



Sveučilište u Zagrebu
Građevinski fakultet
Zavod za hidrotehniku

1. VJEŽBE IZ HM2

05.10.2011.

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1. Uvod

ZADATAK:

- Idejni projekt navodnjavanja za zadano melioracijsko područje

SADRŽAJ PROJEKTA

- 1. Tehnički izvještaj.
- **2. Analiza terenskih i klimatskih podataka melioracijskog područja.**
- 3. Proračun potrebnih voda za navodnjavanje za danu kulturu korištenjem programskog paketa CROPWAT.
- 4. Izbor načina i vrsta navodnjavanja.
- 5. Dimenzioniranje kanala i cjevovoda za navodnjavanje.
- 6. Troškovnik

CROPWAT 8.0

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- Climate/ETo
- Rain
- Crop
- Soil
- CWR
- Schedule
- Crop Pattern
- Scheme

Monthly ETo Penman-Monteith - G:\01_Posao\NASTAVA\melioracije-dva\Wjezbe_IKC...

Country: Hrvatska Station: Dubrovnik

Altitude: 10 m. Latitude: 42.64 °N Longitude: 18.10 °E

Month	Min Temp °C	Max Temp °C	Humidity %	Wind km/day	Sun hours	Rad MJ/m2/day	ETo mm/day
January	-5.9	4.3	88	173	3.7	6.1	0.49
February	-3.7	7.6	80	190	4.9	9.2	0.93
March	1.1	11.4	72	207	5.8	13.1	1.70
April	8.4	15.9	70	207	7.4	18.0	2.72
May	13.4	21.4	70	190	8.6	21.6	3.79
June	18.0	25.5	73	181	9.7	23.9	4.60
July	20.1	25.0	72	164	9.8	23.6	4.61
August	20.3	26.1	74	156	9.2	21.0	4.25
September	14.0	20.7	79	156	7.0	15.4	2.72
October	9.7	15.2	82	156	5.2	10.2	1.56
November	0.7	11.2	86	164	3.1	6.1	0.88
December	-2.9	6.1	89	173	1.9	4.3	0.53
Average	7.8	15.9	78	176	6.4	14.4	2.40

Dry crop - G:\01_Posao\NASTAVA\melioracije-dva\Wjezbe_IKC\CropWat8\krumpir_CRO

Crop Name: Krumpir Planting date: 01/04 Harvest: 23/08

Stage (days): initial (30), development (35), mid-season (50), late season (30), total (145)

Rooting depth (m): 0.30 to 1.00

Critical depletion (fraction): 0.50, 0.50, 0.50, 0.50

Yield response f.: 0.45, 0.80, 0.80, 0.20, 1.10

Cropheight (m): 0.30 (optional)

Monthly rain - G:\01_Posao\NASTAVA\melioracije-dva\Wjezbe_IKC\CropWat8\...

Station: Dubrovnik Eff. rain method: USDA S.C. Method

Month	Rain mm	Eff rain mm
January	6.1	6.0
February	9.0	8.9
March	38.3	36.0
April	62.2	56.0
May	125.7	100.4
June	77.1	67.6
July	41.2	38.5
August	79.3	69.2
September	31.6	30.0
October	44.9	41.7
November	36.1	34.0
December	16.6	16.2
Total	568.1	504.5

Crop irrigation schedule

ETo station: Dubrovnik Crop: Krumpir Planting date: 01/04 Yield red.: 0.0 %

Rain station: Dubrovnik Soil: crvenica Harvest date: 23/08

Table format: Irrigation schedule Daily soil moisture balance

Timing: Irrigate at critical depletion Application: Refill soil to field capacity Field eff.: 70 %

Date	Day	Stage	Rain mm	Ks fract.	Eta %	Depl %	Net Irr mm	Deficit mm	Loss mm	Gr. Irr mm	Flow l/s/ha
1 Apr	1	Init	0.0	0.90	90	56	24.2	0.0	0.0	34.6	4.01
21 Jun	82	Mid	0.0	1.00	100	51	64.6	0.0	0.0	92.3	0.13
10 Jul	101	Mid	0.0	1.00	100	52	65.4	0.0	0.0	93.4	0.57
29 Jul	120	End	0.0	1.00	100	53	66.9	0.0	0.0	95.5	0.58
23 Aug	End	End	0.0	1.00	0	1					

