EarthScan

EarthScan Flood Risk Methodology

December 2023 | earth-scan.com

Flood Risk Explained

The EarthScan flooding framework incorporates a detailed understanding of the terrain (elevation, land cover), water body boundaries (seas, shorelines, estuaries and rivers) and water flows (precipitation, river discharge, storm surges, extreme high tides, and relative sea level change).

The effects of climate change are included by incorporating sea level, storm surges and precipitation change into the methodology.

On EarthScan, users can visualize probabilities of a given location flooding to a specific depth. By leveraging return periods, users can understand their asset's likelihood for flooding. Higher return periods represent more severe, but less likely, flooding events.

For example, a 100-year return period equates to a 1% annual probability of occurrence—floods of this frequency are damaging, however they are not the most severe potential outcomes. **On EarthScan, users can assess flood risk up to a 1000-year return period.**

Following this methodology, EarthScan's flooding signals do not simulate individual events: we take a statistical approach to modeling riverine and coastal flooding, with outputs of inundation depth at a given probability.

This flood modeling approach is undefended—adaptation measures or modifications that may impede (as a defense) or channel (as a broken barrier, such as a dam) flood water are not accounted for. This gives the worst-case scenario for flooding—a scenario that may occur if flood defenses fail.

Three Types of Flooding

Coastal Flooding:

The primary drivers for coastal flooding are sea level rise and extreme local sea levels (due to extreme high tides and storm surges, for example).

Future projections are derived from the IPCC AR6 sea level rise dataset, which is a combination of specialized modeling efforts on sea levels, including:

- Polar ice sheet change from the Ice Sheet model Intercomparison Project (ISMIP)
- Changes in glacial processes from the Glacier Model Interomparison Project (GlacierMIP)
- Thermal expansion from the Coupled Model Intercomparison Project phase 6 (CMIP6)

Riverine Flooding:

The EarthScan riverine flooding signal incorporates riverine discharge projections from the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) hydrological models.

These models incorporate precipitation patterns as a source of water into river systems, as well as snowmelt upstream.

EarthScan's riverine flooding signal leverages these riverine discharge projections to simulate the likelihood of large river systems and inland water bodies flooding in the future.

Smaller rivers have a lower likelihood to flood via this mechanism. Instead, they are more likely to be influenced by swift, heavy precipitation—pluvial flooding.

Pluvial Flooding:

Pluvial flooding is a complicated hazard to represent at a global scale. It requires projections of expected trends in extreme precipitation combined with a sophisticated high-resolution digital representation of the topography and detailed runoff modeling.

Urban areas, with concrete/asphalt surfaces and poor drainage, are susceptible to this hazard. Given the additional challenges required to generate these data, there is **no pluvial flooding signal available on EarthScan at present.**

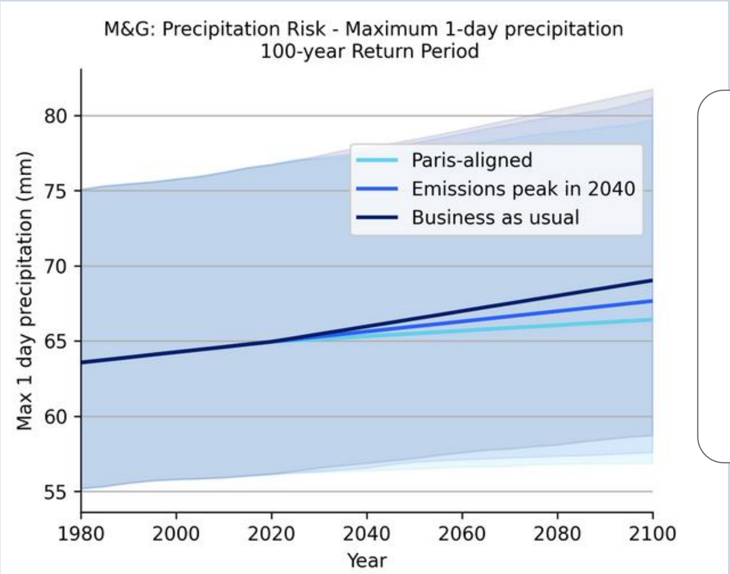
However, we can provide crucial building blocks to this complex signal; for example, 1-day maximum precipitation data can illustrate how climate change is expected to affect heavy precipitation in future. These intense precipitation events are the primary driver for pluvial flooding.

One Day Maximum Precipitation

Our 1-day maximum precipitation data is the next generation of the precipitation risk data that is currently available on EarthScan.

Data deliveries for this hazard can be performed outside of the platform environment prior to its formal release on EarthScan.

This metric incorporates refinements to the extreme value statistical calculations and includes additional state-of-the-art historical datasets such as NASA's IMERG (Integrated Multi-satellite Retrievals for GPM) product to improve how well extreme precipitation events are captured.



