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Research article

MODEL EVALUATION TO PREDICT CADMIUM DEPOSITION IN HOMOGENEOUS POROSITY AND VELOCITY IN UNCONFINED FORMATION AT OKEHI, RIVERS STATE OF NIGERIA

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Abstract

Evaluating the model prediction on cadmium deposition was carried out to monitor the rate of concentration in the study location. Investigation carried out generated some expressed model equation, the equation were resolved and it generated theoretical values, expressing the values in graphical representation shows that the concentration were in exponential phase, optimum values were obtained at thirty metres within the period of twenty and hundred days, both parameters compared faviourably well with experimental results, both parameters developed a best fits validating the expressed model from the study, experts in the field will fine this model faviourable in predicting cadmium transportation in the study environment.

Keywords: model evaluation cadmium deposition, porosity and velocity, unconfined formation

1. Introduction

Cadmium is a heavy metal with a high toxicity. Cadmium is toxic at very low exposure levels and has acute and chronic effects on health and environment. Cadmium is not degradable in nature and will thus, once released to the environment, stay in circulation. New releases add to the lready existing deposits of cadmium in the environment. Cadmium and cadmium compounds are, compared to other heavy metals, relatively water soluble. They are therefore also more mobile in e.g. soil, generally more bioavailable and tend to bioaccumulate. Chronic cadmium exposure produces a wide variety of acute and chronic effects in humans. Cadmium accumulates in the human body and especially in the kidneys. According to the current knowledge kidney damage (renal tubular damage) is probably the critical health effect. Other effects of cadmium exposure are disturbances of calcium metabolism, hypercalciuria and formation of stones in the kidney. High exposure can lead to lung cancer and prostate cancer. Atmospheric deposition seems continuously to cause the content of cadmium in agricultural top soil to increase, which by time will be reflected in an increased human intake by foodstuffs and therefore in an increased human risk of kidney damages and other effects related to cadmium. In the marine environment levels of cadmium may significantly exceed background levels causing a potential for serious effects on marine animals and in particular birds and mammals. Significant quantities of cadmium are continuously stockpiled in landfills and other deposits and represent a significant potential for future releases to the environment. The environmental fate and the toxicity of cadmium calls for a global initiative aimed at minimizing human and environmental consequences of the ongoing cadmium emissions. The relevance of considering a global initiative comes, furthermore, from the fact that cadmium used intentionally in products is traded globally and that effective risk reduction measures thus must be seen in a global context. Global efforts addressing cadmium may include a phase-out of cadmium in products as well as global agreements of improved emission control related to air as well as water emissions. Adequate substitutes exist for many applications for which cadmium is still being used. The current low world market price of cadmium motivates the development of new applications that by time may develop into new sources of emissions to the environment not covered by existing regulation.

Heavy metal contamination of aquatic ecosystems is becoming a prospective global problem. Developing nations such as Nigeria, lack for mechanisms and sensitive tools to detect and observe water quality and are therefore exposed to heavy metal poisoning (Ochieng et al., 2008). Trace amounts of heavy metals are constantly present in fresh waters from terrigenous sources such as weathering of rocks resulting into geo-chemical recycling of heavy metal elements in these ecosystems (Muwanga, 1997; Zvinowanda et al., 2009). Trace elements may be immobilized within the stream sediments and thus could be involved in absorption, co precipitation, and complex formation (Okafor and Opuene, 2007; Mohiuddin et al., 2010). Sometimes they are co-adsorbed with other elements as oxides Hydroxides of Fe, Mn, or may occur in particulate form (Awofolu et al., 2005; Mwiganga and Kansiime, 2005). Heavy metals may enter into aquatic ecosystems from anthropogenic sources, such as industrial wastewater discharges, sewage wastewater, fossil fuel combustion and atmospheric deposition (Linnik and Zubenko, 2000; Campbell, 2001; Lwanga et al., 2003; El Diwani and El Rafie, 2008; Idrees, 2009). Trace elemental concentrations in stream sediment compartments can be used to reveal the history and intensity of local and regional pollution (Nyangababo et al., 2005a). Sentongo (1998); Matagi (1998) and Kansiime et al., (1995) observed significant pollution load by organic and inorganic substances into the

Nakivubo ecosystem. Some work on heavy metal loading of Lake Victoria wetlands, Nakivubo Channel and heavy metal pollution in and around Kampala was recognised (Nyangababo 2003; Nyangababo et al., 2005b; Muwanga and Barifaijo, 2006 and Nabulo et al., 2008). The objectives of the present work were to (1) assess the geochemistry of the Nakivubo stream sediments so as to establish the possibility of secondary pollution of the sediments; (2) establish the association among heavy metals and stream physico-chemical characteristics and (3) determine the source apportionment of heavy metals using cluster and factor analyses (Sekabira, et al 2010).

