URBAN SMS Soil Management Strategy

Tools and data description manual
Web application URBAN SMS suite

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Urban SMS

WP4 Soil Manager Suite

Task 4.3.1: Final version of the desktop computer application
Task 4.3.3: Final version of the web -based evaluation system

Deliverable: Final version of tool description

Web Soil Management Tool

Urban SMS Tools - Description & Functioning

- Urban SMS tools
- Goals, semantics and functioning
- Data description
- Equations
- Legends
- Interpretations

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About a task

Project Urban SMS

http://www.urban-sms.eu

WP4 Soil Manager Suite

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About a document

The document presents detail descriptions and semantics of tool functionalities that were designed and developed in close collaboration with project partners.

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Abstract

According to the project partners selection process the following tools were selected for WP4 development:

1. Ecosystem Soil Quality (ESQ)
2. Loss of soil resource (LSR)
3. Soil contamination (SC) redesigned, now divided to:
    - General agriculture (SCFood)
    - Children's playground areas (SCPlay) and
    - Recreational areas (SCSport)
4. Sealing rate (SR)
5. Agricultural Soil Quality (ASQ)
6. Water drainage (WD)

On a later stage two were proposed by the City of Milano

7. Connectivity tool (CNT)
8. Proximity tool (PROX)

Additional tools were developed in order to ensure adequate input data for the main tools:

9. Nutrient Status tool

Content

1 Urban SMS tools

This document presents the semantics and functional description of Urban SMS tools - integral part of the Urban SMS web system.

It represents beta version of the Urban SMS web tool development which is according to the project plan in lines with the mid of the project time schedule.

The content of this document is temporary functional model of tools which is scheduled to be test implemented, commented and improved and by project partners within WP5.

System will be finalised by the WP4 team in the last stage of the project.

1.1 List of the Urban SMS tools

1.1.1 Main tools

According to the project partners selection process the following tools were selected for WP4 development:

10. Ecosystem soil quality (ESQ) (5 implementations)
11. Loss of soil resource (6 implementations)
12. Soil contamination (SC) (4 implementations) redesigned, now including
    - general agriculture areas (SCFood) (2 implementations) and
    - children's playground areas (SCPlay) (2 implementations) and
    - recreational areas (SCSport) (1 implementation)
13. Sealing rate (SR) (4 implementations)
14. Agricultural soil quality (ASQ) (4 implementations)
15. Water drainage (1 implementation)

Plus the tools additionally proposed by the City of Milano

16. Connectivity tool (2 implementations)
17. Proximity tool (2 implementations)

These two tools are still in the development stage due to the later start.

1.1.2 Secondary tools

Additional tools are developed as integral part of main tools in order to ensure adequate input data for the main tools.

1. Nutrient Status tool (as input required for ASQ, ESQ tools)

2 Scope of analysis (area selection)

All Urban SMS tools perform its evaluation within predefined area (area selected by the user) which can be either

- The whole city area / range of municipality (MA)

or

- Selected smaller planning areas - areas of analysis (AA)

2.1 Range of Municipality Area (MA)

As a default setting several soils information covers entire territory of local community / region / city/ county / municipality (further in text municipality or MA).The entire territory in general equals the municipality area covered with all datasets. When no separate polygons of areas (e.g. planning cases) are selected, each tool evaluates the parameters for the entire MA area. Evaluation is only possible when/if all required data layers are available. In case that a part of data in separate layer is missing tool recognizes this part as No data area. When any of required layers is not available, the analysis cannot be performed or alternatively.

2.2 Range of Analysis Area (AA)

Analysis area (AA) is smaller area (usually the planning case or soil management area) within the MA, typically closed area with specific planned land use. Different AAs usually represent different planning areas - planning cases within municipality spatial planning acts. Each AA represents separate development area in form of a closed polygon. Tolls perform data evaluation within one or more polygons which have to be preselected on screen using Custom areas set of tools. The result of evaluation, a summary and statistical analysis are separately presented / listed according to AA selected.

2.2.1 AA Selection

AA selection is an independent step, which can be repeated for multiple selections. By selection of particular area, user spatially defines the area on which the tool evaluation will be performed. In this way user can evaluate different planning scenarios.
AA polygons are selected using Custom areas set of tools. On or several AA polygons can be selected from:

- An existing polygon layer (← poly data from other sources, e.g. planning departments; Land use, Cadastral data)
- User defines new, custom polygon (On-screen digitized polygons & stored as a poly layer ← technical tool)

Tools which are designed to operate with special datasets (e.g. LSR tools requires planning area polygons with predefined structure) prompt the user to upload required datasets.

3 10 steps for effective definition of the tool

Please see below a screenshot of a typical Admin page with indicated numbers for steps explained in further text.

Admin page is structured from 3 main categories;

1. **Input data definition,**
2. **Tool algorithm, and**
3. **Data interpretation and legend**

Each serves for defining tool results according to user needs.

3.1 I. Input data definition

Describes the data used for calculation; its name (1), path (2) or location where it is stored and importance or weight (3):

1. Data name in Maestro.
    - Input layer should be named according to good practice (see the Data preparation manual) eg:
        i. gAA_XXX; where *g* is abbreviation for ESRI grid GIS layer;
        ii. AA : is the content (e.g. PH);
        iii. XXX : stands for tool name abbreviation ; e.g. ESQ.
    - Example for output layer name; gESQ_result.
2. Data path
    - Locates the data layer in the local file system.
    - Please note that ESRI grids are folders containing several files. Show hdr.adf file in the grid folder.
3. Weight for each input grid.
    - 1 = less significant; 2: normal significance, 3: very significant.
    - result weight = 0

3.2 II. Tool algorithm

Algorithm defines the relation between the input information (layers) combining it into mathematical equation. PLESE NOTE: in order to process these information successfully, Grass specific mathematical operations (commands) must be used. Also see the Grass r.mapcalc user manual - http://grass.fbk.eu/gdp/html_grass64/r.mapcalc.html). The calculation can be performed in several steps. The whole calculation (all steps) are performed in one go.

4. Describe the name of the step of the equation (description is only for your record and it doesn't impact the algorithm)
5. Define the equation
    - We suggest you to use initial equation but which can be adapted to your local data / legislation/ evaluation practices....
    - additional GRASS function can also be embedded (see. r.mapcalc manual)
    - See the example for ESQ tool: Function **float(<expression>)** converts the *integer* grid to real number grid (decimal values) where <exprwession> stand for grid (e.g.

*gAbsESQ***)** or mathematical expression (e.g. *gAbsESQ/3*100*). Please also see additional explanation.

There seems to be a common misconception that ADMIN page settings (number of classes and class description etc) are defined according to the input data rasters. **This is not the case**. All settings are defining the results calculated within each tool.

3.3 III. Testing the equation and output range

To be able to set the class values and definition of each class, you need to know the value span of your results! PLEASE NOTE! The 'SAVE AND TEST' button incorporated under the 'Tool algorithms', enables the Administrator to test the tool result before they are displayed on the map. This function shows the range of your result calculated (Min and Max) and enables you to define the classes accordingly. This function is enabled for every tool.

Save and test operation

- Click save and test → if your algorithm is mathematically correct and the syntax follows the r.mapcalc you should get a message:
  i. *Successfully saved and tested!*
  ii. A range of the output values is presented (min. and max. value of the output grid)
- If your algorithm is mathematically false, this will be displayed and you should correct the algorithm.
- This step must be completed **with range values.**

3.4 IV. Definition of classes, class names, instructions

Prior of using the system, the class names, range and descriptions should be defined.

6. Class ranges
   - Define up to 10 classes for the range values
   - Where applicable, apply your local legislation or best practice guides to set the classes.
7. Define Class description
   - Enter short name of the class. Please note that class name appears in the final report.
8. Define class colours
   - Again follow the good practice, use grading colours
9. Define interpretation of the class
   - **This is a key step for final outcome of the system! Interpretation of each class is meant to be an intuitive text which serves as an instruction to steer the planner/decision maker making a final decision.**

3.5 Fine-tuning of the tool and best practices

In order to fine-tune your system it is advisable to play with different scenarios, evaluating the results the system produces:

- It is highly advisable to convert the output grid to integer using the Grass r.mapcalc functions. On the case of the ESQ tool this was incorporated in 3 step equation: float(AbsESQ/MaxESQ)+100
- Play with weights: change the weights, other integer number can also be used (e.g. 1, 2, 3, 4, 5 where 1- very low importance, 2- low importance, 3- neutral importance, ... 5- highly important)

In case all input grids are integer the output of the equation 5 is integer grid. Depending on the equation the resulting decimal places may be truncated. If any of input grids is real value grid, the output is real value grid. Function float() forces the output raster to be converted to the real number value raster GIS layer → bigger diversity of values which enables larger number of classes.

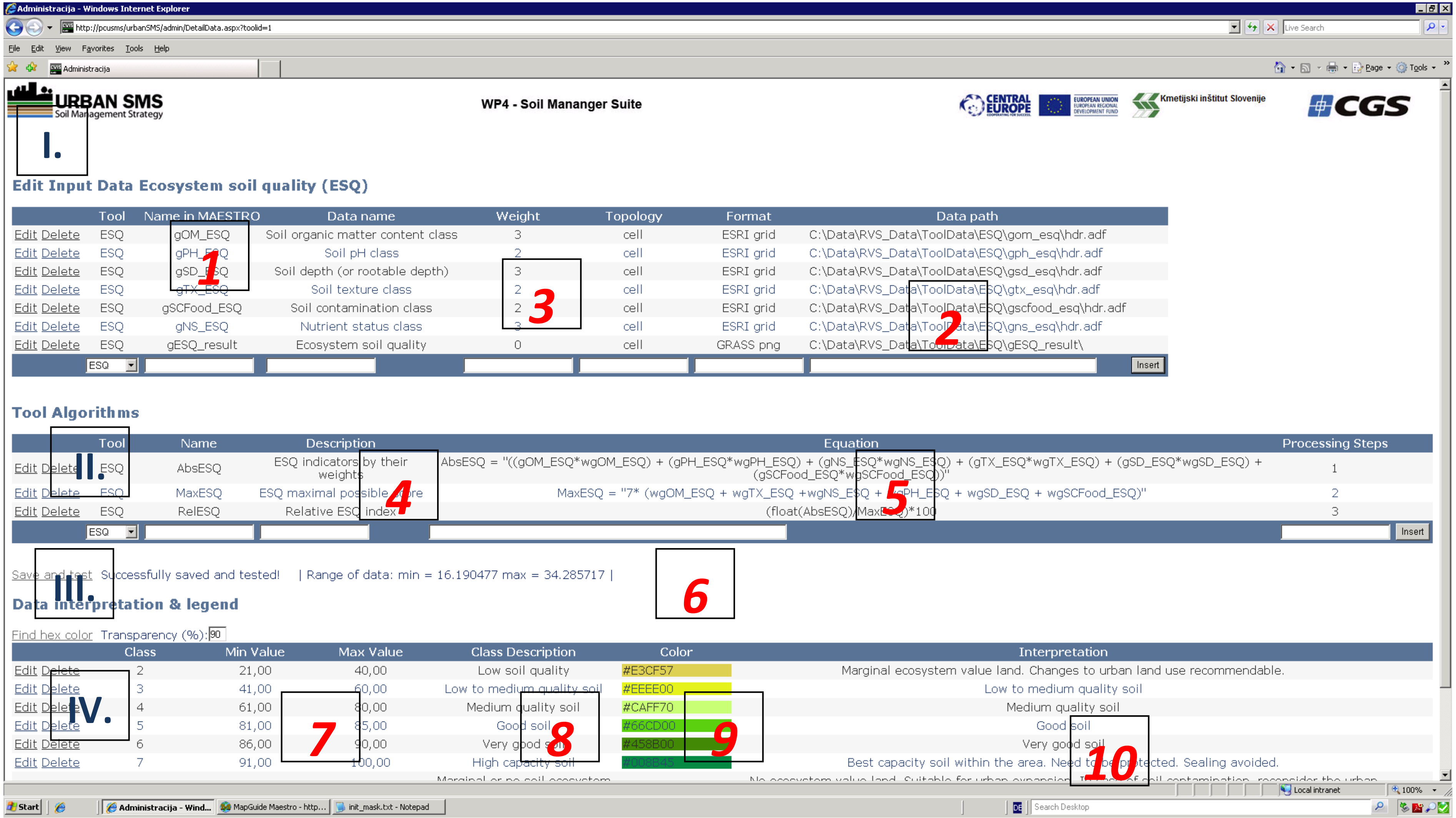

Figure 1: Example of a typical Admin page with indicated numbers for steps explained in previous text.

4 Description of main Urban SMS tools

4.1 Ecosystem soil quality (ESQ)

Planned implementation by the PPs: Prague, Vienna, Pulawy, Celje and Milan.

ESQ reflects the capacity of soil to perform the most important soil functions in terrestrial ecosystem regardless the land use (agricultural, forestry, parks...). It reflects the multifunctional role of soils in one index. ESQ stands for the quality of soil in its broadest sense. Relevant soil quality parameters are evaluated to assess the capacity of soil to perform main environmental functions:

- Filtering & buffering of various substances and water;
- Biomass (food & fibre) production;
- Carbon sequestration;

An additional parameter for the ESQ evaluation:

- Soil contamination.

The ESQ is evaluated using separate measured or estimated soil properties which are widely available and recognisable as the main source of soil data.

In some countries ESQ can also stand for the general agricultural soil quality (ESQ).[1]

4.1.1 The purpose of the ESQ tool

To elaborate the ESQ raster database for the entire MA. ESQ tool is applied on the entire municipality territory or areas where adequate soil data is available.

4.1.2 ESQ data preparation

Soil measured data linked to the soil map of appropriate scale are converted into a quality class values by local soil expert using local threshold values. When the class data is already available this step is not necessary. In the preparation stage vector polygons are rasterised using simple vector to raster GIS tool. The threshold values for the ESQ tool have to be used. The system offers required flexibility for municipalities to set their own threshold values according to their national legislation, own practices, data availability, data situation. This step is important step and carried out in the data preparation phase or repeated when data is replaced with new set. The threshold values should be set by the soil expert.

4.1.3 ESQ calculation

The ESQ index is calculated using elaborated relative SQI which is selected from the Basic/Environmental SQI and set by applying the ESQ equation (in development). In this manual the ESQ is calculated using relevant and most generally available soil quality indicators (SQI) <u>expressed in classes</u>. These are multipurpose and in already acquired.

[1] Soil quality information is in some countries already available (e.g. maps of agricultural soil quality) and is obliged to be used. In such cases the use of ESQ tool can be skipped or it can be used to elaborate additional - ecosystem related soil quality information.

The ESQ function requires weights for each parameter. The values are predefined and can be changed /adapted according to country's practise/legislation. Weights: 1 - less important; 2 - normal importance; 3 - very important. See the following table as an example of the ponder values.

Table 1: ESQ data list (part of the common Data Description Table -DDT)

Tool	Dataset	Weight	Units	DataName	FileName	Topology	Format
ESQ	gOM_ESQ	3	Class	Soil organic matter content class - topsoil	gOM_ESQ	cell	ESRI grid
ESQ	gPH_ESQ	2	Class	Soil pH class - topsoil	gPH_ESQ	cell	ESRI grid
ESQ	gSD_ESQ	2	Class	Soil depth (or rootable depth)	gSD_ESQ	cell	ESRI grid
ESQ	gTX_ESQ	2	Class	Soil texture class	gTX_ESQ	cell	ESRI grid
ESQ	gSCFood_result	3	Class	Soil contamination class	gSCFood_result_ESQ	cell	ESRI grid
ESQ	gNS_result	3	Class	Nutrient status class	gNS_result_ESQ	cell	ESRI grid

ESQ index quantifies the environmental soil quality and the capacity of the soil to perform primary environmental functions in one number.

4.1.4 Outputs

Outputs are:

- ESQ map for: presentation of soil potentials and the ecosystem quality for the MA soil resource or within AA.
- PDF report
    - Small map of the MA or AA section (visualisation of the evaluation results)
    - Statistics and the ESQ distribution (distribution of the ESQ index / ha)
    - Matrix (ESQ values, ha)

The outputs give interpretation of the results distinguishing between "good" and "bad" soil of the area and basic guidelines for planning / soil management activities. ESQ can be as input information for other tools (e.g. sealing): prevention of wasting the soil resource by directing the development to low ESQ areas.

4.1.5 Functional step-by-step description of ESQ tool[2]

- *Run/execution of the ESQ tool (see left - tool section of the Urban SMS web page)*
- *Background processing*
    - *Checking of the availability of soil data (required SQI grids)*
    - *Processing of the predefined ESQ equation (see Admin section of the Urban SMS web page)*
    - *Elaboration of the report (statistics of the soil quality of the area)*
- *Presentation of results*
    - *Visualisation / mapping of the grid on the screen for MA / AA area*
    - *Presentation of the ESQ report (pdf --> system functions Print & Save)*

4.1.6 ESQ algorithms

ESQ calculation is carried out in three steps. These can be arranged as separate equations with the intermediate grids/results that are deleted immediately by the tool itself (no intermediate results saved).

The value of each class is multiplied by the weight DDT.Tool = ESQ.Weight (table = DDT; Tool = ESQ, weight = Weight value of the cell).

[2] *For details also see the Urban SMS Web User Manual*

Where weights are: 1-low impact/less important to the 3-high impact/importance). The product of all parameters is joined to obtain an absolute estimate ESQ (abs.ESQ).

AbsESQ = "((gOM_ESQ*wgOM_ESQ) + (gPH_ESQ*wgPH_ESQ) + (gNS_result*wgNS_result_ESQ) + (gTX_ESQ*wgTX_ESQ) + (gSD_ESQ*wgSD_ESQ) + (gSCFood_result*wgSCFood_result_ESQ))"	Eq. 1

Where:
gXX are separate SQI grids where call values are quality class values; see Table 1, :DDT, field Dataset
wXX are separate weights for corresponding SQI grids

Max.ESQ is calculated by summing all parameter products, where each parameter takes the highest possible rating class 5 (*Class* column).

MaxESQ = "7 * (wgOM_ESQ + wgTX_ESQ + wgNS_result_ESQ + wgPH_ESQ + wgSD_ESQ + wgSCFood_result_ESQ)"	Eq. 2

Where:
wXX are separate weights for corresponding SQI grids
5 = max value of class

The average class ESQ is calculated by dividing the absolute ESQ (abs.ESQ) by the sum of the weights.

The relative assessment of ESQ (RelESQ) is calculated by dividing the parts of absolute evaluation ESQ (AbsESQ) and the potential assessment ESQ (MaxESQ).

RelESQ: AbsESQ/MaxESQ *100	Eq. 3

In the next step the interpretation of results follows (RelESQ and ESQ class).

4.1.6.1 Resulting GIS layers

gESQr = RelESQ - Ecosystem soil quality expressed in %

gESQc = gESQ_result - Ecosystem soil quality expressed as class (1 worst -5 best)

4.1.7 Example of the ESQ calculation

As presented in table below there is a graphical example of the ESQ calculation steps. Table is divided on input data (presented as grid names), corresponding weights, intermediate and final results.

Result of the tool is presented as an index. The **ESQ value** (gESQr) is relative index which is in the next (final) step classified (**ESQ class -** gESQc) and interpreted using the ESQ reclassifications table (see below).

Table 2: ASQ input information required by the ASQ algorithm.

Parameter No.	Data Layer	Quality Indicator	Units	Data Value	Weight	Weighted Value
1	gOM	Soil organic matter content class - topsoil	Class	3	3	4,5
2	gpH	Soil pH class - topsoil	Class	4	2	4
3	gSD	Soil depth (or rootable depth)	Class	3	2	3
4	gTX	Soil texture class	Class	4	2	4
5	gSC	Soil contamination class	Class	3	3	4,5
6	gNS	Nutrient status class	Class	3	3	4,5
Sum of weighted values		20,0				
Maximum possible class		30,0				
ESQ value (%)		**66,7**				
ESQ Class		**6**				
Class Description		**Medium quality soil**				
Class Interpretation		***Land of good ecosystem value. Sealing is to be avoided. Soil to be preserved to perform the ecosystem functions.***				

4.1.8 Reclassification and interpretation of the ESQ grid

4.1.8.1 An example of the ESQ reclassification table

Table 3: An example of the ESQ reclassification table

Class	*Min*	*Max*	Class description	Color	Interpretation
1	1	20	Marginal or no soil ecosystem quality	#EEE8CD	No ecosystem value land. Suitable for urban expansion. In case of soil contamination, reconsider the urban land use and / or take remediation actions.
2	21	40	Low quality soil	#E3CF57	Marginal ecosystem value land. Changes to urban land use recommendable.
3	41	60	Low to medium quality soil	#EEEE00	Land of medium ecosystem value. Sealing should be avoided. Other green urban land uses recommendable.
4	61	80	Medium quality soil	#CAFF70	Land of good ecosystem value. Sealing is to be avoided. Soil to be preserved to perform the ecosystem functions.
5	81	85	Good soil	#66CD00	Land of best ecosystem value land. No sealing. Soil to be protected to perform the ecosystem functions.
6	86	90	Very good soil	#458B00	Very ecosystem important land.
7	91	100	High capacity soil	#008B45	Best capacity land within the area. Need to be protected. Sealing avoided.

The upper rating can be modified to meet specific conditions and/or needs. Up to 10 classes can be used for reclassification and interpretation.

4.1.8.2 Interpretation of the ESQ index

The ESQ equation yields values in a range from 0 to 100. The SEQ values are used for a qualitative description of the ecosystem soil quality and to quantify the terms for *good* and *bad* soil. The higher the ESQ class or the ESQ value the better the soil performs the ecosystem functions.

High ESQ valued soils represent the best soil resource. It is recommendable to preserve soil with high ESQ class / value as natural, semi-natural and agricultural land use. In urban planning and management it is recommendable to avoid soil degradation (erosion) or soil destruction (i.e. sealing) on land with high(er) ESQ value.

The lower the ESQ value, the more is land suitable for other land uses (i.e. housing, infrastructure...).

Medium ESQ value land should be considered for less destructive land uses where soil services are still preserved (i.e. urban green areas). Usually this is the matter of municipality spatial planning policies and specific / local needs.

4.2 Loss of soil resource (LSR)

LSR tool is planned to be implemented by: Stuttgart, Prague, Vienna, Pulawy, Bratislava, Celje.

LSR tool estimates the loss of soil resource when the land use is changed and assesses the impact of land use change. The soil resource is totally or partly lost in case of:

- soil damage (significant part of top soil removed, topsoil extremely and long-term contaminated, severely eroded, etc)
- total soil destruction: (when the soil is sealed with impermeable layer, soil permanently removed, totally eroded, etc.)

In general, the soil is lost / sealed during the construction of housing, industry, infrastructure, etc.

Soil resource can be also improved by soil remediation / reclamation or change to land use which causes topsoil (or entire soil profile) improvements: e.g. change of industrial sites / brown fields to ornamental gardens, intensive arable land to grasslands, etc.

4.2.1 The purpose of the LSR tool

The purpose is to evaluate the impact of the planned land use change on soil resource. Evaluation is carried out in quantitative and qualitative way using the index calculation system. LSR tool is used for evaluation of sealing impacts and complies with the loss of soil resource assessment;

- The impact is negative when soils are sealed[3]. The extent of the potentially sealed area is compared to the soil quality[4], evaluated according the algorithm and finally expressed in form of an index / score for each planning area and soil quality within the AA.
- The result of each evaluation is a PDF based report with:
  - graphical presentation of the area/results showing the distribution of soil quality vs. area
  - statistical figures
  - the impact index - difference in soil resource score between present and planned scenario

The tool is designed to be repeatedly run on different AAs - planning scenarios. The results of each assessment can be compared and used for argumentation/support in decision making process which should reflect the lowest impact on soil resource.

The outputs/results of the LSR evaluations are used to compare different scenarios and their impact on soil quantity / quality and to mitigate the effects of soil sealing.

[3] It can be also positive in case of soil remediation or land change when the soil capacity is improved (i.e. land use is changed previously sealed/degraded area is planned to be revitalised/remediated). This option of the tool is still explored.

[4] ESQ or ASQ, depending on the data availability and binding legislation / procedures

4.2.2 LSR data preparation

vPA is the vector shape file usually provided by planning departments. It contains one or more planning areas (PA), each composed of one or more polygons with different planned land uses → each can be with different rate of sealing. Main vPA attributes are actual and planned sealing degrees; E.g. actual surface of sealed soil for a building, parking place, park etc. Rates of sealing differ.

Table 4: LSR input information required by the LSR algorithm

Tool	Dataset	Weight	Units	DataName	FileName	Topology	Format
LSR	**gASQ_result**	/	**Class**	Soil Quality Score	gASQ_result_LSR	cell	ESRI grid
LSR	**vPA**	/	**%**	Analysis / Planning Area(s)	vPA	polygon	ESRI shape

The tool analysis area is **AA specific**. Planning scenarios must be imported as AA polygons in shp file. Shape file must hold a predefined structure and information:

- Internal polygons with different degree of sealing (for different type of sealing: building 100% , paved parking lot 75%, park 15%, etc...) for each land use within the area of land use change.
- Planned sealing rate (sealing degree) %
- Contamination information (optional)
- Archive/ cultural / natural (optional)

Required fields in the vAA shape file are shown in the table bellow.

Table 5: An example of required fields in vAA shape file.

