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Highlights

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Discovering Thoughts, Inventing Future

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Heavy Metal Uptake by Agro based Waste Materials

By Fatiha Amegrissi, Ibtissam Maghri, Mohamed Elkouali, Abdelkbir Kenz, Mohamed Salouhi & Mohamed Talbi

Faculty of Sciences Ben Msik, Morocco

Abstract- Presence of heavy metals in the aquatic systems has become a serious problem. As a result, there has been a great deal of attention given to new technologies for removal of heavy metal ions from contaminated waters.

Biosorption is one such emerging technology which utilized naturally occurring waste materials to sequester heavy metals from industrial wastewater. The aim of the present study was to utilize the locally available agricultural waste materials for heavy metal removal from industrial wastewater. The wastewater containing hexavalent chromium was treated with biomass prepared from corn stalks. It was fund that a time of one hour was sufficient for sorption to attain equilibrium. The equilibrium sorption capacity after one hour was 0.375 mg.g-1. The optimum pH was (2-2.5) for chromium. Ion exchange was the major removal mechanism along with physical sorption and precipitation. The biosorption data was well fitted to Langmuir adsorption model. The kinetics of biosorption process was well described by the pseudo 2nd order kinetics model. It was concluded that adsorbent prepared from corn stalks can be utilized for the treatment of heavy metals in wastewater.

Keywords: *heavy metals, chromium, biosorption, langmuir isotherm, freundlich isotherm, kinetic models.*

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Heavy Metal Uptake by Agro based Waste Materials

Fatiha Amegrissi [α], Ibtissam Maghri [σ], Mohamed Elkouali [ρ], Abdelkbir Kenz [ω], Mohamed Salouhi [¥] & Mohamed Talbi [§]

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Keywords: heavy metals, chromium, biosorption, langmuir isotherm, freundlich isotherm, kinetic models.

I. Introduction

Heavy metals such as chromium have number of applications in basic engineering works, paper and pulp industries, leather tanning, petrochemicals fertilizers, etc. The hexavalent and trivalent chromium is often present in electroplating wastewater [1]. Other sources of chromium pollution are leather tanning, textile, metal processing, paint and pigments, dyeing and steel fabrication [2].

Heavy metals are toxic to aquatic flora and fauna even in relatively low concentrations. Some metals can be assimilated, stored and concentrated by organisms [3]. Strong exposure of hexavalent chromium causes cancer in the digestive tract and lungs and may cause gastric pain, nausea, vomiting, severe diarrhoea, and hemorrhage [4].

The conventional methods for treatment of chromium wastes include: lime and soda ash precipitation, removing metals from wastewater requires development of new sorbents. A wide range of commercial sorbents including chelating resins and activated carbon are available for metal sorption, but they are relatively expensive. In recent years, numerous low cost natural materials have been proposed as potential adsorbents. These include moss peat [5], algae [6], leaf mould [7], sea weeds [8], coconut husk [9], sago waste [10], peanut hull [11], hazelnut [12], bagasse [13], rice hull [14], sugar beet pulp [15], plants biomass and bituminous coal [16]. In this research adsorbent prepared from corn stalks was used for treatment of chromium wastes. Effect of operating conditions like temperature, pH and initial metal concentration on chromium adsorption were investigated.

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II. Theoretical and Experimental Part

a) Optimization of chromium adsorption

i. Determination of equilibrium time

Batch experiments were carried out to find the equilibrium time for sorption of chromium on corn stalks. All experiments were performed three times and average values were used in all calculations. 1.0 g corn stalks powder of 50 mesh sizes was mixed in 100 ml solutions of chromium. The initial concentration of each solution was 100mg.l-1. It was shaken at 200 rpm and samples were collected at different time intervals. After completion of each batch of experiments the solution was filtered using filter paper. Filtrate was analyzed using atomic absorption spectrophotometer to determine the amount of metal left after sorption. The amount of metal sorbed was calculated by material balance. Sorption capacity q was determined using the formula:

$$q_e = V.\frac{\left(C_0 - C_f\right)}{m} \quad (1)$$

Where C_0 and C_f are the initial and final concentrations of metal in solution, V is the volume of solution and m is the mass of adsorbent.

ii. Effect of pH

Keeping the same operating conditions as mentioned previously, pH of solution was varied from 2 to 7,5. The Cr(VI) is present in solution as CrO_4^{-2} and $Cr_2O_7^{-2}$ at normal pH values but when pH values are reduced below 3 then Chromium exists in the form of $HCrO^{4-}$. When adsorbent developed from corn stalks is intimately mixed with chromium solution at low pH values then OH^- group present in biomass are replaced by chromate ions in the solution.

b) Adsorption Isotherms

The Biosorption data from experiments were fitted with:

i. *Langmuir isotherm [17]*

Langmuir adsorption isotherm sheds no light on the mechanistic aspects of adsorption. It provides information on uptake capabilities and also reflects the usual equilibrium process behaviour The Langmuir non linear equation is:

$$q_e = q_m \cdot \frac{b.C_e}{1 + b.Ce} \quad (2)$$

Where q_e is the amount of metal sorbed per unit weight of biomass at equilibrium, C_e is the residual equilibrium metal, q_m is the maximum possible amount of metal ion adsorbed per unit weight of biomass and b is the equilibrium constant related to the affinity of the binding sites for the metals, lower is b more is the affinity of metal to biomass.

Low values of parameter b indicate that corn stalks have high affinity for chromium. The table 1 presents linear equations of Langmuir model.

The essential characteristic of a Langmuir isotherm can be expressed as a dimensionless constant, defined as the separation factor:

$$R_L = \frac{1}{1 + b.C_0} \quad (3)$$

ii. *Freundlich isotherm [18]*

The Freundlich non linear equation is:

$$q_e = K_F C^n e \quad (4)$$

Where, K_F and n are constants indicating adsorption capacity and adsorption intensity, respectively. The constants were obtained from the plots of the linearized equations:

$$\log q_e = \log K_F + n.\log C_e \quad (5)$$

Another use of the results is to plot the variation of the distribution coefficient K_d as a function of q_e in logarithmic scale:

$$\log K_d = (\frac{1}{n}).\log K_F . + [\frac{(n-1)}{n})].(\log q_e) \quad (6)$$

c) Kinetic Models

To determine order of the adsorption kinetics, first-order and second-order kinetic models were tested to fit the experimental metal removal data and to assist water treatment process design.

i. *First order model*

The model of the first order is generally expressed by [19]:

$$\frac{dq_t}{dt} = K_1(q_e - q_t) \quad (7)$$

Which carry out, after integration, to [20]:

$$\ln(q_e - q_t) = \ln q_e - K_1 t \quad (8)$$

ii. *Second order model*

It is an equation which is often employed on the representation of kinetics of adsorption. It is presented in the form [21]:

$$\frac{dq_t}{dt} = K_2(q_e - q_t)^2 \quad (9)$$

The integration of the equation (14) permits to obtaining the equation [22]:

$$\frac{1}{q_t} = \frac{1}{K_2 . q_e^2} . \frac{1}{t} + \left(\frac{1}{q_e}\right) \quad (10)$$

This presents the linearization of the second class equation; It is the equation which helps us to extract the parameters of the second order kinetic model.

III. Results and Discussions

a) Optimization of chromium Biosorption

i. *Determination of equilibrium time*

As shown in Figure 1 about 55% removal was attained in first 15 min and concentration became almost constant after 90 min. The fast initial uptake was due to the accumulation of metal ions on surface of adsorbent which is a rapid step. More time was consumed on diffusion of ions to binding sites. It was concluded that one hour was sufficient for sorption to attain equilibrium. The equilibrium capacity obtained after one hour of sorption was 0.375 $mg.g^{-1}$ for chromium.

ii. *Effect of pH*

Figure 2 shows the adsorption of chromium at different value of pH. The sorption was pH dependent and optimal pH was [2-2,5] for chromium. Main removal mechanism was ion exchange between metal anions and hydroxyl ions in case of hexavalent chromium. This fact is indicated by the change of pH at the end of adsorption process.

b) Adsorption Isotherm

i. *Langmuir isotherm*

The values of equilibrium relation parameter, R_L were calculated for five Langmuir linearizations. As shown in Table 2, R_L values lie between 0 and 1 which indicate favourable sorption isotherm for chromium metal. Low values of parameter b indicate that corn stalks have high affinity for chromium.

ii. *Freundlich Isotherm*

The values of equilibrium relation parameter, n were calculated for two Freundlich model's, the results

is shown in table 3, n values is high than 1 so the adsorption of chromium adsorption was not well fitted with Freundlich model and The low values of maximum adsorption capacities obtained from the Freundlich model, confirm that the molecule of Methylene Blue is not strongly adsorbed inside the pores because of its size.

c) Kinetic Models

First and second order equation accounting both with theoric and experimental point of view was used to describe the adsorption kinetics of Chromium onto Corn stalks.

i. *First order model*

The experimental qe values are lower than the theoric value. The values of K_1, qe and regression coefficients provided in Table 4, demonstrate that chromium adsorption by Clay are not first-order.

ii. *Second order model*

The correlation coefficient (R^2) for this plot is superior than 0.9 (Table 5). The experimental qe values were compared to theoric qe values determined by second order rate kinetic models. The qe values calculated from the pseudo second order kinetic model exhibit excellent agreement with the experimental qe values (Table 5). Thus, the sorption process is pseudo-second order. The pseudo-second order model is based on the assumption that the rate-limiting step is a chemical sorption between the adsorbate and adsorbent. This provides the best correlation of the data.

Table 1 : Linear equations of Langmuir model

Forms	*Equations*
Langmuir 1	$\frac{1}{q_e} = \frac{1}{C_e}\frac{1}{bq_m} + \frac{1}{q_m}$ (3)
Langmuir 2	$\frac{C_e}{q_e} = C_e\frac{1}{q_m} + \frac{1}{q_m.b}$ (4)
Langmuir 3	$q_e = -\frac{1}{b}\frac{q_e}{C_e} + q_m$ (5)
Langmuir 4	$\frac{q_e}{C_e} = -bq_e + bq_m$ (6)
Langmuir 5	$\frac{1}{C_e} = bq_m\frac{1}{q_e} - b$ (7)

Table 2 : Langmuir adsorption parameters for chromium biosorption

Forms	b	q_m	r^2	R_L	R
Langmuir I	-1,37	0,02	0,965	0,127	0,128
Langmuir II	-1,368	0,02	0,9863	0,127	
Langmuir III	-1,397	0,0196	0,9962	0,125	
Langmuir IV	-1,325	0,0194	0,9962	0,131	
Langmuir V	-1,3372	0,0198	0,965	0,13	

Table 3 : Freundlich adsorption parameters for chromium biosorption

Forms	Log K_F	K_F	n	R^2	$q_m(mg.g^{-1})$
Freundlich 1	-2,5571	0,0775	1,9019	0,9376	0,0036
Freundlich 2	-2,539	0,0789	2,028	0,9928	0,0030

Table 4 : First order parameters for chromium biosorption

C_0	m_s	r^2	q_e	q_e(Theoric)/q_e(experimental)	K_1
0,5	1	0,9464	0,0271	1,01	0,0015

