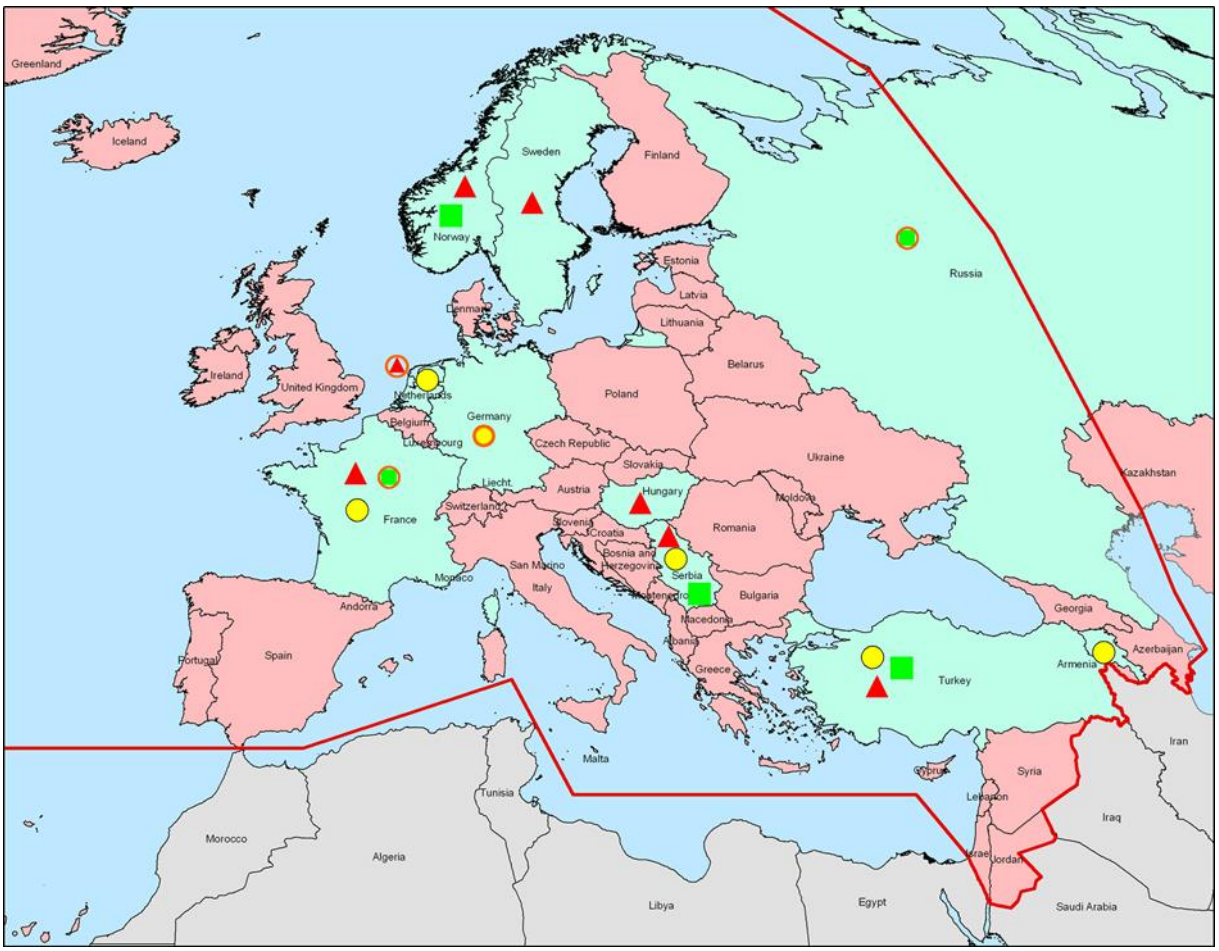


Figure12. The consortia of the 3 Pilot RCCs are in RA VI (RCC-DS – red triangle; RCC-CM – yellow circle; RCC-LRF – green square).

RCC-Network Node on Data Services: The European Climate Assessment & Dataset (ECA&D) forms the backbone of the climate data node in the Regional Climate Centre (RCC) for WMO Region VI (Europe and the Middle East) since 2010. The data and information products contribute to the Global Framework for Climate Services (GFCS). Indices of extremes; for every ECA&D station, a total of 75 indices have been calculated. Indices data are freely available for non-commercial research and education: see our data policy for more details. Each index describes a particular characteristic of climate change (both changes in the mean and the extremes). A core set of 26 indices follows the definitions recommended by the CCl/CLIVAR/JCOMM Expert Team on Climate Change Detection and Indices (ETCCDI). These indices are calculated in a similar way for other regions of the world. An additional set of 49 indices highlights particular characteristics of climate change in Europe (including snow depth, sunshine duration, etc.).

To learn more about the meaning and the way each index is calculated see the Indices dictionary. Products are time series plots, indices maps, E-OBS Indices maps, trend maps, anomaly maps, climatology maps and download indices data (ASCII)

The Regional Climate Centre Node on Climate Monitoring (RCC-CM): DWD has accepted the lead function of a Regional Climate Centre on Climate Monitoring (RCC-CM) of the World Meteorological Organization (WMO Regional Association VI Europe). It generates and distributes various climate monitoring products for the WMO Region VI which comprises Europe, Greenland, parts of the North Atlantic, the Mediterranean and the Middle East. Here some first products are offered:

- Description of outstanding weather events
- Maps of various climate quantities
- Monthly and annual climate reviews (RA VI Bulletin)

National products for individual countries within the WMO Region VI are provided by the National Meteorological and Hydrological Services of the concerning countries. DWD generates, beside the national products for Germany, also transnational maps and reports for the whole WMO Region VI, based on data and contributions from the countries.

