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Supporting Information for

**An urban drainage scheme for large-scale flood models**

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**Contents of this file**

Supporting Text S1

Supporting Table S1

Supporting Figures S1 and S2

Supporting References

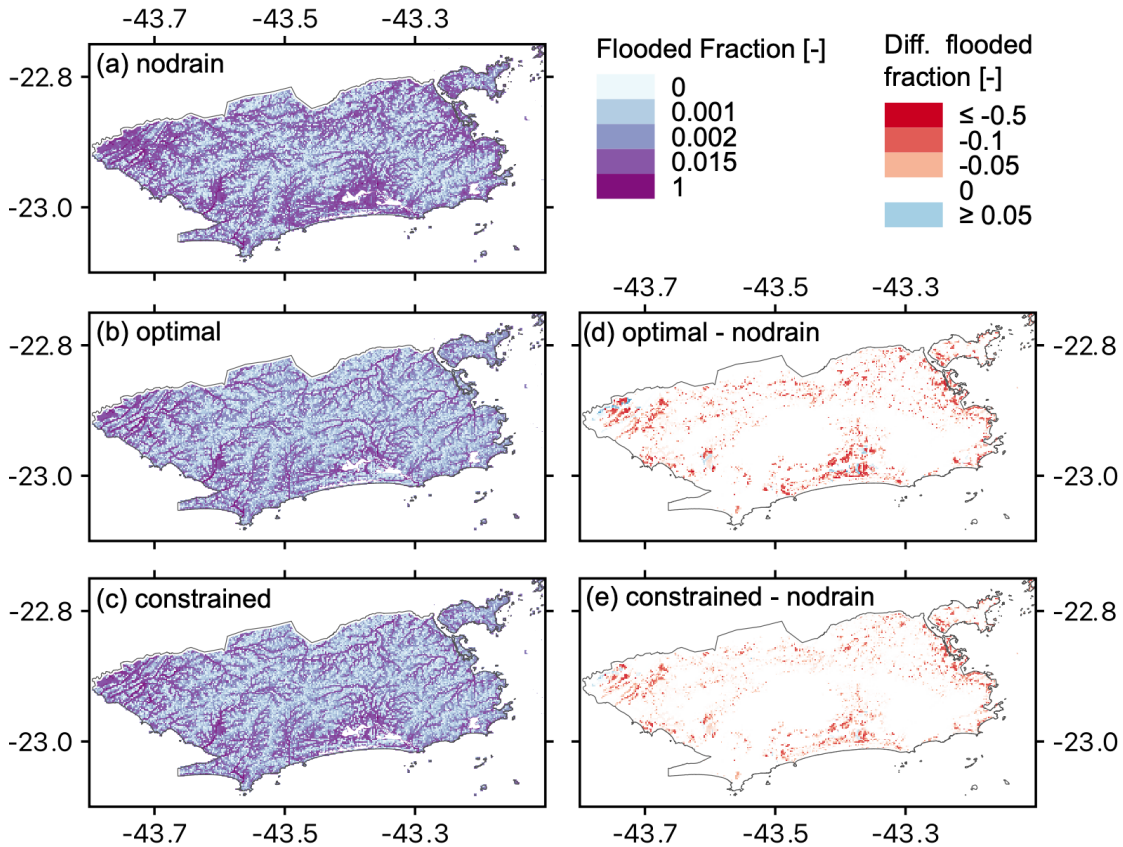
**Supporting Text S1.** Computation of the Normalized Household Income (NHI) index.

Household incomes were normalized as  $NHI_i = 1 - (H - I_i) / (H - L)$ , where  $H$  and  $L$  stand for highest and lowest household incomes among all places surveyed,  $I$  the income being normalized and  $i$  the household the normalization is being performed for. The resulting values range from zero (lowest household income) to 1 (highest household income). This normalization excluded households with no income. More details can be found in <https://www.data.rio/datasets/PCRJ::%C3%ADndice-de-desenvolvimento-social-da-cidade-do-rio-de-janeiro-2010/about>.

