Enhanced risk management strategies for mitigating future droughts in Central Asia

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BACKGROUND

Relevance

Sedimentation reduces the storage capacity of reservoirs and thereby, the ability to conserve water for various intended purposes. Consequently, the frequency and magnitude of failures increases. Therefore, the effect of storage capacity losses on the water availability has to be considered within the management of available water resources, especially under water deficit conditions.

The focus of the study lies on the assessment of ongoing reservoir storage capacity losses of the Tuytymuygyn Hydro-complex (THC) and its effect on the compensation of sediment volumes during exceptional drought years. The risk of reservoir storage capacity losses is a serious problem for the future water supply of the lower Amu Darya region, Central Asia. Especially the in-stream Channel Reservoir as the main reservoir of the THC, proves to be an extremely vulnerable system. The seasonal variation of the Amu Darya inflow. The study assesses effects of past and developed reservoir operation strategies on sediment processes in the Channel Reservoir, to evaluate the risk of storage capacity losses and the effects on the water availability.

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RESERVOIR STORAGE CAPACITY ASSESSMENT

Storage capacity losses, Channel Reservoir

Actual Channel Reservoir bathymetric data (2005) for its comparison with the design capacities (1983).

Characterisation of Channel Reservoir siltation processes

- biggest volume of sediments with 222 million m³ accumulated in the high water years of 1991 - 1992 and with 118 million m³ in 1998
- removal of sediments maximum deposition volume of 135 million m³ during the low water year (THC inflow, 20.8 km³/a) in 1986, with 56 million m³ during 1997 (18.3 km³/a) and with 130 million m³ during the exceptional drought period 2000-2001 (18.7 and 13.6 km³)
- dry years: flushing effects caused by past reservoir operation, with channeling the scarce water through the Channel Reservoir to the lower river without any storage.
- wet years: increased risk of storage capacity losses, by conventional management

The results shows the need for sustainable sediment management for the reservoir in order to avoid further capacity losses. The following model approach has demonstrated the potential of the THC to supply the local population (of the lower Amu Darya region) with more potable water of higher quality even subject to a parallel reduction of water deficits.

RESERVOIR OPERATION ASSESSMENT

Simulation of conventional & enhanced operation

The aims of the following modelling exercises are the definition of the different reservoir operation effects on the sediment dynamics in the Channel Reservoir. Simulation results for the cohesive sediments at the reservoir bottom, in total and average for the conventional and enhanced reservoir operation.

Simulation analysis

Cohesive sediments at the reservoir bottom, for predefined reservoir sections Box 1-4.

- conventional operation: total, 38 300 000 kg
- enhanced operation: total, 34 500 000 kg
- conventional operation: max. 11 900 000 kg
- enhanced operation: max. 22 700 000 kg

The simulation analysis has demonstrated the potential of the THC to supply the local population (of the lower Amu Darya region) with more potable water of higher quality even subject to a parallel reduction of water deficits.

CONCLUSION

The THC significantly influences the sediment regime of the lower Amu Darya as a sediment trap. The results illustrate that a huge amount of sediments is stored at the impact of climate change on water availability during the next 50 years.

The existing risk management system of the Tuytymuygyn Hydro-complex (THC) offers highest capability for an adaptation of the THC management strategies.

Applying the concept of enhanced reservoir operation it was planned to store mainly the low salinity summer flood in the pumping reservoir Kaparas. The results have identified the most suitable combination of water level regimes for all reservoirs of the THC.

- annual water demand: 20.5 km³/a
- conventional inflow THC (dry year, 2001): 12.9 km³/a
- annual inflow THC: 20.2 km³/a enhanced operation for dry years

an effective measure for a rapid and comprehensive improvement of the water quality in water crisis regions.

- possible to adapt the operation strategies has been demonstrated the potential of the THC to supply the local population (of the lower Amu Darya region) with more potable water of higher quality even subject to a parallel reduction of water deficits.

The study has emphasized that a more precise understanding of reservoir sedimentation processes and resulting storage capacity losses provides necessary background information for assessing management options during drought events and the impact of climate change on water availability during the next 50 years.

Enhanced reservoir operation for the THC

The existing risk management system of the Tuytymuygyn Hydro-complex (THC) offers highest capability for an adaptation of the THC management strategies.

These investigations have been demonstrated the potential of the THC to supply the local population (of the lower Amu Darya region) with more potable water of higher quality even subject to a parallel reduction of water deficits.