SWAT-2019

GROUNDWATER INVESTIGATIONS WITH ELECTRICAL RESISTIVITY IN DISTRICT MATIARI, PAKISTAN

Presenter:

RABIA DARS

E-mail: dars.gnabi@gmail.com

Oct-25 Siem Reap, Cambodia

Authors: Rabia Dars, Abdul Latif Qureshi, Jianhua Ping, Shafi Muhammad Kori, Hafiz Abdul Salam,

OUTLINES:

- Introduction
- Problem Statement
- Literature
- Objectives
- Material and Method
- Results & Discussion
- Conclusion & Recommendation
- References

INTRODUCTION

- Water is a gift of nature and in a bounteous proportion, noticeable by its presence (surface, rain, glacier and underground).
- Pakistan is facing severe crises of water deficiency due to increasing population and rapid urbanization, consequently more food and fiber is needed, and required water management for agriculture.
- Groundwater an important alternate resource which is used as supplement for drinking purpose for both urban and rural communities
- The geophysical survey such as Electrical Resistivity Survey (ERS) may be employed for groundwater exploration. The use of ERS to assess aquifer thickness and groundwater quality has been increased all over the world
- Present water shortage is one of the primary world issues, and according to climate change projections, it will be more critical in the future.

PROBLEM STATEMENT:

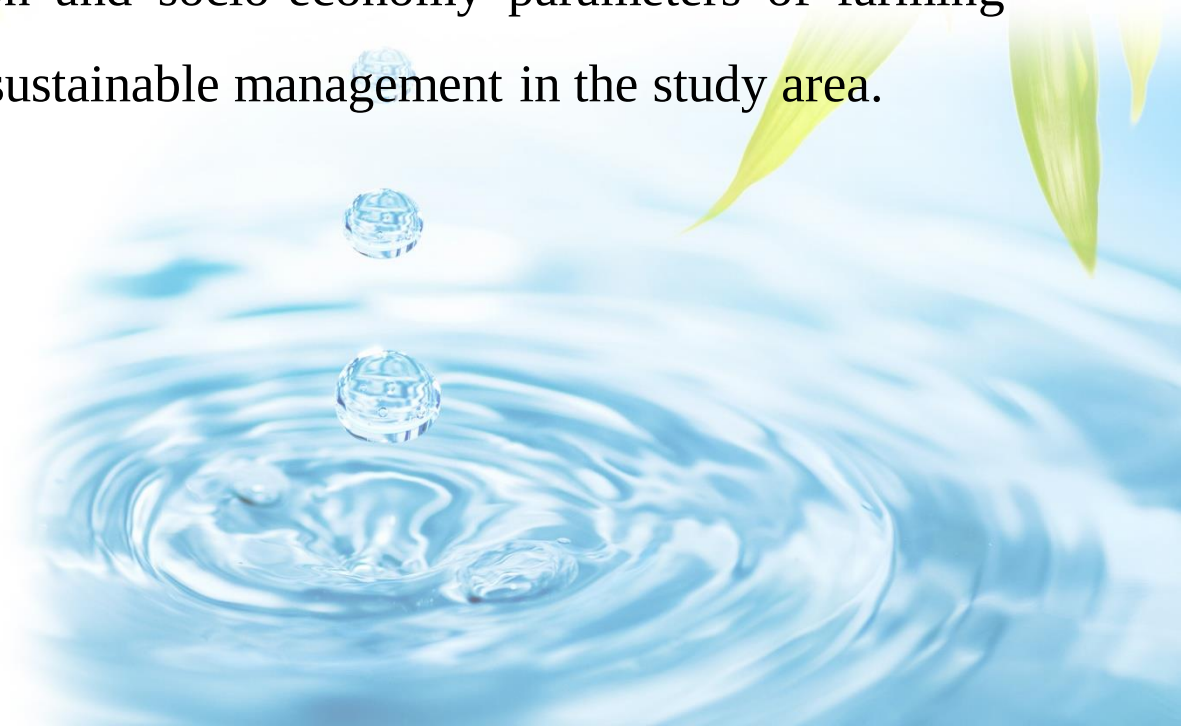
- The process of urbanization often causes changes in groundwater levels
- As a result, issues relative to ground water are often seemingly less dire than issues related to surface water alone.

REVIEW LITERATURE

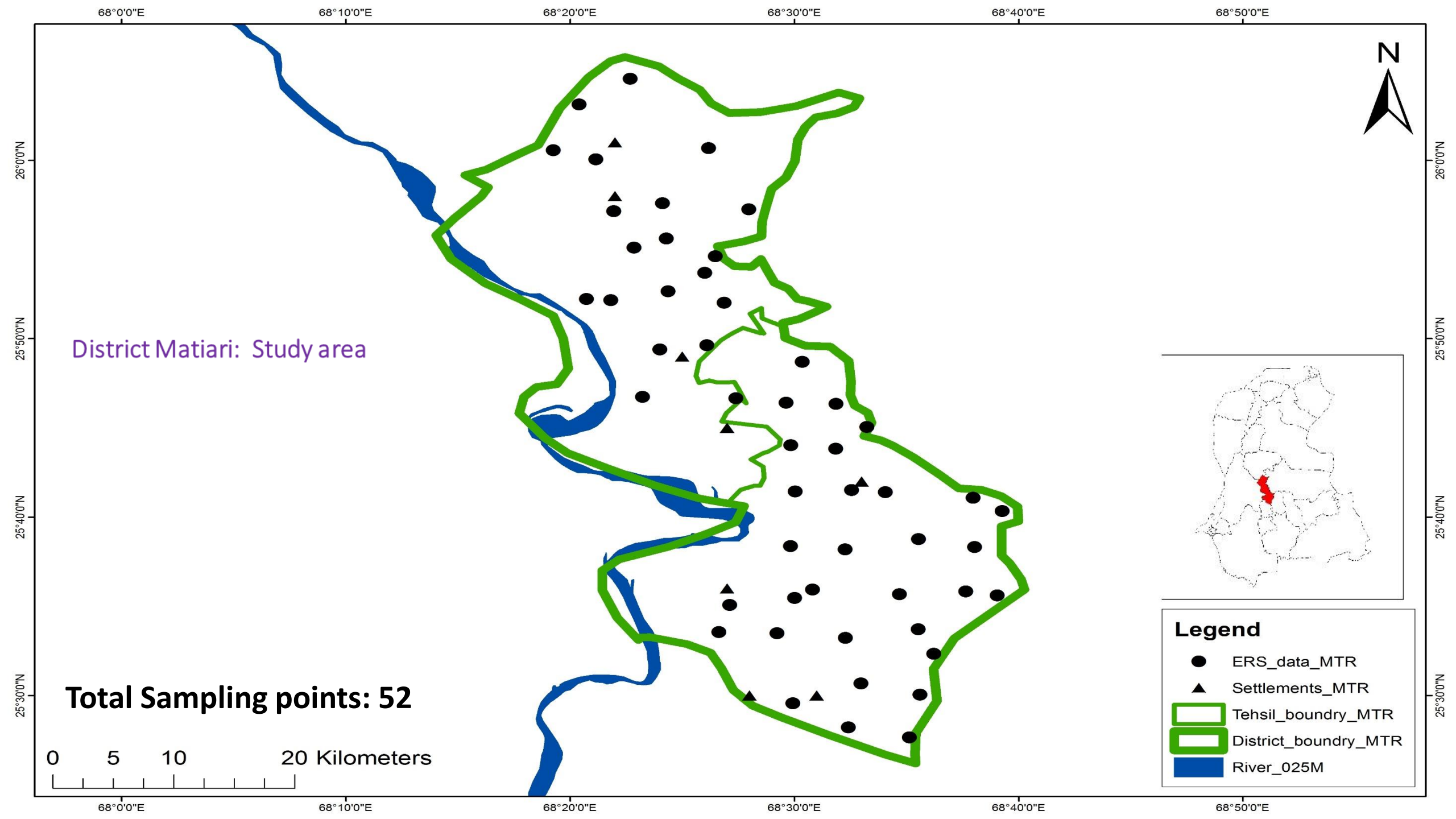
AUTHORS NAMES	YEARS	DESCRIPTION
Sikandar.p	2010	performed VES to locate low salinity groundwater aquifer layers for tube well installation, tube well auditing and categorize different low salinity groundwater zones
Khan et al.	2013	has conducted resistivity survey in Peshawar for investigating groundwater using Terrameter SAS 4000.
Majumdar and Das	2011	used ERS to estimate the aquifer properties of Sager Island Region in India, where they observed that the results correlated significantly with borehole data from the area
Bhoi *et* al	2012	concluded that Vertical Electrical Sounding (VES) is the most widely used geophysical technique for subsurface exploration.

OBJECTIVES:

1. Demarcation and mapping of groundwater quality in the study area using Resistivity Survey and Arc GIS. .
2. To conduct a survey for groundwater utilization and socio-economy parameters of farming community and to suggest recommendations for sustainable management in the study area.



MATERIAL AND METHODS

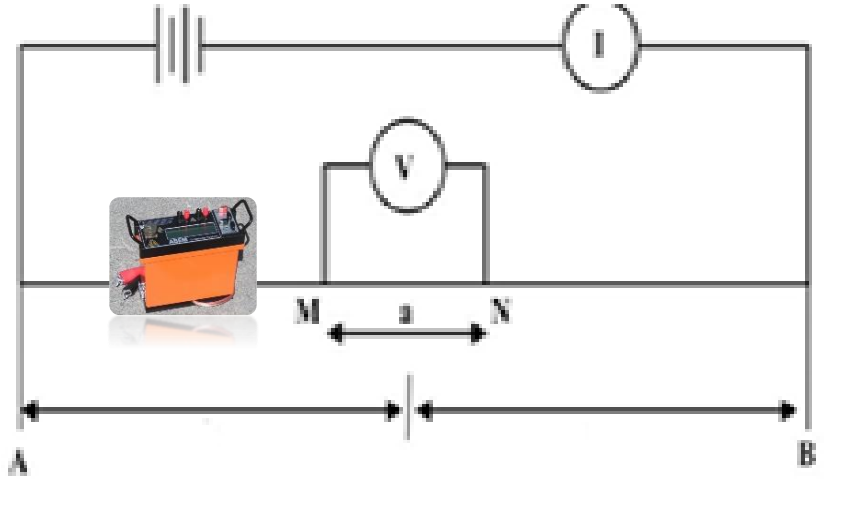

68°0'0"E
68°10'0"E
68°20'0"E
68°30'0"E
68°40'0"E
68°50'0"E
26°0'0"N
25°50'0"N
25°40'0"N
25°30'0"N
N
District Matiari: Study area
Total Sampling points: 52
0 5 10 20 Kilometers
Legend
ERS_data_MTR
Settlements_MTR
Tehsil_boundry_MTR
District_boundry_MTR
River_025M

- **Instrument Used:** Geo-electrical Vertical Electrical Sounding (VES) using ABEM Terrameter 1000 was used to investigate aquifer details and its groundwater quality through various lithological layers.
- ABEM 1000 Terrameter usually comes with self-rechargeable battery, four electrodes, cables, hammer, crocodile clips and measuring tapes.
- Terrameter gives direct reading and then multiplied with corresponding geometrical factor to get apparent resistivity.
- Resistivity survey was conducted at 5x5 km^2 grids for shallow survey up to the depth of 300 meters
-

MATERIALS & METHODOLOGY:

GEO-PHYSICAL TECHNIQUE FOR ERS

- Electrical resistivity Survey (ERS) involves passing an electrical current into the ground through two current electrodes and the resulting potentials created in the field, measured through two potential electrodes.
- The two outer electrodes A and B are used for the current, and the resulting potential difference is measured across the two inner electrodes M and N. The distance of the current and potential electrodes from the center, which are referred to AB/2 and MN/2 respectively.



