XXV SIMPÓSIO BRASILEIRO DE RECURSOS HIDRÍCOS

MUDANÇAS CLIMÁTICAS E FATORES INFLUENTES NA OCORRÊNCIA DE CHEIAS EM GRANDES RIOS DA AMÉRICA DO SUL

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Palavras-Chave – floods; climate change; South America

INTRODUCTION

The frequency and intensity of extreme rainfall events are expected to increase due to global warming. The Clausius-Clapeyron relation indicates that a warmer atmosphere is able to hold more water vapor at a rate of 6-7% per degree Celsius.

These climatic alterations have an immediate impact on flooding. At first, it was expected that global warming would increase the flood frequency following the observed increases in extreme precipitation. However, some recent results showed that increases in precipitation do not necessarily translate to increases in flood magnitude (Wasko and Sharma, 2019).

Using a hydrological model forced with climate projections, we can evaluate expected changes in flood discharge with a reasonable physical representation. In this paper, we use a hydrodynamic-hydrological model for South America forced with projections from Eta for the RCP 4.5 and 8.5 scenarios from CMIP5. In this context, the objective of this study is twofold. First, we investigate climate change impacts on extreme events in South America in terms of antecedent soil moisture, precipitation, and flood discharge at different spatial scales. Second, we assess how projections of flood discharge are related to projected changes in its main drivers.

METHODOLOGY

We use the Eta model nested in 4 GCMs: BESM, CanESM2, HadGEM2-ES and MIROC5 for climate projections. We evaluated 2 representative concentration pathways (RCP) from CMIP5: RCP4.5 and RCP8.5, which correspond to a reasonable controlled and a high emission scenario, respectively. The Eta output data from the historical (1961-2005) and future (2021-2065) periods were bias-corrected and used as inputs to the hydrological model MGB-SA. MGB–SA is a continental-scale, semi-distributed hydrological-hydrodynamic model developed for integrated simulation of large South American basins (Siqueira et al., 2018).

In addition, we proposed to adopt a characteristic time (T_c) to allow comparisons between flood discharge, extreme precipitation, and antecedent soil moisture. We obtained T_c by calculating the flood wave travel time through the catchment mainstream. The analysis was built on comparing the historical (1961-2005) and future (2021-2065) estimates of the highest (RP44), second-highest (RP22), and median (RP2) values of the annual maximum precipitation and discharge.

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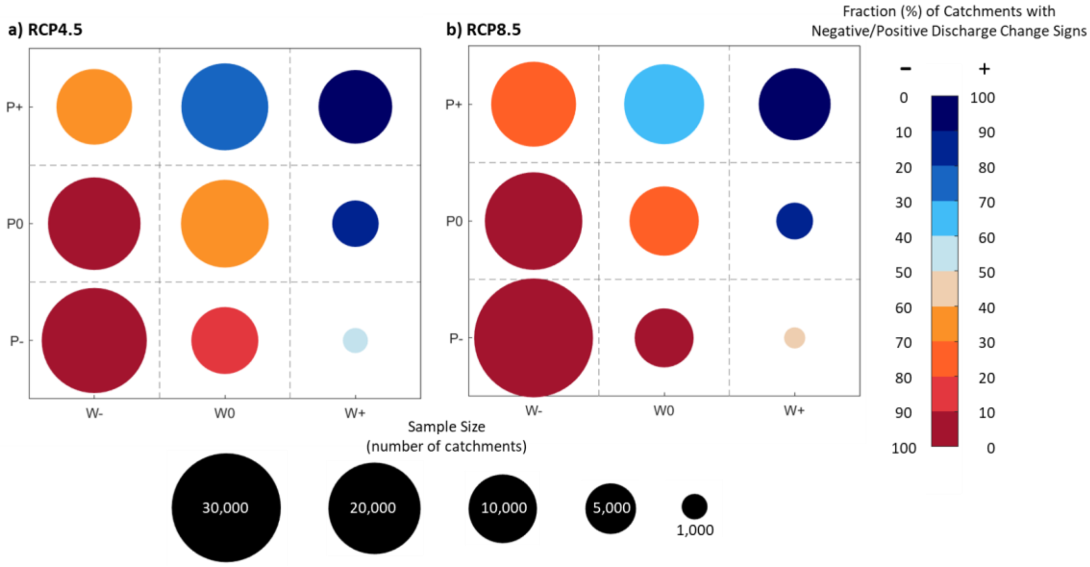
RESULTS

Figure 3. Graphical contingency table relating change signs of RP2 flood discharge, RP2 extreme precipitation (P), and antecedent soil moisture (W) for (a) RCP4.5 and (b) RCP8.5 scenarios. The size of the circle refers to the number of catchments in a sample, and the color is related to the fraction of catchments with a positive/negative change sign.



Some considerations can be made on the size of the circles: a) circles colored from dark yellow to red are larger than those in blue, which means that RP2 discharge will decrease in the future for most catchments; b) the number of catchments that present P+, P0 and P- are approximately the same (sum of columns); c) the circles of column W+ are smaller than circles of column W-, thus antecedent soil moisture will be reduced for most catchments. Overall, while there is no clear change sign for extreme precipitation, flood discharge and antecedent soil moisture are expected to decrease. This suggests that the reduced soil moisture is the main responsible for negative change signs of RP2 discharge.

The fraction of catchments showing positive/negative signs was 50%/50% for extreme precipitation, this relation moved to 30%/70% for flood discharge. This can be attributed to the projected reduction of soil moisture in most of South America. When the average annual maximum precipitation and antecedent soil moisture present different change signs, it is more likely that the average annual maximum discharge follows the same sign as soil moisture. However, because (i) there was a limited sample size for the distribution function (45 years) and (ii) we used a bias removal method that affects the precipitation maxima, we cannot be sure if these change signs would remain negative for even rarer floods (e.g. 100 or 1,000 years return period).

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