

**Online Supplementary Table 1.** Complete phrasing of water insecurity module items. *Italicized* text represents new verbiage added between first and second iterations.

Module Version 1*	Module Version 2*
—	2.2. <i>In the last 4 weeks, how frequently have you or anyone in your household been unable to access the <b>water that you preferred</b>?</i>
1.1. In the last 4 weeks, how frequently did you or anyone in your household <b>worry</b> you would not have enough water for all of your household needs?	2.3. In the last 4 weeks, how frequently did you or anyone in your household <b>worry</b> you would not have enough water for all of your household needs?
1.2. In the last 4 weeks, how frequently have you or anyone in your household <b>worried about the safety of the person</b> getting water for your household?	2.4. In the last 4 weeks, how frequently have you or anyone in your household <b>worried about the safety of the person</b> getting water for your household?
1.4. In the last 4 weeks, how frequently has your household water supply from your main water source been <b>interrupted</b> ?	2.5. In the last 4 weeks, how frequently has your household water supply from your main water source been <b>interrupted or limited</b> (e.g. water pressure, less water than expected)?
1.5. In the last 4 weeks, how frequently has your household not had enough water for your <b>garden, crops, or fruit trees</b> ?	2.6. In the last 4 weeks, how frequently has <i>your household water situation impacted your cultivation of <b>garden, crops, or fruit trees</b></i> ?
1.6. In the last 4 weeks, how frequently has your household not had enough water to give to your <b>animals and poultry</b> ?	2.7. In the last 4 weeks, how frequently has <i>your household water situation impacted your raising of <b>animals and poultry</b></i> ?
1.7. In the last 4 weeks, how frequently has the time spent getting water prevented you or anyone in your household from <b>earning money</b> (e.g. engaging in paid work, economic activities)?	2.8. In the last 4 weeks, how frequently <i>have problems with water</i> prevented you or anyone in your household from <b>earning money</b> (e.g. engaging in paid work, economic activities)?
1.8. In the last 4 weeks, how frequently have you or anyone in your household <b>lacked money</b> needed to <b>buy water</b> ?	2.9. In the last 4 weeks, how frequently have you or anyone in your household <b>lacked money</b> needed to <b>buy water</b> ?
1.9. In the last 4 weeks, how frequently did you or anyone in your household want to buy water but there was <b>nowhere to buy it from</b> ?	2.10. In the last 4 weeks, how frequently did you or anyone in your household want to buy water but there was <b>nowhere to buy it from</b> ?
1.12. In the last 4 weeks, how frequently did the children in your household <b>miss school</b> because they were getting water?	2.11. In the last 4 weeks, how frequently did the children in your household miss <b>school</b> <i>or go to school late because of problems with water</i> (e.g. time spent fetching water, lack of water for bathing, etc.)?
1.13. In the last 4 weeks, how frequently has there not been enough water in the household to <b>wash clothes</b> ?	2.12. In the last 4 weeks, how frequently has there not been enough water in the household to <b>wash clothes</b> ?
1.14. In the last 4 weeks, how frequently have you or anyone in your household had to <b>change what was being eaten</b> because there wasn't enough water (e.g. for washing foods, cooking, etc.)?	2.13. In the last 4 weeks, how frequently have you or anyone in your household had to <b>change what was being eaten</b> because there <i>were problems with water</i> (e.g. for washing foods, cooking, etc.)?
1.15. the last 4 weeks, how frequently have you or anyone in your household had to go without <b>washing hands</b> after dirty activities (e.g., defecating or changing diapers, cleaning animal dung) because you didn't have enough water?	2.14. In the last 4 weeks, how frequently have you or anyone in your household had to go without <b>washing hands</b> after dirty activities (e.g., defecating or changing diapers, cleaning animal dung) because of <i>problems with water</i> ?
1.16. In the last 4 weeks, how frequently have you or anyone in your household not had enough water to <b>wash the faces and hands</b> of children in your household?	2.15. In the last 4 weeks, how frequently have you or anyone in your household not <b>washed the faces and hands of children</b> because of <i>problems with water</i> ?
1.17. In the last 4 weeks, how frequently have you or anyone in your household had to go without <b>washing their body</b> because there wasn't enough water?	2.16. In the last 4 weeks, how frequently have you or anyone in your household had to go without <b>washing their body</b> because of <i>problems with water</i> (e.g. not enough water, dirty, unsafe)?