2. Materials and method

Soil samples from several different borehole locations, were collected at intervals of three metres each (3m). Soil sample were collected in five different location, applying insitu method of sample collection, the soil sample were collect for analysis, standard laboratory analysis were collected to determine the soil formation, the result were analyzed to determine the rate of Cadmium concentration between the unconfined bed through column experiment in the study area.

3. Results and Discussion

Results and discussion from the expressed figures through the theoretical generated values are presented in tables and figures, the expression explain the rate of concentration through graphical representation for every condition assessed in the developed model equations.

Table: 1 Comparison of predictive and experimental values of Cadmium at Different Depths

Depths [M]	Predictive Values Cd	Experimental values Cd
3	0.004	9.53E-03
6	0.016	1.90E-02
9	0.028	2.80E-02
12	0.04	3.80E-02
15	0.052	4.70E-02
18	0.064	5.70E-02
21	0.076	6.70E-02
24	0.088	7.60E-02
27	0.1	8.60E-02
30	0.11	9.50E-02

Table: 2 Comparison of predictive and experimental values of Cadmium at Different Time

Time [Per Day]	Predictive Values Cd	Experimental values Cd
10	2.00E-03	9.53E-03
20	0.012	1.90E-02
30	0.022	2.80E-02
40	0.032	3.80E-02

50	0.042	4.70E-02
60	0.052	5.70E-02
70	0.062	6.70E-02
80	0.072	7.60E-02
90	0.082	8.60E-02
100	0.092	9.50E-02

Table: 3 Comparison of predictive and experimental values of Cadmium at Different Depths

Depths [M]	Predictive Values Cd	Experimental values Cd
3	0.004	9.53E-03
6	0.016	1.90E-02
9	0.028	2.80E-02
12	0.04	3.80E-02
15	0.052	4.70E-02
18	0.064	5.70E-02
21	0.076	6.70E-02
24	0.088	7.60E-02
27	0.1	8.60E-02
30	0.11	9.50E-02

Table: 4 Comparison of predictive and experimental values of Cadmium at Different Time

Time [Per Day]	Predictive Values Cd	Experimental values Cd
10	7.00E-03	0.0093
20	0.017	0.021
30	0.027	0.031
40	0.037	0.04
50	0.047	0.052
60	0.057	0.061
70	0.067	0.069
80	0.077	0.075
90	0.087	0.085
100	0.097	0.094

Table: 5 Comparison of predictive and experimental values of Cadmium at Different Depths

Depths [M]	Predictive Values Cd	Experimental values Cd
3	9.00E-03	9.53E-03
6	0.018	1.90E-02
9	0.027	2.80E-02

12	**0.036**	**3.80E-02**
15	**0.045**	**4.70E-02**
18	**0.054**	**5.70E-02**
21	**0.063**	**6.70E-02**
24	**0.072**	**7.60E-02**
27	**0.081**	**8.60E-02**
30	**0.09**	**9.50E-02**

Table: 6 Comparison of predictive and experimental values of Cadmium at Different Time

Time [Per Day]	Predictive Values Cd	Experimental values Cd
10	1.00E-02	9.53E-03
20	0.02	1.90E-02
30	0.03	2.80E-02
40	0.04	3.80E-02
50	0.05	4.70E-02
60	0.06	5.70E-02
70	0.07	6.70E-02
80	0.08	7.60E-02
90	0.09	8.60E-02
100	0.1	9.50E-02

Table: 7 Comparison of predictive and experimental values of Cadmium at Different Depths

Depths [M]	Predictive Values Cd	Experimental values Cd
3	1.10E-02	9.53E-03
6	0.02	1.90E-02
9	0.029	2.80E-02
12	0.038	3.80E-02
15	0.047	4.70E-02
18	0.056	5.70E-02
21	0.065	6.70E-02
24	0.074	7.60E-02
27	0.083	8.60E-02
30	0.092	9.50E-02

Table: 8 Comparison of predictive and experimental values of Cadmium at Different Time

Time [Per Day]	Predictive Values Cd	Experimental values Cd
2	1.10E-02	9.53E-03
4	0.019	1.90E-02

