

Assessment of Waterlogged and Salt Affected Area in Muktsar District of Southwest Punjab.

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Abstract: The total geographical area of Punjab is 50,362 sq. km out of which cultivable area is 42,150 sq.km (83% of the total area). The irrigation in the state through groundwater is dominant as compared to canals i.e. in the ratio 60:40. The introduction of canals made the state of Punjab surplus in food grains but at the same time this also led to the development of water logging and subsequent salinization, rendering large chunks of land unproductive mainly in Muktsar district located in southwest of the state. The canal system has brought in dilution of shallow saline groundwater due to seepage and percolation of fresh waters but at the same time threatened the agriculture and land development owing to rising water table, water logging and secondary soil salinization. The high salinity in native ground water has impeded extraction and utilization of groundwater. The water table has been constantly rising in these areas. This paper mainly aims at micro level mapping of the district to demarcate water logged area (depth to water level 0-2 mbgl) and area prone to water logging (depth to water level 2-3 mbgl) and to assess salinity of groundwater at shallow depth. Besides, it also aims to know the general hydrogeological conditions and to find out causes and extent of water logging and suggest preventive and curative measures for combating water logging problems in the area.

Key Words: Water logging, Salinization, Secondary soil salinization, Groundwater, Hydrogeological.

1. Introduction

There has been a spectacular increase in food grain production in Punjab, especially after the initiation of green revolution. The large scale extraction of groundwater is also attributed to the 'Green Revolution'. Irrigation accounts for 69 percent of all global fresh water use, while industry and domestic uses consume 23 percent and 8 percent respectively [12].

The cultivated irrigated area increased from 54 percent to 95 percent, while cropping intensity increased from 126 percent to 187 percent between 1960-61 and 1995-96 [9]. The introduction of extensive and enhanced system of canal irrigation system throughout the state could be attributed to this phenomenal increase.

A unique feature of the canal system of Punjab is the interlinking achieved for transfer of surplus supplies from one river basin for use in other basin. This has changed the economic and agricultural status of Punjab, making it one of the prosperous and largest contributors of food grains to the central pool. But this has also brought problems like water logging and secondary salinity [3]. However, due to lack of proper investigations taken up at the planning stage itself of canal introduction, without keeping in view of the regional/local topography, groundwater table, geomorphology and cropping pattern of the area has resulted in large scale land degradation of land resources due to water logging and subsequent salinization [2]. In addition to this natural factors such as topographic depressions,

absence of natural drainage and incessant rains have further compounded the water logging and salinity problems. The groundwater in southwest Punjab is mainly facing problems of water logging, saltwater encroachment, groundwater pollution, and salinity and these are major consequences of intensive irrigation [10]. The menace of water logging assumed alarming proportion especially in and around Muktsar district. [7].

Every year Central Ground Water Board conducts monitoring of water table depth. These surveys are carried out during pre and post monsoon seasons every year for the assessment of damaged crops and villages affected by water logging. In Muktsar district 12.29% of the total geographical area was estimated to be affected by surface and subsurface water logging during the year 1997 [6]. During the year 1998 only Muktsar district suffered a loss of rupees two-hundred crores cotton crop due to water logging according to Department of Agriculture [1]. Keeping in view the above situation, an attempt has been made to quantify the decrease in water table depth since 1985 till 2012 to delineate waterlogged and salt-affected area and devising suitable strategies to protect water regime of southwest tracts of Punjab and give suitable strategies for the protection of those areas that have not yet been invaded by this menace.