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1.18. In the last 4 weeks, how frequently has your or anyone in your household's <b>day been interrupted</b> by your water situation, including getting or distributing water within the household?	2.17. In the last 4 weeks, how frequently has <i>you or anyone in your household had to <b>change schedules/plans</b> due to problems with your water situation, such as problems getting or distributing water within the household? Activities that may have been interrupted include caring for others, doing household chores, etc.</i>
1.19. In the last 4 weeks, how frequently have problems with water prevented you or anyone in your household from <b>attending social events</b> (i.e. church, funerals, community gatherings, etc.)?	2.18. In the last 4 weeks, how frequently have problems with water prevented you or anyone in your household from <b>attending social or cultural events</b> (e.g. church, funerals, community gatherings, <i>cultural practices</i> , etc.)?
1.21. In the last 4 weeks, how frequently have you or anyone in your household drank water that <b>tasted bad</b> ?	2.19. In the last 4 weeks, how frequently have you or anyone in your household drank water that <b>looked, tasted, and/or smelled bad</b> ?
1.22. In the last 4 weeks, how frequently have you or anyone in your household actually drank water that you thought was <b>unsafe</b> ?	2.20. In the last 4 weeks, how frequently have you or anyone in your household drank water that you thought was <b>unsafe</b> ?
1.23. In the last 4 weeks, how frequently have you or anyone in your household asked to <b>borrow</b> water from other people?	2.21. In the last 4 weeks, how frequently have you or anyone in your household asked to <b>borrow</b> water from other people?
1.25. In the last 4 weeks, how frequently did you or anyone in your household have problems with water that caused <b>difficulties with neighbors or others</b> in the community?	2.22. In the last 4 weeks, how frequently did you or anyone in your household have problems with water that caused <b>difficulties with neighbors, water providers, or others</b> in the community?
1.26. In the last 4 weeks, how frequently did you or anyone in your household have problems with water that caused <b>difficulties within your household</b> ?	2.23. In the last 4 weeks, how frequently did you or anyone in your household have problems with water that caused <b>difficulties within your household</b> ?
1.27. In the last 4 weeks, how frequently did you or anyone in your household feel <b>upset</b> about your water situation?	2.24. In the last 4 weeks, how frequently did you or anyone in your household feel <b>angry</b> about your water situation?
1.28. In the last 4 weeks, how frequently has there not been <b>as much water to drink</b> as you would like for you or anyone in your household?	2.25. In the last 4 weeks, how frequently has there not been <b>as much water to drink</b> as you would like for you or anyone in your household?
1.31. In the last 4 weeks, how frequently have you or anyone in your household gone to <b>sleep thirsty</b> ?	2.26. In the last 4 weeks, how frequently have you or anyone in your household gone to <b>sleep thirsty because there wasn't any water to drink</b> ?
1.32. In the last 4 weeks, how frequently has there been <b>no water</b> whatsoever in your household?	2.27. In the last 4 weeks, how frequently has there been <b>no useable or drinkable water</b> whatsoever in your household?
1.3. In the last 4 weeks, how frequently have you or anyone in your household thought of <b>leaving [name of town]</b> because there was no water there?	2.28. In the last 4 weeks, how frequently have you or anyone in your household thought of <b>moving dwellings</b> because of the water situation there?
—	2.29. In the last 4 weeks, how frequently have problems with water caused you or anyone in your household to <b>feel ashamed/excluded/stigmatized</b> ?
1.10. In the last 4 weeks, how frequently has the time spent getting water prevented you or anyone in your household from <b>caring for children</b> in the household?	—

**Online Supplementary Table 1.** Complete phrasing of water insecurity module items. *Italicized* text represents new verbiage added between first and second iterations.

