Co-funded by the
Erasmus+ Programme
of the European Union
Project 2017-1-IT02-KA201-036968 - IO3

DAYLIGHTING RIVERS
SCIENCE EDUCATION FOR CIVIC ECOLOGY

Influence of soil texture and structure on overland flows

Module:

Hydrogeological Risk

Water cycle

Total duration: 6 hours
Field work: Yes
List of materials:

- PC, beamer (IWB)
- Smartphones
- Thematic maps of the area
- Geological map
- Manual auger (120 mm)
- Polyethylene sheets (1 x1 m)
- Sieves (2 and 0.5 mm)
- 1 kg Plastic bags
- Shovels, spatulas
- Graduated cylinders
- Funnels
- Paper filters
- Stopwatch
- Pens and notepads
- Paper bags with labels
- Scale

Worksheets: 3
Students' age: 16-18
Use of apps/software: Q-GIS

Brief disciplinary introduction

This learning unit refer to the Agro Sarnese Nocerino (Italy) but it can be adapted to other locations. The Alveo Comune Nocerino is a tributary of the river Sarno. It originates from the confluence of the stream Solofrana and the stream Cavaiola and enters the Sarno area in the municipality of San Marzano Sul Sarno. This tributary of the Sarno goes through the Sarnese Nocerino area where the "Sensale" high school is located. The aforementioned torrents have been culverted in some parts in order to reclaim land for more intensive uses. However, this area is frequently affected by flooding with negative consequences for road conditions, production activities and public health. As for public health, epidemiological studies have confirmed a close relationship between the pollutants spilled by these torrents and the incidence of tumor diseases. This activity aims at investigating the main causes of flooding, in particular the influence of the soil texture and structure of agricultural lands on the soil infiltration rate and the soil water holding capacity in disturbed (ploughed, dug etc. soils) and undisturbed soils (not tilled), and in set-aside or (semi)natural land.

In the areas characterized by anthropic action there are numerous factors that play an important role in river floods. These factors can be ascribed to: i) pollution caused by the secondary sector (such as leather-tanning industry); ii) river entombing in order to obtain useful land area for communities; iii) pesticides and fertilizers used in the primary sector that modify the edaphic environment and, therefore to the factors that allow water absorption in a soil; iv) the soil sealing of the area by building. In addition, the present work intends to make it clear that also activities as farming may decrease the permeability of the soil, particularly during the autumn season when the soil tillage breaks the ground and destroys the structure created during the previous year, causing floods in this period. All this could be avoided if costly farming techniques were eliminated and land was cultivated using zero-tillage techniques. As a result, microbial populations would be grateful and would re-establish the natural fertility of the soil.

Objective of the learning unit

To learn about:

- ✓ Water properties
- ✓ Structure and composition of water courses
- ✓ Soil-atmosphere interaction
- ✓ Soil texture and structure
- ✓ Water and soil fertility
- ✓ Soil absorbing capacity in terms of water retention and percolation
- ✓ Soil correction
- ✓ Water-soil interaction
- ✓ Water in the soil: maximum water capacity, field capacity, wilting point.

To be able to:

- ✓ Work in groups
- ✓ Plan a scientific experiment
- ✓ Use a data management software
- ✓ Carry out a graphic representation of the territory using Q-Gis
- ✓ Do manual work

Introduction (orientation)

Time estimated: 10 minutes
Where the activity takes place: in the classroom
Method (how the students have to work): in group, and individually
Instructions for the teacher:
In order to arise students' curiosity, photos and videos are shown regarding hydrogeological risk and instability in the world, in Italy and in particular in the area we are concerned about.

For instance,

https://youtu.be/9NVHLqBTK34 "(Land consumption in Italy seen from a satellite)
https://www.youtube.com/watch?v=HkLXFlq2cuI "13 Settembre 2012 - (overflow of torrent Solofrana) "
PPT "Flood stage events, flooding and overflowing risks"
https://drive.google.com/file/d/1o2yNpHVwcFxyczy9I5QbrU0uE_sZd1kz/view?usp=sharing

A brainstorming session is carried out in order to allow the students to come up with possible solutions to the problem. During the session, each student asks questions and formulates any hypothesis they like. The teacher doesn't correct them.

"Is river flooding a problem for a community?"

"Could you mention two or more factors which play an important role in river flooding?"

"Have you ever seen a river flood? Have you ever seen a river overflow in the area where you live?"

"Does anthropic action have an important role in river overflowing?"

"Every year river overflows cause devastation in different degrees. Do you think it is possible to find a solution to the problem?"

Conceptualization

Time estimated: 20 minutes
Where the activity takes place: in the classroom/lab
Method (how the students have to work): group-work
Instructions for the teacher:
During this phase, the questions and hypotheses previously suggested are sorted out, the most bizarre, paradoxical or those which make no sense are discarded, to allow the students to formulate hypotheses that are tested during the next phase through investigation activities in the field, sampling and laboratory tests.