Geometric Arrangement of the Schlumberger Array Configuration

- Source: O. Anomohanran (2015)

Electrical Resistivty Survey (ERS) Survey Points

Total 52 ERS Grids was selected from the marked locations in August 2016. The Taluka wise detail of surveyed ERS is given as under.

Groundwater Sample collection (Hand pumps, tube well):

Groundwater samples from hand pump or tube well were collected from the remote areas which are quite far away from the ERS surveyed area. These samples were analysis for analyzed for only TDS .

Taluka-wise detail of Electrical Resistivity Survey ERS.

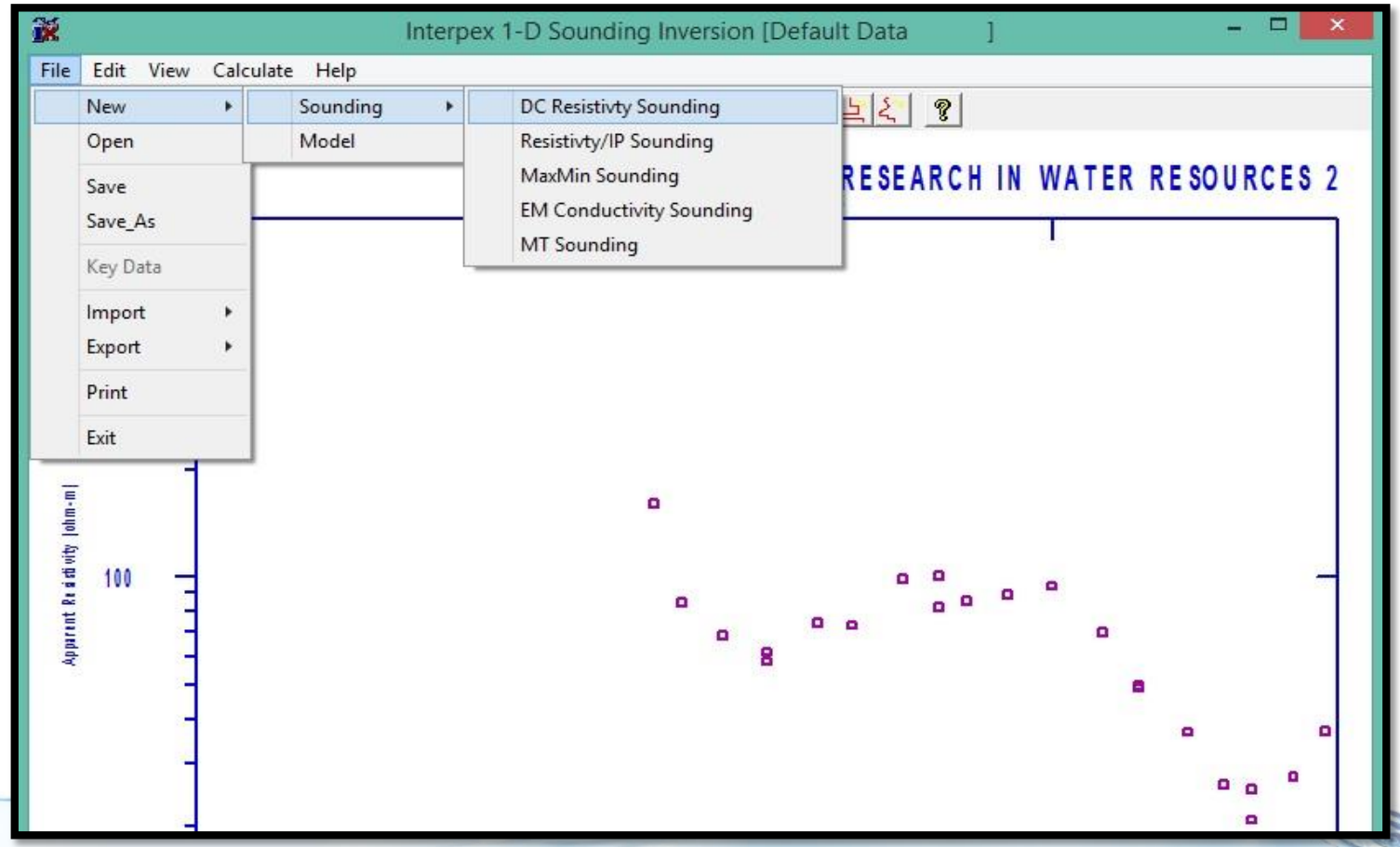
Sr. No	Name of Taluka	No of ERS
1	Saeedabad	12
2	Hala	17
3	Matiari	23

Table 1. Data collection Profarma for ERS

Location	Near Gada Ali Rahoo Village U/C Shahmir Rahu Saboo Rahu to Shahmir Rahoo Road.				
GPS Inoformation				Survey Details:	Probe I.D: MTR - 5 -01
Latituoe N;	Longitude E;	Elevation:	Gride Size	Type	Operating Officer:
26° 04' 33.7"	68° 22' 40.9"	34 m	5 x 5 km	Shallow	Name: Muhammad Khan
Electrode Spacing		Terrameter SAS (1000 or 4000)		Calculated	Designati SDO
AB/2 (Meter)	MN/2 (Meter)	Terrameter Readings R=(Ω)	Geometrical Factor= K	Apparent Resistivity RA=(Ωm)	Signatur e:
					Date: 16/8/2016
2	0.5	1.630	12	19.56	District:
4	0.5	0.426	49	20.87	Matiari
8	0.5	0.109	200	21.80	Tehsil:
10	0.5	0.069	313	21.60	Saeedabad.
15	0.5	0.031	705	21.86	Watertable (ft):
20	0.5	0.018	1255	22.59	6-8 ft
25	0.5	0.012	1962	**23.54**	Hand Pump (ft):
25	5	0.114	188	**21.43**	40 ft
30	5	0.085	275	23.38	Tubewell (ft):
35	5	0.063	377	23.75	-
40	5	0.048	495	23.76	Surface Material:
45	5	0.039	628	24.49	Silty clay .
50	5	0.031	777	**24.09**	Major Crops:
50	10	0.069	377	**26.01**	Sugarcane, cotton,wheat.
60	10	0.049	550	26.95	
70	10	0.036	754	27.14	
80	10	0.028	989	27.69	Field Sample Water Quality:
90	10	0.022	1256	27.63	TDS (ppm 639
100	10	0.017	1554	**26.42**	Source: H.P
100	20	0.037	754	**27.90**	Major Drinking Water Source:
120	20	0.025	1100	27.50	G.water
150	20	0.013	1735	22.90	Others:
180	20	0.008	2512	21.10	-
210	20	0.006	3430	20.24	General Comments:
240	20	0.004	4490	17.96	Survey conducted in agriculture land.
270	20	0.003	5691	15.93	
300	20	0.002	7034	14.77	

INTERPRETATION OF ERS DATA:

IX1D view



Source : Interpex is a software company dedicated to the production of high quality software for the processing, interpretation and display of geophysical data.

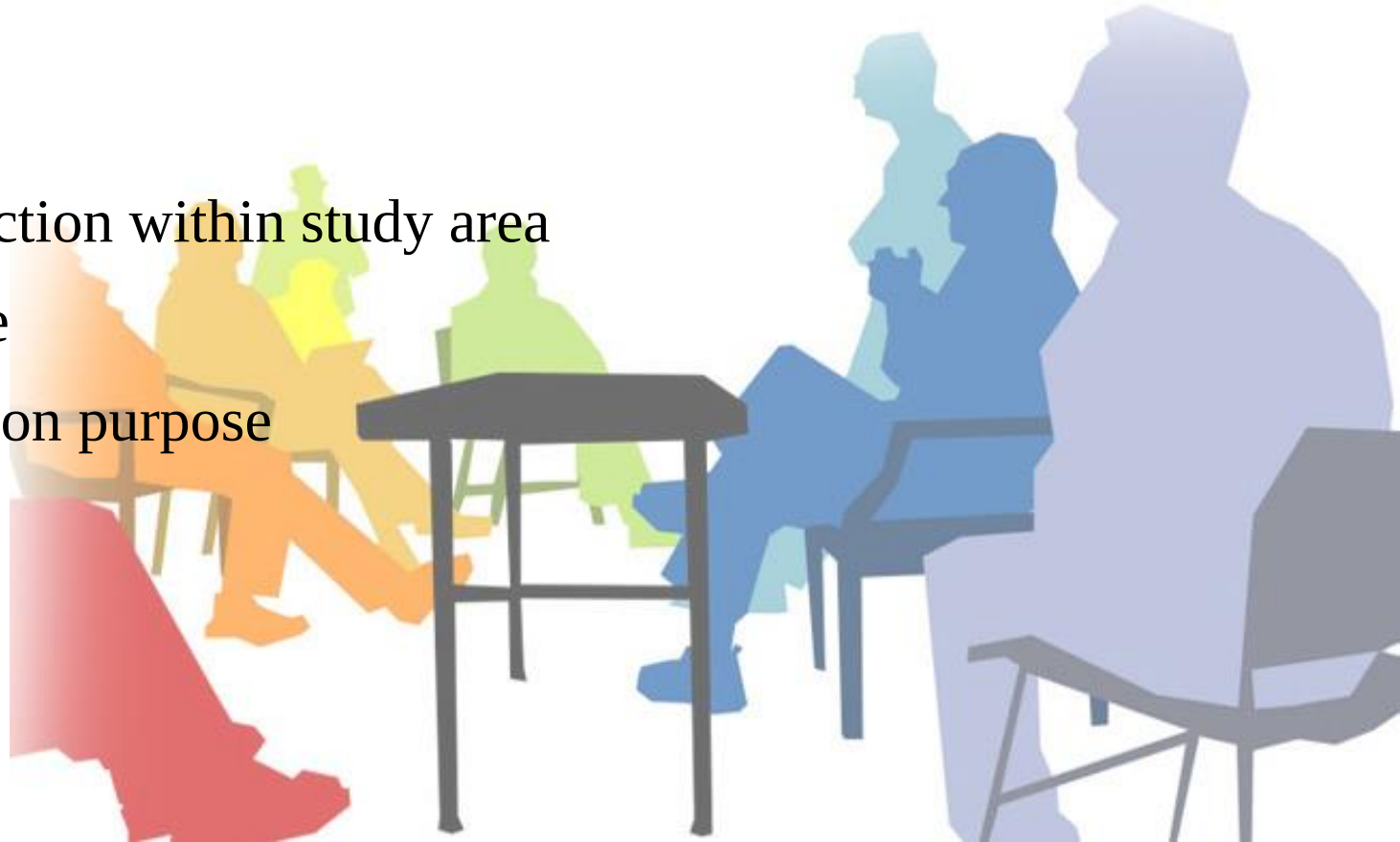
The correlation between Resistivity with Geological Formation and Water Content Quality