Field Name	Field Description	Type	Units	Example
PA_ID	Planning area ID	number	number	3
SealedE	Degrees of sealed soil under **existing/ present** land use	number	%	15
LandUseE	Present / existing land use description	Character	character	grassland
SealedP	Degrees of sealed soil under **planned land use**	number	%	70
LandUseP	Planned land use description	Character	character	building

Caution: m*andatory fields:*

- ***numeric SealedE, SealedP* are required for calculations**
- ***character field LandUseP* for label in map** (Maestro label definition)

4.2.3 Outputs

- Map: Impact of land use change on soil resource within vPA after different land use scenarios. Expressed as an index (BXI)
- Pdf report:
    - Map of the vPA (or same view as set onscreen before the analysis)
    - Distribution graph of class area values
    - Matrices separately presenting statistical data for :
        - gBXE **Existing** (before the land use change) (quantitative and qualitative) for each AA
        - gBXP **Planned** (after the land use change/sealing) for each AA
        - gBXI **Impact** or evaluation result (soil loss / gain?) in index points
        - **Impact** result (soil loss / gain?) in percent (%)

4.2.4 Functional step-by-step description of LSR Tool[5]

- *The vPA shp file must be uploaded using the Custom areas set of tools. User browses and uploads the appropriate shp file from the local disk (if not already uploaded, check the vPA layer under LSR tool)*
- *Execution of the LSR tool.*
  - *selection of the vPA from the list of available layers*
  - *zoom to the vPA area*
  - *selection of desired polygons on screen*
- *Background processing:*
  - *Rasterisation of existing sealing - vPA using the SealedE to gSealE*
  - *Rasterisation of planned sealing - vPA using the SealedP to gSealP*
  - *Processing LSR algorithms / function*
- *Elaboration of Pdf report*
  - *Map of the area*
  - *Distribution of gBXi*
  - *3 x matrix elaborating gBXE, gBXP, gBXi and Impact (%)*

4.2.5 LSR algorithms

LSR calculation is carried out in four steps (equations). In first step the agricultural input soil quality grid (gAQS) is first multiplied by present sealing rate (BXE) to calculate present soil quality points (gBXE) and second by planned sealing (BXP) to calculate /estimate soil quality points after land use change (gBXP). In the third step the impact of land use change (BXI) is elaborated as a difference between BXE and BXP. The last step is to assess the impact of land use change in percent.

gBXE.LSR = gASQ_result * (100 - gSealE)/100)*25	Eq. 4

Where: gBXE = present soil points gQS = soil quality grid; gSealN is existing sealing rate.

gBXP.LSR = gASQ_result * (100 - gSealP)/100)*25	Eq. 5

Where: gBXE = present soil points gQS = soil quality grid; gSealP is planned sealing rate.

gBXI.LSR = gBXP - gBXE	Eq. 6

Where: gBXI is assessed impact of land use change.

Impact = (gBXI / gBXE) * 100	Eq. 7

Where: Impact is assessed impact of land use change in percent %.

4.2.6 Example of the LSR calculation

As presented in table below there is a graphical example of the LSR calculation steps. Table is divided on input data (presented as grid names), corresponding weights, intermediate and final results.

Result of the tool is presented as an index. The **LSR value** is relative index which is in the next (final) step classified (**LSR class**) and interpreted using the LSR reclassifications table (see below).

[5] *For details also see the Urban SMS Web User Manual*

Table 6: An example of LSR calculation.

Planning Area Sections	Land Use of the section	Area of section (ha)	Sealed (%)	Soil Quality	Planned Sealing (%)	Soil quality area (Bx)	Soil Quality Sealed (Bx)	Soil Loss (Bx)
1	Buildings	3,50	0	4,5	90	15,75	1,58	14,18
2	Parking lot	1,50	90	1	90	1,50	0,15	1,35
3	Ways	1,00	90	1	95	1,00	0,05	0,95
4	Allotment gardens	0,30	45	2	45	0,60	0,33	0,27
5			0	0	0	0,00	0,00	0,00
6			0	0	0	0,00	0,00	0,00
7			0	0	0	0,00	0,00	0,00
8			0	0	0	0,00	0,00	0,00
9			0	0	0	0,00	0,00	0,00
10			0	0	0	0,00	0,00	0,00
	Sum	**6,30**				18,85	2,11	**16,75**
	Diff:	6,30						
						Initial Bx	**18,85**	
						Sealed Bx	**2,105**	
						Soil Loss (Bx)	**16,7**	
						Soil Loss (%)	**88,8**	

4.2.7 Reclassification and interpretation of the LSR

Table 7: An example of LSR reclassification table.

Min class value	Max class value	Interpretation	Class Decription	Class No.	Colour
5	100	Positive change. The soil is remediated.	Gain of soil resource	1	#458B00
-5	5	No loss of soil resouces or minimal gain. Land use change is neutral to soil resource.	Neutral land use change	2	#B3EE3A
-5	-15	Minor loss of soil resource. The land use change can be performed.	Minimal loss of soil resource	3	#EEEE00
-15	-50	Significant loss of soil resource. Reconsider land use change.	Significant loss of soil resurce	4	#FF6103
-50	-100	Extreme loss of ssoil resource. Loss is not acceptable. Land use change not recomendable.	Unacceptable loss	5	#B0171F

The upper rating can be modified to meet specific conditions and/or needs. Up to 10 classes can be used for reclassification and interpretation.

4.2.8 Interpretation of the LSR index

As stressed before the LSR tool assesses the difference/change between the current and future/planned land use scenarios, expressing its result as an index. The result of the calculations is first classified, each class being interpreted accordingly:

- **negative BXI** (BXI < 0): the soil points under planned land use are lower than under present land use → **some of soil resource is lost / damaged.**
- **BXI equals or close to 0**: no significant impact of planned land use on the soil resource.
- **positive BXI**: the soil points under planned land use are bigger than under present land use → **soil resource is improved.**

4.3 Soil Contamination (SC)

The soil contamination (SC) tool features three tools - three soil contamination evaluations for three different land uses:

1. General (agricultural) soil contamination (**SCFood**)
2. Children playgrounds soil contamination (**SCPlay**)
3. Sporting areas soil contamination (**SCSport**)

The semantic/calculation/design is the same for all three tools, with a difference that they assess soil contamination according the threshold values of the separate land use:

1. Threshold values for general (agricultural) soil contamination (to be implemented by the PPs; Bratislava, Vienna, Pulawy and Celje)
2. Threshold values for contamination of the children playground areas (to be implemented by the PPs; Pulawy, Bratislava)
3. Threshold values for soil contamination for recreational areas (to be implemented by Pulawy)

In general, all SC tools evaluate soil contamination according to the national threshold values for selected land use. Threshold values for each SC tool are pre-defined in the Urban SMS web page, Admin section, Edit Input Data Soil Contamination table.

4.3.1 The purpose of the SC tools

The purpose is to elaborate information (map) on *legal* status of contamination and/or suitability of assessed land for selected area (AA). Contamination raster files (measured data) are compared to the national legislation (threshold values according to land use) by separate contaminant and classified. The output is “summarized” contamination information in form of a single number, which represents the number of contaminants exceeding the threshold values.

The tool elaborates the map with contaminated areas on MA or AA scale and generates report.

4.3.2 SC data preparation

For SC assessment contamination grid layers are used. Data can be prepared using two different approaches according to the accuracy, data density and spatial variability of contamination (contamination sources):

1. **Geo-statistical methods** (i.e. kriging, IDW, ...), gives the scientific approach to statistical spatial approximation of the soil contamination and does not give the actual measured contamination.

OR:

2. **Simple point to raster conversions** in GIS represents a simple transformation from vector point information to raster point information. The result is actually measured contamination as it was determined by sampling and analytics. Big lack of information bit accurate information supported by the measured values.

Approach should selected according to the internal municipal data preparation and assessment policy.

4.3.2.1 Geo-statistical approach

The input information required by the tool is raster contamination GIS layer generated from point contamination data. Point information is geo-statistically processed using geostatistical spatial interpolation to assess the contamination between individual sampling points (measured data). The result is spatial approximation of the contamination in a raster form. Grids are elaborated (by experts) for separate contaminants.

4.3.3 Modifications of SC according to the land use

As described above, SC tool was multiplied to enable the area assessments according to planned scenarios (land use). With multiplication all functionalities of the tool remained the same. The grid soil contamination status is elaborated with the same semantics using three different sets of threshold values.

4.3.3.1 SCFood

	Tool	Name in MAESTRO	Data name	Threshold Value min	Threshold Value max	Topology	Format	Data path	
Edit Delete	SCFood	gSC_PbF	Pb measured data	0	200	cell	ESRI grid	C:\Data\urbansms\GISData\12.5\USMS\ToolData\gSC_Pb\hdr.adf	
Edit Delete	SCFood	gSC_ZnF	Zn measured data	0	100	cell	ESRI grid	C:\Data\urbansms\GISData\12.5\USMS\ToolData\gSC_Zn\hdr.adf	
Edit Delete	SCFood	gSC_CdF	Cd measured data	0	60	cell	ESRI grid	C:\Data\urbansms\GISData\12.5\USMS\ToolData\gSC_Cd\hdr.adf	
Edit Delete	SCFood	gSC_NiF	Ni measured data	0	85	cell	ESRI grid	C:\Data\urbansms\GISData\12.5\USMS\ToolData\gSC_Ni\hdr.adf	
Edit Delete	SCFood	gSC_AsF	As measured data	0	20	cell	ESRI grid	C:\Data\urbansms\GISData\12.5\USMS\ToolData\gSC_As\hdr.adf	
Edit Delete	SCFood	gSCFood_result	Result	0	0	Result	Result	C:\Data\urbansms\GISData\12.5\USMS\ToolData\gSC_result\	
	ESQ								Insert

Figure 2: Example of admin edit input data table for General (Agricultural) soil contamination (gSCFood).

4.3.3.2 SCPlay

	Tool	Name in MAESTRO	Data name	Threshold Value min	Threshold Value max	Topology	Format	Data path	
Edit Delete	SCPlay	gSC_PbP	Pb measured data	0	200	cell	ESRI grid	C:\Data\urbansms\GISData\12.5\USMS\ToolData\gSC_Pb\hdr.adf	
Edit Delete	SCPlay	gSC_ZnP	Zn measured data	0	100	cell	ESRI grid	C:\Data\urbansms\GISData\12.5\USMS\ToolData\gSC_Zn\hdr.adf	
Edit Delete	SCPlay	gSC_CdP	Cd measured data	0	60	cell	ESRI grid	C:\Data\urbansms\GISData\12.5\USMS\ToolData\gSC_Cd\hdr.adf	
Edit Delete	SCPlay	gSC_NiP	Ni measured data	0	85	cell	ESRI grid	C:\Data\urbansms\GISData\12.5\USMS\ToolData\gSC_Ni\hdr.adf	
Edit Delete	SCPlay	gSC_AsP	As measured data	0	20	cell	ESRI grid	C:\Data\urbansms\GISData\12.5\USMS\ToolData\gSC_As\hdr.adf	
Edit Delete	SCPlay	gSCPlay_result	result	0	0	cell	ESRI grid	C:\Data\urbansms\GISData\12.5\USMS\ToolData\gSCPlay_result\	
	ESQ								Insert

Figure 3: Example of admin edit input data table for Contamination for children playgrounds (gSCPlay).

4.3.3.3 SCSport

	Tool	Name in MAESTRO	Data name	Threshold Value min	Threshold Value max	Topology	Format	Data path	
Edit Delete	SCSport	gSC_ZnS	Zn measured data	0	100	cell	ESRI grid	C:\Data\urbansms\GISData\12.5\USMS\ToolData\gSC_Zn\hdr.adf	
Edit Delete	SCSport	gSC_CdS	Cd measured data	0	60	cell	ESRI grid	C:\Data\urbansms\GISData\12.5\USMS\ToolData\gSC_Cd\hdr.adf	
Edit Delete	SCSport	gSC_NiS	Ni measured data	0	85	cell	ESRI grid	C:\Data\urbansms\GISData\12.5\USMS\ToolData\gSC_Ni\hdr.adf	
Edit Delete	SCSport	gSC_AsS	As measured data	0	20	cell	ESRI grid	C:\Data\urbansms\GISData\12.5\USMS\ToolData\gSC_As\hdr.adf	
Edit Delete	SCSport	gSC_PbS	Pb measured data	0	200	cell	ESRI grid	C:\Data\urbansms\GISData\12.5\USMS\ToolData\gSC_Pb\hdr.adf	
Edit Delete	SCSport	gSCSport_result	Soil Contamination - Sports result	0	0	cell	GRASS png	C:\Data\urbansms\GISData\12.5\USMS\ToolData\gSCSport_result\	
	ESQ								Insert

Figure 4: Example of admin edit input data table for Contamination for sporting areas (gSCSport).

4.3.4 SC calculation

SC processing is carried out in three steps.

- First the algorithm compares measured data/values of each pollutant to the national threshold values of selected land use and elaborates contamination status for each contaminant. Required threshold values are preset in the Admin application.
- Contamination statuses for all contaminants are joined into one common soil contamination information (absolute contamination status - raster elaborated).
- The raster presents the number of contaminants exceeding the national threshold values.

Table 8: Dataset example: SCFood data list (part of the common Data Description Table -DDT).

Tool	Dataset	Weight	Units	DataName	FileName	Topology	Format
SCFood	gSC_Pb	/	Class	Pb contamination class - topsoil	gSC_PbF	cell	ESRI grid
SCFood	gSC_Zn	/	Class	Zn contamination class - topsoil	gSC_ZnF	cell	ESRI grid
SCFood	gSC_Cd	/	Class	Cd contamination class - topsoil	gSC_CdF	cell	ESRI grid
SCFood	gSC_Ni	/	Class	Ni contamination class - topsoil	gSC_NiF	cell	ESRI grid
SCFood	gSC_As	/	Class	As contamination class - topsoil	gSC_AsF	cell	ESRI grid

4.3.5 Outputs

The outputs for all three land uses are raster layers – grid databases, presenting the contamination status of selected area. The report contains general statistics, map and the graph of contamination distribution for the AA.

- Grid soil contamination status for MA/AA suggests suitability of soil for certain use. Grid values showing number of contaminants exciding threshold values
- Pdf report:
  - Map of soil contamination status for selected land use covering the MA/AA
  - General statistics
  - Matrix with contamination data (contamination status, ha, etc…)

4.3.6 Functional step-by-step description of the SC tool

- *Run/execution of the SC tool.*
  - *There are three separate tools in the menu*
  - *Tool prompts / inputs*
- *Background processing*
  - *Reclassification of measured data grid using threshold values (predefined in admin page) to elaborate separate contamination grids;*
  - *Processing SC algorithm (using reclassed contamination grids) (gSCx);*
  - *Interpretation using 'Data interpretation & legend' (Admin page) to elaborate gSCi.*
- *Presentation of pdf report:*
  - *Map of the area*
  - *Distribution of gSCx (values from algorithm 0, 1, ...n)*
  - *Matrix / statistics of gSCi interpretation after reclassification (using admin: Data interpretation & legend definitions)*

4.3.7 SC algorithm

SC calculation is carried out in one step. Input soil contamination grids can have only two values 1 _ contaminated and 5 (not contaminated). These values are classified according to the national / local legislation.

General equation, to be adapted regarding the legislation	Eq. 8
gSCx = gSC_As_cs + gSC_Pb_cs + gSC_Zn_cs + ... + gSC_PCB_cs (example)	
Celje test implementation / test - the Slovenian legislation	
gSCx = (gSC_Cd_cs) + (gSC_Ni_cs) + (gSC_As_cs) + (gSC_Pb_cs) + (gSC_Zn_cs)	

Where:
SCx: soil contamination output. 'x' stands for preselected land use (play - children playgrounds; food - food production; sport - recreational areas)
gSC-AS - gSC_PCB are separate soil contamination grids.

4.3.7.1 Resulting GIS layers

The result is soil contamination grid gSCx:

- gSCx where x = play: contamination assessed using children playgrounds threshold values
- gSCx where x = food: contamination assessed using food production threshold values
- gSCx where x = sport: contamination assessed using recreational areas threshold values

In the next step gSCx is interpreted to gSCi using *'Data interpretation & legend'.*

4.3.8 Example of the SC calculation

As presented in table below there is a graphical example of the SCx calculation steps. The measured data (Grids) are assessed according to the national threshold values. The contamination status and a total number of contaminants are presented as a result.

Table 9: An example of SCx calculating steps.

Contaminant	Min	Threshold Value	Units	Measured Data	Contaminated
Pb	0	200	mg/kg dry soil	50	NOT contaminated
Zn	0	100	mg/kg dry soil	0,3	NOT contaminated
Cd	0	6	mg/kg dry soil	5	NOT contaminated
Ni	0	85	mg/kg dry soil	33	NOT contaminated
As	0	20	mg/kg dry soil	1	NOT contaminated
Contamination Status		**Not Contaminated**			
Cntaminants exceeding TV		**0**			
SC interpretation		**Regarding the soil contamination status land use change possible.**			

4.3.9 Reclassification and interpretation of the SC grid

Table 10: An example of the SCPlay reclassification table.

Class	*Min*	*Max*	Class description	Color	Interpretation
1	0	0	Not contaminated	#FFFFFF	Regarding the soil contamination status land use change possible.
2	1	1	Contaminated	#FFFF33	One contaminant exceed threshold value. Children playground cannot be planned. If existing, it should be remediated!
3	2	2	Contaminated	#FF9900	Two contaminants exceed threshold value. Children playground cannot be planned. If existing, it should be remediated!
4	3	3	Contaminated	#FF6A6A	Three contaminants exceed threshold value. Children playground cannot be planned. If existing, it should be remediated!
5	4	4	Contaminated	#FF3030	Four contaminants exceed threshold value. Children playground cannot be planned. If existing, it should be remediated!
6	5	20	Contaminated	#CD0000	Five or more contaminants exceed threshold value. Children playground cannot be planned. If existing, it should be remediated!

The upper rating can be modified to meet specific conditions and/or needs. Up to 10 classes can be used for reclassification and interpretation.

4.3.10 Interpretation of the SC results

SC tools define land as contaminated, wherever at least one of the contaminants exceeds the threshold value. Soils are defined as contaminated with number greater than 0 and as non-contaminated when equal to 0. The cell value 1 stands for one contaminant, 2 for two contaminants etc. exceeding threshold value.

The result is expressed with a number where:

- Value 0: Not contaminated
- Value 1: Contaminated; one contaminant exceeding the threshold values for selected land use
- Value 2: contaminated; two contaminants exceeding the threshold values.
- …
- Value n: Contaminated; n contaminants exceeding the threshold values.

The interpretation is predefined in Data interpretation & legend (Urban SMS web Admin page).

4.4 Sealing Rate (SR)

The Sealing Rate tool will be implemented by 4 PPs: Prague, Vienna, Pulawy and Bratislava.

The quality of urban environment in terms of quality of living space for humans in many aspects depends on the opened or, better, green areas in cities. In general parks, ornamental gardens, sporting grounds contribute to the quality of urban life. Additionally, unsealed soil of green areas performs important environmental (e.g. cooling effect) and social functions (e.g. recreation).

4.4.1 The purpose of the SR tool

This tool assesses the distribution of green areas within the urban area. The tool visualises the distance to green areas and calculates the ratio of sealing – the rate of unsealed / sealed soils within the analysed area. The sealing rate tool calculates:

- The ratio of unsealed / sealed or better said green areas / urban areas which is used to argument the need for new green areas or to enlarge an existing one. In general it is desired to have a disperse net of medium size green areas (small parks cca 1ha?) across the city.
- The fragmentation ratio - a figure that shows how much of sealed areas (predefined distance 100m) are adjacent to green areas - areas of unsealed soil. In general it is desired to establish more medium or small size green areas and long perimeters (sealed / non sealed transition lines) in the city rather than a few large ones.

The outcome of the tool is a report. It can be used iterative to assess different planning options.

4.4.2 Spatial extent: AA

Tool analysed area: one or more polygons of previously selected analysed areas. Existing city district polygons or polygons created by user can be used. If there is no green areas inside analysed polygons ratio and fragmentation index will not be calculated.

4.4.3 Data requirements

Input data are the existing land use of the planned area.

Table 11: SR input information

Tool	Dataset	Weight	Units	DataName	FileName	Topology	Format
SR	gEucGREEN	/	/	Distance from areas classified as 'green' (in meters)	gEucGreen	cell	ESRI grid

4.4.3.1 Data preparation

The gEucGREEN grid can be derived from any land use polygon layer where all land uses considered as green (e.g. parks, ornamental gardens, playgrounds, sport areas …) are clearly defined polygons.

Example: in the land use polygon layer vGREE land use field named "green" is added. 'Green' polygons are marked with 1 for green and with 0 for non green respectively. The vector to raster tool/command is used to elaborate grid gGREEN

4.4.4 Outputs

- Grid Distance to green areas (gEucGREEN) in meters (within AA)
- Pdf report:
  - Small map of the analysed area
  - Graph distribution of distance to green areas in meters (AA)

- Calculated Ratio = unsealed / sealed for analysed area
- Calculated: Fragmentation Index = area of first buffer zone from green (predefined buffer zone is 100m) / total polygon area

4.4.5 Functional step-by-step description

- Selection of polygons from shp layer or/and on-screen digitised polygons using the *Custom areas* set of tools
- *Run/execution of the SR tool.*
- *Background processing*
  - *Clip of gEucGREEN v with selected polygons*
  - *Reclassification to gEucGREENc using the reclass table (pre-defined in Data interpretation & legend)* ***with several classes of which two are mandatory****:*
    - *0 m = 'green' area (= green poly from vec file)*
    - *100 = less than 100m from 'green' (= definition of the bordering area; can vary - 100m is a predefined example in Urban SMS web Admin section)*
- *Elaboration of report:*
  - *Map gEucGREENc (classified raster data)*
  - *Distribution graph of gEucGREENc*
  - *Statistics and tables with gEucGREENc class data and class in ha per AA*
    - *Sum of gEucGREENc with value = 0 (→ Green area itself)*
    - *Sum of gEucGREENc area within distances predefined in the Data interpretation & legend (Admin page)*
  - *Additional SR table per poly:*
    - *Calculate the ratio AreaGreen : NonGreen per poly*
    - *Calculate the fragmentation index: 1st buffer from green : TotalAAarea per poly*

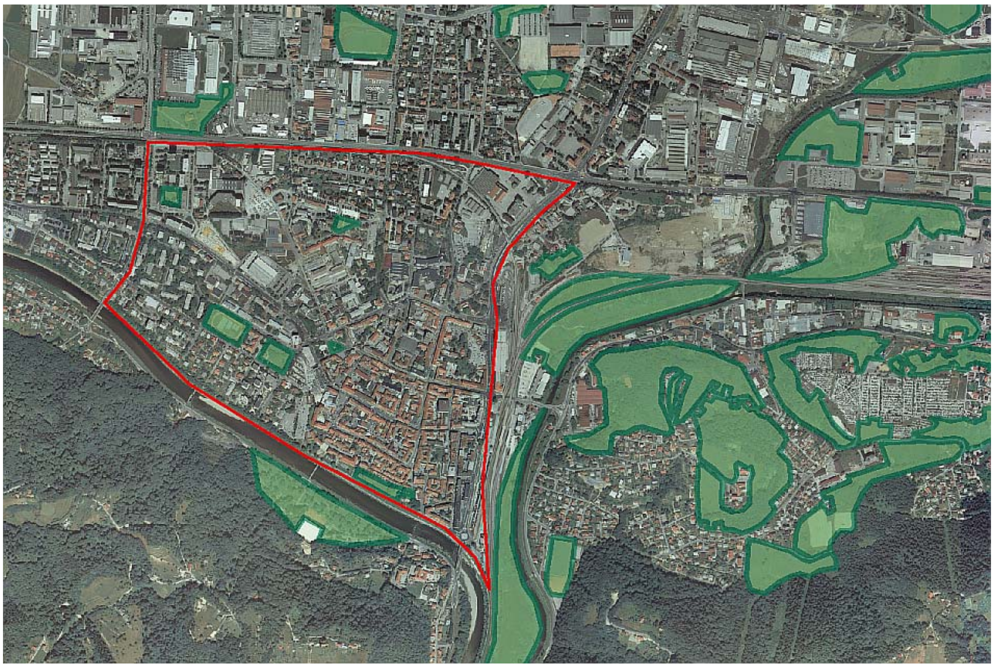

Figure 5: An example of the vGREEN overlaid by the within the on-screen digitized polygon.

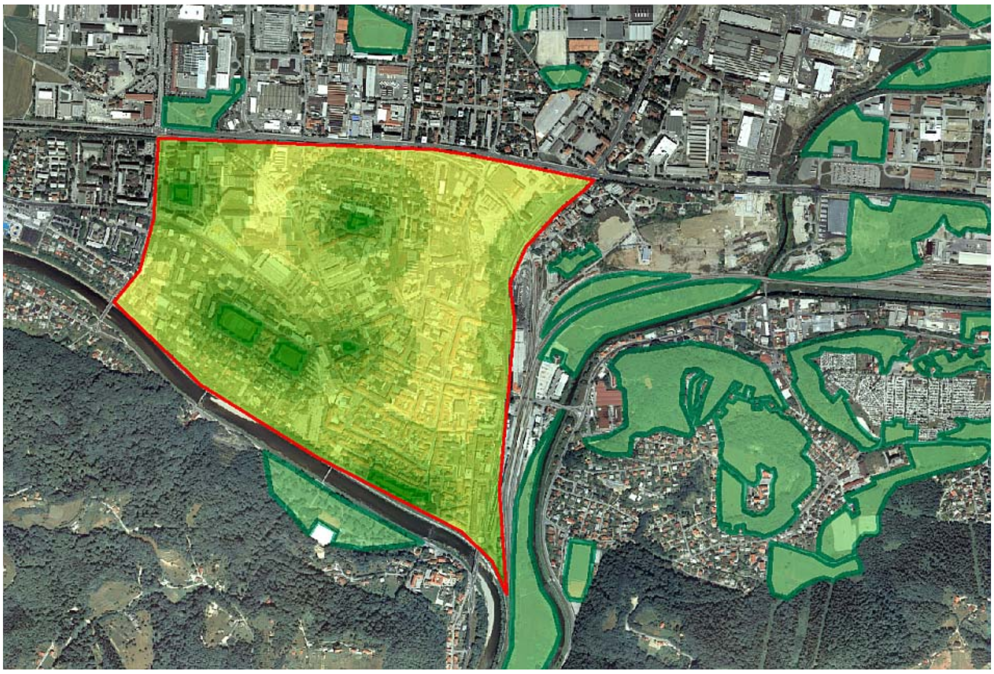

Figure 6: An example of the EUCvGREENc within the on-screen digitized polygon.

