



UNIVERSITI PUTRA MALAYSIA

***QUANTITATIVE ASSESSMNT OF GROUNDWATER RESOURCES
AND AQUIFER HYDRAULIC PROPERTIES USING COMBINED
GEOPHYSICAL TECHNIQUES, IN NORTH GEMAS,, MALAYSIA***

MOHAMED SAHR EGBENDA JUANAH

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QUANTITATIVE ASSESSMENT OF GROUNDWATER
RESOURCES AND AQUIFER HYDRAULIC PROPERTIES
USING COMBINED GEOPHYSICAL TECHNIQUES, IN
NORTH GEMAS, MALAYSIA

By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra **Malaysia**,
in Fulfilment of the Requirements for the Degree of Master of Science

August 2012

DEDICATIONS

This research is dedicated to my two beautiful sons, Sahr M.E Juanah and Tamba

E. Juanah for leaving them at there tender age to pursue for higher education.

*Each page i have written represents time spent away from them and I hope this will
bring a better life for us all.*



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in
fulfilment of the requirement for the degree of Master of Science

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Chair: Associate Professor Shaharin Ibrahim, PhD

Faculty: Environmental Studies

With Malaysia increasingly becoming an industrialized nation, the need for quality water to meet its domestic and industrial requirements is becoming a major challenge, since most of the surface waters are experiencing an increase in pollution and/ or contamination due to industrialization and agricultural activities. Groundwater exploration has become more and more important as most of it is often safe from pollution. Thus, the research aims to develop a much broader understanding of the nature of groundwater potential in the study area and its relations with the local geology.

Laboratory and combined geophysical techniques such as multi-electrode resistivity, induced polarization, and borehole geophysical techniques were carried out on volcano-sedimentary rocks as part of the groundwater resource's investigations. The result obtained identifies fractures and/or fissures and different lithological units. Two types of aquifer systems in terms of storage were also

identified within the area; one within a fracture system (tuff), and an intergranular property of the sandy material. The result reveals that the aquifer occupies a surface area of about 3250555 m^2 with a mean depth of 43.71 m and a net volume of $9.798 \times 10^7 \text{ m}^3$. From the approximate volume of the porous zone (28%) and the total aquifer volume, a usable capacity of $(274.339 \pm 30.177) \times 10^7 \text{ m}^3$ of water in the study area can be deduced.

Increase in demand for the protection, remediation and sustainable management of groundwater resources have resulted in an increased need to determine accurately the distribution of aquifer hydraulic parameters. The use of combined geophysical and hydrological measurement have been proven to be less invasive as compared to the traditional pumping test, which provide information only close to the boreholes and the sample locations. As a result of this, an empirical function between the geoelectrical resistivity of an aquifer and hydrogeological investigations was established to estimate the aquifer hydraulic properties through the use of Kozeny-Carman-Bear equation. The reported mean geometric hydraulic conductivity value for the aquifer under investigation is $(8.67 \times 10^{-3} \text{ m/s}$ or $31.2 \text{ m/day})$, and the estimated average transmissivity is $(2.03 \times 10^{-1} \text{ m}^2\text{s}$ or $731 \text{ m}^2\text{/day})$.

The groundwater and surface water analyses shows that present status of groundwater quality in Kg Londah and its environs is suitable for industrial, drinking and irrigational purposes. Hence, the study provides useful information that can be used to develop a much broader understanding of the nature of groundwater potential in the area and its relationship with the local geology.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**PENILAIAN KUANTITATIF SIFAT HYDROLIC DAN SUMBER AIR
TANAH DENGAN MENGGUNAKAN TEKNIK GEOFIZIK DI
UTARA GEMAS, MALAYSIA**

Oleh

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Ogos 2012

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Fakulti: Pengajian Alam Sekitar

Dalam keadaan di mana Malaysia sedang pesat menuju ke arah negara perindustrian, keperluan untuk membekalkan keperluan domestik dan industri dengan air yang berkualiti merupakan suatu cabaran besar kerana kebanyakan air permukaan yang terdapat di negara ini mengalami peningkatan tahap pencemaran disebabkan oleh aktiviti perindustrian dan pertanian. Carigali air tanah menjadi semakin mustahak memandangkan bahawa air tanah biasanya tidak begitu terdedah kepada pencemaran. Dengan yang demikian, kajian ini bertujuan untuk mendapatkan kefahaman yang lebih luas dan mendalam berkaitan keadaan keupayaan air tanah di dalam kawasan kajian serta kaitannya dengan keadaan geologi setempat.

Kajian makmal dan gabungan teknik geofizik seperti kajian kerintangan elektrik multi-elektrod, pengutuban teraruh dan teknik geofizik lubang gerudi telah dijalankan bagi batuan enapan- volkanik sebagai sebahagian dari kaedah pencarian sumber air tanah. Hasil kajian menunjukkan keujudan rekahan dan/atau fissure serta unit-unit

litologi berbeza di dalam kawasan kajian. Dari segi simpanan air tanah terdapat dua sistem akuifer yang wujud dalam kawasan kajian; satu di dalam sistem rekahan (dalam batuan tuff) manakala satu lagi terdiri dari sifat inter-butiran bahan berpasir (bagi batu pasir dan batu pasir bertuf). Hasil kajian menunjukkan bahawa akuifer tersebut mempunyai luas permukaan lebih kurang $3,250,555 \text{ m}^2$ dengan purata kedalaman 43.71 m serta jumlah isipadu $9.798 \times 10^7 \text{ m}^3$. Dari nilai anggaran isipadu zon berongga (28%) dan jumlah isipadu akuifer, adalah dianggarkan terdapat $(274.339 \pm 30.177) \times 10^7 \text{ m}^3$ air tanah yang boleh digunakan dari kawasan kajian.

