Groundwater Quality Assessment

Potential Hydrogen (pH)

Measured mean pH within the groundwater of the study for the period February to December 2024 ranges from 6.75 to 7.69 (Figure 16) with a mean of 7.33. This means that the groundwater is slightly acidic. Lower pH values can be observed at the central to western portion of the study area. Measured pH levels in the study area were observed to be within the groundwater quality guidelines of 6.5 – 8.5 range given by the Philippine National Standards for Drinking Water (PNSDW) 2017. Generally, groundwater within the study area was suitable for drinking as far as pH is concerned.

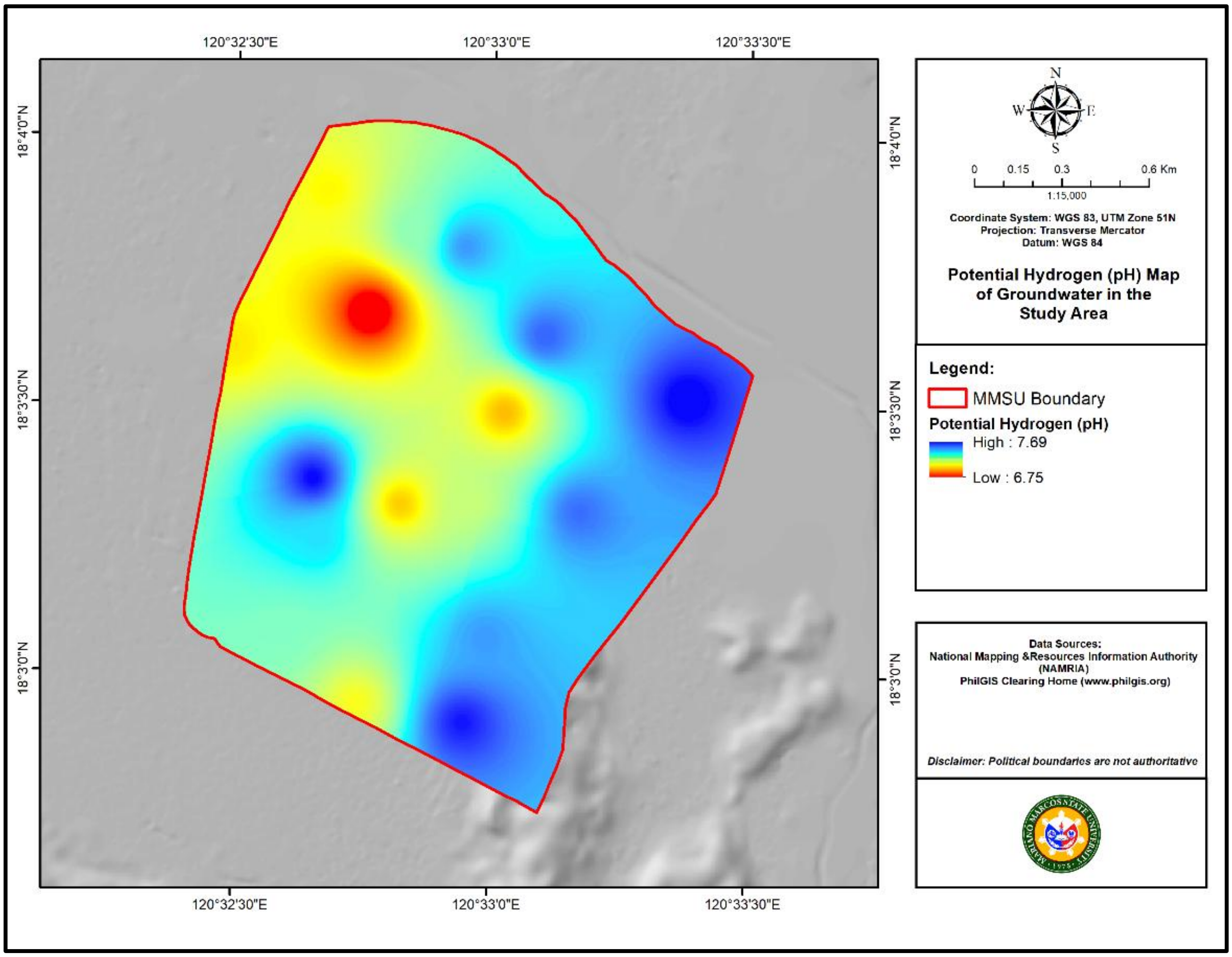

Figure 16. Spatial variation of pH in the MMSU Farm

Total Dissolved Solids (TDS)

The monthly measured concentrations of Total Dissolved Solids (TDS) across the 17 groundwater monitoring wells from February 2024 to June 2025 (Table 5) indicate varying levels of mineralization and salinity, influenced by both natural processes and potential anthropogenic inputs. Throughout the monitoring period, TDS values fluctuated significantly among wells and across different months, with the overall mean values ranging from 479.06 mg/L (October 2024) to as high as 847.94 mg/L (June 2024). The lowest recorded TDS concentration was 367 mg/L in W5 (November 2024), while the highest concentration reached a peak of 1330 mg/L in W16 during June 2024, which is notably beyond the recommended limit of 1000 mg/L for drinking water, indicating possible contamination or saltwater intrusion in that location (Table 6)

Wells such as W16, W7, and W8 exhibited relatively high TDS values throughout the monitoring period. W16 consistently recorded the highest concentrations, particularly between March and June 2024, with values ranging from 959 to 1330 mg/L, suggesting this site may be under the influence of elevated mineral inputs, possibly due to saltwater intrusion, evaporation, or nearby human activities. Similarly, W7 peaked at 994 mg/L in April 2024, while W8 recorded high values in several months, reaching up to 861 mg/L in November 2024 and maintaining elevated levels through March and April 2025. These wells show trends indicative of persistent high salinity levels that could compromise groundwater suitability for domestic and agricultural use.

In contrast, several wells exhibited more stable and moderate TDS concentrations. W4, W9, W10, and W11, for instance, showed lower mean TDS levels (ranging from approximately 550 to 565 mg/L), with relatively consistent readings throughout the monitoring period. These wells had minimum values between 368 and 468 mg/L, suggesting minimal exposure to salinity stress or contamination. Notably, W5 showed considerable variability, ranging from a high of 790 mg/L in March 2024 to a low of just 367 mg/L in November 2024, possibly due to dilution from recharge or changes in groundwater dynamics.

Overall, the temporal pattern reveals that TDS concentrations were generally higher from February to June 2024 (Figure 17), possibly due to dry-season evaporation and concentrated mineral content, followed by a decline in October and November 2024, likely influenced by rainfall and recharge effects. The rise in TDS values again from January to May 2025 suggests seasonal influences on groundwater chemistry. The spatial variability among wells emphasizes the importance of localized hydrogeological conditions, land use, and recharge-discharge mechanisms in determining groundwater quality. These findings highlight the need for continued monitoring, especially in wells with high TDS trends such as W16, W7, and W8, to inform water resource management strategies and prevent further degradation of groundwater quality.

Table 5. Measured monthly TDS (mg/L) in the MMSU Farm.

