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A TRADEOFF ANALYSIS METHOD FOR EVALUATING ENVIRONMENTAL PERFORMANCE AND OPERATIONAL OBJECTIVES OF HYDROPOWER FACILITIES

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ABSTRACT: Water flowing through a river is a renewable resource, but its availability and functionality is limited in time and space. Securing supply reliability for various societal needs are typically addressed by developing operational plans for regulated rivers, and concerns related to maintaining the environmental functionality of a regulated river are generally addressed by identifying minimum flows to benefit a few static within-channel features. This approach largely ignores the consideration of multiple ecological objectives, which can range from providing suitable instream habitat conditions to periodic connection of rivers with floodplains. Although optimization has routinely been used to address water availability among competing societal objectives, environmental objectives are generally treated as constraints, and threshold values are merely used for setting boundary limits. Lack of an objective methodology to quantify the degree to which dynamic functionality of a river has been achieved limits the ability to evaluate tradeoffs between environmental performance and operational objectives for hydropower and other regulated facilities. We developed a method for objectively evaluating the environmental performance of downstream ecosystems that can be achieved by water releases. This method will be incorporated into an integrated optimization system for reservoir operational planning that will allow environmental performance and operational objectives to be considered simultaneously. Users input information about environmental objectives to be met by discharges (e.g., timing, duration, and frequency with which objectives should be met) and identify functional relationships among downstream conditions (e.g., discharge, water temperature) and metrics related to the environmental objectives of concern. Operational constraints, such as minimum discharges and maximum ramp-rates, can also be incorporated into the assessment process. The degree to which a flow regime meets environmental objectives is quantified as an overall environmental performance score (index of river functionality), that is based on the functional relationships defined, the desired frequency with which objectives should be accomplished, the history of achieving objectives during previous time periods, and the suitability of hydrologic conditions for meeting objectives. Desired frequencies can be adjusted to prioritize objectives and for adaptive management purposes. Comprehensive consideration of environmental objectives during operational planning will aid in policy development and sustainable water management.

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