Geographic Determinants of Human Schistosomiasis Transmission in the Sourou Valley, Burkina Faso:

Influence of air temperature on human water contact patterns in Toma-Île

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Outline

1. Introduction- background
2. Materials and method
3. Results
4. Discussion- conclusion

1. Introduction-Background

Human schistosomiasis (bilharziasis) ,NTD, is second only to malaria in terms of public health importance (Hotez & Kamath, 2009)

Endemicity concerns 76 countries worldwide (Utzinger et *al.*, 2009)

Mid-2003: 779 million people were at risk and 207 million individuals were infected (Utzinger et *al.*, 2009)

Chronic infection can modify susceptibility to diseases such as malaria, TB, HCV and HIV-1 (King & Dangerfield, 2008)

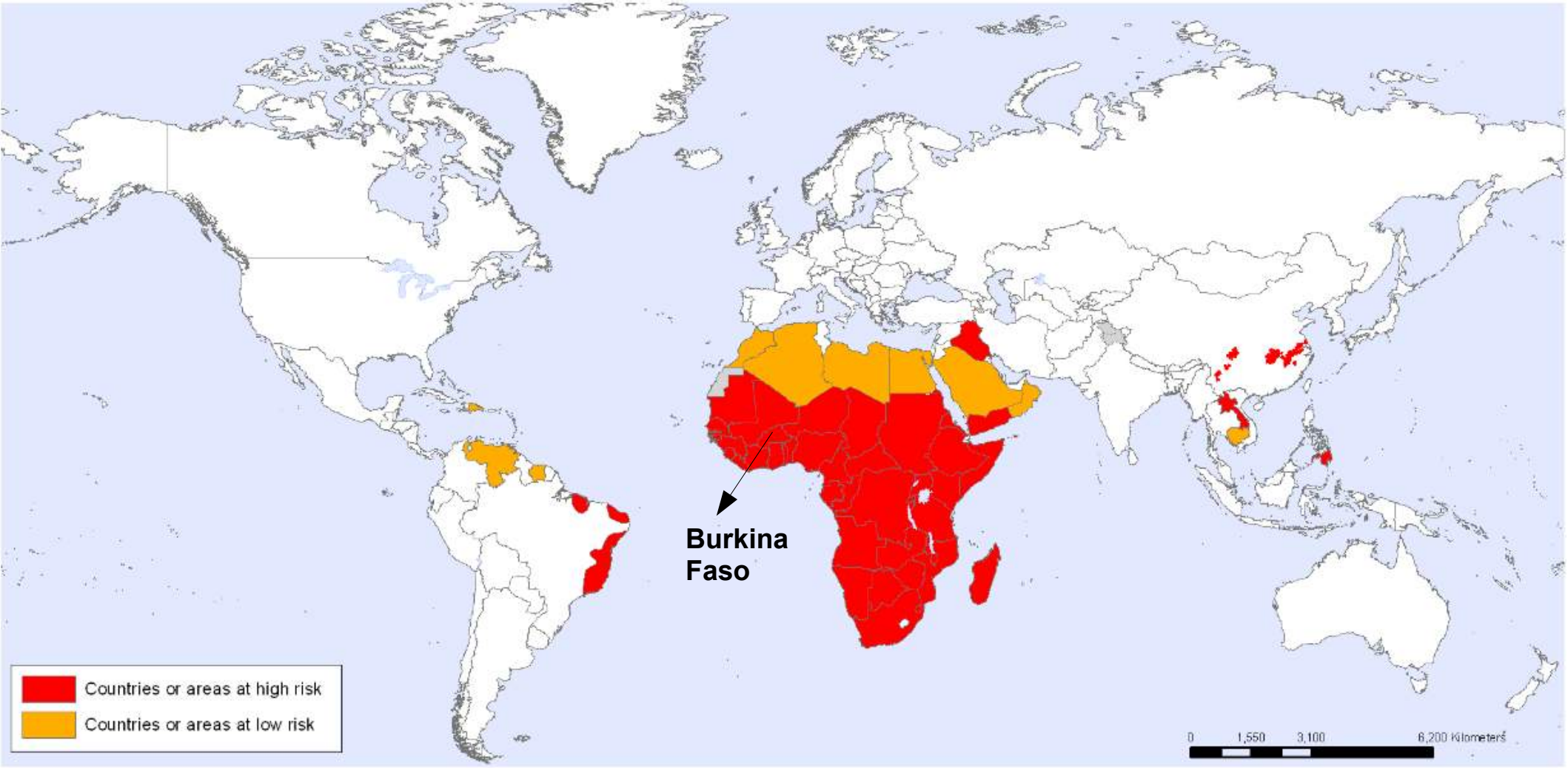
Adverse effects on child cognitive and physical development, pregnancy outcome, agricultural worker productivity (Hotez & Kamath, 2009)

More than 15,000 deaths yearly (van der Werf et *al.*, 2003)

55% of endemic countries, 85% of the total at risk people and 97% of the global infected persons are concentrated in SSA (Utzinger et *al.*, 2009);

Bukina Faso is among the highly endenemic west African countries (Van der Werf et *al.*, 2003; Clements et *al.*, 2008; Schur et *al.*, 2011)

Global geographic distribution of human schitosomiasis

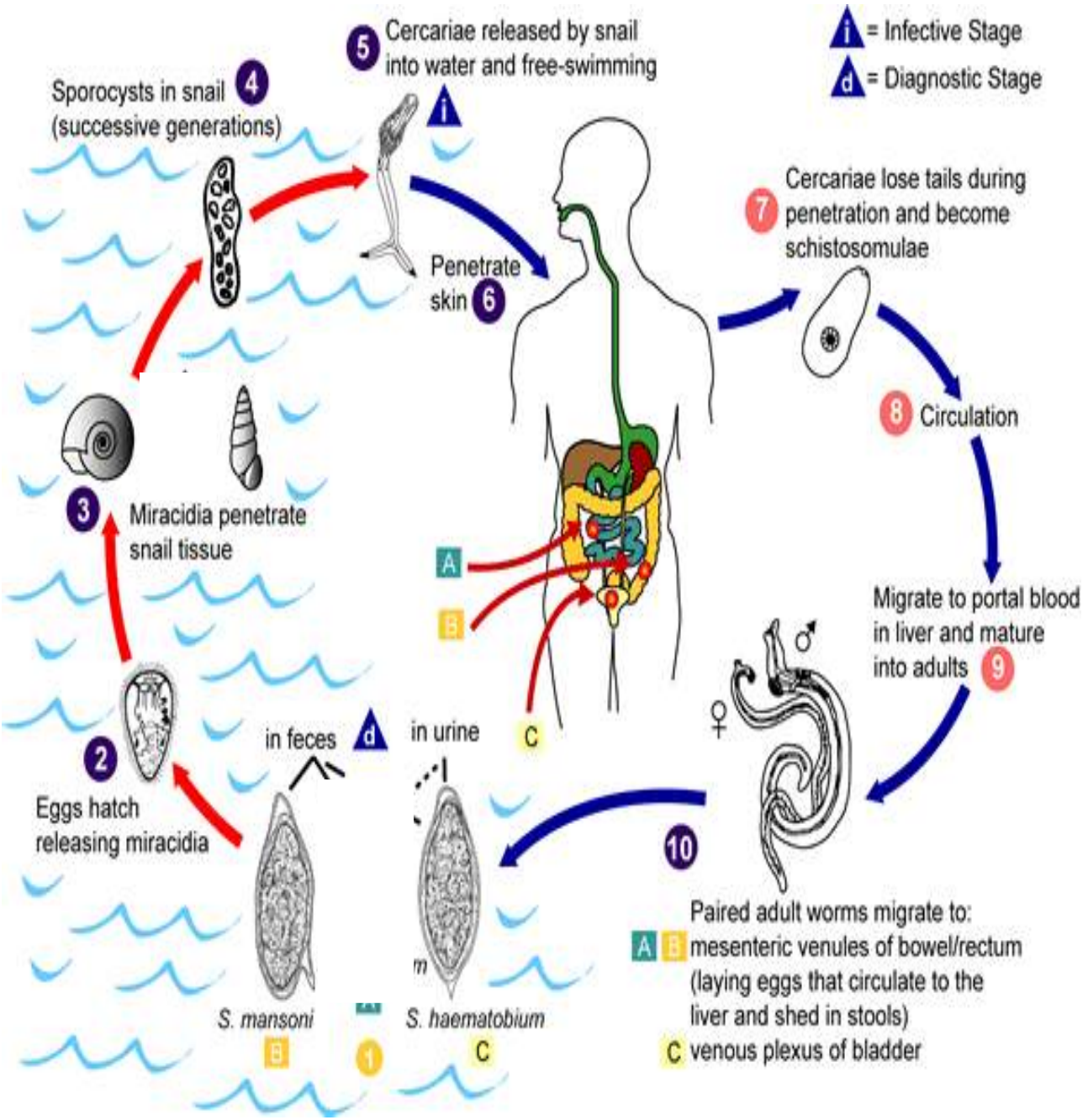


The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization
Map Production: Public Health Information and Geographic Information Systems (GIS)
World Health Organization

World Health Organization

Parasites lifecycle



S. haematobium & *S. mansoni* = digenic trematodes

Eggs hatching: water temperature 10 and 30° C (Weil & Kvale, 1985)

Miracidia and cercariae penetration capacities: 26-28 °C (Stirewalt, 1954; DeWitt, 1985)

Optimal temperature for snails' development and survival rate: 25-26° C. In water at 36 to 38°C all the snails died within three days (Stirewalt, 1954)

Light effect on cercariae emergence: strong influence on *S. haematobium*, little on *S. mansoni* (N´Goran et *al.*, 1997; Wolmarans et *al.*, 2002)

http://www.cdc.gov/parasites/schistosomiasis/biology.html

Circadian emergence of cercariae (South Africa)

Cold dry season: 50 *Bulinus globosus* (*S. haematobium*)

Observation time (h)	0500	0700	0900	1100	1300	1500	1700	1900	2100
Temperature (°C)	15.8	15.8	20.9	24	25.7	25.7	20.9	19.6	17.3
Low intensity	0	0	2	10	42	54	32	0	0
Medium intensity	0	0	8	28	20	16	4	0	0
High intensity	0	0	60	46	26	8	8	0	0
No shedding	100	100	30	16	12	22	56	100	100

Warm dry season: 38 *Bulinus globosus* (*S. haematobium*)

Observation time (h)	0500	0700	0900	1100	1300	1500	1700	1900	2100
Temperature (°C)	17.3	19.8	23.1	24.8	26.3	27.3	25.9	21.5	19.3
Low intensity	0	0	21.0	21.0	31.5	78.9	13.1	0	0
Medium intensity	0	0	21.0	10.5	31.5	0	0	0	0
High intensity	0	0	42.1	55.2	21.0	10.5	0	0	0
No shedding	100	100	14.2	13.1	15.7	10.5	86.8	100	100

Cold dry season: 32 *Biomphalaria pfeifferi* (*S. mansoni*)

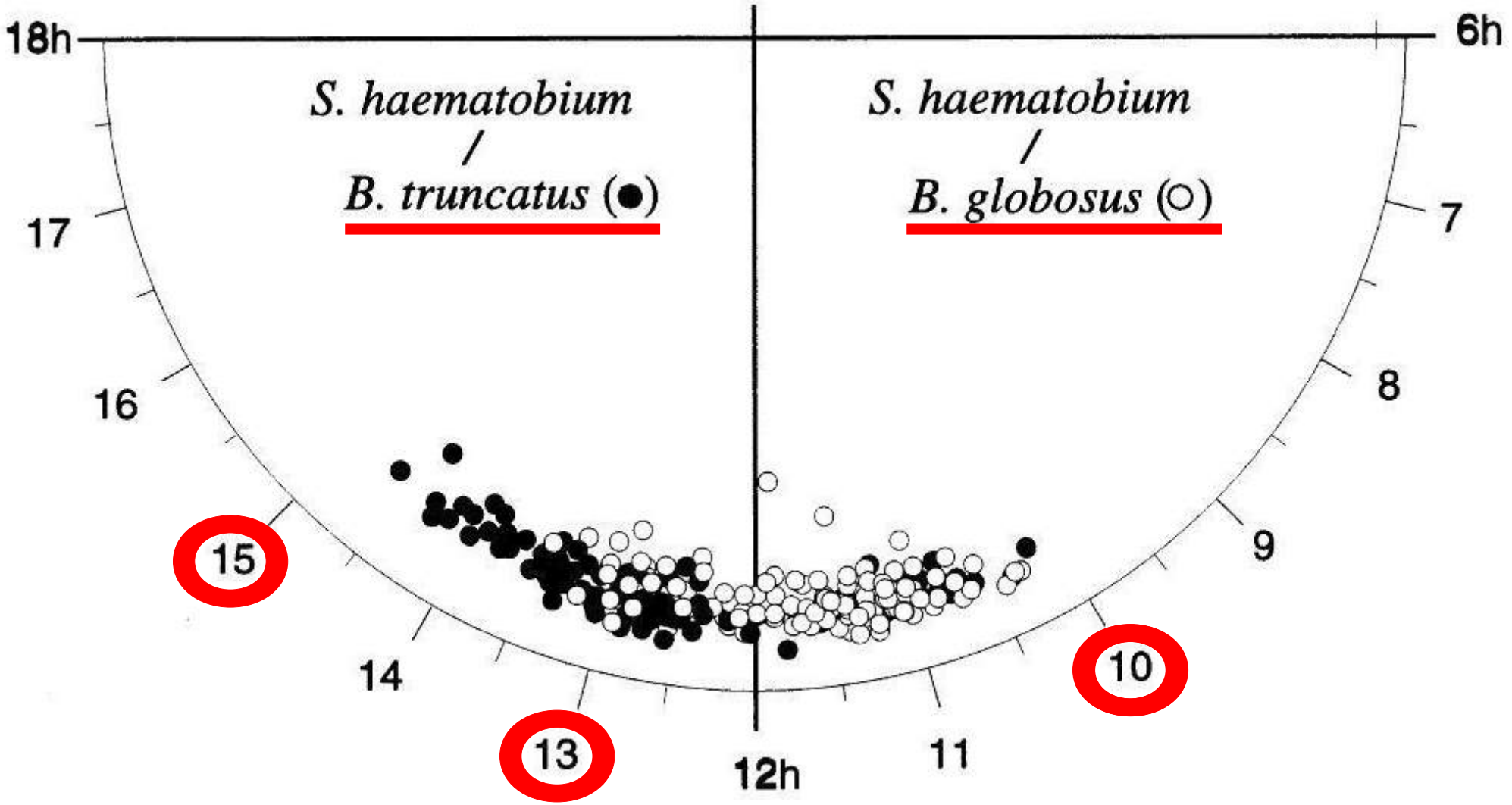
Observation time (h)	0500	0700	0900	1100	1300	1500	1700	1900	2100
Temperature (°C)	15.8	15.8	20.9	24	25.7	25.7	20.9	19.6	17.3
Low intensity	0	0	0	28.1	0	28.1	28.1	0	0
Medium intensity	0	0	0	0	56.2	34.3	0	0	0
High intensity	0	0	100	62.5	6.3	0	0	0	0
No shedding	100	100	0	9.3	37.5	37.5	71.8	100	100

