IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 14, Issue 6 Ser. II (June 2020), PP 47-52
www.iosrjournals.org

Detection of Cadmium Seepage in Settlement Areas Around the West Flood Canal of Semarang City Using Geoelectric Methods and AAS Test

Danusaputro H[1], Suripin[2], Sasongko D.[3], Sutanto. H[3]
[1](*Doctoral Program on Environmental Science, Diponegoro University, Indonesia)*
[2](*Civil Engineering Department, Engineering Faculty of Diponegoro University, Indonesia)*
[3](*Physics Department, Sciences and Mathematics Faculty of Diponegoro University,Indonesia)*

Abstract:
The distribution of cadmium content in the residential area around the Semarang West Flood Canal was carried out by analyzing the element content of cadmium in the community's well water and river water.In addition to knowing the presence of heavy metal infiltration in the form of pollutants is done by the dipole-dipole geoelectric method and to determine the structure of the subsoil area. Based on the low resistivity value, the difference in height between the well and the river and the AAS test results prove that seepage occurred from the river to the residents well.This research carried out around the river in the Dorowati area in Tawang Mas Village and Panggung Kidul in Tanggul Mas Village. At the Dorowati location in the first to the third lane, the resistivity value of 0.762 - 5.42 Ωm can be predicted as a pollutant. At the Kidul Stage on the first to the third trajectory, the resistivity value of 1.81 - 4.58 Ωm can be predicted as a pollutant. Based on the results of the AAS test, the content of cadmium heavy metals in river water and well water is Cd or cadmium with concentrations between 0.096 - 0.108 mg / L

***Key Word**: Resistivity, AAS test, Cadmium concentration.*

Date of Submission: 26-05-2020 Date of Acceptance: 13-06-2020

I. Introduction

Cadmium (Cd) is a white metal that is easily formed because of its soft and bluish color. The relatively low boiling point (767 ° C) makes it extremely flammable and forms cadmium oxide smoke[1]. The metal coating industry uses pure cadmium as a coating. In industry, Pb, and Zn, the refining process will always produce cadmium which is wasted into the environment. Cadmium can enter the human body through contaminated food and drinks[2]. Like other liquids, liquid waste from rivers that have been contaminated by heavy metals moves to spread following the underground topography in the area can be spread vertically or horizontally[3]. If the absorption of this dirty river continues to spread, it will pollute the soil which can then pollute the people's wells. To find out how the distribution of soil pollution can be done geophysical exploration with the resistivity method[4]. The resistivity method utilizes the electrical resistivity properties of subsurface rocks to detect subsurface formations[5]. This study uses geoelectric methods to determine subsurface layers and the presence of pollutants. The supporting method used to determine the value of heavy metal concentrations in rivers and wells is the AAS (Atomic Absorption Spectrophotometer).

II. Materials and Method

Data acquisition was conducted from November 2016 to January 2017 in the Dorowati Area in Tawang Mas Village and Tanggul Mas Village, Panggung Kidul Village. The geoelectrical resistivity method of the dipole-dipole configuration can be applied to obtain a subsurface appearance. This method is often used in resistivity surveys because of the low electromagnetic effects produced between current and potential circuits [6]. In the study area, measurements using a dipole-dipole resistivity configuration were carried out on three parallel trajectories. Data collection is done with a length of 90 meters for each track with the distance between the electrodes or ais 10 meters with n1, 2, 3, 4, and 5. The length of the path is limited due to field conditions that are not possible because the field is located on the edge river and adapted to the needs where it takes the subsurface to a shallow depth of about 10 meters[7].

The resistivity data obtained from the field is then processed using Microsoft Excel to calculate the apparent resistivity value[6]. After getting pseudo resistivity values, the midpoint value, distance, or interface between electrodes, n, and pseudo resistivity are transferred to notepad and stored in * .dat format to be read in Res2dinv software[8]. The results of the process with Res2dinv software obtained cross-sectional resistivity of each trajectory. The resulting cross-section is based on subsurface resistivity and depth measured based on the length of each trajectory at the study site. Each track is named with track D1 (first track), D2 (second track), D3 (third track), for location D (Dorowati). The distance of each track is 5 meters in the same plane. The same steps are carried out at location P (Panggung Kidul).

