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Guidelines for Sustainable Development Curriculum

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Abstract

This document describes the topical areas that will be developed into curricula about sustainable development using qualitative reasoning. These areas include:

1. sustainable development concepts
2. Linkages between ecosystem services and human well-being
3. How sustainability is implemented in different case study regions.

We describe different possible scenarios about how we envision users interacting with the qualitative reasoning content on the NaturNet-Redime web portal. These case models describe interactions between learners based on different kinds of learners (single users or in groups) and different learner goals (general education or case-specific needs).

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1 Introduction

The objective of this document is to:

> Develop a set of guidelines to structure web-based curricula about the use of qualitative models to explore sustainable-development issues, considering possible tie-ins with existing Sustainable Development tools identified in WP1 [Evaluation of Existing Projects and Data] and by the Commission. This Task will thus define the structure of the actual curriculum (Task 6.10 [Curriculum for Learning about Sustainable Development]) and development of content (Tasks 6.2 – 6.6 [which describe several case studies]).[2]

As specified in the Technical Annex, this involved developing a plan about what content should be created within Task 6.10. Hence, this document defines a range of sustainable-development issues that users of the NaturNet-Redime web portal will be able to explore and learn about in depth. The actual creation of this content happens as part of Task 6.10 as well as Tasks 6.2 – 6.6.

1.1 What is Sustainable Development?

Sustainable development (SD) is composed of two concepts: development and sustainability.

Development is the conversion of raw materials into goods and services.
Sustainability implies that development can continue indefinitely into the future.

Taking these two concepts together, *sustainable development* has been further defined as, "a real increase in well-being and standard of life for the average person that can be maintained over the long-term without degrading the environment or compromising the ability of future generations to meet their own needs."[3]

Based on this definition, a curriculum to teach about SD should focus on the following aspects:

1. increase in well-being and standard of life for the average person;
2. environmental health;
3. long-term maintenance of this balance and keeping options open for the future.

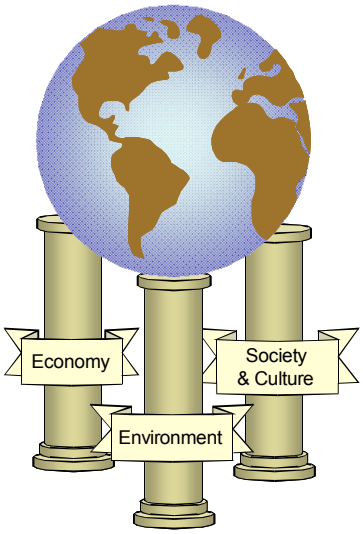
Each of these three concepts requires further elaboration. What factors contribute to the increase in well-being and standard of life for the average person? How does one weigh the importance of well-being of the not only the 'average person' but also of the poor and the wealthy? Just what is 'environmental health'? What processes are important to consider? How do we evaluate long-term sustainability? How open should options be left for the future?

Some of these questions can be answered using simulations and others are valuable points for each of us to consider in making our own decisions as citizens, stakeholders, and consumers. The Curriculum for Learning about Sustainable Development will consider both categories by encouraging learners to consider the effects of different actions on economic, social, and environmental systems. The actions are based on values but the effects are based on our knowledge of cause and effect that is encapsulated in the QR models that drive our Learning Environment.

[2] NaturNet-Redime Technical Annex to the Contract.
[3] William P. Cunningham and Mary Ann Cunningham. *Principles of Environmental Science*. McGraw-Hill online: http://highered.mcgraw-hill.com/sites/0072452706/student_view0/glossary.html. (accessed 6 July 2005).

2 Issues to explore

The European Commission has identified 'three pillars' of sustainable development: the economy, the environment, and society and culture:



We will develop content around each of these pillars as well as content that integrates the pillars together. The approach we will use involves exploration and development of qualitative models of systems that represent specific SD issues, situations, or problems. Understanding SD involves a variety of scales – from local to global – and perspectives – from individual citizens to industry to government, in both developing and developed countries.

In order to assess a wide variety of these scales and perspectives, we will elaborate on the three pillars in models and curricula based on key concepts extracted from:

1. Millennium Ecosystem Assessment,
2. Case studies of real systems, and
3. SD problems of particular relevance to the EU (Considering input from WP1).

