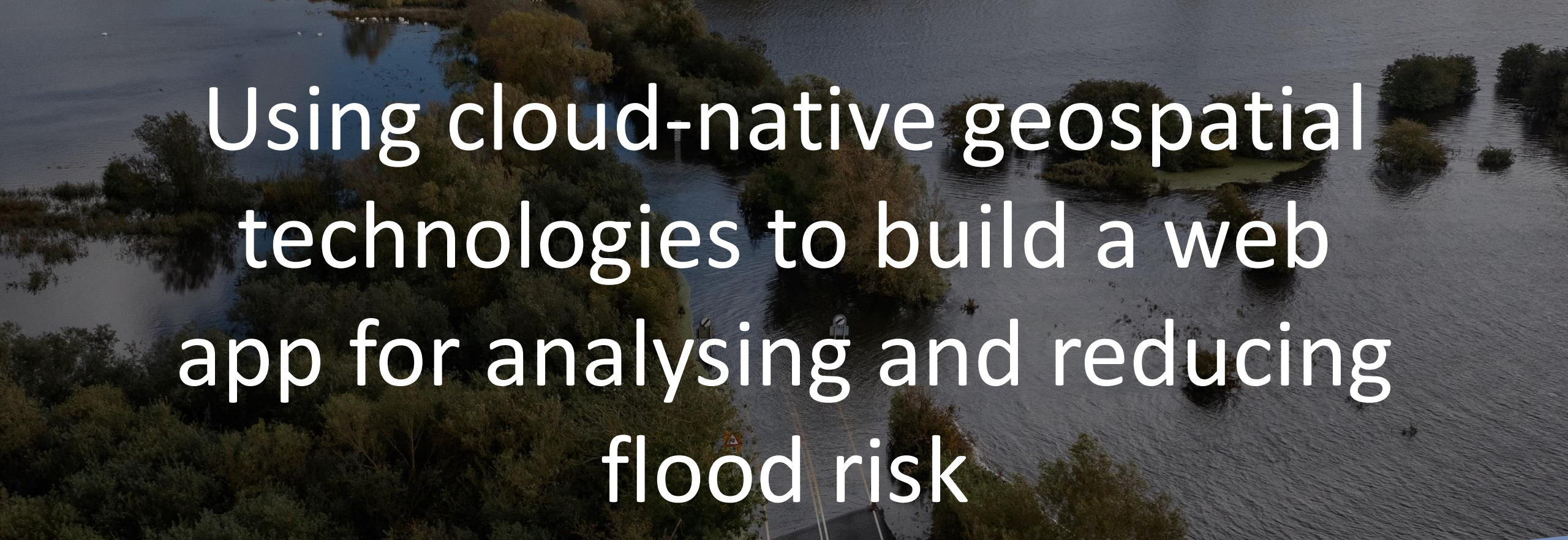


Using cloud-native geospatial technologies to build a web app for analysing and reducing flood risk

Rebalance Earth

Dr Robin Wilson

robin.wilson@rebalance.earth

The business case for Nature :

Who will pay for Nature and why?

The shell garage in Carlisle is now a stranded asset. The floods in 2005 and 2015 caused consistent business disruption and irreparable damage.

Rebalance Earth

In 2015, the McVitie's factory was flooded, leading to a £50 million insurance payout by RSA. This significant payout contributed to a decline in RSA's share price.

Restoring Nature is the solution to these five key risks:

Nature-as-a-service:
Our primary return mechanism

01 Flooding

02 Drought

03 Water quality

04 Biodiversity loss

05 Carbon emissions

Process

1. Identify businesses at risk
2. Identify restoration opportunities
3. Use investment to fund restoration
4. Use NaaS contracts to provide return

Rebalance Earth

Aims of GPAP?

Provide information for assessing assets at risk of flooding under various scenarios

***Prototype in 15 hours during hackathon**

01

Provide a range of asset locations (buildings, roads, businesses etc.)

02

Provide a range of flood outlines (Environment Agency, custom hydrological models)