The AAS method is an analytical method that can be used to determine the elements in material and can even analyze samples in small quantities because this method has a very high sensitivity, accuracy, and selectivity [9]. AAS test is to determine the value of the concentration of cadmium in river water and well water. Research on water samples was taken from rivers and wells in the Dorowati area in Tawang Mas Village and Panggung Kidul area in Tanggul Mas Village. Water samples taken at the residents' wells and the West Flood Canal River were put into 100ml glass bottles because at the time of the AAS test the water needed was very little [10].

III. Results and Discussion

Geoelectric measurements in the Dorowati area have three tracks, each track has a distance of 5 meters. In this area, measurement has a path that is perpendicular to the river. Lane D1 is located close to people's houses which are located around the river bank.

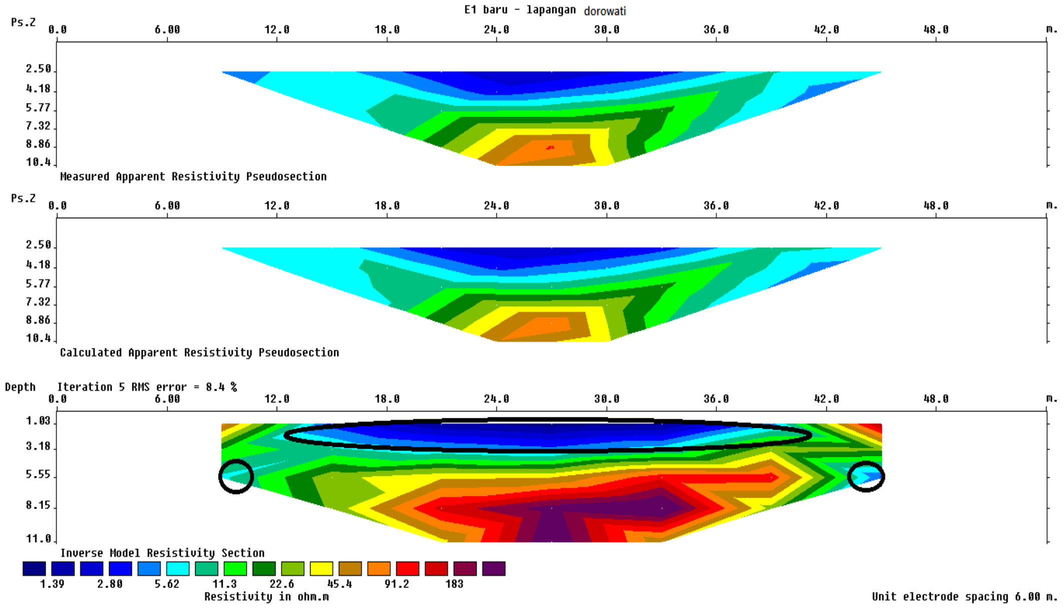

Figure 1. Transverse section of resistivity path D1 with anomaly

In this D1 path (Figure 1), the dominant resistivity value is 2.00 00m to 5.42 Ωm. Low resistivity values indicate that there is heavy metal pollution in the field [11]. As shown in Figure 1, the area encircled at a length of 10 meters with a depth of 1 meter to 5 meters and at a depth of 5 meters and a stretch of 8 meters and 45 meters has a low resistivity value. This can be predicted as a polluted area because there is a difference in resistivity but still one layer of rock. In line D2 (Figure 2) it can be seen that the resistivity values of 0.762 Ωm to 3.09 Ωm marked in dark blue to light blue indicate that there is pollutant pollution in the layer. In figure 2 is displayed on a stretch of 15 meters to 39 meters and at a depth of 1 meter to 5 meters.