4.4.6 SR interpretation

The classification and interpretation of the SR results is predefined in Data interpretation & legend (Admin page). The result is classified according to preset distances from green areas.

The closer the AA to the green areas, the bigger the impact of urban green to AA is. The impact can be economical (e.g. higher price of real estate), higher quality of life (e..g living closer to the parks), microclimate (e.g. cooling effect), etc.

The higher the ratio and fragmentation index the higher quality of life there is.

4.5 Agricultural Soil Quality (ASQ)

The ASQ tool will be implemented by the PPs: Prague, Vienna, Milan and Bratislava.

The existing agricultural soil quality databases have on many occasions too coarse scale which is conditionally applicable for local land planning purposes. ASQ tool is used to elaborate the ASQ dataset of better spatial resolution which is needed for application in local planning procedures. The ASQ assessed on the basis of agricultural production most relevant and generally available soil quality (SQ) parameters. ASQ tool is used when national soil quality dataset is not available or when already available ASQ database has a coarse scale.

4.5.1 The purpose of the ASQ tool

The purpose of the tool is to elaborate agricultural soil quality in better spatial resolution needed in local scale planning procedures to define the suitability / quality of land for general agriculture.

The soil quality is evaluated using separate soil quality indicators (soil properties) and additional spatial data. The tool analysis can be performed only within the area with all required soil quality and spatial data.

ASQ maps are used for the presentation, to distinguish between “suitable” and “less suitable” land for agriculture. Using this results spatial planner is enabled to better protect the soil resource and to direct the urban development to the areas with lower ASQ.

4.5.2 Data requirements

Table 12: ASQ input information (pre-processed).

Tool	Dataset	Weight	Units	DataName	FileName	Topology	Format
ASQ	gOM_ASQ	3	Class	Soil organic matter content class - topsoil	gOM_ASQ	cell	ESRI grid
ASQ	gTX_ASQ	2	Class	Soil texture class - topsoil	gTX_ASQ	cell	ESRI grid
ASQ	gNS_result	2	Class	Nutrient status class - topsoil	gNS_result_ASQ	cell	ESRI grid
ASQ	gSD_ASQ	2	Class	Soil depth class	gSD_ASQ	cell	ESRI grid
ASQ	gPH_ASQ	2	Class	Soil pH class - topsoil	gPH_ASQ	cell	ESRI grid
ASQ	gSCFood_result	3	Class	Soil contamination class - topsoil	gSCFood_result_ASQ	cell	ESRI grid
ASQ	gSLP	3	Class	Slope class (arable land)	gSLP	cell	ESRI grid
ASQ	gAgr	0	Class	Agricultural land use	gagr	cell	ESRI grid
ASQ	gUrbProx	0	Class	Proximity to urban - cell values in meters	gUrbProx	cell	ESRI grid
Tool	Dataset	Weight	Units	DataName	FileName	Topology	Format

Inclusion of grids is optional – (to be discussed). Additional data such as agro-technical parameters can be additionally used for the calculation (ASQ function adapted accordingly).

4.5.3 Outputs

- ASQ index which quantifies the general agricultural soil quality in one number.
- gASQ : Raster database (grid) of general soil quality for agriculture. Raster values are relative index values.
- PDF report with the statistics
  - Small map of the analysed area
  - Graph distribution of ASQ values
  - Statistics per MA (distribution ASQ index / ha?)
  - Optional: matrix (ASQ, ha → Cut&Paste Excel- Word using freeware sw.)

4.5.4 Preparation of measured data for ASQ tool calculations

Preparation stage is done in two steps:

- Soil Quality Index (SQI): measured data are converted to quality class values using the threshold values. When the class data is already available this step is not necessary.
- ESQ calculation**:** ESQ index is calculated using elaborated relative SQI which is selected from the Basic/Environmental SQI and set by applying the ESQ equation (in development).

In the preparation stage vector polygons are rasterised using simple vector to raster GIS tool. The threshold values for the ASQ tool have to be used. The system offers the full flexibility for each municipality to set their own threshold values according to their national legislation, own practices, data availability, data situation. This step is important step and carried out in the data preparation phase or repeated when data is replaced with new set.

The soil quality threshold values should be set by the soil expert.

Separate parameters are usually available as attributes (average values per polygon) in vector soil quality map. Pre-processing is required. From the vector soil quality map soil quality attribute data are used to rasterize separate grids gOM_ASQ, gPH_ASQ, gNS_ASQ, gTX_ASQ, gSD_ASQ.

Rasterization tools are available in ArGIS toolboxes (Conversion Tools; To Raster; Polygon to Raster) or ArcWorkstation (*polygrid* command) environment; to mention only some of the available software.

From input ASQ grids the areas of water, forest and other non-agricultural land use should be removed (set null).

gUrbProx grid is generated by GIS tools :

- EucDistance() function in ArcInfo ArcWorkstation, GRID module; or
- EuclideanDistance in ArcGIS Spatial Analyst ToolBox

4.5.5 Functional step-by-step description of ASQ tool

- *Run/execution of the ASQ tool*.
- *Background processing*
  - *Checking of the availability of soil data (required agricultural SQI grids)*
  - *Processing of the predefined ASQ algorithm*
  - *Elaboration of report (statistics of the agricultural value of the area)*
- *Elaboration of report:*
  - *Map gASQc*
  - *Distribution graph of gASQc*
  - *Statistics and tables with gASQc class data and class / ha per poly*

4.5.6 ASQ algorithms

Step 1: Sum of class values multiplied by weight

AbsASQ = "((gOM_ASQ*wgOM_ASQ) + (gPH_ASQ*wgPH_ASQ)+ (gNS_result*wgNS_result_ASQ) + (gTX_ASQ*wgTX_ASQ) + (gSD_ASQ*wgSD_ASQ) + (gSCFood_result*wgSCFood_result_ASQ) + (gSLP*wgSLP)) * gAgr"	Eq. 9

Where:
gXX are separate SQI grids where call values are quality class values; see Table 1, :DDT, field Dataset
wXX are separate SQI weight for ASQ tool

Step 2: Maximum possible class values multiplied by weight

MaxASQ = "6 * (wgOM_ASQ + wgTX_ASQ + wgNS_result_ASQ + wgPH_ASQ + wgSD_ASQ + wSC Food_result_ASQ+ wgSLP)"	Eq. 10

Where:
wXX are separate SQI weights for ASQ tools
6 = max value of class

Step 3: Relative ASQ

RelASQ = "AbsASQ/MaxASQ * 100"	Eq. 11

Where:
rel.ASQ is are separate SQI weight for ESQ tools
ASQprox = threshold value distance from urbanised area in meters (example: 100)

Step 4: ASQ corrected by proximity to urban areas

ResultASQ : RelASQ * pow (1 - exp (-0.017 * gUrbProx), 0.5)	Eq. 12

The resulting grid holds the agricultural soil quality

Table 13: An example of the ASC calculation.

INPUT DATA AND RESULTS						
Soil parameters						
Parameter No.	**Data Layer**	**Quality Indicator**	**Units**	**Data Value**	**Weight**	**Weighted Value**
1	gOM	Soil organic matter content class - topsoil	Class	4	3	6
2	gTX	Soil texture class - topsoil	Class	4	2	4
3	gNS	Nutrient status class - topsoil	Class	3	2	3
4	gSD	Soil depth class	Class	3	2	3
5	gpH	Soil pH class - topsoil	Class	3	2	3
6	gSC	Soil contamination class - topsoil	Class	3	3	4,5
7	gSLP	Slope class (arable land)	Class	2	3	3
Sum of weighted values		26,5				
Maximum possible class		42,5				
ASQ (%)		**62,4**				
		Distance from urban		**Distance from urban (m)**		**Distance Threshold (m)**
8	gUrbProx	Proximity to urban - cell values in meters		200		150
ASQ quality (%)		**83,1**				
ASQ Class		**6**				
Class Description		**Best agricultural value**				
Class Interpretation		***Land of best agricultural value land. No sealing. Soil to be protected for agricultural use.***				

4.5.7 Reclassification of the ASQ grid

4.5.7.1 ASQ reclassification table

Table 14: An example of the ASC reclassification table.

1	-100	5	No soil OR marginal agricultural value	#FFF8DC	No OR marginal agricultural value land. Suitable for urban expansion. In case of soil contamination, reconsider the urban land use and / or take remediation actions.
2	5,01	15	Marginal agricultural value	#EEE8CD	Marginal agricultural value land. Changes to urban land use recommendable.
3	15,01	25	Low agricultural value	#FFEC8B	Low agricultural value land. If possible avoid sealing. Preserve for green land uses i.e. parks, ornamental gardens or similar non-soil destructing land use.
4	25,01	50	Medium agricultural value	#FFC125	Land of medium agricultural value. Sealing should be avoided. Other green urban land uses recommendable.
5	50,01	70	Good agricultural value	#CD9B1D	Land of good agricultural value. Sealing is to be avoided. Soil to be preserved in agricultural use.
6	*70,01*	*100*	Best agricultural value	#8B5A00	Land of best agricultural value land. No sealing. Soil to be protected for agricultural use.

Up to 10 classes can be used for reclassification of the RelASQ grid to Class.ASQ grid.

Figure 7: An example of the ASQ grid in classes

4.6 Water drainage (WD)

The WD tool will be implemented by the PPs: Bratislava

The WD tool is used to assess the risk of water logging on flat non-sealed soil. The tool does not evaluate the impact of alternative paths (e.g. channels, surface run-off) from the AA. These parameters/factors are difficult to evaluate and control.

4.6.1 The result of the WD tool

WD tool assess the location and the extent of low water infiltration rates and consequently the risk of water logging on flat areas only. As a result, the areas of water logging risk are visualised on the map along with basic statistics. The PDF report is generated.

4.6.2 Data requirements

Table 15: The WD input information (draft list of soil).

Tool	Dataset	Weight	Units	DataName	FileName	Topology	Format
WD	gClay	1	Class	Average topsoil clay content (%)	gClay	cell	ESRI grid
WD	gSand	1	Class	Average topsoil sand content (%)	gSand	cell	ESRI grid
WD	gTSdepth	1	Class	Real soil depth (max up to 40cm)	gTSdepth	cell	ESRI grid
WD	gPores	1	Class	Soil porosity (macro and medium pores) (%)	gPores	cell	ESRI grid
WD	gFlat	1	Class	Only areas on flat landscape (less then 5^{o} inclination)	gFlat	cell	ESRI grid
WD	Days	1	/	Number of rainy days	days	parameter	value
WD	Prec	1	/	Average precipitation per day (mm)	perc	parameter	value

4.6.3 Outputs

- Raster presenting areas of low water drainage (wl.WD) with risk of water logging. Cell values are class values.
- PDF report with the statistics
    - Small map of the analysed area
    - Graph distribution of WD values
    - Statistics per AA

4.6.4 Functional step-by-step description of WD tool

- *Selection of AA polygon(s) (optional).*
- *Run/execution of the WD tool.*
- *Background processing*
    - *Processing of the predefined WD algorithm*
- *Elaboration of report:*
    - *Map gWDc*
    - *Distribution graph of gWDc*
    - *Statistics and tables with gWDc class data and class / ha per poly*

4.6.5 WD algorithms

WD calculation is carried out in one step. Average precipitation per day (mm) and number of days which define the 'heavy rain' are inserted directly in the equation in Urban SMS Admin web page. For the calculation the soil depth and soil porosity information can be used as a grid or a parameter values.

Pedotransfer function (Cosby et al., 1984) for saturated hydraulic conductivity and soil porosity are subtracted from the amount of precipitation in predefined number of days. At the end the whole equation is multiplied with gFlat. Positive results present areas with low drainage and high water logging risk. Negative results present areas with good water drainage and low water logging risk:

Step 1: Calculation / prediction of water logging (mm)

wl.WD = ((Prec * Days) - (10 * gTSdepth * gPores) - (609,6 * pow(10;-0,6 + (0,0126 * gSand) - (0,0064 * gClay))))*gFlat	Eq. 13

Where:

parameter value Prec is average day precipitation (mm)
parameter value Days of topsoil
grid gTSdepth is real soil depth (max up to 40cm)
grid gPores is topsoil porosity (%)
grid gSand is topsoil sand content (%)
grid gClay is topsoil clay content (%)
grid gFlat defines only areas of up to 5 degrees inclination

As a result a gWD grid is calculated and classified. The WD tool result is expressed as class (1 for low and 5 for high water logging risk.

4.6.6 Example of the WD calculation

As presented in table below there is a graphical example of the WD calculation steps. The measured data (Grids) are assessed according to the available national/local databases. Only the areas with inclination less then 5° are considered.

Table 16: An example of WD calculation process.

WD tool				
1. Input parameters				
		talni parameter	**class**	**Data Type**
1	**Average Precipitation per day (mm/day)**	Prec	60	value
3	**Number of Days**	Days	5	value
2	**Real soil depth (max up to 40) (cm)**	gTSdepth	40	grid
4	**Average Topsoil Clay Content (%)**	gClay	70	grid
5	**Average Topsoil Sand Content (%)**	gSand	16	grid
6	**Soil Porosity (macro and medium pores) (%)**	gPores	50	grid
7	**Only area on flat landscape (less than 5° Inclination)**	gFlat	1	grid
2. Water logging assessment				
1.	Amount of precipitation (predefined days) (mm)	300	mm	
2.	Soil water capacity (mm)	200	mm	
3.	Ks - Saturated soil hydraulic conductivity (mm/day)	87	mm/day	
	Water logging	13	mm	
		* negative value = no water logging, good drainage		
		* positive value = water logging, bad drainage		

4.6.7 Reclassification and interpretation of the WD grid

4.6.7.1 WD reclassification table

Table 17: An example of WD reclassification table.

Min class value	Max class value	Interpretation	Class Decription	Class No.	Colour
-200	-10	*No water logging risk. Suitable for sealing. If possible preserve for green land uses (parks, ornamental gardens or similar non-soil destructing land use) or for agricultural use.*	*Very good water drainage*	1	#4EEE94
-10	0	*Very low water logging risk. Suitable for sealing. If possible preserve for agricultural use or for green land uses (parks, ornamental gardens or similar non-soil destructing land use).*	*Good water drainage*	2	#BDFCC9
0	10	*Land of good agricultural value. Sealing is to be avoided. Soil to be preserved in agricultural use.*	*Medium water drainage*	3	#C6E2FF
10	20	*High water logging risk. Sealing should be avoided. Land of low agricultural value. Suitable for grasslands.*	*Low water drainage*	4	#63B8FF
20	200	*Very high water logging risk. Area not suitable for sealing. Land of very low agricultural value. Suitable for grasslands.*	*Very low water drainage*	5	#1874CD

4.6.7.2 Interpretation of the WD index

The WD equation yields values in a range from -150 to 150. The WD values can be used for water drainage/infiltration rate assessment or as a description of water logging risk. Of course the upper rating can be modified to meet specific conditions and/or needs. For reclassification up to 5 classes can be used for reclassification of the wl.WD (mm) to wl.WDc (class).

4.7 Connectivity tool (CNT)

The CNT tool was additionally proposed by the municipality of Milano

4.7.1 The purpose of the CNT tool

CNT tool is needed to evaluate if a new green area in the urban context is close to other existing green areas in order to be connected to them. The distance in not intended in terms of meters, but in terms of cadastral parcels to be bought to connect two green areas. If two green areas are separated by only one parcel they are well connected, if the parcels are three or more they are bad connected, even if they are very close in terms of absolute distance.

4.7.2 Spatial extent

Tool analysis area: one or more polygons of previously selected areas for the analysis (AA). Existing polygon layer or new on-screen digitalised polygons can be used. The single or multiple selections should be done before the tool is run.

The tool can be applied to the whole municipal area or to specific sub-parcels only. The result is calculated based on spatial pre-existing location (not soil properties) of built and open areas.

4.7.3 Data requirements

Input data are:

- Area of Analyses
- Existing green areas
- Cadastral map

Table 18: An example of required input data for CNT tool.

Tool	Dataset	Weight	Units	DataName	FileName	Topology	Format	Suggested Scale
CNT	vAA	/	/	Areas of analysis	vAA	poly	Shapefile	
CNT	EGA	/	/	Existing green areas	vEGA	poly	Shapefile	
CNT	CM	/	/	Cadastral Map	vCM	poly	Shapefile	

vAA areas can be selected from existing polygon shape files (e.g. cadastral map, land use maps, ...) or on-screen digitized polygons.

Predefined CNT tool specific variables in admin page: Buffer distance (m): <BufferDist>

4.7.4 Outputs

A PDF report containing, for each Area of Analysis, the list of every existing green area intersected during the elaboration, its surface (m2) and the measured CNT RATE.

CNT RATE is an adimensional, numeric parameters whose value is 5 if the intersected green area and the AA have a high connection rate, 3 if they have a medium connection rate, and 1 if they have a low connection rate.

4.7.5 Functional step-by-step description of CNT tool

Draw and select one or more new polygons on screen OR select one or more existing poly from CM layer.

Tool execution:

1. Run/execution of the CNT tool
2. Offer to update pre-set buffer distance (if needed)
   a. Buffer distance (m): <BufferDist> (<BufferDist> CNT tool specific variable is predefined admin CNT page)

Background processing:

3. Execute a <BufferDist> m buffer on the selected polygon layer -> create BUF1 layer

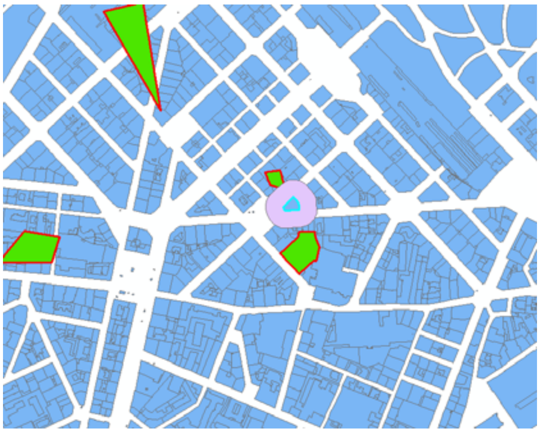

Figure 8: Cadastral layer (blue), urban green areas polygons (green), buffer BUF1.

4. Intersect BUF1 and EGA -> create INT1 layer
5. Select on EGA all the (even partially) intersected polygon, export as a first result (OUT1), add a new field named “CNT_RATE” and put in this field the value “5”
6. Intersect BUF1 and CM -> INT1b layer
7. Select on CM all the (even partially) intersected polygon and execute a <BufferDist> m buffer on this selection -> BUF2 layer

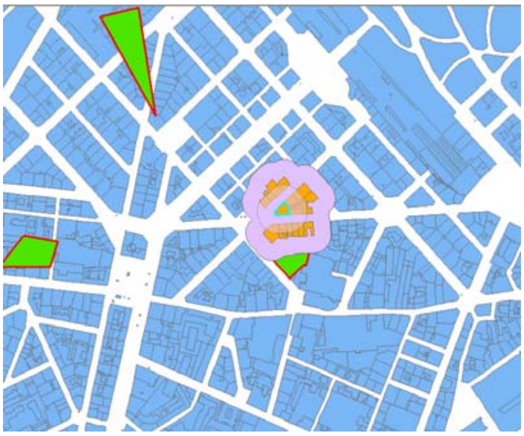

Figure 9: Cadastral layer (blue), urban green areas polygons (green), buffer BUF2.

8. Intersect BUF2 and EGA -> INT2 layer
9. Select on EGA all the (even partially) intersected polygon, export as a second result (OUT2), add a new field named “CNT_RATE” and put in this field the value “3”
10. Intersect BUF2 and CM -> INT2b layer
11. Select on CM all the (even partially) intersected polygon and execute a <BufferDist> m buffer on this selection -> BUF3 layer

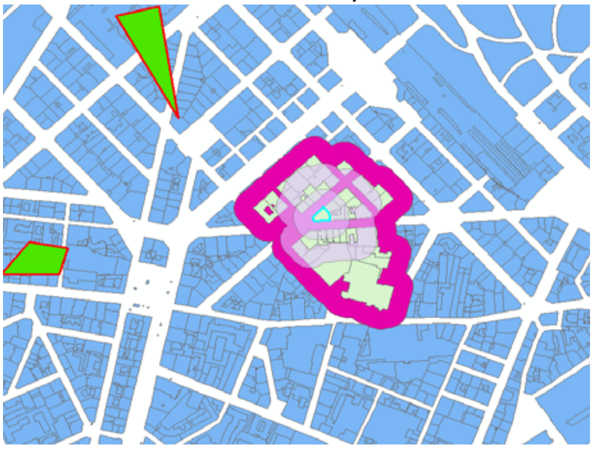

Figure 10: Cadastral layer (blue), urban green areas polygons (green), buffer BUF2.

12. Intersect BUF2 and EGA -> INT3 layer
13. Select on EGA all the (even partially) intersected polygon, export as a third result (OUT3), add a new field named “CNT_RATE” and put in this field the value “1”
14. Cancel (erase function) from OUT2 layer the polygons included in OUT1 layer, then erase from OUT3 the polygons included in OUT2
15. Merge OUT1, OUT2 and OUT3 to CNT_RATE shp file.

The final output should list the green areas intersected in OUT1, OUT2 and OUT3, with the correspondent CNT_RATE value.
Note that in steps 4, 8 and 12 you can produce a void shapefile if no green areas exist in the intersection buffer. In this case inform the user "No green areas within the <BufferDist> meter distance"

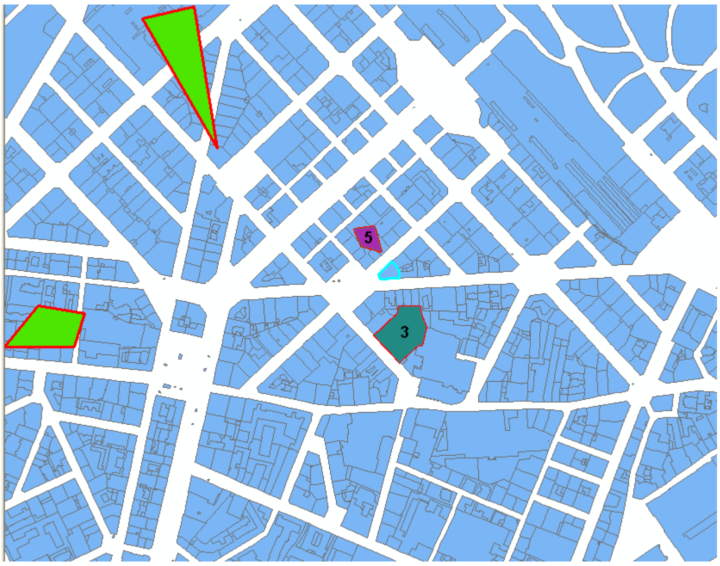

Figure 11:Example of the final output.

Geographic representation of the final output: the pink area has 5 as CNT_RATE value, while the dark green area has 3. No CNT_RATE=1 exists in this example. The remaining green areas are outside the maximum elaboration area, so it can be considered a CNT_RATE=0.

4.7.6 The CNT tool output

4.7.6.1 Figure

as visualised CD, EGA AA layers
CNT_RATE shape file, buffer zones coloured using the colours set in admin page (Interpretation section)
CNT-RATE values in polygons

4.7.6.2 CNT specific table

Table 19: Description/interpretation of CNT result values.

	EGA_ID	Area (m2)	CNT_RATE	CNT_RATE n page)
1	value	value	value	Interpretation text from the pre-set interpretation in admin page
2	value	value	value	Interpretation text from the pre-set interpretation in admin page
…	value	value	value	Interpretation text from the pre-set interpretation in admin page

o

4.8 Proximity tool (PROX)

The PROX tool was additionally proposed by the municipality of Milano

4.8.1 The purpose of the PROX tool

The purpose of the tool is to calculate, for a new planned green area inside the city boundaries, how many people the new area is going to serve, and how it changes the green areas supply per person (m2/person) in every building.

A green area is usually considered available when it can be reached in 5 minutes walking at a 3 km/hour speed.

4.8.2 Spatial extent

Tool analysis area: one or more polygons of previously selected areas for the analysis (AA). Existing polygon layer or new on-screen digitalised polygons can be used.

4.8.3 Data requirements

Input data are:

- Area of Analysis
- Road network (polylines)
- Population (points): the shapefile represents every building entrance door position. The shapefile's attribute table contains <u>two mandatory fieldnames</u>:
    - o Number of inhabitants living in each building; **fieldname: <NumPerson>**
    - o Green areas supply per inhabitant (m^2/inhabitant); **fieldname: <m2Person>**
- Existing green areas (polygons): the shapefile's attribute table contains the population served by each area: fieldname <PopServed>, but this layer is not involved in the elaboration, but has to be visible and queryable in the system.