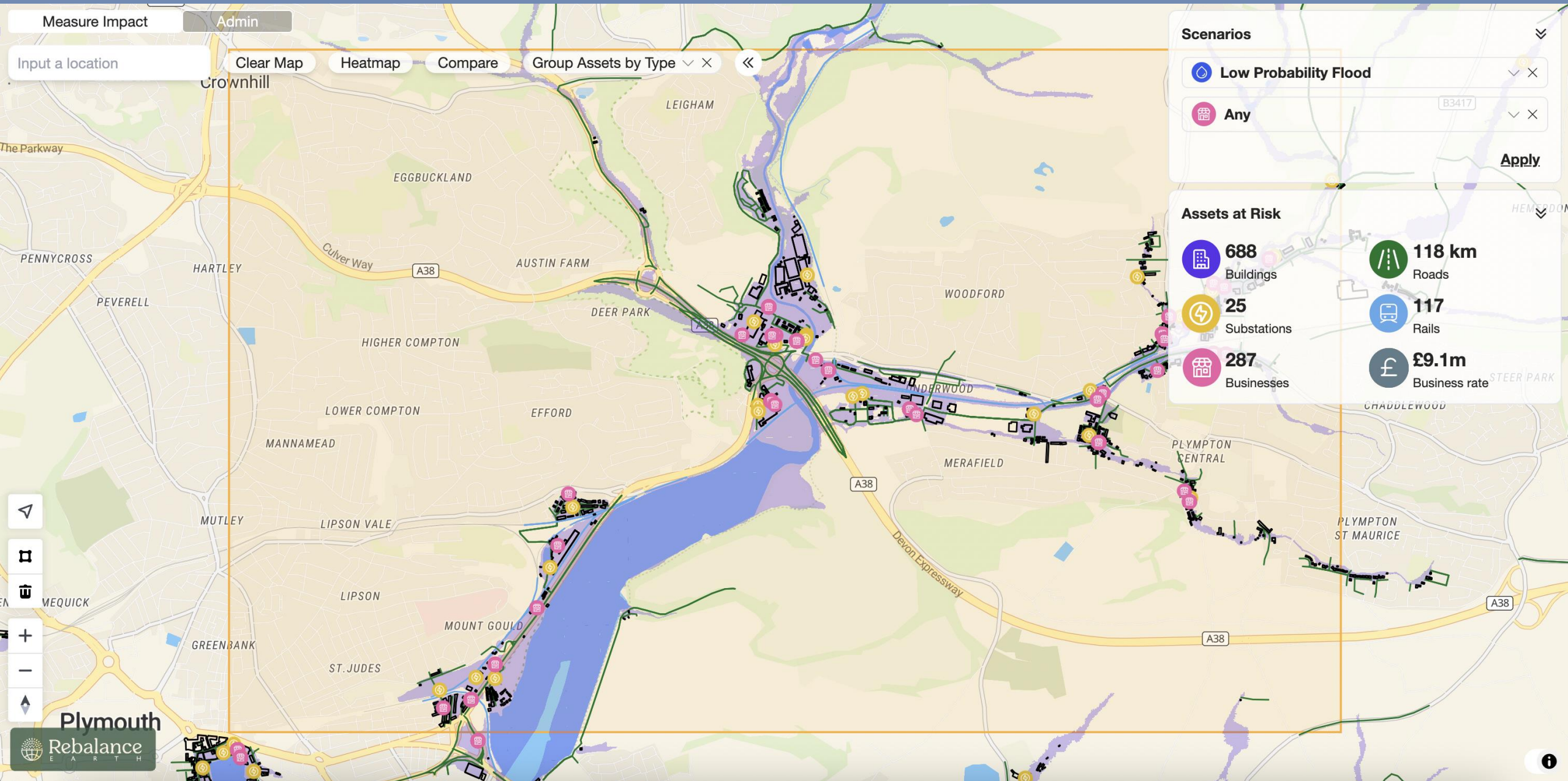
03

Combine the two to assess assets at risk

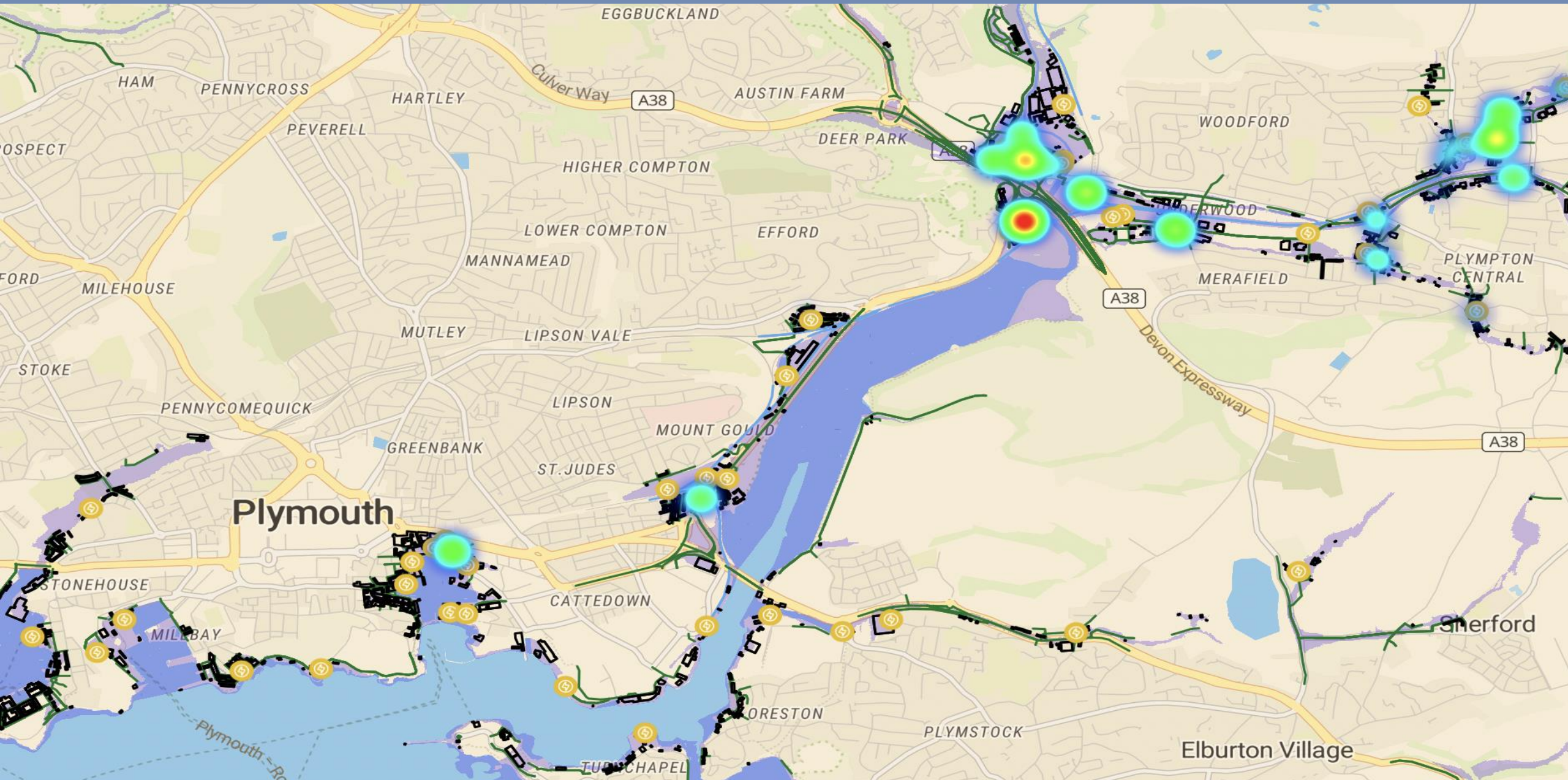
04

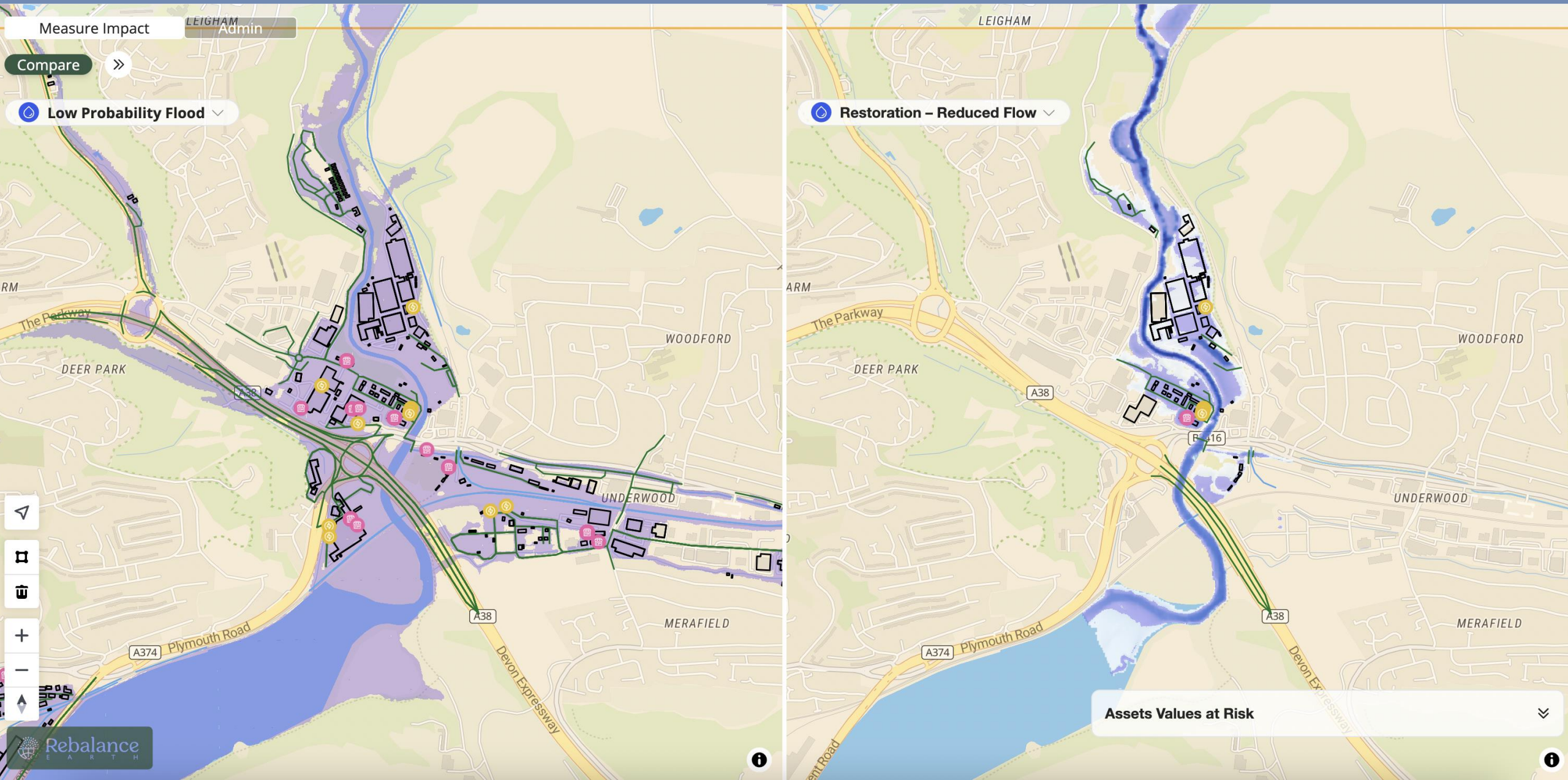
(Extend to assess financial value, secondary effects etc.)

Rebalance
Earth

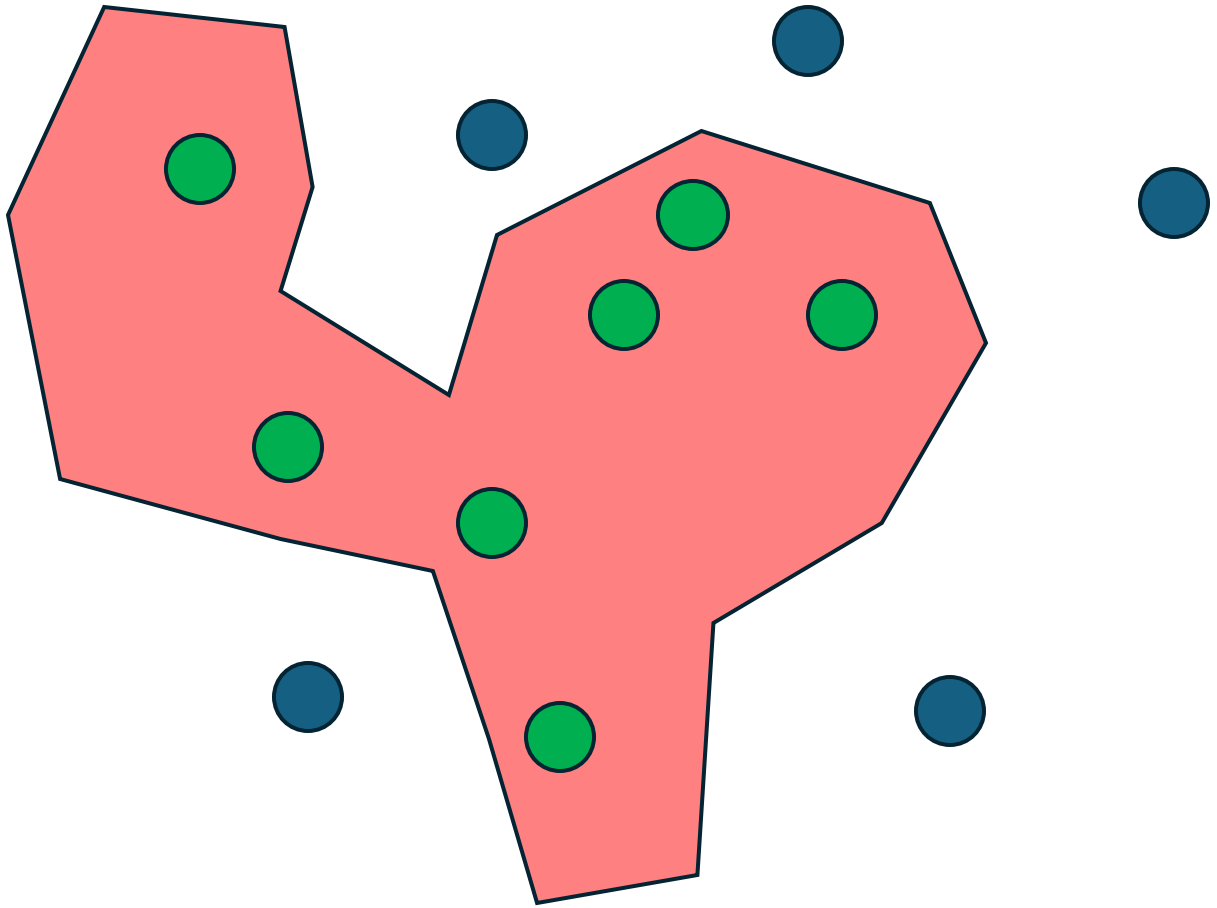



Rebalance
Earth
Measure Impact
Admin
Input a location
Clear Map
Heatmap
Compare
Group Assets by Type
Scenarios
Assets at Risk
St Modwen Road
Longbridge Road
Currys
Marsh Mills
Braddons Hill
Lynwood Avenue
Woodford Crescent
St. Margarets Road
The Knoll
Coypool Road
Woodford Avenue
Plymouth Road
Argos House
Marsh Close
A38
B3416
A374
B341
Blandford Road
Military Road
Thames Gardens
Pike Road
Crabtree Close
J SAINSBURY PLC
Hypermarkets/Superstores (over 2500m^2)
Rateable value: £1810000.0
Floor area: 9813.63m²
ARGOS RETAIL GROUP LTD
Shops Within/Part of Specialist Property
Rateable value: £18750.0
Rebalance
EARTH


EGGBUCKLAND
HAM
PENNYCROSS
HARTLEY
Culver Way
A38
AUSTIN FARM
PEVERELL
DEER PARK
WOODFORD
HIGHER COMPTON
LOWER COMPTON
EFFORD
MANNAMEAD
MILEHOUSE
MERAFIELD
PLYMPTON CENTRAL
MUTLEY
LIPSON VALE
Devon Expressway
STOKE
PENNYCOMEQUICK
LIPSON
MOUNT GOULD
GREENBANK
ST.JUDES
Plymouth
STONEHOUSE
CATTEDOWN
MILLBAY
PLYMSTOCK
Elburton Village