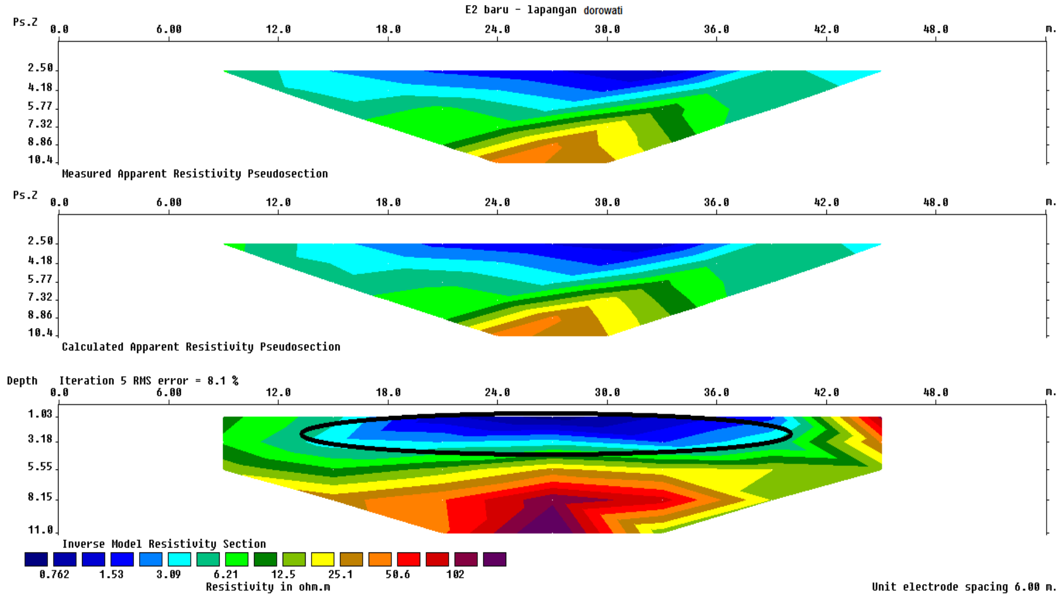

Figure 2. Cross-section of resistivity pathway D2 with anomaly

In path D3 (Figure 3), the anomaly occurs at lengths of 8 meters to 45 meters and depths of 1 meter to 5 meters where the resistivity value is 2.29 Ωm to 4.53 Ωm. So it can be estimated that at that length and depth there is heavy metal pollution [12.]

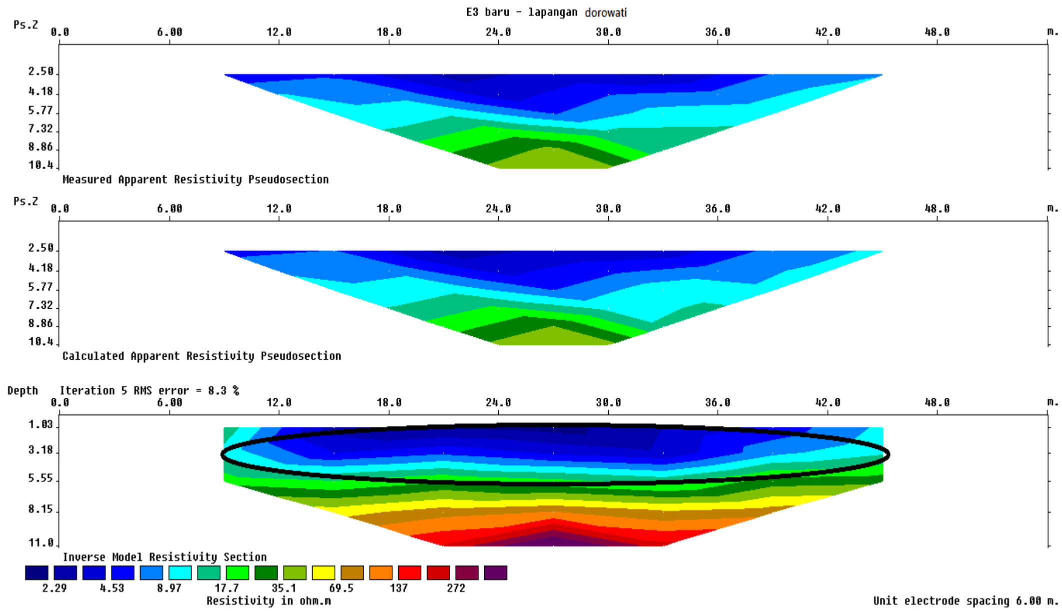

Figure 3. The transverse cross-section of the D3 pathway resistivity with anomaly

