

## Panipat block

Panipat city of Haryana State is located at 29.3989° N latitude and 76.9770° E longitude. It belongs to Rohtak Division and situated at 175 km away from the State capital Chandigarh. Panipat city is surrounded by Bapoli Tehsil towards east, Madlauda Tehsil towards west, Gharaunda (Karnal) Tehsil towards north, Israna Tehsil towards south. Panipat block is spread over an area of about 202 km<sup>2</sup> covering 52 villages and 1,37,103 households.

A total of 162 water samples were collected (1 km x 1 km) from all over the Panipat block and analysed for different water quality parameters (EC, RSC, SAR). Groundwater EC of Panipat block ranged from 0.51 dS/m (village Budhsham, 29.2978° N latitude 76.9531 E° longitude) to 4.56 dS/m (village Brahman Majra, 29.331° N latitude 76.9334 E° longitude) with a mean value of 1.70 dS/m (Table 8). There was very low problem of salinity in underground water of Panipat block as 97.5% of the collected water samples were characterized with EC < 2 dS/m (average EC ~ 1.16 dS/m), the permissible limit of using saline groundwater for irrigation (Table 9). Only 2.5% of the samples had EC range of more than 2 dS/m.

The data presented in Table 8 revealed that residual alkalinity in groundwater (RSC) ranged from 0 to 8.4 me/l with an average value of 1.5 me/l. The highest RSC ~ 8.4 me/l was recorded in village Assan Kala located at 29.4238° N latitude, 76.8814° E longitude. About 22% of the tested water samples were characterized with RSC > 2.5 me/l (average RSC ~ 4.7 me/l) (Table 10), out of which 13% had RSC between 2.5–5 me/l (average RSC ~ 3.7 me/l) and rest 9% with RSC between 5–10 me/l (average RSC ~ 6.4 me/l). More than three-fourth of the water had very low problem of residual alkalinity (average RSC ~ 0.53 me/l).

**Table 8. Range and values of water quality parameters in Panipat block**

Sl. No.	Parameters	Range	Mean
1.	EC (dS/m)	0.5–4.56	1.70
2.	pH	6.60–8.63	7.70
3.	CO <sub>3</sub> <sup>2-</sup> + HCO <sub>3</sub> <sup>-</sup> (me/l)	2.5–24.0	8.4
4.	Ca <sup>2+</sup> + Mg <sup>2+</sup> (me/l)	2.8–16.4	7.9
5.	RSC (me/l)	Nil–8.4	1.5
6.	Na <sup>+</sup> (me/l)	1.4–45.8	6.5
7.	SAR (m mol/l) <sup>½</sup>	0.7–16.6	3.4
8.	Cl <sup>-</sup> (me/l)	0.9–16.5	5.2
9.	SO <sub>4</sub> <sup>2-</sup> (me/l)	2.3–13.4	6.6
10.	PO <sub>4</sub> <sup>2-</sup> (me/l)	BDL–0.16	0.05
11.	F <sup>-</sup> (ppm)	0.4–1.8	0.8
12.	NO <sub>3</sub> <sup>-</sup> (ppm)	0.05–17.6	7.2

BDL: Below Detectable Limit

The sodium adsorption ratio (SAR) ranged from 0.2 (village Binjhol, 29.3567° N latitude, 76.9356° E longitude) to 16.2 (village Brahman Majra, 29.3371° N latitude, 76.9334° E longitude) with a mean value of 3.4 (Table 8). Majority (97%) of water samples were characterized with SAR <10 (average SAR~3.1) while rest 3% had SAR between 10–20 (average SAR~13.1). The increased levels of Na<sup>+</sup> (Table 9 and 10) in groundwater contributed towards higher SAR problem.

**Table 9. Chemical composition of groundwater samples of Panipat block against different EC class**

EC class (dS/m)	No. of samples	EC dS/m	CO <sub>3</sub> <sup>2-</sup> + HCO <sub>3</sub> <sup>-</sup> me/l	Cl <sup>-</sup> me/l	SO <sub>4</sub> <sup>2-</sup> me/l	Ca <sup>2+</sup> + Mg <sup>2+</sup> me/l	Na <sup>+</sup> me/l	RSC me/l	F <sup>-</sup> ppm	NO <sub>3</sub> <sup>-</sup> ppm	SAR (mmol/l) <sup>½</sup>
<2	158	1.16	8.3	4.5	5.4	7.8	6.1	1.4	0.7	7.2	3.2
2–4	3	2.47	12.3	9.7	11.7	11.6	13.3	2.6	0.9	4.7	6.3
4–8	1	4.46	14.5	16.5	13.0	15.2	45.8	0.0	1.1	8.3	16.6
Total*	1.62	1.20	8.4	5.2	6.6	7.9	6.5	1.5	0.8	7.2	3.4

