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The water balance of historical watermills – case of the Strijpen mill in the Scheldt basin (Belgium)

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The strongest early developments in the hydrological theory were related to the practical need to master the surface water balance. Here we investigate the functioning of the hydrological system of overshot mills in rivers with small and irregular discharges. The water balance and its different components are quantified. In addition, a quantitative investigation was done on the possible effects of increasing the mill pond's storage volume and the installation of a parallel stream for fish migration. The research was carried out at a typical overshot mill that has been functioning without interruption for at least five centuries, the Van Den Borre's mill at Strijpen in Belgium. Fieldwork was carried out from August 2017 till April 2018, and involved the installation of three staff gauges, three water pressure transducers, one barometric data logger, as well as one rain gauge, all synchronised. Data were recorded on minute basis. A specific campaign was designed to study the energetic efficiency at different discharges, in which the same parameters were recorded, as well as energy production on half-hourly basis. All terms of the water balance were determined: direct rain, discharge in head- and tailrace, change to storage in mill ponds, groundwater flow and direct evaporation (very small in comparison to the other terms). Average discharge of the incoming Traveinsbeek was between 0.01 m^3 s-1 in August 2017 to 0.12 m^3 s-1 in December 2017. As the discharge of the river is generally too small to operate the mill, storage is crucial – there is a storage capacity of 2962 m^3, of which only 75 m^3 is dead storage. The energetic efficiency of the mill is 62 – 69%. Depending on the available water, in a week's time 62 to 282 kWh of electric power can be generated, what corresponds to the average consumption of one to four households. Assuming a mill that works every day, pond enlargements would lead to an increase in production by 4%, the main limitation being the low incoming discharge. However, the construction of a parallel stream for fish migration would lead to an average decrease of energy production by 43%. The installation of such an ecological asset needs to be balanced against the heritage value of a rare working historical watermill in its full landscape setting. The hydrological system of the Van Den Borre's mill is well designed for a daily use of the mill, in which the potential energy of the water is efficiently converted into electric power. In a context where the studied hydrological system still represents the historical conditions, this indicates an age-old nearly perfect understanding of hydrology and energetic efficiency of watermills.