The Millennium Ecosystem Assessment clarifies how human well-being is related to services provided by Earth's ecosystems, and in so doing clarifies that SD is not just a luxury of wealthy nations but is essential for every person on the planet. Because of the close connection between the MEA and the three pillars of SD, we will extract the main SD issues to be developed into curricula from the MEA (section 3). These issues will be further developed and linked together to explore their interaction in real systems via five case studies (section 4). The main issues will also be further developed to teach about various SD problems of particular relevance to the EU, based on input from WP1, which will identify SD issues and tools that EC has emphasized or supported. Based on the report provided by WP1 (Deliverable 1.2), we will identify issues or projects where a QR approach to teaching would be appropriate.

3 Millennium Ecosystem Assessment

In the Millenium Declaration of 2000, the United Nations established eight Millenium Development Goals (MDG):

1. reduce poverty and hunger
2. universalize primary education
3. equalize opportunity for women
4. reduce mother mortality
5. reduce child mortality
6. reduce diseases like malaria, tuberculosis, HIV/AIDS, etc.

7. environmental sustainability
8. establish and foster global partnerships for development.

Specific aspects of these are further detailed into different indicators and issues. Most of these goals are related to economic and social development in developing countries. For the European Union, however, many of these goals have already been achieved, but this progress is not being supported by sustainable strategies. Hence, the focus should be on MDG 7, environmental sustainability, to address the SD goals where Europe still has progress to make. In creating the Strategy for Sustainable Development, the EU took an important step in recognizing the need to use the environment sustainably.

At the same time that the MDG were identified, the UN initiated the Millennium Ecosystem Assessment (MEA), "the most comprehensive inventory of the Earth's ecosystem services to date."[4] The Statement from the Board of the MEA[5] clearly points out the link between human well-being and the ability of the Earth's ecosystems to provide services. This main idea is made explicit in a variety of figures and text that explain the linkages between specific ecosystem services and specific aspects of human well-being. It is these linkages that we intend to implement into QR models and curricula. Development of these models and curricula will be aided by details provided in various MEA Synthesis Reports (available starting June 2005). However, the main ideas are contained in the Statement from the Board itself, which contains some very good figures to convey these linkages qualitatively. We will expand on these basic ideas by creating causal, QR models of the processes involved.

One of the main sources that we will build from is shown in figure 1.

