# INSTRUCTIONS FOR SEMINAR WORK

In the scope of the seminar work we will conduct several hydrological analyses for the selected river basin in Slovenia:

-Savinja River, Veliko Širje gauging station (Student ID: 26242028), 1847 km2 (ID: 6210)

-Savinja River, Celje gauging station (Student ID: 70093546), 1192 km2 (ID: 6140)

-Sava River, Čatež gauging station (Student ID: 26242031), 10232 km2 (ID: 3850)

-Sava River, Litija gauging station (Student ID: 70093621), 4849 km2 (ID: 3650)

-Sava River, Radovljica gauging station (Student ID: 26242032), 908 km2 (ID: 3420)

-Soča River, Solkan gauging station (Student ID: 26242034), 1580 km2 (ID: 8180)

-Sora River, Suha gauging station (Student ID:), 566 km2 (ID: 4190)

-Idrijca River, Hotešk gauging station (Student ID:), 443 km2 (ID: 8450)

Based on the conducted analyses prepare a report using R markdown tool (export to html or .docx) where you should include all the below listed points. Include short comments of the results.

The report will be graded and will contribute to the 50% of the total grade.

The following tasks should be conducted using R:

**1 DATA PREPERATION**

-Discharge, precipitation, reference evapotranspiration and air temperature data import to R (period 2010-2022 should be used, use at least 5 different precipitation stations located within your catchment, for reference evapotranspiration and air temperature use one station). Data should be downloaded from the web-pages of the Slovenian Environment Agency.

-In case of missing precipitation data fill in the missing data based on the data from other stations.

**2 BASIC ANALYSIS**

-Calculate descriptive statistics of discharge, precipitation, reference evapotranspiration and air temperature.

-Plot graphs of discharge, precipitation, reference evapotranspiration and air temperature for the whole period and only for year 2022.

-Calculate correlation between precipitation data (among stations) and plot correlogram.

-Calculate water balance for individual years (from 2010-2022). Use average catchment precipitation.

-Calculate runoff coefficient for individual years (from 2010-2022). Plot the results. Use average catchment precipitation.

-Calculate ratio between evapotranspiration and precipitation (average catchment precipitation). Plot the results.

**3 LOW FLOW ANALYSIS AND TREND ANALYSIS**

-Conduct low-flow analysis using lfstat package, conduct baseflow separation.

-Plot flow duration curve.

-Calculate BFI, MAM, meanflow, Q95, Q90, Q70, seasindex and seasratio indexes.

-Identify drought periods based on the Q95 threshold. Plot the results

-Plot (or present in a table) seasonal characteristics of annual minimum discharge values (when do these values occur).

-Conduct the Mann-Kendall test for discharge, precipitation (all stations), air temperature and evapotranspiration data.

**4 FLOOD FREQUENCY ANALYSIS**

-Define the annual maxima sample based on the daily discharge data.

-Import the vQvk peak discharge data (for the whole available period) into R and compare values with the ones from previous step.

-Conduct the flood frequency analysis based on the vQvk data using at least 3 different distribution functions. Plot the results, show also the measured discharge data based on the Weibull distribution.

-Calculate confidence intervals using the parametric bootstrap approach or using genci.simple function from the lmomco package. Plot (Return period-design discharge) the results (using only one distribution).

**5 MULTIVARIATE FLOOD FREQUENCY ANALYSIS**

-Extract a sample of discharge, volume and hydrograph duration data based on the daily discharge data from your station. Use the baseflow separation methods from the lfstat package.

-Calculate Kendall correlation coefficients between pairs of variables.

-Fit marginal distribution functions to discharge and hydrograph volume.

-Fit one copula function to the discharge-volume pairs. Apply the statistical test to check the adequacy of selected copula function.

-Show graphical fit between measured and simulated data (scatter plots).

-Calculate OR and AND return periods (i.e., 10, 50, 100, 500 years design values).

**6 PRECIPITATION DATA ANALYSIS**

-Calculate the number of days with precipitation, with precipitation above 10 mm and above 50 mm, calculate the probability of occurrence of such day.

-Calculate different SPI indexes (1, 3, 6, 12 months) for all 5 precipitation stations.

-Compare identified drought periods to the ones from the discharge data (lfstat package). Comment on the results.

-Calculate ED index, compare the between the SPI and ED.

-Download NAO data and calculate correlation between NAO and precipitation data.

**7 SPATIAL DATA**

-Based on the digital terrain model generate a stream network and generate a catchment boundary based on the location of the gauging station.

-Compare generated stream network with actual one.

-Calculate some basic statistics of terrain for the selected catchment such as slope.

-Plot catchment hypsometric curve.

-Calculate weights for Thiessen polygon method with the consideration of multiple precipitation stations. Calculate areal precipitation. Compare the results with data from individual stations.

-Analyse the land-use of your catchment according to the CLC Corine map from 2012.

**8 HYDROLOGICAL MODELLING (AIR GR)**

-Prepare all the relevant data for the GR4J and CemaNeige GR6J hydrological models.

-Calibrate and validate (split the data into 50%) both hydrological models. Use first year of data for warm-up.

-Compare the performance of both models. Comment on the results.

**9 HYDROLOGICAL MODELLING (TUWIEN model)**

-Prepare all the relevant data for the TUWIEN hydrological model.

-Calibrate and validate (split the data into 50%) hydrological model. Use first year of data for warm-up.

-Compare the performance with the CemaNeige GR6J model. Comment on the results.

**10 STOHASTIC CLIMATE SIMULATOR**

-Fit a stochastic precipitation and air temperature simulator (use the GWEX package) to the measured data.

-Simulate 10 realizations (of 5 years of data) of precipitation and air temperature. Compare simulated values with measurements.

-Use the simulated data as input to the calibrated hydrological models (CemaNeige GR6J and TUWIEN). Compare the results of both models.

**11 IDF AND HUFF CURVES**

-Import 30-min rainfall data for one meteorological station into R (at least 3 years).

-Calculate the IDF curves and plot the results.

-Define the Huff curves for the rainfall duration events between the 12 and 24 hours. Plot the results. Include 10 and 90% confidence intervals.

-Define a design storm event with the duration of 24 hours and return period of 100 years. Use Huff curves for the description of temporal rainfall distribution.

-Use design storm as input to the calibrated CemaNeige GR6J model and compare the results with the flood frequency analysis (i.e., design discharge value associated with the 100-years return period).

**12 MODIS AND ERA5 data**

-For your catchment download MODIS snow cover (or surface air temperature data) data for a period of at least 2 years.

-Analyse snow cover (or surface air temperature data) characteristics of your catchment for the investigated period.

-Compare the snow cover (or surface air temperature data) characteristics with measured discharge data (or reference evapotranspiration data).

-Download ERA5, CMORPH and MSWEP data for your catchment (for the whole available period). Compare the data, plot the comparison.

-Compare the spatial precipitation data sources with gauge-based data, plot the comparison.