Teaching sustainability science from a systems analysis perspective: MSc course at Utrecht University

Universiteit Utrecht

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Introduction

Sustainability science has both **disciplinary depth** and **interdisciplinary breadth**

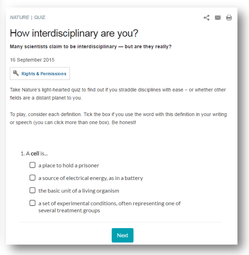
Systems Analysis is central to sustainability science

Interdisciplinary research is on the rise, although it may take time to have an impact

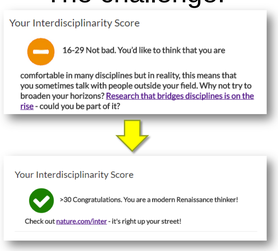
Some fields and geographies are more interdisciplinary

How interdisciplinary are you?

http://www.nature.com/news/how-interdisciplinary-are-you-1.18362



The challenge:



Sustainability science has emerged as a key discipline that embraces both disciplinary depth and interdisciplinary breadth.

The challenge is to design University courses that convey both properties without sacrificing either of them

Key competencies for Masters programs in Sustainability

Sustainability programs aim at achieving three types of competencies:

1. **Intellectual**
2. **Interacting**
3. **Self development**

Our course is presented together with a theories course, and we focus on:

1. Intellectual competencies

1.1. Analyzing, evaluating and crafting future
1.2. Systems and analytical thinking
1.3. Research and ICT skills

2. **Interacting competencies**

2.1. Practical skills
2.2. Communicative skills

3. **Self-development competencies**

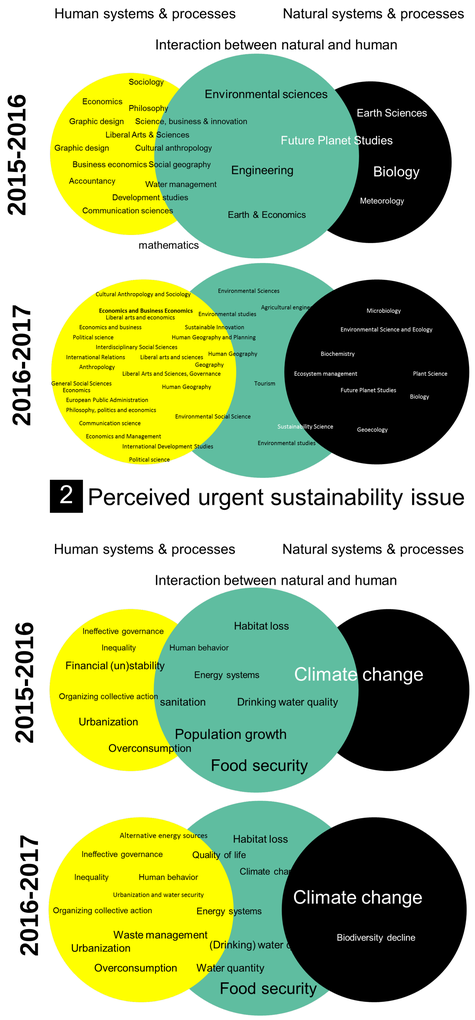
3.1. Normative competency

Higher education level teaching of (master's) programmes in sustainable development: analysis of views on prerequisites and practices based on a worldwide survey
Walter J.V. Vermeulen*, Margien C. Bootsma and Maurice Tijm
Copernicus Institute of Sustainable Development, Utrecht University, P.O. Box 80115, 3508 TC Utrecht, The Netherlands

Sustainability Modeling and Indicators

Know your audience

1 Focus area of students' prior experience



2 Perceived urgent sustainability issue

Knowledge

1 **Sustainability Perspectives**

Introduction of SD	Themes	Solutions
Overview and history	Image of man, behavior and population growth	What to do about population growth? Resource needs/wants, Migration, Poverty, Religion
Concepts, definitions and perspectives	Natural resources – planetary boundaries	Sustainable use of resources: renewable and non-renewable, trade and telecoupling
Need for coupled socio-natural science based approaches	Resource use: food, water, energy, waste, etc	Innovation for sustainability: green business, eco-cities, recycling
	Governance: top-down, bottom up, horizontal	Sustainable governance: rules, actors, institutions
	Economy: principles	Towards a sustainable economy

2 **Modelling and Indicators**

Principles	Themes	Examples
SD Indicators: building blocks of SD indicators	Measuring natural resources	Planetary boundaries
Linking Concepts, definitions and perspectives to data, models and SD indicators	Coupled human-nature	Population growth and resources; Feeding growing population; Agent decisions
	System dynamics: Tipping points	Tipping points
	Energy and material flows	Footprint
	Fully coupled systems	Integrated Assessment

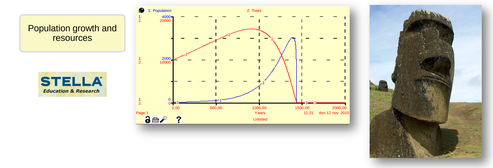
Assignments

Examples	Assignments	
Population growth and resources	Computer lab Reading assignment	Indicators: Individual paper
Feeding growing population	Excel Reading assignment	
Agents	Netlogo Reading Assignment	
Integrated assessment	IMAGE Reading assignment	

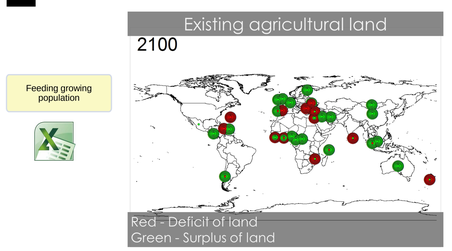
The assignments aimed at:

(1) teaching students the system components by using a pre-existing model in Stella,
(2) challenge students to build their own coupled system in Excel,
(3) assess outputs from the fully-coupled and dynamic model integrated assessment model IMAGE,
(4) understand emergent properties using an agent-based model in Netlogo.

1 Can we use natural resources to prevent societal collapse?



2 Can we feed the growing global population?



Course Objectives

1. Know a set of modelling techniques used in *Sustainability Science*
2. Apply diverse models to research questions about sustainability
3. Explain how the concepts taught in **Sustainable Development: Integrating Perspectives** relate to trend projections and scenarios
4. Understand what are the Sustainable Development Goals and which indicators are used to measure them
5. Describe and critically evaluate the methodology of SD indicators

Key lessons

1. Mathematics were challenging for a part of the students, but still doable
2. Learning curve was steep
3. Students had higher experience with Excel than other modelling platforms
4. Excel exercise received the highest and lowest grades, and students found it time consuming but also indicated that they learned the most
5. Netlogo was the favorite exercise, because plug-and-play software was perceived as better to bring conceptual models to mathematical formulations

Conclusions

1. Relate to **students background**
2. Use **off-the-shelf software**
3. Key challenges: **concepts of systems analysis** and the **applied mathematics** behind it
4. The goal is to **demonstrate process**
5. Can be complemented with **programming**
6. **Learning while doing**