Table 5 : Second order parameters for chromium biosorption

C_0	m_s	r^2	q_e	q_e(Theoric)/q_e(experimental)	K_2
0,5	1	0,9939	0,31	0,998	0,718

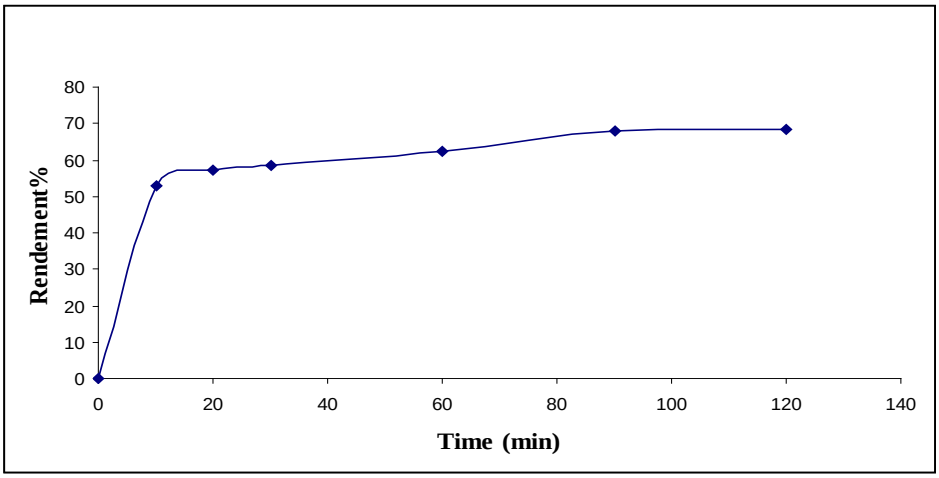

Figure 1 : Equilibrium time of chromium adsorption on Corn Stalks

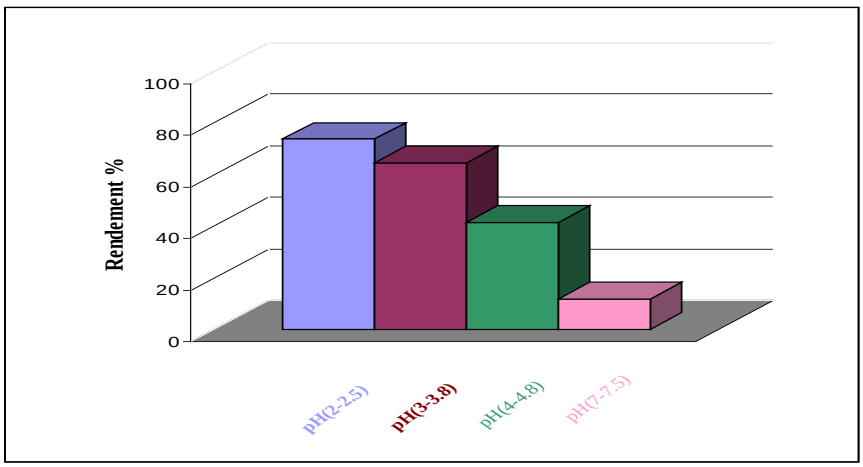

Figure 2 : Effect of pH on the adsorption of chromium on Corn stalks

IV. Conclusion

Corn stalks powder was found to be a very good adsorbent for hexavalent chromium. It has good sorption capacity for both metals. The sorption capacity for hexavalent chromium was 0,375 $mg.g^{-1}$. The sorption was pH dependent and optimal pH was [2-2,5] for chromium. Main removal mechanism was ion exchange between metal anions and hydroxyl ions in case of hexavalent chromium. This fact is indicated by the change of pH at the end of adsorption process. Physical sorption and precipitation also contributed to removal of metals. The adsorption process followed Langmuir model which indicated that ion exchange took place in a monolayer at the surface of adsorbent.

The kinetics of adsorption process was represented well by pseudo 2^{nd} order kinetic model We can conclude that this adsorption of chromium on corn stalks is a favourable Chimisorption.

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Conceptual Design of a Wastewater Treatment Plant for the Dera Bassi Industrial Estate, Punjab (India)

By Farid Ansari & Yashwant K. Pandey

PDM College of Engineering, India

Abstract- There are two fundamental reasons for treatment of wastewater viz., prevention of pollution and thereby protecting the environment, and protecting the public health by safe guarding water supplies and preventing the spread of water borne diseases. Proper design, construction together with good operation and maintenance are essential for waste water treatment plants, in order to produce effluents which are satisfying the safe disposal standards prescribed by the regulatory authorities. In the present study a comprehensive design developed for the units of Inlet chamber, Screen chamber, Grit Removal Unit, Equalization Tank, Clari-Floculator, Aeration Tank, Sand Gravity Filter, Sludge Drying Beds etc. as they are commonly used in the field of wastewater treatment. The plant will use as many sustainable and energy efficient concepts as possible, while still keeping construction and maintenance costs low. The overarching goal of the project is to prevent the contamination of the aquifer, while also minimizing the environmental impacts on the surrounding ecosystems.

Keywords: *wastewater treatment, design, punjab small industries and export corporation limited (PSIECL).*

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Farid Ansari [α] & Yashwant K. Pandey [σ]

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Keywords: wastewater treatment, design, punjab small industries and export corporation limited (PSIECL).

I. Introduction

An industrial estate is a composition of several different types of industries located in one area, each producing effluent is of varying wastewater characteristics. In a scheme of unplanned development, it is a common practice for each company on an industrial estate to develop their individual effluent treatment plant. When the industrial estate is considered as a whole, one observes that, because of this practice, valuable resources are wasted on effluent treatment. These resources include capital cost, land space and maintenance costs. A common effluent treatment plant and industrial ecology offer an alternative to the practice of having individual effluent treatment systems and makes better overall use of the resources of an industrial estate.

Developing low cost technology for wastewater treatment offers an alternative and has been found to be most effective for treatment of domestic and industrial wastewater, particularly for those situated in the tropical and subtropical regions (NgMiranda et al. 1989; Puskas et al. 1991; El-Gohary et al. 1995; Rosen et al. 1998). Technologically because of the simplicity of waste stabilization ponds even affluent nations, which can afford the luxury of expensive wastewater treatment, are planning to use more and more low cost treatment technologies (Khan and Ahmad, 1992; Junico and Shelef, 1994). Damian et al. (2006) analyzed the long-term dynamics in the development of a wastewater treatment Plant. Whereas Shubhra et al. (2011) studied the process design for decentralized sewage treatment system with total natural resource management. Level of wastewater pollution varies from industry to industry depending on the types of processes and the size of the industry (Garcia et al., 1995). Wastewaters that are generated from different sites represent different wastewater generation patterns, flows and constituents (Hii, 2008).

Punjab Small Industries and Export Corporation limited (PSIECL) was established in 1962 with the objective of supporting the individual in his endeavor to set up his own industrial unit and help him and the small-scale industry to grow in Punjab. PSIECL has been acting as a Catalyst & springboard for all round development and promotion of industries in Punjab through the development of Industrial infrastructure, namely Industrial Focal Points (IFP) ranging between 50 acres to 500 acres of land at various towns and cities of Punjab. Therefore to facilitate the spirit of industry, PSIECL provides self-sufficient industrial focal points. These industrial hub, consist of developed plots equipped with power substations & distribution networks, telecommunication facilities, residential area for workers, common effluent treatment plants and parts for the clean environment.

As per the regulatory norms and instructions by pollution control board, the water polluting industries have to set up their own effluent treatment plants to meet the surface water discharge standard before sending into the common sewer line. The industrial as well as domestic wastewater from the individual industries are being discharged (after requisite treatment) to the common sewer line and presently discharged into the nearby canal without any treatment. PSIECL has a distribution network of raw materials across Punjab. It is the handling agency of SAIL, MMTC, IISCO, HZL, HCL. It is also First State Corporation to get

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itself accredited by Joint Accreditation system of Australia and New Zealand (JAS-ANZ) under ISO-9001. Dera Bassi Industrial Estate is spread in about 150 acres and having more than 200 different sized plots for the Industrial Purpose. Presently,115 numbers of industries are functional and 12 numbers of industries are non-functional. The remaining plots are vacant which have already been allotted to the entrepreneurs for setting of the industries.

This project aims to develop the conceptual design of an effective and economically responsible wastewater treatment plant for the PSIECL. The plant will use as many sustainable and energy efficient concepts as possible, while still keeping construction and maintenance costs low. The over-arching goal of the project is to prevent the contamination of the aquifer, while also minimizing the environmental impacts on the surrounding ecosystems. The design process includes taking into account the advantages and disadvantages of different unit processes, analyzing their technical details and determining the removal efficiency of each unit operation.

II. Study Area

Dera Bassi municipal council, Mohali district, Punjab, is located on the National Highway No.22, (Chandigarh-Ambala-Delhi Road), 20 km from Chandigarh. It is strategically located near the boundary of Haryana, Himanchal Pradesh and Union territory of Chandigarh. The site Focal Point – Phase II is situated near 100 meter distance of industrial focal point of PSIEC, Dera Bassi. The industrial focal point of Dera Bassi starts at the northern part of Dera Bassi bounded by the Mubarikpur and Mirpur villages along the Old Kalka Road. Hence, it has been observed that more prominent industrial developments exist and are in full operations. Dera Bassi Industries Association was formed to help overcome the obstacles that the industries in this area had to face and arrange for facilities like well paved roads, water supply, affordable goods transport and proper lighting etc. from government agencies and to cater to the demand for good industrial environment.

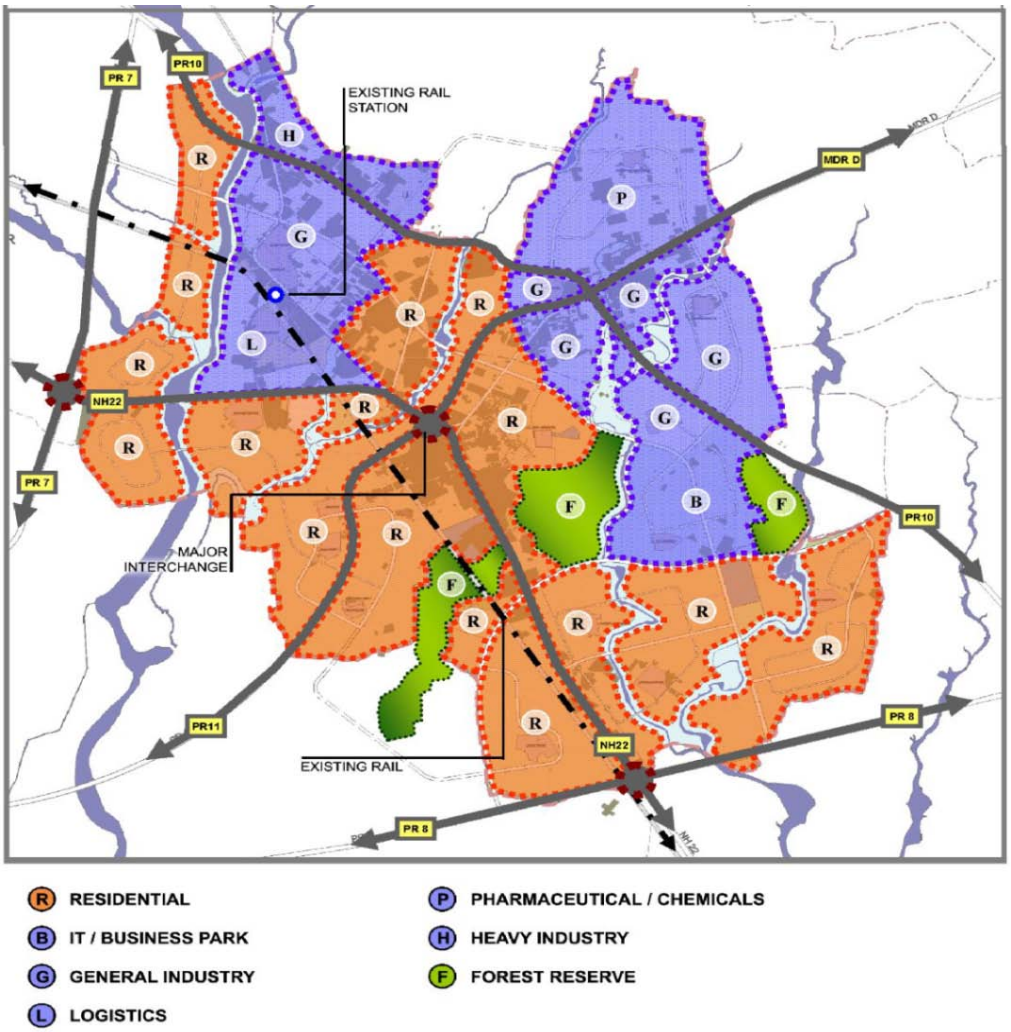

Figure : 1 Study area of the Derra Bassi

III. Materials and Methods

Wastewater samples were analyzed in accordance with the procedure laid down in standard methods for the examination of water and wastewater (APHA, AWWA 2005). Designing of wastewater treatment procedure depended on the inlet quality of effluent. The various principles and rational, scientific as well as empirical formulae used in the design of the treatment units were derived from standard references, hand books and manuals of American Society of Civil Engineers and Central Public Health and Environmental Engineering Organisation.

