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Surface drainage requirement in irrigated command of Central Gujarat

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Abstract
The Mahi Right Bank Canal (MRBC) command area (Figure 1) is characterized by a generally flat topography, restricted natural drainage, comparatively heavy soils and semi-arid climate, all of which are conducive to the development of problem of waterlogging. There is immediate need of accelerated efforts to provide efficient drainage and scientific water management in the area so as to ensure sustained agricultural production and prevent environmental degradation. A study on the daily rainfall data of the 16-raingauge stations in the area reveals that advance showers of high intensity are quite common. However, the rains may not be effective as far as agricultural operations are concerned as they are usually followed by long dry spells. Critical dry spells also occur during the kharif season when irrigation becomes essential even in crop like paddy. Prolonged dry spells will necessitate irrigation in other crops as well. Total rainfall during wet spells occurs in the command area is nearly 726 mm in 91 days. The rainfall surplus during first, second, third and fourth wet spells are of the order of 46%, 26%, 18% and 10% respectively. Due to accumulation of rainwater and the excess irrigation water from the canal system, surface drainage has become a prime need in most part of the command area. In the absence of rainfall-runoff relationship for want of provision in the drainage system , estimation of drainage requirement has been made by different approaches . The graphical method to estimate drainage coefficient is better substitution for the command area over the two methods namely rainfall depth-duration method and USAD-SCS-CN method. The drainage coefficient varies from 16 to 30 mm day $^{-1}$ for the entire command. M R B C command area having the largest culturable command area in the central Gujarat has been focused in the present study.

INTRODUCTION

The Mahi Kadana Irrigation Project is one of the major irrigation projects in the Gujarat state. The head works of the system comprising of the Kadana reservoir and the Wanakbori weir are located on the river ‘Mahi’. The first segment of the command area is served by the Mahi Right Bank Canal (MRBC) covering seven talukas of Kheda and Anand districts namely, Thasra, Anand, Cambay, Nadiad, Petlad, Borsad and Matar. The MRBC project was originally Pick up Weir scheme completed in 1958 on the river ‘Mahi’ at village Wanakbori in Balasinor taluka of Kheda district. It has a total gross command area of 3,15,790 ha and cultivable command area of 2,12,694 ha and lie between $22^{0}26^{'}$-$22^{O}55^{'}$ N latitude and $72^{0}49^{'}$-$73^{O}23^{'}$ E longitude with altitude varying between and m . The canal net works has been completed with total length of 2,660 km. The MRBC has an overall efficiency of 35% for canal supply and irrigation by canals amount to 70.52% intensity. The mains and branches are mostly lined and distributions network systems are unlined.

