Bulletin of the *Transilvania* University of Braşov • Vol. 9 (58) - 2016
Series I: Engineering Sciences

THE INFLUENCE OF CLIMATE CHANGE ON DRAINAGE UTILITY NETWORKS

N. IORDAN[1], G. ȚÂRLEA[2]

Abstract: *Rainfall intensities greater than 20 liters/square meter rains and floods caused by heavy are produced effects of climate change in last decades. The standards and regulations for sizing rainwater* sewage utility network *no takeover offers solutions to large debts and occurring more often. Information provided by weather stations in last decades gives possibility to modify the flow of calculating the size of rainwater drainage pipes. It has started taking a new approach to transport and retention and storage of rainwater.*

Key words: *climate change, floods, torrential rainfall.*

1. Climate Change Globe in Last Decades

2015 was not only the warmest year on record, it broke the record by the largest margin by which the record has been broken. 2015 was the 39th consecutive year with above-average temperatures.

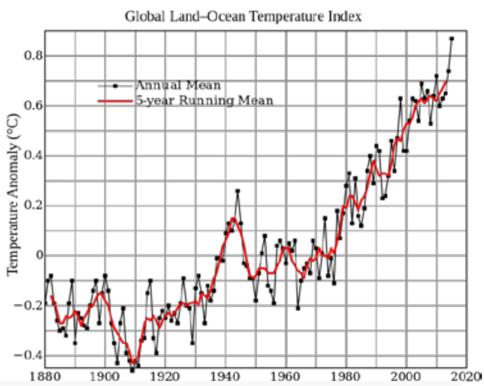

Fig. 1. *Global mean surface temperature change from 1880 to 2015, relative to the 1951–1980 mean.. Source: NASA GISS*

Ocean oscillations like El Niño Southern Oscillation (ENSO) can affect global average temperatures, for example, 1998 temperatures were significantly enhanced by strong El Niño conditions. The large margin by which 2015 is the warmest year is also attributed to another strong El Niño. However, 2014 was ENSO neutral. According to NOAA and NASA, 2015 had the warmest respective months on record for 10 out of the 12 months. The average temperature around the globe was 0.90˚C or 20% above the twentieth century average. In a first, December 2015 was also the first month to ever reach a temperature 2 degrees Fahrenheit above normal for the planet. As of July 2016, for the 15th consecutive month, the global land and ocean temperature departure from average was the highest since global temperature records began in 1880. This

• [1] Faculty of Civil Engineering from "Transilvania" University of Brașov
[2] The Faculty of Building Services from Technical University of Civil Engineering of Bucharest.

marks the longest sufch streak in NOAA's 137 years of record keeping. In addition, NOAA reported that July of 2016 was the hottest month on record.

1.1. Climate Trends in Europe

Climate scenarios indicate significant warming, greater in winter in the North and in summer in southern and central Europe.

Many of the results reported are based on a range of emissions scenarios extending up to the end of the 21st century and assume no specific climate policies to mitigate greenhouse gas emissions.

Winter floods are likely to increase in maritime regions and flash floods are likely to increase throughout Europe. Coastal flooding related to increasing storminess and sea-level rise is likely to threaten up to 1.6 million additional people annually. Warmer, drier conditions will lead to more frequent and prolonged droughts, as well as to a longer fire season and increased fire risk, particularly in the Mediterranean region. During dry years, catastrophic fires are expected on drained peatlands in central

