IOSR Journal of Applied Geology and Geophysics (IOSR-JAGG)
e-ISSN: 2321–0990, p-ISSN: 2321–0982.Volume 7, Issue 6 Ser. I (Nov. – Dec. 2019), PP 22-25
www.iosrjournals.org

Hydraulic Characterization of Hand Pump Boreholes on Maiha Local Government Area of Adamawa State, Nigeria.

Kasidi simon[1], Lazarus G. Ndatuwong[2]
Adamawa State University, Mubi
[1]Department of Geology
[2]Department of Pure & Applied Physics
Corresponding Author: Kasidi Simon

Abstract: *Single-well pumping test was carried out at constantrateon six hand pump boreholes inpart of Maiha town to give information about the draw down and a quifer characteristics resulting from specific pumping rate .The test was carried out for eight hoursat constantdischargerate for each of the borehole.The drawdown result with respect to time was analyse using Cooper-Jacob'sstraight-line method in ordertoestimatethe transmissivity and specific discharge of the boreholes. The magnitude of the transmissivity in the study area fall within the low magnitude class, which impliesthat the transmission rateofthegroundwaterin the aquifer is low. The boreholes in the study area are of moderate performance which is capable of serving a smaller population using hand pump based on the result of the specific capacity obtained from the result.*

Key Words: *Transmissivity, Specific capacity, Single-well, Pumping test, Aquifer.*

Date of Submission: 26-10-2019 Date of Acceptance: 11-11-2019

I. Introduction

Groundwaterisfrequentlychosenasthe mostpotablesource ofdrinkingwater, supplies are broughtto the surface by drilling boreholes. Pumpingtests are a practical wayofobtaining an idea oftheborehole's efficiencyand its optimalproduction yield. Pumpingtestconsistsofpumping groundwaterfroma well, usuallyataconstant rate,and measuringwaterlevels in the pumped wellandanynearbywells (observation wells)orsurfacewater bodies duringandafterpumping. A single-well pumping test is a test in which no piezometers (observation wells) are used. Water-level during pumping or recovery are measured only in the well itself.

Pumpingtestisconductedtoexaminetheaquifer response, undercontrolled conditions,tothe abstraction ofwater. It is apractical, reliable methodofestimatingwellperformance, wellyield,the zone of influenceof the welland aquifercharacteristics i.e.,the aquifer's abilitytostore and transmitwater, aquiferextent, presenceofboundaryconditions and possible hydraulic connectionto surface water through the evaluation of the aquifer parameters.

Aquifer parameter such as transmissivity, hydraulic conductivity, storativity, specific capacity are indispensable forsuccessfulandreliable modelingresults,andtherebyensuringpropermanagement ofvitalgroundwater resources (Abdel_Gawal and El-Hadi, 2009).A knowledge of these parametersveryimportantin proper management of groundwater resources.Transmissivityand strorativity are amongthemostimportanthydrogeologicaldata neededformanaginggroundwaterresources.Tranmissivity is the only one that can be obtainedfromsingle-welltest data (Mawlood and Aziz, 2019). Othercanonlybequantifiedusingmultipleobservation wellsorflowlogs(HansonandNishikawa1996).

Thebasicprinciple ofa pumpingtestis thatifwe pump water froma welland measure thepumpingrateandthe drawdown in the well then we cansubstitute these measurementsinto anappropriate formulaandcan calculate the hydraulic characteristicsofthe aquifer. It is also calledasaquifertests foraquiferparameterevaluation.

Singlewell aquifer tests arefrequently analyzed withtheCooper-Jacob(1946)methodbecauseofitssimplicity.Transmissivityisestimatedbyfittingastraight linetodrawdownson anarithmeticaxis versestimeon alogarithmicaxisinasemi-logplot.Drawdowns inconfined and unconfinedaquifers have been analyzed by many researchersusingtheCooper-Jacobmethod,regardless ofdifferences betweenfieldconditionsandtheory(Halford,etal,2006; Sulistyo, 2018; Amah andAnam, 2016; Mawlood and Aziz, 2019; Hassanet.al,2016; Chenini,et. al, 2008; Okon et. al., 2018; Schaat, 2004)

AstheCooper-Jacobmethodisasimplificationofthe Theissolution,thepumpingwellshouldfullypenetrate aconfined,homogeneous, andisotropicaquifer.Single welltests from partiallypenetratingwellsin unconfined aquifersdepartgreatlyfromtheTheis (1935) model. Moreover,unconfinedaquifertestsareaffected byvertical anisotropy andspecificyieldinadditiontotransmissivity andstoragecoefficient.These additionalparameterscontrol verticalgradients thatarecreatedby partialpenetrationanddrainagefromthe water table.Likewise,leakage fromadjacentconfiningbedsalsocould affecttransmissivityestimates,which likelywillbeoverestimatedby theCooper-Jacobmethod (Halford,etal,2006).

