

## **ARSENIC CONTAMINATION IN GROUNDWATER IN KYONPYAW AREA, AYEYARWADY REGION**

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**KEY WORDS:** Ayeyarwady Region, Kyonpyaw area, Arsenic contamination and tube wells

**ABSTRACT:** Ayeyarwady Region is occupying the delta region of Ayeyarwady River and located in the southern part of the country. Kyonpyaw area, located in the central part of the region, is covered by low lying alluvial flat plain, lakes and most swamps, which are flooded in rainy season. Arsenic contamination varies in different types of water sources like shallow tube wells, deep tube wells, dug wells, lakes and ponds, stream and river. It is especially noticeable in drinking water.

The objectives of the paper are to examine the spatial distribution of arsenic contamination and to identify the arsenic concentrated area comparing with the density raster map of arsenic distribution. The sample points of Arsenic content data are totally 4968 which represent the various sources in Kyonpyaw area. Point density analysis and depth density analysis are applied to study the affected places of arsenic contamination in the study area. Result shows that density of arsenic concentration is high at Northeast and Southeast of Kyonpyaw area. Shallow tube wells contain more arsenic content than other types of sources. Land cover classification based on Landsat image, expresses that high arsenic levels are locally pronounced in settlement areas and some cultivated lands.

### **1. INTRODUCTION**

Arsenic is found widely in surface and groundwater in many parts of the world. It is a metalloid solid, naturally occurring toxic substance characterized as white, semi-metallic powder, tasteless and odourless, frequently found in the earth's crust. Arsenic is present in air, soil, water and rock. Human beings take a little amount of arsenic every day through breaths, food or drinks.

The study area is located in the Ayeyarwaddy Region and it lies between latitude 17° 08' 00" N to 17° 30' 00" N and longitude 95° 07' 00" E and 95° 25' 00" E. It has an area of 878 square kilometers (Figure 1).

Kyonpyaw area is covered by low lying alluvial flat plain, lakes and most swamps, which are flooded in rainy season, act as breeding ground of fish and thus fishing industry is an important local business after growing rice. The content of arsenic varies in different types of water sources like shallow tube wells, deep tube wells, dug well, lakes and ponds, stream and river that it is especially noticeable in drinking water. The sample points of Arsenic content data are totally 4968 which represent the various sources in study area. Kyonpyaw Township consists of 4 wards and 88 villages tracts covering 515 villages that bring about a total of 532 villages and wards.

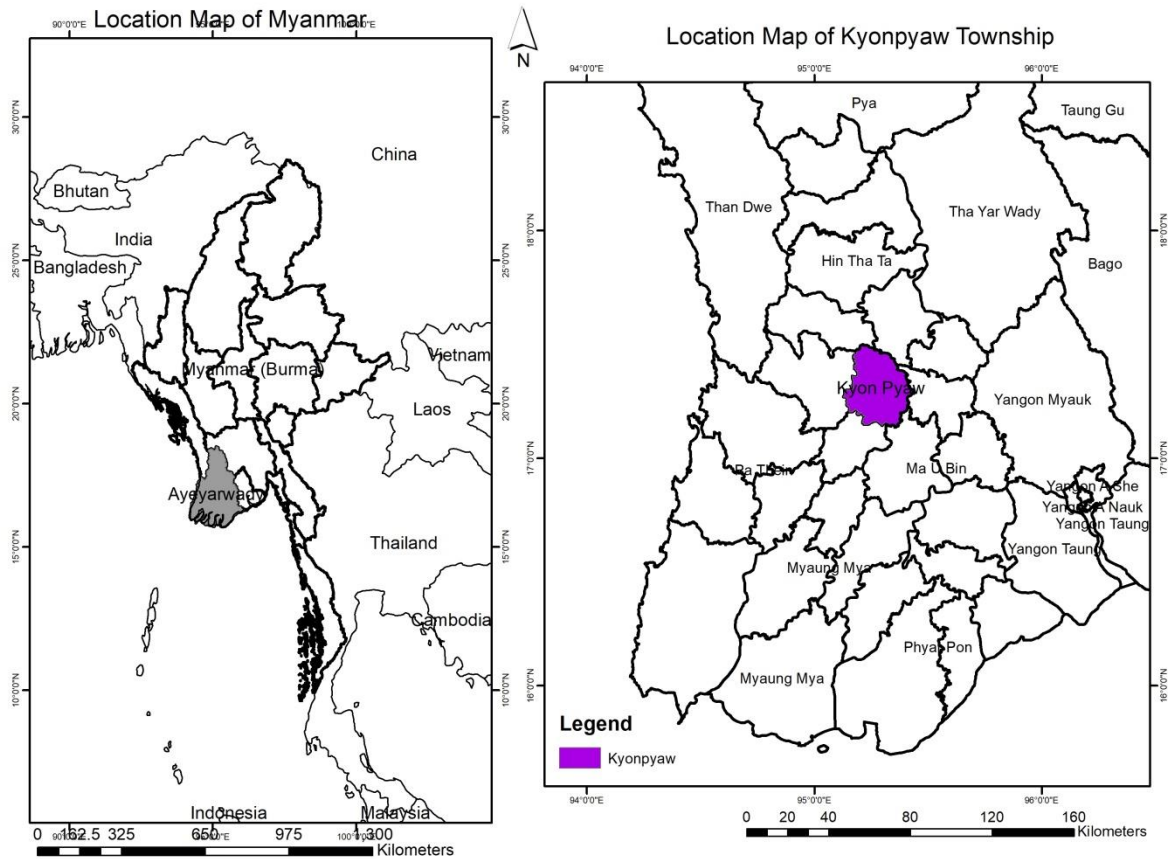


Figure 1: Location map of Kyonpyaw township, Ayeyarwaddy division

### 1.1. Objectives

Objectives of the paper are to examine the spatial distribution of arsenic contamination density, to identify the arsenic concentrated area comparing with the density raster map of arsenic distribution and to study the relationships between density of arsenic contamination and buffer areas and types of tube-wells

### 1.2. Data Sources and Methodology

Topographic map with the attribute of arsenic sample point data was attained from Water Resources Utilization Department (WRUD). Satellite image of Landsat 7 TM (2005) was used for land cover classification dealing with the settlement and vegetated areas.

The study of arsenic contamination is performed by applying GIS and remote sensing. Firstly, reformat the georeferenced data with attribute that are originally designed in Geomedia software to Arc GIS application. This application is handled for the analysis of spatial distribution of arsenic contamination such as Z score rendering, density analysis and buffer analysis. Envi (4.4) software is applied to classify the various kinds of land cover in Kyonpyaw area that reveals the relationship between arsenic distribution and land cover classes. The flow chart of methodology is shown in figure 2.