IV. Result and Discussion

The result and discussion is divided into two parts, first part deals with the study of wastewater which was continuously discharge from Dera Bassi industrial estate and the second part deals with the conceptual design of the wastewater treatment plant.

a) Collection of Wastewater Sample and Analysis Results

Composite combined wastewater samplings have been collected for 24 hours for seven days and the same have been analysed in the laboratory for the relevant parameters. The analysis results are placed in table 1.

Table 1 : Results of Combined wastewater sample

Parameters	Units	Sample 01	Sample 02	Sample 03	Sample 04	Sample 05	Sample 06	Sample 07
pH	–	6.2	6.4	6.5	6.1	6.3	6.2	6.4
Colour	–	yellow	yellow	Yellow	Yellow	yellow	Yellow	yellow
Oil and grease		15	19	16	25	29	32	38
EC	US	1956	2342	2079	2064	2169	2579	2289
Turbidity	NTU	12	15	18	13	16	18	22
Total Suspended Solids	mg/l	653	659	702	715	720	698	740
Total Dissolved Solids	mg/l	1712	1820	1900	1799	1786	1894	1942
Biological Oxygen Demand	mg/l	1159	1283	1169	1243	1320	1349	1284
Chemical Oxygen Demand	mg/l	2210	3320	3120	2389	2486	2512	3100
Lead	mg/l	0.05	0.05	0.08	0.06	0.07	0.06	0.07
Cadmium	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	mg/l	0.15	0.14	0.16	0.11	0.13	0.12	0.14
Zinc	mg/l	0.45	0.58	0.34	0.67	0.59	0.12	0.67
Chromium	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Mercury as Hg	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	mg/l	1	2.3	1	2.45	2.1	1.56	1.92
Iron	mg/l	7.4	7.9	8.3	8.2	7.7	8.5	8.3
Cyanide	mg/l	0.05	0.01	0.021	0.18	0.21	0.05	0.06
Arsenic	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Magnesium	mg/l	78	79	78	79	77	76	78
Calcium	mg/l	80	90	70	80	80	80	130
Chlorides	mg/l	320	374	370	360	329	365	354
Nitrates	mg/l	80	66	51	54	71	77	69
Sulphates	mg/l	168	374	290	190	321	262	301
Total Nitrogen	mg/l	20	40	55	38	45	49	52
Total Alkalinity	mg/l	150	250	290	301	168	252	220
Total Hardness	mg/l	400	500	350	460	500	450	470
Sodium	mg/l	150	170	197	184	169	154	192

b) Design of wastewater treatment plant

The design of the wastewater treatment plant is divided into the units of Inlet chamber, Screen chamber, Grit Removal Unit, Equalization Tank, Clari-Floculator, Aeration Tank, Sand Gravity Filter and Sludge Drying Beds ***etc.***

i. *Design flow and characteristics*

The combined wastewater generated from various industries is being conveyed through the sewer line to the receiving end of the Proposed STP site. The design flow and characteristics of wastewater for the treatment in the proposed STP is placed below in table: 2.

Table 2 : Design flow and characteristics of waste water

Description of Parameter	Value	Unit
Quantity of Sewage Generated	4000000.00	Lpd
	4.00	MLD
	4000.00	Cum/day
Raw Sewage Characteristics		
Average Effluent flow entering the treatment plant	4000000.00	Lpd
Assumed Peak Factor	1.20	
Peak Effluent flow entering the treatment plant	4800000.00	Lpd
COD	3000.00	mg/l
BOD	1500.00	mg/l
TDS	1800-2000	mg/l
TSS	750.00	mg/l
pH	6.50	

ii. *Treatment scheme and size*

Based on the data collected by field visit & research available from the industries on hydraulic load distribution a composite sample was prepared for carrying out laboratory scale treatability study to fix treatment scheme. STP will be compact, smell free and consume less power with best treatment scheme. The process flow diagram for the treatment of wastewater in the proposed STP is placed at **figure - 1**.

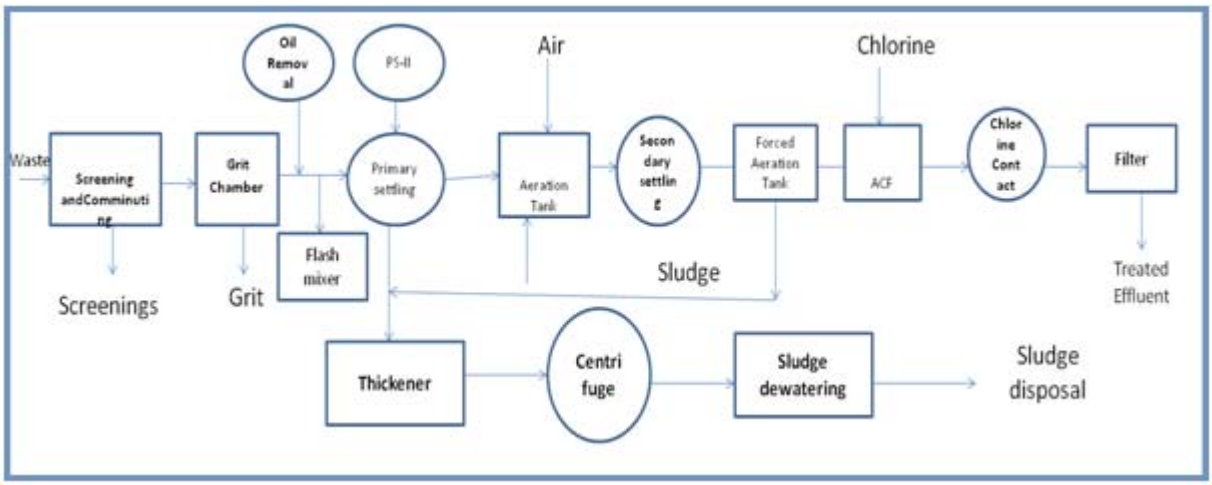

Figure : 2 Process flow diagram for the treatment of wastewater

iii. *Inlet chamber*

The combined wastewater will be passed through the Inlet Chamber. The inlet chamber has been designed for peak flow of 4800 cum/day. The design detail is placed in **table 3**:

Table 3 : Design detail of Inlet Chamber

Quantity of Flow (Ave)	4000.00	Cum/day
Peak Flow	4800.00	Cum/day
	0.06	Cum/Sec
Assumed Detention period	10.00	sec
Volume of the Inlet Chamber	0.56	Cum
Assumed Depth of flow	0.60	M
Area Required for Inlet Chamber	0.93	Sq.m
Assumed Length to Breadth Ratio	1.00	
Breadth of the Tank	1.00	M
length of the Tank	1.00	M

(Provide the Dimension of Inlet Chamber as 1 m x 1 m x 0.6 m SWD + 0.3 m Freeboard)

iv. *Screen chamber*

The wastewater from Inlet chamber will flow by gravity to the screen chamber for the removal of floating material. The design detail is placed below in **table 4.**

Table 4 : Design detail of screen chamber

Peak Design Flow	0.06	cum/s
Assume Clear spacing between bars, o	6.00	mm
Velocity ahead of screen (Va)	0.60	m/sec
Area of Screen Channel, A= (Q/Va)	0.09	m^2
Keeping Side Water Depth	0.50	m
Width of each screen channel, W	0.20	m
Water depth upstream, ha = A/W	0.45	m
T	0.01	m
Number of openings in chamber, W = X.o + (X - 1).t where , X = No. of Opening ; o = Clear Space between bars ; t = Thickness of flat	13.00	no
Total width of opening, Ws =x*o	0.08	m
Assume Angle of inclination	60.00	degree
Assumed Detention Period in the Screen channel	6.00	sec
Assume Length of the screen chamber	3.60	m
Inclined height of the screen, H1	0.52	m
Say		
Velocity through the screen, Vs= Q/H1*Ws	1.37	m/sec
Head loss thru screen in normal condition, $h1=0.0729(V_s^2-Va^2)$	0.11	m
Head loss on 50% clogging $h1=0.0729(2*Vs^2-Va^2)$	0.25	m
Water Depth downstream Hb, $(Za-Zb)+Va^2/2g-Vs^2/2g+Ha$-Headloss thru screen in normal condition	0.26	m
Water Depth downstream Hb, $(Za-Zb)+Va^2/2g-Vs^2/2g+Ha$-Headloss thru screen in clogged condition	0.12	m

(Provide the Dimension of Screen Chamber as 3.6 m x 0.2 m x 0.5 m SWD + 0.3 m Freeboard)

v. *Grit Removal Unit*

The screened wastewater from screen chamber will flow by gravity to the Grit Removal Unit for the removal of grit, sand and silt. The design detail is placed below in **table 5:**

Computation of Settling Velocity: Stoke's Law		
Kinematic Viscosity of Effluent assumed	0.0000011	sqm/sec
Particle Diameter assumed	0.000150	m
Settling Velocity	0.02	m/s
Reynold's number, Re=(d.Vs/Kinematic viscosity)	2.73	
for Transition flows, $Vs=[(0.707(Ss-1)d^{1.6}v^{-0.6})]^{0.714}$	0.02	m/s
Actual Setling velocity	0.02	m/s
removal efficiency	1474.07	cum/sqm/d
Assumed Removal Efficiency	75.00	%
	1105.55	cum/sqm/d
Actual Surface Over Flow Rate :$(Q/A)= V_s n/[(1-\eta)^{-0.125}-1]$	974	cum/sqm/d
Dimensions of grit channel:		

Table 5 : Design & dimension of Grit Removal unit

Peak Flow	4800.00	cum/day
Total Plan area of Grit channel = Qpeak/(Q/A)	4.93	m^2
Assumed Width of the Grit channel	2.50	m
Length of the Channel	2.00	m
Liquid Depth assumed	1.50	m
Provide a depth for the Grit Storage	0.30	m

(Provide the Dimension of Grit Removal unit as 2 m x 2.5 m x 1.5 m SWD + 0.3 m Freeboard)

vi. *Equalization Tank (Collection Chamber)*

The wastewater from Grit Removal Chamber will be collected in the Equalization or Collection Tank so homogenization of the waste water. The design detail is placed below in **table 6.**

Table 6 : Design and dimension of Equalization Tank

Peak Design Flow	4800.00	Cum/day
Assumed Detention period	*4*	hours
Volume of the Tank	*800*	Cum
Assumed Depth of Liquid column	*5*	m
Area required for the equalization tank	*160*	Sq.m
No. of Tanks Proposed	*2*	
area required for each equalization tank	*80*	Sq.m
Length to Breadth ratio	*1*	
Breadth of the tank	*9*	m
Length of the tank	*9*	m

(Provide the Dimension of Equalization Tank as 9 m x 9 m x 5 m SWD + 0.3 m Freeboard)

vii. *Raw Sewage Pump (Transfer Pump)*

The wastewater from the equalization tank will be puped through centrifugal pump to the Clari-floculator for the settling of suspended particle after removal of Oil & Grease and treatment with Chemical. The design detail is placed below in **table 7.**

Table 7 : Dimension detail of Effluent Transfer Pump

Type of Pumps - Submersible/Horizontal Centrifugal		
Average flow	4000.00	Cum/day
Number of working hours	20	hrs
Flow Capacity of Pump required	200.00	Cum/hr
Proposed pumps 4numbers (2W + 2SB), flow per Pump	100.00	Cum/hr
	27.78	lps
Head required	14.00	m
HP required for pump	10.50	hp

viii. *Clari - Floculator*

The wastewater from after treatment with chemical in the flash mixer will be allowed for settling in the Clari-floculator where the suspended particles would be settled. The supernatant will go for the biological treatment in the aeration tank whereas the settled sludge will be send to the thickener for dewatering of sludge and finally disposal into the secured place. It is expected that 40 to 50% reduction in COD and BOD shall be achieved in physico chemical treatment of the industrial waste water. The design detail is placed below in **table 8.**

Table 8 : Design detail of Clarifier

No. of Tanks 2		
Average Flow in each tank	2000.00	cum/day
SOR	25.00	Cum/Sqm/day
SWD	2.00	m

Solid conc. In settled sludge -%	0.8 to 0.9	%
Area Required for the Tank	80.00	Sq.m
Diametre Required for Secondary Settling Tank	10.09	m
Assumed Detention Period	3.10	hrs
	258.33	Cum
Depth of the Clarifier assumed	2.50	m
Area of the Clarifier	103.33	Sq.m
Provide Secondary Clarifier of Diameter	11.50	m
Surface Loading Rate	19.35	Cum/Sq.m/day
Assumed BOD reduction in Clarifier	20.00	%

(Provide the Dimension of Clari-floculator as 11.5 m diameter x 2.5 m SWD + 0.5 m Freeboard)

ix. *Aeration Tank/ Secondary Tank/ Secondary Clarifier/ Forced Aeration Tank*

The wastewater will be allowed for biological treatment in the Aeration tank and forced aeration tank. Air would be supplied through the Surface Aerator. The excess sludge would be settled in the Secondary Clarifier. The settled sludge would be treated in the thickener and after dewatering & drying, it would be disposed in the designated location. The different mode of biological treatment would be worked out for achieving the regulatory norms.

x. *Treated Sewage Sump*

The treated wastewater would be transferred through pump from the Treated Sewage Sump. The design detail of the sump is placed below in table 9.

