GUIDELINE ON BEST PRACTICES IN TEACHING

Results from the participatory workshop "How to enhance teaching and learning practices" held in Cairo on November 29th – 30th, 2016

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Introduction

Tell me and I will forget,
show me and I may remember,
involve me and I will understand!
"Old Chinese proverb"

Institutions of higher learning are required to respond to political, economic, social and technological pressures in order to be more responsive to students' needs and more concerned about improving students' skills to face the new market's requests. Universities are now feeling the pressure to lecture less, to make learning environments more interactive, to integrate technology into the learning experience, and to use collaborative learning strategies when appropriate.

The objective of this document is to provide some of these learning strategies to integrate into classrooms.

The strategies reported in the document were illustrated at the participatory workshop held in Cairo on 29-30 November 2016 in the frame of the Interuniversity Learning in Higher Education on Advanced land Management (ILHAM-EC project) funded by the Erasmus + Programme of the European Union. In that occasion, strategies and methodologies aiming at improving teaching and learning processes were highlighted and traditional learning methodologies and innovative ones were compared. These teaching methodologies have been already tested to help capture students' attention and motivate them to learn with very good results.

In the following pages, you will find a short description of each practice including teaching methods and assessment. To deepen your knowledge, a list of useful references was added at the end.

We would like to thank Stephen Withfield, Damien Howells, Pier Paolo Roggero, Giovanna Seddaiu, Alberto Atzori, Salvatore Camiolo, Atef Nassar, Christos Mattas, Georgios Bilas and Abdou Soaud for their collaboration.

Social E-Learning Management Systems
Teaching through platforms and the power of long distance learning

Technique/tool/methodology description

The electronic learning management system is an interactive learning technology platform that increases students' motivation and engagement in the teaching process. It's a system that facilitates more effective interaction between learners and teachers. The students access the course materials at any time from any place. Students share the responsibility of learning, which increases their motivation to learn through the engagement of interactive websites. The instant feedback is a major advantage where students can see and revise their mistakes as they happen. Moreover, lecturers have more time for research because a lot of repetitive teaching and administration duties are automated. More importantly, the teaching quality is improved through the review and update of teaching practices. This technology saves time and money and so unlocks further resources, which can be used for further enhancement of the teaching process. Remarkably, this platform enhances the image of the educational institution progressively. Hence the employment of innovative teaching practices alongside the traditional approaches enrich the teaching process. E-learning complexity depends on available tools such as computers, digital cameras, audio recorders, interactive whiteboards, mobile and wireless devices. Virtual learning environment (VLE) or learning management system (LMS) such as WebCT, Blackboard, Moodle (platform used by UNISS), and Winjigo (platform adapted by Damanhour University) are widely adapted by educational institutions worldwide because of their significant role in the teaching, discovery of innovator and maximization the involvement of all students.

Educational aims

LMS provides teachers and learners with the following benefits:

- Improve organization of information and communication using a wide variety of modern communication tools such as cloud email, internal messaging & collaboration spaces.
- Enhance the quality and range of learning resources by both online and face-to-face interaction.
- Use different learning objects (Videos, images, audio and Interactive materials), which enable instructors to support the courses with resources compatible with all learning modals.
- Help develop functional technology skills, collaborative skills and critical thinking about digital technology.
- Implement tools for the assessment of learning and teaching process.
- Utilize gamification techniques, award, and badges giving to learners for their improved performance.
- Utilize teaching modules through a social platform.
- Facilitate the managerial work by the university's' administrative through a strong monitoring and communication tools to track that the goals of the university has been achieved.
- Help building the university's identity and community nationally and internationally.

Fields of application
The platform is applicable to all teaching activities

Target
Learners (students), teachers, and administrative

Preliminary knowledge required
General knowledge of computer software including internet browsers, office, and online chat software.

Teaching methods and final assessment

- Online
- Face-to-face teaching
- Virtual classrooms
- Social interaction and collaboration
- Assessments
- Discussions
- In-class interactive polls

Examples/case studies

The Winjigo platform has been adapted by several institutions for example:

- Arab Open University (AOU)
- University of Zawia
- American University in Dubai

The Moodle platform is currently used by the ILHAM-EC project

References/Online resources

- European Commission (2013) Report to the European Commission on Improving the quality of teaching and learning in Europe's higher education institutions. doi:10.2766/42468. European Union, Printed in Belgium.
- WinJiGo Social Learning Space Manual (2015) by ITWORX Education.
- https://docs.moodle.org/32/en/Main_page

Systems diagramming

Technique/tool/methodology description

A system diagram is a visual model of a system, its components, and their interactions. It can capture all the essential information of a system functions and properties, and even a huge amount of information in a very small space. This makes diagrams a dense way to represent information. Diagrams can also represent non-linear information, such as the multi-dimensional relationships between systems, while a text is linear, which prevents it from representing non-linear information efficiently. Diagrams are thus a richer form of information capture than simple text.
Students and generally learners are encouraged to explore the use of systems diagrams in their learning practice because they are powerful tools for:
thinking, learning and acting

- representing information and ideas about complex situations
- allowing to appreciate the complexity while seeing the individual components and the connections
- summarising how ideas or processes are connected much more efficiently than in words
- showing multiple relationships between 'things' in a non-linear fashion
- identifying and working with systems of interest
- planning and implementing changes to a situation
- helping in decision making
- helping with quantitative model building
- communicating with foreign people since they can easily serve as an international language

Educational aims

Systems diagramming are useful for teaching purposes for:

- taking notes during lessons and learn in the meanwhile
- learning having fun
- helping to gain insights during a systemic analysis (e.g., analysis of case studies on agricultural and agri-environmental issues)
- facilitating students to become "system thinkers"
- facilitating the group work and enrich the joint reflection and thinking
- learning how to deal with complex situations
- learning to appreciate that multiple perspectives are more effective than a single one when addressing complex situations

Fields of application

Systems diagrams are tools that are relevant within the framework of system thinking and practice. Within this framework, systems diagrams are more than 'representations of reality, in fact they are considered the representation of structures that do not readily exist, except in the mind. According to this view, we must be prepared to accept that there can be many different perceptions of this 'reality' by different people. No perception can be singled out as being more 'real'. Indeed, people may each have different internal models of 'reality', but may not appreciate that there can be such differences. Systems diagrams can help letting them emerging and appreciating the added values of multiple views. The system thinking approach is particularly well-suited to teaching when issues at stake are complex, wicked and multidimensional challenges that go beyond single disciplines (e.g. climate change). In fact, systems thinking offers a means to combine natural systems with human, political, cultural or economic systems. Students tend to prefer simplified, black and white explanations, which may be only partially accurate. A systems approach can introduce complexity in an elegant, conceptual and “funny” way that students can appreciate. Encouraging students to think from a systems point of view can hence encourage creative problem solving outside the usual discipline-based pathways.

