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River size representation in global flood models: a geospatial investigation

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NERC SCIENCE OF THE ENVIRONMENT

FATHOM

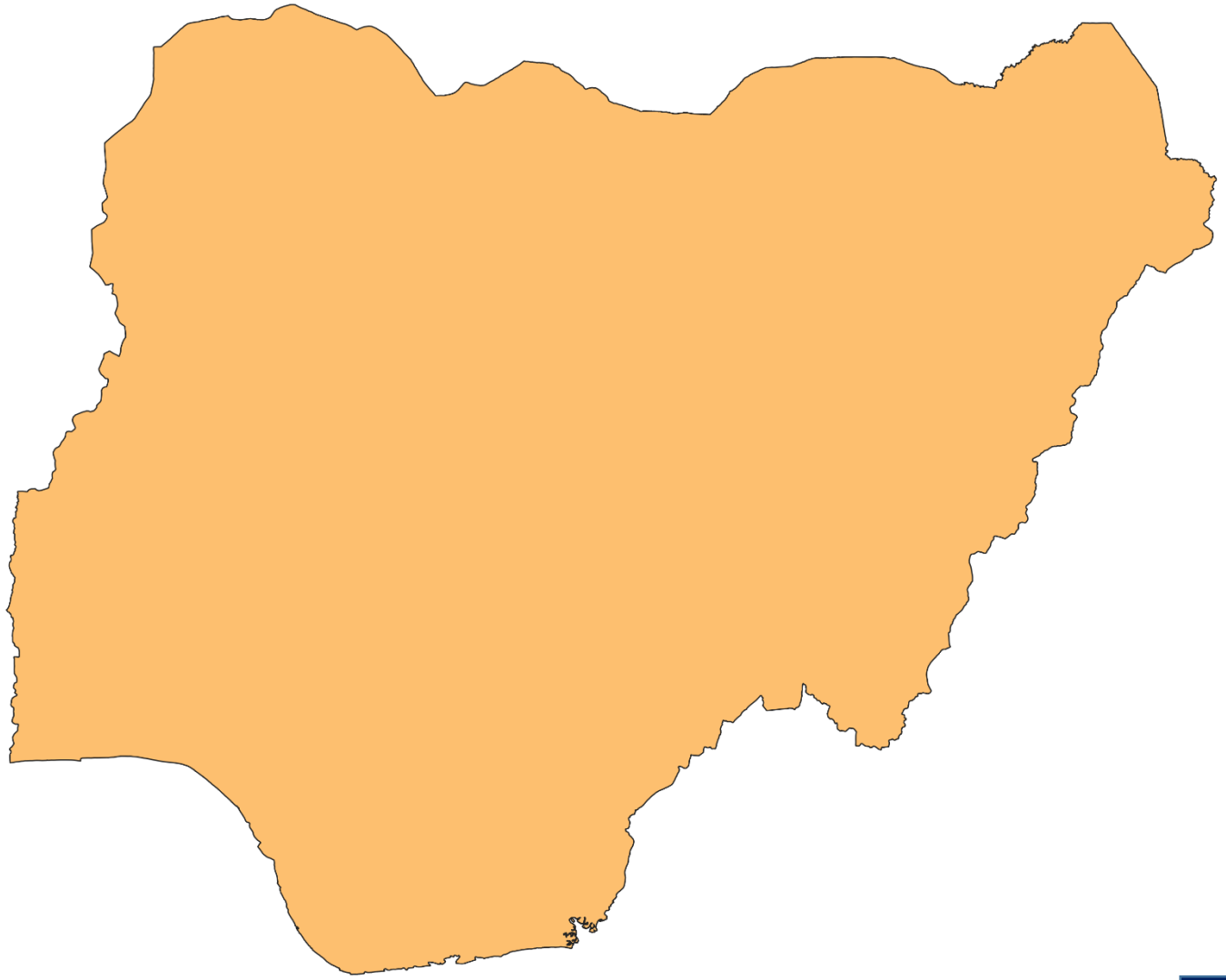
Overview

- Follows on from the global flood model intercomparison work (Trigg et al, 2016).
- Study found 30-40% agreement between 6 global flood models in Africa.
- Difficult to quantify the significance of river size representation on model disagreement using different global flood models.
- Need some independent (from GFMs) measure of flood extent.

How do the Global Flood Model river size thresholds affect exposure estimates?

Global Model Thresholds: Nigeria

Drainage Thresholds	Global Model
50 km^2	Fathom
500 km^2	U-Tokyo, ECMWF
1000 km^2	CIMA-UNEP
5000 km^2	JRC



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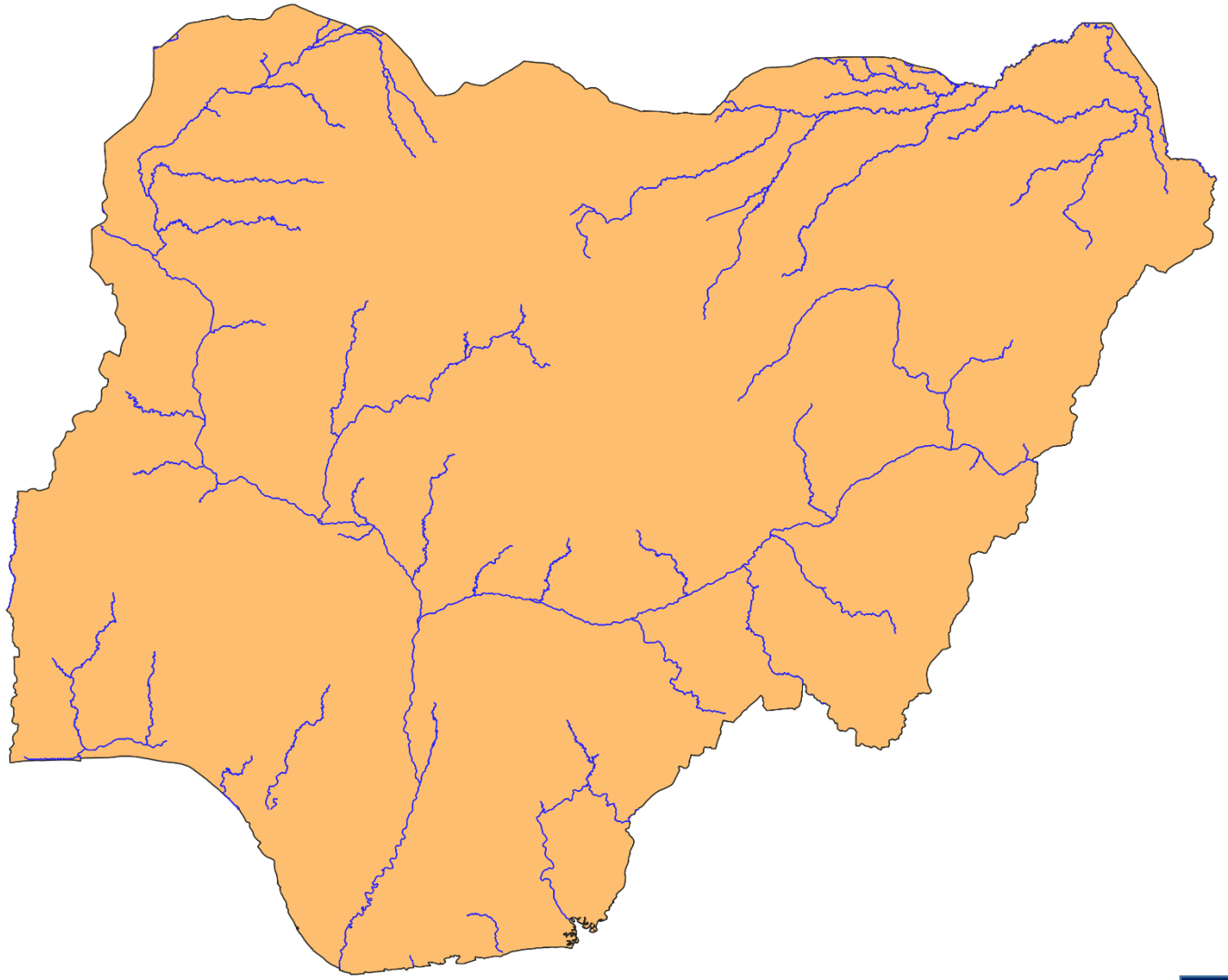

