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Land Suitability Assessment of Wheat in the Nile Delta Using National SOTER Database

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EGYPT occupies the North -East corner of Africa and lies between latitudes 22°N and 32°N , and longitudes 25°E and 36°E. The most important soils in the Nile Delta are stratified loams or clays. These soils have high potential for irrigated crops. The main objective of this study is to determine the suitability assessment of wheat in the Nile delta as one application of the SOTER database in the Nile Delta to assess the potential for increase of the area cultivated with wheat. In this study SOTAL was used and modified for application in the Nile Delta. Two land utilization types (LUT) are distinguished: irrigated wheat cultivation under low input low technology and irrigated wheat cultivation under medium to high input and technology in Nile Delta.

The results show that the major area (SOTER unit 6) is highly suitable and shows no limitations for wheat production even in the case of low input and technology. The obtained values show that SOTER unit 7 is highly suitable for wheat but in case of low input and technology there are limitations of nutrients availability. These soils texture are sandy to sandy loamy with low nutrient buffering capacity. SOTER unit 1 can be considered to be non- suitable for wheat cultivation because there is excess of high salts content and low availability of nutrients. Availability of oxygen, availability of nutrients and high salt contents are slightly limiting in SOTER units 3, 4 and 5. The SOTER unit 8, although it is clayey and highly fertile soil considered not- suitable for wheat due to the high salt contents which is considered as limiting factor for wheat cultivation.

Keywords: SOTER, SOTAL, Suitability, Nile Delta, Wheat.

For the development of a World Soils and Terrain Digital Database (SOTER) scale 1:1,000,000 a methodology for the compilation, coding and storing of data has been made (Van Engelen & Wen, 1995). The SOTER methodology provides a comprehensive framework for the storage and retrieval of uniform soil and terrain data that can be used for a wide range of applications at different scales. A SOTER-based, automated procedure for qualitative land evaluation was developed (Mantel, 1995). This procedure, abbreviated as SOTAL, and created in ALES: the Automated Land Evaluation System (Rossiter & Van Wambeke, 1993).

The objective of current study is to design a procedure that allows a quick separation of potentially suitable from non-suitable mapping units for the intended land use, indicating constraints in different kinds of land use. The SOTER methodology has been developed for applications on a scale of 1:1 million (Batjes, 1990b). At that scale land evaluation will permit identification of the suitability of terrain units for broadly defined land uses as planned by planners (Batjes, 1990a). In several cases SOTER has been applied at large scales (Mantel, 2002 and Mantel *et al.*, 2002). SOTAL can be used as a first and quick assessment to indicate the physically non-suitable area.

The direct and valuable objective of the SOTER program is to make regional land resource information available in a digital format for applications in land evaluation and regional land use planning.

Egypt occupies the North-East corner of Africa and lies between latitudes 22°N and 32°N and longitudes 25°E and 36°E. Most of the country has a hot sub tropical desert climate. No crop can be grown in this climate without irrigation. In the Nile Delta winter temperatures are suitable for wheat (16.4°c).

These soils have high potential for irrigated crops. The total cultivated area of Egypt is 7.2 million feddans (1 feddans = 0.42 ha), representing only 3 percent of the total land area. The total area cropped annually is about 11.5 million feddans, which represents a cropping ratio of about 2:1. Wheat is one of the most important crops grown in Egypt due to high demand for wheat which used in bread production and bread forms the main portion of the Egyptians daily meals. Egypt does not produce enough wheat and needs for imported wheat from forging countries such as USA, Russia, France& Canada forms an essential part of Egyptian Government Policy.

The main objective of this current study is to examine the suitability assessment of wheat in the Nile Delta, as one of the SOTER database applications in order to assess the potential to increase the cultivated area with wheat in Nile Delta.

Material and Methods

ALES computer program: is allows land evaluators to build their own knowledge-based system and using this system to compute the physical and economical suitability of mapping units based on FAO's Framework for Land Evaluation (FAO, 1976 and Rossiter, 1990). ALES works with so called decision trees, being hierarchical multiway keys in which the leaves are results (*e.g.*, severity levels of land qualities) and the interior nodes of the tree are decision criteria (*e.g.*, land characteristic values). These trees are traversed by the program to compute land evaluation of an investigated area based on actual land data of each mapping unit (Rossiter, 1990) (Fig. 2). SOTAL is a SOTER-based,

qualitative model developed in ALES for physical land evaluation (Mantel, 1995) (Fig. 1 & 2).

