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Soil Science Education: Adaptation of Soil Judging (Evaluation) to Libya

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Abstract: Soil judging is a field area of soil science, which is a diverse discipline for soil science education that combines geology, physics, chemistry, and biology to improve the understanding and protection of natural resources. Adaptation of Soil Judging to Libya involves tailoring Soil Judging materials to the country's local context. The objectives of this study were to adapt Soil Judging to Libya and evaluate it in various locations in Libya. Different soil judging handbooks from the United States (US) were used to develop teaching materials for Libya (including tables of soil physical and chemical properties and scorecards). The soil judging scorecard was enhanced by adding more specific information relevant to Libya (e.g., soil salinity, calcium carbonate, etc.). Libyan users were asked to complete a survey on the usefulness of Soil Judging in Libya. Eighty-two percent of those surveyed were unaware of Soil Judging prior to this study. After completing Soil Judging trials in various locations in Libya, 95% of those surveyed indicated that Soil Judging is helpful in natural science education in Libya. Future improvements to Soil Judging should include better equipment and explanation.

تعليم علوم التربة: تكييف تقييم التربة (SOIL JUDGING) لليبيا

الكلمات المفتاحية:
أفريقيا؛
Aridisols
Entisols
الزراعة؛
البيئة؛
التعليم؛
استخدام الأراضي.

المستخلص: يعتبر تكييف تقييم التربة (Soil Judging) المكون الميداني لعلوم التربة وهو تخصص متنوع لدراسة التربة التي تجمع بين الجيولوجيا، الفيزياء، الكيمياء والبيولوجيا لزيادة فهم الموارد الطبيعية وحمايتها. إن عملية تكييف تقييم التربة لليبيا تحتاج إلى تعديل بطاقات قياس الأداء (Scorecards) المستخدمة في هذه العملية بما يتماشى مع البيئة المحلية في البلاد. هدفت هذه الدراسة إلى تكييف عملية تقييم التربة لليبيا وتقييمها في مواقع مختلفة من البلاد. تم استخدام كتيبات مختلفة لتقييم التربة من الولايات المتحدة الأمريكية لتطوير وتجهيز المواد التعليمية المستخدمة في تقييم التربة (بما في ذلك جداول الخصائص الكيميائية، والفيزيائية للتربة، وبطاقات قياس الأداء). تم تحسين بطاقات قياس الأداء المستخدمة في عملية تقييم التربة (Soil Judging) بإضافة المزيد من المعلومات المحددة ذات الصلة بليبيا (على سبيل المثال، ملوحة التربة، كربونات الكالسيوم، إلخ). طُلب من المستخدمين المحليين في ليبيا استكمال دراسة استقصائية حول فائدة تقييم التربة في ليبيا. وأظهرت النتائج أن 82٪ ممن شملهم الاستطلاع لم يكونوا على دراية بعملية تقييم التربة قبل هذه الدراسة. أضف إلى ذلك أنه بعد الانتهاء من تطبيق عملية تقييم التربة في مواقع مختلفة في ليبيا، أشار 95٪ ممن شملهم الاستطلاع إلى أن عملية تقييم التربة (Soil Judging) مفيدة في تدريس العلوم الطبيعية بشكل عام، وعلم التربة بشكل خاص في ليبيا، ويجب أن تتضمن التحسينات المستقبلية لتحكيم التربة معدات، وشرحًا أفضل.

INTRODUCTION

Soil classification is an important component in the exchange and advancement of soil knowledge worldwide. Field descriptions and laboratory analysis results are the foundation of soil classification. Soil judg-

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ing can be defined as a field area of soil science, which is a diverse discipline for soil science education that combines geology, physics, chemistry, and biology to improve the understanding and protection of natural resources. Soil judging (Evaluation) helps us better understand and protect the natural resource that sustains us all. Soil judging is a national collegiate soil judging contest in the USA held at different host institutions each year since 1961 (Post et al., 1974).

In this competition, the soil judging teams compete in contests that test their knowledge of basic soil properties, such as texture, color, and structure, and the student's ability to make interpretations based on these properties and local site characteristics. Soil Judging is used in several countries of the world (e.g., the U.S. and Germany) to train soil scientists on how to describe, classify, and interpret soil for different uses in the field. The first International Soil Judging Contest took place in June 2014 at the 20th World Congress of Soil Science in Korea, with a limited number of countries participating in it (USA, Japan, China, Korea, South Africa, Australia, Taiwan, Mexico, Hungary, and the United Kingdom). Currently, Libya does not have Soil Judging, and adaptation of soil judging to Libya can improve soil science knowledge exchange and can potentially alleviate land use problems in Libya by educating students and planners about important soil properties related to land use, such as: soil infiltration rate, hydraulic conductivity, available water, soil wetness class, and soil interpretations related to suitability for dwellings with basements, septic tank absorption field, and local roads and streets. Numerous studies documented various benefits of soil judging and field trips to enhance soil science learning in the US (Cavinder et al., 2011; Cooper & Dolan, 2003; Galbraith, 2012), and it would be beneficial to use this experience in other parts of the world. Adaptation of educational materials to other countries is a necessary process, which can be divided into the following steps: 1) identification of a reason for adaptation of environmental materials; 2) identification of people that need to be involved; 3) identification of critical environmental issues; 4) identification of solutions to environmental problems; 5) identification, screening, and selecting environmental education materials; 6) copyright issues; 7) adapting and testing materials; 8) implementing an environmental education program; 9) evaluating a program and the effectiveness of adapted materials; 10) following principles of successful adaptation (Corps, 1999). Examples of adaptations of educational materials can range from lessons to programs (Corps, 1999).