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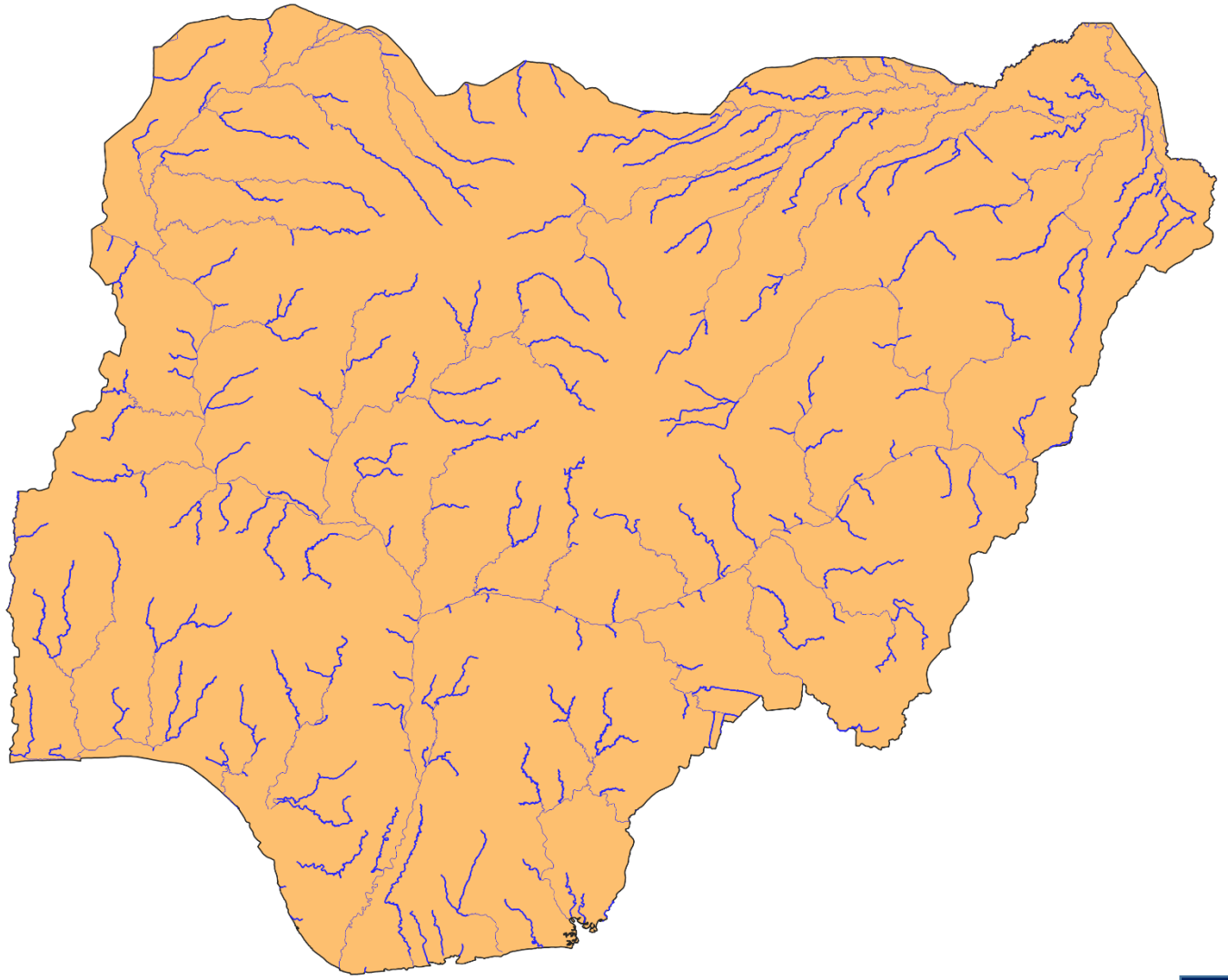

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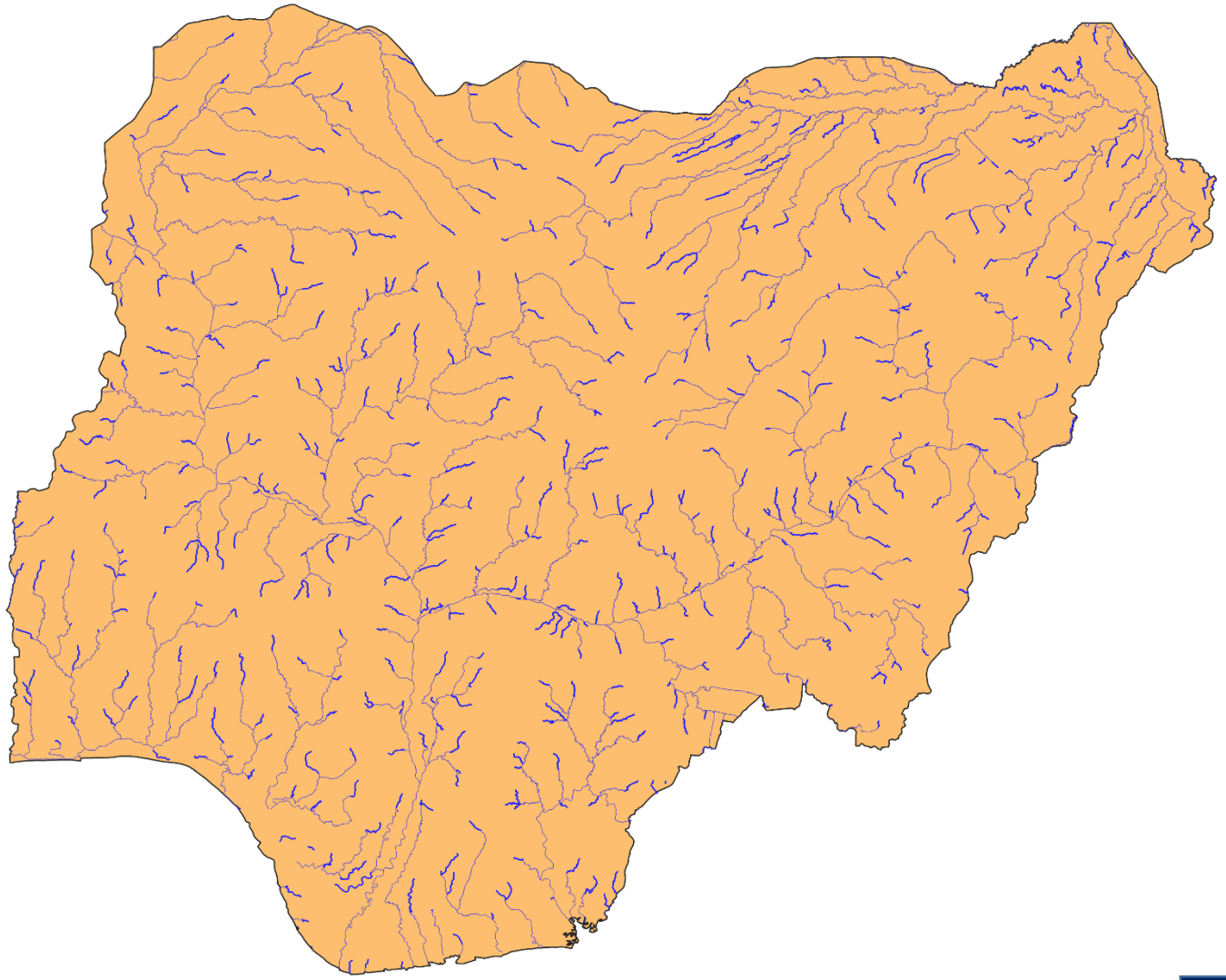

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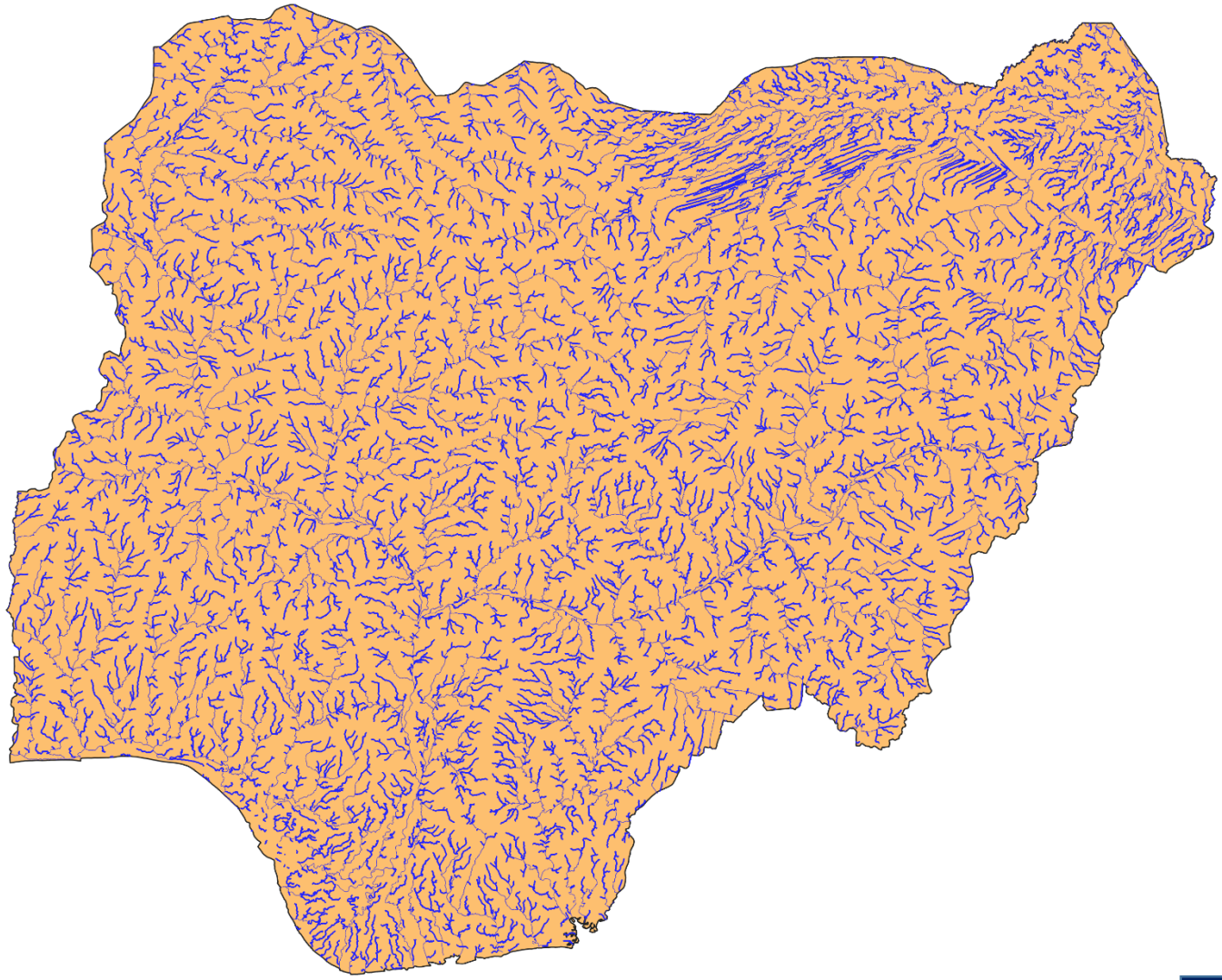

