Date: 20 November, 2018
Please check Mondo for most updated syllabus

Master's Programme: Social-Ecological Resilience for Sustainable Development

Course 2: Systems Theory and Resilience Thinking (15hp)

Course leader: Örjan Bodin

Brief Description

This course introduces qualitative and quantitative approaches to systems theory, and shows how they can be applied in to analyse social-ecological systems. Regime shifts, the reorganization of the structure and processes shaping a social-ecological system, are explored from a theoretical and practical perspective, including the investigation of a set of case studies. Resilience thinking uses systems concepts to understand such abrupt changes. Key resilience concepts will be introduced. Students will be introduced to theoretical concepts, methods for analysis, and conduct group and individual research projects that utilize these concepts and methods.

Course Learning Outcomes

It is expected that the student, after taking the course, will be able to:

1. Understand basic systems concepts and be able to apply basic systems analysis approaches.
2. Understand the concept of regime shifts and be familiar with a number of examples of regime shifts.
3. Define and apply concepts of resilience, adaptive cycle and panarchy to social-ecological systems.
4. Analyse how human action can alter the resilience of a regime shift.

Course Modules

The course consists of the following three modules, which are detailed in the following pages:
Module 4: Systems Thinking (4 hp),
Module 5: Regime Shifts (5 hp),
Module 6: Resilience Thinking (6 hp).

Course Books:

Meadow, D. H. (2008), Thinking in Systems: A primer; Chelsea Green Publishing.

Walker, B. and Salt, D. (2012), Resilience Practice. Building Capacity to Absorb Disturbance and Maintain Function; Island Press, Washington, Covelo, London.

Module 4: Systems thinking (4hp)

Module leaders: Örjan Bodin
orjan.bodin@ su.se
Instructors: Örjan Bodin (ÖB), Blanca Gonzalez (BG)

Brief description

This is the first of three separate modules in the course "Systems theory and Resilience thinking". One of the main objectives with this module is to introduce systems thinking, which is a prerequisite for the following two other modules of the course. Other objectives are to briefly present the historical development of the concept of systems thinking, explain why it has emerged and for what reason, how it has partly branched out into various different subfields, how it can be applied in both more qualitatively oriented ways as well as in formally defined mathematically approaches. Special focus will be on explaining how it has contributed to the development of ecology and more recently into the fields of complex adaptive systems and SES 'resilience theory'.

In addition to the theoretically oriented objectives above, much emphasis will be on providing the students will some practical skills and experiences in applying a 'systems perspective' in Social-Ecological research.

Module content

Concepts	***Methods***	**Applications**
Week 1: Systems theory and the foundation of resilience theory		
Systems theory Complex Systems, Complex Adaptive Systems	System thinking; Non-linear System analysis; Causal Loop Diagram	Small group project analysing case studies
Week 2: Studying/Modelling Social-Ecological Systems (SES)		
System dynamics Complex Systems SES as networks	System dynamics; Causal Loop Diagram; Network analysis	Lab: System dynamics Lab and assignment: Social networks of fishermen in a seascape

Class Schedule

	Lectures	*Class exercises*	Home work
Week 1: Systems theory and the foundation of resilience theory			
November Mond 5 13:00-15:00	**PM: Roll call for Course 2 (ÖB)** **PM:** Introduction to Systems thinking (ÖB, 2 hr)		**Readings**
Tuesd 6 13:00-15:00		**PM:** Seminar: Using a systems approach in different sciences (ÖB, 2 hrs)	**Readings**
Wednesd 7	**READING DAY**		
Thursd 8 10:00-15:30	**AM:** Complex systems, Resilience and Complex Adaptive Systems (ÖB, 2 hrs) **PM**: Complex systems and causal loop diagrams (ÖB, 2.5 hr)		Small student groups. Describe a study system using causal loop diagrams
Frid 9			Group work
Week 2: Studying/modelling Social-Ecological Systems (SES)			
Mon 12 13:00-15:00		**PM:** Possibility for groups to get support/feedback (ÖB)	Group work continue
Tues 13 13:00-15:00		**PM:** Present group work in class (ÖB)	Install VenSim on laptop
Wed 14 9:00-15:00		**AM:** Lab1: System dynamics using VenSim (ÖB, BG) **PM:** Lab1 continues (ÖB, BG)	
Thurs 15 13:00-15:00	**PM:** Lecture: Social and Ecological Systems as networks (ÖB, 2 hrs)		Install Unicet on laptop
Fri 16 9:00-15:00		**AM:** Lab2: Analysing a seascape (ÖB, BG) **PM:** Lab2 continues (ÖB, BG)	Individual projects as follow-ups of the lab
Week 3: Individual reports			
Mon 19			Work on individual projects
Tues 20			Work on individual projects **Due:** Reports from individual work to be handed in before 5 pm

