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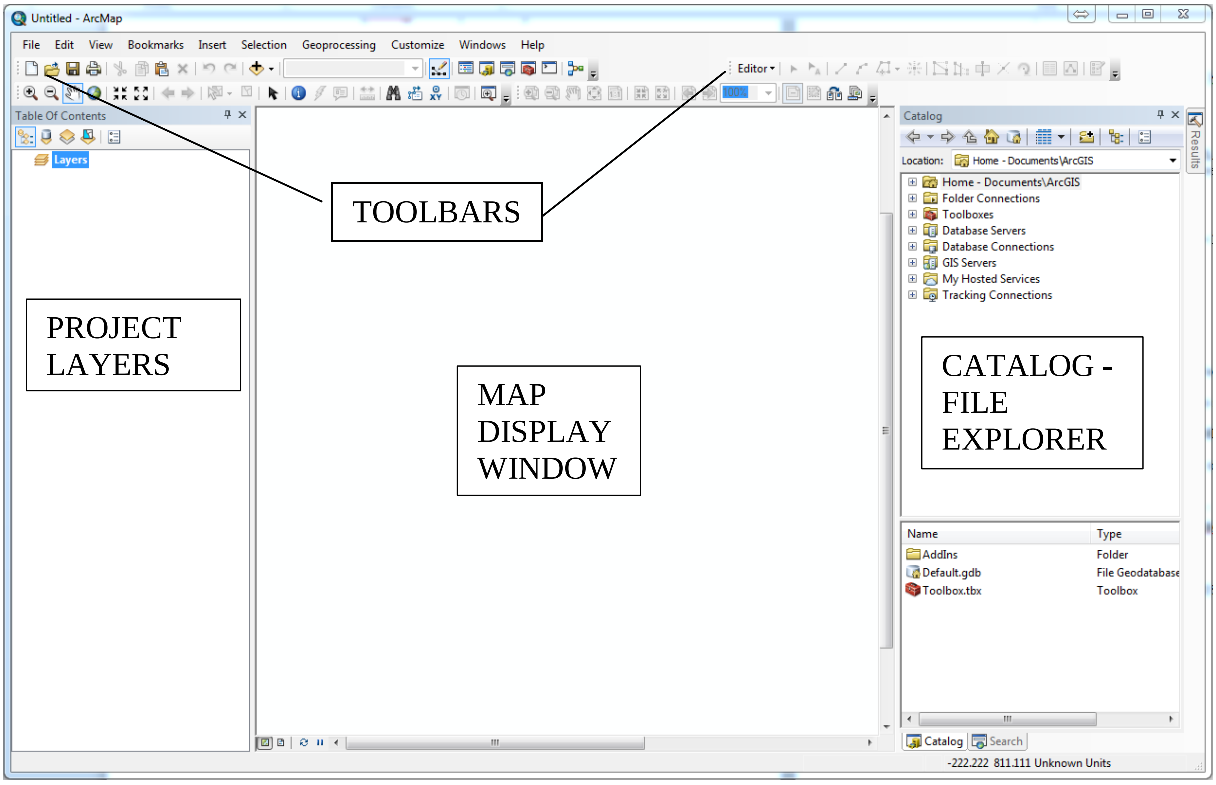
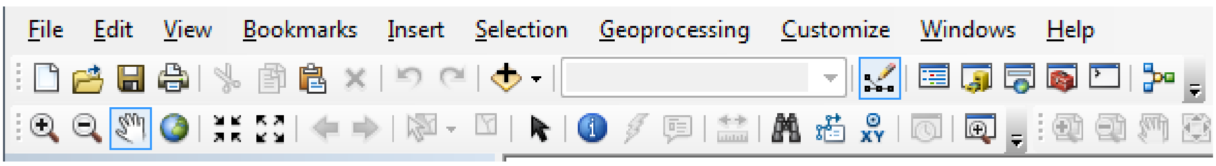
INTRODUCTION TO ARCGIS 10

MAIN WINDOW



ICONES – HOW TO DISPLAY AND USE THE MAP



ZOOM IN	ZOOM OUT	PAN (BY DRAGING)	FULL EXTENT		PREVIOUS/NEXT EXTEND	SELECT FEATURES	CLEAR SELECTION	SELECT ELEMENTS	IDENTIFY		MEASURE	

SOIL LOSS AND SEDIMENT TRANSPORT FROM WATERSHED (using USLE/RUSLE)

USLE: A = R.K.L.S.C.P

A … Average annual soil loss	(t ha^{-1} $year^{-1}$)
R … rainfall erosivity factor	(N ha^{-1} $year^{-1}$)
K … soil erodibility factor	(t N^{-1})
L … slope length factor	(no unit)
S … slope steepness factor	(no unit)
C … crop management factor	(no unit)
P … rates erosion control practices	(no unit)

After having the pure soil loss, we have to estimate for deposition within the watershed.
Soil loss is higher than the sediment yield (transport)!