Soils in Libya are classified according to the U.S. Soil Taxonomy (Zurqani et al., 2012). Libya has six soil orders according to the U.S. Soil Taxonomy (Entisols, Aridisols, Alfisols, Inceptisols, Vertisols, and Mollisols) and the most common soil orders are Entisols and Aridisols. Most Libyan soils have a sandy or loamy sand texture with rapid soil infiltration. (Abdelnaser et al., 2011) reported that rapid expansion of industry, urbanization, and increasing population led to dramatic increases in the amount of municipal solid waste generated in Libya. Libyan soils texture are sands and loamy sands; they have very low available water. Water stress is a common factor limiting crop yield, especially in arid and semi-arid areas where the annual average precipitation does not exceed 300 mm (Zurqani et al., 2019). Septic tanks are used in many parts of Libya, but there is a lack of appropriate wastewater management including collection and treatment facilities in the rural area, which could cause environmental pollutions.

Soil salinity problems in Libya very often result from extensive agricultural activities, lack of precipitation and overdraw of fresh groundwater to the extent of causing seawater intrusion. In addition, low amounts of rainfall and high temperatures are also contributed to soil salinity problems (Zurqani et al., 2018). Sodicity also is common in semi‐arid areas, particularly in sites where incoming water containing dissolved salt is lost by evaporation. The objectives of this study were to adapt Soil Judging for Libya, conduct Soil Judging in various locations in Libya, and evaluate the effectiveness of adapted materials using a survey.

MATERIALS AND METHODS

Study Area: Libya is situated in the northern portion of the African continent and covers 1,759,540 million km^2 (Zurqani, 2021). Desert covers more than 95% of the country while cultivated areas cover slightly over 2% (Zurqani et al., 2019). The population is about 5,673,031 (13% is rural) (Bureau of Statistics and Census Libya, 2012). There are four administrative territories in Libya (Fig. 1). Libya has an arid and semi-arid area climate influenced by the Mediterranean climate (Xeric), characterized by rainfall in the winter and almost no rainfall in the summer, which is the major heat and drought period of the year (Zurqani, 2021). However, the southern part of Libya is under the (Torric) moisture regime (Ben-Mahmoud, 1995).

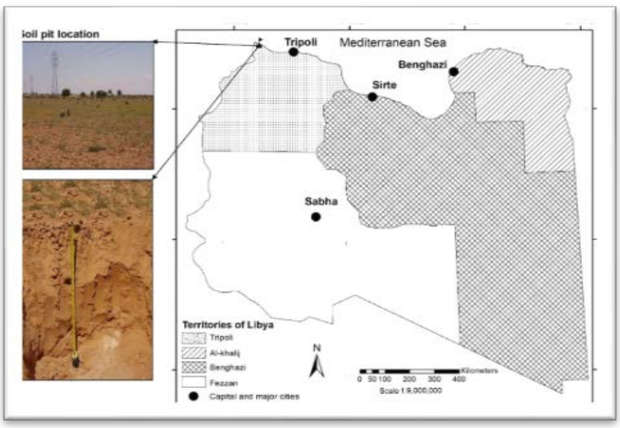

Figure (1). Map of Libya with soil pit location.

The average monthly temperatures range from 13.2 C° to 27.9 C° with an annual level of 20.7 C°, and the soil temperature regime in the study area is thermic (Ben-Mahmoud, 1995). The average annual rainfall varies from region to region according to geographic position and topography. Rainfall occurs during the winter months (October to March) (Zurqani et al., 2012). Land degradation and desertification are the main soil threats facing agricultural development.

Soil Judging Equipment and Materials: Most Soil Judging equipment can be obtained in Libya or ordered from suppliers (Fig. 2). This set of equipment that must be provided for each student involved in a soil judging completion includes: a scorecard, official rules, an Abney level or clinometer, garden spade, bucket, clipboard, soil collection trays, water bottle, measuring tape, a calculator, a pencil, and a Mussel color chart. Soil samples to provide soil physical and chemical data for the students (Fig.3). These soil properties can be analyzed in any one of the several soil nutrient analysis laboratories in Libya: Libyan Universities Institutes, and Libyan Agriculture Research Centers.

Figure (2). Soil Judging equipment.

PIT No. 3

No. of horizons 3

Depth to be described 70 cm

Nail in 3rd horizon @ 60 cm

HORIZON	OC (%)	BS (meq/L)	pH	$CaCO_3$ (%)	SAR (%)	ECe (dS/m)
1	0.19	29.21	7.1	38.51	22.04	4.00
2	0.01	3.37	7.5	36.75	15.85	0.25
3	-	-	-	-	-	-

Flooding: None   Ponding: None

Figure: (3). Soil physical and chemical properties for the soil pit No. 3 in Zuwarah, Libya (Zurqani, 2010).

COURSES BACKGROUND

A soil judging course can be incorporated in various soil science programs currently taught in Libya, for example: University of Tripoli, Omar Al-Mukhtar University, Sebha University, Al Zawia University, Sirte University, University of Elmergib, University of Al-Jabal Al-Gharbi, Higher Institute of agricultural techniques (Al-Gheiran, Tripoli). All of these institutions can use soil judging to improve the soil courses such as Fundamentals of Soil Science course or in a more specific course such as Soil Survey Genesis and Classification course. Soil judging education can directly benefit the agriculture, housing and town planning, transportation, and health services. Computer laboratories and internet services in most of Libyan universities can be used in creating Modular Object-Oriented Dynamic Learning Environment (Moodle). This environment could be used for e-learning learning (e.g. storing course materials and assessing student's learning via electronic quizzes and tests).