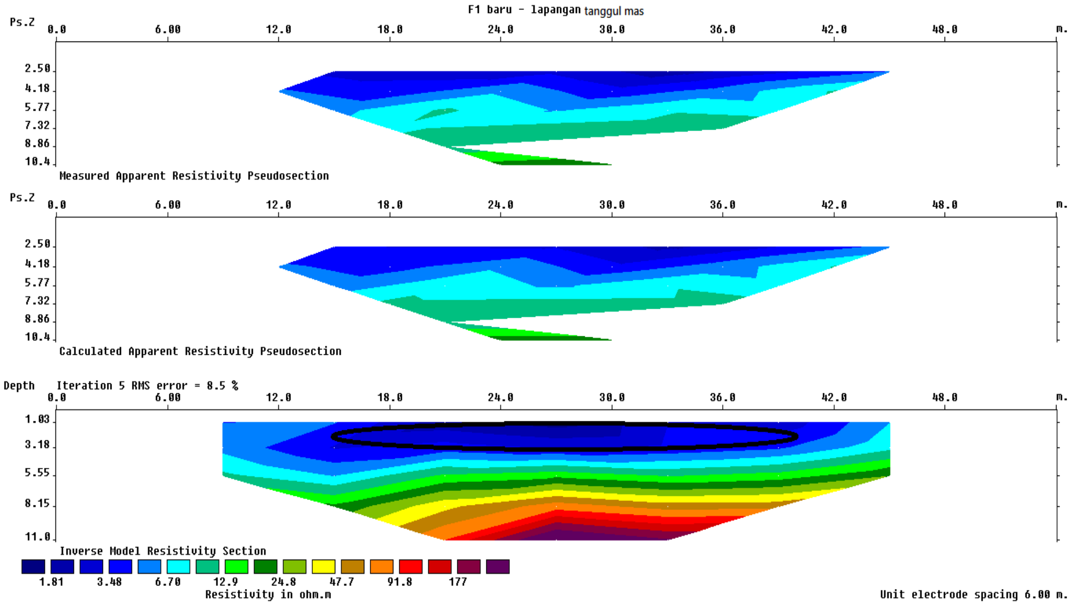

Figure 4. P1 resistivity cross-section with anomaly

Based on Figure 4. there is an anomaly with resistivity values between 1.41 Ωm to 2.98 Ωm it can be predicted that the location of pollution has occurred [13]. Such as the area circled at a length of 15 meters to 45 meters and a depth of 1 meter to 4 meters. This can be predicted as contamination due to differences in resistivity values but still in one rock layer.

