

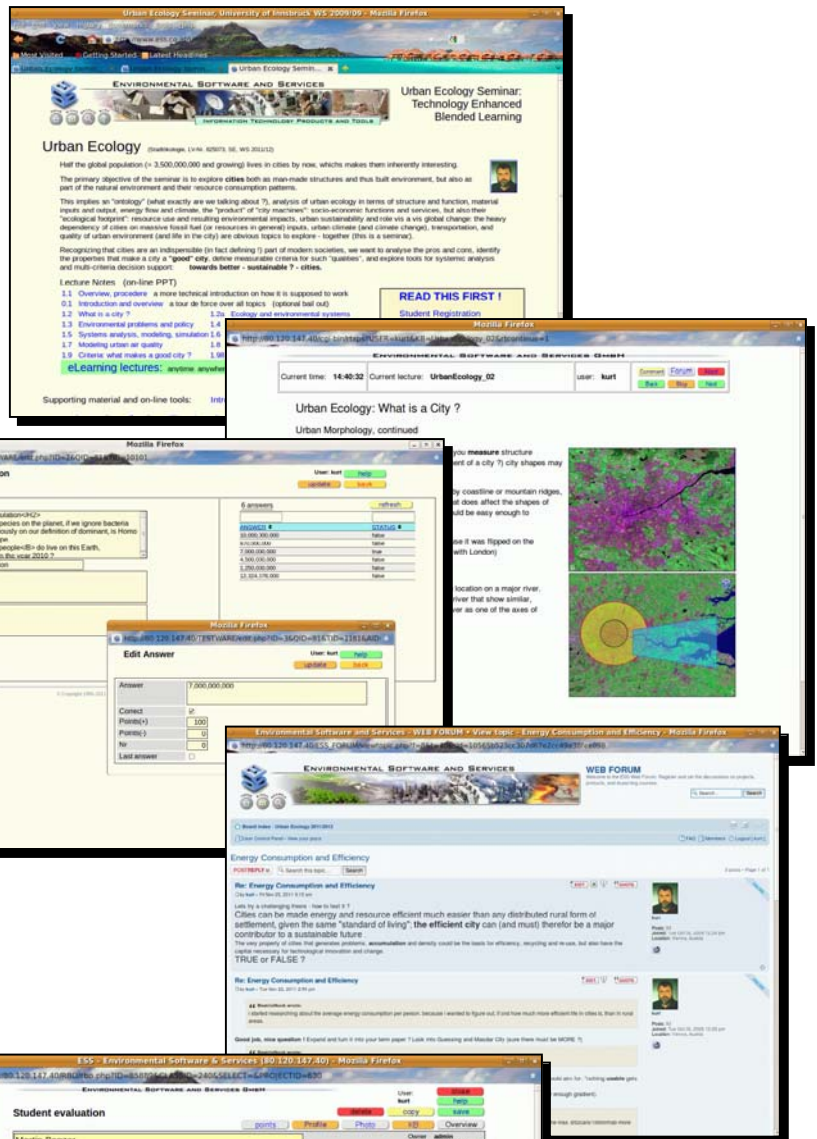
CourseWare: technology enhanced learning

Real-time expert system dialog: web-based eLearning environment

Basic functionality

CourseWare provides flexible, adaptive and "intelligent", intuitive, attractive and fun-to-use learning environments integrating CourseWare integrates key technologies into an innovative eLearning platform: Artificial Intelligence (rule based expert systems) to simulated a personalized tutor; real-time control of the course;

web based interactive lectures, dialog style; and a repertoire of multi-media lecture notes and on-line information resources; and mobile client support; CourseWare provides a complete web-based learning and teaching platform for technology enhanced or blended learning solutions.



<http://www.ess.co.at.CourseWare>

CourseWare components and functionality:

The CourseWare platform and environment includes:

1. [Course and student management tools](#), based on a real-time expert system, including student registration,

verification, and student evaluation and grading (see below), and continuous monitoring and individual dialog between students and tutor;

2. [Course material](#) (lecture notes in different multi-media formats) and auxiliary material such as
 - Supporting lecture notes as on-line presentations (annotated PowerPoint, on-line or for download)
 - PDF document and scientific article library
 - An interactive glossary/ontology, hypertext style;
 - External link collection.
3. [Lectures](#): on-line, interactive lectures (based on a simulated tutor, that controls the lecture presentation depending on dynamic context including simple questions to the student)
4. [Tests](#): embedded and stand-alone tests (multiple choice) with rule-based evaluation, simple individual questions, or complex analytical tasks;
5. [Discussion forum](#): associated dedicated on-line discussion forum, integrated with the lectures
6. Embedded simulation models (simulated laboratory for complex assignments)
7. Embedded problem reporting and comments library, direct access from the lectures
8. Mailing list (members only) with automated, scheduled or event triggered group mailings
9. Course content authoring tools:
 - [Dynamic log files, syntax checking](#)
 - [Multiple-choice test editor](#)

1. Course and Student Management

The management of a course, its students and the lectures that constitute a course, is managed by a rule-based expert system working in real-time, continuously. Access to these functions is through a course specific home page.

o Course Management

Course management is driven by a real-time expert system (forward chaining) that evaluates all data bases relevant for CourseWare once a minute. It updates status-report page, but that summarizes the current state of registered students, logins/visits, progress of lectures taken, basic use statistics etc.