Table 9 : Dimension of Treated Sewage Sump

Assumed Detention time	15.00	Minutes
Average Flow	4000.00	Cum/day
Volume of the tank	41.67	Cum
Provide a depth of tank	4.00	m
Area of the Tank	10.42	Sq.m
Square tank Size	3.20	m

(Provide the Dimension of Treated Sewage Sump as 3.2 m x 3.2 m x 4 m SWD + 0.3 m Freeboard)

xi. *Rapid Sand Gravity Filter*

The treated water will be passed through the Rapid Sand Gravity Filter/ Activated Carbon Filter for the removal of the fine suspended particles and colouring material. The design detail of Rapid Sand Gravity Filter and Filter feed pumps are placed below in table 10:

Table 10 : Dimension of Rapid Sand Gravity filter

Average Flow	4000.00	Cum/day
Filter Operating hours	20.00	Hrs
Operating flow	200.00	Cum/hr
Filter Loading rate	6.00	Cum/hr/Sq.m
Area of the Filter required	33.33	Sq.m
Filter bed required	8.333333333	
Each size of the Filter bed Required	3.30	M

(Provide 4 no.s the Dimension of Rapid Sand Gravity Filter as 3.3 m x 9.5with 2.5 m Shell height)

xii. *Chlorination*

The treated water is further contact with Chlorine for the disinfection of treated water. The design detail is as follows:

Table 11 : Detail of Chlorine dosing

Disinfection through Chlorination		
Bleaching powder Dozers, 1W+1SB	3500.00	litres/hour
or Vacuum Chlorinator 1 W+1 SB	1.00	Kg/hour
Chlorine Contact tank 15 minute detention	8.1*8.1*4	m*m*m

xiii. *Sludge Dewatering/ Filter Press/ Sludge Drying Beds*

The sludge generated from primary and secondary clarifier would be dewatered through the filter press and subsequently the sludge is dried in the Sludge Drying Beds. The design detail of the Sludge Drying Bed is placed below in the table 12.

Table 12 : Dimension of Sludge Drying Beds

Filter press for Sludge Disposal to handle sludge off	2400	kg/day
	228571.43	Cum/day
	1904.76	Cum/hr
OR		
Population Equivalent	30000.00	Persons
area per person	0.03	Sq.m
Total Area required	750.00	Sq.m

(Provide Sludge Drying Beds of Size 16 m x 16 m x 1.8 MTRS -20 No.)

xiv. *Size of Sludge and Sewer Lines*

There are two types of sludge dewatering systems which can be installed: Sludge Drying Bed (Conventional based on natural drying) Mechanical Dewatering System. In this equipment sludge will be filtered in plate and frame type dead end filter. From filter press sludge shall be available in form of Wet Cake having 25% to 35% solid content. Filtrate shall be taken back to effluent treatment plant. Sludge cake shall be packed in bags and shall be stored in hazardous waste storage area for disposal and treatment. The sludge and sewage lines are placed below in the table 13.

Table 13 : Dimension of Sludge & Sewage line

Pipe Sizes (Diameter in mm)		
Gravity Lines		
Sludge line	160.00	mm
Sewage line	125.00	mm

xv. *Hydraulic Calculation*

In order to get the hydraulic profile of the various components of the STPs, the relevant calculation is placed in table 14.

Hydraulic Calculations		
Average Ground Level	100.00	m
Inlet Chamber		
Water Level in the Inlet Chamber be	200.00	m
Liquid Depth Provided in the Inlet Chamber	0.60	m
Bed Level of Inlet Chamber	199.40	m
Bar Screen Chamber		
Water Level in the Bar Screen Chamber be	199.35	m
Bed Level of U/s of Bar Screen Chamber	199.09	m
Bed Level of D/s of Bar Screen Chamber	198.84	m
Grit Chamber		
Water Level in the Grit Chamber be	198.74	m
Bottom Level of Grit Chamber	197.24	m
Silt Depoition Hopper bottom level	196.94	m

Equalization Tank		
Water Level in the Equalization tank	198.24	m
Bed Level of Equalization tank	193.24	m
Secondary Clarifier		
Water Level in the Secondary Clarifier	197.84	m
Bottom Level of secondary Clarifier	195.34	m
Treated Sewage Sump		
Water Level in the Sump	196.84	m
Bed Level of Treated Sewage Sump	192.74	m
Wall Top Level of Treated Sewage Sump	100.50	m
Pump House		
Size of the Pump House	100	Sq.m
Finished Floor Level of the Pump House above Treated Sewage Sump	100.65	m
Roof Bottom Level of Pump house	104.00	m

V. Conclusion

Wastewater treatment plays an important role in water pollution control. Proper design, operation and maintenance only can give good removal efficiency of pollutants. The actual implementation and maintenance of this scheme will give proper idea of process handling and actual benefits. Through this project, it has been shown that it is feasible to have a common effluent treatment plant for an industrial estate. The conceptual design of the wastewater treatment plant described in this report is a very essential part of addressing current pollution problems. All the proposed treatment units were designed to achieve acceptable effluent characteristics in compliance with the national standards, using the least expensive, most traditional, and energy efficient technologies available.

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Assessment of Respiratory Health Impact of Fuel-Wood Utilization on Exposed Rural Women in Odeda, Southwestern, Nigeria

By Oyebanji, F. F, Adeofun, C. O, Adedeji, O. H, Ekpo, U. F, Oguntoke, O. & Ojekunle, O. Z.

Federal University of Agriculture, Abeokuta

Abstract- This study monitored the concentration of seven air pollutants and examined the concentration of Carbon monoxide (CO) and Carboxylhaemoglobin (COHb) in human breath and blood among the exposed rural women. A total of 12 villages were purposively selected from the list of villages in Odeda Local government area, (Southwestern Nigeria). Active air samplers were used to monitor air quality at the cooking points in houses selected through systematic random sampling. Air monitoring was observed in replicates between November 2012 and January 2013. In order to elicit information on energy utilization and occurrence of air pollution related health problems among the rural dwellers, one questionnaire was administered to the available female in each selected house. The mean±SD (ppm) concentrations of pollutants monitored across the villages were CO: 15.18±4.29; CO_2: 44.09±10.74; NO_2: 0.59±0.12; SO_2: 2.05±0.65; CH_4: 0.58±0.51; PM_{10}: 98.64±9.22 and PM2.5: 43.81±11.11 at average wind speed of 3.11±0.57 m/s. The overall means of Breath CO (ppm) and % COHb were 2.17±0.58 and 1.47±0.37 respectively.

Keywords: *ambient environment, air quality, respiratory health, fuel-wood.*

GJSFR-H Classification : *FOR Code: 300899p*

Strictly as per the compliance and regulations of :

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Keywords: ambient environment, air quality, respiratory health, fuel-wood.

I. Introduction

Although fuel-wood is an important source of energy for domestic use in rural areas but is also a major source of air pollutants such as carbon monoxide, particulate matters, Polycyclic aromatic hydrocarbons (PAHs) and others which are detrimental to human health.

Poverty, lack and/or inadequacy of alternative energy sources have promoted the use of fuel-wood which creates high levels of air pollutants (Zafar *et al.*, 2010). Exposure to these substances leads to increased risk of a variety of diseases including pneumonia, chronic respiratory diseases and lung cancer (Bruce *et al.*, 2002).

Biomass fuel smoke has been classified as a probable human carcinogen and coal smoke as a proven human carcinogen (Straif and IARC Monograph Working Group, 2006), mutagens (WHO, 1997) and is as dangerous to health as breathing in emissions from a car exhaust or tobacco smoke (Koning *et al.*, 1985). Comparison of the burden of illness and premature death from solid fuel use (e.g. fuel-wood) with other major risk factors, including outdoor air pollution, tobacco smoking and hypertension indicated that solid fuel use may be responsible for 800,000 to 2.4 million premature deaths each year (Ezzati *et al.*, 2002; Smith *et al.*, 2004). Inhaled air pollutants have diverse effects on people that are exposed, depending on body constitution, lifestyle, nutritional status and age. Studies have shown that women and children, who are the most exposed and vulnerable to the pollutants, are two to six times at risk of contracting serious respiratory infections (WHO, 1997; Jones, 1999). Interest in respiratory health impacts of air pollutants from fuel-wood utilization has been increasing rapidly probably as a result of high cases of illnesses recorded. Traynor *et al.*, (1985) among rural women and children observed that long time exposure to biomass combustion results in chronic obstructive lung diseases, heart diseases, acute respiratory infections, low birth weight, eye disorder, conjunctivitis, blindness and cancer (Edokpa and Ikelegbe, 2012). Children strapped on their mothers' back while cooking with open cook stoves contracted pneumococcal infections 2.5 times higher than non-exposed ones (WHO, 1997; Mac, 2009). Epidemiological studies in developing countries have also linked exposure to air pollutants from dirty (biomass) fuel to Acute Respiratory Infection (ARI) in children; chronic obstructive lung diseases such as asthma and chronic bronchitis; lung cancer; and still-births and other related problems which include irritation of the skin, eyes, nose and throat; dizziness, nausea and long-term chronic health effects (Ayars, 1997). Furthermore, studies have found strong links between chronic lung diseases in women and exposure to smoke from open cook stoves due to high concentration of NO_2 (Frampton, *et al.*, 1991; Goldstein, *et al.*, 1988 and

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Jones, 1999) and SO_2 (Oin *et al*., 1993) while another found a strong correlation between the high elemental concentration of aerosol particles, high mortality and high morbidity in biomass users (Maloni *et al.,* 2002). Owning to the predominant use of fuel - wood for cooking in rural parts of Ogun state and the potential respiratory health hazards that may result. There is paucity of data relating to the concentration, levels of air pollution from sources such as fuel-wood combustion in Nigeria, hence the need for the constant monitoring and assessment of air pollutants from fuel-wood utilization, this paper therefore assessed air quality at the cooking points, CO concentration in breath and % COHb in selected villages in order to ascertain the level of some gases, in selected villages of Odeda Local Government Area of Ogun state, Nigeria.

II. The Study Area

Odeda local government area (LGA) with headquarters at Odeda is one of the 20 local government areas in Ogun State, southwest Nigeria. It lies on the North-eastern zone of the State, on longitude $7^{0}12^{1}$ to $7^{0}31^{1}$ and latitude $3^{0}15^{1}$and $3^{0}45^{1}$ (Figure 1). The local government area shares boundary with Abeokuta south local government area on the West, Obafemi-Owode local government area on the South, on the North and East with Akinyele and Ibarapa Local government of Oyo state. The population figure was 109,449 (NPC, 2006) and a land area of about 1,554 km^2.