An example visualization of 1-day maximum precipitation across the City of London, UK at a 100-year return period. Bold lines denote likely values from the statistical model, while the surrounding shading illustrates the range of uncertainty.

Uncertainties associated with extreme precipitation are large; however, even within this window, there is an increasing trend into the future across all three emission scenarios.

Business as Usual often displays the largest increase over time—this scenario is the worst-case in terms of expected warming by the end of century, with global mean temperatures at 2100 expected to potentially exceed 4°C.

A warmer atmosphere stores more water, thereby increasing the potential for more extreme precipitation events.

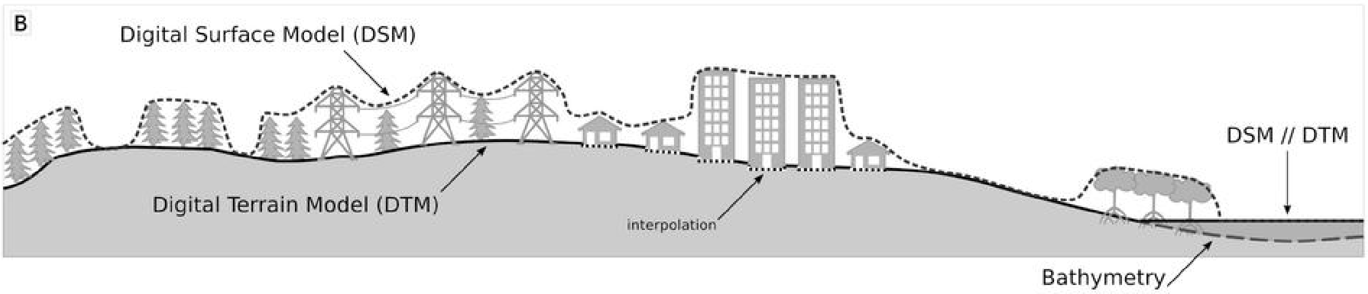
Digital Surface Model

To simulate flood risk, we start with a source of flood water, either from an inland water body such as a river or lake or from the ocean. We simulate how that flood volume will likely change over time due to climate change, associated with changing precipitation, upstream snow/glacial melt, or sea level rise.

However, to determine how this change influences flood risk in the surrounding land areas, we need to know where the extra water should flow. For this, we need an accurate digital map of the surface—we would not expect water to flow up steep hills.

In the Copernicus **Digital Surface Model**—a highly reputable global dataset affiliated with the European Space Agency—buildings and vegetation are included in this digital map of the surface, thereby creating artificial barriers to flood water in e.g., highly urbanized areas. Flood water sees a tall building or tree as a steep hill, and therefore flows no further inland. As a result, flood risk can be underestimated, particularly in urban areas.

Instead, a **Digital Terrain Model** is the preferred product for simulating flood inundation. The following schematic illustrates the difference between a Digital Surface Model (DSM) and Digital Terrain Model (DTM) :



Source: Guth, et al. Digital Elevation Models: Terminology and Definitions. Remote Sens. 2021, 13, 3581. https://doi.org/10.3390/rs13183581.

Digital Terrain Model

Global Digital Terrain Models are not standard products that are readily available—they are resource-intensive to build and validate. Therefore, we built our own!

