Manipal University Jaipur Lead in Water Conservation Off Campus

Manipal University Jaipur plays a pivotal role in enhancing the resilience of local communities against water-related issues, including droughts and floods. Communities that are well-prepared possess the necessary tools to effectively adapt to and manage these challenges. The influence of the university's off-campus water conservation initiatives is profound and long-lasting. The knowledge and practices imparted to local residents result in immediate water savings and cultivate a culture of sustainability. As these practices become integrated into everyday life, communities are better positioned to respond to evolving environmental conditions and promote responsible water management.

Manipal University Jaipur actively collaborates with surrounding communities to enhance awareness regarding water conservation. The university organizes workshops, seminars, and educational programs aimed at educating residents about the significance of efficient water usage and conservation techniques. In partnership with local water authorities and environmental organizations, Manipal University Jaipur formulates comprehensive strategies for water conservation. These collaborations utilize the expertise of academic researchers to address the unique needs of the community. The university also conducts research to evaluate local water resources and the effects of various activities on water availability, which subsequently informs local policies and sustainable management practices. Practical water-saving initiatives implemented off-campus include rainwater harvesting systems, community gardens utilizing efficient irrigation methods, and educational programs that advocate for water-wise landscaping. These off-campus conservation efforts offer valuable experiential learning opportunities for students, allowing them to participate in hands-on research and community projects while gaining practical experience in sustainability initiatives. Through the minimization of water waste and the encouragement of sustainable practices, universities play a vital role in safeguarding local ecosystems, particularly in areas experiencing water scarcity and drought conditions. Implementing water conservation measures can result in financial savings for both the institution and the adjacent community. Notable economic advantages include decreased water bills and lower costs associated with infrastructure maintenance.

Environmental Science and Pollution Research (2023) 30:77713–77728
https://doi.org/10.1007/s11356-023-28004-y

RESEARCH ARTICLE

Geophysical and geostatistical assessment of groundwater and soil quality using GIS, VES, and PCA techniques in the Jaipur region of Western India

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Received: 15 February 2023 / Accepted: 25 May 2023 / Published online: 1 June 2023

Abstract

In present study, geophysical and geostatistical variability of ground water and agricultural soil investigated in the Jaipur region of Rajasthan (Western India) by applying the geographic information system (GIS), vertical electrical sounding (VES) ,and statistical analysis. Ground water and soil samples collected from different sites from the selected study area and variation pattern of quality parameters were assessed. A contour map analysis of distribution of metals and other contaminants in the samples was conducted using GIS. Maximum concentration of metals recorded in the soil samples in order of Fe, 11.25 mg kg^{-1} > Mn, 8.6 mg kg^{-1} > Zn, 7.2 mg kg^{-1} > Cu, 0.455 mg kg^{-1}; however, maximum concentration of metals in the ground water samples was found as Zn, 2.64 mg L^{-1} > Cu, 0.86 mg L^{-1} > Fe, 0.39 mg L^{-1} > Mn, 0.18 mg L^{-1} > Pb, 0.065 mg L^{-1} > Ni, 0.016 mg L^{-1}. Observed data emphasis variability in groundwater and soil quality parameter by PCA technique indicated 84.60% and 66.98% of variance, respectively. Soil quality index (SQI) value was observed as 0.482 indicating that 46% of soil sampling sites deteriorated and shown poor quality. Similarly, water quality index (WQI) value indicates good water quality at the sampling sites TW1, TW8, TW10, and TW12; however, TW3, TW4, TW6, TW19, TW20, and TW22 sites showed very poor water quality. The present study concludes that overexploitation of groundwater and unregulated discharge of wastewater leads to depletion of water and soil quality. Further, applying geographical and geostatistical techniques in assessing water and soil quality could be more effective tools in environmental monitoring and management for environmental and health safety.

Keywords Bioaccumulation · Bioavailability · Biotransformation · Contamination · Groundwater · Metals · Principal component analysis (PCA) · Water quality

Introduction

Rapid urbanization leads to several environmental issues, including poor living conditions, changes in land use pattern, overexploitation of water and soil, transportation congestion, resettlement, disasters, and environmental pollution (Kalayci Onac et al. 2021; Aksoy et al. 2022; Tay and Ocansey 2022; Dogan et al. 2023). Fresh water including ground water is one of the most important components of the environment and essential for human survival and wellbeing (Gavrilescu 2021). However, extensive exploitation of water by human being leads to substantial environmental cost due to contamination, scarcity, and depletion of water resources affecting water supply and health safety (Tzanakakis et al. 2020; Singh et al. 2022). Scarcity of safe drinking water is now becoming a problem due to

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extensive urbanisation, industrialization, agriculture, and climate change affecting about 40% of human population globally (Calzadilla et al. 2011; Bilge Ozturk et al. 2022). Groundwater found underground in cracks and crannies in rock, sand, and soil is the main source of drinking water supply. Exploitation of groundwater may result in dissolution of numerous contaminants as it passes through the rocks and soil during leaching and percolation (Saleem et al. 2018). Trace metals emanating from different industrial, transportation, construction, and agricultural activities affect soil and water quality as recalcitrant and toxic contaminants (Romic and Romic 2003; Cetin et al. 2022a; Sahin et al., 2022). Link between soil quality and socioeconomic well-being of humans, particularly, global food security and human health have been reported (Yu et al. 2018; Kopittke et al. 2019). Soil and water contamination occurs due to various anthropogenic activities and geological processes releasing metals and other elements; therefore, assessment of soil and water quality is becoming more crucial in adapting appropriate strategies to prevent and preserve the land and water resources for human wellbeing (Ahmet et al. 2006; Cesur et al. 2021). More common metal contaminants in soil and water are Pb, Cr, As, Zn, V, Cd, Cu, and Sn reported with high levels of toxicity for biota (Yang et al. 2016; Hanfi et al. 2020; Cetin et al. 2022b).

India is one of the emerging nations with more industrial and other developmental activities having wastewater generation and discharge on the land and in the aquatic ecosystems leads to soil and water contamination (Tiwari et al. 2011). Metals persist in the soil and water, accumulates in the plants by roots uptake, and biomagnifies in the animals through food chain, which causes detrimental impact to the biota (Luo et al. 2012; Ali et al. 2019; Cetin and Abo Aisha 2023). Certain metals easily enter the food chain due to their bioavailability in the rhizosphere, uptake, and accumulation in the plants and can reach to other animals and humans through food (Gu et al. 2016; Rajendran et al. 2022). It has been reported that excessive accumulation of trace elements like cadmium, lead, and nickel in the plants causes toxicity and slows down the growth and productivity (Pandey and Sharma 2002; Zouboulis et al. 2004). A substantial threat to aquatic and terrestrial biodiversity as well as health hazards for humans posed by contaminated water and soil (Olayinka-Olagunju et al. 2021). Types of rock, physicochemical characteristics of soil, atmospheric precipitation, and surface geochemical processes affect the groundwater quality parameters and contamination (Garg and Hassan 2007; Cesur et al. 2021). Groundwater is most reliable source even in India because it provides a significant proportion of the country's drinking and agricultural water requirements (Mahmood and Kundu 2005).

Physico-chemical characteristics of soil also affects the water quality of groundwater at a given regions (Griffiths et al. 2010; Hermans et al. 2020). Different physio-chemical and biological indicators have been used in various studies to evaluate the soil quality (Filip 2002; Schloter et al. 2003). GIS has evolved into a trustworthy instrument for absorbing, analyzing, and displaying spatial data that can be utilized for environmental monitoring, planning, and resource management applications (Cetin 2015; Singha et al. 2015). The geographical information system (GIS) has become an important tool in research for resource management as it allows users to use geographical data in a variety of context and way in an integrated approach. Remote sensing (RS) and GIS studies in integration make it easier to work in relatively broad areas, particularly in environmental impact assessment for sustainable urban planning and resource utilization (Cetin 2019; Pekkan et al. 2021; Cetin et al. 2022c). Convergence of data concerning environmental assessment-related issues as well as the manipulation of spatial data into various forms in response to geosocial requirements may be accomplished using GIS (Cetin et al. 2022d). The principal component analysis (PCA) is a prominent statistical analysis tool for investigating data patterns thorough factor analysis approach. Basic purpose of PCA is to create new variables as principal components, from a set of existing original variables (Wu et al. 2020). Potential of geophysical information system-based geostatistical methodologies in assessing the region's groundwater and soil quality as well as its susceptibility to water-borne diseases reported (Ali and Ahmad 2020).

The Sanganer, Jaipur region of Rajasthan, Western India, having more industrial activities specially printing and dyeing operations leads to huge amount of wastewater generation and discharge in water and agricultural soil through unregulated disposal and irrigation practices. Very limited data are available related to using geographical information system and geostatistical techniques in the ground water and soil quality assessment. Therefore, the present study was conducted to assess ground water and soil quality at different sites based on a minimal set of interconnected geophysical and chemical criteria at Sanganer, Jaipur region of Rajasthan, Western India, and apply geophysical and geostatistical including GIS, VES, and PCA techniques to emphasize the water and soil quality parameters for environmental monitoring and assessment.

Materials and methods

Study area

The whole study conducted in the industrial and agricultural tracts in the north of Jaipur–Sanganer regions at different selected sampling sites, situated between 26° 49° and 26° 51° N and 75° 46° and 75° 51° E in the Jaipur district, Rajasthan, Western India (Fig. 1). One selected study site, the Sanganer, is famous for its hand-printed textiles have land size of 78.24 square kilometres, situated on NH-12, 10 kilometres to the southwest of Jaipur City. The Sanganer is well-known for its distinctive type of printing "Sanganer Printing" basically in the small-scale industries of the Chippas community, involving dyeing and printing of textiles (Dadhich et al. 2016). Dyeing and printing processes release wastewater during water-based color fixing procedure and discharged in the surrounding areas which pollutes water and soil. The chippas community either transport the textiles to a well dug on the bank of the Dravyawati River or

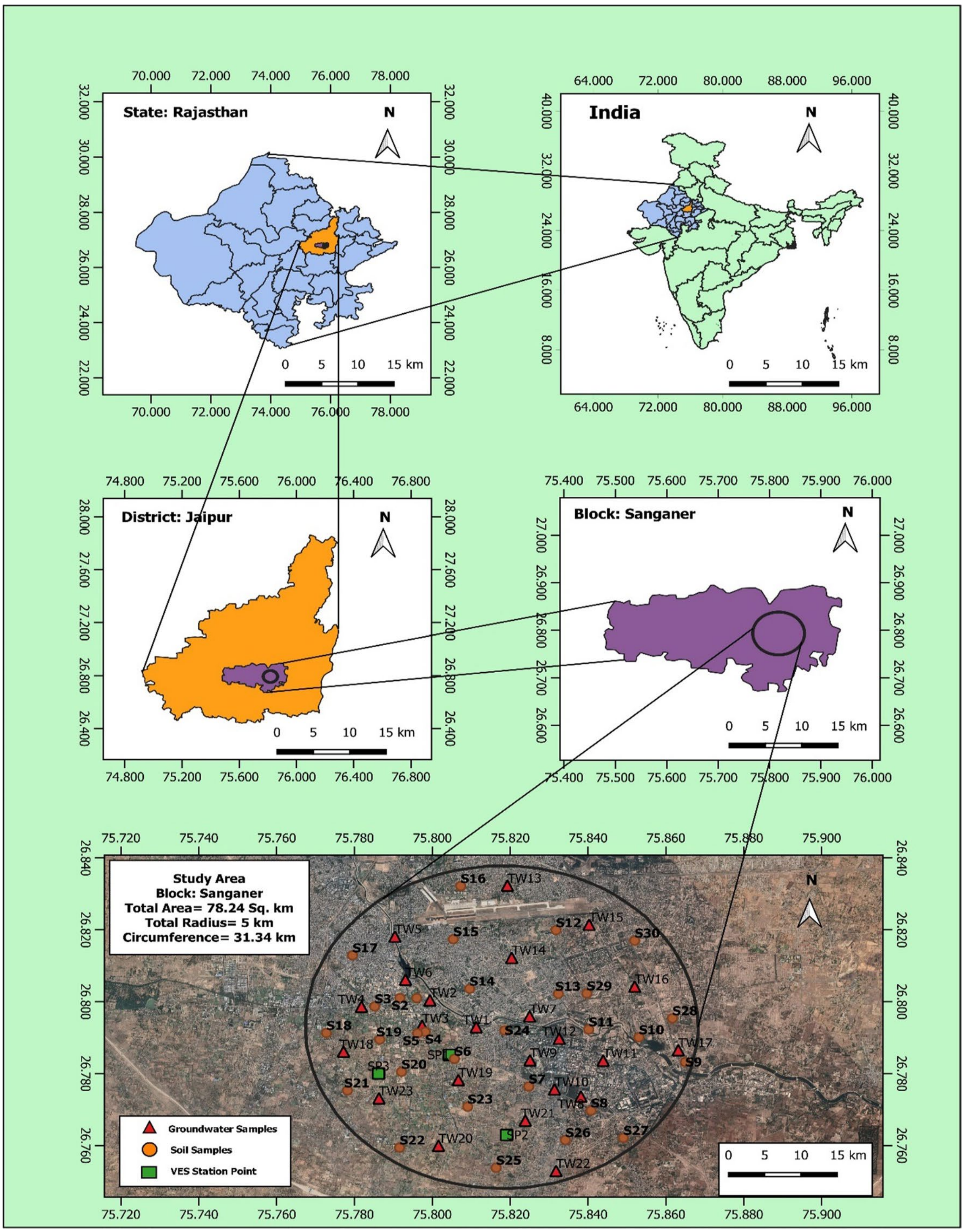


Fig. 1 Sampling sites of soil and ground water selected in the study area, Sanganer, Jaipur, Rajasthan, India

wash it at their wells in the city at various places randomly. Textile wastewater along with sewage from across the of Jaipur city discharged directly into the Dravyawati river in the selected study area is being polluted. Historically, Sanganer was primarily an agricultural region; however, during the last decade, the textile and dying industries have dramatically risen in the area and encroached the previously untapped agricultural land. With more than 250 separate printing units connected, it has emerged as one of the major centers of the printing and dying industries nowadays today in India. Growing demand and low production costs leads to the introduction of synthetic and chemical dyes, which have several environmental impacts. The regions of Jaipur–Sanganer with a high number of dyeing and printing industrial units releasing tonnes of waste into the aquatic environment, agricultural fields, and on open spaces nearby, polluting the water and soil (Sharma et al. 2014). Contamination of water and soil have negative impact on nutrition and human health due to deterioration of drinking water quality and food quality; however, at severe stage, poor quality may prevent soil from performing its natural physio-chemical and biological functions and deteriorate region's overall productivity of the terrestrial ecosystem.

Sampling sites and sampling

One-liter capacity plastic bottle rinsed with distilled water used to collect the groundwater samples. Grab sampling conducted for groundwater water sampling and samples preserved in the bottles with adjusted pH 2 and stored in refrigerator at 4 °C with slightly acidified with nitric acid (HNO_3) for analysis of water quality parameters including metals (Mn, Cu, Ni, Zn, Pb, and Cu). In Sanganer industrial region, having a new industrial area (RICCO) and an industrial zone (RSMDC), a quantitative soil and water sampling conducted to evaluate the water and soil quality parameters of the agricultural land as well as the degree of contamination in water due to industrial activities. Soil samples (250 g) taken from 30 randomly selected sites with a depth of 45 to 60 cm within a 5-kilometer radius of the Sanganer industrial zone and packed in fresh plastic zip-lock bag separately to determine the soil quality parameters (Fig. 2). All the sampling sites were precisely geotagged and labeled from S1 to S30 using a Garmin GPS device (model 68 s), allowing for the retrieval of a variety of location-specific data (Luo et al. 2011). Description of location and sampling sites are shown in the Table 1. The geoelectrical resistivity approach used to conduct field surveys in the study region which requires injecting a man-made current through several electrodes (AB) into the subsurface medium and observing the voltage changes at the potential electrodes (MN) to assess the variation in the ground's resistivity (Binley et al. 2015).

Analysis of soil and water quality parameters

Collected soil samples analyzed for 10 functional indicators parameters (i.e., pH, EC, OC, P, S, K, Zn, Fe, Cu, and Mn) for soil quality (YanBing et al. 2009). Similarly, collected water samples from different selected sites analyzed for water quality parameters in the laboratory. Average of all sets of triplicates calculated and values recorded into the data system (Juhos et al. 2019). All the analysis conducted following the procedure established by the American Public Health Association (Baird and Bridgewater 2017). A typical laboratory digital micro-processor pH meter used to estimate hydrogen ion concentration (pH) in the water samples (Salem et al. 2020). Similarly, electrical conductivity (EC) determined using an electrical conductivity meter (an EC probe and equipment that had been calibrated) by following the procedure of McNeill 1992. A digital water quality test kit used to evaluate total dissolved solids (TDS); however, EDTA titration method was used to calculate total hardness in the water samples. An argentometric titration used to quantify the amount of chloride in a water sample followed by alkalinity determined using the titrimetric method. UV-visible spectrophotometer used to determine the amount of fluoride in the collected water samples. Titration method used to estimate soil organic carbon (SOC) in the soil samples (Walkley and Black 1934) which involves oxidizing organic material in sulfuric acid with a predetermined quantity of chromate (Sato et al. 2014; Gelman et al. 2012). The Johnson–Nishita procedure used to measure sulfur content in the soil samples (Dean 1966). Sulfur and other minerals present in soil solution specially SO_4 ions adsorbed are the principal source of sulfur in soil. The replacement of SO_4 ions is of the utmost importance, and phosphate ions substituted wherever possible for adsorption and monocalcium phosphate, or phosphate ions, are present in the soil. The SO_4 ions are replaced with $CaCl_2$ ions in a more effective way throughout the extraction process and SO_4 extract turbulence determined by using a spectrophotometer. Potash content in soil samples estimated using a flame photometer following the procedure of Brondi et al. (2016).