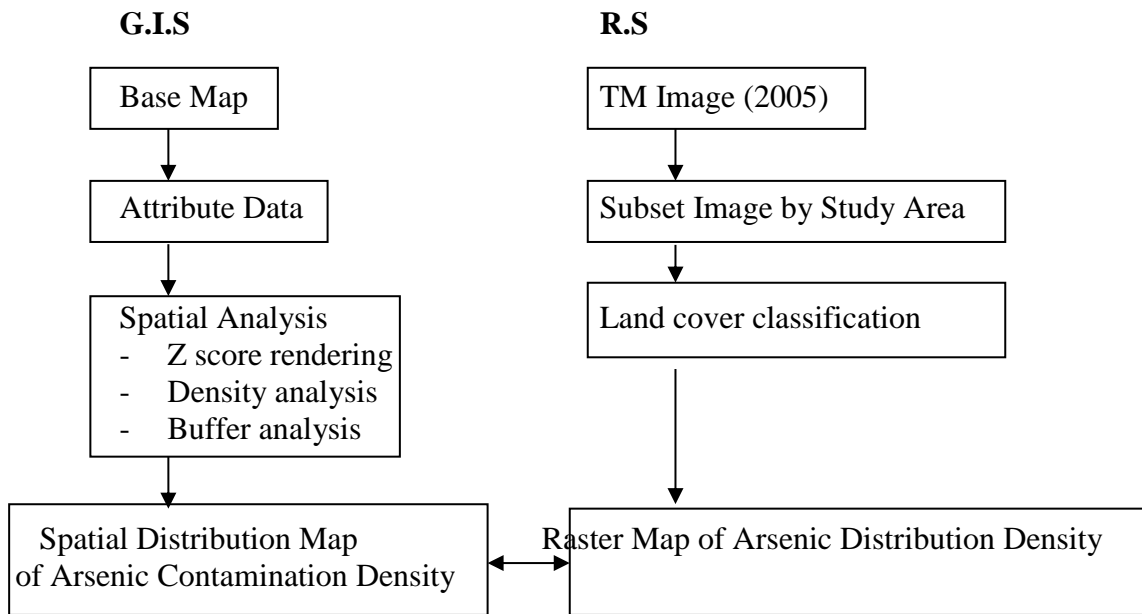


Figure 2 Study Design for the Distribution of Arsenic Contamination

## 2. RESULT AND DISCUSSION

### 2.1. DATA ANALYSIS

4968 sample points data are analyzed for investigation on the distribution of arsenic contamination which relative to various types of sources, depth of sources, and river or lake buffer zones. The distribution result of arsenic content in Kyonpyaw area is shown in figure 3.

### 2.2. Z Score Rendering

This rendering creates a layer file with Z scores rendered, and ranges between below -2 standard deviation and above 2 standard deviation. The Z Renderer is appropriate for rendering output from both the hot spot analysis and diversity analysis. Current map layers may be used to define input feature class. When using layers, only the currently selected features are used in the centre feature operation.

Z score map that rendered from result of arsenic content is shown in figure 4.

