

Recent two-fold increase in the frequency of hydrological extremes in Amazonia

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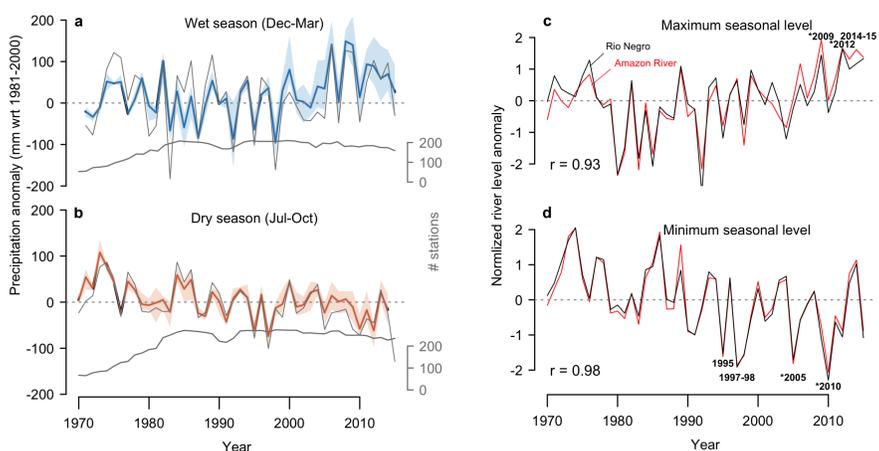
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Abstract

The hydrological cycle of the Amazon basin has intensified since the late 1990s, with a marked increase in extreme events causing disruptions of fluvial transport, and distress to livelihoods and ecosystems. Detailed analysis of the nature, frequency and intensity of these events however is lacking and the cause of the intensification has remained elusive. Here we use continuous daily records of water level from large rivers from 1902 to 2015 to show that the frequency of hydrological extremes in Amazonia has doubled over the past two decades. Notably, flood frequency has experienced an unprecedented five-fold increase, roughly from one every 20 years during the first half of the 20th century to one every 4 years during the 2000s. Although not unprecedented, the frequency of droughts has also increased and since around 1980 it has matched that of floods. These results challenge the established perception that droughts are the dominant feature of change in the hydrological cycle of Amazonia.

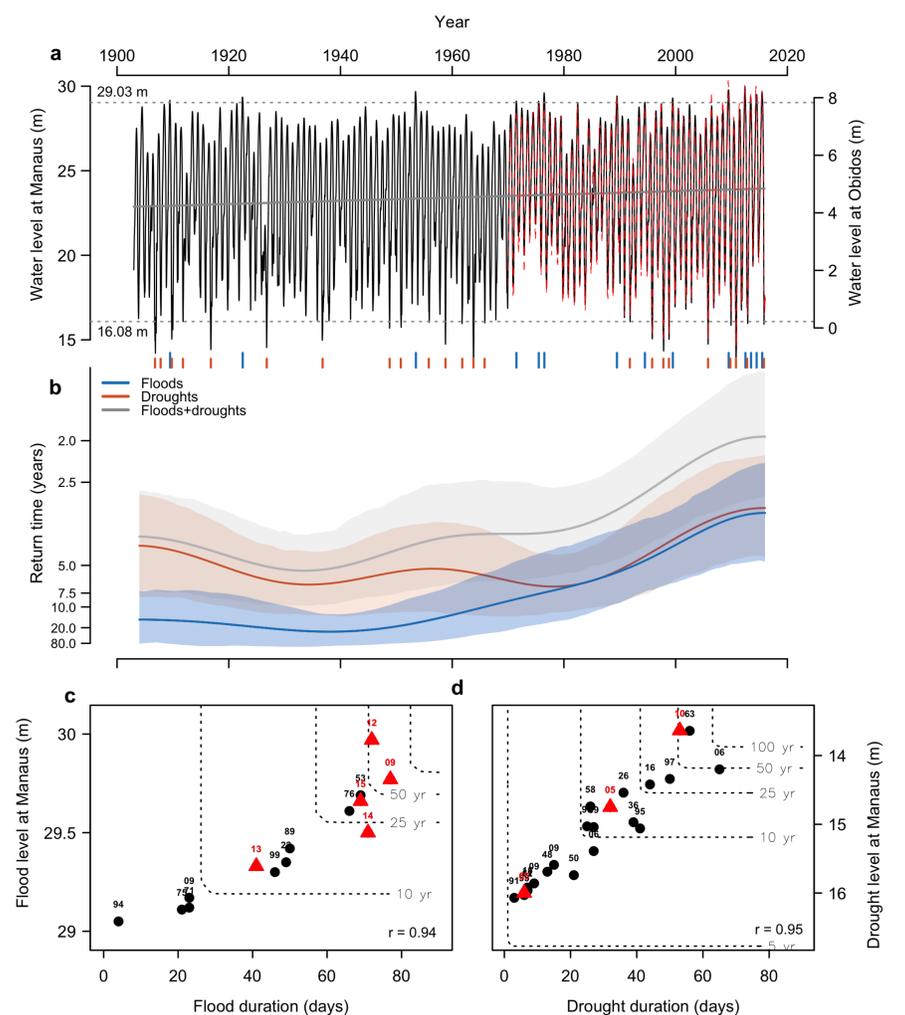
1. Increasing hydrological variability



Key points

1. Precipitation data show a general tendency for wet seasons to get wetter and dry seasons to get drier since the 1990s (Fig. 1a,b)
2. Water level data at Manaus and Obidos show a consistent increase in the amplitude of seasonal variability and a tendency for more frequent record-breaking droughts and floods in recent years (Fig. 1c,d)
3. Variations in minimum and maximum seasonal water levels are highly correlated in the two gauging stations

2. Historical droughts and floods



Key points

1. Mean daily water levels in Manaus show a significant ($p < 0.01$) increasing trend of about 1 m (5% of the mean) during the 113 years of record (Fig. 2a)
2. Floods steadily increased since around 1960, leading to unprecedentedly high levels of flood risk in recent years (Fig. 2b).
3. Droughts typically occur with a frequency ranging from 3 to 6 years with more frequent events during the 1900s, 1960s and late 2000
4. Doubling in the frequency of extreme events since around 2010 (Fig. 2b), with an extreme event (either drought or flood) now occurring every other year.
5. Recent floods are more extreme than earlier events (Fig. 2a,c)
6. The duration and severity of recent drought events (i.e., post-2000) are not unusual (Fig. 2d).