Target

Everyone interested on system thinking approaches and/or dealing with complex, wicked, multidimensional challenges such as climate change, natural resources management at catchment scale, sustainable agroecosystem management, innovation systems development, etc.

Preliminary knowledge required

No specific preliminary knowledge is required, just knowing the rules for “building” the systems diagrams and practicing.

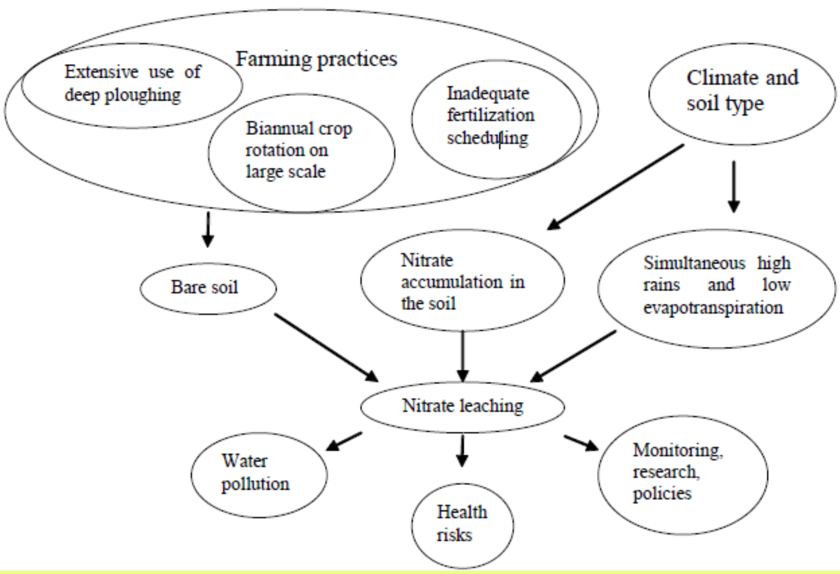
Teaching methods and final assessment

The following steps in teaching systems diagramming can be followed:

- Presentation of what the systems diagrams are useful for by showing examples in teaching, research and/or decision making practice
- Description of the main types of systems diagrams and the conventional rules that have to be followed for each type
- Engaging students to practice with systems diagrams simulating a “real situation” (e.g., designing strategies to adapt to climate change in farming systems)
- Engaging students in a case study analysis (for example organizing farm visits, interviewing the farmers, collecting some quantitative data, etc.) and asking them to explore the use of systems diagrams for the analysis both individually and in group
- Considering the assessment of the presentation of the system diagrams work as part of the overall course assessment

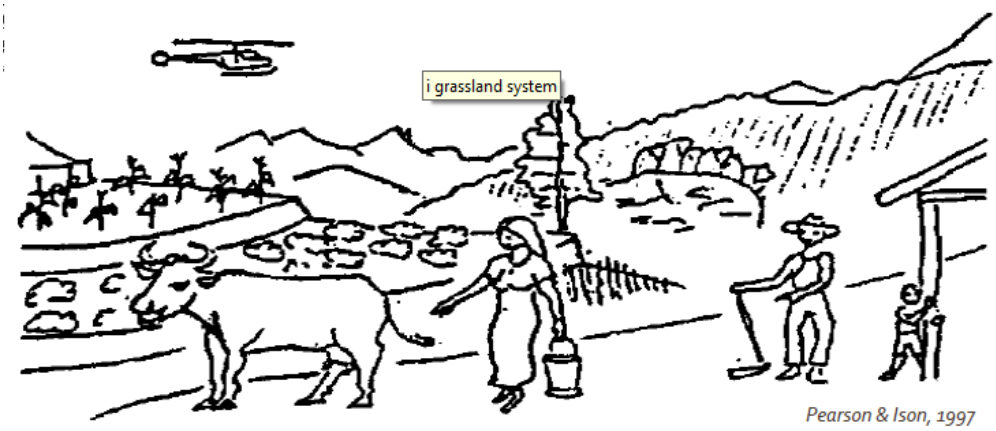
Examples

Causes and consequences of presence of nitrates in the groundwater



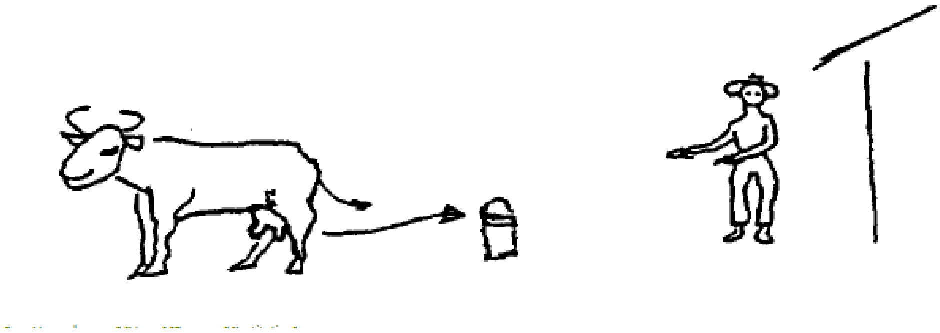
Rich pictures about a case study on an Australian agro-pastoral system

The reality



The perception of the system

Animal scientist



An ecologist

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- http://systems.open.ac.uk/materials/T552/

Case study-based learning: integrating hard and soft system approaches

Technique/tool/methodology description

The presentation illustrates a learning tool for agro-ecology students to enable them to appreciate the complexity of wicked issues such as those related to desertification and land degradation.

The sustainable development of agricultural systems is currently challenged by many complex agro-environmental issues. These are characterized by an incomplete understanding of the situations and the unexpected problems that unavoidably arise, which generate controversies around the uncertain solutions, over boundaries and multiple goals that are often difficult to define. Added to these characteristics, we also have the slow and often inadequate uptake and implementation of research outcomes in the “real” world (Pretty, 1994). In order to improve sustainability of agro-ecosystems, agronomic research must move away from the linear research approaches and extension practices adopted so far that have focused purely on biophysical agroecosystems. The theoretical operational space of agronomic research must be transformed by considering agronomic issues as part of a broader social-agro-ecosystem. One aspect of this transformation is the hybridization of scientific and local knowledge collected on a local level. The integration of local experiential knowledge with traditional agronomic research is by necessity based on the participation of many different stakeholders and there can be no single blueprint for how best to develop and use the input received. Case study research aims to highlight interactions, common behaviors and structures within sectors of society (Hamel *et al.*, 1993). Case studies thus provide the context-dependent knowledge that is necessary to promote detailed understanding and learning, and ultimately expert practice (Flyberrg, 2006).

The case study is a research strategy (Yin, 1994), and the evidence used in case study research may be qualitative and/or quantitative. This evidence may be gained through a variety of data collection methods (Fiss, 2009) including participant observation (involvement in reflective spaces such as interactive workshops and participatory field experiments, supported by formal research interviews).

Educational aims

By researching at case studies scale, students will learn how to deal with context-dependent situations and to appreciate:

- **complexity**: the mix of biophysical (hard) and socio-economic (soft) constraints
- **uncertainties**: unintended/unexpected consequences of a given action/option adopted
- **controversies**: emerging between stakeholders on pathways to engage to improve the situations

Field of application
MSc courses

Target
Lifelong learning students, officers from Agricultural extension or Environmental agency

Preliminary knowledge
Robust (i.e. BSc level or more in Ecology, Agronomy and/or Environmental sciences) background in Ecology, biology, agronomy and biophysical sciences

Teaching methods and assessment
Integration of different teaching methodologies as follows:

- Desk teaching
- Group learning
- Case-study analyses

- Diagramming
- Advanced spreadsheet training
- Modelling cropping systems

Final assessment
- Oral exam on basic topics through problem-based questions;
- Addressing a case study by integrating the various tools and methodologies and design of an improvement pathways

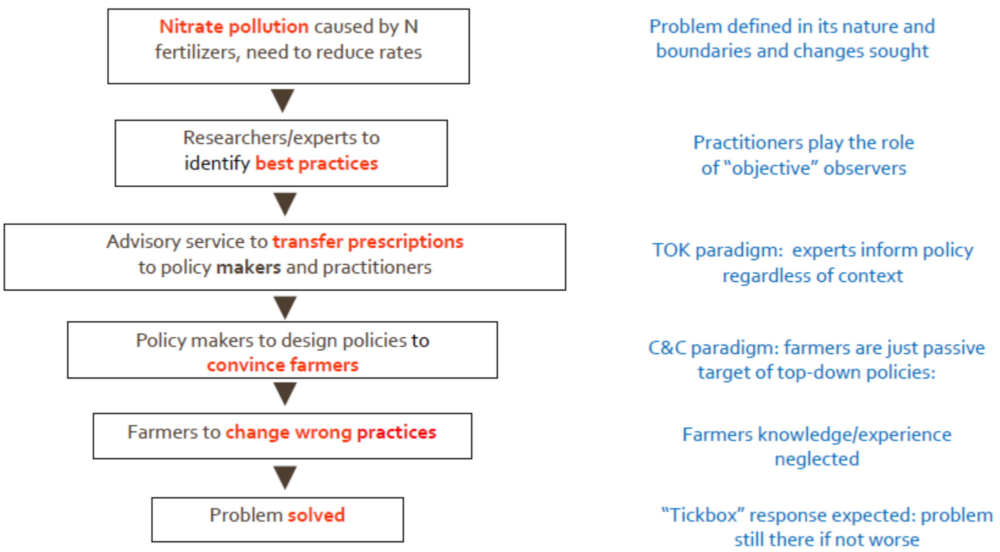
Examples/case studies

Nitrate pollution of groundwater

Although agri-environmental policies have been launched by the European Union to mitigate environmental pollution and sustain agricultural development, there is not much understanding of how to manage the asymmetries between the objectives and the effectiveness of the implementation of the policies on local scale. The nitrate directive (ND) in the European Union is an emblematic case in this context.
The case-study, located at Arborea (Province of Oristano, Sardinia, Italy), an intensive dairy district under Mediterranean conditions, focused on the role of 'hybrid knowledge' (scientific and local) and the process of knowledge integration in understanding the nitrate problem as an agri-environmental issue emerging from a complex set of biophysical and social factors.
The implementation of the ND generated a defensive position of the local farmers based on the uncertain origin of the groundwater pollution and their perception of the business as usual practices (spreading of all animal effluent produced on farm all year round), which they believed to be essential to maintain the fertility of the sandy soils. A participatory action research approach was designed and implemented to elicit stakeholders' knowledge and perspectives and to create new learning spaces among farmers, researchers and policy makers at the case study scale. We explored the effectiveness of social learning processes triggered by participatory field experiments focused on the nitrate issue, by asking farmers to co-design with researchers a new on-farm field experiment on what kind of fertilization system would be the least pollutant. Farmers were actively involved in the application of the different fertilization systems and in the management of the experimental field and were free to attend all measurements made. The experiments was run for three years and at the end of each year the data were understood and discussed together. This generated a new learning space for researchers and farmers that generated new 'hybrid knowledge' for agri-environmental sustainability. The dramatic shift from the initial defensive position of farmers to an agreement on concerted actions proved that the integration between local and scientific knowledge may contribute to a more effective implementation of the ND prescriptions.

