# WATER RESOURCES AVAILABILITY UNDER CHANGING CLIMATE. A CASE STUDY ON TRANCEBOUNDARY RIVERS STRUMA/STRIMON AND MESTA NESTOS.

**Snejana Dakova**
*National Institute of Hydrology & Meteorology, BASc, 66 Tzarigradsko Shosse,1784 Sofia, Bulgaria*

E mail Snejana.Dakova@meteo.bg

At the beginning of the XXI sentry, the sustainable use of water is not only a priority question for water scarce regions and for agriculture in particular but for all sectors and regions in Europe. Imbalances between availability and demand, degradation of surface and ground water quality, inter sartorial competition, inter-regional and internal conflicts, all bring water issues to foreground .The effects of climate change in Europe are already significant and measurable. Scenarios generally predict a change in drought for almost all regions of Europe. According the EU Commission staff Working Document "*Addressing the challenge of water scarcity and droughts in the European Union*", most EU Member States have reported drought events which have taken place since 1976. From 2000 to 2006, an average of 15% of the EU total area and an average of 17% of the EU total population were affected by droughts. They represent a total area of 460 000 km² (about 10% of the total EU area) and host a total population of 82 million (about 16.5% of the total EU population). As regards drought events, they have often been resolved by a crisis management approach dictated by a lack of timely preparedness for extreme events. Water scarcity situations encountered at river basin level have already had noticeable impacts on water supply, economy, society and environment and can last beyond the end of the drought event. The direct economic impact of drought events in the past thirty years is estimated at a minimum of € 100 billion. In total, the proportion of European river basin areas in the severe water stress category is likely to increase from 19% today to 34-36% by the 2070s. Water scarcity and droughts are a transboundary issue requiring a coordinated approach. In particular, 70% of EU territory is part of transboundary river basins. The area of Central Balkan Peninsula belongs to this category also.

All Bulgarian rivers running south as Maritza, Tundja, Arda, Struma and Mesta are trance boundary, covering total area of 48366 $km^2$ which is almost a half of Bulgarian territory. They belong to Mediterranean watershed. Hydrological regime, water quantity and quality in rivers, lakes and aquifers are generated in motley palette of climate conditions from high mountain (in northeast part of the basins) through Moderate continental and Continental Mediterranean to Mediterranean climate in the southeast part of basins next to the Greece border.

The paper is undertaken to present the water resources availability in current conditions and under climate change impact towards 2025 and 2050 years. The hydrological data information of the two tranceboundary rivers with Greece Struma/Strymon and Mesta/Nestos have been applied in the models.

Climate change is defined as the difference between base line climatology which presents average climate conditions over a 30-year period (1961–1990) and average conditions over various time periods simulated by the model. The baseline period (1961–1990) is selected according to the criteria of (IPCC TGSCIA, 1999, 2001). This period is accepted in hydrological models too. Climate changes are stipulated by A2 and B2 storylines in this study. Both are focused on local and regional peculiarities. The presented hydrological simulations are a result of the "*delta change type*" of approach. The changes of climate and hydrological elements were presented as deviation toward the respective values evaluated for the basic period 1961-1990 according (e.g. ANL, 1994; IPCC-TGCIA, 1999, IPCC, 2001a; Houghton et al., 1996). Two climate models HadCM2 and ECHAM4 have been selected and used from the MAGICC)/ SCENGEN package (Models for the Assessment of Greenhouse-gas Induced Climate Change/ SCENario GENerator.) because they are produced in Europe and are the most suitable for the European conditions.

The transient HadCM2 and ECHAM4 GCMs predicted that annual temperatures in the selected hydrological regions are to rise by 0.9 and 1.0° and from 1.1 to 1.3ºC in the 2020s. The HadCM2 projected the following increase of seasonal air temperature: 1.0°C (winter), 0.6°C (spring), 1.2°C (summer) and 0.9°C (autumn). The ECHAM4 model simulated increases of seasonal air temperature equal to/or higher than 1.0°C: 1.0°C (winter), 1.1°C (spring), 1.4°C (summer) and 1.2°C (autumn). A warmer climate is also predicted for the 2050s and 2100s, with an annual temperature increase ranging from 1.6–1.8° (HadCM2) to 2.1–2.2°C (ECHAM4) in the 2050s, and 3.3–3.5° (HadCM2) to 4.2–4.3°C (ECHAM4) in the 2100s. According to the HadCM2 model, warming is projected to be higher during the winter and especially summer months in the 2050s and 2100s. The ECHAM4 model also simulated that the highest warming was expected during the summer season (June–August). Both the HadCM2 and ECHAM4 models simulated decreases of annual precipitation during this century in the selected hydrological regions. This is especially valid for the HadCM2 model, which predicted precipitation decreases in all months throughout the year. The ECHAM4 simulated increases of current normal (1961–1990) precipitation only in August and December. The HadCM2 and ECHAM4 models predicted an average decrease of 3–5% and 2–3% with respect to annual precipitation in the 2020s, relative to the period of the current climate (1961–1990). The annual precipitation reductions would continue to decrease in the 2050s and 2100s: 6–9% (HadCM2) and 4–5% (ECHAM4) for the middle of the current century and 12–18% (HadCM2) and 8–10% (ECHAM4) for the end of the 21st century. The HaDCM2 precipitation reductions are expected to be most significant in July and August, especially in the 2100s.