The following national meteorological and hydrological services contribute to the RCC-CM consortium:

- Deutscher Wetterdienst, Germany (DWD, Lead)
- Armstatehydromet, Armenia
- Météo France, France
- Royal Netherlands Meteorological Institute (KNMI), Netherlands
- Republic Hydrometeorological Service of Serbia (RHMS), Serbia
- Turkish State Meteorological Service (TSMS), Turkey

The WMO RA VI Regional Climate Centre on Climate Monitoring (RCC-CM) will perform basic functions covering the domain of climate monitoring:

- Annual and monthly climate diagnostic bulletins,
- Monthly monitoring maps: global, RAVI, Eastern Mediterranean, South Caucasus,
- Reference climatologies and trend maps,
- RA VI climate monitoring WebPortal,
- Climate watches,
- Training; Research and Development (R&D).

RCC-CM provides products for the following climate variables which are temperature, precipitation, sunshine duration, drought, surface air pressure, cloud cover, water vapour content (precipitable water), radiation, snow, albedo and soil moisture.

Subregional Climate Centres:

- NEACC (North EurAsia Climate Centre)
- EMCC (Eastern Mediterranean Climate Centre)
- DMCSEE (Drought Management Centre for Southeastern Europe)

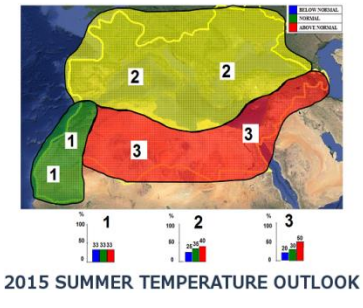
- SEEVCCC (South East European Virtual Climate Change Center)

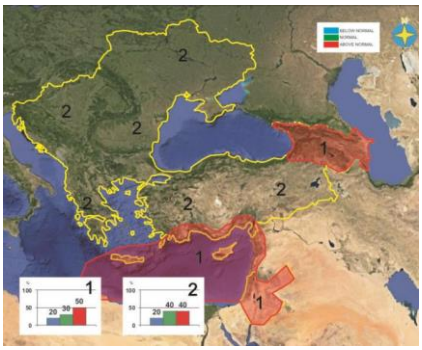
Other:

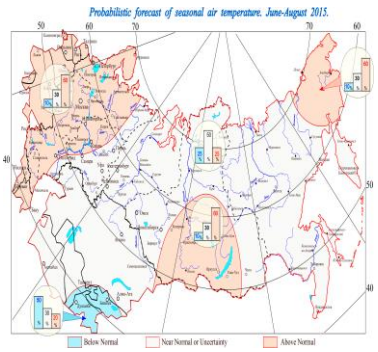
- ECA&D (European Climate Assessment & Dataset)
- ECSN (European Climate Support Network)
- ETCCDI/CRD - Software packages for data homogeneization and indices calculation
- Global Climate Monitoring (DWD)
- GPCC (Global Precipitation Climatology Centre)
- EUMETGRID
- EC Joint Research Centre: European Drought Observatory
- Arctic Report Card - Tracking recent environmental changes; Update for 2012
- SPEI Global Drought Monitor - Drought monitoring and analysis based on climatic indices
- GPCC Drought Index Product

E.2 Regional Climate Outlook Forums (RCOFs) in WMO RA VI

RCOFs in WMO RA VI are South-East European Climate Outlook Forum (SEECOF), North Eurasian Climate Outlook Forum (NEACOF) and Mediterranean Climate Outlook Forum (MedCOF). SEECOF was established in 2008 within the Action Plan of the WMO Regional Association VI Strategic Plan (2008-2011). NEACOF was established in March 2011 within the North-Eurasian Climate Centre. MedCOF was established in June 2013 at the MedCOF scoping meeting, hosted by the Spanish Meteorological Agency (fig. 13, 14 and 15).







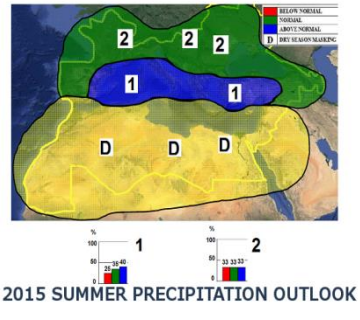


Figure13. MEDCOF 4

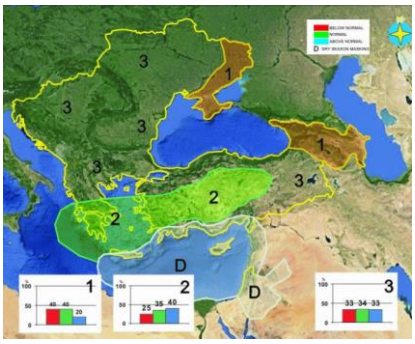


Figure14. SEECOF 13

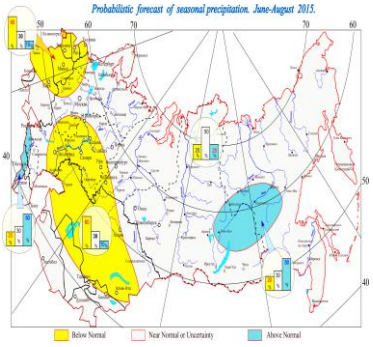


Figure15. NEACOF-8

E.3 NHMS's CMP Language:

Inside of these countries; 15 countries have a website only in their own (official) language, 22 countries have a website in 2 languages, 6 countries have a website in 3 languages and 2 countries have a website in 4 languages (fig.16 and 17).