RESULTSAND DISCUSSION

Libya - Specific Modifications to Soil Judging Scorecard: The main soil orders in Libya are Entisols, Aridisols, Mollisols, Alfisols, Vertisols, and Inceptisols (Agriculture–, 2003; Ben-Mahmoud, 1995; Export, 1980; Zurqani et al., 2019). In general, apart from the JabalAkhdar and some of the Tripoli Mountains (JabalNafusah), the most commonly soil orders are Entisols and Aridisols (Zurqani et al., 2018). Dry climatic conditions and soil parent materials in Libya result in high accumulation of calcium carbonate, and the presence of gypsum in some areas (Zurqani et al., 2018). The precipitation and accumulation of calcium carbonate may result in the development of calcic/petrocalcic horizons that vary in the extent of their development depending on the circumstances and composition. According to Ben Mahmoud (1995) these soils generally cover large areas in the northern region of the country. In order to adapt the soil judging scorecard to Libya, the following additions/modification were made to the already existing soil judging scorecard: adding a column for testing of carbonates, plant sensitivity to salt-affected soils (Table 1), and wind erosion potential classes (Table 2).

Table (1). Plant Sensitivity to salt affected soils (Adapted from (Brady et al., 2008))

Factors affecting use	Degree of limitation			
	Slight (1) (Normal Soils)	Moderate (2) (Saline Soils)	Severe (3) (Sodic Soils)	Extreme (4) (Saline-Sodic Soils)
ECe (dS/m)	< 4	≥ 4	< 4	≥ 4
pH	< 8.5	< 8.5	≥ 8.5	< 8.5
SAR* (%)	< 13	< 13	≥ 13	≥ 13

* If you are using Exchangeable Sodium Percentage (ESP) the degree of should be 15 %

Table (2). Wind erosion potential classes. Adopted from (Blanco-Canqui & Lal, 2008)[1], (Ludwig et al., 1995)[2].

Factors influence wind Erosion relative to the surface horizon texture (Barriers[1], surface roughness[2])	Wind Erosion Potential Classes Surface horizon texture class[3]				
	L, (SiL > 20 % clay), CL, Si, SiCL,	L, (SiL< 20 % clay), SCL, SC	C, SiC, CL, (SiCL> 35 % clay)	L, SL, SiC, CL,	S, LS
- Vegetative barriers with feedlot wind-break - Very Rough Soil surface	Very low	Very low	Very low	Low	Low
- Vegetative barriers (perennial plants or annual plants combination) - Rough Soil surface	Low	Low	Low	Medium	Medium
- Strip Cropping - Medium Soil surface	Medium	Medium	Medium	High	High
- Lack of crop residue - Smooth Soil surface	High	High	High	Very high	Very high
- Bare soil - Very Smooth Soil surface	Very high	Very high	Very high	Very high	Very high

Notes: This table did not take in the consideration of the slope and the water quantity in the\ surface horizon.
Soil Texture Abbreviations: Sand = S, Sandy Loam = SL, Sandy Clay Loam = SCL, Sandy Clay = SC, Silt = Si, Silt Loam = SiL, Silty Clay Loam = SiCL, Silty Clay = SiC,, Clay = C, Clay Loam = CL, Loam = L, Sandy Clay = SC, and Loamy Sand = LS.

No. of Horizons 3
Depth to be described 70 cm
Nail in 3rd horizon @ 60 cm

Contestant ____________

A. Morphology

Horizon						Texture			Color			Structure		Consist.	Redox. Features			CaCO3	Score
Pre.	Master	Sub	No.	Lower depth	Bound. distnct.	Rock fragmnt modif.	USDA class	Clay content	Hue	Val.	Chr.	Grade	Shape	Moist	Redox conc. y/n	Redox depltn. y/n	Red. matrix y/n	HCl 1N (N, Vsli, Sli, St, Vio)	
1	3	2	1	3	1	1	3	1	1	1	1	2	2	1	1	1	1	3	30
-	A	p	-	20	C	-	LS	2.2	7.5YR	5	4	SLS	MA	L	N	N	N	Vio	
-	C	-	1	50	C	-	LS/S	6	7.5YR	5	4	SLS	MA	L	N	N	N	Vio	
-	C	-	2	70+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

B. Soil Profile and Interpretations

Infiltration Rate (5)
___ Rapid
_X_ Medium
___ Slow

Hydraulic Conductivity (5)
___ High
___ Moderate
_X_ Low

Available Water (5)
_X_ Very Low ≤ 7.5 cm
___ Low > 7.5 and ≤ 15.0 cm
___ Moderate > 15.0 and ≤ 22.5 cm
___ High > 22.5 cm

Soil Wetness Class (5)
_X_ > 150 cm
___ 101-150 cm
___ 51-100 cm
___ 25-50 cm
___ < 25 cm

Soil Interpretations (2 each)
_2_ Dwellings with Basements
_3_ Septic Tank Absorption Field
_2_ Local Roads and Streets
_4_ Plant Sensitivity to salt affected soils
(1 = slight, 2 = moderate, 3 = severe, 4 = Extreme)