The impact of climate change on water resources have been evaluated by transferring changes of precipitation and temperature, as output variables from regional climate change models, to hydrological models. Surface water estimate are vulnerable to many inaccuracies due to anthropogenic intervention, in the form of dams and other water-harvesting structure, both along the river and on the river basin. These interventions have not only changed the characteristics of drainage networks and their pattern, but also the flow regime and discharge. That is way, the naturalization of the flow need to be done before evaluation of the climate change impact. To this end, different approaches have been used depending on the data availability like:

- When the analogous is available two approaches could be used: disaggregating model and "Pilot basins"method having natural flow, commonly in the mountains. By coupling the hypsographic curves of the reference basin with the correlation $q = f(H)$, the mean multi-annual specific runoffs for each zone of relief were integrated to obtain the total flow.
- When the analogous be missing the Water-management balance is suitable

Climate change impact on annual and summer – autumn seasonal flow have been assessed by HBV model (modified for Balkan Peninsula conditions) using output precipitation and temperature from each of two above mentioned models HadCM2 and ECHAM4. Both of them indicate a decrease in the Long-term annual mean runoff in comparison with the standard (baseline) 1961-1990 period. The degree of the decrease of runoff varies regarding the assumed time horizons, but exhibits acceleration towards 2100. The second order tributaries will be dry towards 2050, 2100. The magnitude of runoff decrease changes from north to south. Moving in the direction of seasonal horizons, the discharge during the summer will be rapidly decreased (most significantly in July and August) according to the results used by the HadCM2 model. Since ECHAM4 models mark high values of precipitations in July and August, floods will be in these months. During the other seasons, the runoff will gradually decrease. The size of decrease of low flow will be greater according to the HadCM4 scenario.

The results will generate a better understanding of the agronomic, environmental and socio-economic impacts of improved land management along these two tranceboundary rivers. The obtained results have to be considered what might happen if we do not adapt to changing climatic conditions. Its social significance is to guide policy-making, agriculture, electricity producers in order to initiate a practical response for adaptation to these new conditions. It may be includes reassessment of the reservoirs and hydraulic systems, change of their working regimes, reconstruction some of them or building new ones, new dry steady agricultural vegetations, different kind of tourism services etc. A "one-sizefits-all" approach to adaptation would be clear benefits in approaching adaptation in integrated, coordinated manner at Balkan Peninsula level not follow administrative boundaries. Furthermore, certain sectors are largely integrated at EU level through the single market and common policies and it makes sense to integrate adaptation goals directly into them. The adaptation is clearly a question of political coherence, forward planning and consistent and coordinated. Furthermore, detailed insights will be gained on how water users in a river basin are linked through the water flow. One of the solution is to quantify and institutionalize upstream-downstream interdependencies, whereby for example, those situated downstream compensate upstream farmers for their sustainable land use and soil and water conservation practice.

**Key words:** transboundary water resources, climate change impact, water scarcity, low flow and

drought.

**References:**


IPCC (1996), Climate Change 1995– Impacts, adaptations and Mitigation of Climate Change: Scientific- technical Analyses . Contribution of working group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Houghton, J.J., Meiro Filho, L.G., Callender, B.A et al (eds) Cambridge University Press: Cambridge

Intergovernmental Panel on Climate Change (IPCC), 2001a. and 2001 b Climate Change 2001: The Scientific Basis. Contribution of Working Group 1 to the Third Assessment Report of the Intergovernmental Panel on Climate Change (Houghton, J.T., Y. Ding, D.J. Griggs, M. Noguer, P.J. Van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.)). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 881pp.

Mimikou, M., Kouvopoulos, Y., Cavvadias, G. and Vayiannos, N., (1991a). *Regional Hydrological Effects of Climate Change.* J. Hydrol., 123:119-146

Hafzullah Aksoy,a N. Erdem Unal,a Vesselin Alexandrov,b Snejana Dakovab and Jaeyoung Yoonc *Hydrometeorological analysis of northwestern Turkey with links to climate change*,INTERNATIONAL JOURNAL OF CLIMATOLOGY *Int. J. Climatol.* **28**: 1047–1060 (2008), Published online 28 August 2007 in Wiley InterScience(www.interscience.wiley.com) DOI: 10.1002/joc.1599

Alexsandrov, S. Dakova, Bulgaria, H. Aksoy, Turkey, A. Dahamsheh, Jordan, *Analysis of climate change in sought-eastern Bulgaria and northwestern Turkey*, BALWIS , Conference on water observation and information system for decision support,, Ohrid 2004, ,p 32.

**Dakova Sn"***Climate change effect on river flow in basins under different climate conditions—an example from rivers on the Balkan Peninsula"* and is published in " ***Regional Hydrological Impacts of Climatic Change—Impact Assessment and Decision Making*** **" (Proceedings of symposium S6 held during the Seventh IAHS Scientific Assembly at Foz do Iguaçu, Brazil, April 2005). IAHS Publ. 295, 2005.**