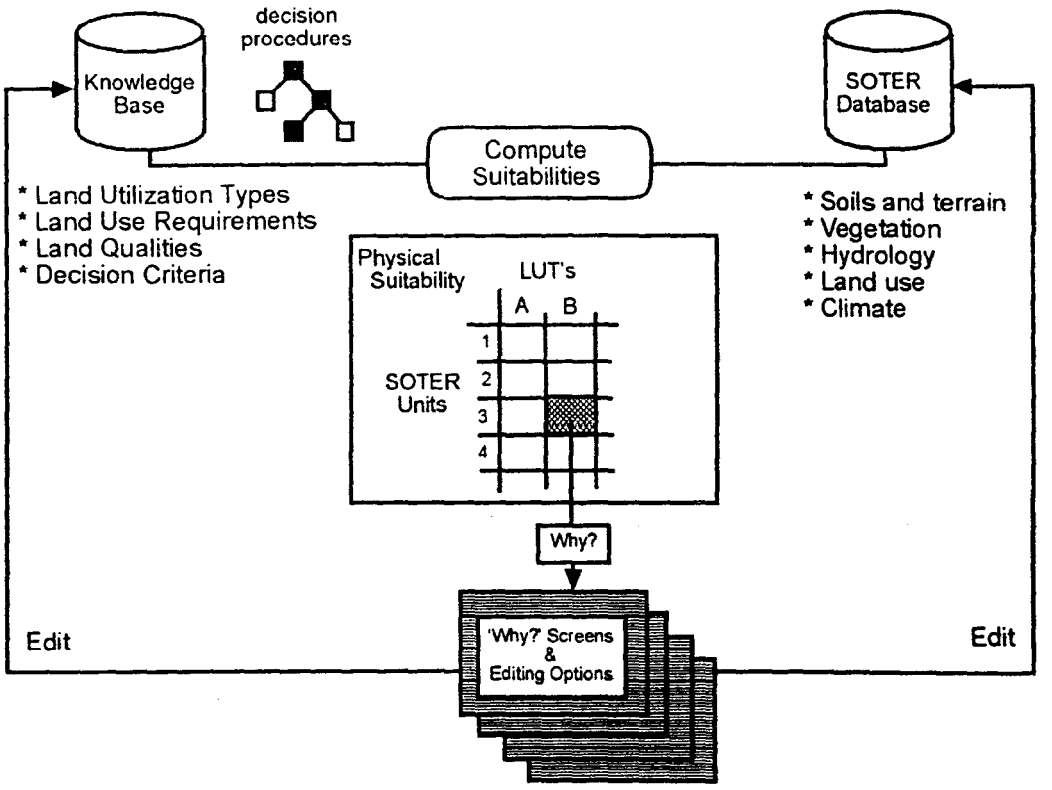

Fig. 1. The ALES program flow (Mantel, 1995, modified after Rossiter 1990).

