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A hydrologic approach to risk assessment for the Volga-Caspian basin

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Both, the Volga cascade and the coastal area of the Caspian Sea (CS) offer enormous economic value, especially with regard to the production of hydro-power (in the Volga cascade) or oil and gas (in the Caspian region), respectively. However, large-scale risk and conflict potentials have to be considered. Due to increased retention times in the Volga cascade and anthropogenic input, the water quality of the Volga river decreased significantly. Problems in the coastal area of the CS have been caused by a substantial rise of the Caspian Sea level (CSL) about 2.5 m beginning in 1977. Especially the north-eastern part of the CS is vulnerable due to shallow water depths and the occurrence of strong winds persisting in direction during several days. In consequence, surges raising the water level up to additional 2.5 m in short time inundated large (flat) areas in the late 1980s and in the 1990s. Due to the leakage of harmful substances from inundated objects (oil, sewage plants etc.), an additional risk regarding water quality in the CS has to be considered. Since about 80 % of river inflow into the CS come from the Volga river, the knowledge of its long-term flow process is a decisive factor in an assessment of the problem.

Regarding multiple, partly conflicting interests along the Volga river and at the CS, an integrated research approach is required. This is the aim of the German-Russian cooperation project “Volga-Rhine”, which is funded by the German Federal Ministry of Education and Research and the Ministry of Industry, Science and Technologies of the Russian Federation. Since the flow process is the main dynamic natural boundary condition in the Volga-Caspian system, hydrologic analyses and simulations are crucial in the scope of the project. This contribution emphasises a top-down oriented approach based on the statistical analysis of long-term series of annual mean flow. For the gauge of Volgograd (representing the overall basin of the Volga), a statistically sig-

nificant, complex oscillation pattern could be identified. Analyses for multiple gauges in the Volga basin revealed that this pattern resulted from a superposition of oscillations with periods of ~ 30 years in the western basin part, and ~ 14 years (flow volume of snowmelt events) and ~ 20 years (flow volume of the remaining months) in the eastern basin part (Kama basin). This result is consistent with those for other rivers in North-Eastern Europe and Northern Asia (Neva, Pechora, Ob, Yenisei). More or less, these oscillations compensated each other most of the time in Volgograd. However, synchronous minima or maxima occurred in the 1930s or 1970/80s, respectively. These are just the periods of substantial changes of the CSL. It can thus be assumed that the described mechanism is crucial for an understanding of the CSL development. In addition, the results may serve as a contribution to a regionally differentiated long-term planning base for the resources management in the Volga basin (renewable energy, water supply).

With respect to the discussed global climate change, it is still difficult to reliably predict the development of the CSL for the 21st century. For this purpose, more detailed, but also more extensive hydrologic process analyses are required for the Volga basin and other Eurasian river basins. Parallel to this, hydrologic simulation tools, e.g., those developed in the scope of the Volga-Rhine project, will have to be coupled with regional climate models, which are driven by General Circulation Models. Hydrologic analyses of the integrated variable “flow” may support the identification of relevant climatologic patterns for the CSL development. On the other hand, an appropriate climate model may provide the input of realistic future climate scenarios for hydrologic models and may contribute to a further utilisation of simulated flow series (water-balance calculations for the prediction of the CSL). With this contribution, we intend to contribute to a discussion regarding research requirements for the Volga-Caspian basin at the interdisciplinary interface of hydrology and climatology.