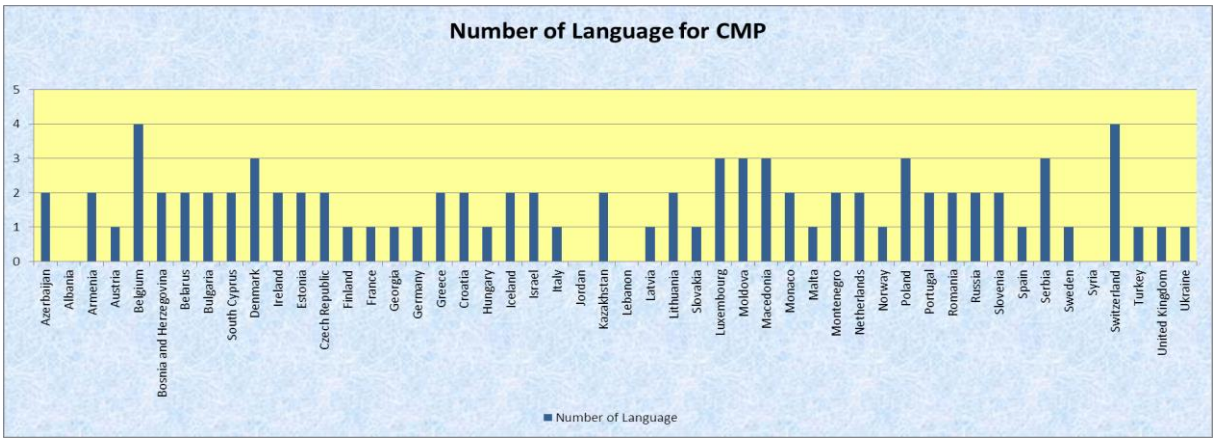


Figure.16 Languages are used in countries website.

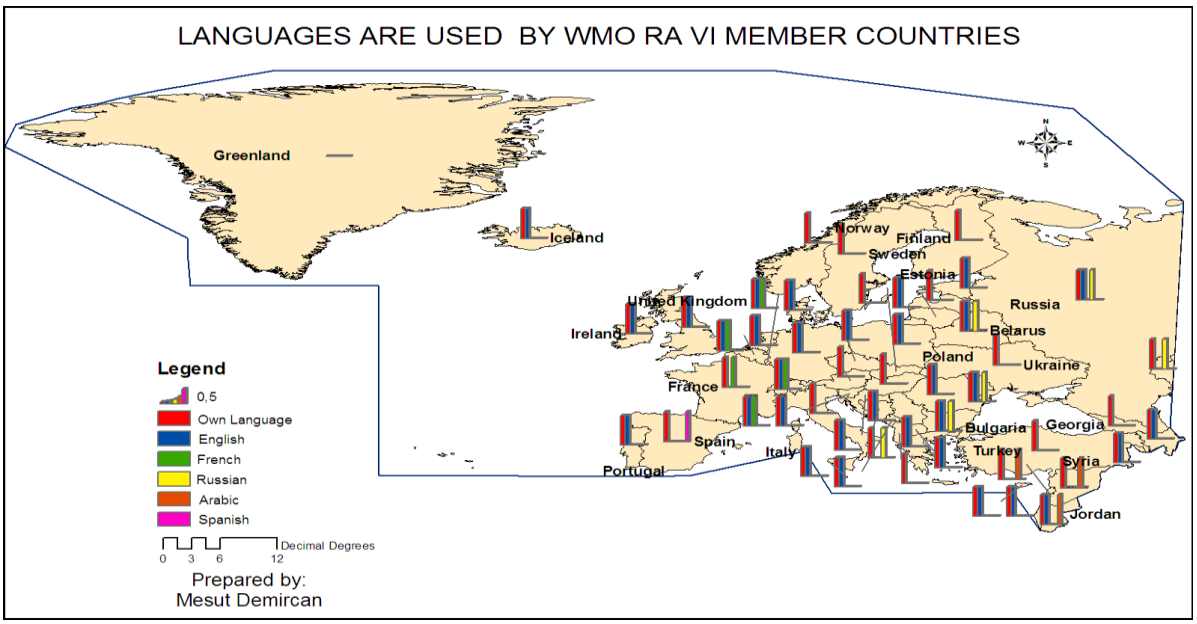


Figure.17 Languages are used in countries website in WMO RA VI.

E.4 NHMS's CMP Long Term Period (Standard Period):

Long term period (Standard Period) for climate monitoring products are used in countries is as follows. 3 countries do not use the standard term. 3 countries use 1961-1990 period for the standard period. 9 countries use 1971-2000 period for the standard period. 3 countries use both as 1961-1990 and 1971-2000 periods for the standard period. The standard period of 22 countries cannot be identified from website (fig.18 and 19).