Module Version 1*	Module Version 2*
1.11. In the last 4 weeks, how frequently has the time spent getting water prevented you or anyone in your household from doing <b>household chores</b> (such as cooking, preparing food, washing clothes, etc.)?	—
1.20. In the last 4 weeks, how frequently did you or anyone in your household want to <b>treat</b> your water, but couldn't?	—
1.24. In the last 4 weeks, how frequently have you or anyone in your household <b>loaned</b> water to anyone?	—
1.29. In the last 4 weeks, how frequently have you or anyone in your household not had enough water to take <b>medications</b> ?	—
1.30. In the last 4 weeks, how frequently have you or anyone in your household not gotten water where you wanted to because you were <b>too sick or weak to get water</b> ?	—

\* Responses to items include: never (0 times), rarely (1–2 times), sometimes (3–10 times), often (11–20 times), always (more than 20 times), don't know, and not applicable/I don't have this

**Online Supplementary Table 2.** Factor loadings and model fit indices for the final 12 HWISE Scale items.\*

	Beirut, Lebanon (n=574)	Gressier, Haiti (n=292)	San Borja, Bolivia (n=247)	Chiquimula, Guatemala (n=314)	Punjab, Pakistan (n=235)	Rajasthan, India (n=248)	Morogoro, Tanzania (n=300)	Labuan Bajo, Indonesia (n=279)	Sistan & Balochistan, Iran (n=306)	Torreón, Mexico (n=249)	Cartegena, Colombia (n=226)
<b>Factor Loadings</b>											
2.3 Worry about enough	0.74	0.71	0.62	0.88	0.52	0.63	0.69	0.75	0.91	0.83	0.59
2.5 Supply interrupted	0.74	0.56	0.63	0.83	0.24	0.36	0.23	0.79	0.69	0.82	0.61
2.12 Wash clothes	0.86	0.81	0.78	0.83	0.75	0.86	0.88	0.82	0.94	0.85	0.76
2.13 Change foods	0.82	0.81	0.68	0.69	0.57	0.54	0.92	0.84	0.88	0.84	0.63
2.14 Wash hands	0.81	0.62	0.70	0.84	0.36	0.72	0.89	0.73	0.89	0.81	0.84
2.16 Wash body	0.81	0.79	0.69	0.71	0.62	0.83	0.82	0.74	0.82	0.86	0.80
2.17 Day interrupted	0.87	0.85	0.68	0.78	0.55	0.77	0.85	0.76	0.82	0.84	0.75
2.24 Upset/angry	0.55	0.75	0.69	0.64	0.40	0.78	0.65	0.75	0.83	0.86	0.56
2.25 Drink as much liked	0.75	0.79	0.72	0.77	0.52	0.56	0.84	0.68	0.86	0.84	0.68
2.26 Sleep thirsty	0.65	0.76	0.60	0.78	0.27	0.50	0.81	0.59	0.94	0.84	0.51
2.27 No water whatsoever	0.71	0.80	0.70	0.76	0.69	0.68	0.74	0.58	0.60	0.85	0.56
2.29 Ashamed	0.67	0.85	0.55	0.71	0.05	0.68	0.74	0.61	0.89	0.74	0.54
<b>Model Fit Indices</b>											
Cronbach's alpha (>0.80)	0.87	0.90	0.86	0.84	0.86	0.86	0.84	0.88	0.93	0.92	0.85
CFI ( $\geq 0.95$ )	0.94	0.98	0.88	0.97	0.94	0.94	0.97	0.87	0.97	0.97	0.89
SRMR ( $\leq 0.08$ )	0.08	0.05	0.08	0.00	0.08	0.08	0.06	0.11	0.08	0.07	0.09

\* HWISE Scale scores can only be calculated for sites that used water insecurity module version 2, which included all 12 scale items; CFI = comparative fit index; SRMR = standardized root mean square residual

**Online Supplementary Table 3.** Approximate invariance results for both aligned intercept (AI) and aligned loadings (AL) parameters of the final HWISE items, by Module Version 1 (A, 11 items) and 2 (B, 12 items) sites.

