ONE-PAGE PLACE ASSESSMENT: LIWONDE, MALAWI
LOCATED IN THE SHIRE RIVER SUBWATERSHED WITHIN THE ZAMBEZI RIVER WATERSHED

CLIMATE ⚑1

AVERAGE HIGH & LOW TEMPERATURES[1] — *1982 – 2012*

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
°C HIGH	28.8	28.7	28.7	28.2	26.9	25.1	25.0	26.9	30.0	32.2	31.8	29.7	28.5
°C LOW	20.2	19.9	19.6	18.3	15.6	13.3	13.2	14.3	16.8	19.7	20.7	20.5	17.7
°F HIGH	83.8	83.7	83.7	82.8	80.4	77.2	77.0	80.4	86.0	90.0	89.2	85.5	83.3
°F LOW	68.4	67.8	67.3	64.9	60.1	55.9	55.8	57.7	62.2	67.5	69.3	68.9	63.9

RECORD HIGH[2]		RECORD LOW[2]	

SUN ⚑2

		MAR 21	JUN 21	SEP 21	DEC 21
	DEGREES N or S of DUE EAST THE SUN RISES[3]	0°	25° S	0°	24° N
	DEGREES N or S of DUE WEST THE SUN SETS[3]	0°	25° S	0°	24° N
LATITUDE -15.07°	SOLAR-NOON ALTITUDE ANGLE (ABOVE HORIZON)[a,3,4]	75°	51°	75°	98°

ELEVATION 493 m / 1,617 FT

SOLAR-NOON WINTER-SOLSTICE SHADOW RATIO[b] 1 : 0.80 ...AND AZIMUTH[c] 0°

9AM & 3PM WINTER-SOLSTICE SHADOW RATIO[b,3] 1 : 1.63 ...AND AZIMUTH[c,3] 50°

WIND ⚑3

PREVAILING WIND DIRECTION[d,5] & AVERAGE SPEED[6]   MAX SPEED[7]

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
													SE
km/h	4.0	4.0	4.0	5.0	5.0	6.0	6.0	7.0	8.0	9.0	8.0	6.0	6.0
MPH	2.5	2.5	2.5	3.1	3.1	3.7	3.7	4.4	5.0	5.6	5.0	3.7	3.7

WATER ⚑4

AVERAGE PRECIPITATION (GAIN)[8] — *1900 – 2012*

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
mm	219.77	226.94	148.73	43.69	9.23	2.83	2.56	0.00	2.65	20.01	71.21	197.00	944.62
INCHES	8.65	8.93	5.86	1.72	0.36	0.11	0.10	0.00	0.10	0.79	2.80	7.76	37.19

AVERAGE PAN EVAPORATION (POTENTIAL LOSS)[e,9,10] — *1951 – 1978*

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
mm	165	145	178	177	167	149	166	192	235	292	257	197	2,320
INCHES	6.50	5.71	7.01	6.97	6.57	5.87	6.54	7.56	9.25	11.50	10.12	7.76	91.34

WETTEST YEAR'S RAIN[11]   DRIEST YEAR'S RAIN[11]

LONGEST PERIOD WITH NO MEASURABLE PRECIPITATION[12]   RAINFALL INCOME[f] 1,755 lpcd / 464 GPCD

AREA[g] 20.0 km² / 7.7 SQ MILES   POPULATION[13] 29,489 / 2008   UTILITY-WATER USE[h,14] lpcd / GPCD

HISTORICAL   DEPTH TO GROUNDWATER[i,15]   CURRENT

CURRENT GROUNDWATER EXTRACTION   NATURAL GROUNDWATER RECHARGE[j,16]

WATERGY ⚑5

TOTEM SPECIES ⚑6
FISH: MAMMAL:
PLANT: BIRD: REPTILE:
AMPHIBIAN: INSECT:

FOR MORE INFORMATION & HOW TO APPLY IT

▶1. For more CLIMATE information, see the introduction and chapters 1, 2, & 4 of *Rainwater Harvesting for Drylands and Beyond (RWHDB), Volume 1, 2nd Edition*

▶2. For more SUN information, see chapters 2 & 4 and appendices 5 & 7

▶3. For more WIND information, see chapters 2 & 4 and appendices 5 & 9

▶4. For more WATER information, see the introduction, chapters 1–4, and appendices 1–5

▶5. For more WATERGY information, see chapters 2 & 4 and appendix 9

▶6. For more TOTEM SPECIES information: the ethics, principles, and strategies throughout *RWHDB* help us shift from a negative to a positive impact on these species and their habitats and ecosystems, on which our quality of life also depends.