Warm dry season: 36 *Biomphalaria pfeifferi* (*S. mansoni*)

Observation time (h)	0500	0700	0900	1100	1300	1500	1700	1900	2100
Temperature (°C)	17.3	19.8	23.1	24.8	26.3	27.3	29.5	21.5	19.3
Low intensity	0	0	0	0	0	13.8	58	0	0
Medium intensity	0	0	0	0	13.8	0	0	0	0
High intensity	0	0	36.1	100	86.1	86.1	27.7	0	0
No shedding	100	100	63.8	0	0	0	13.8	100	100

Source: Wolmarans et *al.*, (2002), Journal of Helmintology, 76, pp. 275-276

Circadian emergence of cercariae (West Africa)



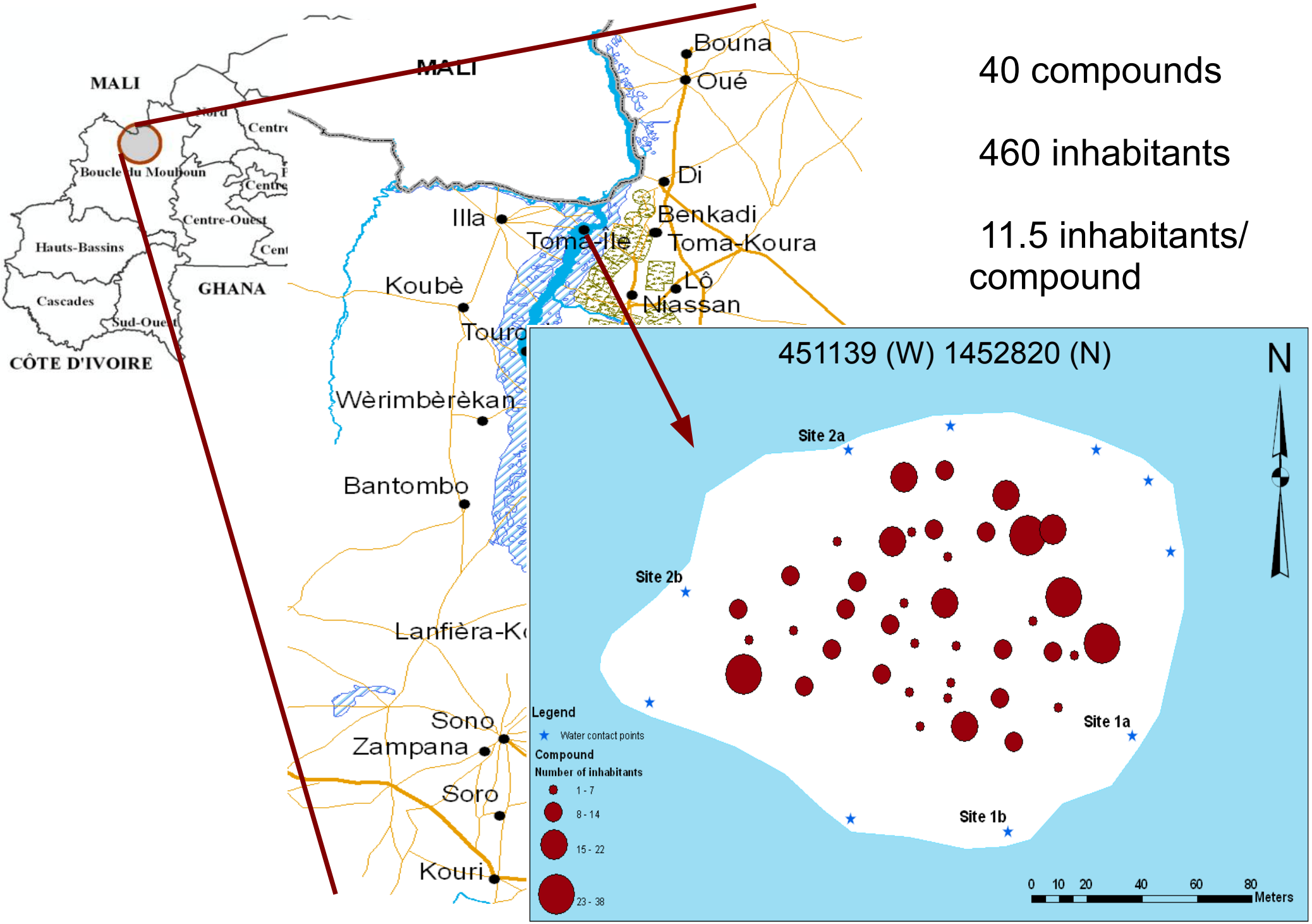
Source: N'Goran et *al.*, (1997), *Acta Tropica*, 66, p. 40.

1. Does the air temperature influence the frequency of human water-contacts?

2. Does the human pressure at the water body coincide with a high emergence of cercariae in the water?

2. Materials and method

Study site: Toma-Île



40 compounds

460 inhabitants

11.5 inhabitants/ compound

Water contact data collection

Two periods (62 days):

Period 1 (31 days): From January 3rd to February 2nd 2011

Period 2 (31 days): From April 3rd to May 3rd 2011

Domestic activities

40 women were followed up:

Recreational swimming

Children recreational swimming

Daytime observation (13 hours):

06:00 to 18:00

Weather data collection

Daily temperatures (°C):

Minima

Maxima

Means

Daily sunshine lasting:

Total number of hours

Di-Sourou weather station
(456070W / 1455315N)

Data: from 1980

3 measurments/day:
06:00-13:00-18:00

Data analysis

Domestic activities

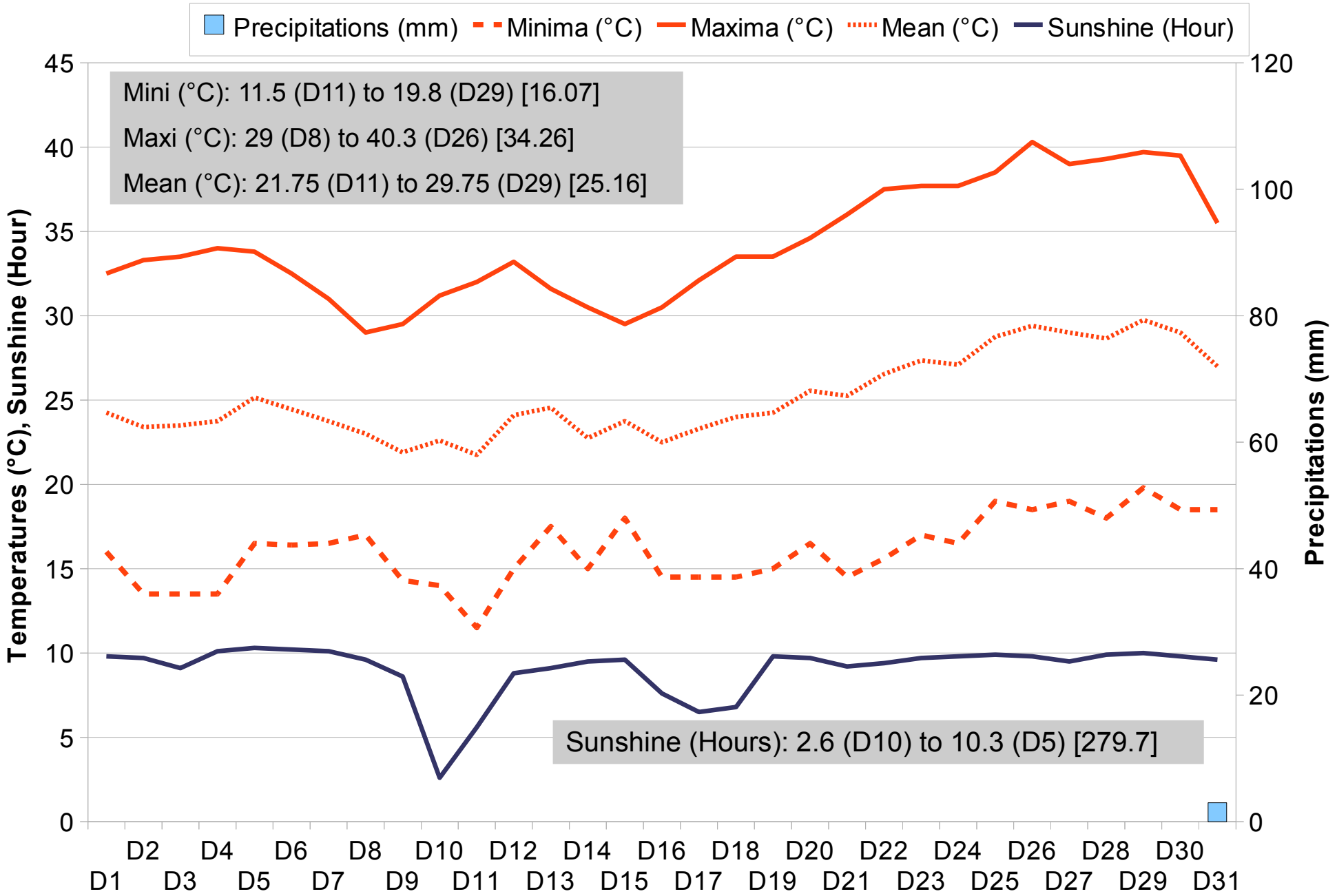
- Dishes & clothes washing
- Women washing themselves directly in the river
- Mothers washing their under five children directly in the river

Children recreational swimming

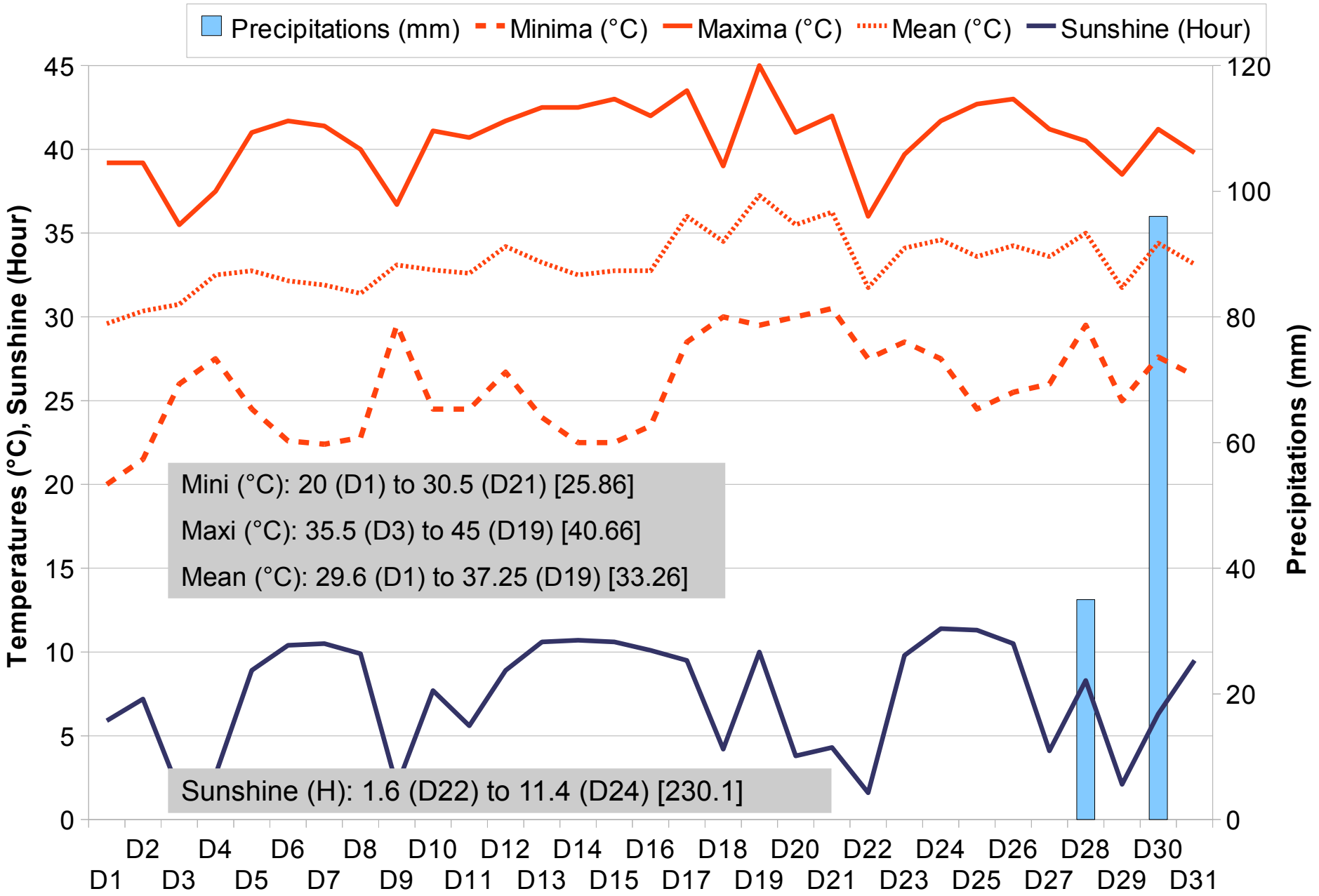
- Daily occurence pattern
- Hourly occurence pattern
- Linear regression (SPSS version 18)