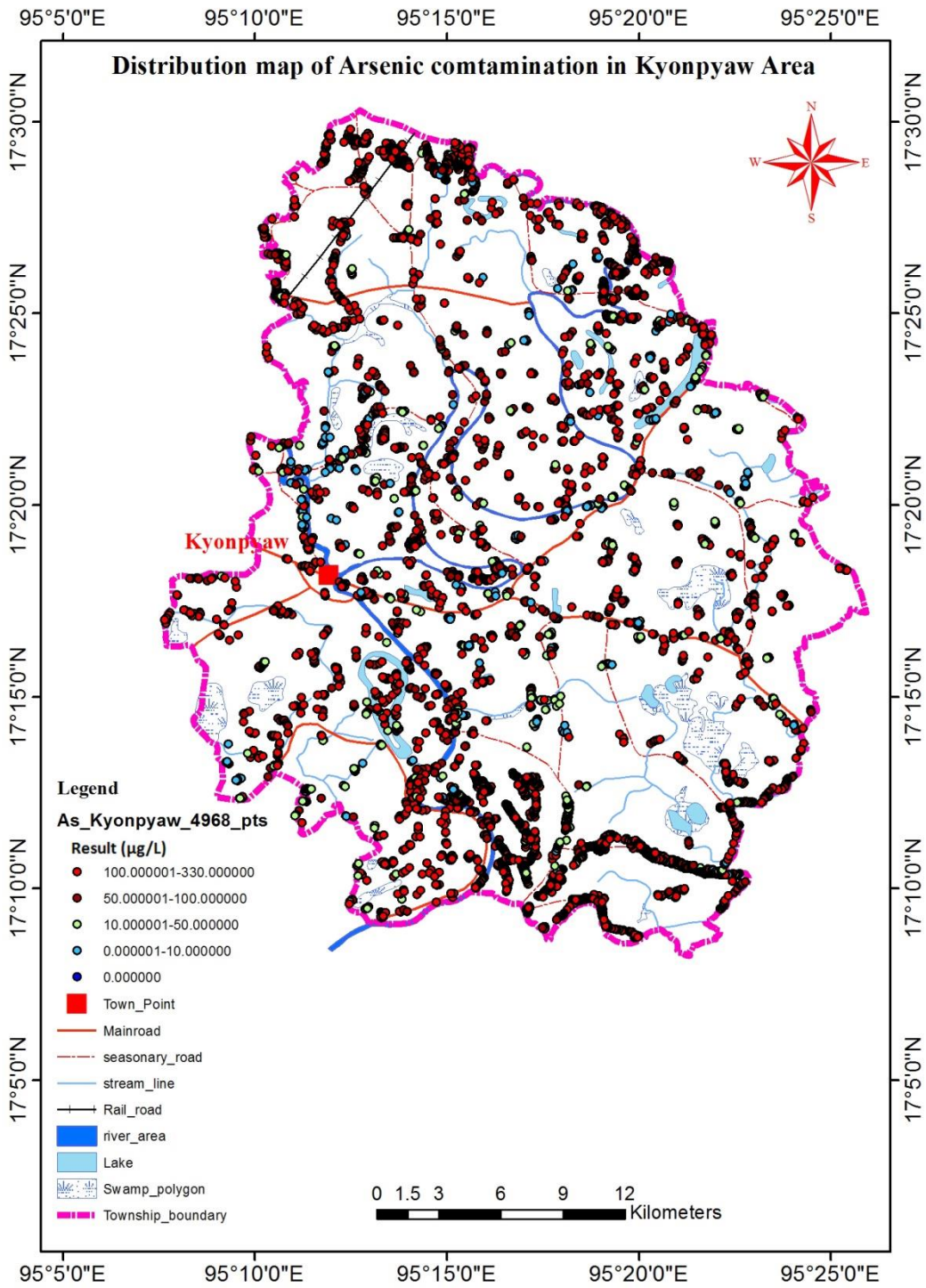


Figure 3: The Distribution of Arsenic Contamination in Kyonpyaw Area

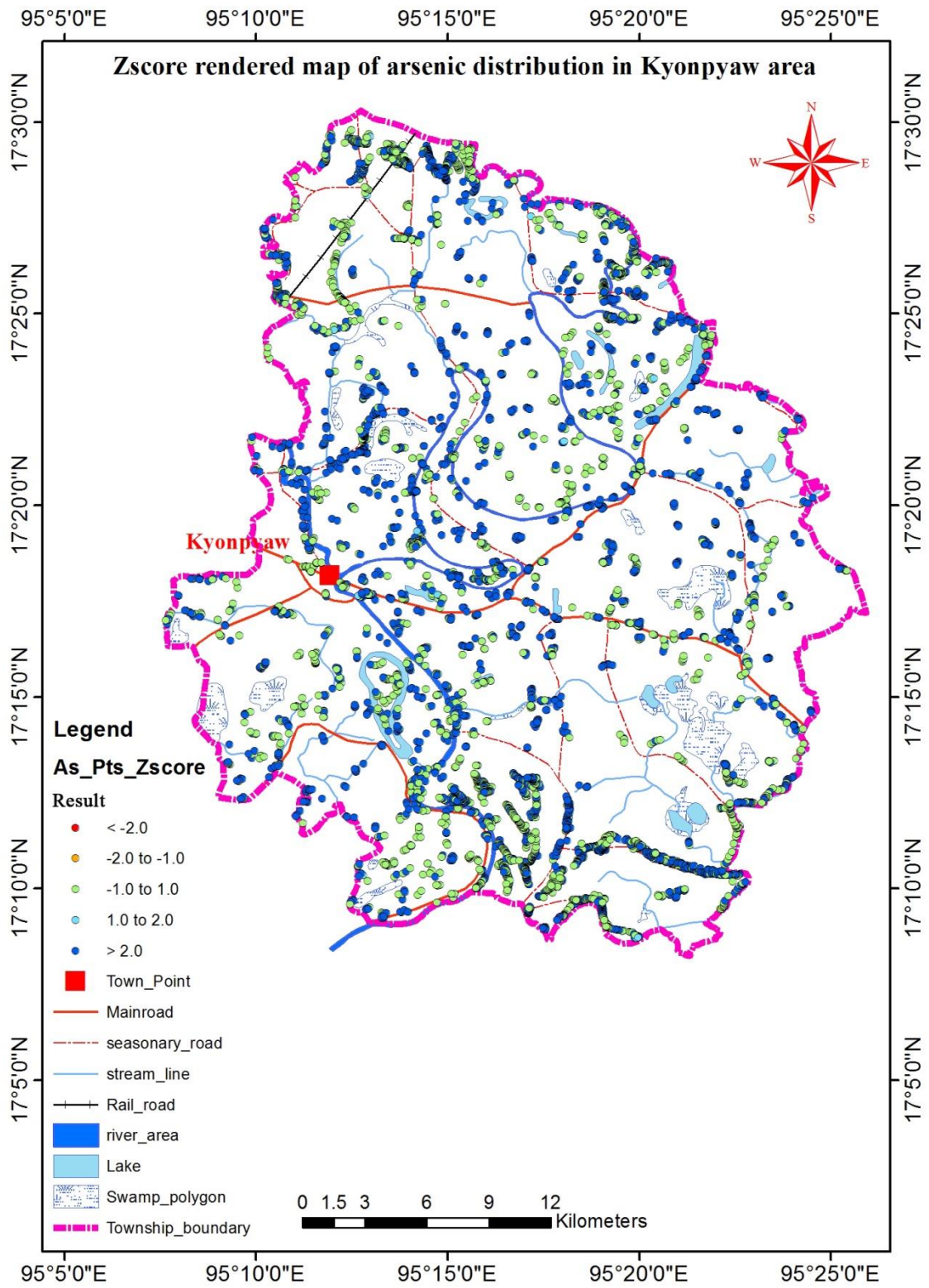


Figure 4: Z score Rendering of Arsenic Distribution in Kyonpyaw Area

### 2.3. Point Density Analysis

Point density analysis calculates a magnitude per unit area from point features that fall within a neighborhood around each cell are considered in calculating the density. If no points fall within the neighborhood at a particular cell, that cell is assigned no data.

Arsenic contamination in all tested points is calculated by density analysis and the result shows that arsenic contamination is rather high at northeastern part and southeastern part of Kyonpyaw (Figure 5).

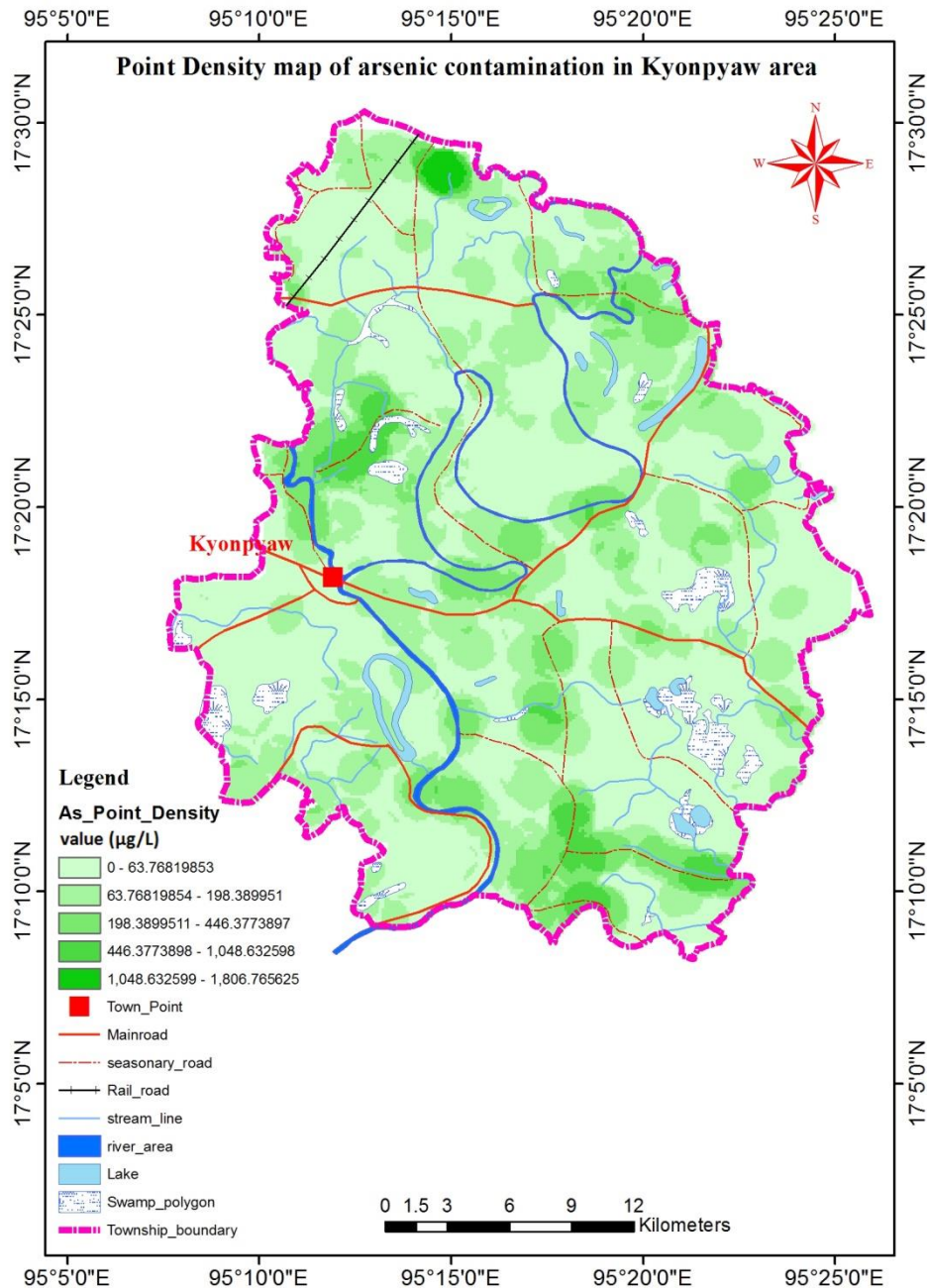


Figure 5: Density Map of Arsenic Contamination in Kyonpyaw Area

### 2.4. Depth Density Analysis

This analysis mainly focuses on the depth of various sources of tested wells in the study area. Most of the tested wells in the west and vicinity of Kyonpyaw town is deeper than that of northeastern and southeastern parts (Figure 6).