1 Source layers overview:

Rasters:

PRUSANKA_LANDSAT_453 – Landsat image in false colors
ORTHOPHOTO_3M – contracted orthophoto (3m resolution)
LANDUSE – land use map of the catchments

- 1 – tracks
- 2 – villages
- 3 – orchards
- 4 – vineyards
- 5 – streams
- 6 – reservoirs
- 7 – forests
- 10 – 161 – arable land fields

Vectors:

CONTOURS – 1:25000 military map
RESERVOIR – reservoir outline
SEDIMENT LAYER – sediment depths in measured samples
SOIL_MAP – soil bonity map
WATERSHED – the catchments area

Notes:

2 DEM preparation

Tool – **TOPO TO RASTER**, 15m resolution

Tool – **FOCAL STATISTICS**, filtering output dmt - 3x3, mean

Tool – **FILL** – establish hydraulic connectivity of the surface. Necessary for rainfall-runoff modelling.

Play with: ***SLOPE (degrees/****percent)*
FLOW DIRECTION -> FLOW ACCUMULATION
(from dmt_filter and dmt_fill – compare differences)

Tool – **RECLASSIFY** (from LANDUSE to MASK)

Old value	New value
0 – 2	NoData
3 – 4	1
5 – 9	NoData
10 – 161	1

Tool – **RASTER CALCULATOR**

- ⇨ Flow direction for mask (FlowD_mask)

  FlowD_mask = MASK * FlowD

- ⇨ Use again **FLOW ACCUMULATION (**FlowA_mask)

3 Factor R

Rainfall erosivity factor based on **rainfall kinetic energy** = 35 N ha^{-1} $year^{-1}$

Notes:

4 Factor K

Soil erodibility (t N^{-1}) – based on **silt content** (texture) **and organic carbon content**

Module **POLYGON TO RASTER –** convert the soil map to raster

Soil category	K	Soil category	K
1	0.24	21	0.11
3	0.25	22	0.19
4	0.14	40	0.18
5	0.21	41	0.25
6	0.24	58	0.28
7	0.19	60	0.23
8	0.26	61	0.25
19	0.25	62	0.28
20	0.21	67	0.32

Module **RECLASSIFY –** assigning K values

Can be done either manually (class by class) or using table file

We press: “Load…”
K_factor_reclass file is in the directory.

We have to examine the soil around RESERVOIR and FORESTS – use **non-zero** values for categories 230, 240, 250 --> average value ---> 0.26.

5 Land use map and factor C

C means: Vegetation impact on soil loss reduction - relative
Bare soil --> C = 1.0
Total protection --> C = 0.0

Differences between orthophoto & Landsat – classification – examine the Landsat map, look at the 3 reservoirs with changing reflectance, different crops, etc.

Module **RECLASSIFY** – assigning the C factor values from LANDUSE categories

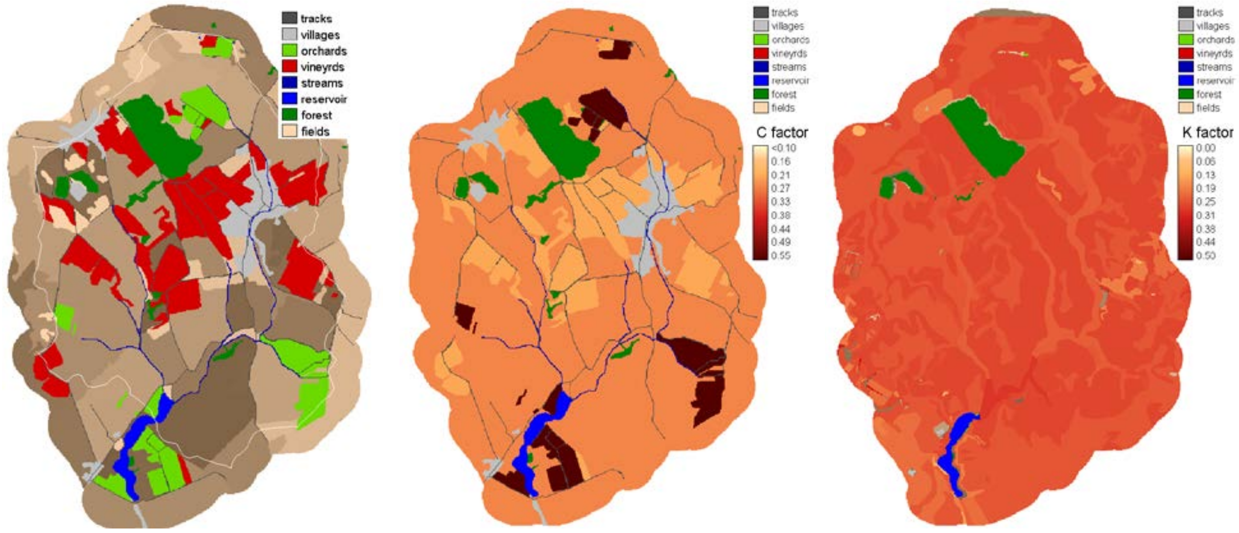
Orchards C = 0.22
Vineyards C = 0.35
Arable Land C = 0.26
Other categories not used → C = 0