Part A ________
Part B ________
Part C ________
Part D ________
Total ________

C. Site Characteristics

Position of Site (5)
___ Depression
___ Drainage Way
___ Flood Plain
___ Footslope
___ Stream Terrace
_X_ Upland

Parent Material (5)
___ Alluvium
___ Colluvium
___ Residuum
_X_ Loess

Soil Slope (5)
_X_ Nearly Level (0 to 2%)
___ Gently Sloping (>2 to 6%)
___ Sloping (>6 to 12%)
___ Moderately Sloping (>12 to 20%)
___ Strongly Sloping (>20 to 30%)
___ Steep (>30%)

Surface Water Runoff (5)
___ Ponded
___ Very Slow
_X_ Slow
___ Medium
___ Rapid
___ Very Rapid

Wind Erosion Potential (5)
___ Very Low
___ Low
___ Medium
___ High
_X_ Very High

Water Erosion Potential (5)
_X_ Very Low
___ Low
___ Medium
___ High
___ Very High

Part C Score ________

D. Soil Classification

Epipedons (5)
___ Mollic
_X_ Ochric
___ Umbric
___ Anthropic

Subsurface Horizons
and Characteristics (5 each)
___ Albic
___ Argillic
___ Cambic
___ Calcic
_X_ Petrocalcic
___ Gypsic
___ Petrogypsic
___ Natric
___ Salic
___ Duripan
___ Fragipan
___ Lithologic Discontinuity
___ Lithic Contact
___ Paralithic Contact
___ None

Order (5)
___ Alfisols
___ Entisols
___ Inceptisols
___ Mollisols
___ Vertisols
_X_ Aridisols

Part D Score ________

Figure (4). A) Example of the front side of completed scorecard for the soil pit No. 3 in Zuwarah, Libya (scorecard adapted from (Karathanasis et al., 2013)). **B)**. Example of the back side of completed scorecard for the soil pit No. 3 in Zuwarah, Libya (scorecard adapted from (Karathanasis et al., 2013)).

The scorecard that used for grading in soil judging competitions must be adapted to local soils and classification. A newly developed soil judging scorecard (Fig. 4a and 4b) is adapted for Libyan soils classified using USDA/SCS Soil Taxonomy (Arabic version in Appendix A). In order to demonstrate how to use soil judging scorecard, soil pit No. 3 (Zurqani, 2010) was used to fill out the "practice" soil scorecard (Fig. 4a and 4b).

In addition to the soil judging scorecard, other supplemental materials were used: 1) Soil physical and chemical properties, 2) optional topographic map of the area, 3) textural triangle (not shown, but it is the same used in Libya and USA), 4) abbreviations of distinctness of soil boundary, texture, modifiers of rock fragment quantity and size, structure grade, structure shape, consistence, redoximorphic features (Appendix B), 5) tables of surface and soil erosion potential classes, and 6) tables of soil use interpretations for dwellings with basement, septic absorption fields, and local roads and streets. Soil pit No. 3, which was one of soil profiles conducted by Zurqani (2010) in the northwest of Libya near the coastal strip. The soil pit has been classified as NatricPetrocalcids in the USDA/SCS Soil Taxonomy (1999). In part B, the infiltration rate was determined to be medium based on soil texture (LS/S) and soil organic carbon content (0.19%) in the Ap horizon (Karathanasis et al., 2013). Hydraulic conductivity was determined to be low based on subsurface horizon characteristics (Karathanasis et al., 2013). Available water was calculated based on depth of 70 cm x 0.05 = 3.5 cm (multiplier for LS and LS/S in all of the horizons) (Karathanasis et al., 2013). The soil wetness class is > 150 cm (not wet at depths of less than 151 cm) because of lack of redoximorphic features through the soil pit (Karathanasis et al., 2013). Soil interpretation for dwellings with basements was identified as "2 = moderate" based on using the following criteria: flooding or ponding (none), slope (< 6 %), depth to seasonally high water table (> 100 cm), and depth to duripan layer (kqm))50 - 100 cm(, and depth to hard rock, R (cm) > 150 cm. Soil interpretation for septic tank absorption fields was identified as "3 = severe", based on using the following criteria: flooding or ponding (none), slope (< 6 %), depth to seasonally high water table (> 150 cm), the limiting hydraulic conductivity "low", and depth to duripan layer (kqm) 50 - 100 cm, and depth to hard rock, R (cm) > 150 cm. Soil interpretation for local roads and streets was identified as "2 = moderate" based on using the following criteria: flooding or ponding (none), slope (< 6 %), depth to seasonally high water table (> 100 cm), and depth to duripan layer (kqm) 50 - 100 cm, and depth to hard rock, R (cm) > 150 cm. Soil interpretation for plant sensitivity to salt affected soils was "4 = extreme" based on the surface horizon, and using the following criteria: pH = 7.1, SAR (%) = 22.04, and the ECe (dS/m) = 4. In Part C, surface runoff class was "slow" based on > 1 – 2 % slope and "medium" infiltration determined in the Part B of the scorecard. In Part C, erosion potential was "very low" based "slow" surface runoff and LS/S surface horizon texture determined in the Part A of the scorecard.

