9 Appendix

9.1 Soil Profiles

Profile:		***T293***
Date:		23rd Sept. 1998
Author:		G. Rappold
FAO-Unesco		Calcaric Regosol
Location:		village: Mia'amirah, Kadas-district, Terrace 293
Elevation:		1900 m a.s.l.
Physiographic position:		steep middel slope n(> 30%), terraced, exposition: N
Land-Use:		non-mechanical agriculture, rainfed, sorghum, millet
Soil Information:		
Parent material:		Colluvium deposits of volcanic origin (Diodorite)
Drainage:		somewhat excessive, permability: moderate
external drainage:		ponded
moisture cond.:		moist 0 - >120
effect. root depth:		
groundwater level:		not observed
rock outcrops:		few rocks in, (distance 35 - 100 m)
surface stones:		common (10 - 50 %)
evid. of erosion:		yes, profile was made at a gully of the terrace
human influence:		terracing
Comment:		
Profile Description:		
Depth	**Horizon**	
0 – 120	Ah	Loamy sand of brown colour, only a few (5 - 15%) fine (< 2 cm) weathered rock fragments of angular shape appear. The soil is strongly calcareous. The structure can be considered very fine grain with loose consistency when dry.

T239												
Depth (cm)	***Mechanical Analysis***				***pH (1:1)***	***EC [ms/cm]***	***$CaCO_3$ [%]***	***Organic matter [%]***	***Total N [%]***	***(Available ppm)***		***CEC (meg/100g)***
	Sand	***Silt***	***Clay***	***Texture Class***						***P***	***K***	
0	36	48	16	L	7.01	0.38	12.97	1.84	0.21	5.63	80	40.0
20	66	26	8	sL	7.01	0.22	13.10	1.41	0.35	2.81	48	19.13
60	36	48	16	L	7.01	0.71	15.9	2.45	0.21	4.37	68	16.95
90	48	36	16	sL	7.01	1.55	16.55	1.77	0.14	3.44	64	21.73
120	54	32	14	sL	7.00	2.37	20.25	2.0	0.07	6.56	60	26.08

Profile:		***T504***
Date:		17th Sept. 1998
Author:		G. Rappold
FAO-Unesco		calcaric Regosol
Location:		Kadas-District, Village Mia'amirah, terrace 504 UTM: 38 P 04111184, 1471805
Elevation:		1920 m NN
Physiographic position:		terraced middle slope, exposition: N
Land-Use:		non-mechanical agriculture sorghum, millet
Soil Information:		
Parent material:		Sandstone (in situ weathered) and volcanic (slope rubble)
Drainage:		well drained
external drainage:		ponded
moisture cond.:		profile moist throughout
effect. root *depth:*		60 cm
groundwater level:		not known, approx. 9 m below surface at a well at the foot of the slope but no effect on profile.
rock outcrops:		few rocks, distance 35 – 100 m
surface stones:		few gravel
evid. of erosion:		profile was made at a fresh gully (break of terrace).
human influence:		very strong,-man-made terrace
Comment:		The profile was made at a terrace wall that had broken apart in a strong rainfall. According to the information of the field owner, the terrace was established 20 years ago. No different horizons could be found. The whole profile was assigned as loamy sand.
Profile Description:		
Depth	**Horizon**	**Description**
0 -150	Ahp	dark brown loamy sand. common rock fragments, angular shape, mostly of volcanic origin; strongly calcareous throughout the profile with a few calcareous concretions; decent mottles in pale yellow appear. The structure is classified according to the sandy texture loose single grain. Only the compaction rises with the depths. A few pores appears. The roots of the sorghum reach a depth up to 60 – 80 cm, big roots of a tree nearby reach more than 150 cm. The depth of the terrace continued for one more meter.

T504												
Depth (cm)	***Mechanical Analysis***				***pH (1:1)***	***EC [ms/cm]***	***$CaCO_3$ [%]***	***Organic matter [%]***	***Total N [%]***	***(Available ppm)***		***CEC (meg/100g)***
	Sand	***Silt***	***Clay***	***Texture Class***						***P***	***K***	
0	68	22	12	sL	7.6	0.26	12.2	1.39	0.35	8.75	56	16.24
30	72	16	12	sL	7.6	0.19	10.3	1.20	0.7	3.13	80	25.24
60	72	18	10	sL	7.8	0.16	11.15	1.1	1.05	8.75	56	16.24
90	76	16	8	sL	7.9	0.15	11.87	0.98	0.7	4.68	44	25.02

Profile:		***T610***
Date:		9th Oct. 1998
Author:		G. Rappold
FAO-Unesco		Calcaric Regosol
Location:		village: Mia'amirah, Kadas-district, Terrace 610 about 100 m above the school on the trail to the core village E 44° 10' 41,8'' , N 13° 18' 41,5''
Elevation:		1981 m a.s.l.
Physiographic position:		middle slope, shallow man made terrace
Land-Use:		non-mechanical agriculture, rainfed, sorghum, millet no (semi-) natural vegetation
Soil Information:		
Parent material:		Tawilah Group Sandstone (Medj-Zir)
Drainage:		well drained, moderate permability
external drainage:		ponded
moisture cond.:		moist 0 - 60 cm
effect. root *depth:*		60 cm
groundwater level:		not observed
rock outcrops:		extremely rocky in close distance (< 3 m)
surface stones:		common (30%)
evid. of erosion:		yes, profile was made at an old (1997) gully of the terrace
human influence:		terracing
Comment:		Clay and silt in the ploughing lines
Profile Description:		
Depth	**Horizon**	
0 – 60	Ah CMc	Pale dark brown sandy clay loam, sand fraction fine; common rock fragment (25-30 %) in fine to medium size (< 7,5 cm), weathered, in subrounded (sandstone) or angular shape. The volcanic stones are slope rubble. The soil is extremely calcareous (10-15 %) but has only a few fine soft segregations of carbonates. Yellow to grey-white mottels are common (5%), they have usually medium (5-15 mm) size and a distinct clear border. The soil structure is a single grain, granular one which has a loose (dry) to very friable (moist) consistency. The soil is slightly sticky and only slightly plastic. Only a few pores of interstitial and channel origin appear, but with a considerable range of size (1 – 5 mm). Roots are common and can be found through the whole depth of the soil. Shells of snails can be found as well as ant channels. The border to the pending rock is abrupt.
> 60	C	Medj-Zir Sandstone (coarse grained)

T610												
Depth (cm)	***Mechanical Analysis***				***pH (1:1)***	***EC [ms/cm]***	***$CaCO_3$ [%]***	***Organic matter [%]***	***Total N [%]***	***(Available ppm)***		***CEC (meg/100g)***
	Sand	***Silt***	***Clay***	***Texture Class***						***P***	***K***	
0-60	70	20	10	sL	7.5	0.17	13.1	1.1	0.35	2.81	60	16.21

Profile:	***T333***
Date:	8th Oct. 1998
Author:	G. Rappold
FAO-Unesco	Regosol
Location:	village: Mia'amirah, Kadas-district, Terrace 333, E 44° 10' 57,3'' , N 13° 18' 31,6''
Elevation:	1935 m a.s.l.
Physiographic position:	middel slope, shallow man made terrace, exposition: W
Land-Use:	abandoned terrace with grass and shrubs for grazing, shrubs
Soil Information:	
Parent material:	Diodorite (volcanic, slope deposits) and Medj-Zir sandstone (in situ weathered)
Drainage:	moderately well drained, permeability: moderate
external drainage:	rapid
moisture cond.:	moist 0 - 200
effect. root *depth:*	50 - 100, (max. root depth 130)
groundwater level:	not observed
rock outcrops:	many rocks, distance (< 10-35 m)
surface stones:	common (10 - 50 %)
evid. of erosion:	yes, profile was made at a gully of the terrace
human influence:	terracing
Comment:	potential rooting depth ~ 180 cm
Profile Description:	

Depth	**Horizon**	
0 - 120	Ah	Dark brown loamy sand (fine – coarse) with common fine but weathered rock fragments of subrounded (sandstone) and angular (volcanic) shape. Carbonate is estimated at 2 – 4 %. Only in the lower part a few pale yellow mottles can be found. The soil structure is, due to the sandy texture, clearly single grain. The consistency in moist conditions is loose. The wet soil is non-sticky and non-plastic. The top soil is considered not compacted though the compaction rises with depth. Only a few interstitial pores (1 – 2 mm) are visible. Many roots occur down to a depth of 15 cm, then they are considered common. A few ant-channels are visible. The boundary has a smooth transition to the lower horizon.