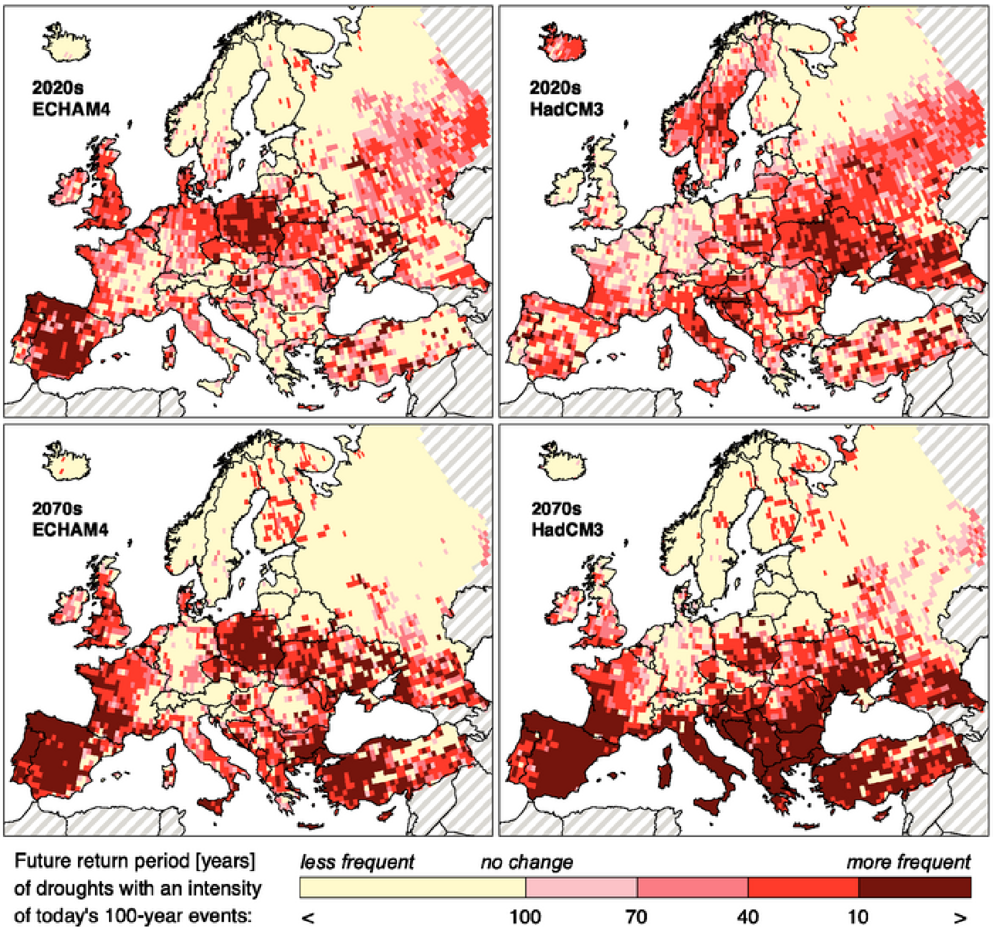

Fig. 2. *Change in the recurrence of 100-year droughts, based on comparisons between climate and water use in 1961 to 1990 and simulations for the 2020s and 2070s. Values calculated with the model WaterGAP 2.1 (Lehner et al., 2005b).*

Europe. Without adaptive measures, risks to health due to more frequent heatwaves, particularly in central and southern Europe, and flooding, and greater exposure to vector- and food-borne diseases are anticipated to increase. Some impacts may be positive, as in reduced risk of extreme cold events because of increasing winter temperatures. However, on balance, health risks are very likely to increase.

The most dominant climatic drivers for water availability are precipitation, temperature, and evaporative demand (determined by net radiation at ground level, atmospheric humidity, wind speed, and temperature). Temperature is particularly important in snow-dominated basins and in coastal areas (due to the impact of temperature on sea level).

1.2. Climate Change Scenarios

The most recent climate modelling results available to the Third Assessment Report (TAR) showed an increase in annual temperature in Europe of 0.1 to 0.4°C/decade over the 21st century based on a range of scenarios and models. The models show a widespread increase in precipitation in the north, small decreases in the south, and small or ambiguous changes in central Europe. It is likely that the seasonality of precipitation will change and the frequency of intense precipitation events will increase, especially in winter. The TAR noted a very likely increase in the intensity and frequency of summer heatwaves throughout Europe, and one such major heatwave has occurred since the TAR.

1.3. Climate Change Scenarios

With regards to its current sensitivities to climate, Europe was found to be most sensitive to the following conditions:

- extreme seasons, in particular exceptionally hot and dry summers and mild winters,
- short-duration events such as windstorms and heavy rains, and
- slow, long-term changes in climate which, among other impacts, will put particular pressure on coastal areas e.g., through sea-level rise.

1.4. Extreme Weather Events in Romania

Determine climate variability, often producing extreme weather. A meteorological phenomenon is considered extremely switching system determines when analyzed on a much different climatic norm. Report III of the Intergovernmental Panel on Climate Change (IPCC, 2001) Extreme weather phenomena are defined as rare events compared to their statistical distributions of reference, a place noted. Typically, the attribute "rare" weather phenomena associated percentile of the statistical distribution is quantified using 10%, 5%, 1% or the 90%, 95% and 99%. By definition, the characteristics of extreme weather may vary greatly from one region to another and they change with statistical distributions that define climate analyzed. An extreme climate event is a summary of several extreme weather events, for a specific time interval (e.g., daily rainfall amount exceeding seasonal percentile 95%).

1.5. The Trends Observed in Median Values

Analysis of trends in seasonal rainfall variability autumn show significant increases (Fig. 2), which is directly reflected in the growth trends of the season respectively flow. However, significant trends are less numerous than during the period 1961-2010. Decreases in precipitation occurred in the Danube Delta (winter and spring) and Southwest (spring). Overall, it should be noted that most stations do not show significant increases or decreases, rainfall is stable period.