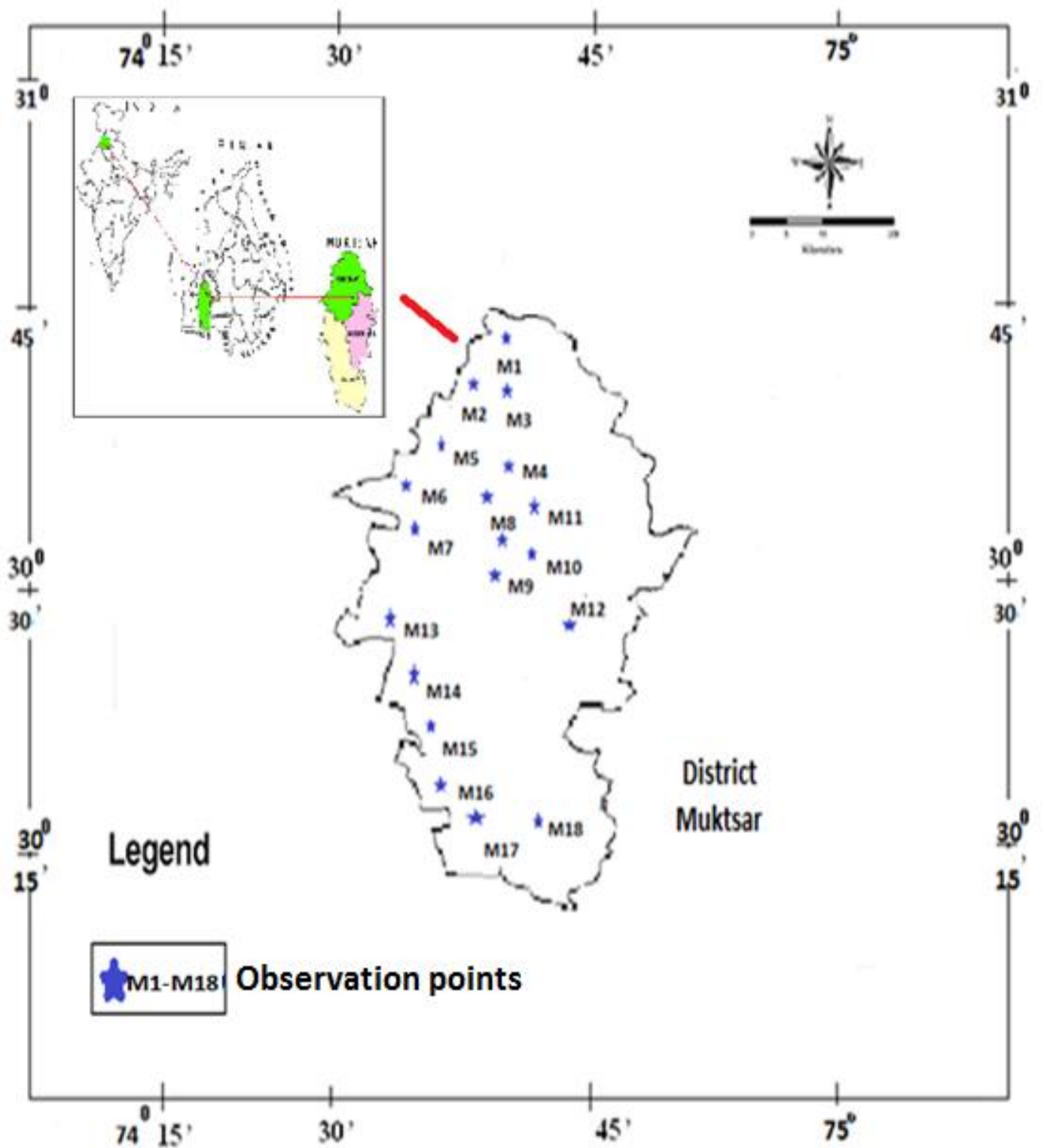


Figure 1: Location of the study area.