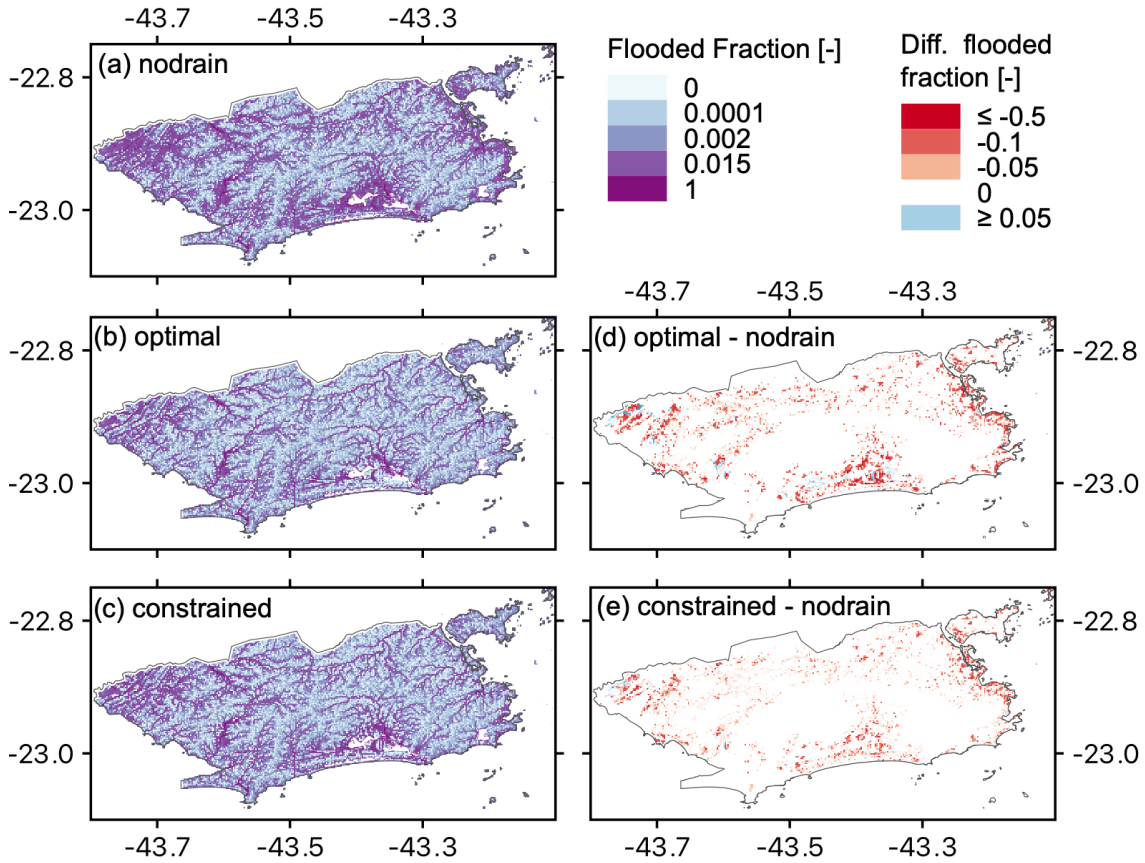
**Supporting Table S1.** Noah-MP options adopted in this study.

<b>Physical process</b>	<b>Noah-MP options</b>	<b>References</b>
Vegetation	Monthly climatology of leaf area index (LAI) and albedo used to represent vegetation dynamic (Option 4)	Niu et al (2011)
Stomatal resistance	Ball-Berry (Option 1)	Ball et al (1987)
Soil moisture factor for stomatal resistance	Noah-type based on soil moisture (Option 1)	Chen et al (1996)
Runoff & groundwater	SIMGM: based on TOPMODEL (Option 1)	Niu et al. (2007)
Surface layer drag coefficient	Monin-Obukhov (Option 1)	Monin and Obukhov (1954)
Radiation transfer	Modified two-stream scheme (Option 1)	Niu and Yang (2004)

*Note: Cold-season related processes and options (e.g., snow fall, accumulation and depth) are not included here.*



**Supporting Figure S1.** Flooded areas at the peak hour of Event 2 (01:00 – 5 February 2019 GMT). Flooded fractions for each experiment are shown in the left panels (a), (b) and (c), and differences between the representation of an urban drainage system (i.e., optimal and constrained) and its absence (i.e., nodrain) are shown in the right panels (d) and (e). Peak hours are derived from flooding time series shown in Fig. 3 using the nodrain experiment as baseline.



**Supporting Figure S2.** Flooded areas at the peak hour of Event 3 (00:00 – 9 April 2019 GMT). Flooded fractions for each experiment are shown in the left panels (a), (b) and (c), and differences between the representation of an urban drainage system (i.e., optimal and constrained) and its absence (i.e., nodrain) are shown in the right panels (d) and (e). Peak hours are derived from flooding time series shown in Fig. 3 using the nodrain experiment as baseline.

## Supporting References

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