Frequently Asked Questions (FAQs)

In order to conduct our climate and socio-economic risk analysis a number of assumptions were made as listed in the technical methodology. Our results also prompt several questions with regards to using global models for a city based analysis. Global modelling of climate risk and impacts does not fully capture the entirety of impacts to cities for a number of reasons. The granularity of our models and coding is also a factor that determines the accuracy of our numbers. The limitations of these models are explained in the technical methodology. This FAQ document summarises common questions that users may have in understanding the data and results.

General

What are the RCP scenarios and Shared Socioeconomic Pathways (SSPs) for all of your statistics?

All of the statistics refer to a RCP 8.5 scenario . RCP 8.5 is considered to be a Business-as-usual scenario, if we continue our current emissions trajectory. Please refer to the latest IPCC report figures here to understand the temperature range. Under this scenario, the most suitable shared socioeconomic pathways are considered to be SSP5 and SSP3. We have chosen SSP3 for our scenarios, which indicate a 'high emissions, low adaptation' scenario.

Riverine Flooding

City has no river, but experiences fluvial flooding in the global fluvial flood model

(e.g., Copenhagen, Abidjan, Lagos, Athens, Dakar, Amman, Lagos, Tshwane)

Several options are possible:
(1) Fluvial flooding in our model can originate from seawater that "runs through" the city – for instance when two parts of the sea are connected via a channel that runs through the city. The model may recognize the canal of seawater as a freshwater stream (Copenhagen, Abidjan, Lagos).
(2) In a more extreme case, fluvial flooding occurs along the coast in our model, without there being any rivers or other visible water bodies. To be fair, I am not sure what is going on in these cases (Athens & Dakar)
(3) The city border may just intersect with a river that runs past the city. This may be due to the physical borders that we used (see also my comments on coastal flooding). It could still lead to some nuisances at the city's edge however if those rivers were to flood, although the impact would likely be much lower compared to a flood in the city center (Amman, Lagos, Tshwane).

City should have river flooding, but does not experience fluvial flooding in the global maps or the river flooding risk is very low.

(e.g., Addis Ababa; Bengaluru; Jaipur; Milan)

Several options are possible:

(1) For these cities, the model either does not notice the river because it may be too small or hard to distinguish. In other words, the river/canal is not well represented in the model.
(2) It can also be related to the input data that goes in our global fluvial flood model. Potentially, the discharge is underestimated in these cities.
(3) For some cities, we do not see any flooding at certain return periods, but this is very well possible. Lower return periods bring along lower water levels and therefore a lower chance of flooding to occur, even in cities familiar with flooding.

In general, it is very difficult to pinpoint the exact cause of the "missing" flood here, if it is missing at all. This is similar to the first category in coastal flooding.

Why do cities have a high river flood volume despite having a flood protection barrier that protects against a 1-100 year river flood - why is the volume so high?
(e.g. New Orleans)
According to our data, the protection standard for coastal flooding in New Orleans is against a ~1 in 50yrs event. As we use global-covering data, these numbers could deviate from the real protection standards unfortunately. In this particular case, the flooding in New Orleans is quite extensive according to our models, especially in the larger return period events, like 1 in 500 or 1 in 1000, which adds to the flooding and annually expected impacts.

Coastal Flooding

Why is the coastal flooding volume lower than expected or none at all for coastal cities?

(e.g., Abidjan; Houston; Hangzhou; Fuzhou; Durban (eThekwini); Dakar; Cape Town; Melbourne; Miami; Oslo; New Orleans; Salvador; Stockholm; Tel Aviv; Washington D.C.; Salvador)

There is no coastal flooding happening for these cities in the global hazard model. This comes inherently from the input data (e.g. elevation maps, sea level data) for the global hazard model. Several underlying reasons for the absence of coastal flooding are therefore possible, including among others:
(1) the coast is steep and high, and/or the sea level does not reach a level at which it can overtop the coastline and enter the land. In some cases, the sea level may only overtop the coastline for a certain return period, RCP, or SSP, or a combination of those;

(2) The hydrological connection (e.g. rivers/canals/inlets that connect the city to the sea) are not present or are not represented properly in the input data for the hazard model;

Why is there a large increase in coastal flooding volumes for a city between certain return periods, RCPs, SSPs, or any combination of those?
(e.g., Accra, Barcelona, Kolkata)

Each combination of the above mentioned scenarios leads to different sea levels. Now imagine there is a part of a city that lies in a depression, hence a lower lying-area relative to the areas around it. When the sea level reaches a certain height, it can just overtop the border of the depression, and flood this part of the city. This can add up to large amounts of additional flood volumes and related damages. In other words, coastal flood volumes are by no means increasing linearly with increasing sea levels. Also, sea levels are not increasing linearly with increasing return periods nor with changing RCPs or SSPs. Another option for a seemingly large relative change could be that only one pixel of the city is inundated in the model for a given combination of scenarios. When three pixels are inundated in another combination of scenarios, flood volumes quickly increase threefold. This is not a large increase overall, but still large relatively

Why are there very small numbers for socioeconomic risk for coastal cities?

