Optimization of reservoir operations

Challenge: Too much water

Adaptation response: Riverine flood protection

Description
Large water reservoirs often serve several purposes, such as for hydropower production, irrigation control, flood-control, navigation and other flow regulation objectives. Reservoirs may include natural water bodies such as lakes or man-made structures such as dams. Due to climate change, the importance of reservoirs is likely to increase – not only for the water storage purposes, but also for maximizing water use benefits and mitigating climate extremes.

Optimizing storage reservoir operations aims to ensure that all planned reservoir objectives are met, without compromising those of ecological water requirements. It takes into account a variety of objectives and variables, including cost and revenue considerations of water allocation for various socioeconomic uses. Various computer simulation models can be used for optimization. The models use algorithms to calculate the optimal balance between water release and reservoir storage volumes.

Implementation
The rationale behind optimizing reservoir operations is to gain additional benefit and reduce risks without making substantial changes to the existing water infrastructure. Desired objectives may include reducing operational costs, but also improving response to increased climate variability (i.e. droughts and floods). Optimization methods rely primarily on computer modelling tools such as hydrological models and optimization models to assess and compare the performance and benefits of reservoir operations under different scenarios. These may be long-term scenarios or real-time optimization measures in response to rapid changes such as floods.

The models use historical data on factors influencing water balance and quality in the reservoirs (e.g. seasonal weather data, water quality trends, water release history etc.) that are fed into the relevant simulation models to run various scenarios. In addition, they may require real-time water level monitoring and detailed weather forecasts for flood control purposes. They may consider not only water availability, but also changes in demand as a response to changing climate conditions. There are numerous optimization approaches and methods available that should be weighed depending on resource availability and specific optimization objectives.

Examples of physical optimization interventions include installation of necessary sensors (for water quality), changes in management practices and response procedures, agricultural cultivation regulations in the basin, scheduling changes in pumping and energy production, and changes to water distribution systems.

Environmental Benefits
- Accounts for suitable water quality and quantity to meet environmental needs, considering the environment as a key water user.
- Reduce ecological risks of water shortages and floods.
Socioeconomic Benefits
- Helps meet management goals with maximum benefit for all users.
- Helps better manage climate-induced water variability, and reduces economic activity risks (depending on water releases).
- Reduces operational expenses and increases economic benefits of water use.

Opportunities and Barriers

Opportunities:
- Models are cost-effective and time-saving for monitoring and managing reservoirs compared to response driven alternatives
- Increases operational cost efficiency and societal benefits where it is most needed and useful, particularly during water shortages.

Barriers:
- Substantial expertise and reliable data are required to run and assess optimization models
- Measures may translate to trade-offs and restrictions to some user groups (for example during droughts), creating potential economic losses.

Implementation considerations*

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* This adaptation technology brief includes a general assessment of four dimensions relating to implementation of the technology. It represents an indicative assessment scale of 1-5 as follows:

- **Technological maturity**: 1 - in early stages of research and development, to 5 - fully mature and widely used
- **Initial investment**: 1 - very low cost, to 5 - very high cost investment needed to implement technology
- **Operational costs**: 1 - very low/no cost, to 5 - very high costs of operation and maintenance
- **Implementation timeframe**: 1 - very quick to implement and reach desired capacity, to 5 - significant time investments needed to establish and/or reach full capacity

This assessment is to be used as an indication only and is to be seen as relative to the other technologies included in this guide. More specific costs and timelines are to be identified as relevant for the specific technology and geography.
Sources and further information


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