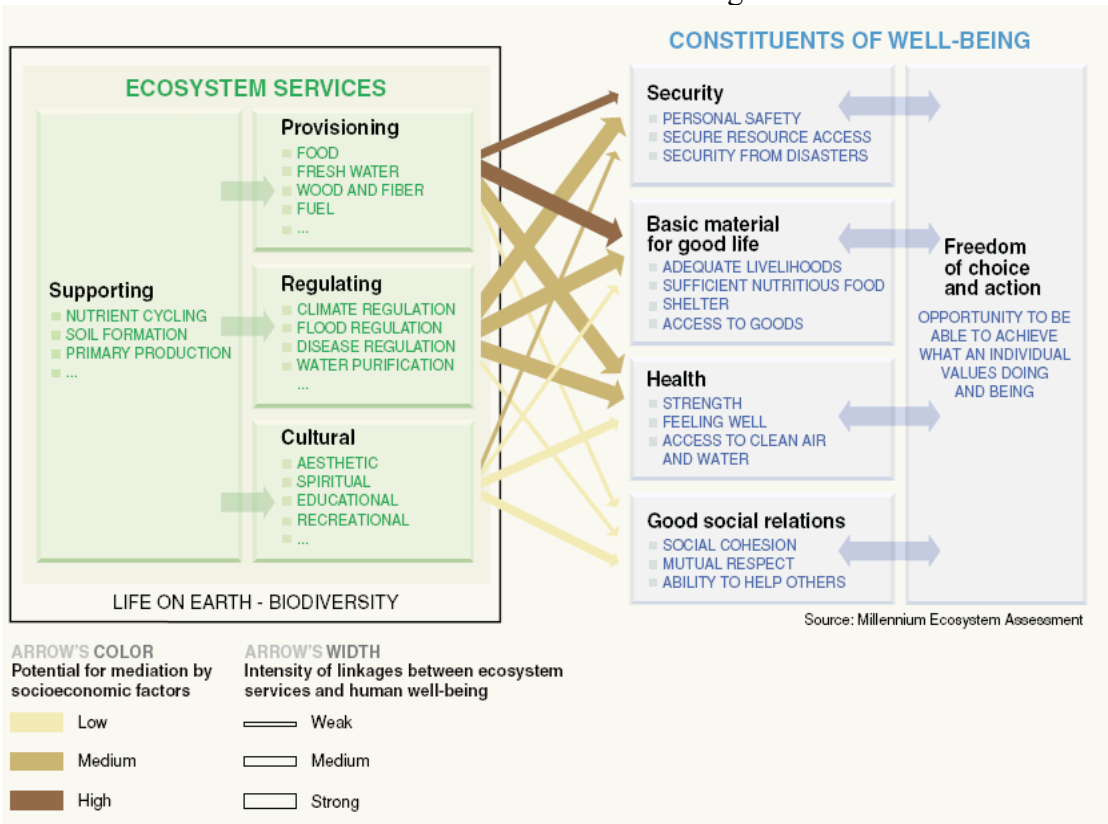


Figure 1. Human well-being depends on services provided by Earth's ecosystems[6]

[4] Gewin, V. 2005. Dispatches: Millennium Assessment means business. *Frontiers in Ecology and the Environment* 3: 180.
[5] Millenium Ecosystem Assessment Board. 2005. *Living Beyond Our Means: Natural Assets and Human Well-being*. Pre-publication Draft.
[6] Ibid, page 4.

Figure 1 shows many linkages between ecosystem services and human well-being. There are many causal processes conveyed in this figure. These can be translated into words as in the following examples:

- Primary production, a 'supporting' ecosystem service, is strongly linked (thick green arrow) to aesthetic cultural values. These values are linked (with medium strength: medium-sized arrow) to good social relations, for example by providing pleasant parks to relax in. This effect has a low potential (the arrow is yellow) to be mediated by socioeconomic factors, compared to other factors that affect social relations. Good social relations have are strongly linked (thick, blue arrow) to freedom of choice and action, and this freedom in turn supports good social relations (the arrow goes both ways).

- Nutrient cycling, a 'supporting' ecosystem service, is strongly linked (thick green arrow) to provisioning of food. Food is strongly linked (thick arrow) to human health, aspects of which include strength and feeling well. This linkage has a medium potential (the arrow is light brown) to be mediated by socioeconomic factors (the figure doesn't show these, but we will incorporate them). Health is strongly linked (thick, blue arrow) to freedom of choice and action, which in turn has a strong effect (arrow goes both ways) on health, particularly feeling well.

Missing from figure 1 are important details about exactly *how* these ecosystem services affect human well-being. In what way is primary production linked to aesthetic cultural values? Is the effect positive or negative? How do disturbances to primary production interact with other factors to affect aspects of well-being?

In a preliminary assessment of the utility of the MEA Board Statement in conveying the basic linkages between ecosystem services and human well-being, university students (primarily first-year undergraduate biology majors) were asked read the MEA Board Statement and write a two-page essay about how the rising human population is likely to affect human-well being. Students were asked to consider especially the diagram shown in figure 1 in their essays. The following quotations from these essays show that the MEA document provides a powerful tool for conveying important concepts related to SD (minor editorial errors have been corrected):

> "Provisioning and regulation of our natural resources is essential to our security, materials for good life and health. Without food, fresh water, wood, fiber, fuel … we are not capable of creating a 'freedom of choice and action' situation like the figure on page 4 of the MA document shows. Biodiversity [sic, the student probably meant 'ecosystem services'] is absolutely essential to our well being."

> "[The authors] explain how the provision of food, fresh water, energy, and materials used for a growing population has come at cost of the complex systems of plants, animals and biological processes that make the planet habitable…This group insists that the only way to stop further weakening of the natural systems is to give humans the chance to learn to appreciate the true value of nature and therefore allow them to make a personal choice in whether they will contribute to the maintenance of a healthy ecosystem."

