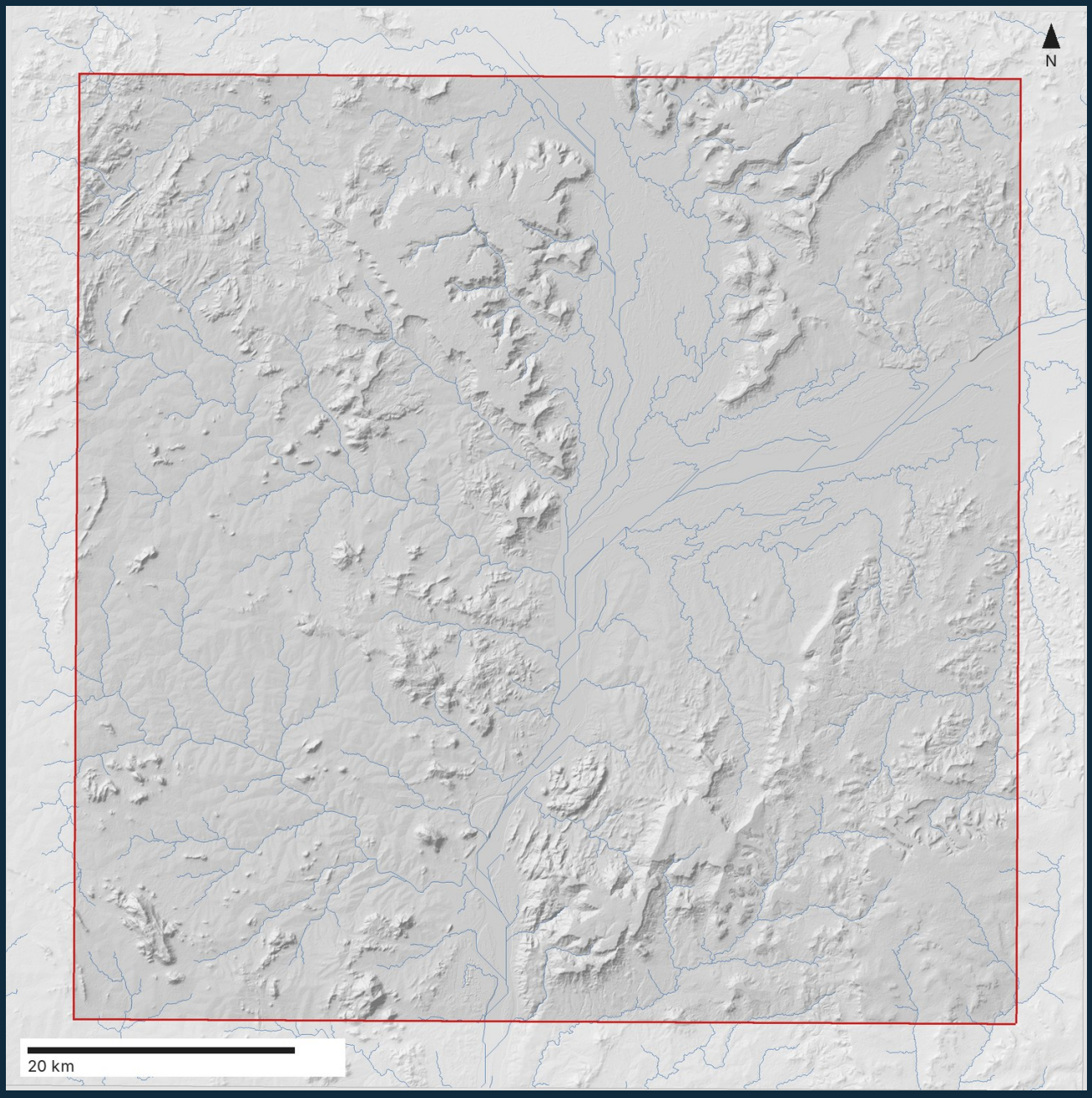
GEOVATRA BASELINE

Flood baseline: Lokoja

5,000 km² · terrain, water history, rainfall, land cover, exposure and data gaps



Area	Lokoja, 5,000 km² (bounding box 6.42, 7.48, 7.06, 8.12, WGS84)
Date	14 November 2026
Run	68be01ad-a452-4f00-8395-d34082093a26
Workflow and engine	baseline/1.3.0 · command line · code f0da4b3 · baseline-report 1.4.0

Produced automatically from open global data. Not checked in the field or by local experts: use it to see where to look and what to check, not to make decisions on its own.

Summary

River flood baseline for Lokoja (5,000 km²): where water flows and collects, where it has been seen, how much rain falls, what the land is used for, and who and what is on flood-prone land.

580 km²
flood-prone land (zones A + B), 11.8 % of the land

45,000-57,000
people on flood-prone land (two population models)

0 / 0
health sites / schools on flood-prone land (mapped in OpenStreetMap)

430 km
of main roads on flood-prone land

Main findings

- 580 km² is flood-prone (zones A and B), 11.8 % of the land: 160 km² where water has been seen and the flood model or terrain agree (zone A), and 430 km² where one kind of evidence points to flooding (zone B). Another 390 km² is low-lying land to check (zone C).
- About 45,000-57,000 people live on flood-prone land, out of 1,300,000 in the area (two population models).
- 0 of 7 mapped health sites, 0 of 20 schools and 430 km of 5,000 km of main roads are on flood-prone land (OpenStreetMap: a minimum).
- Satellites saw water on 210 km² at some time in 1984-2020; 56 km² is permanent water.
- Rain averages 1,360 mm a year (1991-2020), 87 % of it in May-Oct.

Confidence per module

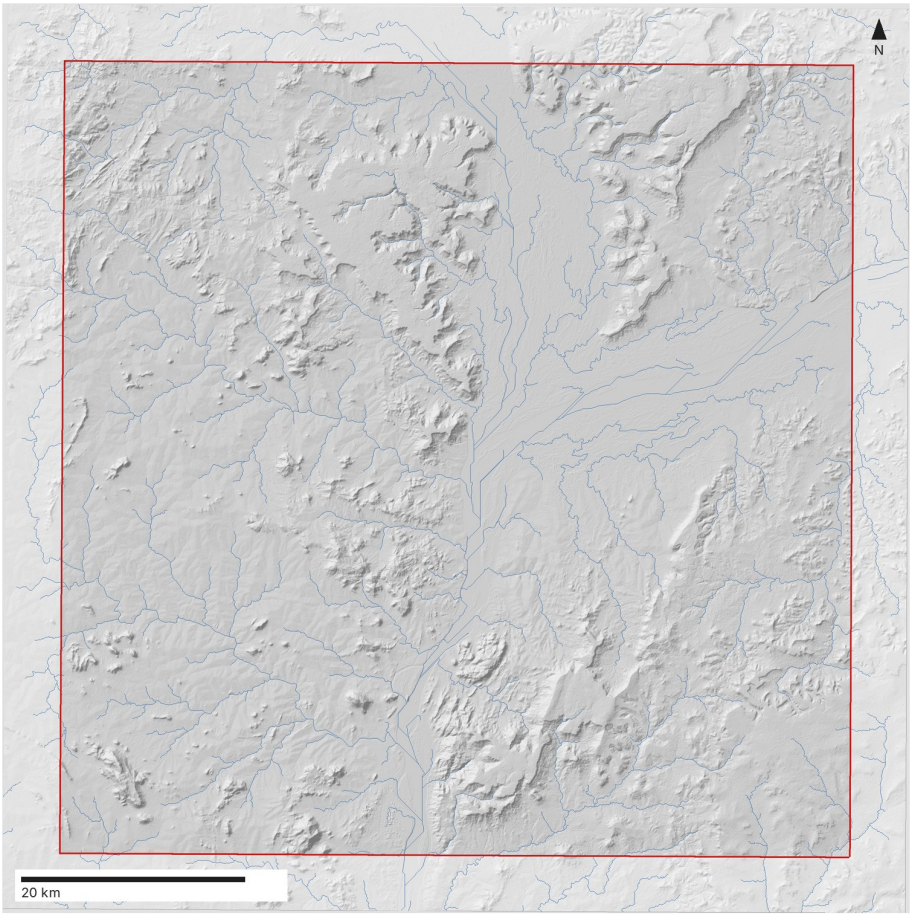
Module	Confidence	Why
M1 terrain	Medium	52 % of the land is under trees: the elevation data (a surface model) measures the tree tops, which distorts heights and streams.
Flood evidence zones	Medium	74 % of the flood-prone land is zone B, which rests on one kind of evidence. No held-back flood was available to check the zones.
M2 water history	High	Optical satellites miss water under cloud and vegetation; the record ends in 2020.
M4 rainfall	High	Rainfall cells are about 5 km (CHIRPS) or 28 km (ERA5): detail smaller than a cell isn't resolved.
M5 land cover	High	ESA WorldCover is from 2021 (10 m).
M6 exposure	Medium	Facilities come from OpenStreetMap, which is often incomplete, especially outside cities: these counts are a minimum. Only 7 health sites are mapped for about 1,300,000 people: OpenStreetMap is likely very incomplete here, so use another facility source if one exists.

Rainfall-only (pluvial) flooding, flash floods and dam failure are not assessed. People, facilities and roads are given as totals per flood zone only, never as names or locations.

1. Terrain, streams and flood-prone land M1

Where water flows and collects, from the Copernicus 30 m elevation data, and which land is flood-prone when the terrain, a flood model and satellite records of water are put together.

> Elevation ranges from 26 m to 661 m, and 32.5 % of the area is flat (slope under 2°). 1,600 km of streams were traced from the elevation data; 430 km² lies less than 2 m above the nearest stream.



Streams (traced from the elevation data) The area (the faded edge is the 5 km buffer used to trace streams)

Terrain

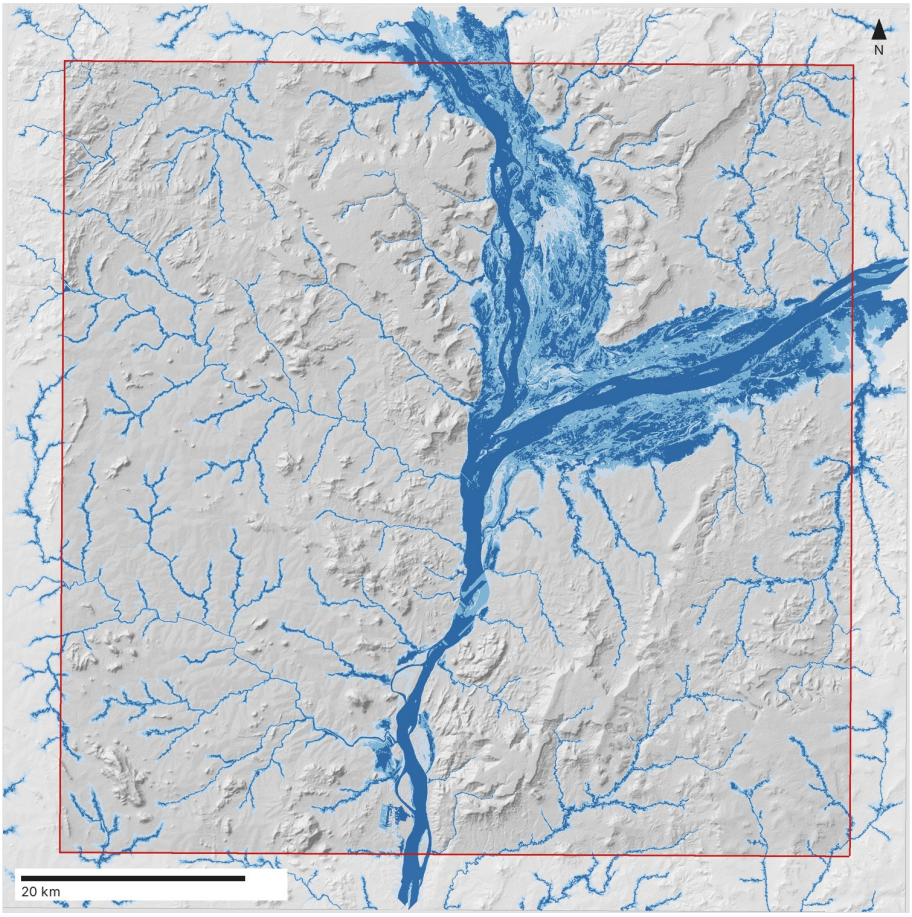
Area	5,000 km²
Elevation (lowest / median / highest)	26 / 156 / 661 m
Streams traced	1,600 km

Slope (share of the area)

Flat, 0-2°	32.5 %
Gentle, 2-5°	40.7 %
Moderate, 5-15°	19.4 %
Steep, over 15°	7.5 %

Height above the nearest stream

Land a few metres above the stream it drains to is the first to flood when the stream rises (HAND, Height Above Nearest Drainage).

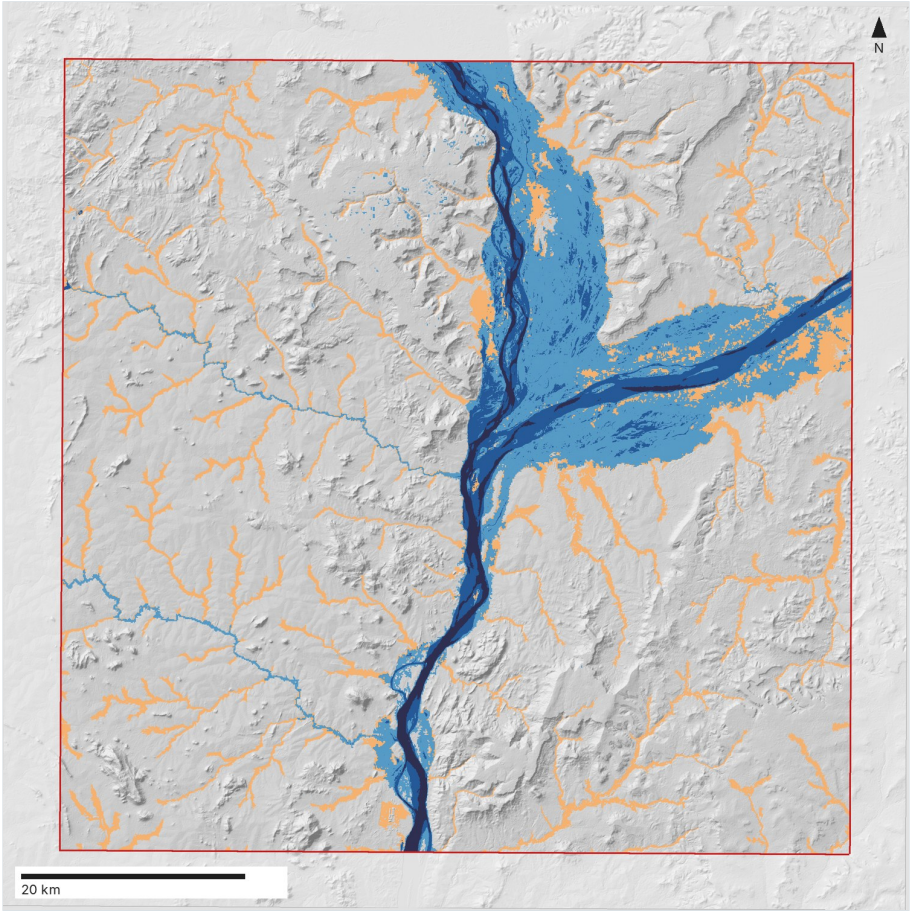


Height above the nearest stream	Area
0-2 m	430 km²
2-5 m	410 km²
5-10 m	370 km²

Flood-prone land: zones A, B and C

Three kinds of evidence are combined with fixed rules: the JRC 1-in-100-year river flood model, water seen by satellites in 1984-2020, and low land near streams (height above the nearest stream under 6 m, set where terrain best matches the flood model). Zones A and B together are “flood-prone”.

> 580 km² is flood-prone, 11.8 % of the land: 160 km² in zone A and 430 km² in zone B. Confidence in the zones is medium.



Zone A: water seen, and model or terrain agree

Zone B: one kind of evidence

Zone C: low-lying land to check (not flood-prone)

Permanent water

Zone	km²	% of area
Zone A	160	3.2
Zone B	430	8.6
Zone C	390	7.8
Permanent water	56	1.1
Not flood-prone	4,000	80

Evidence	km²
Flood model, 1-in-100-year	580
Water seen by satellites	160
Low land near streams	930

Agreement between the kinds of evidence (0 = none, 1 = identical): model and terrain 0.56, model and satellites 0.26, terrain and satellites 0.17.

Medium confidence 74 % of the flood-prone land is zone B, which rests on one kind of evidence. No held-back flood was available to check the zones.

2. Surface-water history M2

Where water has been seen by satellites from 1984 to 2020, and how often (JRC Global Surface Water occurrence).

> Satellites saw water on 210 km² at some time in 1984-2020, of which 56 km² is permanent water and 41 km² was seen only rarely.



Permanent (90 % of the time or more) Frequent (50-90 %) Occasional (10-50 %) Rare (under 10 %)

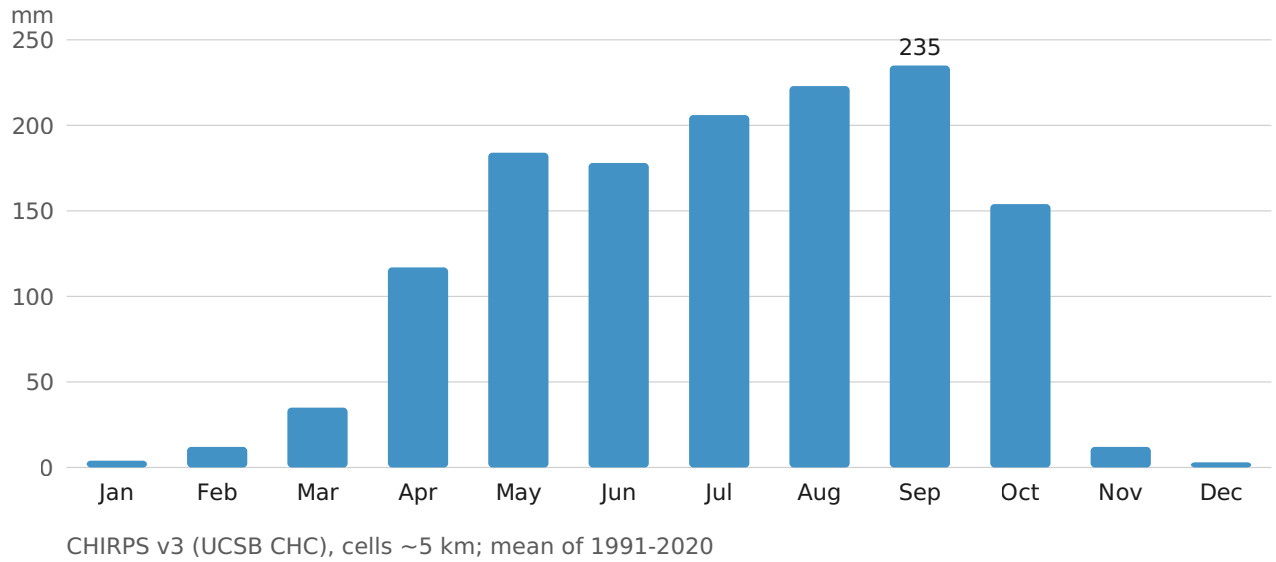
Water seen	Area
Permanent: 90 % of the time or more	56 km²
Frequent: 50-90 %	51 km²
Occasional: 10-50 %	63 km²
Rare: under 10 %	41 km²
Water seen at some time	**210 km²**

Satellite observations cover 100 % of the area. Optical satellites miss water under cloud and vegetation, so short floods in the rainy season are under-counted.

3. Rainfall and climate M4

How much rain falls and when, from CHIRPS monthly rainfall averaged over the area: the 1991-2020 normal and recent years against it.

> Rain averages 1,360 mm a year (1991-2020). The wet season is May-Oct, with 87 % of the year's rain; Sep is the wettest month.



Average monthly rainfall, 1991-2020.

Normal rainfall a year	1,360 mm
Wet season (6 wettest months)	May-Oct, 87 % of the year's rain
Wettest month	Sep
Rain in 2012	110 % of normal
Rain in 2022	89 % of normal
Rain in 2024	103 % of normal
Last 12 months (2025-11 to 2026-10)	92 % of normal

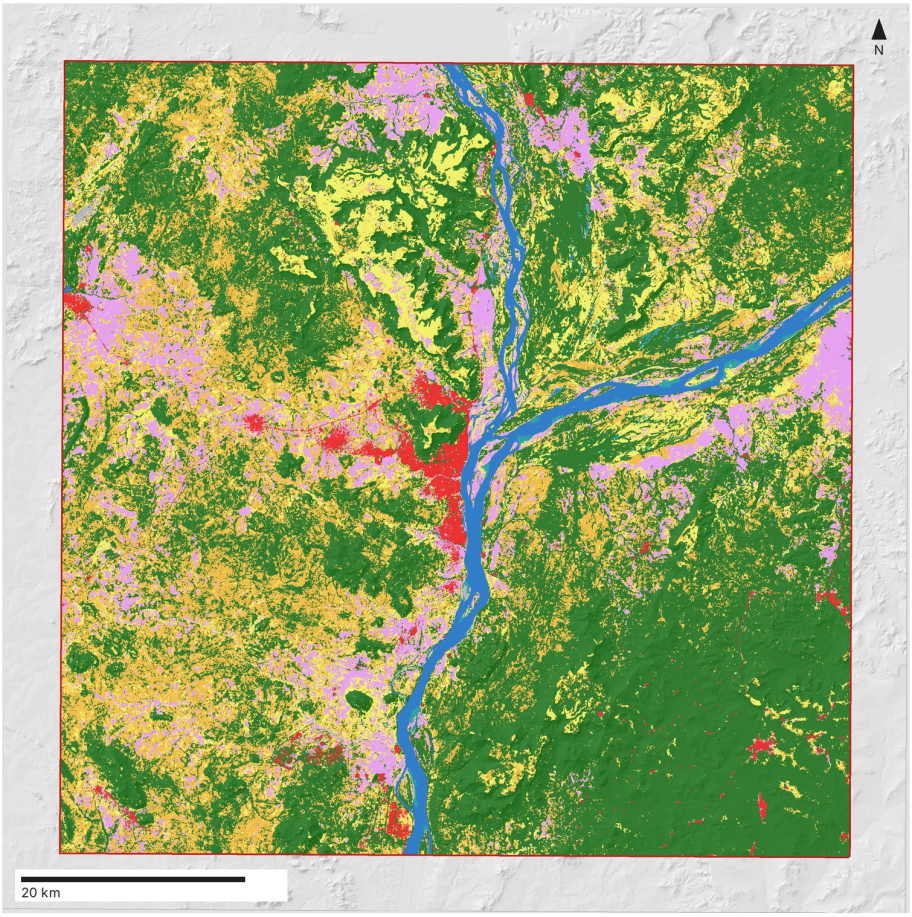
Month	Normal, mm	Month	Normal, mm
Jan	4	Feb	12
Mar	35	Apr	117
May	184	Jun	178
Jul	206	Aug	223
Sep	235	Oct	154
Nov	12	Dec	3

- Rainfall cells are about 5 km (CHIRPS) or 28 km (ERA5): detail smaller than a cell isn't resolved.
- Local rain doesn't explain river floods that come from upstream; compare the river flood evidence.

4. Land cover and vegetation M5

What the land is used for (ESA WorldCover 2021, 10 m, most common class per 30 m cell), and what lies on flood-prone land.

> Tree cover is the most common land cover, 52.5 % of the area. On flood-prone land the most common class is Tree cover (38.2 %).

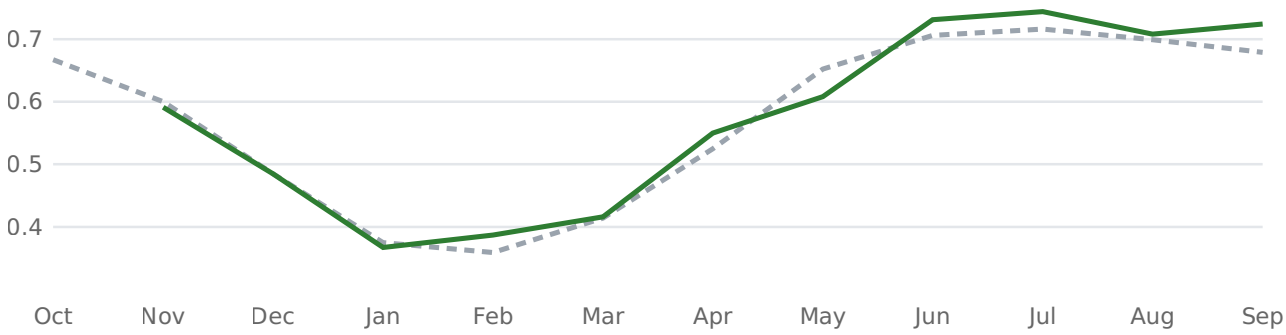


Tree cover · Shrubland · Grassland · Cropland · Built-up · Bare/sparse vegetation · Permanent water · Herbaceous wetland

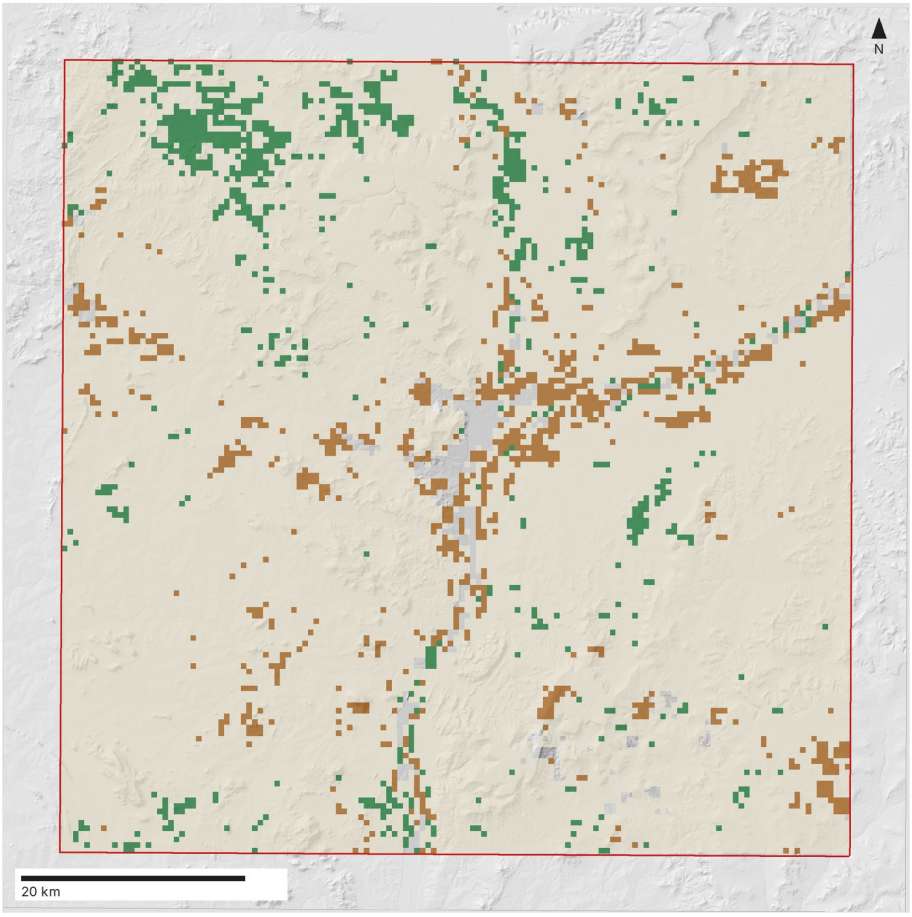
Class	Area, km²	% of the area	% of flood-prone land
Tree cover	2,600	52.5	38.2
Shrubland	1,100	22.1	13.8
Grassland	590	11.8	18.4
Cropland	490	10	13.5
Permanent water	130	1.4	12.2
Built-up	80	1.6	0.4
Herbaceous wetland	18	0.4	3
Bare/sparse vegetation	7	0.1	0.5

Vegetation against its normal

How green the land is (NDVI, from MODIS at 500 m) in 2025-10 to 2026-09, against the 2001-2020 normal for each month. Over the last 12 months the land was on average 0.01 greener than normal (NDVI difference).



Monthly NDVI over the area: the 2001-2020 normal (dashed) and the last 12 months (green). A month without a usable composite is left blank.



Browner than normal (NDVI 0.1 or more lower) · Near normal · Greener than normal (0.1 or more higher)

2026-07 to 2026-09	Browner	Near normal	Greener
All land	5 %	90.7 %	4.3 %
Flood-prone land	17.4 %	75.8 %	6.8 %

Cloud-free MODIS composites covered 98.2 % of the land in these months. NDVI shows how green the land is, not why: drought, harvest, fire, flooding or clearing all lower it. MODIS Terra MOD13A1 v061, 16-day NDVI, 500 m.

5. Exposure M6

People, built-up land, main roads and facilities in each flood zone. Totals only: no names or locations of people, places or facilities.

> About 45,000-57,000 people live on flood-prone land. 0 health sites, 0 schools and 430 km of main roads are on flood-prone land; OpenStreetMap is often incomplete, so these are a minimum.

	Zone A	Zone B	Zone C	Flood-prone (A + B)	Whole area
People (range of two models)	4,100-5,200	41,000-52,000	93,000-94,000	45,000-57,000	1,300,000
Built-up land, km²	0.1	2.2	5.9	2.3	80
Main roads, km	32	400	400	430	5,000
Health sites	0	0	1	0	7
Schools	0	0	1	0	20
Water points	0	0	0	0	9

People: WorldPop and GHSL population models (estimates, not a census), shown as a range. Built-up land: ESA WorldCover. Roads and facilities: OpenStreetMap.

- Facilities come from OpenStreetMap, which is often incomplete, especially outside cities: these counts are a minimum.
- Only 7 health sites are mapped for about 1,300,000 people: OpenStreetMap is likely very incomplete here, so use another facility source if one exists.
- People are modelled estimates (not a census); the two models are shown as a range.

6. Data gaps and confidence M7

What isn't known, and how far each result can be trusted. Levels come from fixed rules on coverage, terrain, land cover and data quality.

Module	Confidence	Reasons
M1 terrain	Medium	• 52 % of the land is under trees: the elevation data (a surface model) measures the tree tops, which distorts heights and streams.
Flood evidence zones	Medium	• 74 % of the flood-prone land is zone B, which rests on one kind of evidence. • No held-back flood was available to check the zones.
M2 water history	High	• Optical satellites miss water under cloud and vegetation; the record ends in 2020.
M4 rainfall	High	• Rainfall cells are about 5 km (CHIRPS) or 28 km (ERA5): detail smaller than a cell isn't resolved.
M5 land cover	High	• ESA WorldCover is from 2021 (10 m).
M6 exposure	Medium	• Facilities come from OpenStreetMap, which is often incomplete, especially outside cities: these counts are a minimum. • Only 7 health sites are mapped for about 1,300,000 people: OpenStreetMap is likely very incomplete here, so use another facility source if one exists.

Not assessed

- Rainfall-only (pluvial) flooding, flash floods and dam failure are not assessed.
- The extent of a particular flood (M3) is mapped only when the Baseline is given the date a flood began.

What would improve it

- Field checks of a sample of zone A, B and C sites, with local flood marks from past floods.
- Information on embankments, dykes and drainage, so protected land isn't shown as flood-prone.
- Radar flood maps for a known flood event, to test the zones.
- Local population and facility lists, where the authorities can share them safely.

7. Questions for the field M8

What to check on site, ask locally, or collect on arrival. Each question comes from a fixed rule on the results above and says which result or gap raised it.