Table 20: An example of PROX tool input information.

Tool	Dataset	Weight	Units	DataName	FileName	Topology	Format	Suggested Scale
PROX	vAA	/	/	Areas of analysis	vAA	poly	Shapefile	
PROX	RN	/	/	Road network	vRN	poly	Shapefile	
PROX	POP	/	/	Population	vPOP	poly	Shapefile	
PROX	EGA	/	/	Existing green areas	vEGA	poly	Shapefile	

Predefined PROX tool specific variables in admin page:

- Walking time (minutes): <WalkDistMin>; preset to 5 in PROX admin page
- Walking speed (km/h): <WalkSpeed>; preset to 3 in PROX admin page

OR:

- Walking distance (m): <WalkDistMeter>; preset to 250 in PROX admin page

AA areas can be selected from existing polygon shape files (e.g. cadastral map, land use maps, ...) or on-screen digitized polygons.

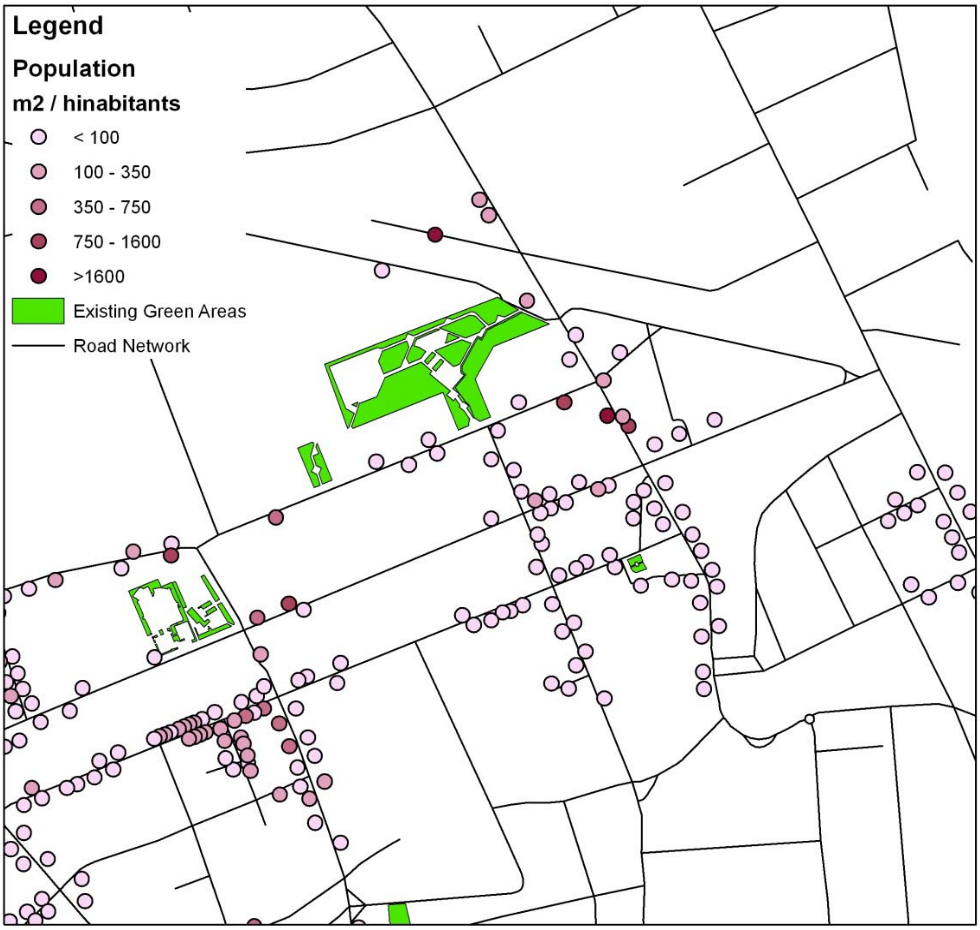

Figure 12: View of the PROX input data

4.8.4 Outputs

A PDF report containing, for each AA area:
- the number of people served by the area (sum of “NumPerson” values in the shapefile field)
- a list of the buildings served by the area and the old and new green area supply parameter (m2/person) (“m2Person” field in attribute map)

4.8.5 Functional step-by-step description of PROX tool

Draw and select one new green area polygon (GAP) on screen OR select one existing poly from EGA layer). NOTE: only one GAP can be selected for analysis.

Tool execution:

1. Run/execution of the PROX tool
2. Offer to update pre-set buffer distance (if needed)
   a. Walking time (minutes): <WalkDistMin>; preset to 5 in PROX admin page
   b. Walking speed (km/h): <WalkSpeed> preset to 3 in PROX admin page

Background processing:

3. Draw GAP on screen (the new green area to be created - see **Fehler! Verweisquelle konnte nicht gefunden werden.**)
4. Run the network analysis on the GAP, and produce the distance polygon (DPOLY) which represents the area reachable in <WalkDistMin> minutes walking from the polygon (see picture 2). [NOTE FOR PROGRAMMERS: I created the algorithm using ArcGIS Network Analyst, but, as far as I know, the SMSTool software must use GRASS functionalities. I checked that the v.net.iso command in GRASS is similar to the one ArcGIS uses a road network and points as input, but produces isolines and not a polygon area as output! In the case the distance polygon DPOLY can be created buffering the output lines. I think we have to talk a bit on this step, if you think that the whole algorithm is possible to realize. I’m still working in order to realize a correct procedure using GRASS instead of ArcGIS]
5. Intersect the distance polygon DPOLY with the population layer to create **PopDist shp file**
6. Sum the **<NumPerson>** to total number of people served by the new green area **TotNumPerson** (sum the number of people living in every point intersected by the distance polygon)
7. Calculate, for each building (point) the new value of green areas supply per inhabitant. To do this divide the new green area surface **<TotGreenArea>** by the number of inhabitants living in each building <**NumPerson>** and sum this value to the existing m2/inhabitant value <m2Person> and write in a new field named **<nm2Person>**.

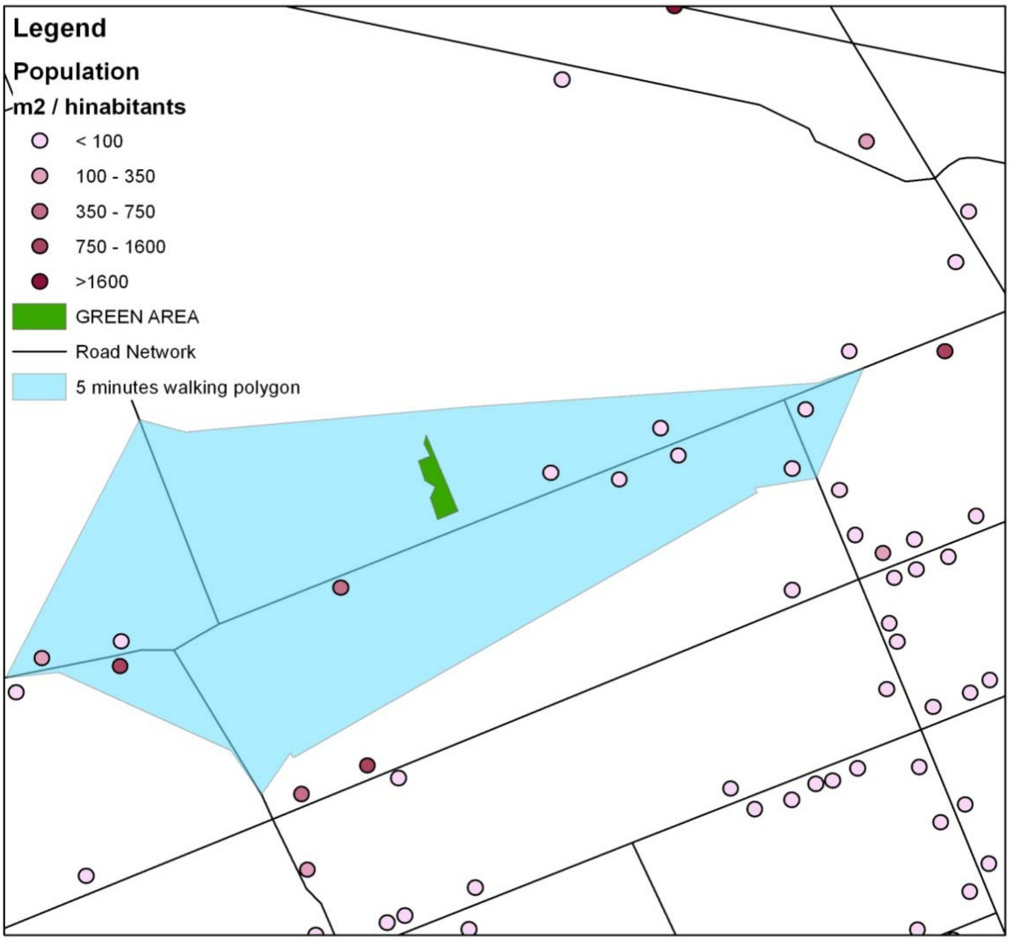

Figure 13: distance polygon (blue) calculated by the network analysis for the represented green area. The points falling into the blue polygon represent the people served by this area.

4.8.6 The PROX tool output

4.8.6.1 Figure

as visualised figure 4, with AA, POP, RN, EGA and DPOLY

4.8.6.2 PROX specific table

Table 21: Detailed variation.

	POP_ID	NumPerson	m2Person	nm2Person	PercVar
1		value	value	value	(nm2Person – m2Person)/m2Person*100
2		value	value	value	(nm2Person – m2Person)/m2Person*100
…		value	value	value	(nm2Person – m2Person)/m2Person*100

Statistics summary: A brief statistic summary of the above listed values should be provided, containing:

- Mean value of **<NumPerson> field**
- **Sum value of <NumPerson> field**
- Mean value of **<m2Person> field**
- Mean value of **<nm2Person> field**
- Mean value of **<PercVar> field**

5 Description of the secondary Urban SMS tools

5.1 *Nutrient Status (NS)*

NS represents an input data for ASQ and ESQ tools.

5.1.1 The purpose of the NS tool

NS is an intermediate result that is needed as an input data for ASQ and ESQ tools.

5.1.2 NS calculation

The soil nutrient reference values should be changed in accordance with local legislation/evaluation practises. The overall rating for a nutrient status consists of partial values of individual nutrients P, K and N.

Table 22: An example of input data and weights for NS tool.

Tool	Dataset	Weight	Units	DataName
NS	**gNS_N**	2	**Class**	Nitrogen content class - topsoil
NS	**gNS_P**	2	**Class**	P content class - topsoil
NS	**gNS_K**	2	**Class**	K content class - topsoil

5.1.3 NS algorithm

Nutrient Function Status (NS), calculates an average grade of all nutrients (Eq. 14). Single nutrient contributes 1 / 3 (or share proportional to the number of nutrients) to assess the total nutrient content (Table 4).

$$NS = (gNS\_P + gNS\_K + gNS\_N) / 3 \quad \text{Eq. 14}$$

5.1.3.1 Resulting NS GIS layers

gNSr = rel.NS: Nutrient status expressed in %

gNSc = rel.NS: Nutrient status expressed in class values (1 worst -5 best)

5.1.4 Example of the NS calculation

Table 23: An example of calculation for NS tool.

ParNo	GridName	Quality Indicator (DDT table)	Units (DDT table)	Value	Weight	Partial Value
1	gNS_N	Nitrogen content class - topsoil	Class	4	2	4
4	gNS_P	Phosphorus content class - topsoil	Class	4	2	4
3	gNS_K	Potassium content class - topsoil	Class	3	2	3
Sum Partial values		11,0				
Maximum possible sum		15,0				
NS value (%)		**73,3**				
NS Class		**5**				
Class Description		**Medium nutrient content**				
NS interpretation		***Medium fertile soil. Alternatively non-agricultural lansd uses can be considered.***				

5.1.5 Reclassification and interpretation of the NS grid

5.1.5.1 NS reclassification table

Table 24: An example of NS reclassification table.

Min class value	Max class value	Interpretation	Class Decription	Class No.	Colour
0	0	*No OR marginal nutrient content. Soil not fertile.*	*No soil OR marginal nutrient content*	*1*	*#EEE8CD*
0	20	*Very low soil fertility. If needed, the sealing can be a good alternative.*	*Very low nutrient content*	*2*	*#FFF8DC*
20	40	*Low soil fertility. Urban green or sporting areas can be planned. Sealing, if needed, c*	*Low nutrient content*	*3*	*#FFEC8B*
40	60	*Low soil fertility. Urban green or sporting areas can be planned. Sealing, if possible,*	*Low to medium nutrient content*	*4*	*#FFC125*
60	80	*Medium fertile soil. Alternatively non-agricultural lansd uses can be considered.*	*Medium nutrient content*	*5*	*#CD9B1D*
80	85	*Best soil. Highest fertility. Exclusive for agricultural production.*	*High nutrient content*	*6*	*#8B5A00*

The upper rating can be modified to meet specific conditions and/or needs. Up to 10 classes can be used for reclassification of the rel.NS grid to Class.NS grid.

5.1.5.2 Interpretation of the NS grid

The NS equation yields values in a range from 0 to more than 12. The NS values can be used for a qualitative description of the soil fertility and to quantify the terms for *good* or *bad* soil fertility. The NS values are rated in 6 classes with interpretation where:

0 stands for no or marginal soil of no or very low nutrient content to 6, which stands for very high nutrient content and signifies the most fertile soils. Urban SMS tools

6 Evaluation parameters and data description

6.1 Common Data Description Table (DDT)

Table is represents an overview of required datasets and their use. The purpose Each use depend on the tool (see *Tool* field)

- Tool: name of the tool (up to 10 characters).
- *Dataset name*: name of the dataset (up to 10 characters)
- *Weight* - is allocated to a parameter in the equation according to its impact /importance. It can be modified according to local data situation and/or legislation.
- *Units*: class or measured data units
- *Data Name:* brief description of the data layer.
- *File Name:* File/layer name in the file system
- *Topology: Type of data*
- *Format*: Format of the data
- Scale: scale of vector data (e.g. 25000 for scale 1:25.000) or resolution of the raster cell (eg. for 5 by 5 m raster cell) .

The Common DDT table holds description of the data layers

Table 25: Common Data Description table (DDT).

Tool	Dataset	Weight	Units	DataName	FileName	Topology	Format	Suggested Scale
ESQ	gOM_ESQ	3	Class	Soil organic matter content class - topsoil	gOM_ESQ	cell	ESRI grid	5 m cell size
ESQ	gPH_ESQ	2	Class	Soil pH class - topsoil	gPH_ESQ	cell	ESRI grid	5 m cell size
ESQ	gSD_ESQ	2	Class	Soil depth (or rootable depth)	gSD_ESQ	cell	ESRI grid	5 m cell size
ESQ	gTX_ESQ	2	Class	Soil texture class	gTX_ESQ	cell	ESRI grid	5 m cell size
ESQ	gSCFood_result	3	Class	Soil contamination class	gSCFood_result_ESQ	cell	ESRI grid	5 m cell size
ESQ	gNS_result	3	Class	Nutrient status class	gNS_result_ESQ	cell	ESRI grid	5 m cell size
Tool	Dataset	Weight	Units	DataName	FileName	Topology	Format	Suggested Scale
LSR	gASQ_result	/	Class	Soil Quality Score	gASQ_result_LSR	cell	ESRI grid	5 m cell size
LSR	vAA	/	%	Analysis / planning area	vAA	cell	hp (Zipped)	
Tool	Dataset	Weight	Units	DataName	FileName	Topology	Format	Suggested Scale
SCFood	gSC_Pb	/	Class	Pb contamination class - topsoil	gSC_PbF	cell	ESRI grid	5 m cell size
SCFood	gSC_Zn	/	Class	Zn contamination class - topsoil	gSC_ZnF	cell	ESRI grid	5 m cell size
SCFood	gSC_Cd	/	Class	Cd contamination class - topsoil	gSC_CdF	cell	ESRI grid	5 m cell size
SCFood	gSC_Ni	/	Class	Ni contamination class - topsoil	gSC_NiF	cell	ESRI grid	5 m cell size
SCFood	gSC_As	/	Class	As contamination class - topsoil	gSC_AsF	cell	ESRI grid	5 m cell size
Tool	Dataset	Weight	Units	DataName	FileName	Topology	Format	Suggested Scale
SCPlay	gSC_Pb	/	Class	Pb contamination class - topsoil	gSC_PbP	cell	ESRI grid	5 m cell size
SCPlay	gSC_Zn	/	Class	Zn contamination class - topsoil	gSC_ZnP	cell	ESRI grid	5 m cell size
SCPlay	gSC_Cd	/	Class	Cd contamination class - topsoil	gSC_CdP	cell	ESRI grid	5 m cell size
SCPlay	gSC_Ni	/	Class	Ni contamination class - topsoil	gSC_NiP	cell	ESRI grid	5 m cell size
SCPlay	gSC_As	/	Class	As contamination class - topsoil	gSC_AsP	cell	ESRI grid	5 m cell size
Tool	Dataset	Weight	Units	DataName	FileName	Topology	Format	Suggested Scale
SCSport	gSC_Pb	/	Class	Pb contamination class - topsoil	gSC_PbS	cell	ESRI grid	5 m cell size
SCSport	gSC_Zn	/	Class	Zn contamination class - topsoil	gSC_ZnS	cell	ESRI grid	5 m cell size
SCSport	gSC_Cd	/	Class	Cd contamination class - topsoil	gSC_CdS	cell	ESRI grid	5 m cell size
SCSport	gSC_Ni	/	Class	Ni contamination class - topsoil	gSC_NiS	cell	ESRI grid	5 m cell size
SCSport	gSC_As	/	Class	As contamination class - topsoil	gSC_AsS	cell	ESRI grid	5 m cell size
Tool	Dataset	Weight	Units	DataName	FileName	Topology	Format	Suggested Scale
SR	gEucGREEN	/	/	Distance from areas classified as 'gree	gEucGreen	cell	ESRI grid	5 m cell size
Tool	Dataset	Weight	Units	DataName	FileName	Topology	Format	Suggested Scale
ASQ	gOM_ASQ	3	Class	Soil organic matter content class - topsoil	gOM_ASQ	cell	ESRI grid	5 m cell size
ASQ	gTX_ASQ	2	Class	Soil texture class - topsoil	gTX_ASQ	cell	ESRI grid	5 m cell size
ASQ	gNS_result	2	Class	Nutrient status class - topsoil	gNS_result_ASQ	cell	ESRI grid	5 m cell size
ASQ	gSD_ASQ	2	Class	Soil depth class	gSD_ASQ	cell	ESRI grid	5 m cell size
ASQ	gPH_ASQ	2	Class	Soil pH class - topsoil	gPH_ASQ	cell	ESRI grid	5 m cell size
ASQ	gSCFood_result	3	Class	Soil contamination class - topsoil	gSCFood_result_ASQ	cell	ESRI grid	5 m cell size
ASQ	gSLP	3	Class	Slope class (arable land)	gSLP	cell	ESRI grid	5 m cell size
ASQ	gUrbProx	/	Class	Proximity to urban - cell values in meters	gUrbProx	cell	ESRI grid	5 m cell size
ASQ	gagr	/	Class	Only areas with agricultural landuse	gagr	cell	ESRI grid	5 m cell size
Tool	Dataset	Weight	Units	DataName	FileName	Topology	Format	Suggested Scale
WD	gClay	1	Class	Average topsoil clay content (%)	gClay	cell	ESRI grid	5 m cell size
WD	gSand	1	Class	Average topsoil sand content (%)	gSand	cell	ESRI grid	5 m cell size
WD	gTSdepth	1	Class	Real soil depth (max up to 40cm)	gTSdepth	cell	ESRI grid	5 m cell size
WD	gPores	1	Class	Soil porosity (macro and medium pores) (%)	gPores	cell	ESRI grid	5 m cell size
WD	gFlat	1	Class	Only areas on flat landscape (less then 5^{o}	gFlat	cell	ESRI grid	5 m cell size
WD	Days	1	/	Number of rainy days	days	parameter	value	
WD	Prec	1	/	Average precipitation per day (mm)	perc	parameter	value	
Tool	Dataset	Weight	Units	DataName	FileName	Topology	Format	Suggested Scale
NS	gNS_N	2	Class	Nitrogen content class - topsoil	gNS_N	cell	ESRI grid	5 m cell size
NS	gNS_P	2	Class	P content class - topsoil	gNS_P	cell	ESRI grid	5 m cell size
NS	gNS_K	2	Class	K content class - topsoil	gNS_K	cell	ESRI grid	5 m cell size
Tool	Dataset	Weight	Units	DataName	FileName	Topology	Format	Suggested Scale
CNT	vAA	/	/	Areas of analysis	vAA	poly	Shapefile	
CNT	EGA	/	/	Existing green areas	vEGA	poly	Shapefile	
CNT	CM	/	/	Cadastral Map	vCM	poly	Shapefile	
Tool	Dataset	Weight	Units	DataName	FileName	Topology	Format	Suggested Scale
PROX	vAA	/	/	Areas of analysis	vAA	poly	Shapefile	
PROX	RN	/	/	Road network	vRN	poly	Shapefile	
PROX	POP	/	/	Population	vPOP	poly	Shapefile	
PROX	EGA	/	/	Existing green areas	vEGA	poly	Shapefile	

Urban SMS

WP4 Soil Manager Suite

Extra task: Final version of the USMS GIS data structure and preparation

Deliverable: Final version of tool data preparation

Web Soil Management Tool

Urban SMS Tools – Data structure and preparation manual

- Data structure
- Main GIS data types used in USMS
- Preparation of raster data
- Preparation of vector layers
- Preparation of image layers
- Recommendations about data preparation
- Instructions about creating LSR input planning area layer

Version: Final version

Saved: 29 November 2011, Printed: 1/29/2012 11:07:00 PM

About the task

Project Urban SMS

http://www.urban-sms.eu

WP4 Soil Manager Suite

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About a document

The document presents instructions/guidelines on proper and correct GIS data structure and preparation. Its purpose is to help GIS experts, to prepare and set the system GIS layers for effective use of Urban SMS tools and WEB display.

SW stage: Final version, December 2011

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Content

1 MAIN DATA STRUCTURE

In further text, data structure of the Web Urban SMS system (in further text the system) is explained. All examples are made according to working, Celje test server installation.

Data Storage location:

The entire dataset is stored as one (main) **folder** and prepared in lines with *standard structure* of subfolders and subfiles anywhere on the hard disk of the server computer (example of name of main data folder: *GISData*).

Each of the subfolders contains data in specific resolution (for example: … GISData\1 → Raster datasets in resolution of 1m x 1m, or …\GISData\5 → Raster datasets in resolution of 5m x 5m).

Each data resolution folder has four subfolders:

- BackData → GIS data and layers displaying as background data on the WEB (DEM, DOF, etc.)
- PlanData → Planning data and GIS layers (land cadastre, cadastre of buildings, etc.),
- SoilData → Soil geospatial data (profile points, soil maps, etc.),
- ToolData → All GIS data used in tool processing.

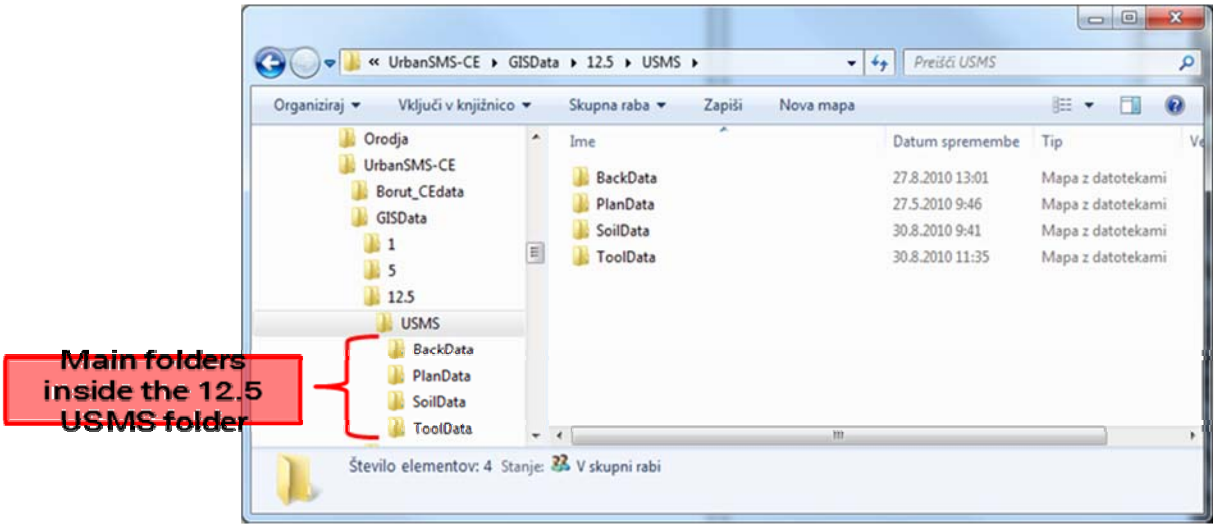


Figure 1: Folder structure inside folder containing 12,5 m resolution rasters.

1.1 BACKDATA FOLDER

Backdata folder is divided into subfolders containing GIS data used for background display on the WEB portal.