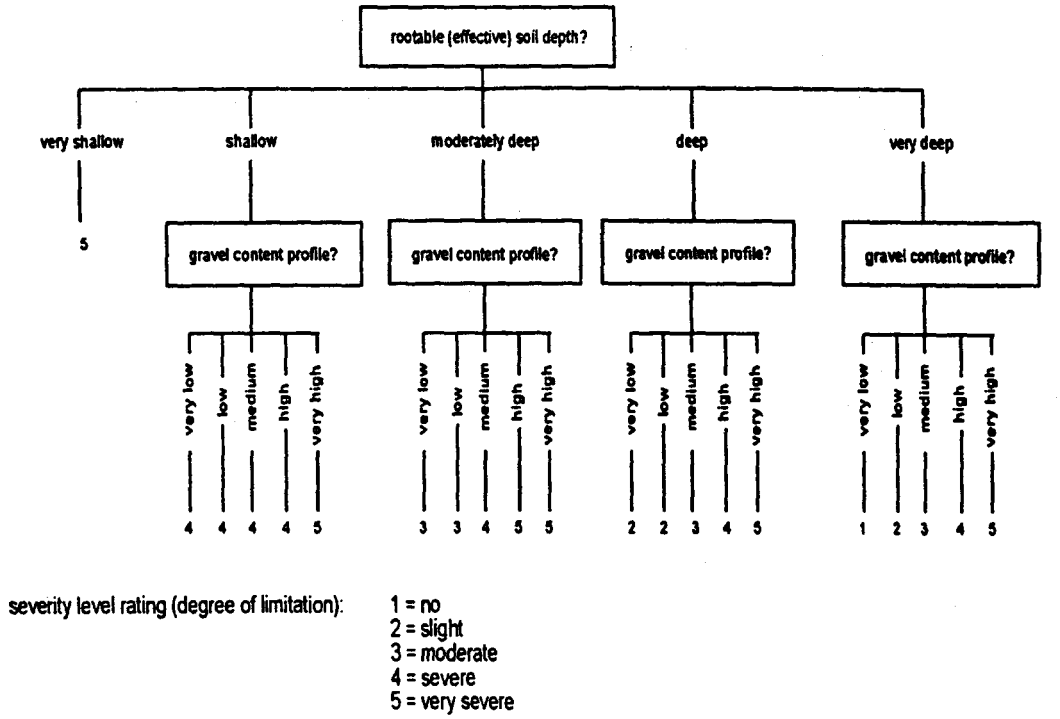

Fig. 2. Decision tree for land quality 'available foothold for roots' (Source: Mantel, 1995).

In this study SOTAL was used and modified for application in the Nile Delta. Two land utilization types (LUT) are distinguished: irrigated wheat cultivation under low input and low technology; and under medium to high input and technology. These LUTs are characterized by 6 land use requirements (LUR) and evaluated by matching the land use requirements with the corresponding land qualities (Fig. 1). The sufficiency of each land quality is assessed from one to (mostly) several land characteristics with the help of (severity level) decision trees before the final suitability rating can be performed (Table 1). The required soil data for evaluation were taken from the soil component and the profile files. For each terrain component the data of dominant soil types were taken as a basis for evaluation.

TABLE 1. Land qualities and land characteristics used in the ALES model for the Nile Delta.

Land quality	Land characteristics
Availability of nutrients	Soil reaction (pH), organic carbon, cation exchange capacity
Available foothold for roots	Soil depth, gravel content
Conditions of germination	Structure size, sailing, surface stone
Potential for mechanisation	Surface rockiness, gravel content, slope
Availability of oxygen	Soil drainage class
Excess of salts	Electric conductivity (EC) in surface and subsoil, exchangeable sodium percent (ESP) in surface and subsoil.

Studied area

Wheat is one of the most important crops in Egypt. 90% of the cultivated area in Nile delta is cultivated with wheat (about 1.49 million Fadden) as irrigated agriculture, and the climate in Egypt is suitable for wheat growing cultivation. Total productivity of wheat in Egypt reaches about 7.2 million ton per year, *i. e.*,2.85 tons /feddan.

Definition of Land Utilization Type (LUT)

The land utilization type of the Nile Delta was defined as irrigated wheat cultivation under low input, low technology and medium to high input and technology. Farm size is generally small (1-3 Fadden). The planting period is October and November and harvest is in April and May. All Egyptian farms have an irrigation system.

Results and Discussions

Rahim (2006) classified the Nile delta into 8 SOTER units by using the SOTER methodology (Table 2). The new model derived from SOTAL was built to accommodate irrigated wheat in the Nile Delta; it is a land evaluation model using SOTER data. Table 3 and Fig. 3 and 4 show the results of suitability assessment and the limitation factors for both LUTs in the Nile delta for the 8 SOTER units.

TABLE 2. Characteristics of SOTER Units.

SOTER unit	Characteristics
1	Sandy to clay, Highly saline, 1-2% slope
2	Sand dunes
3	Fluviomarine, clay, highly saline, 1-2% slope
4	Fine loamy, highly saline, 1% slope
5	Sandy, slightly saline, 2% slope
6	Clay, non saline, 1-2% slope
7	Sandy loam, non saline, 1-2% slope
8	Clay, highly saline, 1-2% slope

Table 3. The Suitability Assessment for Irrigated Wheat in Nile Delta.

SOTER unit	Land Utilization Type		Area (ha)	Area (%)
	RWL#	RWH#		
1	4avn*	3sal*	85868	9.9
2	No data	No data	14483	1.7
3	2ox/sal*	2ox/sal*	17186	2.0
4	3avn/sal*	3sal*	9851	1.1
5	4avn*	3avn*	4973	0.6
6	1	1	666514	77.2
7	2avn*	1	51869	6.0
8	3sal*	3sal*	12979	1.5

#RWL: irrigated wheat cultivation, low input and technology.
#RWH: irrigated wheat cultivation, medium to high input and technology.
*avn: availability of nutrients.
*ox: availability of oxygen.
*sal: excess of salts.