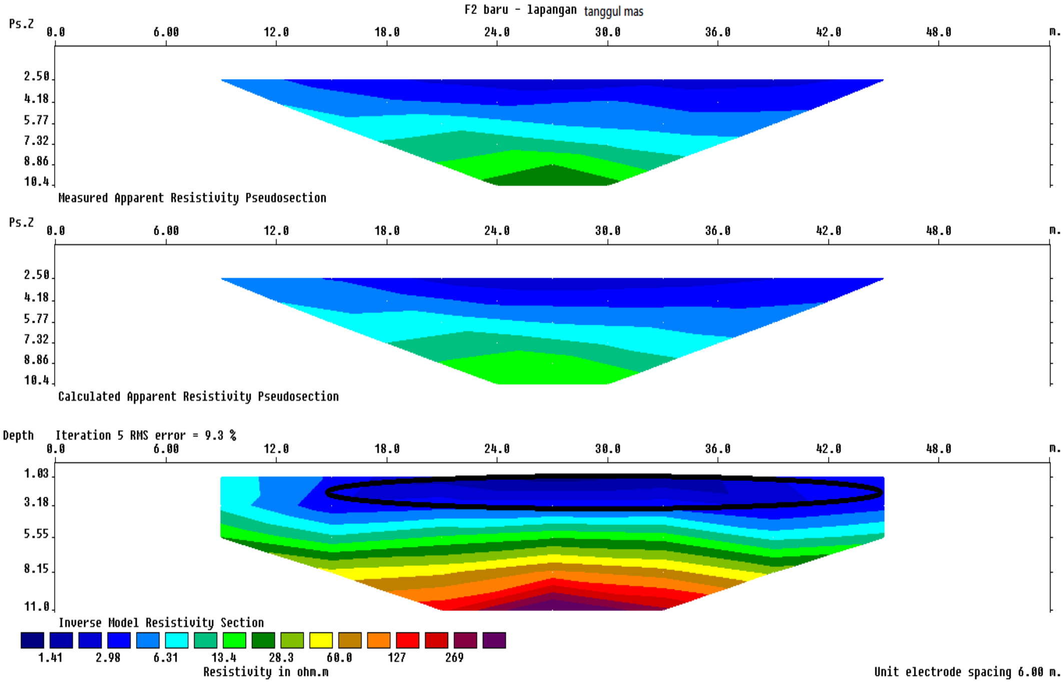

Figure 5. P2 resistivity cross-section with anomaly

In Figure 5, the P2 pathway is dominated by clay which has a resistivity value of 1.41 Ωm to 13.4 Ωm located at a depth of 1 meter to 5.55 meters. then at 5.55 meters to 11 meters with resistivity values of 28.3 Ωm to 68.9 Ωm, there can be predicted silt[14].

In the P3 path shown in Figure 6. that the anomaly is at a length of 8 meters to 42 meters and at a depth of 1 meter to 3 meters where the resistivity value is 1.17 Ωm to 4.58 Ωm.

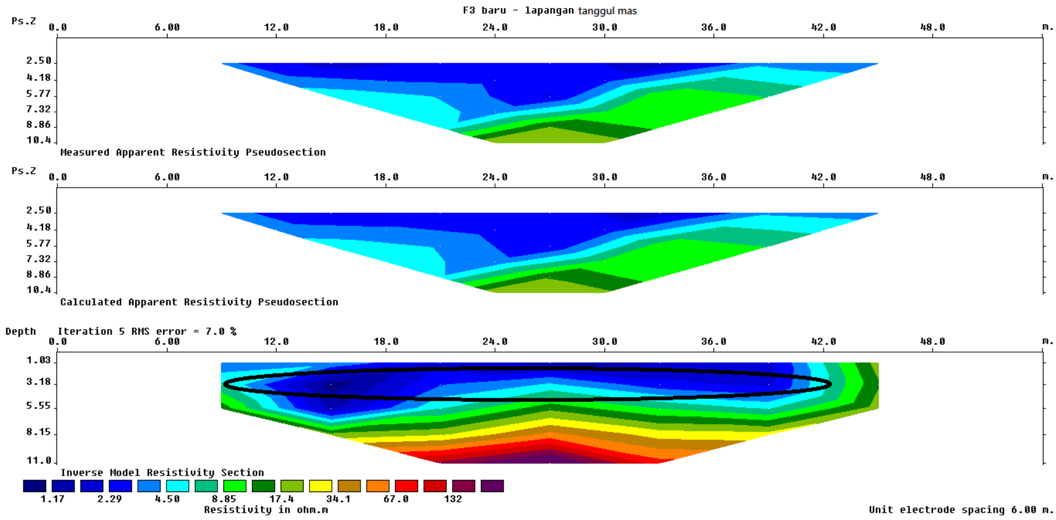

Figure 6. Cross-section of resistivity path of P3 with an anomaly.

The results of the water sample testing using the AAS method were taken in the Dorowati area in Tawang Mas and Panggung Kidul in the Tanggul Mas Village obtained for heavy metal Cd concentrations are shown in Table no 1.

Table no 1: Cadmium concentrations

Heavy Metal	Cadmium Concentrations (mg/L)							
	River D (Dorowati)	Well D1	Well D2	Well D3	River P (Panggung Kidul)	Well P1	Well P2	Well P3
Cd	0.100	0.101	0.108	0.096	0.101	0.105	0.106	0.104

Different concentration values differ due to cadmium which can accumulate in soil and dissolve in water and the difference in distance between wells and rivers. The distance between the river and the well the further the concentration value will be smaller. The highest concentration of heavy metal Cd in well D2 was 0.108 mg / L and the lowest concentration of heavy metal Cd in well D3 was 0.096 mg / L. According to Government Regulation of the Republic of Indonesia, Number 101 of 2014 concerning Management of hazardous and toxic wastes the water quality standard contains a cadmium heavy metal of 0.01 mg / L so that the water quality in the river still meets the quality standard limits[15]

IV. Conclusion

The distribution model of cadmium heavy metal produced is from the underground resistivity value at the study site with resistivity values ranging from 4.32 Ωm to 17.1 Ωm, which are then interpreted as clay rock and The cadmium concentration value gets bigger when the distance between the river and the well gets closer so that it causes pollution in the area around the Semarang Flood Canal.

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