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Analysis and projections of climate change impacts on flood risks in the Dniester river basin based on the ENSEMBLES RCM data

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The pilot project "Reducing vulnerability to extreme floods and climate change in the Dniester river basin" started in May 2010 in the frame of the Dniester-III project which is implemented by OSCE, UNECE and UNEP in close collaboration with authorities and NGOs from Moldova and Ukraine. The project is a part of the Environment and Security initiative (ENVSEC) and aims to reduce risks from climate change - and specifically flooding - for security by improving the adaptive capacity of Ukraine and the Republic of Moldova, taking into account both current climate variability and long-term impacts of climate change on flood risks (http://www1.unece.org/ehlm/platform/display/ClimateChange/Dniester).

The Dniester is a river in Eastern Europe, one of the largest rivers of the Carpathians. The Dniester flows from northwest to southeast on the territory of Ukraine, Moldova and Transdniestria. The length of the Dniester is 1352 km with basin area of 72100 km^2. The river starts in the Carpathian Mountains at an altitude of 900 m above the sea level and flows into the Dniester estuary, which is connected to the Black Sea.

In order to reduce impacts from extreme floods in the Dniester river basin under transient climate conditions the first task of the project was to assess the recent climate changes and particularly extreme precipitation events. For this purpose database of the specially worked out system with inputs from observational data from 1980 up to now of all stations within the Dniester basin was applied. Retrospective analysis of severe hydrometeorological events has revealed that more than 30% of precipitation at warm half of the year are heavy and very heavy rains. And input of such extreme precipitation to annual sum increased during last 30 year by about 7% per decade in the region. Possible reason for this is an intensification of convection in bottom 5km layer of the troposphere which is observed from the middle 90^{th} of the 20^{th} century. During this period an intensive rises of surface air temperature and average temperature of the troposphere (a thickness of 1000-500hPa layer) were found in the investigated region that together with increase of moisture content of the atmosphere led to rise of free convection level and convectively unstable layers of the atmosphere reached almost to 100hPa. The later resulted in an essential increase (almost twice) of Convective Available Potential Energy (CAPE) and, accordingly, speed of updrafts.

Ensemble of seven runs of Regional Climate Models (RCM) driven by four Atmosphere and Ocean General Circulation Models (AOGCM) from the ENSEMBLES database was applied in order to obtain projected values of air temperature and precipitation changes for 2021-2050 period within the Dniester basin on a monthly basis. To make calculations more accurate the Dniester basin was subdivided into 3 regions every with 2 subregions according to river geomorphology and topography. Verification of RCM on control 1971-2000 period by E-Obs and stations' data has allowed to obtain optimum ensembles of RCM for every subregion and climate characteristic. Note, that just two regional climate models REMO and RCA both driven by ECHAM5 provided the best results either for all delineated regions or for the entire Dniester basin. Projections for 2021-2050 period were calculated from the same obtained optimum ensembles of RCM as for the control one. More or less uniform air temperature rise is expected in all subregions and months by 0.7-1.7 ^{o}C. But projections for precipitation change are more disperse: within a few per cents for annual sums, but almost 20% less for the middle and lower Dniester in August and October (drought risk) and over 15% more for the high flow of the river in September and December (flood risk).

Indices of extremes recommended by ECA&D were calculated from daily data of REMO and RCA A1B runs for control and projected periods. The analysis of precipitation extremes (SDII, RX1day, RX5day, etc.) has demonstrated that two models have similar projections for the middle part of the river and opposite tendencies for the upper and lower Dniester. In any case for all regions number of events with very heavy rains (>30mm) and their inputs in monthly and annual sums will increase make flash flood risks more pronounced.