3. Results

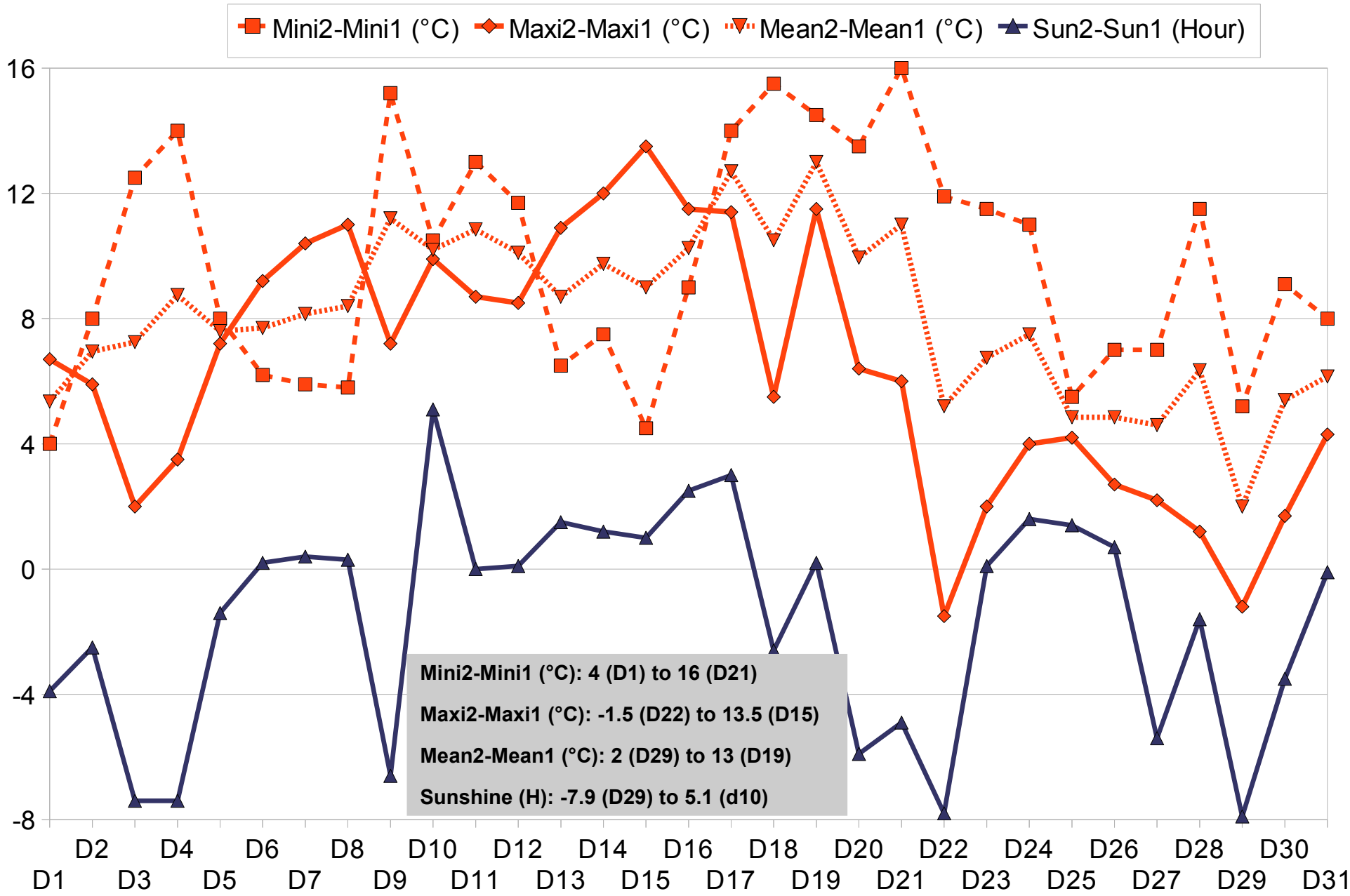
Climatic variables: Period 1



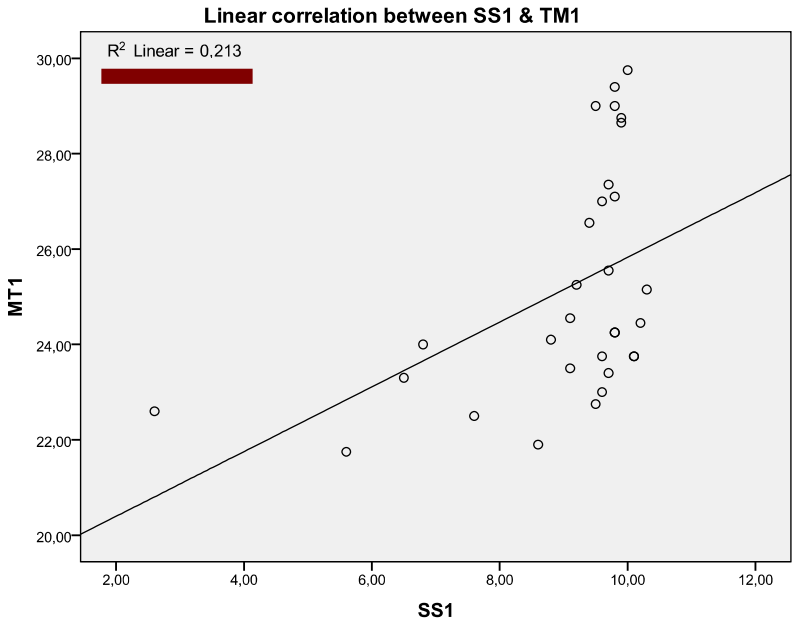
Climatic variables: Period 2

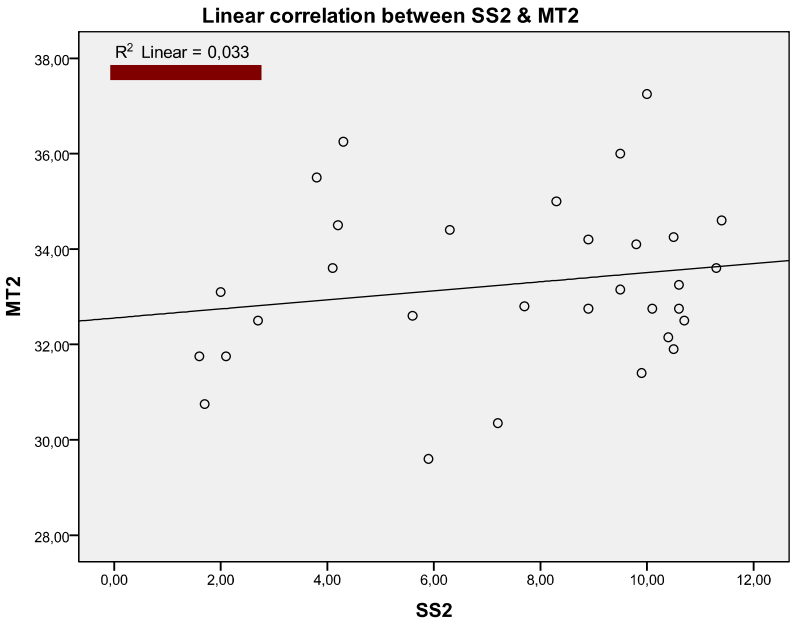


Period 1= cool dry vs. Period 2= warm dry



Linear correlation between sunshine lasting and mean air temperature





$r_1 = 0.461$ p-value = 0.009

$r_2 = 0.181$ p-value = 0.329

General characteristics of women

Number of women per age group (years)					
18 - 22	23 - 28	29 - 33	34 - 38	39 - 43	44 and +
6	16	6	5	5	2

Matrimonial status

11= whit co-wives

29= whitout co-wives

Mother status

23= breast-feeding

3= pregnants

14= not feeding, not pregnant

Number of children U5			
Zero	One	Two	Three
6	15	18	1

Water Activities

- Daily Pattern -

Dishes & clothes washing daily occurrence

Total recordings (P1) = 1190 (mean = 38.4 contacts/day)

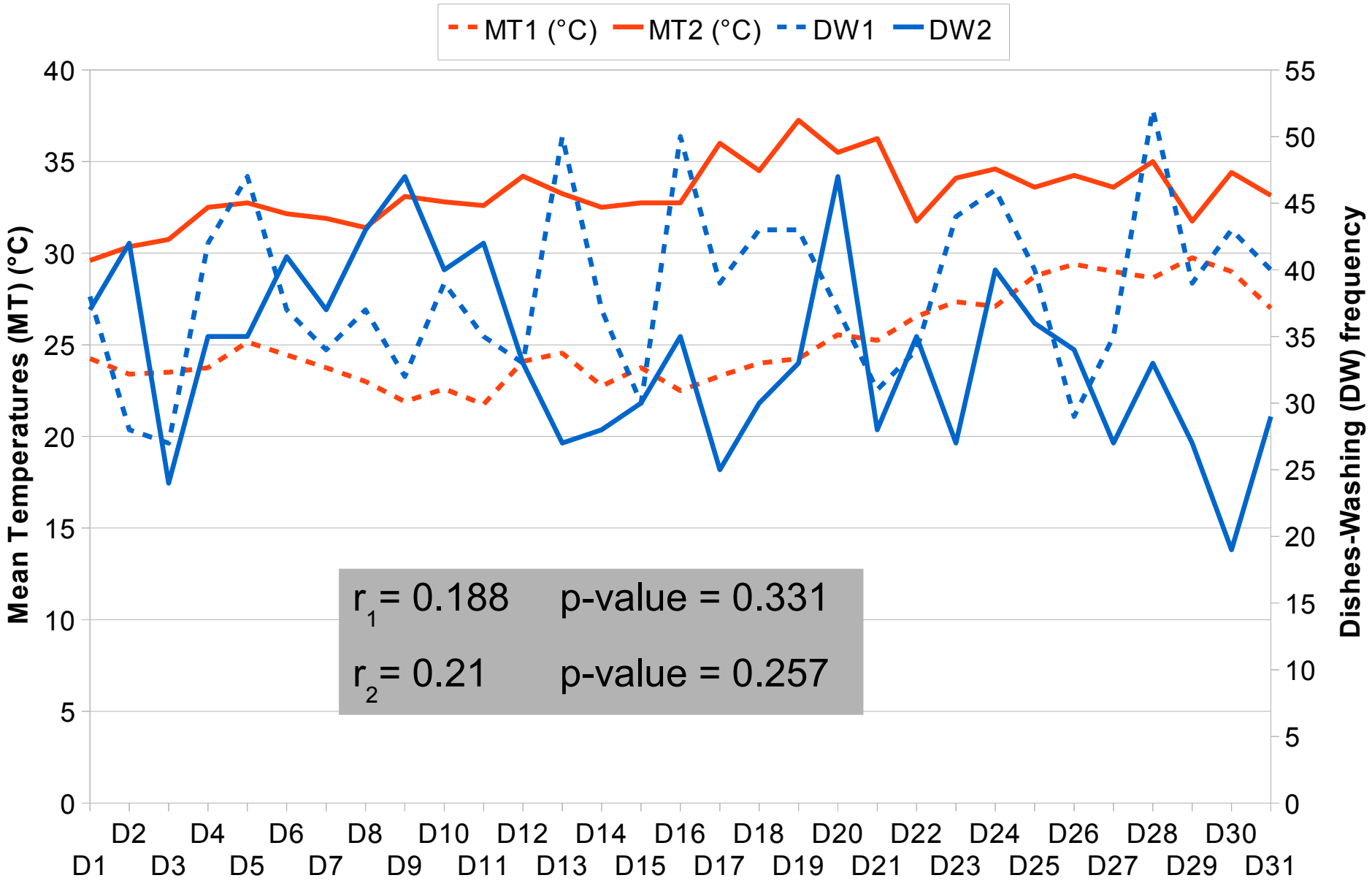
Individual extremes: 0.2 (ID-16) to 1.6 (ID-28)

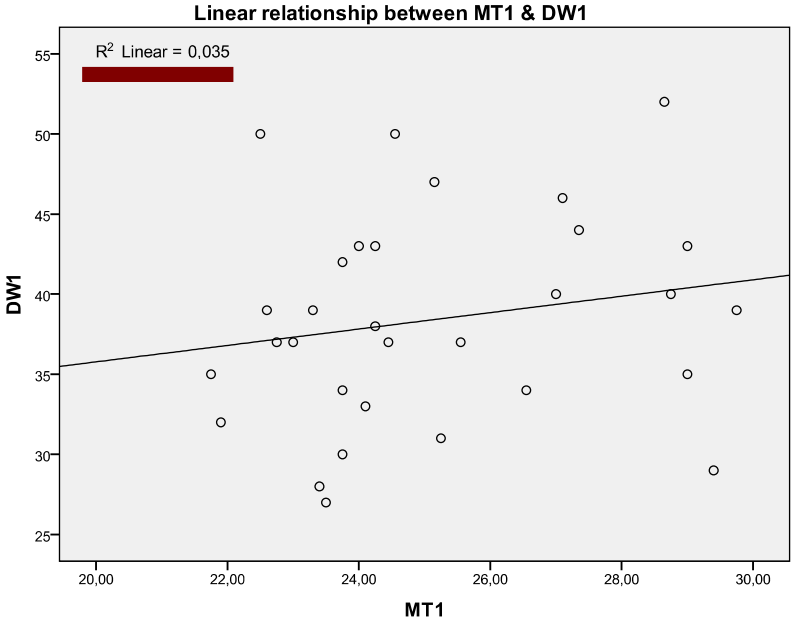
Total recordings (P2) = 1,038 (mean = 33.5 contacts/day)

