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# Computational issues in complex water-energy optimization problems: Time scales, parameterizations, objectives and algorithms

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Modelling of large-scale hybrid renewable energy systems (HRES) is a challenging task, for which several open computational issues exist. HRES comprise typical components of hydrosystems (reservoirs, boreholes, conveyance networks, hydropower stations, pumps, water demand nodes, etc.), which are dynamically linked with renewables (e.g., wind turbines, solar parks) and energy demand nodes. In such systems, apart from the well-known shortcomings of water resources modelling (nonlinear dynamics, unknown future inflows, large number of variables and constraints, conflicting criteria, etc.), additional complexities and uncertainties arise due to the introduction of energy components and associated fluxes. A major difficulty is the need for coupling two different temporal scales, given that in hydrosystem modeling, monthly simulation steps are typically adopted, yet for a faithful representation of the energy balance (i.e. energy production vs. demand) a much finer resolution (e.g. hourly) is required. Another drawback is the increase of control variables, constraints and objectives, due to the simultaneous modelling of the two parallel fluxes (i.e. water and energy) and their interactions. Finally, since the driving hydrometeorological processes of the integrated system are inherently uncertain, it is often essential to use synthetically generated input time series of large length, in order to assess the system performance in terms of reliability and risk, with satisfactory accuracy. To address these issues, we propose an effective and efficient modeling framework, key objectives of which are: (a) the substantial reduction of control variables, through parsimonious yet consistent parameterizations; (b) the substantial decrease of computational burden of simulation, by linearizing the combined water and energy allocation problem of each individual time step, and solve each local sub-problem through very fast linear network programming algorithms, and (c) the substantial decrease of the required number of function evaluations for detecting the optimal management policy, using an innovative, surrogate-assisted global optimization approach.