Name of Resistivity Zone	Resistivity (Ohm-m)	Correlation with Geological Formation and Water Content Quality
Low	<10	This zone indicates the presence of fine materials like clay/shale, with rare sand and therefore has saline to less saline water bearing potential.
Medium	10-30	This zone indicates the presence of intermediate sand with some clay. It may also indicate the presence of alternate bedding of sand and clay/shale. The formation can yield groundwater if below water table.
High	30-100	This zone is interpreted as dominance of coarser material i.e., sand with good quality of groundwater
Very High	>100	The very high resistivity may represent the presence of unsaturated zone above water table and bed rock if below water table.

SOCIO ECONOMIC SURVEY

This survey includes following parameters

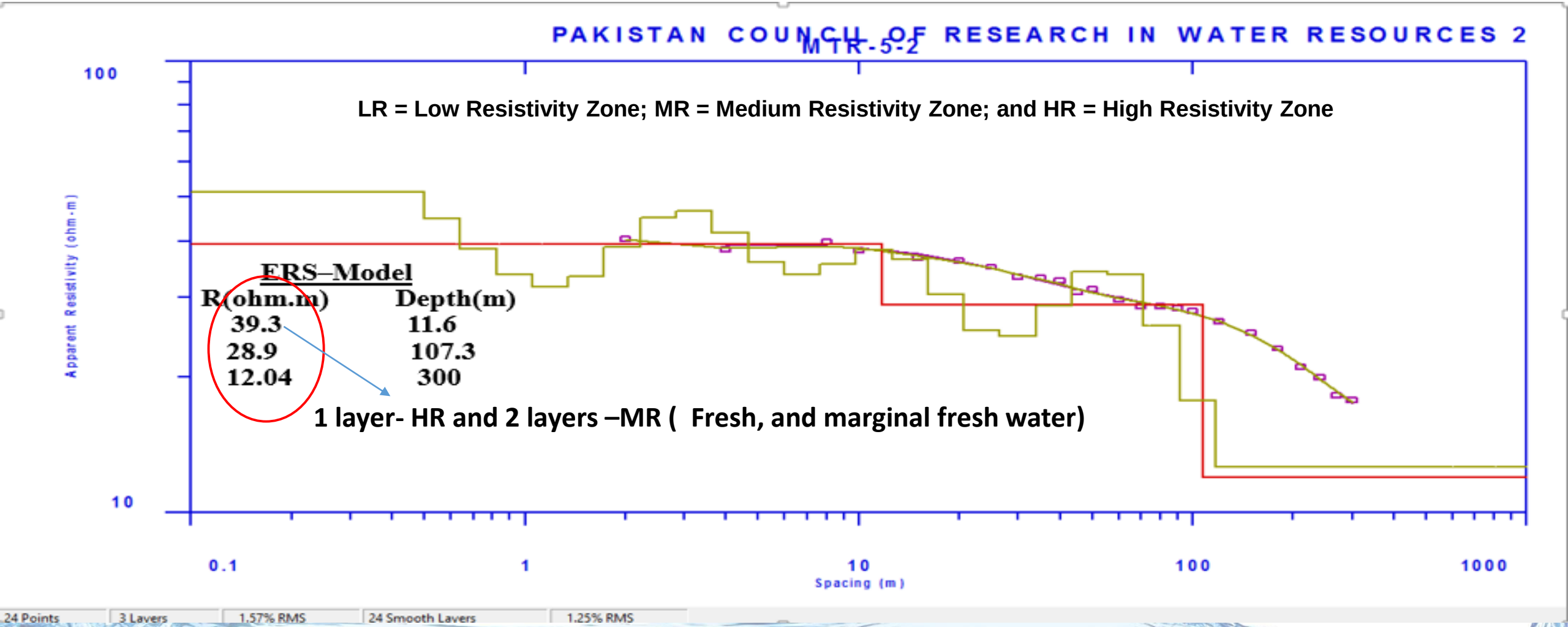
- Educational status
- Land status of farmers
- Ground water Quality
- Usage of ground water for satisfaction within study area
- Groundwater extraction technique
- Usage of ground water for irrigation purpose



