Prospects for improving food availability through combating desertification and restoring degraded lands and soils in the Arab Countries

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1. Introduction

Increased pressure is exerted on limited, exploitable, soil and water resources in the Arab countries. In most cases, human impact has lead to land degradation with little fruitful efforts to reverse or stop the negative trends of soil loss and associated impact on food security. Despite the efforts of UN bodies and International organizations to adapt to extreme climate events, the international community is still not able to mitigate climate change and combat desertification and sustainably mange earth resources. Protecting land resources and restoring degraded lands serve the Sustainable Development Goals (SDGs) to face recurrent drought, stabilize food and water supply to deprived population and secure normal living conditions to next generations.

According to the SDG-15: "*protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss*", the Economic and Social Commission for West Asia is supporting the international efforts to achieve by 2030 target 15.3: "*combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation neutral world*".

In accordance with the United Nations Convention to Combat Desertification (UNCCD) decision 8/COP 11[1], and consistent with the text of the Convention, the Intergovernmental Working Group (IWG) produced a science-based definition of land degradation neutrality (LDN) and submitted to the consideration of parties on COP 12. The definition states: "*Land Degradation Neutrality, in arid, semi-arid and dry sub-humid areas, is a state whereby the amount and quality of land resources, necessary to support ecosystem functions and services and enhance food security, remains stable or increases within specified temporal and spatial scales and ecosystems*". Through adequate land management practices, LDN contributes to maintaining or improving ecosystem services for the social, economic, and environmental benefit of current and future generations. LDN occurs as the result of a combination of measures that avoid or reduce the rate of land degradation and increase the rate of recovery.

Appropriate options to achieve LDN vary depending on: (i) the drivers, types, degree and extent of land degradation; (ii) the underlying potential and resilience of land resources; and (iii) local conditions, priorities and capacities (SWSR, 2016). Based on the need to develop actions and strategies to achieve LDN, and the importance of integrating LDN into national and regional strategies, defining the spatial scales and functional units of LDN implementation and assessing the type and extent of land degradation to establish the baselines is crucial. In agreement with target 15.3, the objectives of this chapter are to: evaluate the potential production of available soil resources in the Arab countries, analyze current state of land degradation and identify the impact of soil and nutriment loss from prime lands, caused by chaotic urban expansion and erosion, on food security. The work will derive indicators and suggest response proactive measures to achieve land degradation

[1] http://www.unccd.int/Lists/OfficialDocuments/cop11/23add1eng.pdf

neutrality and improve food availability. The suggested plan of action will identify the drivers of land degradation and means to alleviate their impact. It will identify and review land management practices based on the assessments, diagnosis and persistence of the drivers of land degradation in the Arab countries. In this regard, the implementation plan needs to develop and use appropriate monitoring and evaluation systems for assessing progress towards LDN and its benefits and establish policy and national governance structures that benefit from legal instruments, institutional and technical capacities, incentive mechanisms, and facilitate partnerships.

2. Methodology and assumptions

One of the direct consequences of soil erosion is the loss of the most productive superficial layer, which is usually, enriched with nitrogen and other essential nutrients like phosphorous and potassium. Even for a tolerable level of soil erosion, estimated at 1.4 ton ha^{-1} y^{-1}, the actual soil erosion rates for tilled, arable land in Europe are, on average, 3 to 40 times greater than this limit (Verheijen et al., 2009). Typically, eroded soil contains about three times more nutrients per unit weight than are left in the remaining soil. A ton of fertile topsoil contains, on average, 1 to 6 kg of nitrogen, 1 to 3 kg of phosphorus, and 2 to 30 kg of potassium, compared to an average nitrogen content of only 0.1 to 0.5 kg per ton for the exposed soil of eroded land (Schertz et al., 1989; Langdale et al., 1992)

Beside direct climate change impacts (floods and drought recurrence), financial, technical and socio-economic constraints, the prevailing weak policies and ineffective measures to protect the soil, are the main indirect causes of land degradation by erosion and urban sprawl, thus reducing the food production capacity in the Arab countries. To assess the impact of erosion and urban expansion on soil and nutrient loss, modeling of the factors affecting food security will be based on the digital soil map of world (FAO, 2007), representing numerical information on soil physico-chemical properties and nutrient content predetermining soil productivity. While soil losses caused by water erosion is estimated by the Universal Soil Loss Equation (USLE)[2], losses of productive soils by chaotic urban expansion is measured using urban layers between 1990 and 2015, created by the Joint Research centre (JRC) using remote sensing. Lost opportunities to support food production are assessed in relation to actual soil loss by urban expansion and potential soil loss by erosion. A conversion of lost nutrients (Nitrogen) into potential food and food calorie equivalency is adopted s to establish a nexus between soil loss, nutrient loss, potential crop production and Arab region. Furthermore, food consumption, in terms of calories, is used to estimate the number of people that could have benefited from the cultivation of food crops on the lost soil cover.

To produce a soil water erosion risk map, using data and information on slope, soil depth, soil texture, and soil organic matter content from the Digital Soil map of the World (DSMW), a model was developed using the following equation (Boukheir et al., 2006):

Soil erosion risk = [slope rate*slope weight]*[soil depth rate*soil depth weight]*[texture rate*texture weight]*[Organic Matter rate*Organic Matter weight], where;
slope weight = 30%, soil depth weight = 25%, texture weight = 20%, and Organic Matter weight = 25%.

[2]https://www.fig.net/resources/proceedings/fig_proceedings/fig2012/papers/ts05e/TS05E_tombus_yuksel_et_al_5848.pdf

The model results show five classes of erosion risk produced in GIS environment using Arcmap 10.1; these are: Very high, high, medium, low and very low.

Two scenarios, critical and favorable, were considered for the rates of soil water erosion in this study. In the critical scenario, the estimated rates of soil water erosion are equivalent to the amount of 5 tons/ha/y, 10 tons/ha/y, 20 ton/ha/y, 30 ton/ha/y and 40 ton/ha/y for the very low, low, moderate, high and very high erosion risk respectively. For the favorable scenario with applied anti erosion measures, 50% of these values were adopted.

To assess soil and nutrient loss by erosion and urban expansion on prime lands, the land capability map of the Arab countries was produced based on the model proposed by USDA[3]. Land capability classification considers the soil geomorphological features (geology and topography), soil parameters like soil depth, texture, organic matter (OM) content, salinity and sodicity hazards. Accordingly, soils of the Arab world were therefore classified into four arable and one non arable soil classes:

A) Class I -highly productive- soil has no limitation with regards the following characteristics: 1) highly productive with soil depth deeper than 100 cm; 2) OM content higher than 2%; 3) medium texture of clay loam, loam and sandy clay loam allowing good field water capacity above 30% V/V and good porosity and aeration; and 4) salinity below 1 $dS.m^{-1}$).

B) Class II -medium productive- soil representing one significant or two moderate soil limiting factors like depth (50-100 cm) or texture (clay, sandy clay and silty clay) and drainage.

C) Class III -low productive- soil representing two significant soil limiting factors like depth (25-50 cm) or three other moderate factors including texture and drainage.

D) Class IV -very low productive- soil representing shallow soils (10-25 cm) with increased hazards of erosion with severe constraints caused by salinity and sodicity.

E) Class V -non-arable- soil representing very shallow, rocky and stony discontinuous soils and lands suitable for natural recharge, wild vegetation and recreation.

Irreversible soil loss by urban expansion on prime lands was assessed for the period 1990-2015, using the space based EU Global Human Settlement information. Raster images downloaded from JRC [4], were used to estimate urban expansion between 1990 and 2015 in the Arab region. JRC Open Data repository data packages contain an assessment of the REGIOOECD “degree of urbanization” model used as input of the population grid cells in 2015 and 1990. Each grid has been generated by integration of built-up areas produced from Landsat image, population data derived from the Center for International Earth Science Information Network, and Gridded Population of the World (CIESIN GPW v4). Raster images of the years 1990 and 2015 were processed using ArcGIS (ESRI). Treated images were converted to vector data that contain attribute data about urban area for further comparison and estimation of urban expansion in the Arab countries. Nitrogen (N) loss from

[3] http://www.envirothon.org/pdf/2012/2012ce_soils_resources/KP4.3land_capability_classification%5B1%5D.pdf
[4] http://ghsl.jrc.ec.europa.eu/ghs_smod.php

the topsoil and subsoil of the Arab countries by urban expansion was quantified in relation to N content in the relevant soil type and extend of built up areas.

For the evaluation of the potential equivalent food calorie loss in the Arab countries by soil erosion and urban expansion, N loss by soil water erosion of prime soils, assumed to be suitable for wheat (and other food crops like pulses or cereals) cultivation was quantified under favorable and critical scenarios. Similar approach was followed for the estimation of soil and N losses under built up areas on highly productive soils. In both cases, the potential wheat equivalent production loss for the conversion into food calorie loss was considered. It is common to convert different commodities and cultivated food crops to wheat equivalency using energy conversion factor to quantify the calorie equivalence of agricultural production and consumption[5]. Thus, for estimating food loss by soil erosion, we considered only the soil showing low and very low erosion rates which are spread on level plains and plateau and usually suitable for large scale field cropping system. For soil-nutrient-food-calorie loss by urban expansion we also considered only the two most productive soil categories.

3. Land and soil classification in the Arab region

The most abundant soil units (or types, orders, classes) in the Arab region are Cambisols[6] (Inceptisols)[7], Fluvisols, Regosols and Arenosols (Entisols), Luvisols (Alfisols), Calcisols, Solonchaks, Solonetz, (Aridisols), Andosols (Andisols), Vertisols (vertisols), Leptosols and Anthrosols.

3.1. Factors limiting soil productivity

As the first element of agricultural production, soil depth depends often on exposure to the type and severity of erosion (USDA, 2007). Water and wind erosion result in the removal of surface, most fertile soil layer that leads to the development of truncated shallow soils. The soil natural capability to produce high yields or the soil potential productivity is affected by the limited soil depth which plays a major role in the provision of available nutrient and water to growing crops and forage plants. The second soil limiting factor affecting soil productivity is the calcium carbonate content which affects basic pH values and restricts the availability of nutrients. The third soil limiting factor is the extreme, sandy or very fine, soil texture. Sandy texture has a very low water holding capacity and cation exchange capacity. Very fine texture can negatively affect soil porosity, hinder water infiltration and restrict soil aeration.

Organic matter in the soil is one of the major soil characteristics which improves soil structure and aggregate stability, promotes air and water flow, and reduces water and wind erosion, thus contributes to the soil exchange capacity plant nutrition and soil stability. Soil salinity and sodicity inhibit the growth and development of most crops, except halophytes which can tolerate salts. Salinity effects differ depending on climate, soil water content, salt composition, kind of plant and the plant's stage of development.

3.2. Soil capability map for the Arab countries

The produced map revealed the quasi absence of high productive soils and limited occurrence of medium productive soils in the Arab countries (Figure 1). It is important to mention that the proportion of highly productive soils in the Arab countries from the total land area is very

[5] http://www.fao.org/docrep/006/y5022e/y5022e04.htm
[6] World Reference Base for Soil Resources http://www.fao.org/3/a-i3794e.pdf
[7] USDA Soil Taxonomy https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_010785.pdf

limited and restricted in decreasing order to Sudan[8] (17.2%), Palestine and Lebanon (9.4% and 10.1%, respectively), Syria (5.1%), Somalia (3.7%) and Iraq (1.6%).

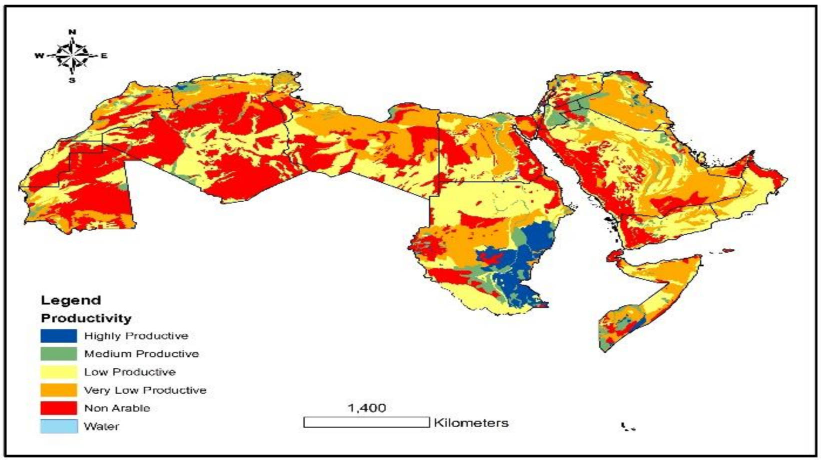

Figure 1. Land capability map of the Arab countries produced using the USDA model and soil information of the DSMW (data source: Land and Water Development Division, FAO, Rome, 2007 (http://www.fao.org/geonetwork/srv/en/metadata.show?id=14116).

The largest proportion of highly and medium productive soils is observed in eight Arab countries (Sudan, Syria, Algeria, Somalia, Iraq, Lebanon, Jordan and Palestine), with total areas of highly and medium productive soils varying in decreasing order between 48.8 and 3.1, 12.8, 8.9, 6.2, 0.14, 5.4 and 0.005 mill. ha, respectively. The area under highly and medium productive soils constitute around 8.4% of the total land area of the Arab countries, equivalent to 108.2 mill. ha. Given the high production potential of these soils, they need to be given priority in water allocation and investment for irrigation schemes. Although the useful agricultural area in these countries is much larger and can reach 516.9 mill. ha, water scarcity and erratic rainfall patters, low fertilizer use, coupled with low investment level and the prevailing conflicts in some countries of the Arab region challenges the useful utilization of much of this land.

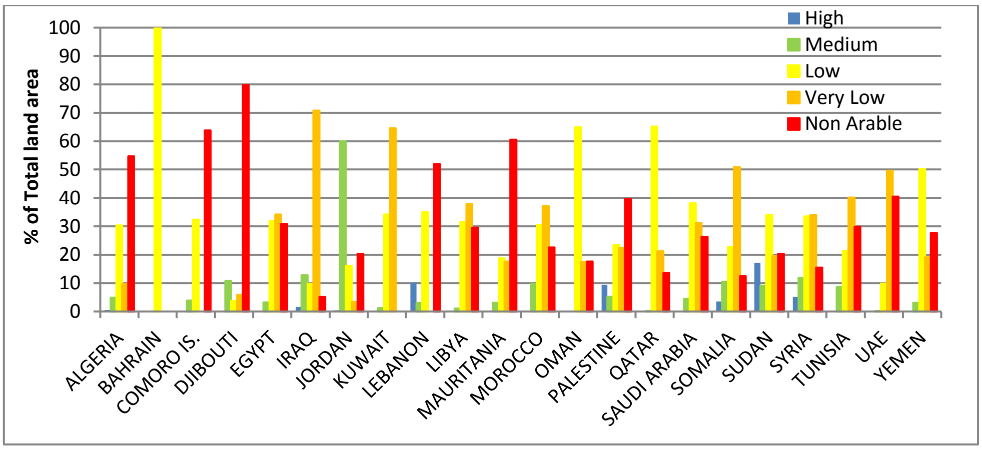

Figure 2. Proportion of land capability classes in the Arab countries (Calculated from the adapted USDA model applied to soil information using the Digital Soil Map of the World (data source: Land and Water Development Division, FAO, Rome, 2007 http://www.fao.org/geonetwork/srv/en/metadata.show?id=14116).).

[8] Due to lack of disaggregated data, presented data is for Sudan prior to the secession of South Sudan..

The remaining 14 Arab countries contain large areas of medium productive arable soils and other soils belonging to lower capability classes. The medium productive soils can be also successfully cultivated to produce food and feed crops. Morocco represents 3.7 mil. ha, while Saudi Arabia possess 7.4 mil. ha, Egypt 2.85 mil. ha, Libya 1.55 mil. ha, Yemen 1.1 mil. ha, Mauritania 0.3 mil. ha and Djibouti 0.2 mil. ha. The Gulf countries together are endowed with less than 0.1 mil ha of medium productive soils. The total area of available productive soils in the Arab countries is estimated at 98.1 mil ha.

The population of the Arab region nearly tripled between 1970 and 2010, climbing from 128 mill. to 359 mill. with additional pressure on limited soil and water resources and thus direct implications on land use change and food security. Currently the percentage of urban population in the Arab countries varies between 28% and 96% but it is expected to continue increasing to between 50% and 99% (Mirkin, 2010). Human pressure and increased food demands lead to large and intensive agricultural production systems. Often mismanaged irrigation practices to increase food availability caused a drop of groundwater levels by intensive pumping, which also resulted in seawater intrusion into coastal aquifers and lead to secondary salinization of the soil-groundwater system (El Moujabber et al., 2006).

Globally, financial losses resulting from salinization of irrigated land are rising to around US$ 250/ha, constituting about US$ 11 billion in total losses (FAO, 2006). There is no recent assessment of the socio economic implications of salt affected soils in the Arab countries. However, the development in biosaline agriculture and the use of salinity tolerant genotypes by the International Center for Biosaline Agriculture (ICBA) shows perspectives for the economic utilization of saline soils in the cultivation of strategic food and feed crops, like sorgho, millet, quinoa, salicornia, sesbania and others (ICBA, 2014). ICBA has identified and developed four high-yielding salt- and heat-tolerant quinoa lines that are being tested in other agro-ecological zones. ICBA is leading a global initiative to make quinoa a crop of choice for marginal environments. This effort has been running in the UAE, Yemen, Egypt, Jordan, Oman, Uzbekistan, Tajikistan, and Kyrgyzstan. FAO has also been at the forefront of quinoa research in the MENA region, where it has initiated a regional project of technical assistance for the introduction of quinoa and institutionalization of its production in Algeria, Egypt, Iran, Iraq, Lebanon, Mauritania, Sudan, and Yemen.

Globally, when land degradation is at a moderate severity level, the amount of income foregone on irrigated, rainfed, and rangeland represents, approximately, a 40% loss in productivity. For irrigated land, this economic loss represents $250 (U.S.) per hectare per year. Income reduction drops to $38 on rainfed cropland and $7 on rangeland (Dregne and Chou, 1992)[9]. Worldwide, productivity reduction by land degradation was equivalent to $11 billion for irrigated land, $8 billion for rainfed cropland, and $23 billion for rangeland. According to these reference sources, rehabilitation of degraded irrigated lands requires three to five years to recover to their previous state after an acceptable drainage system has been installed, and perhaps between 5 and 10 years to improve eroded rainfed cropland, and as much as 50 years to bring rangeland in the drier areas to a good range condition.

Agricultural activities were reported to be the second most common cause of land degradation in Egypt, Iraq, Syria and UAE. Wind erosion was recognized as the first,

[9] http://css.escwa.org.lb/sdpd/30-10_1-11/B3.pdf

dominant and common types of land degradation in 75% of ESCWA countries, located in the arid and semi-arid belt, while water erosion was the most important factor in Lebanon, Syria, Yemen, Jordan and Iraq. Soil salinity is the main type of chemical land degradation in Egypt, Iraq, Syria and UAE.

3.3. Impacts of erosion and urban expansion on land

Erosion, urban encroachment on agricultural land, salinization and nutrient imbalance are frequently cited among the primary causes of soil degradation (Montanarella et al., 2016). These factors will be examined in more details below.

3.3.1. Water Erosion

The abundance of shallow soils in the cultivated areas shows the effect of historic and recent soil erosion. Results based on the soil water erosion risk, considering four major soil geomorphological and physico-chemical parameters (slope, depth, texture and organic matter content) reveals an alarming picture of the high vulnerability of the soils in the Arab countries to water erosion (Figure 3).

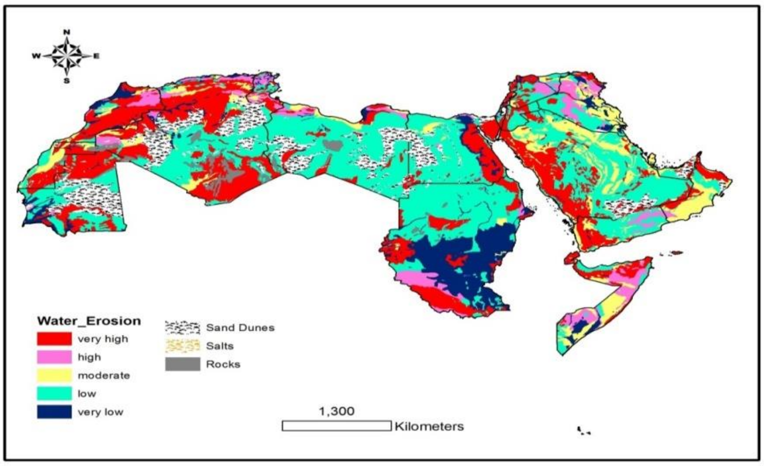

Figure 3. Water erosion risk in the Arab Countries based on the USLE soil erosion model using soil data from the DSMW (Data source: Land and Water Development Division, FAO, Rome 2007 (http://www.fao.org/geonetwork/srv/en/metadata.show?id=14116).).

Figure 3 shows very high vulnerability to water erosion in Comoros Island, Djibouti and Lebanon, with more than 75% of land classified as very high risk. Countries revealing significant risk of soil water erosion are Algeria, Jordan, Morocco, and Palestine, with average erosion risk varying between 25% and 45% of the land in these countries. The remaining Arab countries show low risk of water soil erosion.

There is no complete regional or national quantification of water erosion risk to measure actual soil erosion occurring under different geomorphological and climatic setting in combination with various land cover and land use management systems. Published data point to partial temporal and spatial studies on potential soil water erosion risks based on different methodologies including USLE using remote sensing and GIS.

The accurate estimation of soil erosion from different soil types is complex and requires time, skills and infrastructure. The traditional method for measuring water erosion rates depends on data availability of soil type, slope, rainfall intensity, land cover and applied conservation measures. Using field plots or rainfall intensity simulators, this method can be successfully imitated using the USLE models and large scale soil maps produced in the Arab countries.

3.3.2. Wind erosion

The Arab countries are also highly vulnerable to wind erosion caused by several factors like, the abundance of sandy and weakly aggregated soils, the rarity of vegetation cover, disturbance of surface layer and land use change. Assessment of potential wind erosion risk in the Arab countries, based on soil type and other available information shows prevalence of areas with high and medium risk of wind erosion (Figure 4). The output map of wind erosion risk shows Algeria, the Comoros, Djibouti and Mauritania to have very high risk of wind erosion exceeding 60% of the national territory. Somalia, Syria, Tunisia, UAE, West Sahara and Yemen follow with a risk varying between 40% and 50% of the national territory.

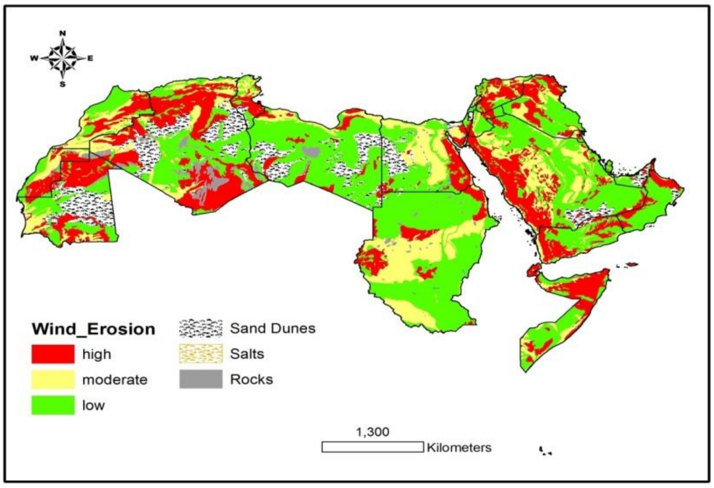

Figure 4. Estimated wind erosion risk map of the Arab countries, based on soil information adapted from the DSMW (data source: Land and Water Development Division, FAO, Rome, 2007 (http://www.fao.org/geonetwork/srv/en/metadata.show?id=14116).

3.3.3. Urban expansion on Arable lands

The assessment of urban spatial distribution using Landsat images in 1990 and 2015 reveals a general increase of the area of human settlements. Changes in urban area coverage shows an increase in 0.4 % of the total land area, a decrease in 0.04 % and no change in 99.56 % of the total area of the Arab countries. The increase as expected occurred mainly on the coastal area and river banks.

The main increase of urban expansion for the last twenty five years is observed on highly and moderately productive soils (Figure 5). It occurred in Jordan (91.5%), Sudan (76.8%), Iraq (54%), Algeria (41%), Egypt (36%), Syria (25.2%), 17% (Libya), and Morocco (13%) No urban expansion in Palestine occurred on highly productive soils compared to average values ranging between 9% (Algeria), 8% (Somalia), 4% (Lebanon, Syria and Iraq) and 1.3% (Yemen).

A decrease of urban density was observed in the newly reclaimed agriculture areas of Egypt mainly along the Cairo-Alexandria desert road. The dense urban concentration observed in the nineties was diluted by 2015 with the expanding agricultural land use resulting in decreased urban agglomeration. Measuring the amount of N loss from the topsoil and subsoil of the Arab countries resulting by urban expansion, causing permanent soil sealing and irreversible loss of essential nutrient, shows a total permanent loss of 19.8 mill. tons of nitrogen (Table 1).

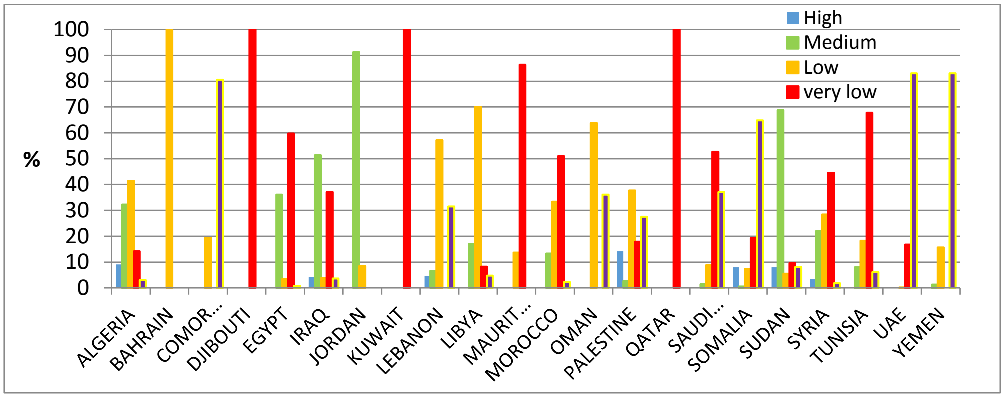

Figure 5. Proportion of urban sprawl on productive lands calculated from the model based on soil information adapted from the DSMW (data source: Land and Water Development Division, FAO, Rome, 2007 (http://www.fao.org/geonetwork/srv/en/metadata.show?id=14116).

The highest values of N loss are observed in Egypt (8.3 mill. tons), Iraq (2.6 Mill. tons), Saudi Arabia (2.0 mill. tons), Syria (1.3 mill. tons) and Algeria (1.0 mill. tons). The lowest N loss is detected in Djibouti, Comoros, Gaza (Palestine), Mauritania and Tunisia. Other Arab countries show total N loss by urban expansion in the range of 176-712 Thousands tons. This loss has indirect negative economic consequences on food security in the region.

Table 1. Total N loss (*10^3 tons) from soil sealed by urban expansion

Country	Land capability				TOTAL
	High	Medium	Low	Very Low	
ALGERIA	1.6	67.4	774.9	157.9	1,001.7
BAHRAIN	0.0	0.0	377.6	0.0	377.6
COMORO IS.	0.0	0.0	5.2	0.0	5.2
DJIBOUTI	0.0	0.0	0.0	3.5	3.5
EGYPT	0.0	0.0	225.7	8,069.7	8,295.4
GHAZA	0.0	0.0	0.0	7.9	7.9
IRAQ	1.7	219.2	17.3	2,358.9	2,597.2
JORDAN	0.0	514.1	18.4	0.0	532.4
KUWAIT	0.0	0.0	0.0	712.1	712.1
LEBANON	2.2	1.2	173.2	0.0	176.6
LIBYA	0.0	1.9	344.0	91.2	437.1
MAURITANIA	0.0	0.0	4.6	51.4	56.1
MOROCCO	0.0	1.2	140.5	487.0	628.7
OMAN	0.0	0.0	147.1	0.0	147.1
QATAR	0.0	0.0	0.0	156.9	156.9
SAUDI ARABIA	0.0	2.6	199.6	1,821.9	2,024.1
SOMALIA	2.3	0.6	25.7	279.9	308.5
SUDAN	24.0	141.9	60.6	115.6	342.1
SYRIA	29.6	59.5	310.1	928.1	1,327.3
TUNISIA	0.0	8.2	66.4	0.0	74.6
UNITED ARAB EMIRATES	0.0	0.0	0.3	213.1	213.4
YEMEN	0.0	1.3	341.9	0.0	343.1
Total	61.5	1,019.0	3,233.2	15,455.1	19,768.7

4. Economic impact of soil and land degradation in the Arab countries.

Soils in the Arab region and whole world are under threat (Montanarella et al., 2016). Starting from 2004, Lebanon, Syria, Jordan, Egypt Tunisia, Algeria and Morocco launched new studies to estimate the cost of environmental degradation using environmental damage cost assessments for priority setting, and to integrate environmental issues into economic and social development (Sarraf et al., 2004). A loss of more than 415 mill. US $/year was attributed to the degradation of natural resources and wildlife in Lebanon and Tunisia only. With more than 14 mill. ha of lands affected by medium and high erosion in Europe, using conservative estimates of wheat yields of 3 tons per hectare and a market price of EUR 300 per ton of wheat, agricultural production in the European Union of EUR 12.633 billion could be under threat (Gardi et al., 2015). Recent estimates on the economic cost of land degradation in the Arab countries are needed to attract the attention of stakeholders and policy makers.

4.1. The hypothetical impacts/lost opportunities of the loss of N and other nutrients resulting from erosion and urban expansion

4.1.1. Nitrogen loss by potential soil water erosion

Modeling of soil erosion and nitrogen loss from cultivated soils was done to assess the potential loss of opportunities related to food production. In the Arab countries, a total of 12.849,356 Km^2 is subject to different degree of soil water erosion. Under the worst scenario, the annual soil loss by water erosion accounts for 25 billion tons with Algeria and Saudi Arabia on top (5.3 and 4.22 billion tons respectively). Somalia, Mauritania, Libya and Sudan can lose between 1.5 and 2.7 billion tons of soil annually (Table 2). The lowest annual soil loss by water erosion is detected in Bahrain (below I mill. tons), followed in increasing order by Comoros, Qatar, Kuwait and Lebanon.

Results showed a potential annual N loss in the Arab countries of 16.5 mill. tons in the best scenario with reduced rates of soil water erosion (Table 3) and 32.9 mill. tons in the worst scenario of soil erosion rates. More than 55% of N loss by erosion is caused by very high erosion rate. The significant contribution of the soils with low erosion rate to N loss (23%), can be explained by their relatively high proportion (24.9%) and higher content of nutrients caused by the application of fertilizers. As expected, the lowest N loss rate is observed in very low erosion rates (5.5% of total N loss). Under best scenario, Algeria, Saudi Arabia, Sudan, Egypt, Libya and Mauritania are the Arab countries with the highest annual loss of total nitrogen with eroded soil material ranging between 3.5 mill. tons and 1.2 mill. tons respectively. For the worse scenario, these losses are doubled.

The average rate of N and organic carbon (OC) loss in the Arab countries was counted separately for each soil type and rate of erosion. Estimations based on the adopted model revealed the highest N loss rate in Lebanon, Morocco, Comoros, Oman, Sudan and Tunisia (between 28 and 33 kg/ha/y). The average estimated loss of N and OC in the Arab countries is 21 kg/ha/y and 108 kg/ha/y respectively. Bahrain and Kuwait represents the lowest total annual OC loss from the soil (5,761 tons, and 81,938 tons respectively).

For an average rate of soil erosion in Lebanon under worst scenario equivalent to 21 ton/ha/y, the total N and OC loss from arable lands is estimated at 53,856 tons and 297,502 tons respectively. For other average values suggested for the Arab countries, the worst scenario of intensive soil water erosion can cause a total annual loss of N and OC in the range of 33 and

158.4 mill. tons respectively. Nearly 25% of total N losses are estimated from prime agricultural lands. In this regard, more than 13 Arab countries are positioned above the regional annual average N loss against 9 countries with annual OC loss exceeding the annual average of the Arab world.

Table 2. Estimated soil degradation and nutrient loss by potential soil water erosion under worst scenario in the Arab countries

Country	Area Affected *1000 Km^2	Total soil loss *1000 tons	soil loss from productive soils, *1000 tons	Average N Loss Kg/ha/y	Total N loss from arable lands, tons	Average OC loss Kg/ha/y	Total OC loss from arable lands, *1000 tons
ALGERIA	2,106.4	5,320,873.9	845,161.7	28	6,866.7	108	34,819.2
BAHRAIN	0.8	758.0	758.0	6	2.1	76	5.8
COMORO IS.	2.2	7,514.7	61.2	30	16.8	258	162.5
DJIBOUTI	23.2	85,713.0	463.9	21	93.4	120	681.6
EGYPT	1,002.0	1,619,946.6	631,670.0	23	2,602.9	130	12,662.5
IRAQ	435.2	838,749.4	57,340.3	18	579.3	119	3,961.6
JORDAN	89.3	180,894.1	8,452.4	15	181.2	119	1,235.2
KUWAIT	17.8	23,208.8	915.9	5	16.2	25	81.9
LEBANON	10.5	34,993.9	1,276,599.2	34	53.9	152	297.5
LIBYA	1,759.5	2,258,883.7	504,653.6	20	2,356.7	119	11,262.7
MAURITANIA	1,025.5	1,819,635.2	84,809.9	22	2,277.1	107	13,518.8
MOROCCO	446.6	1,174,706.2	56,487.1	31	1,765.1	128	7,745.4
OMAN	309.5	724,336.0	10,500.7	30	889.2	124	3,997.1
QATAR	11.6	24,938.4	1,385.8	17	24.6	91	133.9
SAUDI ARABIA	2,149.7	4,220,986.6	1,089,205.0	28	5,956.2	99	22,881.4
SOMALIA	637.7	1,511,580.3	129,000.5	25	1,805.5	115	7,952.1
SUDAN	1,861.5	2,767,573.0	1,084,651.9	30	4,656.0	197	25,626.1
SYRIA	185.2	417,699.4	77,238.9	20	446.5	112	2,367.7
TUNISIA	163.6	377,267.2	49,490.2	29	547.0	115	2,065.6
UAE	83.6	121,447.8	41,624.7	20	154.9	63	451.6
YEMEN	528.0	1,176,370.4	230,910.6	23	1,513.8	98	6,470.5
Total/average	12,849.4	24,708,076.5	6,181,381.5	21	32,805.1	108	158,380.7

Under semi-arid Mediterranean conditions, the average yield of hard wheat is 3,460 kg /ha with a straw yield average of 5.65 tons/ha against an average N application equivalent of 50 kg/ha (Giorgio and Montemurro, 2006). The average N uptake by wheat is 16 kg/ha and 6.5 kg/ha to produce one ton of grain and one ton of straw respectively. Considering N harvest index equivalent to (16/50=0.32), (Rahimizadeh et al., 2010), i.e. only 32% of the applied N as fertilizer is used by the crop for grain production, the rest is being removed with straw, fixed in the soil or leached to groundwater, the equivalent potential wheat production loss under best scenario of soil water erosion is 69.7 mill. tons (Table 3). This value is doubled to reach 139.4 mill. tons under worse conditions favoring intensive soil erosion.

Table 3. Potential annual economic and food calorie loss in the Arab countries by erosion from arable lands under best scenario conditions

Country	N Loss $*10^3$ tons	Ammonium sulfate equivalent $*10^3$ tons	Economic loss, 1000 US $	equivalent wheat production $*10^3$ tons	Food energy value loss, $x10^6$ Kcal	Enough to feed people for one year, $x10^6$
ALGERIA	436.8	2,031.8	568,899.5	6,501.7	21,585,674	25
BAHRAIN	1.1	4.9	1,382.0	15.8	52,438	0
COMORO IS.	0.1	0.4	111.6	1.3	4,233	0
DJIBOUTI	0.6	3.0	845.8	9.7	32,093	0
EGYPT	634.0	2,948.8	825,666.8	9,436.2	31,328,159	36
GHAZA	0.0	0.0	0.0	0.0	0	0
IRAQ	50.1	233.1	65,277.9	746.0	2,476,829	3
JORDAN	28.7	133.3	37,337.9	426.7	1,416,705	2
KUWAIT	4.2	19.7	5,503.9	62.9	208,834	0
LEBANON	0.5	2.1	596.4	6.8	22,629	0
LIBYA	638.3	2,968.8	831,273.9	9,500.3	31,540,907	36
MAURITANIA	288.8	1,343.2	376,083.9	4,298.1	14,269,699	16
MOROCCO	76.3	355.0	99,405.1	1,136.1	3,771,713	4
OMAN	45.9	213.6	59,812.5	683.6	2,269,458	3
QATAR	1.2	5.8	1,624.3	18.6	61,631	0
SAUDI ARABIA	951.9	4,427.6	1,239,736.1	14,168.4	47,039,129	54
SOMALIA	100.9	469.5	131,468.3	1,502.5	4,988,284	6
SUDAN	1,084.1	5,042.3	1,411,855.5	16,135.5	53,569,830	62
SYRIA	67.2	312.8	87,572.6	1,000.8	3,322,756	4
TUNISIA	42.1	195.8	54,814.4	626.5	2,079,813	2
UAE	24.1	111.9	31,334.3	358.1	1,188,914	1
YEMEN	205.6	956.1	267,697.3	3,059.4	10,157,201	12
Total	4,682.6	21,779.6	6,098,300.1	69,694.9	231,386,929	266

Given the food energy value for wheat grain equivalent to 3,320 Kcal/kg[10], the potential loss of calories/nutrient under worst scenario of soil water erosion, converted from 139.4 mill. tons of wheat commodity, is 462, $*10^{12}$ Kcal. Based on the food calorie intake in the NENA region, equivalent to 2380 Kcal/day[11], this estimated loss of food calorie commodity is sufficient to feed 532 mill. people for one year. In the best scenario estimates, assuming less rainfall intensity and more anti-erosion measures, potentially leading to 50% decrease in soil water erosion risk, N loss can be reduced to 4,7 mill. tons, capable under optimal other soil and weather conditions of producing 69,7 mill. tons of wheat. The food calorie loss can be potentially enough to feed 266 mill. people for whole year.

The best estimates of potential total economic loss of soil degradation by erosion in the Arab countries resulting from the possible N loss and the single cost of equivalent ammonium sulfate fertilizers, sold on the market for 280 US$ per ton, is 6.1 billion US$ (Table 4). The economic loss and environmental cost to soil functions is much higher if other nutrients and elements like carbon lost by soil erosion are counted.

[10] http://www.fao.org/docrep/005/y9422e/y9422e04.htm
[11] http://www.fao.org/docrep/x0262e/x0262e25.htm#TopOfPage

4.1.2. Nitrogen loss by chaotic urban expansion on productive soils

Urban expansion in the Arab countries between 1990 and 2015 resulted in significant loss of productive lands and land degradation. Jordan, Iraq, Egypt, Sudan, Algeria and Syria showed the highest loss of prime soils under land sealing. No loss of prime lands was detected in Bahrain, Comoros, Djibouti, Kuwait, Mauritania, Oman, Qatar and UAE. The calculated total economic and environmental loss considering one single element like nitrogen, by urban expansion in the Arab countries, revealed a total loss of 1.232 mill. tons of N from built up prime lands during the last twenty five years (Table 4). This irreversible loss is equivalent to 5.7 mill. tons of ammonium sulfate fertilizers containing 21% N. The relevant total equivalent monetary loss in the Arab countries by urban expansion on productive lands is estimated at 1.6 billion US$.

Following the same approach used for the assessment of potential food calorie loss in the estimated soil water erosion risk, the total N loss by urban expansion on productive soils between 1990 and 2015, measured using remote sensing to detect lost lands, revealed that the permanently lost N (in combination with other optimal soil and climatic factors) could have produced 18 mill. tons of wheat, sufficient to feed a number of people equivalent to 70 mill. people for one year.

5. Assessment of the potential to restore land and soil degradation

5.1. Analysis of the technical measures to conserve agricultural soils and their productivity

Assessing the actual status of soil degradation in intensively cropped and populated Mediterranean regions provides the necessary information to evaluate soil quality deterioration as a result of non-sustainable practices. Good agricultural practices can overcome the soil limiting factors restricting crop yield and food production. With the introduction of modern localized irrigation and fertilization techniques, the implementation of fertigation became a promising practice for irrigated crops. This concept of efficient fertilizer and water use implies updating the traditional land capability systems to meet the progress achieved in soil management, plant nutrition and irrigation.

Equally, sandy soils usually classified into lowest productivity group can be cultivated to generate income if adequately cropped and properly irrigated. This also means more reliance on nutrient input, comparable to soilless culture that could change the concept of the earlier adopted land capability classification.

Low water holding capacity can be improved by organic matter, compost or polymer addition and localized irrigation. These soil amendments can also help overcome the negative effect of water shortages and drought.

High pH values can be treated by diluted acid addition to the irrigation water in modern pressurized irrigation systems. In less intensive agricultural practices, the use of acid forming fertilizers, which deliver acid H^+ ions upon dissociation, can temporary lower the pH value of the soil solution and improve the mobility and availability of macro and micro nutrients even on calcareous soils.

Salinity problems can be overcome by positive water balance with improved drainage to leach and evacuate the salts. A good irrigation scheduling is necessary to prevent secondary soil salinization. In case of water shortage, the development of biosaline agriculture through the cultivation of salt tolerant food and feed crops on saline sandy soils can be a good practice.

Table 4. Estimated economic and food calorie loss from prime lands sealed by urban expansion between 1990 and 2015

Country	N Loss $*10^3$ tons	Ammonium sulfate equivalent $*10^3$ tons	Economic loss, 1000 US $	equivalent wheat production $*10^3$ tons	Food energy value loss, 10^6 Kcal	Enough to feed people, mill.
ALGERIA	68.9	320.6	89,764.6	1,025.9	3,405,925.5	3,921
BAHRAIN	0.0	0.0	0.0	0.0	0.0	0
COMORO IS.	0.0	0.0	0.0	0.0	0.0	0
DJIBOUTI	0.0	0.0	0.0	0.0	0.0	0
EGYPT	167.9	780.7	218,607.3	2,498.4	8,294,583.7	9,548
IRAQ	220.9	1,027.5	287,705.7	3,288.1	10,916,375.6	12,566
JORDAN	514.1	2,391.0	669,473.2	7,651.1	25,401,724.1	29,241
KUWAIT	0.0	0.0	0.0	0.0	0.0	0
LEBANON	3.4	15.7	4,406.9	50.4	167,210.4	192
LIBYA	1.9	9.1	2,538.6	29.0	96,322.9	111
MAURITANIA	0.0	0.0	0.0	0.0	0.0	0
MOROCCO	12.4	57.9	16,204.3	185.2	614,838.4	708
OMAN	0.0	0.0	0.0	0.0	0.0	0
QATAR	0.0	0.0	0.0	0.0	0.0	0
SAUDI ARABIA	2.6	12.0	3,364.6	38.5	127,664.0	147
SOMALIA	2.9	13.4	3,747.0	42.8	142,172.5	164
SUDAN	165.9	771.7	216,085.1	2,469.5	8,198,885.3	9,438
SYRIA	62.4	290.4	81,320.3	929.4	3,085,525.8	3,552
TUNISIA	8.2	38.2	10,699.9	122.3	405,984.4	467
UAE	0.0	0.0	0.0	0.0	0.0	0
YEMEN	1.3	5.9	1,643.0	18.8	62,340.5	72
Total	1,232.8	5,734.1	1,605,560.5	18,349.3	60,919,553.1	70,127

The achievements of the International Center for Biosaline Agriculture[12] are good example of improved management of saline soils and saline waters for the Gulf countries, North Africa and Asia. In this approach, farmers use saline water to irrigate salt tolerant crops and collect drainage water for recycling. They reuse highly saline drainage water for aquaculture with additional animal protein production and income.

Sodicity requires the use of $CaSO4$ with good drainage to leach out the accumulated Na and replace it with a coagulant bivalent cation. This knowledge must be converted into policy and actions in land use and land management and deserve to be transferred to the farmers. The limitation of this method is its economic and environmental cost.

To overcome erosion risks, it is recommended to undertake filed measures to reduce surface water flow on slopping lands and improve natural recharge into the soil and groundwater.

[12] http://www.biosaline.org/

Erosion control involves the creation of physical barriers, such as trees, mulch, dikes, dams, rock lining, sediment traps and storm drain outlet protection, to absorb some of the energy of the wind or water that is causing soil erosion. Vegetation establishment is now recognized as a cost-effective and sustainable erosion-control technique[13]. In sub humid areas terracing of slopping lands has been a successful measure to control surface runoff, improve rainfed agriculture and local recharge. In dry lands, strip planting perpendicular to the slope is a good approach to double the amount of harvest rainfall water for the reuse by plants while reducing slope lengths and improving recharge rate[14].

A winter cover crop can be grown between large spaced fruit trees, notably the leguminous crops that can protect the soil from the splashing effect of rainfall and improve the soil fertility by fixing nitrogen from the air. Equally, crop rotation based on pulses can restore soil fertility and nutrient balance compared to mono cropping systems that can cause nutrient disorders and soil born diseases. The development of agro pastoral system can provide animals with rich feed material and contribute to C sequestration and climate change adaptation and mitigation. In dry semi-arid Lebanese mountains, fields with cherry orchards were planted with cover crop (*Vicia sativa* and a mixture of barley and *Vicia sativa*) in order to provide a winter cover crop that can reduce soil erosion .

The cover crop can provide small ruminants with green feed commodity and supply the soil with additional OM and nitrogen fixed from atmosphere (Darwish et al., 2012). Adopting this practice by local farmers-herders showed a relative yearly increase in soil OM content and leading to an increase of OM stock in the topsoil from the initial 43.3 tons /ha to 47.5 tons/ha. In this experiment, barley was more developed than the *Vicia sativa*, confirming that barley is more tolerant not only to drought but also it is more resilient to cold weather compared to Vetch. Also, the practice of growing rice combined with duck cultivation in Philippines proved to increase rice yield by 20% and can provide subsidiary meat and eggs for farmers with 50% higher net return (FAO, 2015)[15].

The introduction and dissemination of good agricultural practices through national extension services or framer's schools and cooperative associations can contribute to reduce the erosion risks and improve soil resilience to drought. A good practice in Tunisia and Morocco is followed by the phytoremediation of salt affected soils by Atriplex on low lands and needless cactus on slopping lands. The Atriplex provides shading for grass growth underneath which is well palatable by small ruminants. Green cactus improves local landscape, protects the soil from wind and water erosion and provides additional source of water and minerals to grazed animals in periods of water shortage. This practice was applied through a project in Lebanon by the Development Studies Association (DSA) (DSA, 2012).

Improving water accounting and water productivity knowledge and know how at the level of research bodies and implementing ministries and farmer's associations requires capacity building to master new remote sensing and GIS tools to improved water management. New modules and models are developed to improve the ability to map and monitor annual crops, upgrade the capacity to assess crop water status, evapotranspiration and estimate crop

[13] http://www.forestry.gov.uk/fr/urgc-7edgrj
[14] http://www.agriinfo.in/?page=topic&superid=1&topicid=443
[15] http://teca.fao.org/technology/rice-and-duck-farming-means-contributing-climate-change-adaptation-and-mitigation-bicol

biomass production from remote sensing tools like SEBAL, METRIC, SEBI, SAMIR, SEBS, TSM (Liou and kar, 2014).

5.2. Potential additional food production from reducing the risks of land degradation
Assessing the plants evapotranspiration (ET), crop mapping and predicting crop yield through remote sensing tools can support decision makers to identify technical measures to improve food production, reduce and halt land degradation and achieve land degradation neutrality. Results of the model used in this study suggest that a 10% reduction of annual soil water erosion risk from productive soils in the Arab countries can reduce the economic loss and improve food production in the following year to achieve additional food calorie sufficient to feed between 26,6 and 53,2 mill. people. The exponential effect of such measures will positively affect land productivity in the short and medium term and reduce, in long run, the food gaps in the underdeveloped and affected rural areas.

Implementing land use measures based on land capability and land use requirements can stop and alleviate the devastating effect of chaotic urban expansion on productive lands. The loss from urban expansion is tenfold in comparison with the erosion risks because surface erosion removing 1 mm of topsoil layer results in the average soil loss of 12 tons/ha: [(10,000 m^2 x 0.001 m)*1.25].
Where 10,000 m^2 is the area of 1 ha; 0.001 m is the eroded soil layer in m; 1.25 is the average soil bulk density.

Reducing land degradation from high rates of soil water erosion by 50% can, theoretically save large quantities of N and nutrients that allow the production of up to 69.7 mill. tons of wheat equivalent, hypothetically sufficient to feed up to 266 mill. people for one year (Table 4).

Buildings require excavation and removal of most productive top soil and subsoil material. In many cases, the removed material is not reused to terrace new lands but disposed in the wadis and lost in erosion-sedimentation process. Efforts for soil conservation and wise use of fertile and productive lands to halt chaotic urban expansion on fertile lands and achieve 10% annual reduction of soil loss can save money spent on fertilizers and provide additional food to produce equivalent calorie commodities sufficient to feed 7 mill. people for a whole year.