Monitoring Wells	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Oct-24	Nov-24	Jan-25	Feb-25	Mar-25	Apr-25	May-25	Jun-25	Min	*Mean*	*Max*
W1	700	760	820	750	850	537	707	669	565	859	802	908	587	537	*731.85*	*908.00*
W2	708	767	748	720	870	587	577	593	522	528	521	534	552	521	*632.85*	*870.00*
W3	652	657	667	705	1010	488	470	599	473	530	494	512	552	470	*600.69*	*1010.00*
W4	671	676	657	657	645	489	493	528	507	529	506	469	468	468	*561.15*	*676.00*
W5	528	790	562	569	721	628	644	367	468	397	418	401	644	367	*549.00*	*790.00*
W6	700	750	800	730	800	563	584	538	541	566	565	614	587	538	*641.38*	*800.00*
W7	790	750	994	740	884	623	622	546	510	568	569	633	615	510	*680.31*	*994.00*
W8	686	764	811	755	850	490	861	793	796	802	793	768	596	490	*751.15*	*861.00*
W9	661	753	689	706	730	493	490	510	546	507	506	661	542	490	*599.54*	*753.00*
W10	685	711	717	736	679	410	390	448	482	460	470	483	542	390	*554.85*	*736.00*
W11	669	700	723	663	704	505	504	505	511	437	442	514	462	437	*564.54*	*723.00*
W12	652	650	681	806	655	453	459	459	462	462	465	507	446	446	*550.54*	*806.00*
W13	704	714	688	723	709	511	515	490	497	493	493	477	507	477	*578.54*	*723.00*
W14	713	738	802	802	800	508	502	498	467	591	562	580	803	467	*643.54*	*803.00*
W15	756	690	688	647	680	505	549	532	640	610	477	475	805	475	*619.54*	*805.00*
W16	700	959	1040	979	1330	521	966	929	865	700	675	682	574	521	*840.00*	*1330.00*
W17	670	740	758	827	806	609	593	584	605	594	617	572	540	540	*655.00*	*827.00*
Min	*528.00*	*650.00*	*562.00*	*569.00*	*645.00*	*410.00*	*390.00*	*367.00*	*462.00*	*397.00*	*418.00*	*401.00*	*446.00*	*367.00*	*549.00*	*676.00*
Mean	*685.00*	*739.35*	*755.59*	*736.18*	*807.24*	*524.71*	*583.88*	*564.00*	*556.29*	*566.65*	*551.47*	*575.88*	*577.76*	*479.06*	*632.62*	*847.94*
Max	*790.00*	*959.00*	*1040.00*	*979.00*	*1330.00*	*628.00*	*966.00*	*929.00*	*865.00*	*859.00*	*802.00*	*908.00*	*805.00*	*540.00*	*840.00*	*1330.00*

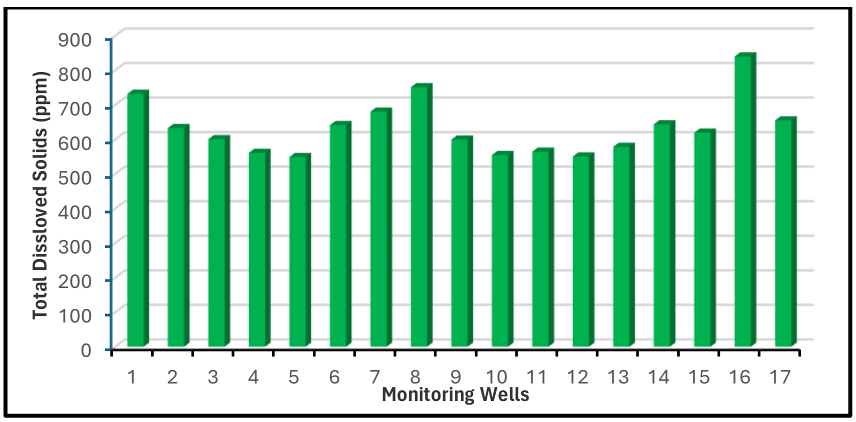

Figure 16. Spatial variation of TDS in the study area.

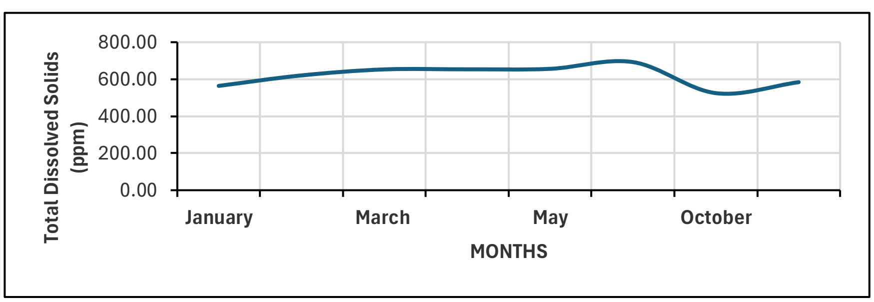

Figure 17. Temporal variation of TDS in the study area.

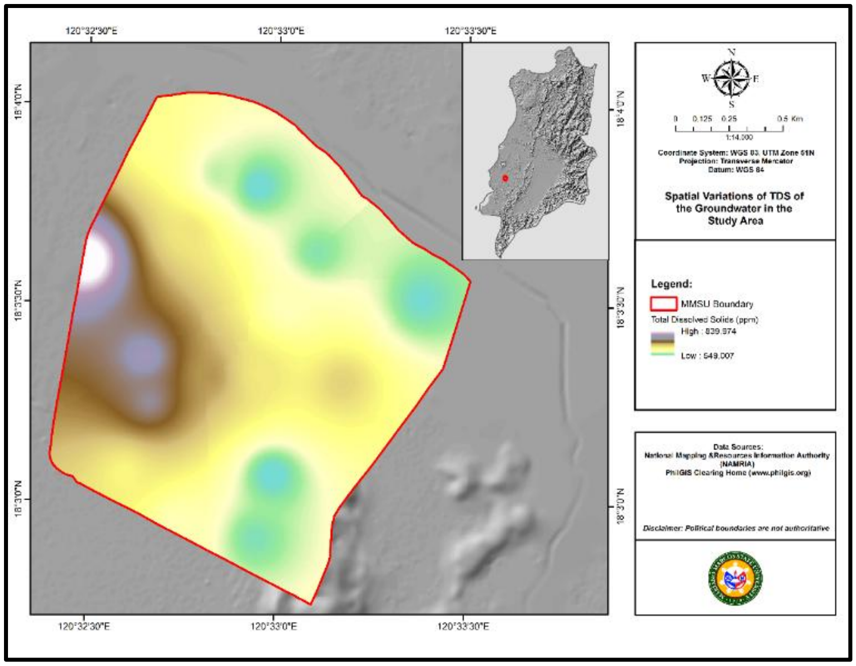

Figure 18. Spatial variations of Total Dissolved Solids concentrations in MMSU

Electrical Conductivity (EC)

The monthly measured concentrations of Electrical Conductivity (EC) across 17 monitoring wells from February 2024 to June 2025 reflect notable variations in groundwater salinity and mineral content across space and time. EC values, which serve as a proxy for the total ionic content of groundwater, ranged widely—from a minimum of 369 µS/cm recorded in W14 (June 2024) to a maximum of 2070 µS/cm observed in W16 (June 2024). These values suggest varying degrees of mineralization and potential saltwater intrusion, particularly in certain wells exhibiting persistently high EC. W16 consistently recorded the highest EC values, with an average of 1511.08 µS/cm, peaking at 2070 µS/cm in June 2024. This trend indicates a high ionic load likely linked to saltwater intrusion, especially if this well is near a coastal area or subject to reduced recharge and high evaporation rates. Similarly, W8 and W7 also showed elevated EC levels across multiple months, with mean values of 1353.69 µS/cm and 1236.00 µS/cm, respectively. W8 notably reached 1720 µS/cm in October 2024, followed by sustained high values in the succeeding months. These elevated readings in several wells may be due to proximity to saline water bodies, groundwater over-extraction, or anthropogenic inputs such as agricultural runoff or wastewater seepage.