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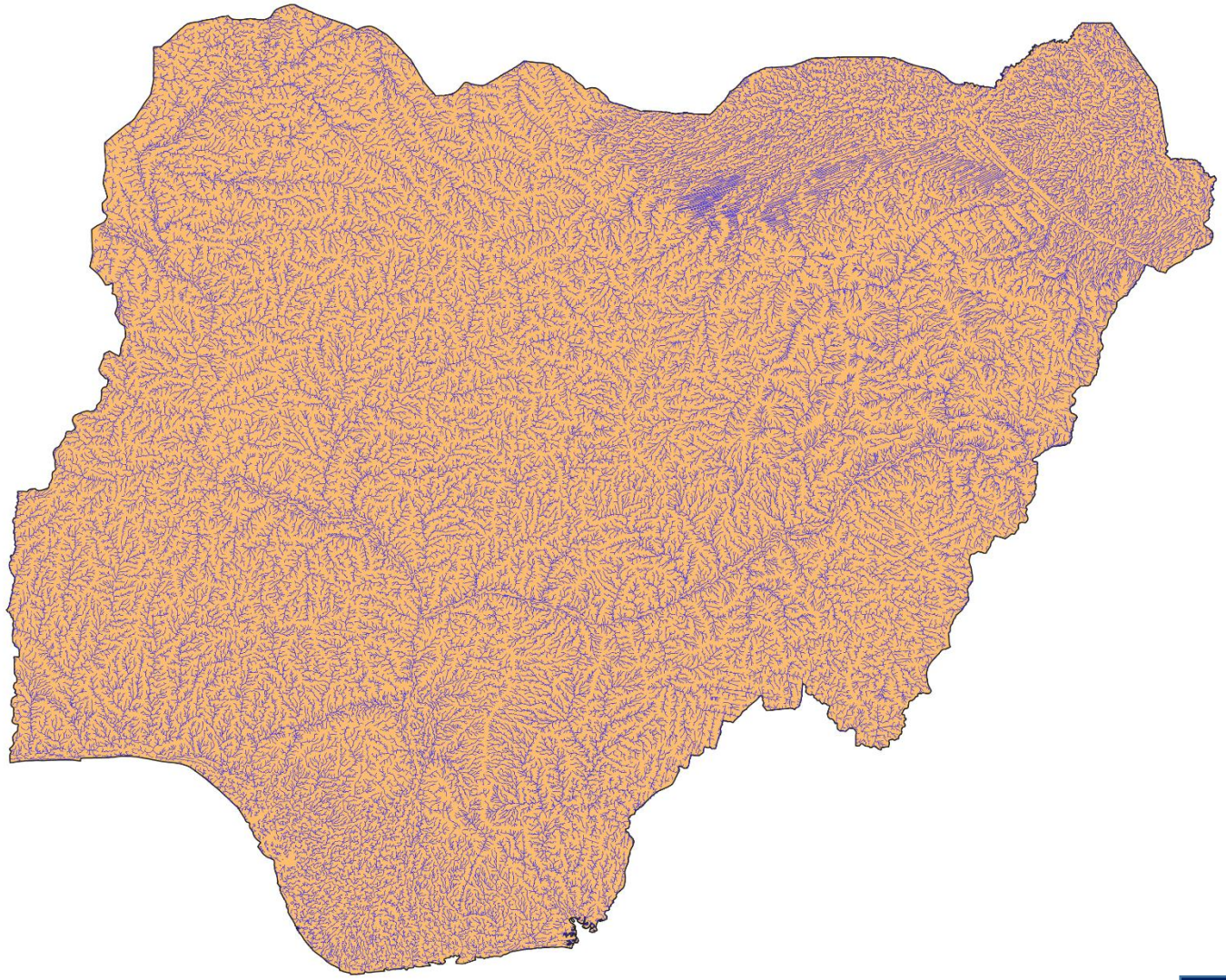
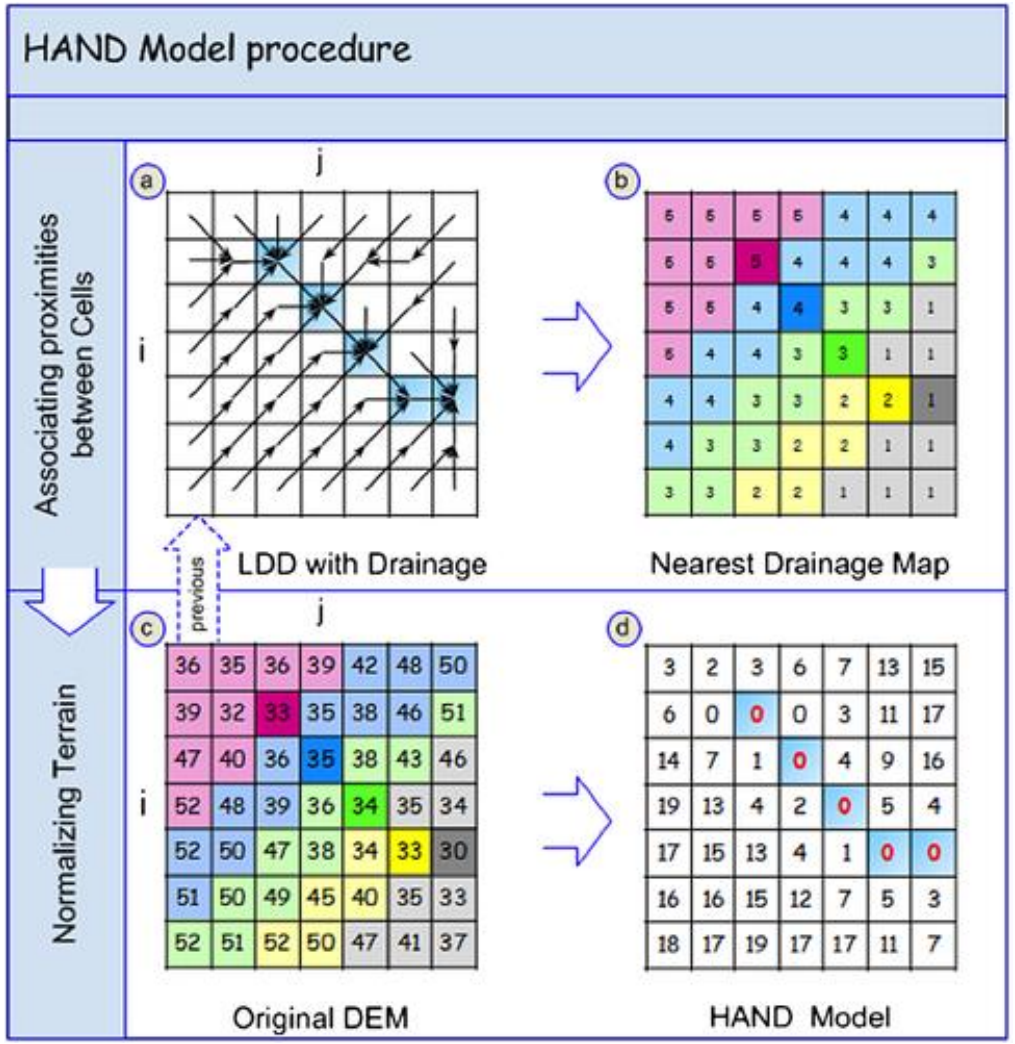


5 km^2 threshold

Height Above Nearest Drainage (HAND)

- Terrain model developed by Nobre et al. (2011)
- Needs only terrain derived datasets as inputs:
  - Digital Elevation Model (DEM)
  - Drainage directions
  - River upstream drainage area
- Has been successfully used in studies as a quasi or (0 dimensional) flood model.
- Quick to run at large-scales.
- Easily produce an auxiliary dataset of river size (upstream drainage area)