> "…It has come clear to me that there is going to be a day when this world won't be able to supply all humans with the basic necessities to live. Many factors lead into humans' necessities here on earth such as the air we breathe and the medicines that nature provides us with…With the exponential growth of

> humans, there will be an increasing demand for those natural necessities for everyone to have a chance of a fruitful life here on Earth."
>
> "The figure…shows that ecosystem services contribute to the well-being of humans. As long as humans have the basic necessities that the chart has outlined…[examples listed]…, then the well-being of humans will allow them the opportunity to achieve whatever they feel like achieving…The figure on page four demonstrates what a perfect ecosystem would do for the human's well-being."

These extracts from the students' essays are telling in a number of ways. First, figure 1 appears to be very effective at conveying the basic idea that ecosystem services are important in many ways to human well-being. However, there remains some basic misunderstanding. For example, in the first example, the student appears not to understand the difference between "biodiversity" and "ecosystem services". Over-generalizing new information and applying terms overly widely seems to be a common mistake among students. Another insight is that there is a tendency to see only the gloom and doom and fail to see the options for improvement that the linkages in the figure attempt to convey. Finally, the last example illustrates that the nature of the causal linkages is not always understood completely. This student does not realize that the linkages exist even if the ecosystem is not "perfect"—provisioning of food, for example, has positive effects on health if the ecosystem is providing this service in a desirable fashion, whereas it has negative effects if the ecosystem is not providing this service in a desirable fashion.

3.1 SD content for web portal developed from MEA

Our QR curriculum will help provide a fuller understanding of causality in the linkages between ecosystem service and human well-being. All pathways through figure 1 will be incorporated into the web portal as interactive links that will lead learners to QR models that teach about specific concepts when they click on one of the arrows or quantities (e.g., "food") in the figure.

Thus, the work of creating this curriculum will largely entail identifying pathways through figure 1 and creating QR models that describe their causality. Not all of the information necessary for these models is actually contained in the figure. Some of the linkages shown in figure 1 are expanded on in other MEA documents[7]. We will further expand on this information by clarifying the causality of the linkages. Learners should be able to see not only *that* certain ecosystem services are linked to human well-being, but also will understand *how* and *why* these linkages function the way they do.

4 Case studies of real systems

The case studies selected are based mainly on riverine systems and catchment areas. These allow in-depth exploration of a wide range of sustainable development problems not only for the European Union, but also internationally. Also, focusing on a particular category of ecosystem allows progressive development of content that builds on itself, which is advantageous not only for the project partners developing the content, but also for learners, whose knowledge will be reinforced by revisiting familiar topics from several related case studies.

The first two case studies to be developed will focus mainly on ecological and environmental processes and later case studies will progressively add integration with social and economic issues. The specific case studies serve as examples that can later be modified to fit other types of systems because many SD problems share the same basic foundations.

[7] See especially pages 100-103 of *Millennium Ecosystem Assessment Synthesis Report*, Pre-publication Final Draft Approved by MA Board on March 23, 2005.

4.1 Task 6.2 Basis QR case study: Danube Delta Biosphere Reserve, Romania

Develop learning materials (models) for the NaturNet-Redime QR sub-portal, focusing on physical, chemical, and biological processes in Danube Delta Biosphere Reserve, including:

- Aquatic ecosystem morphological changes under global warming – its effect on biotic component development;
- Eutrophication and water pollution processes – indicated through aquatic organism composition evolution;
- Water status – implementation of Water Framework Directive (WFD) concerning surface and groundwater protection.

4.2 Task 6.3 Basis QR case study: River Mesta, Southwest Bulgaria

Develop learning materials (models) for the NaturNet-Redime QR sub-portal, focusing on physical and chemical processes, biodiversity, population biology, and community ecology by integrating available long-term data on the river Mesta for:

- Understanding and forecasting effects of organic pollution and other urban and/or industrial pollution on abiotic and biotic structures of the ecosystem;
- Understanding and forecasting impacts to biodiversity and stream ecosystem structures and functioning, such as phytobenthos, zoobenthos, and fish populations as basic biological quality elements;
- Improvement of the river basin planning to support integrated ecological status management as demanded by the modern EU legislation such as WFD 2000/60/EC.