RESULTS & DISCUSSION

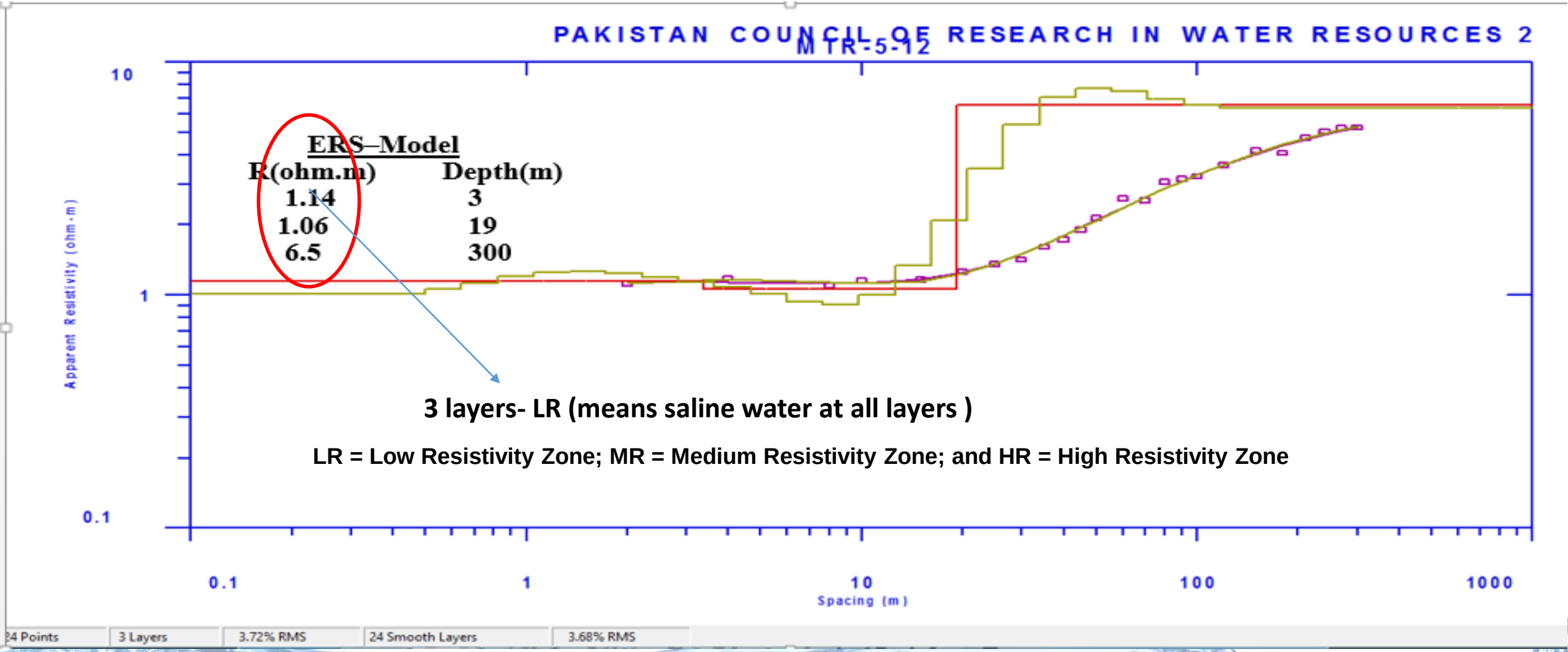
RESULTS AND DISCUSSION

ERS -02: (Near Haji Ahmad waris) created in IX1D resistivity software



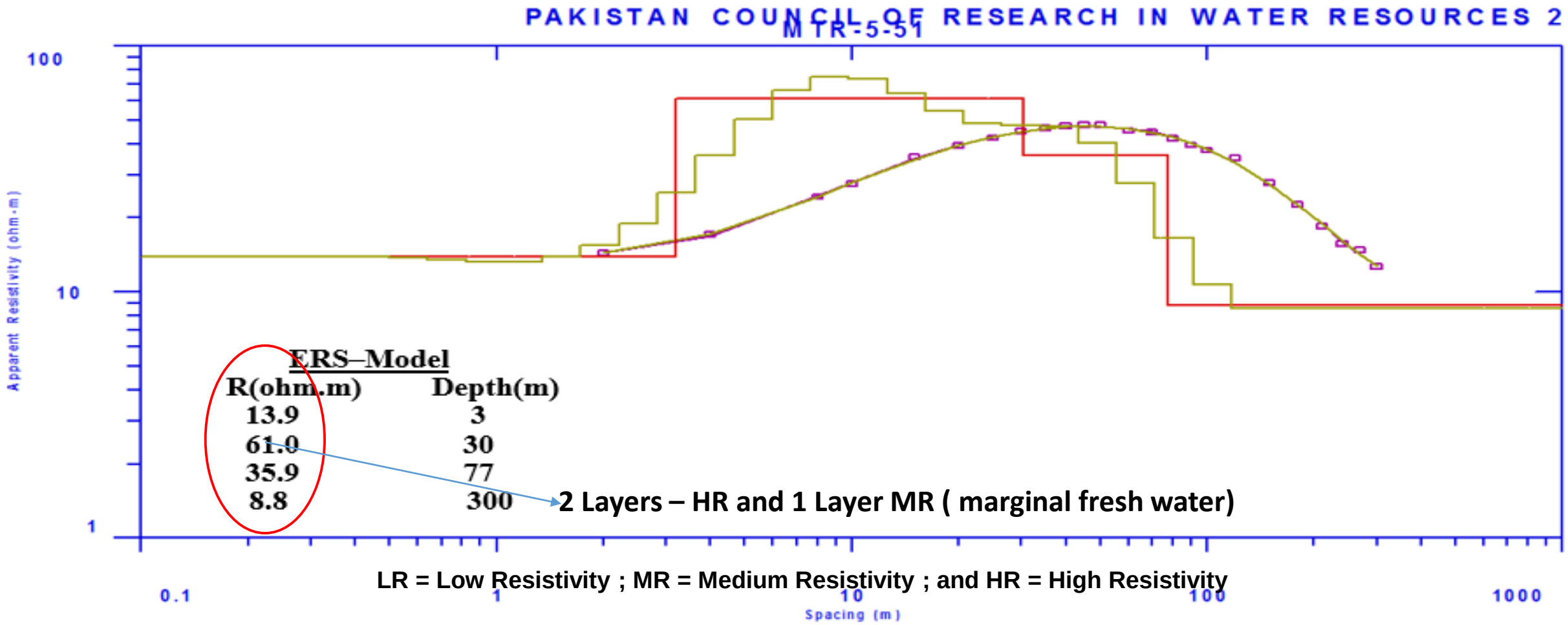
- The first layer shows the dominance of coarse material comprising the fresh water.
- The second layer represent the alternative bedding of sand and clay , having marginal fresh water
- The third layer shows low resistivity i.e. 12 ohm.m, which indicate marginal saline water

ERS -12: Near Kamla village created in IX1D resistivity software



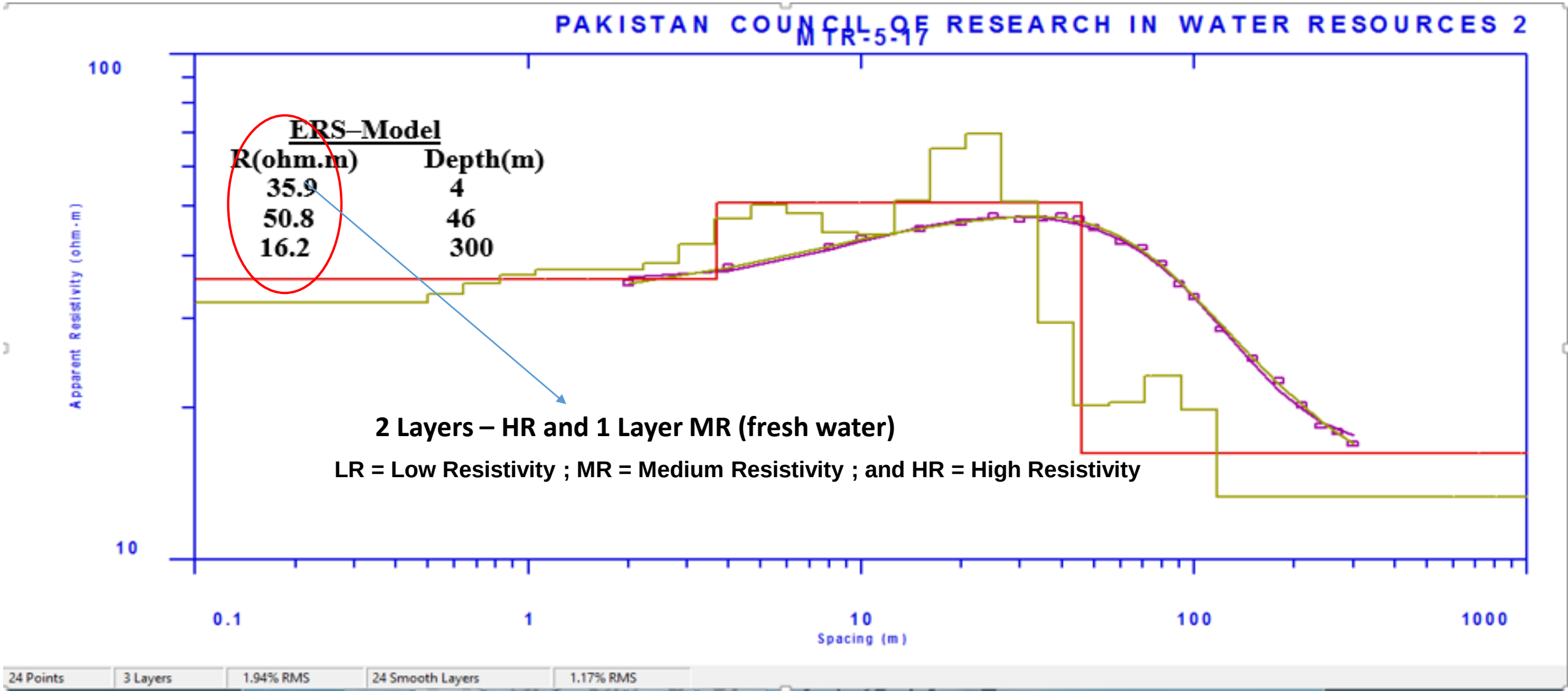
- **In this probe very low resistivity values found through out the investigation depth (300 m) presenting the presence of fine materials like clay/shale with rare sand comprising highly saline water.**

ERS -44(Near Kot Khalid Pandhiani) created in IX1D resistivity software



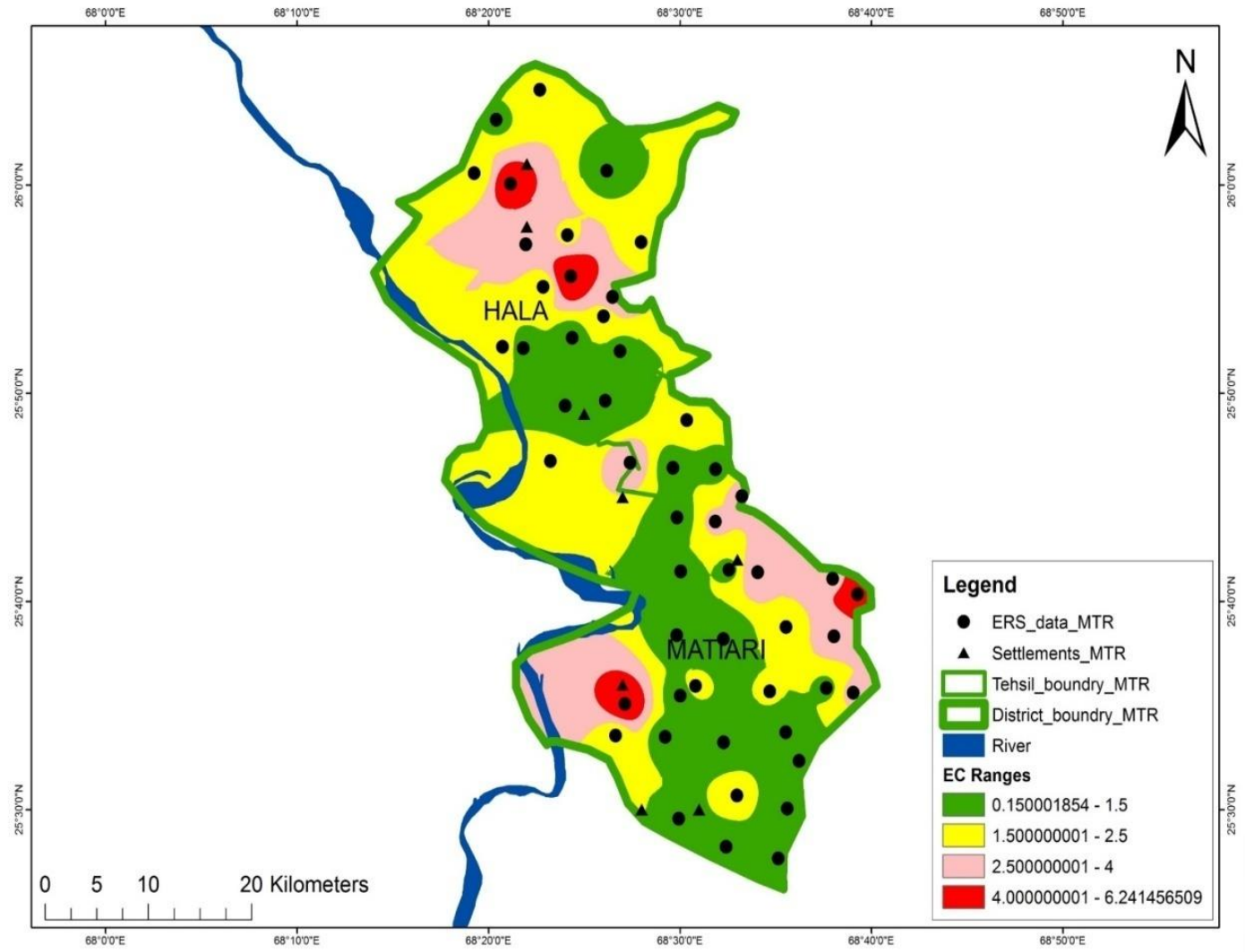
- First layer shows the presence of alternative banding of sand and clay with marginal saline water.
- The two middle layers shows the dominance of coarser material i.e. sand with fresh water
- The fourth layer indicates the presence of fine materials like clay/shale with rare sand comprising saline water

ERS -17: Near Sultan Farash



- **The top two layer shows the presence of courser material with possibility of fresh water. The Third layer indicates that upto the investigation depth (300m) quality of groundwater is marginal saline**