Learning outcomes

Upon completion of this module students will:

1. Understand the concept of systems theory – a systems approach
2. Understand some of the peculiarities of complex systems, e.g. sensitivity to initial conditions, drastic changes of behaviours, highly variable levels of predictability
3. Being able to describe systems as (1) sets of different entities (components) and relations, and (2) as sets of variables and causal links
4. Being able to use software when studying system dynamics
5. Being able to make use of the network approach and some network analytical software

Assessment and Grading

Component	Weighting (%)	Learning Outcomes
Group presentation casual loop diagrams (quality, clarity, creativeness, correctness)	20%	1-3
Individual report (quality, innovativeness, integrative thinking)	80%	3,5
Participation in labs (presence and engagement, quality, preparation, participation in discussions)	Pass/fail	2-5
Participation in class discussions & seminar (presence, quality of questions, preparation)	Pass/fail	1-6
Module Review	Compulsory	
	100%	

Attendance of lectures and participation in all seminars is compulsory. Participation does not only mean attendance, the participant must have prepared for and take an active role in the seminar. The individual course evaluation at the end of the course is compulsory.

Criteria for assessment

The participant must achieve passing grades for all parts of the course in order to pass the course as a whole. Failure to submit on time will result in a maximum grade C. The maximum grade for Fx grade is an E.

The following grades are issued, the lower limits for each grade is expressed as a percentage of the maximum points available:

A 95% Excellent
B 85% Very good
C 75% Good
D 65% Satisfactory
E 60% Sufficient (pass)
Fx 50% Insufficient (fail)
F Below 50% Poor or insufficient conduct (fail)

A	requires excellent insight and deep understanding of how the module concepts are related to research social-ecological systems. Excellence in analysis, assessment and synthesis in written and oral discussions
B	requires very good insight and deep of how the module concepts are related to research social-ecological systems. Shows skills in analysis, assessment and synthesis
C	requires good insight into the module concepts and how they are interrelated, as well as independent sound judgements and analytical skills in discussing them
D	requires additional skills in discussing and explaining the module concepts
E	is issued to participants who can recapitulate the contents of the course and define the basic concepts discussed in the different module components.

Reading list – readings, etc. should be done prior to lectures, seminars and labs!
Course Book:

Meadow, D. H. (2008), Thinking in Systems: A primer, Chelsea Green Publishing

Week 1: Systems theory and the foundation of resilience theory

Lecture: Introduction to Systems thinking

Flood (1990), Rethinking the fifth discipline: learning within the unknowable, Routledge

- Chapters 3, 4, 6

Allen, T. F. H., and T. W. Hoekstra (1992) Toward a unified ecology, Columbia Univ. Press

- Chapter 1

Optional readings:

Capra, F. (1997) The Web of Life, Flamingo

Levin, S. A. (2000). Fragile Dominion: Complexity and the Commons, Perseus Publishing

Seminar 1: Using a systems approach in different sciences

See reading list above

Lecture: Complex (adaptive) systems, resilience and causal loops

Flood (1990), Rethinking the fifth discipline: learning within the unknowable, Routledge.

- Chapter 2

Meadow, D. H. (2008), Thinking in Systems: A primer, Chelsea Green Publishing

- Chapter 1, 2

Folke, C., S. R. Carpenter, B. Walker, M. Scheffer, T. Chapin, and J. Rockström. (2010). Resilience thinking: integrating resilience, adaptability and transformability. Ecology and Society 15(4): 20. URL: http://www.ecologyandsociety.org/vol15/iss4/art20/

Levin, S. A. (1998). Ecosystems and the biosphere as complex adaptive systems. Ecosystems, 1(5), 431-436.

