RUNOFF CURVE NUMBER METHOD IN SICILY: CN DETERMINATION AND ANALYSIS OF THE INITIAL ABSTRACTION RATIO

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Abstract: The Curve Number method is widely used in hydrology because it's simply based on a single parameter, CN, that represents the basin absorption. In this paper CN is evaluated at basin scale from rainfall-runoff multi-daily events (Mockus, 1964), in the observation period 1940-1997 (record length mean equal to 20 years), for 61 Sicilian basin with three different methods: NEH4 method, Asymptotic fitting method (Hawkins, 1990, Hawkins et al., 2002, Hawkins et al., 2009), Least squares method (Woodward et al., 2006, Hawkins et al., 2009).
A first analysis of Sicilian watershed behavior indicates a major occurrence of standard CN response (42 basins), rather than complacent response (11 basins) and no violent behavior.
The original assumption of Initial abstraction ratio (Ia/S or λ) equal to 0.20, is investigated for watersheds with standard CN response, using "natural" and "ordered" rainfall-runoff data. Results indicate a median λ value of 0, for natural data and 0.035, for ordered data, according to recently world-wide researches (Hawkins et al., 2010).

INTRODUCTION

The Curve Number procedure, largely and world-wide used because of its application easiness, allows to estimate the volume of direct runoff for a given rainfall event by means of a single parameter, CN, representing of the basin infiltration storage and depending on soil types, land cover and land use.
This method, developed in late 1950s by SCS (Soil Conservation Service), today NRCS (National Resources Conservation Service) and changed several times until its last form edited by NRCS (1964, 1972, 1985, 2004), was recently revised by Hjemfelt et al. (2001), Woodward et al. (2006) and Hawkins et al. (2009, 2010). These authors formed a joint work group to asses and to develop the Curve Number procedure since 2001 (Hjemfelt et al., 2001), pointing up several issues.
One of the main problems discussed was the assumption of the Initial abstraction ratio, λ=Ia/S (Ia=initial abstraction, S=potential maximum retention) equal to 0.20. Indeed it was verified that the hypothesis of λ=0.20 biases the CN toward high values for small rainfall events, causing an unlikely high median CN value, assumed as the watershed CN value in NEH4 method (Hjemfelt et al., 2001, Hawkins et al., 2009). This observation led the joint work group to introduce two other methods to find CN from P,Q events: asymptotic fitting and least squares methods (Hjemfelt et al., 2001, Woodward et al., 2006, Hawkins et al., 2009, 2010).
In this paper CN are computed for 61 Sicilian basins with NEH4 method and with these last two methods, investigating also the Initial Abstraction Ratio λ value.

CURVE NUMBER METHOD

NEH 4 method. The general runoff equation introduced by SCS-NRCS (1964, 1972, 1985, 2004) is:

$$Q = \frac{(P - Ia)^2}{(P - Ia + S)} \qquad \text{for } P \geq Ia \qquad (1a)$$

$$Q = 0 \qquad \text{for } P < Ia \qquad (1b)$$

where Q= direct runoff (mm), P= total rainfall (mm), S = potential maximum retention (mm), Ia= initial abstraction= λS (mm) and λ=0.20.
S is transformed to a dimensionless coefficient called “Curve Number” (CN):

$$CN = \frac{25400}{S + 254} \qquad (2)$$

that varies from CN=0 (S$\to\infty$) to CN=100 (S=0) and depends on hydrologic properties, series and texture of the soil and by considerations of cover, condition and land use and (perhaps) prior rainfall.
The determination of CN from rainfall-runoff events, is made by the following equation, obtained combining (1) and (2):

$$CN = \frac{100}{1 + 0.019685 \left[P + 2Q - \sqrt{\left(4Q^2 + 5PQ\right)}\right]} \qquad (3)$$

with P and Q in mm and λ=0.20, when P$\geq\lambda$S; if P<λS, CN is not computed because of Q=0. For given P the CN value at which runoff occurs is CN_0, computed as follows:

$$CN_0 = \frac{2540}{25,4 + P/5} \qquad (4)$$

The mean or median value of CNs, obtained from P,Q events sample of a given watershed with (3), is considered the CN of the basin (Hawkins et al., 2009).