In contrast, other wells like W5, W10, and W12 exhibited lower EC values (Figure 19). W5 had a wide fluctuation—from 825 µS/cm in February 2024 to 733 µS/cm in January 2025—averaging 991.00 µS/cm. Notably, W12 recorded an anomalously low value of 9.7 µS/cm in October 2024, which may suggest a data recording or instrumentation error, as it deviates significantly from all other values. Excluding that outlier, W12 generally maintained moderate EC levels, with values ranging from 892 to 1260 µS/cm.

Overall, the mean EC across all wells and months was 1132.13 μS/cm, which suggests that while many wells fall within the acceptable range for irrigation or domestic use, several exceed thresholds that may compromise water quality. The trend of rising EC during the warmer or drier months (particularly May to June 2024 and early 2025) aligns with expected increases due to reduced dilution and higher evaporation, which concentrates dissolved ions. The findings underscore the importance of sustained monitoring and site-specific water management, particularly in wells such as W16, W8, and W7, which may require mitigation strategies to manage salinity-related risks to groundwater-dependent communities.

Table 6. Measured monthly EC (μS/cm) in the MMSU Farm.

Code	MW	EC_F24	EC_M24	EC_A24	EC_May24	EC_J24	EC_O24	EC_N24	EC_J25	EC_F25	EC_M25	EC_A25	EC_M25	EC_J25	Min	Mean	Max
1	W1	1090	1180	1270	1170	1190	1075	1408	1334	1130	1717	1603	1816	1179	1075.00	1320.15	1816.00
2	W2	1110	1200	1170	1120	1320	1173	1154	1185	1043	1057	1042	1067	1104	1042.00	1134.23	1320.00
3	W3	1020	1030	1040	1100	1580	975	941	1197	946	1060	988	1023	1105	941.00	1077.31	1580.00
4	W4	1050	1060	1030	1030	1010	979	987	1056	1025	1058	1011	937	936	936.00	1013.00	1060.00
5	W5	825	1230	878	889	1130	1256	1289	733	936	793	836	802	1286	733.00	991.00	1289.00
6	W6	1090	1160	1240	1140	1230	1125	1165	1073	1153	1142	1133	1229	1179	1073.00	1158.38	1240.00
7	W7	1230	1170	1550	1150	1380	1245	1243	1092	1220	1155	1137	1267	1229	1092.00	1236.00	1550.00
8	W8	1070	1190	1270	1180	1080	980	1720	1585	1594	1603	1586	1534	1206	980.00	1353.69	1720.00
9	W9	1030	1180	1080	1100	1300	984	983	1020	1109	1013	1012	1321	1099	983.00	1094.69	1321.00
10	W10	1070	1110	1120	1150	1060	820	783	896	964	921	940	966	1090	783.00	991.54	1150.00
11	W11	1040	1090	1130	1040	1100	1011	1008	1011	1022	873	885	1027	924	873.00	1012.38	1130.00
12	W12	1020	1020	1060	1260	1030	906	9.7	917	924	923	929	1014	892	970.00	915.75	1260.00
13	W13	1100	1120	1070	1130	1110	1023	1031	981	994	986	985	955	1014	955.00	1038.38	1130.00
14	W14	1110	1150	1250	1250	369	1015	1003	997	934	1182	1125	1160	1607	369.00	1088.62	1607.00
15	W15	1180	1080	1070	1010	1060	1011	1123	1085	1280	1220	954	950	1609	950.00	1125.54	1609.00
16	W16	1090	1500	1630	1530	2070	1041	1931	1859	1731	1401	1349	1364	1148	1041.00	1511.08	2070.00
17	W17	1090	1150	1180	1290	1260	1217	1186	1167	1210	1188	1234	1144	1081	1081.00	1184.38	1290.00
Min		*825.00*	*1020.00*	*878.00*	*889.00*	*369.00*	*820.00*	*9.70*	*733.00*	*924.00*	*793.00*	*836.00*	*802.00*	*892.00*	*369.00*	*915.75*	*1060.00*
Mean		*1071.47*	*1154.12*	*1178.71*	*1149.35*	*1192.88*	*1049.18*	*1115.57*	*1128.71*	*1130.29*	*1134.82*	*1102.88*	*1151.53*	*1158.12*	*933.94*	*1132.13*	*1420.12*
Max		*1230.00*	*1500.00*	*1630.00*	*1530.00*	*2070.00*	*1256.00*	*1931.00*	*1859.00*	*1731.00*	*1717.00*	*1603.00*	*1816.00*	*1609.00*	*1092.00*	*1511.08*	*2070.00*

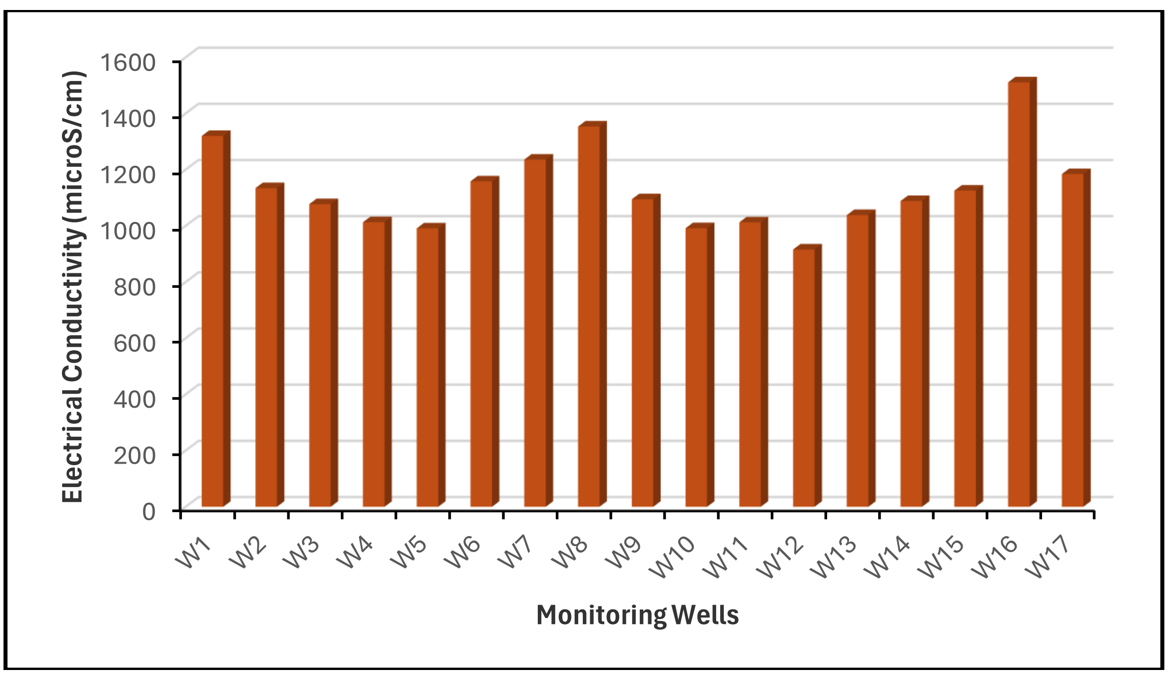

Figure 19. Spatial variation of Electrical Conductivity in the study area.