Optional readings:

Senge, P. M. (1990) The fifth discipline: The art and practice of the learning organization, Doubleday

Walker, B., C. S. Holling, S. R. Carpenter, and A. Kinzig. (2004) Resilience, adaptability and transformability in social–ecological systems. Ecology and Society 9(2): 5. URL: http://www.ecologyandsociety.org/vol9/iss2/art5/

Week 2: Studying/modelling Social-Ecological Systems (SES)

Lectures: Social-Ecological Systems as networks

Webb, C., & Bodin, Ö. (2008). A Network Perspective on Modularity and Control of Flow in Robust Systems. In J. Norberg & G. Cumming (Eds.), Columbia Press.

Lab 1: System dynamics using Vensim

Install Vensim prior to lab (free download at http://vensim.com/free-download/)

Lab 2: Analysing a seascape

Bodin, Ö. and B. I. Crona (2017) Social networks in a landscape context: Uncovering social-ecological (mis)matches in heterogeneous landscapes

Install Ucinet prior to lab (download free trial version at http://www.analytictech.com/ucinet/)

Week 3: Individual work

Work on individual reports

Module 5: Regime Shifts (5 hp)

Module Leader: Garry Peterson
garry.peterson@stockholmresilience.su.se
Instructors: Romina Martin RM, Daniel Ospina (DO), Garry Peterson (GP), Juan Carlos Rocha (JR)

Brief description

This course builds on the systems thinking module, and delves further into the concept of regime shifts and modelling social-ecological systems. Regime shifts, the reorganization of the structure and processes shaping a social-ecological system, are explored from a theoretical and practical perspective, including the investigation of a set of case studies. The module introduces key theoretical concepts associated with regime shifts, and a combination of qualitative and quantitative approaches for analysing regime shifts and modelling social-ecological systems. Practical exercises will include small group projects that utilize these concepts and methods to analyse and write up a case study of a regime shift for the Regime Shifts Database (www.regimeshifts.org), and several social-ecological modelling labs.

Course content

Concepts	***Methods***	**Applications**
Week 1: Regime shift concepts		
Regime shift Feedbacks loops Thresholds Hysteresis Regime shift mechanisms Other related concepts (alternative stable states, phase shifts, path dependence)	Causal Loop Diagrams Literature assessment	Regime Shifts Database
Week 2: Practical project		
Regime shift Feedbacks loops	Causal Loop Diagrams Literature assessment	Regime Shifts Database and case studies
Week 3-4: Modelling SES and Regime Shifts		
System-level dynamics Spatial dynamics Feedbacks Agent-based modelling (ABM) Emergence Micro-Macro interactions	Simple models of spatial aspects of resilience Agent-based modelling (ABM)	Understanding complex dynamics through dynamical modelling