Totals					
Total gross irrigation	315.8 mm	Total rainfall	373.7 mm		
Total net irrigation	221.1 mm	Effective rainfall	297.2 mm		
Total irrigation losses	0.0 mm	Total rain loss	76.5 mm		
Actual water use by crop	449.9 mm	Moist deficit at harvest	0.9 mm		
Potential water use by crop	449.9 mm	Actual irrigation requirement	152.7 mm		
Efficiency irrigation schedule	100.0 %	Efficiency rain	79.5 %		
Deficiency irrigation schedule	0.0 %				

Yield reductions					
Stagelabel	A	B	C	D	Season
Reductions in ETo	0.3	0.0	0.0	0.0	0.0 %
Yield response factor	0.45	0.80	0.80	0.20	1.10
Yield reduction	0.1	0.0	0.0	0.0	%
Cumulative yield reduction	0.1	0.1	0.1	0.1	0.0 %

Soil - G:\01_Posao\NASTAVA\melioracije-dva\Wjezbe_IKC\CropWat8\Soil_crvenica...

Soil name: crvenica

General soil data

Total available soil moisture (FC - WP): 140.0 mm/meter

Maximum rain infiltration rate: 40 mm/day

Maximum rooting depth: 90 centimeters

Initial soil moisture depletion (as % TAM): 55 %

Initial available soil moisture: 63.0 mm/meter

PODLOGE

KLIMATSKE

- *Mjesečna i godišnja količina oborina na meteorološkoj postaji, [mm]*
- *Srednja mjesečna i godišnja temperatura zraka na meteorološkoj postaji, [°C]*
- *Srednje mjesečne i godišnje sume sijanja Sunca na meteorološkoj postaji, [sati]*
- *Srednja mjesečna i godišnja relativna godišnja vlaga zraka na meteorološkoj postaji, [%]*
- *Srednja mjesečna i godišnja brzina vjetra na području meteorološke postaje, [m/s]*

TOPOGRAFSKE

- *Karta područja za koje se radi projekt navodnjavanja*

KLIMATSKE PODLOGE

a) Mjesečna i godišnja količina oborina na meteorološkoj postaji, [mm]

Godina	Mjeseci												Suma
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1981	34.9	26	130.2	33.9	49.2	101.2	25.2	52.0	79.6	91.0	51.8	101.3	776.3
1982	12.3	11.4	65.5	77.1	42.0	91.1	60.5	45.3	9.9	52.0	25.8	74.4	567.3
1983	18.9	47.5	18.6	30.1	41.0	91.1	71.6	18.5	103.2	27.9	18.1	18.8	505.3
1984	75.2	37.6	33.8	66.5	104.5	71.0	74.0	36.1	52.6	43.7	38.3	17.6	650.9
1985	37.1	39.4	54.7	61.9	63.8	105.8	23.0	92.4	11.6	21.5	92.2	33.4	636.8
1986	67.8	62.7	39.8	50.7	43.3	64.9	54.8	60.6	5.0	45.7	19.3	25.9	540.5
1987	88.1	10.4	59.9	60.4	141.2	44							
1988	45.5	38.9	108.6	49.0	12.0	99.2							
1989	5.8	8.6	36.5	59.2	119.7	73.4							

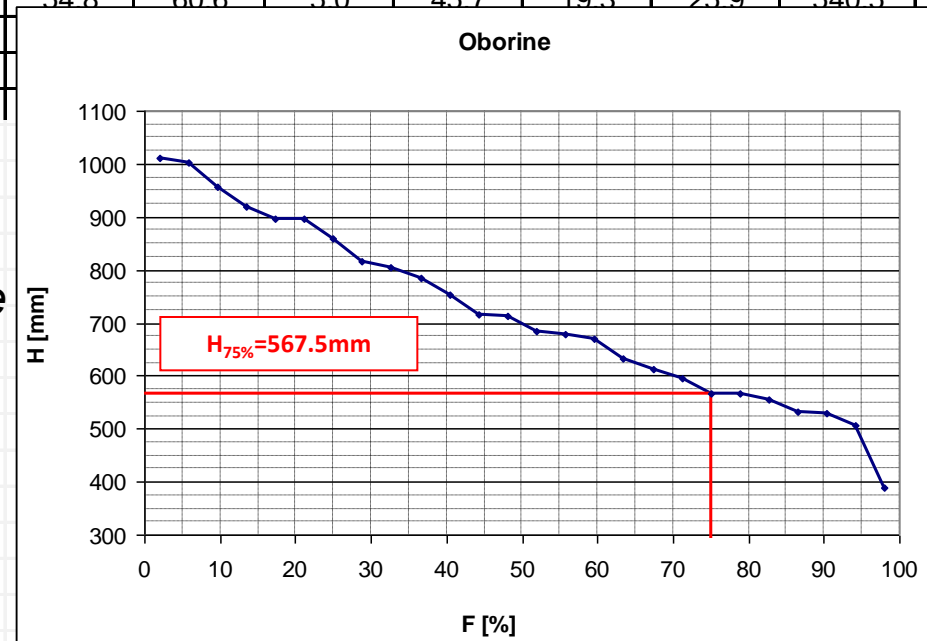
Potrebno je za svaki mjesec odrediti

a) Prag sigurnosti 75-80% kiše

- Odrediti padajući niz uk.god. oborine
- Odrediti vjerojatnost

$$F = \frac{2n-1}{2y} \cdot 100 \text{ \%}$$

- Očitati prag sigurnosti 75-80% kiše



b) Na osnovi uk. godišnje oborine sa vjerojatnošću pojave 75-80% očitati vrijednosti oborine po mjesecima

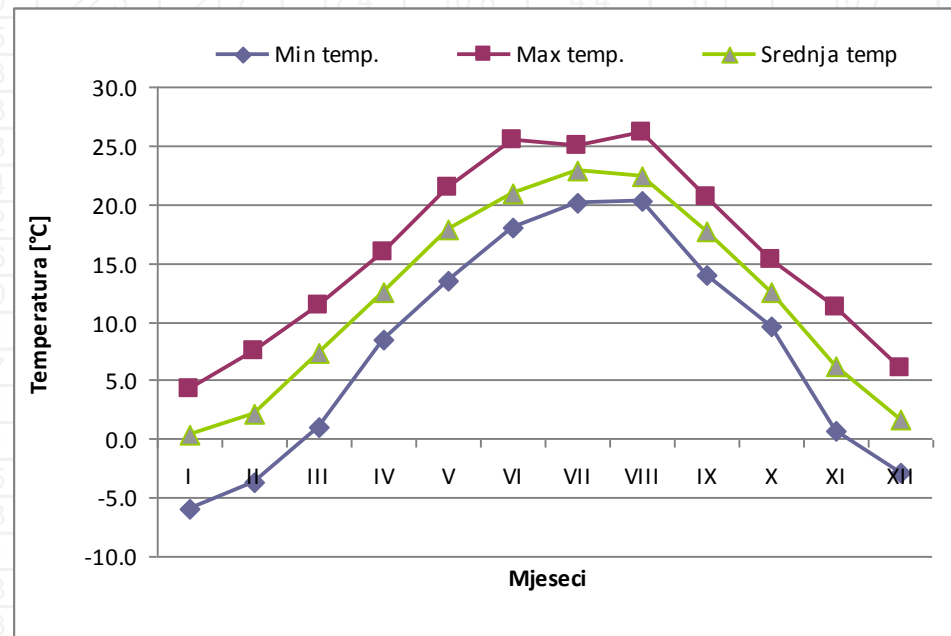
KLIMATSKE PODLOGE

b) Srednja mjesečna i godišnja temperatura zraka na meteorološkoj postaji, [°C]

Godina	Mjeseci												Srednjak
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1981	-2.6	1.3	10.1	11.7	16.8	20.8	21.1	21.2	18.2	13.8	5.3	1.5	11.6
1982	-1.5	-0.3	6.5	8.6	18.3	21.9	22.3	21.4	20.7	13.4	6.2	4.5	11.8
1983	4.3	0.5	8.3	14.9	19.2	20.0	23.6	21.9	17.2	11.8	3.3	0.8	12.2

Potrebno je za svaki mjesec odrediti

- Minimalnu temperaturu [°C]
- Maksimalnu temperaturu [°C]
- Srednju vrijednost temperature
- Standardnu devijaciju temp.



Min. Temperatura [°C]	-5.88	-3.68	1.05	8.40	13.44	17.96	20.06	20.27	13.97	9.66	0.74	-2.94
Max. Temperatura [°C]	4.31	7.56	11.45	15.86	21.42	25.52	24.99	26.15	20.69	15.23	11.24	6.09
Srednja temperatura [°C]	0.29	2.08	7.25	12.43	17.90	20.91	22.81	22.32	17.70	12.54	6.27	1.73
st. devijacija	2.38	3.57	2.50	1.73	1.71	1.58	1.31	1.57	1.56	1.44	2.44	2.07

* Rezultate prikazati tablično i grafički

KLIMATSKE PODLOGE

c) Srednje mjesečne i godišnje sume sisanja Sunca na meteorološkoj postaji, [sati]

Godina	Mjeseci												Suma
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1981	123.5	173.8	201.9	289.6	274.1	306.3	275.8	280.2	156.6	144.5	96.9	49.1	2372
1982	130.0	172.6	199.5	242.2	278.3	306.3	292.2	256.5	255.9	124.2	146.9	38.4	2443
1983	123.9	170.6	194.7	272.1	288.9	306.5	297.7	260.5	227.5	182.4	100.3	61.5	2487

Potrebno je za svaki mjesec odrediti

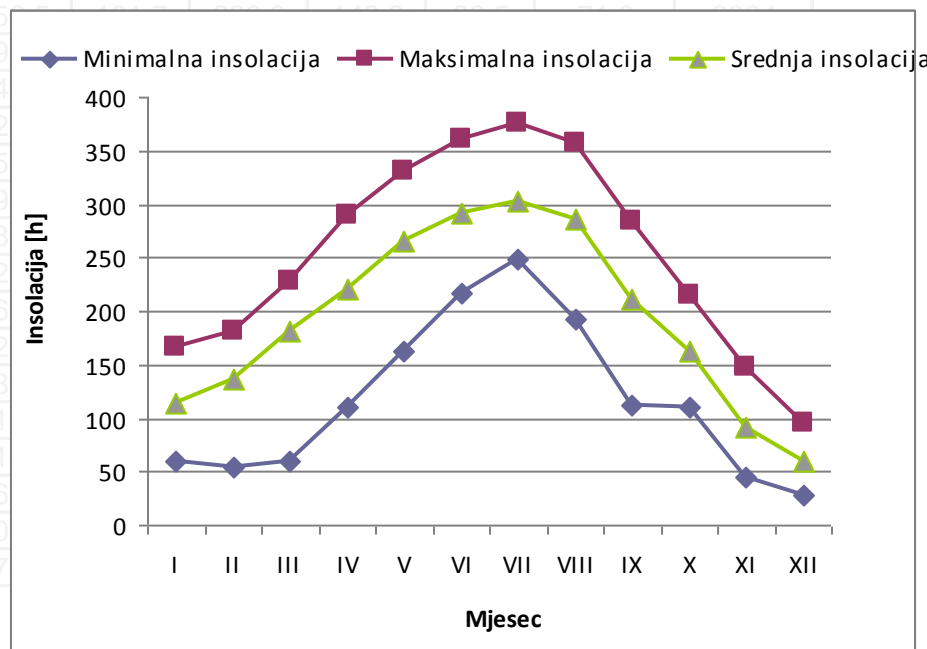
- Minimalnu insolaciju
- Maksimalnu insolaciju
- Srednju vrijednost insolacije
- Standardnu devijaciju insolacije
- Odrediti dnevni broj sunčanih sati

$$SS_{\text{dnevno}} = SS_{\text{mjesečno}} / \text{broj dana}_{\text{za tekući mjesec}}$$

SS – broj sunčanih sati [sati]

* Rezultate prikazati tablično i grafički

Min insolacija [sati]	59.22	53.66	59.33	110.57	162.96	217.35	248.54	191.73	112.56	110.67	44.21	27.72
Max insolacija [sati]	166.64	181.44	227.12	289.59	331.17	360.89	375.17	357.00	283.19	215.88	146.90	94.82
Srednja insolacija [sati]	114.26	136.18	180.60	220.74	265.26	291.42	303.15	285.75	210.85	162.21	92.41	59.13
Broj sunčanih sati / danu	3.69	4.86	5.83	7.36	8.56	9.71	9.78	9.22	7.03	5.23	3.08	1.91
st. Dev	29.22	38.86	36.41	44.74	30.08	34.04	31.40	43.06	42.91	26.51	28.78	19.28



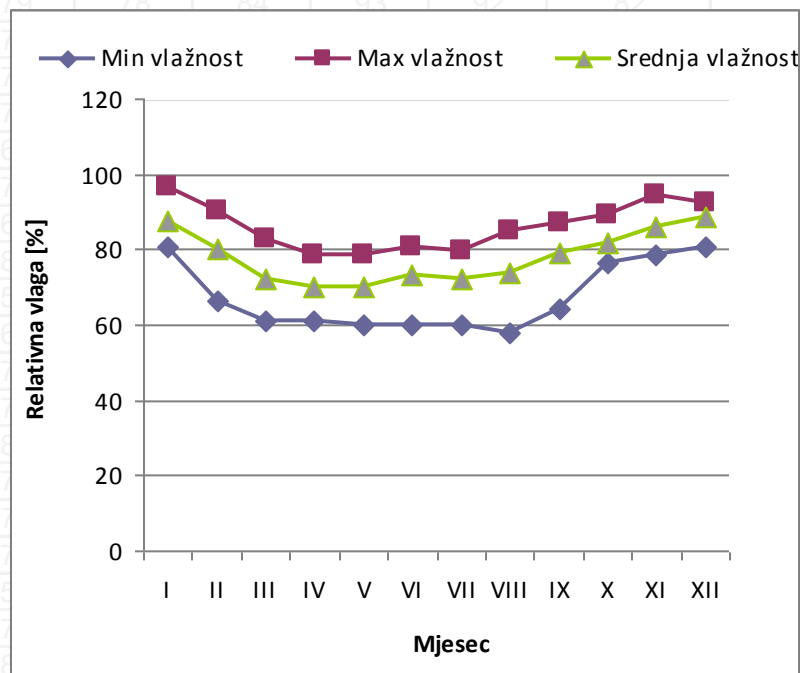
KLIMATSKE PODLOGE

d) Srednja mjesečna i godišnja relativna godišnja vlaga zraka na meteorološkoj postaji, [%]

Godina	Mjeseci												Srednjak
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1981	86	84	79	69	75	79	75	78	87	84	87	90	81
1982	91	88	74	75	67	71	78	83	80	87	81	89	80
1983	81	83	65	68	69	75	76	76	78	77	85	89	77

Potrebno je za svaki mjesec odrediti

- Minimalnu relativnu vlagu
- Maksimalnu relativnu vlagu
- Srednju vrijednost relativne vlage [%]
- Standardnu devijaciju relativne vlage



Min vlažnost [%]	80.85	66.15	60.90	60.90	59.85	59.85	59.85	57.75	64.05	76.65	78.75	80.85
Max vlažnost [%]	96.60	90.30	82.95	78.75	78.75	80.85	79.80	85.05	87.15	89.25	94.50	92.40
Srednja vlažnost [%]	87.55	80.24	72.09	70.23	70.11	73.10	72.41	73.86	78.99	81.66	85.98	88.81
st. Dev	4.22	5.48	5.81	4.71	5.33	5.26	5.65	8.19	5.49	3.47	4.25	3.19

* Rezultate prikazati tablično i grafički

KLIMATSKE PODLOGE

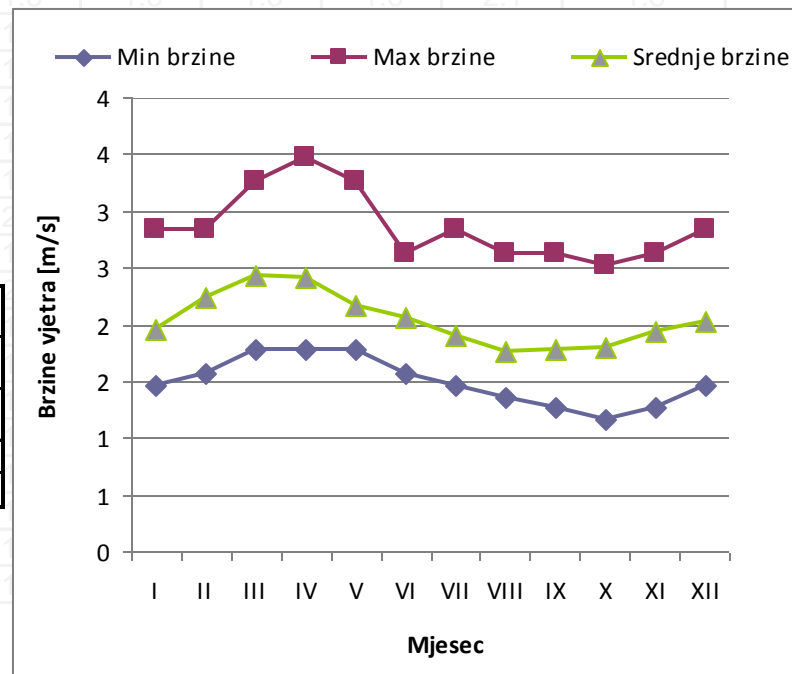
e) Srednja mjesečna i godišnja brzina vjetra na području meteorološke postaje, [m/s]

Godina	Mjeseci												Suma
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1981	2.6	2.5	2.1	2.1	2.1	2.1	2.3	1.8	1.8	2.3	2.5	2.8	2.3
1982	1.8	1.8	2.6	2.6	2.0	1.8	1.6	1.6	1.5	2.1	1.8	2.8	2.0
1983	2.0	2.3	2.5	1.8	1.8	2.1	1.8	1.6	2.0	1.3	1.3	2.0	1.9

Potrebno je za svaki mjesec odrediti

- Minimalne brzine
- Maksimalne brzine
- Srednje vrijednosti brzina [m/s]
- Odrediti vjetar [km/dan]
- Standardnu devijaciju brzina [m/s]

Min brzine [m/s]	1.47	1.58	1.79	1.79	1.79	1.58	1.47	1.37	1.26	1.16	1.26	1.47
Max brzine [m/s]	2.84	2.84	3.26	3.47	3.26	2.63	2.84	2.63	2.63	2.52	2.63	2.84
Srednje brzine [m/s]	1.96	2.23	2.44	2.42	2.17	2.06	1.91	1.77	1.78	1.79	1.94	2.02
vjetar [km/d]	169.58	192.61	210.40	208.66	187.72	177.60	164.69	152.83	153.53	154.92	167.83	174.46
st. Dev	0.36	0.37	0.47	0.38	0.39	0.29	0.31	0.26	0.31	0.38	0.34	0.36