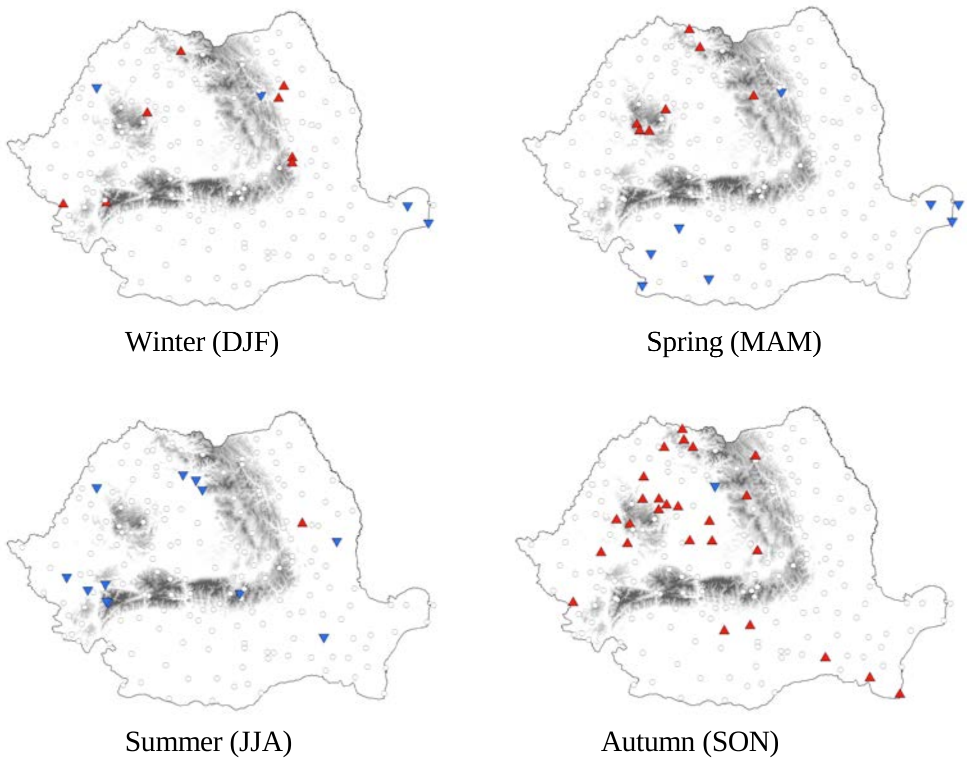

Fig. 3. *Seasonal changes in precipitation seasons (1961-2013). Significant trends of growth (decline) are symbolized by red triangles (blue). [Climate change - from the physical foundations risks and adaptation, The National Meteorological Administration, Printech Press, Bucharest, 2015.]*

1.6. The Trends Observed in the Extreme Values

Although there are no increases in seasonal precipitation amounts in winter, spring and summer, is remarkable upward trend in daily rainfall highs Seasonal both winter (probably due to the ratio change rain/snow) and summer (fig. 4).

Trend analysis was performed with non-parametric Mann-Kendall test at a significance level of 10% - two-dimensional. The results show that, in Romania, there are no major changes in the annual precipitation extremes (Fig. 5); in terms of space, recorded increases in annual quantities of rainfall in main river Tisza and Somes and decreases in the Danube Delta.

With projections for future extreme precipitation, we chose to analyze the index illustrating the number of days per year with precipitation exceeding the amount of

20 liters/square meter. Analysis of the results of numerical experiments with four regional models suggest for mid-century (2021-2050) compared to the reference period (1971-2000), an increase in the frequency of episodes with rainfall exceeding 24 hours in the amount of 20 liters/square meter. The increase covers most regions of Romania. Increasing the number of days with extreme precipitation episodes is higher hills and mountains and near the Black Sea coast compared to the plain, all four models analyzed. Differences between configurations revealed by the four regional climate models aimed mainly magnitude signal growth.