Table 1: Muktsar district at a glance

Particulars	Muktsar
GENERAL INFORMATION	
i)Geographical Area(km ²)	2630
ii)Administrative Division Number of Panchayats/villages	235
iii)Population(as per 2001 census) (as per 2011 census) (% increase)	7,77,493 9,02,702 13.87
iv)Average annual rainfall(mm)	430.7
GEOMORPHOLOGY	
Major physiographic units	Alluvium
Major Drainage	Sutlej
LAND USE(km²)	
a.Forest area	20
b.Net area sown	2260
c.Cultivable area	2210
MAJOR SOIL TYPES	Sierozem soil and desert soil
AREA UNDER PRINCIPAL CROPS (Ha)	Rice-770 Wheat-2000 Cotton-1170
PREDOMINANT GEOLOGICAL FORMATIONS	Alluvium
HYDROGEOLOGY	
Major Water bearing formations	Sand
Pre-monsoon depth to Water Level	1.65-6.43mbgl
Post-monsoon depth to Water Level	1.49-6.63mbgl
Long term water level trend in 10 years in m/yr	-1.16-3.87mbgl

(Source: Statistical Abstract, 2007)

2. Methodology

Prior to introduction of irrigation system in the southwestern parts of Punjab in 1895, the water level in the region was deep, about 20 to 30 m below ground level. From 1965-66, with the introduction of green revolution and with increase in cropping intensity, the water table has started rising [3]. There are 18 observation points (Hydrograph Network Stations) of the Central Groundwater Board, where water level and quality of groundwater is being monitored for the past 30

years, which is presented in Table 2. The water level data of CGWB is compiled and depth to water level measurement of shallow aquifer at these 18 locations along with water quality is analyzed to study water level and salinity in the area. Ground water quality data of hydrograph network stations is being monitored during the pre-monsoon and post monsoon period and the data base of past 20 years is being maintained at CGWB. This data is used for delineation of the pre and post monsoon waterlogged area. Electrical Conductivity of these locations is measured using conductivity meter to

demarcate groundwater of salt affected areas. Based on the differential manifestations in the form of tone, texture, pattern, shape, size and association the waterlogged area and salt affected water were characterized and classified under different

categories. The waterlogged areas (depth to water level 0-2 mbgl), area prone to water logging (depth to water level 2-3 mbgl) (Table 4) and salinity of ground water at shallow depth is used to categorize the area in different salinity zones (Table 6).