Measure Impact
Admin
Compare
Low Probability Flood
Restoration – Reduced Flow
Assets Values at Risk
LEIGHAM
The Parkway
DEER PARK
WOODFORD
UNDERWOOD
MERAFIELD
A38
A374
Plymouth Road
Devon Expressway
Rebalance
EARTH

It’s ‘just’ intersection…



But:

- with **lots** of data
- with **lots** of flexibility

(and some badly created Environment Agency polygons)

Cloud Native Geospatial

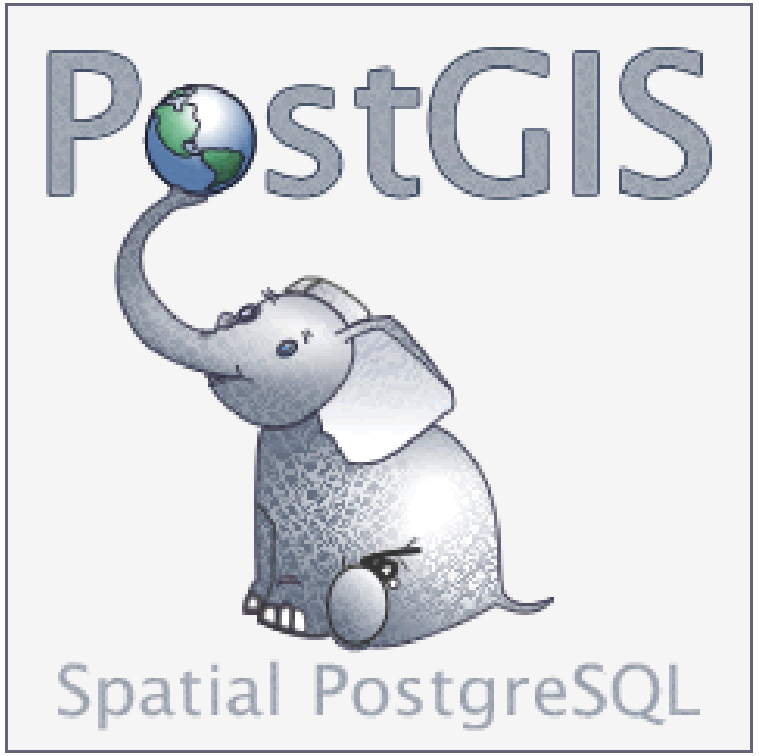
- Use database or file backend to generate tiles on-the-fly
- **Vector:** Database -> Mapbox Vector Tiles
- **Raster:** File -> XYZ raster tiles

- On-the-fly computation
  - Why?
    - Lots of options (different flood outlines, different categories, different depths)
    - Large data – most of it won't be looked at
    - Can cache tiles (not implemented yet)
  - Still want it to be fast!

Database

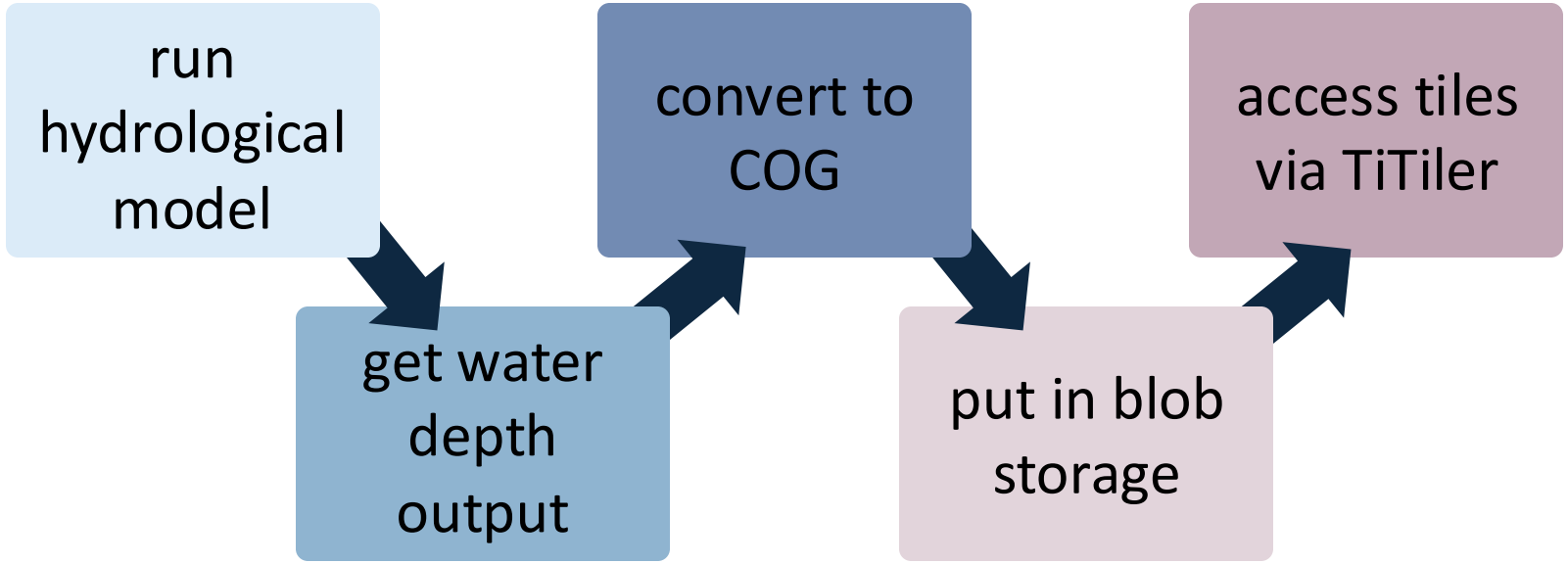
- Generally, a table per layer
  - Buildings
  - Roads
  - Railways
  - Substations