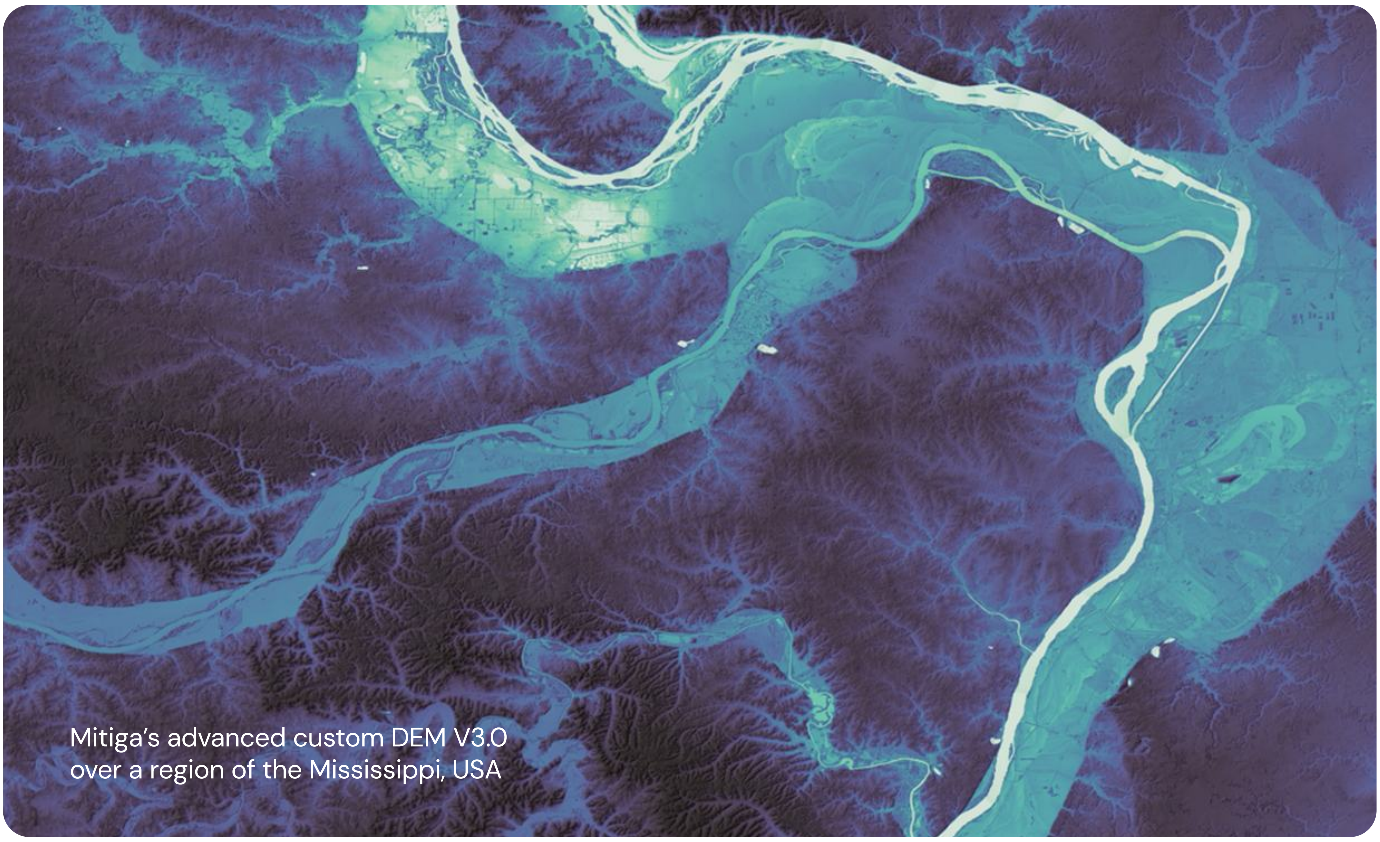
EarthScan's proprietary in-house Digital Terrain Model (DTM) allows for a physically accurate water flow over the topography at high spatial resolution by leveraging advanced deep learning techniques , third-party datasets, and state-of-the-art satellite retrievals.

The algorithm learns to identify buildings and vegetation, so that they can be removed from a Digital Surface Model and provide a more representative reflection of the topography.

As DTMs are resource-intensive to build, we have staggered its release in EarthScan's flooding signals so that we can bring immediate added value to those locations where a large fraction of our users operate—the US and Europe.

EarthScan's DTM is **currently active** in EarthScan's coastal and riverine flooding signals **within the US and Europe**.

Countries outside of these geographical areas currently utilize the Copernicus Digital Surface Model detailed previously. As a result , the flood risk at these locations may be underestimated.



Mitiga's advanced custom DEM V3.0 over a region of the Mississippi, USA

Data Sources

Both flooding signals make use of:

- Copernicus GLO-30 and Copernicus GLO-90 coastal terrain elevation model data.

The riverine flooding data product makes use of:

- Copernicus ERA-5 Global Flood Awareness System (GloFAS) reanalysis data representing recent hydrological activity with a hydrological model driven with ERA5 meteorology.
- Copernicus historical river discharge data under the CEMS-FLOODS datasets license ISIMIP daily discharge data across a number of climate model and hydrological model simulations licensed under CC-BY-4.0.
- HydroLakes, licensed by the authors under a CC-BY-4.0 license.

The coastal flooding data product makes use of:

- European Commission Joint Research Centre's (JRC) Global Surface Water dataset, produced under the Copernicus program.
- GPS station velocities provided by the Nevada Geodetic Laboratory.
- IPCC AR6 sea level Rise Projections, licensed by the authors under a Creative Commons 4.0 International License.
- COAST-RP: A global Coastal dataset of Storm Tide Return Periods dataset, licensed by the authors under the Creative Commons Attribution 4.0 International License.

About EarthScan

EarthScan is powered by Mitiga Solutions. Founded in 2018, Mitiga Solutions provides climate risk intelligence that combines science, AI and highperformance computing. We help our customers analyse, report and act on their business exposure to climate risk through our self-serve platform EarthScan™ and our risk models.

Our mission is to make the world a more resilient place under a changing climate. Mitiga is headquartered in Barcelona, Spain and backed by Elaia, Kibo Ventures, Telefónica, Matmut, Microsoft Climate Innovation Fund, Nationwide Ventures, Creas IMPACTO y Faber.

To learn more, visit earth-scan.com