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Jordan River

GLOWA

The duration and frequency of drought under a changing climate

Key findings

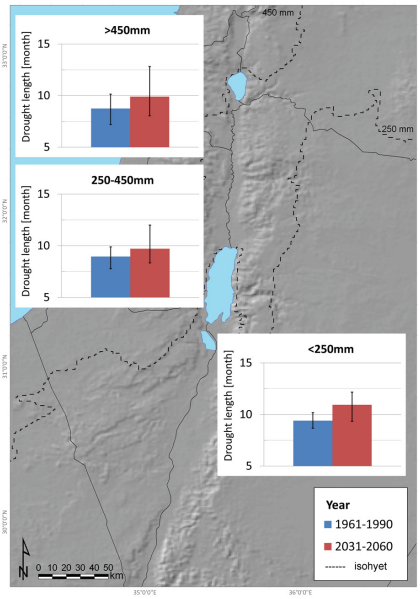
- The (6-month) Standardized Precipitation Index (SPI) is identified as a well-performing drought index.
- Future droughts are projected to become longer and more severe.
- The irrigation water demand is expected to rise under future drought conditions.

Overview and Objectives

Drought is an extended period of time with rainfall deficits. It is a natural hazard having environmental-, social- and economical impacts (Wilhite 2005). An index can be used to define the onset of drought and to simplify the wide range of impacts. By applying such an index, the severity of a current drought event can be quantified and compared to past conditions. In combination with climate projections, future droughts can furthermore be addressed. A drought index also facilitates the communication between scientist, decision makers and the public (Wilhite, 2005). In the present study, a drought index was applied and the duration as well as the frequency of droughts during a future time period (2031-2060) was compared to a current reference period (1961-1990). To furthermore address the impact of droughts on the agricultural sector, the Irrigation Water Demand (IWD) during drought was simulated with the hydrological model TRAIN (Menzel et al. 2009).

Research Methods

A relationship between precipitation and vegetation has been observed in the Jordan River region (Törnros 2010). This suggests that a drought index based on precipitation alone is suitable for the characterization of droughts. In the present study, the Standardized Precipitation Index (SPI) was used. The index defines drought according to the negative deviation from the long-term mean precipitation. The SPI was applied on monthly precipitation on a 1x1 km spatial scale. The performance of the drought index was confirmed by conducting monthly regression analysis with the Normalized Difference Vegetation Index (NDVI) received from remote sensing (Törnros & Menzel 2013). Thereafter the SPI was applied on three climate projections delivered from the GLOWA Jordan River sub-project on climate change simmulations (Briefing 1.3).



Results

The SPI results were evaluated according to three climate regions representing sub-humid, semi-arid and arid conditions. The results show that the mean duration of current droughts is 8 months and 23 days, 8 months and 29 days as well as 9 months and 12 days in the sub-humid, semi-arid and arid region, respectively (Figure 1).
The mean duration of future droughts is projected to be prolonged with 34 days in the sub-humid region, with 22 days in the semi-arid region and with 46 days

Figure 1: Mean drought duration of current and future droughts in a sub-humid (annual precipitation > 450 mm), semi-arid (250-450 mm) and arid (<250 mm) region. The error-bars refer to the most- and least severe climate projection.

Teams of researchers from Germany, Israel, Jordan and the Palestinian Authority work on how best the hazards posed by global change to the future of the Jordan River basin can be faced and overcome.

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The GLOWA Jordan River project is part of a larger research initiative launched by the German Federal Ministry of Education and Research under the title "Global Change and the Hydrological Cycle".

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in the arid region. Also the drought frequency was addressed. Averaged from all three climate regions, the results show that the mean number of moderate droughts per decade is projected to decrease from 2.60 to 2.41 (Figure 2). In contradiction, the severe and extreme droughts are expected to occur more often. The mean numbers of severe droughts per decade is expected to increase from 1.40 to 1.74 and the number of extreme droughts per decade is expected to increase from 0.72 to 1.36. Altogether the results show that future droughts are expected to be longer and more severe than current ones.

The IWD was simulated with TRAIN and by considering cultivated land only. The results show that the mean annual IWD for the time-period 1961-1990 was 80 mm; this value corresponds to about 1810 MCM of water. The annual IWD was simulated also for drought periods. The results give a value of 122 mm (2770 MCM) and 174 mm (3950 MCM) for the longest current- and future drought, respectively. This implies an increased irrigation demand of 53 and 118%, respectively. The IWD is a potential value which in reality and especially during droughts may not be fulfilled. Therefore higher values induce higher vulnerability to drought.

Conclusions

The results of this study show that the mean duration of droughts is expected to increase with around 1.5 months in the future. The results also show that the droughts are expected to become more severe as a shift from moderate- to severe- and extreme droughts is projected. Furthermore, it is shown that the agricultural sector is expected to become more vulnerable to drought as more water has to be allocated to irrigation in order to sustain the agricultural production at the current level.

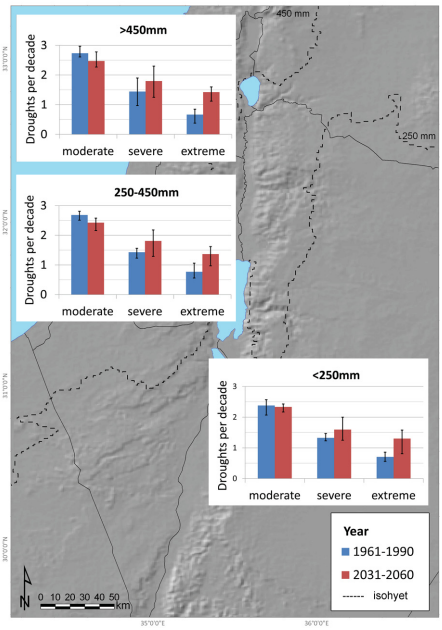

Figure 2: Mean drought frequency of current and future droughts.

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GLOWA JR Briefings present relevant scientific results of the GLOWA Jordan River project concerning the effects of climate and global change in the Jordan River basin.

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