Metal estimation

The concentration of Fe, Cu, Zn, Ni, Mn, and Pb in groundwater samples, whereas the metal Fe, Zn, Cu, and Mn analyzed in the soil samples estimated after complete digestion in $HClO_4$ and HNO_3 (3 : 1), using hollow cathode lamp at a certain wavelength into an atomic absorption spectrophotometer (AAS, Shimadzu) in comparison to standard metal solutions.

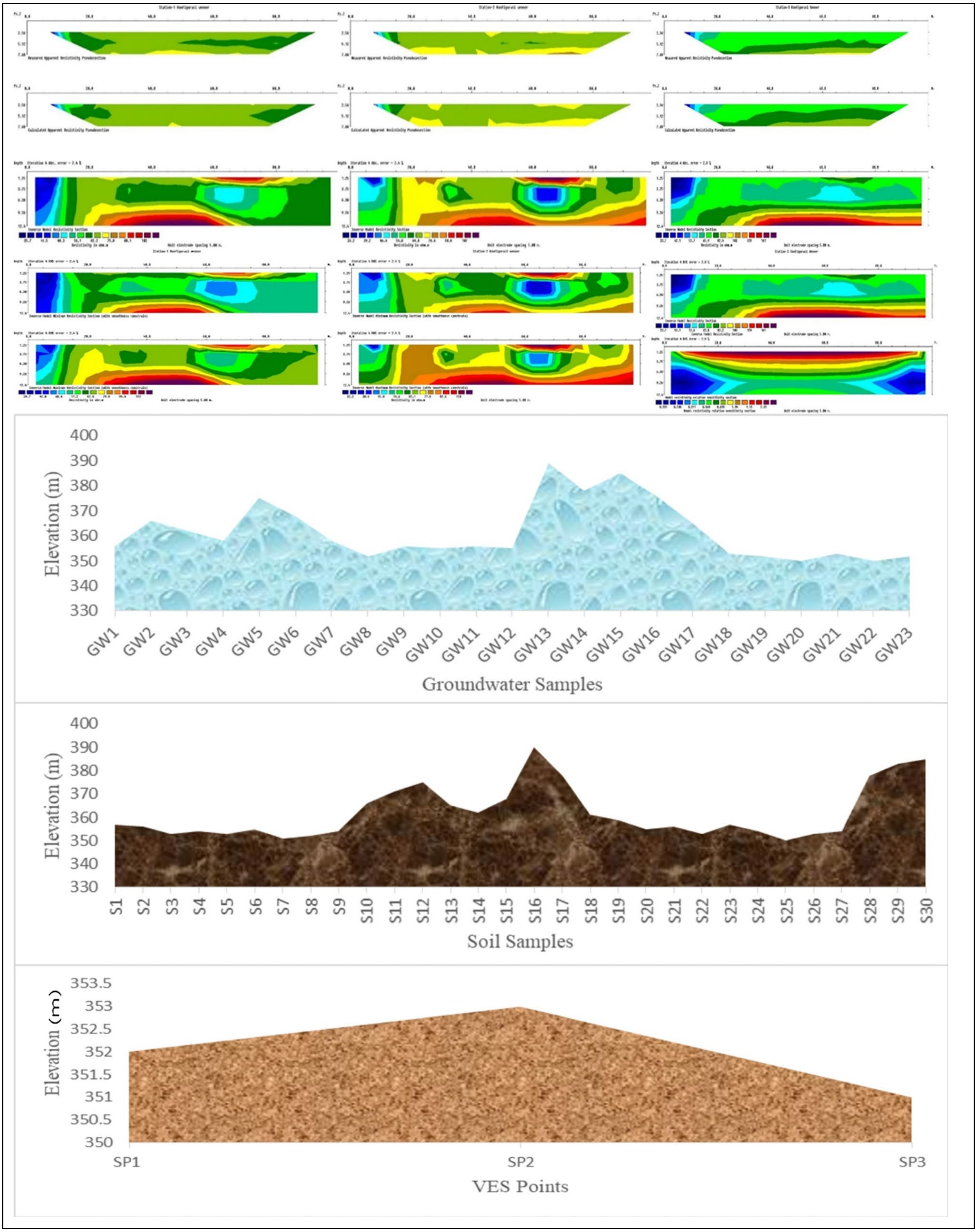


Fig. 2 Geoelectrical layers and elevation point of different sampling sites at the study area, Sanganer, Jaipur, Rajasthan, India

Table 1. Description of sampling sites of ground water samples, soil samples and VES station selected at Sanganer study area, Jaipur (Rajasthan), India

Ground water sample			Soil samples		
Sampling site	Latitudinal and longitudinal position	Elevation (m)	Sampling site	Latitudinal and longitudinal position	Elevation (m)
GW1	26.7929 N, 75.8113 E	357	S1	26.8010 N, 75.7960 E	354
GW2	26.8004 N, 75.7994 E	356	S2	26.8010 N, 75.7917 E	350
GW3	26.7933 N, 75.7974 E	353	S3	26.7987 N, 75.7852 E	353
GW4	26.7986 N, 75.7818 E	354	S4	26.7916 N, 75.7982 E	354
GW5	26.8181 N, 75.7904 E	353	S5	26.7912 N, 75.7962 E	378
GW6	26.8061 N, 75.7931 E	355	S6	26.7841 N, 75.8057 E	383
GW7	26.7959 N, 75.8250 E	351	S7	26.7764 N, 75.8248 E	385
GW8	26.7736 N, 75.8382 E	352	S8	26.7697 N, 75.8408 E	356
GW9	26.7837 N, 75.8251 E	354	S9	26.7832 N, 75.8650 E	366
GW10	26.7756 N, 75.8314 E	366	S10	26.7901 N, 75.8531 E	362
GW11	26.7836 N, 75.8439 E	371	S11	26.7923 N, 75.8402 E	358
GW12	26.7897 N, 75.8326 E	375	S12	26.8199 N, 75.8318 E	375
GW13	26.8323 N, 75.8193 E	365	S13	26.8022 N, 75.8324 E	368
GW14	26.8122 N, 75.8204 E	362	S14	26.8036 N, 75.8096 E	358
GW15	26.8214 N, 75.8403 E	368	S15	26.8174 N, 75.8054 E	352
GW16	26.8042 N, 75.8520 E	390	S16	26.8322 N, 75.8073 E	356
GW17	26.7865 N, 75.8632 E	378	S17	26.8129 N, 75.7795 E	355
GW18	26.7861 N, 75.7772 E	361	S18	26.7913 N, 75.7728 E	356
GW19	26.7782 N, 75.8067 E	359	S19	26.7895 N, 75.7865 E	355
GW20	26.7599 N, 75.8016 E	355	S20	26.7805 N, 75.7921 E	389
GW21	26.7669 N, 75.8239 E	356	S21	26.7753 N, 75.7782 E	378
GW22	26.7529 N, 75.8318 E	353	S22	26.7594 N, 75.7916 E	385
GW23	26.7731 N, 75.7863 E	357	S23	26.7708 N, 75.8091 E	376
			S24	26.7920 N, 75.8186 E	365
	VES		S25	26.7538 N, 75.8164 E	353
SP1 (VES)	26.7852 N, 75.8044 E	352	S26	26.7615 N, 75.8342 E	352
SP2 (VES)	26.7629 N, 75.8191 E	353	S27	26.7621 N, 75.8491 E	350
SP3 (VES)	26.7800 N, 75.7862 E	351	S28	26.7954 N, 75.8617 E	353
			S29	26.8023 N, 75.8397 E	350
			S30	26.8170 N, 75.8520 E	352

Geostatistical analysis

To assess overall quality of water and soil samples collected from the different sites in the study area, data of soil and water quality parameters analysed thoroughly by applying geostatistical tools. Quantitative evaluation's framework combines geotechnical and physicochemical analysis of water and soil samples with descriptive statistics and statistical modelling. Outcome data is gathered after the laboratory chemical analysis of selected soil and water samples, followed by review with analysis of data on SPSS software (version 22 for Windows). Discriminating analysis (correlation) of data performed using Statistical Package for the Social Sciences (SPSS) for Windows, version 23.0. (Ukah et al. 2019, 2020). Several statistical methods used in data analysis and models including MV, SD, and CV (Li et al. 2016; Zhu et al. 2019). Further, water quality index (WQI) and soil quality index (SQI) evaluated to assess the region's overall variations and patterns of water and soil quality parameters using site-specific indicator evaluation outputs. Weighted arithmetic mean technique for WQI was used in this investigation (Tyagi et al. 2013).

$$WQI_A = \sum_{i=1}^{n} qi\ X\ Wi,$$

$$\sum_{i=1}^{n} Wi = 1,$$

where Wi is the unit weight of each parameter, qi is the 0–100 subindex rating for each variable, and n is the number of subindices aggregated. Multivariate statistical technique, the principal component analysis (PCA), was used to reduce the dataset into new variables, create a minimum data set (MDS), and analyze relationships between different metal contents in the water and soil samples and other quality parameters including pH, TOC, and EC along with factor analysis (FA) to identify specific factor weight of a particular metal (Weissmannová and Pavlovský 2017). The SAS Systems for Windows 10 platform and Statistica 12.5® software used to perform principal component analysis (PCA), followed by a Varimax rotation used to rotate each PCA component. The Varimax rotation method of factor analysis and the principal component primary result analysis performed by following the procedure of Kaiser 1958 and Maiz et al. 2000. For the GIS-based evaluation, SQI and WQI maps, spatial distribution maps, area maps, and thematic maps for the region produced by using Sentinel 2 Satellite data (March 2021) in bands: 3, 4, 8 developed on ArcGIS software 10.8 (2020).

Results

Groundwater samples (23) and soil samples (30) collected from selected sampling sites of the study area, Jaipur regions of Rajasthan, Western India, analyzed for quality parameters. Based on the sounding data, the present study inferred with three geoelectrical layers comprising topsoil, unsaturated, and saturated zones (Fig. 2). For all the sections topmost layer assumed to be topsoil, above the water table and substantially drier more often reflects greater resistivity. Peat investigated in the topsoil layer by resistance correlation with soil lithology from neighboring boreholes. Regional lithology of Sanganer shown in the Table 2 which indicates formation depth range as alluvium, 0.0–95 m; weathered, 0.69–128 m; and hard rock, 9.2 m. In present study, the third layer of all the sections represent highest concentration of geoelectrical sections with low resistivities (less than 10 m). Values and their variation pattern of water quality parameters in 23 groundwater samples at different sites of the study area depicted in Fig. 3. Maximum values of different parameters of groundwater samples recorded as pH, 8.0; electrical conductivity (EC), 3.01 S/m, TDS, 1501 mg/l; fluoride, 1.9 mg/l; total hardness, 273 mg/l; Ca, 88.1 mg/l; Mg, 12.67 mg/l; chloride, 227.42 mg/l; HCO_3, 61.87 mg/l; and CO_3, 58.29 mg/l. However, maximum metal concentration in groundwater samples recorded as Zn, 2.64 mg/l; Cu, 0.862 mg/l; Fe, 0.392 mg/l; Mn, 0.181 mg/l, Pb, 0.065 mg/l; and Ni, 0.016 mg\l. pH and TDS level in the ground water samples found in the range of 7.0 to 8.0 and 559 to 1501 mg/l, indicate that values are within the range of 6.5 to 8.5 and 500 to 1500 mg/l, respectively, as per WHO standard of water quality. Similarly, for 30 soil samples, maximum values of soil quality parameters recorded as pH, 8.4; electrical conductivity (EC), 0.27 µS/m; organic carbon, 0.23 %; phosphorous, 50.23 mg/kg; potash, 786 mg/kg; sulfur, 29.68 mg/kg. However, maximum metal concentration in the soil samples recorded as Fe, 11.25 mg/kg; Mn, 8.65 mg/kg; Zn, 7.26 mg/kg; and Cu, 0.45 mg/kg as shown in Fig. 4. Result shows that none of the parameters including pH have a strong correlation. Samples' scores and loadings plots together showed physio-chemical characteristics of soil that affect each order on the score plots. Retained variables divided into groups using the factor analysis technique in accordance with statistical factors and correlation matrix (Table 3). As depicted in the Table 4, maximum WQI found in groundwater sample collected at sampling site TW22 and minimum in the sample collected from TW12. Results of PCA and FA analysis for groundwater revealed that the first component (PC1), which accounted for 39.12% of the total variance, included Mn, pH, and EC; however, S, OC, and P made the second component (PC2) with a total variance of 12.54%. Similarly, pH, Mn,

Table 2. Regional lithology of the study area, Sanganer, Jaipur (Rajasthan), India

Aquifers depth (m)	Aquifers	Geological formation	Depth (m)	Laboratory experiment model
0–95	Alluvium	Surface soil, sandy clay	0–4	
		Clayey sand	4–13	
		Clayey kankar	13–19	
0.6–128	Weathered	Sandy clay with kankar	19–29	
		Kankar and clay	29–38	
		Kankar and sand	38–47	
9.2	Hardrock	Weathered schist	47–73	
		Schist	73–150	

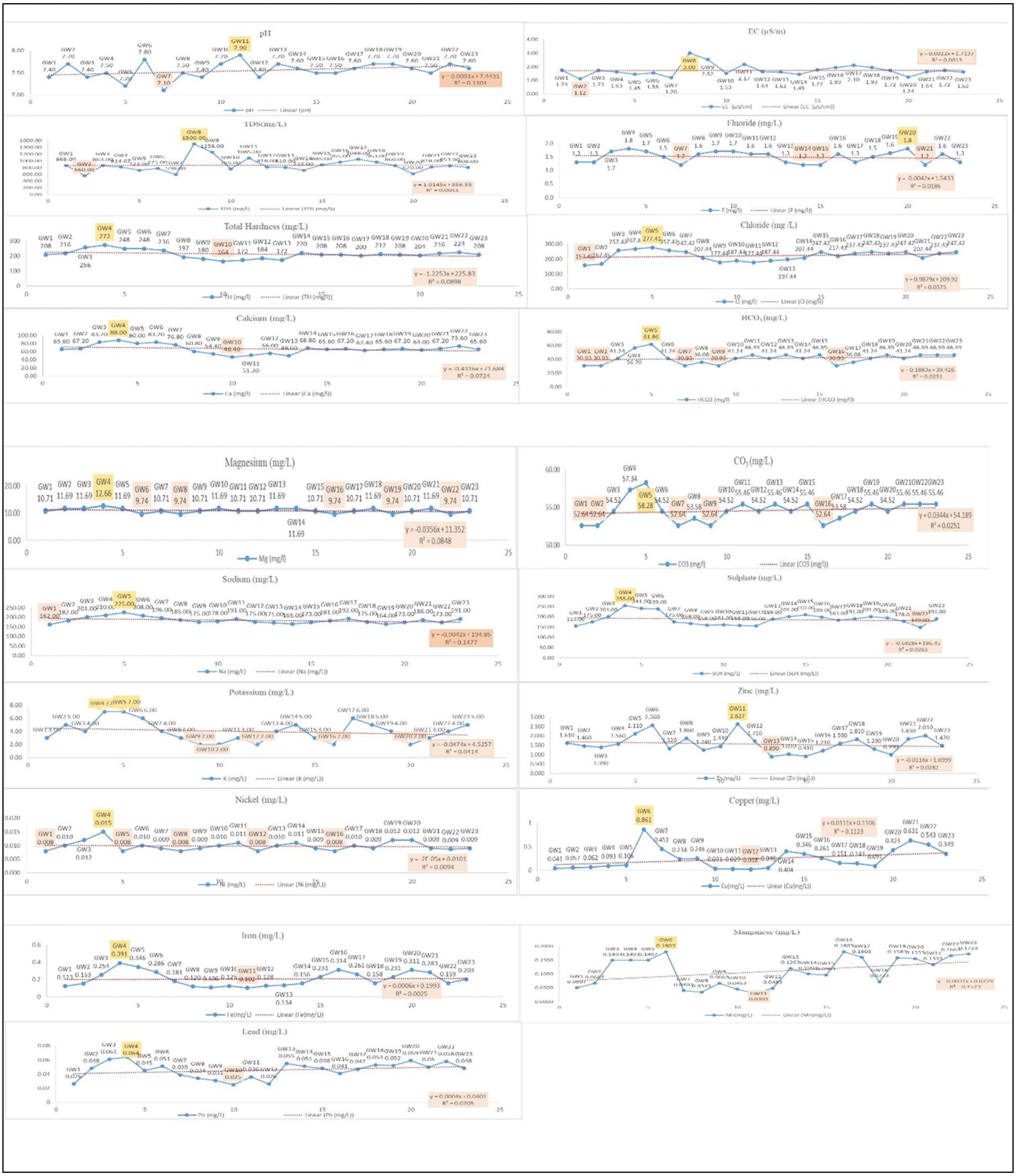


Fig. 3 Variations in water quality parameters of ground water samples collected from in different sites at the study area, Sanganer, Jaipur, Rajasthan, India

and Cu made PC3 with a total variance of 11.42% followed by phosphorous made PC4 a total variance of 9.06%, while all four extraction factors accounted for 72.15% of the overall variation. However, in case for soil samples Mn, pH, and EC produced the first component (PC1) with 24.26% of the variance followed by the second component (PC2) produced included S, OC, and P with a total variation of 17.48%, while PC3 made up of pH, Cu, and Mn with a total variance of