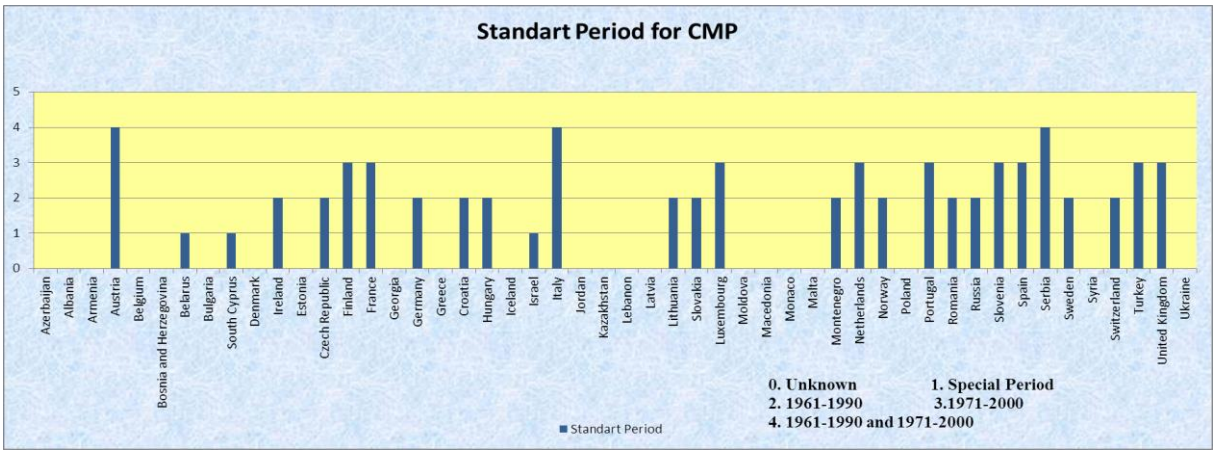


Figure.18 Long term period for CMPs is used in countries.

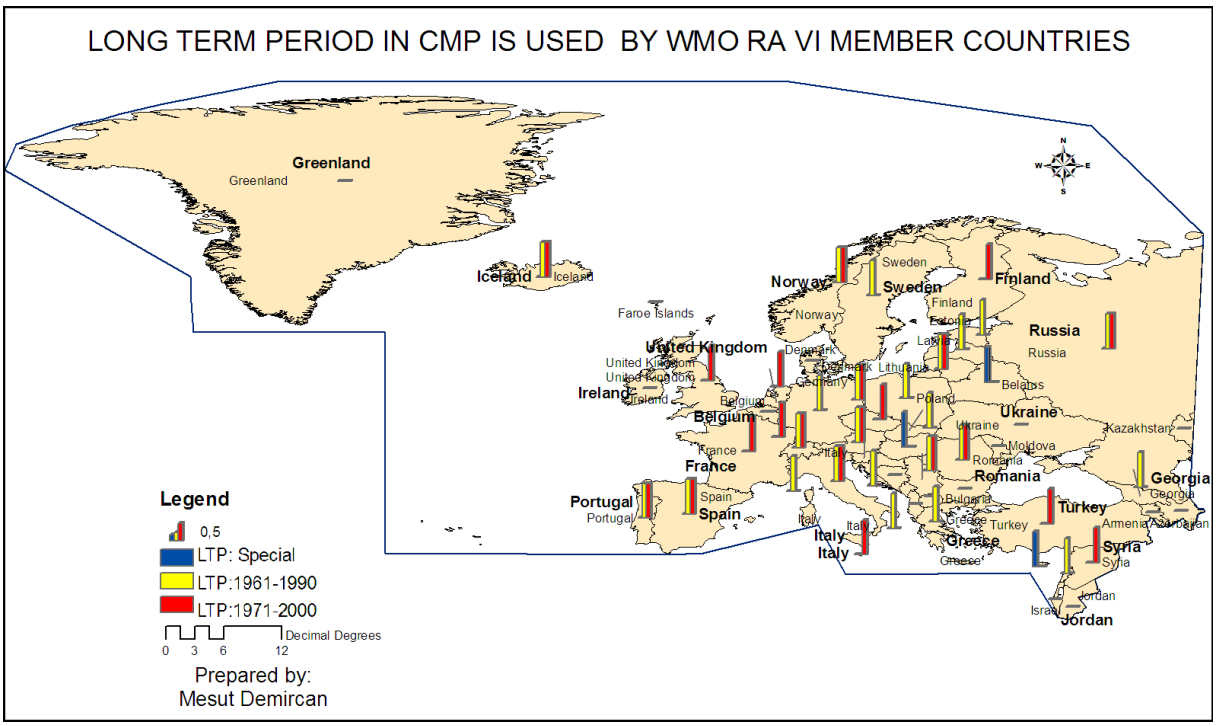


Figure.19 Long term period for CMPs is used in countries website in WMO RA VI.

E.5 NHMS's CMP Products:

Table, report, data, graphic, map and bulletin tools of CMPs are used in countries website in WMO RA VI. Table presentation is used in 2 countries. Report is used in 22 countries. Data presentation is used in 22 countries. Graphic presentation is used in 29 countries. Map presentation is used in 29 countries. Bulletin presentation is used in 4 countries (fig.20 and 21).