In general, the U.S. scorecard can be used in Libya and other countries which have the same climatic conditions with necessary modifications depending on the region and soil interpretations to be used. The scorecard can be further adapted to simultaneously train the user to describe and classify soil in multiple soil classifications. Soil Judging was conducted by professors in soil science departments in Libyan universities by various participants: 54% were students, 23% were researchers, 10% were educators, and 10% were workers. Fifty percent of participants had a high school degree, 35% had a bachelor's degree, 11% had a master's degree, and four percent had a doctorate.

Initially, participants were asked about their knowledge of soil science: 73% responded that they had a fundamental soil science course before and 40% indicated that they had conducted field work related to soil science. Eighty-two percent of participants stated that they had no prior knowledge of Soil Judging, and 95% stated that Soil Judging is useful to natural science education in Libya (Table 3)

Adapted materials (e.g., scorecard) and explanatory materials were evaluated between "good" and "excellent" (Table 4). The evaluation of the soil judging equipment was between "poor" and "good" (Table 4) Specific feedback (Appendix C) from the participants is valuable to provide more specific guidelines on positive and negative aspects of the project (Table 5).

Responses included the desire for additional seminars to increase the awareness and potential impact of Soil Judging in Libya as well as including additional field locations. Access to equipment including soil pH and EC tests was listed as a need.

APPLICATION OF SOIL JUDGING INLIBYA

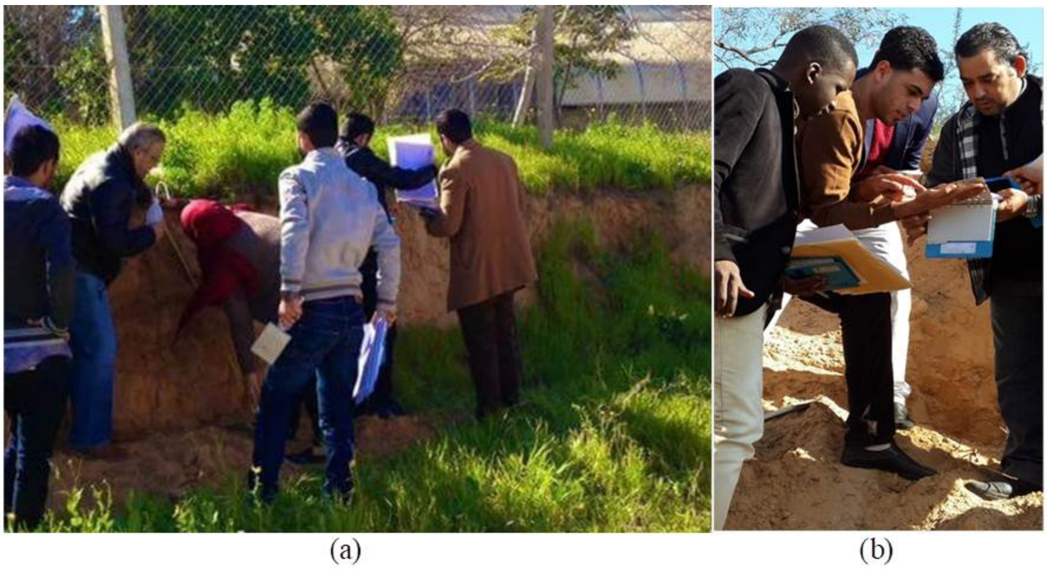

Figure (5). Participants are examining the soil pit during Soil Judging practice in Libya; (a) University of Tripoli, and (b) University of Zawia

Table (3). Responses from Libyan users to questions about the Soil Judging project (total number of participants = 53).

Survey questions	Yes (%)	No (%)	N/A†
1. Have you ever had a soil science course? (Yes / No)	73	27	-
2. Have you ever had field work related to soil science? (Yes / No)	40	60	1
3. Did you know about Soil Judging before this power point presentation? (Yes / No)	18	82	3
4. Is Soil Judging useful to natural science education in Libya? (Yes / No)	95	5	1

† N/A = not answered.

Table (4). Responses about the quality of the Soil judging (total number of participants = 53).

	Survey question	Mean ±, SD†	N/A†
1.	Did you find the Soil Judging power point presentation informative? (1 = not at all, 3 = somewhat, 5= very informative)	4.5 ± 0.8	-
2.	How did you find quality of explanation? (1 = poor, 3 = good, 5 = excellent)	3.7 ± 1.0	-
3.	Did you find the field demonstration for Soil Judging informative? (1 = not at all, 3 = somewhat, 5 = very informative)	4.6 ± 0.9	1
4.	How did you find quality of field demonstration and explanation? (1 = poor, 3 = good, 5 = excellent)	3.8 ± 1.0	1
5.	Did you find the Soil Judging field work informative? (1 = not at all, 3 = somewhat, 5 = very informative)	4.5 ± 0.9	-
6.	How did you find quality of Soil Judging equipment? (1 = poor, 3 = good, 5 = excellent)	2.0 ± 1.0	1
7.	How did you find quality of the Soil Judging scorecard? (1 = poor, 3 = good, 5 = excellent)	4.4 ± 1.0	2

† SD = standard deviation; N/A = not answered.

Table (5). Specific recommendations to improve Soil Judging in Libya.

Do you have any suggestion to improve the adaptation of Soil Judging power point presentation (or suggestion for other "field demonstration and explanation" and "field work related to Soil Judging")
You should organize conferences and seminars about soil judging that will raise awareness about how it is importance and how it is work for soil evaluation as big part of applied science.
I hope if you organize field trips and visits to different fields to practices on with different types of soil and places.
I wish next visit we have the necessary support for equipment and transportation.
You should seek to teach soil judging approach as field practices will help students recognize the importance of soil and study its various properties evaluated.
It was very informative that will help me on both sides an academic and field work in my M.S. research.
We need to know more details about Soil Judging.
We need more field work.
Provide all the equipment that we needed in soil judging test.
Provide the hand measurement for the soil pH test and Soil EC test will help us a lot.
This is my first time I visit the field to study soil properties, and I like it a lot.