\*represents weighted mean for each parameter

**Table 10. Chemical composition of groundwater samples of Panipat block against different RSC class**

RSC class (me/l)	No. of samples	RSC me/l	EC dS/m	CO <sub>3</sub> <sup>2-</sup> + Cl <sup>-</sup> HCO <sub>3</sub> <sup>-</sup> me/l	SO <sub>4</sub> <sup>2-</sup> me/l	Ca <sup>2+</sup> + Mg <sup>2+</sup> me/l	Na <sup>+</sup> me/l	F <sup>-</sup> ppm	NO <sub>3</sub> <sup>-</sup> ppm	SAR (mmol/l) <sup>½</sup>	
<1.25	98	0.17	1.23	7.3	5.7	5.9	8.8	5.9	0.7	7.2	2.9
1.25–2.5	29	1.75	1.16	8.6	3.5	7.0	6.9	7.0	0.6	7.5	3.4
2.5–5	21	3.68	0.99	9.8	3.2	5.6	6.3	5.8	1.1	4.9	3.8
5–10	14	6.44	1.42	12.8	5.1	8.6	6.1	10.3	1.1	8.8	5.6
>10	0	–	–	–	–	–	–	–	–	–	–
Total*	162	1.45	1.20	8.3	5.2	6.6	7.9	6.5	0.8	7.2	3.4

\*represents weighted mean for each parameter

**Table 11. Chemical composition of groundwater samples of Panipat block against different SAR class**

SAR class (mmol/l) <sup>½</sup>	No. of samples	SAR (mmol/l) <sup>½</sup>	RSC me/l	EC dS/m	CO <sub>3</sub> <sup>2-</sup> + HCO <sub>3</sub> <sup>-</sup> me/l	Cl <sup>-</sup> me/l	SO <sub>4</sub> <sup>2-</sup> me/l	Ca <sup>2+</sup> + Mg <sup>2+</sup> me/l	Na <sup>+</sup> me/l	F <sup>-</sup> ppm	NO <sub>3</sub> <sup>-</sup> ppm
<10	157	3.06	1.41	1.18	8.3	4.9	6.4	7.9	5.9	0.7	7.0
10–20	5	13.06	2.72	1.91	10.3	10.4	10.8	7.7	25.5	1.3	12.5
>20	0	–	–	–	–	–	–	–	–	–	–
Total*	162	3.36	1.45	1.20	8.3	5.2	6.6	7.9	6.5	0.8	7.2

\*represents weighted mean for each parameter

Spatial variability for EC (Fig. 4a) and SAR (Fig. 4c) indicated that majority of the area in Panipat block has very low problem of salinity (93%, EC <2 dS/m) and sodium adsorption ratio (96.5%, SAR <10) in groundwater. Nearly half of the area is affected with problem of residual alkalinity; 28% with RSC between 2.5–5 me/l and 20% with RSC between 5–10 me/l (Fig. 4b). Maximum RSC problem was encountered in north–western parts of the

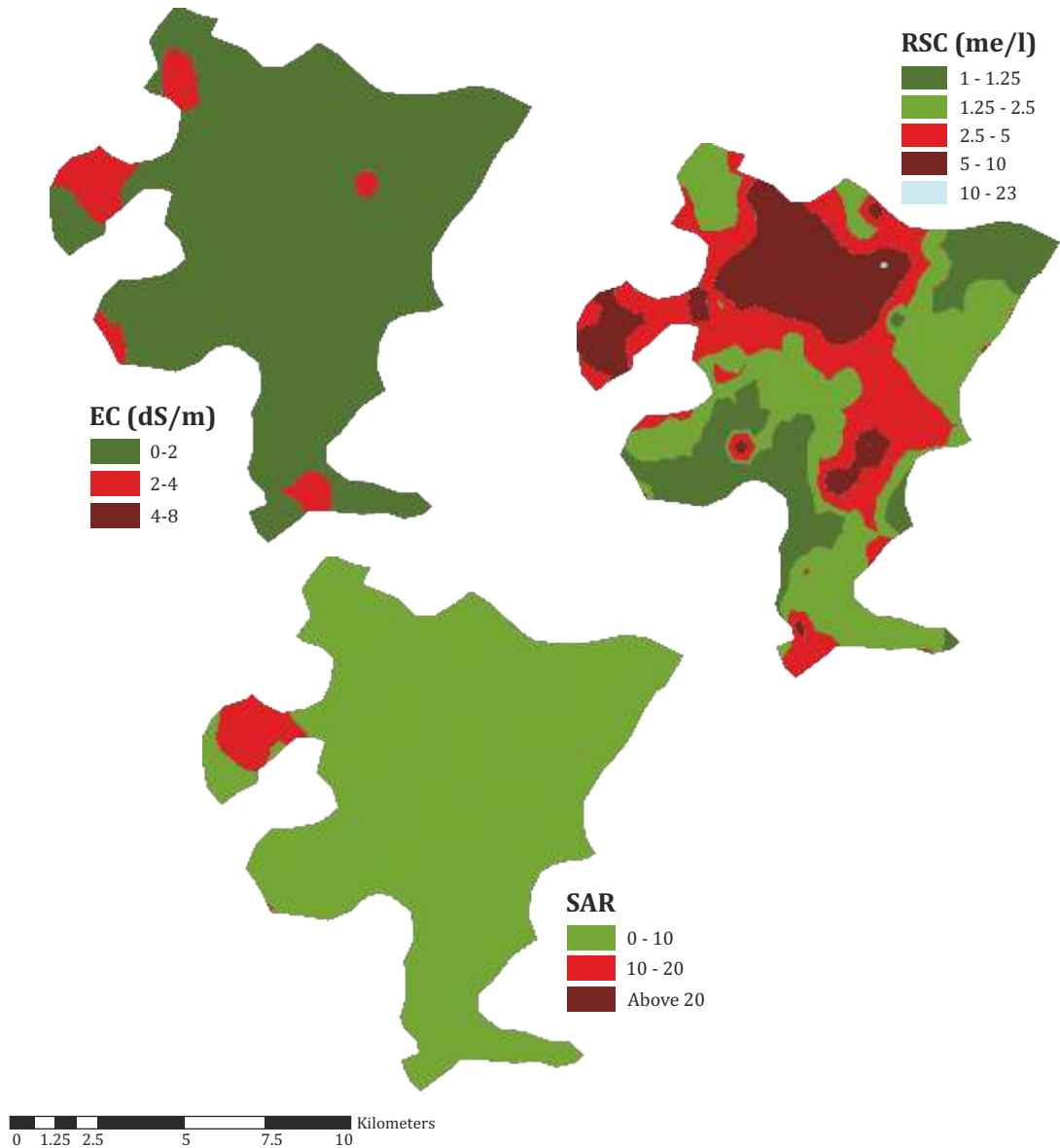
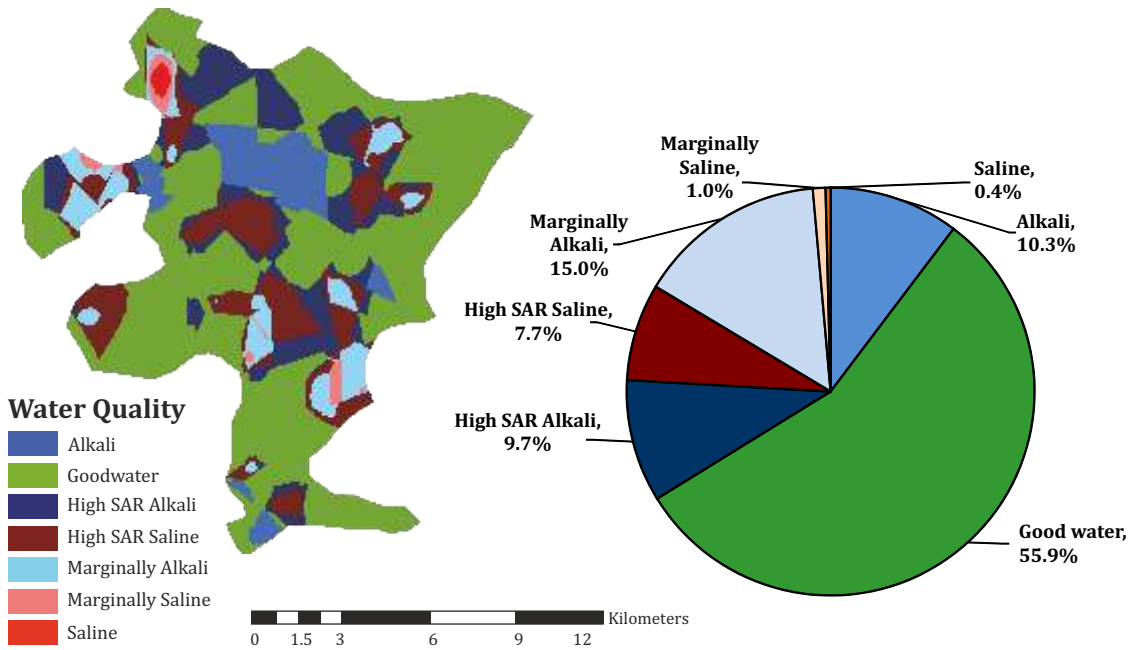


Fig. 4. Distribution of (a) electrical conductivity (EC); (b) residual alkalinity (RSC) and (c) sodium adsorption ratio (SAR) in groundwaters of Panipat block



**Fig. 5. Distribution and characterization of groundwater quality of Panipat block**

Panipat block. In Panipat block covering 202 km<sup>2</sup> area, 56% area represents underground water of good quality (EC <2 dS/m, RSC <2.5 me/l, SAR <10). Nearly 44% area was affected with poor quality water of variable salinity and residual alkalinity (Fig. 5). High SAR problem was encountered in 17.4% area. Residual alkalinity (marginal alkali~15%, alkali~10.3% and alkali~9.7%) and salinity (marginal saline~1%, saline~0.4% and high SAR saline~7.7%) of variable nature was quite critical in 35 and 9% groundwater, respectively.