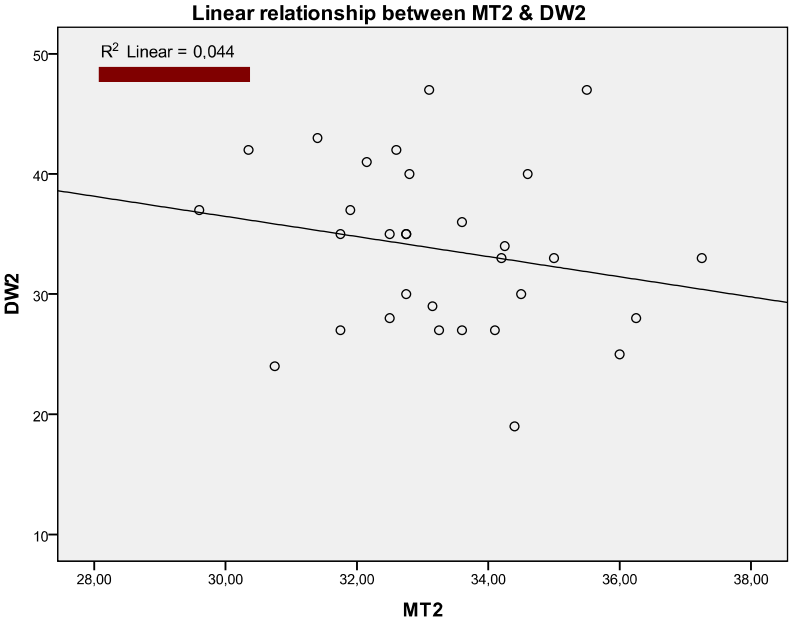
Individual extremes: 0.0 (ID-7) to 1.8 (ID-21)

Mean contact	Period 1	Period 2
0	0	1
0.1 - 0.4	2	8
0.5 - 0.8	16	12
0.9 - 1.2	10	9
1.3 - +	12	10
Total	**40**	**40**

Relationship between mean temperatures and Dishes-clothes washing daily pattern




Linear relationship between MT1 & DW1
R² Linear = 0,035
DW1
MT1
55
50
45
40
35
30
25
20,00
22,00
24,00
26,00
28,00
30,00


Linear relationship between MT2 & DW2
R² Linear = 0,044
DW2
MT2
50
40
30
20
10
28,00
30,00
32,00
34,00
36,00
38,00

Women having had a wash directly in the river

Total recordings (P1) = 524 (mean = 16.9 contacts/day)

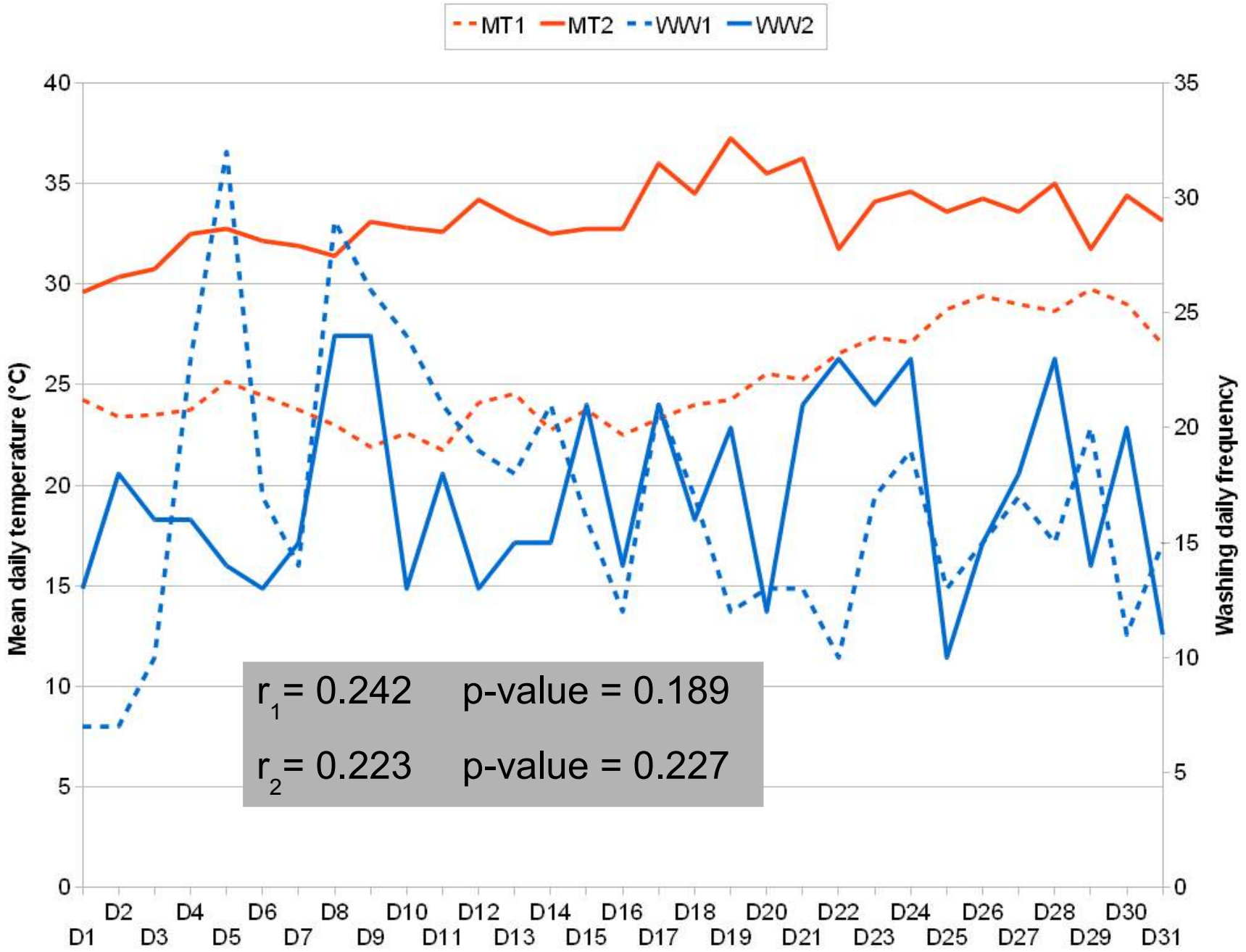
Individual extremes: 0.1 (ID-6) to 1.0 (ID-27)

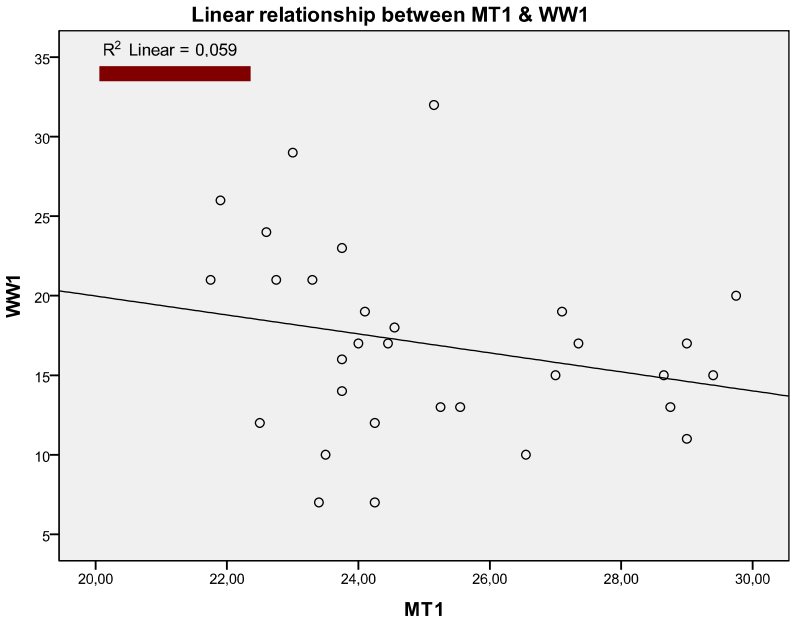
Total recordings (P2) = 530 (mean = 17.1 contacts/day)

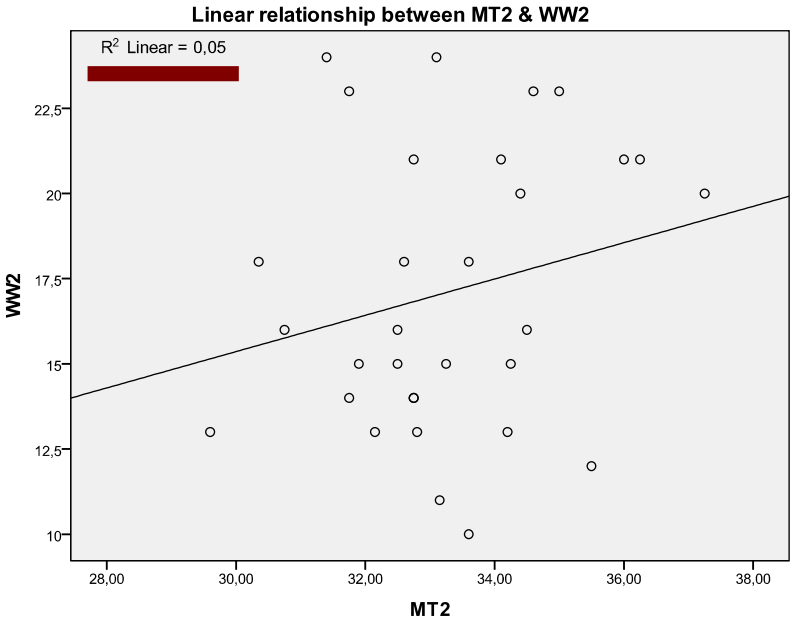
Individual extremes: 0.0 (ID-7) to 1.2 (ID-14)

Mean contact	Period 1	Period 2
0	0	1
0,1 - 0,4	22	21
0,5 - 0,8	16	13
0.9 - 1.2	2	5
1.3 - +	0	0
Total	**40**	**40**

Relationship between mean air temperature and women having had a wash daily pattern




Linear relationship between MT1 & WW1
R² Linear = 0,059
WW1
MT1
35
30
25
20
15
10
5
20,00
22,00
24,00
26,00
28,00
30,00


Linear relationship between MT2 & WW2
R² Linear = 0,05
WW2
MT2
22,5
20
17,5
15
12,5
10
28,00
30,00
32,00
34,00
36,00
38,00

Women having washed their children directly in the river

Total recordings (P1) = 67 (mean = 2.2 contacts/day

Individual extremes: 0.0 to 0.3 contact/day

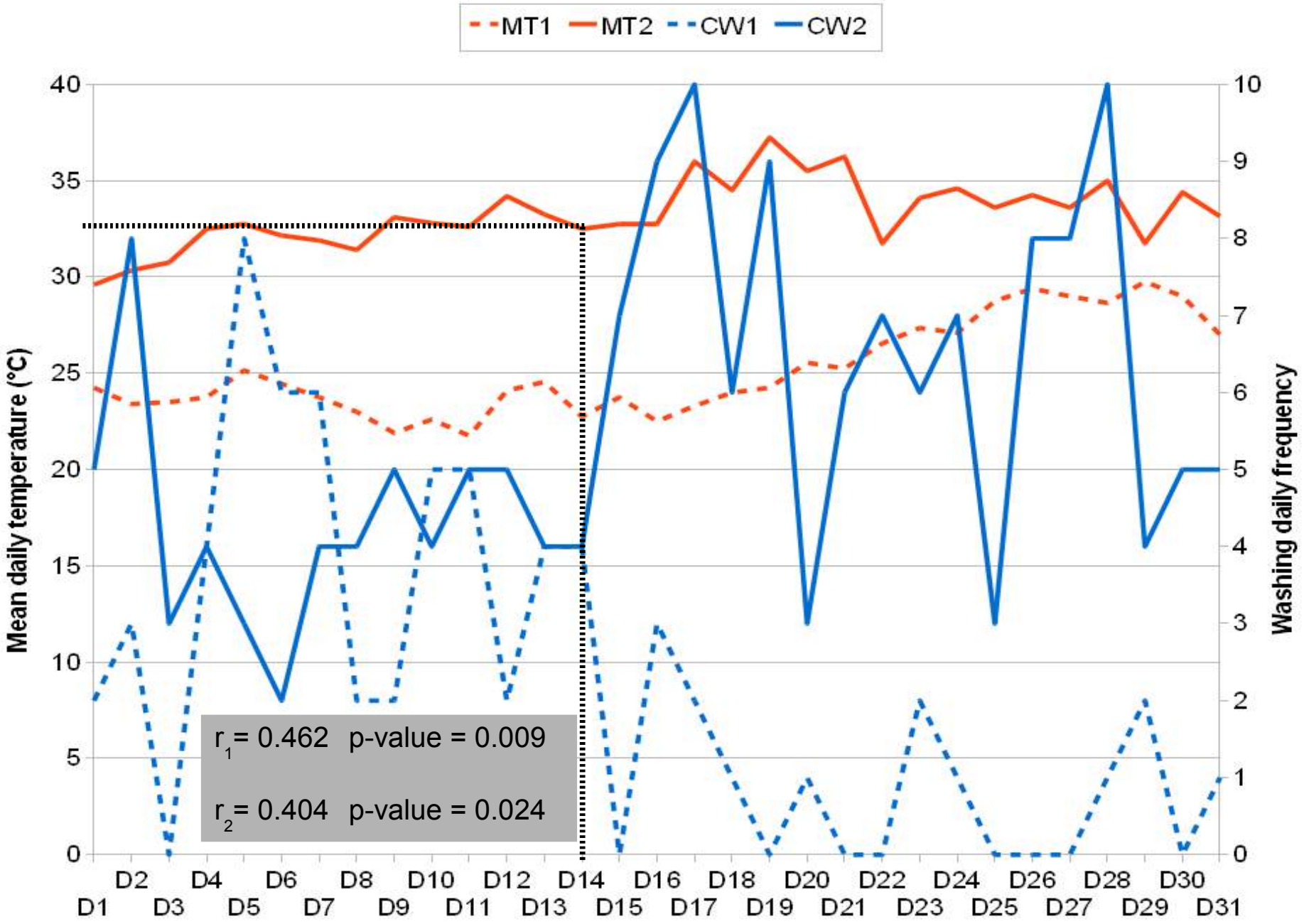
Total recordings (P2) = 173 (mean = 4.9 contacts/day