CONCLUSION

The introduction of soil judging in Libya could have numerous benefits for the country. One of the main advantages is the potential for low-cost, non-traditional education in the techniques of land management and use. This could be especially useful for students and government workers, as it would provide them with hands-on experience and practical knowledge in this important field. Besides, Libya already has the necessary infrastructure in place to support theimplementation of soiljudging competitions in schools (including middle and high schools, colleges, and universities), as well as in various government sectors such as agriculture, health, road construction, and building and town planning. This makes it an ideal location to introduce and promote the benefits of soil judging. Furthermore, soil nutrient analysis data can be easily obtained from any of the soil nutrient analysis laboratories in Libya, making it possible to conduct accurate and comprehensive soil assessments. Overall, the introduction of soil judging to Libya has the potential to greatly improve land management practices and increase the country's overall sustainability.

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Appendix A: The front (a) and back (b) sides of developed Libyan scorecards.

ج: خصائص الموقع

(5) مكان الموقع

منخفضات: ....

نظام الصرف: ....

الفياضانات: ....

قدم المنحدر: .... علامة الانقاض السفحية في الاسفل

مصاطب المياه: .... علامة الطمي في الاسفل

مرتفعات: ....

(5) مواد الاصل

طمي: .... تكونت بفعل جريان المياه

الانقاض السفحية: .... تكونت بفعل الجاذبية، تتواجد اسفل قدم المنحدر

محلية أو متبقية: .... تكونت في نفس المكان

(5) ميل التربة

قريب المستوى (0 الى 2%): ....

قليل الانحدار (>2 إلى 6%): ....

منحدر (>6 إلى 12%): ....

متوسط الانحدار (>12 إلى 20%): ....

شديد الانحدار (>20 إلى 30%): ....

شديد الانحدار (>30%): ....

(5) الجريان السطحي (الشروط في الجدول، تمثل كيفية استخدامها)

نادر الحدوث: ....

قليل جدا: ....

قليل: ....

متوسط: ....

سريع: ....

سريع جدا: ....

(5) حدوث تعرية (الشروط في الجدول، تمثل كيفية استخدامها)

قليله جدا: ....

قليله: ....

متوسطة: ....

عالية: ....

عالية جدا: ....

نتيجة الجزء ج: ....

د. تصنيف التربة

(5) الافاق السطحية

الأفق العضوي المعدني: .... (الافق أ 10 سم، ثم ص او ع ص)

الأفق الأوكري: ....

الأفق المصلي: ....

الأفاق تحت السطحية وخصائصها (لكل 5)

افق الغسيل: .... فاتح اللون > 1 سم

الأفق الطيني: .... (وجود علامات تزوج الطين لاسفل بالرشح)

افق التغيير: ....

الطبقة الصماء القابلة للكسر: ......

طبقة متقطعة التطور: .... (التغير في حجم الحبيبات)

طبقة حجرية متصلة: .... (إتصال التربة بالافق ص)

طبقة شبه حجرية متصلة: .... (إتصال التربة بالافق ع ص)

لاشيء: ....

الرتبة (6)

ترب مناطق الغابات: .... (oc, ar, um A, Bt, C)، نسبة التشبع بالقواعد > 35 % ولكن < 50 %

الترب حديثة التكوين: .... (الأفق الأوكري، أ، ج)

الترب البسيطة التطور: .... (och or um, A, Bw, C)