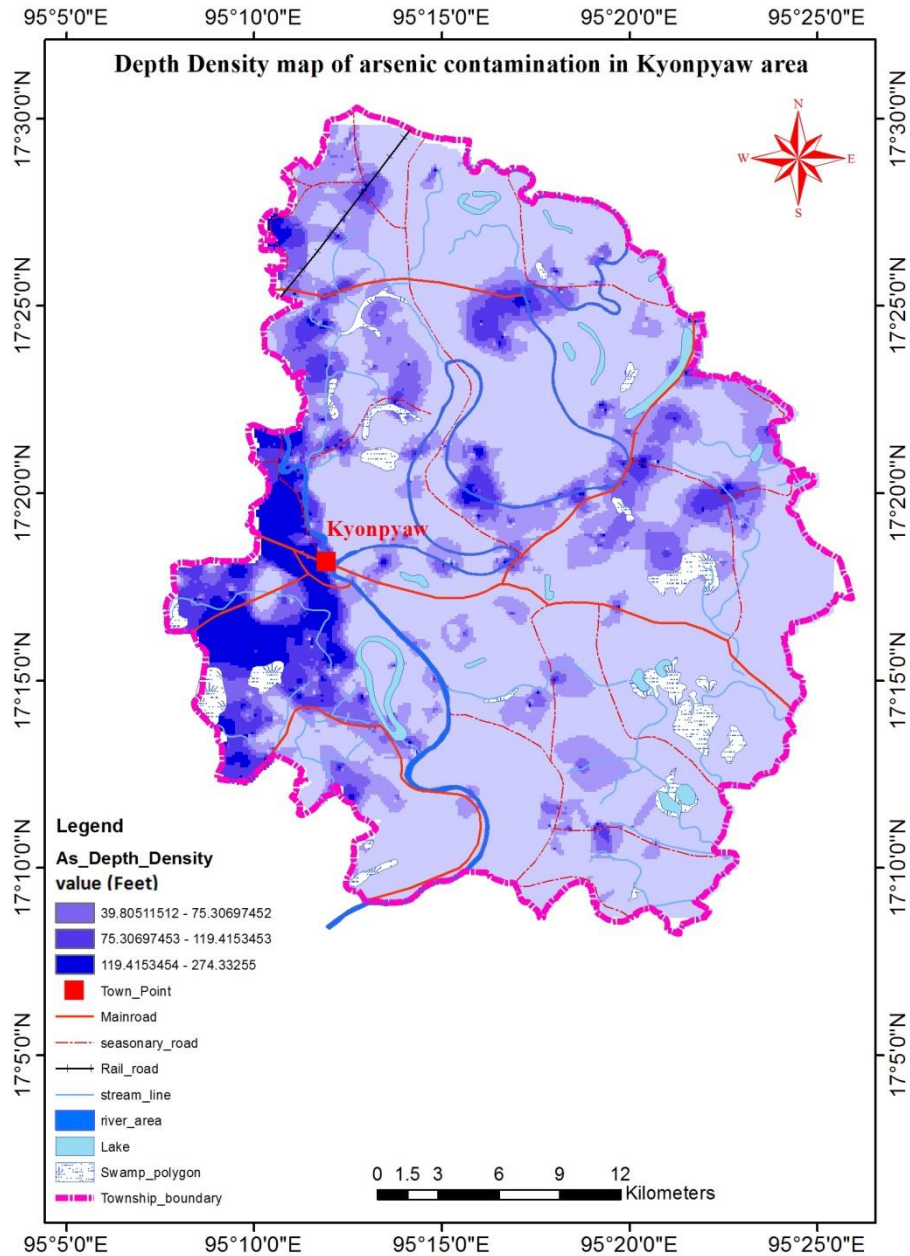


Figure 6: Depth Density Map of Arsenic Contamination in Kyonpyaw Area

### 2.5. Analyzing Attribute

Among the attribute of arsenic sample points data, types of sources provide the inspection of distribution of arsenic contamination that relative to spatial analysis as well as land cover classification. In Kyonpyaw area, five types of sources of tested point for arsenic contamination are examined as shallow tube wells (3455 points), dug wells (1014 points), deep tube wells (426 points), lakes and ponds (24 points) and streams and rivers (49 points). Among them, the former three are applied for the determination of arsenic distribution in study area.

Arsenic contamination and distribution is mostly high in shallow tube wells than other two sources as dug wells and deep tube wells. Although the dug wells are distributed throughout the study area, deep tube wells are mostly studied in the westernmost part (Figure 7, 8 and9).