1.1.1 File type

Background data layers such as DEM, DOF, Topographic maps, etc. must be prepared as georeferenced image (**png, geotiff, tiff** etc). The folder can contain any spatial data that user wants to visualize and that is appropriately set also in Maestro.

1.1.2 Transparency

To achieve the transparency of the background data, each of the layers should be created as transparent images (alpha channel **png** image).

1.1.3 Resolution

It is recommended that images are created in different resolutions (DPI). Mapguide Maestro allows the administrator to set the viewing scale of images according to its resolution (eg. when zooming in Maestro automatically switches to images with higher resolution).

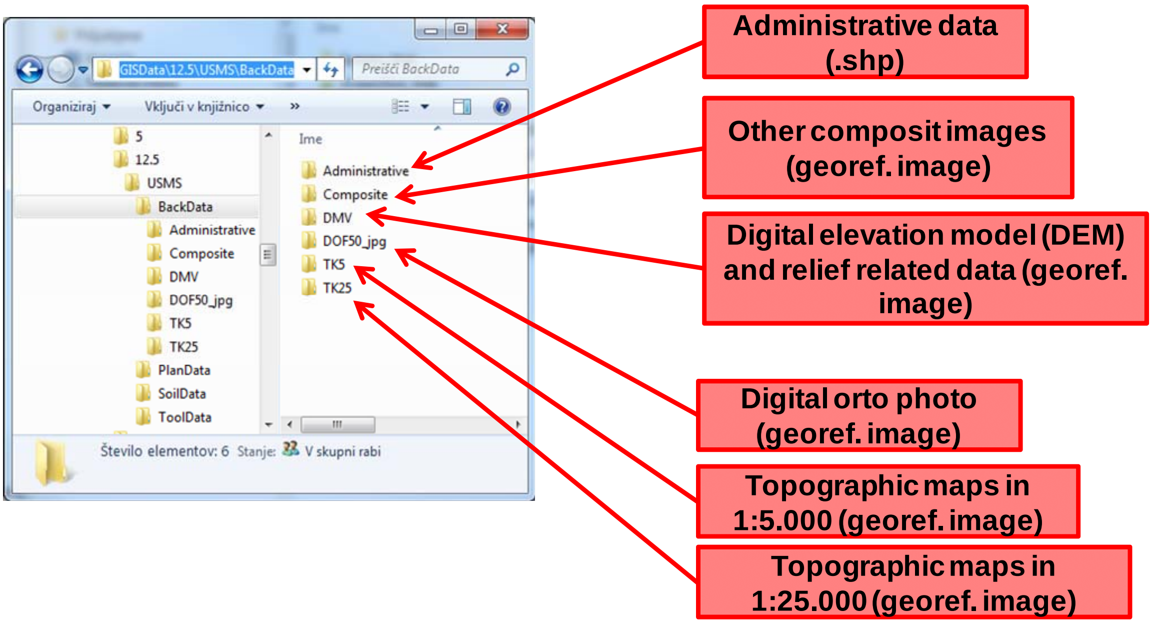


Figure 2:Folder structure inside folder BackData.

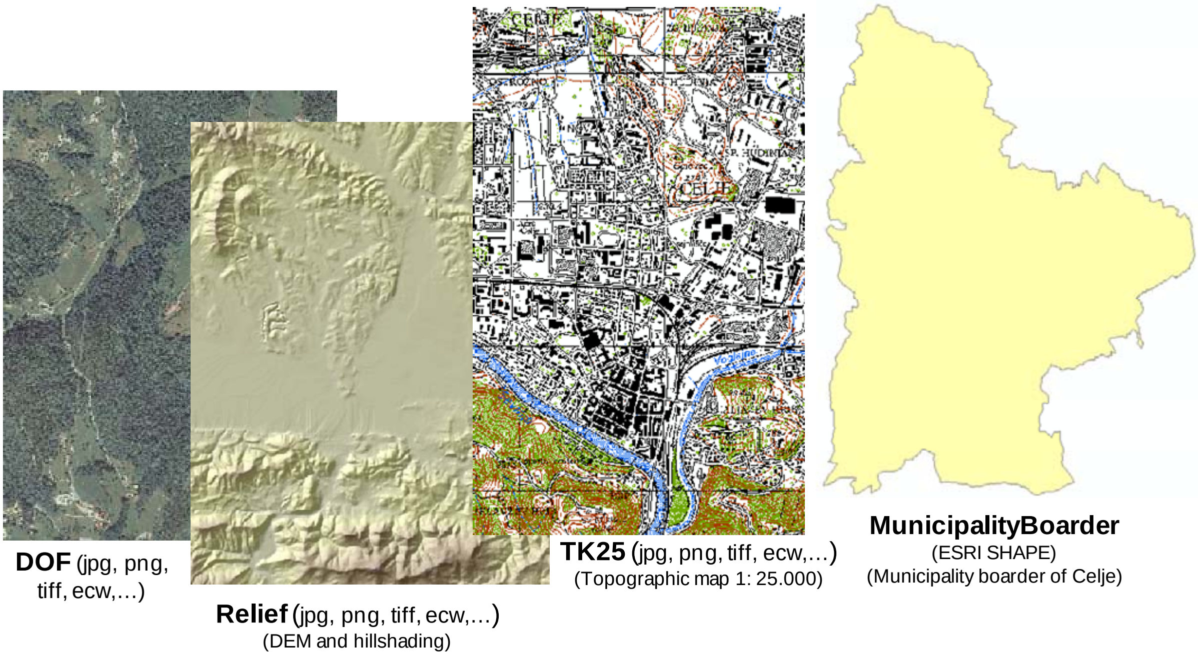


Figure 3:BackData layer examples.

1.2 PLANDATA FOLDER

1.2.1 File type

Folder contains data/layers related to spatial planning (**Digital land cadastre**, **digital cadastre of buildings**, etc.). Usually these are **vector** layers (ESRI shp files).

Transparency and resolution settings do not apply.

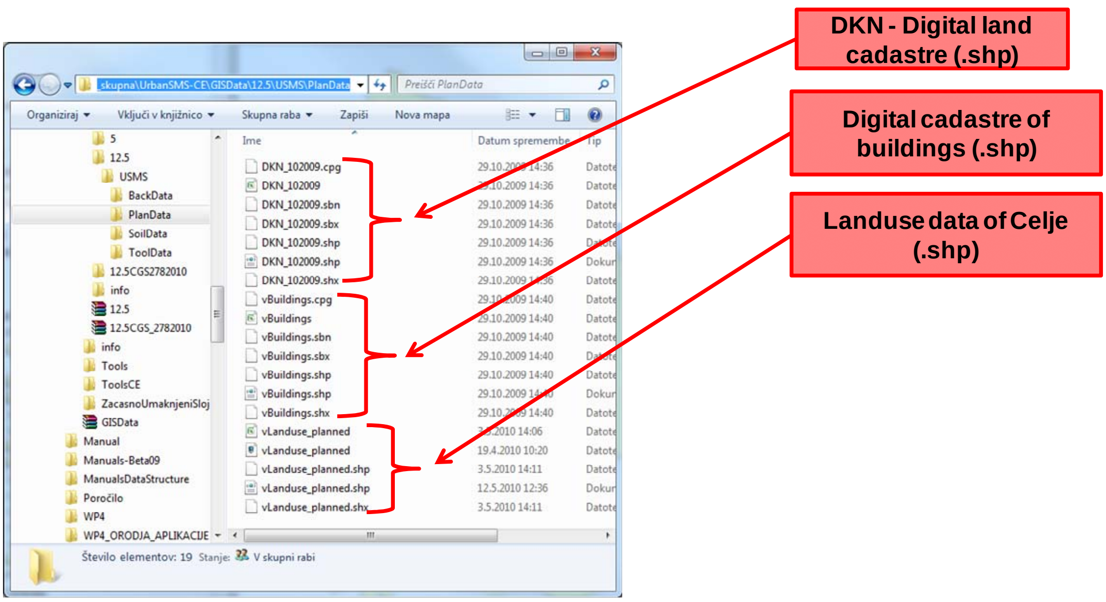


Figure 4: Layers in PlanData folder

Overlayed →

DKN_102009
+
vBuildings
+
vLanduse_planned

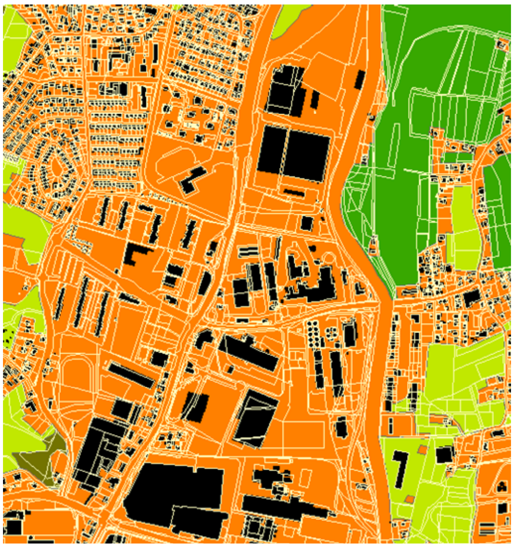


Figure 5. PlanData layers example.

1.3 SOILDATA FOLDER

1.3.1 File type

Folder containing soil related layers (**soil maps**, **soil profile point layers**, etc.). Usually in **vector** format (ESRI shp).

Transparency and resolution settings do not apply.

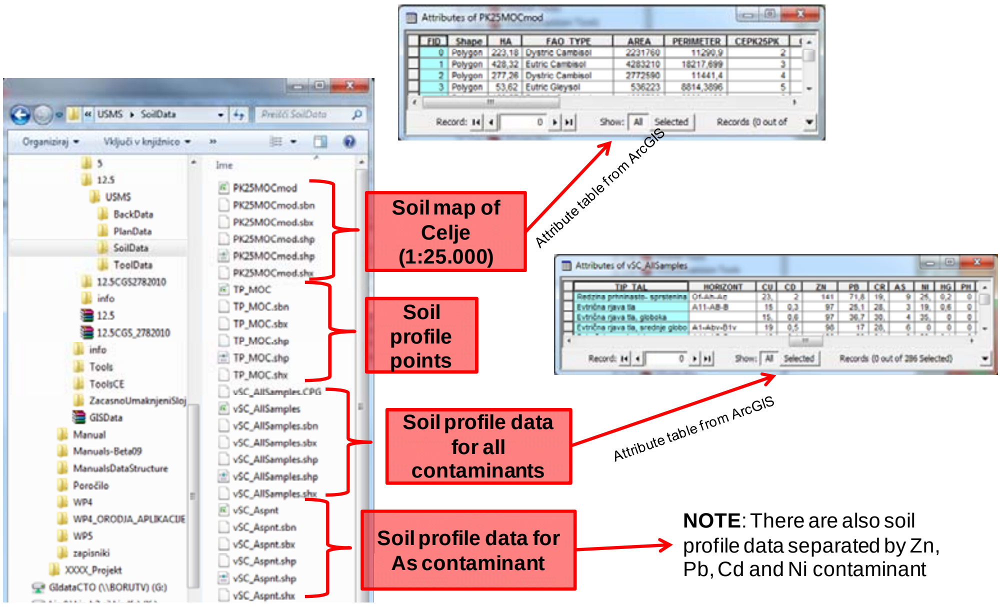


Figure 6: Folder SoilData containing soil related layers.

Overlayed →

vSC_AllSamples (Soil data for all contaminants
+
PK25MOCmod (Soil map of Celje)

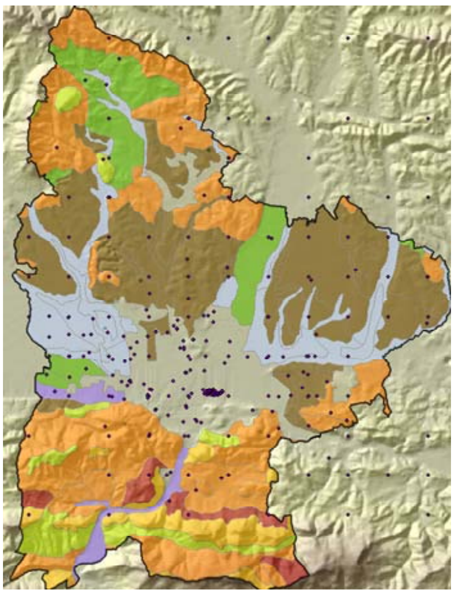


Figure 7: SoilData layers example.

1.4 TOOLDATA FOLDER

This is the most important folder in the data structure. It contains input layers used in Urban SMS tools. It is important that all layers are **strictly defined** and **layer names not changed** during the system use!

Whenever names or structure is changed, administrator will have to repair the settings in web Administrator site (paths to files) accordingly.

For a proper use of the system (all tools functional) the ToolData folder should contain all layers defined in User Manual data list. **Since the PROX and CNT tools were developed and will only be used by Milano partner, description of required datasets will not be included in this document.**

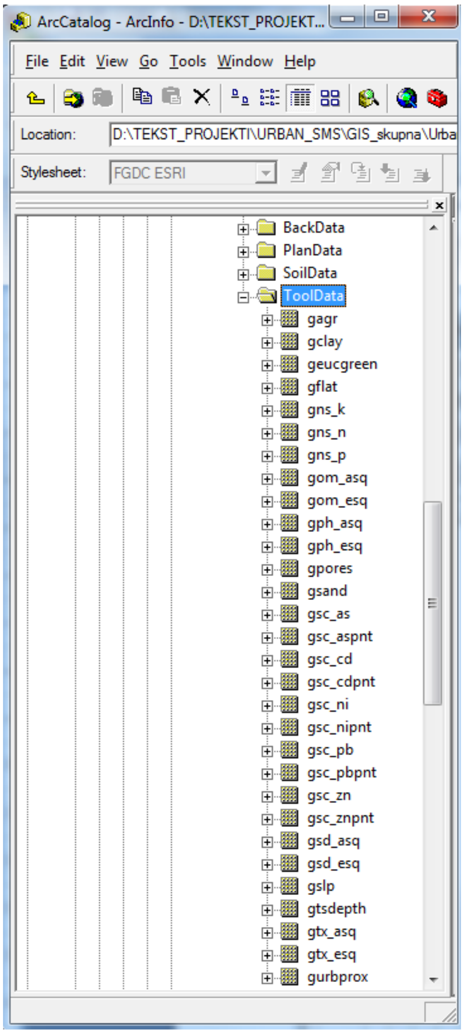


Figure 8: ToolData layers example (view in ArcCatalog).

2 PREPARATION OF SPATIAL DATA (VISUALIZATION AND DATA ANALYSIS)

According to the Urban SMS Installation manual, basic settings should be ensured initially in order to successfully visualize your spatial data in the system.

For better understanding of the Urban SMS system structure and relationships between the separate applications a brief overview is presented below.

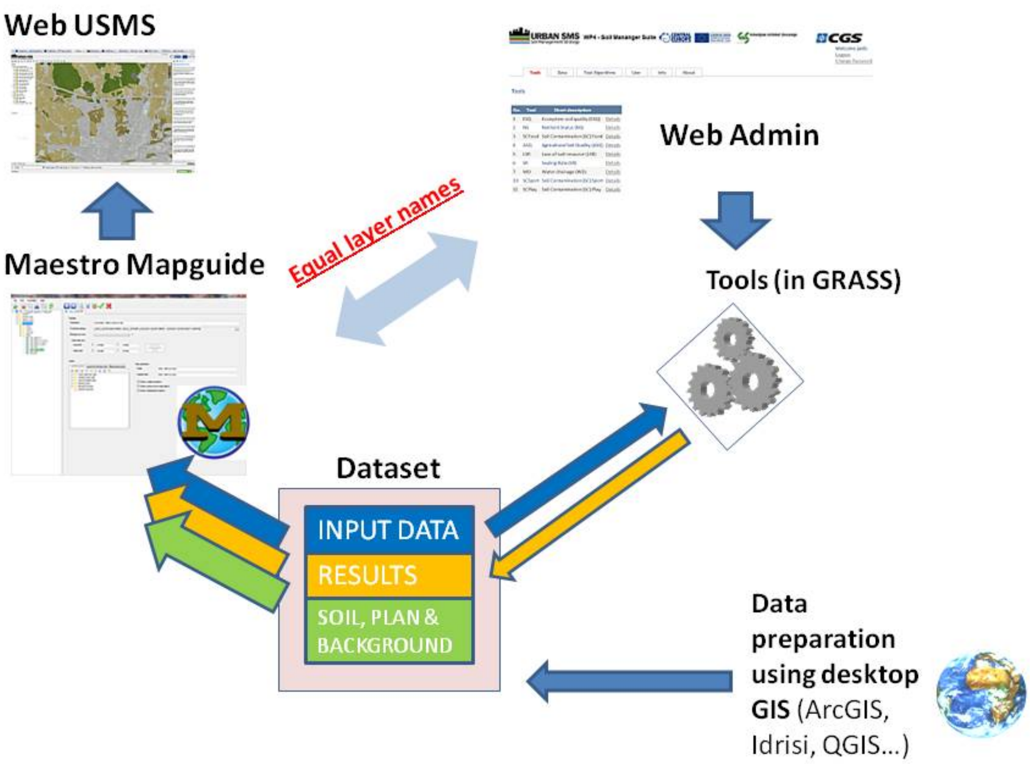


Figure 9: Schematic view of the USMS system

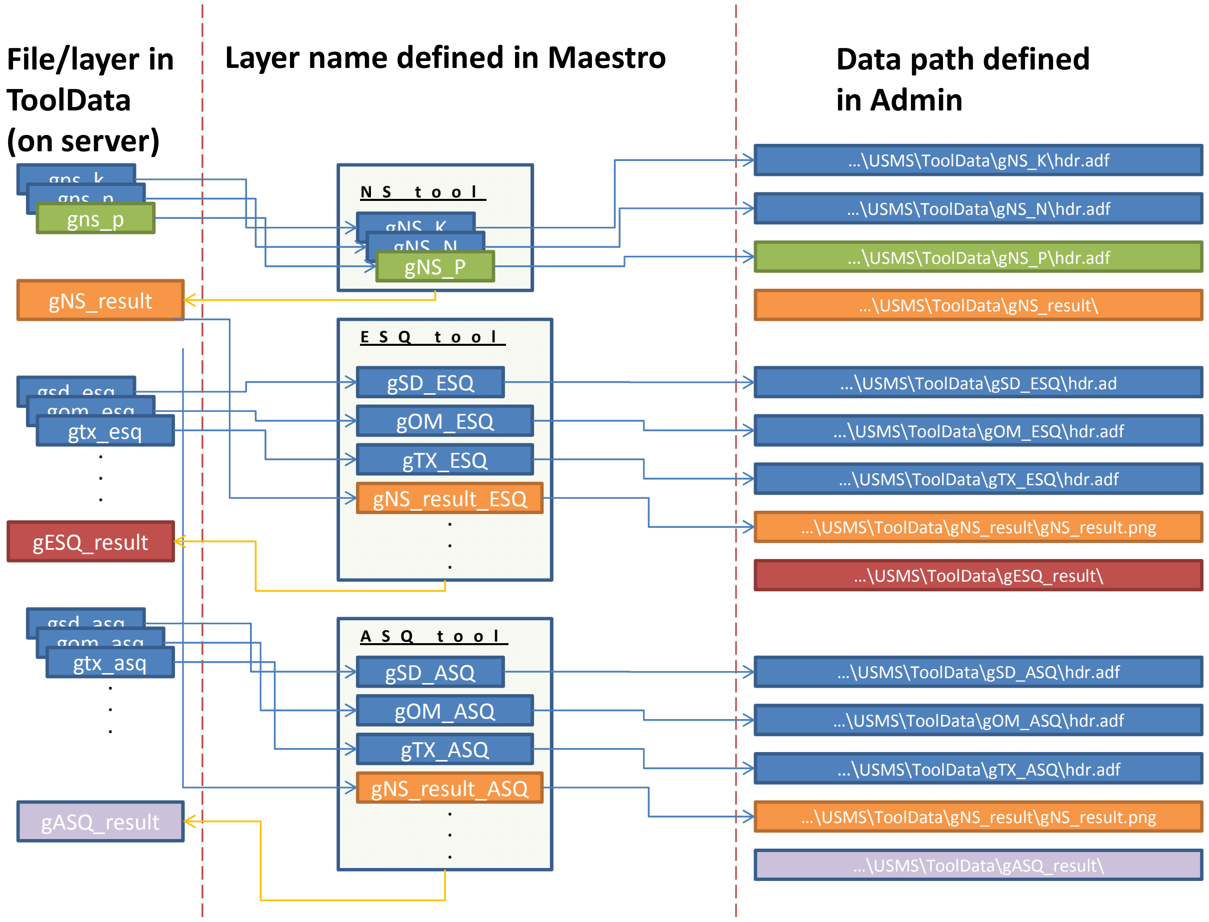


Figure 10: Detailed schematic view of the settings and relationship between data→ Maestro→ Admin Web (example for NS, ESQ and ASQ tools).

2.1 Step one –data preparation in ArcGIS

Appropriate data preparation of ESRI grid, ESRI shape and georeferenced image format files is essential. Especially important are the ESRI grid layers that have the role of the input datasets for tool calculations (raster processing). Each tool has its unique dataset requirements which can be seen at the far right section of the Urban SMS Web portal screen.

System initially checks the availability of datasets. Only when all input raster files are available and correctly set, user is allowed to run the analysis.

2.1.1 Overview of ESRI grid raster technical properties

When preparing raster dataset, it is important to consider the following file properties:

- *Format* - Different file types have different properties and requirements.
- *Number of bands* – The number of spatially coincident layers in the raster. Raster has usually several (from one to more than a hundred).

- *Data or Pixel type* - pertains to the type of values stored in the raster, such as signed integer, unsigned integer, or floating point. Integers are whole numbers, whereas floating points have decimals.
- *Data depth* - also known as pixel or bit depth, determines the possible range of values stored in each band. A depth of eight will store 28 = 256 values (0 to 255), while a depth of 16 will store 216 = 65536 values (0 to 65535)(*see below).
- *Statistics:* The minimum value in the raster, maximum value, mean of all values, and standard deviation.
- *Extents*-These are the left, right, top, and bottom coordinates of the raster dataset.
- *Projection*-This is part of the raster's coordinate system and can be found in the Spatial Reference section. An <Undefined> raster may mean it's not projected or not yet defined. Check with the data's vendor to verify the raster's correct coordinate system.
- *Size of the raster* - The number of rows and columns or the uncompressed size.

** The pixel depth of the raster (bit depth) determines the range of values that a particular raster file can store, which is based on the formula 2^n where n is the pixel depth. For example, an 8-bit raster can have 256 unique values, which range from 0 to 255. The following indicates the range of possible stored value for each type of bit depth:*

- *unsigned 1 bit = 0 to 1*
- *unsigned 2 bit = 0 to 4*
- *unsigned 4 bit = 0 to 16*
- *unsigned 8 bit = 0 to 255*
- *signed 8 bit = -128 to 127*
- *unsigned 16 bit = 0 to 65535*
- *signed 16 bit = -32768 to 32767*

- *unsigned 32 bit = 0 to 4294967295*
- *signed 32 bit = -2147483648 to 2147483647*
- *floating point 32 bit = -3.402823466e+38 to 3.402823466e+38*

Data stored in a raster format typically represent:

- **Thematic data** (also known as discrete), features such as land-use or soils data.
- **Continuous data**, such as temperature, elevation or spectral data - satellite images and aerial photographs.
- **Pictures**, such as scanned maps or drawings and building photographs.

If raster layer represents the categorical → thematic type of data (example: raster classified in 5 classes from 1 to 5), the most effective and reliable raster layers are the **integer** data type. **Floating-point** values are best for continuous data/surfaces such as distances, slope, elevation etc (example: raster classified in continuous values from 1 to 128).

Technical specifications of raster data are defined (or limited) with characteristics of Feature Data Object (FDO) providers (http://fdo.osgeo.org/.

The FDO Provider for GDAL provides FDO with access to a variety of raster file formats supported by the OSGeo GDAL library. For more info please visit http://www.gdal.org/formats_list.html#footnote1.

2.1.2 Input raster data for Urban SMS tools

Majority of the system input raster layers are of categorical type. Especially soil related parameters are usually created by 'rasterising' vector soil maps. Layers that are of ordinal data type (**gns_k, gns_p, gns_n, gom_esq, gom_asq, gph_esq, gph_asq, gsd_esq, gsd_asq, gtx_esq, gtx_asq, gagr, gflat, gslp**) should be an **integer** grid with pixel depth value according to the range of data stored.