Arable land :	corn	40 % - 0.50
	winter wheat	30 % - 0.12
	alfa-alfa	15 % - 0.02
	spring barley	15 % - 0.15

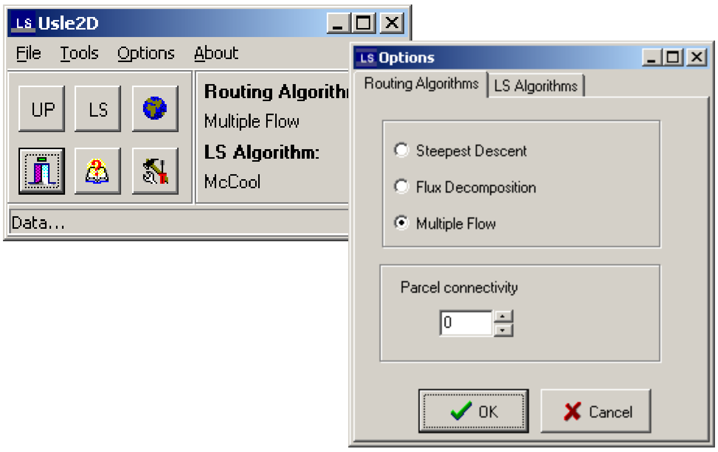
Resulting in average C factor = 0.26

Notes:

LAND USE map C FACTOR map K FACTOR map



were uniform over FIELDS or SOIL GROUPS – based just on reclassifications.
Now we get to spatially distributed modelling –
LS factor is widely implemented in many **USLE/RUSLE based models.**



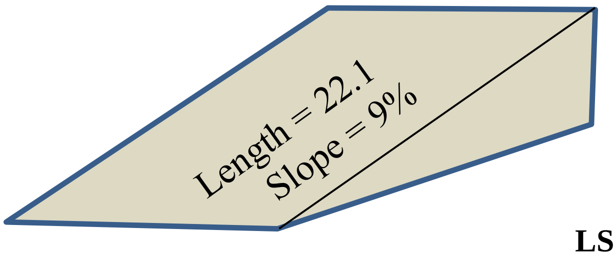
Notes:

6 LS factor

Slope length and slope steepness factors (relative)

USLE plot (Wischmeier's)

$$L = \left(\frac{slope\ length}{22.1}\right)^m$$ *, m between <0.1 – 0.7> based on slope*



S = 10.8*sin θ + 0.03 for slope < 9 %
S = 16.8*sin θ - 0.5 for slope > 9 %, etc. ...
θ .... slope angle (deg/rad)

LS – in 3D topography is based on upslope area

e.g. (Mitasova et al., 1996)

$$LS = (m+1)\left[\frac{norm.\ upslope\ area}{22.1}\right]^m \left[\frac{\sin(\theta)}{0.09}\right]^n$$

noralized upslope area... *is* contributing area per contour width (m)
m <0.4 – 0.7> and *n <1.0 – 1.4> are* calibrating parameters

we: *m = 0.4 ; n = 1.2*

to get **θ**: tool **SLOPE** – slope angle in degrees (already prepared)

to get **norm. upslope area:** Already prepared layer – FlowA_mask

norm. upslope area is number of contributing (upslope) pixels – convert to area (multiply by pixel size in meters), then divide by resolution (=contour width). ➔ FlowA_mask * 15

Use **RASTER CALCULATOR:**
LS_factor =
1.4 * (Power("FlowA_mask" * 15 / 22.1), 0.5) * (Power(Sin("Slope" * 3.14 / 180) / 0.09), 1.2))

7 Factor P

Management factor (relative) – if there are no conservation practices**, P = 1.0**

8 Soil loss – USLE

Soil loss based on 3D USLE is total detachment and redistribution within fields.