T333												
Depth (cm)	***Mechanical Analysis***				***pH (1:1)***	***EC [ms/cm]***	***$CaCO_3$ [%]***	***Organic matter [%]***	***Total N [%]***	***(Available ppm)***		***CEC (meg/100g)***
	Sand	***Silt***	***Clay***	***Texture Class***						***P***	***K***	
0-20	70	22	8	sL	7.01	0.14	7.15	0.95	0.7	2.81	48	17.39
20 - 90	66	18	16	sL	7.9	0.14	6.77	1.07	0.35	3.44	32	26.07
120	80	10	10	sL	7.01	0.17	8.63	0.88	0.35	2.81	52	21.71

Profile:	***T353***
Date:	26.10.98
Author:	G. Rappold
FAO-Unesco	Calcaric Cambisol
Location:	Kadas-District, Village Mia'amirah, terrace 353 in a hole dug for a new well
Elevation:	
Physiographic position:	terraced middle slope, exposition: N
Land-Use:	non-mechanical agriculture, sorghum, millet
Soil Information:	
Parent material:	Sandstone
Drainage:	well rained
external drainage:	ponded
moisture cond.:	dry
effect. root *depth:*	60 cm
groundwater level:	not observed (well was dry and abandoned)
rock outcrops:	few rocks, distance 35 – 100 m
surface stones:	few gravel
evid. of erosion:	some
human influence:	very strong, -man-made terrace
Comment:	
Profile Description:	

Depth	**Horizon**	**Description**
0 – >120	Ah	Grey brown loamy sand with few rock fragments of fine to medium size (weathered); strongly calcareous with a few fine concretions. Some decent mottles appear, the structure is very fine single grain (platy). The dry consistency is extremely hard. The compaction is continuous and strongly cemented by clay and probably carbonates. Fine pores appear. Fine roots are common.

T 353

Depth (cm)	***Mechanical Analysis***				***pH (1:1)***	***EC [ms/cm]***	***$CaCO_3$ [%]***	***Organic matter [%]***	***Total N [%]***	***(Available ppm)***		***CEC (meg/100g)***
	Sand	***Silt***	***Clay***	***Texture Class***						***P***	***K***	
40	76	16	8	sL	7.5	0.21	9.67	1.24	0.35	3.13	40	16.20
100	70	20	10	sL	7.8	0.20	8.5	1.36	1.05	2.5	40	28.70
180	78	12	10	sL	7.0	0.74	11.33	1.21	0.14	2.81	44	21.72
300	72	18	10	sL	7.6	0.18	10.9	1.45	0.35	3.44	56	30.24
340	22	44	34	cL	7.8	0.24	25.57	1.1	1.05	2.5	60	17.39

Profile:		***T557a***
Date:		
Author:		G. Rappold
FAO-Unesco		Fimic Anthrosol (mollic)
Location:		Kadas-District, Village Mia'amirah, terrace 557a
Elevation:		
Physiographic position:		terrace in the wadi
Land-Use:		non-mechanised agriculture sorghum
Soil Information:		
Parent material:		Sandstone
Drainage:		moderately well drained
external drainage:		ponded
moisture cond.:		slightly moist - moist
effect. root *depth:*		
groundwater level:		not observed
rock outcrops:		few rocks
surface stones:		very few
evid. of erosion:		strong (gully erosion)
human influence:		terraces (man-made)
Comment:		
Profile Description:		
Depth	**Horizon**	**Description**
0 – 45	Ah	Brown (moist) loamy sand (fine) without rock fragments. Moderately calcareous. Few fine mottles with distinct contrast and sharp boundary appear. The structure is very weak fine granular. The moist consistency is friable and slightly sticky. Compaction is nil. Medium pores are common. The boundary is clear
> 45		Pale brown (dry) sandy (very fine) clay loam with very few rock fragments. Slightly calcareous with common fine and soft segregations. Fine mottles with sharp boundary are prominent. The structure is very-fine to fine of granular kind. The consistency is very hard, very firm and sticky. Compaction is continuous and massive probably by clay. Very fine pores are common. Burrows are biological features.
		Soil analysis damaged during the transport to the laboratory.

Profile:		***T 147***
Date:		27th Oct. 1998
Author:		G. Rappold
classification:		
FAO-Unesco		Calcaric Regosol
Soil Tax.		
Location:		Kadas-District, Village Mia'amirah, terrace T147
Elevation:		
Physiographic position:		upper slope
Land-Use:		rainfed farming
Soil Information:		
Parent material:		alluvium/colluvium
Drainage:		well drained
external drainage:		ponded, slow
moisture cond.:		moist / dry
effect. root *depth:*		40 cm
groundwater level:		not observed
rock outcrops:		common rocks
surface stones:		many - gravel
evid. of erosion:		yes
human influence:		terraces
Comment:		
Profile Description:		
Depth	**Horizon**	**Description**
0 – 140	Ap	Brown sandy loam. Few fine rock fragments of angular shape, weathered. The soil is extremely calcareous. The structure is very fine single grain and of loose consistency. No compaction with common very fine pores (interstitial/channels). Very fine roots are common and a few biological features (ants) can be observed.

Profile:		***T 383***
Date:		22nd Oct. 1997
Author:		G. Rappold
FAO-Unesco		Anthrosol
Location:		Kadas-District, Village Mia'amirah, terrace T147
Elevation:		
Physiographic position:		cannel
Land-Use:		rainfed farming
Soil Information:		
Parent material:		in situ weathered sandstone
Drainage:		well
external drainage:		ponded
moisture cond.:		slightly moist
effect. root *depth:*		
groundwater level:		not observed
rock outcrops:		common rocks
surface stones:		common
evid. of erosion:		yes (profile at channel wall)
human influence:		terraced
Comment:		yearly levelling good to recognise
Profile Description:		
Depth	**Horizon**	**Description**
0 – 90	Ah	Dark brown sandy loam (coarse sand fraction) with many medium sized rock fragments. The soil is slightly calcareous. The structure is very weak and moist, consistency is loose. The soil is non-sticky and non plastic and is not compacted. Very fine pores are common and a few roots are visible, the boundary is gradual.
> 90		Ochre sandy loam with few rock fragments of medium size and angular shape. The soil is slightly calcareous with common fine, angular and hard concretions (of carbonates?). Fine distinct mottles are common. The structure is very fine and fine and very weak. The dry consistency is very hard and very friable. The material is in wet conditions sticky and slightly plastic. The massive compaction is continuous and strongly cemented by (probably) clay and carbonates. Very fine pores are common while roots are absent.

9.2 Automatic Meteorologic Station

Parameter	*Range*	*Unit*	*Precision*
Air humidity	0 – 100 %	[1]	± 3 % [a]
Air temperature	- 35 – 55° C	[° C]	± 0.2° C [a]
Air pressure	600 – 1060 mb	[mbar] = [hPa]	± 6 mb [a]
Solar radiation	0 – 2000W/m²	[W/m²]	± 10.00 % [a]
Wind speed	0 – 55 m/s	[m/s]	< 1.5 % [a]
Wind direction	0 – 360°	degree	< 0.3 % [b]
Soil temperature	-5 – 105° C	° C	± 0.5.° C [a]
Volumetric Water Content	0 – 100 %	[1]	± 2 % [a]
Precipitation	0.25 mm	[mm/m²]	< 5%; 20% [c]