6	**0.026**	**2.80E-02**
8	**0.034**	**3.80E-02**
10	**0.042**	**4.70E-02**
12	**0.05**	**5.70E-02**
14	**0.058**	**6.70E-02**
16	**0.067**	**7.60E-02**
18	**0.075**	**8.60E-02**
20	**0.083**	**9.50E-02**

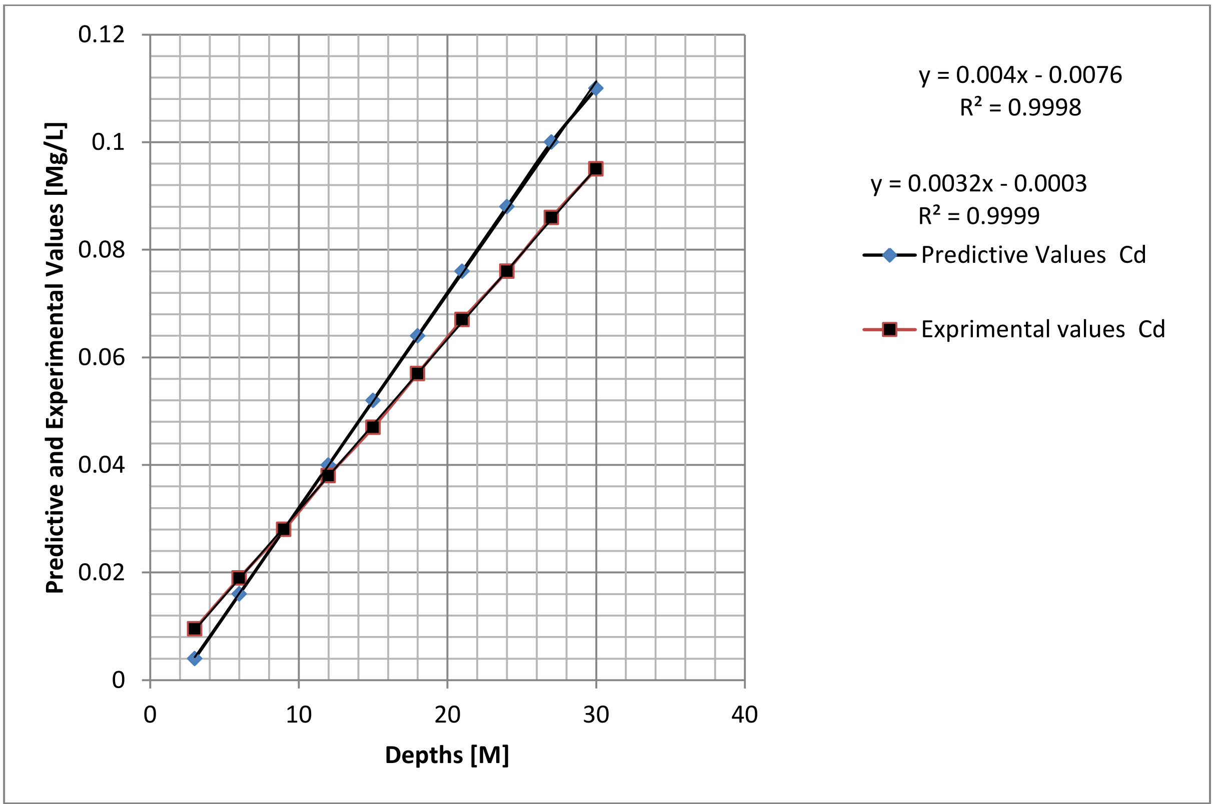

Figure 1: Comparison of predictive and experimental values of Cadmium at Different Depth