	Question	Points to
☐	**Ask locally** Did the 160 km² of zone A flood in recent years? Ask residents and the local authority when, how deep and for how long, and look for flood marks on buildings and trees. Zone A is where satellites have seen water and the flood model or terrain agree: the likeliest place to find flood memory and marks.	Flood-prone zones: zone A, 160 km²
☐	**Check on site** Zone B (430 km², 74 % of the flood-prone land) rests on one kind of evidence. Visit a few of its low places: do they flood, and from where (the river, rain ponding, a blocked drain)? One source alone can be wrong; a few site visits show whether zone B is real.	Flood-prone zones: zone B, 430 km² (74 % of flood-prone land)
☐	**Collect data** Find a recent flood with its date and extent (a map from the authorities, photos or news reports). Its date lets the Baseline map that flood from radar and check the zones. The zones haven't been checked against a flood in this area.	Flood-prone zones: no flood was available to check them
☐	**Ask locally** Does the low-lying land of zone C (390 km²) flood after heavy rain or from small streams? These floods aren't in the flood model. Zone C is low and near streams, but neither the model nor satellites show flooding there.	Flood-prone zones: zone C, 390 km²
☐	**Check on site** 52.5 % of the land is under trees, where the elevation data measures the tree tops. Check the height of river banks and the course of streams under trees near flood-prone land. Tree tops raise the terrain in the data, so flood-prone land under trees can be missed.	M5 land cover: tree cover 52.5 % of the land
☐	**Collect data** Get the lists of health facilities and schools from the health and education offices: OpenStreetMap shows only 7 health sites and 20 schools here. Facilities on flood-prone land are counted from OpenStreetMap, which is incomplete here.	M6 exposure: 7 health sites mapped in the area
☐	**Ask locally** Have there been flash floods, floods from rain alone, or water released from a dam upstream? These aren't assessed. The Baseline covers river flooding only.	M7 data gaps: not assessed
☐	**Collect data** Are there river gauges or flood records (water levels and dates) for the area? Ask the water authority for them, and add them to the area's own data. Measured levels and dates are the strongest check on the zones.	M7 data gaps: no gauge data

Appendix A. Methods log

Every step of run 68be01ad-a452-4f00-8395-d34082093a26 (baseline/1.3.0), in order, with the operation version, settings and data read. The full machine-readable log is the run's run.json.

Software: gdal 3.10.3, django 5.2.5, engine python, python 3.11.18. Engine command line, code f0da4b3. Working grid: EPSG:32632, 30 m, with a 5 km buffer. Compute time 214 s.

Report text (baseline-narrative 1.0.0): drafted by AI with placeholders for every figure; the figures are filled in by code from the results and checked, and any section that failed the check twice uses the plain template text. m1 template, m2 template, m4 template, m5 template, m6 template, zones template, summary template.

#	Operation	Settings and data	Time, s

1	**dem**
	data.fetch_dem 1.2.0
		`buffer_m = 5000, output_crs = EPSG:4326, resolution_deg = 0.0002777777778`
		Copernicus DEM GLO-30, accessed 2026-11-14
		`Copernicus_DSM_COG_10_N07_00_E006_00_DEM, Copernicus_DSM_COG_10_N07_00_E007_00_DEM, Copernicus_DSM_COG_10_N08_00_E006_00_DEM, Copernicus_DSM_COG_10_N08_00_E007_00_DEM`
			4.9

2	**water**
	data.fetch_water_occurrence 1.2.0
		`buffer_m = 5000, output_crs = EPSG:4326, resolution_deg = 0.00025`
		JRC Global Surface Water v1.3 (1984-2020) v1.3 (1984-2020), data 1984-03-01 to 2020-12-31, accessed 2026-11-14
		`0E_10Nv1_3_2020`
			4.4

3	**hazard**
	data.fetch_flood_hazard 1.1.0
		`buffer_m = 5000, return_period = 100`
		JRC/GloFAS global river flood hazard maps v2 2.1.2, accessed 2026-11-12
		`RP100/ID118_N10_W0_RP100_depth.tif`
			3.2

4	**land_cover**
	data.fetch_land_cover 1.2.0
		`year = 2021, buffer_m = 5000, output_crs = EPSG:4326, resolution_deg = 0.0001`
		ESA WorldCover 10 m (2020 v100, 2021 v200) 2021 v200, data 2021-01-01 to 2021-12-31, accessed 2026-11-14
		`ESA_WorldCover_10m_2021_v200_N06E006`
			3.1

5	**population**
	data.fetch_population 1.1.0
		GHSL GHS-POP population GHS-POP R2023A, epoch 2025, 3 arc-seconds (V1-0), accessed 2026-11-14
		`R9_C19`
		WorldPop population (constrained, 100 m) 2025, constrained, 100 m (R2025A v1), accessed 2026-11-14
		`NGA/nga_pop_2025_CN_100m_R2025A_v1.tif`
			3.1

6	**rainfall**
	data.fetch_rainfall 1.0.0
		`start_year = 1991`
		CHIRPS v3.0 rainfall v3.0 monthly, accessed 2026-11-14
		`1991.01 to 2026.10`
			70.2

7	**roads**
	data.fetch_osm 2.0.0
		`kind = roads, max_features = 20000`
		OpenStreetMap Geofabrik extracts of 2026-11-12, accessed 2026-11-14
		`nigeria (2026-11-12)`
			78.5

8	**health_sites**
	data.fetch_osm 2.0.0
		`kind = health_sites, max_features = 20000`
		OpenStreetMap Geofabrik extracts of 2026-11-12, accessed 2026-11-14
		`nigeria (2026-11-12)`
			5.6

9	**schools**
	data.fetch_osm 2.0.0
		`kind = schools, max_features = 20000`
		OpenStreetMap Geofabrik extracts of 2026-11-12, accessed 2026-11-14
		`nigeria (2026-11-12)`
			3.8

10	**water_points**
	data.fetch_osm 2.0.0
		`kind = water_points, max_features = 20000`
		OpenStreetMap Geofabrik extracts of 2026-11-12, accessed 2026-11-14
		`nigeria (2026-11-12)`
			3

11	**m1** module.m1_terrain 1.1.0	`buffer_m = 5000, stream_start_km2 = 5`	25.9
12	**zones** module.flood_zones 1.0.0	`buffer_m = 5000`	3