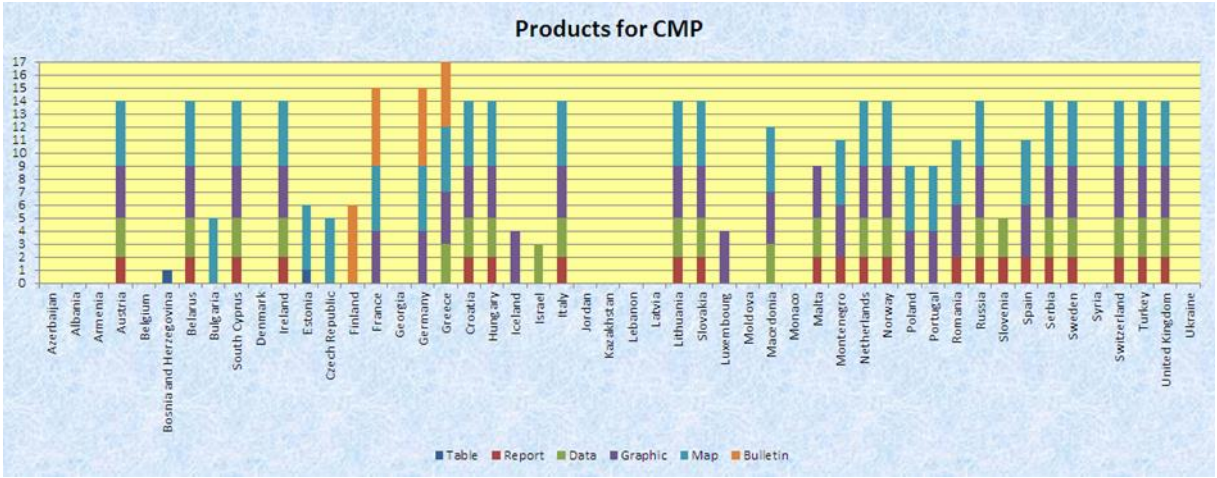


Figure.20 CMPs Products are used in countries.

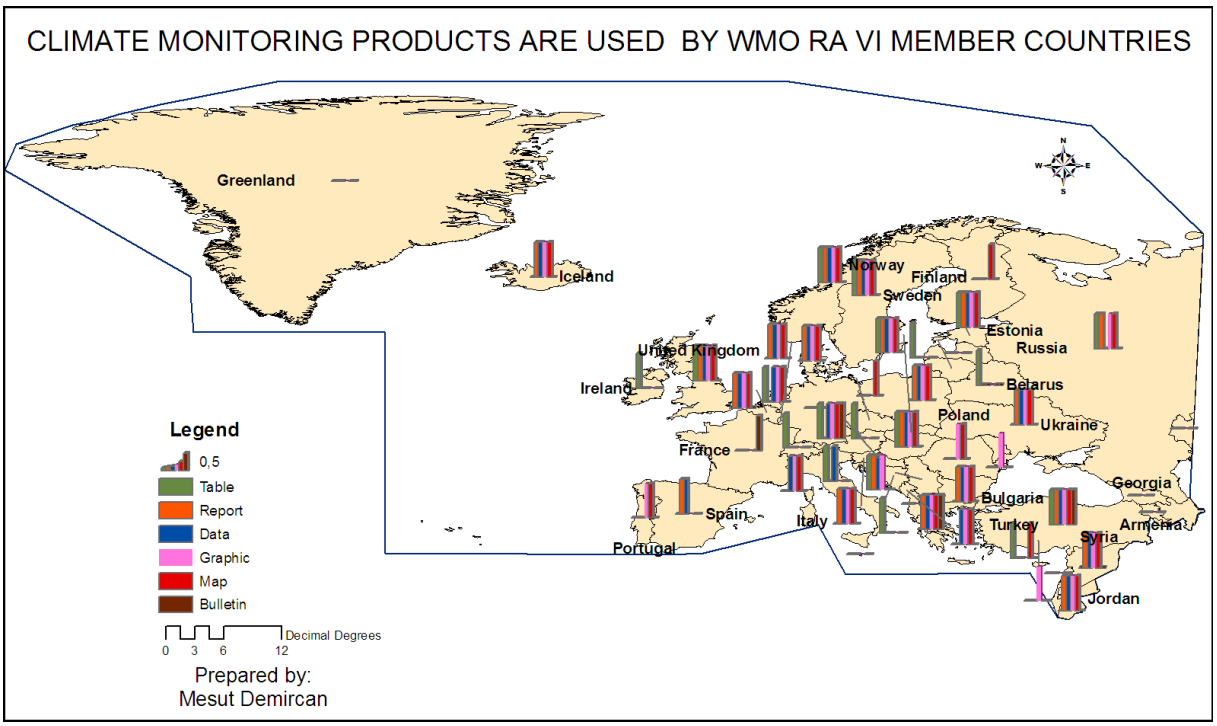


Figure.21 CMPs Products are used in countries website in WMO RA VI.

E.6 NHMS's Climate Variables Presented in CMP:

Temperature, precipitation, wind, sunshine duration, radiation, snow are climate variables and extreme events and seasonal forecast are presented in countries website in WMO RA VI. Temperature is presented in 30 countries. Precipitation is presented in 29 countries. Wind is presented in 10 countries. Sunshine duration and radiation are presented in 4 countries. Snow is presented in 3 countries. Humidity and Extreme events are presented in 5 countries. Seasonal forecast is presented in 1 country (fig.22 and 23).