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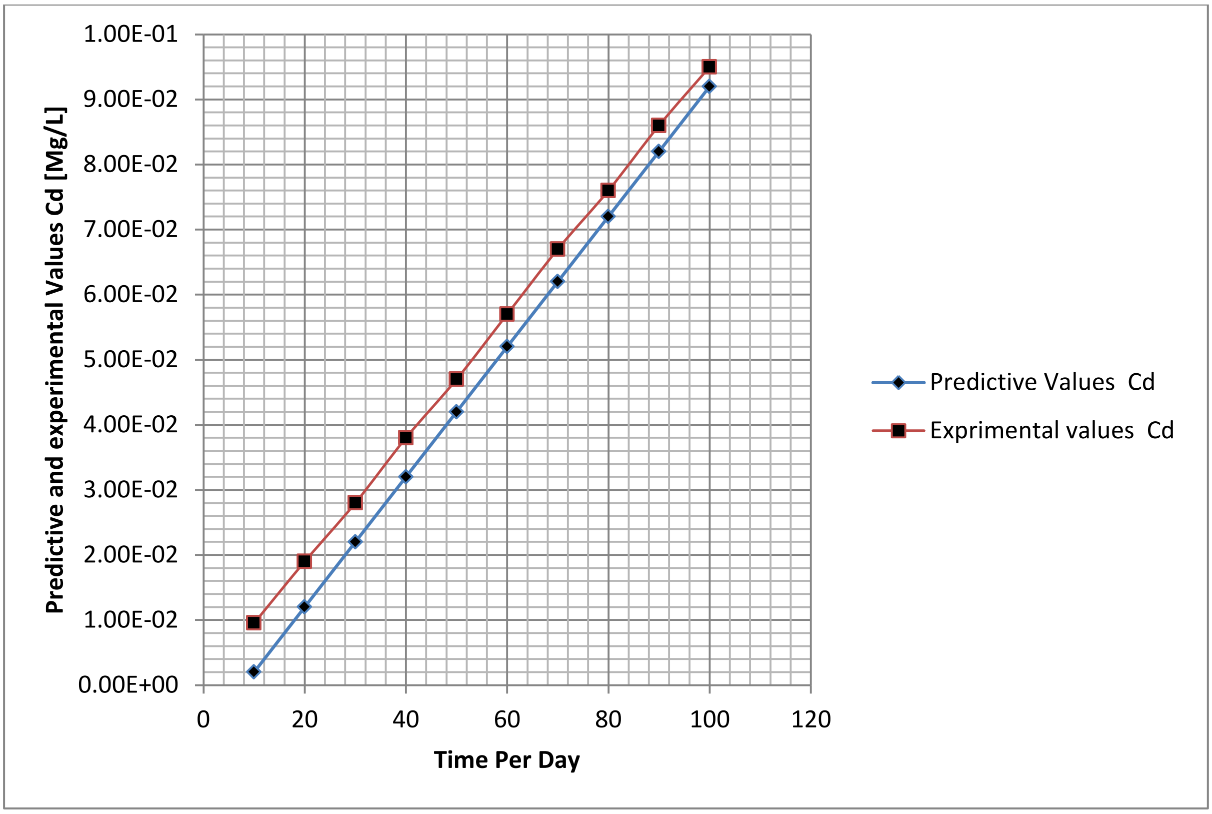

Figure 2: Comparison of predictive and experimental values of Cadmium at Different Time