Table 2: Change in water level in 1985-2012

S.No.	Location	1985		1990		1995		2000		2005		2010		2012	
		(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
1.	Abulkharana	10.5	10.0	6.0	6.1	2.0	1.8	0.3	0.3	0.6	0.5	0.9	0.7	1.1	0.8
2.	Bhaliana	9.2	8.8	8.4	8.1	7.5	7.1	5.1	5.5	6.7	6.4	7.8	7.5	7.9	8.2
3.	Bhamma (Bam)	3.2	3.1	2.7	2.4	1.9	0.9	0.9	0.1	2.1	2.5	2.2	2.2	2.5	2.0
4.	Chakdhor wala	3.2	3.1	2.9	2.6	1.8	1.1	1.3	1.5	2.5	2.2	2.7	2.3	3.0	2.9
5.	Doda	4.3	4.1	3.5	3.2	2.6	1.6	0.2	1.7	1.2	1.8	2.6	1.5	2.2	2.5
6.	Labanianwala	1.7	0.8	2.8	1.9	1.6	0.7	2.0	2.2	1.8	1.0	2.7	2.5	2.8	2.5
7.	Lambi	6.8	12.7	9.5	9.3	6.8	5.9	5.7	5.3	1.7	1.9	1.7	1.5	2.1	3.0
8.	Muktsar	1.6	3.1	2.4	2.4	2.5	1.4	3.6	3.1	3.5	1.8	1.9	1.9	1.8	1.7
9.	Smagh	1.8	0.5	2.8	1.4	1.8	1.3	1.2	0.9	1.4	0.8	2.0	1.5	2.2	1.9
10.	Fakkarsar	5.2	4.8	1.5	1.2	2.5	2.1	1.6	1.9	3.1	3.3	3.4	3.0	3.5	3.0
11.	Gidderbaha	13.2	12.7	9.8	9.7	8.2	7.7	1.9	2.5	4.3	3.9	4.4	4.0	4.8	4.2
12.	Hakkuwala	14.1	13.6	13.5	12.9	9.2	8.4	1.2	1.7	2.4	1.8	2.6	2.5	2.9	2.3
13.	Karniwala	2.6	0.8	2.0	1.6	0.9	0.3	0.1	1.0	0.5	1.2	0.8	0.7	1.1	0.8
14.	Kuttianwali	12.7	11.7	11.6	11.3	8.6	7.1	0.6	0.5	3.1	1.4	1.3	0.8	1.3	1.0
15.	Lakhe	4.8	4.6	4.8	4.8	4.2	3.9	1.7	2.1	3.9	4.6	3.3	3.9	4.1	4.7
16.	Malout	5.5	5.3	6.1	5.7	0.7	0.3	-0.05	0.4	1.5	0.9	1.8	1.7	2.1	1.7
17.	Jhabelwali	0.3	0.2	1.5	1.3	1.1	0.2	1.3	0.03	1.7	1.8	1.4	1.1	1.9	1.6
18.	Thandewal	4.2	4.1	3.9	3.6	3.5	2.4	2.0	2.2	2.0	2.3	2.2	2.4	2.4	2.7
District Mean		5.8	5.8	5.3	4.9	3.8	3.0	1.7	1.8	1.9	1.8	1.7	1.5	1.9	1.5
Minimum		0.3	0.2	1.5	1.2	0.7	0.2	-0.0	0.03	0.47	0.5	0.85	0.7	1.07	0.81
Maximum		14.1	13.6	13.6	12.9	9.2	8.4	5.7	5.5	6.7	6.5	7.8	7.5	7.9	8.2

(a refers Pre monsoon , b refers to post monsoon)

(Source: CGWB water level data report,2013)

3. Results and discussions

Present study mainly aims at micro level mapping of the district to demarcate waterlogged areas (depth to water level 0-2 mbgl) and area prone to water logging (depth to water level 2-3 mbgl) (Table 4) and to assess salinity of ground water at shallow depth (Table 6). Besides, the investigation also aims to know the general hydrogeological conditions and to find out causes and extent of

water logging and suggest preventive and curative measures for combating water logging problems in the area. Table 2. shows the water level of 18 locations from 1985 to 2012, at 5 year interval. This gives an idea about the change in depth to water level in the district. The mean water level in the district during the post-monsoon season has

risen from 5.8 m in 1985 to 4.9 m in 1990 to 3 m in 1995 to 1.8 in 2000 to 1.5 m in 2012. The maximum water level ranges from 14.1 m in 1985 to 8.2 m in 2012. It shows that deep water

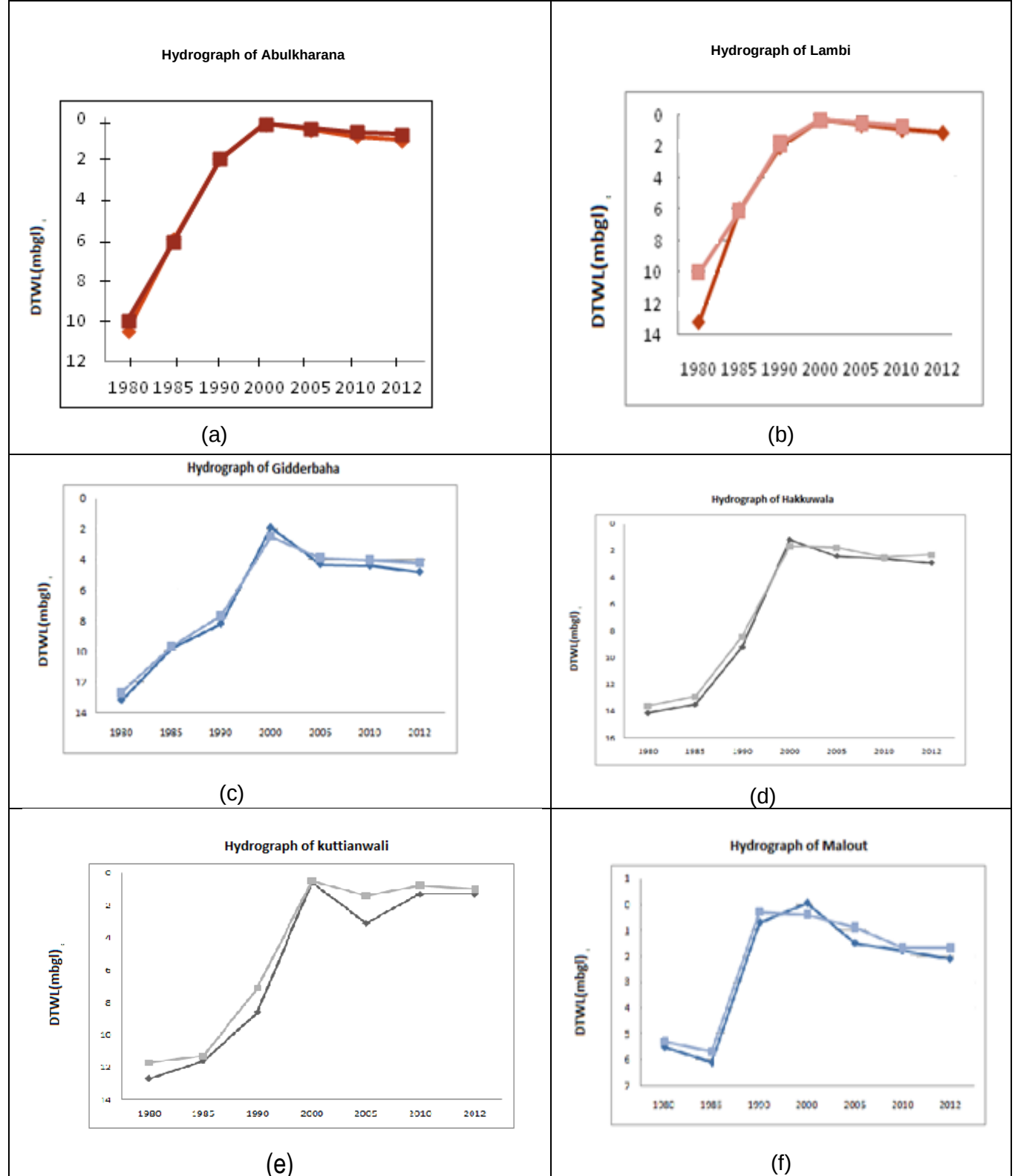
level zones are becoming shallow zones with rising water table. There is no significant change in the minimum water level.

Table 3: Long-term water level trend of national hydrograph network stations

S.No	Location	Block	Pre-monsoon		Post-monsoon	
			Rise(m/yr)	Fall(m/yr)	Rise(m/yr)	Fall(m/yr)
1	Abulkharana	Lambi	0.34		0.34	
2	Baliana	Kotbhai	0.04		0.02	
3	Bhamma	Malout	0.02		0.04	
4	Chakdohewala	Malout	0.007		0.007	
5	Doda	Kotbhai	0.07		0.05	
6	Labianwali	Muktsar		0.04		0.06
7	Lambi	Lambi	0.17		0.35	
8	Muktsar	Muktsar		0.007	0.051	
9	Smagh	Muktsar		0.014		0.05
10	Fakkarsar	Kotbhai	0.06		0.06	
11	Giddarbaha	Kotbhai	0.31		0.31	
12	Hakkuwala	Lambi	0.41		0.42	
13	Kaniwala	Malout	0.05		0	
14	Kutianwali	Lambi	0.42		0.39	
15	Lakhe	Muktsar	0.02			0.003
16	Malout	Malout	0.12		0.13	
17	Jhabelwali	Muktsar		0.05		0.05
18	Thandewal	Muktsar	0.06		0.05	