Fig. 4 Variations in soil quality parameters of soil samples collected from different sites at the study area, Sanganer, Jaipur, Rajasthan, India

13.65% and PC4 contained phosphorus with a total variance of 11.58% (Fig. 5A). Result shows that water quality of groundwater samples collected at TW1, TW8, TW10, and TW12 sampling sites in the Sanganer area are in very good quality category; however, groundwater samples from TW3, TW4, TW6, TW19, and TW22 sites recorded under very poor water quality category with high level of contaminants (Fig. 5B). Similarly, total 9 soil quality parameters including pH, EC, OC, P, S, K, Zn, Fe, and Mn used to evaluate the soil quality index (SQI), and an average soil quality index (SQI) value 0.517 recorded for the selected study area based on MDS, with a range of 0.341 to 0.635 (Fig. 5B). According to the suggested framework, the SQI values for the entire selected region divided into three categories viz; category 1 (C1), SQI value less than 0.4 (degraded); category 2 (C2), SQI value between 0.41 and 0.5 (moderately degraded); and category 3 (C3), SQI value greater than 0.51(least degraded). SQI revealed that soil samples at S19 site showed highest SQI score, 0.636, followed by S6, S7, S12, S13, S15, S16, S17, S18, S20, S21, S22, S23, S25, S27, S29, and S30 more than average as shown in Fig. 5B. Data shows that 13.3% of the soil samples from the study area have low soil pollution with good soil health; however, 40% of the soil samples have moderate contamination with SQI values in the range of 0.41 to 0.5 and 46.6% of soil samples shown as degraded soil under the poor-quality category with SQI values more than 0.51. At 5 kilometers away from the Sanganer industrial regions, high-intensity farming techniques, and conventional farming practices, excessive fertilizer use may be responsible for the soil degradation in the selected sites. Based on SQI score, the S19 site showed highly contaminated soil in the study area; however, it is crucial to note that the high score may be due to increased chemical build-up and other components like sulfur rather than trace metals having low concentration; however, it may be useful in environmental health assessment. Results of the factor analysis (FA) recorded insufficient if the Kaiser–Meyer–Olkin (KMO) test result value found to be less than 0.5; however, KMO found less FA findings in the test's outcome than the chemical examination of soil samples. FA did not alter KMO testing significantly because there is no related cut-off point, and the results for the sample given a less clear indication of the applicability of the FA as KMO values estimated 0.487 and 0.466 (less than 0.5) for the groundwater and soil samples, respectively. Percentage (%) of variance evaluated by placing three components out of

Table 3. Correlation matrix[a] of ground water and soil samples collected from different sites at Sanganer study area, Jaipur, Rajasthan, India

Groundwater quality parameters

		pH	EC	TDS	F	TH	Ca	Mg	Cl	HCO_3	CO_3	Na	K	SO_4	Zn	Ni	Mn	Cu	Fe	Pb
Correlation	pH	1.000	.080	.082	.047	− .348	− .338	− .–	− .207	.078	.078	− .284	.008	− .087	.250	.300	.121	.047	− .213	.219
	EC	.080	1.000	1.000	.217	− .366	− .327	− .371	− .211	− .185	− .185	− .088	− .251	− .282	.214	− .241	− − .241	− .147	− .309	− .326
	TDS	.082	1.000	1.000	.217	− .367	− .328	− .370	− .212	− .185	− .185	− .088	− .252	− .279	.212	− .239	− .242	− .149	− .308	− .326
	F	.047	.217	.217	1.000	.068	.074	− .040	.194	.267	.267	.257	− .111	.155	.213	.337	.131	− .259	.240	.036
	TH	− .348	− .366	− .367	.068	1.000	.993	.217	.695	.320	.320	.605	.671	.698	.153	.351	.491	.322	.693	.599
	Ca	− .338	− .327	− .328	.074	.993	1.000	.096	.705	.282	.281	.586	.641	.676	.180	.307	.517	.374	.687	.580
	Mg	− .132	− .371	− .370	− .040	.217	.096	1.000	.028	.361	.361	.241	.346	.280	− .190	.399	− .131	− .366	.156	.244
	Cl	− .207	− .211	− − .212	.194	.695	.705	.028	1.000	.538	.538	.572	.569	.734	.044	.295	.645	.345	.735	.659
	HCO_3	.078	− .185	− .185	.267	.320	.282	.361	.538	1.000	1.000	.441	.480	.560	.242	.343	.381	− .032	.462	.449
	CO_3	.078	− .185	− .185	.267	.320	.281	.361	.538	1.000	1.000	.441	.480	.560	.242	.343	.381	− .032	.462	.449
	Na	− .284	− .088	− .088	.257	.605	.586	.241	.572	.441	.441	1.000	.615	.590	.498	.154	.288	.115	.582	.215
	K	.008	− .251	− .252	− .111	.671	.641	.346	.569	.480	.480	.615	1.000	.672	.284	.314	.411	.074	.459	.529
	SO_4	− .087	− .282	− .279	.155	.698	.676	.280	.734	.560	.560	.590	.672	1.000	− .010	.451	.589	.185	.811	.590
	Zn	.250	.214	.212	.213	.153	.180	− .190	.044	.242	.242	.498	.284	− .010	1.000	− .145	− .054	.175	− .008	− .143
	Ni	.300	− .241	− .239	.337	.351	.307	.399	.295	.343	.343	.154	.314	.451	− .145	1.000	.281	− .117	.388	.604
	Mn	.121	− .241	− .242	.131	.491	.517	− .131	.645	.381	.381	.288	.411	.589	− .054	.281	1.000	.393	.750	.695
	Cu	.047	− .147	− .149	− .259	.322	.374	− .366	.345	− .032	− .032	.115	.074	.185	.175	− .117	.393	1.000	.270	.288
	Fe	− .213	− .309	− .308	.240	.693	.687	.156	.735	.462	.462	.582	.459	.811	− .008	.388	.750	.270	1.000	.582
	Pb	.219	− .326	− .326	.036	.599	.580	.244	.659	.449	.449	.215	.529	.590	− .143	.604	.695	.288	.582	1.000

Soil quality parameter

		pH	EC	OC	Phosphorus	Sulfur	Potash	Zn	Fe	Cu	Mn
Correlation	pH	1.000	.163	− .071	.166	.148	.111	− .324	.291	− .039	− .089
	EC	.163	1.000	.125	.059	.113	.075	− .064	.079	.131	− .264
	OC	− .071	.125	1.000	− .237	.226	− .174	.023	− .382	− .331	.288
	Phosphorus	.166	.059	− .237	1.000	.290	.250	− .178	.385	.400	− .109
	Sulfur	.148	.113	.226	.290	1.000	.493	− .101	.202	− .026	.314
	Potash	.111	.075	− .174	.250	.493	1.000	− .291	.160	− .064	− .012
	Zn	− .324	− .064	.023	− .178	− .101	− .291	1.000	− .362	.149	.110
	Fe	.291	.079	− .382	.385	.202	.160	− .362	1.000	.054	− .234
	Cu	− .039	.131	− .331	.400	− .026	− .064	.149	.054	1.000	− .059
	Mn	− .089	− .264	.288	− .109	.314	− .012	.110	− .234	− .059	1.000

Table 4. Water quality and soil quality Index

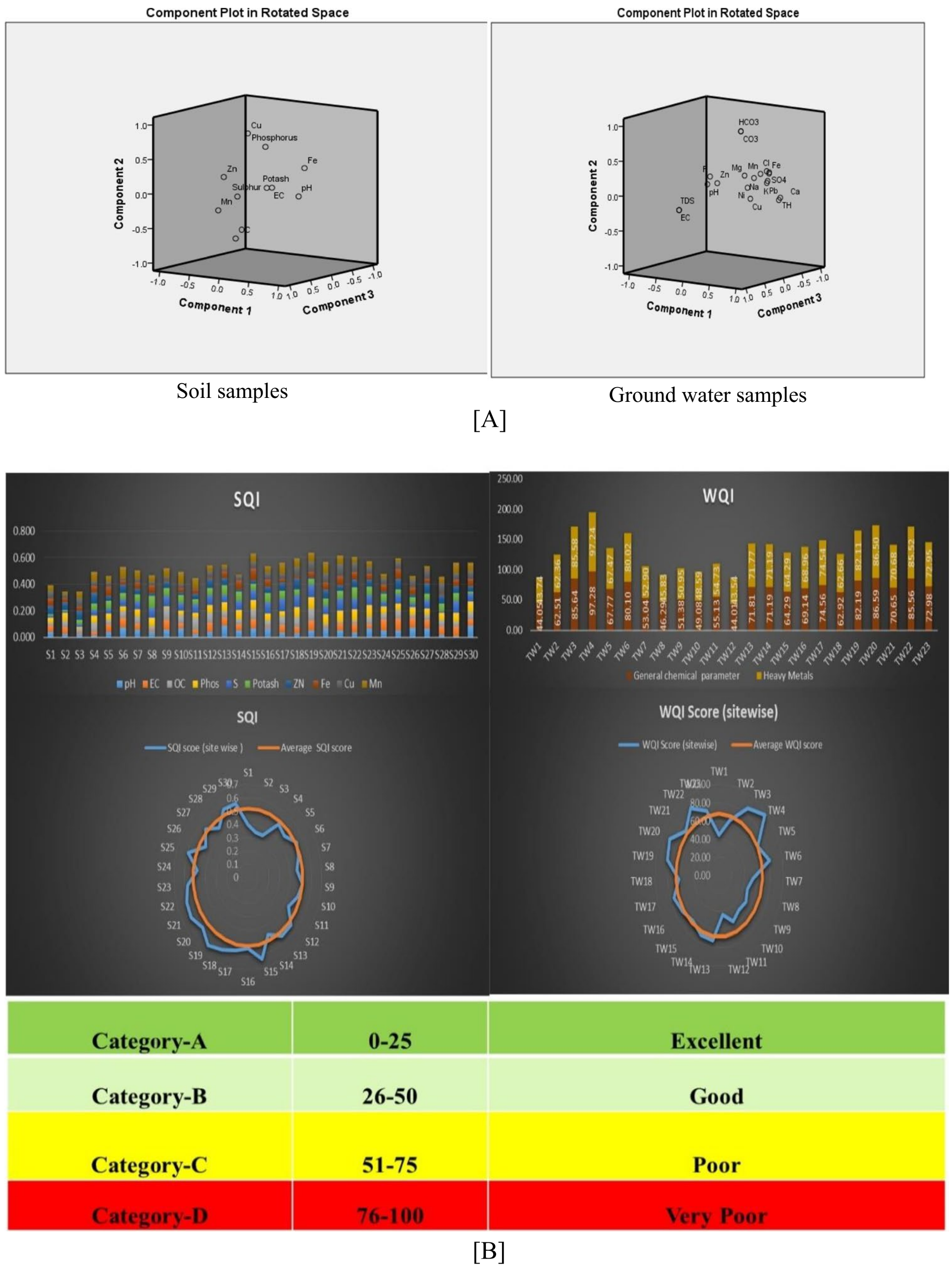
Groundwater quality index						
Parameters	Quantity of sample	WQI (mean)	Std. deviation	Std. error	Maximum	Minimum
pH	23	7.5522	.0035	.0020	8.0000	7.0000
EC (µS/m)	23	1.7400	.0027	.0015	3.0100	1.1100
TDS (mg/l)	23	868.7246	.7633	.4407	1501.0000	559.0000
Fluoride (mg/l)	23	1.4928	.0054	.0031	1.9000	1.1000
TH (mg/l)	23	211.1304	.5325	.3074	273.0000	163.0000
Ca (mg/l)	23	66.5043	.0035	.0020	88.1000	46.3000
Mg (mg/l)	23	10.9249	.0009	.0005	12.6700	9.7300
Cl (mg/l)	23	221.7787	.0025	.0014	277.4200	157.4400
HCO_3 (mg/l)	23	41.6862	.0041	.0024	61.8700	30.9200
CO_3 (mg/l)	23	54.6017	.0082	.0047	58.2900	52.6300
Na (mg/l)	23	184.0000	.6035	.3484	226.0000	161.0000
K (mg/l)	23	3.9565	.6745	.3894	8.0000	1.0000
SO_4 (mg/l)	23	188.2609	.8165	.4714	256.0000	148.0000
Zn (mg/l)	23	1.5612	.0083	.0048	2.6400	1.6000
Ni (mg/l)	23	0.0098	.0010	.0006	.0160	.0011
Mn (mg/l)	23	0.1099	.0004	.0002	.1810	.0300
Cu (mg/l)	23	0.2442	.0008	.0005	.8620	.0170
Fe (mg/l)	23	0.2068	.0008	.0005	.3920	.1010
Pb (mg/l)	23	0.0456	.0008	.0004	.0650	.0240
Soil quality index						
Parameters	Quantity of sample	SQI (mean)	Std. deviation	Std. error	Maximum	Minimum
pH	30	8.11	.0064	.0037	8.40	7.98
EC (µS/m)	30	.2240	.0008	.0005	.2760	.1580
Organic carbon (%)	30	.1793	.0061	.0035	.2300	.1400
Phosphorous (mg kg^{-1})	30	38.1197	.0009	.0005	50.2310	21.0500
Sulfur (mg kg^{-1})	30	24.9634	.0006	.0004	29.6810	18.3620
Potash (kg/ha)	30	607.1889	.7385	.4264	786.00	410.00
Zn (mg kg^{-1})	30	5.6635	.0010	.0006	7.2630	4.0890
Fe (mg kg^{-1})	30	9.0579	.0006	.0003	11.2510	7.2890
Cu (mg kg^{-1})	30	.3261	.0005	.0003	.4550	.2130
Mn (mg kg^{-1})	30	6.8290	.0007	.0004	8.6560	4.6810

the four PC ranges (component based on Jolliffe's criterion) and recorded 84.60% and 66.98% for groundwater and soil samples, respectively (supplementary data).

Discussion

Collected samples from the selected study area, Jaipur regions of Rajasthan, Western India, evaluated for water and soil quality parameters which indicate slightly basic in nature as pH varied within the ranged of 7.0 to 8.0 in the samples. pH is one of the essentially functional parameters for evaluating the quality of soil and water (Filip 2002). Depending on the underlying geological units' actual resistivity, the geoelectrical characteristics utilized to create earth models which displayed as subsurface stratigraphy and from which possible aquifer zones mapped for sampling and assessing the groundwater quality parameters at different sites in the selected region (Mogaji and Omobude 2017). Higher value of EC in groundwater samples indicates impurity as compared to pure water which is not an excellent conductor of electricity having a lower EC than the groundwater. According to previous studies, groundwater exhibits low resistivities between 10 and 100 Ωm in the context of sedimentary (Adagunodo et al. 2018). Kaiser's criterion replaced with Joliffe's criterion since it is too high and allows for a graphic representation of the factor loading through a dipole using the first three components (Jolliffe 1972). However, soil solutio"s EC indicates total amount of salts and ions present in the soil (Bronson et al. 2005; Peralta and Costa 2013). A significant indicator of the soil quality is electrical conductivity, which reflects the salinity of the soil

Fig. 5 Component plot of ground water and soil samples (**A**). Soil quality index (SQI) and water quality index (WQI) of collected samples (**B**)



(Hardie and Doyle 2012). Studies revealed that low resistivity values inside the underlying strata likely caused by high ion concentrations and fine-grained sediments like silt and clay (Amaya et al. 2018). Another soil quality parameter of soil is known as soil organic carbon (SOC) contains organic remains of dead animals and plants at various stages of decomposition which affects physicochemical characteristics of the soil (Campbell 1978). Concentration of SOC in the soil samples is one of the fundamental criteria for soil quality (Unger 1997). Agricultural production, plant development, and soil fertility also depend on phosphorus content, which is the second-most important macronutrient in soil after nitrogen (Malhotra et al. 2018). Similarly, soil fertility, pH levels, plant development, and efficient nitrogen fixation processes dependent on its existence in the soil (Jordan and Ensminger 1959). Potash content is another essential macronutrient for preserving soil fertility and pH homeostasis. Fertilizer used usually to supplement K into the soil in case of its deficiency because plants require K for their growth and development during the life cycle (Morgan and Connolly 2013). However, high concentration of potash in soil also effects soil quality and causes soil degradation (Sillanpaa 1982). Water and soil quality assessment studies have sparked interest on a global scale due to growing attention on the depletion of water and soil quality to assess the environmental impact of anthropogenic activities for environmental sustainability (Raiesi and Kabiri 2016). Various attempts have been made to measure the quality of the soil and water using different indicators (Armenise et al. 2013; Seybold et al. 2018). Water quality index makes it possible to examine water quality in a variety of ways that affect a stream's ability to sustain by its processes and to ensure sustainable use of water resources to minimize risks and preserve aquatic ecosystems (Akkaraboyina and Raju 2012). WQI is an important distinctive grade which summarizes overall quality of water and helps in selecting the most effective treatment strategy for wastewater before its final discharge and disposal to prevent water contamination (Tyagi et al. 2013). Status and level of contamination of water has been evaluated by using water quality parameters and quality index (Shah and Joshi 2017). The WQI and SQI approach is one of the best and most widely used techniques for assessing the quality of soil and water for adapting treatment and conservation strategies (Arshad and Martin 2002; YanBing et al. 2009). Physio-chemical and biological characteristics of soil indicated by the soil quality which is crucial to its long-term functionality and productivity and sustainability. An encompassing view of the region's overall soil quality evaluated assessing the soil quality index (Bhattacharyya 2017). Similarly, minimum data set (MDS) for the data reflecting the soil's functional capacity used in evaluating the soil quality index (Klimkowicz-Pawlas et al. 2019). By using multivariate geostatistical techniques, contemporary data analysis and metal content estimation of four metals (Zn, Cu, Mn, and Fe) in the soil and six metals (Zn, Cu, Mn, Fe, Pb, and Ni) in groundwater emphasis water and soil quality (Lu et al., 2010). Metals Zn, Ni, Mn, Cu, Fe, and Pb chosen based on PCA, FA, and CA investigations as reference elements for soil and groundwater contamination. Several studies evaluated metal contamination of soil and water in the different urban and industrial regions using principal component analysis (Manta et al. 2002; Skrbic and Djurisic-Mladenovic, 2007, Guo et al., 2013). PCA technique used to show the relationship among metals concentration and other parameters (pH, EC, TOC) in the soil and water (Weissmannová and Pavlovský 2017). FA produced using a constant value for all the soil and water quality parameters with a correlation matrix to minimize the effect of varying units on the variables (Lin et al. 2002). Kaiser–Meyer–Olkin (KMO) test used to evaluate whether the sample is large enough to use factor analysis (Kaiser 1974). In principal component analysis (PCA), variables referred to as principal components (PC) used to illustrate the relation between two elements (Esbensen and Geladi 2010). In similar study, Tripathi and Singal (2019) evaluated water quality of the Ganga River using PCA technique. In contrast, Praus (2019) used primary component weighted index (PCWI) for assessing the quality of both untreated and treated wastewater to evaluate WQI. Data indicate that unregulated discharge of wastewater including urban sewage contaminate water and soil by the process of seepage and leaching or irrigation with wastewater leads to depletion of groundwater and soil quality. High concentration of metals and other contaminants in the soil and groundwater may be due to continuous and long-term disposal of wastewater containing metals from industrial units leading to health hazards (Wuana and Okieimen 2011). Therefore, applying geographical and geostatistical techniques with an integrated approach could be more effective ways in environmental monitoring and assessment of soil and water contamination to ensure environmental and health safety.