STUDY AREA

Thesix (6) boreholes boreholes usedforthestudy are located in Maiha town the head quarter of Maiha Local Government Area of Adamawa State. It is situated in crystalline basement rock of the North-Eastern Nigeria. Theboreholes locations are shown in Table 1.

Table 1: Location of the boreholes

Borehole location	Borehole label	Latitude	Longitude	Elevation (m)
Vokuna	M1	10° 07' 52.3"	13° 10' 12.1"	553
Nguli	M2	10° 03' 53.3"	13° 11' 50.1"	558
Magara	M3	10° 00' 27.4"	13° 08' 33.4"	536
Holmare	M4	10° 03' 48.7"	13° 10' 47.7"	569
Maiha Central	M5	10° 03' 07.9"	13° 01' 03.4"	563
Yadafa	M6	10° 12' 42.6"	13° 10' 46.4"	552

METHODOLOGY

Data from the pumping test were collated and analysed to determine the following hydraulic parameters; Transmissivity and Storage coefficient.

According toCooper–JacobMethodin Todd,1980 avalue of transmissivity(T) is governedby;

$$T = \frac{2.30Q}{4\pi\Delta S}$$

WhereQ ispumping rate, ΔSis drawdown difference per log cycle.

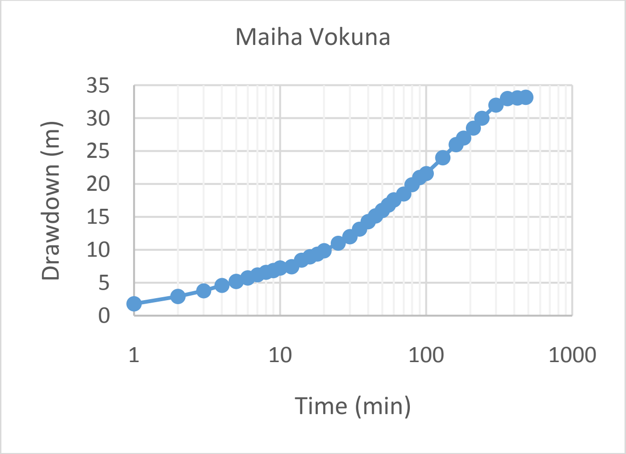
Transmissivity (T)isestimatedbyfittingastraight linetodrawdownson anarithmeticaxis versustimeon alogarithmicaxisinasemi-logplot.

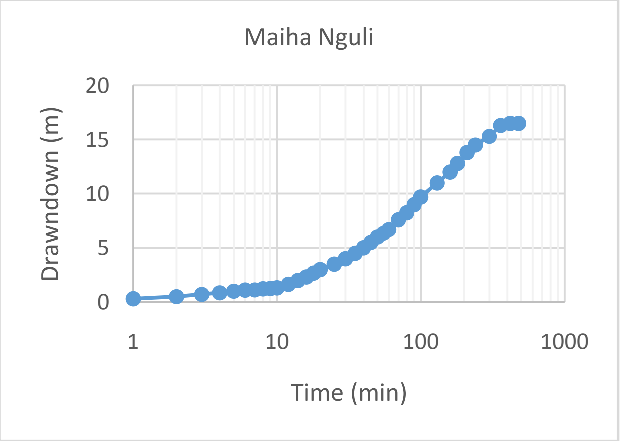
Specific discharge iscalculatedbydividing pumping rateover finaldrawdown(Q/S).

II. Result And Discussion

The well in the study area were pumped for 480minutes at constant rate until drawdown was stabilized. The result of well properties from the pumping test which include pumping rate, stable water level (SWL) and final drawdown are presented on Table 2.

The drawdown were measured at different time interval. The data were then fitted to a semi logarithm graph excluding the data which does not satisfy the condition of Jacob Cooper approximation (see figure 1).





