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GIS-Based Statistical Models for Mapping the Potential Zones of Groundwater in the Western Desert of Iraq

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By

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

وَاللَّهُ أَنْزَلَ مِنَ السَّمَاءِ مَاءً فَأَحْيَا بِهِ الْأَرْضَ بَعْدَ مَوْتِهَا ۚ إِنَّ فِي ذَٰلِكَ لَآيَةً لِقَوْمٍ يَسْمَعُونَ (٦٥)

صدق الله العلي العظيم

سورة النحل

الاهداء

الى معلم البشرية وسيد الخلق (مُحَمَّد ﷺ)

إلى من أوصاني الله بهما خيرا ..أمي و أبي

الى زوجتي وفلذات كبدي . . . حسين وفدك الزهراء.

الى اخوتي واخواتي الاعزاء . . .

الى الجيش العراقي البطل. . .

الى الحشد الشعبي وشهداء العراق. . .

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We certify this thesis was prepared under our supervision as a partial fulfillment of the requirement for the **degree of Master of Technology in Surveying Engineering Technology**.

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I certify that I have read this thesis entitled "**GIS-Based Statistical Model for Mapping the Potential Zones of Groundwater in the Western Desert of Iraq** "by "Fadhil Mezher Shnewer", and I examined the language of the thesis and, in my opinion it is adequate as a thesis for the **degree of Master of Technology in Surveying Engineering Technology**.

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ABSTRACT

Combination of remote sensing (RS) data with the geographical information system (GIS) for the investigation of groundwater (GW) resources has become an advance approach in the field of GW researches, which helps in evaluating, protecting and monitoring GW resources. The aim of this thesis is to apply a bivariate statistical models such as frequency ratio (FR) , evidential belief function (EBF), and multivariate statistical model such as logistic regression (LR) for mapping of GW potential at the region of interest as a part of Iraqi western desert (located at Al-Ramadi and Shithatha). The exploration of GW in the study area is a very important step to increase and develop the water resources because the absence of surface water in that region.

The approaches of FR, EBF and LR have not been applied to delineate GW potential in Iraq so far, and this contribution is uniqueness of this research. Furthermore, this study contains the analysis of the spatial associations between GW wells data and numerous GW conditioning elements such as slope, altitude, stream density, aspect , fault, curvature, lithology, stream power index, soil, topographic wetness index , Normalized Difference Vegetation Index and rain-fall for this region. Those elements are affecting the occurrences of GW, and were derived from satellite imagery, relevant government institutions and geological data. The thematic map for each element was prepared using GIS software. The GW wells (43 wells) used in this study were obtained from ministry of water resources - General Commission for Groundwater in Iraq. All observed GW wells were randomly separated into two groups: 30 wells as a training data assigned to the analysis with models (70 % of the total GW wells), and 13 wells as a testing data allocated for model's results validation (remaining 30 %). All element layers were combined and modeled using the suggested approaches to generate various maps of GW

potential areas. The final GW maps included five potential classes namely "very high", "high", "moderate", "low" and "very low" susceptible zones. The model's outcomes acquired in this research were validated with the GW wells data using AUC method "area under the curve". The validation of the results showed that the values of AUC were 57%, 76.5% and 71.5% of success rate for FR, EBF and LR respectively. The prediction rate for the same methods was 53%, 73.7% and 70%, respectively.

Both benefits and shortcomings of application for the used approaches were shown in the study. The outcomes attained from the present study indicated the capability of EBF and LR method in GW potential mapping. They can provide results in acceptable accuracy with low time and cost. Accordingly, the results of these models will be useful for the competent authorities in the field of groundwater in Iraq for evaluation and management of GW exploration for future planning.

TABLE OF CONTENTS

Table of Contents

TABLE OF CONTENTS

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الخلاصة

أن الجمع بين بيانات الاستشعار عن بعد ونظم المعلومات الجغرافية للكشف عن موارد المياه الجوفية اصبح اسلوب متطور في مجال ابحاث المياه الجوفية، أذ تستخدم هذه البيانات في تقييم وحماية و مراقبة موارد المياه الجوفية. ان الهدف من هذه الرسالة هو تطبيق نماذج احصائية ثنائية المتغير مثل نموذج نسبة التكرار(FR) ، ونموذج اثبات الدليل (EBF) بالإضافة الى نموذج احصائي متعدد المتغيرات مثل نموذج الانحدار اللوجستي(LR) لرسم خرائط تتضمن مواقع احتمال وجود المياه الجوفية في منطقة الدراسة كجزء من الصحراء الغربية العراقية (تقع في الرمادي وشثاثة). ان الكشف عن المياه الجوفية في هذه المنطقة يعتبر خطوه مهمة جدا من اجل زيادة وتطوير موارد المياه بسبب غياب المياه السطحية في تلك المنطقة.