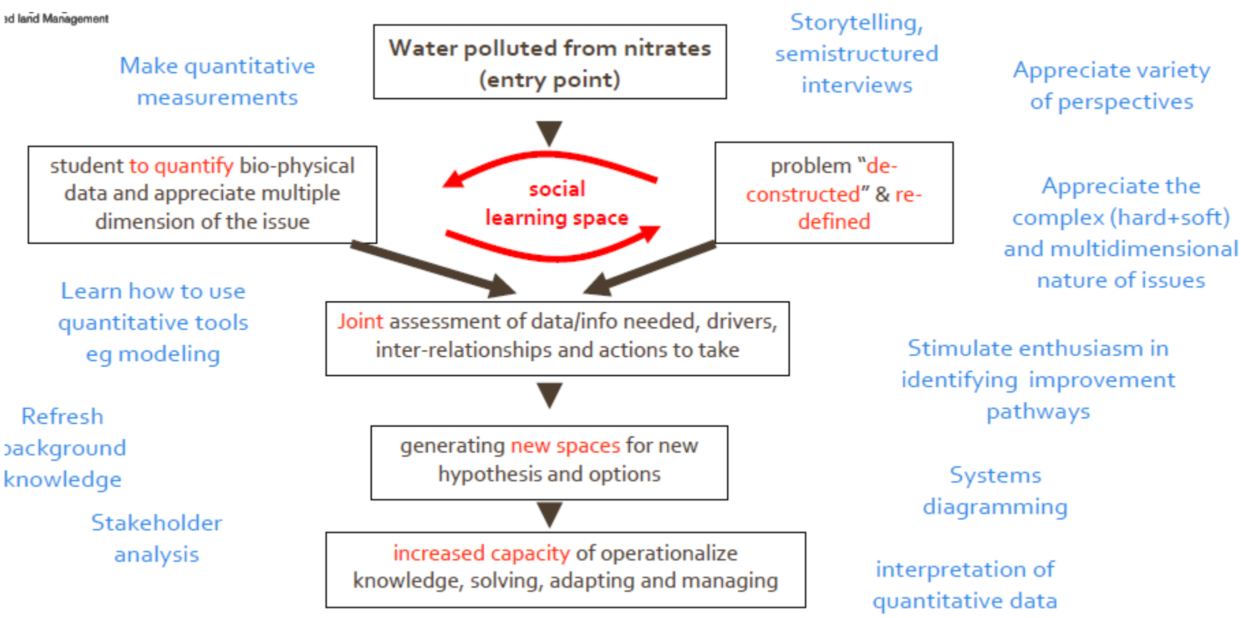
The ND prescriptions rely on the paradigm of linear transfer of knowledge (from science to policy and practice) and the implementation of inflexible rules (a Best Practice code) to achieve a given status (keep nitrate concentration below the threshold). The scientific research model followed in the linear transfer of knowledge paradigm was framed as 'mode 1' science by Gibbons et al. (1994): research is produced in an academic setting through experiments and observations and is organized in a hierarchical way using academic peers to control the quality of the knowledge outputs. Subsequently, stakeholders use knowledge in determining actions for environmental use (Kristjanson et al. 2009).
The linear transfer of a knowledge paradigm has been recognized as inappropriate when applied to the management of complex agri-environmental issues (Ison and Russell, 2007).

Type 1 approach (linear transfer of knowledge paradigm)



The nitrate issue is inherently complex, involving multiple stakeholders with contrasting interests and powers, which demands scientific and political approaches that are appropriate to this complexity (Oenema 2004). It has been suggested that the development of sustainable strategies in the context of environmental complexity requires an integrated and holistic systems approach (Collins et al. 2007) that relies on the generation of 'hybrid' knowledge (i.e. the integration of local and scientific knowledge), whereby bio-physical processes are considered in the context of their socio-economic drivers and responses (Nguyen et al., 2014). This approach can be considered as Mode 2 Research (Gibbons et al. 1994) focused on 'knowledge for action' (Cornwall and Jewkes 1995) which is closely linked to the potential usefulness of results for multiple stakeholders and the community at large.

Type 2 approach (Knowledge for action)



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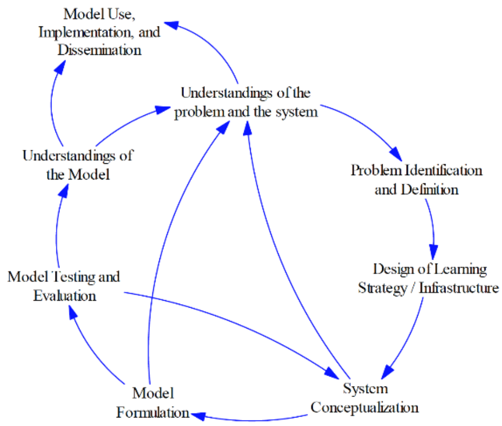
System thinking and system dynamics modelling

Technique/tool/methodology description

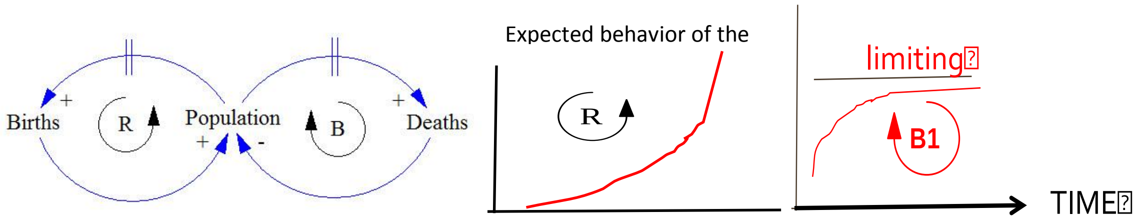
SD is a methodology for understanding, discussing and simulating complex systems over time (Sterman, 2000). Jay Forrester created the SD methodology in 1956 at the Massachusetts Institute of Technology. It has been widely used in many management and engineering application areas, including the management of supply chain and food systems.

SD is a methodology capable of addressing a system structure, characterized by feedbacks among its parts. Model development is an iterative process to get better system understanding. As shown in Figure 1, the modeling process demands the identification and definition of a problem. The overall system conceptualization results in a qualitative or quantitative model formalization, which often improve our initial system understanding. The simulation model allows for testing the model validity with empirical data, experimenting with policy alternatives and eliciting insights which increase the likelihood of performing a good policy analysis.



The dynamics of a system can be qualitatively conceptualized through Causal Loop Diagram (CLD), which is a map of the feedbacks present in the system. Drawing causal maps or CLD is a technique for mapping the existence of the feedback within and across interacting subsystems.
The system can also be quantitatively analyzed through a simulation, which is possible after the construction of a Stock and Flows Diagram (SFD). A SFD is a quantitative assessment of the system. The Dynamics are pictured in the SFD and the model formulation is done by the elaboration of equations that expresses how the variables are interconnected with others and how the accumulation process is determined by the change in the flows altering the state of the system levels. In the following section, an example of a qualitative modeling using CLD will be provided.

In qualitative terms mapping the system elements and seeking causality by drawing the connections among variables, people can identify the main feedback loops driving the system behaviors. There are two kind of loops which are studied on the basis of their characteristics: 1) Reinforcing indicated by the sign (R) or (+): self-reinforcing loops, which imply that if they were the only loops operating in the system, or if they are the dominant loops, they grow exponentially, 2) Balancing indicated by the signs (B) or (-): self-correcting loops which counteract change. Each connection is characterized by an arrow (indicating causality) and a + or - polarity (indicating correlation, intended as variation of the depended variable in relation to positive variation of the independent one. The feedback loop label (B or R) is determined by the aggregate polarity of the whole loop (multiplication of the signs).

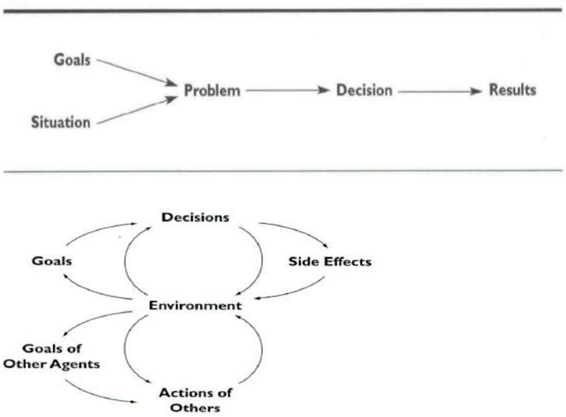


Just qualitatively reading a causal loop diagram, when positive or reinforcing loops are dominant, system variables growth exponentially. Whereas when negative or balancing loops are dominant the system tends to have a goal seeking behavior. S-Shape growth behavior derivate from their combination. The dynamics of the system arise from the interacting complex network of these two kind of loops; Reinforcing and then Balancing = S-Shape growth (Sterman, 2012).

Educational aims

The main educational aim is to change the mental approach to problem solving: from a linear to a systemic perspective.

Linear thinking → Systemic perspective



(Sterman, 2000)

The system dynamics modeling allows students to stimulate:
- system understanding and the system thinking approach
- capacity to discuss the studied topics.
- ability to explain causes, effects and unintended consequences of the system links
- habitude to contextualize the defined problems
- ability to propose viable solutions to given problems
- playing with policy formulation in studied systems
- using of powerful communicative tools to show ideas, concepts and theories.

Fields of application

System dynamics can be applied in all the research and application fields (Life science, Phisical science and engineering, Social sciences and humanities).

Target

All levels of education. Application of SD have been successfully tested from K-12, to primary and High school, undergraduate and graduate academic levels of masters and PhD, and in consultancy and business applications of public and private sectors.

Preliminary knowledge required

No specific preliminary knowledge is required. It is suggested to read a narrative book addressing the systemic perspective such as "Thinking in systems: A primer" (by Donella Meadows) or "The Fifth Discpline" (by Peter Senge).

Teaching methods and final assessment

Start with a preliminary lesson explaining the basis of the methodology and the rules of the causal diagram annotation.
Then start playing with causal diagrams of the desired topic;
- read a book chapter, or review article or scientific or divulgate literature, or a newspaper article addressing the topic we want to address in the classroom; (the paper can be read the day before

the lesson, or in the first part of the lesson); the paper can be substituted buy a classical (but short) power point presentation.

- define together the limits of the addressed systems and try to map the key variables;
- work together (students and teacher) or in groups or individually, drawing connections and links (remember arrows and polarity!) to describe the system;
- identify the loops arising from the connections among variables and their expected behavior;
- define the loop polarity (R or B) and give them a label for their role;
- highlight the consequences of the most important loops;
- formulate policies to change the expected behavior of the system; look for sustainable behaviors!!!

Examples/case studies

The teacher can show a causal model from literature showing applications of causal diagrams in the same field. Further examples and case studies can be developed in each lesson.

A simulation model for wheat-related policies and food insecurity in Egypt

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Cairo University, Cairo, Egypt

Stock and flow diagram

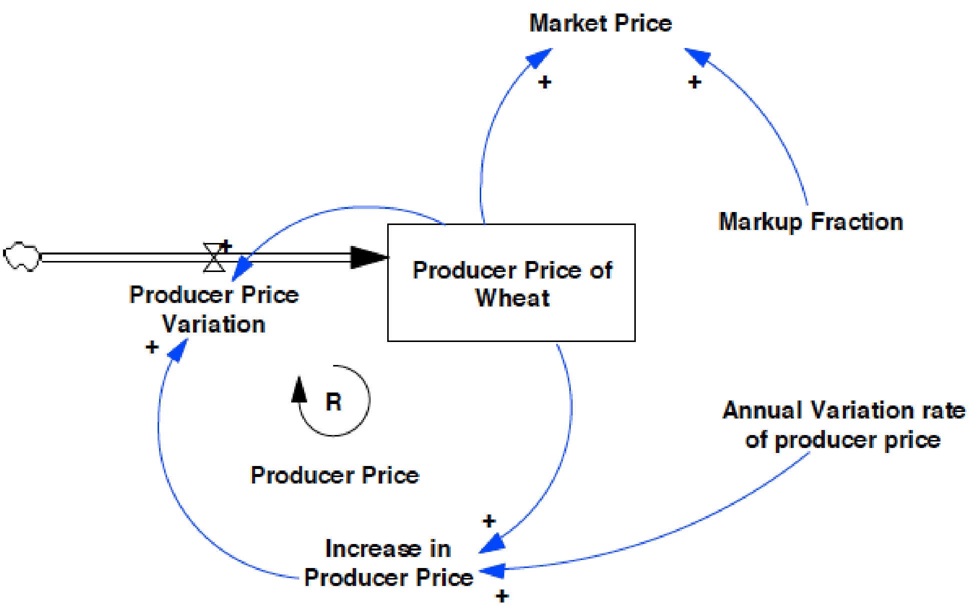

Figure 5. Producer price of wheat

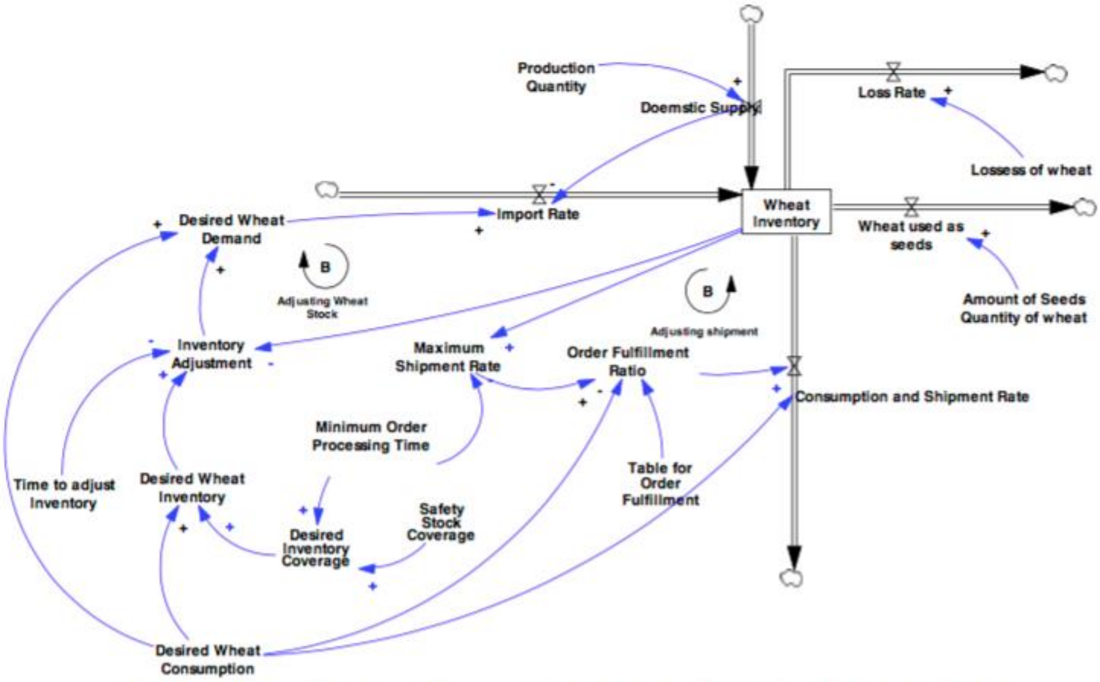

Figure 3. Wheat inventory and the process of domestic supply, imports and shipment quantities

Quantitative simulation policies

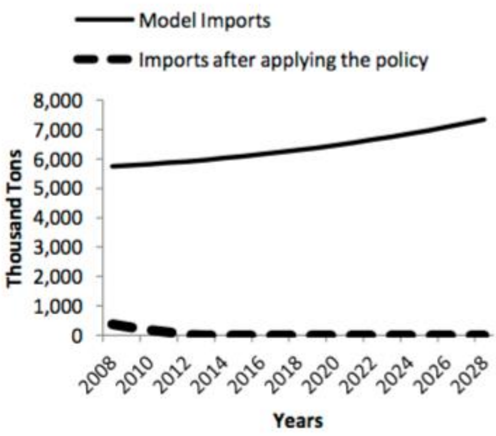

Figure 18. Imported wheat after applying the policies of birth rate, annual income and productivity

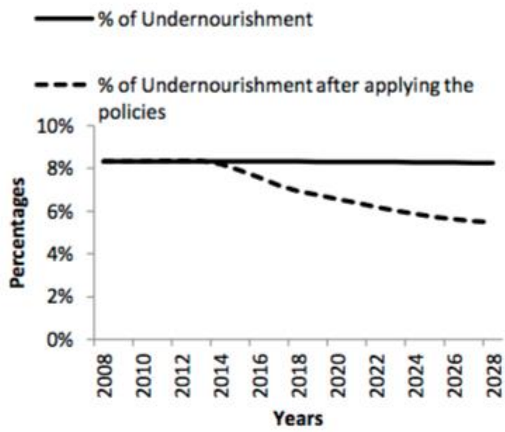

Figure 19.The percentage of undernourishment

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Flipped classroom teaching

Technique/tool/methodology description

Flipped Classroom Teaching aims to move beyond 'receiving' and 'exploring' as the main characteristics of the student education experience, to making space for 'debating', 'creating', 'meta-learning' (Office for Digital Learning, 2007). Challenges depends strongly on student engagement (may need to build up confidence over time); technology (but doesn't have to be high-tech –pre class work could be reading a paper; requires careful advanced planning; students over-reliance on video content (rather than independent study).

Educational aims

- To encourage and facilitate independent engagement with learning resources
- To use classroom time effectively to engage learners in a variety of learning experiences that embedded and involve critical reflection on learning resources.
- To give students and teachers opportunities to reflect on and respond to learning processes

Fields of application

Broadly applicable across all subjects where remote independent learning can be blended with classroom activities

Target

All levels of education

Preliminary knowledge required

No preliminary knowledge is necessarily required, although for producing online tutorials it is useful to have knowledge of basic video creation and editing software (e.g the mymediasite system).

Teaching methods and final assessment

Combining online tutorials with in class exercises to create/debate with students focusing on engagement and interaction. Debates will be based on students learning experiences.

In traditional class, learners receive information that will support their learning (eg. lectures, recommended reading, content delivery). After class, they will learn by personal exploration (eg. internet searches, literature review, information handling). Before class, no information is provided. In flipped classrooms, a time and space for learner engagement is created.
Learners will receive the information before class (instruction to watch/read material relating to subject X and Y and, in some cases: contribute to discussion forum). In the class, they will create something new, producing work as an individual or as a group (essay/assignments, projects, portfolios). Learning will be a process resulting from social interactions where learners engage in collaborative and challenging discussions (eg. face to face debates, online discussions) and from meta-learn (self-reflection, self-analysis) where learners think about their own learning.

Did the student meta-learn? Reflected on classroom activities is the basis for thinking about principles of participation. Students questionned on meta-learning activity, provided good feedback in answering that it helped him to see links between issues and it really developed interest in the topic.

After class, personal exploration will complete the learning process.

The Hybrid Learning model developed by Ulster University as part of a Centre of Excellence in Teaching and Learning project in 2007, can be useful to develop interaction with students. It is designed to capture, describe, reflect on and plan good practices in teaching and learning.

The model proposes eight interactional concepts (learning events) which encapsulate learning and teaching: receives, debates, experiments, creates, explores, practices, imitates and meta-learns. These events can then be explored further in terms of the teacher and learner, using associated verbs. The model is supported by flash cards visually depicting each of the eight learning events (8LEM). See http://addl.ulster.ac.uk/odl/hybridlearningmodel.

Examples/case studies

Produce video tutorials that introduce basic concepts or subjects (e.g. food security) for students to watch in their own time, in preparation for class
Use the class room time for an interactive session in which concepts are applied to a real world case study (e.g. a role play debate about GM crops in Africa).

References/Online resources

Office for Digital Learning (2007) Hybrid Learning Model. Available at: http://addl.ulster.ac.uk/odl/hybridlearningmodel

Making Group Work Work

Technique/tool/methodology description

The “Making group work work” technique aims to build on strengths and overcome challenges of group work

Benefits:

- Development / consolidation / deepening of knowledge
- Thinking skills development (Critical thinking, Creative skills)
- Academic skills (Research / practical skills, Time / Project management)
- Complex Skills (Interpersonal communication, Conflict resolution / Problem solving, Increased self-awareness)
- Complex Skills (Interpersonal communication, Conflict resolution, Problem solving, Increased self-awareness)

Challenges:

- Conflict /group dynamics (Free-riding)
- Communication problems (Disciplinary / cultural)
- Time management / workload (Different for each student)
- Perceived unfairness of assessments (Links to problem of free-riding)

Educational aims

- To improve the effectiveness of small group learning and teaching
- To give students a fair and satisfactory experience of working as part of a group within an academic environment
- To enhance the benefits of cooperative learning that are derived from group work
- To build key life skills relating to teamwork

Fields of application

Broadly applicable principles in all group work tasks

Target

All levels of education

Preliminary knowledge required

No preliminary knowledge required.

Teaching methods and final assessment

Strategies to make Group-work Work:

- Be transparent: explain why you’re using group work
- Help students take responsibility for resolving conflicts: peer-marking
- Teach the process of working in a team: prompt reflection
- Meet with groups: increases engagement

Examples/case studies

Case Study 1:

- Belbin team roles taught before students began group work (Appreciated group dynamics, Appreciated skills developed through group work);
- Students peer-marked other group members (Provided an opportunity to raise concerns);
- Marks incorporated into final assessment mark

Case Study 2:

- In-class, task to reflect and plan for next assessment: reflections / plans shared with the lecturer
- Individual group meetings one week after assessment was set: forced early group meetings / reduced “free-riding”;
- Lecturer will continue with this new approach: increased engagement / reduced problems

References/Online resources

No references

Problem-Based Learning and e-Learning Approach for Teaching Soil Science Course

Technique/tool/methodology description

To promote engagement, improve comprehension, and enhance retention of content by students, courses can be developed and delivered on-line using Blackboard® or Moodle® (Course Management Platforms), and employing problem-based learning (PBL) approach.
Problem-based learning (PBL) is an instructional method that challenges students to "learn to learn," working cooperatively in groups to seek solutions to real world problems. These problems are used to engage students' curiosity and initiate learning the subject matter. PBL prepares students to think critically and analytically, and to find and use appropriate learning resources (Duch, 1996; James, 1998; Duch, et al. 2001).
Delivering the course using PBL shifts the focus to student-centered learning by assigning student teams to work and report on a number of current soil science themes. Teams of students are responsible for problem investigation and definition, for identifying and obtaining the information and skills they will need for development of a satisfactory solution. Each of the problems undertaken by student teams concludes with student presentations and the preparation and submission of a professional quality work product. Teams work semi-competitively on the same problems so that students can learn from the experience of other students that are reflected in the oral reports.
When we bring PBL and E-Learning together we have an excellent way to get our students using online global knowledge as well as developing the necessary flexible acquiring knowledge skills.

Educational aims

The main aims of courses taught using PBL and e-learning platform is problem-solving skills, which make student (1) be able in individual and team/group settings to use the scientific method to solve problems related to soil resource management; (2) be able to identify and treat problem causes, rather than effects; (3) be able to see the whole of a problem, including the social and economic aspects, along with the soil resource management aspects; (4) be able to make logical decisions based on available information and (5) be able, when appropriate, to include the personal values of those involved in decision-making. Also, to get students using online global knowledge and developing the necessary flexible acquiring knowledge skills.

Fields of application
Soil science courses and any science courses require problem-solving skills.

Target
Introduction to soil science course was developed and delivered to students in level one or two in faculty of agriculture.

Preliminary knowledge required
Students must have IT skills and information about PBL methodology.

Teaching methods and final assessment
Synchronous and asynchronous e-learning deliveries have been incorporated into Introduction to Soil Science course. The synchronous delivery method includes (1) mini lectures, (2) in-class discussion and analysis, (3) face- to- face student teams meetings in class, (4) student oral report presentation, and (5) online laboratory skills virtual resources and hands-on experience during the laboratory time. The asynchronous delivery method includes (1) E-mail & digital drop box and (2) browsable documents on Blackboard or Moodle.

The PLB process includes the following steps:

- students are divided into groups.
- the problem is presented and discussed
- students identify what is known, what information is needed, and what strategies or next steps to take
- individuals research different issues, gather resources
- resources are evaluated in group
- cycle repeats until students feel the problem has been framed adequately and all issues have been addressed
- possible actions, recommendations, solutions, or hypotheses are generated
- tutor groups conduct peer/self assessments

Examples/case studies

Introduction to Soil Science course was developed around four learning modules employing the Problem-Based Learning and active learning methodology, supported by Blackboard or Moodle and computer technologies. Each learning module is of four weeks' duration. Each module is structured as a short project in which students work to understand, explore, and recommend contributions to soil science goals. Table 1 shows an example of the structure of Module 1.

The course learning modules are:

1. Module 1 – Soil Genesis
2. Module 2 – Soil physics
3. Module 3 – Soil Mineralogy, Chemistry and Fertility
4. Module 4 – Soil Survey and Classification

Table 1. The Structure of Module 1 - Soil Genesis

Week-1	Week-2	Week-3	Week-4
Meeting 1 Course Introduction 1. Introductions 2. Distribute outlines 3. Demonstrate Blackboard Resources 4. Mini-lecture: Introducing Problem-Based Learning 5. Assign PBL readings	Meeting 3 Problem Exploration 1 1. Team work and consultations * Lab -2	Meeting 5 Problem Solving 1 1. Team work and consultations * Lab -3	Meeting 7 Outcomes & Solutions 1. Team Meetings 2. Student Presentations & Report submission * Lab -4
Meeting 2 Team formation and Problem Assignment 1. Group formation 2. Problem Assignment 3. Team work session 4. Mini-Lecture: Introduction, Ecological Functions, Rocks and Minerals, Chapter 1, 2 and hand out * Lab -1	Meeting 4 Problem Exploration 2 1. Mini-Lecture: Soil Formation, Chapter 4 2. Team work and consultations	Meeting 6 Problem Solving 2 1. Mini-Lecture: Soil Development, Chapter 4 2. Team work and consultations	Meeting 8 Module Test: Chapters 1, 2, 4

The following text boxes show an example of problem of soil Genesis Module:

Problem one: Soil Genesis Module

What are the soil development consequences when some area in arid region will be changed from desert land to agricultural land within the next century?

Introduction

Soil is a product of the environment. The study of soils in their present stage is of considerable importance to reveal processes and history of soil development. To understand soil development as processes of the past is a necessity in order to predict soil development in the future. Only when the processes are known can the consequences of the intensive use of agricultural land be understood. Detailed knowledge of soil processes is necessary if the consequences of extensive land use changes are to be predicted.

Objectives

Discover the factors and processes of soil formation. Find out why rock and mineral types are important in creating our productive soils. Why are there soil layers and how many are there in soil.

Recourses

1. **Textbook: Pedospher and Its Dynamics**
   Chapters 1, 2 and 4
2. **Soil Formation-1**
http://library.thinkquest.org/J003195F/soil.htm
3. **Soil Formation-2**
http://www.harcourtschool.com/activity/dirt/
4. **Soil**
https://blackboard.uaeu.ac.ae/webapps/portal/frameset.jsp?tab=courses&url=/bin/common/course.pl?course_id=_19825_
5. **Factors Affecting Soil Development**
http://www.uwsp.edu/geo/faculty/ritter/geog101/modules/soils/soil__development_soil_forming_factors.html

The following pictures show an example of problem group discussion:

The following pictures show an example of student problem solution presentation

Use of Technology

Blackboard or Moodle and computer technology have been employed in all class session. Many additional technology, activities and resources links have been added to provide depth for student exploration and use following graduation. Additional technology, activities and links include (1) educational videos, (2) internet sites & links and browse documents, (3) communication/interaction between faculty/students & student/student (using e-mail, new groups, white board and broadcast), (4) online quizzes. Students gain access to a large database of high quality questions and answers covering a broad range of topics. The answers and explanations will enable student to learn more about the topic as well as related material), (5) online laboratory skills virtual resources and hands-on experience during the laboratory time, (6) Net.OP (class management software) for monitor student activity in class, (7) PowerPoint for basis of course and student presentations, and (8) Chime Plug-In for 3-D silicates minerals visualization.

Restructuring Lectures (Learning Activities - integrating lectures and Hands-on)

The class time is 100 min. The lecture is divided into two sessions, 50 min. each. Based on the activities in each session, the distribution of session time (different from one class to another, see Table 1) is as follow: (1) 20 min. mini-lecture or team work, (2) 15 -20 min. consultation or watching educational videos or/and accessing web sites searching for specific information, (3) 5-10 min. taking online quizzes, (4) 5 min. homework/assignment, (5) interacting with instructors or classmate, e-mail, new groups and browse documents, anytime, and (6) doing Lab exercises (hands-on experience) during the laboratory time.

References/Online resources

- Amador, J. A. and J. H. Görres. 2004. A Problem-Based Learning Approach to Teaching Introductory Soil Science. J. Nat. Resour. Life Sci. Educ. 33:21–27.
- Duch, B. J., 1996. Problem-based learning. A Newsletter of the Center for Teaching Effectiveness.
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- James, R (ed.). 1998. Problem-Based Learning: An Introduction. The National Teaching & Learning Forum Vol. 8, No. 1.
- Kelley, D. W. 2004. Incorporating GIS into Problem-Based Learning Pedagogies for Environmental Studies Courses. User Conference Proceedings, Earth Systems Research Institute Press, San Diego, CA.
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Existing web tools for sustainable land management

Technique/tool/methodology description

Internet sources can be used not only for obtaining data concerning Sustainable Land Management, but for educational purposes as well. First of all students are trained to investigate and evaluate the provided scientific knowledge on a large basis that covers a wide range of topics. The data on the web tools that were proposed during the presentation in Cairo (29-30 Nov2016) are updated during time and therefore, they can be used by the students not only during their studies, but in their professional life too. The web tools provide teachers with the ability to assign essays to the students in new sectors of science that arise due to the rapid development of GIS and modeling. This would not be possible without the web tools due to the fact that the primary data would require too much effort in order to be produced (e.g. digitized maps) or too much time (e.g. creation of adequate time series).

Educational aims

By using data derived from web tools, students will learn how to deal with the problems they will have to address after their graduation as professionals.
Web tools also offer a "Window to the world" since they provide data from all over the world. Students acquire a perception of the world than they would otherwise have. Their understanding of world changes. They can see what the scientific trends are and which tools are used in other countries. Students, through exercises, are guided to investigate scientific knowledge and data in internet in order to find data, case studies and solutions that will enable them to cope with their assignment.

Fields of application

The field of application includes all disciplines, and especially evaluation of students performance through exercises and assignments.

Target

The final target is to provide students with a broad overview of the biological, economic, and social components of SLM, revoke limitations on access to data and technology and to spur the development of geographic information and tools.

Preliminary knowledge required

A sufficient scientific background in the fields of agriculture, soil and water resources management, ecology and basic socioeconomics is required, in order to screen, evaluate and exploit information. Furthermore, a good knowledge of basic computer software (text, tables, pdf, internet), and GIS software and techniques is essential for acquiring and handling data.

Teaching methods and final assessment

Teaching method includes lectures on the broader field of SLM that introduce students in the components and disciplines of SLM. Also includes elaboration on specific national or international case studies that can be assignment to students as midterm evaluation.
Final assessment is performed through assignments. Each student is asked to search for specific data in the internet, evaluate them, summarize the information, and present the work in the class.

Examples/case studies

Examples are all internet sites mentioned in the references (and relevant data providers) that students can investigate and use them in their assignments as well.

References/Online resources

- http://www.pecad.fas.usda.gov/cropexplorer/global_reser voir/
- http://asnerlab.stanford.edu/
- http://hydrosheds .cr.usgs.gov
- http://www.hydro.washin
- http://www.iwmi.cgiar.org/assess ment/Research_Projects/River_Basin_Development_and_Management/gton.edu/Lettenmaier/Models/DHSVM/index .shtml
- http://www.dartmouth.edu/~floods/
- http://www.isric.org/
- http://www.fao.org/soils-portal/en/
- http://eusoils.jrc.ec.europa.eu/
- http://www.nrcs.usda.gov/wps/portal/nrcs/site/soils/home/
- http://www.fao.org/soils-portal/soil-management/other-slm-tools/en/
- http://www.cbmglobe.org/softwaredev.htm
- http://www.fao.org/gtos/igol
- https://qcat.wocat.net/en/wocat/
- https://earth.esa.int/web/guest/home;jsessionid=FF1B164E8F13CA5E8575F4BE9F7CC9E4.jvm1
- http://remotesensing.usgs.gov/
- https://modis.gsfc.nasa.gov/