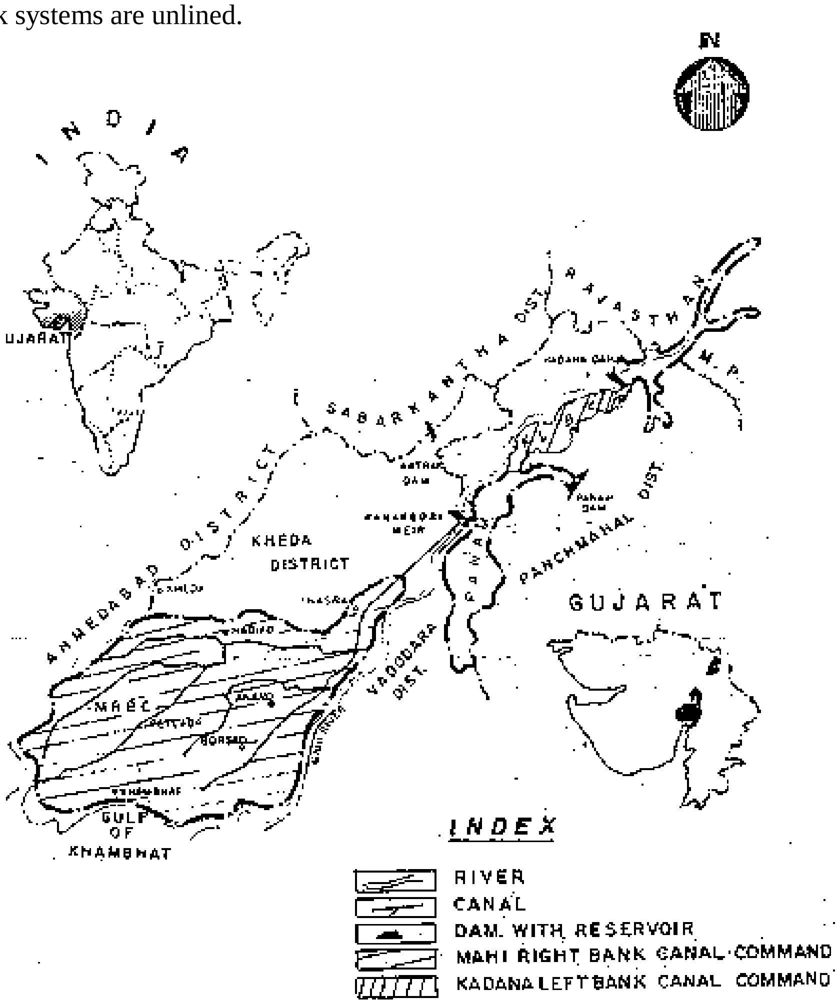

Figure 1. Mahi right bank canal command, Kheda district, Gujarat.

Originally there was no provision of drainage system in the MRBC project stage I. But with problem of submergence of lands in the command area cropped up, it became necessary to justify the need of drainage and accordingly Drainage Master Plan amounting to Rs 1300 lakhs was submitted to the Government in 1972 after careful consideration it was estimated to Rs 722.36 lakhs. However, because of additional drains found necessary, subsequently the revised plan of Rs 1,946 lakhs was sanctioned in 1984. The latest revised master plan of Rs 3094 lakhs was approved in 1991 and is programmed to tackle all the drainage problems, which covers 400.68 km existing main drains, 1516.35 proposed sub main laterals and sub laterals and 219.30 km new main drains (Anonymous, 1991 and 1998).

The characteristics of the soils, topography, cropping pattern and ground water situation indicate the necessity for substantially augmenting the drainage system in the area. The factors contributing to the inadequate performance of the existing drains are low drainage density and blockage of drains due to excessive weeds and silt deposits. Keeping all these factors in view, it was considered that the immediate measures have to be adopted to improve surface drainage system. A comprehensive programme for augmenting the surface drainage system will comprise renovating existing open drains and providing additional drains in the command area.

Originally the drains were designed for ¼" runoff per day. Looking to the experience of heavy monsoon climatic condition, flat topographic features with somewhat poor outfall condition, concentration of heavy rainfall in the command damages to the crops, it was decided to adopt ¾" runoff per day for design criteria of drains with a provision of future expansion to accommodate 1" runoff per day. As per summary recommendation by the Central Water Commission, the coefficient of runoff may be 15% of and 30% of the 3-day consecutive maximum rainfall in case of relatively flat area with ground slope of 1/5000 to 1/3000 and 1/3000 to 1/1000 respectively (Anonymous, 1998). Accordingly, based on daily rainfall of 1993-97, an average surface drainage coefficient of 30 mm day^{1} has been used for design purpose.

Climate

The climate of the MRBC area is tropical and semi-arid. In general cold season prevails from December to February, followed by hot summer from March to middle June. The period from mid June to September constitutes the southwest monsoon season. October to November forms the post monsoon season, characterized by moderate temperature and scarce rains. It has been experienced that due to perennial irrigation practices in the command area for last nearly twenty five years the condition of ambient climate has been somewhat sub-humid. Annual rainfall at Anand varied from 286.9 mm (1986) to 1633.0 mm (1976) with average at 849.1 mm and 37.7 per cent coefficient of variation. Similarly annual pan evaporation varied from 1729.4 mm (1983) to 2230.7 mm (1987) with average at 1940.8 mm with 5.7 per cent coefficient of variation.

