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Supplementary information

Satellite imaging reveals increased proportion of population exposed to floods

In the format provided by the authors and unedited

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SI Table 1 | Accuracy labels of GFD accuracy metrics from comparison of validation data and GFD classification of water and non-water.

Validation Data	GFD Classification	GFD Flood Accuracy
Dry	**Dry**	**True negative**
Water	**Dry**	**False negative**
Dry	**Permanent Water**	**Removed**
Water	**Permanent Water**	**Removed**
Dry	**Flood**	**False positive**
Water	**Flood**	**True positive**

SI Table 2. Overall Accuracy by Flood Event for Validation Events

Flood	Overall Accuracy	Commission	Omission
4098	0.94	0.07	0.02
2570	0.91	0.08	0.06
4115	0.87	0.11	0.09
2584	0.77	0.33	0.22
2586	0.37	0.76	0.00
2075	0.42	0.76	0.14
2076	0.81	0.26	0.02
2597	0.82	0.00	0.22
2599	0.94	0.09	0.00
3625	0.98	0.00	0.03
2099	0.53	0.65	0.16
3123	0.97	0.05	0.00
2104	0.74	0.38	0.00
3132	0.49	0.74	0.00
4159	0.84	0.24	0.00
4163	0.68	0.46	0.01
2629	0.78	0.30	0.03
2119	0.94	0.08	0.01
3657	0.88	0.18	0.00
3658	0.61	0.58	0.02

4171	0.99	0.00	0.02
3667	0.81	0.25	0.06
4179	0.64	0.49	0.05
3673	0.89	0.16	0.00
3162	0.92	0.10	0.01
4188	0.95	0.05	0.02
3166	0.95	0.03	0.04
3678	0.93	0.10	0.10
1641	0.90	0.02	0.11
3179	0.92	0.12	0.00
3692	0.97	0.04	0.00
3696	0.72	0.16	0.23
4211	0.85	0.08	0.14
2167	0.66	0.49	0.02
4218	1.00	0.00	0.00
3198	0.67	0.48	0.00
2688	0.98	0.01	0.02
2177	0.69	0.43	0.05
4226	0.99	0.00	0.01
2180	0.95	0.05	0.03
3205	0.85	0.23	0.00
2183	0.83	0.25	0.00
2191	0.74	0.30	0.33
4241	0.89	0.15	0.01

3218	0.78	0.30	0.02
2711	0.98	0.02	0.01
2206	0.94	0.06	0.02
4258	0.46	0.80	0.00
2214	0.87	0.11	0.08
2216	0.92	0.11	0.01
3754	0.72	0.39	0.01
4272	0.73	0.37	0.06
3267	0.96	0.05	0.01
3274	0.93	0.10	0.01
3786	0.93	0.06	0.04
3282	0.72	0.40	0.01
2261	0.91	0.10	0.03
3285	0.81	0.28	0.00
4314	0.80	0.29	0.01
4315	0.68	0.44	0.00
2780	0.78	0.39	0.02
2269	0.96	0.04	0.02
4325	0.66	0.50	0.00
4339	0.82	0.07	0.17
4340	0.78	0.30	0.02
2296	0.91	0.12	0.02
4346	0.75	0.38	0.00
2303	0.77	0.32	0.00

2821	0.59	0.59	0.00
3846	0.81	0.28	0.01
3850	0.83	0.23	0.02
4364	0.95	0.06	0.01
2829	0.36	0.92	0.17
2832	0.76	0.35	0.01
3345	0.97	0.05	0.00
1810	0.97	0.04	0.01
3856	0.95	0.05	0.03
1818	0.97	0.03	0.01
2332	0.94	0.08	0.00
3871	0.83	0.22	0.03
3365	0.92	0.05	0.06
3366	0.93	0.00	0.10
2345	0.90	0.15	0.00
2366	0.96	0.05	0.00
4427	0.90	0.14	0.01
3916	0.75	0.37	0.01
4435	0.71	0.41	0.00
2395	0.83	0.23	0.02
3931	0.68	0.43	0.07
4444	0.79	0.14	0.16
4464	0.61	0.56	0.02
1910	0.79	0.29	0.03

