Adaptation of the Meuse to the Impacts of Climate Evolutions

HOW CLIMATE CHANGE COULD AFFECT THE HYDROLOGY IN WALLOON REGION ?

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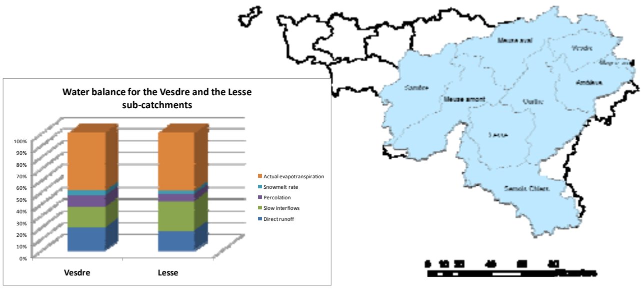
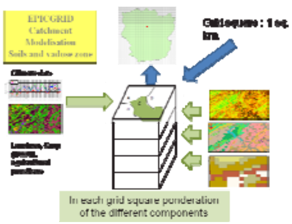
⬧Study area:



	Station	Drainage area (km²)	Main land-use	Highest gauging discharge value in high flows	Lowest gauging discharge value in low flows	Anthropogenic influence on natural flow
Vesdre	Chaudfontaine	683	Forest	274,46 m³/s	0,21 m³/s	dams
Lesse	Gendron	1284	Forest	390,80 m³/s	0,62 m³/s	

⬧EPICGrid model:

The hydrologic model EPICGrid is a physically based distributed model at catchment scale. It has been designed by the unit of Hydrology of Gx-ABT.
It works at 1 km² resolution at daily timestep.
It is built upon a « major components » approach and takes into account the climate data, landuse, crop growth, agricultural practices, topography, soils and geology. For every cell, the different combinations are balanced.



⬧CCI-HYDR Perturbation Tool:

The CCI-HYDR Perturbation tool is a perturbation algorithm which was developped to assess hydrological impacts of climate change for Belgium. It was developped by the KUL and the RMI. Observed series of data are perturbed in view to generate future time series.The observed series are perturbed on the basis of 4 SRES scenarios (A1B, A2, B1 and B2).The tool generates 3 scenarios: high/wet, mean, low/dry scenarios. These scenarios are based upon the expected hydrological impacts. The high scenario is the most severe case for flood risk analysis. The low scenario is the most severe low flow situation.

% change in rainfall for the different scenarios for Walloon Region:

Scenarios	Annual	Winter	Spring	Summer	Autumn
2020-2050 high	2.7	28.2	-0.8	-23.6	10.7
2020-2050 low	-9.0	-5.1	-0.8	-23.6	-0.7
2070-2100 high	2.6	55.3	-11.2	-47.2	19.7
2070-2100 low	-19.2	-7.1	-11.2	-47.2	-8.1

Change in temperature [°C] fort the different scenarios for Walloon Region:

Scenarios	Annual	Winter	Spring	Summer	Autumn
2020-2050 high	1.9	1.3	2.1	2.6	1.7
2020-2050 low	0.8	0.5	0.8	1.2	0.7
2070-2100 high	4.0	2.6	4.4	5.3	3.6
2070-2100 low	1.6	1.0	1.6	2.4	1.5

⬧Results:

Evolution of water balance:

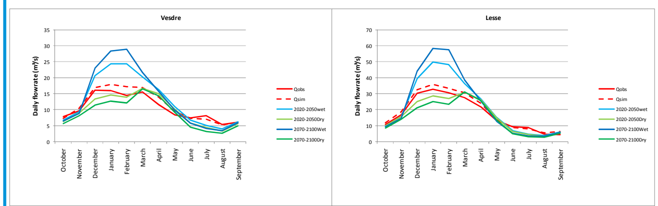
Vesdre

	Qsim (mm/an)	2020-2050 Wet	2020-2050 Dry	2070-2100 Wet	2070-2100 Dry
Rainfall	1110	3%	-12%	4%	-19%
Direct runoff	226	14%	-14%	19%	-23%
Slow interflows	195	18%	-12%	25%	-21%
Percolation	109	11%	-10%	13%	-19%
Actual evapotranspiration	573	-8%	-11%	-11%	-17%

Lesse

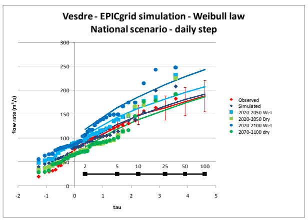
	Qsim (mm/an)	2020-2050 Wet	2020-2050 Dry	2070-2100 Wet	2070-2100 Dry
Rainfall	1016	4%	-11%	5%	-19%
Direct runoff	164	16%	-12%	24%	-20%
Slow interflows	248	18%	-14%	25%	-23%
Percolation	62	3%	-11%	4%	-17%
Actual evapotranspiration	539	-7%	-9%	-10%	-16%

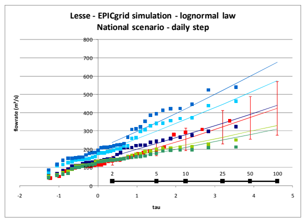
Monthly mean flow rate:



Daily discharges:

The method of yearly maximum is the classical method used to evaluate exceptionnal high-flow discharge values. It consists in adjusting a statistical law to the set of yearly maximum flow rate observed or simulated. The HYFRAN software was used in this study.





T	Qobs	2020-2050wet	2020-2050Dry	2070-2100Wet	2070-2100Dry
100	188	8%	4%	27%	-3%
50	176	8%	3%	26%	-4%
25	163	9%	2%	27%	-5%
10	143	10%	-1%	27%	-6%
5	124	12%	-4%	27%	-8%
2	88.7	14%	-10%	27%	-12%

T	Qobs	2020-2050Wet	2020-2050Dry	2070-2100Wet	2070-2100Dry
100	424	31%	-25%	54%	-30%
50	372	31%	-24%	54%	-28%
25	321	30%	-23%	53%	-27%
10	256	30%	-20%	51%	-25%
5	207	30%	-18%	50%	-23%
2	138	29%	-14%	48%	-19%

Low-flows:

The « mean annual 7-days minimum flow » (MAM7) was used as low flow indicator.

T	Qobs	2020-2050wet	2020-2050Dry	2070-2100Wet	2070-2100Dry
50	1.31	7%	-25%	16%	-37%
25	1.54	8%	-23%	13%	-35%
10	1.89	7%	-20%	11%	-32%
5	2.23	7%	-18%	10%	-29%
2	2.87	6%	-14%	6%	-25%

T	Qobs	2020-2050wet	2020-2050Dry	2070-2100Wet	2070-2100Dry
50	1.4	22%	-11%	28%	-21%
25	1.58	18%	-12%	23%	-21%
10	1.84	0%	-11%	17%	-20%
5	2.09	10%	-11%	12%	-19%
2	2.52	5%	-11%	6%	-18%

⬧Conclusions:

The hydrological modeling using a physically based model that includes water-soil-plant continuum permits to highlight effects of climate change on plant growing and water uptake. ETR decreases in each simulation, due to temporary saturation (particularly in grasslands during spring) and water deficit during the growing period. 10% decrease of ETR is observed for 2070-2100 wet scenario and 17% decrease for the dry one.
Extreme daily flow rate could increase between 27% and 54% for 2070-2100 wet scenarios in the Vesdre and Lesse subcatchment. Low flow (MAM7) could decrease between 21% and 37% following the dry scenario.

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