13	**m2** module.m2_water_history 1.0.0	`buffer_m = 5000`	0.6
14	**m4** module.m4_rainfall 1.0.0	`compare_years = 2012,2022,2024`	0
15	**m5** module.m5_land_cover 1.0.0	`buffer_m = 5000`	4.9

16	**veg**
	module.m5_vegetation 1.0.0
		`normal_to = 2020, normal_from = 2001`
		MODIS Terra Vegetation Indices 16-day 500 m (MOD13A1 v061) MOD13A1 v061; normal 2001-2020; latest 2025-10 to 2026-09, accessed 2026-11-14
		`MOD13A1.A2001001.h18v08.061.2020061200111, MOD13A1.A2001017.h18v08.061.2020061215716, MOD13A1.A2001033.h18v08.061.2020064143926, MOD13A1.A2001049.h18v08.061.2020062005300, MOD13A1.A2001065.h18v08.061.2020062024229, MOD13A1.A2001081.h18v08.061.2020062051538 and 475 more`
			93.3

17	**m6** module.m6_exposure 1.0.0	`facilities_source = OpenStreetMap`	89.1
18	**m3** module.m3_event_flood 1.0.2	`buffer_m = 5000, days_after = 7, event_date = , days_before = 60`	0
19	**m7** module.m7_data_gaps 1.0.0		1.1
20	**m8** module.m8_field_questions 1.0.0		0

Appendix B. Licences and attribution

Every dataset this report uses, with its licence and how it must be credited, from Geovatra's dataset catalog.

Dataset	Licence	Attribution and citation
CHIRPS v3.0 rainfall UCSB Climate Hazards Center	CC BY 4.0 checked 2026-11-05	Climate Hazards Center, UC Santa Barbara Funk, C. et al. (2015). The climate hazards infrared precipitation with stations. Scientific Data 2, 150066 https://www.chc.ucsb.edu/data/chirps3
Copernicus DEM GLO-30 ESA / Copernicus (via Microsoft Planetary Computer)	Copernicus DEM licence (GLO-30): free use with attribution	© DLR e.V. 2010-2014 and © Airbus Defence and Space GmbH 2014-2018 provided under COPERNICUS by the European Union and ESA; all rights reserved European Space Agency, Sinergise (2021). Copernicus Global Digital Elevation Model. Distributed by OpenTopography. https://doi.org/10.5069/G9028PQB https://planetarycomputer.microsoft.com/dataset/cop-dem-glo-30
ESA WorldCover 10 m (2020 v100, 2021 v200) ESA (via Microsoft Planetary Computer)	CC BY 4.0 checked 2026-11-12	© ESA WorldCover project / Contains modified Copernicus Sentinel data processed by ESA WorldCover consortium Zanaga, D. et al. (2022). ESA WorldCover 10 m 2021 v200. https://doi.org/10.5281/zenodo.7254221 https://esa-worldcover.org/
GHSL GHS-POP population European Commission JRC	CC BY 4.0 (help page); requires citing the paper checked 2026-11-05	Schiavina, M. et al. (2023). GHS-POP R2023A - GHS population grid multitemporal (1975-2030). European Commission, JRC https://human-settlement.emergency.copernicus.eu/
JRC Global Surface Water v1.3 (1984-2020) European Commission JRC / Google (via Planetary Computer)	Free use with attribution	Source: EC JRC/Google Pekel, J.-F., Cottam, A., Gorelick, N., Belward, A. S. (2016). High-resolution mapping of global surface water and its long-term changes. Nature 540, 418-422 https://global-surface-water.appspot.com/

JRC/GloFAS global river flood hazard maps v2 Copernicus Emergency Management Service / JRC	ODbL 1.0 (README); the EC's own rights also CC BY 4.0 (copyright.txt) checked 2026-11-12	Contains information from the Global river flood hazard maps (European Commission, JRC; Copernicus Emergency Management Service), made available under the Open Database License (ODbL) v1.0 Baugh, C. et al. (2024). Modelled flood inundation for different return period scenarios at the global scale. European Commission, JRC https://jeodpp.jrc.ec.europa.eu/ftp/jrc-opendata/CEMS-GLOFAS/flood_hazard/
MODIS Terra Vegetation Indices 16-day 500 m (MOD13A1 v061) NASA LP DAAC	Openly shared without restriction on use, sale or redistribution (NASA EOSDIS data use guidance); cite the dataset checked 2026-11-14	NASA LP DAAC (MODIS MOD13A1 v061) Didan, K. (2021). MODIS/Terra Vegetation Indices 16-Day L3 Global 500m SIN Grid V061. NASA EOSDIS Land Processes DAAC. doi:10.5067/MODIS/MOD13A1.061 https://doi.org/10.5067/MODIS/MOD13A1.061
OpenStreetMap OpenStreetMap contributors (via Geofabrik extracts)	ODbL 1.0 checked 2026-11-05	© OpenStreetMap contributors © OpenStreetMap contributors, https://www.openstreetmap.org/copyright https://www.openstreetmap.org/copyright
WorldPop population (constrained, 100 m) WorldPop, University of Southampton	CC BY 4.0 checked 2026-11-05	WorldPop (www.worldpop.org) https://www.worldpop.org/

Map data © OpenStreetMap contributors, available under the Open Database Licence (ODbL). This report gives only totals derived from it; derived OpenStreetMap data is shared under the same licence.

Report baseline-report 1.4.0. Numbers are rounded: 1 decimal under 10, whole numbers under 100, otherwise 2 significant figures; people to 2 significant figures.