Conclusion

Groundwater and soil quality parameters of water and soil samples varied with different sites of the selected study area, indicate about 13.3% of the sites found to have good soil health with minimum contamination level followed by 40% of sites with moderate contamination; however, 46.6% of sites shown high level of contamination of soil. Evaluating WQI and SQI values in the present study offers insightful information about site-wise variation pattern of quality parameters including metals identifying the sites with high level of contamination to opt appropriate strategies and mitigation measures to ensure preserving groundwater and soil quality. Further, a study concludes that contamination of water and soil with metals and other contaminants leads to depletion of quality parameters which affects nutrients cycling in the aquatic and terrestrial ecosystem with more imbalances in availability of NPK. GIS-based WQI maps provide more description of sites in categorizing contaminated regions to ensure safe water supply and developing wastewater treatment facilities for sustainable urban planning. Besides, water and soil quality assessment using GIS and geostatistical technique provide regional and spatial variability of contaminants with their correlation to establish standards of soil health and drinking for effective natural resource management in a particular region. Therefore, the present study could be a new insight in in environmental monitoring involving quantitative and qualitative assessment of water and soil quality for sustainable resource utilization and conservation applying geographical and geostatistical techniques.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11356-023-28004-y.

Acknowledgments The authors are thankful to Manipal University Jaipur, India, for providing facilities and continuous encouragements and Ground Water Department, Jaipur, Rajasthan, India for support.

Author contribution All authors contributed to the study conception and design. Sampling of water and soil samples, analysis, and drafting of manuscript were performed by J. Khan and G. Gupta. All authors commented on previous versions of the manuscript. Hypothesis and designing of the experiment were done by N. K. Singh; data analysis and improving the manuscript were done by V.N. Bhave and V. Bhardwaj; map designing and statistical analysis were done by P. Upreti and R. Singh; and geophysical analysis and editing were done by A. K. Sinha. All authors read and approved the final manuscript.

Data availability This is not applicable.

Declarations

Ethical approval This is not applicable.

Consent to participate The authors mutually agreed to submit the manuscript in the esteemed journal ESPR.

Consent to publish All authors are mutually agreed to publish the manuscript in the journal ESPR.

Competing interests The authors declare no competing interests.

References

Adagunodo TA, Akinloye MK, Sunmonu LA, Aizebeokhai AP, Oyeyemi KD, Abodunrin FO (2018) Groundwater exploration in Aaba residential area of Akure, Nigeria. Front Earth Sci 6

Ahmet D, Fevzi Y, Tuna AL, Nedim O (2006) Heavy metals in water, sediment and tissues of *Leuciscus cephalus* from a stream in southwestern Turkey. Chemosphere 63:1451–1458

Akkaraboyina MK, Raju PS (2012) A comparative study of water quality indices of River Godavari. UJERT 2:161–167

Aksoy T, Dabanli A, Cetin M, Senyel Kurkcuoglu MA, Cengiz AE, Cabuk SN, Agacsapan B, Cabuk A (2022) Evaluation of comparing urban area land use change with Urban Atlas and CORINE data. Environ Sci Pollut Res Int 29:28995–29015

Ali H, Khan E, Ilahi I (2019) Environmental chemistry and ecotoxicology of hazardous heavy metals: Environmental persistence, toxicity, and bioaccumulation. J Chem 6730305

Ali SA, Ahmad A (2020) Analysing water-borne diseases susceptibility in Kolkata Municipal Corporation using WQI and GIS based Kriging interpolation. Geo Journal 85:1151–1174

Amaya GA, Mårdh J, Dahlin T (2018) Delimiting a saline water zone in Quaternary fluvial–alluvial deposits using transient electromagnetic: a case study in Punata, Bolivia. Environ Earth Sci 77:46

Armenise E, Redmile-Gordon MA, Stellacci AM, Ciccarese A, Rubino P (2013) Developing a soil quality index to compare soil fitness for agricultural use under different managements in the Mediterranean environment. Soil Tillage Res 130:91–98

Arshad MA, Martin S (2002) Identifying critical limits for soil quality indicators in agro-ecosystems. Agric Eco Environ 88:153–160

Baird R, Bridgewater L (2017) Standard methods for the examination of water and wastewater. APHA, Washington, DC

Bhattacharyya P (2017) Soil quality index under organic farming. Organic farming in tropical islands of india, 260-267

Bilge Ozturk G, Ozenen Kavlak M, Cabuk SN, Cabuk A, Cetin M (2022) Estimation of the water footprint of kiwifruit: in the areas transferred from hazelnut to kiwi. Environ Sci Pollut Res Int 29:73171–73180

Binley A, Hubbard SS, Huisman JA, Revil A, Robinson DA, Singha K, Slater LD (2015) The emergence of hydrogeophysics for improved understanding of subsurface processes over multiple scales. Water Resour Res 51:3837–3866

Brondi AM, Daniel JSP, de Castro VXM, Bertoli AC, Garcia JS, Trevisan MG (2016) Quantification of humic and fulvic acids, macro- and micronutrients and C/N ratio in organic fertilizers. Commun Soil Sci Plant Anal 47:2506–2513

Bronson KF, Booker JD, Officer SJ, Lascano RJ, Maas SJ, Searcy SW, Booker J (2005) Apparent electrical conductivity, soil properties and spatial covariance in the US Southern High Plains. Precision Agriculture 6:297–311

Calzadilla A, Rehdanz K, Tol RSJ (2011) Trade liberalization and climate change: a computable general equilibrium analysis of the impacts on global agriculture. Water 3:526–550

Campbell CA (1978) Soil organic carbon, nitrogen and fertility. In: Schnitzer M, Khan S.U. (Eds.). Developments in soil science 8:173–271

Cesur A, Zeren Cetin I, Abo Aisha AES, Alrabiti OBM, Aljama AMO, Jawed AA, Cetin M, Sevik H, Ozel HB (2021) The usability of *Cupressus arizonica* annual rings in monitoring the changes in heavy metal concentration in air. Environ Sci Pollut Res Int 28:35642–35648

Cetin M (2019) The effect of urban planning on urban formations determining bioclimatic comfort area's effect using satellitia imagines on air quality: a case study of Bursa city. Air Qual Atmos Health 12:1237–1249

Cetin M, Abo Aisha AES (2023) Variation of Al concentrations depending on the growing environment in some indoor plants that used in architectural designs. Environ Sci Pollut Res Int 30:18748–18754

Cetin M, Aksoy T, Bilge Ozturk G, Cabuk A (2022d) Developing a model for the relationship between vegetation and wind power using remote sensing and geographic information systems technology. Water Air Soil Pollut 233:450

Cetin M, Aljama AMO, Alrabiti OBM, Adiguzel F, Sevik H, Cetin IZ (2022a) Determination and mapping of regional change of Pb and Cr pollution in Ankara City Center. Water Air Soil Pollut 233:163

Cetin M, Aljama AMO, Alrabiti OBM, Adiguzel F, Sevik H, Cetin IZ (2022b) Using topsoil analysis to determine and map changes in Ni Co pollution. Water Air Soil Pollut 233:293

Cetin M, Isik Pekkan O, Bilge Ozturk G, Anil Senyel Kurkcuoglu M, Kucukpehlivan T, Cabuk A (2022c) Examination of the change in the vegetation around the Kirka Boron Mine Site by using remote sensing techniques. *Water Air Soil Pollut* 233:254

Cetin M (2015) Using GIS analysis to assess urban green space in terms of accessibility: case study in Kutahya. Int J Sust Devel W Ecol 22:420–424

Dadhich PN, Jain H, Meena J, Meena H, Meena CS (2016) Water resource management based on GIS- a case study of municipality of Sanganer, Jaipur. IJERT, NCACE 4:23

Dean GA (1966) A simple colorimetric finish for the Johnson-Nishita microdistilation of sulphur. Analyst 91:530

Dogan S, Kilicoglu C, Akinci H, Sevik H, Cetin M (2023) Determining the suitable settlement areas in Alanya with GIS-based site selection analyses. Environ Sci Pollut Res Int 30:29180–29189

Esbensen KH, Geladi P (2010) Principles of proper validation: use and abuse of re-sampling for validation. J Chemom 24:168–187

Filip Z (2002) International approach to assessing soil quality by ecologically related biological parameters. Agric Ecosys Environ 88:169–174

Garg NK, Hassan Q (2007) Alarming scarcity of water in India. Curr Sci 93:932–941

Gąsiorek M, Kowalska J, Mazurek R, Pająk M (2017) Comprehensive assessment of heavy metal pollution in topsoil of historical urban park on an example of the Planty Park in Krakow (Poland). Chemosphere 179:148–158

Gavrilescu M (2021) Water, Soil, and Plants Interactions in a Threatened Environment. Water 13:2746

Gelman F, Binstock R, Halicz L (2012) Application of the Walkley–Black titration for the organic carbon quantification in organic rich sedimentary rocks. Fuel 96:608–610

Griffiths BS, Ball BC, Daniell TJ, Hallett PD, Neilson R, Wheatley RE, Osler G, Bohanec M (2010) Integrating soil quality changes to arable agricultural systems following organic matter addition, or adoption of a ley-arable rotation. Appl Soil Ecol 46:43–53

Gu YG, Gao Y, Lin Q (2016) Contamination, bioaccessibility and human health risk of heavy metals in exposed-lawn soils from 28 urban parks in southern China's largest city, Guangzhou. Appl Geochem 67:52–58

Guo X, Yuan D, Jiang J, Zhang H, Deng Y (2013) Detection of dissolved organic matter in saline-alkali soils using synchronous fluorescence spectroscopy and principal component analysis. Spectrochim Acta A 104:280–286

Hanfi MY, Mostafa MY, Zhukovsky MV (2020) Heavy metal contamination in urban surface sediments: sources, distribution, contamination control, and remediation. Environ Monitor Assess 192:1–21

Hardie M, Doyle R (2012) Measuring soil salinity. In: Methods in molecular biology (Clifton, N.J.), 913:415–425

Hermans SM, Buckley HL, Case BS, Curran-Cournane F, Taylor M, Lear G (2020) Using soil bacterial communities to predict physico-chemical variables and soil quality. Microbiome 8:79

Jolliffe IT (1972) Discarding variables in a principal component analysis. I: artificial data. J R Stat Soc Ser C Appl Statics 160–173

Jordan HV, Ensminger LE (1959) The role of sulfur in soil fertility. In: Normax AG (ed) Advances in agronomy, vol 10. Academic Press, pp 407–434

Juhos K, Czigány S, Madarász B, Ladányi M (2019) Interpretation of soil quality indicators for land suitability assessment–a multivariate approach for Central European arable soils. Ecol Indic 99:261–272

Kaiser HF (1958) The varimax criterion for analytic rotation in factor analysis. Psychometrika 23:187–200

Kaiser HF (1974) An index of factorial simplicity. Psychometrika 39:31–36

Kalayci Onac A, Cetin M, Sevik H, Orman P, Karci A, Gonullu Sutcuoglu G (2021) Rethinking the campus transportation network in the scope of ecological design principles: case study of Izmir Katip Çelebi University Çiğli Campus. Environ Sci Pollut Res 28:50847–50866

Klimkowicz-Pawlas A, Ukalska-Jaruga A, Smreczak B (2019) Soil quality index for agricultural areas under different levels of anthropopressure. Inter Agrophys 33:455–462

Kopittke PM, Menzies NW, Wang P, McKenna BA, Lombi E (2019) Soil and the intensification of agriculture for global food security. Environ Int 132:105078

Li D, Gao G, Shao M, Fu B (2016) Predicting available water of soil from particle-size distribution and bulk density in an oasis–desert transect in northwestern China. J Hydrol 538:539–550

Lin YP, Teng TP, Chang TK (2002) Multivariate analysis of soil heavy metal pollution and landscape pattern in Changhua country in Taiwan. Landsc Urban Plan 62:19–35

Lu X, Wang L, Li LY, Lei K, Huang L, Kang D (2010) Multivariate statistical analysis of heavy metals in street dust of Baoji, NW China. J Hazd Mater 173:744–749

Luo XS, Ding J, Xu B, Wang YJ, Li HB, Yu S (2012) Incorporating bio accessibility into human health risk assessments of heavy metals in urban park soils. Sci Total Environ 424:88–96

Luo Y, Su B, Yuan J, Li H, Zhang Q (2011) GIS techniques for watershed delineation of SWAT Model in Plain Polders. Procedia Environ Sci 10:2050–2057

Mahmood A, Kundu (2005) "Stattus of water supply, sanitation and solid waste management in urban areas" New Delhi, National Institute of Urban Affairs (NIUA)

Maiz I, Arambarri I, Garcia R, Millán E (2000) Evaluation of heavy metal availability in polluted soils by two sequential extraction procedures using factor analysis. Environ Pollut 110:3–9

Malhotra H, Vandana Sharma S, Pandey R (2018) Phosphorus nutrition: plant growth in response to deficiency and excess. In: Hasanuzzaman M, Fujita M, Oku H, Nahar K, Hawrylak-Nowak B (eds) Plant Nutrients and Abiotic Stress Tolerance. Springer, pp 171–190

Manta DS, Angelone M, Bellanca A, Neri R, Sprovieri M (2002) Heavy metals in urban soils: a case study from the city of Palermo (Sicily), Italy. Sci Total Environ 300:229–243

McNeill JD (1992) Rapid, accurate mapping of soil salinity by electromagnetic ground conductivity meters. In: Advances in measurement of soil physical properties: bringing theory into practice. John Wiley & Sons, Ltd, pp. 209–229

Mogaji KA, Omobude OB (2017) Modeling of geoelectric parameters for assessing groundwater potentiality in a multifaceted geologic terrain, Ipinsa Southwest, Nigeria – a GIS-based GODT approach. NRIAG J Astron Geophys 6:434–451

Morgan JB, Connolly EL (2013) Plant-soil interactions: Nutrient uptake learn science at scitable. National J Edu 4:2

Olayinka-Olagunju JO, Dosumu AA, Olatunji-Ojo AM (2021) Bioaccumulation of heavy metals in pelagic and benthic fishes of Ogbese River, Ondo State, South-Western Nigeria. Water Air & Soil Pollut 232:44

Pandey N, Sharma CP (2002) Effect of heavy metals Co^{2+}, Ni^{2+} and Cd^{2+} on growth and metabolism of cabbage. Plant Sci 163:753–758

Pekkan OI, Senyel Kurkcuoglu MA, Cabuk SN, Aksoy T, Yilmazel B, Kucukpehlivan T, Dabanli A, Cabuk A, Cetin M (2021) Assessing the effects of wind farms on soil organic carbon. Environ Sci Pollut Res Int 28:18216–18233

Peralta NR, Costa JL (2013) Delineation of management zones with soil apparent electrical conductivity to improve nutrient management. Comp Electron Agricul 99:218–226

Praus P (2019) Principal component weighted index for wastewater Quality Monitoring. Water 11:2376

Raiesi F, Kabiri V (2016) Identification of soil quality indicators for assessing the effect of different tillage practices through a soil quality index in a semi-arid environment. Ecol Indicat 71:198–207

Rajendran S, Priya TAK, Khoo KS, Hoang TK, Ng HS, Munawaroh HSH, Show PL (2022) A critical review on various remediation approaches for heavy metal contaminants removal from contaminated soils. Chemosphere 287:132369

Romic M, Romic D (2003) Heavy metals distribution in agricultural topsoils in urban area. Environ Geol 43:795–805

Sahin G, Cabuk SN, Cetin M (2022) The change detection in coastal settlements using image processing techniques: a case study of Korfez. Environ Sci Pollut Res Int 29:15172–15187