(A)

	Lagos, Nigeria (n=239)		Lilongwe, Malawi (n=302)		Kathmandu, Nepal (n=263)		Accra, Ghana (n=229)		Kisumu, Kenya (n=247)		Dushanbe, Tajikistan (n=225)		Singida, Tanzania (n=564)		Arua, Uganda (n=250)		Mérida, Mexico (n=250)		Kampala, Uganda (n=246)		Ceará, Brazil (n=254)		Bahir Dar, Ethiopia (n=259)	
	AI	AL	AI	AL	AI	AL	AI	AL	AI	AL	AI	AL	AI	AL	AI	AL	AI	AL	AI	AL	AI	AL	AI	AL
1.1. Worry about enough																								
1.4. Supply interrupted																								
1.13. Wash clothes																								
1.14. Change foods																								
1.15. Wash hands																								
1.17. Wash body																								
1.18. Day interrupted																								
1.27. Feel upset																								
1.28. Drink as much as liked				X																				
1.31. Sleep thirsty																								
1.32. No water whatsoever																								

X = significant non-invariance

(B)

	Beirut, Lebanon (n=573)		Gressier, Haiti (n=292)		San Borja, Bolivia (n=247)		Chiquimula, Guatemala (n=314)		Punjab, Pakistan (n=235)		Rajasthan, India (n=248)		Morogoro, Tanzania (n=300)		Labuan Bajo, Indonesia (n=279)		Sistan & Baolchistan, Iran (n=306)		Torreón, Mexico (n=249)		Cartagena, Colombia (n=266)		
	AI	AL	AI	AL	AI	AL	AI	AL	AI	AL	AI	AL	AI	AL	AI	AL	AI	AL	AI	AL	AI	AL	
2.3. Worry about enough																							
2.5. Supply interrupted							X																
2.12. Wash clothes																							
2.13. Change foods																							
2.14. Wash hands															X								
2.16. Wash body																							
2.17. Day interrupted																							
2.24. Feel upset			X				X																
2.25. Drink as much as liked				X																			
2.26. Sleep thirsty																							
2.27. No water whatsoever																		X					
2.29. Ashamed																					X	X	

