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Quantifying the water soil erosion rate using RUSLE, GIS, and RS approach for Al-Qshish River Basin, Lattakia, Syria

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Soil erosion is one of the most prominent geomorphological hazards threatening environmental sustainability in the coastal region of western Syria. The current war conditions in Syria has led to a lack of field data and measurements related to assessing soil erosion. Mapping the spatial distribution of potential soil erosion is a basic step in implementing soil preservation procedures mainly in the river catchments. The present paper aims to conduct a comprehensive assessment of soil erosion severity using revised universal soil loss equation (RUSLE) and remote sensing (RS) data in geographic information system (GIS) environment across the whole Al-Qshish river basin. Quantitatively, the annual rate of soil erosion in the study basin was 81.1 t ha^{-1} year−1 with a spatial average reaching 55.2 t ha^{-1} $year^{-1}$. Spatially, the soil erosion risk map was produced with classification into five susceptible-zones: very low (41 %), low (40.5%), moderate (8.9%), high (5.4%) and very high (4.2%). The current study presented a reliable assessment of soil loss rates and classification of erosion-susceptible areas within the study basin. These outputs can be relied upon to create measures for maintaining areas with high and very high soil erosion susceptibility under the current war conditions.

Keywords: soil erosion, RUSLE, GIS, RS, conservation, Syria

1. Introduction

Soil is an important and vital non-renewable resource that gives a broad set of ecological services and goods (Almohamad, 2020; Brevik et al., 2017; Pal, 2016). However, current scientific literature indicates that soil erosion is responsible for about 85% of the degradation of the agricultural lands, and hence a decrease in productivity by 17% (AbdelRahman and Arafat, 2020; Fayas et al., 2019; Lal, 2001; Nyesheja et al., 2019). Soil erosion by water (SEW) is one of the most severe environmental challenges influencing human sustainability and welfare throughout the world (Wagari and Tamiru, 2021; Zika and Erb, 2009). SEW is dynamically created as an output of spatial interaction between physical and human factors, and produced a total reduction in the quality of soil health, water resources pollution, and perturbation the global carbon cycle, therefore a decrease in ecosystem quality and productivity (Nosrati and Collins, 2019; Thomas et al., 2018; Van Oost et al., 2007; Zika and Erb, 2009). Mitigation of soil erosion is an essential matter in the context of agricultural productivity that influenced by soil erosion in many ways. Moreover, humans gain more than 99.7% of their nourishment from the soil, while 0.3% from the oceans and other water ecosystems (Pimentel, 2006).

In the context, Syrian soils, as part of the Mediterranean basin soils, are prone to a remarkable water soil erosion risk due to climate, terrains, soil features, vegetation and human activity motivating water erosional cycle, especially in the coast region of Syria (Mohammed et al., 2020a). Moreover, about 18% of the agricultural land in Syria is exposed to soil erosion risk which exceeds 100 t ha^{-1} yr^{-1} in some western mountainous areas (ACSAD, 1997). SEW in coastal region of Syria in general and in Al-Qshish river basin in particular is the fundamental risk that threats agricultural, feed, and secure sustainability. The heavy pattern of rainfall intensities, runoff, flash flood, rugged topography, shallow soil profiles, and degraded vegetation are the main physical factors that cause SEW. Simultaneously, SEW can be fostered by the expansion of human intensifications such as: deforestation, overcrossing, urbanization, landuse/landcover change, intensive cultivation on steep slopes, excessive soil plowing, land abandonment, poor maintenance procedures, military infrastructure, and armed conflicts (Abdo, 2018; Almohamad, 2020; Barakat et al., 2019; Emadodin and Bork, 2012; Jafari and Bakhshandehmehr, 2016; Mohammed et al., 2021, 2020b).

Hence, the issue of SEW modeling was the core of many studies in the Syrian coastal region. Barakat et al. (2013, 2014) used the Coordination of Information on the Environment (CORINE) method to model the hazard of SWE for some rainy coastal mountainous of Syria. Mohammed et al. (2016) simulated SEW by using the Water Erosion Prediction Project (WEPP) model for Lattakia governorate in the temporal dimension of 2016 to 2039. The Revised Universal Soil Loss Equation (RUSLE) method was implemented in the GIS software to assess the

SEW in many catchments in Syrian coastal region (Almohamad, 2020; Salloum and Abdo, 2016).

Investigating the spatial distribution of SEW rates is a critical stage for conservation soil and water resources at the catchments scale. Meanwhile, using the experimental models is the most common methods of SEW modeling, especially in areas with limited data. In details, the integration of remote sensing (RS) data, geographic information system (GIS) environment and RUSLE model is a useful, reliable and accurate manner in generating the spatial distribution of SEW (Phinzi and Ngetar, 2019). Almohamad (2020) verified the rates of soil erosion using RUSLE model in the basin of the Northern Al-Kabeer River in Syria by comparing them with an analysis of the sediments in the reservoir. The RUSLE estimation presented a good match with the measured sediments data. Moreover, many soil erosion scholars indicated to good correlation between the rates provided by the application of the RUSLE model with the actual sedimentary yield in Syria, especially in the western region. Mohammed et al. (2020a) reported that the correlation values between runoff and the results of RUSLE applying model were 0.56 emphasized a spatial consistency between the results of the RUSLE application and the sedimentary yield in the northwestern coastal region of Syria.

The war in Syria has contributed to increasing pressure on natural resources in the coastal region of Syria (Ghanem and Rukia, 2020). The lack of relevant data also plays a major role in impeding the creation of post-war environmental rehabilitation measures. For several decades now, studies have used USLE/RUSLE, therefore, providing reliable results in assessing soil erosion, especially in light of the lack of relevant data under the conditions of war in Syria. For the prior issue discussed, the present paper will reveal the quantities and spatial distribution of SEW in a Al-Qshish river basin by utilizing the RS data in calculating RUSLE parameters in GIS environment, and thus the possibility of proposing the better spatial conservation strategies with appropriate implementations.

2. Materials and methods

2.1. Study area

Al-Qshish river basin is one of the coastal river basins in Lattakia governorate in the west of Syria (Fig. 1). The study basin occupies an area roughly 165 km^2 and lies between the latitudes of 35° 57' and 35° 55' N and longitudes of 35° 58' and 35° 13' E with altitude varying from 0 to 1267 m above sea level. The total area of basin is 164.3 km^2. This basin boarded Al-Kabeer alshamali river basin and Wadi-Qandil river basin to the east, the Mediterranean to the west, Wadi-Qandil river basin to the south, Turkey to the north. The basin primarily subjects to the Mediterranean climate pattern: mild and rainy winter and long, dry, and

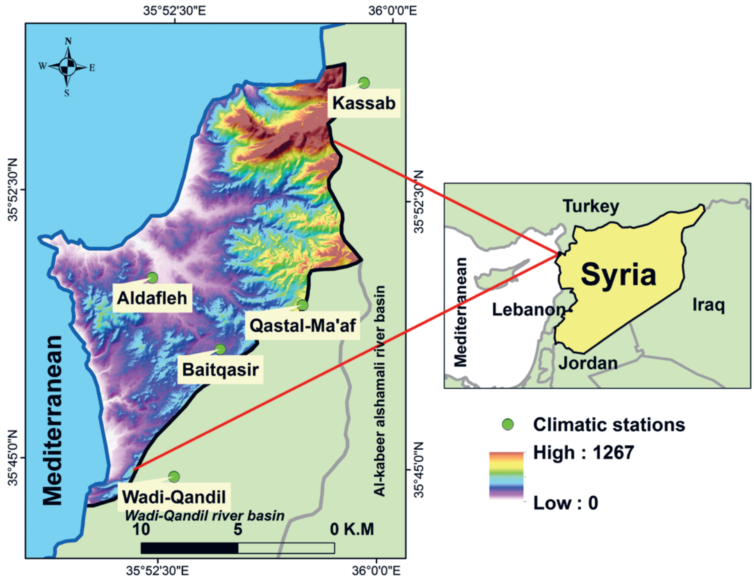

Figure 1. Site of Al-Qshish river basin.

hot summer. The average annual rainfall in the basin varies from 835 to 906 mm (Fig. 2), and most precipitation is concentrated in the winter months (68%). Additionally, the annual mean summer temperature is 23 °C and in winter 14 °C.

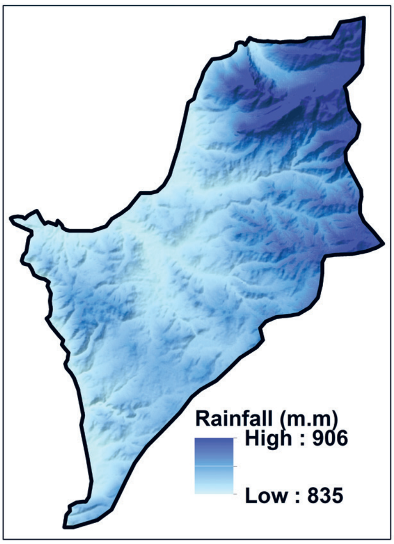

Figure 2. Spatial distribution of rainfall values.

The warmest month is August and the coldest is January. High relative humidity prevails throughout the year due to the effects of the Mediterranean water mass. The annual average of humidity is 72%. Agriculture and tourism are the basic economic pivots of the population. Olives, citrus and field crops are among the most important crops in the basin (Abdo, 2020; Ülker et al., 2018).

2.2. RUSLE model parameters

The universal equation of soil loss RUSLE (Renard, 1997; Wischmeier and Smith, 1978) has been commonly utilized to evaluate the spatial dimension of soil erosion rates in order to create the preservation aims, with an efficient scale of validity (Balasubramani et al., 2015; Phinzi and Ngetar, 2019). RUSLE as empirical model consists of five geo-factors which represent the following inputs: rainfall erosivity, soil susceptibility to erode based on its physical-chemical properties, relief, flora, and conservation, respectively (Karydas et al., 2020). However, RUSLE model has been implemented in areas with various cases worldwide generally and in the Mediterranean basin environment in particular: Gaubi et al. (2017), in Tunisia; Demirci and Karaburun (2012), in Turkey; Meliho et al. (2020), in Morocco; Diodato (2004), in Italy; Benkadja et al. (2013), in Algeria, etc. The average annual soil erosion per unit area is given by the following equation (Eq. 1) of RUSLE (Wischmeier and Smith, 1978):

$$A = R \times K \times LS \times C \times P, \tag{1}$$

where A is the average annual soil erosion (t ha^{-1} yr^{-1}), R is the rainfall erosivity, K is the soil erodibility, LS is the hill slope length and steepness, C is the vegetation factor, and P is the support practice. In order to standardize pixel resolution DEM and Landsat imageries resolution, all inputs and outputs for the calculation of erosion risks is in 30-pixel resolution (900 m^2) for each sub-factors of RUSLE model.

2.2.1. Rainfall erosivity factor (R)

The rainfall erosivity (R) factor reflects the impact of rainfall kinetic energy and produced runoff on the erosion cycle (Demirci and Karaburun, 2012; Wischmeier and Smith, 1978). R factor, however, is significantly influenced by the pattern, volume, intensity, duration of precipitation events (Farhan et al., 2013) R factor index should be acquired by multiplying the total rainstorm energy (E) and the maximum 30-min rainfall intensity ($I30$) (Renard, (1997). The calculation of the R factor values by the prior approach can implement only in regions that are equipped by recording gauging stations that record the rains instantaneously. To overcome this issue, available monthly rainfall data (1989–2019) of climatic stations established in and around the study basin the map of R-value was prepared by using the following Eq. (2) developed by Wischmeier and Smith, (1978):

$$R = \sum_{i=1}^{12} 1.735 \times 19^{(1.5 log_{10}(\frac{P_i}{P}) - 0.08188)}, \tag{2}$$

where R is a rainfall erosivity factor (MJ mm ha^{-1} h^{-1} year^{-1}); P_i is monthly rainfall (mm); P is an annual rainfall (mm).

2.2.2. Soil erodibility factor (K)

K factor characterizes the strength of topsoil particle against the rainfall storms events, which is commonly obtained by assessing the physical-chemical topsoil attributes of a specific area (Das et al., 2018). K factor is an estimate of the sensitivity of topsoil to detachment and transport by rainfall and runoff. It represents the soil loss rate motivated by rainfall erosivity factor (R) in each point of study area (Koirala et al., 2019). In the study basin, soil properties were assessed based on the analysis of soil samples carried out by the National Center for Agricultural Research in Al-Hanadi region. K factor map was designed by using the following equation introduced by Panagos et al. (2015), Renard, (1997), and Wischmeier and Smith (1978).

$$K = \frac{2.1 \times 10^{-4}(12 - OM) \times M^{1.14} + 3.25(s - 2) + 2.5(p - 3)}{100}, \tag{3}$$

where OM is the organic matter (%), s is soil structure class, p is permeability class, and M is aggregated variable derived from the granular soil texture: M = (%Msilt) × (%silt + %sand), and the modified silt (Msilt) is a percentage of grain size between 0.002 and 0.1 mm. However, this Eq. (3) was used based on its compatibility with the topsoil characteristics in the Mediterranean region.

2.2.3. Slope length and steepness (LS) factor

Slope Length and Steepness Factors (LS) assess the effect of the topography on the acceleration of soil loss (Lu et al., 2004). LS factor was produced from two sub-parameters: a slope degree parameter (S) and a slope-length parameter (L); which are extracted from the Digital Elevation Model (DEM) (Hickey, 2000). In this regard, the LS factor is the most important causative factor of overland flow which considers the main cause of soil erosion. The nexus of soil erosion to slope degrees of hill and mountains area is affected by the vegetation density and soil properties (Koirala et al., 2019). The relief of the study area is characterized by steep slopes which reach more than 70 degrees, as Fig. 3 indicates. By using the digital elevation model (DEM) with 30 m resolution (ASTER GDEM Validation Team 2009). LS factor map was generated according to the following equation Eq. (4):

$$LS = (FlowAccumulation \times \frac{CellSize}{22.13})^{0.5} \times (\frac{\sin slope}{0.0896})^{1.3}, \tag{4}$$

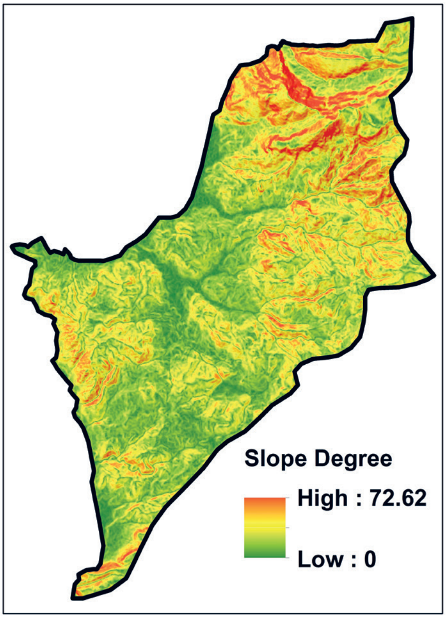

Figure 3. Spatial distribution of slope values.

where *FlowAccumulation* is the grid layer of flow accumulation expressed as the number of grid cells, and *CellSize* is the length of a cell side. The previous method of calculating *LS* factor values is considered reliable and accurate, and it has been used in many relevant studies in the Mediterranean region (Bhandari et al., 2015; Durães et al., 2020; Zhang et al., 2013).

2.2.4. Land cover management factor (C)

Land cover represents a complex criterion in soil erosion control, because of dissipating the kinetic energy of raindrops, delaying the surface runoff, and setting the infiltration capacity (Hu et al., 2015; Ozsoy and Aksoy, 2015; Salloum and Abdo, 2016). In this regard, *C* factor represents the landuse/landcover (LULC) case which can be swiftly varied than other RUSLE factors (Beskow et al., 2009). LULC and Normal Difference Vegetation Index (*NDVI*) are two methods which soil erosion modelling scholars use in calculating *C* values. In the present evaluation, the *C* values were calculated using the landuse/landcover which is extracted by Landsat 8 OLI (taken in June 2022).

In this regard, Fig. 4 presents the LULC classes in study area, including agriculture, bare, built-up, forest, grass and water bodies areas. Figure 5 shows the values of C factor given for each classification of LULC in the study area.

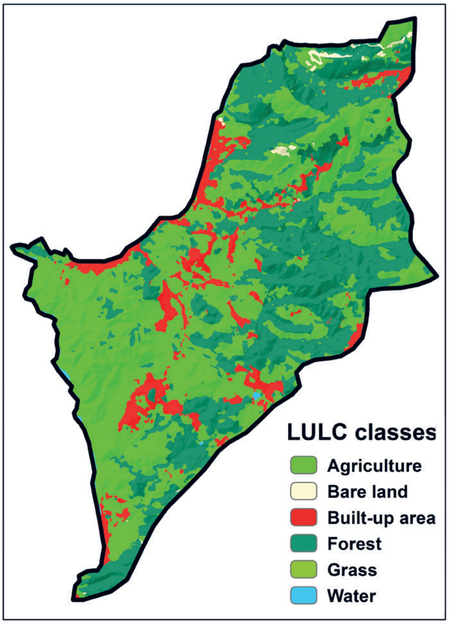

Figure 4. LULC classes in the study area.

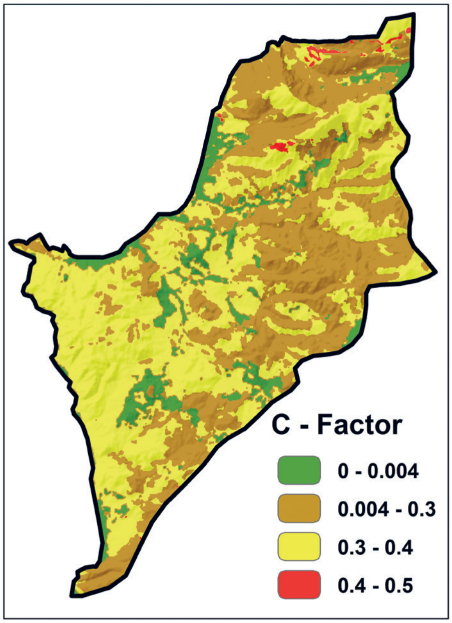

Figure 5. Spatial distribution of C factor.

2.2.5. Conservation support practice factor (P)

Maintenance practice factor (*P*) is the proportion of soil erosion after a selective support exercise to the corresponding soil loss after up and down farming (Samanta et al., 2016). However, *P* factor fundamentally affects soil loss by modifying the streaming pattern, degree or orientation of overland flow, and by decreasing the runoff potentials (Ozsoy and Aksoy, 2015). For cultivated land, the conservation practices included contouring, terracing, strip cropping, and subsurface drainage (Renard, 1997). *P* factor values range from 0 to 1, the value 0 suggests good conservation support practices and the value 1 suggests poor conservation support practices Das et al. (2018); Wischmeier and Smith (1978). Field monitoring indicates the loss of prevention support procedures in the study area. Consequently, *P* factor value for the entire study basin is 1 as proposed by Wischmeier and Smith (1978).

3. Results and discussion

Based on the data entered into the GIS environment (Fig. 6), four thematic raster maps were accurately produced representing the spatial parameters of RUSLE: *R*, *K*, *LS*, and *C* raster factors. Figure 7 illustrates the spatial distribution of rainfall erosivity. On value, *R* factor values ranged from 634.53 to 1512.54 MJ mm ha^{-1} h^{-1} year^{-1} with a spatial mean of 1045 mm ha^{-1} h^{-1} year^{-1}. High

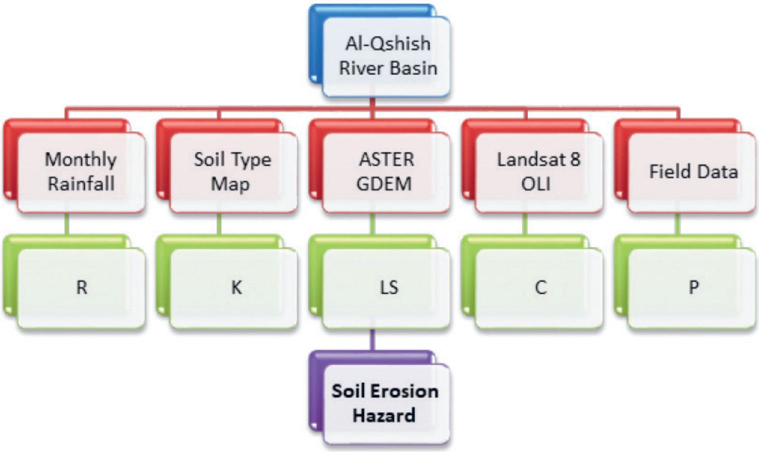

Figure 6. Data and information used in spatial modeling of annual soil erosion risk in Al-Qshish river basin.

values of R factor are concentrated in the northern and eastern regions of the study area. This result can be explained by the topographic elevation which enhances the rainfall intensities, and thus greater rainfall erosivity. The results of calculating the R values are consistent with the calculated global values for

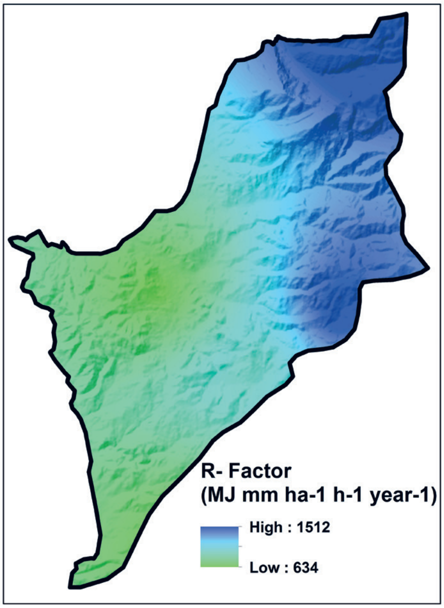

Figure 7. Spatial distribution of R factor values.

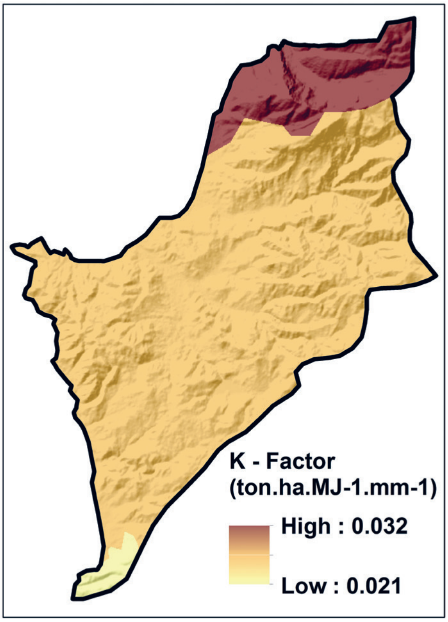

Figure 8. Spatial distribution of *K* factor values.

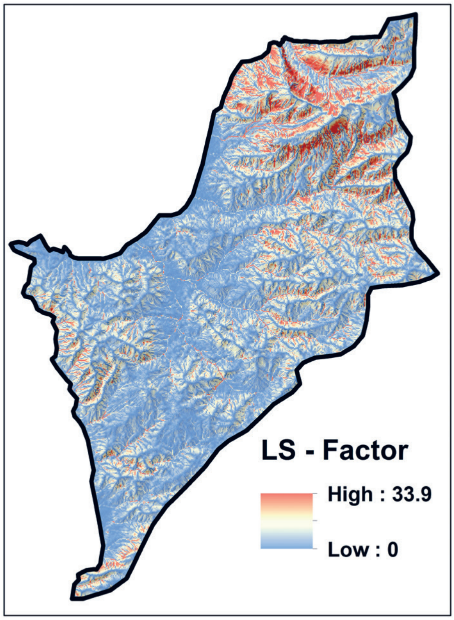

Figure 9. Spatial distribution of *LS* factor values.

erosivity, which ranged between 1100–1600 MJ mm ha^{-1} h^{-1} year^{-1} in the study area (Papageorgiou and Hadjimitsis, 2020). Also, the current results of the *R* values agree with the statistical-spatial outputs of (Panagos et al., 2017) study that reported that the values of *R* factor in the western region of Syria ranged between 1150–1700 MJ mm ha^{-1} h^{-1} year^{-1}.

In case of Soil erodibility, Fig. 8 indicates the spatial distribution of the *K* values, which ranged from 0.021 to 0.032 t ha h ha^{-1} MJ^{-1} mm^{-1} with a spatial mean of 0.029 t ha h ha^{-1} MJ^{-1} mm^{-1}. However, it can be seen that the study area is divided into three sectors according to the susceptibility of soil erosion, which was the highest in the far north. Referring to impact of slope factor, *LS* values of the study area are in the range of 0–33.9 as illustrated Fig. 9 with a spatial mean of 21.47. The higher values of *LS* factor were distributed mainly in the northern and eastern regions. These areas show a high erosion susceptibility due to the terrain roughness and the slope steepness. As regards the LULC influence, *C* factor values ranged between 0–0.5 with a spatial mean of 0.23 (Fig. 5). The spatial distributions of *C* factor values showed that the southern and western regions showed high values due to the pressure of human activity, particularly urban sprawl, dense agriculture and forest fire (Abdo et al., 2022). Meanwhile, low values of factor *C* are concentrated in the northern and eastern regions due to the density of vegetation and grass cover, which enhances the biological protection of the soil profile.

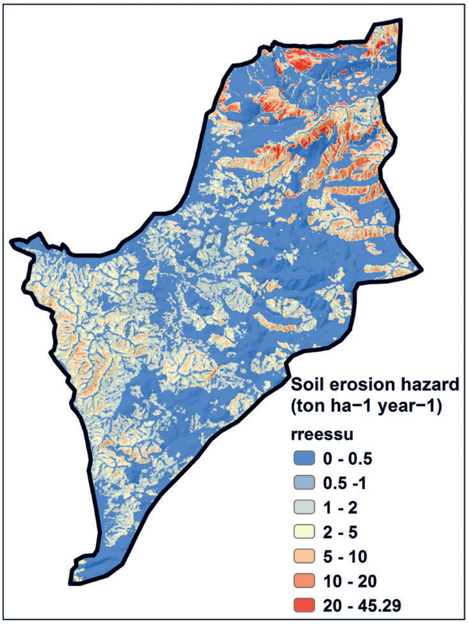

Figure 10. Spatial distribution of annual soil erosion values in Al-Qshish river basin (t ha^{-1} year^{-1}).

Prior RUSLE factor raster were spatially multiplied in order to generate the spatial distribution of potential soil erosion per hectare per year at cell level as Fig. 10 represents. In the context of present findings, the annual rate of soil erosion in the study basin ranged from 0 to 45.29 t ha^{-1} year^{-1}, with spatial mean reached to 19.87 t ha^{-1} year^{-1}. Using the *Natural Breaks* method, the resulting soil loss map was categorized into five risk classes (Almohamad, 2020): very low (61.16%), low (1.45%), low moderate (15.83%), moderate (10.53%), high moderate (7.74%), high (2.51%), and very high (1.23%) as Tab. 1 illustrates.

Table 1. Classification of soil erosion in study basin.

Soil erosion classes	Rate of soil loss class [t ha^{-1} year^{-1}]	Area (km^2)	Percentage (%)
Very low	< 0.5	100.55	61.16
Low	0.5 – 1	2.38	1.45
Low moderate	1 – 2	25.29	15.38
Moderate	2 – 5	17.31	10.53
High moderate	5 – 10	12.72	7.74
High	10 – 20	4.12	2.51
Very high	20 – 45.29	2.03	1.23

Although the current results were not subject to direct field evaluation, hence some limitations, but it constitutes an important step in clarifying the spatial distributions of soil erosion sensitivity degrees and thus the possibility of applying conservation and maintenance procedures. Meanwhile, resulting soil erosion rate is spatially consistent with the estimates provided by scholars in river basins environment in the eastern Mediterranean, as shown in Tab. 2. Also, the results of previous literature give the current results sufficient validity to be used in proposing measures for spatial maintenance of areas with boundaries and critical soil erosion.

In this regard, Farhan and Nawaiseh (2015), Irvem et al. (2007), and Trabucchi et al. (2012) suggested that 10 to 12 t ha^{-1} $year^{-1}$ is the acceptable soil loss tolerances limits for the purposes of agricultural and economic sustainability in the Mediterranean environment. Moreover, (Ibrahiem, 1986; Kbibo and Nesafi, 1997) stated that the tolerable limit of soil loss ranged between 6 to 7 t ha^{-1} $year^{-1}$ for the coastal region of Syria. Moreover, the Organization for Economic Co-operation and Development (OECD) indicates as tolerable a soil erosion rate less than 2 t ha^{-1} $year^{-1}$, and the 10 to 11 t ha^{-1} $year^{-1}$ is considered as the threshold

Table 2. Some erosion assessments in different parts of Mediterranean areas using RUSLE model.

Location	Study area	Average of soil erosion [t ha^{-1} $year^{-1}$]	Aerial extent (km^2)	Reference
Syria	Southern part of Syria	174	515.3	Mohammed et al. (2020b)
Syria	Northern Al-Kabeer river basin	4.2	845	Almohamad (2020)
Syria	Lattakia Governorate west of Syria	4.7	295.5	Safwan et al. (2021)
Syria	Khawabi river basin, Tartous, Syria	27.14	25	Abdo (2022)
Jordan	Wadi Kerak basin	37.14	191	Farhan and Nawaiseh (2015)
Morocco	Tensift basin	31.45	20.4	Meliho et al. (2020)
Algeria	Wadi Mina basin	48.54	4800	Benchettouh et al. (2017)
Italy	Portofino promontory area	182.36	18	Rellini et al. (2019)
Portugal	Foupana basin	44.89	145	Panagopoulos and Ferreira (2010)
Turkey	Alaca basin	82.47	1656.4	Imamoglu and Dengiz (2017)
Greece	Crete	8.12	8336	Panagos et al. (2014)
Cyprus	Mediterranean island of Cyprus	11.75	9251	Karydas et al. (2015)

for severe erosion (Di Stefano and Ferro, 2016). Consequently, in light of these limits, it can be emphasized that most of the study area lands need integrated spatial management of erosion.

In addition, the spatial distributions of high and very high erosion risk hazards are mainly concentrated in the north, northeast and northwest slopes of study area. Importantly, these areas are prone to high risk of soil erosion as a result of the spatial integration between the kinetic energy of raindrops, runoff and steep slopes. Several studies indicate the severe impact of rainstorms on the acceleration of soil erosion in the study area (Mohammed et al., 2021). The orographic pattern of precipitation leads to hitting the topsoil structure and increasing the mobility of the slope materials. The field investigation revealed that areas with high and very high values of soil erosion are sloping areas with dense vegetation cover. Importantly, vegetation did not reduce the soil erosion amounts in these areas according to the produced map. This finding can be explained by the intense spatial competition between slope and vegetation factors in favor of the slope factor. Moreover, the slope degrees in these areas reaches more than 70 degrees as shown on Fig. 3. These results are consistent with many studies that have indicated the effect of slopes in soil stability (Karydas et al., 2014; Thomas et al., 2018). Thus, it can be stated that the slope is a critical factor in the acceleration of soil erosion and sediment yield in the study area.

The results presented in this study, that assessed the spatial distribution of potential soil erosion in study basin, are spatial estimates, and thus are still questionable. In this regard, due to the absence of sufficient data, information and field measurements throughout the basin due to several influencing factors, especially the consequences of the current war, a RUSLE model provides reliable spatial estimates of soil erosion quantities. These mapped estimates can be useful for decision-makers in creating strategies for conserving soils and mitigating the erosion. The RUSLE application could also be expanded at the regional and national levels as part of the spatial management plans for river basins.

4. Conclusions

Soil erosion is considered as one of the most geo-environmental challenges threats agricultural and economic sustainability in the coastal region of Syria. In light of the paucity of spatial data associated with soil erosion, this study has provided an objective assessment of the spatial distribution of soil erosion susceptibility in one of the coastal river basins most vulnerable to soil erosion. The aim of this research was achieved by feeding the GIS environment with multi-source data, especially RS data, in the calculation of RUSLE parameters. In the context of current outcomes, the produced soil erosion map illustrates a maximum rate of erosion 45.29 t ha^{-1} $year^{-1}$. Further, the soil erosion amount exceeded the tolerable threshold of soil loss for the coastal region of Syria (1 to 2.5 t ha^{-1} $year^{-1}$). These estimates are closely related to the estimates computed in Syria and the Mediterranean countries using the RUSLE model. Additionally, it was concluded the high effect of slope factor in accelerating soil erosion, especially in the north, northeast and northwest slopes of study area. The spatial integration process between GIS and RS data provided an objective platform for estimating annual rates of soil erosion in study basin, especially in light of the ongoing war conditions in Syria. Thus, it is possible to build on the present outcomes to provide a solid foundation for starting the creation of conservation and maintenance strategies with related spatial applications.

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SAŽETAK

Kvantificiranje stope erozije vodenog tla korištenjem pristupa RUSLE, GIS i RS za sliv rijeke Al-Qshish, Latakija, Sirija

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Erozija tla jedna je od najistaknutijih geomorfoloških opasnosti koja prijeti održivosti okoliša u obalnoj regiji zapadne Sirije. Trenutni ratni uvjeti u Siriji doveli su do nedostatka terenskih podataka i mjerenja vezanih za procjenu erozije tla. Kartiranje prostorne distribucije potencijalne erozije tla osnovni je korak u provedbi postupaka očuvanja tla uglavnom u riječnim slivovima. Ovaj rad ima za cilj provesti sveobuhvatnu procjenu ozbiljnosti erozije tla korištenjem revidirane univerzalne jednadžbe gubitka tla (RUSLE) i podataka daljinske detekcije (RS) u okolišu geografskog informacijskog sustava (GIS) u cijelom slivu rijeke Al-Qshish. Kvantitativno gledano, godišnja stopa erozije tla u istraživanom bazenu iznosila je 81,1 t ha^{-1} $godina^{-1}$ s prostornim prosjekom od 55,2 t ha^{-1} $godina^{-1}$. Prostorno, izrađena je karta rizika od erozije tla s razvrstavanjem u pet osjetljivih zona: vrlo niska (41 %), niska (40,5 %), umjerena (8,9 %), visoka (5,4 %) i vrlo visoka (4,2 %). Sadašnja studija dala je pouzdanu procjenu stopa gubitka tla i klasifikaciju područja osjetljivih na eroziju unutar istraživanog bazena. Na te se rezultate može osloniti za stvaranje mjera za održavanje područja s visokom i vrlo visokom osjetljivošću tla na eroziju u trenutnim ratnim uvjetima.

Ključne riječi: erozija tla, RUSLE, GIS, RS, konzervacija, Sirija

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