4.3 Task 6.4 Bridging QR case study: Riacho Fundo, Brazil (UnB responsible)

Develop learning materials (models) for the NaturNet-Redime QR sub-portal, focusing effects of deforestation, erosion, water pollution, and the creation of urban areas in the Riacho Fundo in the Paranoa Lake basin, Brasilia, Brazil on:

- biological populations and communities, biodiversity, habitats, and ecosystems;
- social, economic, and cultural processes and values;
- integrated management to meet sustainable development objectives.

4.4 Task 6.5 Collaborative QR case study: River Restoration in Austria (BOKU responsible)

Develop learning materials (models) for the NaturNet-Redime QR sub-portal, focusing on ecosystem, social, economic, and cultural processes and integrated management related to restoration of rivers and catchment planning in Austria. The model will be developed for a larger river restoration case study (e.g., river Kamp) and will:

- Give insights in the main driving forces of the riverine ecosystem;
- Provide understanding of the mechanisms underlying the restoration actions;
- Enable users to create restoration scenarios by selecting different combinations of restoration actions;
- Give feedback to users to which extend ecological, economic and social objectives are achieved.

4.5 Task 6.6 Collaborative QR case study: River Trent and Yorkshire River Ouse, England (UoH responsible)

Develop learning materials (models) for the NaturNet-Redime QR sub-portal, focusing on ecosystem, social, economic, and cultural processes and integrated management of two

contrasting rivers in England, the rivers Trent and Ouse, which suffer from different degrees of water quality, flow regulation and habitat degradation problems.

A primary focus will be promoting understanding of the need to find balance between societal, statutory and ecological imperatives in compliance with the Water Framework Directive and the Strategy for Sustainable Development. Thus, we will:

- Integrate model segments developed by other partners in the Integrated Library of Reusable QR Model Fragments to provide catchment management scenarios for sustainable development of rivers
- Account for social (risk analysis) as well as economic arguments for the various actions to ensure the most cost effective and socially acceptable methods of improving ecological status of the rivers
- Compare qualitative reasoning modelling outputs with those produced by traditional scientific methods of quantitative sampling of the biota
- Develop learning curricula for using the QR-tools and libraries by end-users and thus to support river basin planning and management.

5 Learner Interaction with the QR content on the NaturNet-Redime web portal

We envision that people will find out about the NaturNet-Redime web portal through one of the following paths:

- A web search on key words ‘sustainable development’ (or equivalent in other languages, eventually);
- Referral from someone they know;
- Link from other web site (e.g., other EC projects, educational sites, etc.);
- A web search on key words describing one of case studies.

Hence, we anticipate that learners will differ in their primary reason for being interesting in the QR content on the web portal:

1. Those interested in issues surrounding sustainable development or the environment; or
2. Those interested specifically in one of the case study systems.

This difference is important because learners in the first category are more likely to be interested in learning concepts and perhaps their application to case studies, whereas learners in the second category may not be interested in sustainable development per se but are mainly interested in learning about the issues relevant to whatever case study they are interested in. They are therefore likely to want to skip all the basic content and jump right to the case study, where they will learn about sustainable development within the specific context of the case study.

5.1 Organization of QR sub-portal

On the NaturNet-Redime web portal, the learner reads some basic ‘home page’ information about SD, which may include the definition cited in Section 1.1. We envision there being several buttons on the Naturnet-Redime web portal leading to different content areas, including ‘k-learning’, GIS-based content, and QR-based content. The button leading to the QR content looks something like this:

Learn about Cause-Effect processes affecting Sustainable Development

This button is linked to the NaturNet-Redime web portal's QR content home page (the QR sub-portal). This page displays some background information about the content contained in the sub-portal, like:

Welcome to the NaturNet-Redime QR sub-portal!

Here, you have the opportunity to learn about cause and effect processes affecting sustainable development.

Where would you like to start?

Learn about basic concepts of SD

Learn how ecosystem services affect human well-being

Explore case studies of SD in different regions

Build your own QR model

Each of these buttons leads the learner through different curricula on sustainable development.

Learn about basic concepts of SD
This button leads to a page that explains the three pillars of SD and offers the choice of exploring content from one of the three pillars (see section 2). Each of the three choices will give a pop-out menu of concepts to explore when the cursor hovers over it. Models in this section will be simplified versions of some of the ecosystem services / human well-being models contained in that curriculum.

Learn how ecosystem services affect human well-being
This button causes the figure from the MEA (see section 2.1) to be displayed, but without the arrows (or they are subdued). When the learner moves the mouse over one of the categories in the "Ecosystem Services" column, the arrows will appear (or become highlighted) showing "Constituents of Well-being" that are affected. Conversely, when the learner moves the mouse over one of the categories in "Constituents of Well-being", the arrows will appear showing which "Ecosystem Services" affect it. When the learner clicks on one of the categories, he or she will be directed to a QR content curriculum that seeks to educate about the causality of the arrows.

Explore case studies of SD in different regions
If the learner selects this option, the browser will lead to a menu of the available case studies, each with a short description and thumbnail map of the location on the globe. As case studies are added, they might be grouped by geographic area, focal topic, etc.

Build your own QR model
This option allows users to create their own QR models of SD scenarios to meet specialized learning needs. The full functionality of this portion of the QR sub-portal will not be available until the Library of Re-usable QR Model Fragments is completed. This option will facilitate the re-use of model parts into unique scenarios put together by the user. It will also facilitate modifying these model parts for further customization. Content will be indexed and organized

hierarchically, to facilitate identification of relevant processes to include in a model. For example, menu choices are listed below, and clicking on the option in bold opens up sub-menus:

*{**water**, forests, deserts}*
*{pollution, health, **uses of water**}*
*{supply, **irrigation**, sewage, fisheries}*
{farm runoff, instream flow regulation, mineralization, erosion}

This content will be organized using a hyperbolic tree or similar construct. This type of hierarchical organization has the advantage of being able to simultaneously depict the complexity of the whole system while focusing attention only on what the user is currently interested in. This is accomplished by enlarging the content of interest (as determined by cursor position or clicks) and reducing the rest of the content in size but keeping it visible. An adaptation is necessary, however, because our content is not strictly hierarchical—there are multiple links between higher and lower levels of organization, so it is more web-like than tree-like in structure.

5.2 Case Models – examples of users interacting with models

To guide the development of the SD curriculum, we describe several case models (not the same as 'case studies'). Case models are useful tools in software and curriculum development where the developer creates a scenario of a 'typical' learner interaction with the software and curriculum. This scenario is then used to create the software and curriculum.

In addition to the two primary interest (SD or case study), we envision different approaches to teaching content. Learners may explore content in each of the following ways:

1. A single learner explores a model developed by experts,
2. Several users collaborate to explore a model developed by experts,
3. A single user develops his or her own model or models of system behavior based on defined goals, and
4. Several users collaborate to develop their own model or models of system behavior based on defined goals.

Based on these different user options and content interests, we envision specific interactions with specific content on the QR web portal. The first of these case models (section 5.1.1) has more detail about the web portal structure, which serves as a guide for our vision of the 'look and feel' of the web portal that is also valid for the other examples.

Besides the more detailed description of the first example, each case model shares a common structure:

Users: people using software

Scenario: what is the situation, what are important aspects

Stakeholders: people or organization who have a vested interest in the outcome of the SD-related decision or insight (NOT necessarily the Users).

A priori Opinions: who in the SD scenario (stakeholders) has what opinion before use of QR curriculum

Learning needs: what does the USER need to learn (not necessarily what the stakeholders need to learn)

Overall Goal: always the same: SD (see definition in section 1.1) but put in context.

Procedure: way Users address overall goals and their own learning needs using models.
– Multiple steps.

5.2.1 Single user exploring models (general SD interest)

Users: Citizen

Scenario: The citizen develops an interest in learning more about SD issues because of a newspaper article, television program, etc.

Stakeholders: no one specific – depends on issue learner explores

A priori Opinions: citizen is ignorant about concepts of SD

Learning needs: citizen needs/wants to learn fundamentals of SD.

Overall Goal: citizen should learn how three pillars inter-relate in making SD decisions.

Procedure: The learner realizes that he or she has an interest in SD or a related concept (e.g., the environment) and decides to search for information on that subject. Based on a web search, link from another site, or referral from an acquaintance, the learner finds the NaturNet-Redime web portal. The learner is attracted to the large button leading to the QR sub-portal and starts to explore the curricula, starting with "Learn about basic concepts of SD", moving to "Learn how ecosystem service affect human well-being", and finally exploring a few case studies of real systems. After selecting a particular case study, the learner's interaction merges with that of someone interested in a particular case study (see next section). The learner might also play around with building his or her own models.

5.2.2 Single user exploring a model (focusing on case study)

Users: Journalist interested in learning about SD issue.

Scenario: Journalist is covering the SD issues for a continuing newspaper series on SD issues in Riacho Fundo, Brazil.

Stakeholders: Journalist doesn't know – they are specified in the case study.

A priori Opinions: Journalist is ignorant about SD issues in the Riacho Fundo.

Learning needs: Journalist wants to learn about SD issues specific to the Riacho Fundo, and how these relate to SD concepts in general.

Overall Goal: Journalist should be able to write an article explaining the SD issues in the Riacho Fundo.

Procedure: The journalist searches for information pertaining to the Riacho Fundo on the web and finds a link to the case study on the NaturNet-Redime QR web portal. The journalist is presented with a 'home page' for the Riacho Fundo case study, which contains the following background information:

- Where the case study takes place (a map and description);
- What type of system is involved (e.g., a river that flows through a forested landscape with three towns…);
- What the environmental, economic, and social/cultural concerns are;
- Who the main stakeholders are;
- What the objectives of the case study are (e.g., to find a sustainable solution that addresses concerns of all stakeholders).

The journalist is provided the opportunity to start interacting with the model of the case study system.

5.2.3 Collaborative exploration of models (general SD interest)

Users: Students interested in learning about SD issue.

Scenario: Students have to learn about SD as part of secondary education.

Stakeholders: Varies depending on the specific model – students explore several models.

A priori Opinions: Students are ignorant about SD issues.

Learning needs: Students need to learn fundamentals of SD, as well as how these are applied in specific cases.

Overall Goal: Students need to understand how three pillars of SD inter-relate in making SD decisions.

Procedure:

1. Students receive assignment from teacher
2. Students log on to the QR sub-portal, find assignments, write a paper about what they learned.

5.2.4 Single user building a model

Users: Farmer.

Scenario: The farmer wants to increase production of creops so he can make more money. For that he needs water for irrigation.

Stakeholders: Farmer, other users of water.

A priori Opinions: Farmer believes he should have the right to use water any way he wants.

Learning needs: Farmer needs to understand other uses/users of water in the watershed in order to best make his case as well as present a reasonable proposal.

Overall Goal: Convince local water authority to permit more water extraction from river and that it won't cause any environmental damage.

Procedure: Prior to using the QR sub-portal, the farmer fails to convince the water authority to grant the permit because they want him to show that the benefits outweigh the costs (in

economic, social, and environmental terms) of the project. The farmer reads the articles written by the journalist (section 4.1) and decides to use the NaturNet-Redime QR tools to achieve his aims.

The farmer starts by finding related topics under "Learn how ecosystem services affect human well-being" and works through its assignments. Next, the farmer explores some case studies that seem to deal with related problems. In doing so, the farmer learns the basic concepts of SD and about QR approaches to exploring SD problems. For example, the farmer explores models related to food provisioning, water purification, and fresh water. All of these topics are potentially interesting and relevant, so the farmer starts exploring them one by one. Though all of the processes are generally relevant, they are not specific to the farmer's immediate needs for his farm. The farmer wonders how to assess which processes are most important when combined, and how they are related. Each of the assignments mentions that if the presentation of topics is not sufficient to address learning needs, it is possible to build your own model. He realizes that would be a good idea, because he can use the model to show the water authority that he is meeting their requirements. He follows the instructions to learn how to do that. [Details on how to build your own model still need to be developed.]

5.2.5 Collaborative using existing models

Users: Stakeholders

Scenario: In a small town (Littleton) in a poor rural area, a company (Giant Paper) wants to build a paper mill on the banks of the Pretty River.