Odeda LGA is predominantly a rural community with numerous villages. Apart from farming which is the major occupation of the residents, people also engage in trading of farm produce, which is done on the periodic market days and hunting. There are approximately 438 settlements/communities spread across the three zonal divisions in the local government namely Odeda, Opeji and Ilugun.

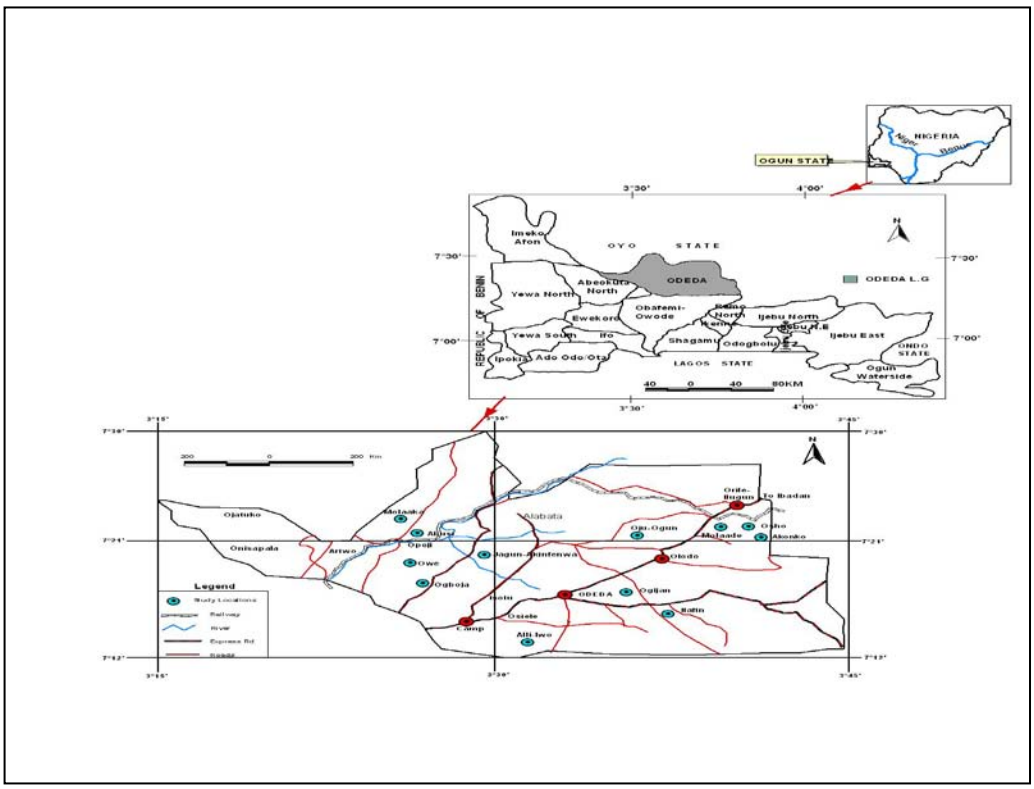

Figure 1 : Map of study area

III. Research Methodology

Data collection for this research work adopted a multi-staged procedure involving three (3) phases. A pre -sampling survey was conducted to select communities for the research, including needed permission for community entry. However, this research work is gender specific hence the target audiences were married women who dominate cooking using fuel-wood.

a) Sample Size and Sampling Procedure

Communities sampled were drawn purposively and based on exclusive criteria such as absence of social amenities (such as tarred roads, electricity supply

and other modern facilities) and 2 km distance from any known major road (these criteria were paramount in order to prevent interference from vehicular emission and to allow air pollutant dispersion respectively). A total of 12 communities were selected after considering the criteria earlier mentioned. The 12 are Iwo-Alli, Jagun Akinfenwa, Ilafin, Ogijan (Odeda zone), Ogboja, Abusi, Owe, Molaaka (Opeji zone), Molaade, Akonko, Osho and Oju-ogun (Ilugun zone). Ten (10) houses were randomly selected from each of the 12 sampled villages for both air quality monitoring and questionnaire survey.

b) Stage One: Questionnaire Administration

A pretested structured questionnaire was administered to elicit information on the sources of energy, source of wood, type of wood used for cooking, location of cooking points, number of cooking points, hours of cooking per day, problems encountered in energy sourcing, commonly treated health problems and the experience of some selected ailments. A total of 120 copies of questionnaire were administered.

c) Stage Two: Air quality monitoring

The preliminary results from the first stage (i.e. questionnaire survey) were used to identify the households where air quality monitoring were conducted. Hence, random selections of 10 households were sampled in each community making a total of 120 households in all. Wind vane was used to determine the wind direction; the MultiRAE lite QRAE systems multigas sampler was used to monitor the concentration of Nitrous oxide (NO and NO_2), Carbon monoxide (CO), Carbon dioxide (CO_2), Sulphur dioxide (SO_2); the $QRAE^+$ was used to monitor Lowest Explosive Limit (LEL i.e. CH_4), Kanomax Anemometer was used to monitor wind speed and velocity while Dust track II Aerosol monitor R11593 for measuring suspended particulate matter (PM_{10}, $PM_{2.5}$). These gases are emitted during wood combustion and are known to induce or cause respiratory disease in exposed humans and also contribute to the problem of global warming (NO_2 and CO_2 being greenhouse gases). These gases were monitored in replicates, in each of the communities between November, 2012 and January, 2013.

d) Stage Three: Respiratory Health Status Assessment

Carboxyl-haemoglobin level and carbon monoxide concentration in the breath of respondents that fully complete their questionnaire and voluntarily agree to participate were assessed using Oximeter (Breath Analyzer).

IV. Data Analysis

The data collected from the three sources were subjected to descriptive, one-way ANOVA and correlation analyses using the statistical package for Social Sciences (SPSS version 17.0.1 and Microsoft Excel, 2007).

V. Results and Discussion

a) Household Survey

Table 1 shows the socio-demographic characteristics of the respondents. About 40 % of the rural women were 50 years old and above and have had between four and six children 51.7 %. Many of them have no formal education or just primary school education (42.5 %). About 45 % of these women are farmers, while others are engaged in selling of farm produce (35 %). These results were supported by a similar study by Oguntoke *et al.*, (2010).

Over 80 % of the respondents depend on fuel-wood for their energy provision (Table 2), while 15 % use both kerosene and fuel-wood, utilization of fuel-wood is closely linked to its availability and affordability (46.7 %). Also, this choice may be due to the attitude of the rural dwellers to want to retain rural habits in relation to energy use, even though other sources exist (Cline-cole, 1988).

Over 80 % of the respondents spend an average 4 hours daily using fuel-wood stove (Table 3); while majority of the respondents (87.5 %) of the respondents have spent above 10 years cooking with fuel-wood. Taking critical consideration, 4hrs daily intake of air pollutants for a period of ten years may have impacted negatively on the respiratory system of the fuel-wood users.

In all the villages about 68 % of the respondents have their cooking cited outdoor; 13.3 % have their cooking points inside and 18.3 % have both indoor and outdoor locations. Most outdoor cooking points are in close proximity to the dwelling units. More than 33.3 % of the respondents have their outdoor cooking points at a distance of not more than 5 m to the house. This may be a source of fuel-wood smoke penetration into houses thereby impairing the Indoor Air Quality (IAQ) according to the study by Oguntoke *et al.*, (2010). Majority of the respondents have minimum of two cooking points (50.8 %) which could possibly double the concentration of air pollutants when the two are been used simultaneously.

Concerning treated illnesses due to air pollutant, table 4 shows that catarrh (85.83 %) topped the list of frequently treated diseases, followed by eye irritation (81.67 %), cough (53.33 %), sneezing (50 %) and nausea (42.50 %). However, for occasionally experienced ailments, it is in order of shortness of breath (51.67 %), headache (50%) and skin irritation (46.67 %) while dizziness is rarely experienced.

Most of the respondents did not consider these respiratory ailments suffered by them as a serious problem probably because health problems from air pollution are known to be subtle (Mac, 2009) and serious outcomes take a fairly long latency period. The respiratory diseases may have become quite frequent that the respondents might have developed means of

coping with or they live by them Oguntoke *et al*., (2010). A critical consideration of health problems suffered by these respondents showed that ailments closely associated with human exposure to air pollutants are prevalent among the respondents (Oin, *et al*; 1993; Frampton, *et al*; 1991 and Jones, 1999; Theuri, 2009).

b) Air quality measurement

The mean concentration of CO among the villages ranged between 8.70±0.31 and 21.79±1.13 ppm with an overall mean value of 15.18±4.29 ppm, which is within the permissible limit (10 - 20 ppm) allowed by WHO (WHO, 2005), Carbon dioxide (CO_2) ranged between 25.21±2.07 and 65.34±0.22 ppm with an overall mean value of 44.09±10.74 ppm, while NO_2 ranged between 0.31±0.00 and 0.78±0.00 ppm with an overall mean value of 0.59±0.12, which were higher than the WHO limit of 0.06 ppm (WHO, 2005), SO_2 ranged between 1.45±0.01 and 3.67±0.00 ppm with an overall mean value of 2.05±0.65. Methane (CH_4) concentration monitored in the selected villages ranged between 0.00 and 1.00±0.01 ppm, with an overall mean value of 0.58±0.51 ppm and these exceeded the limit of 0.06 ppm set by WHO (WHO, 2005). Particulate Matter i.e. PM_{10} have mean concentration that ranged between 81.00±3.17 and 111.20±9.86 ppm, an overall mean of 98.64±9.22, $PM_{2.5}$ ranged between 27.00±1.33 and 61.50±1.08 ppm, and an overall mean value of 43.81±11.11 ppm. Also on the same table 5 shows the mean values of CO concentration in breath which among the villages ranging between 0.78±0.49 and 2.58±2.69 ppm and overall mean value of 1.51±0.49 ppm. The COHb in blood ranged between 0.33±0.23 and 2.64±2.88, with an overall mean value of 1.04±0.62, which falls within the 1 – 3 % permissible limit of WHO, 2005. It is to be noted that CO does not accumulate in the body because once an exposure ends, the lungs exhale CO and COHb reverts back to oxyhaemoglobin, the form of hemoglobin that can carry oxygen. Half of the CO in the blood will be removed in approximately 5 hours (MIOSHA, 1974).

The mean value of CO observed in this study was lower unlike Oguntoke *et al*., (2010), however the trend is not the same for NO_2, SO_2 and CH_4. This trend may not be unconnected to some phenomenon that may affect pollutants' concentration in an outdoor environment. Such factors include temperature inversion, atmospheric stability, lapse rate and mixing height. Table 6 shows that there is no significant variation ($p>0.05$) in air pollution among the villages except for CH_4. This may not be unconnected to the common wood been used, common activities and the variation in CH_4 may be due to addition of supplement materials such as polythenes, pet bottles, biofuels e.g. cow dung, plant residues such as "iha" and "eesan" for quick burning (Zafar et al., 2010). A significant negative correlation exists between $PM_{2.5}$ and Breath CO. which implies that as one increase the other decreases as shown on Table 7.

VI. Conclusion

Utilization of fuel-wood as a source of energy is a major source of air pollution in the study area. Apart from the fact that these gases affect human health negatively, their eventual release into the ambient environment is capable of increasing the concentration of air pollutants in the already polluted atmosphere.

Hence, the reduced concentration of air pollutants in breath and blood should not be assumed to mean that the population is totally free from respiratory problems as a result of their fuel-wood utilization. Further studies that will encompass other respiratory health assessment should be encouraged to further ascertain this fact. Reasonable distances should be given between cooking points and dwelling houses in order to protect the indoor air quality. A sustainable alternative source of energy that is readily available should be developed for the use of rural dwellers. Cooking stove with efficient combustion design should be introduced into the rural communities so as to minimize the emission of pollutants during cooking process. Environmental awareness and education should be embarked upon in the rural areas to sensitize the residents to the health problems associated with exposure to high level air pollutants within the house.

Table 1 : Socio-demographic characteristics of respondents from the study area

Demographic characteristics	No. of Respondents	Percent
Age-group		
21 – 30	14	11.7
31 – 40	27	22.5
41 – 50	31	25.8
> 50	48	40.0
Total	120	100.0
No. of children		
≤ 3	31	25.8

4 – 6	62	51.7
> 6	27	22.5
Total	120	100.0
Educational background		
No formal education	51	42.5
Primary education	51	42.5
Secondary education	17	14.2
Tertiary education	1	0.8
Total	120	100.0
Occupation		
Petty trading	17	14.2
Farming	54	45.0
Artisan (e.g. local hairdresser, carpenter etc)	5	4.2
Civil servants	2	1.7
Petty trading and farming	42	35.0
Total	120	100.0

Table 2 : Cooking energy source, reason for choice, hours of cooking and years of utilization by the respondents in the study area

	No. of Respondents	Percent
Energy source		
Kerosene	2	1.7
Firewood	98	81.7
Charcoal	2	1.7
Kerosene and Firewood	18	15.0
Total	120	100.0
Reason for choice of fuel-wood		
Easy to source	43	35.8
Cooks faster	21	17.5
Available and cheap	56	46.7
Total	120	100.0
Hours of cooking		
≤ 1hr	4	3.3
2 - 4hrs	20	16.7
> 4 hrs	76	80.0
Total	120	100.0
Years of fuel-wood utilization		
< 5 years	4	3.3
5 - 7 years	6	5.0
8 - 10 years	5	4.2
> 10 years	105	87.5
Total	120	100.0

Table 3 : Kitchen location and distance to cooking point in the study area

	No. of Respondents	Percent
Kitchen location		
Indoor	16	13.3
Outdoor	82	68.3
Indoor and Outdoor	22	18.3
Total	120	100.0
No. of cooking points		
1	6	5.0
2	61	50.8
3	49	40.8
4	4	3.3
Total	120	100.0
Distance to cooking points		
Indoor	16	13.3
≤5m	40	33.3
6 - 10m	37	30.83
11 - 20m	20	16.67
> 20m	7	5.83
Total	120	100.0

Table 4 : Frequency of health problems in fuel_wood users

Health problem	Frequently (%)	Occasionally (%)	Rarely (%)
Eye irritation	98 (81.67)	15(12.5)	7(5.83)
Dry throat	58(48.33)	42(35)	20(16.67)
Headache	26(21.67)	61(50.83)	33(27.5)
Sneezing	60(50)	49(40.83)	12(9.17)
Skin irritation	18(15)	56(46.67)	47(38.33)
Shortness of breath	29(24.17)	62(51.67)	29(24.17)
Cough	64(53.33)	38(31.67)	18(15)
Dizziness	25(20.83)	47(39.17)	48(40)
Nausea	51(42.50)	26(21.67)	43(35.83)
Catarrh	103(85.83)	17(14.17)	0.00(0)

Table 5 : Mean values of parameters monitored in the selected villages

VILLAGES	CO (ppm)	CO_2 (ppm)	NO_2 (ppm)	SO_2 (ppm)	CH_4 (ppm)	PM_{10} (ppm)	$PM_{2.5}$ (ppm)	CO BREATH	% COHb
Iwo-Alli	10.21±0.32	25.21±2.07	0.62±0.00	1.45±0.01	1.00±0.01	105.45±5.21	60.40±1.68	0.92±0.98	0.49±0.49
Ogijan	15.86±0.12	51.34±1.32	0.31±0.00	1.75±0.11	0.00	100.5±9.21	61.50±1.08	2.58±2.69	1.15±0.72
Jagun Akinfenwa	21.79±1.13	45.32±1.00	0.63±0.18	3.67±0.00	1.00±0.00	111.20±9.86	60.20±2.14	0.78±0.49	0.94±1.24
Ilafin	19.30±0.04	52.99±2.36	0.59±0.19	1.59±0.00	0.00	88.40±4.76	38.20±1.98	1.16±0.88	0.33±0.23
Ogboja	18.40±0.09	34.09±2.19	0.54±0.00	1.89±0.02	1.00±0.00	88.00±3.78	36.00±3.10	1.48±1.08	1.28±0.84
Owe	17.80±0.23	39.01±1.10	0.38±0.00	1.67±0.13	0.00	81.00±3.17	38.40±1.93	1.81±1.48	0.71±0.76
Molaaka	19.71±0.32	65.34±0.22	0.55±0.19	1.46±0.21	1.00±0.00	96.80±4.52	27.00±1.33	1.63±1.38	0.93±1.17
Abusi	10.10±0.02	41.98±2.07	0.63±0.12	2.19±0.13	1.00±0.00	99.10±3.81	38.20±0.32	1.29±0.93	1.14±1.11
Molaade	14.10±0.11	51.45±1.27	0.54±0.00	2.78±0.29	1.00±0.00	94.90±5.77	40.50±1.74	1.75±1.38	1.59±0.96
Osho	13.80±0.13	34.98±1.61	0.72±0.00	2.45±0.19	0.00	108.20±6.07	40.20±2.45	1.76±1.39	0.67±0.66
Oju-ogun	8.70±0.31	38.19±1.20	0.66±0.00	1.98±0.02	0.00	107.00±3.91	46.97±2.19	1.16±0.87	2.64±2.88
Akonko	12.40±0.22	49.19±2.26	0.78±0.00	1.69±0.01	1.00	103.10±5.01	38.17±1.04	1.74±1.38	0.55±0.49
Mean±Stdev	15.18±4.29	44.09±10.74	0.59±0.12	2.05±0.65	0.58±0.51	98.64±9.22	43.81±11.11	1.51±0.49	1.04±0.62
Permissible Limit	**10.0 - 20.0**	**NA**	**0.04 - 0.06**	**0.01 - 0.1**	**0.06**	**NA**	**NA**	**NA**	**1-3**

**NA- Not Available*

Table 6 : Variations in air pollutants' concentration between villages ($p < 0.05$)

Pollut-ants	Locations grouping											
CO	Iwo-Alli[a]	Ogijan[a]	Jagun Akinfenwa[a]	Ilafin[a]	Ogboja[a]	Owe[a]	Molaaka[a]	Abusi[a]	Molaade[a]	Osho[a]	Oju-ogun[a]	Akonko[a]
CO_2	Iwo-Alli[a]	Ogijan[a]	Jagun Akinfenwa[a]	Ilafin[a]	Ogboja[a]	Owe[a]	Molaaka[a]	Abusi[a]	Molaade[a]	Osho[a]	Oju-ogun[a]	Akonko[a]
SO_2	Iwo-Alli[a]	Ogijan[a]	Jagun Akinfenwa[a]	Ilafin[a]	Ogboja[a]	Owe[a]	Molaaka[a]	Abusi[a]	Molaade[a]	Osho[a]	Oju-ogun[a]	Akonko[a]
NO_2	Iwo-Alli[a]	Ogijan[a]	Jagun Akinfenwa[a]	Ilafin[a]	Ogboja[a]	Owe[a]	Molaaka[a]	Abusi[a]	Molaade[a]	Osho[a]	Oju-ogun[a]	Akonko[a]
CH_4	Ogijan[a]	Ilafin[a]	Owe[a]	Osho[a]	Oju-ogun[a]	IwoAlli[ab]	Jagun Akinfenwa[ab]	Molaaka[ab]	Abusi[ab]	Molaade[ab]	Akonko[ab]	Ogboja[b]
PM_{10}	Iwo-Alli[a]	Ogijan[a]	Jagun Akinfenwa[a]	Ilafin[a]	Ogboja[a]	Owe[a]	Molaaka[a]	Abusi[a]	Molaade[a]	Osho[a]	Oju-ogun[a]	Akonko[a]
$PM_{2.5}$	Iwo-Alli[a]	Ogijan[a]	Jagun Akinfenwa[a]	Ilafin[a]	Ogboja[a]	Owe[a]	Molaaka[a]	Abusi[a]	Molaade[a]	Osho[a]	Oju-ogun[a]	Akonko[a]

Means with the same superscript row-wise are not significantly different according to Duncan Multiple Range test

Table 7 : Relationship between air pollutant concentration and human body concentration

VARIABLES	CO	CO_2	NO_2	SO_2	CH_4	PM_{10}	$PM_{2.5}$	BREATH CO	% BLOOD CO
CO	1.00	0.46	-0.36	0.22	0.02	-0.36	-0.13	-0.03	0.53
CO_2		1.00	-0.24	-0.03	0.06	-0.16	-0.38	0.09	-0.25
NO_2			1.00	0.18	0.26	0.46	-0.24	-0.07	-0.41
SO_2			0.18	1.00	0.22	0.44	0.31	-0.53	0.03
CH_4					1.00	0.15	-0.10	-0.36	-0.16
PM_{10}						1.00	0.53	-0.38	-0.21
$PM_{2.5}$							1.00	-.598*	0.54
BREATH CO								1.00	-0.27
% BLOOD CO									1.00

**Correlation is significant at the 0.05 level*

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Estimation of Aquifer Parameter of Pabna District, Bangladesh

By M S Islam

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Abstract- The amount of groundwater in any area depends on the characters of the underlying aquifer, its extent and the frequency of discharge. Quantitative hydro-geological studies of aquifer parameters are important pre-requisites for scientific management of groundwater resources. Lithological data can be used as an important source for hydro-geological investigation.

In this work, the lithological character encountered in borehole of 303 locations and static water levels of 81 locations have been collected, compiled, processed, analyzed and interpreted for studying the hydro-geological properties of nine upazillas of Pabna district, Bangladesh. Various types of map of hydro-geological properties of subsurface formation like porosity, specific yield, transmissivity, hydraulic diffusivity have been prepared for the proper identification of groundwater occurrence, distribution and potentiality of the area studied. Porosity and specific yield are the two important properties of an aquifer material to identify the storage of the aquifer. The yield determines whether or not the water saturated zone is a source of groundwater and the natural characteristics of the water bearing formations affect the yield. The transmissivity map represents its average water transmitting property which depends mainly on the number and diameter of the pores present and determines the effectiveness of groundwater reservoir. Hydraulic diffusivity determines the time that is need for a given head change to occur in an aquifer as a response to a great change in head at another point. Finally, groundwater potential zones have also been identified for groundwater exploration.

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Estimation of Aquifer Parameter of Pabna District, Bangladesh

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Abstract- The amount of groundwater in any area depends on the characters of the underlying aquifer, its extent and the frequency of discharge. Quantitative hydro-geological studies of aquifer parameters are important pre-requisites for scientific management of groundwater resources. Lithological data can be used as an important source for hydro-geological investigation.

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I. Introduction

Groundwater is the only source of water supply for drinking and main source of irrigation in the area studied. Water scarcity is found in this proposed area during irrigation period due to the increasing population and development activities. The increasing population has suddenly increased the demand for consumption of water and stimulated investigations oriented towards quantifications of this resource. The large scale abstraction of groundwater for irrigation without proper planning and management has caused many environmental degradation. So, a detailed study is now essential for the conservation of this important resource in the area.

Aquifer parameter of subsurface formations plays an important role for groundwater occurrence, distribution and reservation. These parameters can be classified in two categories. One of them is formation parameter and the other is hydro-geologic parameter. Formation parameters are very important for groundwater investigation and detection of its condition. Detection of effective groundwater reservoir, measurement of the rate of propagation of groundwater, selection of suitable well-sites etc. are important for groundwater development .Hydraulic conductivity transmissivity, hydraulic diffusivity and radius of influence are the measuring instruments for the identification and estimation of the hydro-geologic parameters. Those parameters have been estimated and presented in the form of contour maps. So the estimation of various types of aquifer parameter would definitely identify the actual feature of groundwater in the study area.

II. Materials and Methods

Any successful research does not depend not only upon the availability and quality of requisite data but also on the appropriate methodology. It is not possible to identify and estimate the invisible properties of subsurface formations. Because it is far beyond the access of direct visual measurement and experiment. So present research work has conducted and completed through data acquisition. Analysis has been made on integrated hydro-geological approach. About 303 borehole data and static water level data of 81 locations during the period of 1994-2007 have been collected from various relevant organizations for the measurement of aquifer parameters. Borehole data would provide valuable information of subsurface water bearing formations and help to estimate the different types of aquifer parameter of the investigated area.