The obtained results show that the major area (SOTER unit 6) is highly suitable and shows no limitations for wheat production even in the conditions of low input and technology. This underscores the potential of this area and is confirmed by the high fertility and high production. This area represents 77.2% of the total area in Nile Delta. The obtained data show that SOTER unit 7 is highly suitable for wheat but in case of low input and technology there are limitations of availability of nutrients. These soils are sandy to sandy loamy with low nutrients buffering capacity. This unit represents about 6% of the total area of the Nile delta. SOTER unit no 1 can be considered to be non-suitable for wheat cultivation because of its high content of salts and low availability of nutrients. It represents about 9.9% of the total area of Nile Delta. Availability of oxygen, availability of nutrients and excess of salts are slightly limiting in SOTER units 3, 4 and 5which represent 2.0, 1.1 and 0.6% of the delta respectively. SOTER unit 8, although characterised by a clayey and highly fertile soil it is considered unsuitable for wheat due to its high salts contents. These soils represent about 1.5% of the total area of the Nile Delta.

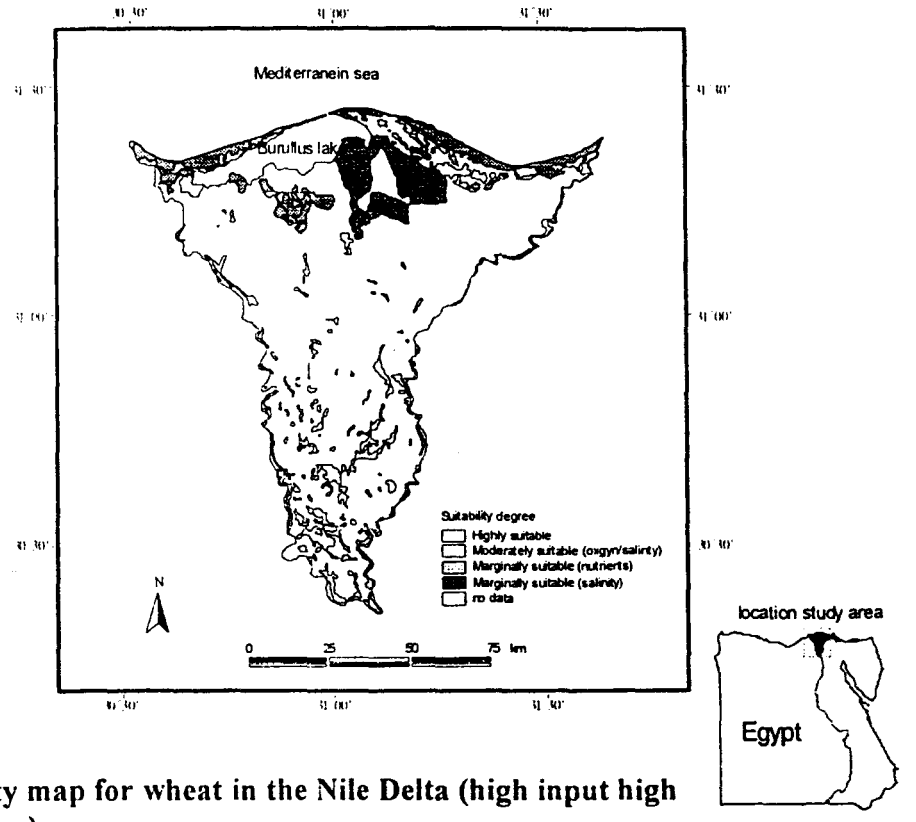

Fig. 3. Suitability map for wheat in the Nile Delta (high input high technology).

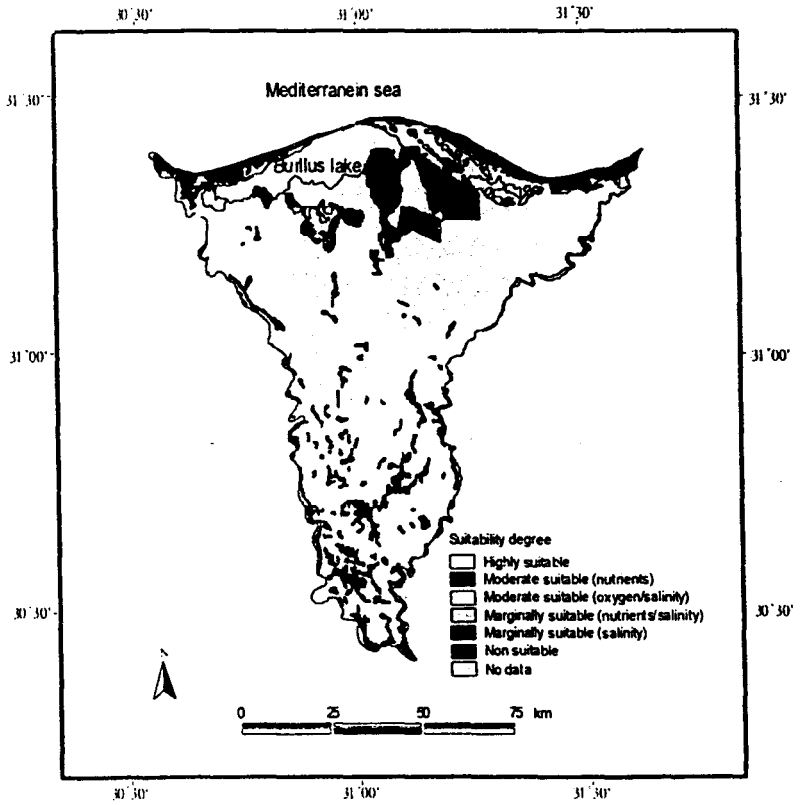

Fig. 4. Suitability map for wheat in the Nile Delta (low input low technology).

Conclusion

Based on this current study data we can conclude that about 83.2% of total area of Nile Delta is suitable for cultivation of wheat and while there are limitations in the rest of the Nile delta area (16.8%) such as salinity, availability of nutrients and availability of oxygen could be corrected by using proper inputs of drainage, leaching of salts and adequate and suitable fertilizers..

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تقييم ملاءمة الاراضى لزراعة القمح فى دلتا النيل بمصر باستخدام قاعدة بيانات Soter

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تشغل مصر الركن الشمالى الشرقى من قارة افريقيا ، وتقع بين خطى العرض ٢٢ ٣٢٥ ° شمالا وخطوط الطول ٢٥٥ ° و ٣٦ ° شرقا. أهم انواع التربة فى دلتا النيل بمصر هى الطمبية او الطينية وهذه التربة ملائمه للمحاصيل المرويه والقمح من اهم المحاصيل التي تزرع فى مصر حيث يصنع منه الخبز الجزء الرئيسى فى غذاء المصريين والهدف الرئيسى من هذه الدراسه هو تقييم ملائمة زراعة القمح فى دلتا النيل كواحدة من تطبيقات قاعدة soter للبيانات لتقييم امكانيه الزيادة فى المساحة المنزرعة قمح وفى هذه الدراسه تم استخدام sotal المعدل للتطبيق فى دلتا النيل و اثنين من الانماط المتبعه فى استخدام الاراضى هما زراعة القمح المرويه تحت المدخلات والتكنولوجيات المنخفضه والمرويه فى اطار مدخلات متوسطة الى عالية .

تبين النتائج المتحصل عليها ان غالبية المناطق (الوحدة ٦) مناسبة للغاية ولاتظهر أى قيود لانتاج القمح حتى فى حالة انخفاض المدخلات والتكنولوجيا. كما تظهر البيانات ان قيم soter للوحدة ٧ مناسب جدا بالنسبة للقمح فى حالة انخفاض المدخلات والتكنولوجيا ولكن هناك محددات توافر المغذيات بالتربة. اما فى حاله التربة الرملية والرملية الطمبية تتميز بانخفاض قدرتها التنظيمية للعناصر المغذية. والوحدة (١) تعتبر غير ملائمة لزراعة القمح لأن هناك زيادة فى تركيز الاملاح وقلة فى المغذيات و الاوكسجين ، وتوافر المواد المغذيه والاملاح الزائده تعتبر عوامل محددة بدرجة قليلة في الوحدات ٣ و ٤ و ٥.اما الوحده (٨) وبالرغم من انها طينية خصبة الا انها تعتبر غير مناسبة للقمح بسبب زيادة محتواها من الاملاح الذى يعتبر عاملا مقيدا لزراعة القمح فى هذه المنطقة.