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Sustainable Land Use Planning of Siwa Oasis, Western Desert of Egypt Using Remote Sensing and Gis Techniques .

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SIWA OASIS occupies a large depression west of the Egyptian Western desert, approximately 300 Km south from the Mediterranean coast. It stretches roughly from east to west for approximately 82 Km, with a width that varies between 9 and 28 Km, and a total area of about 2,950 sq. km. Siwa oasis is opening from the border of the Libyan plateau to the large desert sandy area of the Great Sea of Sand. Ten physiographic units have been identified. Soils of the depression followed two orders 1- Entisols 2-Aridisols. Current land suitability was studied to identify the major constraints that preclude productivity. Land management scheme was suggested to overcome these constraints. Sustainable land use planning of Siwa Oasis aimed at making the "best" use of limited resources by executing different goals. These goals could be grouped under three headings: (1) Efficiency (2) Equity and acceptability (3) Sustainability.

Keywords: Landuse, Physiography, Soils, Remote sensing and GIS.

Wise sustainable land-use planning of Siwa involves making knowledgeable decisions about land use and the environment. Holistic planning involves input from multiple, interrelated data sources and types. In order to accomplish this feat, a great deal of information must be considered simultaneously. Soil information, water resources and socio-economic conditions work together playing a vital rule in the planning process and reflecting directly upon land-use suitability.

Location

Siwa Oasis lies between latitudes 29° 7'- 29° 21' N and longitudes 25° 16' - 26° 7'E. Fig. 1 represents Location of the studied area.

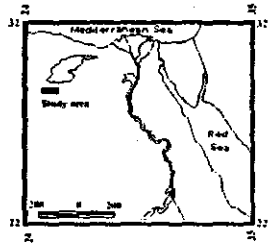

Fig. 1. Location .

Material and Methods

Remote sensing materials

Enhanced Thematic Mapper ETM dated to1999 bath 180 and row 40. Panchromatic aerial-photographs (scale 1: 10000) dated to 1992.

Digital image processing

ETM Image was enhanced and geometrically corrected using ERDAS imagine software. Band combination 7,4,2 was used according to Lillesand & Kiefer (1979) to recognize land use pattern.

Aerial photographs interpretation

Aerial photographs were interpreted stereoscopically to identify the main physiographic units.

Field work

A detailed survey was made to gain an appreciation of the broad soil patterns, the landform and landscape. One hundred questionnaires were carried out institute to identify the socio-economic conditions of the oasis's farmers. Eighteen soil profiles were dug to represent the main characteristics of the mapping units in addition to collecting 10 representative water samples from some springs and wells.

Soil laboratory analysis

Physical analyses

Particle size distribution was determined due to Rowell (1995). Soil color (wet & dry) was identified with the aid of Munssel colour charts, (Soil Survey Staff, 1951).

Chemical analyses

Electric conductivity EC, $CaCO_3$, O.M, pH, Exchangeable Na^+ ,CEC, Gypsum, available N,P,K, and water analyses were determined according to Rowell (1995).

Maps production

Physiography& soil, suitability and landuse planning primary maps were geometrically corrected, transformed , projected and finally produced using Arc GIS 8.1 software.

Results and Discussion

Physiography and soils

The main physiographic units could be summarized as follows:- Dissected plateau.- Overflow basins - Decantation basins - Sand sheets - Alkali flats (wet& dry sabkhas) - Inselberg-conical hills-mesas-buttes -Sief sand dunes -Hummocks-Hills footslopes and Mountainous footslopes. Applying Soil Survey Staff (1999), two soil orders were recognized 1-Entisols with sub great groups of - Typic

Psammaquents-Typic Torripsamments and 2-Aridisols with sub great groups of - Calcic Aquisalids -Duric Haplosalids - Gypsic Haplosalids - Lithic Haplocalcids - Typic Aquisalids - Typic Haplocalcids - Typic Haplosalids, Fig. 2 represents physiography and soils of the oasis.

Land suitability classification

Land characteristics as shown in Table 1 influence the suitability of land that will depend on the fact whether some of these characteristics are optimal, marginal or suitable,meanwhile Table 2 shows suitability classes of the investigated soils using simple limitation method, (Sys *et al.* 1991) ,where S1 (very suitable), S2 (moderately suitable), S3(marginally suitable), N1(actually unsuitable and potentially suitable) and N2 (unsuitable).

It is noticed that mapping units of MHK,DSA,WSA,LDB,HFS and MFS are not suitable for all selected crops, this may be refered to unsuitable soil characteristics, insufficient management, misuse of land and water resources, shortage of agricultural services, absence of governmental financial aids, extension and credits.

Water resources and classification

In Siwa oasis, there are two sources of water for irrigation purposes 1-water of springs that flow to the surface under hydrostatic pressure 2- Water of wells. Table 3 illustrates irrigation water classification of some selected springs and wells according to Richards (1954) ,where C1-S1 class represents water of 1 km deep wells(Dakrour& Kuraishet) .Water of this class can be used for irrigation with most crops on most soils and there is no limiting factors. On the other hand, water of springs and wells which classified as C2-S4 have moderate alkalinity hazard and very high salinity hazard . This water can not be used on soils with restricted drainage even with adequate drainage. It is advised to mix water of deep wells with water of very high salinity values (2:1 ratio at least) to get rid of these constraints.

Sustainable landuse planning

Sustainable land use planning of Siwa Oasis as shown in Fig. 3 aimed at making the "best" use of limited resources by executing different goals. These goals may be grouped under three headings; 1- Efficiency, land use must be economically viable; 2- Equity and acceptability, land use must also be socially acceptable including food security, employment and income security; 3- Sustainability, by meeting the needs of the present while, at the same time, conserving resources for future generation (FAO,1993). Analyzing the questionnaires that hold with the land users in situ and putting in mind natural resources, current suitability and land management practices sustainable land management plan has been suggested as follows:

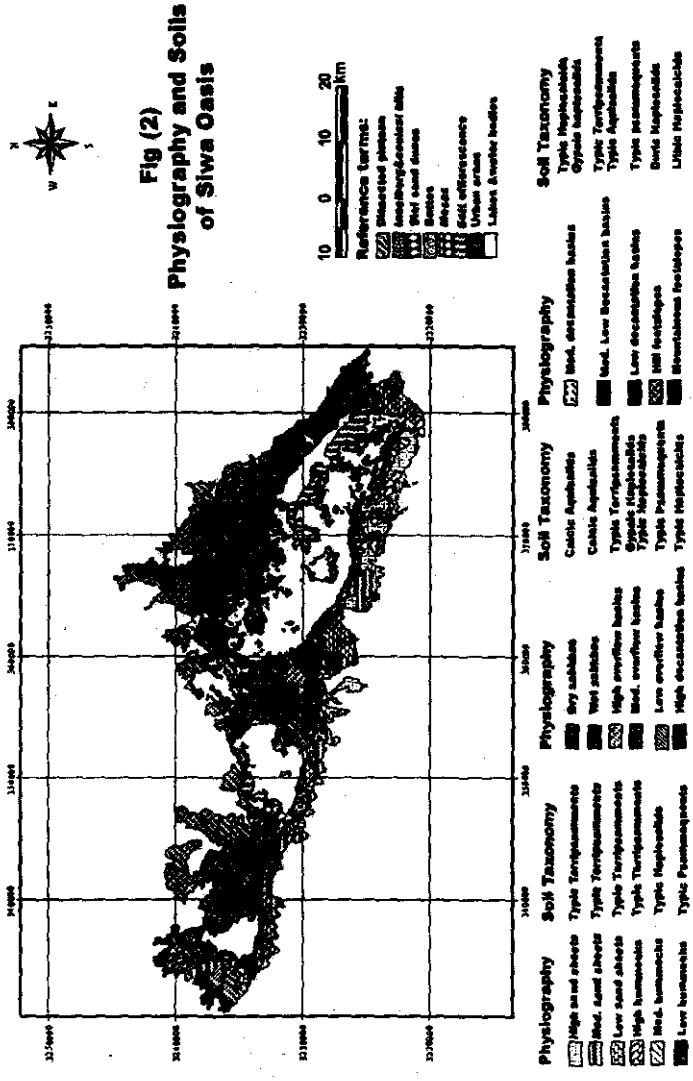

Fig.2. Physiography and soils of Siwa Oasis.

TABLE 1. Land characteristics of the investigated area.

Map Unit	s %	f	d	T/s	de cm	K %	Y %	CEC	O	n	z
HSS	<2	f0	w	cs	150	9.3	0.5	3.8	0.1	4.1	9.6
MSS	<2	f0	w	cs	120	6.3	0.6	4.0	0.1	21.1	14.8
LSS	<2	f0	w	cs	60	11.6	0.5	5.7	0.2	3.7	8.8
HHK	5	f0	w	sl	150	10.7	1.2	14.7	0.1	1.5	8.3
MHK	4	f0	w	ls	100	8.3	1.5	8.5	1.2	70.9	14.9
LHK	3	f0	w	s	80	6.7	2.8	4.3	0.1	2.8	10.2
DSA	<2	f1	p	sl	60	44.6	3.8	14	0.1	63.5	38.2
WSA	<2	f1	p	sil	50	51.4	4.1	37.2	3.6	36.3	34.9
HOB	<2	f0	w	sl	150	6.8	1.5	17.9	1.4	13.6	12.9
MOB	<2	f0	w	sl	100	14.8	1.6	13.3	0.8	2.8	8.7
LOB	<2	f0	w	s	70	11.5	1.0	4.2	0.6	1.4	6 9
HDB	<2	f0	w	ls	130	38.5	2.9	6.9	0.1	20.4	14.6
MDB	<2	f0	w	sl	110	1.9	5.2	13.1	0.1	35.7	13.8
MLD	<2	f0	w	sl	80	36.2	1.2	9.5	0.1	9.39	10.3
LDB	<2	f0	w	s	65	11.4	1.2	3.6	0.1	11.9	9.9
HFS	4	f0	w	s	40	21.7	4.1	4.8	0.2	46.3	10.9
MFS	5	f0	w	s	25	40.6	4.2	4.1	0.4	33.9	11.6

Abbreviations : HSS (high sand sheets) , MSS (moderate sand sheets) , LSS (low sand sheets), HHK (high hummocks) , MHK (moderate hummocks) , LHK (low hummocks), DSA (dry sabkhas) ,WSA (wet sabkhas), HOB (high overflow basins), MOB (moderate overflow basins), LOB (low overflow basins), HDB (high decantation basins), MDB (moderate decantation basins), MLD (moderately low decantation basins), LDB (low decantation basins), HFS (hill footslopes), MFS (mountainous footslopes). Flooding:f0 (no flooding) and f1 (flooding is closed to the surface).Texture / structure:CS(coarse sand), SL (sandy loam), LS (loamy sand), SiL (Silty loam).s (slope), f (flooding), d (drainag) w (well), p(poor), t/s (texture/structure), de (soil depth), k ($CaCO_3$),y(gypsum),CEC (cation exchange capacity),o (organic carbon),n (salinity EC dS/m) and z (ESP, Exchangeable Sodium Percentage).

TABLE 2. Land suitability classes.

Map unit	Ol	Alf	Wh	Ba	So	Ma	Be	Pe	On	To
HSS	S3	S3	N1	N1	N1	S3	N1	N1	N1	N1
MSS	S3	N1	N1	N1	N1	N1	N1	N1	N1	N1
LSS	N1	S3	N1	N1	S3	S3	N1	S3	S3	S3
HHK	S3	S3	S3	S3	N1	S3	N1	N1	N1	N1
MHK	N1	N1	N1	N1	N1	N1	N1	N1	N1	N1
LHK	S3	S3	N1	N1	N1	S3	N1	N1	N1	N1
DSA	N1	N1	N1	N1	N1	N1	N1	N1	N1	N1
WSA	N1	N1	N1	N1	N1	N1	N1	N1	N1	N1
HOB	S2	S3	N1	S3	N1	S3	N1	N1	N1	N1
MOB	S2	S2	S3	S3	S3	S2	N1	N1	S3	S3
LOB	N1	S3	N1	N1	S3	S3	S3	S2	S3	N1
HDB	S2	N1	N1	S3	N1	N1	N1	N1	N1	N1
MDB	S3	N1	N1	S3	N1	N1	N1	N1	N1	N1
MLD	S3	S3	N1	S3	S3	S3	N1	N1	N1	S3
LDB	N1	N1	N1	N1	N1	N1	N1	N1	N1	N1
HFS	N1	N1	N1	N1	N1	N1	N1	N1	N1	N1
MFS	N1	N1	N1	N1	N1	N1	N1	N1	N1	N1
SEF	N2	N2	N2	N2	N2	N2	N2	N2	N2	N2

Abbreviations : Ol (olive),Alf (alfa alfa), Wh (wheat), Ba (barley), So (Soya), Ma (maize), Be (beans), Pe (green pepper),On (onion) and To (tomatoes).

TABLE 3. Irrigation water classes of some selected springs/wells .

S/ W	pH	EC μm /cm	Soluble cations meq/l				Soluble anions meq/l			SAR	I.W.C
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Cl^{-}	CO_3^{--} & HCO_3^{-}	SO_4^{--}		
S Ze	7.8	2795	2.92	2.24	21.9	0.8	21.2	2.41	4.26	13.6	C4-S2
Za	8.3	2580	2.95	2.00	20.1	0.6	19.8	2.46	3.42	12.8	C4-S2
Zo	8.2	2254	2.39	2.40	15.5	0.6	17.1	2.26	1.62	10. 1	C4-S2
Me	7.6	9332	13.48	13.50	65.2	1.9	76.0	2.67	15.47	17.7	C4-S2
Ku	7.9	11292	18.93	22.14	69.5	2.1	100	3.01	9.65	15.3	C4-S2
w Kh	7.8	7560	11.86	14.04	47.8	1.5	62.6	2.46	10.17	13.2	C4-S2
Ag	7.9	4950	8.47	8.88	30.4	1.1	35.8	2.64	10.41	10.3	C4-S2
Si	7.8	3308	4.64	4.07	23.0	1.1	24.2	2.67	5.81	11.2	C4-S2
DDa	7.9	450	0.63	0.36	3.3	0.1	3.3	0.36	0.79	4.71	C1-S1
DKu	8.0	596	0.83	1.27	3.6	0.1	4.3	0.47	1.04	3.51	C1-S1

Abbreviations: S (Spring), Ze (Zeitun), Za (Zahra), Zo (Zomak), Me (Meshendet), Ku (Kuraishet) / W (well), Kh (Khamisa), Ag(Aghormy), Si (Siwa), Dda(DeepDakrur), Dku (Deep Kuraishet), μ m (Micromohs), I.W.C (Irrigation water classification).

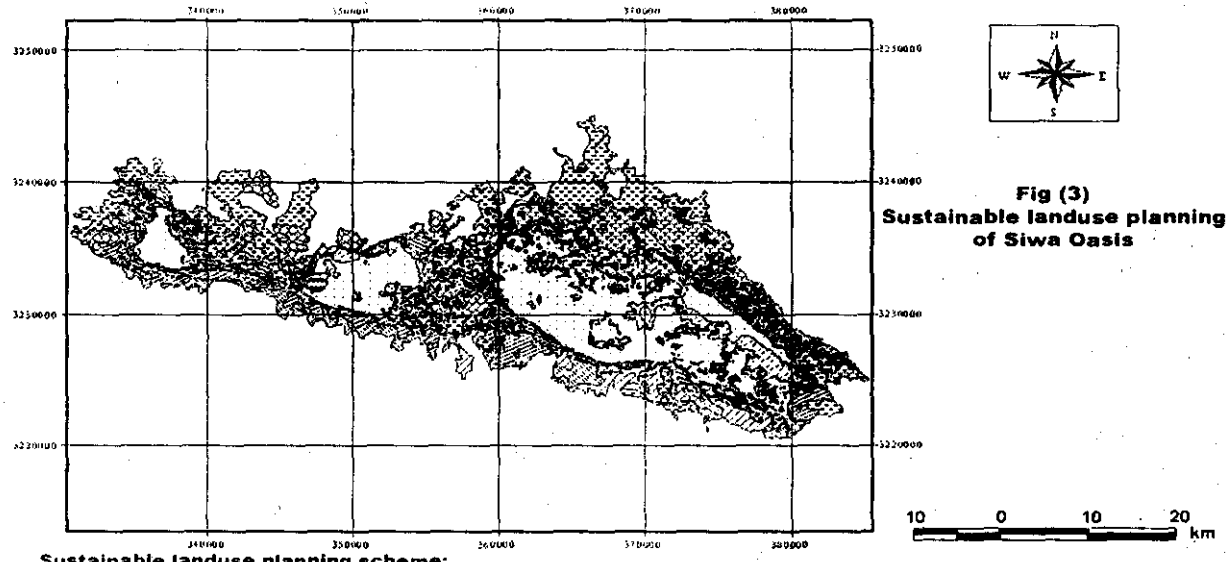

Fig (3)
Sustainable landuse planning of Siwa Oasis

Sustainable landuse planning scheme:

Agricultural use	Area km²	Agricultural use	Area km²	None Agricultural use	Area km²
Short Root Vegetables	98.514	Forests medicinal herbs forage	4.004	Fish ponds&salina	134.954
Dates,Olive,Field crops	22.395	Medicinal herbs	0.816	Housing	6.590
Wheat and Barley	4.879	Olive dates legum intercropping	7.721	Limestone quarries	21.808
Olive,Dates,Alfa Alfa	13.260	Vegetables medicinal herbs forests	26.165	Salina	33.363
Olive,Dates,Forage	6.038	Forests olive dates forage medicinal h.	8.045	Tourism attraction areas	2.369
Olive,Dates,Vegetables	17.340	Tomatoes,onion,potatoes&green peper	1.303	Tourism &safari	8.694
Dates-vegetables	8.852	Fish ponds	26.800	Village cons. raw material	75.773

Fig. 3. Sustainable land use planning of Siwa Oasis .

Productivity management

Cropping pattern must include high yielding crops such as olive, date palm and medicinal herbs beside legume inter cropping below the orchards especially alfa alfa and broad bean to enrich the humus pool of the soil . It is important also to pay attention to various horticultural and none conventional crops, especially high-salinity-resistant. Applying farmyard manure ,organic wastes, potash and nitrogenous fertilizers. Leaching, adding gypsum and constructing drainage network especially in poorly drained soils (El-Nahry, 2001).

Security management

Supply the deprived regions with the required water .Regarding high-lying land adjacent to the southern sand dunes, water definitely has to be pumped by lifting stations to provide irrigation water .Improving water quality of some springs like Quraishet spring by mixing these water with the water of deep wells using an adequate ratio.

Protection management

Establishing concrete lake walls to protect the adjacent agricultural lands whenever essential. Cultivating *Casuarinas sp., Eucalyptus* and date palm as a wind break and for biological drainage. Cropping pattern in the form of double cropping with hedgerow.

Economic management

Increasing the benefit /cost ratio through suitable choice of the cropping pattern and following the proper management practices. Increasing subsidies of conservation packages. Increasing farmer's off farm income. Establishing marketing circles near the production units to reduce the differences between farm gate price and the nearest markets. Increasing the agricultural loans and credits.

Social management

Tenure the new reclaimed soils to the long-term users. Supporting the farmers with intensive extension services. Supporting the farmers with adequate health and educational facilities .Training the farmers on soil and water conservation. Supplying the oasis with agro-input stores.

Conclusion

Although Siwa Oasis has a promising natural resources, it is still suffering from mismanagement. The key point of the study is that land use planning is something that can be realized by the land user who is making optimizing decisions about costs and benefits of his cropping system.

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التخطيط المستدام لاستخدامات اراضى واحة سيوه باستخدام وسائل الاستشعار من البعد ونظم المعلومات الجغرافية

علاء الدين حسن النهرى
الهيئة القومية للاستشعار من البعد وعلوم الفضاء – القاهرة – مصر .

تمثل واحة سيوه بمنخفض واسع يقع غرب الصحراء الغربية المصرية حيث تبعد ٣٠٠ كم عن شاطىء البحر المتوسط وتمتد الواحة طوليا من الشرق الى الغرب الى نحو ٨٢ كم بينما يتراوح عرضها من ٩ الى ٢٨ كم .

هذا وتبلغ مساحتها نحو ٢٩٥٠ كم٢ وعموما تنحصر الواحة بين الهضبة الليبية وبحر الرمال الاعظم ومن خلال الدراسة فقد تم التعرف على عشرة وحدات فيزيوجرافية أساسية وتم أيضا تقسيم أراضى الواحة الى رتبتين أساسيتين هما ١- رتبة الاراضى حديثة التكوين. ٢- رتبة الاراضى الجافة واهتمت الدراسة بالتعرف على مدى الملائمة المحصولية الحالية لانواع الاراضى المختلفة للتعرف على أهم معوقات العملية الانتاجية الزراعية وبالتالى فقد تم اقتراح خطة للتغلب على تلك المعوقات وهدفت دراسة التخطيط المستدام لاراضى واحة سيوه الى ايجاد أفضل استخدام للموارد الطبيعية المتاحة والمحدودة من خلال تطبيق عدة اهداف تم وضعها فى ثلاثة مجموعات على النحو التالى : ١- كفائة الاستخدام . ٢- القبول الاجتماعى للطرق والوسائل المستحدثة . ٣- تحقيق استدامة استخدامات الاراضى .