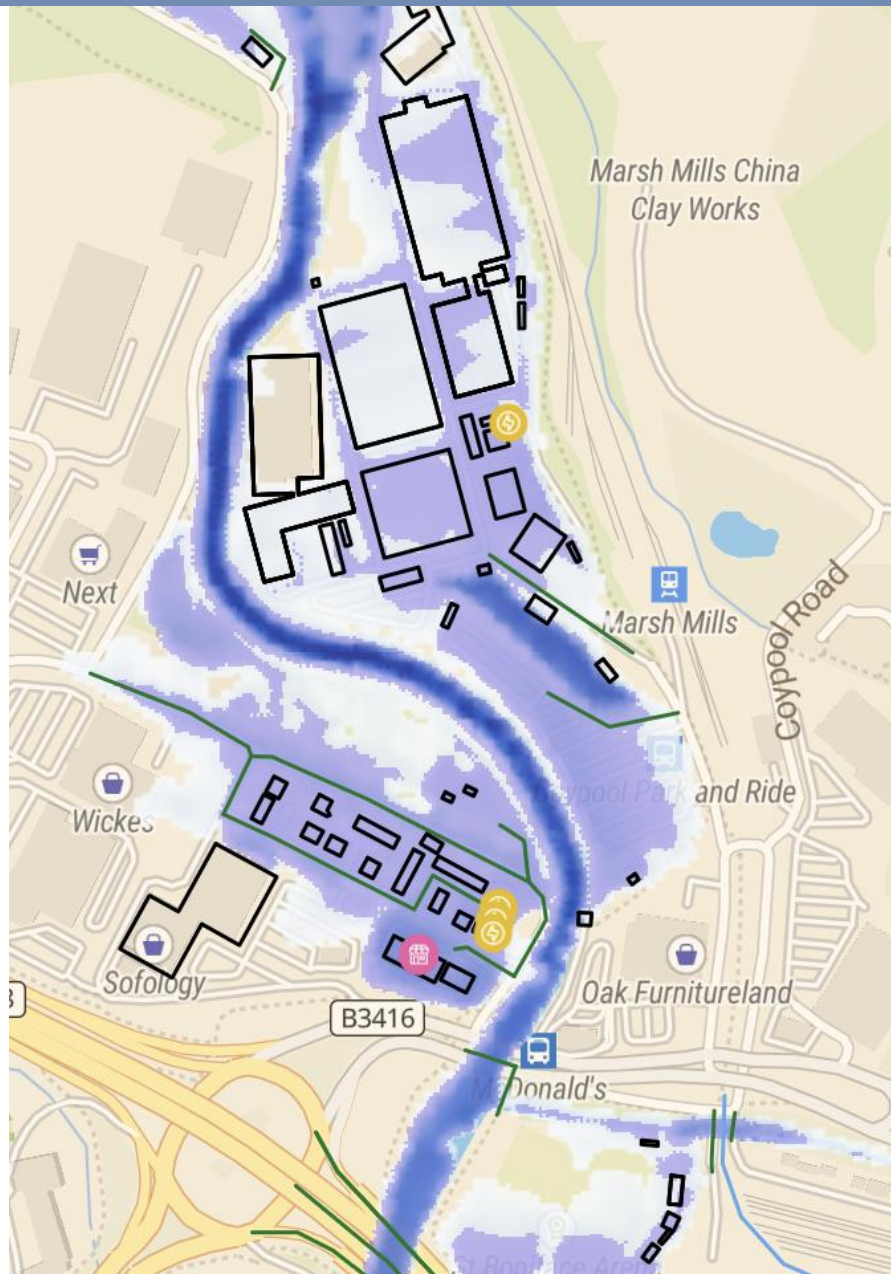
  } OS OpenData
  - Environment Agency Flood Zones
  - Businesses
- All for the **whole of England**
- Loading data via ogr2ogr
  - `--config PG_USE_COPY YES`
- Remember indexes!



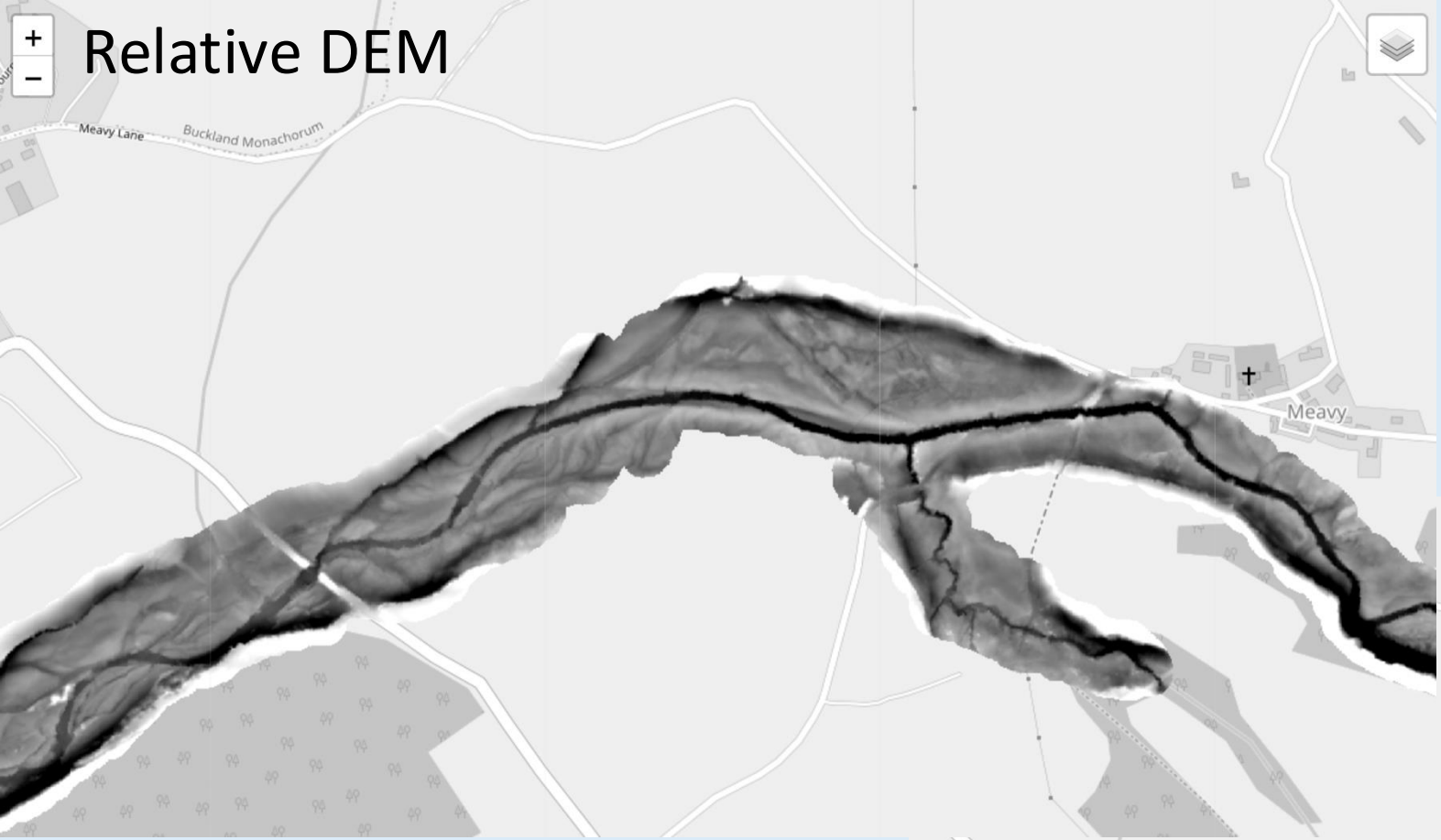
TiTiler

- Generates raster XYZ tiles ‘on the fly’ from Cloud Optimized GeoTIFF (COG) files
- Python FastAPI application on Azure Functions



