



Effects of urbanization on soil loss and water cycle

1

Module:

Water cycle

Total duration: 5 hours

Field work: No

List of materials:

- PC, beamer (IWB)
 - 3 plastic bottles with
 - Undisturbed bare soils
 - Undisturbed soil with vegetation
 - Undisturbed bare soils with plastic film
- Informatics laboratory

Worksheets: 2

Students' age: 16-18

Use of apps/software: Q-GIS

Brief disciplinary introduction

Soils are the most important resource for all living beings. Many are the services that they provide:

- Provision (of food with agriculture, provision of other biomass like timber and firewood, fibers etc.);
- Regulation of water, carbon and nutrient cycles
- Support of human settlements, infrastructures;
- Filter/buffer contaminants acting as a filter between the surface where they are distributed and the water table;
- Preserve biodiversity of soil organisms and plants
- Regulation of (micro)climate.

European soils face many threats such as the irreversible loss due to the increasing soil sealing from urbanization, soil erosion, and continuing deterioration due to local and diffuse contamination (acidification and heavy metals). These issues will be likely nurtured by other environmental threats such as climate change or land-use changes and other human activities. In some areas e.g. southern and central Europe and the Caucasus face high risks of soil erosion, other face high urbanization rates and infrastructure development (western and northern Europe).



In Italy for instance, despite a deceleration, the loss of soil is still very high rating from 2016 about 3 square meters per second, The total sealed surface is 23039 km² (7,64% of the total surface) with a 184% increase from the fifties (Ispra report, 2018). The sealed surfaces, from 2006 to 2012 are mostly represented by new industrial areas (27.9%), new urban areas with low density (23.1%) and the densification of urban areas (22.3%). Other transformations regarded the creation of new infrastructures, sport areas, building sites, quarries, new green areas.

Strategies for soil protection, and systems for monitoring of soil, are not adequately developed at European or national level. A policy framework which recognizes the environmental importance of soil is needed to protect soils and their functions,

In this activity, students will know how to analyze the land cover change and the soil loss in their region/province during a period of time. They will understand the effects of soil sealing due to urbanization especially on the water cycle, decreasing the water storage and increasing the superficial runoff.

Training materials on how to use QGIS are available at this Google Drive link https://drive.google.com/open?id=170DWr3JclxkBAByoA5_aRiXcmnl6JAuR, in the folder Action_C1_QGIS Training in which you can also find an exercise in the folder Data/Campania, about Sarno river catchment that can be used as an example.

Objective of the learning unit

To learn about :

- ✓ Soil use, soil cover
- ✓ Geographical mapping
- ✓ Changes in soil use
- ✓ Soil properties in water retention and runoff
- ✓ Effects of soil sealing on water cycle
- ✓ Environmental and social-economic issues

To be able to:

- ✓ Use cartographic maps
- ✓ Use of GIS software
- ✓ Work in groups

Introduction (orientation)

Time estimated: 15 minutes

Where the activity takes place: in the classroom

Method (how the students have to work): as a class

Instructions for the teacher:



Show the students three plastic bottles filled with soil (taken from the field and possibly undisturbed) as in the picture: one with bare surface, one covered with grass and the third one covered with a plastic film. Put them on a slight slope.

Spray gently a known amount of water until observing run off on the surface, observe what happens to the water percolated from the three bottles into the transparent containers.

“What does it happen to a sealed surface?”

“What is the colour of the percolated water due to?”

“What is the role of vegetation? What is the function of soil?”

Conceptualization

Time estimated: 15 minutes

Where the activity takes place: in the classroom/lab

Method (how the students have to work): work-groups

Instructions for the teacher:

The students are asked to formulate questions to investigate, using worksheet 1 for this phase. *Taking into consideration your province/region/municipality.*

“Can you give an estimate of the sealed surface? How much is the forested area? (how would you calculate it?)”

“Do you think that have been changes in the last century?”

Investigation

Time estimated: 3 hours

Where the activity takes place: in the computer lab, and outdoor

Method (how the students have to work): group-work

Instructions for the teacher:

1) Planning

In the computer room, the teacher should provide the informative materials in terms of GIS layers (shapefiles and additional files). Students decide the steps of investigation.

"How would you calculate the soil loss due to urbanization using two land cover maps, one old and one recent?"

Use worksheet 1 for this phase.
Time needed: 15 minutes.

2) Performing

Students perform the GIS activity using QGIS or other software and provide a layout with the actual land cover map. If skilled, using an older map, they can provide a map of the land use change by intersecting the two maps. They can derive the table with the surfaces for cover classes and calculate (in Excel) the land cover change in that period of time. Use the files of the exercise on Sarno catchment as example to run in your administrative district. At this Google Drive link to Action_C1_QGIS Training https://drive.google.com/open?id=170DWr3JclxkBAByoA5_aRiXcmnl6JAuR, search for the folder Data/Campania. The exercise about Sarno river catchment can be used as an example. We suggest to look at this exercise in large advance.

Time needed: 3 hours.

Conclusion

Time estimated: 45 minutes

Where the activity takes place: in the classroom

Method (how the students have to work): group-work

Instructions for the teacher:

Students provide the map layouts of the soil cover of the area in the past and more recently. They report the calculations made during the previous phases in a report (answering questions of worksheet 2).

Use worksheet 2.

Discussion

Time estimated: 30 minutes

Where the activity takes place: in the classroom

Method (how the students have to work): group-work

Instructions for the teacher:

The discussion focuses on the effect of sealing on water cycle.

Students answer the questions on worksheet 2 on land cover and land cover changes but also on the effect of soil sealing on the water cycle and the ecosystem services that would be lost.

Use worksheet 2.