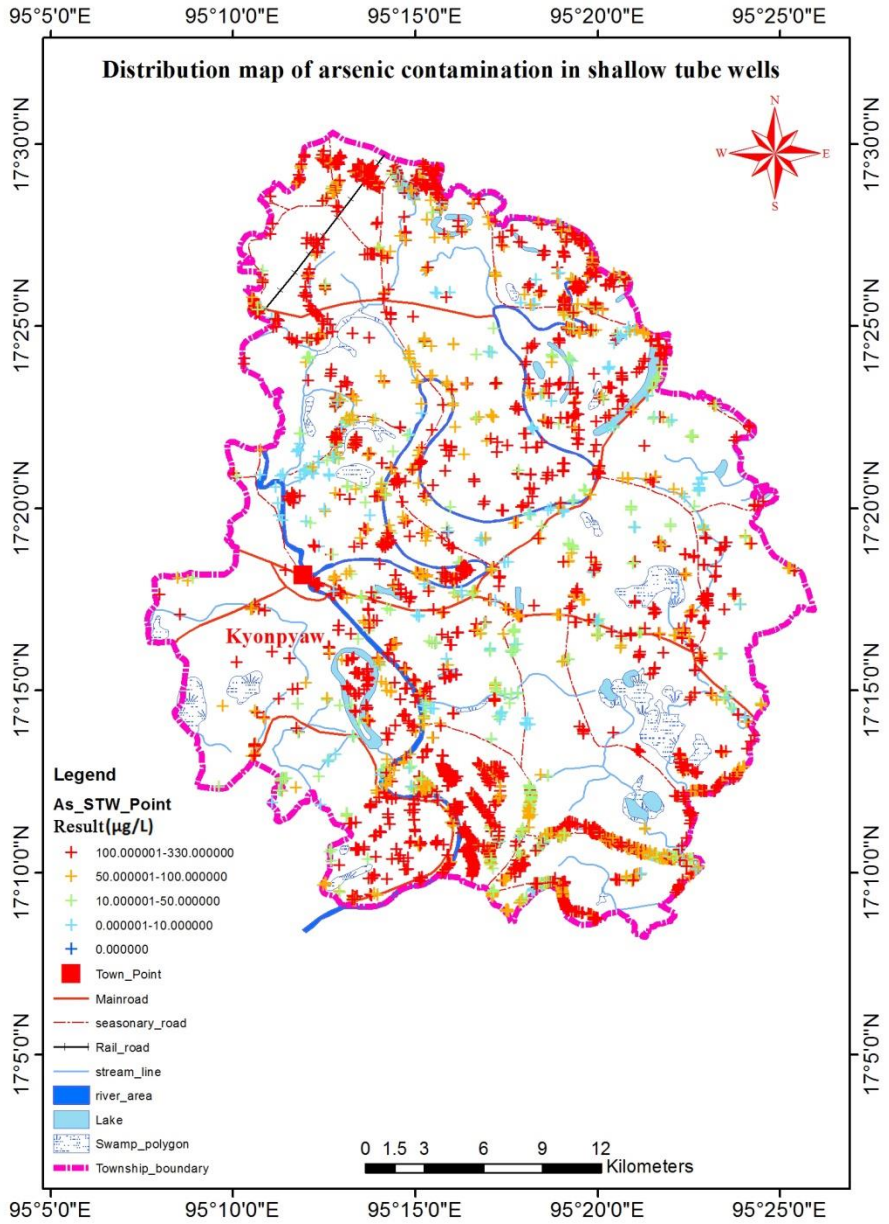


Figure 7: Distribution Map of Arsenic Contamination in Shallow Tube Wells



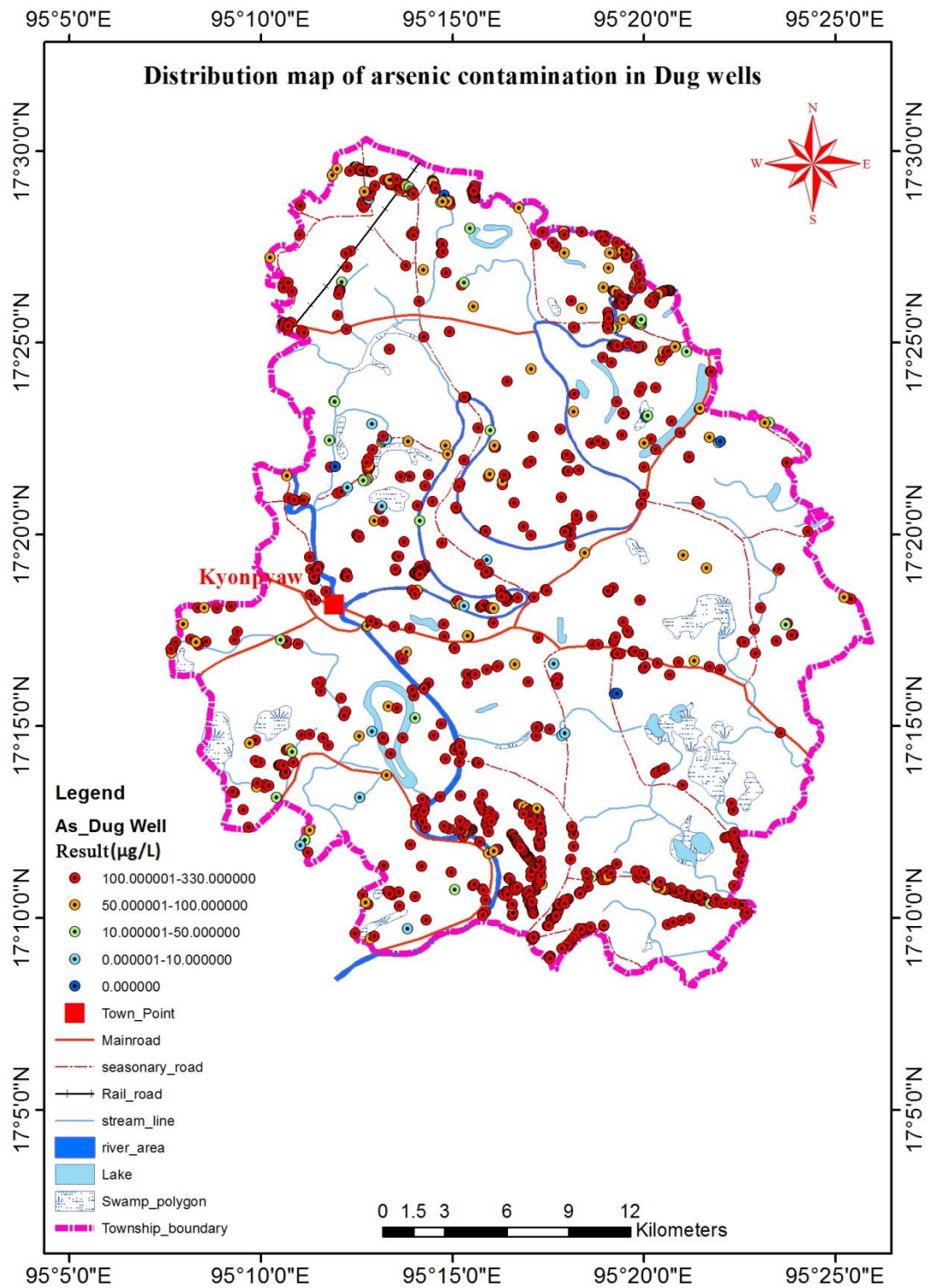


Figure 8: Distribution Map of Arsenic Contamination in Dug Wells

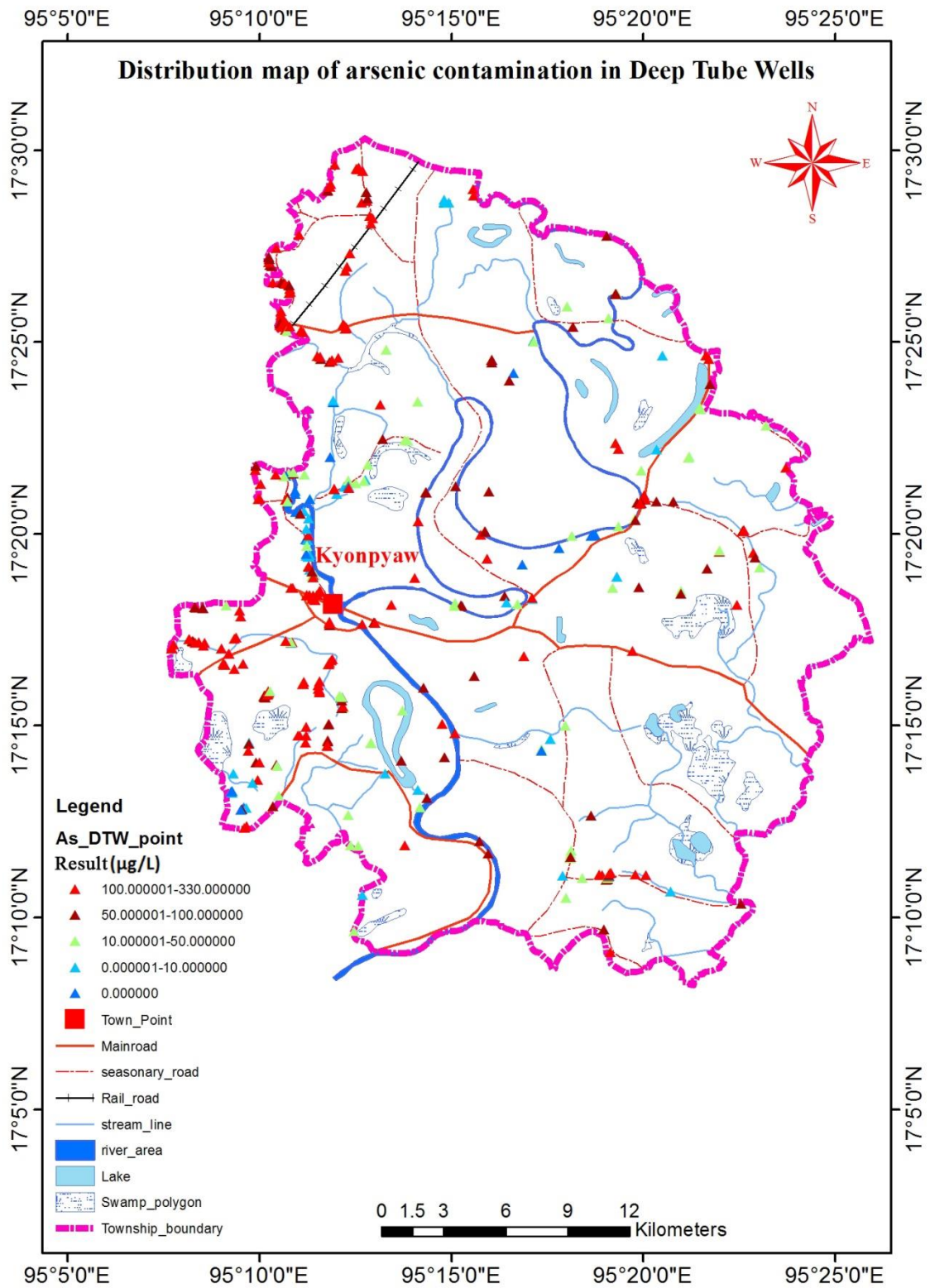


Figure 9: Distribution Map of Arsenic Contamination in Deep Tube Wells

## 2.6. Analysis on TM Image

Remote sensing application also helps for the examination of the distribution of arsenic contamination. TM image of Kyonpyaw area is analyzed with band combination (4/5/3) by Envi software and then study the arsenic distribution on the image (Figure 10).