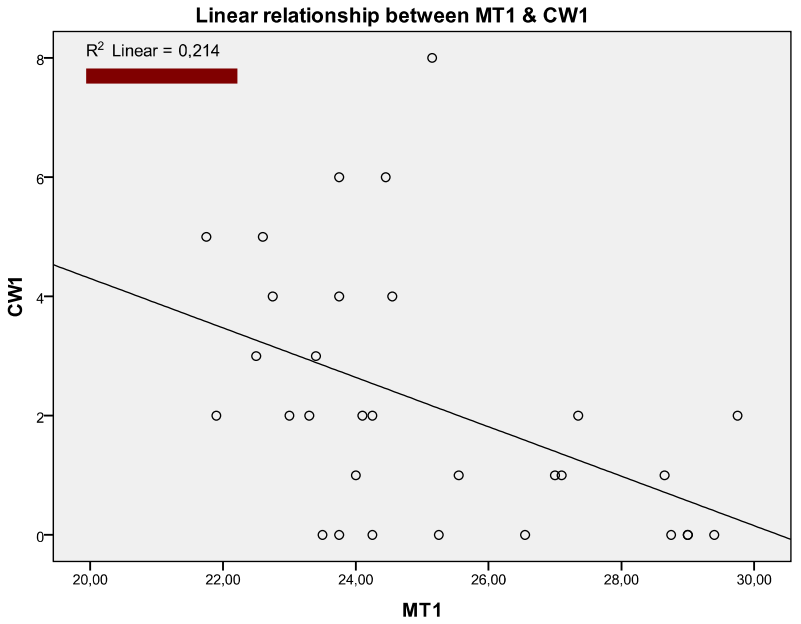
Individual extremes: 0.0 to 0.6 contact/day

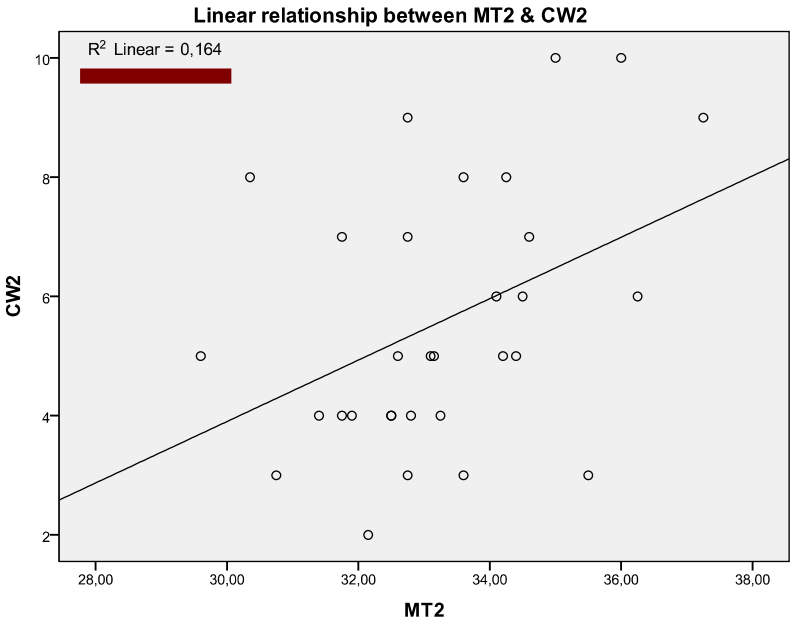
Mean contact	Period 1	Period 2
0	13	16
0.1 - 0.4	27	20
0.5 - 0.8	0	4
0.9 - 1.2	0	0
1.3 - +	0	0
Total	**40**	**40**

Age (month)	Period 1	Period 2
4	0	3
6	0	1
7	0	11
9	5	0
11	6	0
12	0	20
14	5	10
16	2	0
19	1	11
20	0	4
24	0	44
26	0	6
27	0	6
28	0	12
30	0	19
36	1	6
ND	47	20
Total	**67**	**173**

Relationship between mean air temperature and women washing their children directly in the river

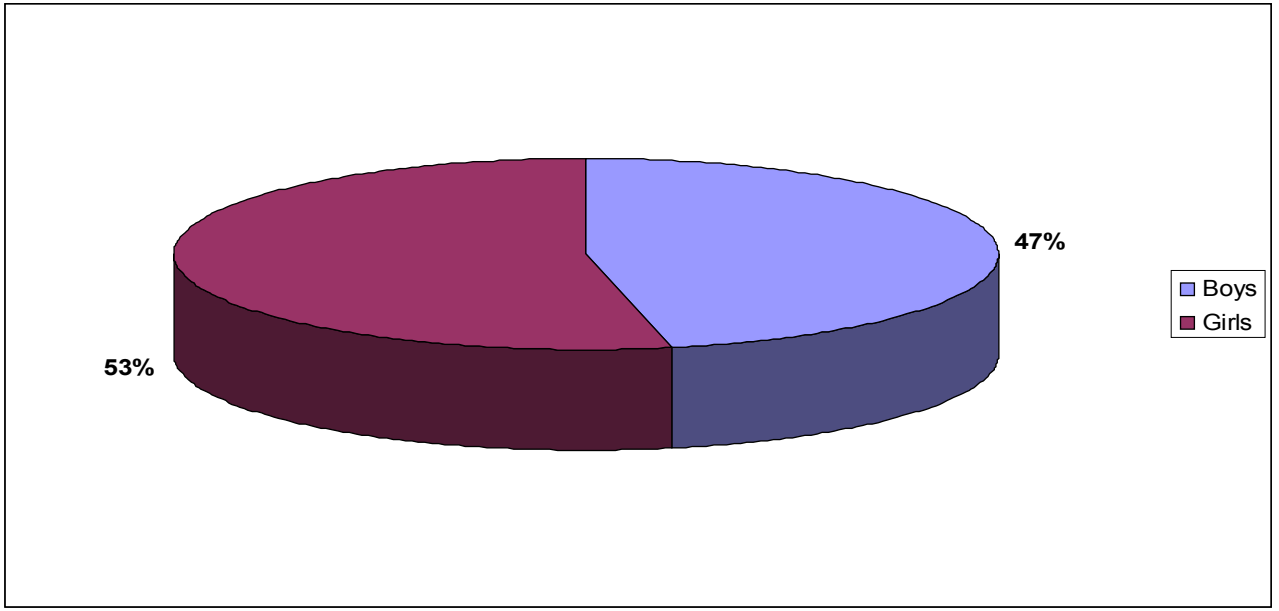



Linear relationship between MT1 & CW1
R² Linear = 0,214
CW1
MT1
0
2
4
6
8
20,00
22,00
24,00
26,00
28,00
30,00

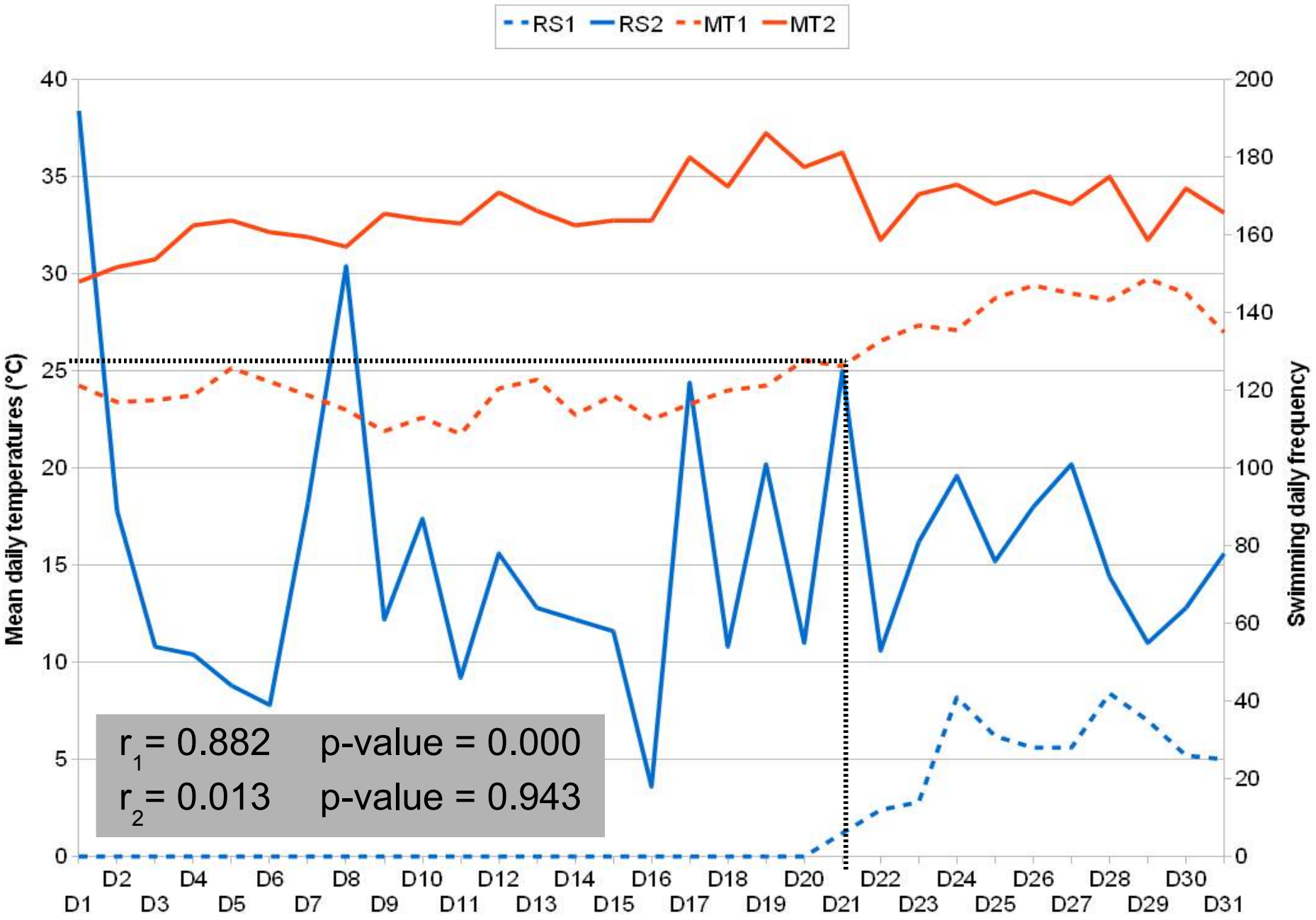

Linear relationship between MT2 & CW2
R² Linear = 0,164
CW2
MT2
2
4
6
8
10
28,00
30,00
32,00
34,00
36,00
38,00

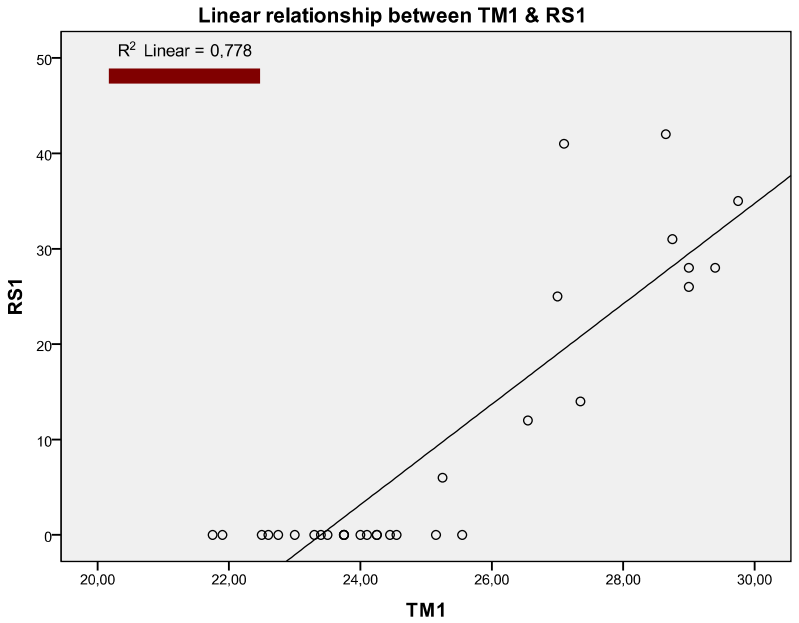
Children recreational swimming: Age group and sex distribution