Saleem M, Hussain A, Mahmood G, Waseem M (2018) Hydrogeochemical assessment of groundwater in shallow aquifer of greater Noida region, Uttar Pradesh (U.P), India. Appl Water Sci 8:186

Salem A, Dezső J, El-Rawy M, Lóczy D (2020) Hydrological modeling to assess the efficiency of groundwater replenishment through natural reservoirs in the Hungarian Drava River Floodplain. Water 12:250

Sato JH, de Figueiredo CC, Marchão RL, Madari BE, Benedito LEC, Busato JG, de Souza DM (2014) Methods of soil organic carbon determination in Brazilian savannah soils. J Agric Sci 71:302–308

Schloter M, Dilly O, Munch JC (2003) Indicators for evaluating soil quality. Agric Ecosys Environ 98:255–262

Seybold CA, Mansbach MJ, Karlen DL, Rogers HH (2018) Quantification of soil quality. In: Soil processes and the carbon cycle. CRC Press, pp 387–404
Shah KA, Joshi GS (2017) Evaluation of water quality index for River Sabarmati, Gujarat, India. Appl Water Sci 7:1349–1358
Sharma N, Sharma S, Gehlot A (2014) Influence of dyeing and printing industrial effluent on physicochemical characteristics of water – case study on the printing cluster of Bagru, Jaipur (Rajas than), India. IOSR J Appl Chem 7:61–64
Sillanpaa M (1982) Micronutrients and the nutrient status of soils: a global study. FAO Soil Bulletin No. 48, Food and Agriculture Organization, Rome
Singh R, Upreti P, Allemailem KS, Almatroudi A, Rahmani AH, Albalawi GM (2022) Geospatial assessment of ground water quality and associated health problems in the Western Region of India. Water. 14:296
Singha SS, Devatha CP, Singha S, Verma MK (2015) Assessing ground water quality using GIS. International J Eng Res Technol 4:11
Skrbic B, Djurisic-Mladenovic N (2007) Principal component analysis for soil contamination with organochlorine compounds. Chemosphere 68:2144–2152
Tay DA, Ocansey RTA (2022) Impact of urbanization on health and well-being in Ghana. Status of research, intervention strategies and future directions: a rapid review. Front Pub health 10:877920
Tiwari KK, Singh NK, Patel MP, Tiwari MR, Rai UN (2011) Metal contamination of soil and translocation in vegetables growing under industrial wastewater irrigated agricultural field of Vadodara, Gujarat, India. Ecotoxicol Environ Saf 74:1670–1677
Tripathi M, Singal SK (2019) Allocation of weights using factor analysis for development of a novel water quality index. Ecotoxicol Environ Saf 183:109510
Tyagi S, Sharma B, Singh P, Dobhal R (2013) Water quality assessment in terms of water quality index. Am J Water Resour 1:34–38
Tzanakakis VA, Paranychianakis NV, Angelakis AN (2020) Water supply and water scarcity. Water 12:2347
Ukah BU, Ameh PD, Egbueri JC, Unigwe CO, Ubido OE (2020) Impact of effluent-derived heavy metals on the groundwater quality in Ajao industrial area, Nigeria: an assessment using entropy water quality index (EWQI). IJWREE 4:231–244
Ukah BU, Egbueri JC, Unigwe CO, Ubido OE (2019) Extent of heavy metals pollution and health risk assessment of groundwater in a densely populated industrial area, Lagos, Nigeria. IJWREE 3:291–303
Unger PW (1997) Aggregate and organic carbon concentration interrelationships of a Torrertic Paleustoll. Soil and Tillage Res 42:95–113
Walkley A, Black IA (1934) An examination of the degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. Soil Sci 37:29–38
Weissmannová HD, Pavlovský J (2017) Indices of soil contamination by heavy metals—methodology of calculation for pollution assessment (minireview). Environ Monit Assess 189:616
Wu J, Li P, Wang D, Ren X, Wei M (2020) Statistical and multivariate statistical techniques to trace the sources and affecting factors of groundwater pollution in a rapidly growing city on the Chinese Loess Plateau. Hum Ecol Risk Assess 26:1603–1621
Wuana RA, Okieimen FE (2011) Heavy metals in contaminated soils: a review of sources, chemistry, risks and best available strategies for remediation. ISRN Ecol 402647
Yanbing Q, Darilek JL, Huang B, Yongcun Z, Weixia S, Zhiquan G (2009) Evaluating soil quality indices in an agricultural region of Jiangsu Province, China. Geoderma 149:325–334
Yang K, Nam T, Nam K, Kim YJ (2016) Characteristics of heavy metal contamination by anthropogenic sources in artificial lakes of urban environment. KSCE J Civ Eng 20:121–128
Yu P, Han D, Liu S, Wen X, Huang Y, Jia H (2018) Soil quality assessment under different land uses in an alpine grassland. CATENA 171:280–287
Zhu Y, Chen L, Wang K, Wang W, Wang C, Shen Z (2019) Evaluating the spatial scaling effect of baseflow and baseflow nonpoint source pollution in a nested watershed. J Hydrol 579:124221
Zouboulis AI, Loukidou MX, Matis KA (2004) Biosorption of toxic metals from aqueous solutions by bacteria strains isolated from metal-polluted soils. Process Biochem 39:909–916

MANIPAL UNIVERSITY JAIPUR
INSPIRED BY LIFE

FACULTY OF DESIGN

SCHOOL OF ARCHITECTURE AND DESIGN

REJUVENATING ANCIENT WATER SYSTEMS:
A Case Study of Mokalsar, Rajasthan, India

(Enhanced SEED Grant Project with Ar. Anu Mridul Architects under MoU)

Jan-Dec 2023

Index

1. Introduction

Under the MoU signed between School of Architecture and Design, MUJ and Anu Mridul Architects Jodhpur, SA&D has been granted SEED Grant to undertake a project on 'Rejuvenating Ancient Water Systems – A Case Study of Mokalsar, Rajasthan, India'. As part of MoU, on secondary data and on site local resources persons are provided by Anu Mridul Architects.

Project Background: The state of Rajasthan in India is characterised by arid climatic conditions and is renowned for its significant architectural heritage in the realm of water conservation and management. The region is renowned for its architectural features such as stepwells, kunds, and baolis etc. Mokalsar, a rural settlement situated in Barmer district of Rajasthan, has historically been known for its water systems. However, through time, these water systems have been neglected and subsequently abandoned, resulting in a significant water scarcity issue for the local population. As stated in the report prepared for Mukhyamantri Jal Swavalamban Yojana (MJSY), it has it has been observed that out of the total of 33 districts, 19 districts are currently facing a shortage of water resources. Barmer and Jaisalmer have been designated as the districts with the highest prevalence of droughts and water scarcity. The region is currently facing a substantial shortage of water resources. The objective of this study is to concentrate on the revitalization of water systems in Rajasthan.

This project aims to examine and evaluate the traditional water systems in Mokalsar village, with a focus on identifying areas that require restoration or improvement. The study uses Qualitative and quantitative approach. Primary data is collected through onsite observations, interviews of officials and senior citizens of the village and secondary data analysis is done with the help of Geographic Information Systems (GIS), which leads to the formulation of strategies for rainwater collection, aquifer recharge, and the promotion of efficient water usage by rejuvenating the traditional water systems.

2. Objectives of the Project

The objectives of the project are as following-

➢ To map the tangible and intangible features of study area including topography, water bodies, ancient town morphology and cultural aspects within the village.

➢ To assess the present condition of ancient water supply systems in the identified settlements, historical structures and local water bodies.

➢ To perform assessment of the development of settlement with respect to natural drainage channel, rainwater recharge potential, water demand, projections for future.

➢ To propose revival strategies for the ancient water systems and restoration techniques for historic water structures and integration of ancient and contemporary water supply systems.

3. Beneficiaries of the Project

- Local People of the Mokalsar Village
- Mokalsar Panchayat
- Tourists

4. Brief Description of the Project

The lack of awareness regarding traditional water conservation structures and understanding of sustainable living practises in Mokalsar have resulted in ineffective water management and the wasting of valuable rainfall resources ultimately leading to a scarcity of water resources. The community is currently struggling with environmental consequences, such as the depletion of groundwater resources and soil erosion. Resolving these challenges has significant importance in ensuring the preservation of the community's welfare and the attainment of sustainable development.

The research methodology outlined for the rejuvenation of traditional water systems in Mokalsar village consists of a comprehensive framework for data collection, analysis, and interpretation. The data is collected from remote sensing sources, topographic data, and historical records, followed by field surveys and spatial analysis through ArcGIS. The GIS-based analysis encompasses various spatial assessments, including buffer analysis, hydrological analysis, slope analysis, and contour analysis, all aimed at understanding the condition of water bodies, drainage channels, and terrain features. Further, the methodology includes the identification and demarcation of traditional water conservation systems through desk study, field surveys, and community engagement followed by the integration of data on ArcGIS to understand the traditional water system in Mokalsar village. The methodology opted in the study helps in formulating the strategies to rejuvenate ancient or traditional water systems in Mokalsar village which can further implemented to identify and rejuvenate similar areas.

5. Progress of the Project for the year 2023

- Site Visit Conducted in the Month of February.
- Primary Data Collection during Site Visit.
- Reccy Survey of Mokalsar Town.
- Data Analysis and GIS Analysis of the Mokalsar Town (Annexure 1).

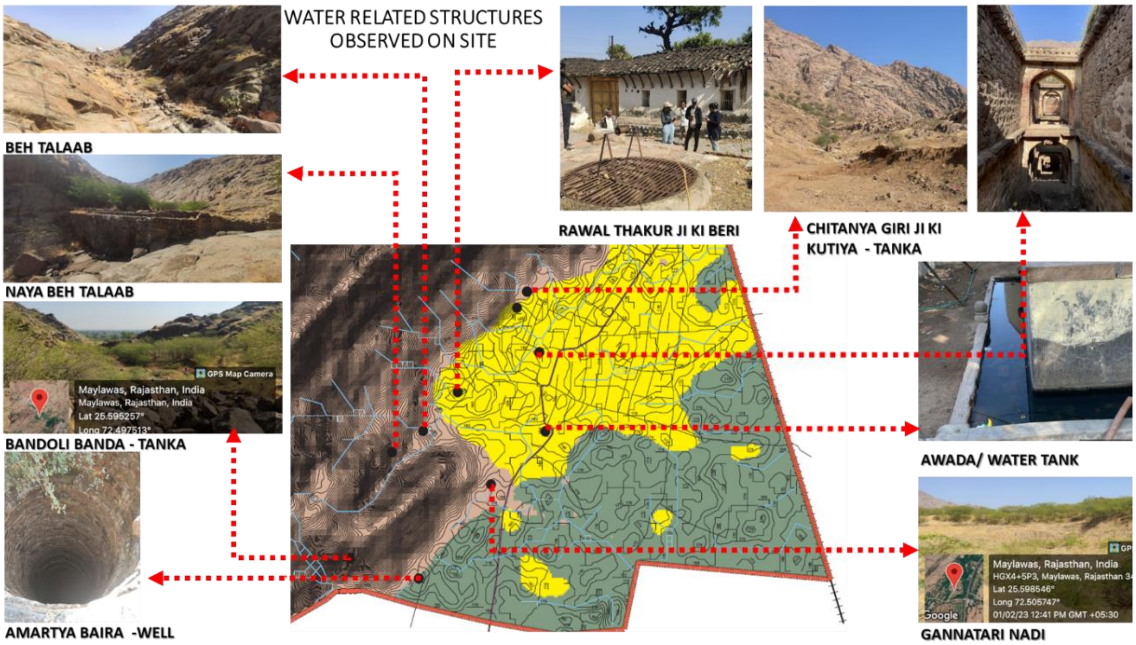
6. Photographs of the Site Visit

Bandoli Banda - Tanka

Team At Rawal Thakur Ji Ki Beri

Team At Awada

Team At Gannatrari Nadi - Tanka



Location Map

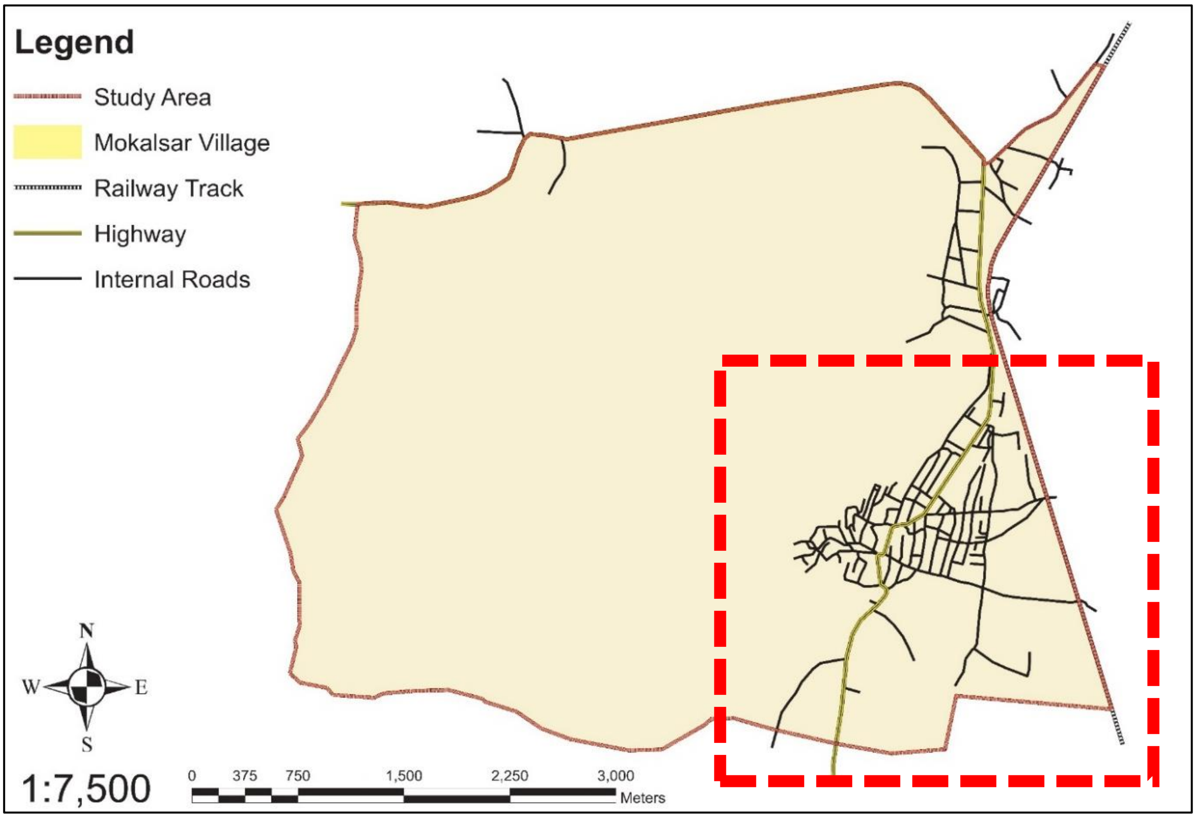
7. Weblink

8. Project Investigators

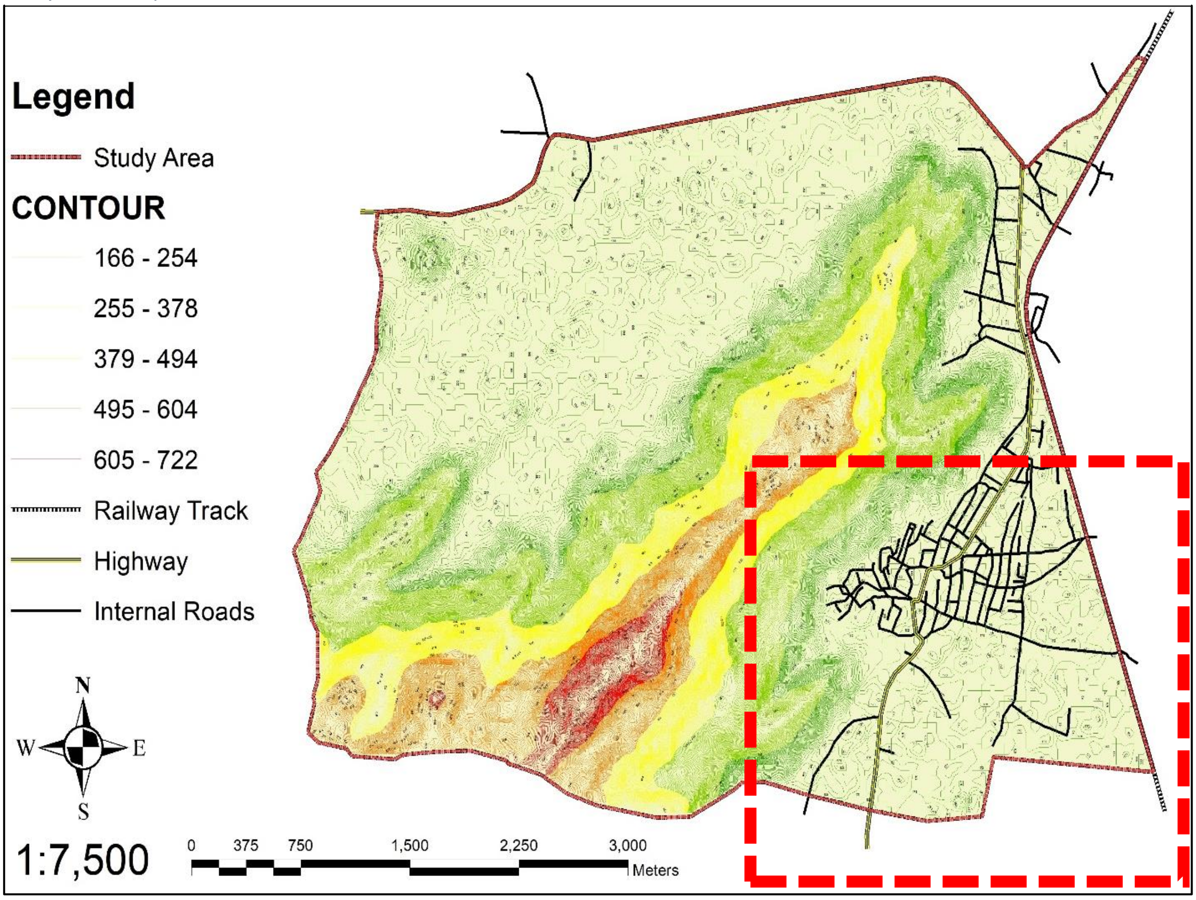
- Prof. (Dr.) Madhura Yadav (Principal Investigator)
  Dean, Faculty of Design
- Ar. Neha Saxena (CO-PI)
  Associate Professor
- Dr. Ashutosh Saini (CO-PI)
  Assistant Professor