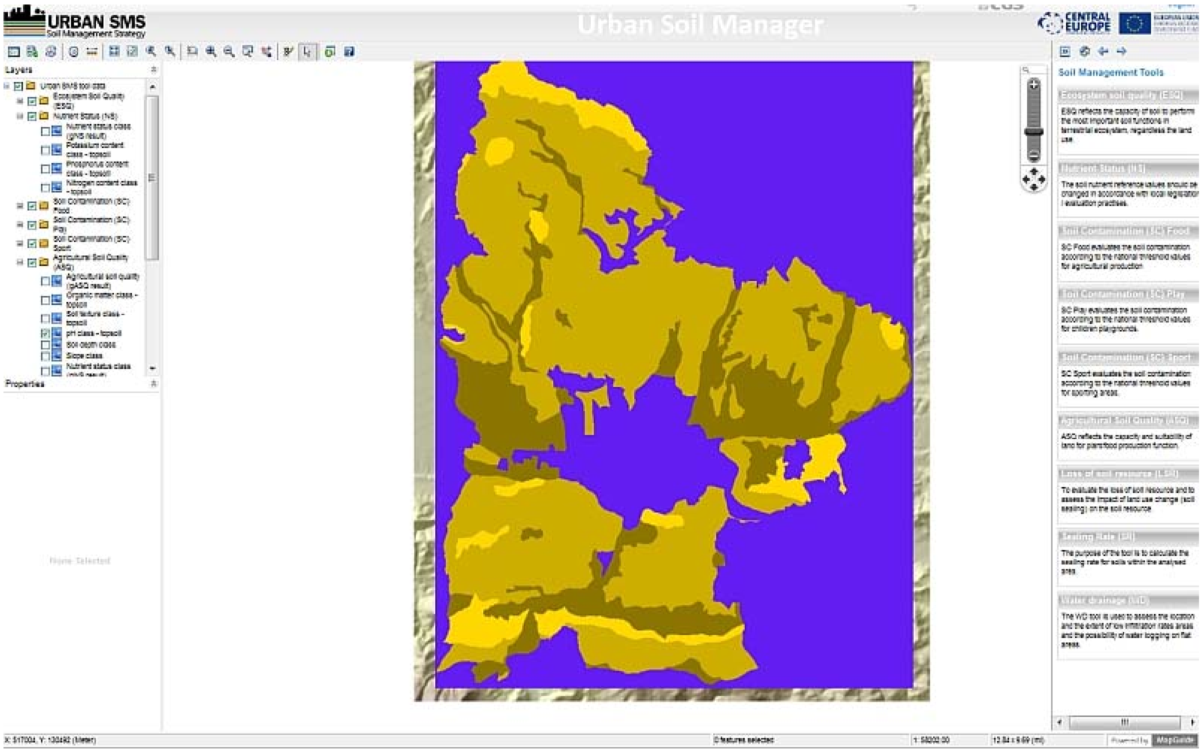


Figure 11: Example of integer raster of pH (gPH_ASQ) with imported colour file.

In order to reduce the size of the grid layers, some of them have been stored as an integer grid (geucgreen, gurbprox), even though they are more of continuous type (example: distance raster).

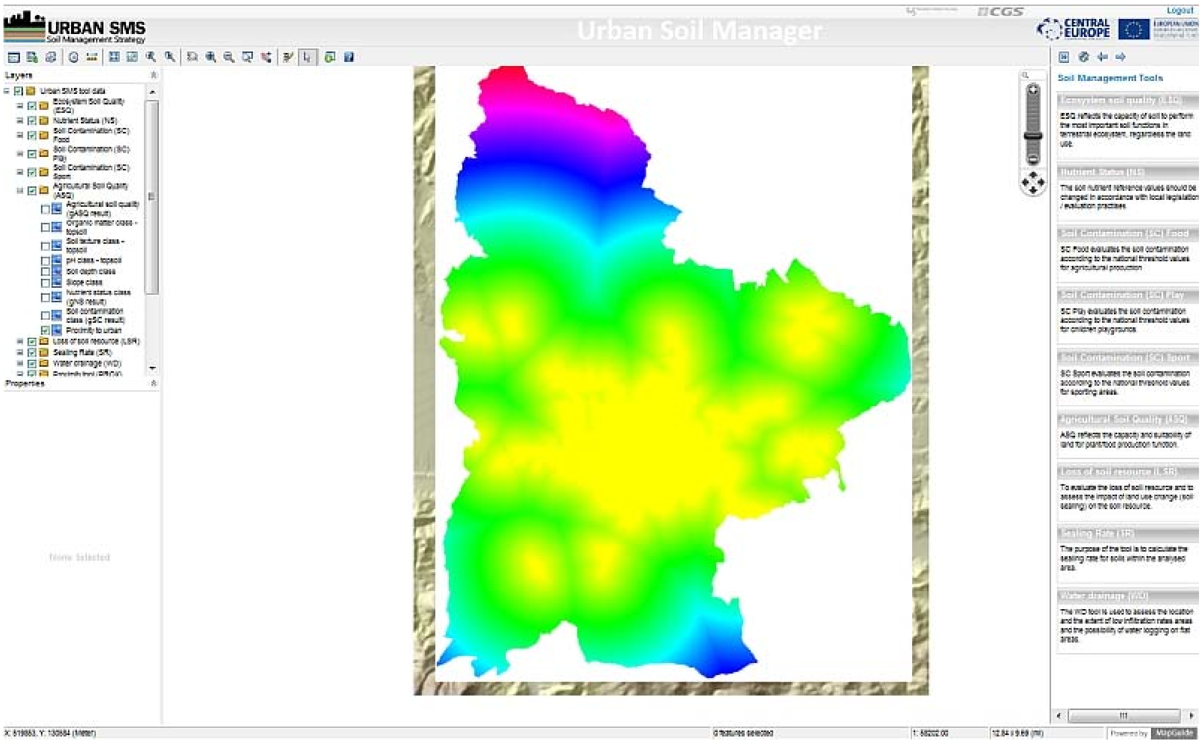


Figure 12: Example of 16 bit signed integer distance raster (gUrbProx) without colour file.

Grid data can also be a **floating-point** grid. These represent the data in decimal numbers (example: percent of clay → 45,5 %, or sand → 54,5 %). Those raster layers should be **floating-point** type with pixel depth value according to the range of data stored (gclay, gsand, gpores, gtsdepth and all contamination layers).

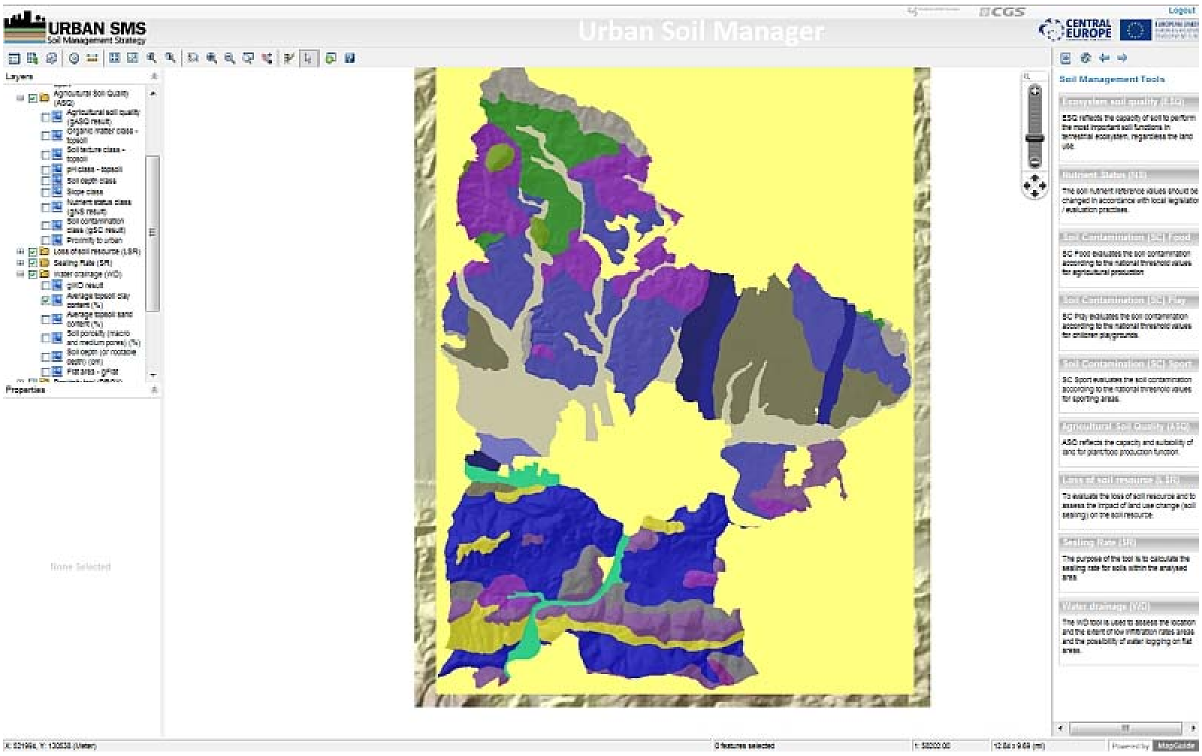
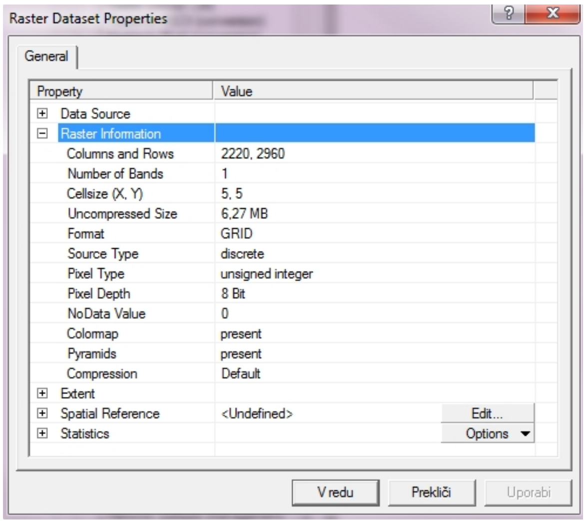


Figure 13: Example of continuous 32-bit floating-point raster (gClay) without colour file.



Raster Dataset Properties

General

Property	Value
⊞ Data Source	
⊟ Raster Information	
Columns and Rows	2220, 2960
Number of Bands	1
Cellsize (X, Y)	5, 5
Uncompressed Size	6,27 MB
Format	GRID
Source Type	discrete
Pixel Type	unsigned integer
Pixel Depth	8 Bit
NoData Value	0
Colormap	present
Pyramids	present
Compression	Default
⊞ Extent	
⊞ Spatial Reference	<Undefined> Edit...
⊞ Statistics	Options

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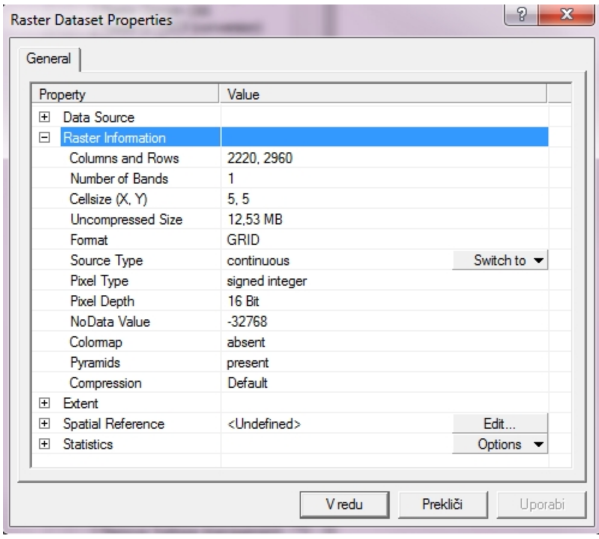
Figure 14: Example of raster information description for 8 bit unsigned integer data (gPH)



Raster Dataset Properties

General

Property	Value
⊞ Data Source	
⊟ Raster Information	
Columns and Rows	2220, 2960
Number of Bands	1
Cellsize (X, Y)	5, 5
Uncompressed Size	12,53 MB
Format	GRID
Source Type	continuous Switch to
Pixel Type	signed integer
Pixel Depth	16 Bit
NoData Value	-32768
Colormap	absent
Pyramids	present
Compression	Default
⊞ Extent	
⊞ Spatial Reference	<Undefined> Edit...
⊞ Statistics	Options

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Figure 15: Example of raster information description for continuous 16 bit signed integer (geucgreen).

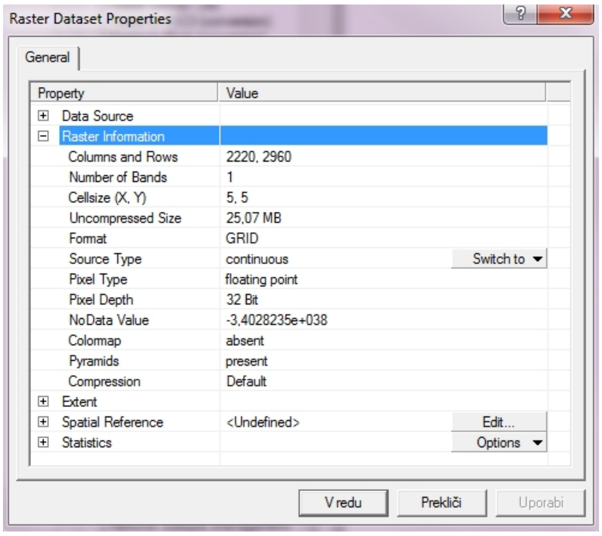


Figure 16: Example of raster information description for continuous floating-point data (gClay)

Technical specification of ESRI grid layer

Using ArcCatalog GIS specialist can check what are the basic technical properties of the raster data by: **right click** on the selected layer, choose **properties** and click **Raster information**.

Converting raster data from floating point to integer

If using ESRI software grids can be converted using **integer** function **in** the **Raster Calculator** module with expression:

Int([Your_Float_Grid] + 0.5)

Integer function by default always truncates the data. For example 2,7 becomes 2. If we want to round the values, we have to add 0,5. Value of 2,7 then becomes 3.

Maestro Mapguide and GRASS software support integer and floating point raster data types. Unfortunately Maestro itself doesn't allow user to set the colour pallet for values of the uploaded grid. Raster data handling is limited while using the Maestro software.

2.1.3 Recommendations for data preparation in ArcGIS

1. Uploading input raster files into Maestro Mapguide normally shows that colour pallet for raster value is random while theses are visualised. To set user-defined colour for each value in a layer user should create a **colour file (.clr)** for each integer raster. *Please note that **colour files can't be created for floating-point grids** but only for the integer grids*.
2. All grid layers should initially be clipped with Municipality polygon. Everything outside the municipality border should have **NO DATA** value in GIS and *not value of 0 for example*!
3. Where layers have no data inside the Municipality (example for soil data: missing data, sealed areas with no soil, etc.) values should be **NO DATA** in GIS (*not 0 or -9999*)!
4. **Advice:** Please make sure that features of raster and vector layers **have no projection defined** (no .prj file) before uploading them into Maestro. There are no technical limitations for using different projections, however it is strongly recommended to initially decide for only one. Different data projection and/or format definitions might cause a lot of problems later on with the system implementation.
5. According to previous experience **16-bit floating point raster** layers are special (hard to control) and should be avoided where ever possible. Please convert such grids to other pixel depths.
6. Extent of ALL layers should be **equal** and **rounded** to 1 (if 1m x 1m rasters), 10 (if 5m x 5m rasters), 100 (if 12,5m x 12,5m data).

Creating colour file

Within directory **ToolData** create a .clr file for any integer raster. Clr file assigns user-defined colour to each raster value of the raster layer. Clr file must be named exactly like ESRI grid file, but with extension .clr (*for gom_esq, clr file should be gom_esq.clr*). User can create clr file with text editor → Write the grid value in the first column and than RGB values (separated by space).

Example of clr file:

 # cell value red green blue

1 202 225 255

2 162 181 205

3 171 130 255

4 105 89 205

5 25 25 112

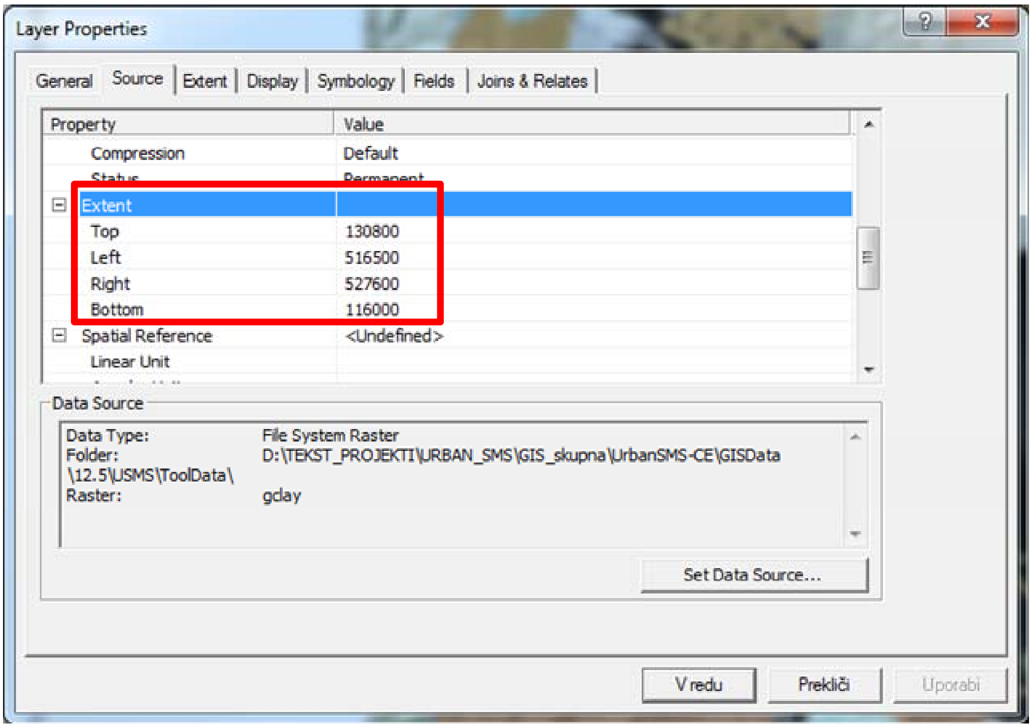


Figure 17: Equal extent for all layers (view in ArcCatalog)

2.2 Step two – file upload into Maestro Mapguide

When all data layers are prepared as described above, these should be uploaded inMaestro. Initially in Maestro the server should be predefined. ***Please note**: the user is prompted to define the server when Maestro application is run for the first time (please also see the installation manual).*

As a next step it is important to define the **data connection** for every data layer (vector or raster). Data connection represents the link to the physical data stored on disk and should be named with the unique data path for each file.

Once data connection is created, **layer** should be added to folder '*Layer*' in Maestro's 'Table of Contents' (TOC). User defines the name of the layer hence links it to the right data connection, specified before.

The Map definition/project inside the 'Map' folder should be created and saved next, consisting of all Urban SMS spatial data. **Layers** from the 'Layer' folder are then added and the final name of the layer in the Map definition/project is defined. ***Please note**: this name must be identical to the name in Admin Web page (please see below)! If this is not the case, the system will not run correctly.*

Example: The same physical data file (*example: gSC_As*) can be used as an input layer in more than one tool. However, the same layer (physically stored on the server's HD) is defined in Maestro under different (tool specific) names and used for different calculations. It is that for important to create a tool specific (that is different) data connections or define different layer name inside Map definition/project. Regardless that the names are different they are linked to the same data. We could say that each Layer name inside Map Definition/project is like an ID for every data.

For step by step instructions on how to upload files into Maestro, please also see the **Software installation manual**, and its chapter "**Setup of Mapguide Maestro web service**".

2.3 Step three –Urban SMS Admin Web page setup

The Admin Web page is the central component of the Urban SMS Web system. On this page the administrator defines/edits the tool input **data properties** (names, weights, data paths etc.). Also the page enables administrators to write/edits **algorithms**, the mathematical equations, using GRASS rules (Grass specific rules for writing the operations).

Important guidances for the Administrator:

1. The most important is the Layer name (Name in Maestro), which must be identical to the layer name defined in Map definition/project in Maestro. *Please note: The layer name is case sensitive and that names can't be duplicated.*
   Example; ASQ and ESQ tools both require the result of NS tool (gNS_result) so the layer name must differ (*note: data paths are the same for both tools*). The gNS_result layer, which is used as an input layer is named gNS_result_ASQ in ASQ tool and gNS_result_ESQ in ESQ tool.
2. It is additionally essential to correctly set the data paths as well. *Please note: There are different ways of writing the data paths. It depends on dataset format and the status/role of the tool data:*
   a. If the dataset is ESRI grid format (usually tool input layer, except if input is the result of other tools) the data path should end with **"*layer name*\hdr.adf"** *(example: C:\Data\urbansms\GISData\5\USMS\ToolData\gSD_ESQ\hdr.adf).*
   b. If dataset is an image file (usually when input is the result of other tool) then data path should end with **"*image name*.png"** (example: *C:\Data\urbansms\GISData\5\USMS\ToolData\gNS_result\gNS_result.png).*
   c. For the result layer data path should end with **"layer name_result \"** (example: *C:\Data\urbansms\GISData\5\USMS\ToolData\gNS_result*\).

For detailed information about managing the administrator page please also refer to Web Administrator Manual.

3 SEMANTIC ASPECT OF THE DATA PREPARATION

There are/should be three types of data in Urban SMS GIS database:

1. **Raster data (ESRI GRID format),**
2. **Vector data (ESRI SHAPE format),**
3. **Georeferenced image data (png** or **jpg** or **tiff** or **ecw, etc)**

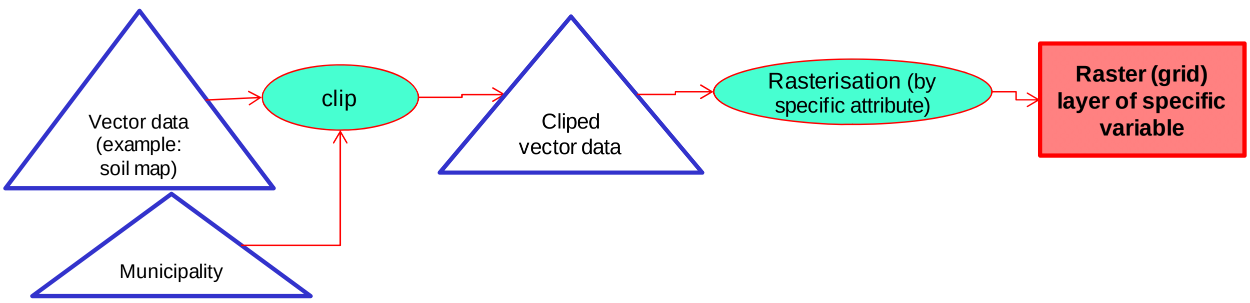
The most important are the raster grid layers (saved in ToolData folder) which are directly used as an input data for Urban SMS tool evaluations. Vector and image layers/data are mostly used for graphical presentation or displaying background (outfit). Raster data in ESRI binary grid format are input layers for all the tools and therefore each error in input data results in corrupted output data or even wrong (not correct) results. *Please note: The LSR tool is an exception, where the shape file (ESRI SHAPE) is part of analytical process.*

3.1 Raster data preparation in ArcGIS

Raster grid layers are usually prepared in ESRI ArcGIS – ArcInfo software using standard GIS functions and algoritms.

- Most input grids are derived from **shapefile** data, such as soil map vector file. Rasterization should be performed separately by each selected variable at the time.
- grids created with **geostatistical interpolation** functions (kriging),
- grids derived from **Digital Elevation Model** (DEM),
- grids created by calculating the **euclidean distance** form a selected object/plot etc.

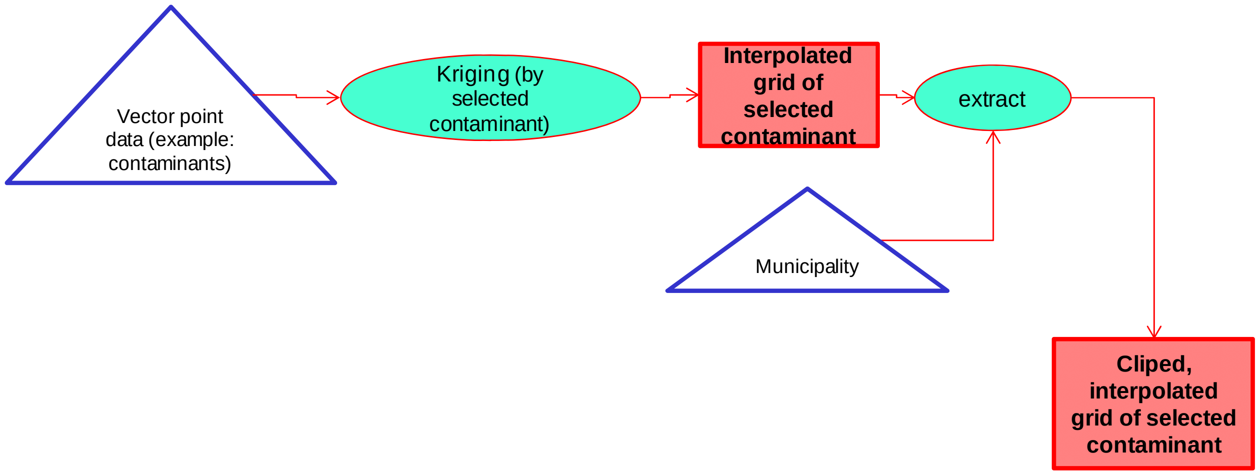
3.1.1 Raster grids created with rasterization by variable



Grids created by using this process:

gOM_ESQ, gPH_ESQ, gSD_ESQ, gTX_ESQ, gOM_ASQ, gTX_ASQ, gSD_ASQ, gPH_ASQ, gClay, gSand, gTSdepth, gPores.