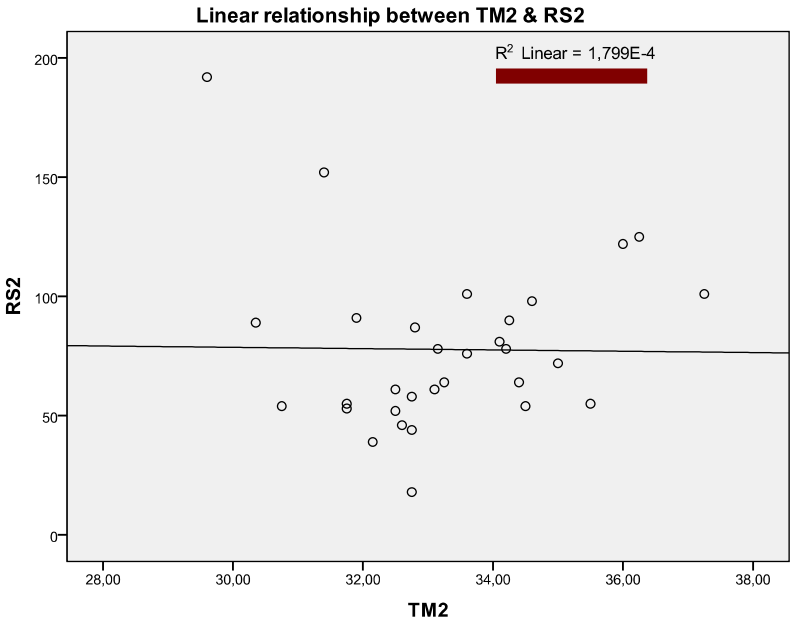
	Boys			Girls			TOTAL
	<10 years	10 to 15 years	>15 years	<10 years	10 to 15 years	>15 years	
Period 1	121	19	0	137	11	0	**288**
Period 2	1040	78	1	1149	138	5	**2411**
TOTAL	**1161**	**97**	**1**	**1286**	**149**	**5**	**2699**



Relationship between mean air temperature and children recreational swimming daily pattern



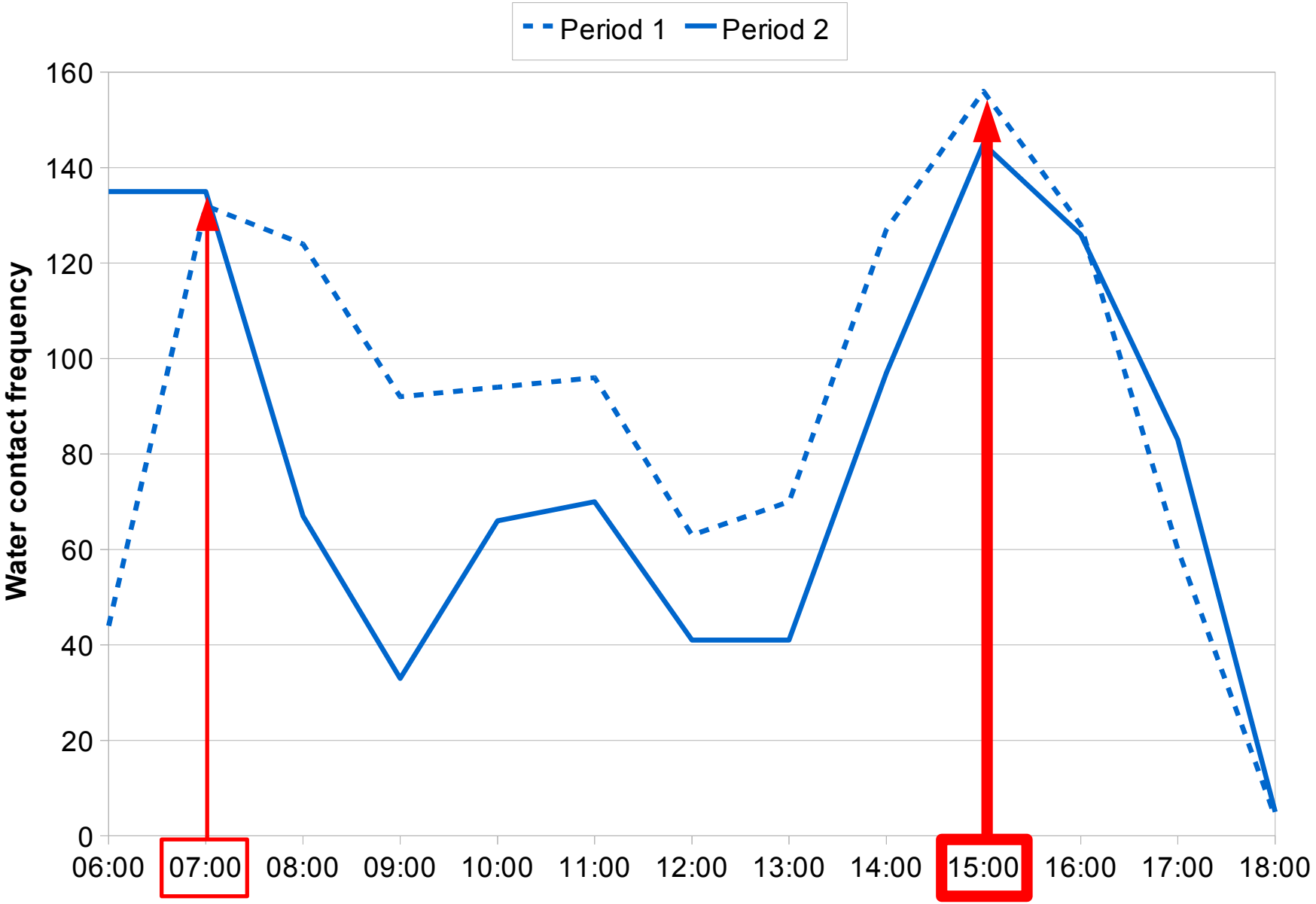

Linear relationship between TM1 & RS1
R² Linear = 0,778
RS1
TM1
0
10
20
30
40
50
20,00
22,00
24,00
26,00
28,00
30,00


Linear relationship between TM2 & RS2
R² Linear = 1,799E-4
RS2
TM2
0
50
100
150
200
28,00
30,00
32,00
34,00
36,00
38,00