Prof. (Dr.) Sunanda Kapoor
Head, School of Architecture and Design

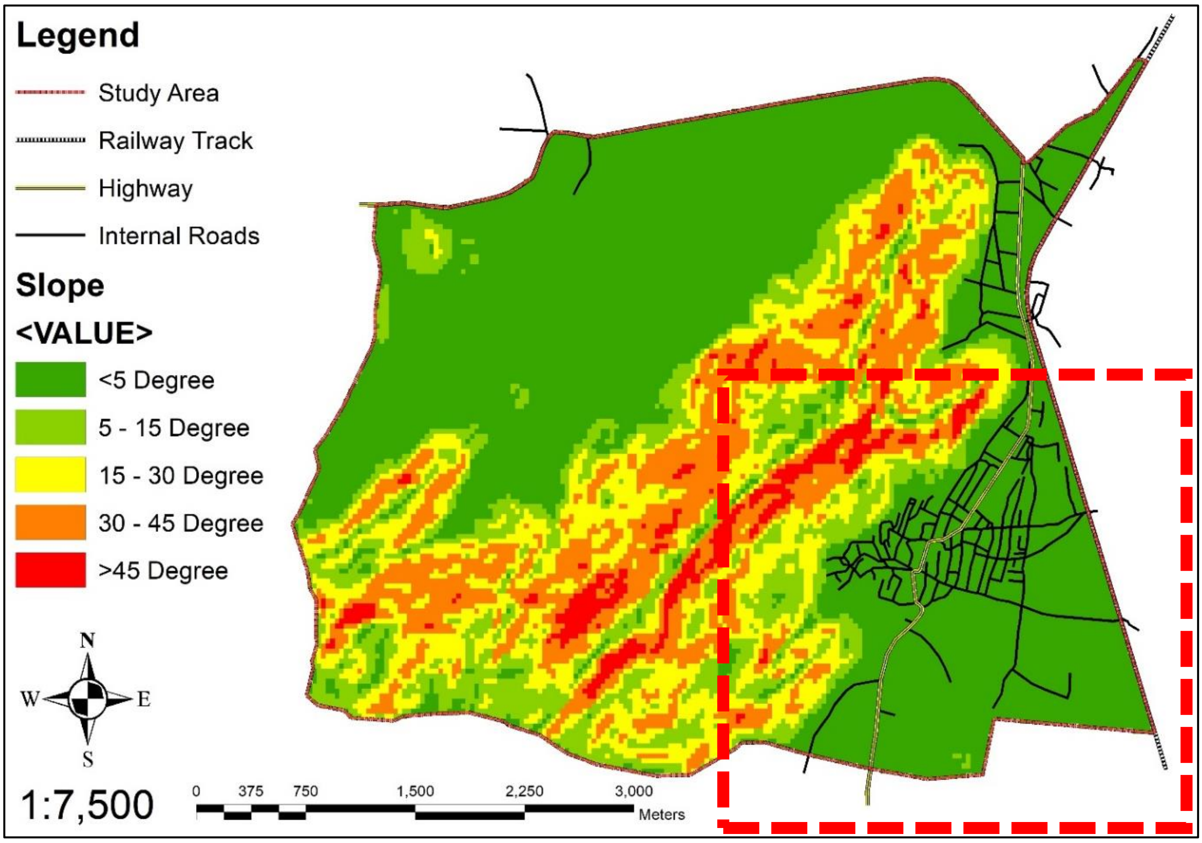
Annexure: 1



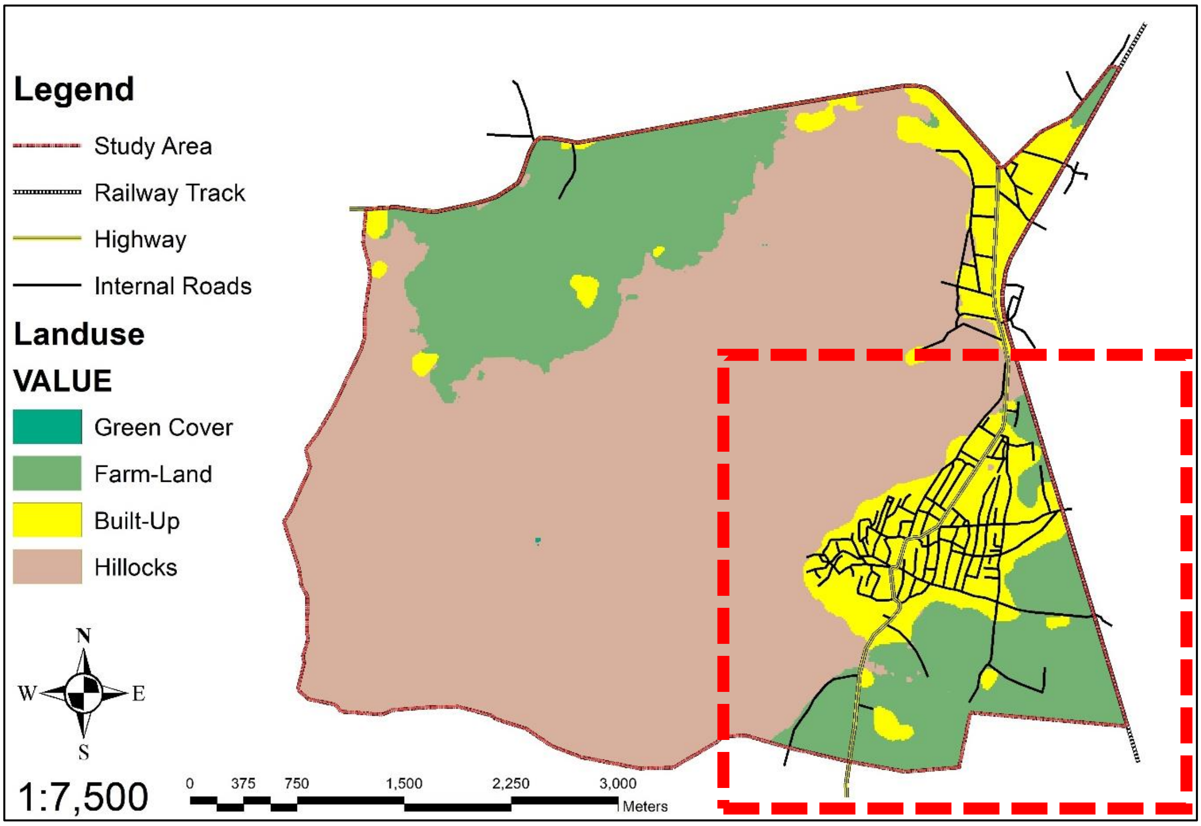
Study Area Map



Contour Map



Slope Map Generated through GIS



Land Use Map Generated through GIS

DIRECTORATE OF STUDENTS' WELFARE

POSTER MAKING AND QUIZ COMPETITION
on Occasion of
World Water Day

Cultural Event

ENVIRO CLUB

"Connecting Hearts to

Nature's Beat."

OFFLINE EVENT

Date of Event (22nd March 2023)

(11:00 AM to 2:00 PM)

Index

1. Introduction of the Event

ENVIRO CLUB organized a '**POSTER MAKING AND QUIZ COMPETITION'** on the 22nd of March 2023. On the occasion of World Water Day. This exclusive event brought together environmental enthusiasts to engage in lively poster-making and Quiz Competitions. Embarking on a journey to raise awareness and ignite change, our event unfolded as a dynamic fusion of creativity and intellect. This event has alliance with SDG 6 (Clean water and sanitation) which focuses on equitable access to safe and affordable drinking water for all.

2. Objectives of the Event

- Raise Awareness: Foster a deeper understanding of global water challenges, encouraging participants and attendees to comprehend the significance of water conservation and sustainable practices.

- Promote Creativity: Provide a creative platform for individuals to express their perspectives on water-related issues through artistic endeavors, emphasizing the power of visual communication in conveying complex messages.

- Encourage Research and Knowledge: Stimulate participants to delve into the multifaceted aspects of water-related problems, promoting research and the acquisition of knowledge about current water issues on a global scale.

- Cultivate a Sense of Responsibility: Instill a sense of responsibility and urgency in participants regarding water conservation, emphasizing the individual and collective roles in preserving this essential resource.

3. Beneficiaries of the Event

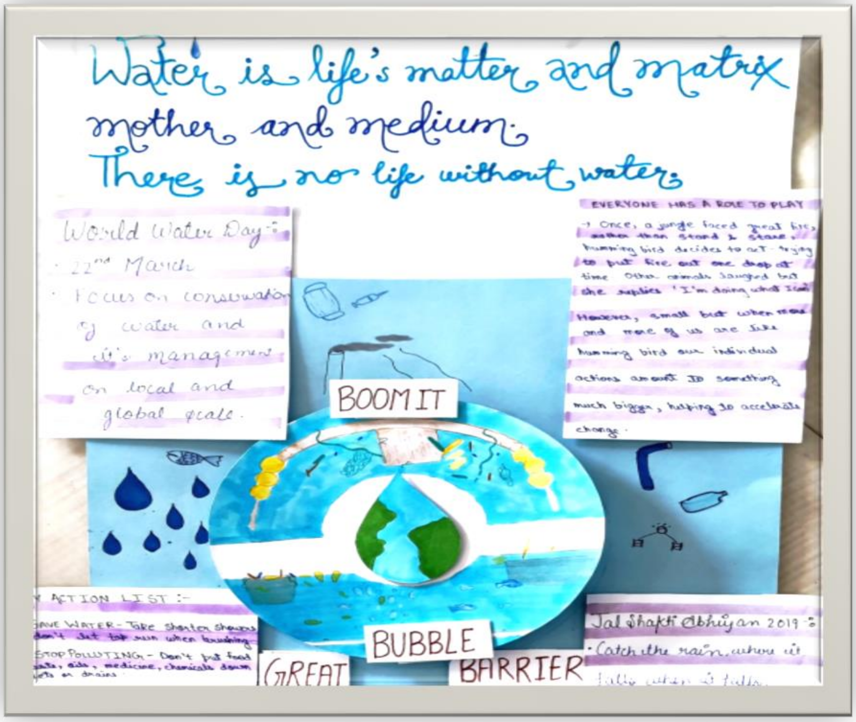
- MUJ students

4. Brief Description of the event

- "Embarking on a journey to raise awareness and ignite change, our event unfolded as a dynamic fusion of creativity and intellect. The Poster Making and Quiz Competition on water issues, held in commemoration of World Water Day, provided a platform for participants to channel their artistic prowess and depth of knowledge. As we dove into the intricacies of global water challenges, each stroke of the brush and every quiz question became a powerful tool for advocacy. This report encapsulates the vibrant expressions of concern, innovation, and determination that emerged from our collective endeavor to address pressing water issues on a global scale. Together, we not only celebrated World Water Day but also laid the foundation for a shared commitment to a sustainable water future.

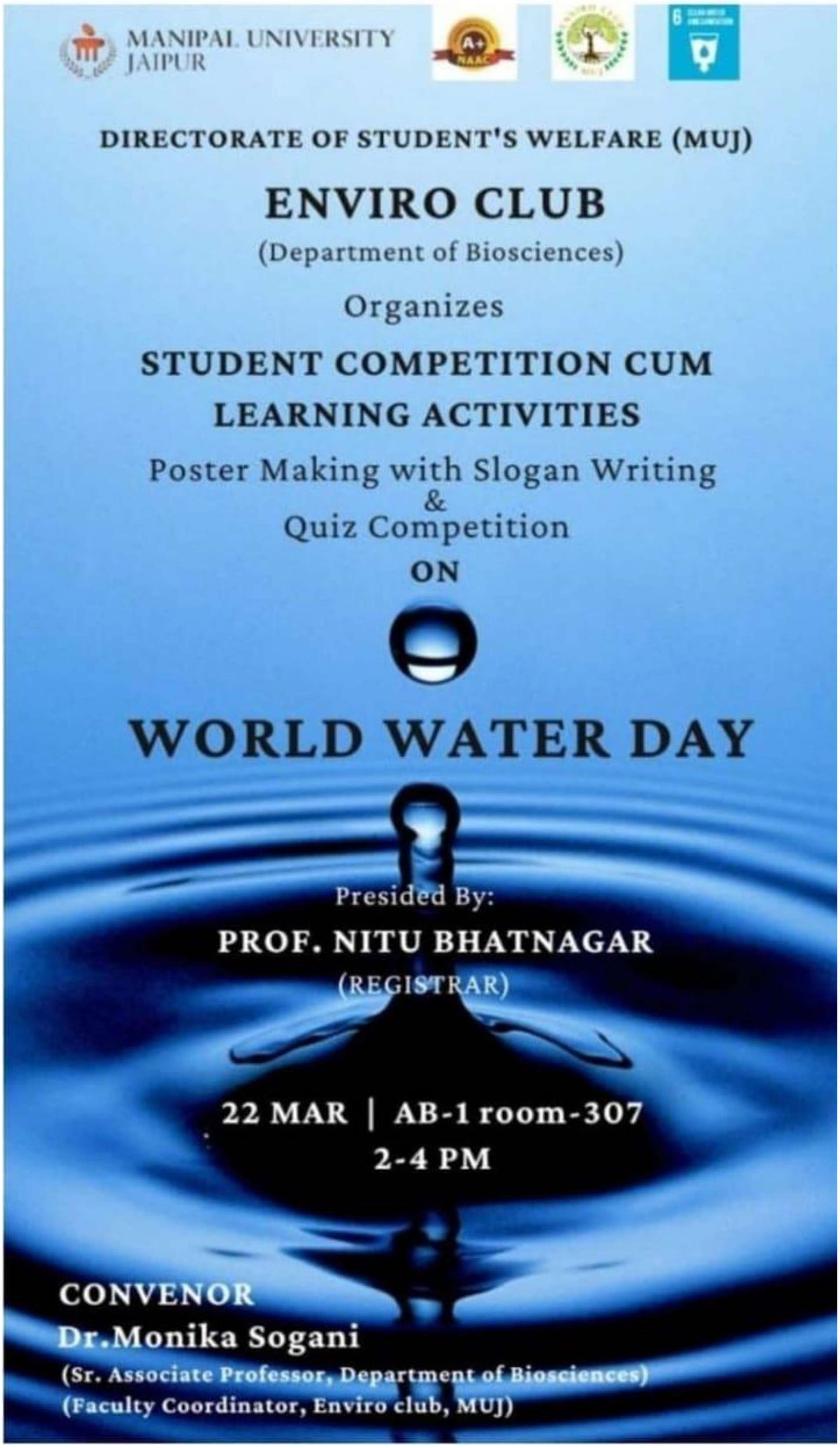
Following thorough evaluations across various criteria, the first, second and third positions were announced, marking the culmination of the event. The evening concluded with the facilitation of the winners by Dr Nitu Bhatnagar Registrar MUJ.