Peningkatan dari segi keperluan untuk pemeliharaan, pemuliharaan dan pengurusan mapan sumber air tanah telah menyebabkan meningkatnya keperluan untuk menentukan secara tepat taburan parameter-parameter hidrolik akuifer. Penggunaan gabungan pengukuran geofizik serta hidrologi telah membuktikan ianya satu kaedah yang kurang invasif berbanding dengan kaedah tradisinal ujian pampa yang hanya dapat memberikan maklumat bagi kawasan yang hampir dengan lubang telaga dan lokasi persampelan. Dalam kajian yang dilaksanakan ini, satu kaitan empirikal antara parameter kerintangan geoelektrik akuifer dengan parameter hidrogeologi telah diterbitkan melalui penggunaan persamaan Kozeny-Carman-Bear. Dari hasil kajian kini, didapati bahawa purata kekonduksian hidrolik geometri bahan akuifer adalah $(8.67 \times 10^{-3} \text{ m/s}$ atau 31.2 m/hari dan anggaran purata transmissiviti adalah $731 \text{ m}^2 / \text{hari}$).

Analisis air tanah dan air permukaan menunjukkan bahawa status terkini air tanah di persekitaran Kg Londah adalah sesuai untuk kegunaan industri, minuman dan pengairan. Dengan yang demikian, hasil kajian ini telah memberikan maklumat yang sangat berguna dan dapat digunakan untuk membangunkan pemahaman yang

lebih mendalam berkaitan kemampuan pembekalan air tanah kawasan kajian serta kaitannya dengan keadaan geologi setempat..



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I certify that a Thesis Examination Committee has met on **10th August 2012** to conduct the final examination of **Mohamed Sahr Egbenda Juanah** on his thesis entitled “**QUANTITATIVE ASSESSMENT OF GROUNDWATER RESOURCES AND AQUIFER HYDRAULIC PROPERTIES USING COMBINED GEO-PHYSICAL TECHNIQUES, IN NORTH GEMAS, MALAYSIA**” in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the **Master of Science**..

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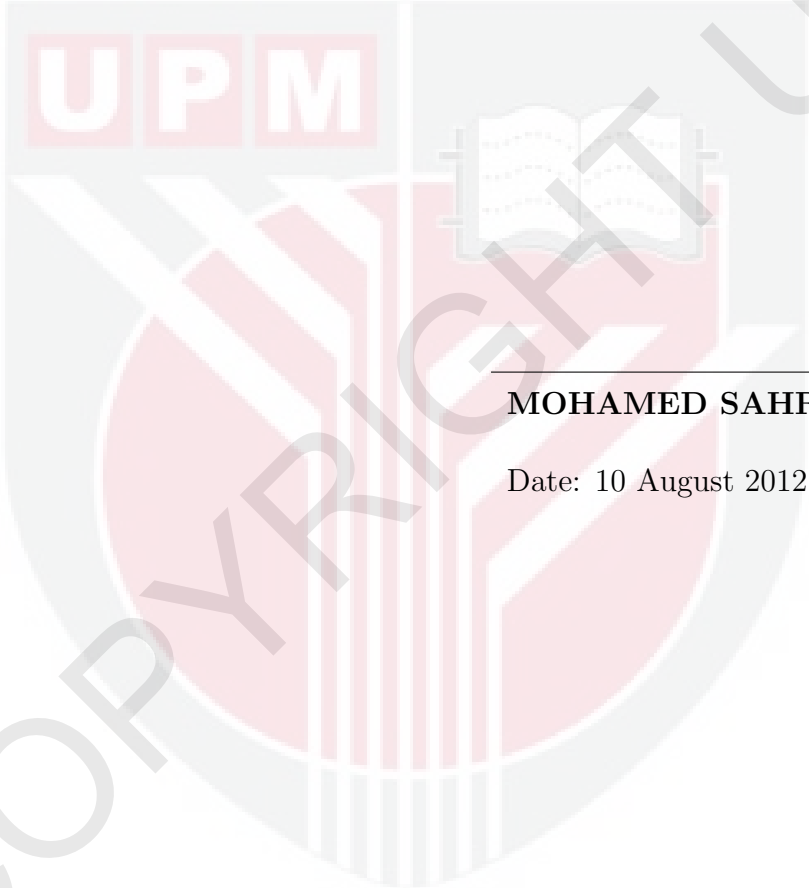
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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

The logo of Universiti Putra Malaysia (UPM) is a shield-shaped emblem. At the top left, the letters 'UPM' are written in white on a red rectangular background. Below this, the shield is divided into several sections: a central red section with a white stylized 'M' shape, a white section with a red book icon, and a bottom section with vertical red and white stripes. A large, faint watermark reading 'COPYRIGHT UPM' is overlaid diagonally across the entire page.

MOHAMED SAHR EGBENDA JUANAH

Date: 10 August 2012

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