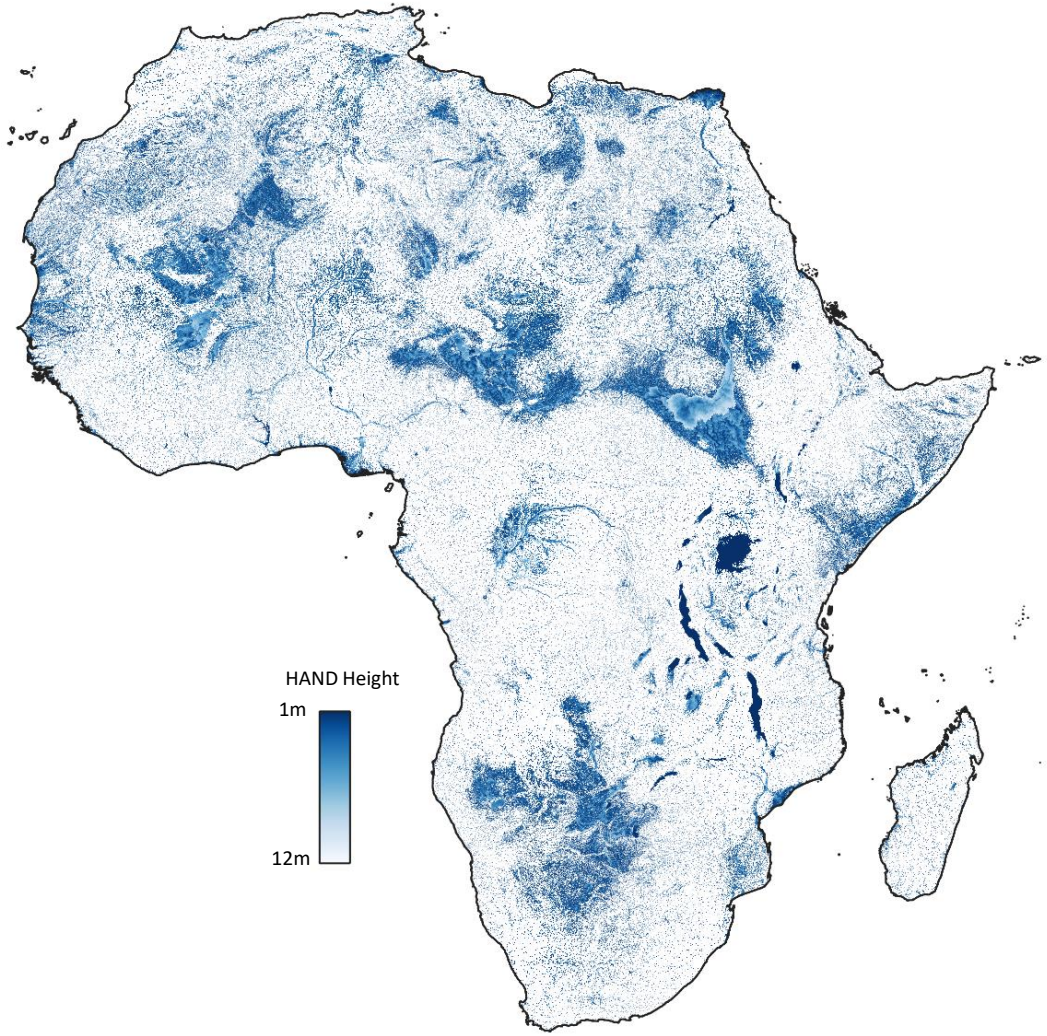
from Nobre et al. (2011)

HAND Model Setup

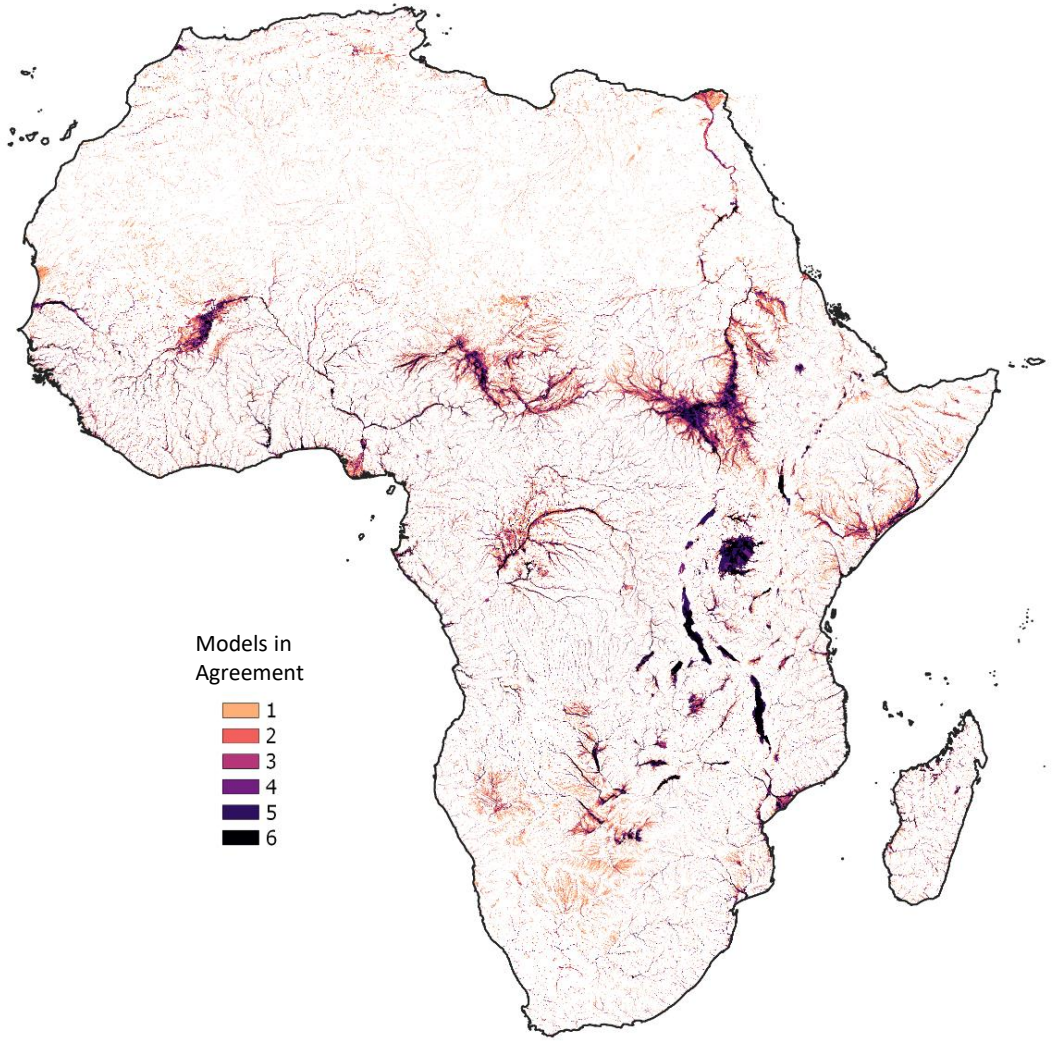
- Using MERIT Hydro data
- HAND heights were “calibrated” using 100y flood maps in Nigeria and the UK.
- For rivers with Strahler Stream Orders >=6, JRC’s 100 year flood map was used in Nigeria.
- JRC’s model was the best of the GFMs in a previous validation study in Nigeria (Bernhofen et al, 2018)
- For smaller rivers with stream orders <=7 the Environment Agency’s 100 year flood zone map for the UK was used.

Strahler Stream Order	HAND height
1	2 m
2	2 m
3	3 m
4	4 m
5	5 m
6	6 m
7	7 m
8	8 m
9	10 m
10	12 m
11	12 m