Long term trend of pre monsoon and post monsoon water levels of national hydrograph network stations of CGWB is compiled and presented in Table 3. Rising trend of water level ranges from 0.02 m /yr in Lakhewali to 0.42 m /yr in Kutianwali. The pre and post monsoon water level

trend is almost same in all the locations in the district. The decline of water levels observed in other 5 stations is not significant, showing absence of any trend. The hydrographs of the locations with pre and post monsoon rising trend greater than 0.1m/yr is given in Fig.2.



— Post monsoon — Post monsoon — Post monsoon
— Pre monsoon — Pre monsoon — Pre monsoon

Figure 2 (a-f): Hydrographs of different locations showing Pre and Post monsoon trend in water level

Table 4: Pre monsoon and post monsoon waterlogged area statistics tehsil wise

Season	Tehsil	Tehsil Area (ha)	Category		Area tehsil wise ha
			Waterlogged Area ha (%)	Area sensitive to water logging ha (%)	
Pre monsoon	Muktsar	90,275	10,020.5 (11.1)	15,076 (16.7)	25,096.5 (27.8)
	Malout	1,06,379	5,850 (5.5)	17,765 (16.7)	23,615 (22.2)
	Lambi	66,467	11,100 (16.7)	7,377.8 (11.1)	18,477 (27.8)
Total	Distt. Area	2,63,121			
Post monsoon	Muktsar	90,275	15,076 (16.7)	10,020.5 (11.1)	25,076.5 (27.8)
	Malout	1,06,379	11,808 (11.1)	11,808 (11.1)	23,616 (22.2)
	Lambi	66,467	7,377.8 (11.1)	14,755.6 (22.2)	22,133.4 (33.3)
Total	Distt. Area	2,63,121			

Table 5: Area falling in different depth ranges of water level

DTWL (mbgl)	1985		1990		1995		2000		2005		2010		2012	
	Area (%)	Area (km ²)	Area (%)	Area (km ²)	Area (%)	Area (km ²)	Area (%)	Area (km ²)	Area (%)	Area (km ²)	Area (%)	Area (km ²)	Area (%)	Area (km ²)
0.00-1.00	5.6	145.3	NIL	NIL	16.6	430.9	38.9	1009.8	11.1	288.1	11.1	288.1	11.1	288.1
1.00-2.00	16.6	430.9	16.6	430.9	33.4	867	27.8	721.6	33.4	867	27.8	721.6	16.6	430.9
2.00-3.00	5.6	145.3	27.8	721.6	16.6	430.9	16.6	430.9	22.2	576.3	33.4	867	44.4	1152.6
3.00-5.00	33.4	867	16.6	430.9	5.6	145.3	5.6	145.3	27.8	721.6	22.2	576.3	22.2	576.3
5.00-10.00	16.6	430.9	27.8	721.6	27.8	721.6	11.1	288.1	5.6	145.3	5.6	145.3	5.6	145.3
>10.00	22.2	576.3	11.1	288.1	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL

Depth to water level measurement of shallow aquifer at these 18 locations along with water quality, is analyzed to study water level and salinity in the area.

The area statistics reveals that out of the total geographical area (2630 sq. km) of Muktsar district 27.7% or 719 km² (Table 5) are of land is affected by water logging and 33.3% during pre

monsoon (Table 4) and 38.9% of water from shallow aquifer during post monsoon is affected by water logging (Table5). Of the total land 44.5% area is sensitive to water logging during pre monsoon (Table 4) and 44.4% or 36,584.1 ha area of land during post monsoon falls under area sensitive to water logging category (Figure 3).