Partially reducing urban expansion on productive soils, in the range of 1 km^2 can prevent further loss of nutrients and could save up to 821 tons of N, equivalent to 3,900 tons of ammonium sulfate fertilizer and theoretically save up to 1.0 mill. US dollars. Assuming all other production inputs are secured, this saving can provide 12.2 thousand tons of wheat commodity equivalent corresponding to 40.6 mill. Kcal, which can be sufficient to provide food up to 46.7 thousand people for a whole year.

5.3. Deficiency in legislation and policy and institutional weakness

Subsidies of sugar beet cultivation in water scarce Bekaa region of Lebanon resulted in sewage water application to irrigate this water demanding crop. Shifting subsidies from sugar beet to wheat cultivation resulted in expansion of wheat to arid areas and additional pressure on groundwater reserve and soil exhaustion by the development of deep cracks and compact soil layers.

Recent expansion of the area under water demanding banana in the Jordan valley witnessed the deterioration of these plantation due to drought, water scarcity and crop sensitivity to irrigation using saline water. Observations from South and East Jordan showed that even the more tolerant barley cannot survive in dry years and the general practice is grazing of failed crop. Irrigation of cotton on gypsiferous soils in Syria caused the dissolution of the impermeable $CaSO_4$ layer and brought a rise of saline water table that expanded the area of salt affected soils.

With rice cultivation in North Delta of Egypt, similar rise of groundwater table was observed. Promoting cotton production in Yemen and wheat in Saudi Arabia caused the depletion of groundwater resources and seawater intrusion into coastal aquifer. Thus, there is a need to produce a new generation of studies on soil degradation that are more rigorously designed, forge a stronger link between technical and socioeconomic analysis, and provide more policy-relevant findings. Geo-referenced databases containing information on terrain, soils, land use, climate, vegetation, land degradation and conservation, etc., have proven to be an excellent tool for land use planning, monitoring changes (positive or negative), modeling and scenario research (Spaargaren and Van Engelen, 1999).

Meanwhile, soil degradation leading to reduced land productivity is not seen as posing a serious policy concern. Many regional policymakers remain unconvinced that agricultural soil degradation warrants priority attention. Information on the physical aspects of soil degradation, as traditionally reported by soil scientists (rates of soil erosion, the extent of farming areas with particular degradation processes and tons of soil lost), is inadequate as a guide and catalyst to policy action (Scherr, 1999). Economic loss and food calorie loss caused by soil erosion can have more socio-economic impact on decision makers and stakeholders as they touch food security concern and social stability.

Land use policies, based on what crops give the highest economic return with associated subsidies and price signals do not usually take into account impacts on the environment, which must be considered in analysis. The percentage of soil surface and landscape reorganization that accompanies modern intensive farming strongly influences erosion. There are many examples of the encouragement of certain crops or practices leading directly to degradation (Boardman et al., 2003).

Only few international agencies and countries contribute to the protection of soil cover through appropriate policies, legislation and practices. The creation of the Global and Regional Soil Partnerships and announcement of 2015, by FAO, as the International Year of Soil and the declaration of 2015-2024 as the international decade of soil by the International Union of Soil Science (IUSS) contributed to the development of guidelines and action plans to raise awareness and promote sustainable land management.

The five pillars of Global Soil Partnership (GSP)[16] support soil management, awareness raising, promoting soil research production, harmonization and sharing of soil data. The second GSP pillar addresses soil information system, aiming to raise awareness on the multiple and diverse functions of the soil, education and policy to conserve the soil to meet food security of increased population and answer the needs and demands of future generations.

[16] http://www.fao.org/global-soil-partnership/pillars-action/en/\

The development of regional action plan released in 2015 by FAO[17] is a step in the right direction. The action plan created five Arab working groups of the Intergovernmental Technical Panel on Soil-ITPS, and aim to mainstream and implement, in cooperation with other stakeholders, regional and national activities to protect and sustainably use the available soil resources to support food provision and food security.

The ignorance and negligence of the role of the soil as an essential part in the soil-water-plant-animal and human continuum obstructs the support of soil targeted research and constrains the efforts for improved soil quality information system. Building and updating soil information can be hampered by the lack of resources, administrative constraints and absence of interest from decision makers and end users. A proper soil education and communication policy can serve awareness rising for the benefits of sustainable land management and protection of soil resources. Capacity building, strong governmental commitment and public-private partnership can assist in developing and implementing good national and local governance in soil management and protection.

6. Recommendations

1. One of the first criteria to mitigate land degradation and achieve land degradation neutrality is to maintain sustainable management of currently cultivated lands to prevent erosion, urban expansion and soil salinity hazards. This can be achieved through appropriate land conservation policy, governance and good practices (advanced, precise, fertilization and watering techniques “fertigation” considering soil and climatic conditions and crop nutrient and water demands under conditions of good drainage and water reuse policy.

2. Expand into additional areas of marginal lands, saline soils and sandy soils using salinity resistant and drought tolerant crop varieties and the development of biosaline agriculture, which merge crop production with aquaculture using brine water.

3. A prerequisite for arable land conservation is the update of land evaluation system and the proper implementation of land use planning based on land quality and land use requirements. Advancement in production tools shall be brought to end users through farmer’s schools and extension services to learn more efficient production methods and assessment of crop water demands and water application.

4. Define and map the hot spots and green spots to implement curative measures to restore degraded lands and encourage the use of preventive measures to protect stable lands.

5. Improve production and access to food in the Arab countries through restoration policies, appropriate legislation and technical/socio economic measures to halt land degradation and to try to achieve land degradation neutrality.

6. Awareness-raising on the importance of soil functions for water-vegetation-food cycle and interaction in the media, education circles and at the decision making levels.

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[17] http://www.fao.org/3/a-bl105e.pdf

7. Fund raising to support soil studies and complete the detailed national soil surveys, upgrade soil information and maintain research on adapted to water stress and salinity hazards crop varieties that support the sustainability of food production.

7. Conclusion

In this work, an assessment of available soil resources and land capability classification in the Arab countries was undertaken to estimate the potential for food production. Land degradation through erosion, modeled using the USLE approach, and expansion of urban settlements, mapped using remote sensing tools, on productive lands, was analyzed to account for the economic and environmental loss. Food calorie loss by potential erosion and urban expansion were estimated for the Arab countries. This simplified and hypothetical approach to startle the reader on the importance of land degradation can reach different stakeholders. The expected reaction is the understanding of the severity of food calorie loss by land degradation and existing food problem in the Arab world. The desired pro-action is the elaboration and implementation of national and regional policies to protect the soil legacy and reduce the economic and environmental loss of soil nutrients and organic carbon, which contribute to food-calorie commodities and adaptation to climate change. Equally, adopting soil protection measures will reduce the risk of erosion-sedimentation and soil sealing and prevent the loss of nitrogen and other nutrients that can affect food production, decrease soil fertility and pollute water bodies. Adopting good agricultural practices and field anti erosion measures can protect productive lands from erosion. Equally, implementing land use planning based on land potential and suitability can protect prime lands.

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