Metadata and methods for the dataset: Hydrometric data and stable isotope data for streamflow and rainfall in the Marolaona catchment, Madagascar, 2015-2016

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Hydrometric data

Hydrometric data were collected in the 31.7 ha Marolaona catchment in the Ankeniheny Zahamena Corridor on the Eastern escarpment of Madagascar (18.970°S, 48.422°E; Figure 1) in 2015 and 2016. Rainfall and streamflow were measured at 2 locations, perched water table levels at 10 locations, and soil moisture at 3 locations (at 1 to 3 depths below the surface).

Table 1 describes the contents of the HydrometricData_Marolaona.csv file. All data are provided at a 5-minute time interval for the February 3, 2015 to March 3, 2016 period; missing data are denoted by NaN. More information on the background of this study and the measurements can be found in Zwartendijk et al. (2020 and 2023).

Rainfall

Rainfall was measured between February 3, 2015 and March 3, 2016 using two tipping-bucket rain gauges (Rain Collector II, Davis Instruments; 0.2 mm per tip, ±4% for intensities up to 50 mm/hr; ±5% for intensities up to 100 mm/hr) connected to HOBO Pendant event loggers (Onset Computer Corporation). The two gauges (downstream: 18.9678°S, 48.4258°E; Upstream: 18.971°S, 48.4212°E) were installed at ~1.2 m above the soil surface to avoid ground-splash effects.
Due to battery failure, no data were gathered at the upstream tipping bucket gauge between July 1 and August 17, 2015. The raw data were converted into values per 5 minutes, where 00:00 represents the 00:00 to 00:05 period.