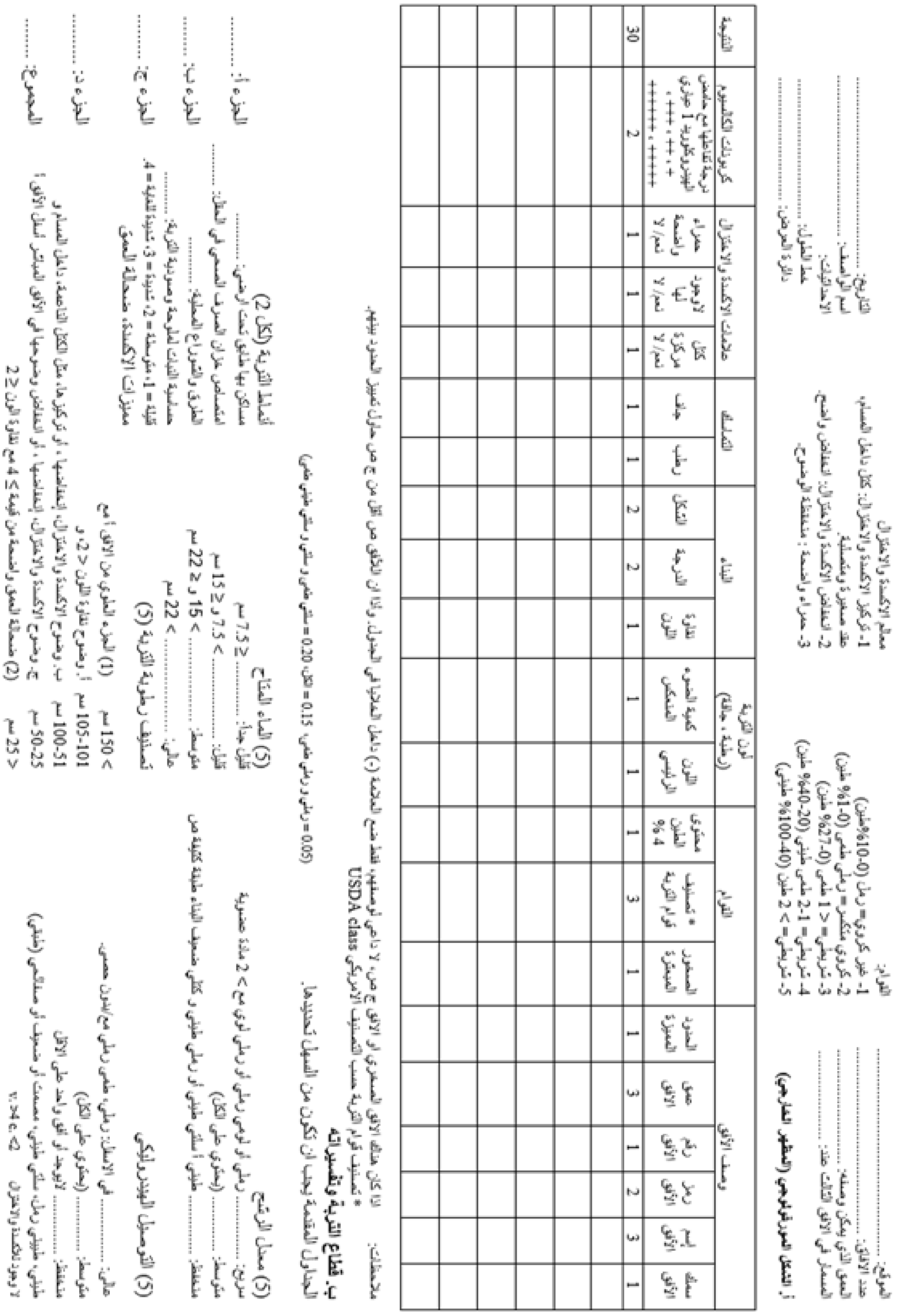
ترب مناطق الحشائش والاعشاب الطبيعية: ...... (m, ar, A, Bt, C)، (B.S. >50%, OC >0.6%)

الترب الجافة: .... (arg, oc, A, E, Bt, C)، نسبة التشبع بالقواعد < 35 %

الترب الطينية المتشققة السوداء: .... (a|g, oc, A, E, Bt, C)

نتيجة الجزء د: ....

(a). The front side of developed Libyan scorecards.



بطاقات تقييم التربة (Soil Judging) في ليبيا

الموقع: ....
عدد الافاق: ....
العمق الذي يمكن وصفه: ....
المسمار في الافق الثالث عند: ....

أ. الشكل المورفولوجي (المظهر الخارجي)

القوام:
1- غير كروي= رمل (0-10%طين)
2- كروي متكسر= رملي طمي (0-1% طين)
3- شريطي= < 1 طمي (0-27% طين)
4- شريطي= 1-2 طمي طيني (20-40% طين)
5- شريطي= > 2 طين (40-100% طيني)

معالم الاكسدة والاختزال
1- تركيز الاكسدة والاختزال: كتل داخل المسام، عقد صغيرة ومتصلبة.
2- انخفاض الاكسدة والاختزال: انخفاض واضح.
3- حمراء واضحة ; منخفضة الوضوح.

التاريخ: ....
اسم الواصف: ....
الاحداثيات:
خط الطول: ....
دائرة العرض: ....

وصف الأفق						القوام			لون التربة (رطبة ، جافة)		البناء			التماسك		علامات الاكسدة والاختزال			كربونات الكالسيوم	النتيجة
سمك الأفق	إسم الأفق	رمز الأفق	رقم الأفق	عمق الافق	الحدود المميزة	الصخور المبعثرة	* تصنيف قوام التربة	محتوى الطين 4 %	اللون الرئيسي	كمية الضوء المنعكس	نقاوة اللون	الدرجة	الشكل	رطب	جاف	كتل مركزة نعم/ لا	لاوجود لها نعم/ لا	حمراء واضحة نعم/ لا	درجة تفاعلها مع حامض الهيدروكلوريد 1 عياري + ، ++ ، +++ ، +++++ ، ++++++	
1	3	2	1	3	1	1	3	1	1	1	1	2	2	1	1	1	1	1	2	30

ملاحظات: اذا كان هناك الافق الصخري او الافق ج ص، لا داعي لوصفهم، فقط ضع العلامة (-) داخل الخلايا في الجدول. وإذا ان الأفق ص أقل من ج ص حاول تمييز الحدود بينهم.
* تصنيف قوام التربة حسب التصنيف الامريكي USDA class

ب. قطاع التربة وتفسيراته

الجداول المقدمة يجب ان تكون من السهل تحديدها.
(0.05 = رملي و رملي طمي، 0.15 = الكل، 0.20 = سلتي طمي و سلتي و سلتي طيني طمي)

(5) معدل الرشح
سريع: .... رملي أو لومي رملي أو رملي لوي مع > 2 مادة عضوية
متوسط: .... (يحتوي على الكل)
منخفض: .... طيني أ سلتي طيني أو رملي طيني و كتلي ضعيف البناء طبقة كثيفة ص