Asymptotic fitting method. Asymptotic fitting method uses P,Q pairs obtained re-ordering separately P and Q values and re-aligning them on a rank order basis. These P,Q pairs have equal return period and are called “ordered” data, with runoff Q not necessarily associated with the original rainfall P, as contrasted with “natural” data (Hjelmfelt, 1980, Hjelmfelt et al., 2001, Hawkins et al., 2002, 2009, 2010). Plotting CNs obtained from ordered data with (3), against the causative rainfall P, it’s possible to notice three main different response patterns (Hawkins,1993, Hawkins et al., 2009):

1. Standard behavior, characterized by a declining CN with P, but approaching a constant or near stable value at large storms, called CN_∞ and assumed as the watershed CN value. This is the most common scenario.
2. Complacent behavior, characterized by a declining CN with P, but without approaching a stable value at large storms. This type of response could indicate probably a partial source area watershed behavior; in this case CN model seems to be inappropriate.
3. Violent behavior, characterized by CN declining at low rainfalls, as in complacent behavior, and a suddenly CN rising at some threshold rainfall value, approaching to a higher near stable CN_∞ value at large storms, typically in the 85-95 range.

Least squares method. This very common curve-fitting technique allows to find both λ and S values by iterative least squares procedure fitting of (1) equation. The target of the fitting is to find the values of λ and S such that

$$\sum_{\text{events}} \left\{ Q_{obs} - \frac{\left(P - \lambda S\right)^2}{\left[P + \left(1-\lambda\right)S\right]} \right\}^2 \tag{5}$$

is a minimum, where Q_{obs} is observed direct runoff.
Because of CN biased toward high values for small rainfall events, only events with P>25.4 mm are used. In addition, both ordered and natural data sets may be used (Hawkins et al., 2009).

DATA SETS

Daily runoff data used in this study are measured in 61 Sicilian watersheds (figure 1), in the observation period 1940-1997 (record length mean equal to 20 years), while correspondent daily rainfall data are gauged in 130 pluviographs placed inside basins. In tables 1 and 2 watershed characteristics are showed.

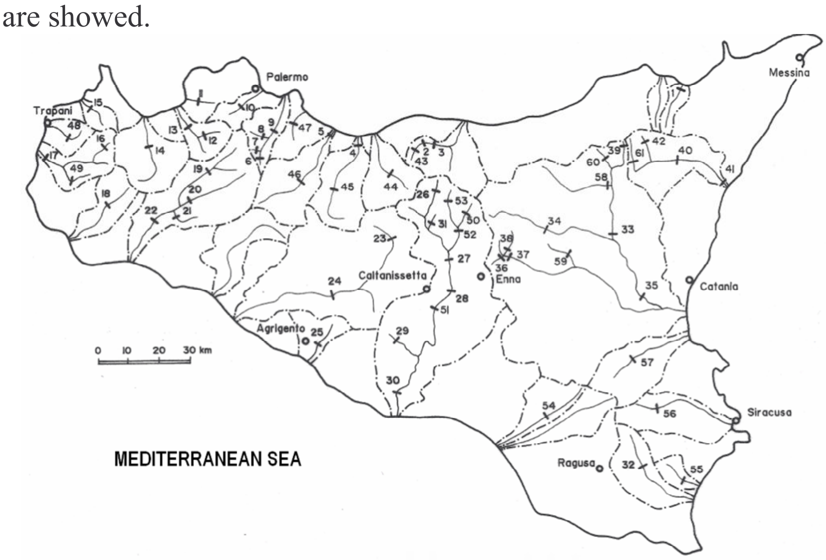

Figure 1. Sicily Island and location of 61 watersheds studied.