Use **RASTER CALCULATOR:**
Soil_loss = **35 * "K_factor" * "LS_factor" * "C_factor" * 1 / 100 / 100**

!!! Important: **units** – C and K factor!!!

We create a map of Soil_loss [t/ha/year] over the Landuse map.

Module **ZONAL STATISTICS**
Create: Average SOIL LOSS per parcel (check vineyards and orchards!!!) → **map**
Module **ZONAL STATISTICS (AS TABLE)**
Compute : **Total SOIL LOSS per WATERSHED** – TO TABLE

9 Sediment transport – SDR

Sediment delivery ratio accounts for eroded soil depositions between field-reservoir.

$$SDR = \frac{sediment\ yield}{total\ soil\ loss} = \frac{SY}{A}\ [\%], \qquad \longrightarrow \quad SY = A * SDR$$

SDR = function (area, relief, CN) = a * $(F)^b$ * $(RR)^c$ * $(CN)^d$

F	*watershed area (km^2)*	
RR	*relief ratio (m/km)*	$\frac{average\ divide\ altitude - watershed\ outlet\ altitude}{maximal\ streamlength}$
CN	*Average SCS curve number value within the watershed*	

a = 1,366 . 10^{-11}, b = - 0,0988, c = 0,3629, d = 5,444

Compute WATERSHED area in square km (**CALCULATE GEOMETRY –** in attribute table).

Compute WATERSHED divide average and minimum heights:
ZONAL STATICTICS AS TABLE (watershed divide, DEM, minimum; average)
Measure approximate WATERSHED maximal streamlength – by **MEASURE tool**

Compute average SCS curve number value within the WATERSHED:
CN values (assumed the same soil texture group):

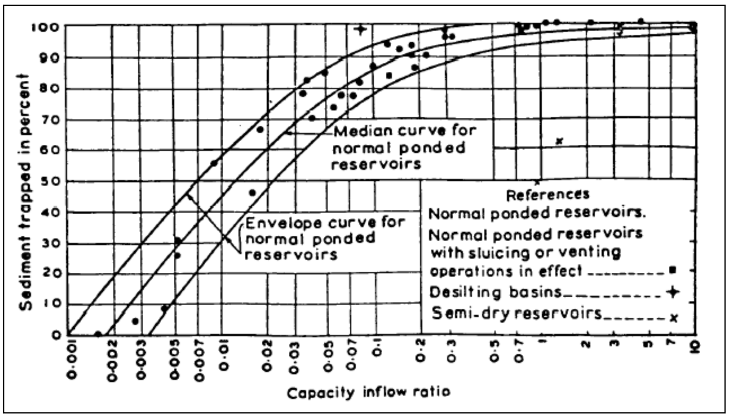
RECLASSIFY
ZONAL STATISTICS

1 – tracks = 92	5 – streams = 100
2 – villages = 90	6 – reservoirs = 100
3 – orchards = 76	7 – forests = 65
4 – vineyards = 81	10 – 161 – fields = 80 (average)

Compute SDR and SY.

Notes:

Reservoir trapping efficiency (Brune, Dendy)



$$TE = 100 \cdot 0{,}97^{0{,}19^{\log(C/I)}}$$

C (volume) = 142 000 m^3
I (outflow) = 1 419 120 m^3/year

Sediment bulk density: 1,2 t/m^3
Reservoir duration: 25 years

Further analyses

Average vs. total erosion rates on the parcels (fields)
Conversion scenarios – grassland to the steepest slopes – erosion reduction (C factor change)
Fly, layers investigation, map outputs – ortho, aspect.
Contribution of every parcel to total sediment transport (difference files from sediment yields). Etc.

Notes:

11 Sediment amount measurement and calculation – reservoir

Overview of ortho-photo (aerial) map (**raster**), overview of measured values points (**vector**)

Tool **– CREATE TIN**

Tool – **TIN TO RASTER**

Tool **– FOCAL STATISTICS**, filtering output dmt - 7x7, mean

Sediment amount extraction **by ZONAL STATISTICS AS TABLE** (total sum)

Important: units conversion (cm, pixel size → m^3)

Comparison – measured vs. computed

Questions, discussions, further analyses, ...

Notes: