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Abstract:

The low flow phenomenon is significantly concerned since it severely impacts socio economic activities. During low flow periods, diminished freshwater resources are often unable to provide adequate water for crop production, hydropower generation and urban water supply, as well as to maintain water quality of freshwater bodies due to high concentration of pollutants and saltwater intrusion. Accordingly, determining the required minimum flows in rivers during low flow periods is important to reduce the impact of saltwater intrusion and maintain a sustainable water supply for different water users such as agriculture, domestic use and industries.

Located in the central coastal zone of Viet Nam, the Vu Gia – Thu Bon river basin experiences drought during the dry season along with salt intrusion due to low flow. The region was chosen as an in-depth case study since it provides crucial information regarding the low flow phenomenon and drought situation during the period 1976 - 2014. This research aims to develop a generally applicable methodology to assess minimum flow requirements in the rivers. The goal of this thesis is (1) to analyze the low flow phenomenon and minimum flow requirements; (2) to quantify the potential water demand from the different user categories; (3) to assess the performance of the existing irrigation system in regards to water supply availability and water demand; (4) to determine the required minimum flow to prevent salt intrusion and satisfy the water demand from different activities during low flow periods; and (5) to derive a generally applicable methodology to assess minimum flow requirements in multi-sectorial water management scenarios.

Firstly, statistical analysis was conducted to examine trends in precipitation and flow during the study period. Thereafter, a flow duration curve and SPEI index were calculated to understand the flow pattern and drought events in the region. The potential water demand was quantified for the agricultural sector, as well as domestic and industrial uses to map the water utilization pattern. The Penman – Monteith equation was applied to calculate the potential evapotranspiration using the data from the dry year 2005. Furthermore, the performance of the irrigation system was accessed by analyzing the two indicators of Relative Water Supply and Relative Irrigation Supply. Finally, a calculation of the minimum flow requirement was carried out by applying the hydrodynamic model MIKE 11. The model was run for different upstream discharge datasets to test the response of the salt concentration, and then define where the salt concentration remains under threshold values at chosen measurement points. Six different scenarios were developed to predict the minimum flow requirements toward the changes in potential water use, sea level rise and water use efficiency.

In general, the analysis of precipitation and flow revealed strong increasing trends, however these were mostly seen in rainy season. On the other hand, the SPEI index showed a decrease of drought events in the years post 2000. The yearly potential demand of the Vu Gia -Thu Bon Delta was calculated as 309 million m3, of which 203 million m3 is for agriculture, 89 million m3 is for domestic use, and only 17 million m3 is for industry. Furthermore, the analysis of Relative Water Supply and Relative Irrigation Supply revealed the constraints of the irrigation system to supply sufficient water for the crops, especially from February to June. Finally, the results of the six scenarios were mapped presenting the spatial and temporal extents of the minimum flow requirements in the Vu Gia – Thu Bon river basin.

The described methodology includes transferable state-of-the-art techniques, making it an applicable approach to determine the minimum flow requirement in an anthropogenically influenced river basin. This methodology has been successfully tested in the Vu Gia - Thu Bon river basin and can be extrapolated to similar river basins.