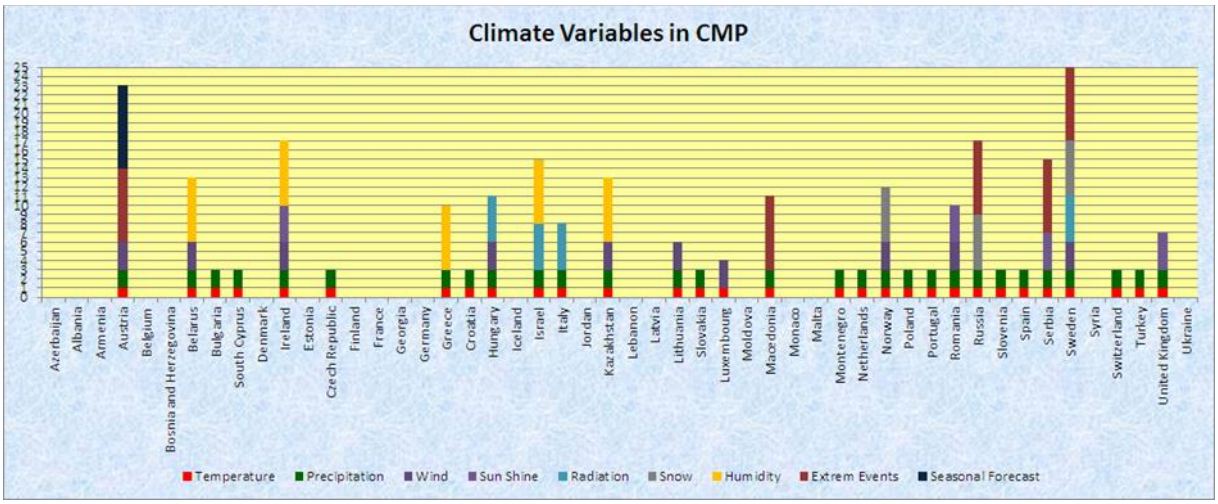


Figure.22 Climate variables are used in CMPs Products in countries.

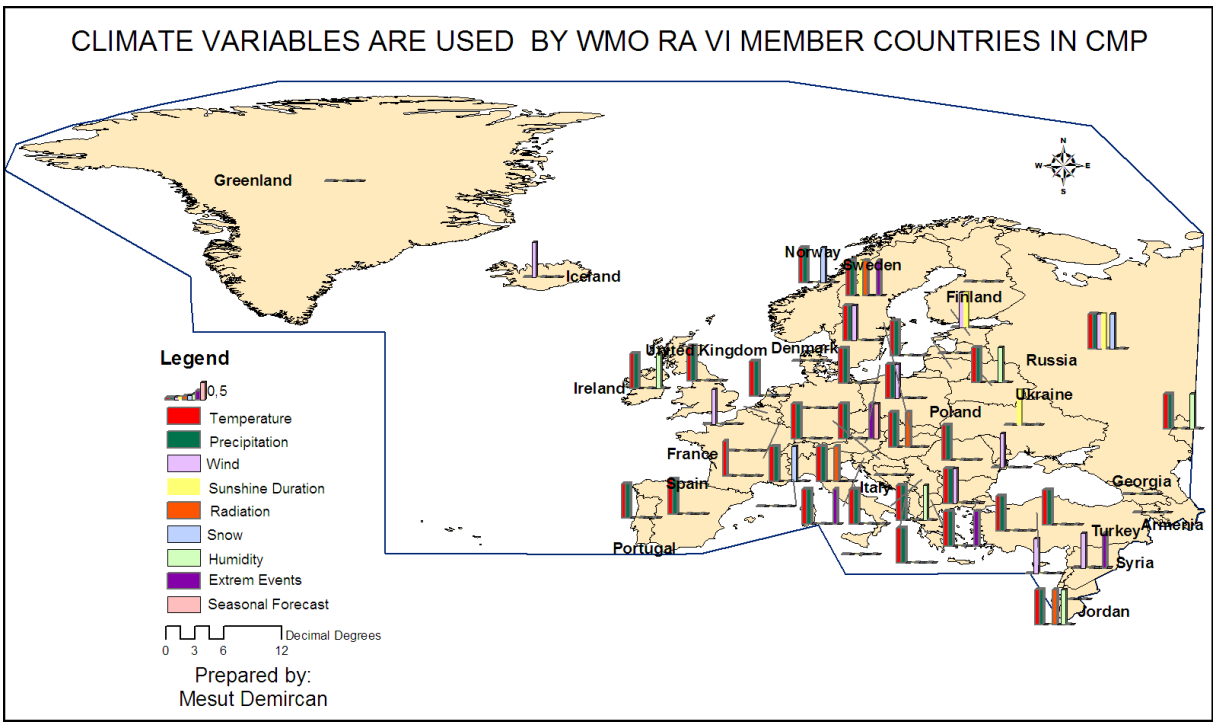


Figure.23 Climate variables are used in CMPs Products in countries website in WMO RA VI.

E.7 NHMS's CMP Samples:

Spanish Meteorological Service (AEMET) (fig.24 and 25)

(http://www.aemet.es/documentos/es/elclima/datos_climat/resumenes_climat/anuales/res_anual_clim_2010.pdf)