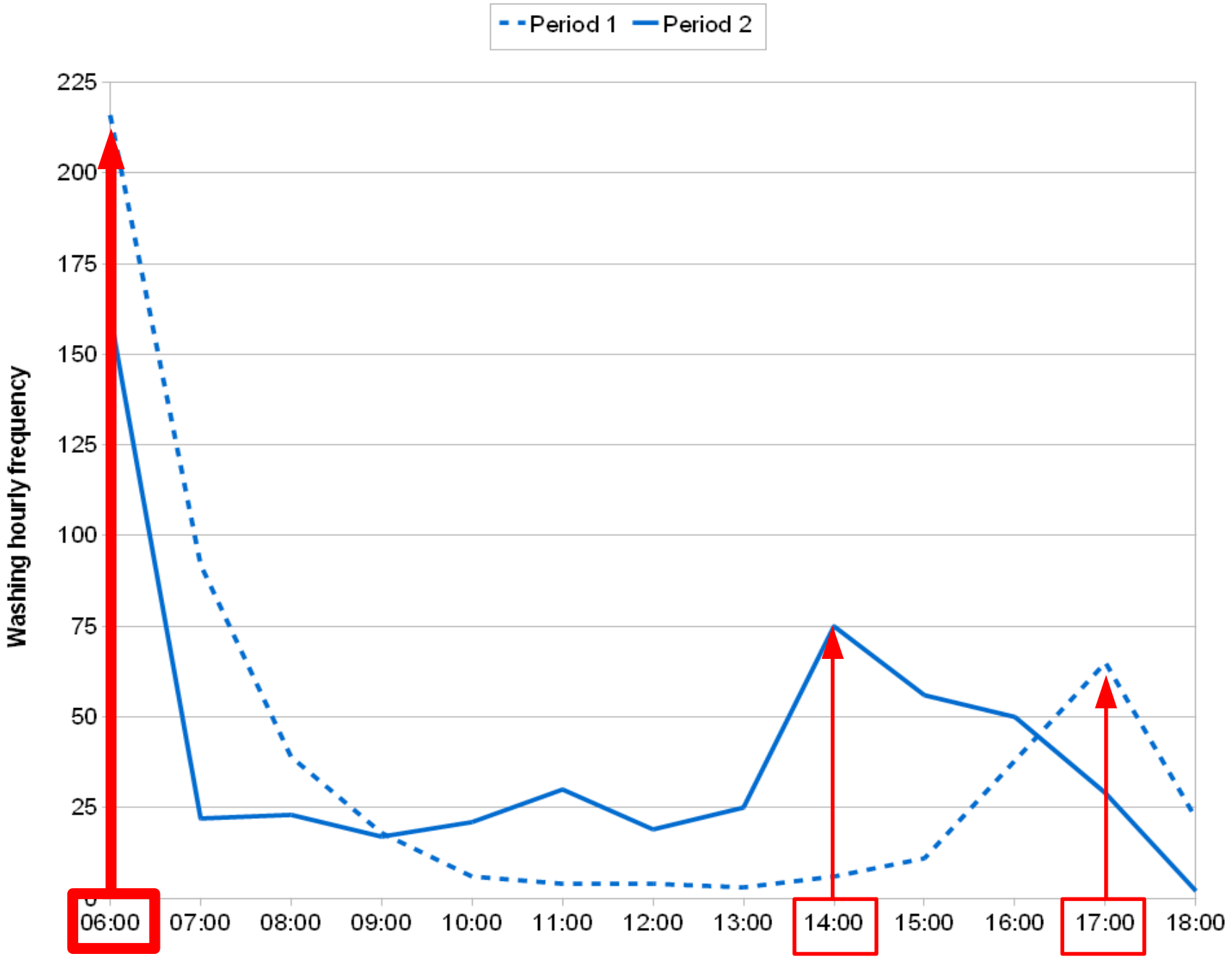
Water Activities

- Hourly Pattern -

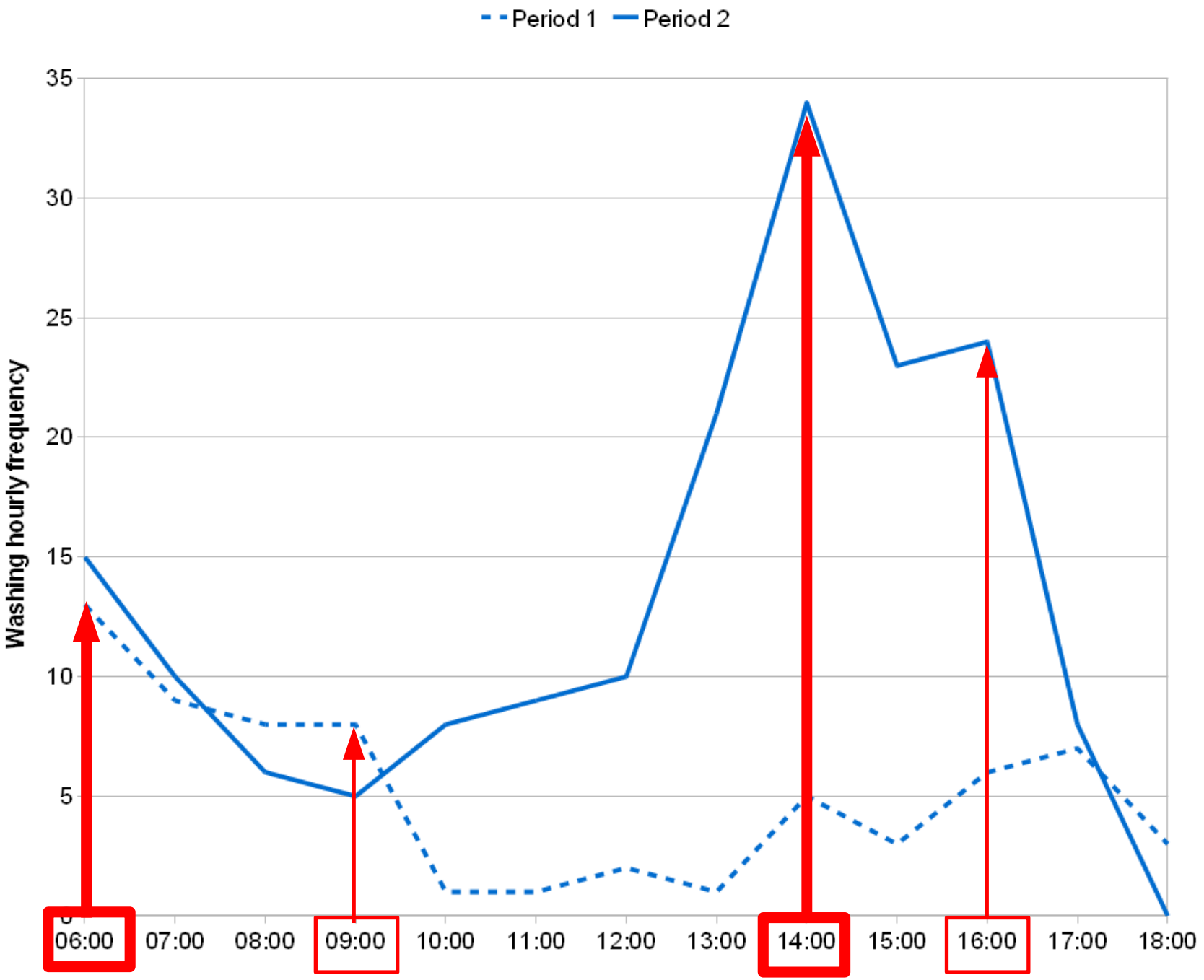
Dishes-clothes washing hourly pattern



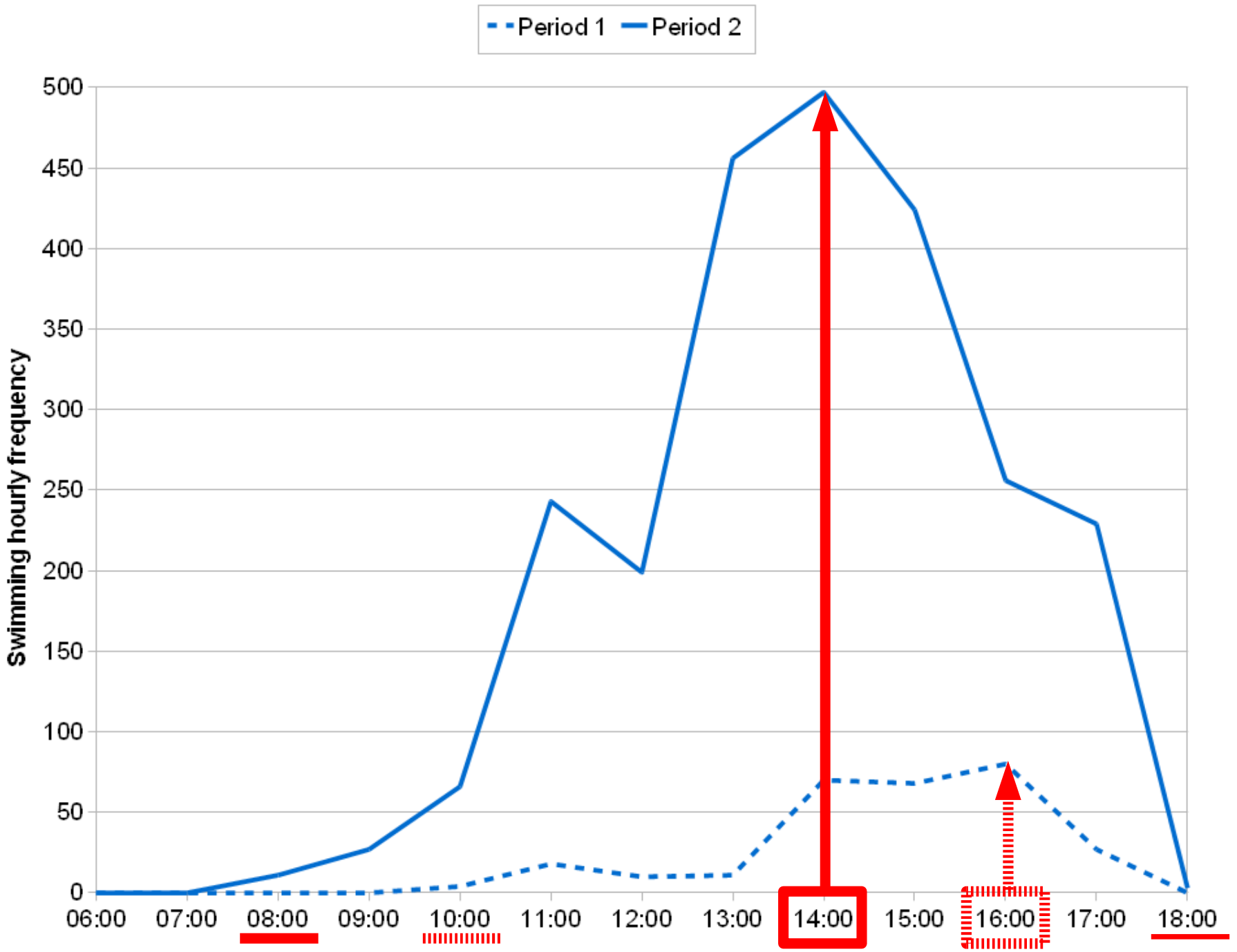
Women having a wash hourly pattern



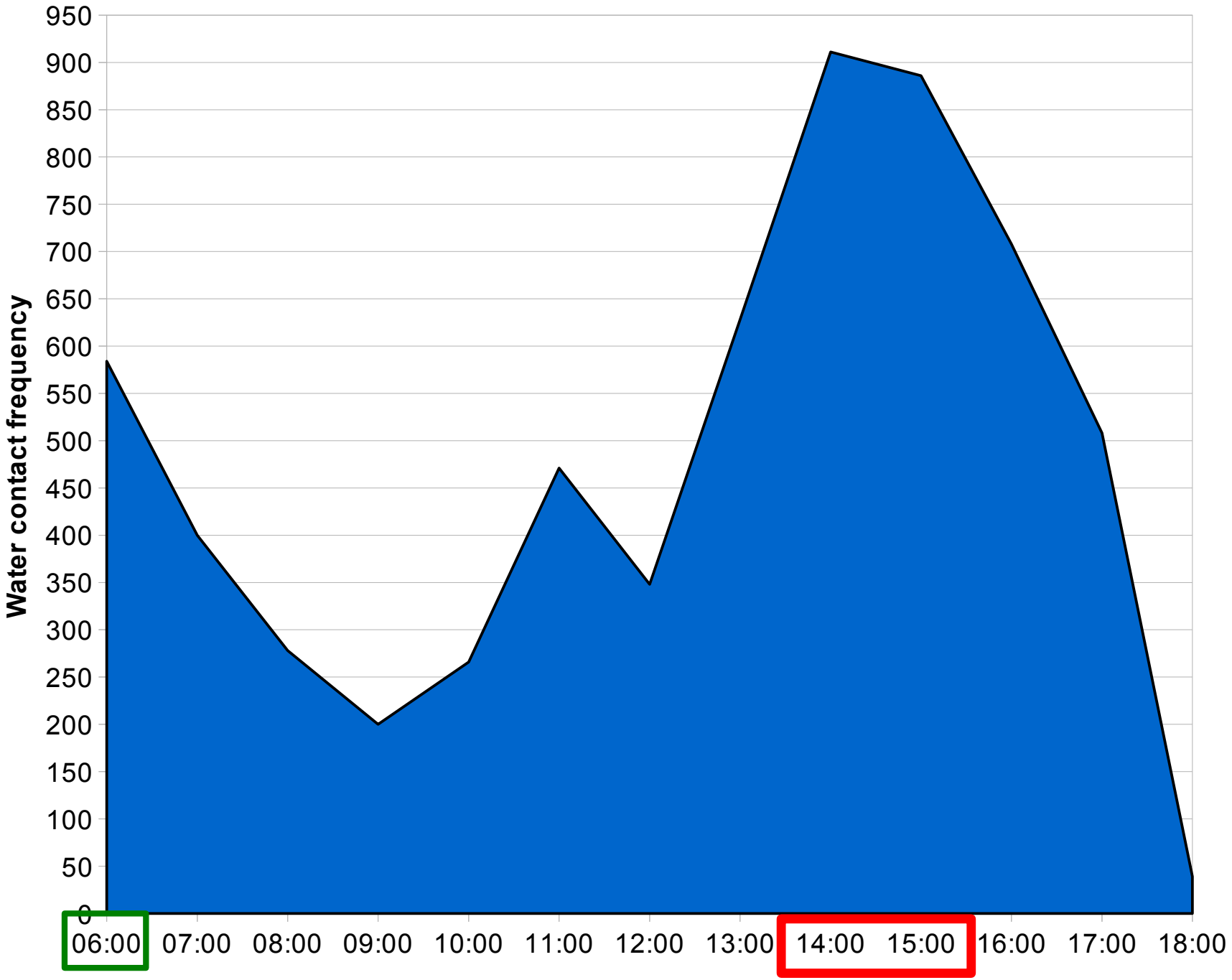
Women washing their children hourly pattern



Children recreational swimming hourly pattern



Water contacts: global hourly pattern



4. Discussion-Conclusion

Strong influence of air temperature on children recreational swimming

Weak influence of air temperature on women domestic tasks

The human water contact behavior followed a circadian pattern

The highest pressure of people on the river occurred between 14:00 and 15:00

The river remains the unique water source in the village and stands for a natural refrigerating

What can be done to change human water exposure behavior?

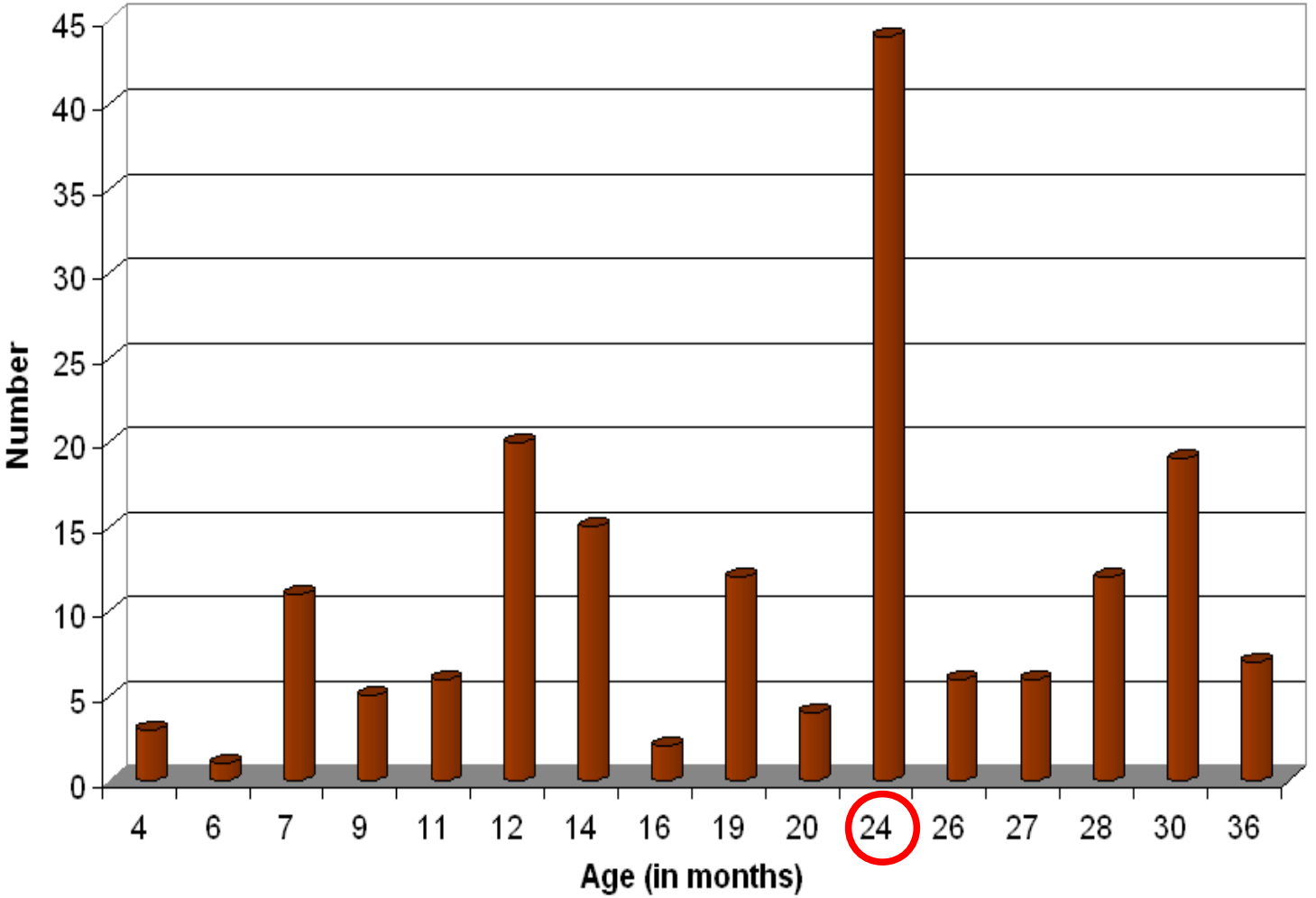
Supply safe water (quantity and quality)

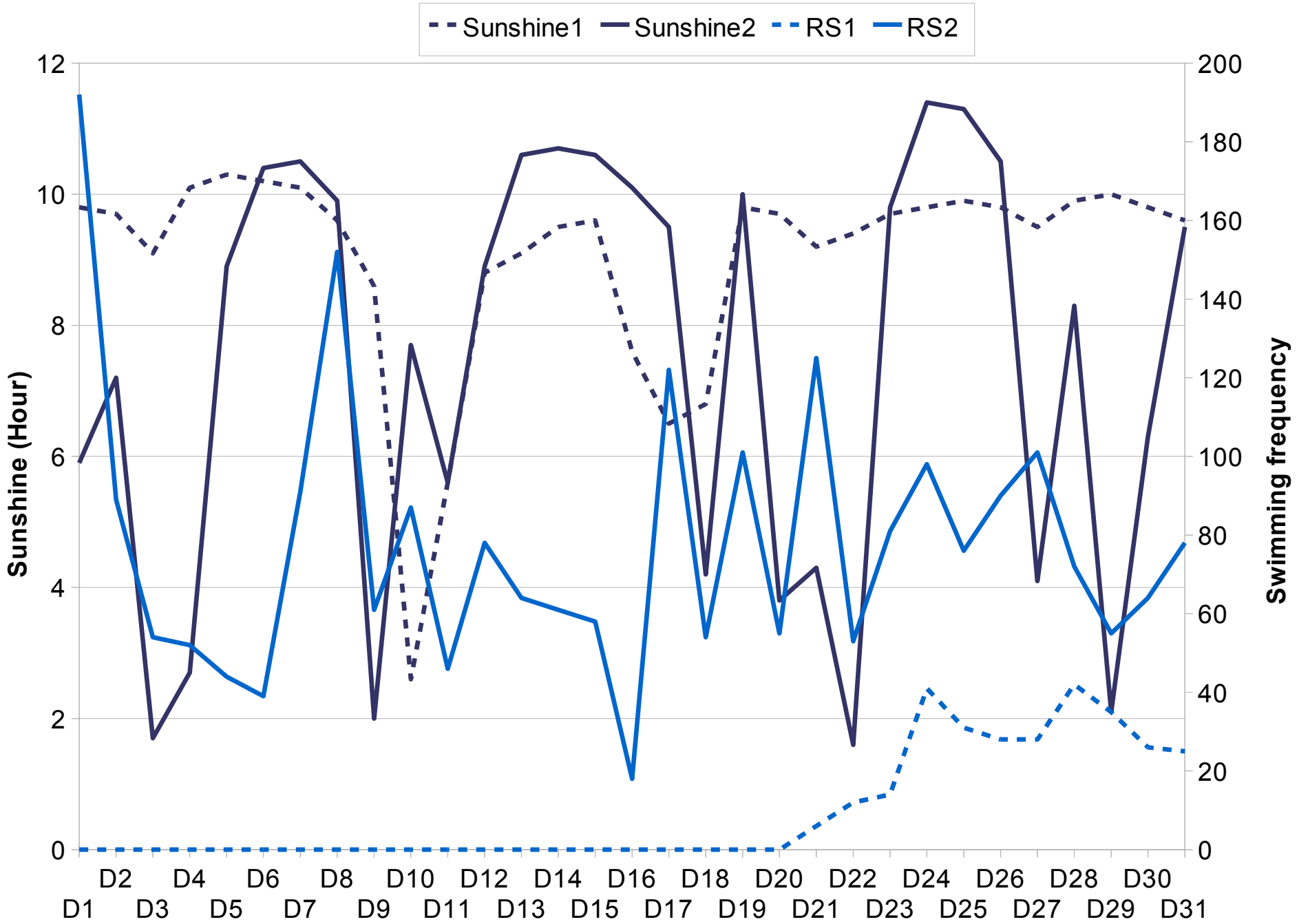
Provide familial latrines or at least public latrines