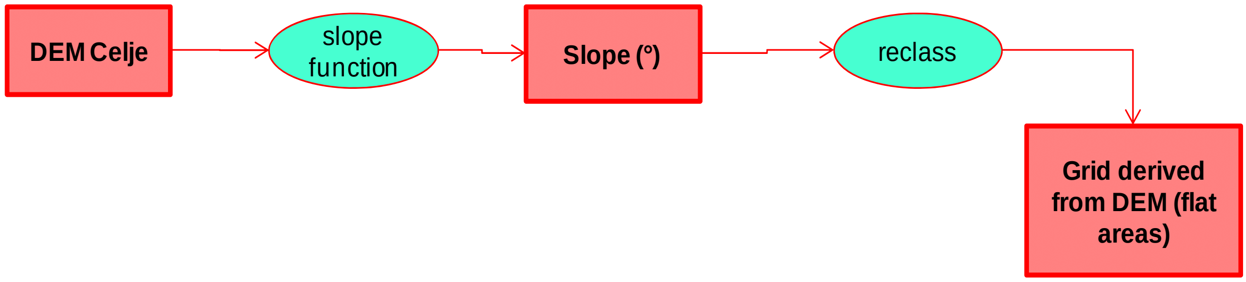
3.1.2 Raster grids created with interpolation (kriging)



Grids created by using this process:

gSC_Pb, gSC_Zn, gSC_Cd, gSC_Ni, gSC_As

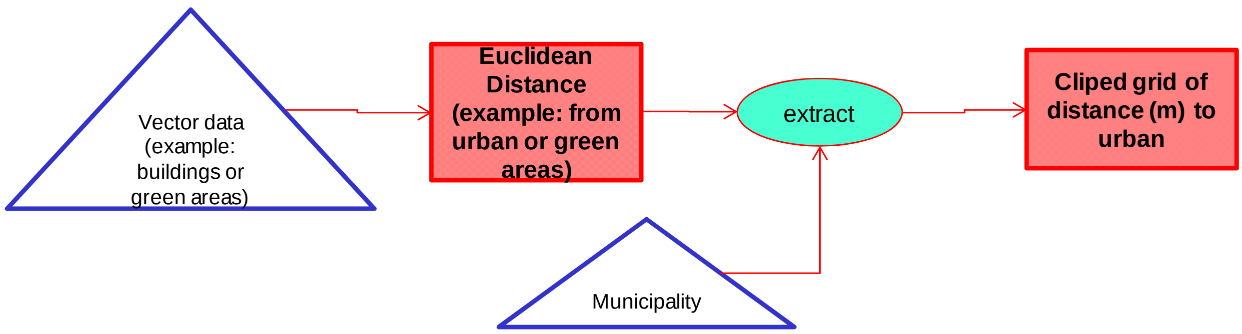
3.1.3 Raster grids derived from DEM



Grids created by using this process:

gFlat , gAgr

3.1.4 Raster grids created by calculating euclidean distance



Grids created by using this process:

gUrbProx, gEucGREEN

3.2 Vector (ESRI shape) data preparation in ArcGIS

Vector data layers were all prepared in ESRI ArcGIS – ArcInfo software. Point, line and polygon vector data can be displayed and uploaded on the system. Vector shapefiles saved on disk were used only for displaying complementary (background) information and not used for processing (*LSR, CNT and PROX tools are again an exception!*). Instructions about creating a vector layer for the purpose of LSR tool will be given at the end of this manual (*Please refer to the chapter: CREATING INPUT LAYER OF PLANNING AREAS FOR LSR TOOL**).***

Uploading shapefiles on the Urban SMS WEB (only for LSR tool):

1. Before uploaded Shapefile (one or more polygons) should be saved as a .zip folder (*Please note: shapefiles should have column names as defined in user Manual's chapter; Creating input layer of planning areas for LSR*).
2. Then within the *LSR tool*, '*custom areas'* menu should be selected,
3. Then select '*Browse Files'* button
4. Find the location and select previously prepared .zip file,
5. Click the *Upload* button to finish the process.

Once uploaded, the shapefile is stored to the system (under the user ID with uploaded it), and can be used for other tools as well. If user wants to use the uploaded shapefile layer in another tool there is **no need to repeat the upload process**. The shapefile should simply be selected from a lit within 'custom areas' section and confirmed.

3.3 Georeferenced image data preparation

Georeferenced images are used as background layers on the map. Images can be in **.png, .jpg, .tiff, .ecw** formats. It is recommended to save the images in **.png** format, because of its size (much less KB then .tiff).

Example of image layer: DOF, DEM, TK25 (Topographic map 1:25000)

Creating georeferenced images using ArcGIS:

1. Set the layer drawing order and symbology in ArcMap,
2. In '*Data View'* click *File → Export Map*,
3. Select the image data type *(.png),*
4. Under '*General'* toolbar set the resolution and check '*Write World File'*.
   (World file contains information about the geographic position of the data: tfw for tiff, jgw for jpg, pgw for png).

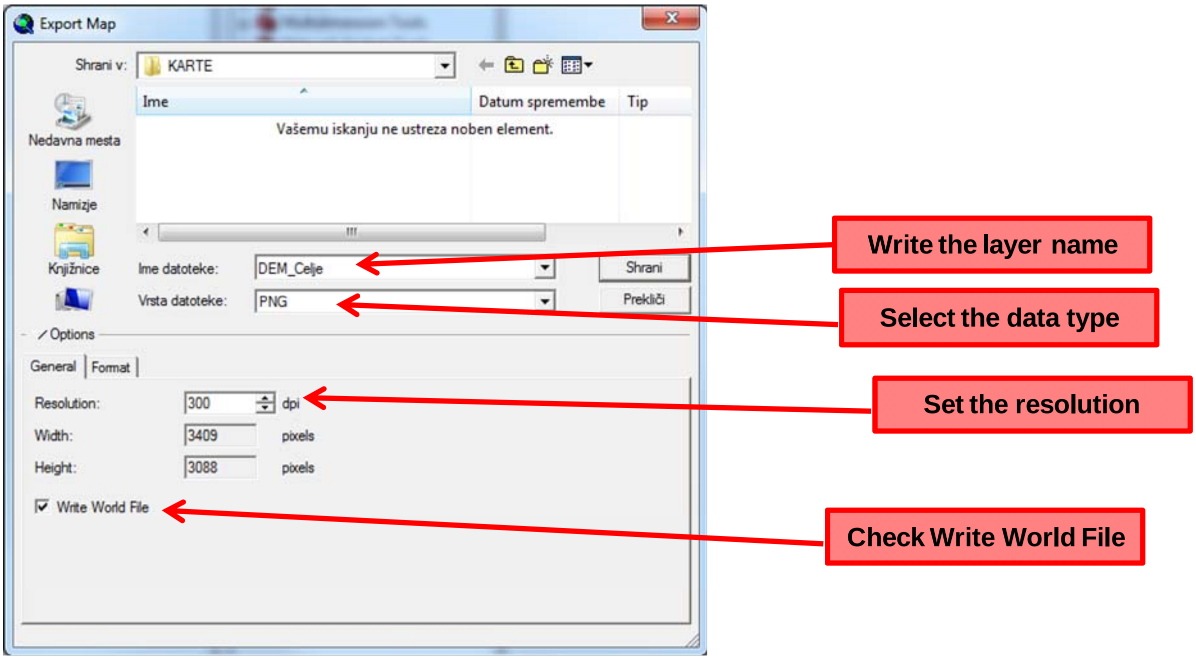


Figure 18: Exporting maps to georeferenced image file.

4 CREATING INPUT LAYER OF PLANNING AREAS FOR LSR TOOL

For the proper use of LSR tool in Urban SMS application, polygons of existing and planned land use need to be uploaded into the program. Polygons have to be in **SHP** (shapefile) and compressed in **ZIP** format. Polygons can be created in ESRI ArcGIS.

4.1 Creating the polygons in ESRI ArcGIS

4.1.1 Empty shapefile

1. Select the ArcCatalog Button to launch ArcCatalog.
2. browse to the desired folder where new **Shapefile** will be created.
3. Right-click on the **Shapefile** folder and select **New - Shapefile**, to open the **Create New Shapefile** dialog box (Figure 19).

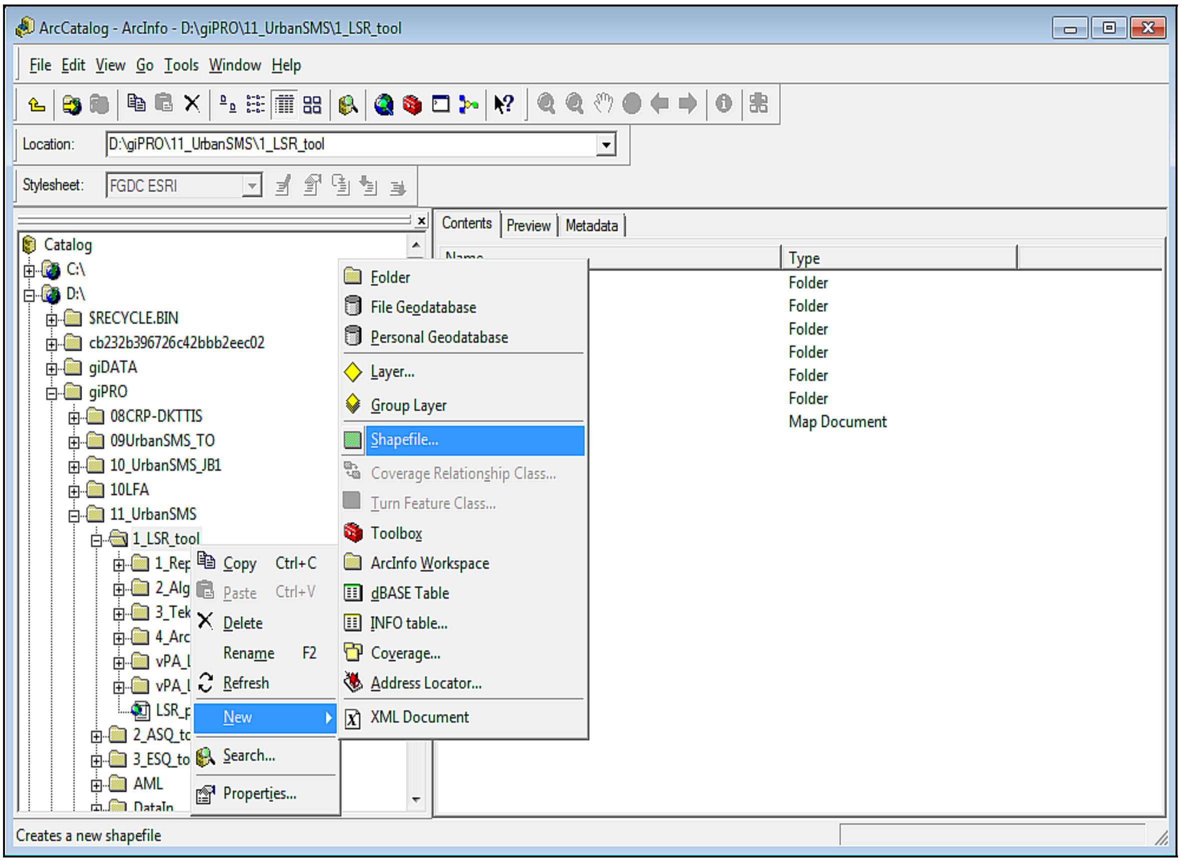


Figure 19: Create new shapefile.

4. When new dialog box appears type in the **name** of the new shapefile (e.g. vPA_LSR_1.shp) and select **Feature Type** as **'Polygon'**, then click '**Edit**' button under

the **Spatial Reference Description** to open the **Spatial Reference Properties** dialog box (Figure 20).

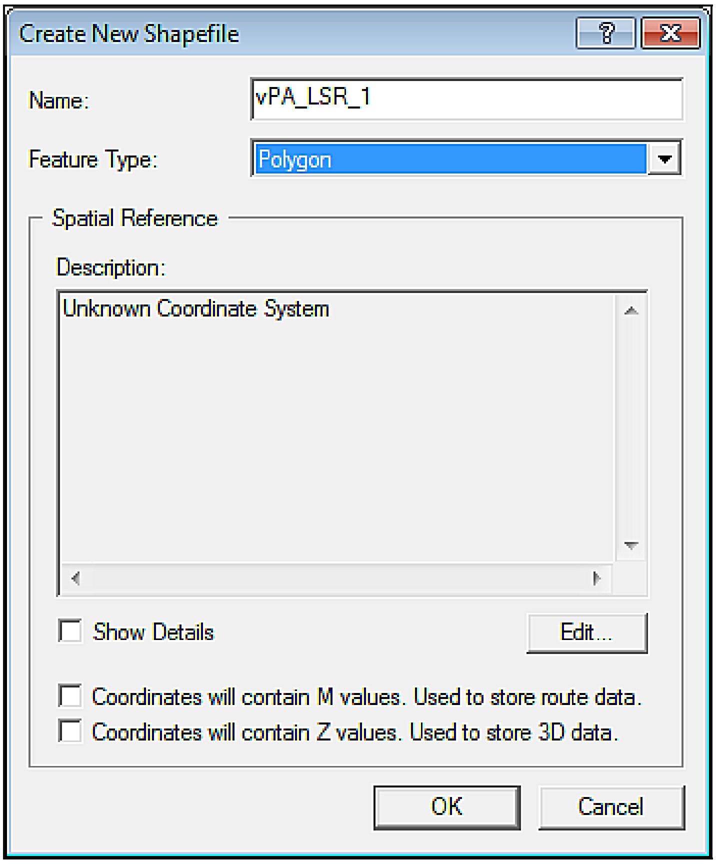


Figure 20: Enter Name and Feature Type of the shapefile and open Spatial Reference Properties Dialog box.

5. In the next step you can either:
    1. create new coordinate system by clicking 'New' button and select a predefined coordinate system
       Confirm your choice with a click on 'Select'
    2. or import the coordinate system from the existing shapefile, raster,… from your Desktop
       For import click 'Import' (Figure 21)

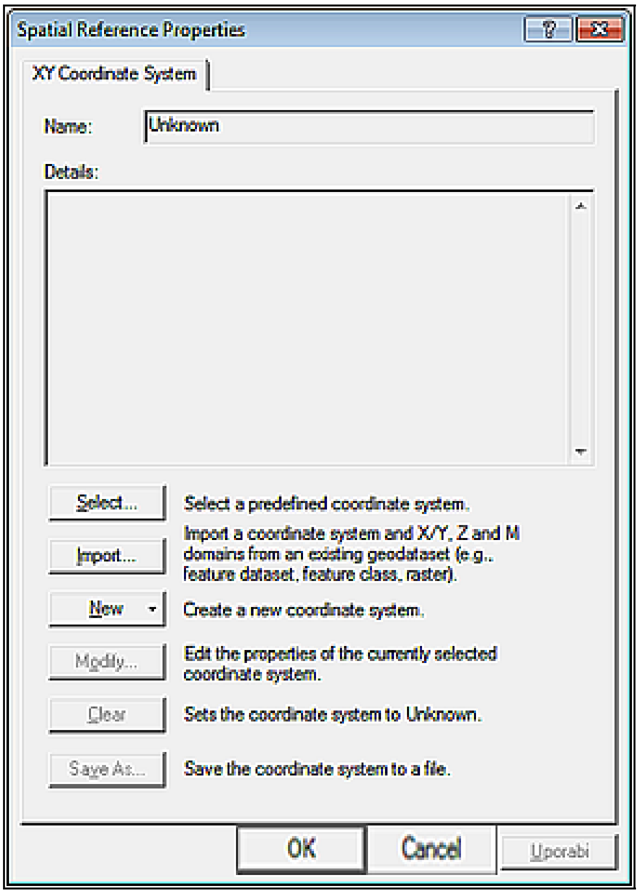


Figure 21: Define the coordinate system of created shapefile

To finalize and confirm your selection click 'Add' button.

When the coordinate system is set click 'OK' to accept the imported Spatial Reference Properties. **There is even more reliable if coordinate system in not defined**.

Similarly to create new shapefile click OK (Figure 22).

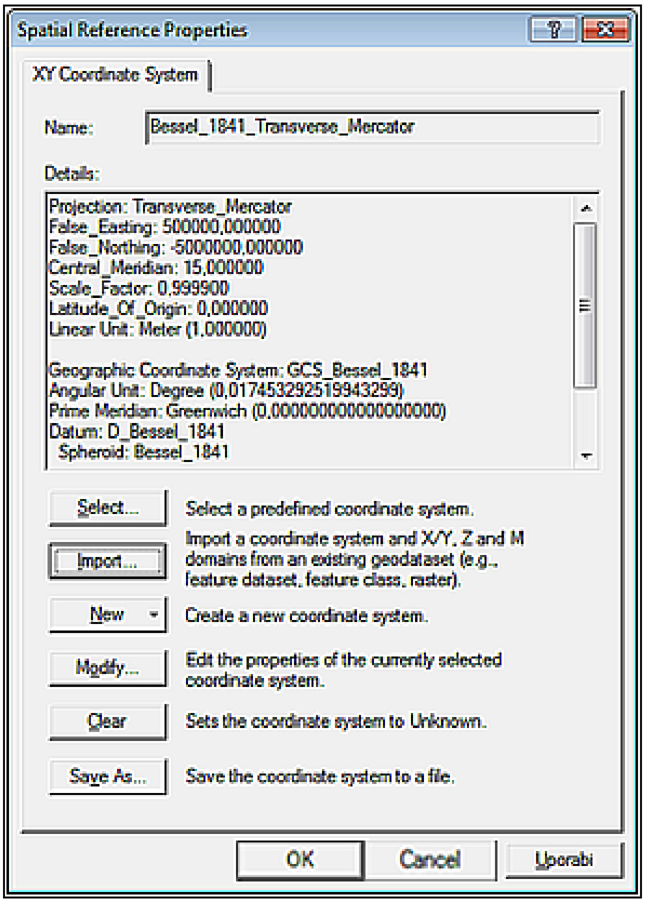


Figure 22: Confirm the selected coordinate system.

4.1.2 Add the Attribute Fields to Polygon Shapefile

1. In ArcCatalog right-click on the new shapefile name (e.g. vPA_LSR_1.shp) and open the Properties Dialog (Figure 23).

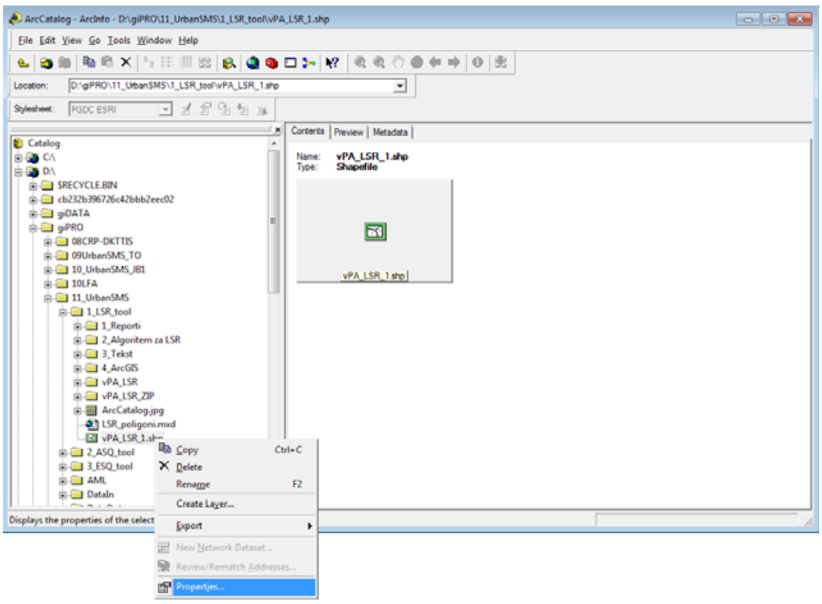


Figure 23: Select properties option to start setting the Field Names.

2. Select the **Fields Tab** in Shapefile Properties dialog box.

3. Click in the first blank cell of **Field Name** and enter the field names of the new attribute table (Figure 24)

   Field name must not exceed 10 letters.

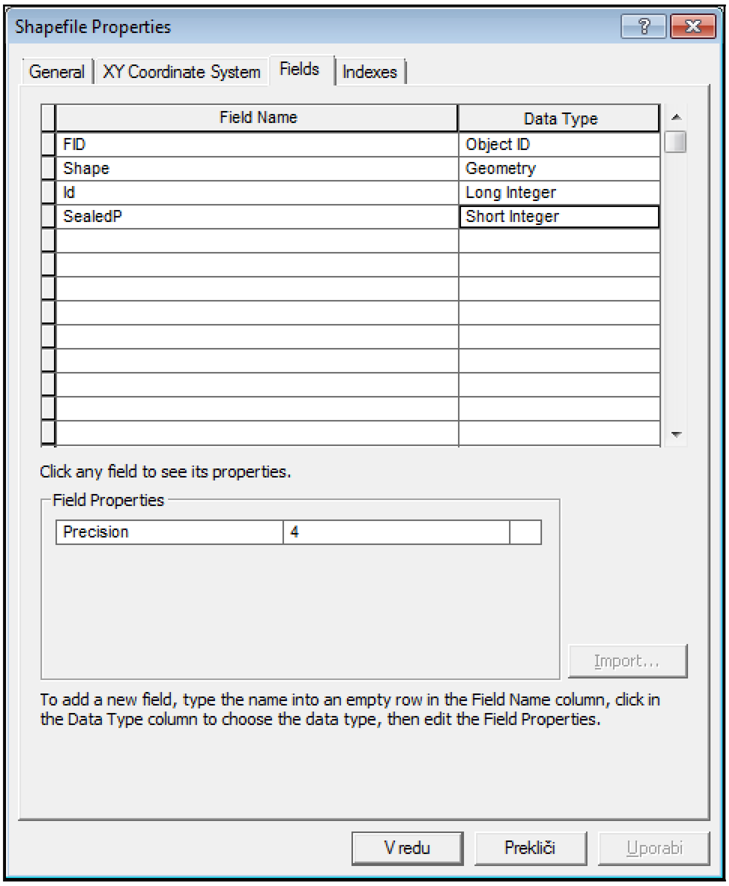


Figure 24: Shapefile Properties window to enter Field Names.

- If the cell data are **numbers: S**elect **Data Type**: Long or Short integer option + **Precision:** 0.
- If cell data are **letters:** Select **Data Type**: Text + **Length**: 25 (words).

Please Note:

a. Shapefile Field Names for LSR tool use:

SealedP field: Data Type: Short Integer & Precision: 0
SealedE field: Data Type: Short Integer & Precision: 0
LandUseP field: Data Type: Text Length: 25
LandUseE field: Data Type: Text Length: 25

b. For a proper use of LSR tool Field Names (*they are also case sensitive!*) should be **correctly spelled** (look above).

c. For a proper use of LSR tool the column order (eg. Field Name sequence) in the attribute table is **not** important.

4.2 Create New, Modify, Delete, Cut Polygon Features

4.2.1 Create New Polygon Features

1. Return to ArcMap and use the ‘Add Data’ Button to add the empty (e.g. vPA_LSR_1.shp) shapefile to the map document. The best way to start creating polygons is to add georeferenced aerophoto of the evaluated area into ArcGIS tool (Add Data Button). In this way the user can see all the features of the planning area. When zoomed in the creation of polygons can begin.
2. In Tools menu click on the ‘Editor Toolbar’ button  (Dock the toolbar somewhere convenient, if necessary).
3. Click on the ‘Editor’ button and select ‘Start Editing’ to begin an editing session (Figure 25).

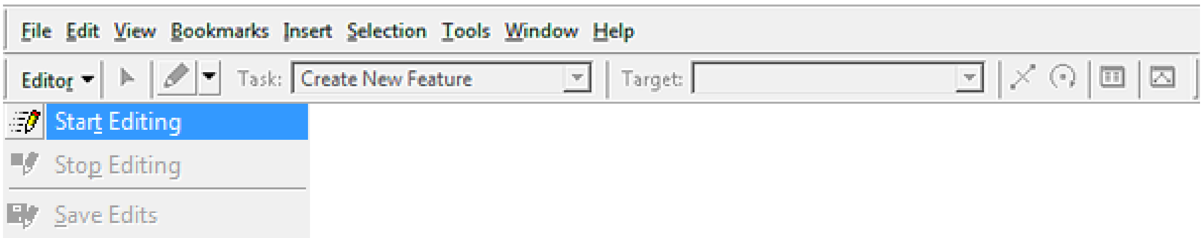


Figure 25: Start Editing button.

4. Make sure that the **Task** is set to **Create New Feature** and that the **Target** is set to **vPA_LSR_1** (the name of the added shapefile) (Figure 26).

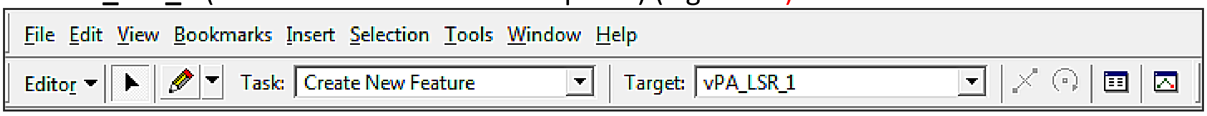
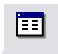


Figure 26: Proper data settings for editing (Task, Target).

5. Use the **Zoom**  **& Pan**  **Tools** to focus on the right position of the aerophoto.
6. Click on the **Sketch Tool**  on the **Editor Toolbar** to enable. You can now start drawing polygons by using the mouse. To finish double mouse click is required.
7. Click on the **Attributes Button**  to open the **Editor Toolbars Attributes Window.** Place the cursor in the **Value** cell for your **SealedP, SealedE, LandUseP, LandUseE** (field names)**.** Type values in the cells (e.g. SealedP = 80) (Figure 27).