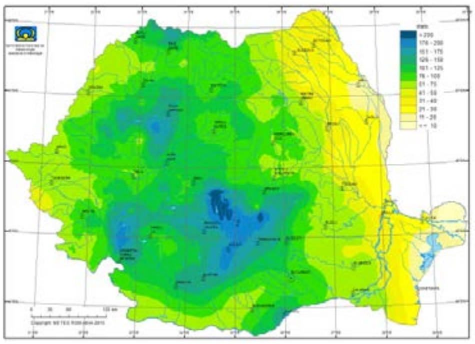

Fig. 4. *The annual amount of precipitatio (2015)*

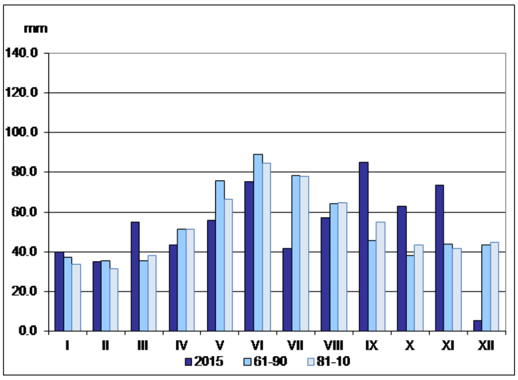

Fig. 5. *The average amount of monthly precipitation Romania in 2015, compared with climatological normal (1961-1990, 1981-2010*

In 2015, the average annual temperature in the country (10.5ºC) was higher than normal climatological 1.3ºC standard (1981-2010). Positive deviations of monthly mean temperature of normal climatological standard for each month hand, were recorded in almost all months and ranged 0.3ºC (June) and the 2.9ºC (December). The only exception were April and October when the average monthly temperature in the country was lower than the climatological normal standard 0.5°C.

The annual amount of precipitation, the national average (630.1 mm) was less than 1% lower than standard climatological normal (1981-2010). Thus, the deviations were positive in the months from January to March and September to November, oscillating between 10% (February) and 77% (November) and negative deviations ranged from 11% in June and 88% in December.

2. Research Directions

Long term evolution of walking time from one day to another and from one region to another describes climate. In turn, the global signal of climate change are projected at regional and local scales very different.

Current debates taking place in the international scientific community focuses not so much the existence of this signal, and especially the uncertainty surrounding the magnitude of regional and projections.

Altered water cycle to climate change increases the frequency of rainfall episodes of increasingly plentyful on limited areas and for short periods, which causes flash flooding increasingly numerous.

2.1. Towards Review of Standards

The revised standards will have on the duration and intensity of rains calculation taking into account the evolution of climate in Romania in the last 30 years (1990-2020) and making a projection for the next 50 years based on climate scenarios developed.

2.2. Approach on Principles of Rainwater Drainage Networks

Soil sealing is one of the most important challenges, considering the changes in land cover and their impact on the consequences of natural disasters. Soil sealing is determined by "the permanent covering an area of land and soil impermeable material such as asphalt or concrete artificial".

Soil sealing in built areas may decrease the ability to store water meadows, leading to an increased flood risk and damage caused by them.

Soil sealing plays an important role in increasing temperature and urban heat island development associated with the city. Urban areas may be up to 20% warmer than or covered with vegetation not waterproof.

Rainwater should not channeled directly to the emissaries but first detained in retention basins, infiltration into the soil part to restore groundwater and the rest channeled through emissaries.

2.3. Rainwater Must be Stored

It appears that, in general, during the XXI century, in winter and spring there is no coherent temporal evolution in terms of design environments tend multiansamblu precipitation averaged over Romania.

Instead, for months the warm season there is a decreasing trend in rainfall which is increasing in general, towards the end of the XXI century.

Therefore rainwater drainage networks should be designed to retain rainwater and discharged into the environment only quantities that can not be stored.

References

1. *** "Global Analysis - July 2016" NOAA, Retrieved on 24 August 2016.
2. Intergovernmental Panel on Climate Change (IPCC), 2001, *The Scientific Basis*. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change, [Houghton JT, Ding Y, et al.], Cambridge University Press, Cambridge, UK, p 249.
3. Intergovernmental Panel on Climate Change (IPCC), 2007a. *Climate Change 2007: The Physical Science Basis*, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panelon Climate Change [Solomon, S., et al. (eds.)] (Cambridge, UK: Cambridge University Press). 196 pp.
4. Intergovernmental Panel on Climate Change (IPCC), 2007. *Climate Change 2007: Impacts, Adaptation and Vulnerability* Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [M.L. Parry, O.F. Canziani, et al], Eds. Cambridge University Press, Cambridge, UK, p 354.
5. Bojariu R., Bîrsan M., Cică R., et al.: *Climate change - from the physical foundations risks and adaptation*, The National Meteorological Administration, Printech Press, Bucharest, 2015, p. 50, 113 şi 134.
6. *** STAS 9470-73 Hydrotechnics. Maximum rainfall. Intensity, duration, frequency.
7. *** NP 133 / 2-2011. Standard on the design, implementation and operation of water supply systems and sanitation in localities. Sewer systems settlements.