Table 9.1 Parameters of the meteorological station

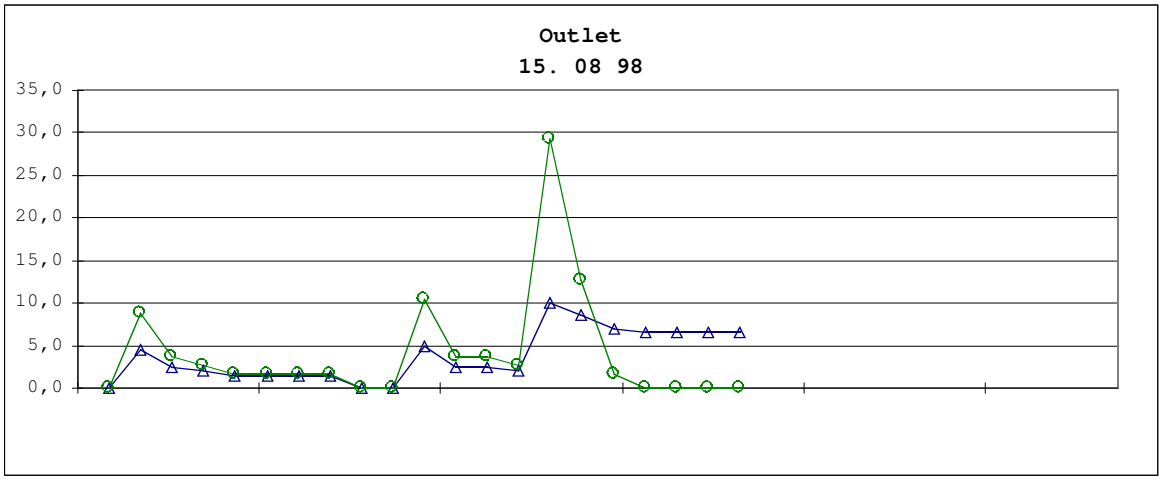
a A measurement was conducted every 2 min and stored as 30 min averages
b A measurement was conducted every 10 s and stored as 30 min averages
c The device counted the moves of the seesaw within a 10 min interval. The results were only stored if they were different from 0.

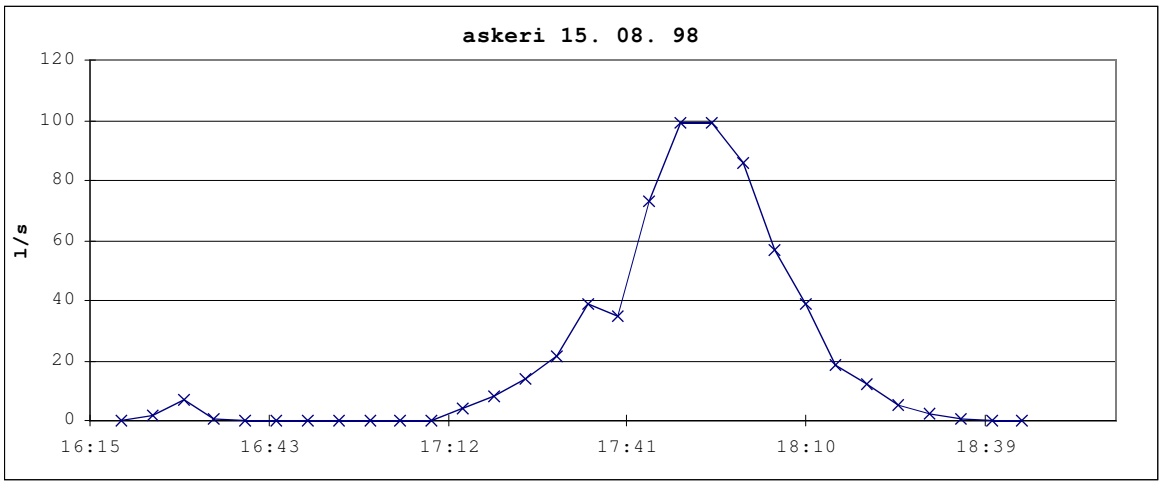
9.3 Other Parameters

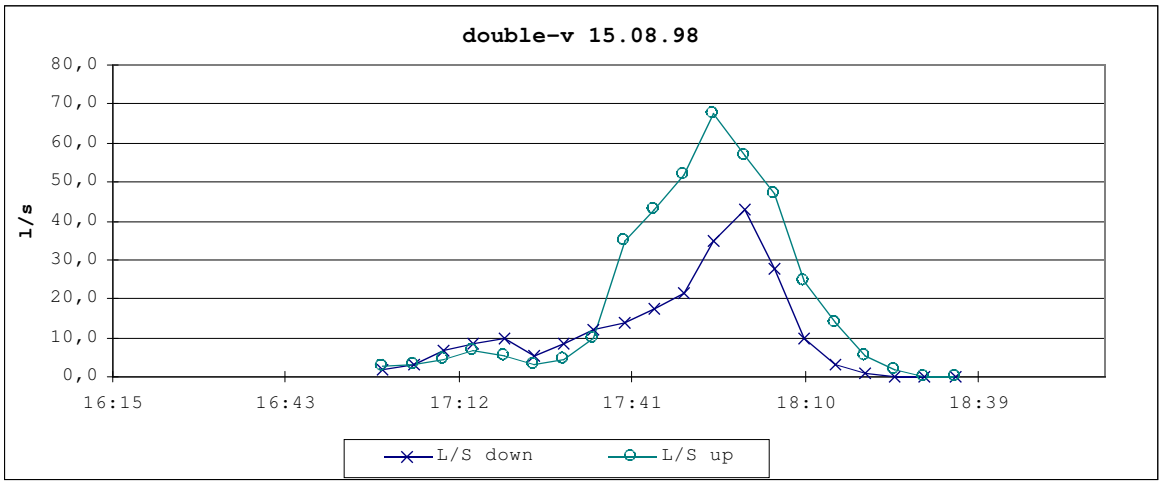
Parameter	*Measurement*	*Estimated error*	*Comment*
Soil moisture	gravimetric	10.00%	
Soil moisture	TDR	< 5%; > 20%	not practicable
Runoff outlet 97	water level estimation	40.00%	
Runoff outlet 98	flume with float	20.00%	
Runoff other	v-notch	10.00%	