ان النماذج الاحصائية المذكوره اعلاه لم يتم تطبيقها في تعيين مواقع المياه الجوفية في العراق سابقا، وهذا يعطي خصوصية لهذا البحث. بناءا على ذلك ، قد تضمنت هذه الدراسة تحليل العلاقة المكانية بين مواقع ابار المياه الجوفية المنتشرة في منطقة الدراسة والعوامل او العناصر التي تؤثر على حدوث المياه الجوفية مثل: "الميل الطوبوغرافي، الارتفاع، كثافة التصريف، اتجاه الميل، الفوالق، معدل التغير في الميل (الانحناء)، الخصائص الصخرية، مؤشر قوة الجريان، خصائص التربة، مؤشر البلل الطوبوغرافي، مؤشر الغطاء النباتي وكمية الامطار الساقطة لهذه المنطقة". هذه العوامل تؤثر على حدوث المياه الجوفية، وتم الحصول عليها من صور الاقمار الصناعية، والمؤسسات الحكومية ذات الصلة، ومن البيبانات الجيولوجية، وقد تم استخدام برنامج نظم المعلومات الجغرافية لرسم الخارطة الموضوعية لكل عنصر.

ان ابار المياه الجوفية المستخدمة في هذه الدراسة والبالغ عددها ٤٣ بئرا، تم الحصول عليها من وزارة الموارد المائية – الهيئة العامة للمياه الجوفية في العراق.صنفت هذه الابار بشكل عشوائي الى مجموعتين: المجموعة الاولى تضمنت ٣٠ بئر(٧٠% من عدد الابار الكلي) استخدمت في تحليل النماذج الاحصائية، واحتوت المجموعة الثانية على ١٣ بئرا (٣٠ %) خصصت للتحقق من نتائج النماذج. تم دمج ونمذجة طبقات جميع العناصر بأستخدام النماذج المستخدمة في هذه الدراسة لأنتاج خرائط لمناطق تواجد المياه الجوفية. ان خرائط المياه الجوفية النهائية تضمنت خمسة اصناف لتوقع المياه الجوفية وهي: مناطق ذات توقع عالي جدا، مناطق ذات توقع عالي، مناطق ذات توقع متوسط ، مناطق ذات توقع منخفض، ومناطق ذات توقع منخفض جدا. تم التحقق من النتائج التي تم الحصول عليها من النماذج الاحصائية بأستخدام طريقة المساحة تحت المنحني (فقط المجموعة الثانية من الابار تم استخدامها في عملية التحقق).

هذه الطريقة بينت ان معدل النجاح كان ٥٧% ، ٧٦.٥% و٧١.٥% لنموذج نسبة التكرار، نموذج اثبات الدليل ونموذج الانحدار اللوجستي على التوالي. وان معدل التنبوء لنفس النماذج هو ٥٣% ، ٧٣.٧% و٧٠% على التوالي.

وقد بينت هذه الدراسة كلا من الفوائد واوجه القصور الحاصل في تطبيق هذه الطرق الاحصائية، وأشارت النتائج التي تم الحصول عليها على قدرة نموذج EBF ونموذج LR في التنبوء بحدوث المياه الجوفية في منطقة الدراسة، حيث ان هذه النماذج اعطت نتائج بدقة مقبولة بفترة زمنية قليلة وكلفة اقل. وبناءا على ذلك، ستكون نتائج هذه النماذج مفيدة للجهات المختصة في مجال المياه الجوفية في العراق لتقييم وإدارة استكشاف المياه الجوفية للتخطيط في المستقبل.

جمهورية العراق
وزارة التعليم العالي والبحث العلمي
الجامعة التقنيه الوسطى
الكلية التقنية الهندسيه ـ بغداد

نمذجه مواقع المياه الجوفية بأستخدام النماذج الاحصائية في نظم المعلومات الجغرافية للصحراء الغربية العراقية

رسالة مقدمة
إلى مجلس الكلية التقنية الهندسية ـ بغداد كجزء من
متطلبات نيل شهادة الماجستير التقني في اختصاص
تقنيات المساحة

من قبل الطالب

فاضل مزهر شنيور

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