ID Station	Station	Watershed	Area [Km^2]	River length [Km]	Station altitude [m]	Maximum basin altitude [m]	Mean basin altitude [m]
1	Falcone	Elicona	54.00	22.20	9	1311	710
2	Aculeia	Pollina	51.60	15.40	330	1979	1041
3	Ponte Vecchio	Castelbuono	99.00	24.80	230	1950	896
4	Bivio Cerda	Torto	414.00	60.80	25	1326	491
5	Monumentale	S. Leonardo	521.50	56.00	2	1615	578
6	Lupo	Eleuterio	10.26	5.40	524	1613	826
7	Rossella	Eleuterio	10.47	4.50	484	1016	670
8	Serena	Valle dell'Acqua	21.70	9.00	285	1029	638
9	Risalaimi	Eleuterio	52.90	10.50	198	1029	631
10	Parco	Oreto	75.60	13.00	113	1333	608
11	Zucco	Nocella	56.67	13.80	80	1186	540
12	Fellamonica	Iato	49.00	15.00	210	1333	480
13	Taurro	Iato	163.80	33.50	124	1333	406
14	Alcamo Scalo	Fiumefreddo	273.00	37.00	60	825	253
15	Lentina	Forgia	45.70	14.00	88	1008	285
16	La Chinea	Fastaia	22.60	8.00	178	751	313
17	Chinisia	Birgi	293.00	43.50	4	751	194
18	Pozzillo	Delia	138.77	21.40	97	713	259
19	Sparacia	Belice destro	116.48	32.50	251	1333	555
20	Casebalate	Belice sinistro	342.45	42.50	179	1613	578
21	Finocchiara	Senore	76.80	26.50	126	1180	422
22	Ponte Belice	Belice	807.20	94.20	58	1613	467
23	Bruciato	Belici	131.00	23.00	363	1081	625
24	Passofonduto	Platani	1186.00	76.10	136	1580	525
25	Mandorleto	S. Biagio	74.00	20.00	92	607	351
26	Petralia	Imera Merid.	27.90	8.50	760	1912	1231
27	Cinquearchi	Imera Merid.	545.00	45.00	340	1912	726
28	Capodarso	Imera Merid.	631.00	62.00	270	1912	690
29	Donna Paola	Gibbesi	63.00	15.60	260	652	427
30	Drasi	Imera Merid.	1782.15	125.00	56	1912	586
31	Castello	Castello	26.00	7.70	460	1007	655
32	Castelluccio	Tellaro	102.00	22.50	160	770	452
33	Biscari	Simeto	696.00	60.50	211	3274	1031
34	Ponte Gagliano	Salso	499.00	46.70	375	1558	794
35	Giarretta	Simeto	1832.23	120.00	17	3274	793
36	Casecelso	Girgia	24.94	10.70	340	920	494
37	Bozzetta	Dittaino	79.20	15.20	330	1192	554
38	Case Carella	Crisà	46.92	15.60	331	1025	597
39	Chiusitta	Saraceno	19.00	6.10	1170	1754	1479
40	Moio	Alcantara	342.00	34.00	510	3274	1142
41	Alcantara	Alcantara	569.60	58.00	20	3274	920
42	S. Giacomo	Alcantara	25.00	7.00	1100	1611	1230
43	Ponte Grande	Isnello	33.00	10.70	566	1979	1187
44	Scillato	Imera Settent.	105.00	15.70	236	1869	829
45	Roccap. Scalo	Torto	173.00	31.70	335	999	565
46	Vicari	S. Leonardo	253.00	27.00	250	1615	672
47	Milicia	Milicia	112.00	22.70	130	1007	485
48	Sapone	Baiata	29.20	9.80	44	383	113
49	Rinazzo	Chitarra	37.00	17.80	50	368	170
50	Re Giovanni	Gangi	61.00	11.80	540	1333	856
51	Besero	Imera Merid.	995.10	74.00	230	1912	632
52	Monzanaro	Salso	184.00	24.90	389	1660	786
53	Raffo	Salso	21.00	8.60	685	1640	1062
54	S. Pietro	Ficuzza	128.00	27.00	130	692	369
55	Noto	Asinaro	55.00	14.50	70	590	369
56	S. Nicola	Anapo	82.00	20.80	356	986	634
57	Rappis	Trigona	72.00	23.40	88	747	465
58	Serravalle	Troina di Sopra	157.00	32.00	545	1686	1025
59	Torricchia	Sciaguana	67.00	29.60	200	824	414
60	Petrosino	Martello	43.00	11.00	800	1800	1300
61	Zarbata	Flascio	31.00	27.00	970	1611	1292

Table 1. Streamflow gauging stations and watershed main characteristics

ID Station	Observation period	Number of years observed [years]	Mean annual rainfall P [mm]	Mean annual runoff Q [mm]	Number of Rainy days for year [day/year]
1	1976-1996	18	897.40	273.40	130
2	1952-1961	10	884.80	241.70	107
3	1978-1997	18	923.00	219.00	117
4	1969-1989	17	535.00	90.70	125
5	1940-1984	34	705.20	192.80	173
6	1940-1995	43	797.30	301.40	154
7	1940-1957	9	971.90	408.80	128
8	1961-1996	35	819.80	202.80	143
9	1965-1990	24	790.50	214.60	120
10	1940-1997	49	1049.90	464.80	127
11	1958-1997	37	932.90	184.30	130
12	1973-1997	16	875.90	337.30	112
13	1955-1967	12	798.80	252.50	126
14	1972-1987	10	617.00	118.00	75
15	1971-1996	24	573.60	110.60	102
16	1972-1997	24	595.00	153.40	94
17	1971-1997	21	517.90	82.10	107
18	1959-1978	20	672.50	146.40	101
19	1955-1987	33	690.00	235.00	139
20	1955-1980	26	706.00	203.00	140
21	1961-1986	13	652.00	155.00	119
22	1955-1994	29	678.40	162.50	173
23	1972-1994	20	597.10	105.60	115
24	1956-1994	32	611.00	106.00	145
25	1968-1997	26	567.90	86.50	85
26	1971-1997	24	860.50	602.10	115
27	1960-1988	16	680.00	152.00	144
28	1953-1996	27	660.50	130.40	158
29	1972-1992	14	535.00	86.00	84
30	1960-1997	34	574.00	110.30	158
31	1983-1997	15	554.10	54.90	109
32	1974-1997	17	601.40	90.80	97
33	1940-1986	11	656.00	113.00	155
34	1975-1997	21	689.50	160.00	140
35	1940-1967	19	750.40	313.70	182
36	1958-1980	21	694.00	208.00	127
37	1950-1968	16	738.20	238.70	140
38	1958-1986	25	657.00	181.00	109
39	1982-1997	14	1204.20	844.20	168
40	1940-1996	27	890.00	238.00	165
41	1940-1995	23	982.00	420.00	182
42	1983-1997	15	1079.00	681.00	137
43	1984-1997	14	1001.00	277.00	99
44	1976-1997	21	761.00	230.60	118
45	1983-1997	15	527.80	80.20	124
46	1972-1987	16	708.00	189.50	159
47	1976-1997	20	626.90	133.20	137
48	1968-1997	23	482.60	69.20	94
49	1972-1988	16	480.00	68.90	93
50	1978-1996	16	613.30	131.10	115
51	1959-1997	8	652.00	112.60	180
52	1983-1997	14	658.70	115.60	146
53	1979-1997	16	751.90	356.90	108
54	1974-1994	17	541.40	42.50	101
55	1973-1997	13	649.80	188.70	79
56	1972-1997	26	718.70	300.50	100
57	1972-1984	11	593.30	171.60	93
58	1975-1997	20	700.40	219.40	142
59	1969-1989	16	450.00	46.40	106
60	1981-1995	13	935.00	573.40	142
61	1981-1997	16	1029.00	672.00	128

Table 2. Watershed hydrologic characteristics

METHODOLOGY

Daily rainfall event, P, that regards watershed, is estimated by using Thiessen Polygon method. Direct runoff Q_i at the i day is calculated as

$$Q_i = Qt_i - Qb_i \tag{6}$$

where Qt_i is total runoff measured at i day, Qb_i is daily baseflow at the i day, evaluated by means of a single parameter digital filter:

$$Qb_i = (1-\alpha) Qb_{i-1} + \alpha \min(Qt_i ; Qt_{i-4}) \tag{7}$$

where Qb_{i-1} is the baseflow at the i-1 day, Qt_{i-4} is the total runoff at the i-4 day and $(1-\alpha)$ is the recession constant equal to 0.93 for South Italy (Manfreda et al., 1993).
Digital filter expressed by (7) is different by the original filter proposed by Chapman and Maxwell (1996) because of using $\min(Qt_i;Qt_{i-4})$ instead of Q_i. Last assumption allows to avoid the unrealistic sharp peak of baseflow right under the measured hydrograph peak found in Chapman digital filter (Tan et al., 2009).
Once obtained rainfall-runoff P_i,Q_i data as above reported, multi-daily events are considered and CNs are evaluated by means of (3) in the whole observation period in two cases:

1) all multi-daily events data set;
2) annual maximum multi-daily events data set, considering the annual maximum multi-daily event that one corresponding to multi-daily annual maximum runoff.

At last, asymptotic fitting method and least squares method are used to evaluate CN for each watershed in case 1 and 2, while NEH4 method is only studied in case 1 because of few data in case 2 (table 3).

Data sets	**Methods**		
	NEH 4	Asymptotic fitting	Least squares
All multi-daily events	Natural data	Ordered data	Natural data Ordered data
Annual maximum multi-daily events	---------------	Ordered data	Natural data Ordered data

Table 3. Data sets an data types for each method

RESULTS

CN determination Results obtained for asymptotic fitting method indicates a major occurrence of "standard" CN response (42 basins reported in table 4), rather than "complacent" response (11 basins, ID= 17, 19, 23, 24, 26, 27, 34, 40) and no violent behavior (Hawkins et al., 2009). For 8 basins (ID=16, 18, 25, 32, 33, 35, 38, 49) the bad data quality and/or low sample size doesn't allow to identify a CN response. Example of watershed with standard response is reported in fig. 2, while in fig. 3 is reported an example of complacent behavior.

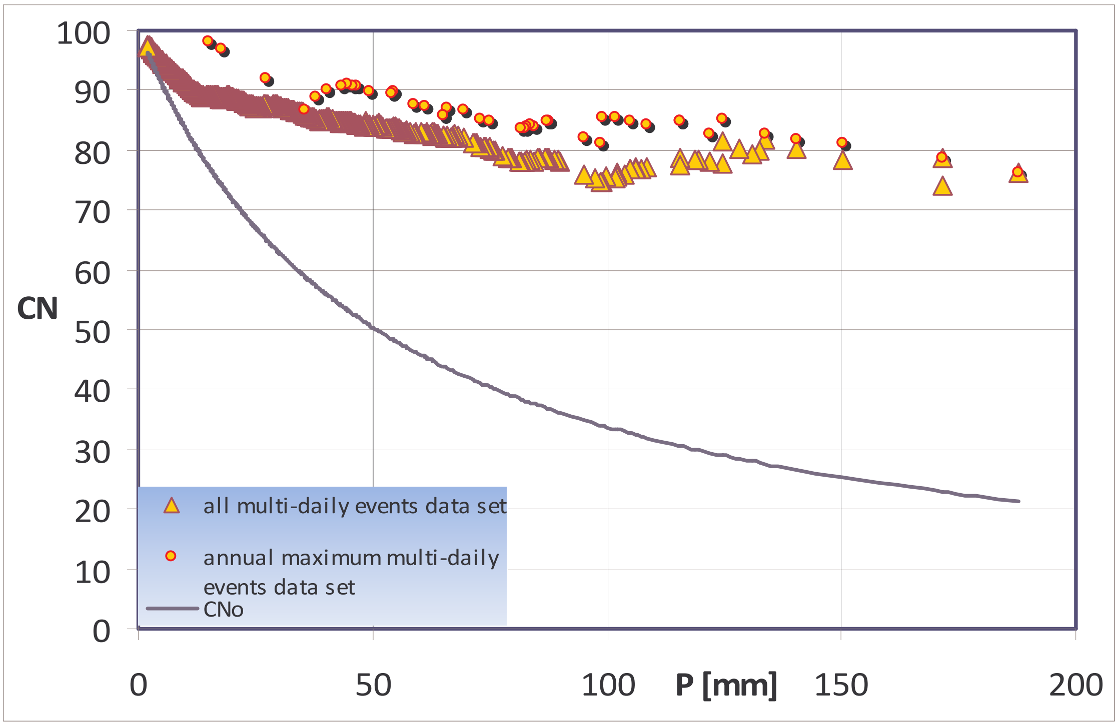

Figure 2. Example of standard behavior (Eleuterio a Lupo, ID=6). The asymptotic CN for all multi-daily events data set is 77 (case 1) and for annual maximum multi-daily events data set is 78 (case 2).

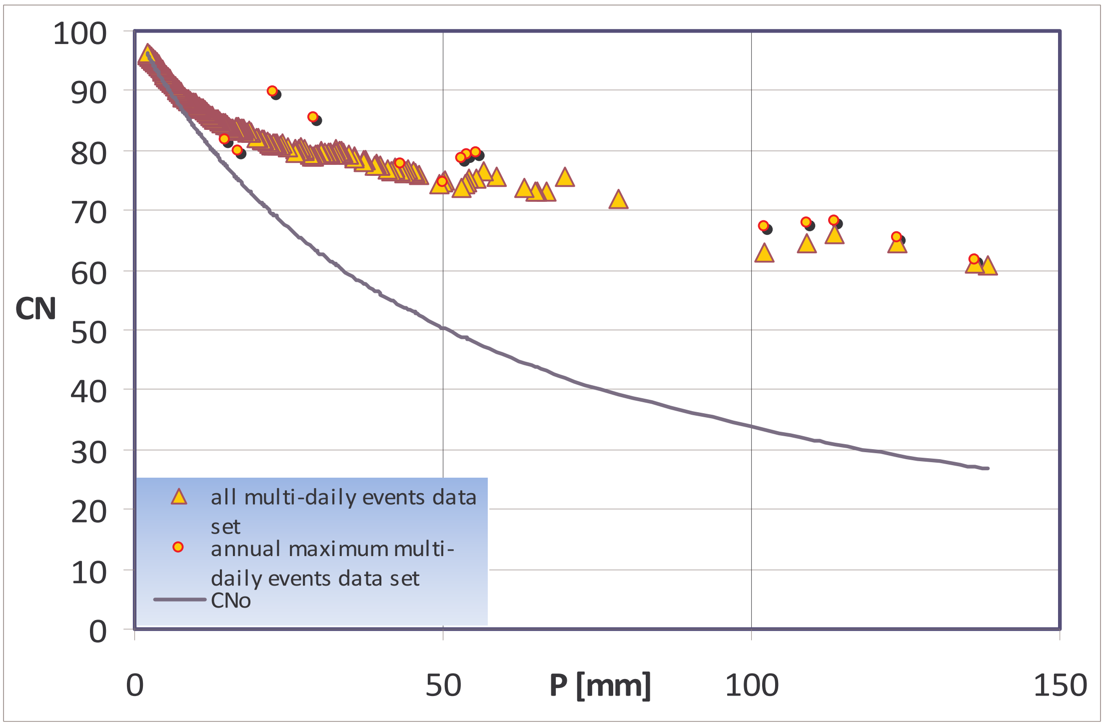

Figure 3. Example of complacent behavior (Salso a Monzanaro, ID=52). No asymptotic CN is determined in this case.

ID Station	Number of multi-daily events	Number of annual maximum events	NEH4 METHOD (natural data, λ=0.20)			ASYMPTOTIC FITTING METHOD (ordered data, λ=0.20)		LEAST SQUARES METHOD							
								Natural data				Ordered data			
			All multi-daily events			All multi-daily events	Annual maximum multi-daily events	All multi-daily events		Annual maximum multi-daily events		All multi-daily events		Annual maximum multi-daily events	
			CN (mean)	CN (median)	Coeff. Var. CN	CN∞	CN∞	λ	CN	λ	CN	λ	CN	λ	CN
1	657	18	85	88	0.14	54	54	0	44	0	57	0	52	0	59
2	319	10	83	87	0.18	56	57	0.01	33	0	40	0.01	39	0	41
3	592	18	84	88	0.15	68	72	0	46	0	59	0.07	63	0.06	66
4	469	17	86	89	0.12	76	71	0.03	59	0	63	0.06	69	0	64
5	1072	34	88	91	0.12	79	80	0	61	0	78	0.13	78	0	81
6	972	43	88	91	0.12	77	78	0	64	0	75	0	72	0	78
7	230	9	85	88	0.15	63	70	0	58	0	66	0	63	0	66
8	1095	35	83	86	0.15	70	73	0	49	0	61	0.01	59	0	64
9	806	24	86	90	0.13	71	70	0	49	0	58	0.02	61	0	62
10	1633	49	85	88	0.14	61	64	0	49	0	55	0	55	0	61
11	1204	37	81	84	0.18	57	63	0	29	0	41	0.02	41	0.05	51
12	472	16	86	90	0.14	79	84	0	56	0	80	0.04	71	0	82
13	374	12	88	91	0.12	83	87	0.11	76	0	81	0.17	82	0	81
14	236	10	85	88	0.14	70	68	0	43	0	52	0.02	61	0	59
15	503	24	86	89	0.14	66	65	0	43	0	48	0	58	0	57
20	835	26	88	91	0.11	81	81	0	60	0	77	0.1	77	0	80
21	376	13	86	89	0.14	72	70	0	48	0	61	0.01	61	0	64
22	921	29	86	90	0.13	77	84	0	50	0	76	0.09	71	0.05	80
28	839	27	87	90	0.13	71	74	0	46	0	64	0	58	0	68
29	353	14	86	89	0.15	60	68	0	22	0	31	0.02	44	0.03	55
30	1055	34	88	90	0.11	65	73	0	49	0	64	0	59	0	67
31	416	15	85	88	0.14	50	50	0	22	0	28	0.01	35	0	34
36	439	21	85	90	0.15	72	82	0.06	60	0.03	76	0.33	78	0.08	80
37	431	16	85	89	0.15	67	66	0	49	0	72	0.04	61	0	74
39	478	14	89	89	0.15	76	84	0	59	0	80	0.14	75	0.03	81
41	893	23	86	90	0.14	54	54	0	46	0	49	0	49	0	50
42	468	15	84	87	0.14	68	72	0	57	0	72	0.07	70	0	73
43	450	14	84	88	0.16	66	74	0	43	0	63	0.01	52	0.05	68
44	697	21	86	90	0.14	73	76	0	52	0	68	0.23	77	0.03	70
45	454	15	87	90	0.12	78	78	0.09	64	0	65	0.08	72	0	67
46	451	16	88	91	0.13	78	86	0	59	0	82	0.03	74	0.02	85
47	602	20	87	90	0.13	74	75	0	49	0	61	0.12	71	0.05	69
48	535	23	87	87	0.12	70	75	0.1	61	0.13	73	0.08	67	0.05	71
50	521	16	86	90	0.14	68	81	0	41	0.14	80	0.13	68	0.42	86
51	269	8	88	91	0.12	71	70	0	43	0	65	0	52	0	67
53	480	16	89	92	0.13	82	92	0	65	0.17	93	0.29	85	0.17	93
54	456	17	84	88	0.16	59	63	0.04	28	0.03	40	0.07	46	0.02	45
55	328	13	83	88	0.17	58	55	0	32	0	35	0.12	55	0.45	67
56	809	26	87	91	0.13	62	65	0	50	0	51	0	57	0	54
57	258	11	86	89	0.14	78	78	0	55	0.32	82	0.32	81	0.28	82
58	590	20	87	90	0.14	70	70	0	45	0	51	0	61	0	60
59	406	16	87	90	0.12	68	70	0.03	42	0	41	0.08	59	0.07	61
Statistics		Mean	86	89	0.14	69	72	0.011	49	0.020	62	0.070	63	0.045	67
		Median	86	90	0.14	70	72	0.000	49	0.000	64	0.035	61	0.000	67
		Stand. dev.	1.75	1.64	0.02	8.37	9.65	0.028	11.77	0.061	15.64	0.088	12.21	0.102	12.71
		Maximum	89	92	0.18	83	92	0.110	76	0.320	93	0.330	85	0.450	93
		Minimum	81	84	0.11	50	50	0.000	22	0.000	28	0.000	35	0.000	34

Table 4. CN and λ values obtained for 42 Sicilian watershed with standard response, using asymptotic fitting method and least squares method in case 1 (all multi-daily events) and case 2 (annual maximum multi-daily events) and with NEH4 method in case 1.

In table 4 are reported CN values obtained for watersheds with standard response with NEH4 method, asymptotic fitting method and least squares method. Results indicate that NEH4 method detects high CN values in a short range (CN=84÷92) confirming the unlikely high median CN value (Hawkins et al., 2009). So, NEH4 method is not able to give a correct CN for Sicilian watersheds. The asymptotic fitting method doesn't show relevant differences by using annual maximum or all multi-daily data sets (table 4 and figure 4). The same result occurs for least squares method if CN evaluation is made by means of ordered data using annual maximum events series instead of all events series; on the contrary some differences occur in CN evaluations when natural data are used (table 4 and figure 4).
Comparing asymptotic fitting and least squares methods for ordered data, it's possible to notice some differences between these two techniques for lower CN (table 4 and figure 5).

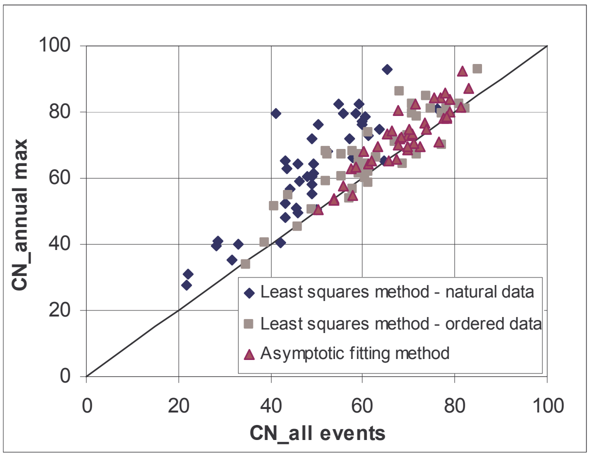

Figure 4. Comparisons between CN obtained for all events and annual maximum events data sets.