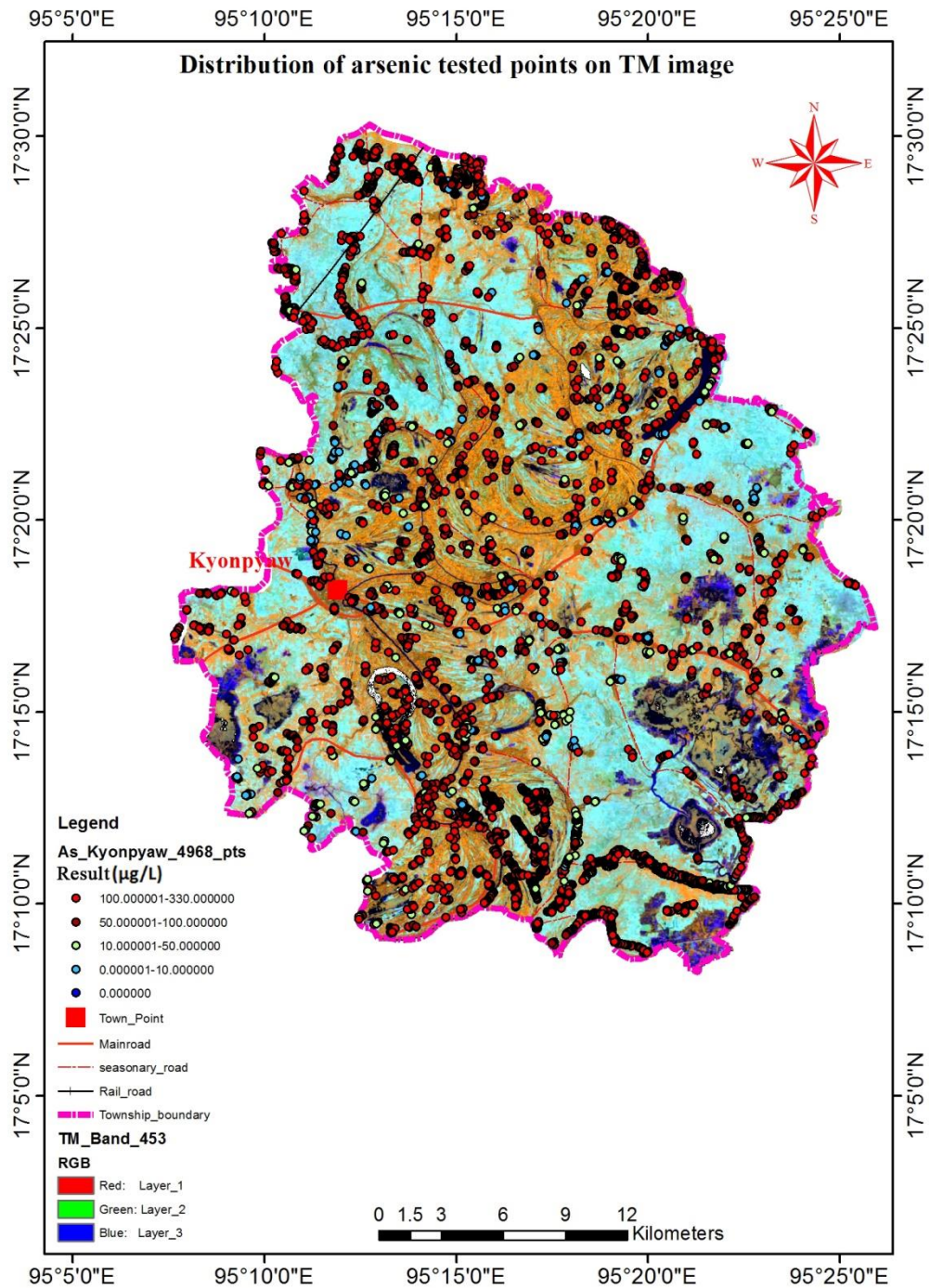


Figure 10: Distribution of Arsenic Tested Points on TM image

## 2.7. Land Cover Classification

This analysis gives valuable information that can be correlated between classes of land cover and arsenic distribution in Kyonpyaw area. According to the land use and geomorphology, six classes of land cover are determined. They are (i) settlement, (ii) mixed forest, (iii) river, (iv)

cultivated land, (v) lake and (vi) sandbar. Relationship between types of land cover and arsenic distribution suggests that arsenic content is mostly gathered in settlement areas and some cultivated land (Figure 11).