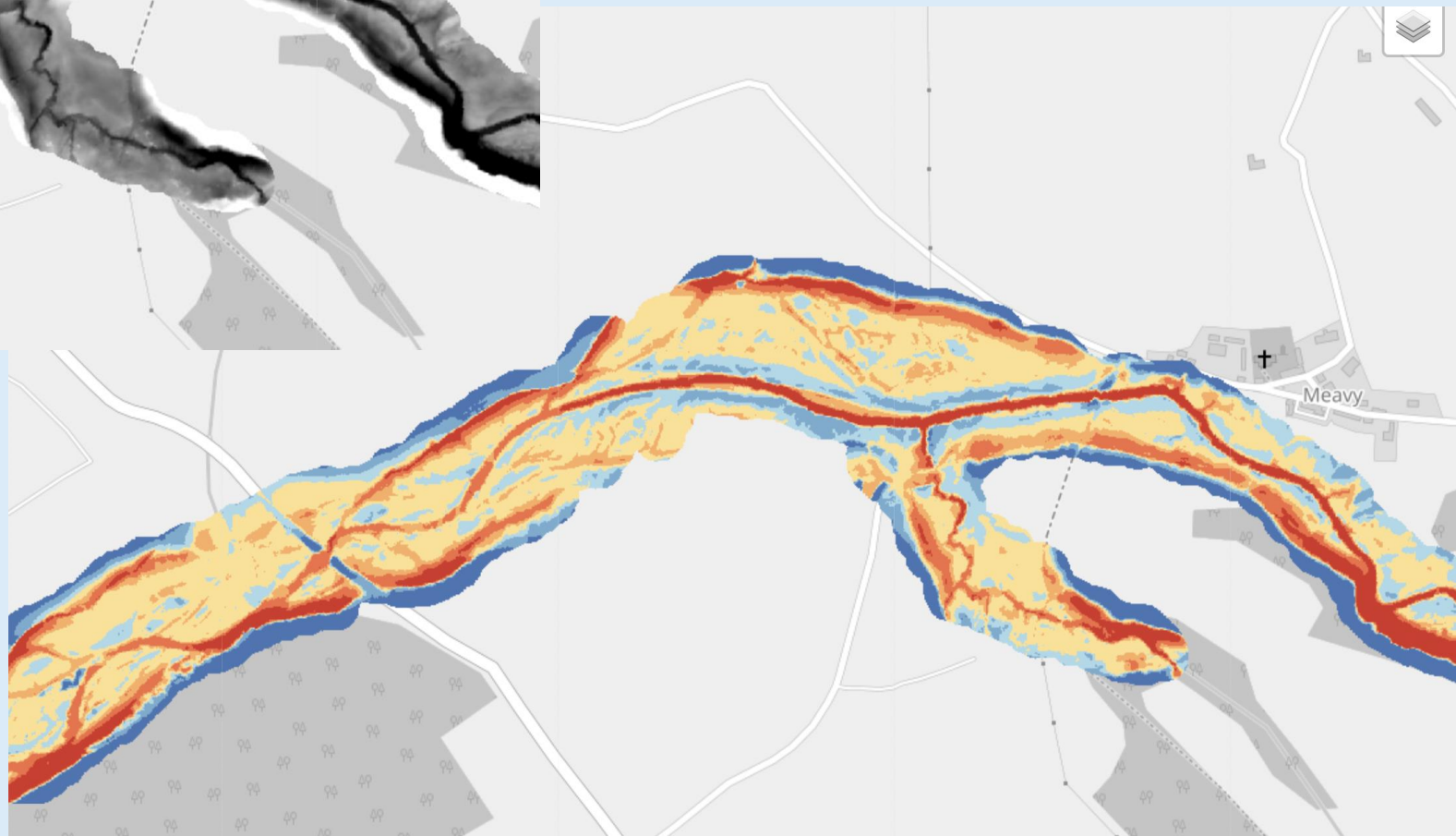


Relative DEM



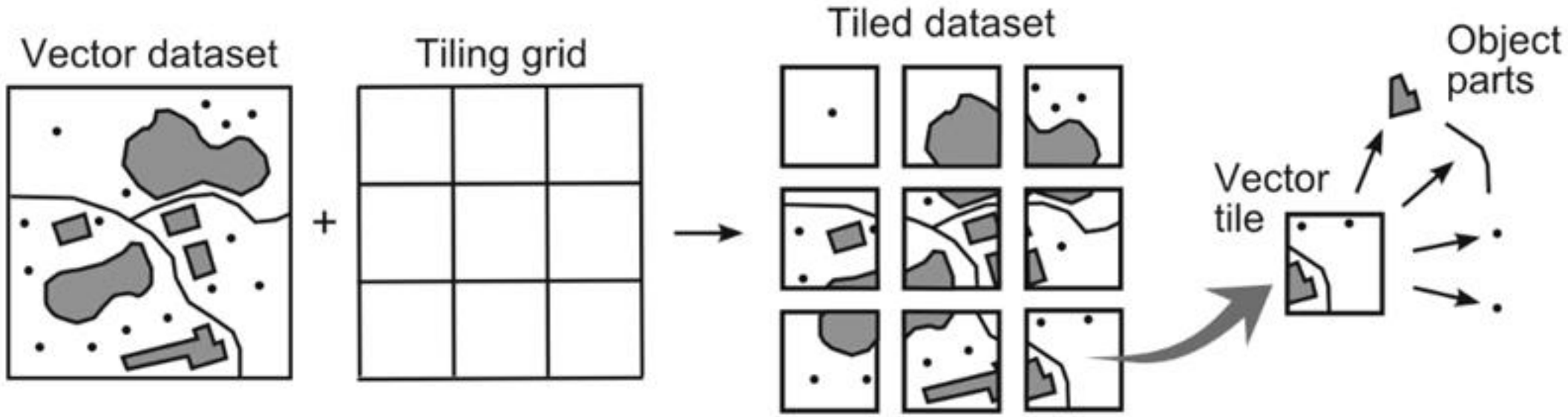

```
...&colormap=[
[[-100,-1], [215,48,39,255]],
[[-1,-0.5],[244,109,67,255]],
[[-0.5,-0.2],[253,174,97,255]],
[[-0.2,0.2],[254,224,144,255]],
[[0.2,0.5],[171,217,233,255]],
[[0.5,1.0],[116,173,209,255]],
[[1.0,100],[69,117,180,255]]
]
```

```
...&rescale=-1.5,1.5
```



Mapbox Vector Tiles

- XYZ tiles, but for vector!



MVTs & PostGIS

- PostGIS can create MVT output directly using `ST_AsMVT` and `ST_AsMVTGeom`
- Just need a simple server to convert HTTP requests to Postgres queries
- Various options – we picked `pg_tileserv`
  - Others include Martin, timvt, vectipy and more
  - Does anyone want to do a speed comparison between them?