Schedule

	Lectures	*Class exercises*	Home work
Week 1: Regime shift concepts			
NOVEMBER **Wednesday 21** **13:00-15:00**	**AM:** (11-12) Students to discuss and evaluate module 4 (in the lobby) **PM**: Introductory lecture on Regime Shifts and the Regime Shifts Database [GP DO]	**PM:** Discussion and questions in small groups based on lecture and readings – criteria and examples/ non-examples of regime shifts.	Prepare readings in advance (Biggs et al. 2012)
Thursday 22	**READING DAY**		Readings (Biggs et al. 2018)
Friday 23 **9:30-12:00**	**AM:** The Regime Shifts Database, Template & Assignment for the module [GP]	**AM:** Form groups of 2-3 and select a regime shift or case study for class project [GP]	
Week 2: Practical project – Group work			
Monday 26 **13:00-15:00**		**PM:** Short presentation by each group (alternate regimes) & class discussion and feedback. Clarification of questions related to regime shifts database template. Identify which parts of write-up will be done by whom. [DO GP JR]	Identify the alternate regimes & key feedback mechanisms (work in small groups) Prepare questions on regime shifts template
Tuesday 27	**READING DAY**		Develop draft CLD, identify key feedbacks and drivers Prepare readings in advance (Biggs et al. 2016)
Wednesday 28 **9.30-12:00**		**AM:** Feedback on causal loop diagrams, problems with examples – discuss in mixed groups of students [GP JR]	Start fleshing out the regime shifts database example
Thursday 29	**READING DAY**		Continue group exercise
Friday 30 **9:30-12:00**	**AM:** Introduction to methods to study regime shifts in SES [GP JR]	**AM:** Example of a coupled SES model, to explore spatial aspects of resilience [GP JR]	
Week 3: …			
DECEMBER **Monday 3** **9:30-12:00**	**READING DAY**		Prepare group presentation Draft regime shift write up
Tues 4	**AM:** Regime shifts in an ABM (example) [RM]		Prepare readings (Filatova et al. 2016)
Wed 5 **9:30-12:00** **13:00-14:30**		**AM:** Presentation by each group [GP DO] **PM:** Group Feedback on presentations [GP DO]	Peer review of regime shifts 17:00 Hand in final peer review of regime shifts
Thursday 6	**READING DAY**		Revise regime shift write up
Friday 7	**READING DAY**		Revise regime shift write up 17:00 Hand-in final regime shift write-up

Week 4: …		
Monday 10 **10:00-12:00** **13:00-15:00**	**AM**: Reflections on regime shifts [GP]	
		PM: Feedback on case study exercise, and Evaluation of Module 4 and 5 [GP] *Half way through this evaluation, the students will continue the evaluation discussion by themselves*

Learning outcomes

It is expected that the student, after taking the course, will be able to:

1. Understand the concept of regime shifts, and related concepts such as hysteresis, amplifying and damping feedbacks, and thresholds.
2. Appreciate the difficulties in identifying and detecting regime shifts in real-world settings, both qualitatively and quantitatively.
3. Be familiar with a number of iconic examples of regime shifts and be able to explain the key dynamics that maintain the alternative regimes.
4. Be able to analyse a case study of a regime shift, i.e. identify the alternate regimes, key feedbacks, drivers that precipitate the shift, and key impacts on ecosystem services.
5. Be able investigate the dynamics of simple mathematical/qualitative models commonly used in social-ecological systems research, and relate these behaviours to the concepts discussed in the course so far.

Assessment and Grading

Component	Weighting (%)	Learning Outcomes
Group component of RSDB write-up	50%	1-5
Group presentation of RSDB write-up (with individual grades)	15%	1-5
Group presentation "peer review" of RSDB presentation	10%	1-5
Causal-loop diagram	15%	1-5
Participation in class discussions & exercises (Pass/Fail*)	10%	
Modelling exercises (Pass/Fail**)	Compulsory	5
Module Review	Compulsory	
	100%	

*If you participate in all class discussions and exercises, you get 10%. If you miss one or more of the RSDB classes you lose 5%; if you miss one or more of the modelling classes you lose 5%. If you miss one or more of both you get 0% for this component.

**The modelling part of the course will not contribute to your final grade, but you MUST pass this component in order to pass the module.

Criteria for assessment

The participant must achieve passing grades for all parts of the course in order to pass the course as a whole. Failure to submit on time will result in a maximum grade C. The maximum grade for Fx grade is an E.

The following grades are issued, the lower limits for each grade is expressed as a percentage of the maximum points available:

A 95% Excellent
B 85% Very good
C 75% Good
D 65% Satisfactory
E 60% Sufficient (pass)
Fx 50% Insufficient (fail)
F Below 50% Poor or insufficient conduct (fail)

A	Requires excellent insight and deep understanding of how the module concepts are related to researching social-ecological systems. Excellence in analysis, assessment and synthesis in written and oral discussions.
B	Requires very good insight and deep of how the module concepts are related to researching social-ecological systems. Shows skills in analysis, assessment and synthesis.
C	Requires good insight into the module concepts and how they are interrelated, as well as independent sound judgements and analytical skills in discussing them.
D	Requires additional skills in discussing and explaining the module concepts.
E	Is issued to participants who can recapitulate the contents of the course and define the basic concepts discussed in the different module components.