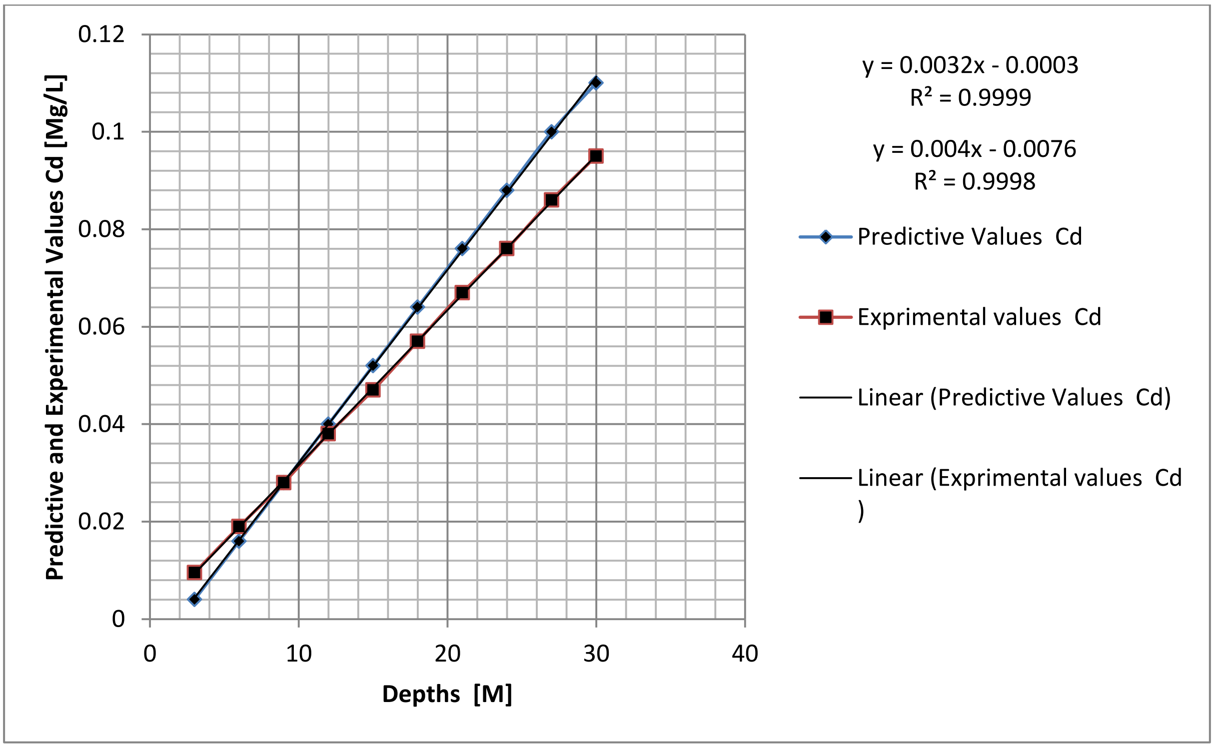

Figure 3: Comparison of predictive and experimental values of Cadmium at Different Depths

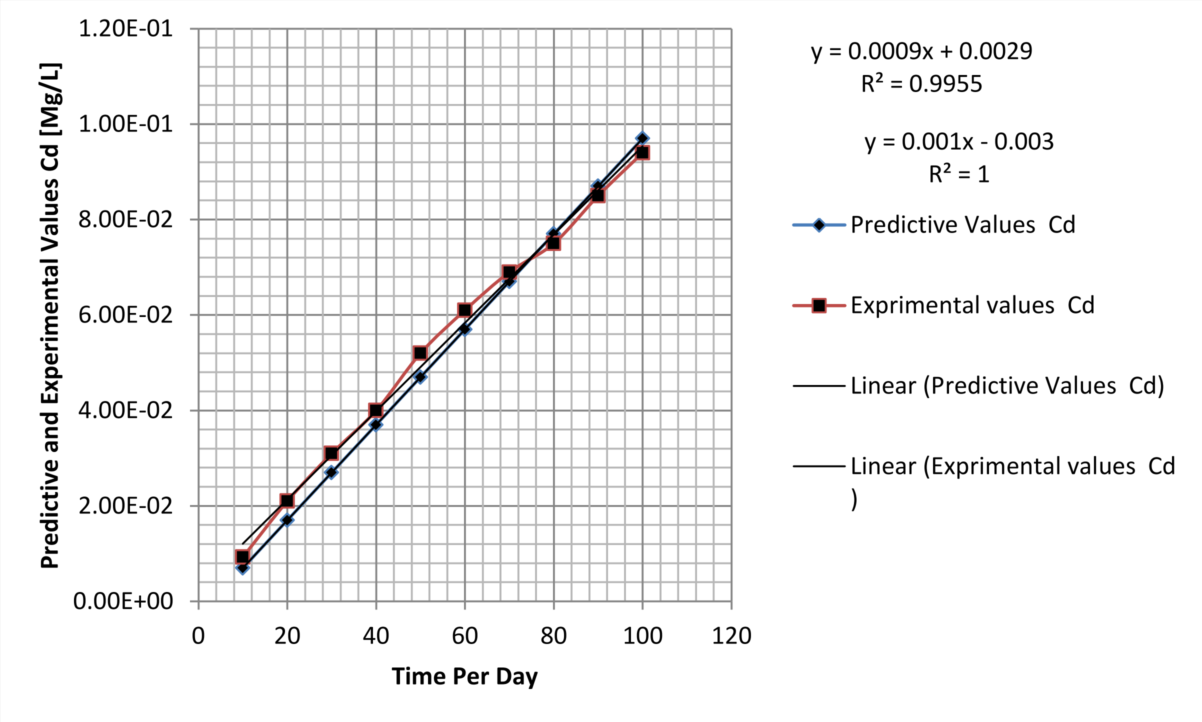

Figure 4: Comparison of predictive and experimental values of Cadmium at Different Time