The real-time expert system is configured in terms of RULES and

The screenshot shows a web page for the 'Urban Ecology Seminar, University of Innsbruck WS 2006/07 - Maria Furek'. The page layout includes a top navigation bar, a main content area with a title 'Urban Ecology' and a list of lecture topics (1.1 Overview, 1.2 What is a city?, 1.3 Environmental problems and policy, 1.4 Environmental impact assessment, 1.5 Systems analysis, modeling, simulation, 1.6 Modeling land use change, 1.7 Modeling urban air quality, 1.8 Rational decision making, 1.9 Criteria: what makes a good city?, 1.9.1 Urban planning, 1.9.2 Does it work?), and a sidebar with a 'READ THIS FIRST!' section. The sidebar contains links for 'Student Registration', 'Student evaluation', 'Test results tracking', 'Comments and Questions', 'Discussion Forum', and 'Course Management configuration tool'. The bottom of the page mentions 'Supporting material and on-line tools: Introductory Multiple-choice test'.

ACTIONS triggered by the RULES, which in turn process the entries in the data base and logs (including the external discussion forum) to summarize the current course status.

The RULES can also trigger specific scheduled events such as weekly reminders, or specific, individual messages e.g., based on the number of days inactive for a particular student, encouraging feedback for specific student activities recorded (for details of student evaluation see below), or welcome messages for new registrations etc.

The RULES based real-time monitoring supports a high level of individualized response, and a range of pedagogical models that can be configured with the near-natural language first order production RULES.

- o **Student management** (manually verified by the tutor based on an email triggered the registration), user data base and monitoring of logins; the student registration template leads to; For each student registered, a user account is created to provide access to all the tools related to the CourseWare system.



The student registration includes:

- a basic form to compile the student data; once submitted, a password will be assigned;
- An optional student profile (hypertext and optional image import)
- The user data base (admin access only, where the newly created account gets verified)

- o **Student evaluation:** a ranking page of students sorted by their achievement in the course (Brownie points); each entry leads to a detailed student specific individual evaluation page that indicates all activities that have been considered in the evaluation. These activities are automatically determined (and updated once per minute) by the real-time expert system; While most of the activity data are determined automatically and thus read only, the tutor can also edit "manual bonus points" for specific activities not automatically detected, or quality: while the system can count posts to the discussion forum,



Lecture notes

The on-line interactive hypertext lectures refer, each on their start page, to a parallel set of lectures notes in MS PowerPoint format; these can be browsed on line (slides with annotations) or downloaded for local study.

Access to the PowerPoint lecture notes is password protected, restricted to registered students.

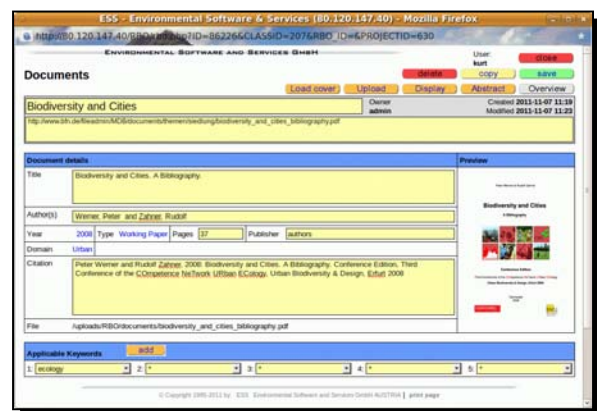
All downloads are logged, and can be made part of the activities relevant to the student evaluation.

As an alternative to the short, but highly structures PowerPoint presentations, lecture notes can also be produced from the HTML files that provide the basic material for the dynamic lectures: these can, following a "standard" path through each lecture, be concatenated into PDF documents for self-study.

Background material

Additional material offered in support of the lecture topics include:

- an on-line PDF library with articles organized by topic, several keywords for easy identification and retrieval, an abstract (HTML), and the possibility to read on-line or download for local (client side) use.
- a GLOSSARY of term and concepts that defines each technical term used in the lectures and support material
- a collection of individual articles (HTML pages, linked from the [course home page](#))
- links to a number of external information resources.