HAND Model Quality

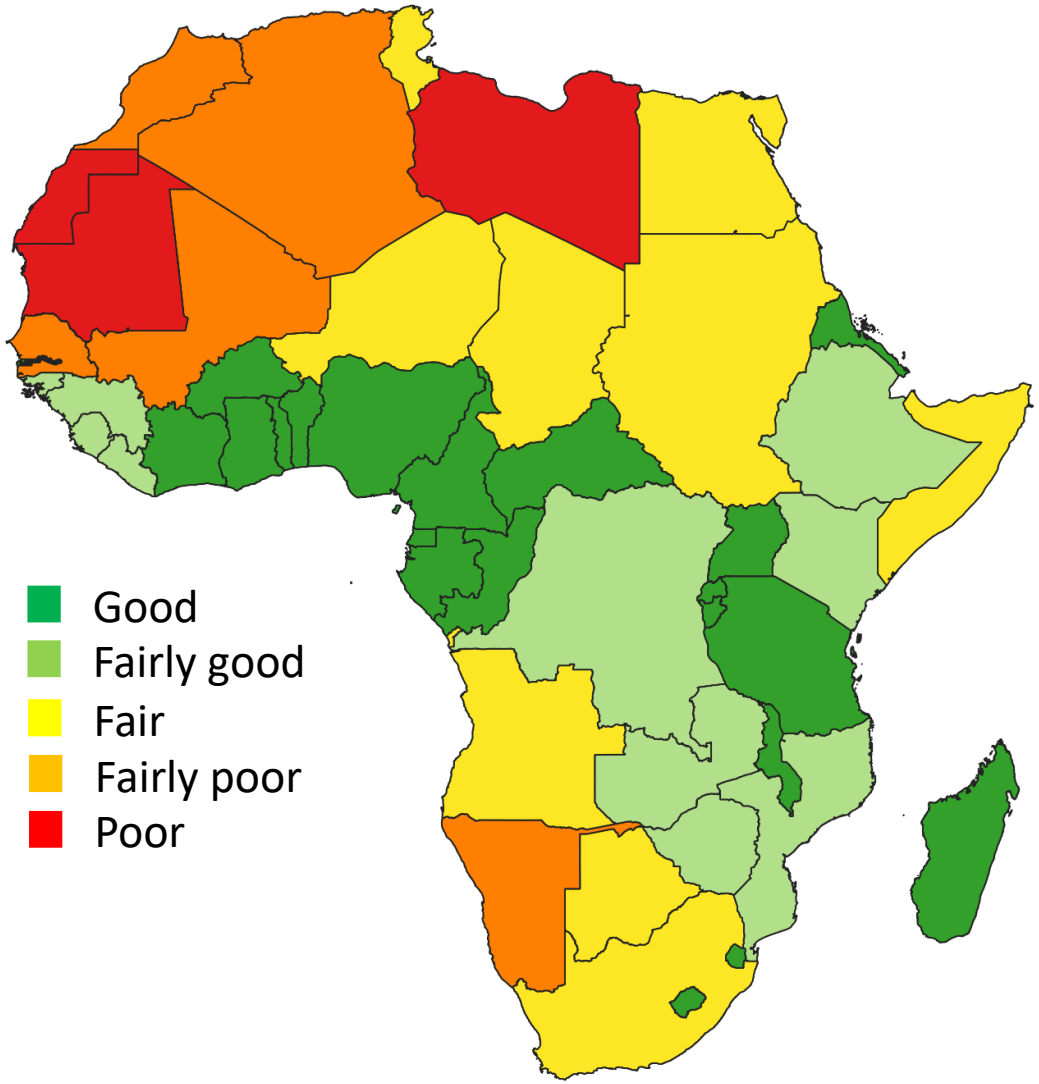


HAND Model

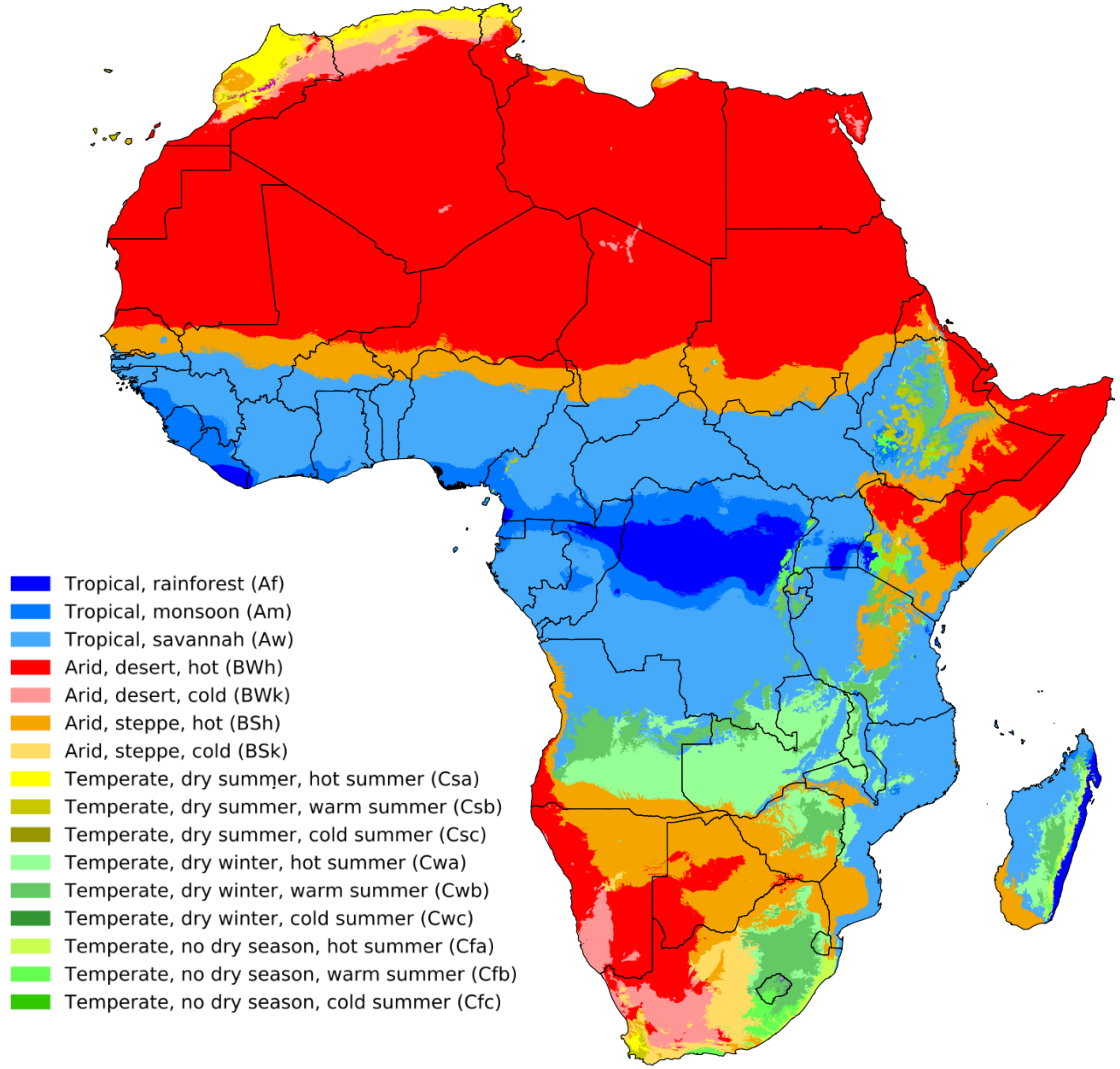


Aggregated GFMs (from Trigg et al, 2015)