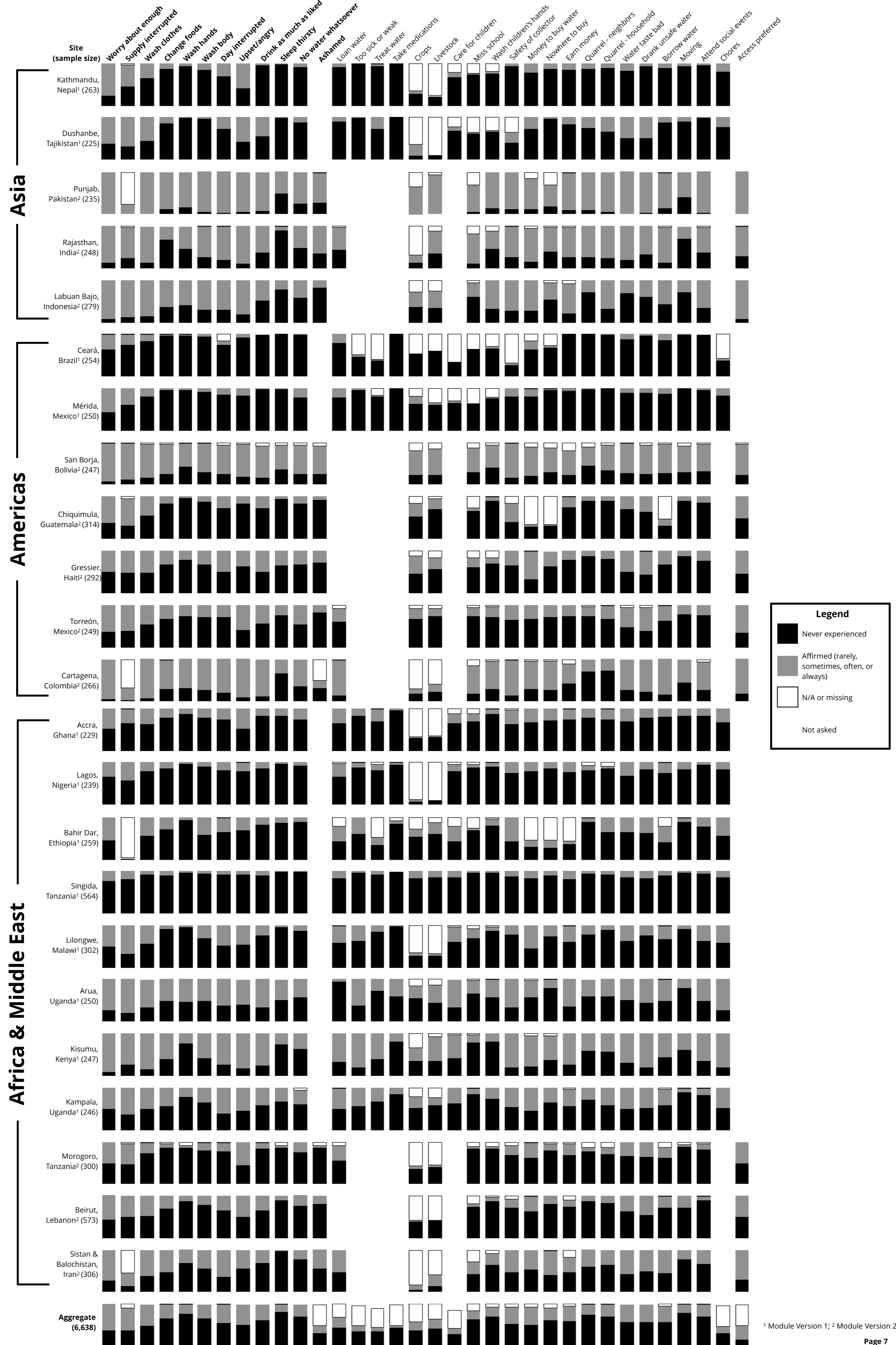
X = significant non-invariance

**Online Supplementary Table 4.** Sensitivity analysis of potential HWISE Scale cut-points to changes in associated phenomena.

	Cut-point at HWISE score of 10	Cut-point at HWISE score of 12 <sup>†</sup>	Cut-point at HWISE score of 20
<b>Predictive validity, B (SD)</b>			
Satisfaction with water situation <sup>a</sup>	-1.11 (-1.34, -0.88)***	-1.07 (-1.29, -0.86)***	-0.89 (-1.17, -0.61)***
Perceived water standing in community <sup>b</sup>	2.39 (1.93, 2.84)***	2.26 (1.79, 2.73)***	1.83 (1.01, 2.64)***
4-item Perceived Stress Scale score (0-16)	0.69 (0.12, 1.25)*	0.59 (0.04, 1.13)*	0.76 (0.22, 1.29)**
Household Food Insecurity Access score (0-27)	5.43 (4.47, 6.39)***	5.51 (4.23, 6.73)***	5.32 (3.51, 7.13)***
<b>Convergent validity, OR (CI)</b>			
Time (minutes) to water source	1.02 (1.01, 1.04)**	1.02 (1.01, 1.03)**	1.01 (1.00, 1.02)*
<b>Discriminant validity, OR (CI)</b>			
If injured while fetching water	4.03 (1.66, 9.78)**	3.66 (1.87, 7.17)***	3.09 (1.67, 5.71)***

<sup>†</sup> Cut-point of 12 ultimately selected; \* p<0.05; \*\* p<0.01; \*\*\* p<0.001; <sup>a</sup> range is 1-5, 5 = very satisfied; <sup>b</sup> scored using a ladder with range 1-10, 1 = highest standing