5. Photographs



6 CLEAN WATER AND SANITATION

6. **Brochure or Creative of the Event**



7. Schedule of the event

22nd March 2023 from 11:00 AM onwards

8. Attendance of the event:

Team Name	Name of Students	Registration no.	Course	Mobile
Team 1	Abhilash	229301548	Btech Cse	7701938215
	Shananya	229301571	Btech Cse	976546152
	Anany	229310172	btech Cse (AI Ml)	8279796177
	Aditi Joshi	221002029	BscBiotech	8851398684
Team 2	Harsh Saxena	201003004	Bsc Microbio	7007027383
	Tarushi Jain	201003001	Bsc Microbio	9818045153
	Isha Buwalka	201003005	Bsc Microbio	8777422133
	Garima Ghaley	201003007	Bsc Microbio	9863211472
Team 3	Nikunj Aggarwal	221007054	Bsc Hons Psych	8570853030
	Devika Yadav	221007022	Bsc Hons Psych	9557675550
	Manya Wadhwani	221007008	Bsc Hons Psych	7228916868
Team 4	Samrat Banerjee	211003008	Bsc Microbio	8118073849
	Archita Vyas	211003006	Bsc Microbio	7706003736
	Mrunal	211003007	Bsc Microbio	8951062077
	Debarghya Sarakr	211002015	Bsc biotech	8100134106
Team 5	Vimansh Badwal	221007070	Bsc Pysch	7340125793
	Vaishanavi Mehta	221103025	Bsc Pysch	7043291265
	Urvi Thakare	221007004	Bsc Pysch	9604407113
	Jacqueline pinto	221007044	Bsc Pysch	9999850539
	Purvi pansari	221007081	Bsc Pysch	9653881299
Team 6	Sylvia Parveen	211003009	Bsc Microbio	8690924251
	Anushka Singh	211002003	Bsc Biotech	8765405845
	Divya	211002056	Bsc Biotech	8879657943
	Shreyansh Rai	209302258	Btech CSE	9792044265
Team 7	Anshi Agarwal	211002008	Bsc Biotech	9793727555
	Rahul Shrivastava	211002050	Bsc Biotech	8789915714
	Priyasha Paul	211002035	Bsc Biotech	9340723867
	Anvarshu Gopal	211002011	Bsc Biotech	9506532226
Team 8	Kushal Sharma	211301021	BA LLB	6375347904
	Yash Chaturvedi	211301035	BA LLB	9610023722
	Bharat Sogarwal	211301084	BA LLB	9461587141
	Anshika Garg	211301041	BA LLB	7814888586
	Shashwati Soumya	211301047	BA LLB	6202219520
Team 9	Ayush Goyal	221007042	Bsc Psych	7619798493
	Arnav Choudhary	221007045	Bsc Psych	8221824141
	Alok Kumar	221007060	Bsc Psych	7300214005
	Krishna Kuntal	221007043	Bsc Psych	7239884102
	Gaurav Sharma	221007035	Bsc Psych	8209854342
	Harshita Mishra	221007778	Bsc Psych	8980519479
Team 10	Austin	201002015	Bsc Biotech	8306533489
	Ananya Singh	201002002	Bsc Biotech	9423043461
	Ayushi Gupta	201002029	Bsc Biotech	8860083202
	Ananya Bijoy	201002026	Bsc Biotech	7600098701
	Ankita Sharma	201002012	Bsc Biotech	9549185737

9. Winners of the event

1st Place

Team 1	Abhilash	229301548	Btech Cse	7701938215
	Shananya	229301571	Btech Cse	976546152
	Anany	229310172	btech Cse (AI Ml)	8279796177
	Aditi Joshi	221002029	BscBiotech	8851398684

2nd Place

Team 8	Kushal Sharma	211301021	BA LLB	6375347904
	Yash Chaturvedi	211301035	BA LLB	9610023722
	Bharat Sogarwal	211301084	BA LLB	9461587141
	Anshika Garg	211301041	BA LLB	7814888586
	Shashwati Soumya	211301047	BA LLB	6202219520

3rd Place

Team 6	Sylvia Parveen	211003009	Bsc Microbio	8690924251
	Anushka Singh	211002003	Bsc Biotech	8765405845
	Divya	211002056	Bsc Biotech	8879657943
	Shreyansh Rai	209302258	Btech CSE	9792044265

Sakshi Mohan

President, ENVIRO CLUB, MUJ

Sakshi

Signature of the Student Coordinator

Dr Monika Sogani
Sr. Associate Professor
Department of BioSciences
Faculty Coordinator Enviro Club MUJ

Monika Sogani

Signature of the Faculty Coordinator

MANIPAL UNIVERSITY JAIPUR

MANIPAL UNIVERSITY JAIPUR

FACULTY OF ARTS

SCHOOL OF HUMANITIES AND SOCIAL SCIENCES

DEPARTMENT OF ECONOMICS

COOMUNITY OUTREACH VISIT

Date of Event- October 31, 2023

Content of Report (index)

1. Introduction of the Event

The practical knowledge about the subject is of immense importance for the students of B.A, Economics (Hons.), M.A. Economics (Hons.), and as such apart from regular classroom teaching there is a strong case for exposing them to innovative and practical outdoor sessions/visits to the nearby areas & projects. Taking this pedagogy of teaching, a one day visit to the renowned Laporiya village and interaction with **Padma Shree Laxman Singh** was planned to closely to observe how the water stressed Laporiya village became self-sufficient in water with all the efforts of **Laxman Singh** Ji. He has been awarded the Padma Shree for his significant contribution to the field of saving water and the environment for the last 40 years. He changed the picture of more than 50 villages with the technique of saving water and the campaign launched for it. He recharged the ponds with the Chowka technique to save water and pastures.

To take insights into his dedication, efforts, and commitments, this visit was planned for students to interact with him so that the **environmental sustainability** thought will sustain forever with **Gen-Z** and they will transfer the same to **Gen-Alpha.**

2. Objective of the Event

Water is a finite and shared resource. As well as being a basic human right and fundamental to healthy ecosystems, water is vital to the functioning of the global economy. However, increasing demand and competition, climate change and pollution are putting pressure on global water resources, creating risks for business and society. To experience the outstanding achievements and gain practical knowledge about environmental economics, an academic visit to "Laporiya village, near Dudu" is organized for the betterment and knowledge enhancement of the students.

3. Beneficiaries of the Event

Students and faculty members of Manipal University Jaipur.

4. Details of the Guests

The President of India has awarded Shri Laxman Singh Ji Padma Shree for his commendable work of reviving the Chowka system, a traditional water harvesting method in Rajasthan. He has founded the NGO Gram Vikas Navyuvak Mandal Laporiya (GVNML). The efforts of Sh. Laxman Singh Ji has borne fruits in a drought-ridden small village (Lapodiya), 80 km from Jaipur.

5. Brief Description of the event

It was an expert lecture on Syllogism of knowledge of economics, entrepreneurial and data skills: Unpack the Why? by Mr. Abhishek Jain, EY, Senior project consultant E & Y. The aim of the lecture is to provide economic knowledge, entrepreneurial skill with basic data analytics knowledge and skills when it comes to leveraging data while growing their businesses, regardless of their respective industries. Student's always be in prisoners dilemma of Why?

Photographs

3 to 5 geotagged photographs of the event or screenshots of the event (if online) with captions

Mr Laxaman Singh Ji discussing the importance of ecosystem

Mr Laxaman Singh Ji Addressing the students

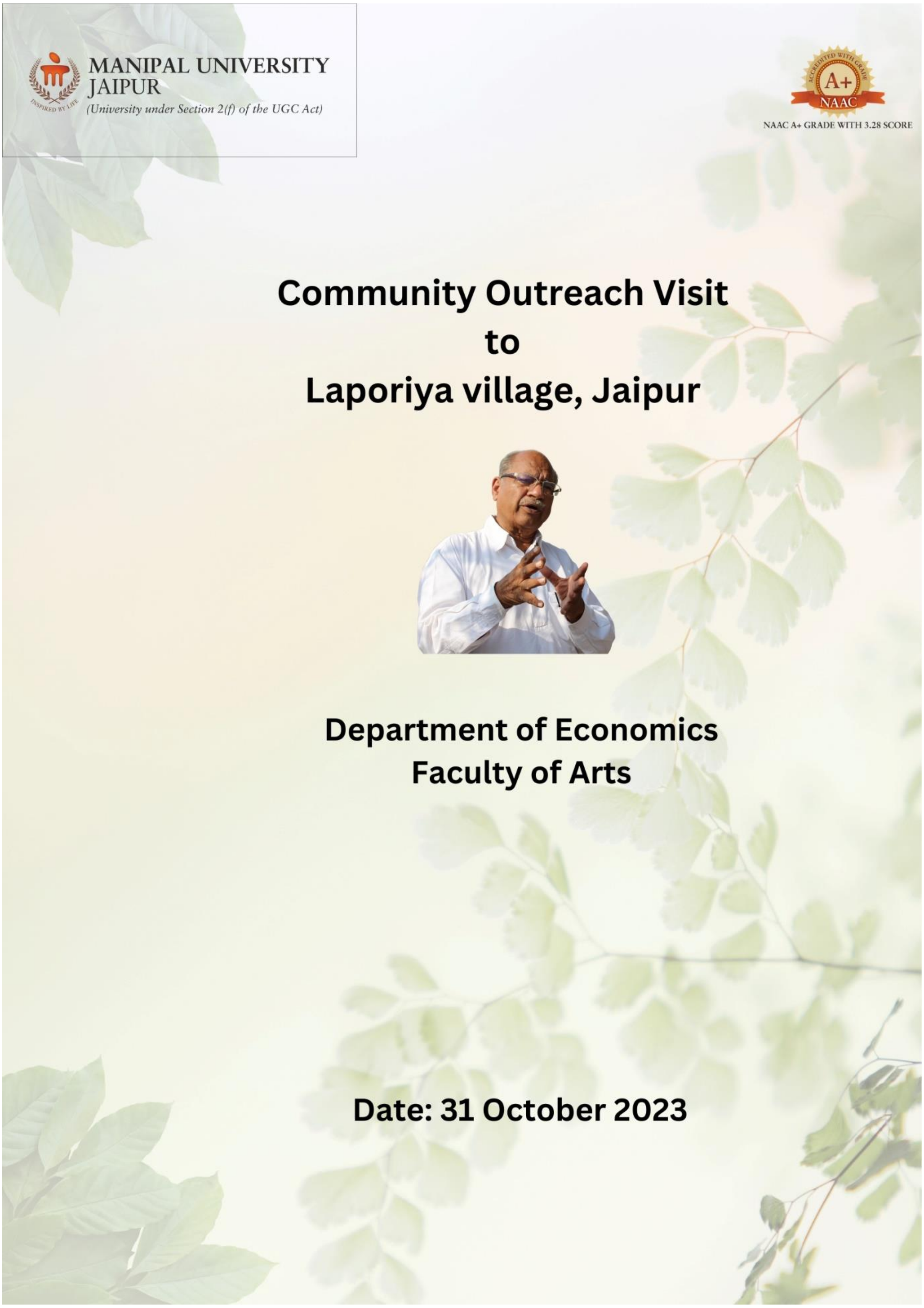
The Village well

Taking a short break, Mr Lakshman Singh Ji, faculties and students

Mr Singh (centre) discussing the young mind's learnings and impressions in his house at the end of the visit.

The students, Mr Lakshman Singh (towards right in white) and Dr Shilpi Gupta, outside his house.

6. Brochure or creative of the event (insert in the document only)



7. Schedule of the event (insert in the report)

Date of the event –October 31, 2023 7:30 AM

8. Attendance of the Event (insert in the document only)
Total attendee-

Registration No.	Name of the Students	Column1	Column2
211101046	Akshay	P	
211101035	Anubhav	p	
211101003	Dakshita	P	
211101043	Gaurav basniwal	P	
211101050	Gaurav kumar	P	
211101013	Saarthak tiwari	P	
211101042	Praseeda	P	
211101004	Rishita	P	
211101006	Shivangi	P	
211101015	Sumriddhi	P	
211101040	Yash	P	
211101041	Yashi	P	
211101039	Anushka	P	
211101007	Utkarsh	P	
211101044	Riti	P	
211101021	Paritosh	P	
211101028	Divya surana	P	
211101025	Atharv	P	
23FA20MEA00004	Santanu Bhowmick	P	
23FA20MEA00007	Anubhav Joshi	P	
23FA20MEA00005	Bhumita Yadav	P	
23FA20MEA00006	Shweta Choudhary	P	
23FA20MEA00003	Medini Choudhary	A	Unwell
23FA20MEA00002	Nisha Choudhary	A	Unwell
231151001	Devanshi Kapoor	P	
Dr. Shilpi Gupta	Associate professor - Department of Economics	P	
Mr. Apoorva Saxena	Head, community Radio Station	P	
Mr. Parul Kanwar	Jr. Assistant SHSS	P	

News Publication- News printed in newspaper or online links (if any) for news – insert images)

NA

9. Feedback report of the Event

Students experienced Padam Shree Laxman Singh Ji's dedication, efforts, and commitments, and take away from him the **environmental sustainability** thought which will sustain forever with **Gen-Z** and they will transfer the same to **Gen-Alpha.**

10. Link of MUJ website stating the event is uploaded on website

Dr. Monika Mathur
Head, Department of Economics
Manipal University Jaipur

Seal and Signature of Head with date

GOVERNMENT OF INDIA
Ministry of Science & Technology
Department of Science & Technology
DST/TMD-EWO/WTI/2K19/EWFH/2019/102 (G)/2

Terms & Conditions

1. The grantee organization will furnish to the Department of Science & Technology, financial year wise Utilization Certificate (UC) in the proforma prescribed as per GFR 2017 and audited statement of expenditure (SE) along with up to date progress report (Vis-a-Vis Target Vs-Achievement) at the end of each financial year duly reflecting the interest earned / accrued on the grant received under the project. This is also subject to the condition of submission of the final statement of expenditure, utilization certificate and project completion report within one year from the scheduled date of completion of the project.

2. The grantee organization will have to enter & upload the Utilization Certificate in the PFMS portal besides sending it in physical form to this Division. The subsequent/final installment will be released only after confirmation of the acceptance of the UC by the Division and entry of previous Utilization Certificate in the PFMS.

3. If the grant has been released under capital head through separate sanction order under the same project for purchase of equipment(s), separate SE/UC has to be furnished for the released Capital head grant.

4. The grant-in-aid being released is subject to the condition that:-

a) A transparent procurement procedure in line with Provisions of General Financial Rules 2017 will be followed by the Institute/Organization under the appropriate rules of grantee organization while procuring capital assets sanctioned for the above mentioned project and a certificate to this effect will be submitted by the Grantee organization immediately on receipt of the grant.

b) While submitting Utilization Certificate/Statement of Expenditure, the organization has to be ensure submission of supporting documentary evidences with regard of the purchase of equipment/capital assets as per the provisions of GFR 2017. Subsequent release of grants under the project shall be considered only on receipt of the said documents.

5. As per the GFR 2017 Rule 230 (8) the Grantee Institute should ensure that all the interests or other earnings against Grant-in-Aid or advances (other than reimbursement) released to any Grantee institution should be mandatorily remitted to the Consolidated Fund of India immediately after finalization of the accounts. Such advances will not be allowed to be adjusted against future releases.

6. As per the GFR 2017 Rule 230 (17) "the Grantee Institute should agree to make reservations for Scheduled Castes and Scheduled Tribes or OBC in the posts or services under its control on the lines indicated by the Government of India"

7. The grantee organization will maintain separate audited account for the project and the entire amount of grant will be kept in an interest bearing bank account. For Grants released during F.Y. 2017-18 and onwards, all interests and other earnings against released Grant shall be remitted to Consolidated Fund of India (through Non-Tax Receipt Portal (NTRP), i.e. **www.bharatkosh.gov.in**), immediately after finalization of accounts, as it shall not be adjusted towards future release of Grant. A certificate to this effect shall have to be submitted along with Statement of Expenditure/ Utilization Certificate for considering subsequent release of Grant/ Closure of Project accounts.

8. DST reserves sole rights on the assets created out of grants. Assets acquired wholly or substantially out of government grants (except those declared as obsolete and unserviceable or condemned in accordance with the procedure laid down in GFR 2017), shall not be disposed of without obtaining the prior approval of DST.

9. The account of the grantee organization shall be open to inspection by the sanctioning authority and audit (both by C&AG of India and Internal Audit by the Principal Accounts Office of the DST), whenever the organization is called upon to do so, as laid down under Rule 236(1) of General Financial

Rules 2017.

10. Due acknowledgement of technical support / financial assistance resulting from this project grant should mandatorily be highlighted by the grantee organization in bold letters in all publication / media release as well as in the opening paragraphs of their Annual Reports during and after the completion of the project.

11. Failure to comply with the terms and conditions of the Bond will entail full refund with interest in terms of Rule 231 (2) of GFR 2017.

12. It is mandatory to use EAT module in PFMS, failing which no further funds shall be released.

13. Goods (Consumable/Equipment) available in GeM portal are to be procured mandatorily online through GeM only as per the provisions of Rule 149 of GFR.

14. The Grantee Institute should follow Global Tendering Enquiry (GTE) conditions as per Department of Expenditure ID Note No:4/1/2021-PPD dated 10.09.2021.

15. If One time assistance or non-recurring grant as Grant-in-Aid for Rs. 10.00 lakhs to Rs. 50.00 lakhs, it should be included in the Annual Report of the Institute.

16. The Grantee Institute must ensure any other provisions of GFR-2017 and guidelines/amendments issued from Govt. of India from time to time.