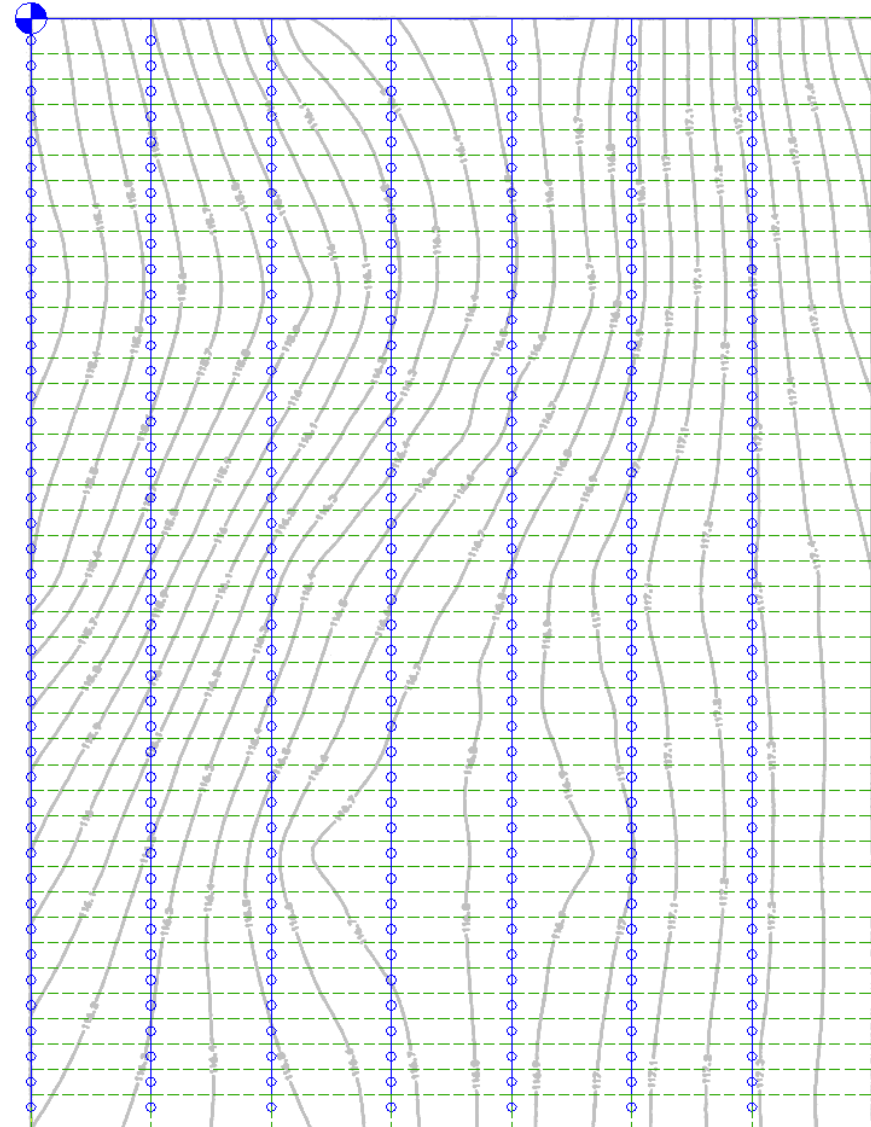
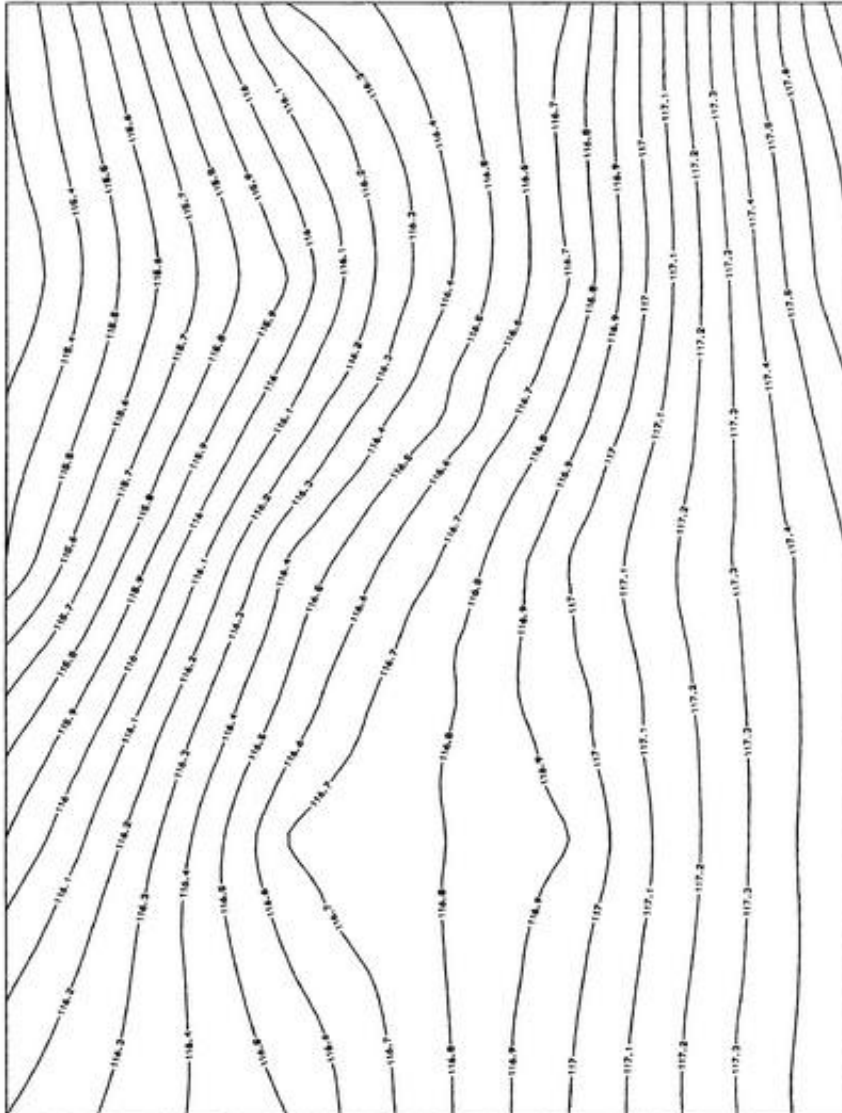
* Rezultate prikazati tablično i grafički

TOPOGRAFSKE PODLOGE

a) Karta područja za koje se radi projekt navodnjavanja

LEGENDA:

-  Crpka
-  Cjevovod
-  Hidrant
-  Područje rada jednog tifona



CROPWAT 8.0

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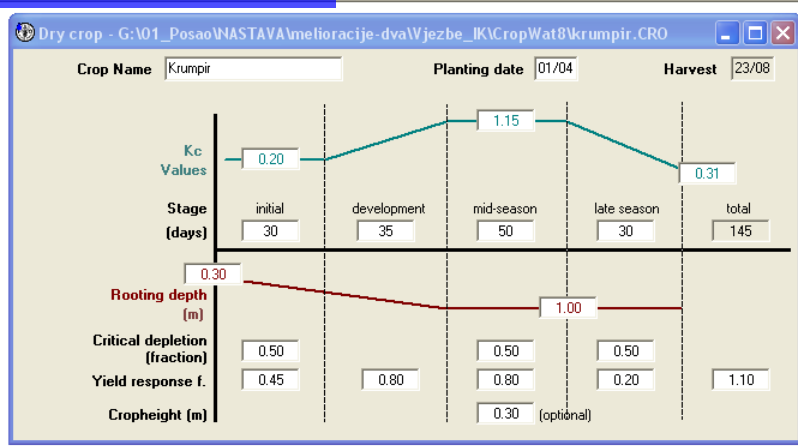
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Monthly ETo Penman-Monteith - G:\01_Posao\NASTAVA\melioracije-dvaVjezbe_IKC...

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April	8.4	15.9	70	207	7.4	18.0	2.72
May	13.4	21.4	70	190	8.6	21.6	3.79
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July	20.1	25.0	72	164	9.8	23.6	4.61
August	20.3	26.1	74	156	9.2	21.0	4.25
September	14.0	20.7	79	156	7.0	15.4	2.72
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November	0.7	11.2	86	164	3.1	6.1	0.88
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Average	7.8	15.9	78	176	6.4	14.4	2.40



Monthly rain - G:\01_Posao\NASTAVA\melioracije-dvaVjezbe_IKC\CropWat0\...

Station: Dubrovnik

	Rain mm	Eff rain mm
January	6.1	6.0
February	9.0	8.9
March	38.3	36.0
April	62.2	56.0
May	125.7	100.4
June	77.1	67.6
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September	31.6	30.0
October	44.9	41.7
November	36.1	34.0
December	16.6	16.2
Total	568.1	504.5

Crop irrigation schedule

ETo station: Dubrovnik Crop: Krumpir Planting date: 01/04 Yield red.: 0.0 %

Timing: Irrigate at critical depletion

Application: Refill soil to field capacity Field eff.: 70 %

Date	Day	Stage	Rain mm	Ks fract.	Eta %	Depl %	Net Irr mm	Deficit mm	Loss mm	Gr. Irr mm	Flow l/s/ha
1 Apr	1	Init	0.0	0.90	90	56	24.2	0.0	0.0	34.6	4.01
21 Jun	82	Mid	0.0	1.00	100	51	64.6	0.0	0.0	92.3	0.13
10 Jul	101	Mid	0.0	1.00	100	52	65.4	0.0	0.0	93.4	0.57
29 Jul	120	End	0.0	1.00	100	53	66.9	0.0	0.0	95.5	0.58
23 Aug	End	End	0.0	1.00	0	1					

Totals			
Total gross irrigation	315.8 mm	Total rainfall	373.7 mm
Total net irrigation	221.1 mm	Effective rainfall	297.2 mm
Total irrigation losses	0.0 mm	Total rain loss	76.5 mm
Actual water use by crop	449.9 mm	Moist deficit at harvest	0.9 mm
Potential water use by crop	449.9 mm	Actual irrigation requirement	152.7 mm
Efficiency irrigation schedule	100.0 %	Efficiency rain	79.5 %
Deficiency irrigation schedule	0.0 %		

Yield reductions					
Stagelabel	A	B	C	D	Season
Reductions in ETo	0.3	0.0	0.0	0.0	0.0 %
Yield response factor	0.45	0.80	0.80	0.20	1.10
Yield reduction	0.1	0.0	0.0	0.0	%
Cumulative yield reduction	0.1	0.1	0.1	0.1	0.0 %

Predviđeno za sljedeće auditorne vjezbe

Soil - G:\01_Posao\NASTAVA\melioracije-dvaVjezbe_IKC\CropWat0\Soil_crvenica...

Soil name: crvenica

General soil data

Total available soil moisture (FC - WP)	140.0 mm/meter
Maximum rain infiltration rate	40 mm/day
Maximum rooting depth	90 centimeters
Initial soil moisture depletion (as % TAM)	55 %
Initial available soil moisture	63.0 mm/meter