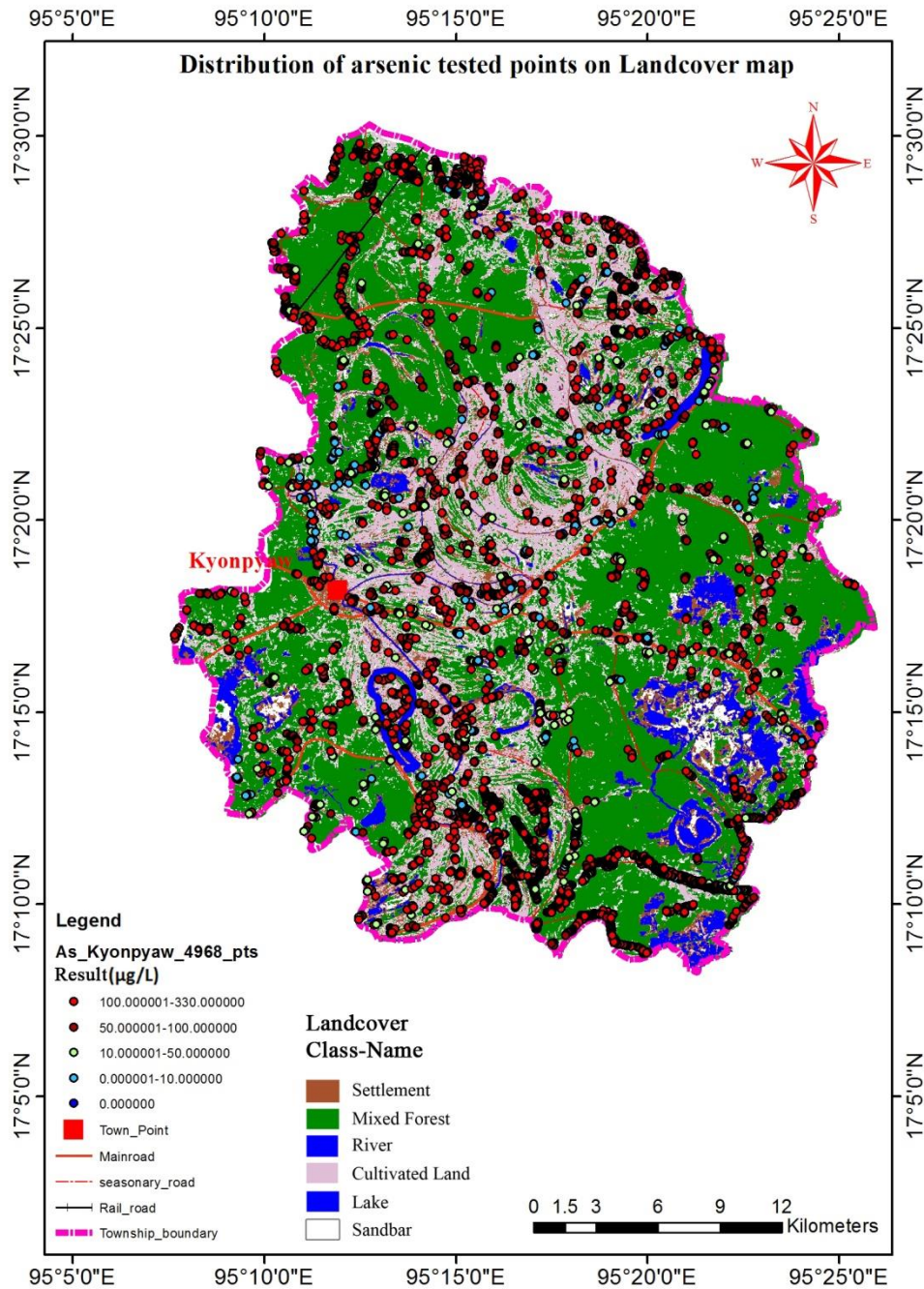


Figure11: Distribution of Arsenic Tested Points on Land Cover Map  
 The depth density correlated with result distribution of arsenic contamination also point out the relationship between the arsenic level and the depths of various types of tested points or tube wells (Figure12).