Moreover, students identify the variables and relations relevant to this learning activity and state what their expectations are.

Students:

- Make predictions about possible representations by cartography of the Sarnese Nocerino area taken into consideration, in order to determine the sampling locations where water samples are collected for later lab analysis.
- Predict the interaction between soil texture and structure and overland flows which can eventually occur inside cities.
- Define risks components (exposure value, danger and vulnerability).
- Predict the interaction between soil texture and structure, the movement of water within the soil through gravity, the water holding capacity of the soil and the floods that occur when the Alveo Comune Nocerino riverbed flows through the plain of the Sarnese – Nocerino area.

Investigation 1

Time estimated: 50 minutes
Where the activity takes place: in the classroom and outdoor by the river
Method (how the students have to work): group-work
Instructions for teacher:
In the classroom, the students are divided in groups.

1) Planning

- Introducing QGIS program
- Reading thematic maps by using QGIS
- Locating the Alveo Comune Nocerino between the torrents Solofrana and Cavaiola, tributaries of the river Sarno tramite QGIS.

2) Performing

Students have to:

- Print planimetric extracts of the thematic maps of the area under study.
- Fill in worksheet 1 online using Google Form i.e. they have to make hypotheses about relevant points where samples can be collected and later analyzed, the number of samples to collect and the distance between the sampling points.

3) Concluding

The students are able to identify areas and points of the territory on the thematic maps created in QGIS, they can go from the graphic representation on the planimetric excerpts to the identification of these areas and sampling points in the field. They are also able to add to the map any variation that may occur during sampling. This activity allows students to identify in advance the area and the sampling points, also taking into account the geology highlighted in the thematic maps provided, and to predict the level of expected risk.

Investigation 2

Time estimated: 2 hours
Where the activity takes place: in the field in the areas located by the students and in the science lab.
Method (how the students have to work): group-work
Instructions for the teacher:

1) Planning

- Field trip to the river Sarno to collect samples in the sampling points selected during the previous activity
- The students are divided into 4 groups

2) Performing

- Each group fills in worksheet 2, with all the data regarding the sampling carried out on both banks of the 'Alveo Comune Nocerino river at different distances from the river bed in order to test the influence of the river on the soil texture and structure.

3) Concluding

Field sampling leads students to discover the interaction between the soil texture and structure and soil absorbing power in terms of water retention and percolation in the subsoil as well as to test these properties in conditions of water stagnation and asphyxia in the soil. They connect the soil absorbing power with the floods that occur in the investigated area and are able to identify the different levels of hydrogeological risk.

Investigation 3

Time estimated: 50 minutes
Where the activity takes place: in the science lab, in the ITC lab.
Method (how the students have to work): group-work
Instructions for the teacher:

1) Planning

- Simulation of soil water percolation on samples taken on land cultivated using zero-tillage techniques (if this can be found) or on temporarily not cultivated or abandoned land.

2) Performing

- Each group uses the necessary equipment (worksheet, funnels, filters, graduated cylinders, etc.) to investigate the texture and structure, calculate percolation times on the samples taken. The students in groups note down in worksheet 3 the percolation times, the water introduced and the percolated water expressed in milliliters. Undisturbed soil samples are subjected to physical analysis to evaluate the influence of the structure on the parameters.

3) Concluding

The students during the identification of soil texture realize how sand, silt, clay particles and skeleton influence the absorbing power of the soil. The aggregation of soil particles is defined both while carrying out field and lab activities.

The definition of the soil structure helps understand whether the soil is able to make water percolate in depth and retain it in the micropores. Students also understand that a good soil structure allows water to percolate in the ground through the macropores and to be retained in the micropores. In this way the absorbing power of the soil can be defined and they realize that this value is useful to predict hydrogeological risk.

Conclusion

Time estimated: 80 minutes
Where the activity takes place: in the classroom
Method (how the students have to work): group-work
Instructions for the teacher:
In the classroom students analyze the data from the three worksheets and compare them with the hypotheses made in the conceptualization phase. The different groups can present their results via apps like *thinglink* and *powerpoint* or create a project using QGIS software. In particular, students are able to implement a territorial information system using the thematic maps already available on the web. They put their findings gathered during the field activity on the maps, creating specific thematic layers from time to time.

By the use of GIS, new thematic maps are produced using layouts chosen by the students themselves. In a later phase the same maps could be converted into formats compatible with the publication and sharing via web. The conclusions allow them to understand the interaction between the soil texture and structure of both disturbed and undisturbed land; between the absorption and / or percolation of water in a soil cultivated in a traditional way, cultivated with zero tillage and not cultivated. The activity makes the students aware of the influence of land properties to forecast and mitigate the risks associated with flooding.

Discussion

Time estimated: 30 minutes
Where the activity takes place: in the classrooms
Method (how the students have to work): group-work
Instructions for teacher:
This phase aims to verify students' knowledge at school. The products are evaluated by the teacher and the students can present their findings in front of their colleagues and teachers. (using apps like ThingLink or Power Point)