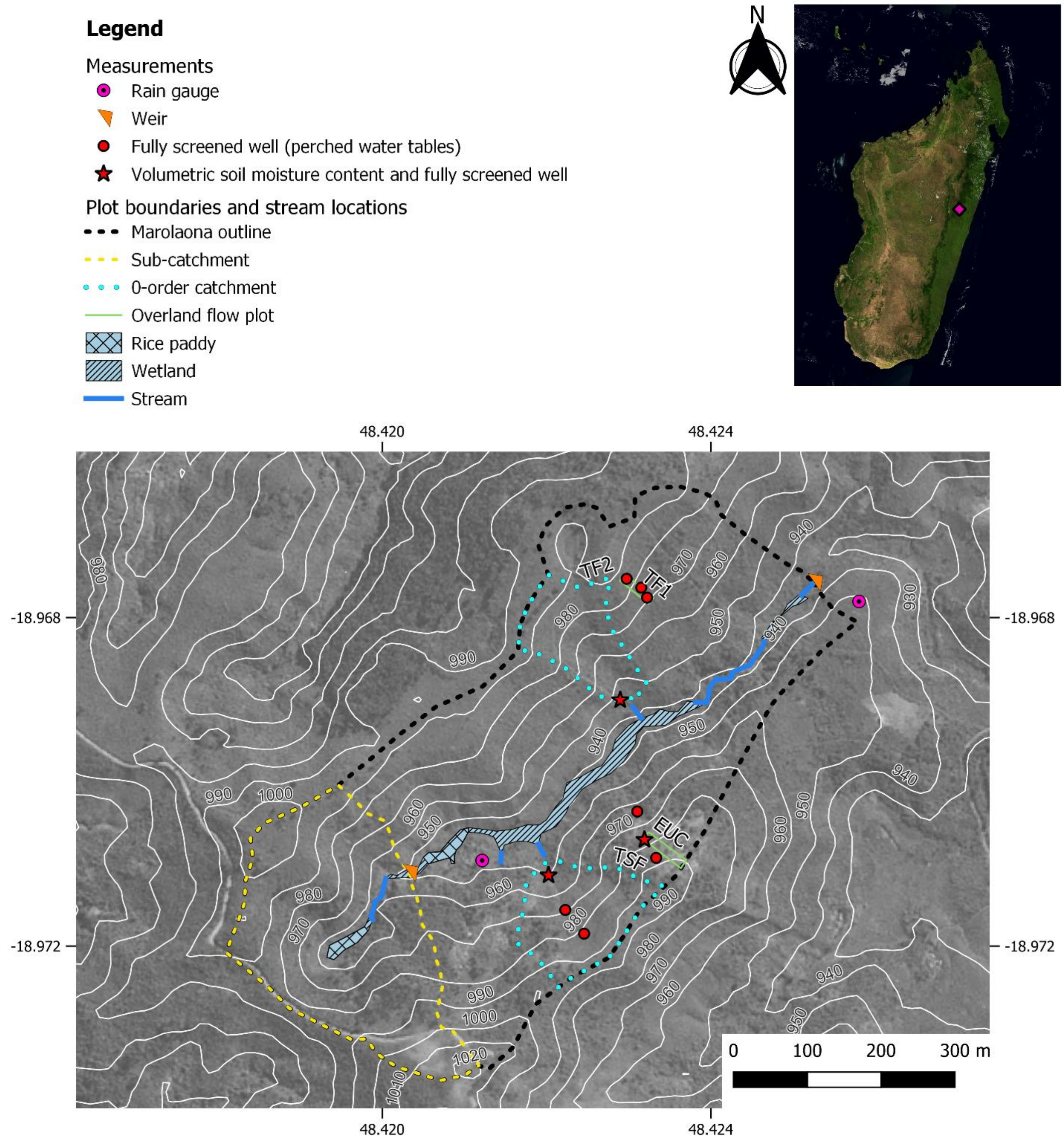

Figure 1. Map of the Marolaona catchment showing the locations of measurements, the boundaries of the catchment, the upper sub-catchment, the 0-order catchments, and overland flow plots, the location of the streams, and the 10 m contour lines (from 12 m DEM from © DLR TerraSAR-X / TanDEM-X 2021, Wessel (2016) and Zink et al. (2014). Background imagery: SPOT6 image (Panchromatic 1.5 m, acquired on 21 July 2013; Horning and Hewson (2017)). Inset: location of the catchment in Madagascar (NASA True Marble 500 m; Stöckli et al., 2006).

Streamflow

Suppressed broad crested weirs were constructed at the catchment outlet (31.7 ha) and in the upper part of the catchment (7.11 ha) during the 1960s to measure streamflow (Figure 1; Baily et al., 1974). We reconstructed the weirs and replaced the weir at the upper catchment with a 90° V-notch. The water level was measured behind the weirs at 5-min intervals. Due to sensor failure, we only have stream level data for two measurement periods: February 15 to May 13, 2015 (87 days) and December 12, 2015 to March 3, 2016 (82 days). During the first period, water levels were measured with a Decagon CTD-10 sensor connected to a Decagon EM50-logger. During the second period, water levels were measured with a pressure transducer (Sensor Technik Sirnach AG STS DL/N 70 sensor). Streamflow at the lower weir was measured using the salt-dilution-slug-injection method (cf. Moore, 2004 and 2005) during a range of flow conditions to establish the rating curve. The rating curve for the upper catchment is based on the equations for a truncated-triangular sharp-crested weir (Bos, 1989; Jan et al., 2006), and validated with bucket measurements. For more information on the rating curves, see the supplementary materials of Zwartendijk et al. (2023).

Soil moisture

Volumetric soil moisture content was measured on three hillslopes: TF2 (young tree fallow), EUC (coppiced *Eucalyptus robusta* trees and degraded fire-climax grassland), and TSF (terraced shrub fallow)(Figure 1). We used Decagon ECHO-EC-TM sensors for the measurements at 5 cm and 15 cm depth and Decagon ECHO-TM-5 sensors for the measurements at 30 cm depth (accuracy ± 3%, resolution 0.1%). The soil moisture sensors in the TF2 and TSF plots were installed ~10 m upslope from the lower plot boundary, where overland flow was measured. In the EUC plot, the sensors were installed ~5 m upslope from the lower boundary. The sensors were installed horizontally, pointing in the upslope direction. Measurements were taken each minute and 5-min averages were stored on a Decagon EM50 datalogger.

Perched groundwater

At the TF1, EUC and TSF sites (Figure 1), three fully screened wells were installed at 0.30 m below the surface. At TF2, the fully screened well was installed next to the soil moisture measurement sites (Zwartendijk et al., 2020). The water levels were measured every minute using a Decagon CTD-10 sensor (corrected automatically for atmospheric pressure) and 5-min averages were stored on the Decagon EM50-logger. At the TSF site and in the up- and downslope wells at the EUC site, water levels were measured every 5 minutes using Keller DCX-18 sensors.

Table 1. Contents of the HydrometricData_Marolaona.csv file. Note that the perched water tables are given in mm above the low-permeability layer, located at 300 mm below the soil surface (in other words, a perched water table of 300 mm means saturation up to the soil surface).

	Column title	Units	Explanation
1	Datetime		Date and time of the (averaged) measurements DD-MM-yyyy hh:mm format
2	P_{down_a}	mm	5-minute rainfall amount measured at downstream gauge
3	P_{down_i}	mm hr^{-1}	5-minute rainfall intensity at downstream gauge given as hourly intensity
4	P_{up_a}	mm	5-minute rainfall amount measured at upstream gauge
5	P_{up_i}	mm hr^{-1}	5-minute rainfall intensity at upstream gauge given as hourly intensity
6	Q_{down_q}	L s^{-1}	Streamflow at the downstream weir
7	Q_{down_i}	mm hr^{-1}	Specific discharge at the downstream weir (catchment area: 31.7 ha)
8	Q_{up_q}	L s^{-1}	Streamflow at the upstream weir
9	Q_{up_i}	mm hr^{-1}	Specific discharge at the at the upstream weir (catchment area: 7.11 ha)
10	PWT_TF2	mm	Perched water table in mm above the low-permeability layer at TF2
11	SMC_TF2_5cm	[-]	Volumetric soil moisture content at TF2, at 5 cm below the soil surface
12	Temp_TF2_5cm	°C	Soil temperature at TF2 at 5 cm below the soil surface
13	SMC_TF2_15cm	[-]	Volumetric soil moisture content at TF2, at 15 cm below the soil surface
14	Temp_TF2_15cm	°C	Soil temperature at TF2 at 15 cm below the soil surface
15	SMC_TF2_30cm	[-]	Volumetric soil moisture content at TF2, at 30 cm below the soil surface
16	Temp_TF2_30cm	°C	Soil temperature at TF2 at 30 cm below the soil surface
17	PWT_EUC_down	mm	Perched water table in mm above low-permeability layer at EUC down-slope
18	PWT_EUC_mid	mm	Perched water table in mm above low-permeability layer at EUC mid-slope
19	PWT_EUC_up	mm	Perched water table in mm above low-permeability layer at EUC up-slope
20	SMC_EUC_5cm	[-]	Volumetric soil moisture content at EUC at 5 cm below the soil surface
21	Temp_EUC_5cm	°C	Soil temperature at EUC at 5 cm below the soil surface
22	SMC_EUC_15cm	[-]	Volumetric soil moisture content at EUC, at 15 cm below the soil surface
23	Temp_EUC_15cm	°C	Soil temperature at EUC at 15 cm below the soil surface
24	SMC_EUC_30cm	[-]	Volumetric soil moisture content at EUC, at 30 cm below the soil surface
25	Temp_EUC_30cm	°C	Soil temperature at EUC at 30 cm below the soil surface
26	PWT_TSF_down	mm	Perched water table in mm above low-permeability layer at TSF down-slope
27	PWT_TSF_mid	mm	Perched water table in mm above low-permeability layer at TSF mid-slope
28	PWT_TSF_up	mm	Perched water table in mm above low-permeability layer at TSF up-slope
29	SMC_TSF_5cm	[-]	Volumetric soil moisture content at TSF, at 5 cm below the soil surface
30	Temp_TSF_5cm	°C	Soil temperature at TSF at 5 cm below the soil surface
31	SMC_TSF_15cm	[-]	Volumetric soil moisture content at TSF, at 15 cm below the soil surface
32	Temp_TSF_15cm	°C	Soil temperature at TSF at 15 cm below the soil surface
33	PWT_TF1_down	mm	Perched water table in mm above low-permeability layer at TF1 down-slope
34	PWT_TF1_mid	mm	Perched water table in mm above low-permeability layer at TF1 mid-slope
35	PWT_TF1_up	mm	Perched water table in mm above low-permeability layer at TF1 up-slope

Isotope data

Water samples were taken from streamflow (upstream of the weirs) and overland flow (lined gutters at the TF2, EUC, and TSF plots; see Figure 1 for location), before, during, and after several rainfall events.

In January and February 2016 (wet season), daily bulk precipitation samples were taken from a rain gauge at plot TF2 (emptied daily around 8 AM). During specific field campaigns, a sample was taken for every 13 mm of rain using a sequential sampler (cf. Kennedy et al., 1979) installed near the downstream rain gauge. The sampler was emptied after an event, before 10 AM the next morning. In total, we collected:

- 39 rainfall samples (26 from the sequential rainfall sampler and 13 bulk samples)
- 209 samples of streamflow:
    - 173 from the catchment outlet (downstream weir)
    - 36 from the upper sub-catchment (upstream weir)
- 31 samples of overland flow:
    - 6 from TF1
    - 10 from TF2
    - 8 from TSF
    - 7 from EUC

All water samples were analysed for the stable isotopes of oxygen and hydrogen using a Cavity Ring-Down Spectroscope (L2130-i (CRDS), Picarro Inc.) at the laboratory of the Chairs of Hydrology at the University of Freiburg (Germany). The isotope ratios were expressed relative to the Vienna Standard Mean Ocean Water standard using the delta notation. The stated precision was ±0.16‰ for $\delta^{18}O$ and ±0.6‰ for $\delta^{2}H$. Table 2 describes the contents of the IsotopeData_Marolaona.csv file. For more information, see Zwartendijk et al. (2023).

Table 2. Contents of the IsotopeData_Marolaona.csv file.

	Column title	Units	Explanation
1	Location	-	Location where sample was taken (abbreviations / descriptions related to the map in Figure 1).
2	Water_type	-	Type of sampled water (rainfall, streamflow or plot runoff/overland flow)
3	DateTime		Date and time of sample collection DD-MM-yyyy hh:mm format (local time)
4	Delta18O	‰	Abundance of oxygen-18 ($\delta^{18}O$) relative to the Vienna Standard Mean Ocean Water
5	Delta2H	‰	Abundance of deuterium ($\delta^{2}H$) relative to the Vienna Standard Mean Ocean Water
6	DEx	‰	Deuterium excess

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