III. General Feature s of the Study Area

The study area, Pabna district, is located in the south-eastern corner of greater Rajshahi division (Fig.1). The area comprises nine upazillas covering 2371.50 Sq.km. The two major rivers, the Padma and the Jamuna, are flowing along the boundaries of the study area sustaining the environmental balance and socio-economic development (ZUP,2005). The entire study area is almost a plain land of an average elevation of 14m whereas the northwestern part is slightly more elevated with maximum elevation of 22m.The investigated area is located in the shelf region zone of

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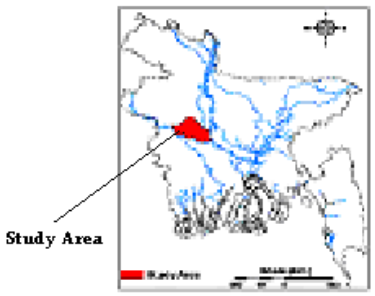
Bangladesh and was formed by the deposition of sediments carried by the river Padma and its tributaries in the Pleistocene age. The alluvium is composed of clay and sand of different grains. The overall soil quality is suitable for groundwater potential. The topmost formation, composed of clay and silt, is underlain by fine, medium and coarse sand. The aquifer system in the investigated area may be schematized into an aquifer of variable thickness.



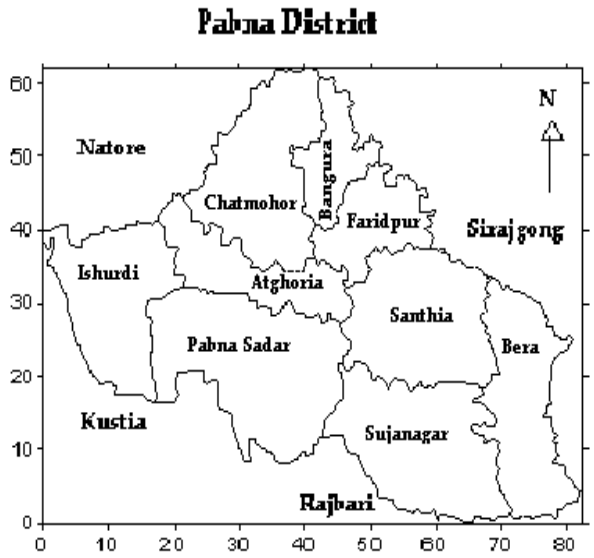


Figure 1 : Representation of the study area map

IV. Analysis of Litholog Data

The development of groundwater requires knowledge about the characteristics of the subsurface aquifer parameters. So, analysis of litholog and static water level data are very important for the measurement of aquifer parameters. In this context, the distribution of borehole locations along with static water level positions in the study area has been shown in Fig.2.

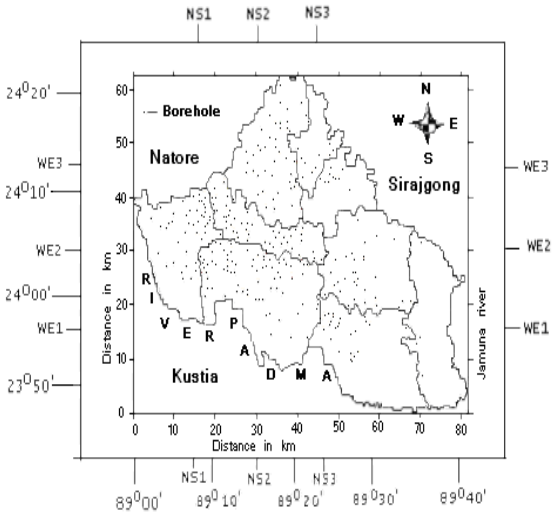


Figure 2 : Area under investigation showing borehole locations

V. Porosity

The groundwater can get stored in the underground rock, only if, they are sufficiently porous, because the water is actually stored in the pores of the rocks. Porosity is the measure of the volume of void spaces in geological formation and it is also a measure of absorptive power of the material. In terms of groundwater supply, granular sedimentary deposits are of major importance of porosity. Porosities in these deposits depend on the shape and arrangement of individual particles, distribution by size and degree of cementation. Fig.3 shows the distribution of average porosity which ranges from 38% to 43%. From the figure it is observed that the average value of porosity is maximum in the east-southern part of the area studied. The lower range of porosity in between 35.50% to 38% occupies some discrete places in a scattered way. The porosity of the geological formations of the area indicates a good reserve of groundwater which could be explored.

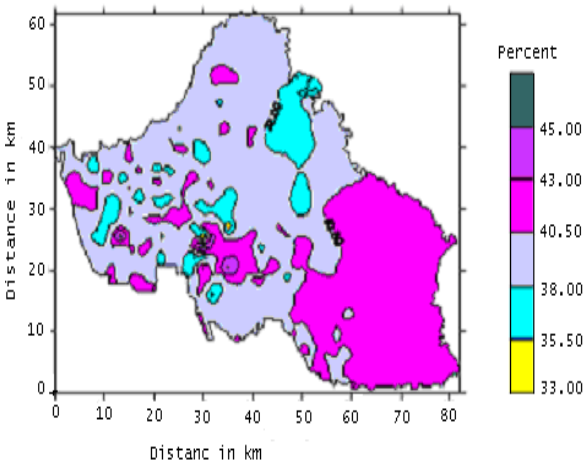


Figure 3 : Representation of porosity in the study area

VI. Specific Yield

The term specific yield is defined as the volume of water released by the downward movement of a unit distance. According to Meizner (1923) specific yield is the ratio of volume of water that drains from a saturated rock owning to the attraction of gravity to the volume of the rock. The specific yield depends upon the composition; the more sand in the sediments the higher the specific yield. The higher the clay content, lower the specific yield.

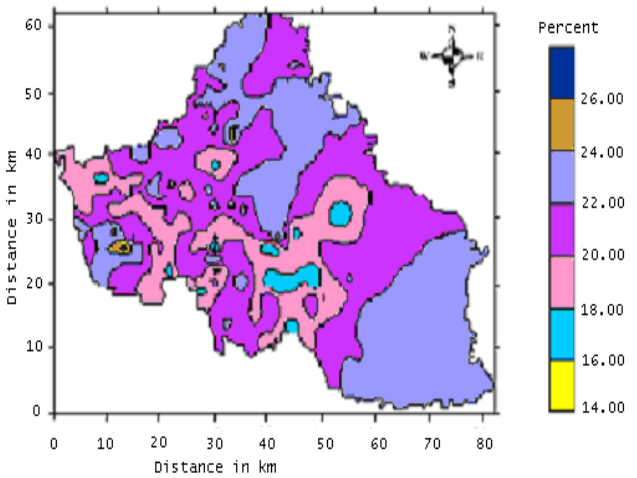


Figure 4 : Representation of specific yield in the study area

The specific yield of the study area has been estimated from the borehole and static water level data. A shaded contour map of specific yield has prepared depending upon the representative values of specific yield and the saturated thickness of the formations as shown in Fig.4. From the map it is observed that the specific yield values change from 18% to 24%.The values of specific yield in between 22% to 24% are found in the southeastern portion and in the north region. There is also a small pocket in the southern part of Ishurdi upazilla of the study area. The specific yield values of 20% to 22% are observed in north-east and north-west regions. There are some pockets of the range of 18% to 20% are identified in the west and south regions of the area. From the observations, it is found that the existing aquifer in the study area is unconfined in nature and it can be concluded that the overall values of specific yield of the area is suitable and satisfactory for groundwater potentiality.

VII. Specific Retention

The quantity of water retained by the material against the pull of gravity is termed as the specific retention. The specific retention is the amount of water held between the grains due to molecular attraction. The amount of this water will depend upon the total interstitial surface in the rock. If the total interstitial surface is more, the specific retention will be more and vice versa. The specific retention of the study area has been estimated from the lithologic data and a shaded contour map has been prepared at an interval of 2.5% as shown in Fig.5. From the figure it is observed that a track extended from north-east to south-west having the specific retention higher and its value ranges from 19.50% to 22%. The north-west and south-east part of the study area have the specific retention of medium type of 17% to 19.50%. The lowest value of specific retention is found in the upper portion of northeastern part of the study area. Besides, there are some pockets of the lower value of specific retention distributed in a scattered form. The areas containing the lower specific retention indicate the suitable regions for groundwater exploitation. Some small regions of the study area have the highest (above 22%) value of specific retention. These regions are not suitable for better exploitation of groundwater.

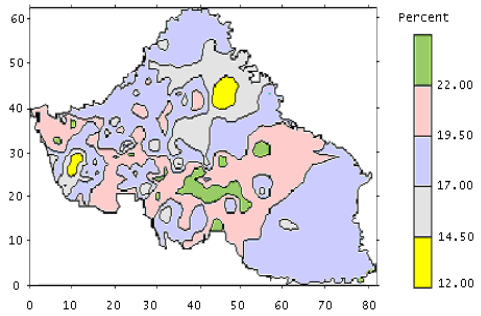


Figure 5 : Distribution of specific retention of the study area

VIII. Hydraulic Conductivity

The hydraulic conductivity of a water saturated zone represents its average water transmitting property which depends mainly on the number and diameter ofthe pores present. It may be classified in two parts: one of them is vertical conductivity and the other is horizontal conductivity.

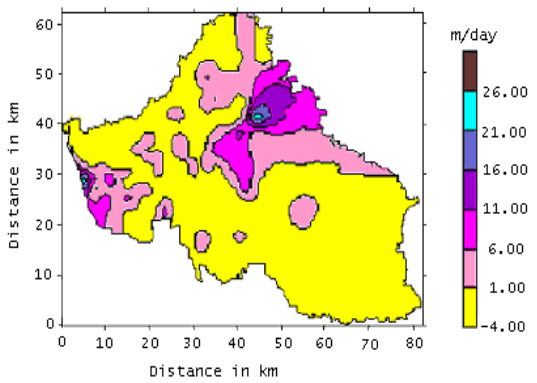


Figure 6 : Distribution of vertical conductivity in the study area

A shaded contour map of vertical conductivity has been prepared from the estimated values using the borehole litholog data as shown in the Fig.6. It is

observed from the figure that the vertical conductivity of the most part of the study area is very low. The northeastern and the southwestern parts of the investigated area have the higher value of vertical conductivity. Some pockets of the higher value are shown in the figure. The higher value of vertical conductivity indicates the higher recharge area.

Another shaded contour map of horizontal conductivity of the investigated area is shown in Fig.7. It is observed from the figure that the horizontal conductivity of the study area ranges from 10 m/day to 85 m/day. It is also observed that the south-eastern side of the study area have the minimum value of horizontal conductivity and this observation indicates that the area is not good for groundwater resource. From the analysis it can also be concluded that heavy runoff occurs in this place due to the slopping nature of the surface and the bulk thickness of clay formation. So, the area is less potential for groundwater exploitation. The rest parts of the study area have the suitable range of horizontal conductivity and the groundwater recharge condition is suitable and satisfactory.

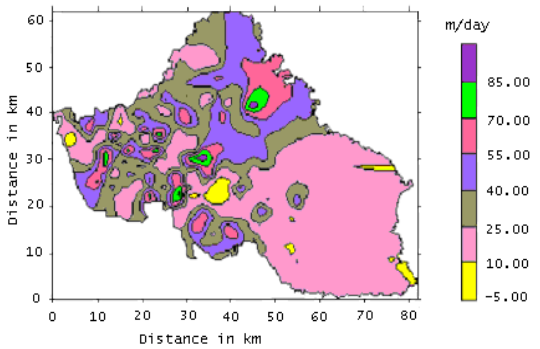


Figure 7 : Distribution of horizontal conductivity in the study area

IX. Transmissivity

Any water saturated zone could be used for exploration if the formation permits the flow of water through it. The hydraulic conductivity of a water saturated zone represents its average transmitting property, which depends mainly on the number and the diameter of the pores and fluid characteristics. It is the product of mean aquifer thickness and mean aquifer permeability, decreasing aquifer thickness will cause a decrease in transmissivity for the same type of sand and lower mean permeability cause by train towards fine or poorly sorted sand will have the same effect.