Table 6: Pre monsoon and Post monsoon salinity statistics tehsil wise

Season	Tehsil	EC ($\mu\text{S}/\text{cm}$) Category		
		Fresh (0-2000)	Brackish (2000-4000)	Saline (>4000)
Pre monsoon	Muktsar	30%	-	10%
	Malout	16.7%	6.7%	10%
	Lambi	10%	3.3%	10%
Post monsoon	Muktsar	30%	-	10%
	Malout	16.7%	3.3%	13.3%
	Lambi	10%	10%	10%

The above table shows that the shallow ground water was fresh in about 56.7% of the area and brackish in 10% of the area and saline in 30% of the area during pre monsoon (Table 6) and 33.3% area falls under saline category during post monsoon. The higher values of EC in the district may be attributed to leaching effect and intensive irrigation practices [12]. Salinity was particularly high in villages Birankhera, Chakmori in Lambi

block, Dohak Jagatsingh wala , Rahurianwali, Sangrana in Muktsar blocks. All the three villages with high salinity falls under water logged areas in Muktsar block. After comparing the Depth to water level map and EC map (Fig. 4), it is found that, there is no direct correlation between the two and it is also observed in the field that, there is a very high lateral and vertical variation in the EC values in the district [4].

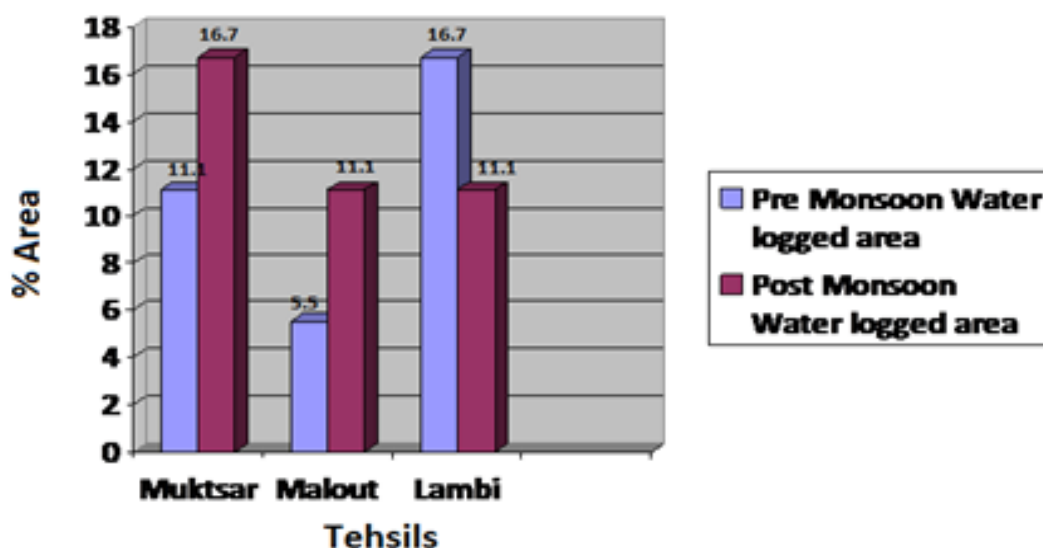


Figure 3: Relationship between waterlogged area during pre and post monsoon tehsil wise.

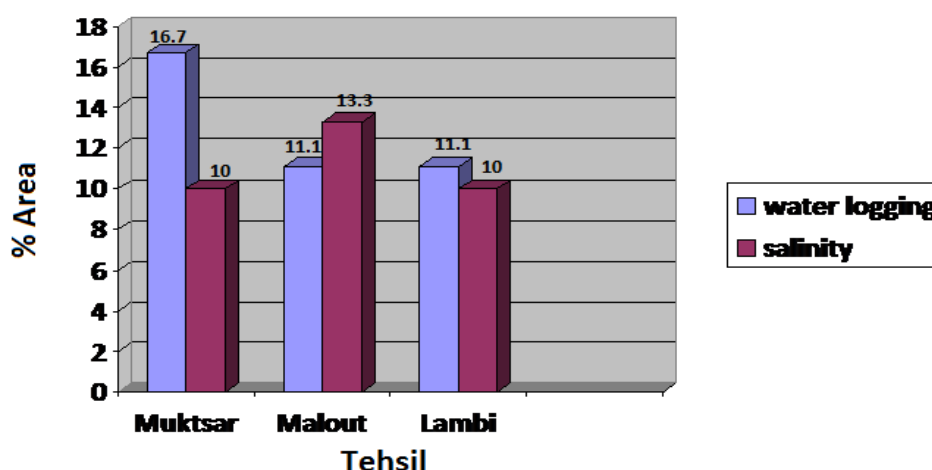


Figure 4: Relationship between waterlogged and salt affected area during pre monsoon tehsil wise.

4. Conclusion

Water logging and salinity problems are a major concern of this region. The areas under water logging change from year to year. The problem of salinity is more extensive and varied in nature. It is present everywhere, varying in degree, both spatially and vertically which limits use of ground water for irrigation and drinking purpose and thereby dependence on canal water is immense. Cropping pattern has to be changed so that brackish to saline water can be used for irrigation.

Conjunctive use of ground and canal water is to be encouraged to reduce the dependence on canal water. Need of the hour is not only the implementation of anti-water logging measures by the government, but creating awareness among the farmers about the long term effects of rising water logging and salinity problem and educate them about certain measures like change in cropping pattern, irrigation methods, irrigation schedules and benefits of conjunctive use of surface and groundwater in irrigation.

5. References

- [1] Anonymous, "Ground water resources and development potentials of Muktsar district, Punjab", unpublished report, CGWB, 2000.
- [2] Anonymous, "Ground water resources and development potentials of Muktsar district, Punjab", unpublished report, CGWB, 2008.
- [3] Anonymous, "Ground water resources and development potentials of Muktsar district, Punjab", unpublished report, CGWB, 2013.
- [4] A.S. Qureshi, P.G Cornick, M. Quadia and Z. Aslam, "Managing salinity and water logging in the Indus Basin of Pakistan," *Agricultural Water Management*, 95.1., 1-10. 2008.
- [5] C.M. Bhatt, R.K Singh P.K. Litoria and P.K. Sharma, "Use of remotely sensed data and GIS techniques for assessment of waterlogged and salt-affected area Tehsilwise in Muktsar district of Punjab."
- [6] G.S. Dhillon, "Waterlogging Menace in Muktsar", *The Tribune*, October 2, 1997.
- [7] K. Singh, H.S. Hundal and D. Singh, "Geochemistry and assessment of hydrogeological process in groundwater in southern part of Bhathinda district of Punjab," *Environment Earth Science*, 59-64. 7., 1823-1833. 2009.
- [8] Kamaldeep, M.S. Rishi, N. Kochhar and N. Ghosh, "Impact of industrialization on groundwater quality in relation to incidence of cancer in parts of southwest Punjab, India," *Asia Journal Water Env. And Poll.*, 4.2.,107-112. 2011.
- [9] P.J.S. Bhamrah, "Non-judicious use of water resources, suggestions for sustainable management", *Congress International DE KASLIK-LIBAN*, 18-20 June, 1998.
- [10] P.K. Sharma, V.K. Verma, P.K. Litoria, A. Sood, D.C Loshali, A. Kumar, C. Singh, C.M. Bhatt, and R. Chopra, "Resource Atlas Muktsar District," *Punjab Remote Sensing Centre Publication*, 2003.
- [11] R. Chopra, V.K. Verma, , P.K. Sharma and C. Singh, "Surface flooding and waterlogging in south western districts of Punjab, Technical report", *Punjab Remote Sensing Centre Publication*:1-20, 1998.
- [12] R. Sharma, "Water table: Going down deep into depletion", *Hindustan Times*. June 24, 2003.