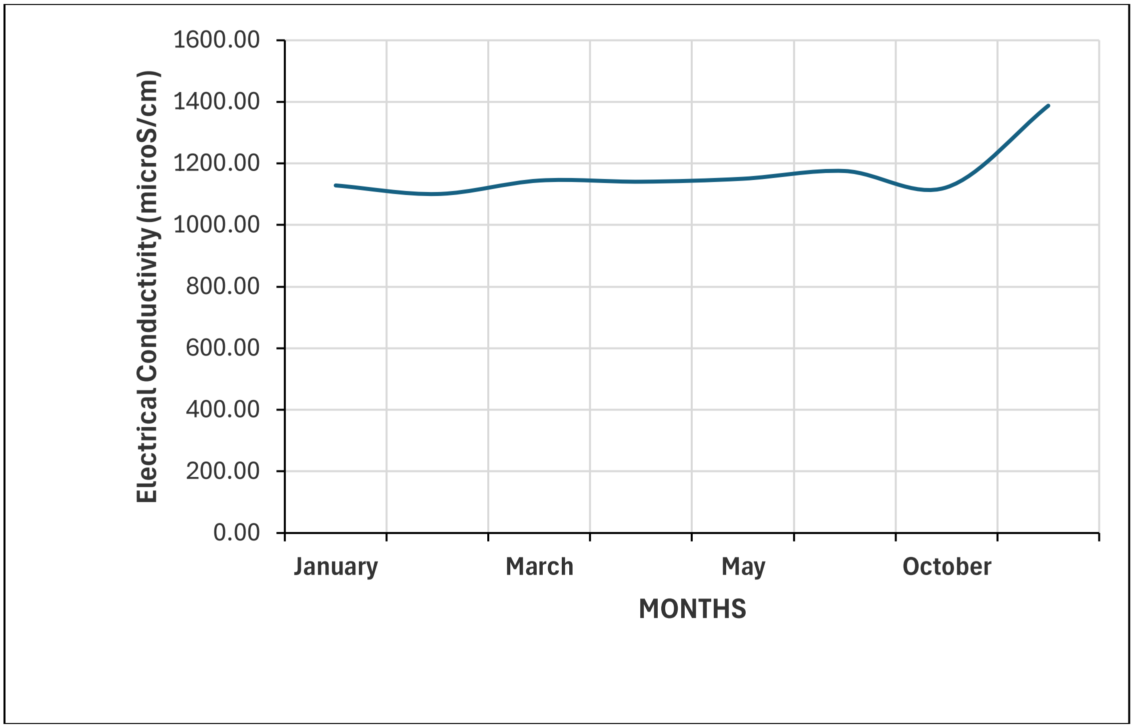

Figure 20. Spatial variation of Electrical Conductivity in the study area.

Chloride

The monthly measured concentrations of chloride (Cl^-) across 17 groundwater monitoring wells from February 2024 to April 2025 (Table 8) indicate substantial spatial and temporal variability, reflecting differences in saltwater intrusion, evaporation patterns, and possible anthropogenic influences. In the early months of monitoring, particularly from February to April 2024, chloride levels were generally moderate, with average concentrations ranging from 51.8 to 72.5 mg/L (Figure 28). However, a notable spike in concentrations was observed starting in October 2024, with a dramatic increase in the mean value to 145.0 mg/L, followed by even higher levels in January, February, March, and April 2025, where mean concentrations reached 195.5, 199.5, 195.2, and 253.6 mg/L respectively. The progressive rise in chloride levels during these months suggests increasing saltwater intrusion or accumulation of dissolved salts, particularly during the dry season when dilution from rainfall is limited.

Several wells exhibited consistently high chloride concentrations and significant fluctuations. Notably, W8 showed the highest concentrations across almost all months, with values surging from 63.5 mg/L in August 2024 to a peak of 927.0 mg/L in February 2025, followed by a slightly lower yet still elevated value of 900.0 mg/L in April 2025. Similarly, W16 also exhibited elevated levels, reaching 473.0 mg/L in January 2025 and peaking at 320.4 mg/L in April 2025. These trends suggest that these wells are likely influenced by either coastal proximity, excessive groundwater extraction, or saline recharge sources. Other wells such as W6, W7, W14, W15, and W17 also showed high chloride levels, with multiple months recording values exceeding 200 mg/L, which may be indicative of progressive salinization or local contamination sources.

In contrast, some wells—particularly W4, W9, W10, and W13—maintained relatively low chloride levels throughout the monitoring period. For instance, W4 recorded values as low as 10.7 mg/L in May 2024 and remained under 100 mg/L for most of the year. These wells may be located farther inland or in areas with better aquifer protection and less saline intrusion. The minimum recorded chloride concentration was 9.6 mg/L in W14 (June 2024), while the highest was 927.0 mg/L in W8 (February 2025), reflecting a wide range of values across the study area.

Overall, the increasing trend in chloride concentrations toward the latter part of the monitoring period, particularly from October 2024 onward, is concerning. This trend may be driven by seasonal factors such as increased evaporation, reduced recharge during dry months, and potentially rising sea levels affecting coastal aquifers. The data underscores the need for ongoing groundwater monitoring and proactive management strategies, especially for wells showing signs of chronic salinization, to safeguard freshwater resources from long-term degradation due to saltwater intrusion or contamination.

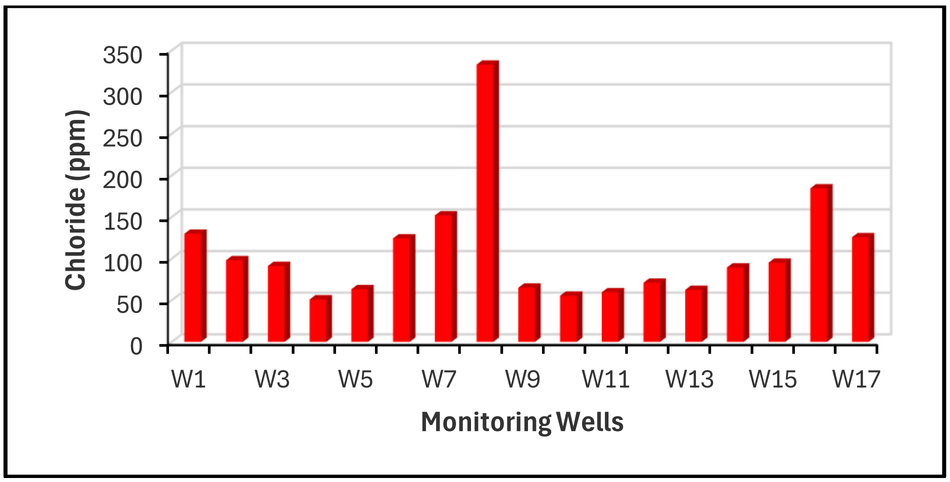

Figure 25. Spatial variation of Chloride in the study area.

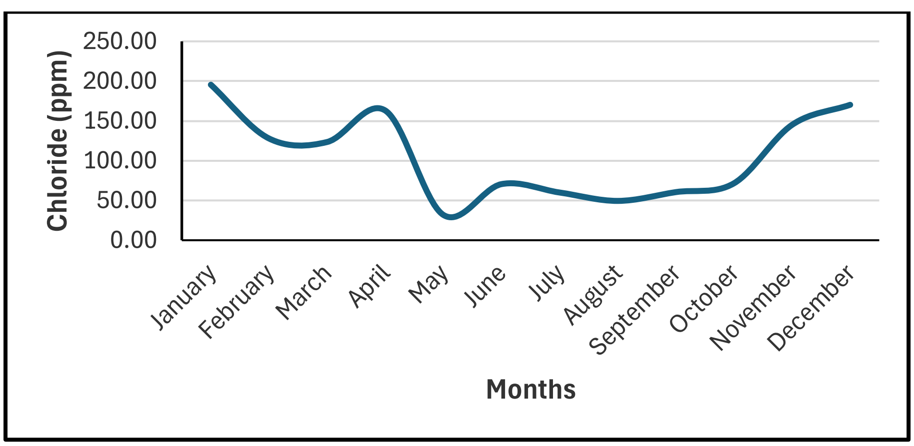

Figure 26. Temporal variation of Chloride in the study area.

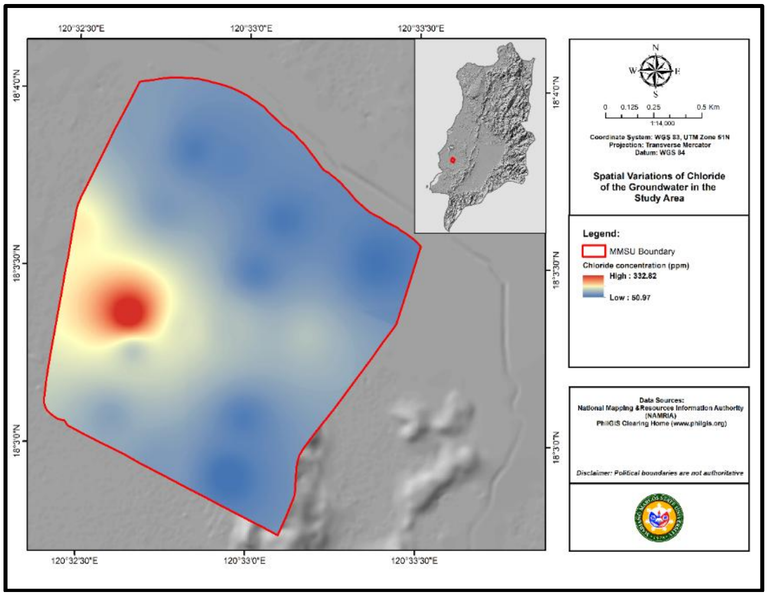

Figure 27. Map showing spatial variations of Chloride concentrations in MMSU

Nitrate-N

The monthly measured concentrations of nitrate-nitrogen (NO_3-N) in the 17 monitoring wells from February to October 2024 show considerable variability across both time and space, reflecting the diverse hydrogeological and land use conditions influencing groundwater nitrate levels (Table 9). On average, NO_3-N concentrations were relatively low in the early months of monitoring, particularly in February and March 2024, with mean values of 0.55 mg/L and 0.48 mg/L, respectively. A general increase in concentrations was observed in April (1.07 mg/L) and June (1.12 mg/L), with a slight dip in May (0.45 mg/L) (Figure 29), possibly influenced by seasonal recharge or dilution effects. A more notable rise was recorded in August and October 2024, with mean concentrations of 0.81 mg/L and 2.22 mg/L, respectively—the latter representing the highest monthly average across the period.

Among the wells, W5 showed the most extreme NO_3-N concentration, peaking at 7.80 mg/L in October 2024 (Figure 28), which significantly raised the overall mean and maximum values. W3 also exhibited consistently elevated levels, reaching as high as 3.60 mg/L in August. Wells such as W8 and W16 also demonstrated higher-than-average values, with peak concentrations of 3.80 mg/L and 3.30 mg/L, respectively. These wells may be located near agricultural areas or areas affected by human activities such as fertilizer application or domestic waste discharge, leading to elevated nitrate infiltration into the aquifer. In contrast, wells like W11, W12, and W13 showed consistently low nitrate concentrations throughout the monitoring period, with minimum values ranging between 0.20 and 0.33 mg/L, suggesting these locations are either more protected from nitrate inputs or benefit from natural attenuation processes.

The minimum recorded concentration across all wells and months was 0.16 mg/L, while the mean concentration ranged from 0.45 mg/L in May to 2.22 mg/L in October. The overall average NO_3-N concentration across all wells and months was 0.96 mg/L, which is still within the

World Health Organization (WHO) drinking water guideline of 50 mg/L NO_3^- (equivalent to 11.3 mg/L NO_3-N), but some wells—especially W5—warrant closer attention due to recurrent high values. The temporal pattern of increasing concentrations towards the latter months of monitoring, particularly in October 2024, could be attributed to the accumulation of nitrates during dry months and their subsequent mobilization during rainfall or irrigation events.

In summary, the data highlights spatial heterogeneity in NO_3-N contamination, with certain wells acting as potential hotspots of nitrate pollution, likely linked to land-based sources. Continued monitoring is essential to identify trends and potential risks, and to support the implementation of best management practices to protect groundwater quality.

Table 9. Monthly NO3-N concentration (mg/L) measured in different monitoring wells within MMSU.

Code	MW	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Aug-24	Oct-24	Min	Mean	Max
1	W1	0.74	0.53	1.15	0.41	1.35	0.95	2.3	0.41	1.06	2.30
2	W2	0.51	0.46	1.10	0.6	1.76	0.85	1.5	0.46	0.97	1.76
3	W3	0.16	0.29	0.93	0.85	3.00	3.60	3.3	0.16	1.73	3.60
4	W4	0.17	0.16	0.74	0.5	0.78	0.68	1.5	0.16	0.65	1.50
5	W5	1.00	1.30	1.10	0.64	0.51	1.80	7.8	0.51	2.02	7.80
6	W6	0.81	0.56	1.22	0.45	0.86	0.69	1.7	0.45	0.90	1.70
7	W7	0.55	0.47	1.70	0.43	0.67	0.54	2.4	0.43	0.97	2.40
8	W8	0.59	0.51	1.00	0.33	1.60	0.77	3.8	0.33	1.23	3.80
9	W9	0.40	0.41	0.97	0.35	1.20	0.24	1.5	0.24	0.72	1.50
10	W10	0.51	0.53	0.96	0.36	0.59	0.33	1.9	0.33	0.74	1.90
11	W11	0.49	0.46	0.54	0.36	0.20	0.37	1.4	0.20	0.55	1.40
12	W12	0.51	0.44	1.00	0.41	0.42	0.51	1.1	0.41	0.63	1.10
13	W13	0.44	0.36	1.10	0.38	0.41	0.33	1.3	0.33	0.62	1.30
14	W14	0.48	0.41	1.20	0.39	0.84	0.43	1.4	0.39	0.74	1.40
15	W15	0.75	0.34	1.10	0.26	0.87	0.31	1.3	0.26	0.70	1.30
16	W16	0.56	0.45	1.20	0.46	3.30	0.6	2.1	0.45	1.24	3.30
17	W17	0.66	0.50	1.10	0.48	0.74	0.73	1.4	0.48	0.80	1.40
Min		0.16	0.16	0.54	0.26	0.20	0.24	1.10	0.16	0.54	1.10
Mean		0.55	0.48	1.07	0.45	1.12	0.81	2.22	0.35	0.96	2.32
Max		1.00	1.30	1.70	0.85	3.30	3.60	7.80	0.51	2.02	7.80

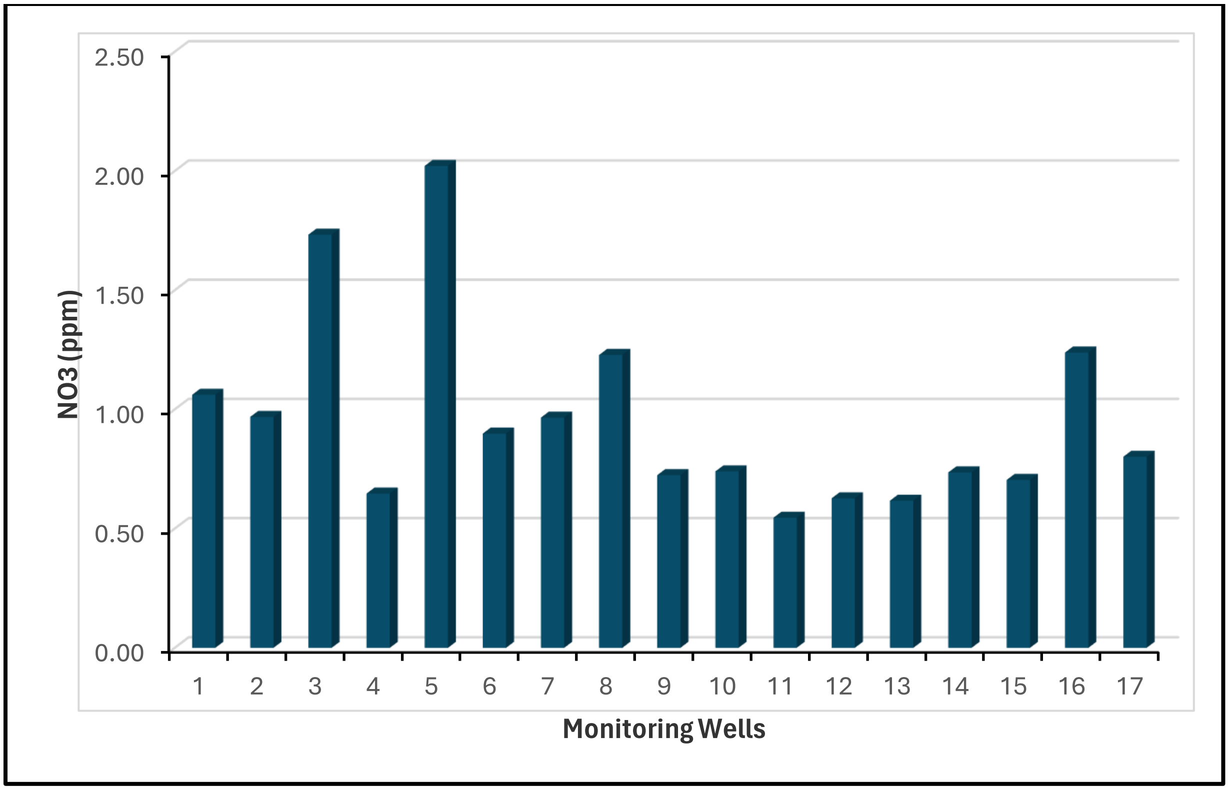

Figure 20. Spatial variation of NO3-N in the MMSU Farm

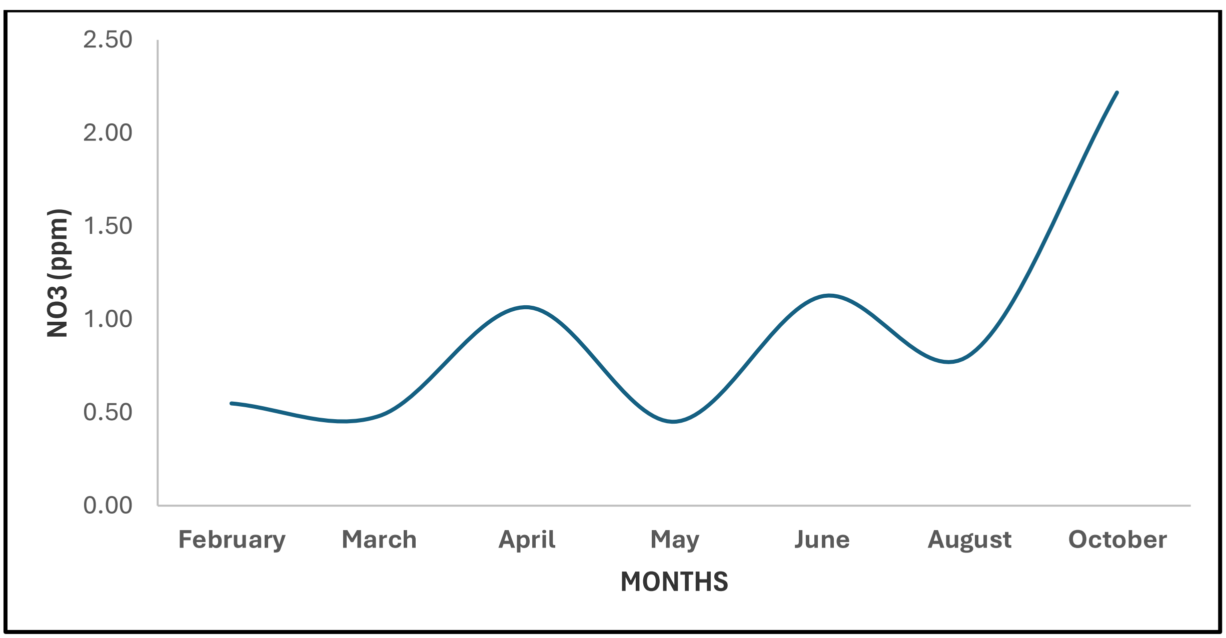

Figure 21. Temporal variation of NO3 in the study area.

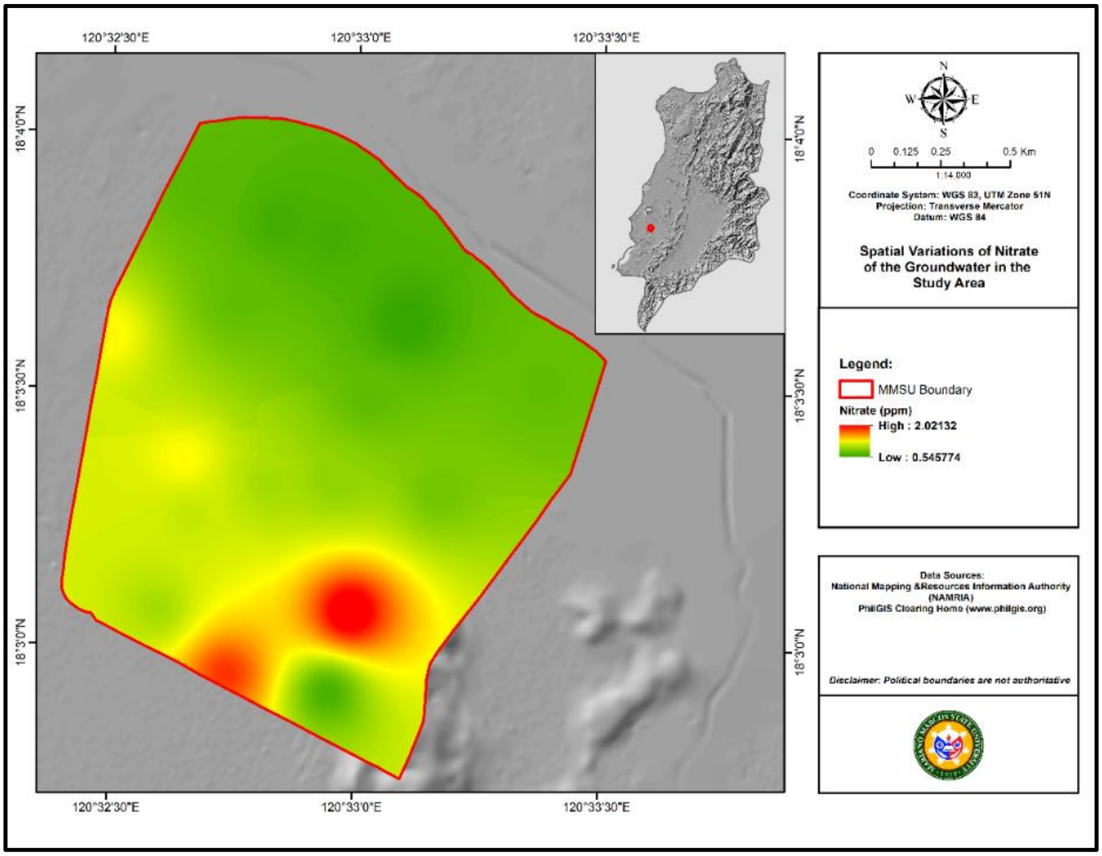

Figure 22. Map showing spatial variations of NO3 concentrations in MMSU

Ammonium Nitrogen (NH4-N)

The monthly measured concentrations of ammonium-nitrogen (NH_4-N) in the 17 monitoring wells from February 2024 to May 2025 (Table 10) revealed both spatial and temporal variations, indicating potential influences from seasonal changes, land use activities, and nitrogen inputs in the area. During the early months of monitoring (February to August 2024), the concentrations were generally low and stable, with mean values ranging from 0.21 to 0.39 mg/L across the wells. However, a significant increase was observed beginning in October 2024, where concentrations began to rise in several wells, notably W1, W2, W6, W8, W14, and W15. This trend continued through the dry months into May 2025, when the highest recorded NH_4-N concentration of 5.90 mg/L was observed in W1. These elevated values suggest possible contamination from agricultural runoff, septic systems, or accumulated nitrogen being mobilized during the dry-to-wet seasonal transition.

Wells W1, W2, W6, W8, W14, and W15 consistently showed higher NH_4-N levels compared to others (Figure 31), with W8 exhibiting a sharp increase starting in October 2024 and peaking at 3.30 mg/L in May 2025 (Figure 32). In contrast, wells such as W4, W5, W10, and W11 maintained relatively low concentrations throughout the monitoring period, with minimum values as low as 0.07 to 0.11 mg/L, suggesting these wells may be less influenced by anthropogenic sources or are located in areas with limited nitrogen loading. The highest mean concentration was recorded in W8 (1.32 mg/L), while W11 had the lowest mean value of 0.40 mg/L. Across all wells, the mean concentration steadily increased over time, culminating in an overall peak in May 2025 with an average of 2.86 mg/L, compared to just 0.39 mg/L in February 2024.

These findings indicate that nitrogen accumulation in the groundwater system is likely influenced by both human activities and seasonal hydrological processes. The observed increases during the later months could be attributed to delayed infiltration, reduced dilution in dry periods, and the flushing of accumulated nitrogen following rainfall events. The presence of NH_4-N concentrations exceeding 0.5 mg/L in several wells highlights potential risks to groundwater quality and underscores the importance of continuous monitoring, identification of pollution sources, and implementation of appropriate land and water management interventions to safeguard groundwater resources.

Table 10. Monthly NH4-N concentration (mg/L) measured in different monitoring wells within MMSU Farm

Code	Monitoring Wells	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Aug-24	Oct-24	Nov-24	Jan-25	Feb-25	Mar-25	Apr-25	May-25	**Mean**	**Max**	**Min**
1	W1	0.11	0.20	0.29	0.20	0.20	0.18	0.23	1.96	1.24	0.30	1.40	0.96	5.90	**1.01**	**5.90**	**0.11**
2	W2	0.34	0.12	0.23	0.26	0.20	0.22	0.38	2.50	0.67	0.71	0.37	0.48	2.60	**0.70**	**2.60**	**0.12**
3	W3	0.29	0.28	0.22	0.39	0.19	0.17	0.17	0.39	0.48	0.72	0.54	0.76	2.80	**0.57**	**2.80**	**0.17**
4	W4	0.25	0.14	0.12	0.09	0.07	0.11	0.13	0.20	0.29	0.62	0.64	0.57	2.70	**0.46**	**2.70**	**0.07**
5	W5	0.18	0.13	0.14	0.08	0.40	0.17	0.26	0.28	0.28	0.55	0.19	0.14	2.80	**0.43**	**2.80**	**0.08**
6	W6	1.30	1.40	0.24	0.18	0.20	0.20	0.22	1.29	0.54	0.56	0.77	0.51	2.91	**0.79**	**2.91**	**0.18**
7	W7	0.14	0.15	0.36	0.20	0.13	0.10	0.15	2.50	0.39	0.37	0.22	0.13	2.80	**0.59**	**2.80**	**0.10**
8	W8	0.57	0.29	0.32	0.18	0.21	0.20	0.21	2.50	2.10	2.00	2.80	2.50	3.30	**1.32**	**3.30**	**0.18**
9	W9	0.23	0.20	0.13	0.16	0.12	0.36	0.18	0.25	0.38	0.74	1.10	0.38	2.30	**0.50**	**2.30**	**0.12**
10	W10	0.18	0.19	0.15	0.11	0.12	0.15	0.17	0.15	0.21	0.39	0.80	0.17	2.80	**0.43**	**2.80**	**0.11**
11	W11	0.11	0.32	0.13	0.11	0.08	0.18	0.12	0.22	0.18	0.24	0.29	0.50	2.70	**0.40**	**2.70**	**0.08**
12	W12	0.34	0.17	0.12	0.43	0.38	0.13	0.17	0.29	0.58	0.45	0.63	0.37	2.70	**0.52**	**2.70**	**0.12**
13	W13	0.28	0.28	0.13	0.41	0.21	0.17	0.23	0.53	0.39	0.49	0.40	0.70	1.40	**0.43**	**1.40**	**0.13**
14	W14	0.33	0.55	0.49	0.32	0.20	0.52	0.20	0.81	0.97	0.72	1.70	0.94	2.50	**0.79**	**2.50**	**0.20**
15	W15	1.10	0.19	0.22	0.12	0.22	0.25	0.21	0.74	0.60	0.85	0.87	0.44	2.70	**0.65**	**2.70**	**0.12**
16	W16	0.45	0.35	0.25	0.22	0.15	0.28	0.21	0.42	0.90	0.46	0.60	0.34	2.93	**0.58**	**2.93**	**0.15**
17	W17	0.46	0.43	0.17	0.18	0.43	0.22	0.47	0.78	0.75	0.54	0.91	0.59	2.70	**0.66**	**2.70**	**0.17**
mean		**0.39**	**0.32**	**0.22**	**0.21**	**0.21**	**0.21**	**0.22**	**0.93**	**0.64**	**0.63**	**0.84**	**0.62**	**2.86**	**0.64**	**2.86**	**0.13**
max		**1.30**	**1.40**	**0.49**	**0.43**	**0.43**	**0.52**	**0.47**	**2.50**	**2.10**	**2.00**	**2.80**	**2.50**	**5.90**	**1.32**	**5.90**	**0.20**
min		**0.11**	**0.12**	**0.12**	**0.08**	**0.07**	**0.10**	**0.12**	**0.15**	**0.18**	**0.24**	**0.19**	**0.13**	**1.40**	**0.40**	**1.40**	**0.07**

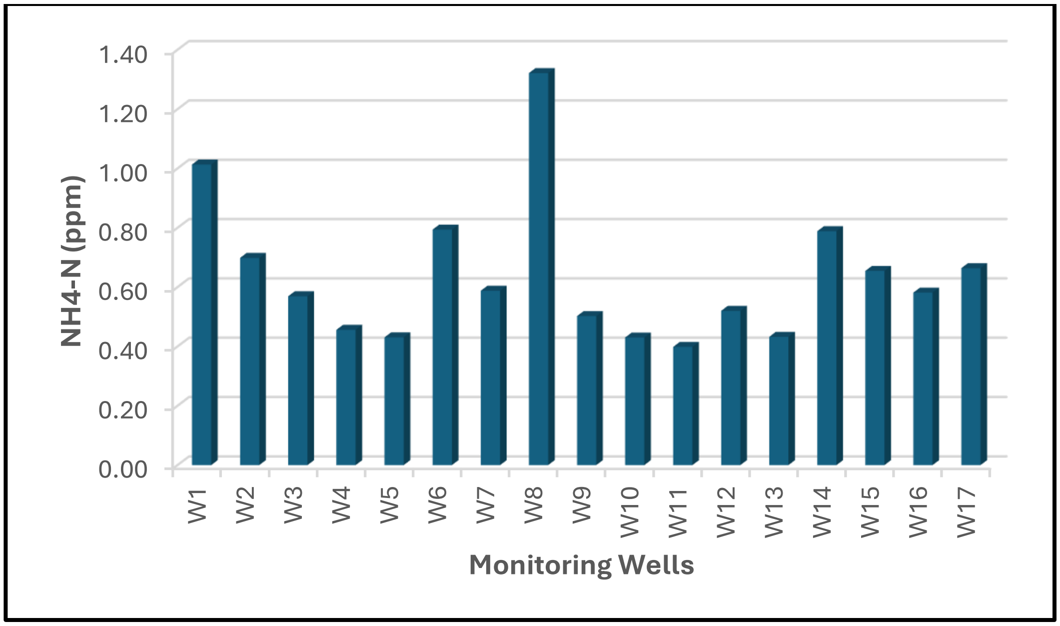

Figure 20. Spatial variation of Ammonium-Nitrogen in the MMSU Farm.

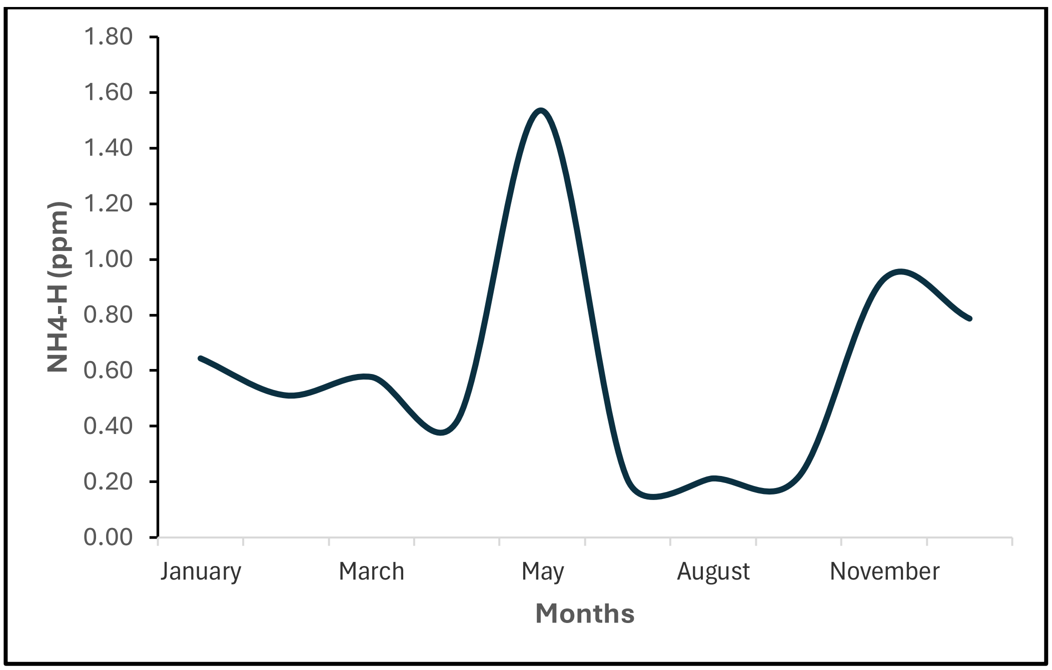

Figure 21. Temporal variation of Ammonium-Nitrogen in the study area

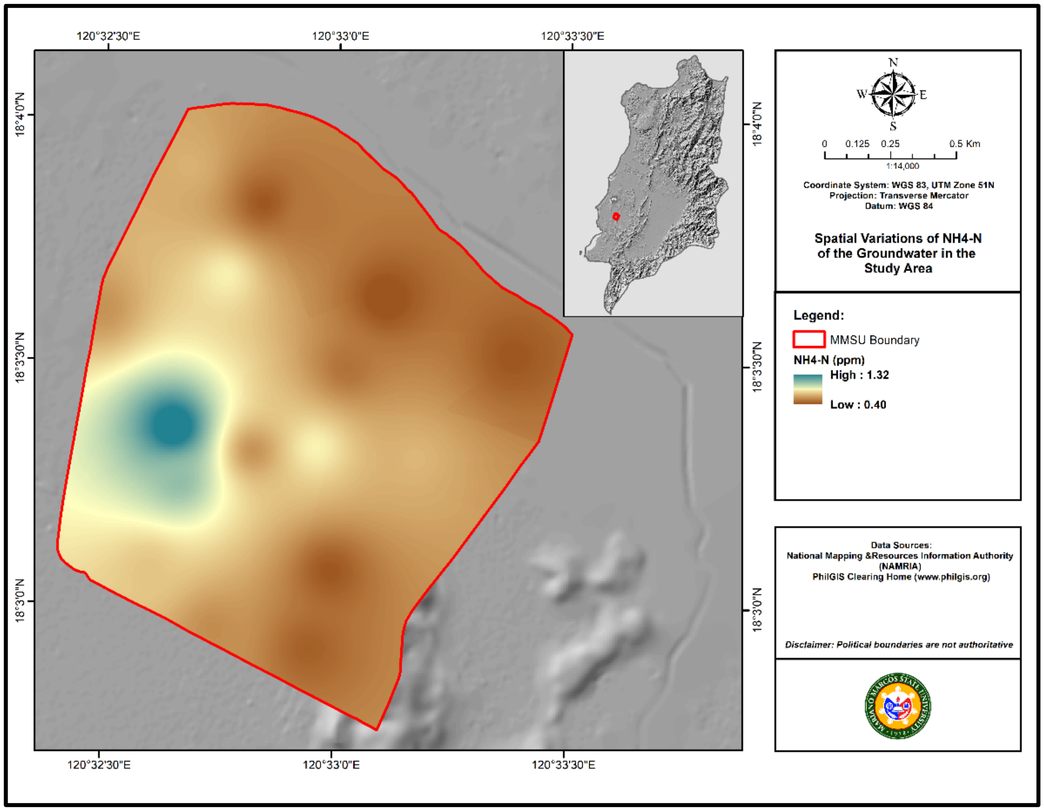

Figure 22. Map showing spatial variations of NH4-N concentrations in MMSU