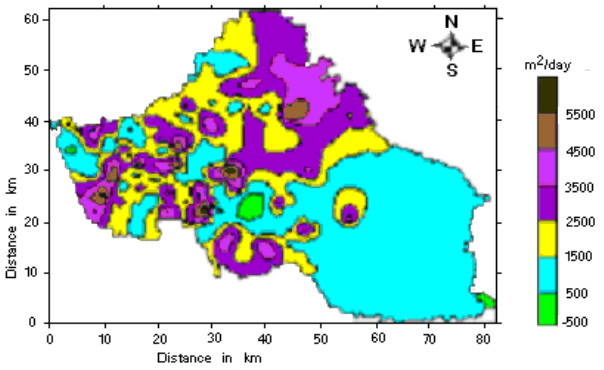


Figure 8 : Distribution of transmissivity in the study area

The value of transmissivity has been studied using the borehole information. In the present study, transmissivity of water in the saturated formation has been taken into account. Considering the thickness of the layer of different grain size as obtained from the borehole data and the corresponding hydraulic conductivity, the transmissivity in different layers have been calculated. Then the individual values are added to get the transmissivity of that location. The value of transmissivity in the study area has been estimated and presented in the form of shaded contour map at the interval of 1000 m^2/day as shown in Fig.8. The figure illustrates a high contrast of transmissivity over the area, which ranges from 500 m^2/day to 3500 m^2/day. In southeastern part of the area, the value of transmissivity covers 500 m^2/day to 1500 m^2/day. In the north-eastern part and the some discrete parts of western-southern side of the study area the value of transmissivity is the highest. The transmissivity of the rest of the area is within the range of 1500m^2/day to 3500m^2/day. It could be said that the estimated value of transmissivity of the aquifer is very much favourable for groundwater exploration.

X. Hydraulic Diffusivity

The ratio of transmissivity to the storage coefficient is defined as the hydraulic diffusivity (Karnath,1990). The hydraulic diffusivity is the rate of propagation of change in head in an aquifer. Actually this parameter indicates the regions having higher values are comparatively favourable for groundwater development due to small head change.

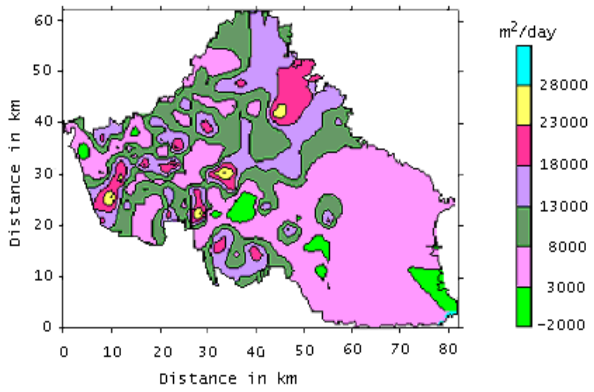


Figure 9 : Representation of hydraulic diffusivity in the study area

A contour map of hydraulic diffusivity has been prepared as shown in Fig.9. The major portion of the area covers the range of diffusivity from 3000 m^2/day to 18000 m^2/day. The southeast corner of the area having the value of diffusivity of 3000 m^2/day to 8000 m^2/day which covers above 50% of the entire area. The central, northern and western parts of the study area have the value of diffusivity from 8000m^2/day to 13000m^2/day, but it is not in a regular form.

XI. Radius of Influence

The radial distance from the centre of well to the limit where the drawdown is zero is called the radius of influence. Water to the extent of radius of influence from the well is under motion to fill up the pumping rate. Tube-wells have been generally located without any scientific studies, till recently. Pumping wells should be spaced far apart so that their cones of depression will not overlap over each other resulting in the reduction of their yields and /or increased drawdown. If two or more wells are constructed in such a way that they are near to each other and their cones of depression intersects, they are said to be interfere. Such mutual interference of wells decrease the discharge of the interfering wells (Garg,2004).

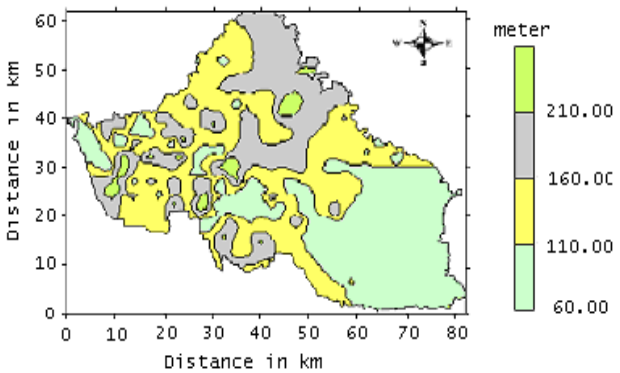


Figure 10 : Radius of influence of the pumping wells in the study area

A contour map of radius of influence is prepared depending upon the values of storage coefficient and the transmissivity as shown in Fig.10. As the aquifer of the study area is unconfined in nature, so the storage coefficient S is chosen as 0.21. From the figure it is observed that the value of radius of influence of the study area ranges from 60m to 210m. The southeastern part of the study area has the radius of influence of 60m-110m. Some portions of the northeastern side and the remaining parts of the study area have the radius of influence of 110m to 160m. But there are some pockets of various values of radius of influence almost all over the area except the southeastern part. A very few regions of the study area have the radius of influence of 160m-210m. From the observation it can be concluded that all the area except the southeastern part is suitable for well construction and exploration.

XII. Groundwater Potential Zone

The principal aim of the interpretation of borehole data and the preparation of different aquifer properties maps are to provide input information to the groundwater potential map (Krisnamurthy et.al,1992). Groundwater potential map can be prepared from the geometric properties of aquifer. A thick layer of coarse sand represents higher potential and a thin layer of fine sand with slit represents low potential. Therefore, groundwater potential of an area depends on the aquifer thickness and aquifer composition material. It is well known that groundwater head gradient plays an important role in exploration of groundwater. An area with high gradient of groundwater head means low conductivity and hence it is not suitable for bulk extraction. Therefore, suitable location for water-wells is the place, which is potential for groundwater and have low groundwater head gradient. A location is marked as suitable for water-wells if the location is potential for groundwater and has a good hydraulic permeability. A high gradient of groundwater head represents less permeability and a low gradient means high permeability.

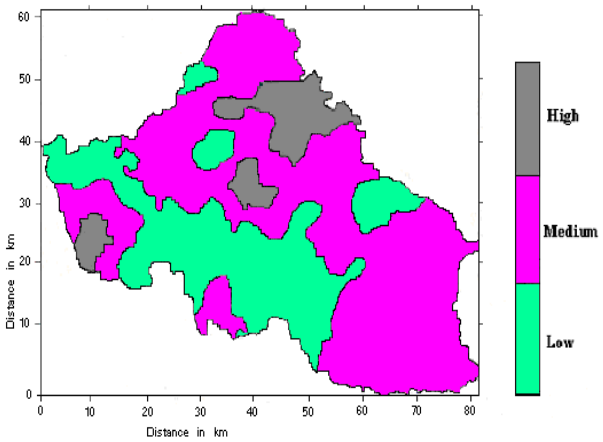


Figure 11 : Representation of groundwater potential zone in the study area

Groundwater potential map has been prepared on the basis of specific yield, transmissivity and yield index maps (Fig.11). Three zones are identified in the figure as high, medium and low potential. In general, that area could be identified as a medium potential zone. In the northeastern corner and two other pockets also identify as high potential zone. From the map it is observed that the brown portions of the investigated area are high potential and the orange portions are medium potential. A low potential profile is observed from west to the southeast portion in the study area. The blue portions of the investigated area indicate low potential area. In general, it could be said that the investigated area is favourable for groundwater exploration, but large scale abstraction of water should be avoided.

XIII. Conclusion

Borehole data have been processed and analyzed to estimate the hydro-geologic parameters of subsurface formations of the study area and presented in the form of maps. From the analysis it is clearly observed that various parameters have the values within the recognized limits. The overall thickness of the composite sandy formation is suitable for groundwater potentiality. No other impermeable layer is found below the sandy formation. Basically, the area is unconfined in nature. Porosity, specific yield, specific retention, transmissivity, vertical and horizontal conductivities, hydraulic diffusivity, radius of influence of the study area have been measured and presented with the contour maps. Finally, groundwater potential zone of the study area has been prepared for the detection of potentiality of the investigated area. From all the maps it is very clear that the hydro-geologic sub-surface properties of the investigated area are favourable for groundwater abstraction.

XIV. Acknowlegement

The work has been accomplished in the Geophysics Laboratory of the Department of Applied Physics and Electronic Engineering of Rajshahi University with the full co-operation of the institution of 'Panasi Project' under the department of Bangladesh Agriculture Development Corporation (BADC), Pabna, Bangladesh and the direct supervision of my guide who is appointed for this research work. I am very much grateful to the stated institution for giving us relevant information about the work.

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The IBOARS can initially review research papers of their institute and recommend them to publish with respective journal of Global Journals. It can also review the papers of other institutions after obtaining our consent. The second review will be done by peer reviewer of Global Journals Incorporation (USA) The Board is at liberty to appoint a peer reviewer with the approval of chairperson after consulting us.

The author fees of such paper may be waived off up to 40%.

The Global Journals Incorporation (USA) at its discretion can also refer double blind peer reviewed paper at their end to the board for the verification and to get recommendation for final stage of acceptance of publication.

The IBOARS can organize symposium/seminar/conference in their country on behalf of Global Journals Incorporation (USA)-OARS (USA). The terms and conditions can be discussed separately.

The Board can also play vital role by exploring and giving valuable suggestions regarding the Standards of "Open Association of Research Society, U.S.A (OARS)" so that proper amendment can take place for the benefit of entire research community. We shall provide details of particular standard only on receipt of request from the Board.

The board members can also join us as Individual Fellow with 40% discount on total fees applicable to Individual Fellow. They will be entitled to avail all the benefits as declared. Please visit Individual Fellow-sub menu of GlobalJournals.org to have more relevant details.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time. This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

After nomination of your institution as "Institutional Fellow" and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.
The board can also take up the additional allied activities for betterment after our consultation.

The following entitlements are applicable to individual Fellows:

Open Association of Research Society, U.S.A (OARS) By-laws states that an individual Fellow may use the designations as applicable, or the corresponding initials. The Credentials of individual Fellow and Associate designations signify that the individual has gained knowledge of the fundamental concepts. One is magnanimous and proficient in an expertise course covering the professional code of conduct, and follows recognized standards of practice.

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We shall provide print version of 12 issues of any three journals [as per your requirement] out of our 38 journals worth $ 2376 USD.

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- • This individual has learned the basic methods of applying those concepts and techniques to common challenging situations. This individual has further demonstrated an in–depth understanding of the application of suitable techniques to a particular area of research practice.

Note :

"

- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.
- In case, the chairperson needs to be replaced then consent of 2/3rd board members are required and they are also required to jointly pass the resolution copy of which should be sent to us. In such case, it will be compulsory to obtain our approval before replacement.
- In case of "Difference of Opinion [if any]" among the Board members, our decision will be final and binding to everyone.

"

Process of submission of Research Paper

The Area or field of specialization may or may not be of any category as mentioned in 'Scope of Journal' menu of the GlobalJournals.org website. There are 37 Research Journal categorized with Six parental Journals GJCST, GJMR, GJRE, GJMBR, GJSFR, GJHSS. For Authors should prefer the mentioned categories. There are three widely used systems UDC, DDC and LCC. The details are available as 'Knowledge Abstract' at Home page. The major advantage of this coding is that, the research work will be exposed to and shared with all over the world as we are being abstracted and indexed worldwide.

The paper should be in proper format. The format can be downloaded from first page of 'Author Guideline' Menu. The Author is expected to follow the general rules as mentioned in this menu. The paper should be written in MS-Word Format (*.DOC,*.DOCX).

The Author can submit the paper either online or offline. The authors should prefer online submission.Online Submission: There are three ways to submit your paper:

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1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

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Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

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27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

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30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

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Key points to remember:

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- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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