Reading List – readings should be done prior to lectures!

Week 1: Regime Shift Concepts

Mandatory:

Biggs R., T. Blenckner, C. Folke, L. J. Gordon, A. Norström, M. Nyström, and G. D. Peterson. 2012. Regime Shifts. *In* A. Hastings and L. Gross, editors. *Sourcebook in Theoretical Ecology* (609-617). University of California Press, Berkeley.

Biggs, R., G. D. Peterson, and J. C. Rocha. 2018. The Regime Shifts Database: a framework for analyzing regime shifts in social-ecological systems. *Ecology and Society* 23(3):9. https://doi.org/10.5751/ES-10264-230309

Explore the Regime Shifts Database: www.regimeshifts.org

Highly recommended optional literature (short articles that focus on clarifying concepts)

van Nes, E. H., B. M. S. Arani, A. Staal, B. van der Bolt, B. M. Flores, S. Bathiany, and M. Scheffer. 2016. What Do You Mean, "Tipping Point"? *Trends in Ecology & Evolution* 31:902–904.

Walker, B. H., S. R. Carpenter, J. Rockström, A.-S. Crépin, and G. D. Peterson. 2012. Drivers, "Slow" Variables, "Fast" Variables, Shocks, and Resilience. *Ecology and Society* 17:1–4.

Suggested literature to go deeper:

Scheffer M., S. R. Carpenter, J. A. Foley, C. Folke, and B. H. Walker. 2001. Catastrophic shifts in ecosystems. *Nature*, **413:**591-596.

Cumming, G. S., and G. D. Peterson. 2017. Unifying Research on Social–Ecological Resilience and Collapse. *Trends in Ecology & Evolution* 32:695–713.

Steffen et al 2018. Trajectories of the Earth System in the Anthropocene. Proceedings of the National Academy of Sciences DOI:10.1073/pnas.1810141115

Week 2: Introduction to Modelling SES and Regime Shifts

Mandatory:

Biggs, R., W. J. Boonstra, and G. Peterson. 2016. The domestication of fire as a social-ecological regime shift. *PAGES Magazine* 24:22–23.

Filatova, T., J. G. Polhill, and S. van Ewijk. 2016. Regime shifts in coupled socio-environmental systems: Review of modelling challenges and approaches. Environmental Modelling & Software 75:333–347.

Selgrath, J. C., G. D. Peterson, M. Thyresson, M. Nyström, and S. E. Gergel. 2017. Regime Shifts and Spatial Resilience in a Coral Reef Seascape. IN: Gergel, S. E., M. Turner. *Learning Landscape Ecology* (301–322). Springer New York, United States.

Suggested literature to go deeper*:*

Andersen, T., J. Carstensen, E. Hernández-García, and C. M. Duarte. 2009. Ecological thresholds and regime shifts: approaches to identification. *Trends in Ecology and Evolution* 24:49–57.

Lade, S. J., S. Niiranen, J. Hentati-Sundberg, T. Blenckner, W. J. Boonstra, K. Orach, M. F. Quaas, H. Österblom, and M. Schlüter. 2015. An empirical model of the Baltic Sea reveals the importance of social dynamics for ecological regime shifts. *Proceedings of the National Academy of Sciences* 112:11120–11125.

Rocha, J.C., Peterson, G.D. and Biggs, R., 2015. Regime shifts in the Anthropocene: drivers, risks, and resilience. *PLoS One*, *10*(8), p.e0134639.

Scheffer M. and S. R. Carpenter. 2003. Catastrophic regime shifts in ecosystems: linking theory to observation. *Trends in Ecology and Evolution*, **18:**648-656.

Schlüter, M., R. R. J. Mcallister, R. Arlinghaus, N. Bunnefeld, K. Eisenack, F. Hölker, E. J. Milner-Gulland, and B. Müller. 2012. New horizons for managing the environment: A review of coupled social-ecological systems modeling. *Natural Resource Modeling* 25:219–272.