(5) التوصيل الهيدروليكي
عالي: .... في الاسفل: رملي، طمي رملي مع/بدون حصى.
متوسط: .... (يحتوي على الكل)
منخفض: .... لايوجد أو أفق واحد على الاقل
طيني، طيني رمل، سلتي طيني، مصمت أو ضعيف أو صفائحي (طبقي)
لا وجود للاكسدة والاختزال v. >4 c. <2

(5) الماء المتاح
قليل جداً: .... ≤ 7.5 سم
قليل: .... > 7.5 و ≤ 15 سم
متوسط: .... > 15 و ≥ 22 سم
عالي: .... > 22 سم

تصنيف رطوبة التربة (5)
> 150 سم (1) الجزء العلوي من الافق أ مع
105-101 سم أ. وضوح نقاوة اللون < 2، و
100-51 سم ب. وضوح الاكسدة والاختزال، إنخفاضها ، أو تركيزها، مثل الكتل الناعمة، داخل المسام و
50-25 سم ج. وضوح الاكسدة والاختزال، إنخفاضها ، أو انخفاض وضوحها في الأفق المباشر أسفل الأفق أ
< 25 سم (2) ضحالة العمق واضحة من قيمة ≤ 4 مع نقاوة الون ≥ 2

أنماط التربة (لكل 2)
مساكن بها طابق تحت ارضي: ....
امتصاص خزان الصرف الصحي في الحقل: ....
الطرق والشوارع المحلية: ....
حساسية النبات لملوحة وصودية التربة: ....
قليلة = 1، متوسطة = 2، شديدة = 3، شديدة للغاية = 4.
مميزات الاكسدة، ضحالة العمق

الجزء أ: ....
الجزء ب: ....
الجزء ج: ....
الجزء د: ....
المجموع: ....

(b). The back side of developed Libyan scorecards.

Appendix B

Abbreviations (Adapted from Handbook for Collegiate Soils Contest, 2011).

Distinctness of Boundary			
Abrupt = A	Gradual = G		
Clear = C	Diffuse = D		
Texture			
Sand = S	Silt = Si	Clay = C	Loam = L
Sandy Loam = SL	Silt Loam = SiL	Clay Loam = CL	Sandy Clay = SC
Sandy Clay Loam = SCL	Silty Clay Loam = SiCL		Loamy Sand = LS
Sandy Clay = SC	Silty Clay = SiC		
Modifiers of Rock Fragment Quantity and Size			
Gravelly = GR	Cobbly = CB	Stony = ST	
Very Gravelly = VGR	Very Cobbly = VCB	Very Stony = VST	
Extr. Gravelly = XGR	Extr. Cobbly = XCB	Extr. Stony = XST	
Structure Grade			
Structureless = SLS	Weak = WK	Moderate = MO	Strong = ST
Structure Shape			
Granular = GR	Prismatic = PR	Angular Blocky = ABK	
Platy = PL	Single Grain = SG	Subangular Blocky = SBK	
Massive = MA			
Consistence			
Loose = L	Friable = FR	Very Friable = VFR	
Firm = Fi	Very Firm = VFi	Extremely Frim = EFi	
Redoximorphic Features			
Enter “Yes” (Y) if present, and “No” if none are present.			
presence or absence of carbonates (e.g., CaCO3)			

Effervescence class	Criteria
Non effervescent (N)	No bubbles detected
Very slightly effervescent (VSli)	Few bubbles seen
Slightly effervescent (Sli)	Bubbles readily seen
Strongly effervescent (St)	Bubbles from low foam
Violently effervescent (Vio)	Thick foam from quickly

Appendix C

Soil Judging survey form.

Soil Judging Survey

Thank you for participating in this Survey of “Potential Adaptation of Soil Judging in Libya.” Your responses will be very useful in further improvement and development of this project.

Please, fill in the bubble with your answers ●or circle the appropriate answer.

Part A. General Information.

I am a: ○ student; ○ farmer; ○ worker; ○ engineer; ○ educator; ○ researcher; ○ other

My highest education is: ○ school; ○ university; ○ M.S; ○ Ph.D.; ○ other: ______

My academic major or specialty is: ____

1. Have you ever had a soil science course? (Yes / No)
2. Have you ever had field work related to soil science? (Yes / No)

Part B. Questions about Soil Judging power point presentation.

3. Did you find the Soil Judging power point presentation informative?
   1 = not at all   3 = somewhat   5 = very informative
4. How did you find quality of explanation?
   1 = poor   3 = good   5 = excellent
5. Did you know about Soil Judging before this power point presentation? (Yes / No)
6. Is Soil Judging useful to natural science education in Libya? (Yes / No)?
7. Please, provide specific comments about further improvements to this power point presentation:

Part C. Questions about field demonstration:

8. Did you find the field demonstration for Soil Judging informative?
   1 = not at all   3 = somewhat   5 = very informative
9. How did you find quality of field demonstration and explanation?
   1 = poor   3 = good   5 = excellent
10. Please, provide specific comments about further improvements to this field demonstration and explanation:

Part D. Questions about field work.

11. Did you find the Soil Judging field work informative?
    1 = not at all   3 = somewhat   5 = very informative
12. How did you find quality of Soil Judging equipment?
    1 = poor   3 = good   5 = excellent
13. How did you find quality of the Soil Judging scorecard?
    1 = poor   3 = good   5 = excellent
14. Please, provide specific comments about further improvements to field work related to Soil Judging: