ENVR 662 – Systems Methods for Environmental Managers

Course Outline

Faculty
Social and Applied Sciences

School
Environment and Sustainability

Program
Master of Arts/Master of Science in Environment and Management

Course Title
Systems Methods for Environmental Managers

Course Number
ENVR 662

Credits
3

Calendar Description
Environmental Management is concerned with systems: Ecosystems, Social Systems, Economic Systems and Governance Systems. Consequently some basic understanding of what a system is, how it is distinguished and bounded, and how one can discriminate and influence both its internal operations and external functions, is highly relevant. Furthermore, given that systems are dynamic entities, a manager should understand what dynamics govern the formation, conservation, and change, as well as the stability, resilience or robustness, of different types of systems. The relevance of feedback, scale, dispersal, and complexity, will be considered with respect to our desire to control or manage systems.

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Course Start
February 6, 2012

Course End
April 27, 2012

Delivery Method
On-campus residency
ENVR 662 is offered in mixed mode. One third, that is, one credit will be offered in Residency, and the rest will continue online, directly after the Residency. The Residency class time portion will be 15 hours, and the online portion will be delivered over 8 weeks. In residency approximately 6 hours will be required further to the actual delivery for group projects and reporting, and the online portion will require up to 10 hours per week of learner engagement for a total of approximately 100 hours. The course content will be delivered through hands on exercises including work in a computer lab, readings, both moderated and un-moderated team discussions, assignments and instructor commentaries on the team assignments. There will be a final individual essay that synthesizes the course content and expands on the implications to Environmental Management.

**Co-requisites**

n/a

**Pre-requisites**

ENVR 505, ENVR 550

**Course Overview**

Environmental Management is concerned with systems: Ecosystems, Social Systems, Economic Systems and Governance Systems. Consequently some basic understanding of what a system is, how it is distinguished and bounded, and how one can discriminate and influence both its internal operations and external functions, is highly relevant. Furthermore, given that systems are dynamic entities, a manager should understand what dynamics govern the formation, conservation, and change, as well as the resilience or robustness, of different types of systems. The relevance of designed or evolved systems, open or closed systems, embedding and emergence will be considered with respect to various dimensions of system sustainability.

Many methodologies have been developed for the study and management of different types of systems. The methods to be presented and used in this course will be grouped into three types: a) those suited for examining and managing the operation of ecosystems; b) those suited for engaging humans in either social or organizational systems, including stakeholder and policy participation for ecosystem management; and c) those which take into account both the system and the people involved. For the first type, the course will focus on feedback analysis, impact hypotheses, and simulation modeling at various scales suitable for local to global issues. Models and modeling scenarios will be used for population dynamics, energy and material flows, and ecosystem dynamics. For the second type, a Viable Systems Model for organizations, Syntegration and World Cafe as a group information sharing process will be presented. Methods that explicitly take people as well as systems into account will include various Soft System methodologies, Systemic Management, Global Simulation Systems, and Panarchy, as well as a few conceptually based readings. The use of scenarios for regional or global futures, backcasting, and design for resilience and adaptive management will be reviewed with reference to a variety of large scale projects, such as the UN based Millennium Ecosystem Assessment and the ongoing work of the Resilience Alliance Network.

Systems terminology will be introduced and used throughout the course as a means of understanding and implementing basic systems concepts. Course activities will include readings, exercises, computer labs (in residence) independent and instructor moderated discussion teams, and both individual and team reports.

This course can be viewed as an introduction to the cybernetics of how one understands and operates with any organization or system. ENVR 661, a course in the third residency on Systems Thinking will extend this analysis.
Resources
Resources in ENVR 662 will include a combination of required texts, and required and recomme nded journal articles and websites, as well as instructional notes and overviews. The following is an initial listing. Updates will be posted on the course web site.

Required Texts and Chapters selected from Texts:


Required journal article, readings and websites:


A Special Integration Group of the International Society for Systems Sciences. Welcome to the Primer Project.  [http://www.isss.org/primer/primer.htm](http://www.isss.org/primer/primer.htm)


The World Café. About the World Cafe  [http://www.theworldcafe.com/about.html](http://www.theworldcafe.com/about.html)


**Recommended References:**


**Classic Systems/Cybernetics References**


Wiener, Norbert. (1948) *Cybernetics; or, Control and communication in the animal and the machine*. New York: J. Wiley

**Systems Ecology References**


**Unit Descriptions/Schedule**

This course provides an overview of systems concepts and a selection of different systems methodologies. The overview of methods is not intended to be exhaustive (that would be exhausting, and in fact impossible in the time constraints of this course). Rather we will select a few representative methods and engage with them sufficiently to understand how they work, what benefits they offer, and what their limitations are. The implications of similar methods and the different focus they would offer can then be discussed.

**Understanding Systems**

In this unit we will consider several forms of sketching the dynamics of systems including systems maps, feedback loop diagrams and impact hypotheses. Any presentation of such dynamics in a quantitative fashion is referred to as a simulation model. Simulation models are the backbone of most, if not all, methods for projecting consequences of internal or external changes in a complex dynamic system. Hence we will devote adequate time to understand how such tools work, both conceptually and in implementation, for local issues and global concerns. Simulation and projection will be discussed further in Unit 3 on dealing with complex systems.

**Background Reading**

Kauffman’s book, “An Introduction to Systems Thinking” and Capra’s book, "The Web of Life" will provide a good background for many of the notions that underpin this course. In particular, read “The Rise of Systems Thinking” up to page 110 of Capra’s “The Web of Life”. Unless you are mathematically inclined, you need not be concerned with the chapter on Mathematics of Complexity. The section on Living Systems is of interest, and it will be relevant for the Third Residency course on Systems Thinking (ENVR 661).
The Meadows papers, “Dancing with Systems” and “Leverage Points” as well as the Resilience Alliance’s work on “Panarchy” will provide a grounding on how to think about and approach systems theory. There is no explicit pre-residency assignment that relates to these readings, but the ideas will be referred to throughout, and reading it early in the course will enhance your experience - and hopefully make some of the work easier.

During your reading reflect on how our understanding of “systems” as a field of study has influenced the management of linked ecological, social, and economic concerns. What benefits have we obtained? What new problems can be attributed to how we have managed these concerns based on our understanding of them as systems? What hopes and fears (possibilities and dangers) for the future of environmental management based in systems thinking do you have?

Further to the content, this reading selection is intended to deepen your awareness that how we now think is not final; that is, ideas evolve.

**Systems Concepts**

Based on the Readings and on a selection of websites, including Wikipedia and the Principia Cybernetica web dictionary of Cybernetics and System, each learner is asked to compile a short glossary of 15 selected Systems Concepts. These will serve as grounding for in Residency classes and Assignments.

The concepts have been selected to provide an overview and a grounding in three areas; a) distinguishing systems, their nature and limits, b) systems dynamics, and c) the possibilities and limits for management or “control” of systems.

**Conceptual Models**

Interactive lectures will be presented on developing Systems Maps, and Rich Pictures; on discrimination between stocks, flows, transformations, and influence, regulation or control. In class exercises will be used to clarify these concepts as well as the difference between direct and indirect effects, linearity and circularity. Feedback diagrams will be drawn as an in class activity. A demonstration impact hypothesis will be created collaboratively in class leading to the individual assignment of formulating an Impact Hypothesis to represent an example from the learner’s domain of knowledge.

**Simulation Models**

Simulation modeling will be introduced with a literal “bean counting” in class exercise to explain the concepts of iteration and cumulation of model results in the form of a projection. In the computer lab, two types of computer models will be demonstrated and interactive activities will be presented for exploring these models.

The first is a model that extends the “bean counting” notion by automating calculations that would be difficult to perform by hand. Namely an age class specific human population model will be demonstrated and the learners will be asked to manipulate the model with a list of leading questions in mind. The second will be an equation based abstraction of population dynamics in the form of a competitive coexistence and harvesting model. The instructor will be present to coach people through any difficulties.

**Complex Management Models and Sustainability**

The Pedagogic version of the Global Simulation System (GSS) has been developed expressly to provide learners with an in-depth understanding of global sustainability concerns and simulation based approaches for resolving them. The GSS exercise will be used to design a potential path to a sustainable future that takes into account human population size and quality of life while providing the required resources in the form of food, energy, wood, and minerals.

The underlying purpose of the computer based exercise is to generate an in depth understanding of trade-off issues in navigating a path through a complex system. Furthermore,
Managing Systems Including People

This unit provides a forum for determining which methods are appropriate to the sorts of problems or circumstances for which an environmental manager may be responsible. As before, we will consider the diversity of methods by engaging with a selected set and extrapolating the implications of emphasizing the different axes.

Integrating People and Systems

Methods for engaging with people emphasize different aspects – some are more concerned with information and knowledge exchange, and others are more concerned with generating an inclusive group process. Some are rigorous with respect to the form of a viable structure, others encourage invention. Some are more concerned with working out agreements; others are more concerned with the implications of activities to various groups and a larger context.

All learners will read the following references and then, during your time in residency we will be applying various aspects of these methods to the ENVR 665 case study while exploring others together in class.

- Truss and Leonard on Team Syntegrity
- Leonard on The Viable System Model. (Alternatively, you may wish to read the longer article by Espejo on the Viable System Model.)
- World Café website.
- Bob Williams on Soft Systems Methodology
- “Thinking” and “Practice” sections of the Open University Systems Thinking website
- Donella Meadows on Leverage Points and Dancing with Systems

Choosing an Approach

Learners will now have been introduced to the following systems methods:

- Time Series Data Correlations
  (eg. Gapminder)
- Systems Process Diagrams
  (eg. Systems Dynamics (+/- feedback), Multiple Cause, Impact Hypotheses)
- Simulation Modeling
  (eg. population models including forests, fish, mammals or people, with or without

the implications in terms of management activities and policies necessary for conducting a similar navigation in real-life terms are made more apparent. Finally, the need for a systems methodology adequate to support our understanding of complex issues is opened for serious consideration.

The Simulation System will be introduced and demonstrated, and the computer lab will be used as a tutorial to show learners how the model can be used. Each individual will be expected to create a simple scenario in order to understand the concepts and the modeling technology. Two alternative future scenarios that have been developed in GSS will be presented and used as a basis for discussion, and the in Residency portion of this topic will be completed with a demonstration and discussion of several real-life applications of complex models, their benefits and limitations.

The GSS work will continue online as each team develops two new scenarios for plausible and liveable futures and explores their robustness in the face of unexpected disturbances. The unit will be completed with a team assignment which considers the difficult questions of implementation and evaluation of scenarios. The value of models in offering processes suitable for sustainability that take into account social equity and biophysical limitations will be an explicit topic for team discussions and will form an element of the assignment.
dispersal,
land use, watershed or stream reach models)
Note that Models for Complex Systems will be discussed further in Assignment 5.
- Human Collaboration Methods
  (Syntegration, World Café, Viable Systems, etc.)
- Mixed Methods
  (Systemic Inquiry, Soft Systems Methods, other combinations)

This learning will form the basis for the team presentation at the end of the third week.

**Dealing with Complexity (Online)**

All methods have limitations as they are all simplifications or abstractions of some aspects of a complex whole. The very distinctions of ecological, social, economic and political systems are limited views of a complex intersected and interactive systemic network of happenings. In this final unit we will look at various approaches that recognize the complexity yet attempt to offer a means of addressing it without becoming mired or overwhelmed to the point of despair, cynicism, or any other form of inaction.

This unit is devoted to readings for the exploration of various approaches or examples of programs designed to deal with complex systems. This exploration of complex systems, methods of dealing with them, and concerns for sustainability culminates in an individual term paper.

**Panarchy and Millenium Ecosystem Assessment**

The book “Panarchy” was part of an ongoing attempt to develop an integrative theory to help us understand the source and role of change in systems. In particular the concern is with the kinds of changes that are transforming and take place in systems that are adaptive. Such changes comprise economic, ecological, and social systems, and they are evolutionary. They concern rapidly unfolding processes and slowly changing ones; gradual change and episodic change; and they take place and interact at many scales from local to global.

The readings this unit are all found on the Resilience Alliance website. Learners should read all sections under “key concepts” comprising Adaptive Capacity, Adaptive Cycle, Adaptive Management, Panarchy and Resilience.

The Millennium Ecosystem Assessment was an immense UN sponsored project conducted around the turn of the century in order to obtain a global perspective on the state of our ecosystems and what major issues and concerns we must contend with over the next few decades. Simulation modeling was used in conjunction with a number of other systems methods, in particular consultation with regional experts and local communities.

Explore the website to obtain an overview of the project. Note, for example, that several PowerPoint presentations are available. Download Ch. 5 Scenarios Overview and Ch 8 the Four Scenarios. These are long readings, you can browse and select from them as appropriate to your choice of how you wish to address the Assignment questions.

**Sustainability: a Complex Systems Issue**

The final week of the course is provided for individuals to produce the final assignment for this course. Most of the questions for this assignment are grounded in the previous week’s readings (Millennium Ecosystem Assessment) but also make reference to the Global Simulation System methodology that was introduced in the residency and Donealla Meadow’s overview papers (Leverage Points and Dancing with Systems). Further questions explore each learner’s specific opportunities to apply the methods (or similar methods) discussed in the course, and for
the learners to express what they consider their significant ideas, insights from the course are, and what way they would like to pursue some of the ideas further.

**Assignment Descriptions**

**Assignment 1: Impact Hypotheses (Individual, 10%)**

Prepare an Impact Hypothesis for a topic you are familiar with (from work, your thesis, or from your general knowledge). That is you are to construct a diagram that follows through the implication of one action to its influence on one VEC/VSC (Valued Ecosystem Component/Valued Social Component).

Your chain of influences should be selected for a sufficiently complex problem that you are able to discriminate five links between the Action and the VEC/VSC. The idea here is to be able to express one or more chains of influence between some action and some valued ecosystem/social component while being careful to discriminate between direct effects and indirect effects.

Each “box” should be a measurable variable (e.g. population numbers, temperature of lake, pollution level, etc.) For each of the links between the variables (the arrows on your diagram) propose a graphical relationship between the input and output. You are not expected to know the details of the relationship, normally this requires research. However you should be able to propose a logical hypothesis is it linear? Are there thresholds? Does the effect on the output saturate or accelerate as the input increases? Is there an optimum level?

The report should consist of one page for the drawing (hand drawn is fully acceptable!) of the impact hypothesis, and second page with a graph of the relationships implicit in the links between your components.

Lastly, choose one relationship that you feel reasonably confident about. Provide a short descriptive paragraph that comments on what the chosen link implies in terms of management for the VEC/VSC.

You may submit this report on paper (so there is no need to scan hand drawn figures) or if you are using a scanner or drawing the figure using software, you can submit in the drop box. A mixed delivery may be confusing, so choose either paper or the Assignment 1 drop box.

**Assignment 2: Simulation Models (Team, 10%)**

Write a team report addressing the following questions. Each set of questions for the three sections (I to III) is marked as a whole, and is given an equivalent weighting. Assessment is made according to the Letter Grade Description as posted in the course introductory pages.

Post the completed report in the Assignment 2 drop box.

**I. Models for Harvesting**

1. Imagine that you are responsible for managing an elk population over a fairly large area that is also used for logging and hunting. You have a fairly good idea of the basic biology of the animal, and have data concerning its rate of reproduction.
   a. How would you go about estimate the carrying capacity of your management area? The maximum sustainable harvest?
   b. How would you set the hunting licenses based on this knowledge?
   c. Consider the response rates you saw in the single species aspect of the model and the number of years that a manager may experience the system - perhaps 30 years or so.

2. Forestry practices might change the habitat sufficiently so that a natural predator, for example the wolf, changes what it hunts. This can be considered in a similar light as the
two species model; that is a slight external change alters the dynamics that happened to
be in balance so they no longer are. Similarly, changes to the ecosystem dynamics
might result from climate change.
   a. The question is, how can a manager respond?
   b. Compare the situation where s/he has access (and competence) with population
models and the situation where s/he must respond to a flow of field data only.
3. How could a fisheries manager use a multispecies model to manage fish stocks?
   a. Consider the difficulty of estimating ocean survival, changes to spawning habitat,
un-managed fishing (eg. poaching, or other jurisdictions accessing the same
stocks), and changes in species composition (eg. due to changes in ocean
currents, pollution, etc.)
   b. Given the complexity of models that take all these concerns into account, how do
you think an average biologist will use a model that has been prepared by
experts?

II. Spatial Concerns
1. Imagine that you are responsible for Forest Harvest practices on a broad scale, perhaps
a provincial level. Clearly ecosystems differ:
   a. So how would you go about dividing up this large spatial area so you could make
biologically reasonable regulations?
   b. What scale would be appropriate for determining annual allowable harvest rates?
(You do not need to provide an actual scale, but rather the reasoning that would
go into choosing a scale).
2. Now change your job. Imagine that you have a small sawmill with a license for a large
enough area that you can maintain the mill, making a living for yourself and your
employees. Assuming no disasters, such as huge fires or extensive pest outbreaks:
   a. How would you determine where to log each year and
what degree of spatial
resolution would you need to consider in order to sustain the resource
indefinitely?
   b. How would a model help?
   c. How would you keep the model current?
3. Global climate models divide the atmosphere into huge cubes, 1 to 10 km on a side. The
models calculate the flow of air from cube to cube, with all the attendant influences and
effects (heat transfer, evaporation, precipitation, greenhouse gases, etc.) The questions
for you to consider is:
   a. How can such a model be initialized?
   b. Given that everything is in constant flux, how can you get the data for the initial
conditions to start the model?
4. One of the difficulties with setting an appropriate scale for a model is how to treat that
which crosses the boundary into or out of the area. Let's say you are responsible for the
wildlife species in a park, so the park boundaries specify the scale of your model.
However, wildlife doesn't recognize jurisdictional boundaries.
   a. What cross-boundary movements would you have to take into account?
   b. How would you include these influences in a model? (Consider not only the high
profile species, but also their predators, and other prey species - and how the
treatment of these may change outside your jurisdiction)
5. Sometimes it is not the species of concern that moves, but rather something that
influences it - eg. a contagious disease, or a forest pest. Contagion rates and the
dispersal of epidemics are often simulated.
a. What kind of model structure would allow you to calculate spread? For example, could you impose a grid over your environment, much like used in climate models?

b. What would you have to know to calculate the movement of the disease or pest from one grid cell to the next? What if there were corridors or barriers in the real world, how could you take these into account?

III. Human Population Model
1. What parameters is population growth particularly sensitive to?
   What parameters are less sensitive?
   Were these a surprise to you; and do you think these dynamics are generally understood by those who are concerned with population growth encouragement or stabilization?

2. What social measures could you use to change population growth?
   What potential measures that would work in a model are intractable or impossible in the real world?
   Are there any that should be avoided, and if so why? You might consider further social or biological repercussions of any measures or the vulnerability of the approach to various other changes in human systems.

3. In what way is a human population model useful?
   What errors, omissions or other misleading beliefs and actions could arise from using a population model for policy or planning?
   How does this compare to the alternative of no forecasting or using other means of forecasting (eg. trends)?

Assignment 3: Choosing an Approach (Team, 10%)
Each team will be required to prepare a presentation that matches a project type with a suitable approach listed here.
- Time Series Data Correlations (eg. Gapminder)
- Systems Process Diagrams (eg. Systems Dynamics (+/- feedback), Multiple Cause, Impact Hypotheses)
- Simulation Modeling (e.g. population models including forests, fish, mammals or people, with or without dispersal, land use, watershed or stream reach models)
  Note that Models for Complex Systems will be discussed further in Assignment 5.
- Human Collaboration Methods (Syntegration, World Café, Viable Systems, etc.)
- Mixed Methods (Systemic Inquiry, Soft Systems Methods, other combinations)
Further details will be given in residency.

Assignment 4 Global Scenarios and Sustainability (Team, 20%)
I. Generating Two Livable Scenarios (P/F)
As demonstrated in the Residency Tutorials, each of you will have had the experience of generating at least one scenario, though you will likely not have had time to balance all the tensions. During the first week of the online portion of the course each team is to work together to generate two different balanced and, “livable” scenarios (i.e. socially equitable and environmentally sustainable). As will be described in the residency, you will be asked to create vision statements regarding the nature of your scenarios, i.e. develop the two scenarios along two different basic policy goals.
You will also be given the task of testing your two scenarios for robustness to unexpected events; such as a global epidemic, a war, or a serious environmental disaster. The method for this testing will be explained in the residency.
You will have the GSS website as a reference and as a reminder for how the GSS can be used.
II. Written Report: Evaluating Scenarios (10%)
You will have generated two different scenarios of how tensions between material and energy supplies and demands in various sectors could be resolved. Further, you will have tested both of these scenarios for robustness to some unexpected changes. Compare and contrast your two scenarios. You may find it convenient to generate a table as part of your answer.
1. In general, what are the desirable features of each scenario? Does either of them favour particular groups or sectors? Are there implicit social, economic or environmental issues left unresolved in these scenarios?
2. Which scenario has the more desirable the transient response (the path of getting there) and which has the more desirable long term results? Please indicate in what sense you mean “desirable” in what dimensions, for whom, and according to what criteria?
3. Which scenario would be easier to implement? Consider both an enlightened governance situation and one where there is competition or conflict between governing bodies. Support from who, or what system, would be needed to implement either of your scenarios? What kind of adaptive strategy would have to be included in the implementation plan? How could one create conditions now so that an adaptive implementation strategy is likely to be followed over time?
4. Who should be involved in a discussion regarding global futures, and what kind of commitment of time and energy would this take? What alternatives do we have - i.e. is there a better way than the understanding we can gain through considering the limitations of material and energy flows?

III. Written Report: Reflections on Global Models (10%)
During the residency and over the course of working on the Global Simulation System several concerns will have discussed in class and in each teams. Based on the insights contributed by team members, answer the following questions and develop them as part of this team report (approximately 2000 words).
1. What are the values of using a simulation system such as the GSS, that is one which calculates imbalances (tensions) that need to be iteratively resolved in a scenario generation process? (Other models simply project the result, taking any limitations of supply into account internally) What are the difficulties inherent in realizing the advantages of iterative policy design?
2. If a model were to be limited to a single region, what advantages might you gain and what would you lose? How would you treat the global context and globally influenced concerns?
3. If the model were to be broken into multiple regions that together represented the globe, one would clearly need data for each region.Would it make sense to just treat each region totally independently? If not, what other processes would have to be taken into account? What complications and uncertainties would arise from these additions?
4. Should scenarios be used at all in future planning? If so, at what scale? Under what circumstances? By whom?
5. There are two aspects to the GSS - the creation of the model framework itself, as provided to you, and the creation of scenarios to test within the system, as you did. Let us name these two phases “model design” and “scenario design” Who should be involved in each of these phases?
6. Are the two aspects, “model design” and “scenario design” an art or a science, or is it a combination of the two? Provide grounds for your answer, indicating how art or science are relevant? Does this (art, science, or both) apply only to the development...
and use of simulation models, or does it also apply to other systems methods? Examples?

Place the completed report in the Assignment 4.dropbox.

Assignment 5: Sustainability, a Complex Systems Issue (Individual Term Paper, 50%)
The individual term paper is intended as a synthesis of the course as well as an opportunity to reflect on and express that learning which has been most relevant to each learner. It is in this sense open – ended. Nonetheless, the content should of course be drawn from the course and the application of the insights gained from the course to those Environmental Management situations that each learner is engaged in or expects to engage with. The total report is expected to be approximately 4-5000 words; to be distributed equally over the four questions, or as discussed with the instructor. The word length is only a guideline; it depends on how concisely you write. A better guide would be that each answer should contain at least ten substantive ideas; some of which should represent the learner’s own intellectual contribution.

I. Implementing a Global “megaproject” (10%)
Write a short report that addresses each of the three questions below. There should be at least 10 different ideas, concepts, or points made and substantiated for each of the three questions. You may find it useful to write 10 short numbered paragraphs than to write in essay format.

1. In the GSS approach, each user is required to develop a scenario using the model as a base. The intent is to understand the interactive dynamics of the system. In the Millennium Scenarios, experts developed four plausible scenarios and used these in policy contexts to support discussions. What are the advantages and shortcomings of the Millennium Ecosystem Assessment approach to scenarios?

2. The Scenarios were only a part of the whole Millennium Ecosystem Assessment project. Another significant aspect was the data collection concerning the current state of ecosystems and the influences on them. How useful do you think the data were in and of themselves? Can one make global sense of the patterns in data without developing Scenarios? If so, how? If you do use scenarios, do they need to be quantitative to be plausible and credible?

3. Consider the level of support (funding and collaboration) that went into the Millennium Ecosystem Assessment Project. What has been achieved through this? Is it enough? Is this what it takes? Or is it a waste of time and resources best spent in some other way? What would you recommend be done if you had that level of support at your disposal?

Other relevant questions or concerns about the Global Modelling, or the Millennium Ecosystem assessment that inspire you or your teams may also be addressed; the above are provided as a guideline. Feel free to check with the instructor if you wish to modify the assignment questions.

II Panarchy, Leverage Points and Dancing with Systems (10%)
The compelling core notions of Panarchy have to do with cycles of change (the adaptive cycle) spatial and temporal scales, linkages between human, biological and physical systems, and the possibility of finding general patterns within the complexity. The notions of resilience, adaptation, and robustness and rigidity are developed in a manner that enables their application to management.

Before her untimely death, Donella Meadows had come to the view that none of the methods or approaches that were available, or could be conceived dealt adequately with
the richness and complexity of actual management. Consequently, in additions to her earlier paper Leverage Points, she published the view that engagement with systems in an ongoing relationship of care, reflection, and responsiveness was the fundamental requirement for sustainability.

Assignment:
Write a short essay that addresses the following questions. There should be at least 10 different ideas, concepts, or points made and substantiated.

• What do you find compelling in these approaches (Panarchy, Leverage Points and Dancing)?
• How do they differ, or support one another?
• How do they expand or deepen your understanding of the more technical work that you have covered so far in the course?

III. Application to your work (10%)
Choose a systems approach that is relevant to work you are engaged in, or planning to do, and indicate how you would apply the approach to further this work. Include appropriate vocabulary and systems concepts as relevant.

IV. Insights and Ponderables (15%)
Given the rich domain of ideas that has been covered in this course, no single question could properly represent the learning of all the individuals. Instead, this part of the assessment of individual learning will be achieved through an approach known as “Observing for Learning.” In other words, there are no pre-determined answers; different people will have learned different things that are relevant to their background and position. Consequently you are encouraged to stress that which has been significant for you and emphasize your insights. You may also indicate areas of nagging uncertainty or ambiguity, and the directions you intend to take for any further exploration.
This is an open question; you may write about any meaningful insights that have to do with the course content, including ideas that you are still pondering or concerns that you have. (ie. the domain for the question is Systems concepts, approaches or methods as relevant to Environmental Management.) You may write about a practical application, an expansion of some of the concepts, or anything about systems methods that is particularly relevant to you. We are looking for a contribution of ideas from you; this section is not intended as literature research or as a report on your thesis. You may choose to write about your thesis topic but the emphasis should be on what new ideas, insights, or concerns you attribute to the material covered in this course.
Describe the question or topic you have chosen in a sentence or two in order to provide a context for evaluation.
Place the completed report in the Assignment 5 drop box

Course Project 1: Systems Concepts
Using a selection of the readings and websites provided for this course, as well as general website searches (Wikipedia is acceptable as one of several sources) each individual is to prepare a glossary of the following systems concepts. The definitions and explanations of concepts vary with source; this exercise is to focus on an understanding of the systems concept as it is relevant for environmental managers concerned with both ecosystems and social systems.

1. System
2. Open and Closed Systems
3. Boundary
4. Self-organization
5. Emergence
6. Homeostasis
7. Resilience and Robustness
8. Stability
9. Equilibrium
10. Thresholds
11. Regulation and Control
12. Transient Response
13. Path Dependence or Hysteresis
14. Complexity
15. Requisite Variety
Course Project 1: Global Scenarios  
This assignment will be explained and evaluated during the Global Simulation System Team Tutorials. Each person is expected to create future policies for a selection of 3 to 5 variables and combine these in a scenario. An attempt should be made to develop a scenario that is more liveable and has fewer resource tensions than the Business as usual scenario that is provided.

Activities and Assignments Schedule

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<tr>
<th>Date Range</th>
<th>Description</th>
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<tbody>
<tr>
<td>Feb 6 – Feb 12</td>
<td><strong>Preparation for Residency</strong>&lt;br&gt;Read Capra’s “The Web of Life”, Kauffman’s “An Introduction to Systems Thinking”, Gunderson &amp; Holling’s “Pamarchy” and Meadow’s “Leverage Points” and “Dancing with Systems”&lt;br&gt;Compile systems glossary</td>
</tr>
<tr>
<td>February 13-17</td>
<td><strong>In Class Activities</strong>&lt;br&gt;Systems Maps, Systems Dynamics, Rich Pictures, Problem Jostle, Syntegration, Impact Hypothesis, Into to Simulation</td>
</tr>
<tr>
<td>February 20</td>
<td><strong>Assignment 1 (Individual)</strong>&lt;br&gt;Impact Hypothesis diagram and graph</td>
</tr>
<tr>
<td>February 20 - 24</td>
<td><strong>In Class Activities</strong>&lt;br&gt;Human population model lab, Competitive Co-existence model lab, GSS lab, Transportation &amp; Dispersal, World Café</td>
</tr>
<tr>
<td>February 26</td>
<td><strong>Assignment 2 (Team)</strong>&lt;br&gt;Simulation Models</td>
</tr>
<tr>
<td>Feb 27 – Mar 2</td>
<td><strong>In Class Activities</strong>&lt;br&gt;Viable Systems Model, Soft Systems Methodology, Panarchy</td>
</tr>
<tr>
<td>March 2</td>
<td><strong>Assignment 3 (Team)</strong>&lt;br&gt;Choosing an Approach Presentation</td>
</tr>
<tr>
<td>March 11</td>
<td><strong>Assignment 4 (Team)</strong>&lt;br&gt;GSS - Evaluating Liveable Scenarios</td>
</tr>
<tr>
<td>April 1</td>
<td><strong>Assignment 5 (Individual)</strong>&lt;br&gt;Sustainability; a Complex Systems Issue</td>
</tr>
</tbody>
</table>

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**Learning Outcomes**

The Learning Outcomes for this course are articulated based on the MA/MSc in Environmental Management (MEM) program Core Competencies as posted on the program website. Since these are generalized outcomes, the criteria are described here in a manner that is directly applicable to this course.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2. Knowledge</strong></td>
<td></td>
</tr>
<tr>
<td>2.9 Demonstrates an understanding of basic concepts in the field of systems studies as these are relevant to linked biological and socioeconomic systems.</td>
<td>Identifies the concerns and insights that gave rise to the emergence of systems studies and the relevance of these to the field of environmental management. Evidences understanding of key terms and concepts from the field of systems studies as these are relevant to the understanding and management of ecological, social and institutional systems.</td>
</tr>
<tr>
<td>2.10 Applies an understanding of selected systems methods to various systems management concerns.</td>
<td>Develops adequate awareness of and competence in a selection of systems methods so that s/he is able to select an appropriate method for investigation and management of different types of environmental management issues, problems or projects in various institutional contexts. Indicates an awareness of the benefits and limitations of using various systems methods as well as the consequences of not using them.</td>
</tr>
<tr>
<td><strong>3. Leadership and Teamwork</strong></td>
<td></td>
</tr>
<tr>
<td>3.1 Facilitates effective teamwork</td>
<td>Explicitly and critically evaluates relevant assigned or available information, evidence and argument for reliability and authority. Selects, collects, analyzes and interprets relevant scientific, social and economic data. Presents perspectives in a way that is sympathetic to the intentions of the source. Assesses the consequences of implementation of proposed actions or inaction at various scales and in various domains of concern, and considers the implications to sustainability. Recognizes and takes into account sources of uncertainty when drawing inferences and reaching conclusions. Searches for, identifies and challenges implicit assumptions in own, peer or professional opinion.</td>
</tr>
<tr>
<td><strong>4. Critical Thinking</strong></td>
<td></td>
</tr>
<tr>
<td>4.1 Applies critical thinking to the integration of knowledge and practice</td>
<td>Explicitly and critically evaluates relevant assigned or available information, evidence and argument for reliability and authority. Selects, collects, analyzes and interprets relevant scientific, social and economic data.</td>
</tr>
</tbody>
</table>
Presents perspectives in a way that is sympathetic to the intentions of the source
Assesses the consequences of implementation of proposed actions or inaction at various scales and in various domains of concern, and considers the implications to sustainability
Recognizes and takes into account sources of uncertainty when drawing inferences and reaching conclusions. Searches for, identifies and challenges implicit assumptions in own, peer or professional opinion

5. Global Awareness

5.2 Demonstrates how a global issue can be reflected in local events and how local action can impact on global events

Determines the scale at which issues are distinguished and the scales at which the actions to address them would have to be undertaken in order to be effective and sustainable.
Projects the implications of various actions and non-action for both the biosphere and human society at various spatial and temporal scales.