भारत सरकार
विज्ञान और प्रौद्योगिकी मंत्रालय
विज्ञान और प्रौद्योगिकी विभाग

DST/TMD-EWO/WTI/2K19/EWFH/2019/102 (G)/2

निबंधन और शर्तें

1. अनुदानग्राही संस्थान प्रत्येक वित्त वर्ष के अंत में इस परियोजना के अंतर्गत प्राप्त अनुदान पर अर्जित/प्रोद्भूत ब्याज को विधिवत रूप से दर्शाते हुए अद्यतन प्रगति रिपोर्ट (लक्ष्य बनाम उपलब्धि) के साथ जीएफ़आर 2017 में विनिर्दिष्ट प्ररूप में वित्तीय वर्ष-वार उपयोग प्रमाण पत्र (यूसी) और व्यय का लेखापरीक्षित विवरण (एसई) विज्ञान और प्रौद्योगिकी विभाग को प्रस्तुत करेगा। यह परियोजना की समाप्ति की निर्धारित तारीख से एक वर्ष भीतर व्यय का अंतिम विवरण, उपयोग प्रमाण-पत्र और परियोजना समाप्ति रिपोर्ट प्रस्तुत करने की शर्त के भी अध्यधीन है।

2. अनुदानग्राही संस्थान को उपयोग प्रमाण-पत्र इस प्रभाग में भौतिक रूप में भेजने के साथ-साथ पीएफ़एमएस पोर्टल पर प्रविष्ट और अपलोड करना होगा। अनुवर्ती/अंतिम किस्त प्रभाग द्वारा यूसी की स्वीकृति की पुष्टि और पीएफ़एमएस में पूर्ववर्ती उपयोग प्रमाण-पत्र की प्रविष्टि के बाद ही जारी की जाएगी।

3. यदि अनुदान एक ही परियोजना के अंतर्गत उपस्कर (रों) की खरीद के लिए पृथक संस्वीकृति आदेश के माध्यम से पूंजी-शीर्ष के अंतर्गत जारी किया गया है तो जारी किया गया पूंजी-शीर्ष अनुदान के लिए पृथक एसई/यूसी प्रस्तुत करना होगा।

4. जारी किया जा रहा सहायता अनुदान निम्नलिखित शर्तों के अध्यधीन है-

क) उपर्युक्त परियोजना के लिए संस्वीकृत पूंजी आस्तियों की खरीद करते समय अनुदानग्राही संस्थान के उचित नियमों के तहत संस्थान/संगठन द्वारा सामान्य वित्तीय नियमावली 2017 के उपबंधों के अनुरूप पारदर्शी खरीद प्रक्रिया का अनुपालन किया जाए और अनुदान प्राप्ति पर तुरंत प्रभाव से अनुदानग्राही संगठन द्वारा इस आशय का प्रमाण-पत्र प्रस्तुत किया जाए।

ख) उपयोग प्रमाण-पत्र/ व्यय विवरण प्रस्तुत करते समय, संगठन को जीएफ़आर 2017 के उपबंधों के अनुसरण में उपस्कर/पूंजी आस्तियों की खरीद के संबंध में संबन्धित दस्तावेज़-साक्ष्य प्रस्तुत करना सुनिश्चित करना होता है।

5. जीएफ़आर नियमावली 2017 के नियम 230 (8) के अनुसार अनुदानग्राही संस्थान को सुनिश्चित करना चाहिए कि किसी भी अनुदानग्राही संस्थान को जारी किए गए सहायता अनुदान या अग्रिम (प्रतिपूर्ति से भिन्न) पर प्राप्त समस्त प्रकार के ब्याज या अन्य आय को लेखों को अंतिम रूप दिए जाने के तुरंत बाद भारतीय समेकित निधि में अनिवार्य रूप से विप्रेषित किया जाए। ऐसे अग्रिमों को भविष्य में जारी की जाने वाली निधियों में समायोजित करने की अनुमति नहीं दी जाएगी।

6. जीएफ़आर नियमावली 2017 के नियम 230 (17) के अनुसार, "अनुदानग्राही संस्थान को भारत सरकार के निर्देशानुसार अपने नियंत्रणाधीन पदों या सेवाओं में अनुसूचित जाति या अनुसूचित जनजाति या ओबीसी के लिए आरक्षण रखने पर सहमत होना चाहिए।"

7. अनुदानग्राही संस्थान परियोजना का पृथक परीक्षित लेखा रखेगा और अनुदान की समस्त राशि बैंक खाते में सब्याज रखी जाएगी। वित्तीय वर्ष 2017-18 के दौरान और उसके बाद जारी अनुदान के लिए, अनुदान के लिए सभी प्रकार के ब्याज या अन्य आय ऐसे लेखों को अंतिम रूप दिए जाने के तुरंत बाद भारतीय समेकित निधि में

(गैर कर प्राप्ति पोर्टल (एनटीआरपी) अर्थात www.bharatkosh.gov.in के माध्यम से) विप्रेषित की जाएगी, क्योंकि यह राशि भविष्य में जारी की जाने वाली राशि में समायोजित नहीं की जाएगी। अनुवर्ती अनुदान के निर्गम/ परियोजना खाते को बंद करने पर विचार किए जाने के लिए, व्यय विवरण/ उपयोग प्रमाण-पत्र के साथ इस आशय का प्रमाण पत्र प्रस्तुत करना होगा।

8. डीएसटी, अनुदान से सृजित परिसंपत्तियों पर एकमात्र सुरक्षित अधिकार रखता है। सरकारी अनुदानों से पूरी तरह से या पर्याप्त रूप से अर्जित संपत्ति (जीएफआर 2017 में निर्धारित प्रक्रिया के अनुसार अप्रचलित और अनुप्रयोज्य, अनुपयोगी घोषित अनुदानों से इतर), का निपटारा डीएसटी का पूर्व अनुमोदन प्राप्त किए बिना नहीं किया जाएगा।

9. जैसा कि सामान्य वित्तीय नियमावली 2017 के नियम 236 (1) के तहत निर्धारित किया गया है, अनुदानग्राही संगठन का लेखा स्वीकृति प्रदाता प्राधिकरी और लेखा परीक्षक (भारत के नियंत्रक एवं महालेखापरीक्षक और डीएसटी के प्रधान लेखा कार्यालय दोनों द्वारा आंतरिक लेखा परीक्षा) द्वारा निरीक्षण किए जाने, जब भी संगठन को ऐसा करने के लिए कहा जाता है, हेतु अभिगम्य होगा।

10. इस परियोजना अनुदान से प्राप्त तकनीकी सहायता/वित्तीय सहायता की उचित पावती को अनुदानग्राही संगठन द्वारा सभी प्रकाशनों/मिडिया प्रकाशनी में मोटे अक्षरों में और परियोजना के पूरा होने के दौरान और तदुपरांत उनकी वार्षिक रिपोर्टों के शुरुआती पैराग्राफों में अनिवार्य रूप से दिखाया किया जाना चाहिए।

11. बॉन्ड के नियमों और शर्तों का पालन करने में असफल होने पर जीएफआर 2017 के नियम 231 (2) के अनुसार पूरी राशि सब्याज वापस करनी होगी।

12. पीएफएमएस में ईएटी मॉड्यूल का उपयोग करना अनिवार्य है, ऐसा न करने पर अन्य कोई भी आगामी निधि जारी नहीं की जाएगी।

13. जीएफआर के नियम 149 के उपबंधों के अनुसार जीईएम पोर्टल पर उपलब्ध वस्तुओं (उपभोज्य वस्तु / उपस्कर) का अनिवार्यतया आनॅ लाइन प्रापण जैम (जीईएम) ही के माध्यम से किया जाना है।

14. अनुदान ग्राही संस्थान को व्यय विभाग के आईडी नोट संख्या: 4/1/2021-पीपीडी दिनांक 10.09.2021 के अनुसार वैश्विक निविदाकरण जांच-पड़ताल (जीटीई) नियमों का पालन करना चाहिए।

15. यदि एकबारगी सहायता या गैर-आवर्ती अनुदान 10.00 लाख रुपये से 50.00 लाख रुपये के सहायता अनुदान का हो तो इसे संस्थान की वार्षिक रिपोर्ट में दर्ज किया जाना चाहिए।

16. अनुदान ग्राही संस्थान को जीएफआर-2017 के किसी भी अन्य उपबंध और समय-समय पर भारत सरकार द्वारा जारी दिशा-निर्देश/संशोधन का अनुपालन सुनिश्चित करना चाहिए।

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GOVERNMENT OF INDIA
Ministry of Science & Technology
Department of Science & Technology
DST/TMD/EWO/WTI/DM/2021/20 (G)
(Technology Mission Division)

Technology Bhawan, New Delhi
Dated: **23/02/2023**

Sanction Order

Subject: Financial assistance for the project entitled **"Providing low cost solution and appropriate management framework for the reject disposal of Community-based RO Plants in many areas of Rajasthan"** submitted by **Dr. Monika Sogani, MANIPAL UNIVERSITY JAIPUR,DEHMI KALAN, OFF JAIPUR-AJMER EXPRESSWAY, BAGRU-JAIPUR, 303007** Release of the **first** installment regarding

Sanction of the President is hereby accorded to the approval to the above mention project at a total cost of **Rs. 82,48,118/- (Rupees Eighty Two Lakh Forty Eight Thousand One Hundred Eighteen only)** for a duration of **3 Years Days** . The detailed breakup of the grant for General as well as Capital Components are given below:-

General Component : **₹ 73,58,118/-**
Capital Component : **₹ 8,90,000/-**

Items	(All Institute) Budget Summary (in Rs.)			
	Year-1	Year-2	Year-3	Total
1- Non-Recurring				
Electronic TDS Meter-1 Unit - 1	80000	0	0	**80000**
Dissolved Oxygen Meter-1Unit - 1	250000	0	0	**250000**
Chlorophyll Meter-1Unit - 1	300000	0	0	**300000**
Magnetic stirrer (10 plate)- 1 Unit - 1	100000	0	0	**100000**
Laptop-1 Unit - 1	60000	0	0	**60000**
Water analyser-1 Unit - 1	100000	0	0	**100000**
Subtotal (Capital)	890000	0	0	**890000**
2- Recurring				
Project Staff	1104480	1104480	1161120	**3370080**
Junior Research Fellow (JRF)-1 ((@ 31,000/- + 18% HRA (For 1st & 2nd Year & SRF 35,000/- +18% HRA for 3rd year)	438960	438960	495600	**1373520**
Research Associate-II-1 ((@ 47000/-+ 18% HRA for full three years))	665520	665520	665520	**1996560**
Consumables	200000	125000	50000	**375000**
Contingency	150000	100000	50000	**300000**
Travel	250000	175000	150000	**575000**
Overhead	248669	198669	190700	**638038**
Other Cost-(fabrication of Lab Scale CW-MDC Unit and its Operation, fabrication of Culture Cabinet, Designing and Construction of Pilot Scale CW-MDC unit of Cement Concrete, Operation & maintenance and various testing cost of Pilot Scale CW-MDC unit, Outsourcing and Stakeholders workshop organization for dissemination of key findings and knowledge generated)	500000	600000	600000	**1700000**
Other Cost-(Membrane development for CW- MDC using agro based material,	400000	0	0	**400000**

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Development of agro based PNSB absorbent, Outsourcing)				
Subtotal (General)	2853149	2303149	2201820	7358118
Total Project Cost (Cap.+ Gen.)	3743149	2303149	2201820	8248118

1 MANIPAL UNIVERSITY JAIPUR (Dr. Monika Sogani)

Items	Budget Summary (in Rs.)			
	Year-1	Year-2	Year-3	Total
1- Non-Recurring				
Laptop-1 Unit - 1	60000	0	0	60000
Chlorophyll Meter-1Unit - 1	300000	0	0	300000
Dissolved Oxygen Meter-1Unit - 1	250000	0	0	250000
Electronic TDS Meter-1 Unit - 1	80000	0	0	80000
Magnetic stirrer (10 plate)- 1 Unit - 1	100000	0	0	100000
Subtotal (Capital)	790000	0	0	790000
2- Recurring				
Project Staff	665520	665520	665520	1996560
Research Associate-II-1((@ 47000/-+ 18% HRA for full three years))	665520	665520	665520	1996560
Consumables	100000	75000	50000	225000
Contingency	50000	50000	50000	150000
Travel	150000	100000	100000	350000
Overhead	146552	149052	146552	442156
Any Other (Other Cost)-(fabrication of Lab Scale CW-MDC Unit and its Operation, fabrication of Culture Cabinet, Designing and Construction of Pilot Scale CW-MDC unit of Cement Concrete, Operation & maintenance and various testing cost of Pilot Scale CW-MDC unit, Outsourcing and Stakeholders workshop organization for dissemination of key findings and knowledge generated)	500000	600000	600000	1700000
Subtotal (General)	1612072	1639572	1612072	4863716
Total Project Cost (Cap.+ Gen.)	2402072	1639572	1612072	5653716

2 UNIVERCITY OF RAJASTHAN (Dr. Placheril John)

Items	Budget Summary (in Rs.)			
	Year-1	Year-2	Year-3	Total
1- Non-Recurring				
Water analyser-1 Unit - 1	100000	0	0	100000
Subtotal (Capital)	100000	0	0	100000
2- Recurring				
Project Staff	438960	438960	495600	1373520
Junior Research Fellow (JRF)-1((@ 31,000/- + 18% HRA (For 1st & 2nd Year & SRF 35,000/- +18% HRA for 3rd year)	438960	438960	495600	1373520
Consumables	50000	50000	0	100000
Contingency	50000	50000	0	100000
Travel	50000	50000	25000	125000
Overhead	47117	47117	41648	135882
Subtotal (General)	636077	636077	562248	1834402

3 KASHI INSTITUTE OF TECHNOLOGY (Mr. Kumar Sonu)

	Budget Summary (in Rs.)			
Items	**Year-1**	**Year-2**	**Year-3**	**Total**
1- Non-Recurring				
Subtotal (Capital)	0	0	0	
2- Recurring				
Consumables	50000	0	0	**50000**
Contingency	50000	0	0	**50000**
Travel	50000	25000	25000	**100000**
Overhead	55000	2500	2500	**60000**
Any Other (Other Cost)-(Membrane development for CW- MDC using agro based material, Development of agro based PNSB absorbent, Outsourcing)	400000	0	0	**400000**
Subtotal (General)	605000	27500	27500	**660000**
Total Project Cost (Cap.+ Gen.)	605000	27500	27500	660000

2. The sanction of the President is also accorded to the release of **Rs. 28,53,149/- (Rupees Twenty Eight Lakh Fifty Three Thousand One Hundred Forty Nine only)** to the **"Director/Registrar/Principal/Controller/Comptroller, MANIPAL UNIVERSITY JAIPUR"** being the **first** installment of grant as mentioned above table under **"General Component"** for the above mentioned project.

3. The expenditure involved is debitable to **Demand No. 89**, Department of Science & Technology for the year **2022-23:**

3425	Other Scientific Research(Major Head)
3425.60	Others : (Sub-Major Head)
3425.60.200	Assistance to Other Scientific Bodies(Minor Head)
3425.60.200.70	Innovation,Technology Development and Deployment
3425.60.200.70.00	Detailed Head
3425.60.200.70.00.31	Grants-in-aid General
	(Previous: 3425.60.200.26.01.31)

4. The amount of **Rs. 28,53,149/- (Rupees Twenty Eight Lakh Fifty Three Thousand One Hundred Forty Nine only)** will be drawn by DDO, DST and disbursed to the **"CNA account of Autonomous body SERB in respect of Innovation,Technology Development and Deployment Scheme".**

Name of A/C Holder	**Innovation Technology Development and Deployment**
Bank A/C No	**349902010051240**
Name of the Bank & branch	**Union Bank of India, Safdarjang Enclave - New Delhi**
RTGS/IFSC code	**UBIN0534994**

5. The amount of **Rs. 2853149/- (Rupees Twenty Eight Lakh Fifty Three Thousand One Hundred Forty Nine only)** will be drawn by the **"CNA account of Autonomous body SERB and will be disbursed to the Director/Registrar/Principal/Controller/Comptroller, MANIPAL UNIVERSITY JAIPUR .** The bank details for electronic transfer of funds through RTGS are given below:-

Name of A/C Holder	**MANIPAL UNIVERSITY JAIPUR**
Bank A/C No	**219012010000703**
Name of the Bank & branch	**Union Bank of India**
RTGS/IFSC code	**UBIN0821900**

6. As per Rule 234 of GFR 2017, the sanction has been entered at S. No **200**. in the register of grants maintained in the **Technology Mission Division** for the scheme **WTI Call 2021 on Desalination Technologies .**

7. This issues with the concurrence of IFD vide their Concurrence Dy. No. **IFD/C/III/170223/31/03435 dated 17/02/2023.**

8. The GI will keep all the funds received in the Central Nodal Account only and shall not transfer the funds to any other account or not divert the same to Fixed Deposits/ Flexi-Account/ Multi-Option Deposit Account/ Corporate Liquid Term Deposit (CLTD)

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account etc. The funds released to GI shall not be parked in bank account of any other agency.

9. The GI will ensure the compliance of OM. No. F. No. **1/(18)/PFMS/FCD/2021 dated March 9, 2022** of Department of Expenditure, Ministry of Finance.

10. Out of the release of Rs. 28,53,149 / - (G) (Rs. 16,12,072/- for Manipal University Jaipur, (Darpan ID-RJ/2017/0115730), Rs. 6,36,077/- for University of Rajasthan and Rs. 6,05,000/- for Kashi Institute of Technology (Darpan ID-UP/2017/0152961)under the recurring head and out of release of Rs. 8,90,000/-(C) (Rs. 7,90,000/-(Manipal University Jaipur) and Rs.1,00,000/- (University of Rajasthan, Jaipur) towards the First-year installment.

11. This sanction order is subject to the **Terms & Conditions** as annexured .

Dr. Sanjai Kumar
(Scientist - 'D')
sanjai.k@gov.in

To,
The Pay & Accounts Officer,
Department of Science & Technology,
New Delhi – 110 016.

Copy of information and necessary action to:

1. The Principal Director of Audit, Scientific Department, IIIrd floor, AGCR Building, I.P. Estate, New Delhi.
2. The Financial Advisor, Integrated Finance Division,Technology Bhavan, New Mehrauli Road, Block C, Qutab Institutional Area, New Delhi, Delhi 110016
3. The Internal Audit Wing, Department of Science & Technology,Technology Bhavan, New Mehrauli Road, Block C, Qutab Institutional Area, New Delhi, Delhi 110016
4. Drawing and Disbursing Officer, DST, Cash Section. (two copies)
5. Dr. Monika Sogani, Associate Professor Senior Scale, Department of Biosciences, MANIPAL UNIVERSITY JAIPUR, Dehmi Kalan. Off Jaipur-Ajmer Expressway, Jaipur, Rajasthan - 303007
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8. The Director/Registrar/Principal/Controller/Comptroller, KASHI INSTITUTE OF TECHNOLOGY, Varanasi, Varanasi, Uttar Pradesh - 221307
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11. Secretary, SERB, New Delhi (for allocation of limits to implementing agency)
12. Head (Technology Mission Division) DST
13. Sanction Folder (Technology Mission Division)

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