SOIL GEOGRAPHY IN EDUCATION

Ana Vovk Korže, Univerza v Mariboru, Filozofska fakulteta,
Mednarodni center za ekoremediacije,
Koroška c. 160, 2000 Maribor, Slovenija,
ana.vovk@um.si

Knowing the soil is all the more important due to the fact that food grows in the soil and its quality depends on the health of the soil. There are many problems with fertile soil around the world as conventional methods of farming are destroying it. At the local level, soil knowledge is important for planning the use of land and for self-sufficiency. Therefore is soil geography important for the use of procedures to analyse physical, chemical and biological properties of the soil, for used techniques and interpretation of results as well as developing thinking about how we can take care of our own soil to keep it healthy and adaptable to climate changes. This is especially important because the soil is the basis for plant growth, and the plants are the carrier of biodiversity in the ecosystem. By this we emphasize the responsibility towards the environment, which directly affects the social dimension, i.e. human health and their well-being. And this again affects the economic dimension of sustainability

Key words: agroecology, education, enivornment, soil geography.

INTRODUCTION

The most widely recognized function of soil is its support for food production. It is the foundation for agriculture and the medium in which nearly all food-producing plants grow. Food availability relies on soils: nutritious and good quality food and animal fodder can only be produced if our soils are healthy (V0vk Korže, 2014). A healthy living soil is therefore a crucial ally to food security and nutrition (Web pages1, 3).
Healthy soils supply the essential nutrients, water, oxygen and root support that our food-producing plants need to grow and flourish. Soils also serve as a buffer to protect delicate plant roots from drastic fluctuations in temperature. Soil health, also referred to as soil quality, is defined as the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans.

Within the soil geography for education, the students will learn soil geography from all aspects, that is, physical, chemical and biological aspect (Hemenway, 2009). The soil education expresses above all the **educational innovation**, since the methodological approach enables deep and direct transfer of knowledge through own experiences in real circumstances into practice, which enables the individual to upgrade the new theoretical knowledge through practical experience into a permanent, useful and lifelong knowledge.

Environmental innovation is also highlighted with the emphasis on natural food production approaches that reduce negative environmental pressures while encouraging biodiversity and the rational use of renewable resources. Furthermore, the emphasis is on **technological innovation**, which presents various innovative agroecological practices for the protection and improvement of soil health, with an emphasis on adapting to climate changes without the use of heavy machinery and chemicals (WEb page 4).

Students will learn through the module that by using natural approaches such as the use of mulch, the installation of irrigation system in garden beds, the addition of organic biomass / compost, we can improve the properties and quality of the soil, which also reduces the susceptibility of the soil to drought. The **social innovation** can be identified through the module primarily as the individual awareness of responsible behaviour and protection of the soil, spreading the awareness of self-sufficiency on the level of individuals and of the community in everyday life and the opportunity for creating own green jobs in the field of self- sufficiency (Web page 2).

Another general thread to agricultural land and food security is caused by non-reversible land consumption. Cities and transport infrastructure are expanding all over the world, particularly in developing countries and emerging economies. If arable land has been built on, it can no longer be used to grow food (Web pages 3, 4). Therefore, the dedication of land for various purposes should be planned and implemented in a wise, sensitive and sustainable manner while minimizing the consumption of arable land. On the other hand, the forests should not be considered as reserve for gaining new arable land since the forests are ecosystems in their own right and importance.

Table 1: Soil education in geography (Dunphy, Spellman, 2009; Green, 2012 and Frameworks for Teaching and Learning 2015)

Soil education	Soil context
Interdisciplinary connections	Learning activities connected to agronomy, ecology, biology, geography, food production, organic farming and gardening, experimentation and innovative practice, organic approaches in plant production, systemic approach, group work and learning, environmental protection, self-sufficiency.
Requirements	Learning module could be implemented in the local vicinity (at school or student's home garden) or organised as a study visit to the local organic farm. It is recommended that students see samples of innovative sustainable agricultural practices to improve soil properties and its health on the basis of an interview with the head of the farm before carrying out quick soil tests on the selected farm. When interpreting the obtained results, the students will be able to identify and suggest the use of innovative agroecological practices to improve soil quality and adapt to climate change.
Results of the education	Students will learn the importance of the concept healthy soil in the food production at various levels (garden, plot, farm, landscape). They will understand it is important to consider this at different levels. They will also be able to understand that soil is the basic natural resource for food production and that

	health of plants and animals depends on different aspects of healthy soil: ● **The environment:** to talk about traditional and innovative practices and their impacts on soil quality improvement at different levels: plot, farm, landscape. Thus reducing environmental pressures - adapting to climate change, not using chemical agents.... ● **The economy:** to understand the reduction of the inputs to improve the soil conditions (simple arrangements in the garden, in the field and in the landscape) ● **The social aspect:** to detect the impact of collective work between different stakeholders to improve the practice at local level. Students understand that the land owner is obliged to monitor the conditions of the soil and that he must prevent soil degradation and handle the soil with respect. ● **The science:** by measuring the selected properties of the soil they will understand that the soil is a very complex system and that any human intervention, which is not considered before, directly affects the soil's conditions and it is therefore necessary to learn and know the soil formation laws. ● **the practice:** students identify different innovative agricultural practices based on traditional knowledge and innovations to improve the soil conditions at different levels: plot (adding mulch, quartz gravel, installation of moist retaining layers in beds, raised beds, compost), farm (biodiversity, planting of individual trees and shrubs, compost,...),landscape (windbreaks and shelterbelts, water retainers, wetlands).
Teaching approach and didactics	In this module, we focus on technical aspects but also on the environmental and social approach. Students can learn in different ways: they start from observations, field visits and exchanges with farmers/soil experts, experiences of the students. Then, guided by the teachers through open questions, the students can discuss all the

	information in group work. They place themselves in the role of the landowner, who wishes to obtain information about the soil conditions. They decide which soil will be analysed, why it is important to analyse the soil right there and how the results of the analysis will help to understand the sustainable use of soil. Their own research activity, that is, the soil analysis in the field, often encourages young people to want to know what their soil characteristics at home are (if they were actively involved in soil sampling and analyses at school). In this way they transfer the knowledge gained from their practical experiences to their own practice at home and reflect on the results, what they should do to improve their soil at home and achieve the desired standards. In agroecology, there is not only one solution to solve a problem. Various practices and changes can be set up regarding different contexts/depending on the context.
Context	The students carry out field analysis of the soil: ● Soil sampling ● Soil depth ● Soil colour ● Water in soil ● Soil structure ● Soil texture ● Reactions of the soil ● Carbonates in the soil **When analysing the soil, students get acquainted with key concepts that enable their understanding of soil formation. These are:** **Pedogenetic factors:** students through environmental observations understand the importance of individual factors, i.e. water, rock, relief, slope and land use. **Pedogenetic processes:** When observing the soil, students learn that soil properties are the result of processes that rule in the soil, such as humification, braunisation, decay and erosion. **The structure of the soil:** when observing soil particles (grudges) students understand the importance of soil structure and their role in retaining soil moisture, soil breathing and plant growth potential.

	The selected properties of the soil are measured either by means of an observation sheet and instructions, or by using field work cases. Then they interpret the obtained results and evaluate the condition of the soil. **Sustainable farming practices for healthy soil** Due to the loss of land fertility, we are more and more concerned about the soil care at all levels, from local to global. A new Soil Strategy is being developed for this purpose. In Slovenia, the 5th December 2017 Partnership for Soil was established, with the sole purpose of devoting greater responsibility to the soil, from education, promotion to production and decision-making on sustainable approaches. https://esdac.jrc.ec.europa.eu/projects/SOCO/FactSheets/SI%20Fact%20Sheet.pdf - Owners of the land themselves already decide to introduce sustainable approaches of their land use (garden, field, estate), as they find they have a positive effect on the soil conditions. Students can collect information in their own local environment about how garden owners care for their soil (either they use e.g. silicate sand, egg shells, charcoal, mulch, domestic compost). The same can be asked about how organic farmers care for the soil on cultivated areas, how they plough, what kind of manure they use, and what protective agents. In the province, they can also observe how nature has adapted itself to the flow of water, to retain water, how the man has shaped a cultural landscape (terraces, borders) and why and whether today's rules of sustainable agricultural practices derive from tradition only or are innovations (ecoremediation). Sustainable approaches in a simple way, with minimal financial resources, with minimal energy used to improve the quality and fertility of the soil, as we adapt to climate changes effectively, reduce soil susceptibility to drought and increase biodiversity.
Place or classroom and auxiliary accessories needed for the activities	Classroom; computer, projector, working space for practical work **On-site:** garden tools for excavation, suitable

	footwear, pen, notebook, camera, sound recorder, case for soil and water analysis. Activities can be performed at a school or home garden, community garden, in the field, organic farm or agricultural landscape. For a better implementation of the module, seeing a good practice can be organized at a local farm, which is already implementing sustainable agricultural practices to improve soil properties and adapt to climate changes. In the frame of an interview, the head of the farm will present good practices, problems and the advantages of implementing measures to improve soil quality to the students.
Evaluation	The students have to explain: ● The students explain the soil as natural source; ● They understand the healthy soil as the basis for food production; ● They explain the importance of agroecology for the preservation of soil fertility and responsible management of the natural resource; ● They explain the key physical, chemical and biological characteristics that affect the fertility of the soil; ● They can perform simple, quick soil analysis; ● They can interpret the results of the analysis; ● They can identify sustainable approaches for improving soil properties in the field in various criteria (garden, field, farm, landscape); ● They recognize the strengths and weaknesses of the measures and can propose improvements. Students are evaluated three ways: ● By the teacher on their class work and presentation; ● By their peers in a group assessment; ● Through a self-assessment.
Exercise	Observation of pedogenetic factors that directly influence the formation of soil (students draw a sketch of interaction of natural and social as well as historical factors) and draw attention to the regulations which often dictate soil management. In the field survey, students assess where (on the site), it would be appropriate to take soil samples, why there, and what data should be measured; why, what these data will tell them and how they can be

	included into sustainable soil management. When taking soil samples, the students observe the upper layer, the roots, the humus, the life in the soil, the moisture, the texture, and determine the state/conditions of the soil. The analytical part is performed according to the possibilities they have, either on the field with a quick observational test or in a school laboratory. The choice of methods and methods themselves depend on the school equipment, needs, the interest of students and time capabilities. The results of analyses are interpreted by the students in terms of natural conditions, how rocks affect texture, how weather affects moisture, and how plants affect the organic matter. The results are also evaluated from the social point of view, how the man as an anthropogenic factor changes the soil, how this increases the compaction, how this affects the proportion of humus in the soil through fertilization. They also evaluate the results of the measurements from the economic point of view, what can be cultivated in particular soil and how soil should be improved.
Intended learning outcomes	● Understanding all aspects of agroecology through soil, that is, environmental, social and economic aspect in connection with science, as well as understanding the formation of soil with its properties and the possibility of changing them; ● Understanding the concept of soil fertility and soil property factors; ● Students are familiar with soil properties and their representation in the environment; ● Learning the methods of simple soil analyses; ● Learning about necessary tools for their job, determine the structure, texture, moisture, colour and acidity of the soil; with the help of the results and soil characteristics they identify the type of soil and make a conclusion about a possible agrarian land use, soil intervention with the purpose to improve the quality of the soil; ● Connecting the results of the analysis with the use of soil and its cultivation; ● Value and appreciate the soil as heritage given to us, which as a natural resource allows us the

	cultivation of food, feed, industrial feed stocks and energy materials; ● Through the learning process, students develop the skills of critical thinking, collaborative learning, they upgrade theoretical knowledge through their own practical experiences.
Teaching and learning methods	Introductory lecture implemented by the teacher (methods and content), case study exploration (interview, observation etc.), group or individual self-study, presentation, group work, excursions, exercises
Teaching materials and media	Notepad, pen, video, soil research equipment
Project working day	Lecture: **Soil and landscape** ● Short introductory presentation of the concept of agroecology and the presentation of a learning topic related to agroecology (AE) - Soil protection by food production for the health of ecosystems; ● A short film about the importance of the soil - the option http://soilsolution.org/watch-the-film/ and a presentation of the Euro-Educates film to understand the importance of AE diversity; ● Before going to the field, students gain insight into the soil research area and learn about geological, climatic, water and plant characteristics through expert literature, thematic maps and other sources - they are acquainted with pedogenetic factors, processes and soil properties. The use of online atlases is recommended to learn basic pedogenetic factors; ● A garden tour in the school surroundings, a field or a local farm visit is proposed. A teacher or an expert (head of the farm) presents the importance of the soil as an integral part of the landscape, a carrier of biodiversity and a medium for food production in connection with agroecology. The head of the farm presents sustainable practices carried out on the farm to improve fertility and adapting to climate changes (60 min); ● Students receive instructions for carrying out field work and are divided into smaller groups (5 min); ● On the basis of the interview with the head of the farm or an expert and the field visit, they

	describe agroecological practices for improving soil quality and adapting to climate changes (15 min). **Open guided questions for the interview with the farmer:** ● How do you assess soil health in the field? ● What are the agroecological practices contributing to the improvement of soil health? ● What are the benefits experienced by farmers in applying these kind of practices? ● Where are the constraints of these practices? ● What are the challenges farmers face in the field regarding the soil? ● By means of worksheets students independently carry out quick soil tests. The teacher guides them through key questions in interpreting the obtained results (30min); ● Independently, using online sources or an interview with a farmer, the students get acquainted with policy measures to promote soil-friendly practices, identify the strengths and weaknesses of individual measures; ● Developing an improvement plan / a proposal for improvement of soil health on a selected system (school or home garden, field, farm) based on taking up and sharing the roles (head of your garden or school, farm manager, farmers' community, decision makers on agricultural policies, etc.); students propose solutions from various aspects of AE (technical, educational, political) to learn and understand the concept of AE and the systemic approach to solving the problem, with emphasis on the bottom-up approach and knowledge transfer, farmer-to-farmer approach; ● Preparation of the PPT presentation or poster and presenting it to other students in the group, an open discussion to exchange the experiences and opinions;

	● New knowledge evaluation.
Practical suggestions for additional learning activities	Proposals for the implementation of different learning activities to understand the importance of soil: ● How much soil is in earth – experiment with an apple, demonstration: ● Use of ICT tools; ● Field characteristics of soil for understanding the physical, chemical and biological properties of soil; ● Re-using organic matter for humus in the use of rainwater for self-sufficiency: rainwater accumulation in pond and basic physical and chemical characteristics.
Field characteristics of soil for understanding the physical, chemical and biological properties of soil	● Recognizing the soil in the field using a quick test; ● Observation and comparison of soil properties; ● Using simple tools for monitoring soil carbonates and soil reactions; ● An integrated view of the soil: what is our soil like/ what are its characteristics?
Re-using organic matter for humus in the soil	● An experiment which demonstrates the re-use of organic matter for the formation of humus; ● In agriculture the humus is often lacking in the soil, therefore, the humus content can be increased with the re-use of organic matter; ● The importance of humus in the soil for adapting to climate changes.
Using rainwater for self-sufficiency: rainwater accumulation in pond and basic physical and chemical characteristics	● Rainwater retention is an old approach where people used rainwater for watering and irrigation and as an ecosystem for animals; ● We know simple approaches how to make a puddle or pond (grassy basin, or using tires and foil), where we can collect rainwater to use in a school garden or at home; ● With simple tools - indicators, we can check the content of nitrites, nitrates, phosphates, reaction and colour and the content of floating particles; ● Collecting rainwater and re-using it reduces the possibility of flooding, drought and supports the ecosystem balance.

CONCLUSION

Soils are habitats for human, animal and plant life. They are a vital foundation for biodiversity. Soils perform buffer and storage functions and have the capacity to transform organic material into nutrients, thereby helping to regulate the cycle of matter and to conserve and regenerate groundwater. They do not only act as carbon sinks but also release carbon into the atmosphere and thus, have a significant impact on the climate. After the oceans, soils are the world's greatest reservoirs of the carbon. Soils are highly significant for humans. They are essential for growing food crops as well as non-food renewable resources. They are the foundation of global food security, at the same time they are an important source of income, especially in the agrarian economies of many developing countries.

Challenges and need for action: soils are a non-renewable and non-multipliable resource – it can take centuries or even millennia for new soil to form. Soil resources get under ever-increasing pressure from global population growth and the ensuring demand for additional food and raw materials.

Climate changes will have an increasing impact on soil fertility and erosion in the future. The increasing occurrence of drought and heavy rainfall will further exacerbate soil degradation and erosion. Changes in temperature and water balance will intensify the pressure on soils. But even the soil itself can contribute to climate change. Land-use changes and improper fertiliser use result in the release of greenhouse gases. The human beings are thus faced with the challenge of increasing soil productivity despite the deteriorating climatic conditions. The long-term aim must be to increase soil productivity and to conserve the area of land usable for agriculture by adopting sustainable land-use methods.

Recent developments: there is international consensus that we must respond to the anticipated changes by intensifying agriculture and land use in a sustainable manner. At the same time, we must protect the soil from degradation. However, opinions differ as to how soil productivity can be increased in the best way.

Approaches and best practices: soil conservation is a basic requirement for the maintenance of soil fertility. It is a priority that needs to be addressed before rather than after serious damage has been done. Protecting the soil demands good agricultural practices which improve the soil structure, balance nutrients and improve its water and nutrient-use efficiencies.

Land degradation and soil health: land degradation is defined as any form of deterioration of the natural potential of land that affects ecosystem integrity either in terms of reducing its sustainable ecological productivity or in terms of its native biological richness and maintenance of resilience. This is mainly caused by human activities. Main drivers are unsustainable agricultural practices, deforestation and ceiling of landscapes. Land degradation and desertification threaten fertile land and the benefits human society derives from throughout the world.

In order to maintain soil functions, its health is of key importance. Soil health has been defined as the capacity of soil to function as a living system. Healthy soil maintains a diverse community of soil organisms that help to control plant disease, insect and weed pests, form beneficial symbiotic associations with plant roots, recycle essential plant nutrients, improve soil structure with positive repercussions for soil water and nutrient holding capacity, and ultimately improve crop production. Hence, nutrients and microorganisms available in the soil need to be well managed to maintain its fertility in a sustainable manner.

Resources

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Author

Ana Vovk Korže is a full professor, researcher and project leader at the Faculty of Arts University of Maribor. Teaching areas: water, soil, regional geography, field and laboratory work, natural resource protection, regional development. Research areas: self-sufficient supply, ecoremediation, public participation in environmental decision-making, regional development and sustainable regions. Innovative research achievements: learning polygons for self-sufficient supply and ecoremediation experiential research, testing green technologies for the economy. Establishment of Learning Regions Dravinja valley. Setting up Development Centre of nature in the municipality Poljčane - Centre for Sustainable Development.