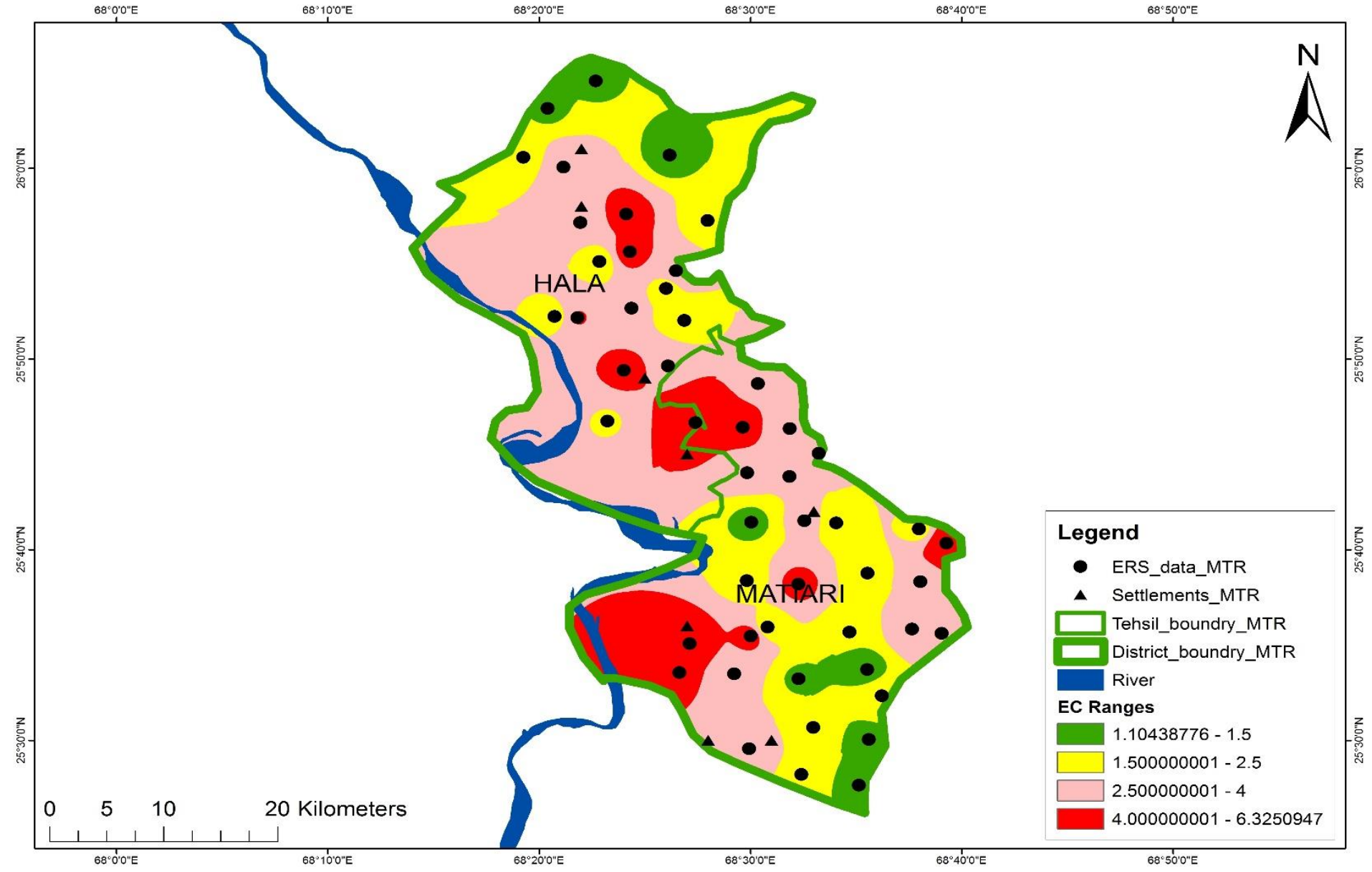
DEMARCATION OF MAPPING GROUND WATER QUALITY



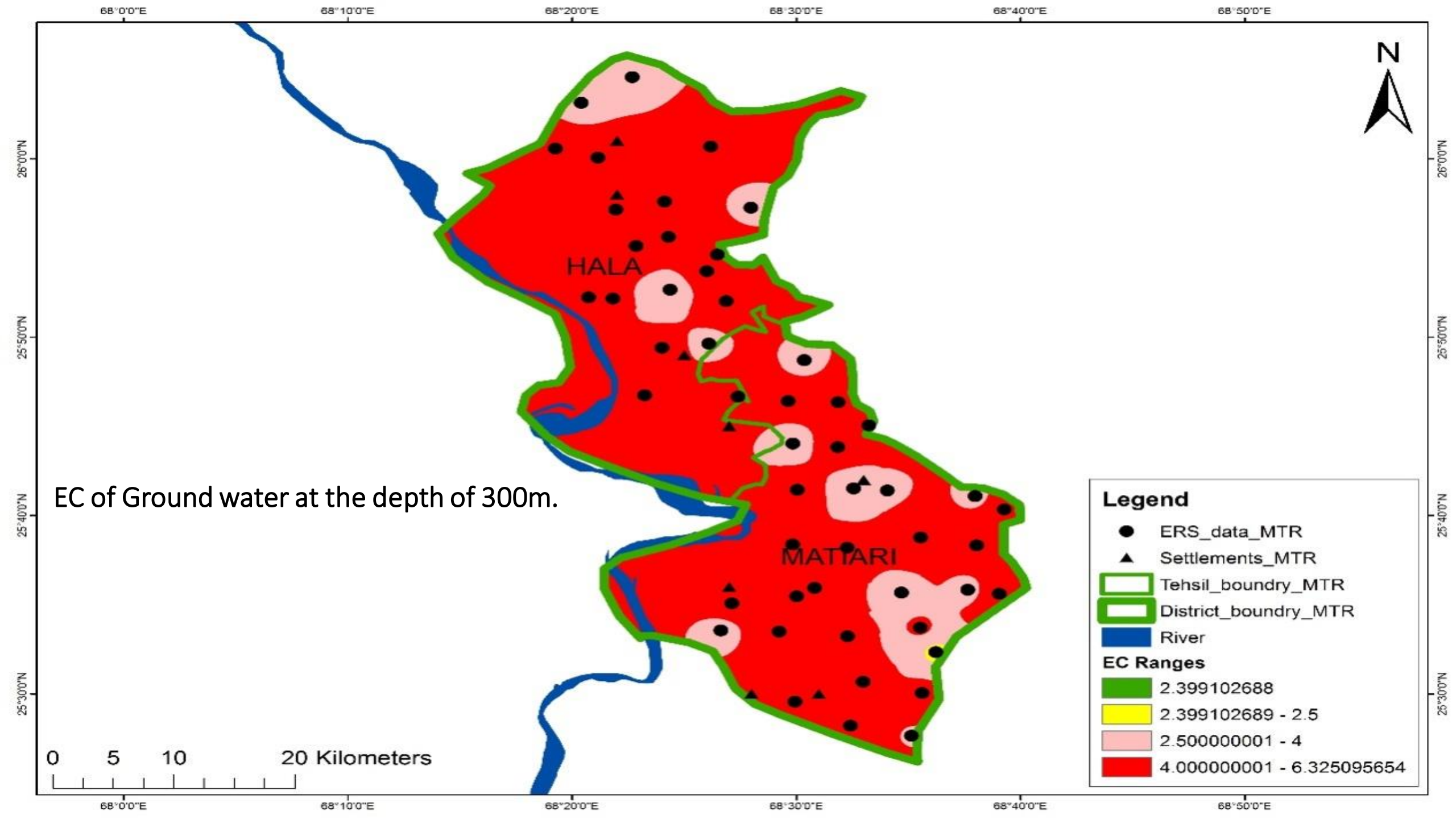
EC of Ground water at the depth of 25m.

This figure Shows the ground water EC of District Matiari. The quality of ground water of tehsil Matiari is fresh up to depth of 25m. Whereas, the ground water quality of tehsil Saeedabad and Hala found marginal fresh.

EC of Ground water at the depth of 75m



- The quality of ground water of tehsil Matiari is marginal Fresh up to depth of 75m similarly the ground water quality of tehsil Saeedabad and Hala priming the marginal saline water pockets.


68°0'0"E
68°10'0"E
68°20'0"E
68°30'0"E
68°40'0"E
68°50'0"E
26°0'0"N
25°50'0"N
25°40'0"N
25°30'0"N
N
HALA
MATIARI
EC of Ground water at the depth of 300m.
Legend
ERS_data_MTR
Settlements_MTR
Tehsil_boundry_MTR
District_boundry_MTR
River
EC Ranges
2.399102688
2.399102689 - 2.5
2.500000001 - 4
4.000000001 - 6.325095654
0 5 10 20 Kilometers

THE GROUND WATER QUALITY UPTO DEPTH OF 25,75

EC RANGES (DS/M)	AREA (Km^2)	Percentage (%)	QUALITY
0.15 - 1.5	489	33.56	Fresh
1.5 - 2.5	632	43.38	Marginal fresh
2.5 – 4.0	288	19.77	Marginal Saline
4.0 - 6.24	48	3.29	Highly Saline
Total	1457	100%	

EC RANGES (DS/M)	AREA (Km^2)	Percentage (%)	QUALITY
0.15 - 1.5	110	7.55	Fresh
1.5 - 2.5	426	29.24	Marginal fresh
2.5 – 4.0	714	49.00	Marginal Saline
4.0 - 6.24	207	14.21	Highly Saline
TOTAL	1457	100%	

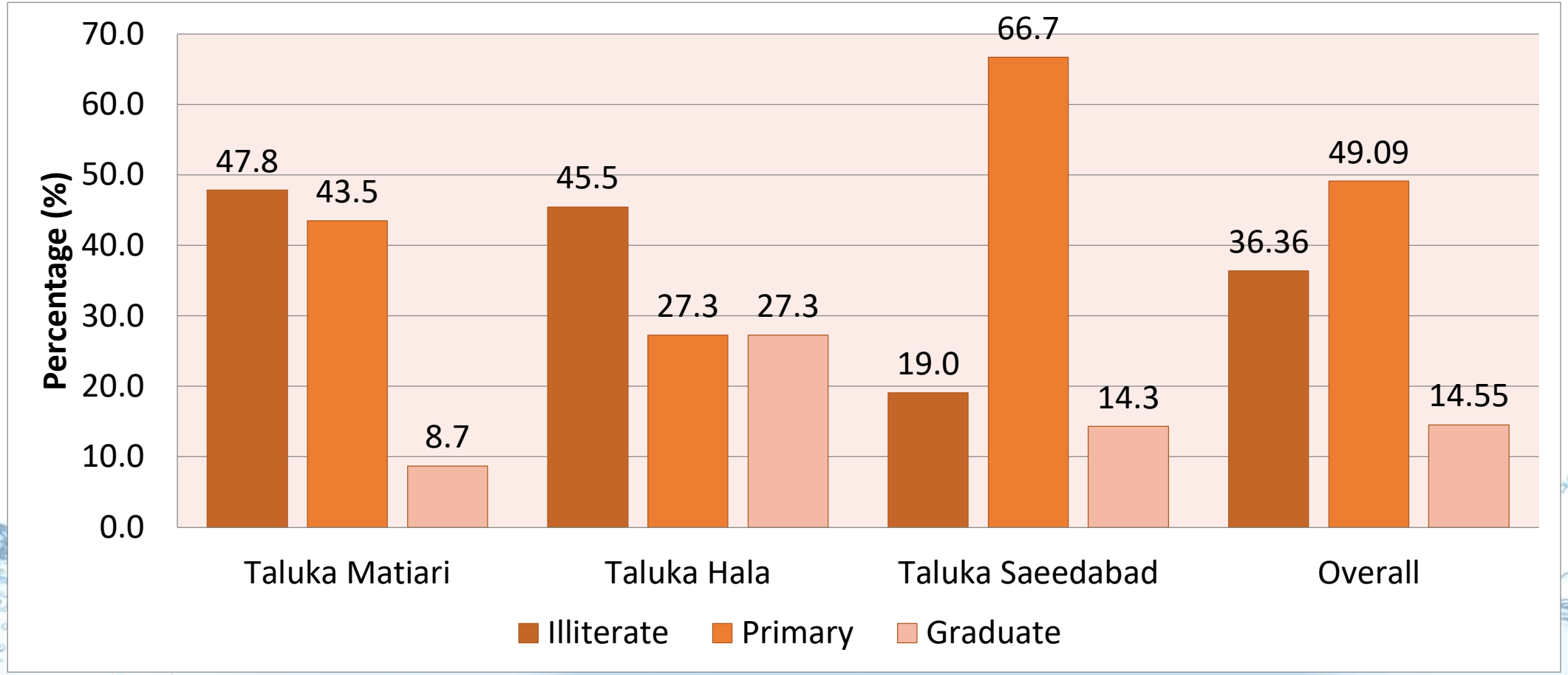
THE GROUND WATER QUALITY UPTO DEPTH OF 300m