Topography

The topography of the MRBC command is generally of a low relief. The command is in general sloping towards southwest, the Gulf of Cambay. The special characteristics of the topography is that the land near the bank of the river Mahi and Shedi is at higher levels and the land slope falls towards the Central region for most of the length east to west of the command and then gradually falls towards the gulf of Cambay with a very gentle slope 1 in 1600. There are no distinct valleys in the command area to facilitate easy natural drainage. The southwest region comprises a relatively flat land locally referred to as *Bhal* area. The command area comprises several watersheds of distinct topographic features.

Soils

The soils of the MRBC command area are deep and are formed through alluvial carried by Mahi and Sabarmati rivers. Soils ranging from sandy loam to loam occur in the eastern talukas of Thasra, Anand and parts of Nadiad, Borsad and Petlad. These soils lie on a comparatively higher elevation and are inherently porous and permeable. Hence they are internally well drained (Land Irrigability Class I). These soils become deeper and darker towards the west and have medium to medium fine texture. The soils occur in western part of Nadiad, Petlad, and Borsad talukas and the eastern portion of Matar taluka are moderate but have salt problems (Land Irrigability Class II and III). Further west, the surface as well as sub surface soils have finer characteristics. In the western most portion lying to the west of the Alang Drain, the area is covered by deep black soils, having a flat topography and poor outfall conditions. The soils lie over the old sea bed and hence are affected by salinity and saline high ground water (Land Irrigability Class IV & V). In the entire MRBC command area, soil texture of top 30 cm accounts to 44.1% coarse and medium (sandy loam to loam) and 55.9% for fine texture (clay loam and to silt clay). Moisture holding capacity of Keen's box method for these soils vary from 38.0 to 44.0 % (61% surveyed area) to 44 to 50% (20.2% studied area). Low hydraulic conductivity (up to 5 mm hr^{-1}) accounts for 61.15% of area surveyed in the MRBC command.

There are many old existing drains, which serve the purpose of surface drainage of different area in the command. Most of the old drains have been silted up and required to be improved promptly. Due to gradual increase in the irrigation network since the irrigation practice through canal system in last 4 decades and unprecedented heavy monsoon of year 1950, 1956, 1970, 1973, 1976, 1977, 1981, 1988, 1990 and 1994, the existing drains have been proved to be insufficient to take care of surface runoff during high intensity of rain storms and extensive submergence of the command area.

Table 1. Raingauge stations and salient features of rainfall analysis for the MRBC command.

Station	Latitude	Longitude	Data	Min 1-day	Max 1-day	Mean 1-day	CV
Anand	22^{O}33.10	72^{O} 57.40	58 - 99	47.0	247.4	125.2	0.39
Anklav	22^{O} 22.68'	73^{O} 2.59'	88 - 99	66.0	325.0	126.5	0.55
Borsad	22^{O} 24.50'	72^{O} 56.29'	62 - 99	38.2	339.0	126.4	0.46
Cambay	22^{O} 18.65'	72^{O} 39.62'	74 - 99	50.0	263.0	112.6	0.46
Changa	22^{O} 35.41'	72^{O} 48.07'	88 - 99	63.0	228.0	123.0	0.37
Jalundh	22^{O} 21.50'	72^{O} 44.62'	88 - 99	40.0	150.0	79.9	0.42
Kanewal	22^{O} 27.96'	72^{O} 31.5'	75 - 99	49.0	345.4	112.5	0.53
Limbasi	22^{O} 36.65'	72^{O} 37.22'	65 -99^{*L}	42.3	341.0	134.1	0.54
Matar	22^{O} 42.34'	72^{O} 39.62'	69 - 99	39.0	317.0	122.4	0.51
Nadiad	22^{O} 41.55'	72^{O} 51.85'	69 - 99	31.0	356.7	133.4	0.53
Petlad	22^{O} 28.55'	72^{O} 50.44'	66 - 99^{*P}	54.0	259.0	149.1	0.35
Sojitra	22^{O} 32.31'	72^{O} 43.25'	77 - 99	55.0	225.0	102.6	0.39
Tarapur	22^{O} 29.25'	72^{O} 42.0'	88 - 99	55.0	142.0	76.9	0.31
Thasara	22^{O} 48'	73^{O} 13'	58 - 99^{*T}	40.6	312.0	122.7	0.49
Vasad	22^{O} 27.31'	73^{O} 6.92'	57 - 99	41.0	316.0	122.9	0.45
Wanakbori	22^{O} 56.47'	73^{O} 25.37'	59 - 99^{*W}	38.0	272.5	131.4	0.45

Except for L (1966,1967,1974), P (1972,1973), T(1978) and W (1960,1961,1962,1964,1965,1999)

MATERIALS AND METHODS

Historic data of daily rainfall of longest possible period of Anand and Vasad have been collected from Gujarat Agricultural University, Anand and Central Soil & Water Conservation Research and Training Institute, Vasad respectively. Similarly, daily rainfall data for thirteen raingauge stations, namely Anklav, Borsad, Cambay, Changa, Kanewal, Limbasi, Matar, Nadiad, Petlad, Sojitra, Tarapur, Thasra and Wanakbori spread over in the MRBC (Table 1) and soil properties have been collected from Mahi Irrigation Circle, Nadiad. Average of rainfall of different rainstorm periods, 1 to 7 consecutive days was considered to compute drainage coefficient based on rainfall depth-duration relationship. The same rainfall values on 5-year return period basis were plotted to determine the drainage coefficient by graphical method. For computation of surface drainage coefficient by the USDA-SCS-CN method, it is assumed that the entire MRBC command area is characterized by medium to heavy textured soils with low water transmission and high runoff rates (hydrologic soil group C&D) and curve number 88 is valid for all stations.

RESULTS AND DISCUSSION

Rainfall Depth-Duration Relationship

Average of 1-day annual maximum rainfall varied from a minimum of 76.9 mm (Tarapur) to a maximum of 149.1 mm (Petlad). Similarly average of 7 day consecutive maximum annual rainfall varied from 147.8 mm (Jalundh) to 317.0 mm (Anklav). The 1-day annual maximum rainfall of the all the sixteen stations showed minimum coefficient of variation of 0.31 (Tarapur) to 0.49 (Thasra). The 7-day consecutive maximum rainfall showed highest coefficient of variation 1.06 (Petlad, Sojitra) to 2.75 (Anklav). Coefficient of variation of more than one merely indicates more variation in rainfall of consecutive rainstorm periods. Correlation of rainfall of 2 to 7 day consecutive maximum rainfall with that of 1- day annual maximum rainfall showed that coefficient of determination significantly decreased with increase in duration of rainstorm, which is attributed to inconsistent rainfall (aridity) of the region. Correlation of periodic rainfall (June, July, August, September, for entire monsoon period and year) of different stations with that of Anand also showed significant relationships. Such regression and correlation relationships would be useful in planning and execution of improved agricultural water management practices in the region.

Onset and Withdrawal of Effective Monsoon

The results presented in Table 2 reveal that the earliest probable date (P=0.68) of onset of effective monsoon (OEM) in the command (Table 2) ranges from June 7 (Anand) to June 25 (Jalundh). Latest probable date (P=0.68) of onset of effective monsoon ranges from Jul 12(Anklav) to Aug 8 (Changa). On an average for the entire command (P=0.50) onset of effective monsoon is expected to set in during June 29 (Anand) to Jul 16 (Cambay). Standard deviation for onset of effective monsoon in the entire command ranged from 11 (Anklav) to 23 day (Changa). Average date of withdrawal of effective monsoon ranges from September 1 (Jalundh) to September 30 (Cambay). Duration of effective monsoon thus in the command varies 54 days (Jalundh) to 85 days (Anand) which can be expected to extend from 68 days (Jalundh) to 107 (Anand) respectively. On an average the entire command experiences at least one critical dry spell each year. First critical dry spell of 19 days (Cambay, Nadiad, Thasara) to 28 days (Chang, Limbasi) occurs mostly in July. Similarly second critical spell of 17 days (Anklav) to 36 day (Kanewal) occurs mostly in August. Total of critical dry spell ranged from 62 day (Wanakbori) to 88 days (Kanewal). Such a large variation in critical dry spells demands for area specific canal water supply.

Table 2. Onset and withdrawal of effective monsoon and critical dry spells in different places in the command

Rain Gauge Station	Probable date OEM (p=0.68)		Standarid Deviation	Mean Date of OEM (p=0.50)	Mean Date of With Drawl	Mon Soon Duration (days)	Date of start of critical dry Spell			Length of critical dry spell (days)			
	Earli-est	Latest					First	Second	Third	First	Second	Third	Total
Anand	Jun 7	Jul 22	22	Jun 29	Sep 22	107	Jul16	Aug16	Sep9	25	31	20	76
Anklav	Jun 19	Jul 12	11	Jun 30	Sep 16	92	Jul22	Jul28	Aug 17	20	17	26	63
Borsad	Jun 16	Jul 20	17	Jul 3	Sep 17	93	Jul18	Aug9	Aug 29	20	27	17	64
Cambay	Jun 27	Aug 5	19	Jul 16	Sep 30	95	Jul30	Aug24	Sep 26	19	29	39	87
Changa	Jun23	Aug 8	23	Jul 16	Sep 13	82	Jul25	Aug9		28	25		53
Jalundh	Jun25	Jul 23	14	Jul 8	Sep 1	68	Jul24	Aug2	Sep 20	26	29	27	82
Kanewal	Jun24	Jul 28	17	Jul 10	Sep 21	86	Jul24	Aug16	Aug 27	23	36	29	88
Limbasi	Jun18	Jul 27	20	Jul 7	Sep 23	94	Jul23	Aug11	Aug 20	27	28	24	79
Matar	Jun12	Jul 22	20	Jul 1	Sep 18	98	Jul17	Aug6	Sep 3	20	27	28	75
Nadiad	Jun10	Jul 23	21	Jul 1	Sep 17	99	Jul17	Jul 29	Aug 19	19	31	28	68
Petlad	Jun14	Jul 23	20	Jul 3	Sep 25	103	Jul19	Aug10	Aug 27	20	27	26	73
Sojitra	Jun24	Jul 30	18	Jul 12	Sep 14	82	Jul25	Aug11	Sep 13	28	32	25	85
Tarapur	Jun17	Jul 26	20	Jul 6	Sep 5	80	Jul23	Aug9	Aug 18	24	23	22	69
Thasra	Jun17	Jul18	15	Jul 2	Sep 19	94	Jul19	Aug3	Aug 30	19	32	28	79
Vasad	Jun17	Jul 18	16	Jul 2	Sep 25	97	Jul 22	Aug9	Sep 3	22	27	24	73
Wanakbori	Jun 15	Jul17	16	Jun 30	Sep 12	87	Jul 15	Aug5	Aug 27	25	18	29	72

Table 3. Average Rainfall (mm) and duration of wet spells in MRBC command

Rain Gauge	Rainfall surplus (mm) during different wet spells				
Station	First	Second	Third	Fourth	Total
Anand	351.2 (Jun29-Jul19)	253.6(Aug12-Aug25)	72.0 (Oct 1- Oct 6)		676.8
Anklav	424.3 (Jun30-Jul21)	187.2 (Aug13-Aug23)	101.0(Aug15-Aug 21)	277.5(Sep14-Sep19)	890.0
Borsad	344.8 (Jul3-Jul20)	199.8 (Aug9-Aug21)	147.7 (Sep6-Sep14)	121.5 (Sep14-Sep21)	813.8
Cambay	308.0 (Jul16-Aug3)	208.6 (Aug20-Aug31)	92.4 (Sep23-Sep30)	31.8 (Nov5-Nov10)	640.8
Changa	354.6 (Jul16-Aug2)	158.7 (Aug24-Sep1)	224.7 (Sep5-Sep16)		738.0
Jalundh	215.7 (Jul8-Jul25)	79.6 (Aug20-Aug27)	55.0 (Sep1-Sep6)		424.1
Kankewal	294.3 (Jul10-Jul29)	114.2 (Aug18-Aug25)	75.2 (Sep23-Sep26)	17.4 (Sep26-Sep28)	501.1
Limbasi	357.2 (Jul7-Jul28)	178.8 (Aug21-Aug30)	163.6 (Sep9-Sep15)	138.2 (Sep14-Sep22)	837.8
Matar	313.0 (Jul1-Jul19)	182.8 (Aug8-Aug18)	162.7 (Sep4-Sep13)	27.4 (Oct2-Oct4)	685.9
Nadiad	352.4 (Jul1-Jul20)	215.5 (Aug6-Aug18)	224.4 (Aug30-Sep8)	85.1 (Sep18-Sep21)	877.4
Petlad	391.7 (Jul 3-20)	229.8 (Aug9-18)	161.1 (Sep8-Sep15)	63.6 (Sep23-Sep26)	846.2
Sojitra	311.0 (Jul12-Jul28)	145.6 (Aug23-Aug30)	98.2 (Sep3-Sep19)	15.7 (Oct10-Ooct12)	570.5
Tarapur	279.8 (Jul16-Jul25)	99.5 (Aug17-Aug24)	78.3 (Sep2-Sep6)	42.5 (Sep10-Sep17)	500.1
Tharsara	332.4 (Jul2-Jul20)	282.6 (Aug9-Aug24)	132.1 (Sep15-Sep22)	177.6 (Sep28-Oct4)	924.7
Vasad	360.8 (Jul2-Jul24)	261.6 (Aug15-Aug29)	106.7 (Sep17-Sep23)	74.2 (Sep28-Oct3)	729.1
Wanakbori	339.3 (Jun30-Jul20)	271.1 (Aug11-Aug25)	233.1 (Aug25-Sep5)	107.7 (Sep27-Oct1)	951.2

Rainfall during first, second, third and fourth wet spells varied widely for all the rain gauge stations. Sum of the rainfall during the four wet spells varied from 424.1 mm (Jalundh) to 951.2 mm (Wanakbori). Rainfall during the first wet spell is higher than the rest of the wet spells, which shows the region receives advance rainstorms (Table 3).

Surface Drainage Coefficient

The design of surface drainage is commonly taken as 9.3 mm day^{-1} (1.6 ls^{-1} ha^{-1}) for the agricultural watershed of various command areas of the country irrespective of agro-meteorological conditions (Bhattacharya and Sarkar,1982). Existing practice of dividing 1-day annual rainfall of 5-year return period by 72 hrs is also reported (Khandelwal, 1988). However, surface drainage coefficient as worked out by different approaches would serve the required criteria for planning and implementation of drainage system (Table 4).

Table 4. Surface drainage coefficient (mm day^{-1}) based on different approaches

Station (period) Soil Suitability	Soil Class	Rainfall based method			USDA- SCS- CN method			Graphical method	Provision Drainage Master Plan	
		1 day rain/ 3 days	3 day rain/ 3 days	7 day rain/ 7 days	1 day rain/ 3 days	3 day rain/ 3 days	7 day rain/ 7 days	7 day rain/ 7 days	Based On RL (slope)	Based on last 5 years
Anand	IA	41.73	61.70	34.14	30.49	49.8	28.85	21.50	10.20	29.23
Anklav	IA	42.17	68.30	45.29	30.91	56.1	39.85	16.00	10.20(e)	29.23(e)
Borsad	III	42.13	65.20	36.17	30.87	53.2	30.85	24.50	10.20(e)	29.23(e)
Cambay	IV	37.53	60.10	32.36	26.53	48.1	27.10	21.43	15.67	27.00
Changa	III	41.00	66.70	35.43	29.80	54.6	30.12	21.43	21.33(e)	33.00(e)
Jalundh	III	26.63	39.40	21.11	16.49	28.3	16.16	23.30	10.20(e)	29.23(e)
Kanewal	III	37.50	57.70	30.27	26.50	45.8	25.05	21.70	15.67(e)	27.00(e)
Limbasi	IV	44.70	72.00	37.63	33.32	59.8	32.28	22.00	21.33(e)	28.39(e)
Matar	II	40.80	63.50	33.69	29.61	51.4	28.40	22.10	21.33(e)	28.39
Nadiad	IB	44.47	66.50	36.80	33.09	54.5	31.47	20.00	10.20	28.20
Petlad	IA,IB	49.70	73.00	42.83	38.11	60.8	37.42	25.00	21.33	33.00
Sojitra	II	34.20	54.30	29.61	23.41	42.5	24.41	21.50	21.33(e)	33.00 (e)
Tarapur	II	25.63	43.20	23.04	15.60	31.9	18.02	25.00	15.67(e)	27.00(e)
Thasara	IA	40.90	63.70	37.96	29.70	51.7	32.61	20.00	5.83	29.23(e)
Vasad	IA	40.97	61.30	34.61	29.77	49.3	29.32	30.00	10.20(e)	29.23(e)
Wanakbori	IA	43.80	65.30	38.71	32.46	52.9	33.36	20.00	10.20 (e)	29.23(e)

(E) estimates based on topography and soil suitability classification

Surface Drainage Coefficient Based on Rainfall Depth-Duration Relationship

Average of 1-day annual maximum rainfall and thereby one day tolerance period yields surface drainage coefficient varying from 76.9 mm day^{-1} (Tarapur) to 149.1 mm day^{-1} (Petlad). Similarly average of 1-day annual maximum rainfall with tolerance period of three days (Bhattacharya and Sarkar, 1982) produced surface drainage coefficient varying from 25.63 mm day^{-1} (Tarapur) to 49.70 mm day^{-1} (Petlad). Rainfall of 3- day consecutive storm divided by three day tolerance period for dry foot crops yielded surface drainage coefficient varying 39.40 mm day^{-1} (Jalundh) to 73.00 mm day^{-1} (Petlad). Rainfall of 7-consecutive days rainstorm with tolerance period of 7 day yields surface drainage coefficient varying 21.1 mm day^{-1} (Kanewal) to 45.3 mm day^{-1} (Anklav).

Surface Drainage Coefficient Based on USDA-SCS-CN Method

Average of 1-day annual maximum rainfall and thereby one day tolerance period yields surface drainage coefficient varying from 46.8 mm day^{-1} (Tarapur) to 114.3 mm day^{-1}

(Petlad). Similarly average of 1-day annual maximum rainfall with tolerance period of three days (Bhattacharya and Sarkar, 1982) produced surface drainage coefficient varying from 15.60 mm day^{-1} (Tarapur) to 38.11 mm day^{-1} (Petlad). Rainfall of 3-consecutive days rainstorm divided by three day tolerance period (dry foot crops) yielded surface drainage coefficient varying 16.49 mm day^{-1} (Jalundh) to 60.80 mm day^{-1} (Petlad). Rainfall on 7 consecutive days rainstorm with tolerance period of 7 day yields surface drainage coefficient varying 16.16 mm day^{-1} (Jalundh) to 39.85 mm day^{-1} (Anklav). In general USDA-SCS-CN method yielded less values of surface drainage coefficient for the similar day storm and tolerance period in comparison to graphical method that yielded to the values ranging from 16.00 to 30.00 mm day^{-1} for the entire command. These values lie within the computed values of the two methods namely rainfall depth-duration method and USDA-SCS-CN method. Hence the graphical values may be considered for design of surface drainage system for the command area.

CONCLUSIONS

The provision of drainage system in the command area has to be based on the characteristics of topography, soils, crops and climatic conditions. The study indicates necessity for substantially augmenting the drainage system in the command area. On one hand prolonged dry spells requires efficient irrigation water management and on the other hand, four distinct wet spells yield sufficient excess rainwater, which is needed to be drained out. There are many old drains, which serves the purpose of surface drainage but requires proper remodeling and maintenance. Also, a quite few new drains are required to be constructed to improve upon the drainage network. All the approaches used in the study to estimate drainage coefficient for various stations would serve the required purpose of design criteria for drainage requirement. However, the graphical method seems to be most appropriate as all the values of drainage coefficient lie within computed values by rainfall depth-duration method and USDA-SCS-CN method. Drainage coefficient for the entire command in range of 16 to 30 mm day-1 can be suitably adopted for remodeling and execution of the drains in different areas.

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