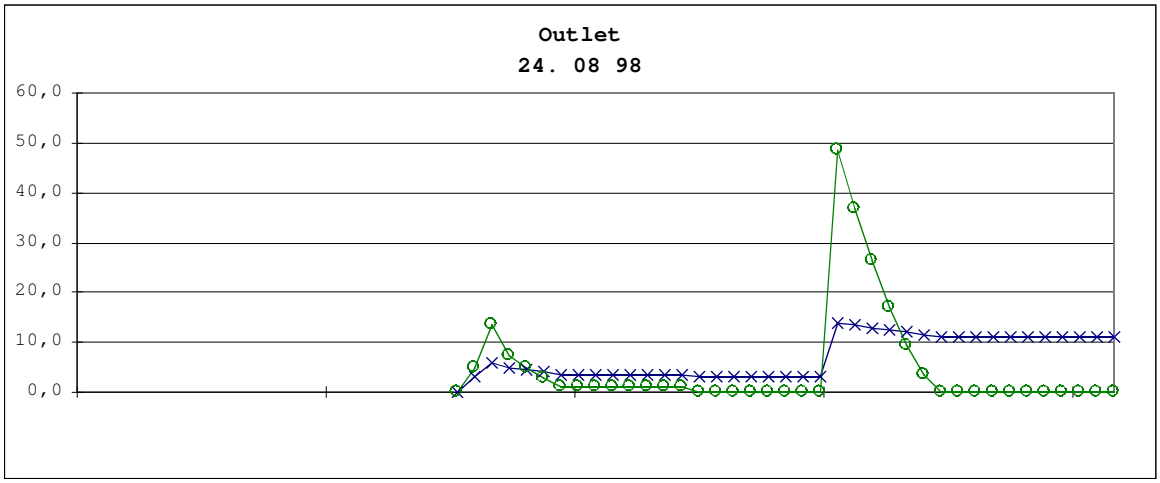
Table 9.2 Hydrological parameters

9.4 Hydrographs





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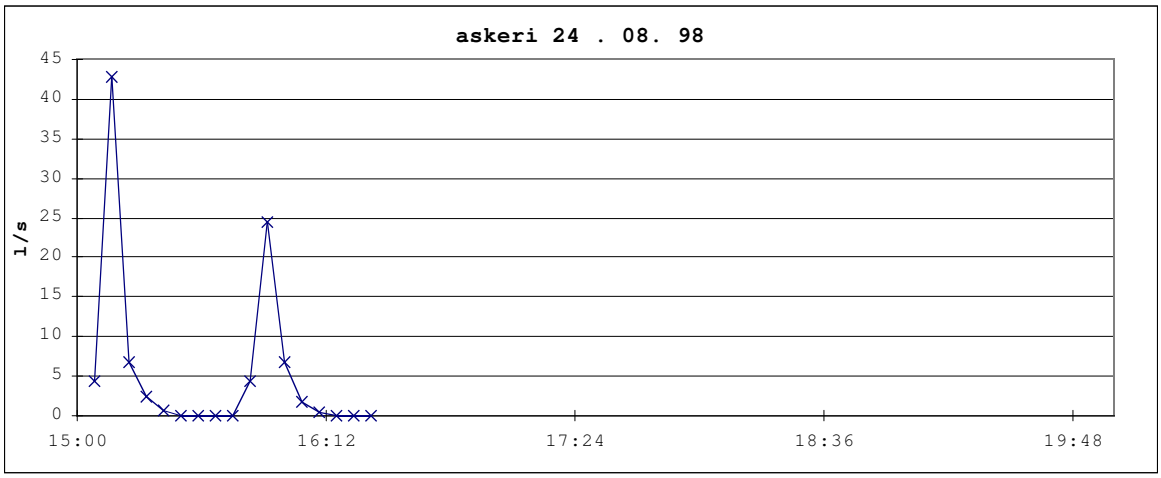
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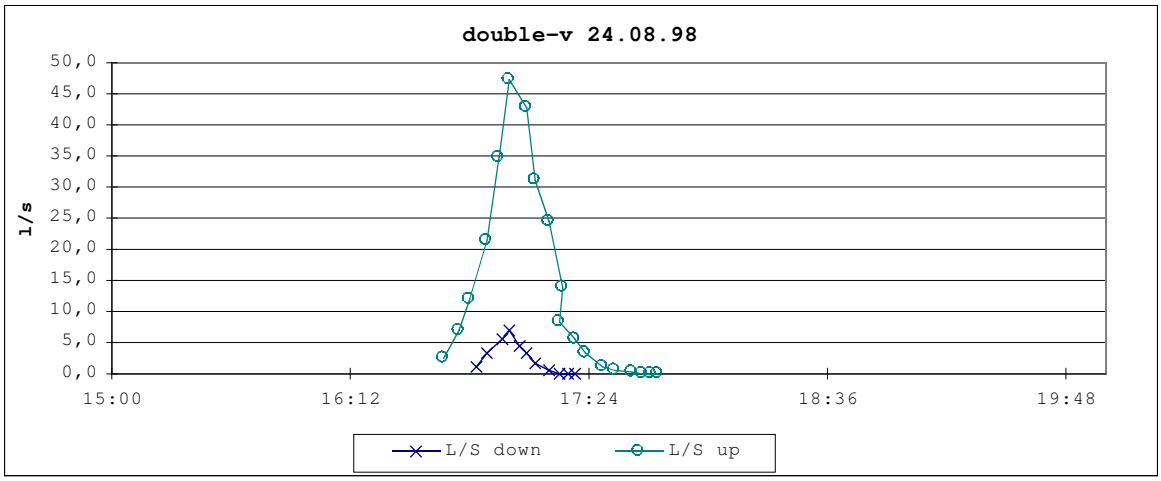
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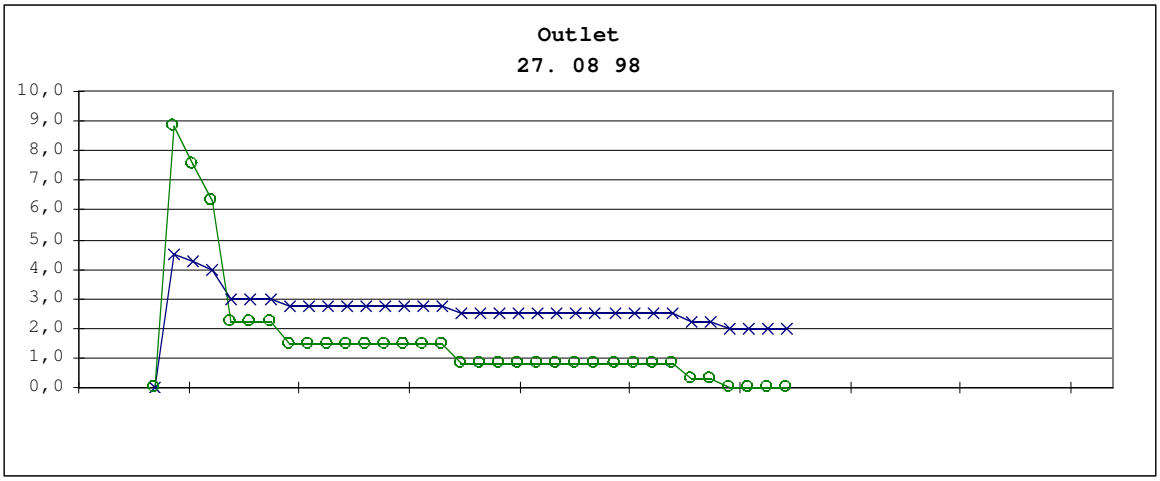
L/S down
L/S up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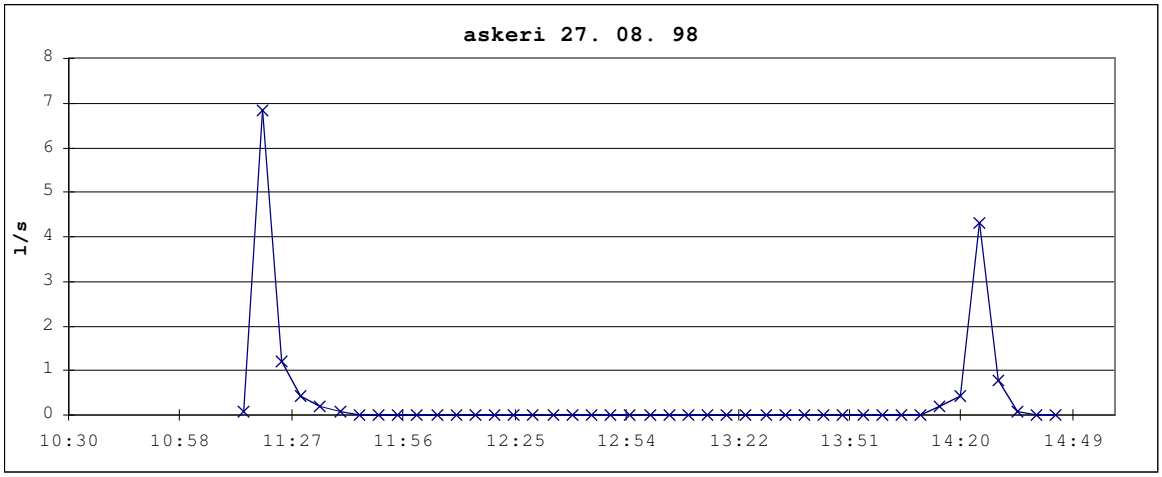
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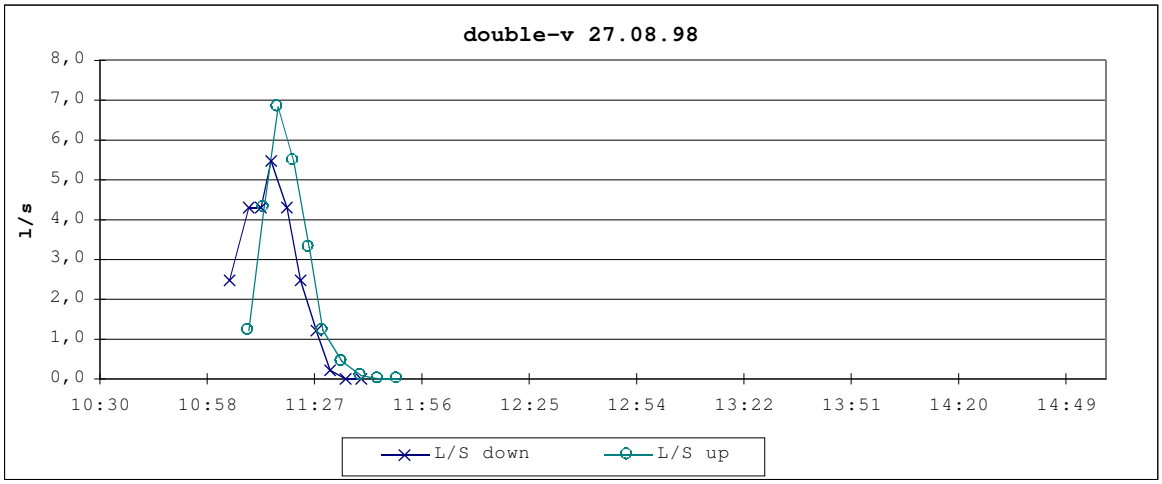
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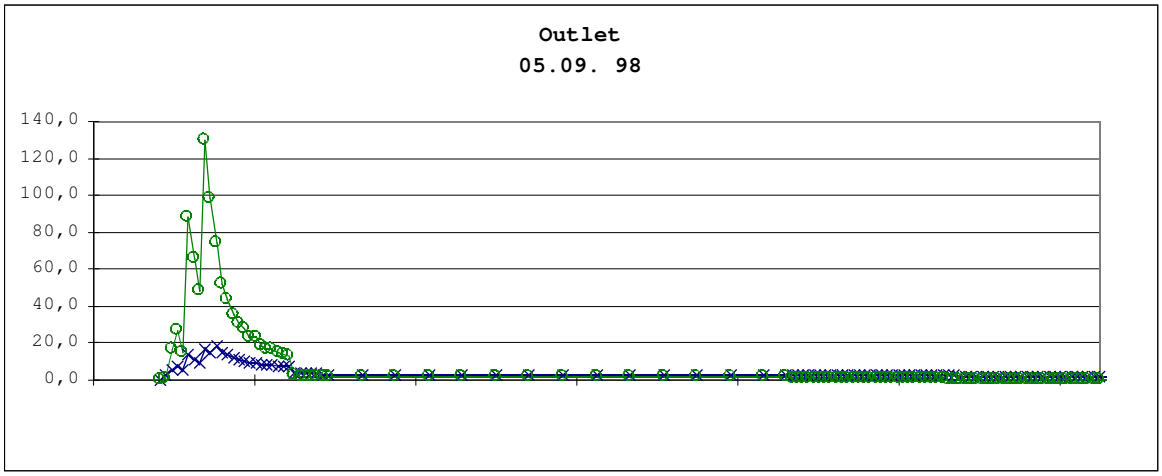
L/S up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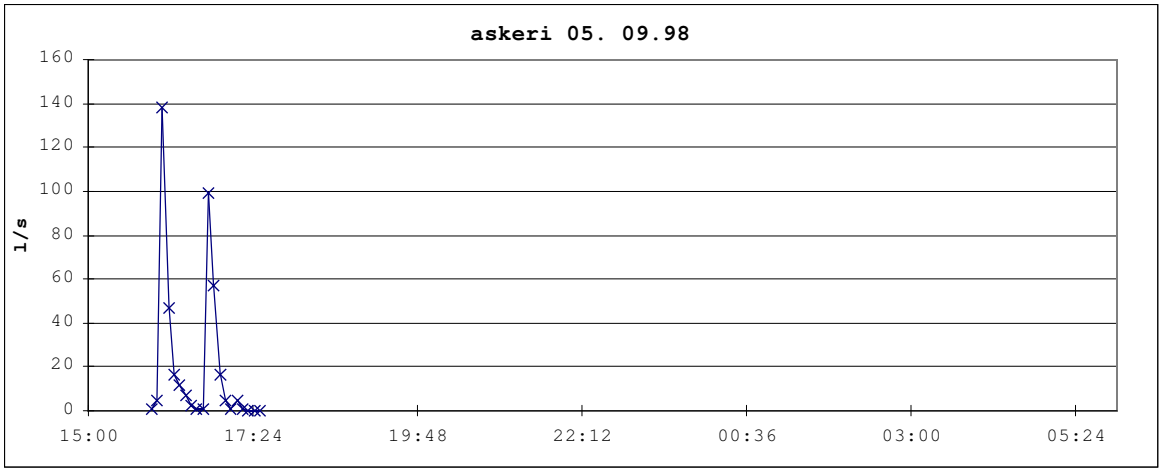
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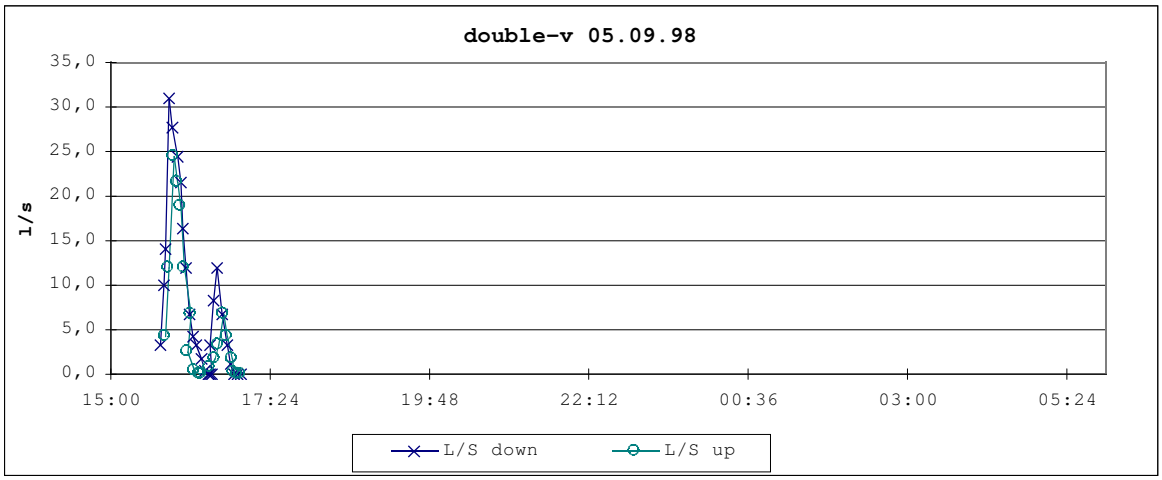
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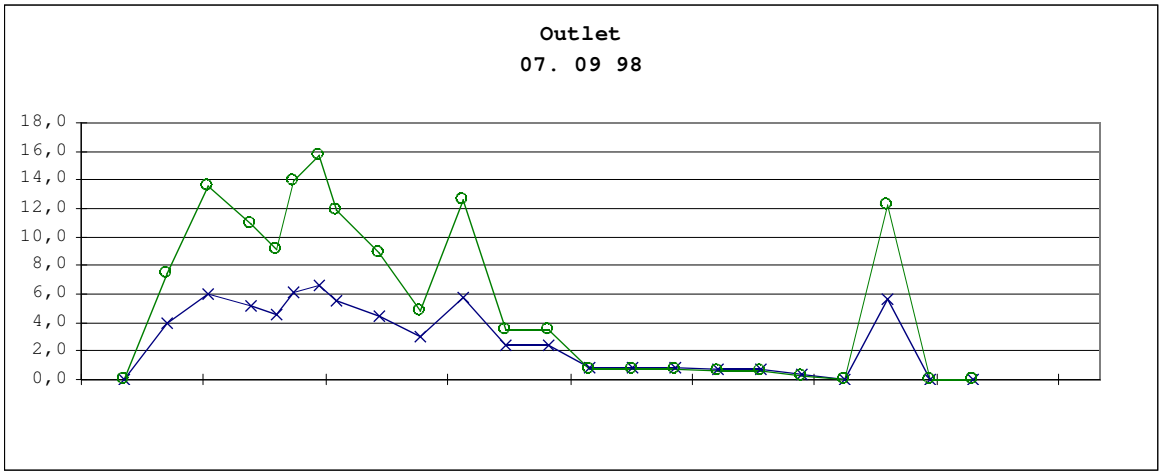
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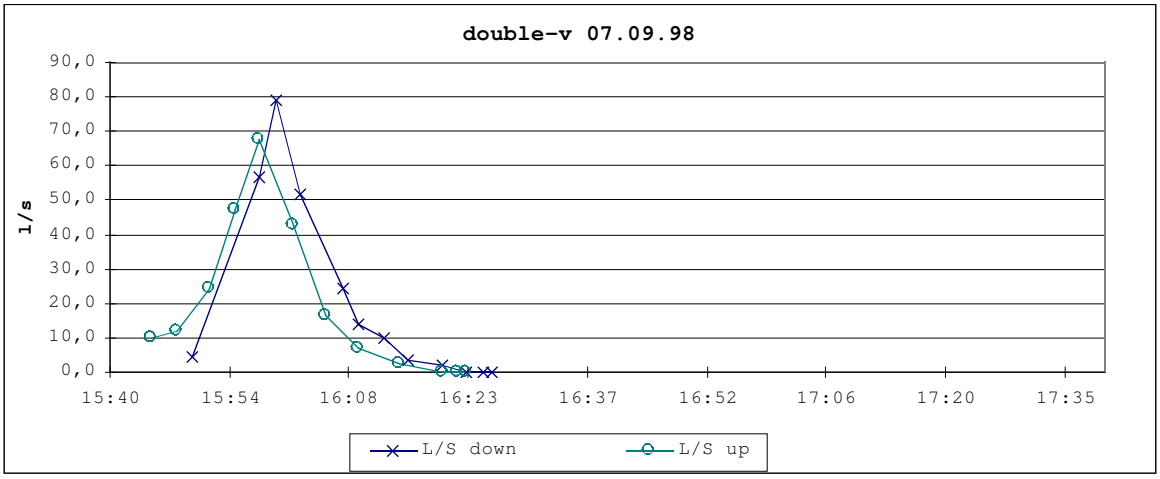
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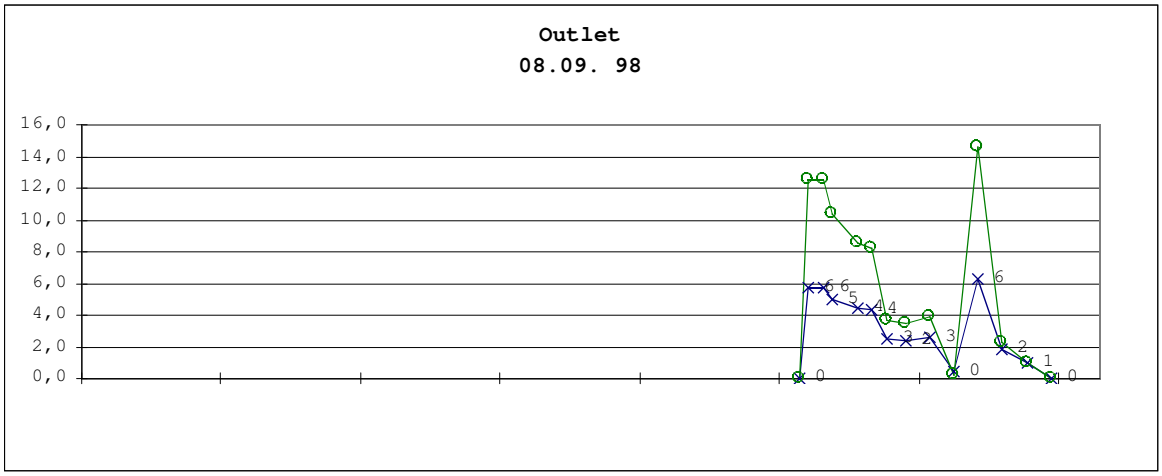
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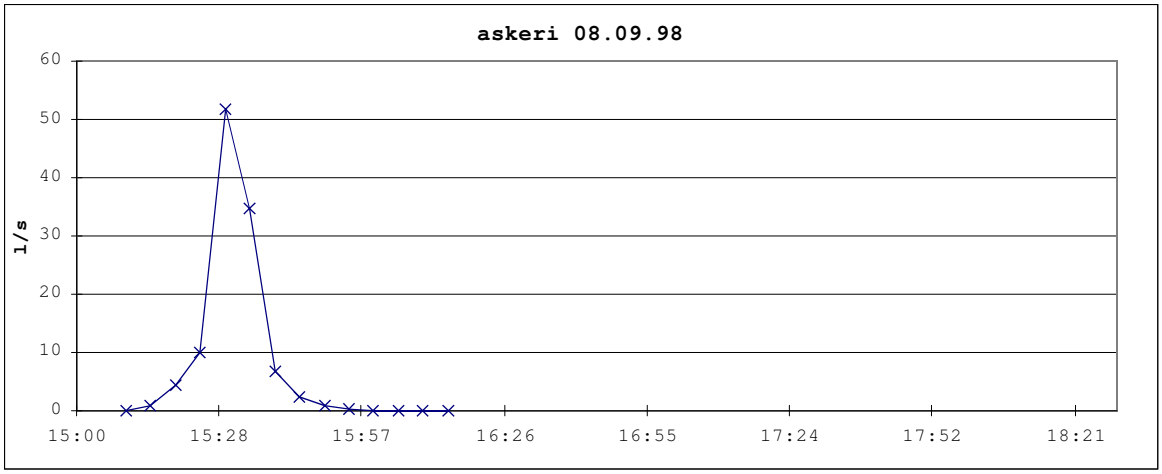
askeri 08.09.98
l/s
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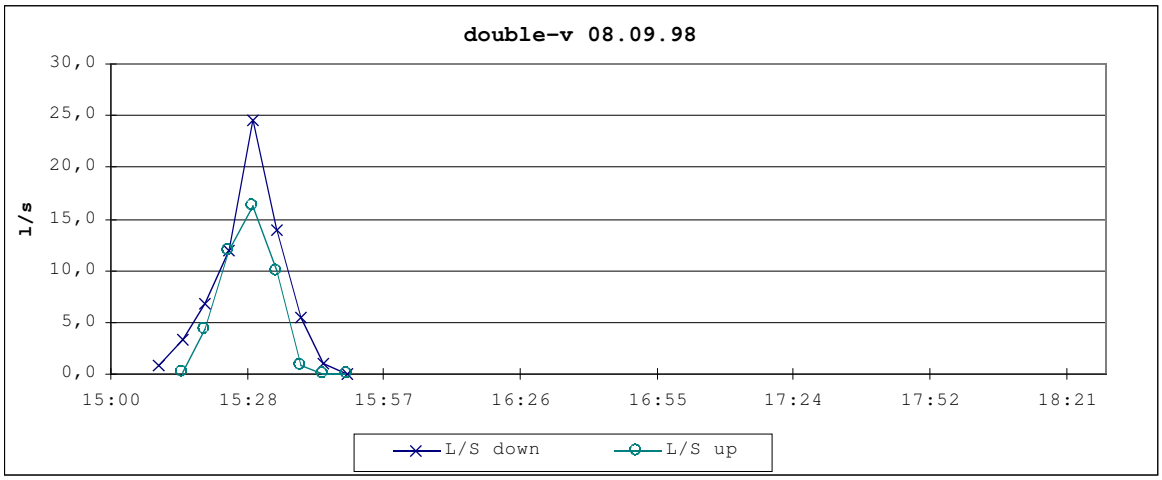
50
40
30
20
10
0
15:00
15:28
15:57
16:26
16:55
17:24
17:52
18:21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l/s
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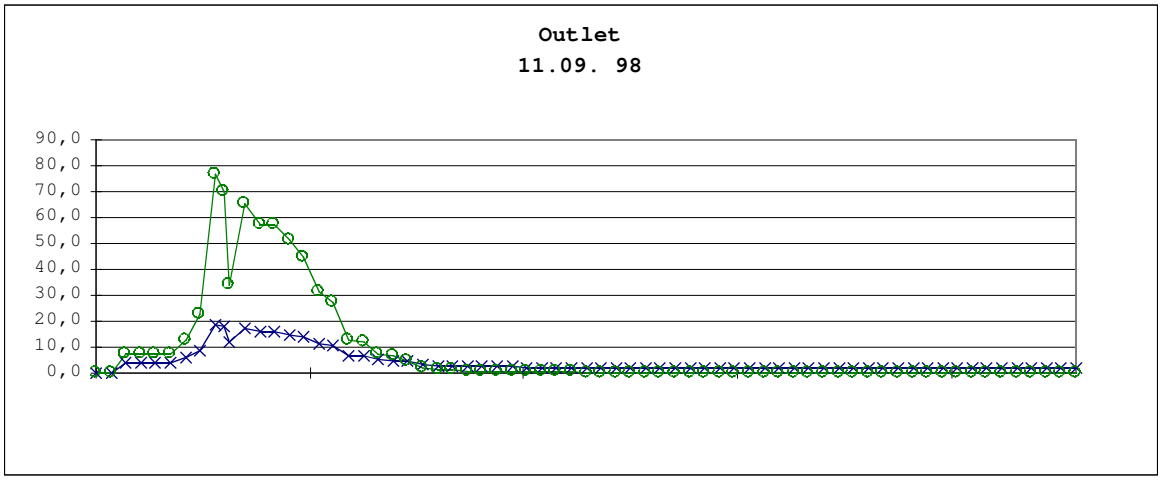
25,0
20,0
15,0
10,0
5,0
0,0
15:00
15:28
15:57
16:26
16:55
17:24
17:52
18:21
L/S down
L/S up


Outlet
11.09. 98
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80,0
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60,0
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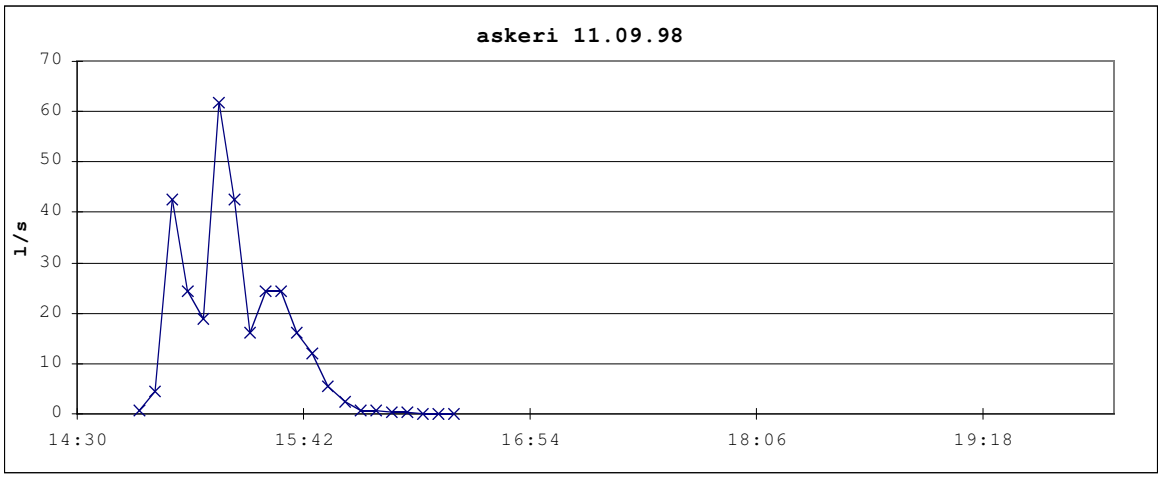
40,0
30,0
20,0
10,0
0,0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l/s
70
60
50
40
30
20
10
0
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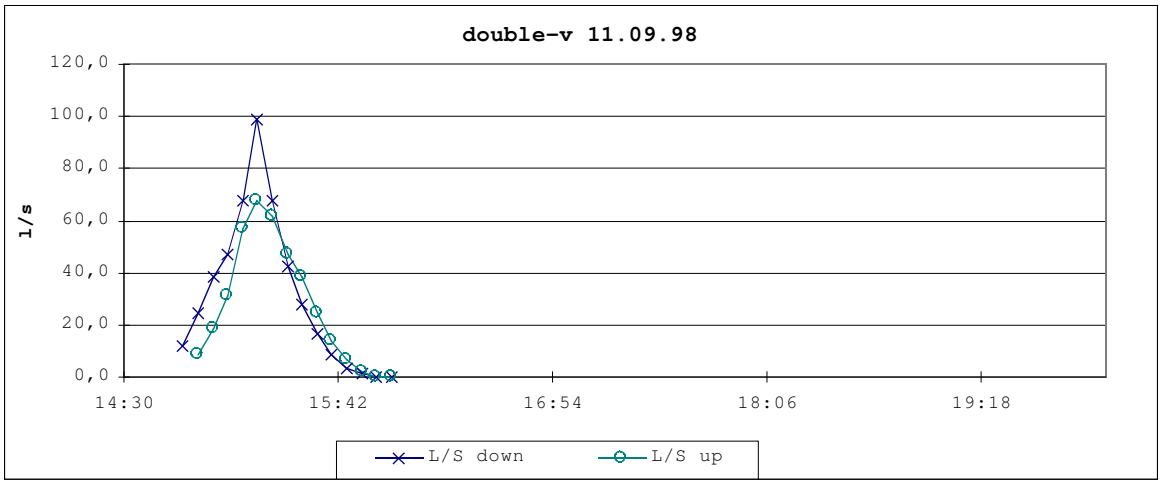
15:42
16:54
18:06
19:18