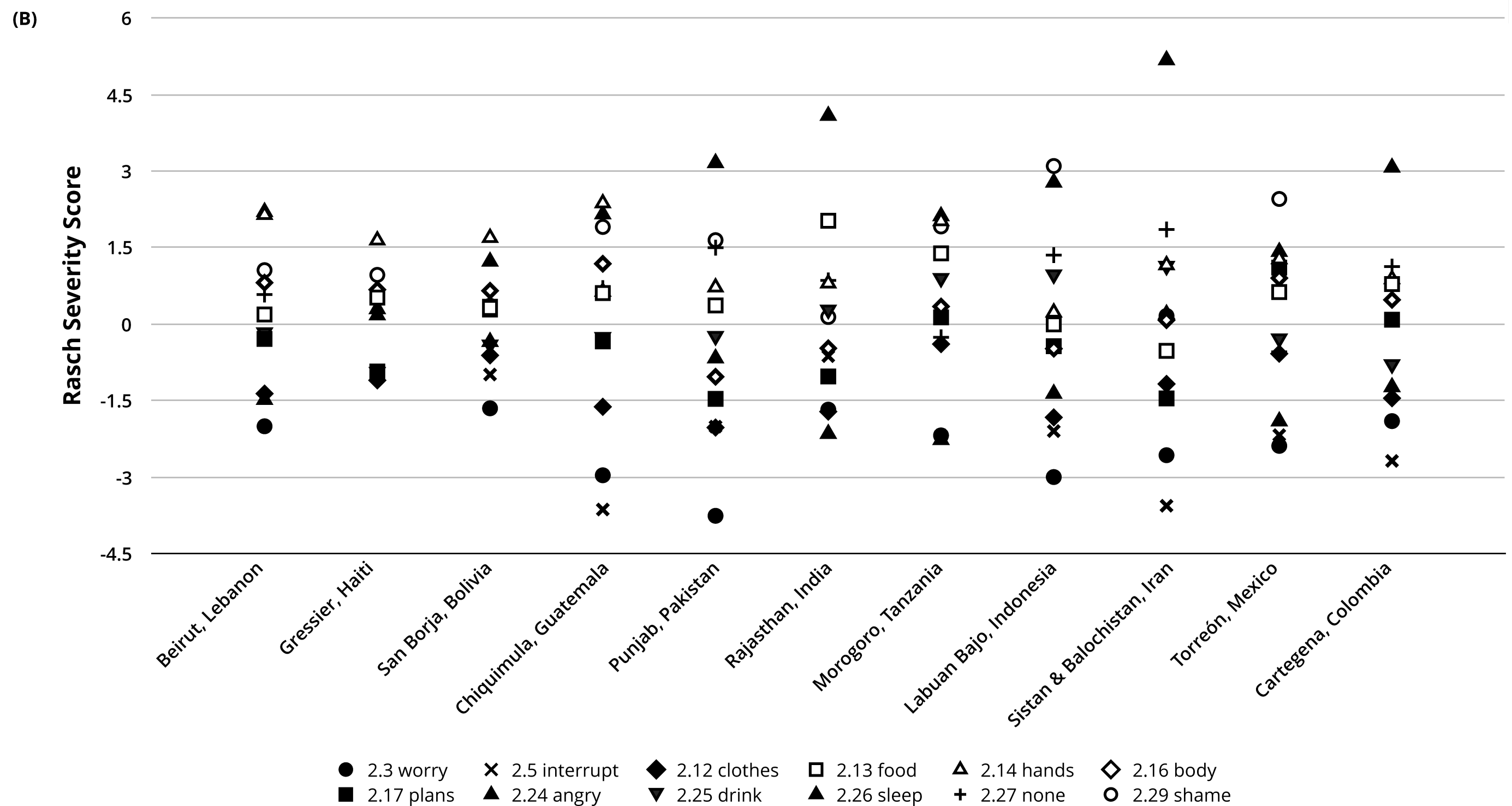
**Online Supplementary Figure 1.** Frequency of affirmation of household water insecurity experiences across the 23 sites retained for scale development, by World Bank region. Full phrasing of water insecurity module items can be found in Online Supplementary Table 1 (n=6,638).