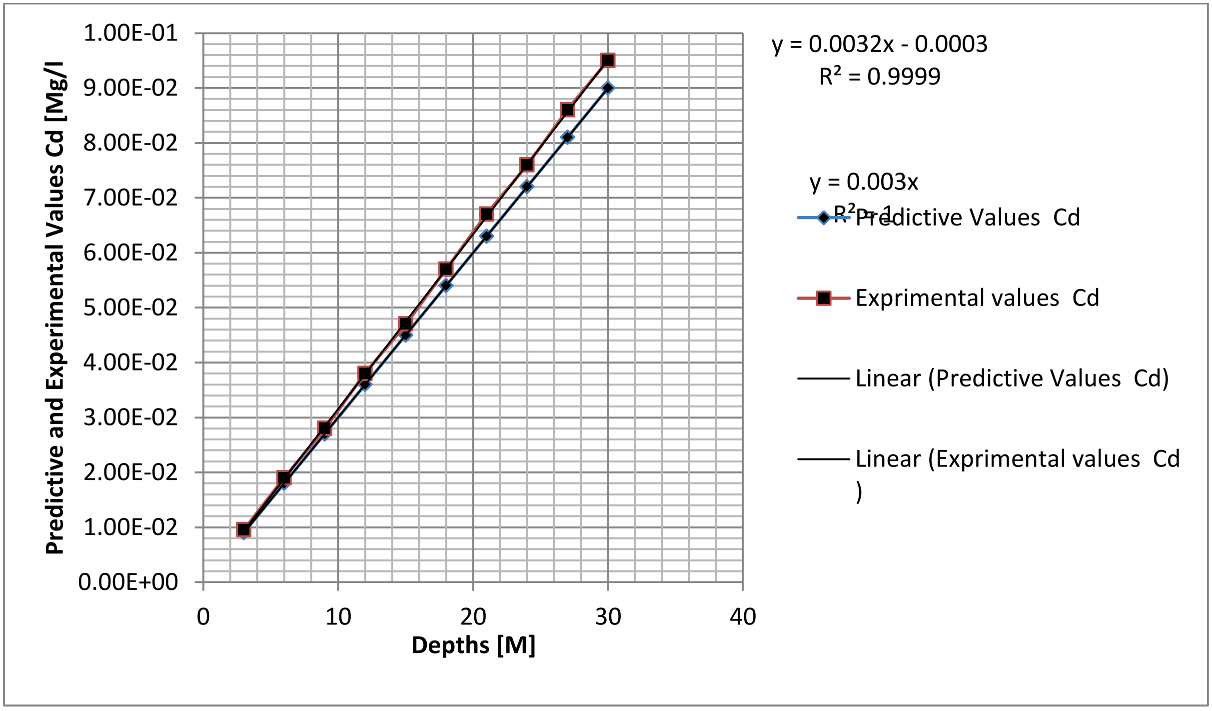

Figure 5: Comparison of predictive and experimental values of Cadmium at Different Depths