LIWONDE'S PLACE-ASSESSMENT NOTES

a. The solar-noon altitude angle (a.k.a., solar-noon elevation angle) refers to the number of degrees the sun is located above the equator-facing horizon at solar noon on the given date. In the southern hemisphere, the equator-facing horizon is to the north. In the northern hemisphere, the equator-facing horizon is to the south.

b. The solar-noon winter-solstice shadow ratio is the object's height : length of object's shadow cast on June 21 at noon (the longest noontime shadow of the year). The ratio is 1 : x, where x = 1 ÷ tangent (90 - (latitude + 23.44)).

c. Azimuth is the angle formed between a reference direction (here, due north) to the point on the horizon directly below a given object. Solar noon is the time on any day when the sun's azimuth is 0°. The 9 am & 3 pm winter-solstice azimuth indicates the sun's deviation, in degrees, east/west of due north at those times (±3 hours from solar noon) on June 21.

d. The direction of a prevailing wind is the direction *from* which the wind blows.

e. An evaporation pan holds water whose depth is measured daily as water evaporates. These data allow us to determine evaporation rates at a given location. Compare average rainfall (water gain) to potential water loss via evaporation by looking up pan-evaporation rates for your area. According to one definition, if pan-evaporation rates exceed rainfall rates, you are in a dryland environment. Another definition states that drylands are "land areas where the mean annual precipitation is less than two thirds of potential evapotranspiration (potential evaporation from soil plus transpiration by plants), excluding polar regions and some high mountain areas which meet this criterion but have completely different ecological characteristics" (Greenfacts.org). The higher the ratio of potential evaporation to rainfall, the more important evaporation-reducing strategies such as mulch, windbreaks, shading, and covered water storage become.

Pan evaporation is highest in the southern region of Malawi along the Shire River Valley (ref. 9). Therefore, while there are other weather stations that track pan evaporation closer to Liwonde, their locations farther from the river, at higher elevations, mean their pan-evaporation rates are lower than Liwonde's. Of the available stations along the Shire, Matope and Mangochi stations are closest both geographically and elevation-wise. Mangochi's data were used due to a slightly longer period of record, closer elevation (48 m) and average annual rainfall (805 mm), and Mangochi's location relative to large lakes, similar to Liwonde's.

f. Rainfall income calculated in situ w/ average rainfall, estimated approximate area, and population

g. Approximate area given for land inside perimeter shown on Google Maps for Liwonde, calculated using scale shown on map

CREDITS: Brad Lancaster, Resource concept | **Megan Hartman,** Resource creation, research | **Eric Carlberg,** Research assistance

LIWONDE'S PLACE-ASSESSMENT REFERENCES

1. Climate-Data.org, Climate Table for Balaka, Malawi, en.climate-data.org/location/27569/, accessed 12/21/2015

2.

3. Rainwater Harvesting for Drylands & Beyond, Vol 1, or esrl.noaa.gov/gmd/grad/solcalc, accessed 12/21/2015

4. RWHDB Vol 1, or Mar 21 = 90–latitude, Jun 21 = 90–(latitude–23.44), Sep 21 = 90–latitude, Dec 21 = 90–(latitude+23.44)

5. Wind Rose (Balaka), www.meteoblue.com/en/weather/forecast/modelclimate/balaka_malawi_931865, accessed 12/21/2015

6. Wind Speed option selected in Average Temperatures and Precipitation graph for Balaka (viewed by hovering cursor over each month's bar), www.meteoblue.com/en/weather/forecast/modelclimate/balaka_malawi_931865, accessed 12/21/2015

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8. Average Monthly Temperature and Rainfall for Malawi at Location (-15.07,35.23) from 1900–2012 (exact data viewed by hovering cursor over each month's bar), sdwebx.worldbank.org/climateportal, accessed 12/21/2015

9. Zonation of Mean Annual Pan Evaporation in Malawi (fig. 3.20, p. 89), in Context of Small-Scale Integrated Agriculture-Aquaculture Systems in Africa: A Case Study of Malawi, a publication of the International Center for Living Aquatic Resources Management & Deutsche Gesellschaft Urtechnische Zwsammenarbeit, 1991, pdf.usaid.gov/pdf_docs/PNABL265.pdf, accessed 1/4/2016

10. Table VI: Rainfall and Pan Evaporation at the Evaporation Stations in the Southern Region, in A Summary of Rainfall, Pan Evaporation and Temperature Data at Pan Evaporation Stations in Malawi, J. van der Velden, Ministry of Agriculture and Natural Resources, Water Resources Department, Department of Agricultural Development, August 1979, Lilongwe, Malawi, library.wur.nl/WebQuery/file/isric/fulltext/isricu_i7128_001.pdf, accessed 1/4/2016

11.

12.

13. Liwonde, en.wikipedia.org/wiki/Liwonde, accessed 12/21/2015