Some cities, like Rio de Janeiro, have very little coastal flooding according to our historical global models, which lead to low population exposure. On top of that, these cities often have no coastal flooding in the shorter return periods (2, 5, 10 ,etc.). So when we are calculating the expected annual population exposed – and thus consider the exposure in all the return periods – the total number of population exposed becomes small and can even drop below 1. "The calculation of the expected annual exposed population/damage/exposed GDP is further explained in section 5.1.1 of the technical methodology"

Is permanent coastal flooding taken into account in the future due to sea level rise?

We did not consider permanent inundation in a city due to sea level rise. This would be return period 0 (=flooding that occurs all the time), whereas we only go as low as return period 2 (= flooding that occurs approximately once every two years). However, there is still a sea-level-rise-related flood component included. There are two components that together make up the total inundation depth (yellow line) at any location in the city. The first component is the event (storm surge or tidal event) that causes extreme sea levels (green line). These extreme sea levels are at their highest when they enter the land, and gradually decrease in height further inland. The second component is the sea level rise component (blue line), which denotes the, let's say, average sea level due to climate change. This is a flat line reaching inland at the level of the sea. So to summarize, we did not calculate the damage that would occur if a (part of a) city would be permanently inundated due to sea level rise, but we did include the damage of sea level rise for the different return periods.

The coastal flood hazard is so high for certain cities but the socioeconomic risk is so low? (e.g., New Orleans, Amsterdam & Rotterdam)

We did not consider any protection measures (e.g. dikes, levees, storm barriers) in the flood hazard calculations, but on the other hand, we did include them in the socioeconomic risk calculations. When including protection measures, the total amount of water that is able to reach the city decreases. Using protection standards in the risk calculations, but not in the hazard calculations, is common practice in the scientific literature and presents the opportunity to distinguish the effect of the protection measures. If we would exclude the protection standards for a city, we would raise the suggestion that certain cities are not threatened by flooding at all, whereas there may be a significant threat. For Amsterdam and Rotterdam, as the cities are below sea level, the coastal flooding volumes are extremely high, creating anomalous results. This therefore affects the scale of coastal flooding for all cities. However the impacts to these cities are low due to the robust flood defence systems and infrastructure that the cities have put in place. Hence there are low urban damage costs and exposed populations.

Stormwater Flooding

There are no flood volumes or socioeconomic impacts of stormwater flooding

For pluvial flooding, the same approach as riverine and coastal flooding is not possible, as the model is not yet able to create global inundation maps for precipitation. Therefore, the change in extreme precipitation events per pixel is used as a proxy for the future pluvial flooding hazard. The indicator is the factor change in the frequency of occurrence of a current 10 year return period precipitation event. For example, if in a given city a current 10 year return period precipitation event is 40mm/hour, while in the future this amount of rain corresponds to a 5 year return period precipitation event, then the hazard indicator takes on a value of 2, because the event becomes twice more frequent in the future compared to now.

Why did you choose a 10 year return period for stormwater flooding?

For pluvial flooding we calculated the changes in the occurrence of extreme precipitation events. We have chosen the current 10 year return period precipitation event as our baseline and calculated how much the frequency of this event may change in the future scenarios. This was mainly due to the data used in our methodology which only contained 30 years of precipitation for the historical time period to calculate return periods from. Furthermore, on consulting with city advisors 10-year return periods are the most commonly used for city planning for rainfall.

Hydrological Drought

There are several cities with significant hydrological drought issues in the past that have no drought impacts (e.g. Cape Town, Melbourne)

The database we have used to calculate subsurface water withdrawals has no data for several cities, even though it is the most comprehensive dataset on subsurface water levels to date. For cities that we have been unable to calculate hydrological drought, we have included a qualitative analysis and also looked into agricultural drought. More details can be found of how we conducted our qualitative analysis in the Technical Methodology.

Socioeconomic impacts to flooding

How did you calculate population exposure within cities?

We originally chose C40 borders, but these were very inconsistent in terms of how they defined cities. Therefore we resorted to a dataset that uses a physical definition of a city (based on for instance population totals, population density, building density), as opposed to an administrative definition like the one in the C40 borders dataset. With the GHS-SMOD we could better compare cities across the world. We did adjust some of the borders, because some C40 cities merged in the GHS-SMOD borders. We splitted those cities along the C40 city borders.

How do you calculate the critical infrastructure impacts from flooding?

- We started with global datasets on hospitals (from OpenStreetMap) and power stations (Byers, 2021 <https://datasets.wri.org/dataset/globalpowerplantdatabase>).
- For each city, we selected the hospitals and power stations that were located in that city.
- For each city, we then created an overlay of the hospitals and power stations with the flood hazard maps.
- Then counted the number of hospitals and power stations that were in the inundated zone (inundated zone = all pixels that had a flood volume > 0) and we noted their ID numbers/names. We did this for every flood hazard map, so for every combination of climate model (GCM), climate scenario (historical, rcp4.5, rcp8.5), and return period.