MVT URLs

Table:

```
http://server/public.buildings/{z}/{x}/{y}.pbf
```

Function:

```
https://server/public.buildings_in_aoi/
{z}/{x}/{y}.pbf?l=-4.116&t=50.403&b=50.376&r=4.060&
scenario=flood_1000yr_scenario&source=2
```

```
CREATE OR REPLACE FUNCTION public.buildings_in_aoi(
        z integer,
        x integer,
        y integer,
        l float8,
        t float8,
        b float8,
        r float8,
        scenario text,
        source integer
        )
RETURNS bytea
```

```
WITH
args AS (
        SELECT
        ST_TileEnvelope($1, $2, $3) AS bounds,
        ST_Transform(ST_TileEnvelope($1, $2, $3),                    27700)
AS bounds_osgb,
        ST_Transform(ST_MakeEnvelope($4, $6, $7,                     $5,
4326), 27700) AS area
),
```

```
aoi_buildings AS (
        SELECT building_assets.geom
        FROM args, building_assets
        WHERE ST_Intersects(building_assets.geom,
        args.bounds_osgb)
),

aoi_flood AS (
        ...
)
```

```
mvtgeom AS (
        SELECT
                ST_AsMVTGeom(
                        ST_Transform(aoi_buildings.geom,
                3857), args.bounds) AS geom
        FROM args, aoi_flood
        JOIN aoi_buildings ON
        ST_Intersects(aoi_flood.geom,
                aoi_buildings.geom)
                )

SELECT ST_AsMVT(mvtgeom, 'default') from mvtgeom
INTO result USING z,
```

```
mvtgeom AS (
        SELECT
                ST_AsMVTGeom(
                        ST_Transform(aoi_buildings.geom,
                3857), args.bounds) AS geom
        FROM args, aoi_flood
        JOIN aoi_buildings ON
        ST_Intersects(aoi_flood.geom,
                aoi_buildings.geom)
                )

SELECT ST_AsMVT(mvtgeom, 'default') from mvtgeom
INTO result USING z,
```

```
mvtgeom AS (
        SELECT
                ST_AsMVTGeom(
                        ST_Transform(aoi_buildings.geom,
                3857), args.bounds) AS geom
        FROM args, aoi_flood
        JOIN aoi_buildings ON
        ST_Intersects(aoi_flood.geom,
                aoi_buildings.geom)
                )

SELECT ST_AsMVT(mvtgeom, 'default') from mvtgeom
INTO result USING z,
```

```
mvtgeom AS (
        SELECT
                ST_AsMVTGeom(
                        ST_Transform(aoi_buildings.geom,
                3857), args.bounds) AS geom
        FROM args, aoi_flood
        JOIN aoi_buildings ON
        ST_Intersects(aoi_flood.geom,
                aoi_buildings.geom)
                )

SELECT ST_AsMVT(mvtgeom, 'default') from mvtgeom
INTO result USING z,
```

Asset Statistics

- FastAPI app connecting to database
- Simple SQL queries
- Use WITH statement to get AOI subsets before join

```
SELECT COUNT(*), voltage
FROM aoi_substations
JOIN aoi_flood ON ST_Intersects(aoi_substations.geom, aoi_flood.geom)
GROUP BY voltage;
```

Frontend

- MapLibre JS
- Leaflet used for prototype
  - I prefer Leaflet's API
  - But…MVTs seem to be a second-class citizen in Leaflet
  - Eg. no cancellation of unneeded HTTP requests
  - All seems a bit 'behind the times' when it comes to MVTs
- Switched to MapLibre and far faster for MVTs
  - Weighted heatmap functionality nice too

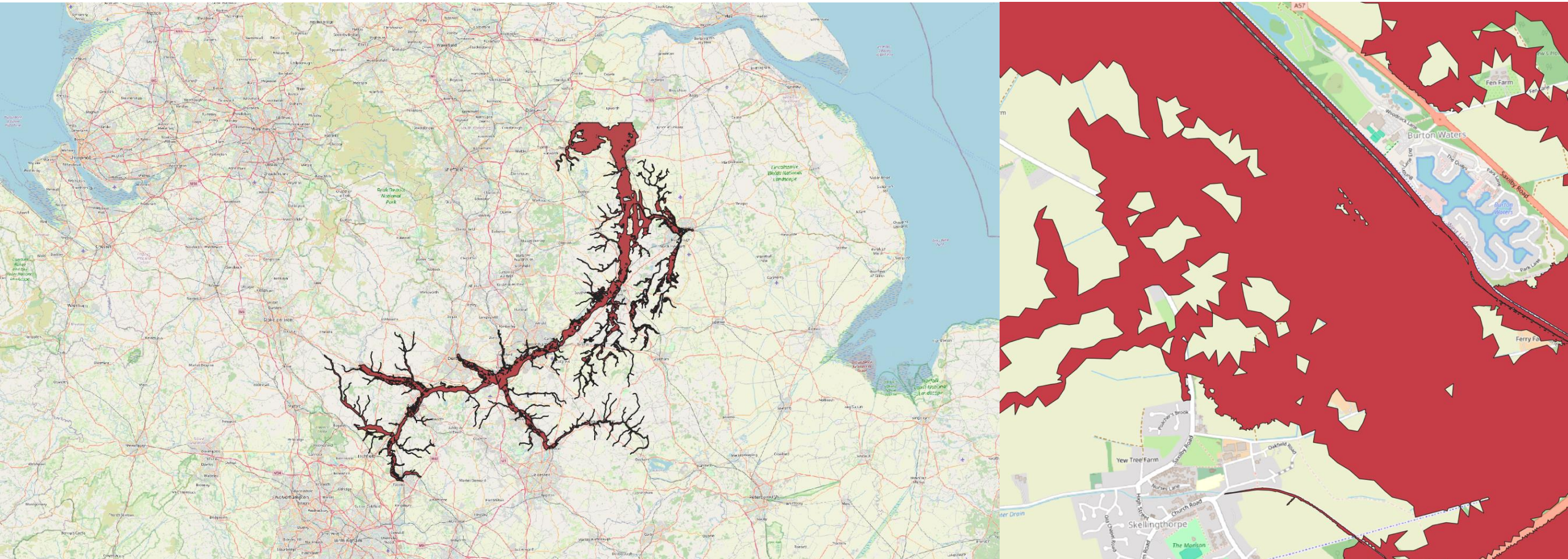
Architecture

- All hosted on Azure

- **Database** – Postgres + PostGIS
- **TiTiler** – Python Function App connecting to Blob Storage
- **pg_tileserv** – Container App connecting to database (proxy for auth)
- **asset_queries** – Python Function App running SQL queries