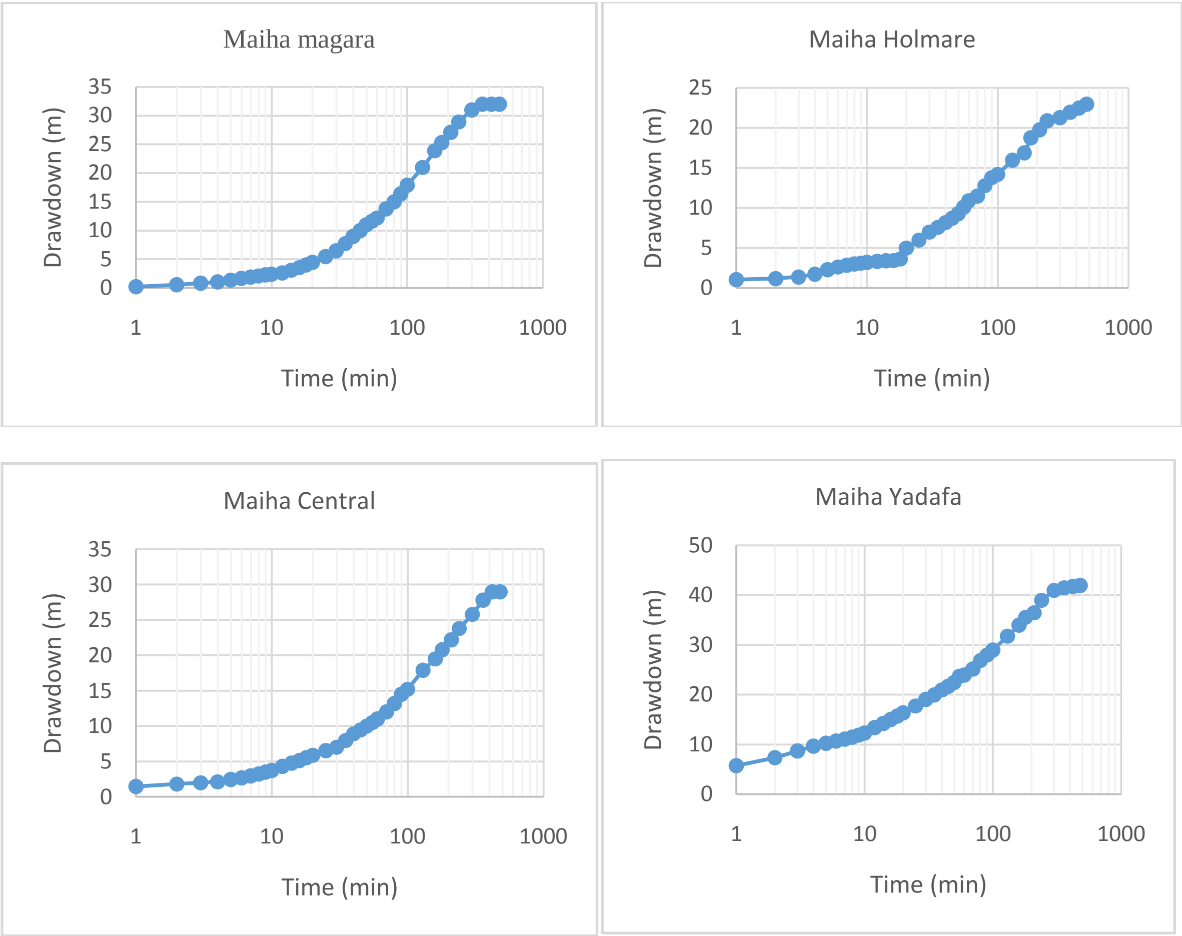


Figure 1: Drawdown vs. pumping duration of the six boreholes

The drawdown per logarithm cycle i.e the drawdown between 10 and 100minutes of pumping along with final drawndown values were obtained for each well and presented in Table 2.

Table 2: Result of transmissivity and specific capacity of the boreholes

Borehole label	ΔS (m)	Q (m^3/day)	T (m^2/day)	Final draw down (m)	Sc (m^3/day)
M1	13.64	57.84	7.76E-01	33.2	1.74E+00
M2	7.32	90.72	2.27E+00	16.5	5.50E+00
M3	14.5	34.56	4.36E-01	32	1.08E+00
M4	9.9	46.66	8.63E-01	23	2.03E+00
M5	11.62	39.74	6.26E-01	29	1.37E+00
M6	15.56	28.51	3.35E-01	42	6.79E-01

The transmissivityvalues recorded in the study area ranges from3.35x$10^{-1}$$m^2$/dayto 2.27$m^2$/daywithaverageof8.84x$10^{-1}$$m^2$/day(Table 2).The values indicates therate offlowofgroundwaterundera unithydraulic gradientthrough an aquiferof unitwidth andunitthickness. Itisthemeasureofthe amountofwaterthatcanbetransmitted horizontallythroughaunitwidthby afullsaturatedthicknessof theaquiferunderahydraulicgradient.Accordingtotheclassification of transmissivitymagnitude(Krasny,1993),the transmissivity magnitude of the study area fall within the low magnitude class, which impliesthat the transmission rateofthegroundwaterin the aquifer is low.

The Specificcapacity ratio (Sc) ofall the boreholes ranges from 1.08 to 6.79 m^3/day/m in the study area. It refers to whether the well provides adequate water supply. According to Ishakuet. al, (2009) classification of specific capacity of wells in basement aquifers, the boreholes in the study area are of moderate performance which is capable of serving a smaller population using hand pump.