2940	0.99	0.03	0.00
2947	0.95	0.07	0.00
2948	0.92	0.11	0.01
3464	0.91	0.01	0.08
3977	0.80	0.30	0.00
1931	0.93	0.08	0.02
2443	0.92	0.09	0.04
2444	0.66	0.44	0.06
3476	0.92	0.07	0.04
2458	0.99	0.00	0.02
4507	0.95	0.04	0.04
2461	0.91	0.10	0.03
2463	0.34	0.95	0.14
4516	0.88	0.14	0.04
2473	0.97	0.03	0.01
1971	0.94	0.09	0.01
4019	0.84	0.09	0.21
4022	0.63	0.54	0.00
4024	0.85	0.21	0.01
3544	0.82	0.25	0.01
2024	0.96	0.06	0.00
2543	0.80	0.30	0.00
3567	0.69	0.46	0.00
3572	0.88	0.17	0.01

2045	0.86	0.24	0.08
3070	0.92	0.11	0.00

SI Table 3. Quality Control Questionnaire

Question #	**Question Text**
1	Does the map capture flood dynamics above and beyond permanent water? (yes or no).
2	Did you notice a reason the flood map seems obscured or wrong? Was it in an urban area, Were clouds a problem? Was there considerable snow/ice? (yes or no).
3	Is this product a useful representation of this flood event? (yes, no, or maybe)
4	Is the Otsu flood map better than the Standard map to represent this event? (yes or no, with a comment). Otsu often overpredicted the flood extent, as noted by the analyst, but sometimes, the standard thresholds did not map a flood and Otsu captured the flood well.
5	Does the flood continue upstream (e.g. should we extend the mapping area)? (yes or no)
6	Are the dates of the flood correct based on hyetographs (yes or no) (e.g. should the start or end date be expanded to include a precipitation peak that was missed according to a hyetograph)
7	What countries does this flood affect? (list). This metric helped identify errors in the DFO catalogue and areas where the wrong place was being mapped.
8	Comments - Any other observations the user made.

SI Table 4. Proportion of population exposed in past and future by region.

region	**change in proportion of pop. exposed, observed 2000-2015**	**change in proportion of pop. exposed, modeled 2010-2030 RCP 8.5, SSP2**	**change in future-past**	**Directional change in flood exposure**
Australia and New Zealand	1.03	1.01	-0.01	continuously increasing
Caribbean	1.04	0.84	-0.19	future decreasing
Central America	1.62	0.88	-0.73	future decreasing
Central Asia	1.07	1.01	-0.06	little change
Eastern Africa	1.24	1.07	-0.17	continuously increasing
Eastern Asia	0.96	1.14	0.18	newly increasing
Eastern Europe	1.06	1.03	-0.03	continuously increasing
Melanesia	0.71	0.95	0.24	continuously decreasing
Middle Africa	1.19	1.20	0.01	continuously increasing
Northern Africa	1.11	1.12	0.02	continuously increasing
Northern America	0.95	1.05	0.10	newly increasing
Northern Europe	0.97	1.07	0.10	newly increasing
South America	1.16	1.02	-0.14	continuously increasing
South-Eastern Asia	1.06	1.09	0.04	continuously increasing
Southern Africa	1.83	0.92	-0.91	future decreasing
Southern Asia	1.12	1.11	-0.02	continuously increasing
Southern Europe	1.01	1.05	0.04	newly increasing
Western Africa	1.93	1.04	-0.89	continuously increasing
Western Asia	1.20	1.01	-0.19	Little change
Western Europe	0.86	1.09	0.23	newly increasing

SI Table 5. Proportion of population exposed in past and future by country.