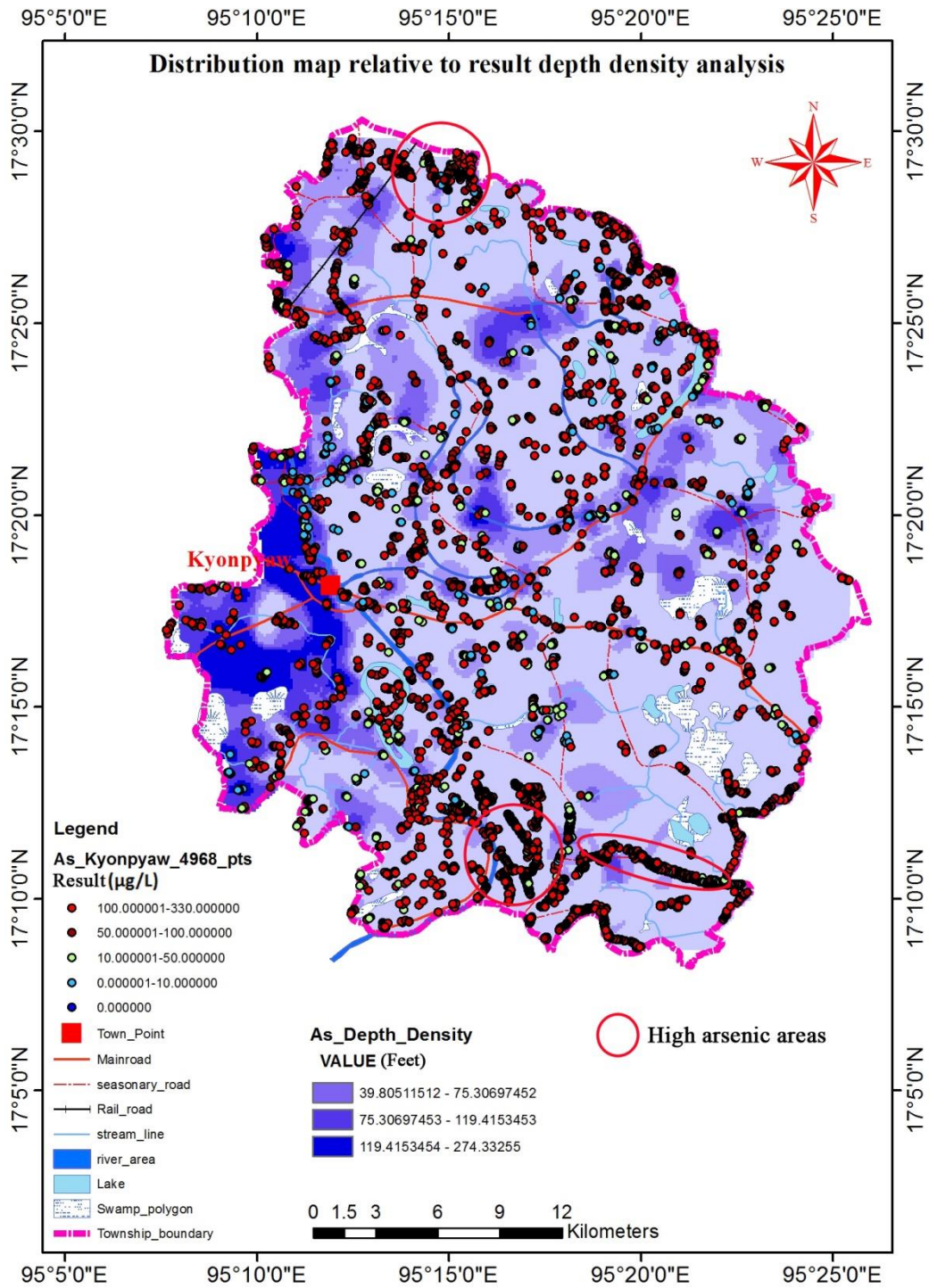


Figure 12: Distribution Map of Depth Density Analysis. Most of shallow tube wells comprising highest arsenic level are located in or around the buffer zones especially at the contact zones of river and lake buffers (Figure 13).

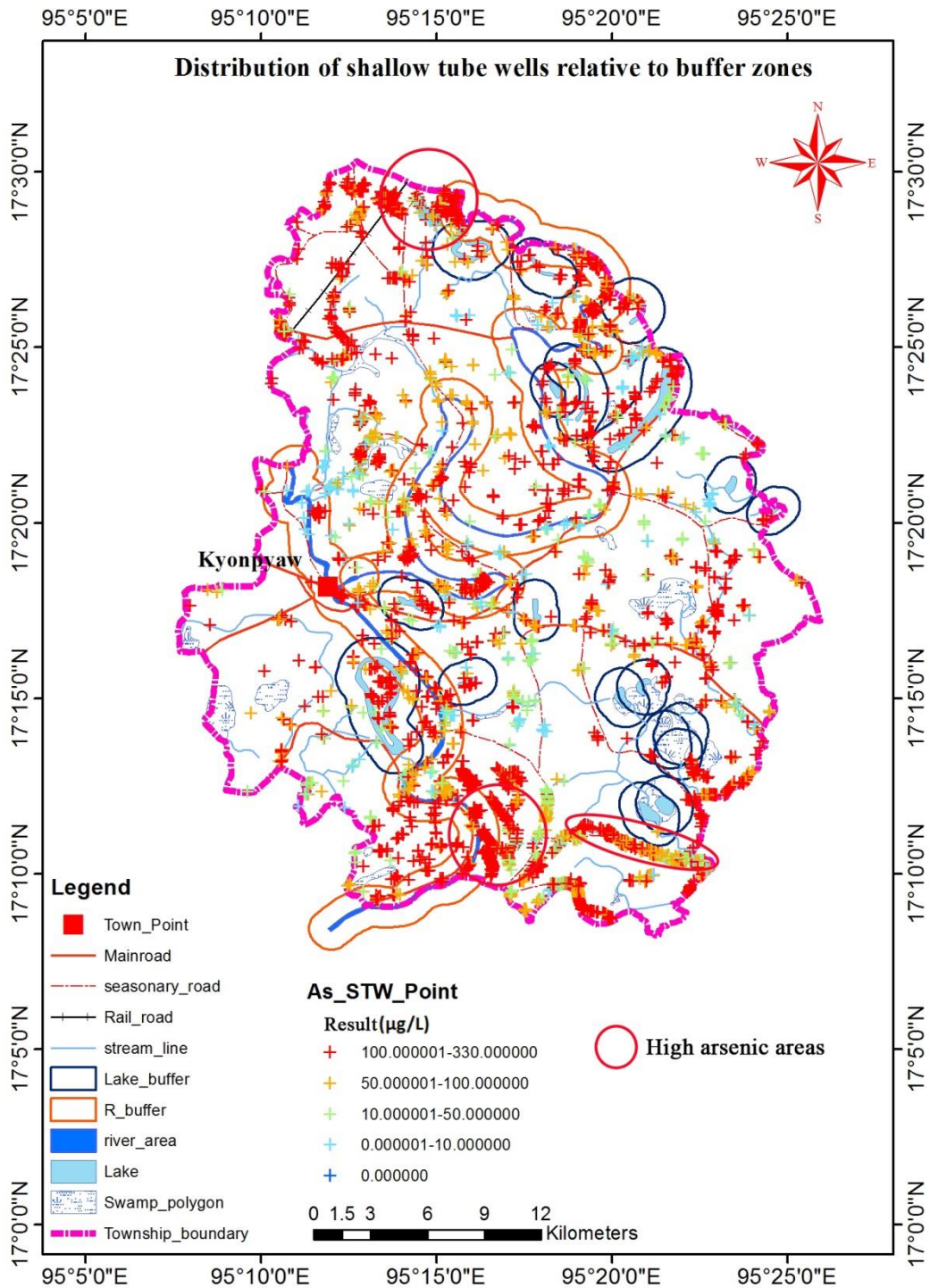


Figure 13: Distribution of Shallow Tube Wells Relative to Buffer Zones

### 3. CONCLUSION

Kyonpyawn Township is located in Ayeyarwaddy Delta and it is also a alluvial flat plain consisting meandering features which are created by Ayeyarwaddy River. 4968 sample points of various sources are analyzed for spatial distribution of arsenic contamination in study area.

Analysis of spatial distribution of arsenic contamination such as Z score rendering, density analysis and buffer analysis are carried out by using Arc GIS. Envi (4.4) software is applied for land cover classification in Kyonpyaw area.

Distribution pattern of different level of arsenic content in Kyonpyaw area is resulted by analyzing the arsenic result of various sources. Density analysis of all tested points shows that arsenic contamination is rather high at northeastern and southeastern parts of Kyonpyaw town. Depth density analysis suggests that test wells in west and vicinity of Kyonpyaw town are deeper than others.

Buffer analysis of both rivers and lakes are calculated by inputting the buffer distances as 500 meters away from these rivers and lakes. This analysis reveals that the distribution of arsenic is probably controlled by rivers and lakes in the study area.

Three types of sources of tested point are analyzed for correlation between spatial distribution of arsenic contamination and types of sources. Arsenic level and its concentration are more pronounced in shallow tube wells than other two as dug wells and deep tube wells.

TM image of Kyonpyaw area analyzed with band combination (4/5/3) is classified as six types of land cover and this classification expresses that high arsenic levels are mostly associated with settlement areas and some cultivated land.

Result density correlated with buffer zones of rivers and lakes points out that the high arsenic concentrated areas are located in or around the buffer zones mainly in northeastern part of study area.

In the shallow tube wells existed at the contact zones of river and lake buffers, arsenic contents are rather high than other places throughout the area.

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