Module 6: Resilience Thinking (6 hp)

Module leader: Maria Tengö

maria.tengo@su.se

Instructors: Katja Malmborg (KM), Zuzana Harmackova (ZH), Elin Enfors (EE), Tim Daw (TD) others to be confirmed (My Sellberg, Per Olsson/Michele-Lee Moore)

Brief description

This module is the final part of the course Systems theory and Resilience Thinking. It aims to integrate the earlier modules on systems thinking and regime shifts by applying those ideas to the resilience analysis of social-ecological systems. The module will use the Wayfinder tool developed within GRAID that builds on the resilience assessment approach developed by the Resilience Alliance, to be applied on a set of case studies.

In the first week, students will work with key concepts of resilience thinking, including social-ecological systems, system identity, the adaptive cycle, panarchy, adaptation and transformation. Students will work in groups to apply one of the resilience assessment approaches to a centre case study. During the first two weeks, a set of lectures and exercises will guide the students to the steps of a resilience assessment, including defining the system of study, assessing system dynamics over time and key feedback linkages, and cross-scale interactions. In the final two weeks of the module, the students will build on this experience and complete a resilience assessment of the case study. The group findings will be presented to the class and in a written report. The last step of the course will be done individually and presented in a separate report. The Wayfinder is a new tool and a useful component of the course will be reflections about the potential and limitation of the approaches and resilience assessment in general.

Class schedule- All lectures are in room 251 unless otherwise noted.

	Lectures	*Class exercises*	Home work
DECEMBER **Wed 12** **9.30-12.00**	**AM:** Module intro and overview (MT, KM) Intro to the Wayfinder (EE) Introducing group and individual tasks (MT, KM) Case study descriptions (EE, TD) Decide groups		**PM:** make a plan of work and read case lit + Wayfinder
Thu 13			read cases lit + Wayfinder
Fri 14 ***9.30-12.00***	***AM:*** *Teacher-led session Zuzana Harmackova.* *Lecture on resilience thinking: principles and assets.*	***AM:*** *Exercise on aspirations, systems identity*	***PM:*** *Timeline exercise* *Think about key components* *System boundaries - tematiskt* *Synch across groups with same case*
Mon 17 ***9.30-12.00***	***AM:*** *Teacher-led session* *Katja Malmborg:* *System boundaries and dynamics*	***AM:*** *Exercise:* *- adaptive cycle*	***PM:*** *Connections and networks* *Cross scale drivers* *Governance, actors, actor groups*
Tues 18 ***9.30-12.00***	***AM:*** *Teacher-led session: Maria Tengö* *Agency and resilience* *Participation, stakeholders, knowledge*	***AM:*** *actor mapping and discussions*	***PM:*** *Causal loop diagram of case* ***SEND IN VERSION TO KATJA by 16.00 pm***
Wed 19 ***9.30-12.00***	***AM:*** *Teacher-led session:* *Katja Malmborg:* *Multiple stable states,* *traps and transformation*	***AM:*** *Exercise* ***PM:*** *Potential to connect with case owners (KM, TD)*	*Group work*
Thu 20		*Potential to connect with case owners (KM, TD)*	*Group work*
Fri 21 ***9.30-12.00***	**Feedback session** **AM:** Mid-assessment check-in: All groups to meet with MT and KM for 30 minutes		**15.00: Work plan for each group sent into KM**
CHRISTMAS BREAK 24 DEC- 7 JAN			
After Christmas			
JANUARY **Mon 7**			Group work
Tu 8			Group work
Wed 9			Group work
Thu 10 **9.30-12.00**	REMEMBER MANDATORY **AM**: Teacher led session: Case study presentations, reflecting on approach for dealing with complexity and general vs specific resilience. My Sellberg Zuzana Harmackove Katja Malmborg	**AM:** Exercise: Reflection on general and specific resilience in case work	**PM:** Group work
Fri 11 **9.30-12.00**	**AM:** Teacher-led session: Resilience and transformation	**AM**: Exercise Transformation, option space, opportunity context.	**PM:** Group work

	Per Olsson/Michele-Lee Moore (unconfirmed)		
Week 4: Resilience Assessment Step 3			
Mon 14 **9.30 - 12**	**AM:** Discussion session with KM and MT, open for needs		**PM:** Work on group assessments
Tue 15			**12.00 Written reports, sent to KM and circulated to class.** **PM:** prepare presentations
Wed 16 **9.30-12.00** **13.00-13.30**	**AM:** Group presentations and discussions (MT, KM)	**PM:** Intro to individual assessment	
Thurs 17			Work on individual assessment
Fri 18 **13.00-15.00**		***PM:*** *Course evaluation*	**AM:** Work on individual assessment **12.00. Hand-in: Individual report to KM**

Learning outcomes

Upon completion of this module students will:

1. Understand theories of dynamics of resilience;
2. Understand components of a resilience assessment;
3. Be able to conduct a resilience assessment
4. Present scientific information verbally and in written form.