HAND Model Quality



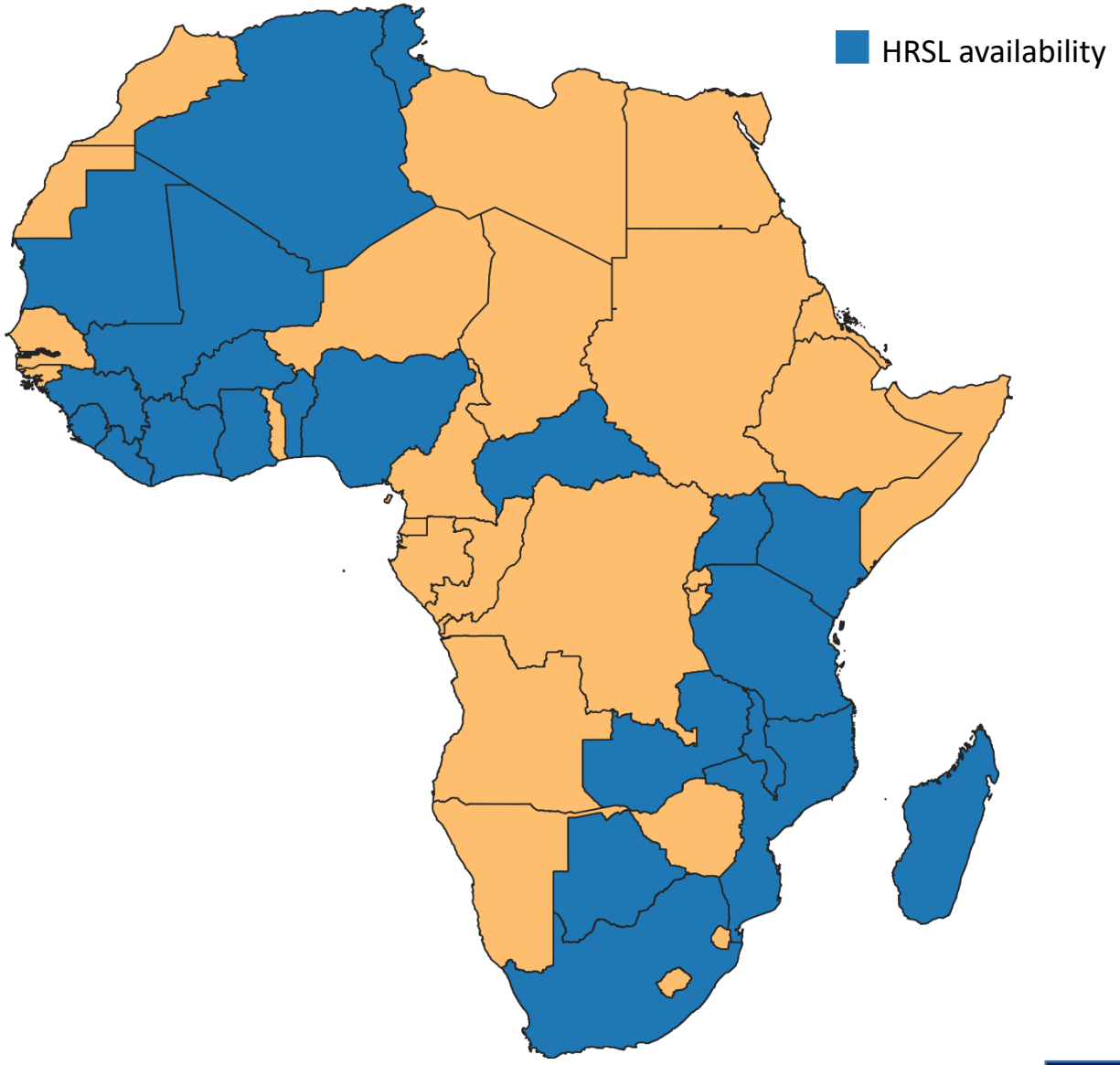
HAND Model Performance



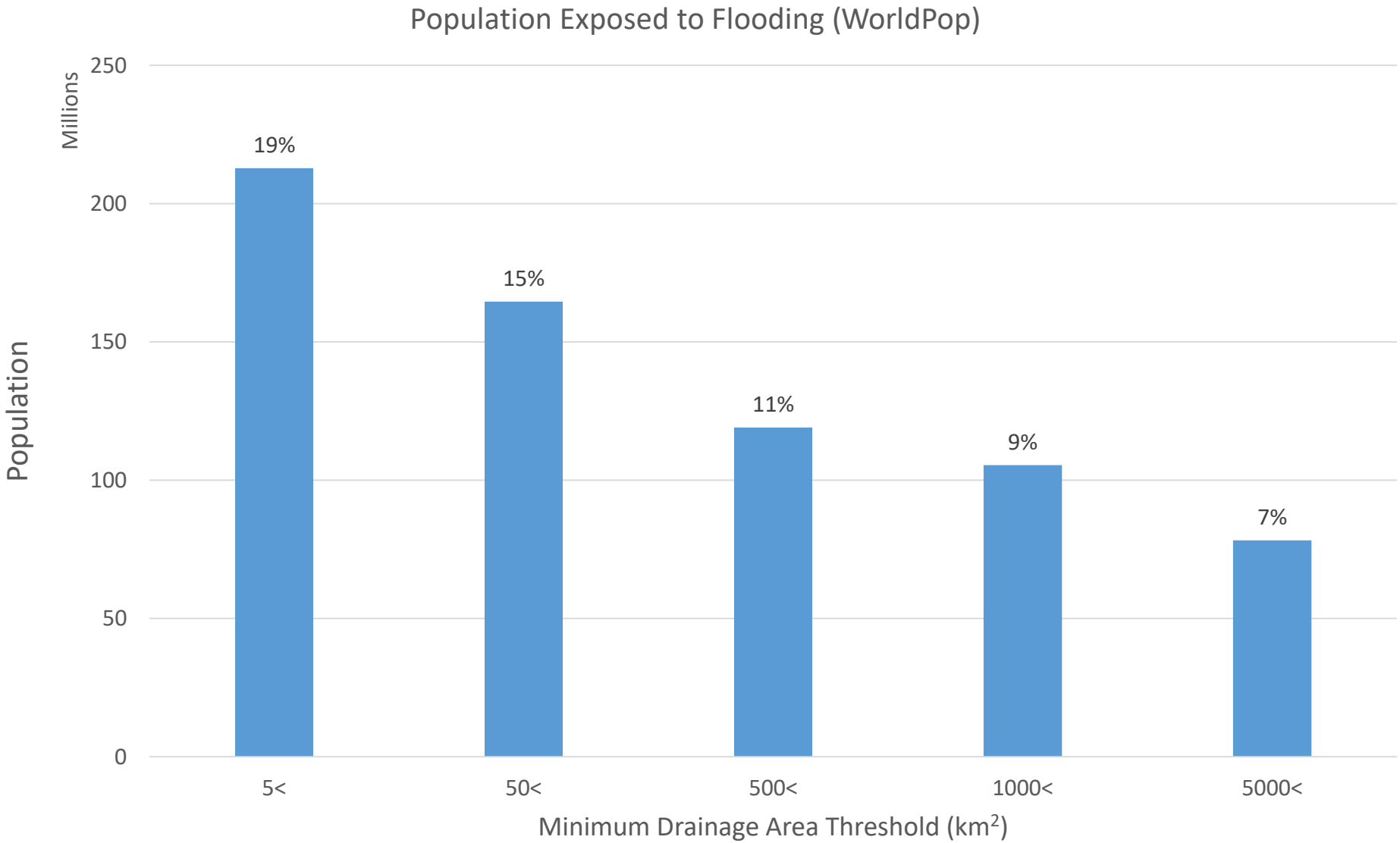
Koppen-Geiger Climate Classifications

Exposure Data

- Using Facebook and Columbia University's High Resolution Settlement Layer (HRSL) (30m resolution) in the 22 countries it is available.
- Use WorldPop data (100m resolution) in all countries.
- Can compare results to see how population data affects the exposure estimates.



Flood Exposure - Africa



"%" relates to total population

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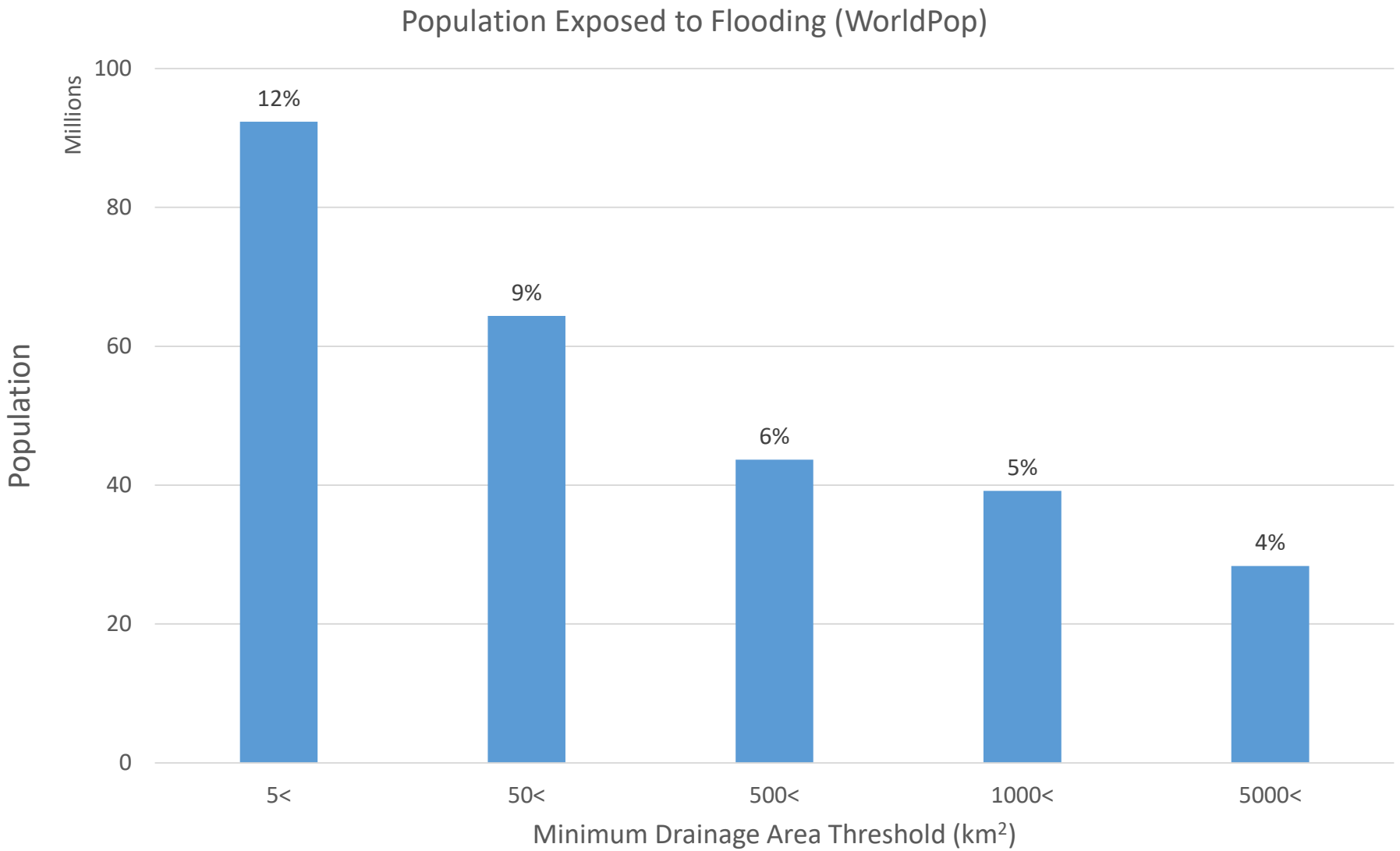

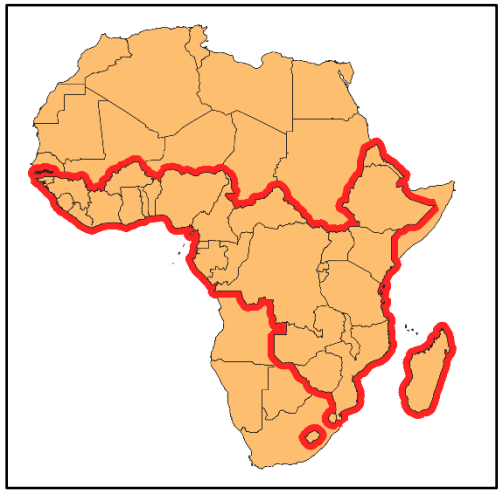

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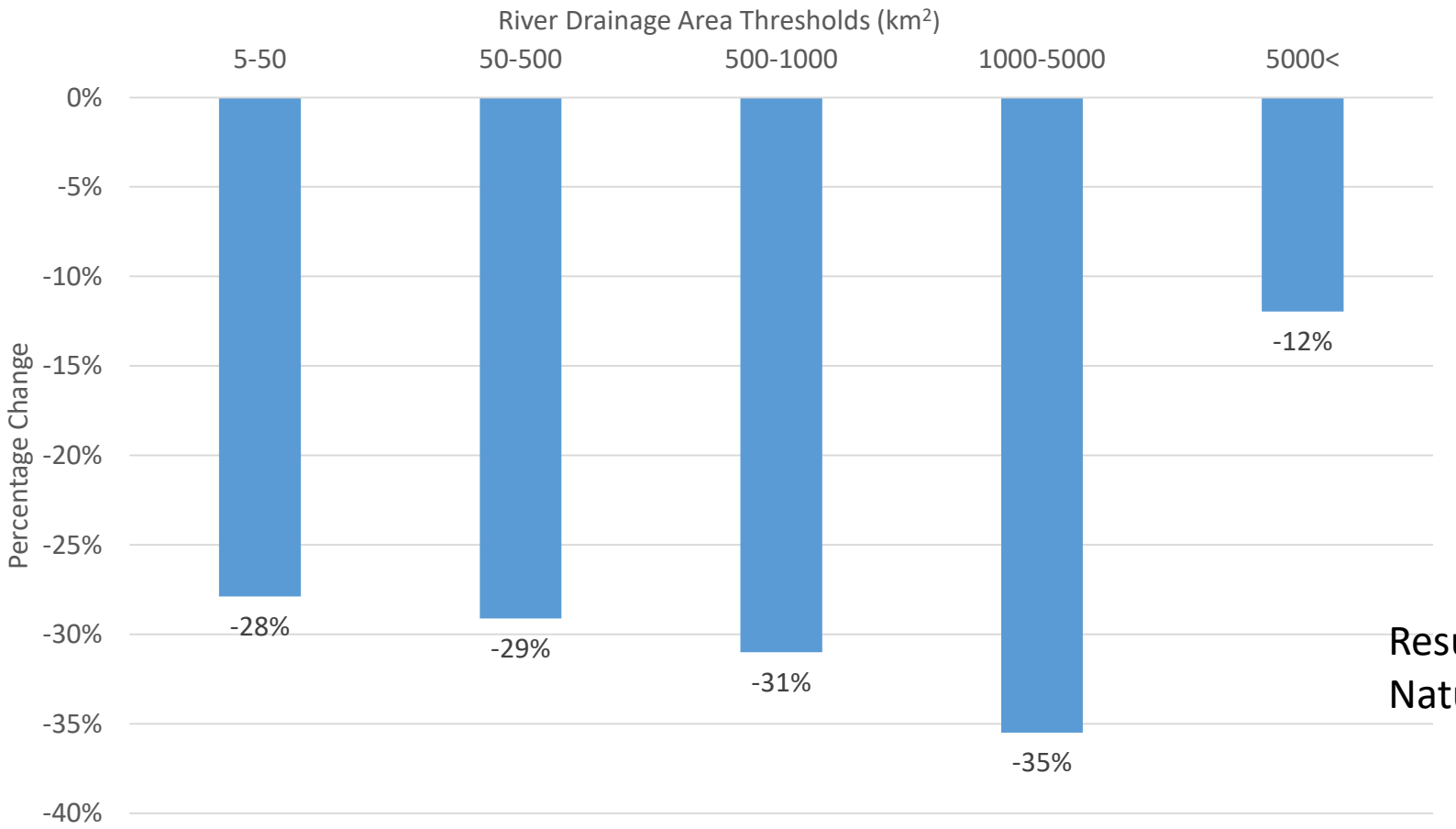
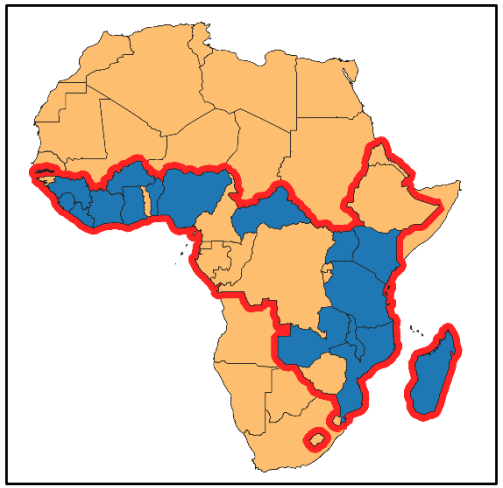
HRSL vs. WorldPop