Stakeholders:
The company
Mayor
Town Council
Nature Group
People who live on the riverside
Restaurant owner in town
Farmers

A priori opinions:
Company wants to build mill to make money.
Mayor thinks will create jobs and raise tax base of town
Town Council is mixed—there are lots of close ties with o there stakeholders
Nature Group thinks paper mill will pollute water and destroy habitat for endangered squiggly snail
People who live on riverside think the mill will destroy property values; they don't want to move away
Restaurant Owner thinks mill will create jobs and bring more customers with money
Farmers think the mill will pollute water and make it so they can't grow crops.

Learning needs:
The company: eco-friendly options.
Mayor: alternatives to meet goals
Town Council: how to weigh needs of stakeholders
Nature Group: possibilities of eco-friendly production and different ways of conserving nature.
People who live on the riverside: other people have needs too

Restaurant owner in town: Pollution might make fish he serves less desirable
Farmers: water conservation techniques, how to clean water

Overall goal: Address concerns of all stakeholders, keeping to principles of SD: increase quality of life without degrading environment
Aspects:
Social: people like small town atmosphere, people are concerned about what kind of people newcomers might be
Economic: jobs, revenue for other businesses, taxes for community
Environmental: water quality, endangered species

Procedure: One night there is a meeting at the Town Hall and the Giant Paper Co. presents plans for their paper mill. There is heated discussion, and the Town Council decides to form a focus group with representatives from each of the stakeholder groups described above. They hope that they can come up with a solution that everyone can accept.

The regional Environment Ministry realizes that this is a SD issue, and recommends using the QR tools on the NaturNet-Redime web portal. Everyone is very relieved that there is a good source for more information to help balance the conflicting opinions and they decide to give it a try.

After becoming familiar with the basic concepts of SD, the members identify relevant content on portal by filling out a questionnaire that is indexed to relevant models. For example, they would pull out models related to water, pollution, agriculture, endangered species, employment, etc. Many of these topics may be contained in a single model, but most likely, several models will need to be investigated.

There is a discussion based on conclusions from the different models. Some of the members bring up alternative options that would also meet many of the goals. For example, one of the Nature Group members suggests an Eco-park could also bring in tourists that would serve many of the same goals by stimulating tourism. These alternatives need to be evaluated with the QR models based on principles of SD.

Based on their interaction with models and discussion, the focus group decides:

1. on a recommendation for the mayor and town council, or
2. to investigate the issue in more depth.

There are different ways to investigate in more depth. One way is to look at a broader set of models from different points of view. One of the prepared case studies might also be useful if it is similar enough to their own situation. Another way to investigate in more depth is to work collaboratively to build a model specific to their system; this would require consultation with an expert.

5.2.6 Collaborative building a model

Users: students along with stakeholders

Scenario: The citizens of Natureland need to decide what is the best use of the large amount of publicly owned, mountainous wildlands in their region. Several options have been proposed: protect for biodiversity and wilderness; conserve for forestry, mining, and

recreation; sell to private timber or mining companies; sell to small land-holders for recreation.

A priori opinions: varied

Learning needs: Students: need to learn principles of SD and how to build models that address SD issues
Stakeholders: need to learn how choice of land use affects SD and how to make the best decision.

Goal: Decide which is the best use of land that meets SD objectives.

Procedure:

1. Students learn about concerns of stakeholders
2. Students go to NaturNet QR portal to learn about all the SD issues
3. Students bring the most relevant models to a town meeting and present issues to stakeholders for feedback
4. Everyone realizes that it is difficult to determine what is the best option without considering how the various issues and processes interact.
5. Students notice that building your own model collaboratively is an activity supported by the QR portal and they decide to proceed with that. [Details on how to build your own model still need to be developed.]

6 Conclusions

Sustainable development may at first appear to be a nebulous and self-contradictory topic, but there currently exists a good foundation for educating the public about its basic concepts and applications in real world situations. The Millennium Ecosystem Assessment provides an excellent basis for educating about the connections between ecosystem services and human well-being, which coincide almost perfectly with the definition of sustainable development. These guidelines will focus the development of curricula that use QR technology to make explicit how the connections actually operate and interact together, both in general and in applied case studies.