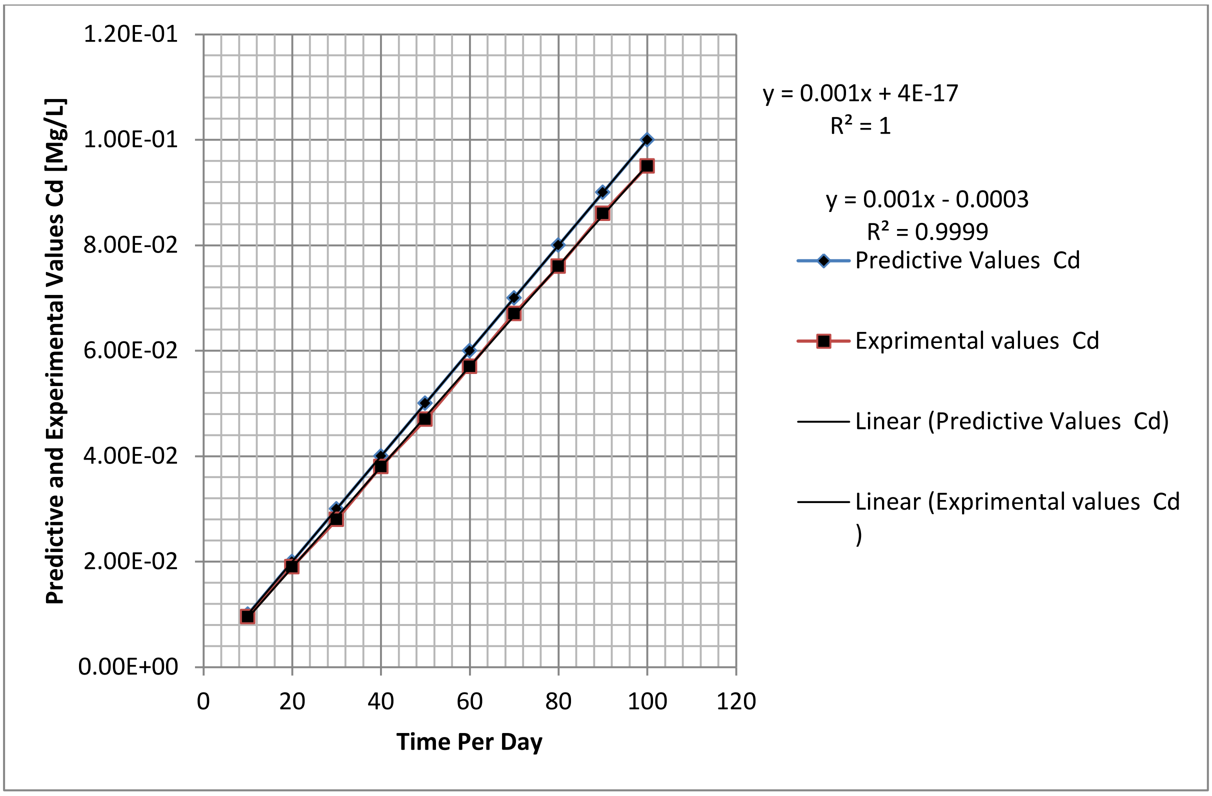

Figure 6: Comparison of predictive and experimental values of Cadmium at Different Time

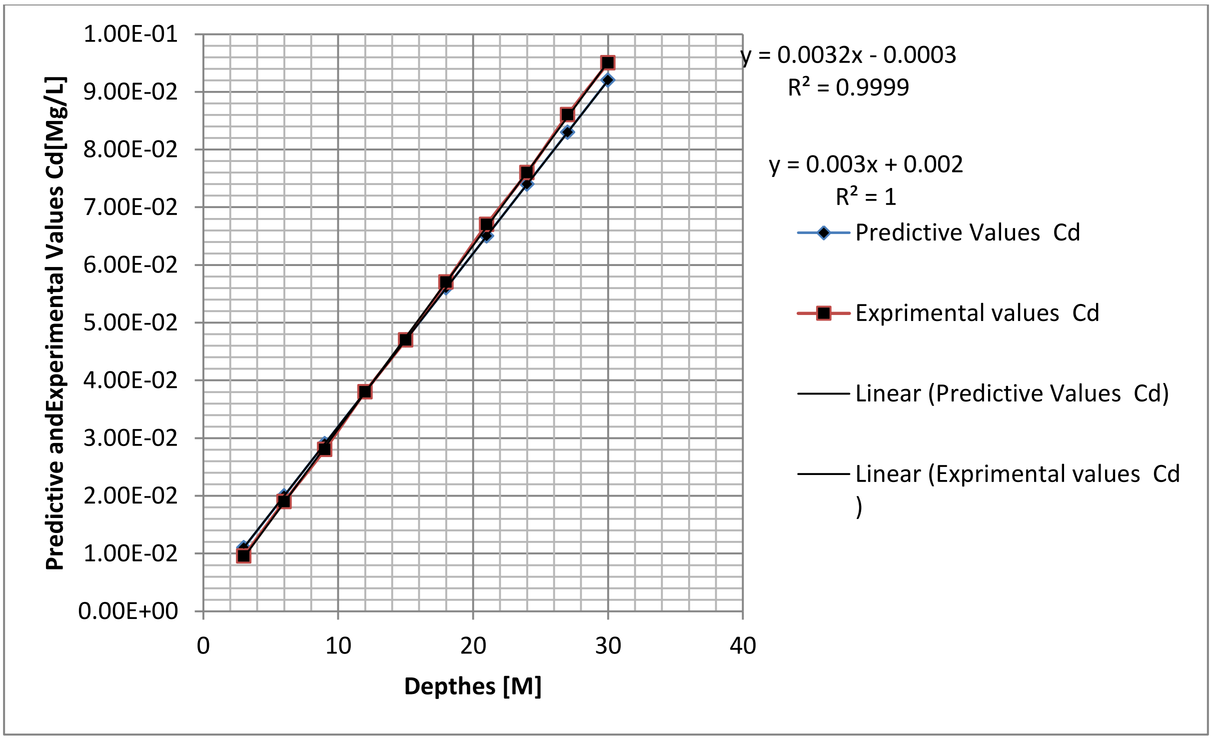

Figure 7: Comparison of predictive and experimental values of Cadmium at Different Depths