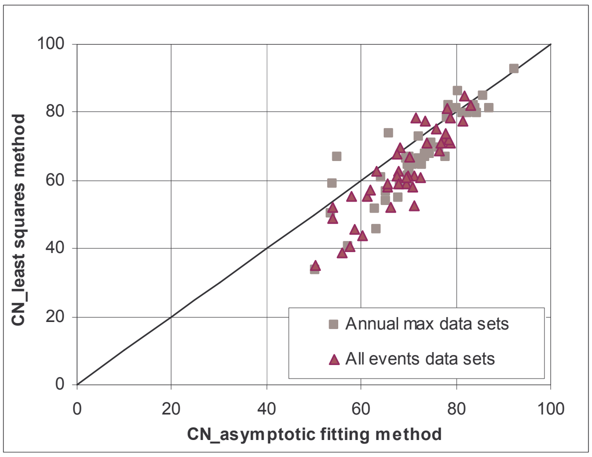

Figure 5. Comparisons between asymptotic fitting and least squares methods

Initial abstraction ratio. Results, obtained using least squares method to get λ and S for Sicilian watersheds with standard behavior in case 1 and 2, show that λ varies from watershed to watershed and that the method original assumption of λ=0.20 is unusually high (table 4). Referring to case 1 because of larger sample size, frequency distribution of λ values for natural and ordered data (fig. 6) highlights that λ=0 is the most common value. Median and mean λ values are respectively λ=0 and λ=0.011 for natural data and λ=0.035 and λ=0.070 for ordered data.
These λ values are very close to those reported by Hawkins et al. (2002, 2009) for USA basins, by Baltas et al. (2007) for Greek basins, by Shi et al. for Chinese basins (2009).

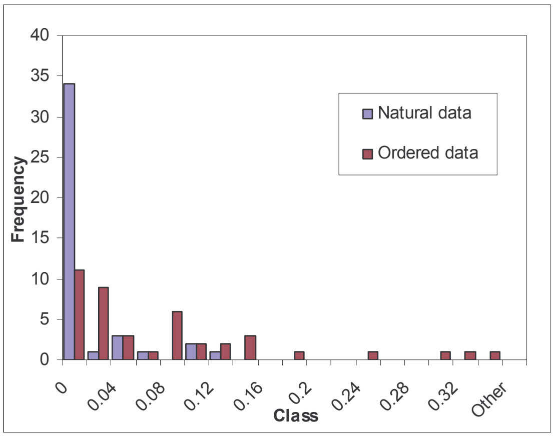

Figure 6. Frequency distribution of λ values for natural and ordered data

No relationships between λ values and morpho-climatic characteristics of watersheds were found, while classification techniques as "trees" method (Brieman et al. 1984) allowed to identify groups of watersheds with different behavior.

If area S is used as independent variable, two groups of basins are determined: the first one corresponds to large watershed (S>25 Km^2) with λ values close to 0, and the second one, corresponds to small watershed (S<25 Km^2) with higher λ values.

If CN is considered as independent variable, three groups of basins are determined: the first one corresponding to CN<67.02 has λ values close to 0, the second one corresponding to 67.02≤CN≤74.93 has λ value softly higher than 0 and the last one corresponding to CN>74.93 has high λ value.

CONCLUSIONS

In this paper CN is evaluated from rainfall-runoff multi-daily events (Mockus, 1964), in the observation period 1940-1997 (record length mean equal to 20 years), for 61 Sicilian basin with three different methods: NEH4 method, Asymptotic fitting method, Least squares method.

First remark confirms that NEH4 method is not able to identify a correct watershed CN value.

The asymptotic fitting method indicates a major occurrence of standard CN response (42 basins), rather than complacent response (11 basins) and no violent behavior. This method doesn't show relevant differences in CN evaluation by using annual maximum or all multi-daily data sets. The same closeness between annual maximum and all multi-daily data sets occurs for least squares method if CN evaluation is made by means of ordered data; on the contrary some differences occur in CN evaluations when natural data are used.

Using ordered data, comparison between asymptotic fitting and least squares techniques gives some differences in CN evaluations.

The Initial abstraction ratio value, Ia/S or λ, investigated for watersheds with standard CN response, is resulted much less than original value (0.20), reported in NRCS report (2004).

For Sicilian watersheds median λ value is 0 for natural data and 0.035 for ordered data, pointing out the need to assume these λ values for application in Sicilian basins.

By first analysis seems that λ value softly growths up if CN rises and area S decreases.

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