double-v 11.09.98
l/s
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100,0
80,0
60,0
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20,0
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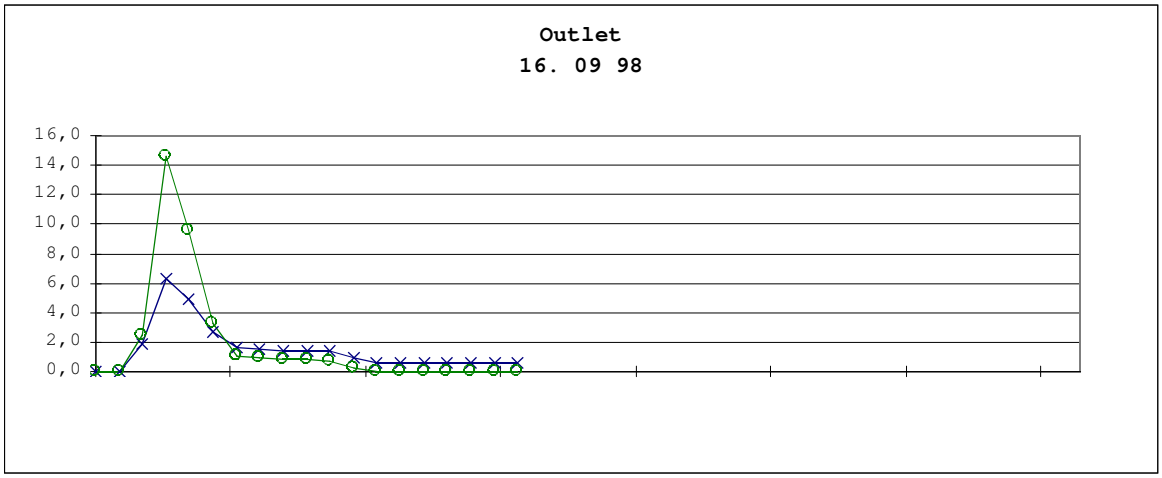
14:30
15:42
16:54
18:06
19:18
L/S down
L/S up


Outlet
16. 09 98
16,0
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12,0
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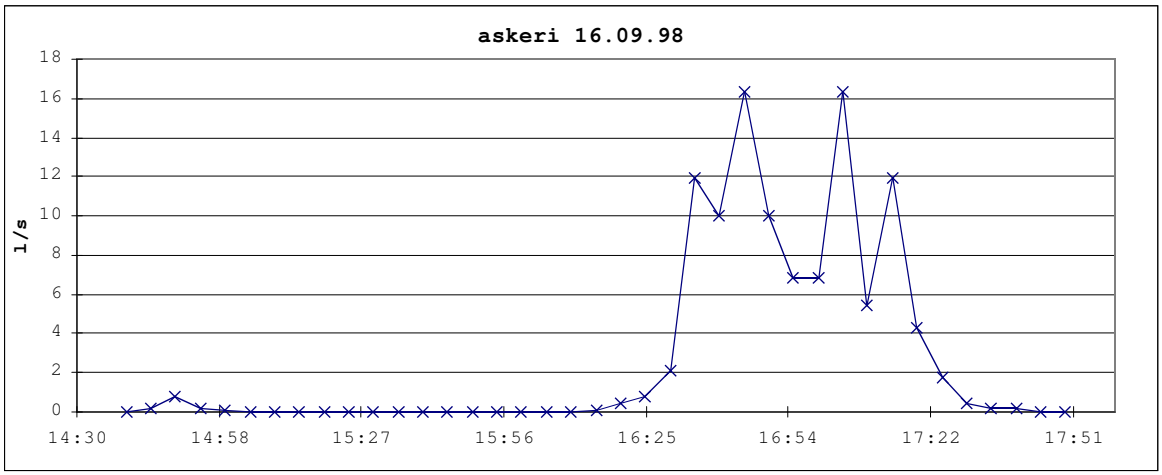
8,0
6,0
4,0
2,0
0,0