EC RANGES (DS/M)	AREA (Km^2)	Percentage (%)	QUALITY
0.15 - 1.5	0.0	0.0	Fresh
1.5 - 2.5	2	0.14	Marginal fresh
2.5 – 4.0	218	14.96	Marginal Saline
4.0 - 6.24	1237	84.90	Highly Saline
TOTAL	1457	100%	

SOCIAL SURVEY

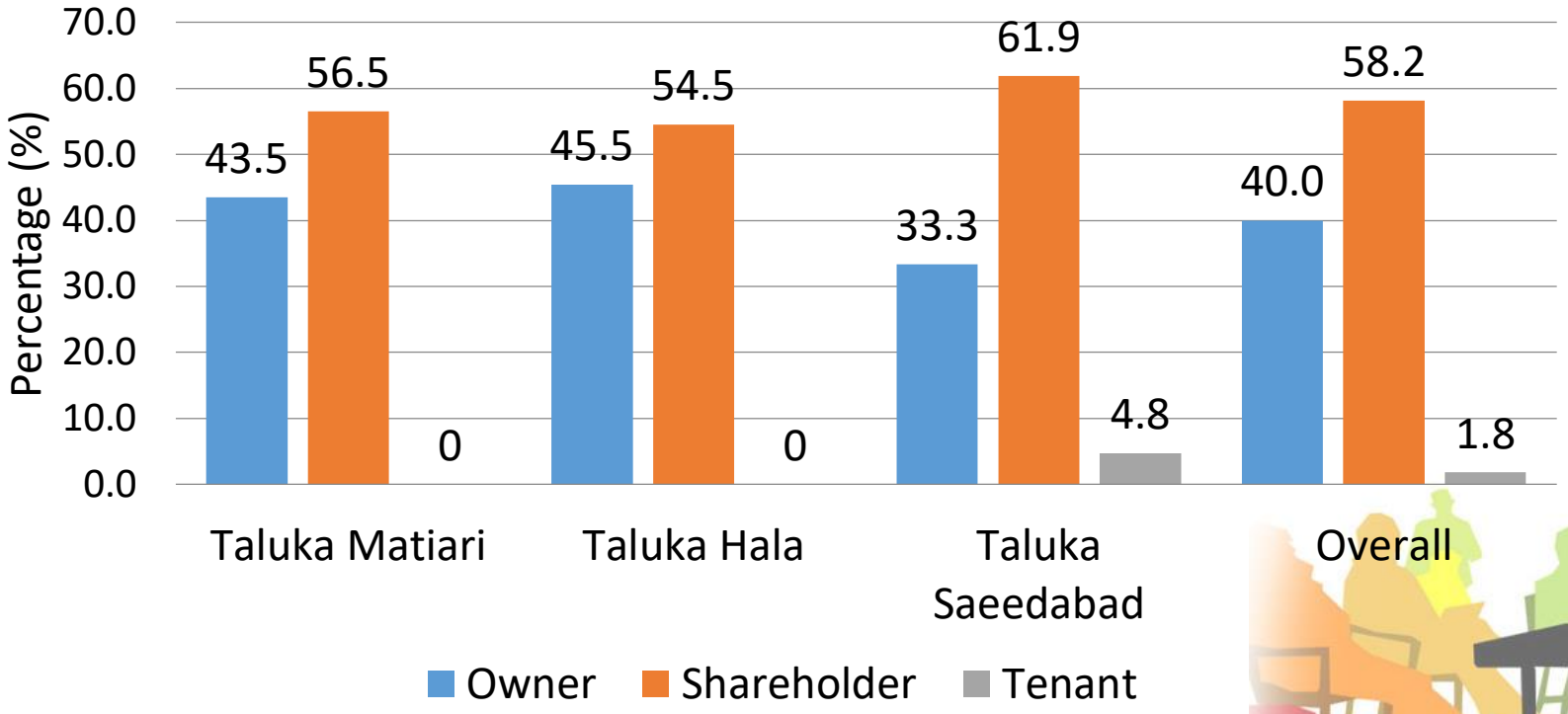
EDUCATIONAL STATUS IN THE STUDY AREA (SOCIO- ECONOMIC SURVEY)

- A questionnaire survey of the 55 respondents has been conducted form February to March 2017.
- Shows that 49% farmers got primary education, 36.3% are illiterate and 14.5% are graduates, .

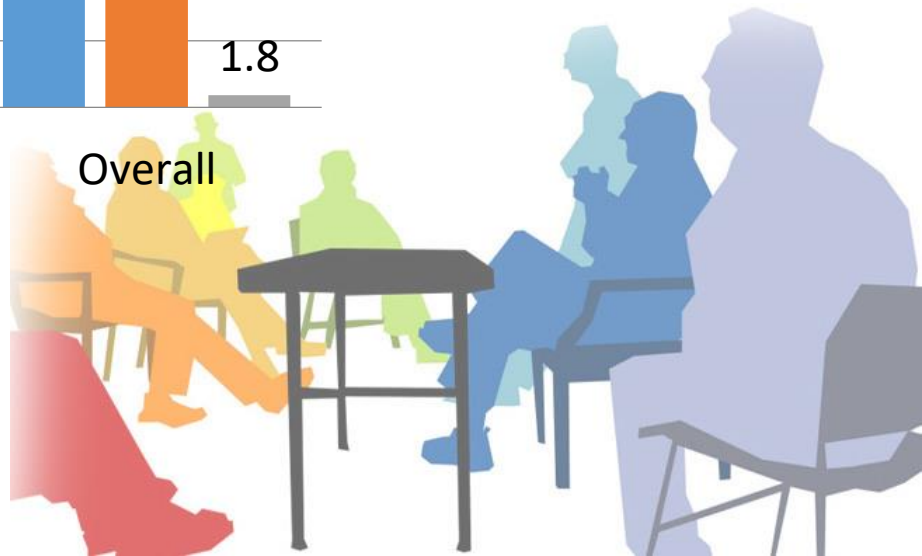


LAND STATUS

- The questionnaire survey regarding the land holding statistics of the District Matiari indicates that about 58% farmers are shareholders, the tenant are 1.8% and the real owner are 40%, respectively.