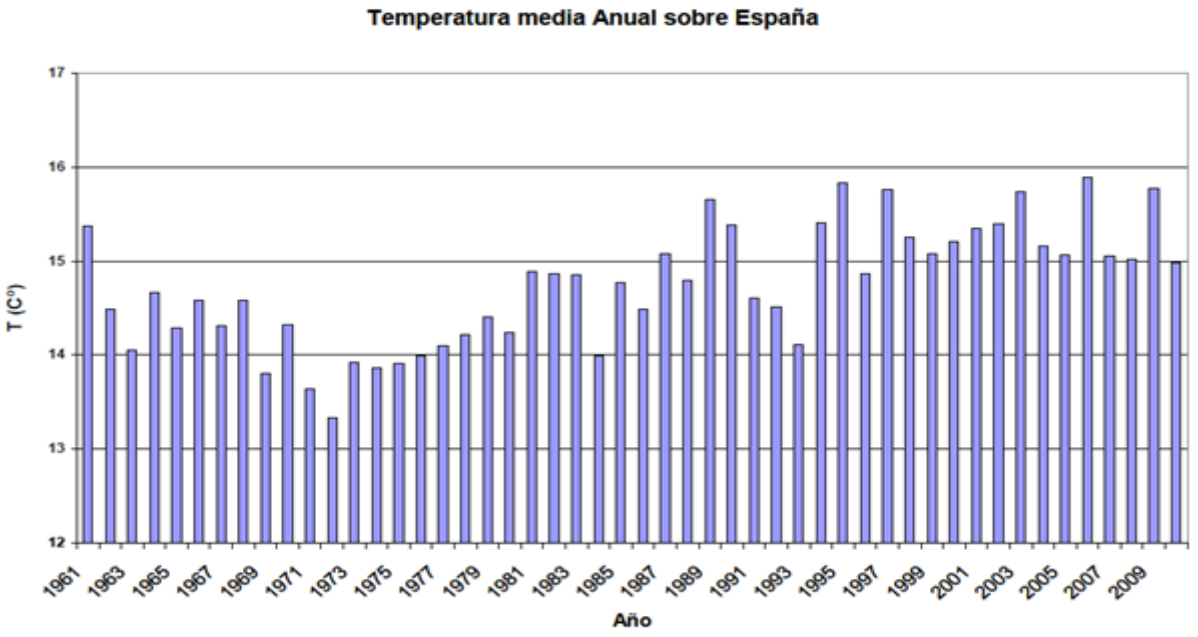


Figure.24 Temperature graphic from AEMET Climate in 2010 Report

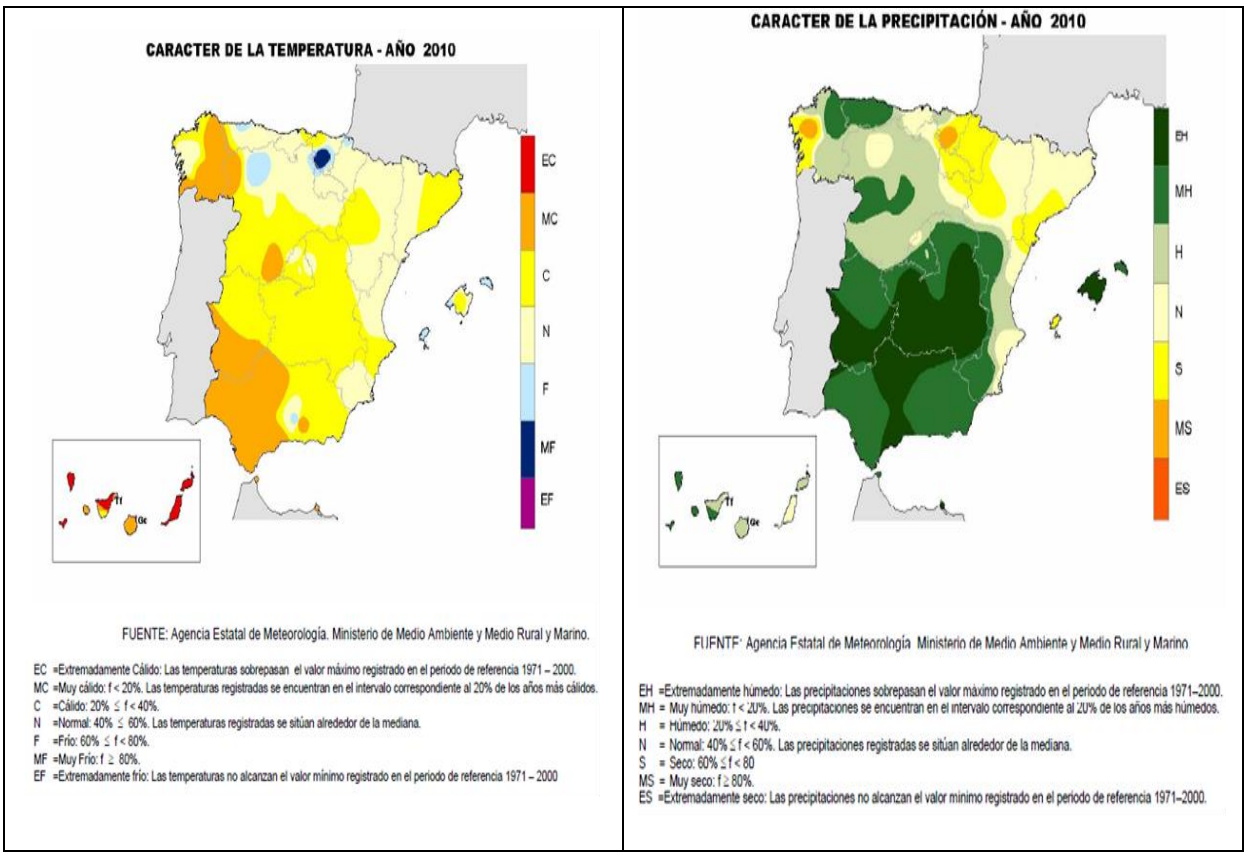


Figure.25 Temperature and Precipitation maps from AEMET Climate in 2010 Report

Norwegian Meteorological Institute (fig.26 and)