askeri 16.09.98
l/s
18
16
14
12
10
8
6
4
2
0
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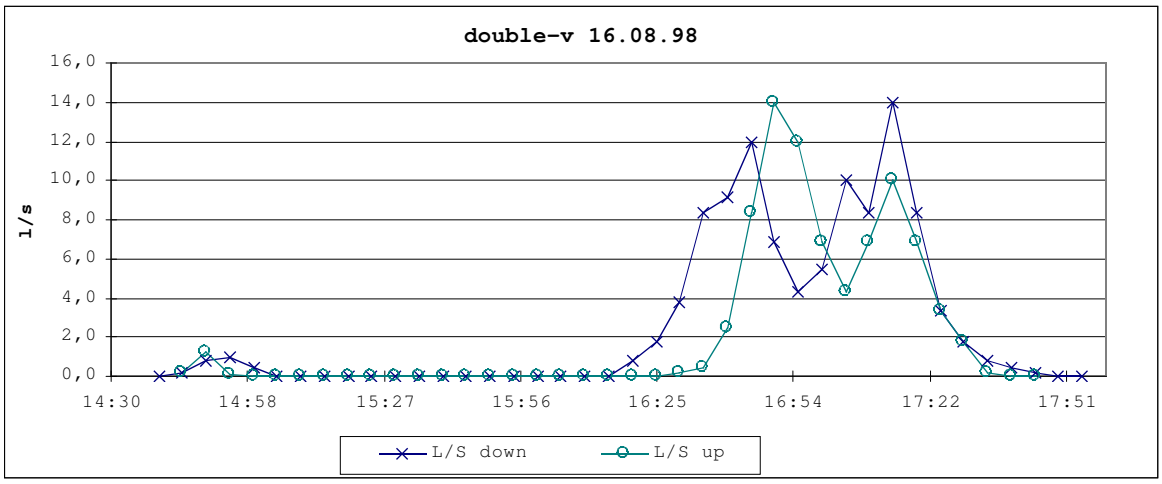
17:51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8,0
6,0
4,0
2,0
0,0
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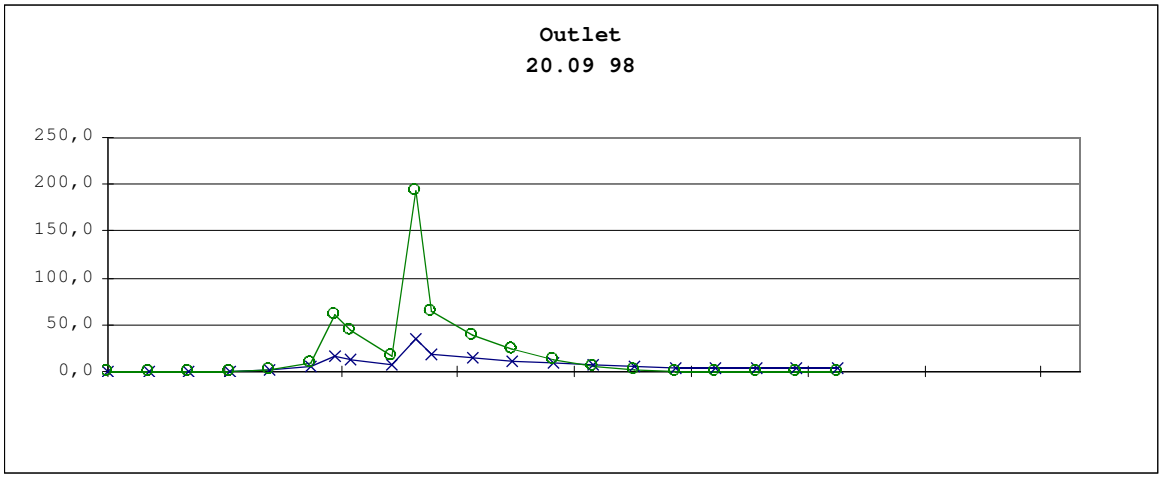
14:58
15:27
15:56
16:25
16:54
17:22
17:51
L/S down
L/S up


Outlet
20.09 98
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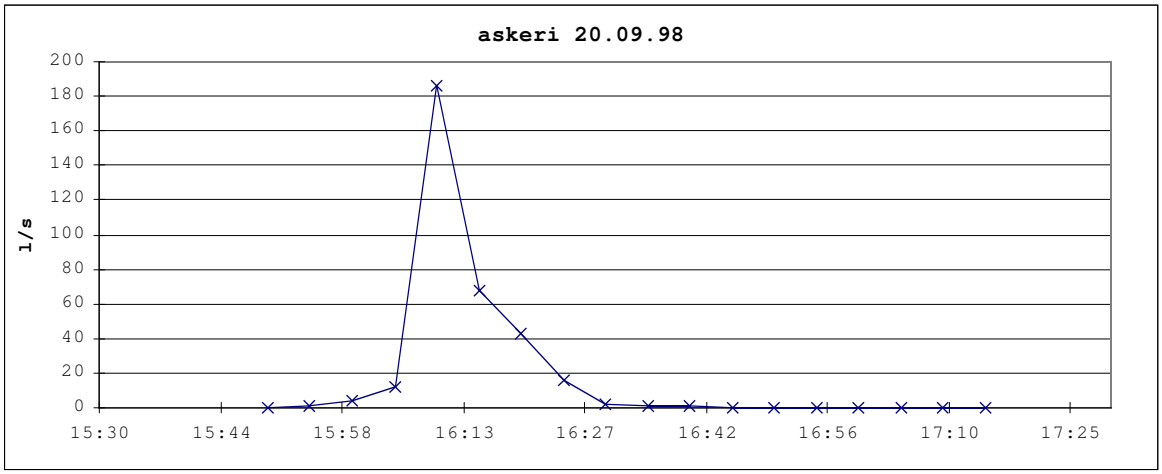
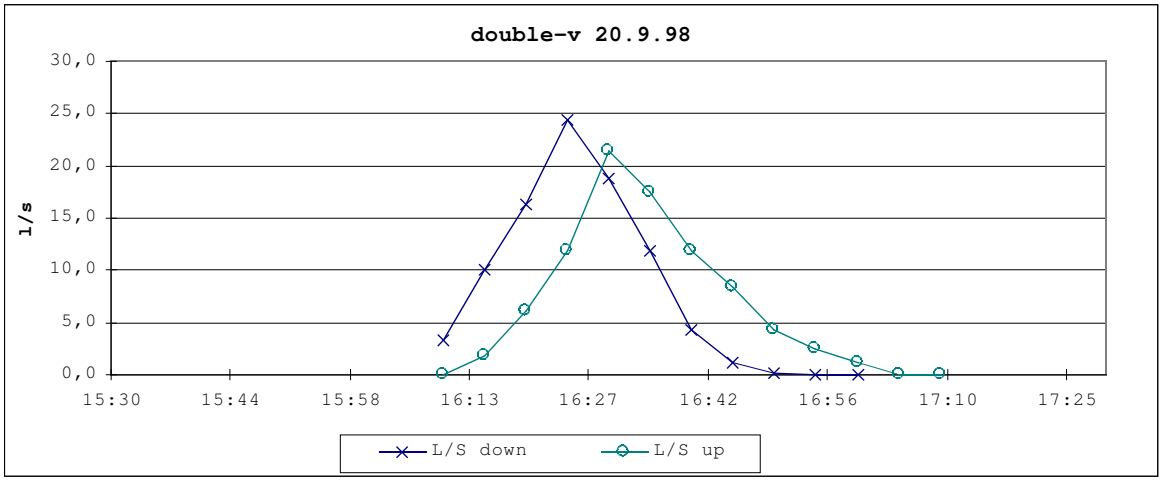
150,0
100,0
50,0
0,0


askeri 20.09.98
l/s
200
180
160
140
120
100
80
60
40
20
0
15:30
15:44
15:58
16:13
16:27
16:42
16:56
17:10
17:25


double-v 20.9.98
l/s
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25,0
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10,0
5,0
0,0
15:30
15:44
15:58
16:13
16:27
16:42
16:56
17:10
17:25
L/S down
L/S up