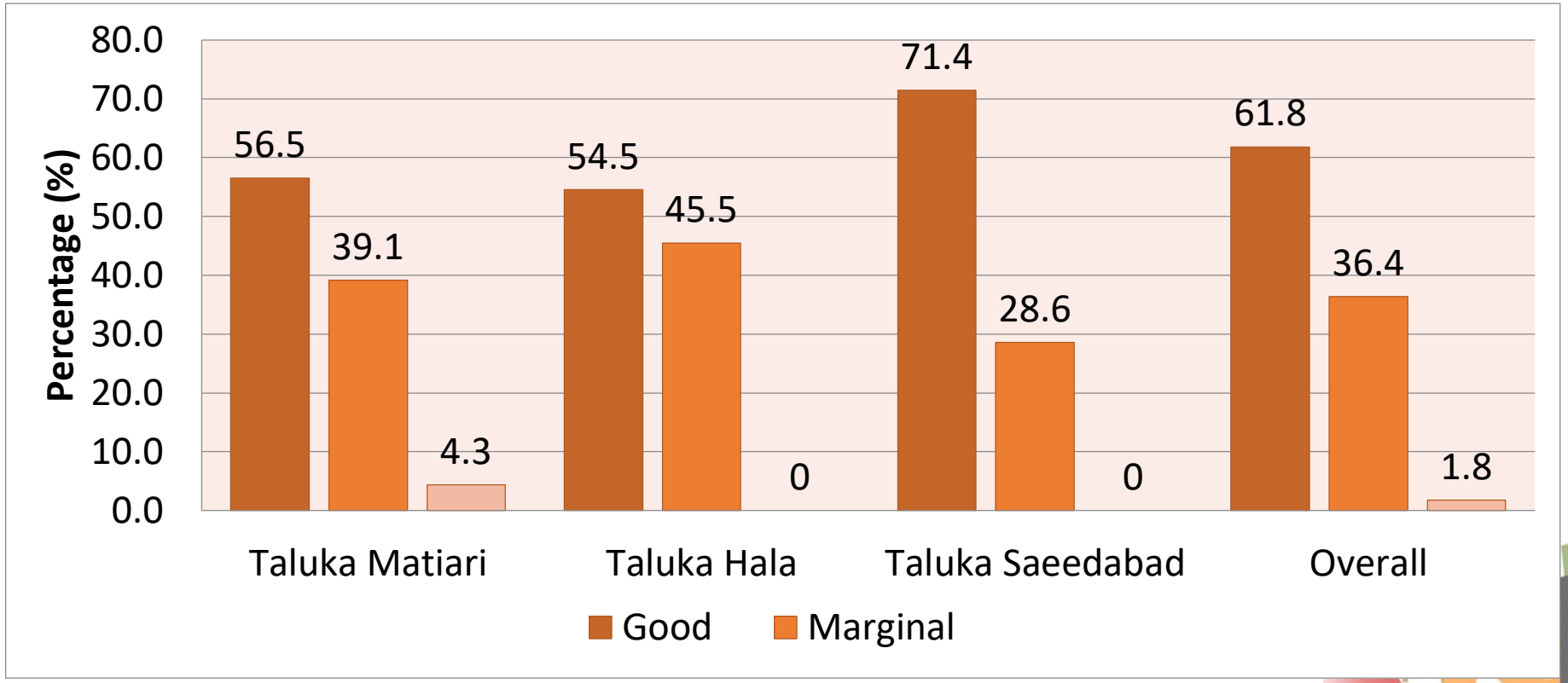


Taluka wise Status of farmers in terms of land holding



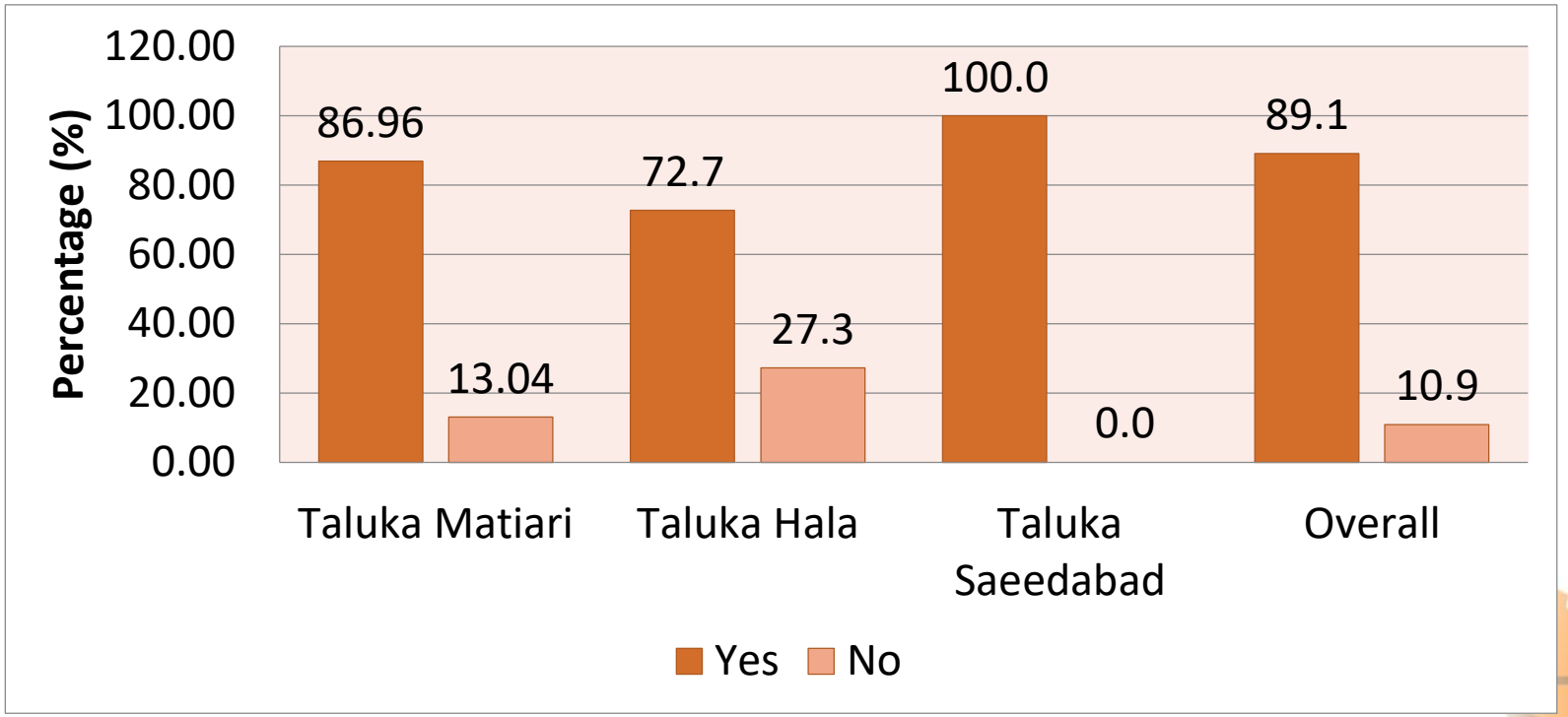
GROUND WATER QUALITY

Based on the respondents interviews, it was observed that 61.8% is good quality ground water, and used for drinking purpose, whereas 36.4% is marginal and 1.8% is hazardous.



USAGE OF GROUND WATER SATISFICATION WITHIN STUDY AREA

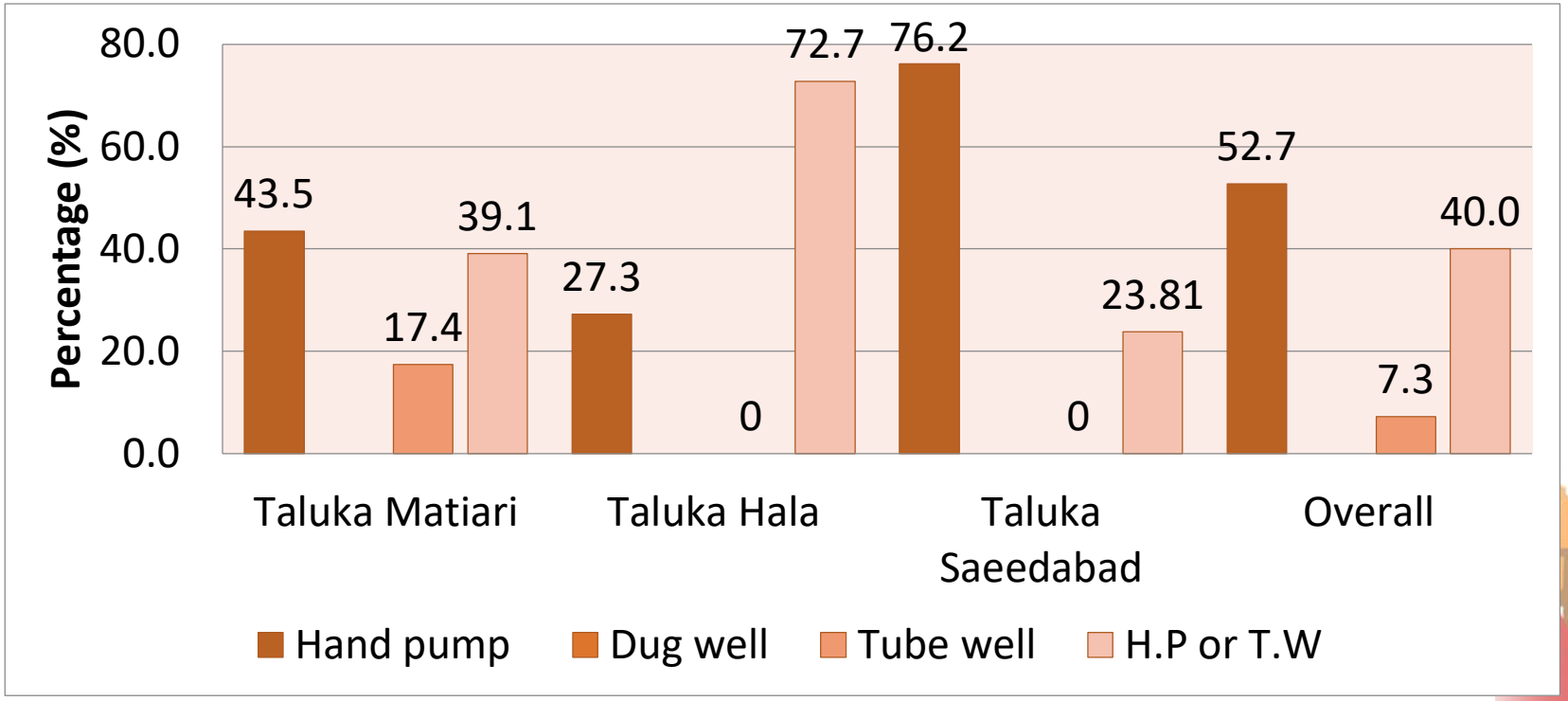
- 89% respondents was satisfy with used of ground water
- Approximately 11% farmers was not satisfied with the groundwater.



Taluka wise consumers satisfaction

GROUND WATER EXTRACTION TECHNIQUES

- The questionnaire based survey revealed that 52.7% farmers use hand pumps
- Whereas 7.3% used tube well,
- While 40% respondents use both hand pump & tube well.



Overall and Taluka wise percentage of ground water extraction techniques

Usage of water for irrigation purpose

- The results illustrated that 61.8% o farmers used surface water,
- only 20% of the respondents voted for moderately supplied surface water plus ground water
- 18.2% used ground water for the agriculture purpose,

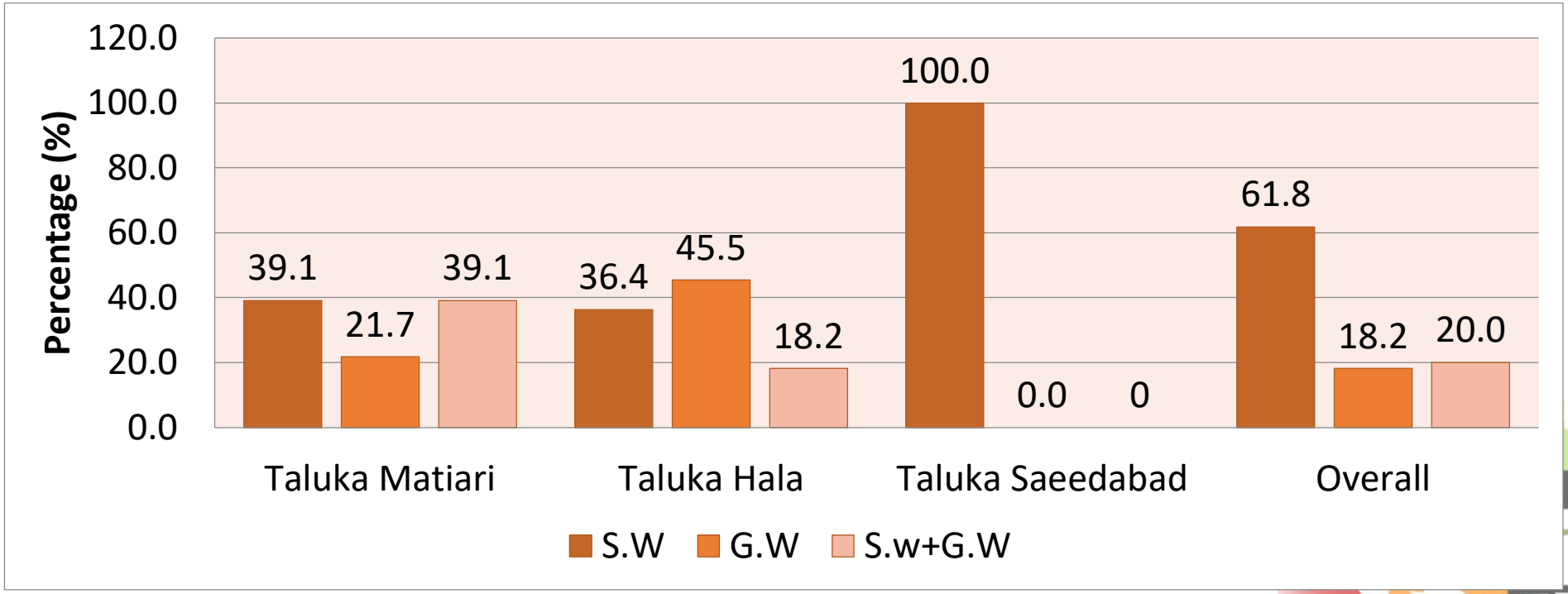
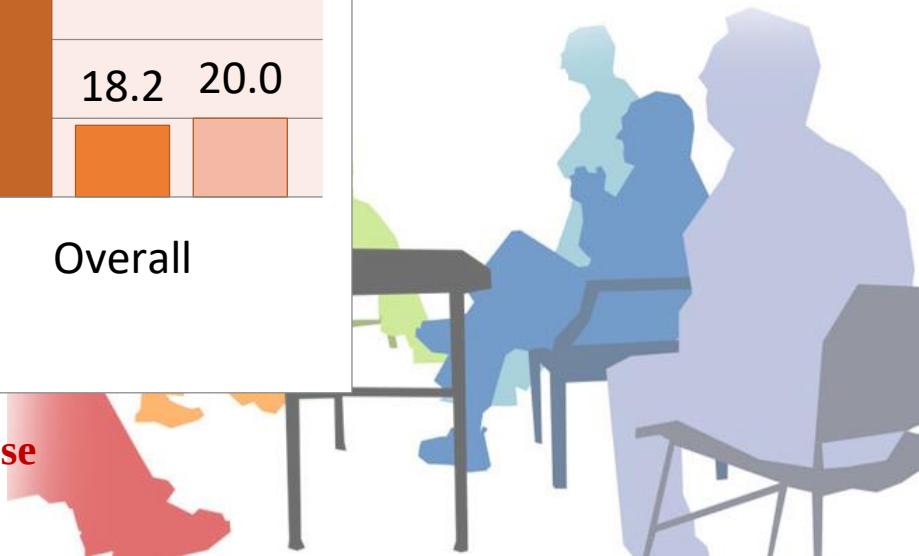


Figure 4.71 Taluka wise Usage of water for irrigation purpose



CONCLUSION

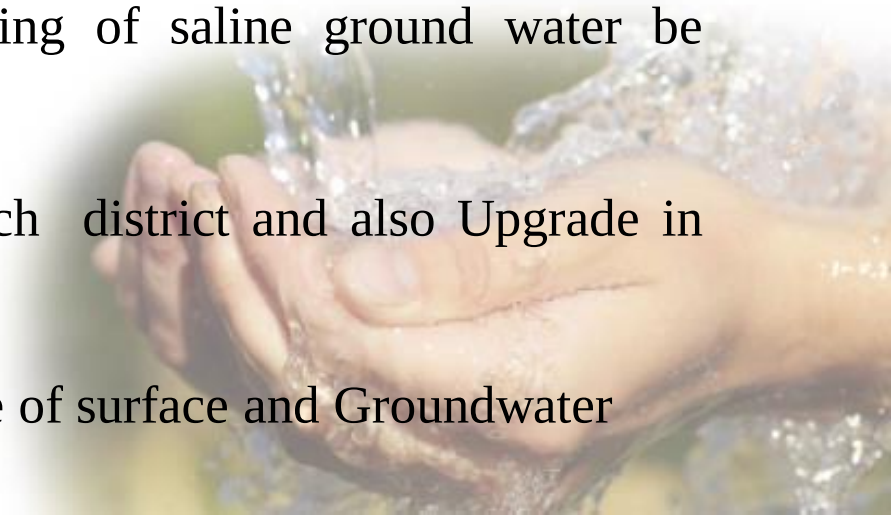
- The quality of ground water of Tehsil Matiari is fresh up to depth of 25m. Whereas, the ground water quality of tehsil Saeedabad and Hala found marginal fresh. It was observed that the areas which are far away from river showing the marginal fresh to marginal saline quality of ground water.
- The over all dominant quality of ground water of tehsil Matiari, Hala and Saeedabad up to depth of 50 m found marginal fresh, whereas trend of groundwater quality from 51 to 100 m depth found marginal saline
- Socio questionnaire survey of the 52 respondents shows that 49% farmers got primary education, 36.3% are illiterate and 14.5% are graduates, .
- Through survey it was observed that 61.8% is good quality ground water and used for drinking purpose, whereas 36.4% is marginal and 1.8% is hazardous.
- The land holding statistics of the District Matiari indicates that about 58% farmers are shareholders, the tenant are 1.8% and the real owner are 40%
- Survey shows that the 92.7% respondents use the ground water for drinking purpose 38.27% used for agriculture purpose.

RECOMMENDATIONS

- Hydrological models are useful tools to analyze for present and future conditions of water quantity and quality. SWAT model is a semi-distributed, eco-hydrological model which is quite flexible and can be integrated with ArcGIS it is capable running on a daily time step and enable effectively stimulating hydrological process.
- It is recommended that water quality analysis by ERS-IX1D should be analysed by ArcSWAT and results of both tools ArcSWAT and ERS-IX1D should be compared.
- SWAT is an advantageous way meeting the requirements of the more Researchers, deterministic in structure, In Additions, SWAT model with a modified groundwater module could be better represent the groundwater flow behaviors.
- In Addition, SWAT–MODFLOW also capable of simulating a spatial-temporal distribution of groundwater recharge rates, aquifer evapotranspiration and groundwater levels.

RECOMMENDATIONS

- Such study must be carried on trial bores to validate VES findings.
- In addition, other parameters which are necessary to find water quality for drinking purpose must be analyzed.
- Strength District and Tehsil administration for drinking-water quality monitoring.
- As it was observed that at shallow depth groundwater quality of District Matiari found marginal fresh due to recharge or seepage from ponds/channels, therefore fresh water bodies/small reservoirs may be developed for recharge of aquifer.
- The groundwater Monitoring be made practically that upcoming of saline ground water be controlled.
- Ground water quality testing laboratories should be made at each district and also Upgrade in terms of staff and equipment.
- Agricultural productivity can be enhanced through conjunctive use of surface and Groundwater



REFERENCES

1. Majumdar R.K, And Das D (2011), "Hydroulogical Characterization and Estimation of Aquifer Properties from Electrical Rounding Data in Sagar Island Region", South Asian journal of Earth Science 4(2): 60-70,2011

2. Dars,R,.2018 Demarcation Of Groundwater Quantum And Quality For Its Sustainable Management In District Matiari thesis submitted to U.S Pakistan Center for Advanced Studies in Water Faculty of Architecture and Civil Engineering Mehran University of Engineering & Technology, Jamshoro Sindh Pakistan.

3. Mahran university and engineering and technology Jamshoro Ven kateswarana, V. and Ayyanduraib, R., (2015), "Groundwater Potential Zoning in Upper Gadilam River Basin Tamil Nadu", presented in International Conference on Water Resources, Coastal and Ocean Engineering (ICWRCOE 2015), J. Aquatic Procedia, Vol. 4, pp 1275-1282.

4. Lawrence, A. O., and Ojo, T. A., (2012), "The Use of Combined Geophysical Survey Methods for Groundwater Prospecting in a Typical Basement Complex terrain; Case Study of ado – ekiti, southwest Nigeria", Research Journal in Engineering and Applied Sciences, vol. 1, No. 6, pp. 362-376.

5. Sirhan, A. Mohammad O., (2012), "Characterization by electrical and electromagnetic geophysical methods of the shallow hydrogeological system at Hebron (West Bank, Palestine) in a semi-arid zone", Geoscience, vol. 344, pp 449–460.

6. Doneva, B. Delipetrov,M.(2012), " Geo electrical measurements with terrameter SAS 1000" International Multidisciplinary Scientific Geo Conference : SGEM : Surveying Geo logy & mining Ecology Management vol 2: 563-568.

7. Khan, G. D., Waheedullah, Bhatti, A. S., (2013), "Groundwater Investigation by Using Resistivity Survey in Peshawar, Pakistan", Journal of Resources Development and Management, vol. 2, pp. 9-20.

8. Sikandar .P, 2010. Groundwater management using vertical electrical sounding survey and tube well auditing at farmers' fields (Doctoral dissertation, University of Agriculture, Faisalabad)

Conti….

9 .Ven kateswarana, S., and Ayyanduraiba, R. 2015. “Groundwater Potential Zoning in Upper Gadilam River Basin, Tamil Nadu”, International Conference on Water Resources, Coastal and Ocean Engineering. (ICWRCOE 2015) Aquatic Procedia 4: 1275 – 1282.

10. Khan, G. D., Waheedullah and Bhatti, A. S., (2013), Groundwater Investigation by Using Resistivity Survey in Peshawar, Pakistan”, Journal of Resources Development and Management, 2: 9-17.

11. Lashkaripour, G.R., 2003.An investigation of ground water condition by geo-electrical resistivity method: A case study in Kori aquifer, Southeast Iran.J.Spatial Hydrology, 3:1-5.

12. Lashkaripour,G .R. and M.Nakhaei, (2005) Geo electrical investigation for the assessment of ground water conditions: acasestudy. Annalsof Geophysics.48:937-944.

13. McNeill, J.D., 1980. Electrical conductivity of soils and rocks, Technical NoteTN-5, Geonics Limited, Missisauga.

14. Oseji, J.O., M.B.Asokhia and E.C.Okolie.2006. “Determination of groundwater potential in Obiaruku and environs using surface geoelectric sounding”, Environmentalist.26: 301-308.

15. Ugwu, S. A. and Nwosu, J. I. 2009. Effect of Waste Dumps on Groundwater in Choba using Geophysical Method, J. Appl. Sci. Environ. Manage. 13(1) 85 – 89.

16. Ako, A. O. and M. O. Olorunfemi. 1989. Geoelectric survey for groundwater in the Newer Basalts of Vom Plateau State, Nigeria.J. Mining and Geology.25 (1&2):247-450.

QUESTIONS AND SUGGESTIONS