Cold and Mountain Region Hydrological Systems Under Climate Change: Towards Improved Projections
Proceedings of H02, IAHS-IAPSO-IASPEI Assembly, Gothenburg, Sweden, July 2013 (IAHS Publ. 360, 2013). 131-140

Exploring the relationship between polar motion and a natural river's runoff based on Granger causality

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Abstract Assessing the sensitivity of cold and mountain hydrological systems to climate change needs long-term hydrological data. The data in cold and mountain regions are either available on the very short-term, or absolutely unavailable due to high elevation and cold environments, which are hard to access for conducting field observations. In order to explore the possibility of whether we can seek assistance from some already existing long-term data in other disciplines to fill the blank of data of river flow in these regions, the relationship between the runoff of Yarlung Zangbo, a natural river in Tibet, China, and polar motion, which has data records from 1864 up to the present, is explored. First, the action path framework was structured based on geophysical principles. The Granger causality test was conducted at monthly, seasonal and annual time scales. It is found that on a monthly scale the X component of polar motion influences the runoff at the lag being from the 1st to the 21st month, with the 9th month being an exception. The Y component of polar motion influences the runoff at the lag from the 1st to the 9th month and from the 17th to the 24th month. At seasonal scale, the influence of the X component of polar motion on river runoff can be seen in the 2nd season (i.e. from the 4th month to the 6th month). The influence of the Y component of polar motion on river runoff can be seen at seasonal scale from the 4th to the 6th season (i.e. from the 10th month to 18th month). We cannot see evidence of Granger causality from polar motion to river runoff at annual scales. For the Granger influence of river runoff to polar motion, it is found that at monthly scale the influences are prominent at the lag being from the 3rd to the 25th months for the X component and from the 3rd to the 25th for the Y component. At seasonal scale, these influences can be seen at the lag from the 2nd to the 8th season (corresponding to the 4th to 24th months) for the X component and at the lag from the 1st to the 8th season (corresponding to from the 1st to the 24th month) for the Y component. Again, at the annual scale no evidence of Granger causality can be found from runoff to polar motion. The different behaviours at monthly, seasonal and annual scale suggest that using the monthly data of polar motion to obtain the monthly runoff data is more practicable than to borrow the data from polar motion for river runoff at seasonal and annual scale.

Key words runoff; polar motion; Granger causality; Yarlung Zangbo