Assessment Matrix

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Due date</th>
<th>2.9</th>
<th>2.10</th>
<th>3.1</th>
<th>4.1</th>
<th>5.2</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Impact Hypothesis (Individual)</td>
<td>Feb 20</td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>2. Simulation Models (Team)</td>
<td>Feb 26</td>
<td>5</td>
<td></td>
<td>5</td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>3. Choosing an Approach (Team)</td>
<td>Mar 2</td>
<td>5</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>5. Sustainability: a Complex Systems Issue (Individual)</td>
<td>Apr 1</td>
<td>10</td>
<td>15</td>
<td>10</td>
<td>15</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td></td>
<td>15</td>
<td>20</td>
<td>15</td>
<td>25</td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>
Program Policies

Evaluation Descriptions

http://www.royalroads.ca/about-rru/governance/academic-regulations/grading-policy0805.htm

The specific letter grades that will be assigned during summative assessment of each competency and that are combined to become an overall grade for a course are:

<table>
<thead>
<tr>
<th>Letter Grade</th>
<th>Percentage</th>
<th>Grade Point</th>
<th>Specific Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+</td>
<td>90-100</td>
<td>4.33</td>
<td>Learner consistently meets and has 2 or 3 significant instances of exceeding all A-level assessment criteria specified for the competency and learning outcomes.</td>
</tr>
<tr>
<td>A</td>
<td>85-89</td>
<td>4.0</td>
<td>Learner consistently meets all A-level assessment criteria specified for the competency and learning outcomes.</td>
</tr>
<tr>
<td>A-</td>
<td>80-84</td>
<td>3.67</td>
<td>Learner meets all A level assessment criteria specified for the competency and learning outcomes with 2 or 3 minor instances of not doing so.</td>
</tr>
<tr>
<td>B+</td>
<td>77-79</td>
<td>3.33</td>
<td>Learner consistently meets and has 2 or 3 significant instances of exceeding all B-level assessment criteria specified for the competency and learning outcomes.</td>
</tr>
<tr>
<td>B</td>
<td>73-76</td>
<td>3.0</td>
<td>Learner consistently meets all B-level assessment criteria specified for the competency and learning outcomes.</td>
</tr>
<tr>
<td>B-</td>
<td>70-72</td>
<td>2.67</td>
<td>Learner meets all B level assessment criteria specified for the competency and learning outcomes with 2 or 3 minor instances of not doing so.</td>
</tr>
<tr>
<td>F</td>
<td>0-69</td>
<td>0.0</td>
<td>Learner meets some but not all B level assessment criteria specified for the competency and learning outcomes with 2 or 3 major instances of not doing so; OR Learner has not provided sufficient and/or sufficiently timely evidence to enable a determination as to whether all B level assessment criteria specified for the competency and learning outcomes have been met.</td>
</tr>
</tbody>
</table>

Late Policy

Course assignments should be submitted no later than ten working days after the assignment due date. Assignments received later than ten working days after the due date will not normally be accepted and will be given an “INC” (Incomplete) grade. A penalty of 5% per day will normally be applied to assignments submitted after the due date, leading to a maximum late penalty of 50%. Learners who fail to meet the assignment requirements of a course will be assigned a final grade of ‘Incomplete’ (INC) and will normally be expected to acquire the course credits through re-enrollment in order to satisfy the course requirements for the program. Learners wishing an extension for individual assignments should approach the instructor in the first instance. Extensions will only be granted under exceptional circumstances. Instructors will normally consider any application for an extension on a case-by-case basis.

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INC Clearance Policy
INC is a temporary grade that is assigned when the required course work has not been completed by the course end date or to the satisfaction of the instructor. This is used only when a student's performance has been satisfactory and successful completion of the remaining assignments or final examination would enable the student to pass. A maximum grade achievable on completion of the requirements is a “D” for undergraduate and a “B-” for graduate courses. To cover additional grading costs, students will be assessed a fee in accordance with the University’s approved ancillary fees. If the outstanding course work is not completed satisfactorily within 20 working days of the course end date, a student will automatically receive a grade of F.
If the learner fails to clear an INC or series of INCs, they may be required to withdraw from the MEM Program, at the discretion of the MEM Program Head.

Grade Appeals
A student may appeal the final grade for a course if there are grounds to believe that:
- Evaluation criteria for the course were changed from those articulated;
- Evaluation standards are substantially unreasonable or different from those applied to other students; or,
- Evaluation was determined on some basis other than performance.

For complete academic regulations governing the grade appeal process, see http://myrru.royalroads.ca/learners/learner-services/section-5-grade-appeal-process

Plagiarism
Plagiarism is the act of presenting the ideas or works of another as one’s own. This applies to all materials, electronic or in print, including essays, work term reports or assignments, laboratory reports, seminar presentations, computer programs, research projects and results, postings in discussion groups, and statistical data. The use of such material either directly or indirectly without proper acknowledgement (e.g. footnotes or endnotes, URL) is contrary to the norms of academic behaviour. For further information see Policy on Integrity and Misconduct in Research and Scholarship.

For complete Academic Regulations see:
http://myrru.royalroads.ca/learners/learner-services/policies-and-procedures