(http://met.no/Klima/Klimastatistikk/Klimanormaler/?module=Articles;action=ArticleFolder.publicOpenFolder;ID=390)

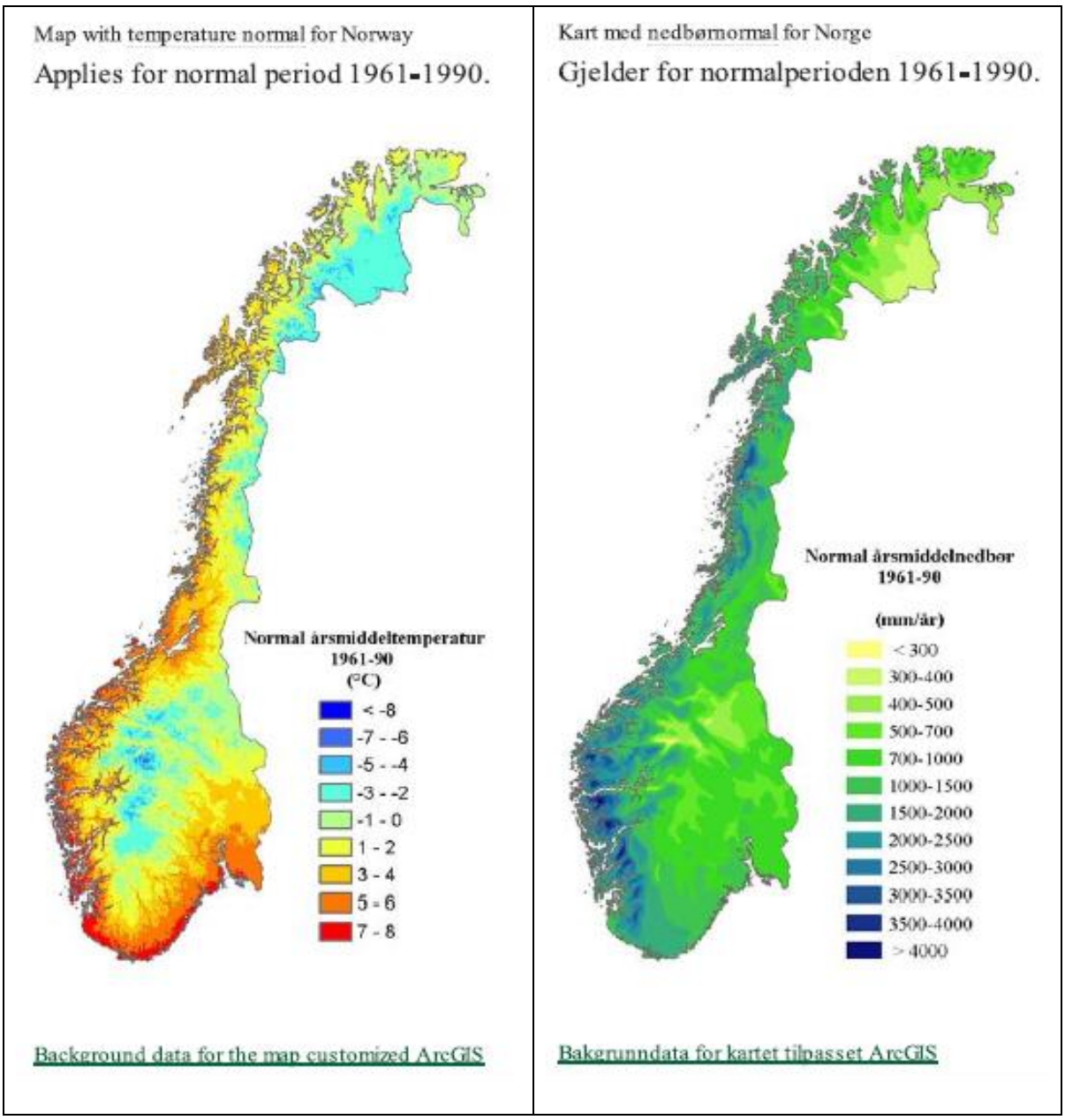


Figure.26 Temperature and Precipitation maps from Norway

Source:

Demircan, M., Alan, I., Sensoy, S., Increasing resolution of temperature maps by using geographic information systems (GIS) and topography information,5th Atmospheric Science Symposium, 27-29 April 2011, Istanbul Technical University, Istanbul – Turkey

Demircan, M., Basic Approach to Climate Monitoring Products and Climate Monitoring Products in WMO RAVI, Geneva, 2012
http://www.metoffice.gov.uk/hadobs/opace2_tt_ncmp/Climate_Monitoring_Product_Europe.pdf

Robert J. H., Susan E. C., Juan L. P., Peter G. J. And Andy J., Very High Resolution Interpolated Climate Surfaces For Global Land Areas, International Journal of Climatology, Int. J. Climatol. 25: 1965–1978 (2005)

Abridged Final Report with resolutions and recommendations (WMO-No. 1062), Fifteenth session of the Commission for Agricultural Meteorology (CAgM), 15 to 21 July 2010, Belo Horizonte, Brazil

Yildirim, M. U., Demircan, M., Özdemir, F. A., Sarihan, E. O., Effect of Climate Change on Poppy (Papaver somniferum L.) Production Area, 11. Field Crops Congress, Canakkale, 2015

GFCS, Annex to The Implementation Plan of The Global Framework for Climate Services - Capacity Development, World Meteorological Organization, 2014