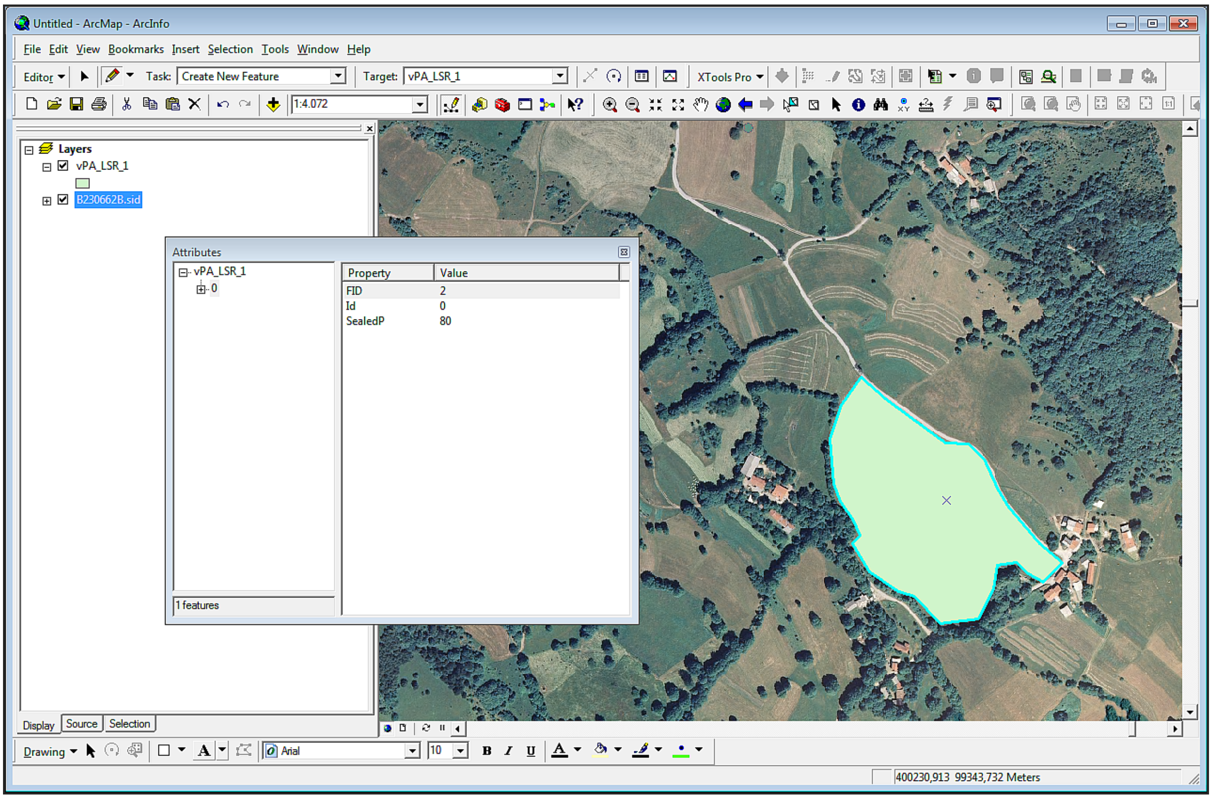


Figure 27: Setting values in the new polygon attribute table.

8. If you want to save the modifications and continue drawnig new ones, click **Editor - Save Edits** in case you want to stop editing completely click **Editor - Stop Editing** (Editor Toolbar) **+ Save** (Figure 28).

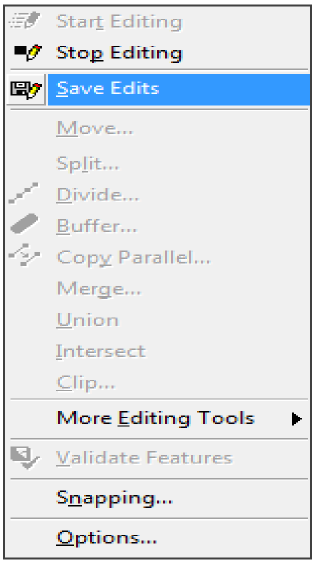


Figure 28: Save Edits button to save all new corrections.

9. Click  to save your work.

4.2.2 Modify Polygon Features

To change the shape of some pre-existing polygon, use 'Modify Feature' option (Task).

Open **ArcMap** and use the **Add Data Button** to add shapefile (e.g. vPA_LSr_1.shp) to the map document.

1. Click on the **Editor Button** and select **Start Editing** to begin an editing session.
2. On the **Editor Toolbar**, go to **Editor - Snapping** to open the **Snapping Environment Panel.**
3. Check all **three checkboxes**, next to the **vPa_LSR_1** layer.
4. Close the **Snapping Environment Panel.**
5. On the **Editor Toolbar,** change the **Task** to **Modify Feature** (Figure 29).

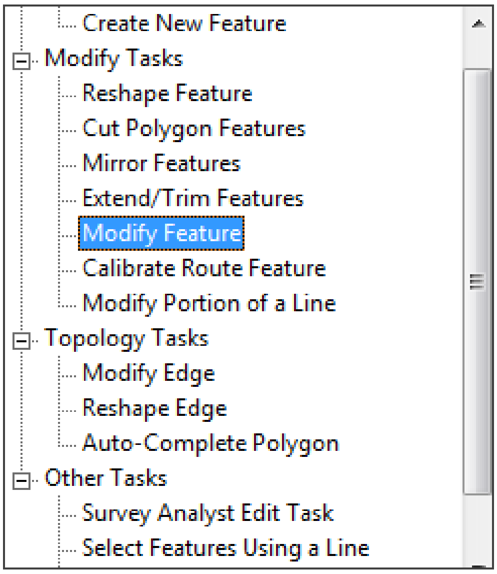
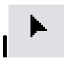


Figure 29: Modify Feature option in Task Menu.

6. Click the **Edit Tool** .
7. Using the **Edit Tool**, click once on the feature (polygon) to select it. Vertexes appears on the edges of the polygon (Figure 30).

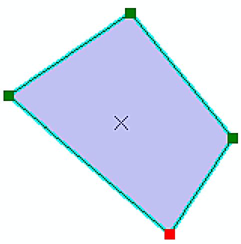


Figure 30: Vertexes on the polygon.

8. Place the mouse cursor over the spot on the edge of the polygon feature where you want to add a new **vertex.**
9. Right mouse click and select **Insert Vertex** to create a new vertex for this corner (Figure 31). You can move vertex to the desired position by left mouse click on the vertex + HOLD.

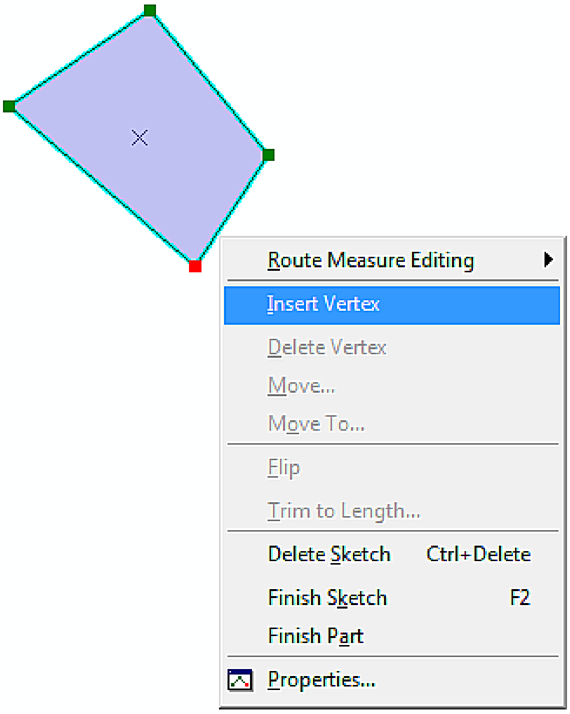
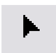


Figure 31: Insert Vertex option.

10. Click outside the feature to deselect it and apply the change.
11. Go to **Editor - Save Edits**.
12. Click  to save your work.

1.1.1. Delete Polygon Features

To delete some pre-existing polygons use 'Modify Feature' option (Task).

1. Open **ArcMap** and use the **Add Data Button** to add shapefile (e.g. vPA_LSr_1.shp) to the map document.
2. Click on the **Editor Button** and select **Start Editing** to begin an editing session.
3. On the **Editor Toolbar,** change the **Task** to **Modify Feature** (Figure 32).
4. Activate the **Edit Tool** .
5. Using the **Edit Tool**, click once on the feature (polygon) to select it
6. Right-click on the selected feature and select **Delete** (Figure 32).

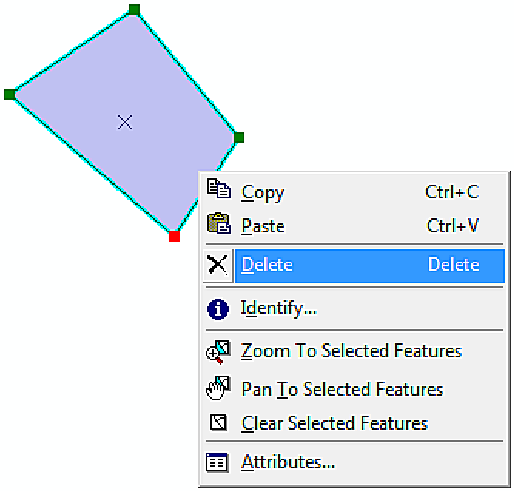


Figure 32: Delete feature option.

7. Go to **Editor - Save Edits**.
8. Click  to save your work.

4.2.3 Cut Polygon Features

1. Open **ArcMap** and use the **Add Data Button** to add shapefile (e.g. **vPA_LSr_1)** to the map document.
2. Click on the **Editor Button** and select **Start Editing** to begin an editing session.
3. On the **Editor Toolbar**, go to **Editor - Snapping…** to open the **Snapping Environment Panel.**
4. Check all **three checkboxes**, next to the **vPa_LSR_1** layer.
5. Close the **Snapping Environment Panel.**
6. On the **Editor Toolbar,** change the **Task** to **Cut Polygon Features** (Figure 33).

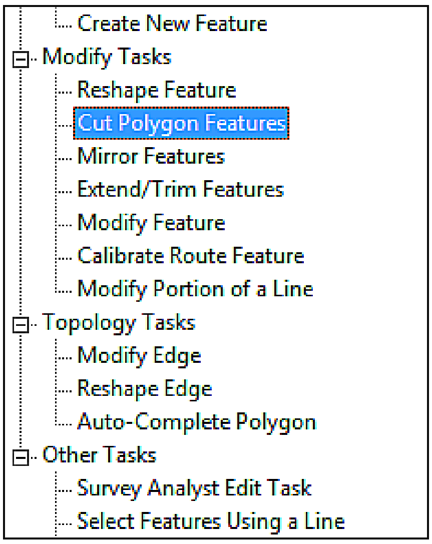
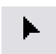


Figure 33: Cut polygon feature option.

7. Activate the **Edit Tool** .

8. Using the **Edit Tool**, click once on the feature (polygon) to select it.
9. Select the **Sketch Tool** from the **Editor Toolbar** and click on the desired spot of the polygon edge and go to the other side of the polygon and finish with double mouse click (Figure 34).

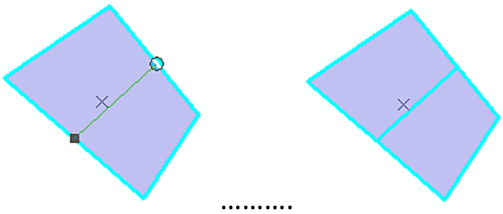


Figure 34: Cutting polygons procedure.

10. Go to Editor - Save Edits.
11. Click to save your work.
12. You are done.

5 Appendix 1: Data description for each USMS ESRI grid layer (example of ArcInfo describe command)

Description of Grid gagr

Cell Size = 5.000 Data Type: Integer
Number of Rows = 2960 Number of Values = 1
Number of Columns = 2220 Attribute Data (bytes) = 8

BOUNDARY STATISTICS

Xmin = 516500.000 Minimum Value = 1.000
Xmax = 527600.000 Maximum Value = 1.000
Ymin = 116000.000 Mean = 1.000
Ymax = 130800.000 Standard Deviation = 0.000

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gclay PARAMETRI:

Description of Grid gclay

Cell Size = 5.000 Data Type: Floating Point
Number of Rows = 2960
Number of Columns = 2220

BOUNDARY STATISTICS

Xmin = 516500.000 Minimum Value = 8.660
Xmax = 527600.000 Maximum Value = 62.100
Ymin = 116000.000 Mean = 22.046
Ymax = 130800.000 Standard Deviation = 9.085

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:geucgreen PARAMETRI:

Description of Grid geucgreen

Cell Size = 5.000 Data Type: Integer

Number of Rows = 2960 Number of Values = 7827

Number of Columns = 2220 Attribute Data (bytes) = 8

BOUNDARY STATISTICS

Xmin = 516500.000 Minimum Value = 0.000

Xmax = 527600.000 Maximum Value = 7847.000

Ymin = 116000.000 Mean = 2277.503

Ymax = 130800.000 Standard Deviation = 1724.224

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gflat PARAMETRI:

Description of Grid gflat

Cell Size = 5.000 Data Type: Integer

Number of Rows = 2960 Number of Values = 1

Number of Columns = 2220 Attribute Data (bytes) = 8

BOUNDARY STATISTICS

Xmin = 516500.000 Minimum Value = 1.000

Xmax = 527600.000 Maximum Value = 1.000

Ymin = 116000.000 Mean = 1.000

Ymax = 130800.000 Standard Deviation = 0.000

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gns_k PARAMETRI:

Description of Grid gns_k

Cell Size = 5.000 Data Type: Integer
Number of Rows = 2960 Number of Values = 3
Number of Columns = 2220 Attribute Data (bytes) = 8

BOUNDARY STATISTICS

Xmin = 516500.000 Minimum Value = 3.000
Xmax = 527600.000 Maximum Value = 5.000
Ymin = 116000.000 Mean = 4.045
Ymax = 130800.000 Standard Deviation = 0.493

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gns_n PARAMETRI:

Description of Grid gns_n

Cell Size = 5.000 Data Type: Integer
Number of Rows = 2960 Number of Values = 3
Number of Columns = 2220 Attribute Data (bytes) = 8

BOUNDARY STATISTICS

Xmin = 516500.000 Minimum Value = 3.000
Xmax = 527600.000 Maximum Value = 5.000
Ymin = 116000.000 Mean = 4.107
Ymax = 130800.000 Standard Deviation = 0.575

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gns_p PARAMETRI:

Description of Grid gns_p

Cell Size = 5.000 Data Type: Integer
Number of Rows = 2960 Number of Values = 3

Number of Columns = 2220 Attribute Data (bytes) = 8

BOUNDARY STATISTICS

Xmin = 516500.000 Minimum Value = 3.000
Xmax = 527600.000 Maximum Value = 5.000
Ymin = 116000.000 Mean = 3.615
Ymax = 130800.000 Standard Deviation = 0.726

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gom_asq PARAMETRI:

Description of Grid gom_asq

Cell Size = 5.000 Data Type: Integer
Number of Rows = 2960 Number of Values = 3
Number of Columns = 2220 Attribute Data (bytes) = 8

BOUNDARY STATISTICS

Xmin = 516500.000 Minimum Value = 3.000
Xmax = 527600.000 Maximum Value = 5.000
Ymin = 116000.000 Mean = 4.169
Ymax = 130800.000 Standard Deviation = 0.506

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gom_esq PARAMETRI:

Description of Grid gom_esq

Cell Size = 5.000 Data Type: Integer
Number of Rows = 2960 Number of Values = 3
Number of Columns = 2220 Attribute Data (bytes) = 8

BOUNDARY STATISTICS

Xmin =	516500.000	Minimum Value =	2.000
Xmax =	527600.000	Maximum Value =	4.000
Ymin =	116000.000	Mean =	3.169
Ymax =	130800.000	Standard Deviation =	0.506

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gph_asq PARAMETRI:

Description of Grid gph_asq

Cell Size =	5.000	Data Type:	Integer
Number of Rows =	2960	Number of Values =	3
Number of Columns =	2220	Attribute Data (bytes) =	8

BOUNDARY STATISTICS

Xmin =	516500.000	Minimum Value =	2.000
Xmax =	527600.000	Maximum Value =	5.000
Ymin =	116000.000	Mean =	4.036
Ymax =	130800.000	Standard Deviation =	0.793

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gph_esq PARAMETRI:

Description of Grid gph_esq

Cell Size =	5.000	Data Type:	Integer
Number of Rows =	2960	Number of Values =	3
Number of Columns =	2220	Attribute Data (bytes) =	8

BOUNDARY STATISTICS

Xmin =	516500.000	Minimum Value =	3.000
Xmax =	527600.000	Maximum Value =	5.000
Ymin =	116000.000	Mean =	4.135
Ymax =	130800.000	Standard Deviation =	0.561

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gpores PARAMETRI:

Description of Grid gpores

Cell Size = 5.000 Data Type: Floating Point

Number of Rows = 2960

Number of Columns = 2220

BOUNDARY STATISTICS

Xmin = 516500.000 Minimum Value = 0.514

Xmax = 527600.000 Maximum Value = 0.823

Ymin = 116000.000 Mean = 0.593

Ymax = 130800.000 Standard Deviation = 0.080

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gsand PARAMETRI:

Description of Grid gsand

Cell Size = 5.000 Data Type: Floating Point

Number of Rows = 2960

Number of Columns = 2220

BOUNDARY STATISTICS

Xmin = 516500.000 Minimum Value = 7.280

Xmax = 527600.000 Maximum Value = 61.200

Ymin = 116000.000 Mean = 26.616

Ymax = 130800.000 Standard Deviation = 13.935

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gsc_as PARAMETRI:

Description of Grid gsc_as

Cell Size = 5.000 Data Type: Floating Point
Number of Rows = 2960
Number of Columns = 2220

BOUNDARY STATISTICS

Xmin =	516500.000	Minimum Value =	-119.697
Xmax =	527600.000	Maximum Value =	43.955
Ymin =	116000.000	Mean =	7.125
Ymax =	130800.000	Standard Deviation =	9.760

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gsc_aspnt PARAMETRI:

Description of Grid gsc_aspnt

Cell Size = 5.000 Data Type: Floating Point
Number of Rows = 2960
Number of Columns = 2220

BOUNDARY STATISTICS

Xmin =	516500.000	Minimum Value =	1.000
Xmax =	527600.000	Maximum Value =	33.000
Ymin =	116000.000	Mean =	0.000
Ymax =	130800.000	Standard Deviation =	0.000

NO COORDINATE SYSTEM DEFINED

Description of Grid gsc_cd

Cell Size = 5.000 Data Type: Floating Point
Number of Rows = 2960
Number of Columns = 2220

BOUNDARY STATISTICS

Xmin = 516500.000 Minimum Value = -310.481
Xmax = 527600.000 Maximum Value = 1237.190
Ymin = 116000.000 Mean = 8.300
Ymax = 130800.000 Standard Deviation = 56.223

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gsc_cdpnt PARAMETRI:

Description of Grid gsc_cdpnt

Cell Size = 5.000 Data Type: Floating Point
Number of Rows = 2960
Number of Columns = 2220

BOUNDARY STATISTICS

Xmin = 516500.000 Minimum Value = 0.200
Xmax = 527600.000 Maximum Value = 343.760
Ymin = 116000.000 Mean = 28.658
Ymax = 130800.000 Standard Deviation = 52.956

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gsc_ni PARAMETRI:

Description of Grid gsc_ni

Cell Size = 5.000 Data Type: Floating Point
Number of Rows = 2960
Number of Columns = 2220

BOUNDARY STATISTICS

Xmin = 516500.000 Minimum Value = -500.660

Xmax = 527600.000 Maximum Value = 322.682

Ymin = 116000.000 Mean = 17.558

Ymax = 130800.000 Standard Deviation = 57.242

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gsc_nipnt PARAMETRI:

Description of Grid gsc_nipnt

Cell Size = 5.000 Data Type: Floating Point

Number of Rows = 2960

Number of Columns = 2220

BOUNDARY STATISTICS

Xmin = 516500.000 Minimum Value = 1.900

Xmax = 527600.000 Maximum Value = 76.400

Ymin = 116000.000 Mean = 0.000

Ymax = 130800.000 Standard Deviation = 0.000

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gsc_pb PARAMETRI:

Description of Grid gsc_pb

Cell Size = 5.000 Data Type: Floating Point

Number of Rows = 2960

Number of Columns = 2220

BOUNDARY STATISTICS

Xmin = 516500.000 Minimum Value = -8713.431

Xmax = 527600.000 Maximum Value = 59494.051

Ymin = 116000.000 Mean = 159.830

Ymax = 130800.000 Standard Deviation = 675.739

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gsc_pbpnt PARAMETRI:

Description of Grid gsc_pbpnt

Cell Size = 5.000 Data Type: Floating Point

Number of Rows = 2960

Number of Columns = 2220

BOUNDARY STATISTICS

Xmin =	516500.000	Minimum Value =	17.500
Xmax =	527600.000	Maximum Value =	59494.051
Ymin =	116000.000	Mean =	2743.105
Ymax =	130800.000	Standard Deviation =	6562.765

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gsc_zn PARAMETRI:

Description of Grid gsc_zn

Cell Size = 5.000 Data Type: Floating Point

Number of Rows = 2960

Number of Columns = 2220

BOUNDARY STATISTICS

Xmin =	516500.000	Minimum Value =	-136017.953
Xmax =	527600.000	Maximum Value =	186124.719
Ymin =	116000.000	Mean =	962.782
Ymax =	130800.000	Standard Deviation =	13618.301

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gsc_znpnt PARAMETRI:

Description of Grid gsc_znpnt

Cell Size = 5.000 Data Type: Floating Point

Number of Rows = 2960

Number of Columns = 2220

BOUNDARY STATISTICS

Xmin =	516500.000	Minimum Value =	67.000
Xmax =	527600.000	Maximum Value =	112279.773
Ymin =	116000.000	Mean =	6299.486
Ymax =	130800.000	Standard Deviation =	11698.420

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gsd_asq PARAMETRI:

Description of Grid gsd_asq

Cell Size = 5.000 Data Type: Integer

Number of Rows = 2960 Number of Values = 3

Number of Columns = 2220 Attribute Data (bytes) = 8

BOUNDARY STATISTICS

Xmin =	516500.000	Minimum Value =	3.000
Xmax =	527600.000	Maximum Value =	5.000
Ymin =	116000.000	Mean =	4.780
Ymax =	130800.000	Standard Deviation =	0.607

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gsd_esq PARAMETRI:

Description of Grid gsd_esq

Cell Size = 5.000 Data Type: Integer

Number of Rows = 2960 Number of Values = 4
Number of Columns = 2220 Attribute Data (bytes) = 8

BOUNDARY STATISTICS

Xmin = 516500.000 Minimum Value = 2.000
Xmax = 527600.000 Maximum Value = 5.000
Ymin = 116000.000 Mean = 4.606
Ymax = 130800.000 Standard Deviation = 0.935

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gslp PARAMETRI:

Description of Grid gslp

Cell Size = 5.000 Data Type: Integer
Number of Rows = 2960 Number of Values = 5
Number of Columns = 2220 Attribute Data (bytes) = 8

BOUNDARY STATISTICS

Xmin = 516500.000 Minimum Value = 1.000
Xmax = 527600.000 Maximum Value = 5.000
Ymin = 116000.000 Mean = 3.404
Ymax = 130800.000 Standard Deviation = 1.564

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gtsdepth PARAMETRI:

Description of Grid gtsdepth

Cell Size = 5.000 Data Type: Floating Point
Number of Rows = 2960
Number of Columns = 2220

BOUNDARY STATISTICS

Xmin = 516500.000 Minimum Value = 34.600
Xmax = 527600.000 Maximum Value = 135.000
Ymin = 116000.000 Mean = 68.915
Ymax = 130800.000 Standard Deviation = 15.128

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gtx_asq PARAMETRI:

Description of Grid gtx_asq

Cell Size = 5.000 Data Type: Integer
Number of Rows = 2960 Number of Values = 4
Number of Columns = 2220 Attribute Data (bytes) = 8

BOUNDARY STATISTICS

Xmin = 516500.000 Minimum Value = 2.000
Xmax = 527600.000 Maximum Value = 5.000
Ymin = 116000.000 Mean = 3.470
Ymax = 130800.000 Standard Deviation = 0.913

NO COORDINATE SYSTEM DEFINED

REPEAT AML:describe_grid.aml COVER:gtx_esq PARAMETRI:

Description of Grid gtx_esq

Cell Size = 5.000 Data Type: Integer
Number of Rows = 2960 Number of Values = 4
Number of Columns = 2220 Attribute Data (bytes) = 8

BOUNDARY STATISTICS

Xmin = 516500.000 Minimum Value = 1.000
Xmax = 527600.000 Maximum Value = 4.000
Ymin = 116000.000 Mean = 2.470

Ymax = 130800.000 Standard Deviation = 0.913

NO COORDINATE SYSTEM DEFINED

Description of Grid gurbprox

Cell Size = 12.500 Data Type: Integer

Number of Rows = 1184 Number of Values = 5789

Number of Columns = 888 Attribute Data (bytes) = 8

BOUNDARY STATISTICS

Xmin = 516500.000 Minimum Value = 0.000

Xmax = 527600.000 Maximum Value = 6102.000

Ymin = 116000.000 Mean = 1234.809

Ymax = 130800.000 Standard Deviation = 1316.166

NO COORDINATE SYSTEM DEFINED

URBAN SMS Soil Management Strategy

This paper belongs to the following section of URBAN SMS work plan:
WP4 Soil manager suite / 4.4 update according local tests / 4.4.4 soil manager suite

www.urban-sms.eu

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