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## Operationalizing Justice in Integrated Water Resources Modeling and Management

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Justice in the allocation and distribution of water is one of the most recent topics in the water resources management literature. This topic, i.e., justice/equity/fairness, is especially noteworthy in integrated water resources management where competing needs, sectors, and societal segments are involved in the utilization of water. Although the concept of justice, such as procedural justice, in general and in water management in particular is not as new, the concept of distributive justice and tools and technics for the allocation and distribution of water resources is very recent. As a result, particularly tools and techniques for the operationalization of such concepts are still lacking.

In this study, we operationalized theoretical justice theories in terms of moral principles into functions and parameters for use with traditional water resources optimization models and frameworks. These moral principles include Utilitarianism (which evaluates measures according to their effect on welfare), Sufficientarianism (which makes sure that each individual gets a sufficient threshold), Prioritarianism (which guarantees extra weight to worse-off individuals), and envy-freeness (which requires that each individual prefers his share to the share of others).

The result of the study as applied in the case study of the Susquehanna basin, USA, displays understanding and outlooks of various perspectives of fairness on integrated water resources management among competing stakeholders and needs. Such perspectives are presented together with traditional resource efficiency and/or conservation oriented optimization techniques and methods to highlight synergy and trade-offs in integrated water resources management. We think that the methods and approaches presented here will advance the scientific discussion on the operationalization of justice/equity/fairness in real-world modeling and management of integrated water resources.