III. Conclusion

The borehole depth in the study area varies from 25m at MaihaNguli to 63m at Maiha central. The static water level correspond to depth of the boreholes with the lowest values of 0.52m at MaihaNuguli and the highest value of 12.1m at Maiha Central. The yield of the boreholes varies from 0.33l/s to 1.05l/s typical of basement complex wells (Carter et. al., 2014). The borehole at MaihaNguli is the most prolific in the study area base on its yield and specific capacity value.

The result of the aquifer parameters that were calculated from the single well pumping test in the study area has the highest transmissivity of 2.27m^2/day at MaihaNguli and the lowest of 3.35x10^{-1}m/day at MaihaYadafa.

References

[1]. Abdel-Gawad H. A. A andEl-Hadi H. A (2009): Parameterestimationof pumping test data using genetic algorithm *Thirteenth InternationalWater TechnologyConference, IWTC13 2009,Hurghada, Egypt* 823 – 838

[2]. AmahE.A.andAnamG.S.(2016)"Determination of AquiferHydraulicParameters fromPumping TestDataAnalysis:ACaseStudy ofAkpabuyoCoastalPlainSandAquifers, CrossRiverState, S-ENigeria"IOSRJournalofAppliedGeology andGeophysics,vol.4, no.1, pp.1-8.

[3]. Carter, R.C., Chilton, J., Danert, K. and Olschewski, A., (2014). Siting of Drilled Water Wells - A Guide for Project Managers, Rural Water Supply Network (RWSN), St Gallen, Switzerland

[4]. Chenini,Ietall(2008),"ASimpleMethodtoEstimate Transmibillity andStorativityofAquiferUsing SpecificCapacity ofWells",journalofapplied science,vol.8, no.14,pp.2640-2643.

[5]. Cooper,H.H.,andC.E.Jacob.1946.Ageneralizedgraphical methodforevaluatingformationconstantsandsummariz-ingwellfieldhistory.AmericanGeophysicalUnionTransactions27:526–534.

[6]. Halford,K.J., Weight,W.D.andSchreiber,R.P.(2006) "InterpretationofTrasmissivity Estimatesfrom Single–WellPumping Aquifer Tests".Ground water, vol.44,no.3, pp.467-471.

[7]. Hanson,R.T.,andT.Nishikawa.1996.Combineduseofflowmeterandtime-drawdowndatatoestimatehydrauliccon-ductivitiesinlayeredaquifersystems.GroundWater34, no.1: 84–94.

[8]. Hassan H,Waru S. M,Bukar G. A,Abdullahi K. M (2016): GroundwaterPotentialsEstimationofa Basement TerrainUsingPumpingTestDataforPartsof SangaLocalGovernmentArea,KadunaState, NorthwesternNigeria. Open Journal of Modern Hydrology, 6,222-229

[9]. Ishaku,J.M,andKwada,I.AAdekeye,J.I.D.,(2009):HydrogeologicalCharacterizationandWaterSupply PotentialofBasementAquifersInTarabaState,N.E.Nigeria.NatureandScience;7(3), ISSN1545-0740.

[10]. Krasny J (1998): Classification of transmissivity magnitude and variation. Groundwater, 31:b230-236

[11]. Mawlood D. K andAziz Y. W (2019): Analyze theTranmissivityforPumping Welltesting withSingle andObservation Well. ZANCO JournalofPure and Applied Sciences31(1);70-76

[12]. OkonI. AAkaerueE.IFelixI..P (2008): DeterminationofAquiferHydraulicParametersUsingSingle WellPumpingTestBoreholeDatawithinBokiLocalGovernment Area,CrossRiverState,SouthEasternNigeria. Journal of EnvironmentandEarthScience Vol.8,No.3

[13]. Schaaf S (2004): Asinglewellpumpingandrecoverytesttomeasurein situ acrotelmtransmissivity inraisedbogs, JournalofHydrology290152–160

[14]. SulistyoT (2018): Identificationaquiferparametersthroughsingle wellpumpingtestseriesatpt.Kaltimkariangauterminal,balikpapan,eastKalimantan. JUTEKS -JURNALTEKNIKSIPILVol.3No. 2,Halaman:293–300

[15]. Theis,C.V.1935.Therelationbetweentheloweringofthepie-zometricsurfaceandtherateanddurationofdischargeof a wellusing ground water storage. Transactions ofthe AmericanGeophysicalUnion16:519–524.

[16]. Todd, D. K. (1980).Groundwater hydrology 2ed.JohnWiley.

IOSR Journal of Applied Geology and Geophysics (IOSR-JAGG) is UGC approved Journal with Sl. No. 5021, Journal no. 49115.

* Kasidi Simon. " Hydraulic Characterization of Hand Pump Boreholes on Maiha Local Government Area of Adamawa State, Nigeria.. "IOSR Journal of Applied Geology and Geophysics (IOSR-JAGG) 7.6 (2019): 22-25.