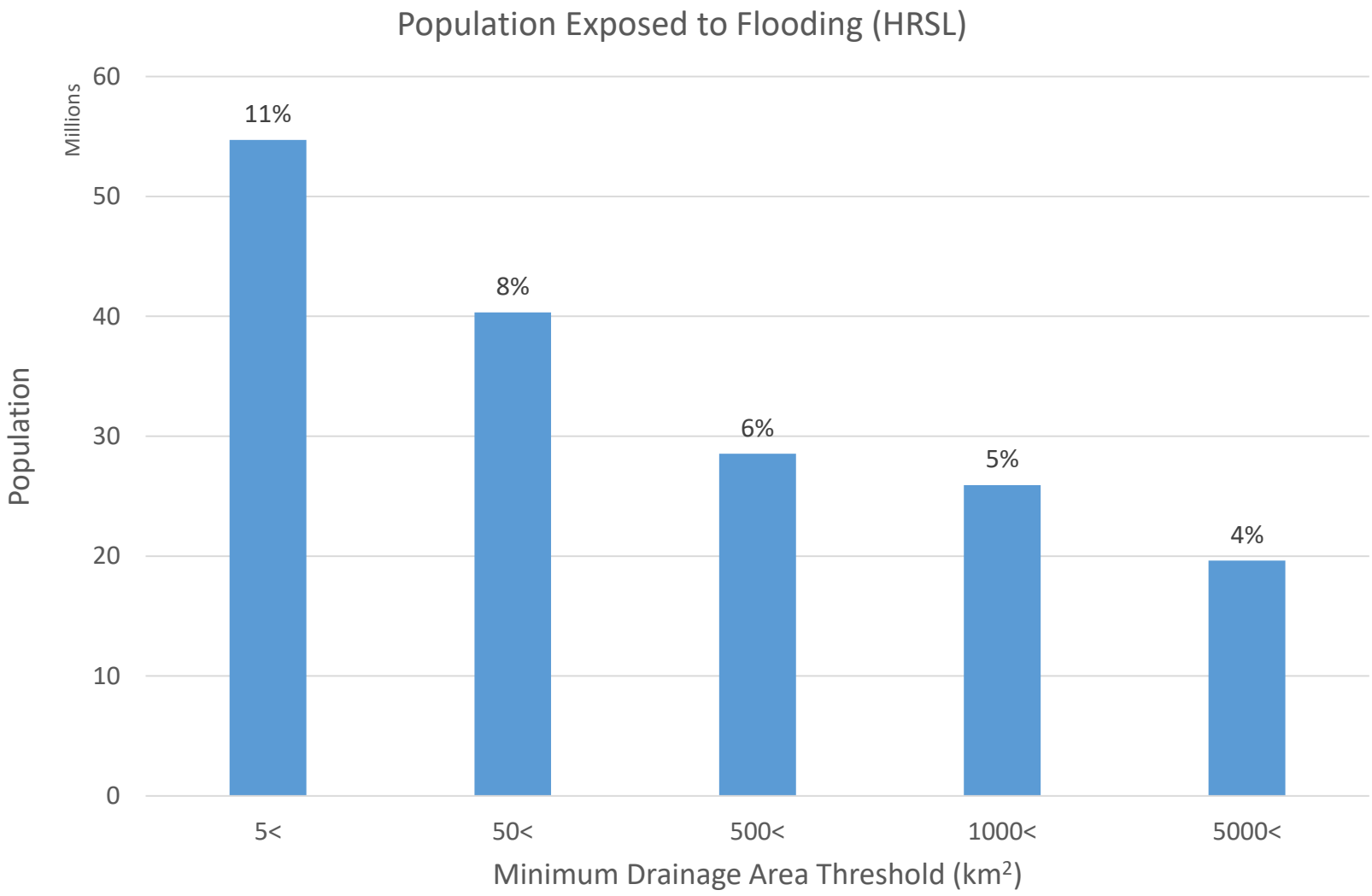
Percentage change in exposure estimates when using HRSL vs. WorldPop

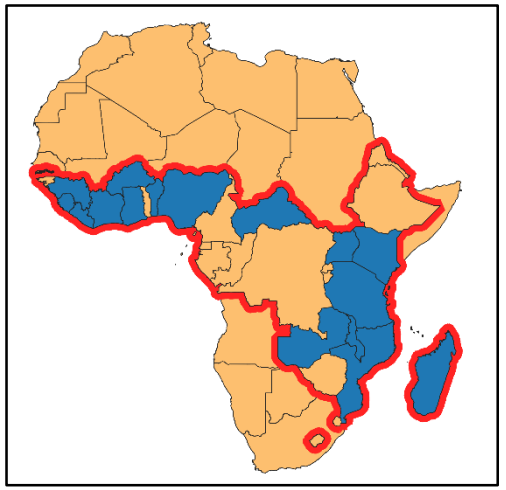




Results correspond with Smith et al (2019) Nature Comms.