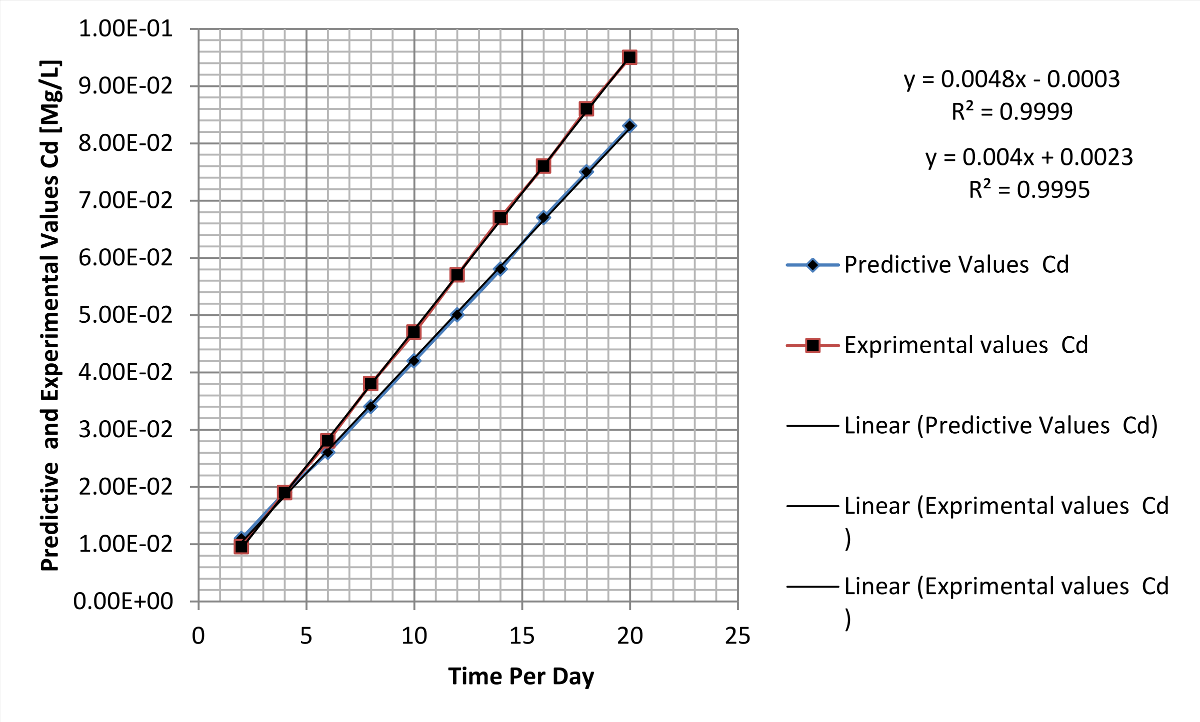

Figure 1: Comparison of predictive and experimental values of Cadmium at Different Time

The figure from [1-8 shows that the concentrations of cadmium are on exponential condition , the concentrations rapidly increase to the point where an optimum values were recorded, the depths of the concentration varies because the study were carried out in different locations and the migration of cadmium was observed at different depths to determine the rates of concentration at different location, the objective of the concept was to evaluate the rate of migration at different depth in various location , such conceptual design generated results , the concentration within the limited depths at different location experience different concentration as observed from the figures presented, there are lots of other influences that were observed on the cause of monitoring the rate of cadmium concentration in the study environment, the study location develop homogeneous velocity and porosity in the study area, the rate cadmium transport in the study location are influenced by the observed homogeneous porosity and velocity of flow in the formation , this condition were part of the rapid migration of the contaminants as expressed from the figures, the homogenous velocity influences on cadmium deposition and migration at various strata in the study area provided a platform to determine the period it can migrate to ground water aquifers, this conceptual setting implies that the shallow deposition of aquifers will definitely experiences increase in concentration through the homogeneous porosity of the formation, the study of cadmium transport in this condition has establish the deposition of high degree of porosity that pressure the rate velocity of fluid in the formation, other influences on the formation is the deltaic nature of the soil, it is observed to constantly produces shallow water tables and high rain intensities through the effect from climatic change, the figures evaluated that generated predictive values that were compare with other experimental values, , both parameters developed a faviourable fits validating the predictive results , more so, the influences from these stated formation characteristics and climatic conditions. Definitely provide the mechanism to monitor the rate of cadmium migration in soil and water environments.

4. Conclusion

The validation of cadmium expressed model is to determine the rate of concentration and dispersion rate under the influences of homogeneous porosity and velocity in the study area. The results from the predicted values were observed to deposit rapid increase under exponential phase in the transport system , formation characteristics stated above were the paramount variables that pressure the migration of the contaminant in this rapid state, such expression in the figures shows how the rate of formation characteristics develop influences on the migration of cadmium in the formations, the predictive values were establish through developed model from experimental values , the expressed equation were resolved to generate predictive results, the data were compared other experimental values, both parameters compared faviourable well, the study will be applied in predicting the rate of cadmium concentration in the study environment.

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