Drought in Marsabit County, Kenya

The drought Baseline's vegetation and rainfall steps against Kenya's drought early warning system (NDMA), pasture seen on the ground, and the failed rains of 2020-2022.

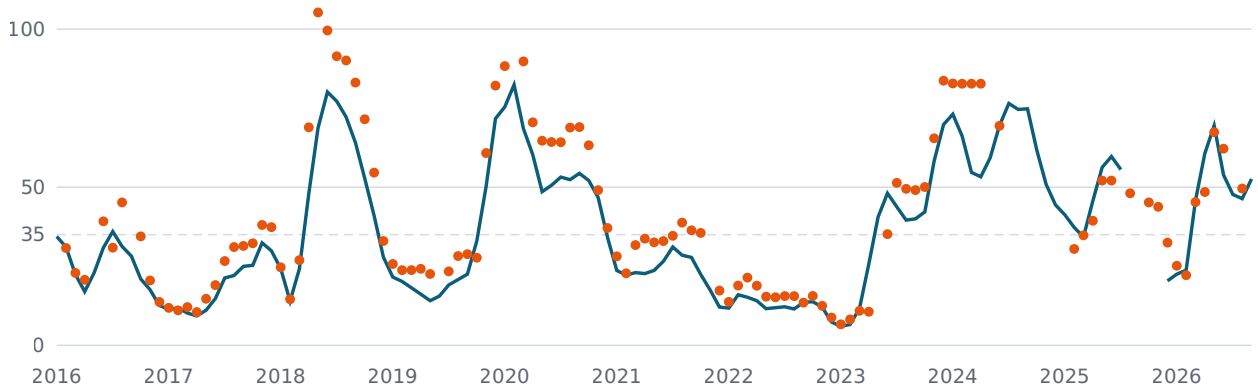
> **Draft, not yet independently reviewed (2026-11-22).** Numbers come from `case_study_kenya.json` and the files beside it (`manage.py case_study_drought`, code 7084162). What would be compared, and what counts as a match, was written down and committed before any drought number was computed: docs/drought-validation/plan.md (commit 9961834).

What was compared

- **Ours:** D2 vegetation stress (VCI3M, the 3-month mean Vegetation Condition Index, from MODIS Terra 500 m NDVI since 2001) and D1 rainfall drought (SPI from CHIRPS v3 since 1981), run exactly as in the Baseline on Marsabit County (75,925 km², a validation-only area, larger than a Baseline may be) and on Laisamis ward (3,974 km²).
- **NDMA's county bulletins:** 116 monthly Marsabit bulletins listed from February 2016 to August 2026; the county VCI3M was read from the text of 110. 2023-05, 2024-07, 2024-08, 2024-09, 2024-10, 2025-07 could not be read (four files are missing from NDMA's server; two give no value in their text) and are left out, never filled in.
- **Pasture on the ground:** Bowell et al. (2021, *Environ. Res. Lett.* 16, 084066), monthly pasture condition from household surveys in Marsabit, January 2016 to May 2019 (data: Zenodo 10.5281/zenodo.4670526, CC BY 4.0).
- **The 2020-2022 drought:** five failed rainy seasons, October-December 2020 to October-December 2022 (Kimutai et al. 2025).

Results

Check	Target, fixed in advance	Result	
A. County VCI3M against NDMA's, month by month	r ≥ 0.80 and the same side of 35 in ≥ 80 % of ≥ 60 months	107 months: r 0.953, same side of 35 in 90.7 % (kappa 0.809)	**Met**
B. Laisamis ward against NDMA's ward table	Descriptive	11 of 15 months: r 0.911, same side of 35 in 72.7 %	
C. Against pasture condition (r^2)	≥ 0.46 (theirs 0.56 − 0.10)	0.624 (34 months; their method on their data gives 0.555)	**Met**
C. Against pasture condition, compared with the same time in other years (r^2)	≥ 0.60 (theirs 0.70 − 0.10)	0.772 (34 months; their method on their data gives 0.696)	**Met**
D. SPI-3 ≤ −1 at the end of the five failed seasons	≥ 4 of 5, county and Laisamis each	County 1 of 5, Laisamis 1 of 5	**Not met**



Marsabit County VCI3M: ours (line, monthly) and NDMA's bulletins (dots). Below the dashed line at 35, NDMA calls it drought. Gaps in the line are months without MODIS Terra composites.

What the checks show

- **The vegetation index follows NDMA's closely.** r 0.953 over 107 months; ours reads on average 6.2 points lower. Both sides of the drought line agree in 90.7 % of months; in NDMA's five classes, 76.6 %. The largest differences are in very green months, where NDMA's values run much higher than ours (up to 105 in May 2018, and 82.75 in each of February to April 2024). Over grass and shrubland only, r is 0.959. VCI3M is a 3-month running mean, so neighbouring months share data: each series is correlated 0.92 (0.91 for NDMA) with the next month, and the 107 months count as only about 9 independent ones (Bretherton et al. 1999). Even so, the correlation is clearly not chance. Ours reads lower mainly in green months: by 13.2 points on average when NDMA is 50 or more, 3.1 when it is under 35. One possible reason was that the very green years 2020 and 2024 set our record's maxima. **Tested afterwards (22 November 2026), and adopted as D2 1.1.0:** with each month's range taken from its 5th to 95th percentile instead of its lowest and highest values, r is 0.952, ours reads 1.8 points lower, the same side of 35 in 90.7 % of months, and ours is under 35 in 59 of the 107 months (NDMA: 59; the version above: 65). This was done after the result above was seen, so it is reported beside it, not as a pass or fail.
- **It tracks pasture on the ground as well as the published index.** Fitted as Bowell et al.'s code does, ours explains 0.624 of the variance in pasture condition (theirs 0.56) and 0.772 against pasture compared with other years (theirs 0.70). 34 months is a short record: the difference between the two is not meaningful, the agreement is.
- **The rainfall check failed.** At the end of the five failed seasons, SPI-3 from CHIRPS v3 was at or below −1 in 1 of 5 seasons for the county and 1 of 5 for Laisamis. Seven of the ten values were below −0.4, so most seasons were drier than normal, but not by as much as the check asked; by this index October-December 2020 was near normal in both. On CHIRPS v2, checked afterwards because most studies of this drought used it, the counts are 0 and 1 of 5: the result is not down to the CHIRPS version. The "five failed seasons" is a regional statement (eastern Horn of Africa, Kimutai et al. 2025). In Laisamis, October-December 2020 was near normal in both rain (SPI-3 0.0) and vegetation (VCI3M 54); in the county the vegetation was borderline (ours 34, NDMA 37). That explains at most one of the misses: in the other four seasons the vegetation was in severe or extreme deficit while SPI-3 at the season's end stayed between -0.5 and -1, so the rainfall index under-stated this drought here. The check stays not met. **Added afterwards (D1 1.3.0, expert's suggestion), not a pass or fail:** judged as NDMA, FEWS NET and ICPAC judge seasons, by each season's total against its 1991-2020 median and terciles, 3 of the 5 seasons were below normal for the county (127 %, 99.6 %, 49.4 %, 70.3 %, 63.4 % of the median) and 4 of 5 for Laisamis (129 %, 55.8 %, 90.3 %, 79.4 %, 70.5 %), with 3 and 4 below-normal seasons in a row. A season only a little below its median can fall in the lowest tercile where a few very wet years stretch the record (Laisamis, October-December 2021: 90 % of the median). By this measure the 2020-2022 drought shows: a run of moderately poor seasons, which single-season SPI-3 under-states.
- **The vegetation saw the drought the rainfall index under-stated.** At the end of the same seasons:

Season	SPI-3, county	SPI-3, Laisamis	VCI3M, NDMA	VCI3M, ours, county	VCI3M, ours, Laisamis
Oct-Dec 2020	0.32	-0.01	37.1	34.2	53.6
Mar-May 2021	-0.04	-1.01	32.6	23.7	16.2
Oct-Dec 2021	-1.09	-0.55	17.3	12.1	10.1
Mar-May 2022	-0.73	-0.47	15.4	11.6	13.6
Oct-Dec 2022	-0.76	-0.89	8.8	7.4	9.9

One reading, not tested here: in an arid county a season's rain can be near normal on average and still badly spread in time and place, and pasture also carries the losses of the seasons before. SPI-3 at a single month sees neither. The Baseline reports both indices, and this case shows why it should.

Limits

- Check A is a method check: NDMA's VCI also comes from MODIS, so agreement shows the same signal computed two ways (theirs: Terra and Aqua, 250 m, smoothed, weekly; ours: Terra 16-day composites, 500 m), not that either is right on the ground. Check C is the ground check, and it is short (34 months, one county).
- NDMA's values were read from PDF text by fixed rules (written down in the README). 3 values repeat the previous month exactly (2024-03, 2024-04, 2025-06) and may have been carried over; they are kept, and leaving them out gives r 0.96.
- Ours has no value for 2025-08, 2025-09, 2025-10, 2025-11: MODIS Terra NDVI for July to October 2025 is missing from the archive the Baseline reads (Microsoft Planetary Computer), and VCI3M needs two of its three months. Terra is near its end; a move to VIIRS is planned.
- Ward values (check B) were read by hand from the 2025-2026 bulletins, the only ones with a ward table in their text: 11 months, too few for a target.
- One county in one climate. Nothing was tuned on these results.