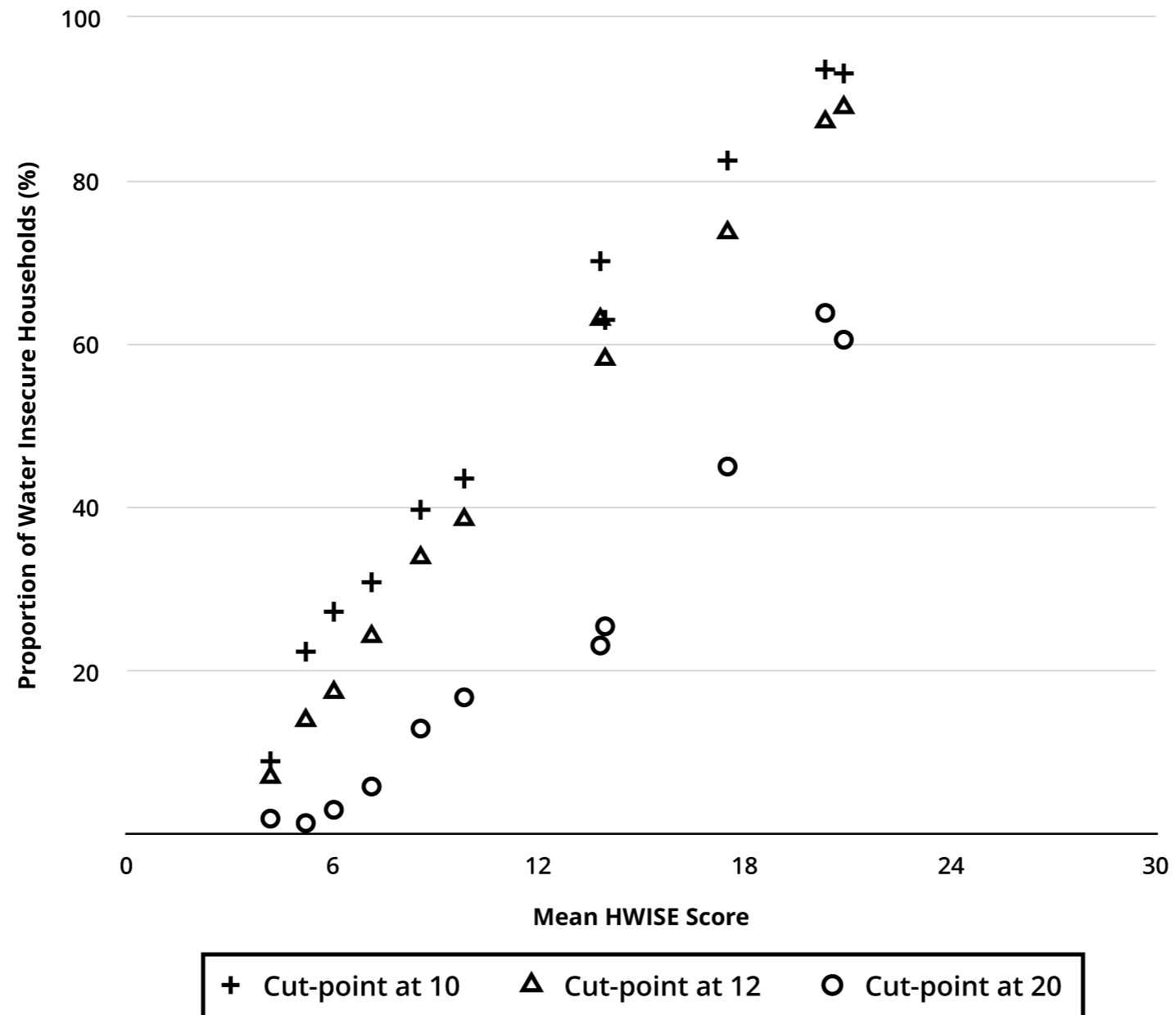
**Online Supplementary Figure 2.** Rasch severity scores for HWISE Scale items did not exhibit Guttman ordering, i.e. severity ordering for each item was not consistent across sites. Across sites, items varied by ranked severity (1= least severe, 12=most severe) (A) and severity score (B).