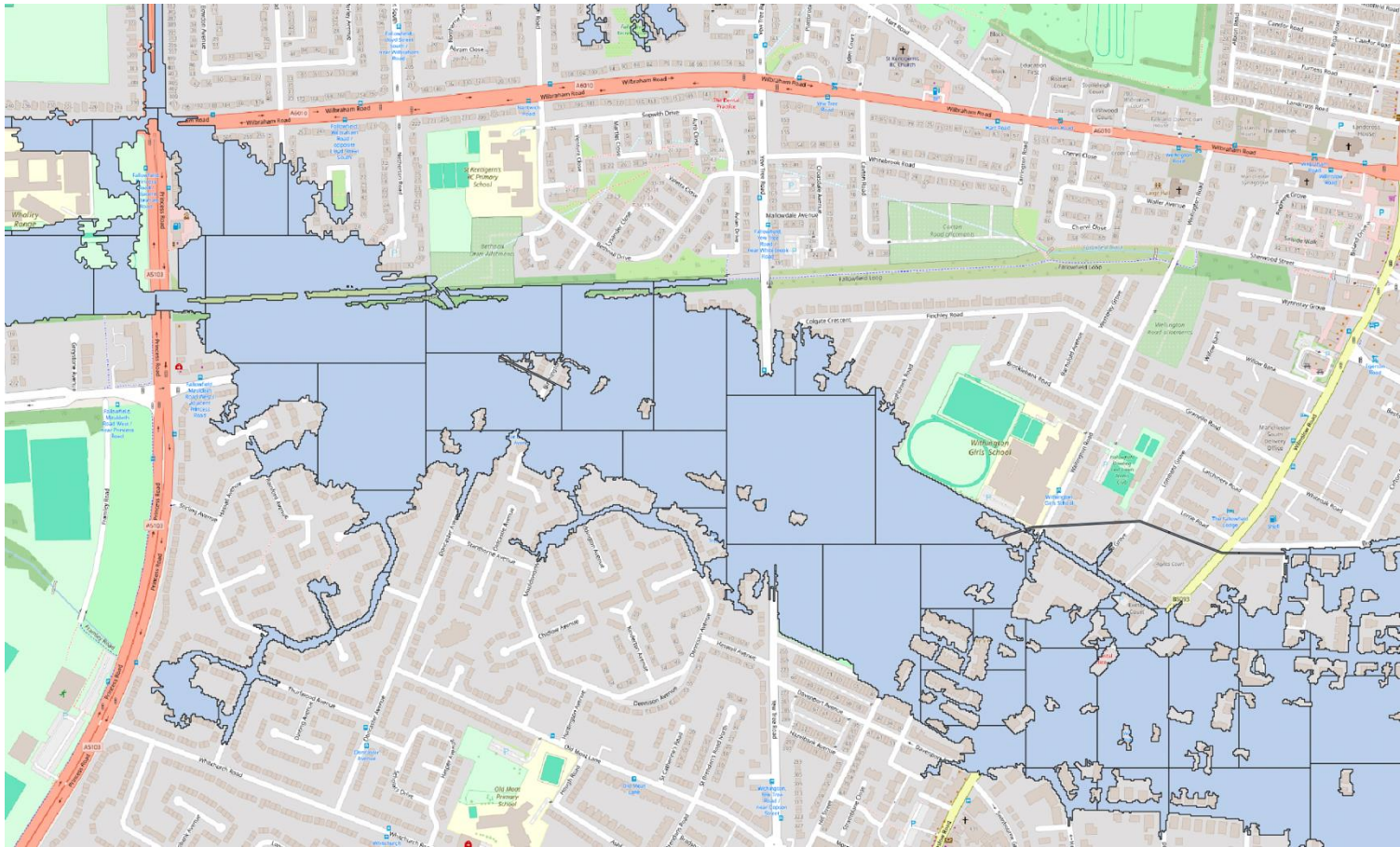
Crazy Environment Agency polygons…

- Some of the EA flood polygons have **over 1 million vertices**!



Aside: Crazy flood polygons…

- Some of the EA flood polygons have **over 1 million vertices**!
- This makes everything slow!
- `ST_Subdivide` to the rescue…

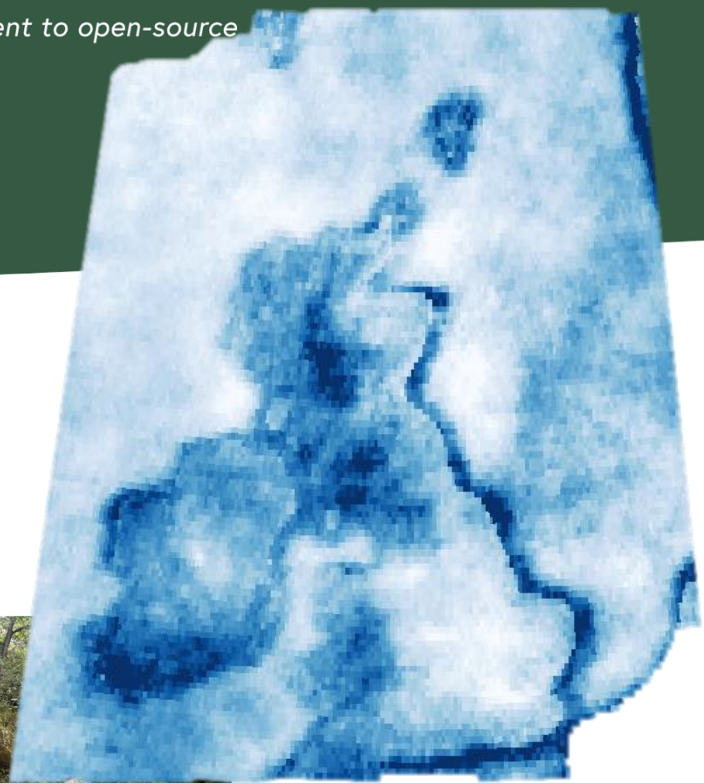


www.rebalance.earth/open-source-manifesto

Rebalance Earth

Open-Source Manifesto

"We believe in the power of openness to drive innovation, collaboration, and positive change. Our commitment to open-source and open-data is central to our mission of creating a world worth living in"



What is **Open-Source**, and why does it matter?

Open-source is a movement centred around the belief that software source code and data should be freely available for anyone to view, modify, and distribute. This openness fosters a global collaborative environment where developers and

Rebalance Earth Hackathon:

GeoTAM Challenge

20th Nov 2024 to 26th Nov 2024
Online / Virtual Event

Scan QR Code to learn more or visit:
WWW.REBALANCE.EARTH/GEOTAM-CHALLENGE

BRIEF:
Develop an open-source proof of concept method to estimate business turnover at specific locations across the UK, with a retained focus on Manchester

SUPPORT:
Gain access to non-public datasets, expert mentorship, and a collaborative community via Discord

PRIZES:
Up to £2,000 in monetary awards, with the prospect to continue developing your work as part of a role at our fund