Assessment and Grading

Component	Weighting (%)	Learning Outcomes
Group Resilience Assessment, written report 4p	35%	1-4
Individual 2-pager	35%	1-4
Presentation of group resilience assessment	15%	1, 4
Presentation and participation in discussion on the adaptive cycle	Compulsory	1-4
Participation in discussions	15%	1-4
Exercises participation	Pass/ fail	2, 3
Module Evaluation	Compulsory	
Individual Course Evaluation at end of the course	Compulsory	
	100%	

Attendance of lectures and participation in all seminars is compulsory. Participation does not only mean attendance, the participant must have prepared for and take an active role in the seminar. The individual course evaluation at the end of the course is compulsory.

Criteria for assessment

The participant must achieve passing grades for all parts of the course in order to pass the course as a whole. Failure to submit on time will result in a maximum grade C. The maximum grade for Fx grade is an E.

The following grades are issued; the lower limit for each grade is expressed as a percentage of the maximum points available:

A 95% Excellent
B 85% Very good
C 75% Good
D 65% Satisfactory
E 60% Sufficient (pass)
Fx 50% Insufficient (fail)
F Below 50% Poor or insufficient conduct (fail)

In addition to specific grading criteria handed out with specific assignments, the following criteria are used for grading assignments:

A	requires excellent insight and deep understanding of how the modules' concepts are related to understanding and assessing resilience. Excellence in analysis, assessment and synthesis in written and oral discussions
B	requires very good insight and deep of how the modules' concepts are related to understanding and assessing resilience. Shows skills in analysis, assessment and synthesis
C	requires good insight into the modules' concepts and how they are interrelated, as well as independent sound judgements and analytical skills in discussing them
D	requires additional skills in discussing and explaining the modules' concepts
E	is issued to participants who can recapitulate the contents of the module and the course and can define the basic concepts discussed in the different module components.

Reading List

Core reading:

Wayfinder webpage: https://wayfinder.earth/

Walker, B. and Salt, D. (2012), Resilience Practice. Building Capacity to Absorb Disturbance and Maintain Function. Island Press, Washington, Covelo, London.

Additional useful readings:

From earlier parts of the course:

Biggs et al. 2012. Toward principles for enhancing the resilience of ecosystem services. *Annual Review of environment and resources* 37:421-48

Folke, et al., 2010. Resilience thinking: integrating resilience, adaptability, and transformability. *Ecology and Society* 15 (4), 20.

Case study papers as potential resources (see also suggestions within Wayfinder)

- Allison H.E. and R.J. Hobbs. 2004. Resilience, adaptive capacity, and the "Lock-in Trap" of the Western Australian agricultural region. Ecology and Society 9(1):3.
- Enfors, E. 2013. Social–ecological traps and transformations in dryland agro-ecosystems: Using water system innovations to change the trajectory of development. Global environmental change 23: 51-60.
- Sellberg, M. M., C. Wilkinson, and G. D. Peterson 2015. Resilience assessment: a useful approach to navigate urban sustainability challenges. *Ecology and Society* 20(1):4
- Mathevet, R., A. Allouche, L. Nicolas, V. Mitroi, C. Fabricius, C. Guerbois, J. Anderies, R. Mathevet, A. Allouche, L. Nicolas, V. Mitroi, C. Fabricius, C. Guerbois, and J. M. Anderies. 2018. A Conceptual Framework for Heuristic Progress in Exploring Management Regime Shifts in Biodiversity Conservation and Climate Change Adaptation of Coastal Areas. Sustainability 10(11):4171.