(A)

	Beirut, Lebanon (n=574)	Gressier, Haiti (n=292)	San Borja, Bolivia (n=247)	Chiquimula, Guatemala (n=314)	Punjab, Pakistan (n=235)	Rajasthan, India (n=248)	Morogoro, Tanzania (n=300)	Labuan Bajo, Indonesia (n=279)	Sistan & Balochistan, Iran (n=306)	Torreón, Mexico (n=249)	Cartegena, Colombia (n=226)
2.3 Worry about enough	1	3	1	2	1	3	3	1	2	1	2
2.5 Supply interrupted	3	2	2	1	3	5	2	2	1	2	1
2.12 Wash clothes	4	1	3	3	2	2	4	3	4	4	3
2.13 Change foods	7	8	7	6	8	11	9	7	5	7	8
2.14 Wash hands	11	12	12	12	9	9	11	8	10	10	10
2.16 Wash body	9	10	10	9	5	6	7	5	6	8	7
2.17 Day interrupted	5	5	6	4	4	4	6	6	3	9	6
2.24 Upset/angry	2	6	5	7	6	1	1	4	8	3	4
2.25 Drink as much liked	6	4	4	5	7	8	8	9	9	6	5
2.26 Sleep thirsty	12	7	11	11	12	12	12	11	12	11	12
2.27 No water	8	9	9	8	10	10	5	10	11	5	11
2.29 Ashamed	10	11	8	10	11	7	10	12	7	12	9

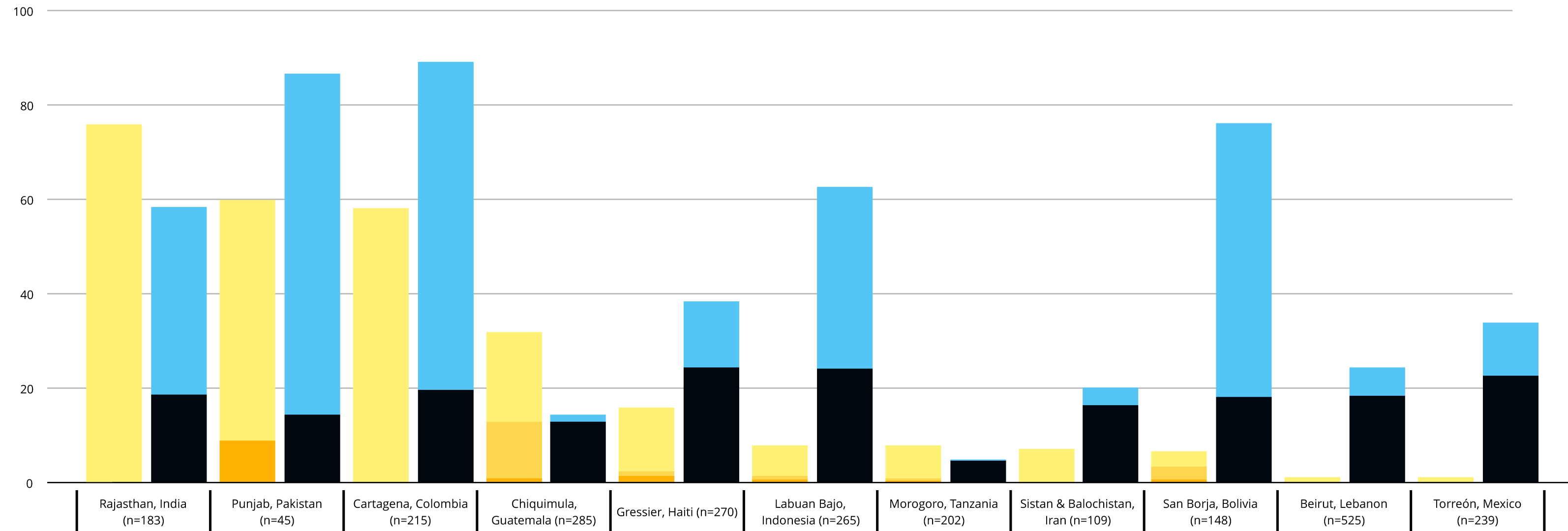






**Online Supplementary Figure 3.** Proportion of water insecure households using three different cut-points, by mean HWISE Scale score for each site.

**Online Supplementary Figure 4.** Proportion of households whose primary drinking water source is below JMP's "basic" service level (e.g. limited, unimproved, or surface water), compared to the proportion of households that are considered water insecure based on HWISE Scale scores.



**Households whose primary drinking water source < "basic", per JMP**



Limited



Unimproved



Surface water

**Households that are water insecure, per HWISE Scale (score ≥ 12)**



Proportion of water-insecure households without "basic" water service level



Proportion of water-insecure households with "basic" water service level