Country	Change in proportion of pop. exposed, observed 2000-2015	GHSL/HRSL bias correction factor	Change in proportion of pop. exposed, modeled 2010-2030 RCP 8.5, SSP2	Change in future-past	Trend in flood exposure
Afghanistan**	0.77	0.57	1.11	0.34	newly increasing
Albania	0.96	0.6	0.96	0	never increasing
Algeria	1.03	0.62	0.95	-0.08	future decreasing
Angola**	0.79	0.79	0.78	-0.01	never increasing
Argentina*	1.55	0.66	1.01	-0.54	continuously increasing
Australia	1.03	0.94	0.98	-0.05	future decreasing
Austria	1	0.88	1.19	0.19	newly increasing
Azerbaijan	1.89	0.44	0.9	-0.99	future decreasing
Bangladesh*	1.2	1.03	1.18	-0.02	continuously increasing
Belarus	0.92	0.99	0.9	-0.02	Little change
Belgium	0.99	0.99	1.07	0.08	newly increasing
Benin	1.79	0.79	0.9	-0.89	future decreasing
Bhutan	1.08	0.39	1.03	-0.05	continuously increasing
Bolivia	1.03	0.11	0.95	-0.08	future decreasing
Bosnia and Herzegovina	1.09	0.35	1.12	0.03	continuously increasing
Botswana	2.88	0.48	0.96	-1.92	future decreasing
Brazil	1.13	0.12	1.05	-0.08	continuously increasing

Bulgaria	1.02	0.71	1	-0.02	little change
Burkina Faso	3.74	0.73	1.13	-2.61	continuously increasing
Cambodia**	0.87	0.05	1.14	0.27	newly increasing
Cameroon	1.23	0.84	1.08	-0.15	continuously increasing
Canada	0.98	0.21	1.08	0.1	newly increasing
Central African Republic	1.76	0.94	1.87	0.11	continuously increasing
Chad**	0.97	0.46	1.06	0.09	newly increasing
China	0.93	0.87	1.06	0.13	newly increasing
Colombia	1.1	0.63	1.02	-0.08	continuously increasing
Costa Rica	1.13	0.22	0.76	-0.37	future decreasing
Croatia	1.01	0.83	1	-0.01	little change
Cuba	1.38	0.34	0.86	-0.52	future decreasing
Czech Republic	0.95	0.71	1.06	0.11	newly increasing
Djibouti	1.27	0.41	0.98	-0.29	future decreasing
Dominican Republic	0.92	0.51	1.02	0.1	little change
Ecuador*	1.31	1.17	0.97	-0.34	future decreasing
El Salvador	2.57	0.26	0.73	-1.84	future decreasing
Eritrea*	1.09	2.72	0.91	-0.18	future decreasing
Estonia	0.92	0.97	1.02	0.1	newly increasing
Ethiopia	1.14	0.08	1.14	0	continuously increasing
France	1.01	0.91	1.03	0.02	newly increasing
Gambia, The	1.43	0.42	0.93	-0.5	future decreasing
Georgia	1.31	0.44	1.08	-0.23	continuously increasing

Germany	1.07	0.92	1.05	-0.02	continuously increasing
Ghana	1.75	0.16	0.85	-0.9	future decreasing
Greece	0.98	0.89	0.93	-0.05	never increasing
Guatemala	1.65	0.11	0.97	-0.68	future decreasing
Guinea	1.26	0.14	0.97	-0.29	future decreasing
Guinea-Bissau	5.05	0.01	0.96	-4.09	future decreasing
Guyana	1.01	0.69	0.99	-0.02	little change
Haiti	0.98	0.43	0.86	-0.12	never increasing
Honduras	1	0.59	0.95	-0.05	never increasing
Hungary*	1.23	1.01	1.01	-0.22	future decreasing
India	1.36	0.57	1.22	-0.14	continuously increasing
Indonesia	1.01	0.61	1.01	0	little change
Iran	1.29	0.57	1.07	-0.22	continuously increasing
Iraq	1.42	0.38	1.04	-0.38	continuously increasing
Ireland	0.95	0.98	1.21	0.26	newly increasing
Ivory Coast	2.83	0.34	1.06	-1.77	continuously increasing
Jamaica	0.86	0.09	0.68	-0.18	never increasing
Jordan	1.2	0.35	0.71	-0.49	future decreasing
Kazakhstan	0.86	0.62	1.08	0.22	newly increasing
Kenya	1.26	0.42	1.14	-0.12	continuously increasing
Kuwait	0.81	0.82	1.17	0.36	newly increasing
Laos	0.94	0.68	1.11	0.17	newly increasing
Latvia	0.97	1.03	1.04	0.07	newly increasing

Lithuania*	1	1.23	1.03	0.03	newly increasing
Luxembourg*	0.14	0.91	1.1	0.96	newly increasing
Macedonia	1.02	0.71	1.11	0.09	continuously increasing
Madagascar	1.54	0.3	1.12	-0.42	continuously increasing
Malawi	1.24	0.22	0.98	-0.26	future decreasing
Mali	1.14	0.59	1.22	0.08	continuously increasing
Mauritania	1.34	0.09	1.09	-0.25	continuously increasing
Mexico	1.15	0.61	0.96	-0.19	future decreasing
Moldova	1.17	0.77	1.05	-0.12	continuously increasing
Mongolia	0.9	0.87	1.06	0.16	newly increasing
Morocco	1.24	0.45	0.9	-0.34	future decreasing
Mozambique	1.65	0.53	0.99	-0.66	future decreasing
Myanmar (Burma)	1.35	0.86	1.11	-0.24	continuously increasing
Namibia**	0.79	1.07	0.91	0.12	never increasing
Nepal*	1.32	0.78	0.99	-0.33	future decreasing
Netherlands*	0.95	1.07	1.08	0.13	newly increasing
New Zealand*	1.03	1.08	1.05	0.02	continuously increasing
Nicaragua	2.2	0.21	0.94	-1.26	future decreasing
Niger	2.17	0.23	1.4	-0.77	continuously increasing
Nigeria	1.51	0.12	1.05	-0.46	continuously increasing
Oman**	0.47	0.23	1.19	0.72	newly increasing
Pakistan	1.37	0.57	1.19	-0.18	continuously increasing

Papua New Guinea	0.71	0.27	0.95	0.24	never increasing
Paraguay	1.29	0.45	0.88	-0.41	future decreasing
Peru	1.05	0.33	1.03	-0.02	continuously increasing
Philippines	0.97	0.84	1.05	0.08	newly increasing
Poland	1	0.83	1.04	0.04	newly increasing
Romania	1.08	0.7	1.08	0	continuously increasing
Russia	0.98	0.77	1	0.02	little change
Rwanda	1.15	0.25	1.57	0.42	continuously increasing
Senegal**	1.01	0.16	1	-0.01	little change
Sierra Leone**	1	0.71	1	0	little change
Slovakia	1.1	0.67	1.09	-0.01	continuously increasing
Slovenia	1.01	0.9	1.16	0.15	newly increasing
Somalia	1.05	0.54	1.01	-0.04	continuously increasing
Sri Lanka	0.6	0.37	1.07	0.47	newly increasing
Sudan	0.94	0.45	1.67	0.73	newly increasing
Syria	1.43	0.44	1.01	-0.42	future decreasing
Taiwan*	1.05	1.21	1.31	0.26	continuously increasing
Tanzania, United Republic of	1.18	0.39	0.98	-0.2	future decreasing
Thailand*	1.21	0.97	1.19	-0.02	continuously increasing
Togo	1	0.1	1	0	little change
Tunisia	1.22	0.28	0.97	-0.25	future decreasing
Turkey	1.05	0.44	0.96	-0.09	future decreasing
Turkmenistan	1.08	2.41	0.94	-0.14	future decreasing
Uganda	1.13	0.41	1.27	0.14	continuously increasing

Ukraine	1.02	0.77	0.94	-0.08	never increasing
United Kingdom	1	0.99	1.04	0.04	newly increasing
United States	0.93	0.94	1.02	0.09	newly increasing
Uruguay	0.92	0.84	1.27	0.35	newly increasing
Uzbekistan	1.26	0.78	1.01	-0.25	continuously increasing
Venezuela	1.18	0.65	1.01	-0.17	continuously increasing
Vietnam*	1.03	1.2	1.04	0.01	continuously increasing
Zambia	0.92	0.56	0.88	-0.04	never increasing
Zimbabwe	1.48	0.35	0.88	-0.6	future decreasing
Yugoslavia	1.04	0.77	0.81	-0.23	future decreasing

* Uncertainty analysis for these countries with respect to population data revealed the trend could be sensitive to population estimates and is not robust. See Supplementary Discussion.
**These countries have rapid urbanization rates (>3% annual growth) from 2000-2015 and estimated flood trends do not capture the potential increasing exposure in urban floodplains in these locations due to the coarse spatial resolution of the satellite used in this study.

SI Table 7. Proportion of population exposed, total population exposed, and total inundated area for the five largest and most flood affected basins.

Watershed	Change in proportion of pop. exposed, observed 2000-2015	Flood exposure increased, constant, or decreased	Total population exposed in observed dataset (in millions)	Countries included
UK	1	constant	21.83-22.05	Scotland, England, Wales
Indus	1.36	increased	17.04-19.86	Pakistan
Ganges-Brahmaputra	1.26	increased	107.82-134.93	India and Bangladesh
Mekong	1.11	constant	20.22-32.82	Cambodia, Vietnam, Laos, Thailand, China
Yangtze	0.83	decreased	25.39-29.17	China

SI Table 8. Proportion of population exposed, total population exposed, and total inundated area by four flood types (dams, ice/snow, tropical storms, and heavy rain).

Flood Mechanism	**Count of Events**	**Sum of Population Exposed (millions)**	**Sum of Area Exposed (km2)**	**Mean proportion of population exposed (2000-2015) (std)**
Dam	13	9.23-13.05	96346.58	2.77(4.7)
Heavy rain	751	248.65-861.49	4800233.41	1.26(0.74)
Snowmelt, Ice, Rain	52	12.70-13.30	1020307.71	1.16(0.55)
Tropical Storm, Surge	97	39.4-61.29	372790.04	1.25(0.70)

Supplementary Discussion

Population Uncertainty Analysis

Our selected population distribution dataset, the Global Human Settlement Layer (GHSL) dataset, lacks uncertainty measures in their population estimates at any scale. Thus, we are unable to directly infer uncertainties in our estimates of flood exposure from GHSL. Rather, we use the High-Resolution Settlement Layer (HRSL) dataset (*High Resolution Settlement Layer (HRSL)* 2016) to perform a sensitivity analysis. We use the HRSL dataset to determine country correction factors that can be applied to GHSL to adjust for under- or over-estimates. With ranges of exposed population between HRSL and GHSL datasets, we then determine if uncertainty in our country trend analysis is plausibly limited.

HRSL differs from GHSL in its higher-resolution of 30-meters and the use of a deep-learning algorithm to identify physical buildings used to evenly distribute census block population counts. HRSL relies on DigitalGlobe imagery taken over a spread of time from to achieve cloud free coverage with 90% of the data taken between 2011-2015 (Tiecke et al. 2017). These improvements lead to more conservative estimates of flood exposure, especially in developing countries (Smith et al. 2019). However, the reliance on high-resolution satellite imagery limits the temporal coverage to one time point (2011-2015) and 183 countries. We collected all 183 HRSL individual country files produced by Facebook uploaded from the Humanitarian Data Exchange (HDX)[1].