Flood Exposure – HRSL





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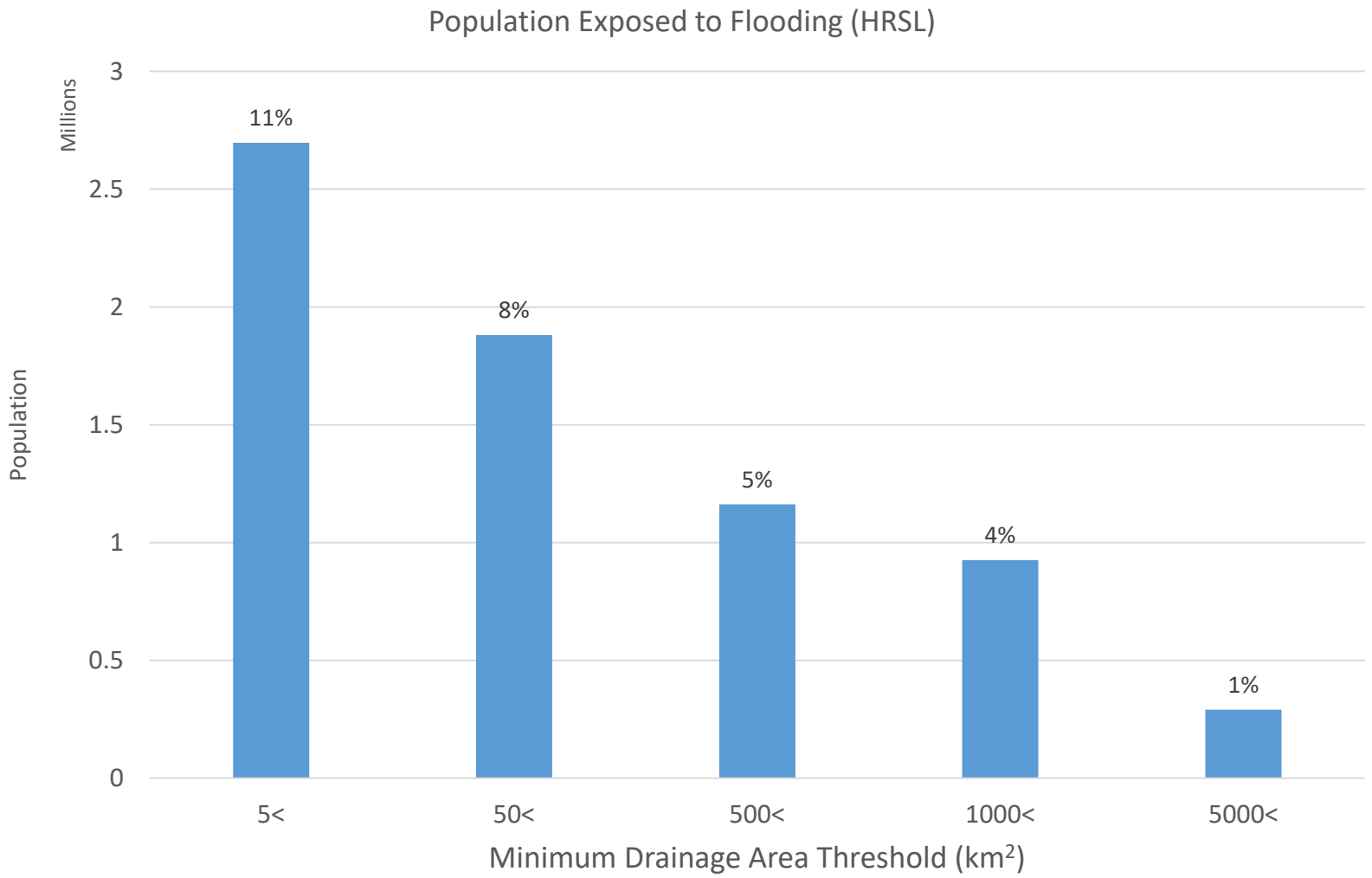
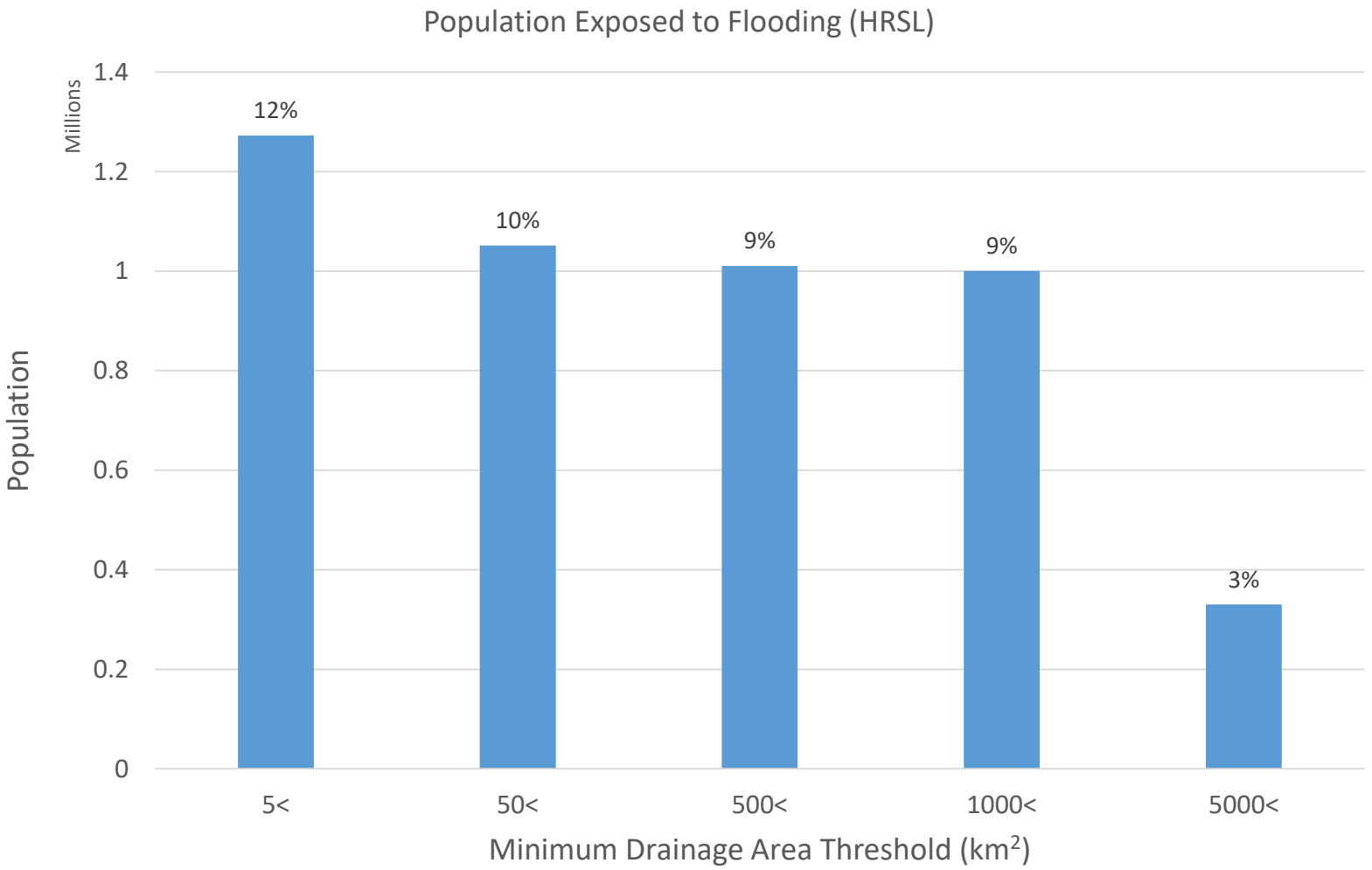
Interesting Countries



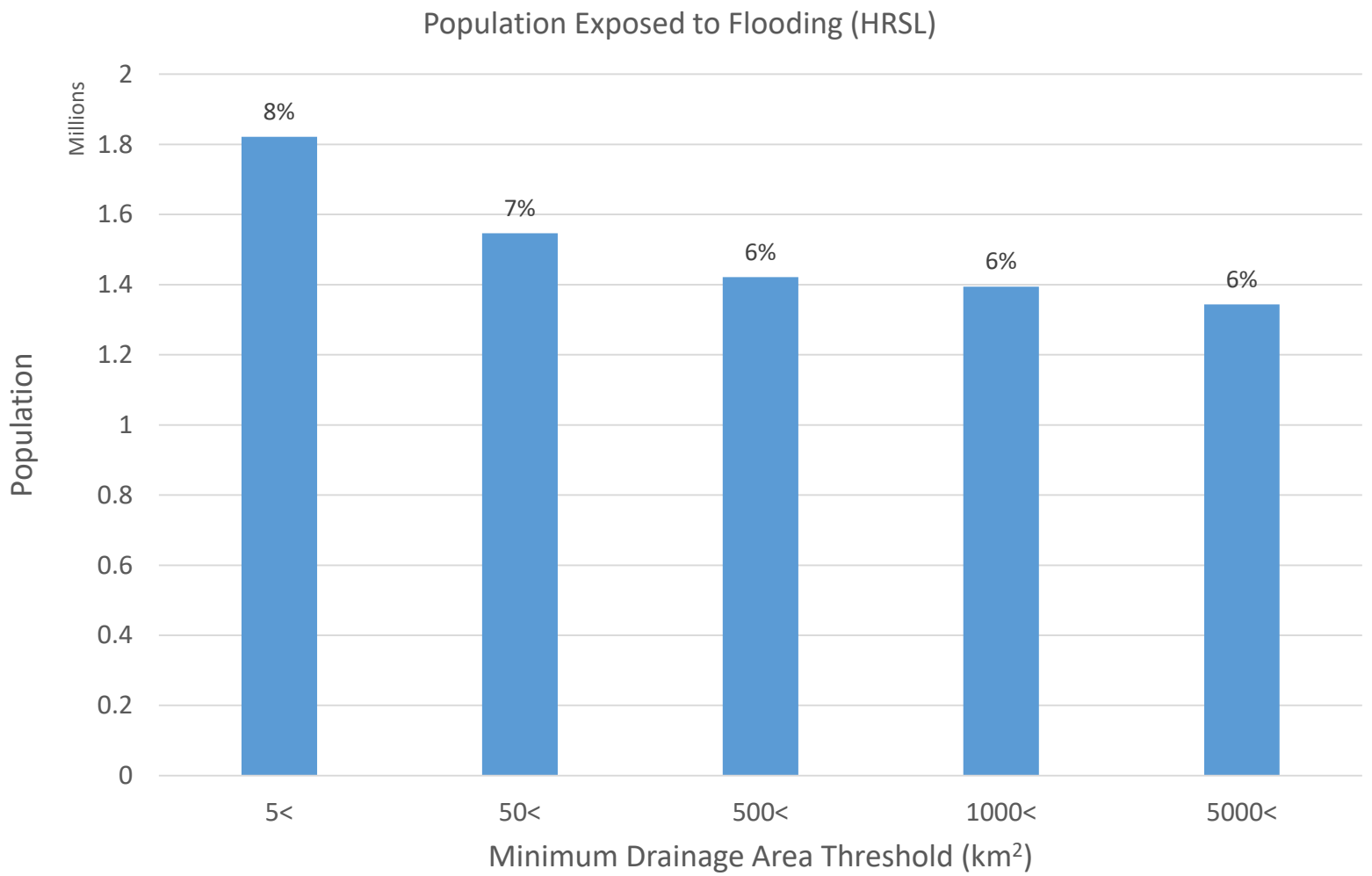
Madagascar

Interesting Countries



Benin

Interesting Countries



Ivory Coast

Conclusions

- Different GFM minimum threshold river sizes result in significantly different exposure estimates (on average, up to a factor of 2.0).
- Certain country's exposure estimates are more sensitive to river size representation than others.
- Improving river representation beyond current GFM limits could incorporate an additional 30% of potential exposed population into the modelling frameworks
- WorldPop population data overestimates exposure compared to Facebook High Resolution Settlement Layer, especially on smaller rivers.

Next Steps

- Fine tune the HAND model calibration to include different climate zones.
- Expand study globally

- Global picture of flood exposure from different size rivers.
- Can inform global flood modelling community about where it’s important to consider river size representation and which countries would benefit from improved representation

Thanks for listening.