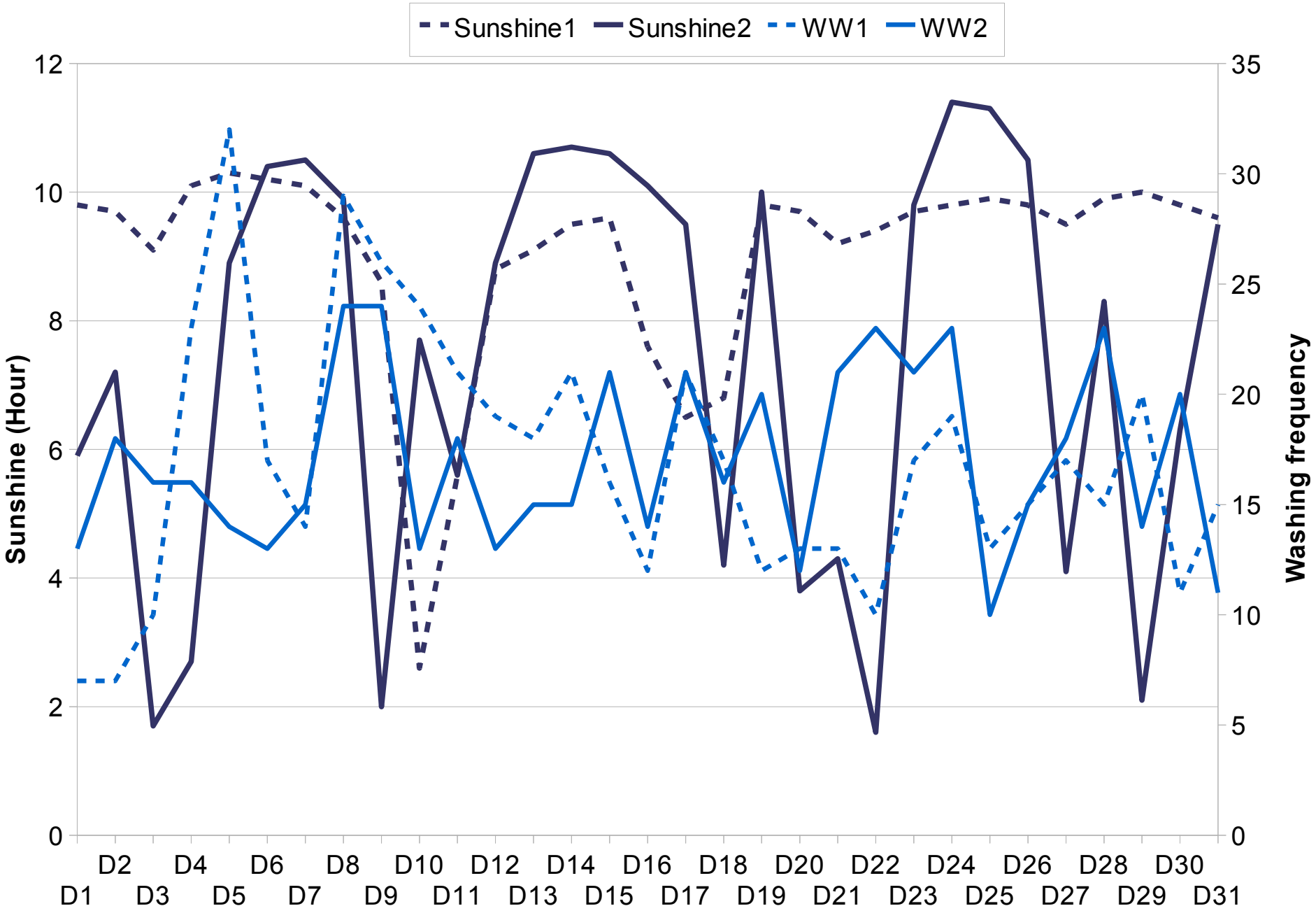
Educate the local populations about the danger of the use of the river

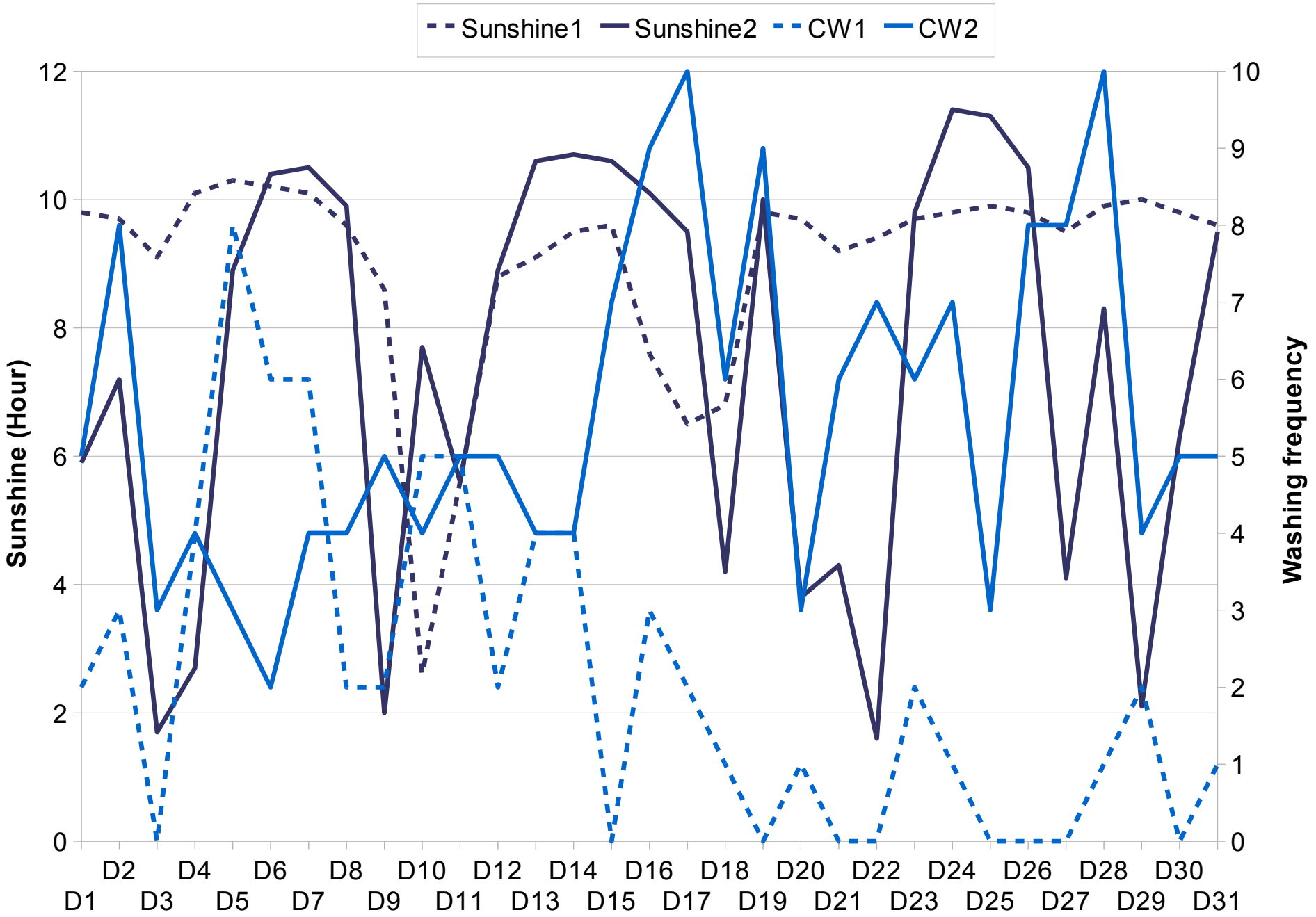

MERCI !!

Age distribution of children washed in the river




Sunshine1
Sunshine2
RS1
RS2
Sunshine (Hour)
Swimming frequency
0
2
4
6
8
10
12
0
20
40
60
80
100
120
140
160
180
200
D1 D2 D3 D4 D5 D6 D7 D8 D9 D10 D11 D12 D13 D14 D15 D16 D17 D18 D19 D20 D21 D22 D23 D24 D25 D26 D27 D28 D29 D30 D31


Sunshine1
Sunshine2
WW1
WW2
Sunshine (Hour)
Washing frequency
0
2
4
6
8
10
12
0
5
10
15
20
25
30
35
D1
D2
D3
D4
D5
D6
D7
D8
D9
D10
D11
D12
D13
D14
D15
D16
D17
D18
D19
D20
D21
D22
D23
D24
D25
D26
D27
D28
D29
D30
D31


Sunshine1
Sunshine2
CW1
CW2
Sunshine (Hour)
Washing frequency
0
2
4
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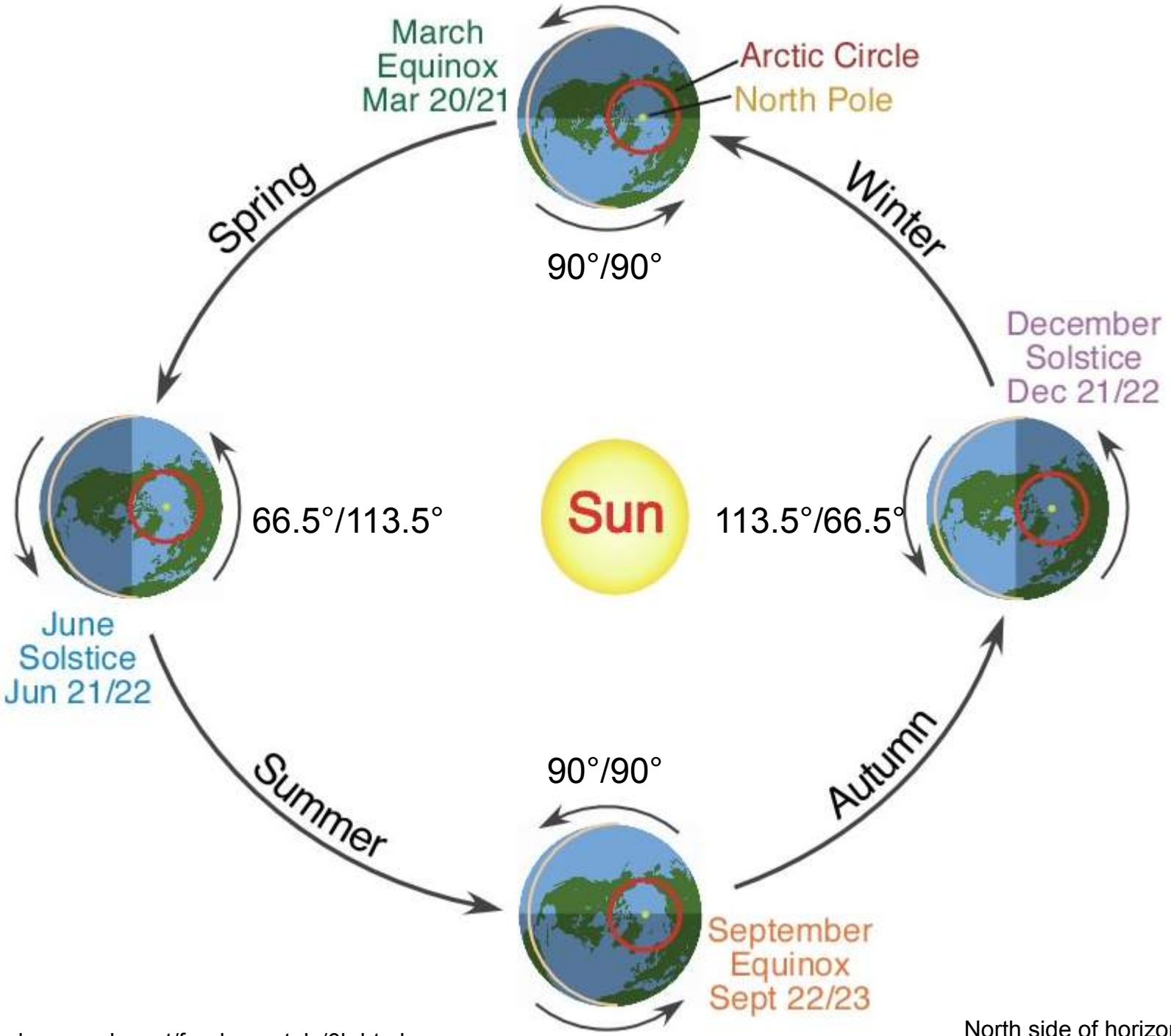

http://www.physicalgeography.net/fundamentals/6h.html

North side of horizon/ true south