To estimate population exposure per country using the HRSL dataset, we follow similar methods as in the main text with the GHSL dataset. We estimate flood population exposure by intersecting maximum inundation extent from the Global Flood Database (GFD) with HRSL at

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[1] A compiled mosaic of all country datasets was made available to the Earth Engine community by Samapriya Roy. (2020, March 31). samapriya/hdxpop: hdxpop: Simple tool to download High Resolution Population Density Maps fromHumanitarian Data Exchange (Version 0.0.3). Zenodo. http://doi.org/10.5281/zenodo.3735435
see: https://medium.com/@samapriyaroy/community-datasets-in-google-earth-engine-an-experiment-b72daa474819 for description of the method. Note we used the country specific HRSL data for this analysis, and remove all country duplicates to use only the most recent version of HRSL for each country.

its native resolution and sum total flood exposure per country for one time point (2011-2015). Of the 183 countries with HRSL data, we observed 136 countries with flood exposure using both HRSL and GHSL data. With GHSL and HRSL estimates, we calculate correction factors using Equation 1:

$$correction\ factor = flood\ pop_{hrsl} / flood\ pop_{ghsl} \quad \text{[Eq 1]}$$

A correction factor of 1 indicates a perfect match between HRSL and GHSL datasets. Values below 1 indicate instances where GHSL predicts higher flood exposure. Finally, values over 1 are cases where GHSL underestimates flood exposure. We find overestimates of flood exposure by GHSL are concentrated in Africa where building detection is more challenging (Extended Data Fig. 7A). HRSL and GHSL exhibit the greatest agreement in Europe.

On a country basis, our correction factors are multiplied by GHSL estimates of flood exposure for year 2015. Using the adjusted flood exposure, we then report *ranges* (with HRSL often representing the lower bound) of all flood population exposure data. Of the 119 countries with sufficient flood observation in our analysis, 99 had available HRSL data (notable missing countries include China, India, and Pakistan). For countries with missing HRSL data, we estimated the correction factor based on the regional average (calculated for 20 regions) according to Large Scale International Boundary (LSIB) (United States Department of State, Office of the Geographer 2017) classifications. All country correction factors are reported in Supplementary Table 5.

Unfortunately, there are no HRSL or similar high-resolution population estimates for the year 2000, so we are not able to conduct a sensitivity analysis on those flood exposure trends. If we assume the same bias correction from GHSL to HRSL for both 2015 and 2000, then it has no effect on the trend (because the correction factor term cancels out).

Rather, our approach to estimating potential uncertainty on flood exposure trends was to estimate if flood exposure trends for each country were sensitive to potential overprediction in flood exposure from GHSL. We did this by determining what error in flood exposure in 2015 would lead to no trend (e.g. the trend is equal to 1) for each country. We solve equation so that the *change in proportion of flood exposed* $pop_{2000\text{-}2015}$ is held equal to 1 to calculate a flood population estimate for 2015 that would yield no trend (Equation 2). We then estimate the absolute difference between the population if there were not trend and the actual estimate population in 2015 in equation 3. This provides the population margin of error that, if our sensitivity in population estimates exceeds (difference in GHSL and HRLS estimates), then our estimates of flood exposure trends exceed a margin that would allow us to definitively state a trend.

$$flood\ pop\ if\ there\ is\ no\ trend_{2015} = \frac{flood\ pop_{2000}}{pop_{2000}} * pop_{2015} \quad \text{[Eq 2]}$$

$$pop\ margin\ of\ error = flood\ pop\ if\ there\ is\ no\ trend_{2015} - floodpopGHSL_{2015} \quad \text{[Eq 3]}$$

The population margin of error estimates how large the population error estimate would have to be to *nullify or reverse* a trend (i.e the estimate would be greater than 1, the value equal to no trend). For example, in India, we estimate approximately 45 million people moved in the flood exposed areas from 2000-2015, and the population margin of error would have to be greater than 2,323,000 people (2.32 million) to nullify the trend estimate. In order to assess whether our population error (range of GHSL and HRSL estimates) is plausibly limited so as to not influence the trend result, we assessed the difference between the population error range and the GHSL 2015- HRSL 2015 flood exposure estimate spread (Eq 4) to obtain a feasible uncertainty range.

$$uncertainty\ range = \frac{pop\ margin\ of\ error - (FloodpopGHSL_{2015} - FloodpopHRSL_{2015})}{popGHSL_{2015}} \quad \text{[Eq 4]}$$

Since countries have different uncertainty ranges (due to differences in population size), we normalized the uncertainty range by total population exposed to floods in 2015. We plot the normalized uncertainty ranges against the flood trend (i.e. the proportion of population exposed to floods from 2015-2000). All countries with normalized uncertainty ranges < 0 (left of the y-axis) represent countries for which the difference between plausible population error is lower than the trend effect, and thus the uncertainty in our results is plausibly limited. However, for the 15 countries where the normalized uncertainty range > 0 (right of the y-axis), the uncertainty between HRLS and GHSL estimates is high enough that population estimates could potentially invalidate the reported trend. These 15 countries are Argentina, Bangladesh, Ecuador, Eritrea, Hungary, Lithuania, Myanmar, Nepal, Netherlands, New Zealand, Taiwan, Thailand, Turkmenistan, Vietnam, and Luxembourg. For three of these countries, we report a decreasing flood exposure trend (<1 on the x-axis) that could be reversed using another population dataset (Lithuania, Luxembourg, and the Netherlands). For the remaining twelve, we report an increase in the proportion of population exposed to floods (>1 on the x-axis) that could potentially be an error due to population estimates.

We remove these 15 countries from trend analysis and reporting due to these uncertainties. We also report flood trends mean global numbers as a range, one that includes and another that excludes these countries. We mark these countries as "uncertain or no data" in maps, and identify these countries in Supplementary Table 5. We display the results of this analysis in Extended Data Figure 7. While some countries subsequently excluded from the analysis, such as Myanmar, other studies may indicate trends (e.g. of increased exposure) that our data could not confirm (Brakenridge et al. 2017) .

Sensitivity analysis of return periods and population exposure changes 2010-2030

While previous studies analyzed flood exposure trends of 100-year return periods (Jongman et al. 2012, Tanoue et al. 2016, Formetta and Feyen 2019), we also examined the sensitivity of results to different return periods reported by Aqueduct (500, 250, 100, 25, and 10). The total number of people exposed to floods from 2030 as compared to 2010 increases as the return period increases (Extended Data Fig. 8A), with Asia accounting for the highest population increases. When analyzing the percent change from 2030 as compared to 2010, however, the percent increase for flood exposure assessed for each region across return periods is similar (Extended Data Fig. 8B). The only continent with changes in trends of population exposure that differ by return period is Europe, where there is an expected 5% increase in the proportion of population exposed to floods in the 10-year return period, but a 10% increase in the 250- and 500-year return periods. While Africa has the highest percentage increase in flood exposed population, it also has the highest total population increase, with a mean of 47% (Extended Data Fig. 8C), suggesting the increase in flood exposure is due to population growth. In Asia, however, while the total population percentage increase is 25% on average, the percent change in flood exposed population is on average over 30%. As a result, after normalizing for population growth, Asia has the highest increase in the proportion of population exposed to floods across all return periods (Extended Data Fig. 8D). Extended Data Fig. 8D shows the change in proportion of flood exposed population is not sensitive to return periods (except for potentially Europe), indicating the choice of return period does not influence country and continent level trends in changes in the proportion of population exposed to floods.

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