3. Interactive lectures

The interactive lectures consist of a sequence of HTML/multi-medai pages, that are dynamically generated, their sequence determined by RULES based on a student's observed response. The driving engine is a real-time forward chaining, rule-based expert system.

Each lecture is configured in terms of:

- o a sequence of RULES that trigger ACTIONS
- o a set of ACTIONS that defined the content and context of individual units;
- o the basic material of the units, which are individual hypertext (HTML) files, extended by specific tags to insert variable component.

Forward chaining RULES

The RULES basic first-order logic production RULES of the simple generic format:

**IF condition1
AND/OR condition2
THEN ACTION**

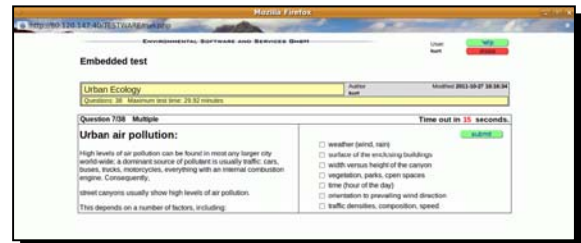
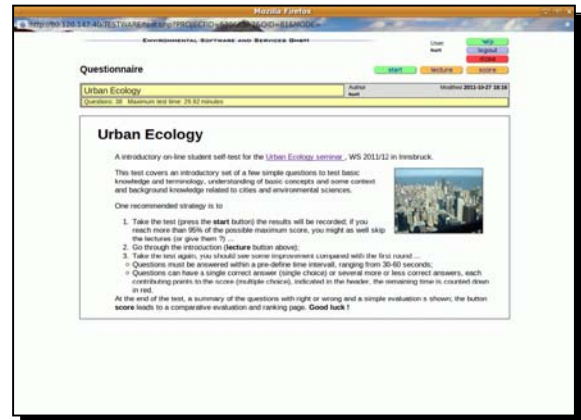
4.Embedded multiple choice tests

Multiple choice tests are an important component in CourseWare;

they can be used as a stand-alone component, at the same logical level as lectures, or they can be embedded into a lecture, conditionally triggered and subsequently evaluated - by RULES.

The primary purpose of the embedded tests is not so much to test the student's factual knowledge, but to maintain a dialog, where the questions can be designed more to test (a) attention or (b) more generic attitudes and beliefs, that can be used to steer the dialog designed for the student to discover concepts rather than rote learn facts.

Tests can consist of one or more questions, and can be run with or without an introductory page. The sequence of questions can be fixed, or randomized. The test shows the current question's sequential number against the total number of question in the test to indicate progress.



Depending on test configuration, at the end of the test an evaluation, question by question, can be shown. Alternatively, a student can go to the overall test results ranking page, find its test results (ranked against all other students results for that test, and display the detailed evaluation.

Questions and answers

For each question, a given amount of time available for the answers is defined. Elapsed (or rather remaining) time counted backward until expired, in which case the next questions is show.

After selecting one or more appropriate answers (ticking the corresponding boxes, the question header indicates whether only one or more answers are applicable), the current set of answers is submitted (green submit button), and the next question is displayed.

The text of the question is plain HTML, and may contain images in any HTML compatible data format.

Evaluation, log and ranking

For each of the answers offered, the test designed can allocate points (positive or negative) that are credited to the student for that question.

Please note that for complete wrong answer large penalties can be assigned. Also, it is possible to assign point to individual answers, but also offer an answer such as "all of the above", or none of the above" where the position of the final choice can be guaranteed at the end of the list, irrespective of a possible random sequence of all other answers.

Question	Answer	Result
1 Biochemistry	marginally lower levels	false
2 Magnetism	20	true
3 Water consumption	500 liters	false
4 Dust	attraction from road traffic	true
5 City population density	25,000 - 50,000	true
6 Urbanization	mainly rural to urban migration	true
7 Street clogging	traffic, densities, congestion, speed	true
8 climate change	carbon tax and CO2 trading	false
9 cooperative games	individual loss minimization	false
10 Environmental movement (EM)	Sierra Spring	true
11 EC Directives	Technological risks, major accidents	true
12 Acronym: HDI	Human Development Index	true
13 Living Systems	maintain certain physicochemical properties constant in a fluctuating environment	true
14 Rio and Agenda 21	1992	true
15 Human population	6,900,000,000	true
16 Population growth rate	1.2%	false
17 exponential growth	10	true
18 Ethiopian GDP	350	true
19 Acronym: EPA	Environmental Protection Agency	true
20 Agenda 21	The Rio Declaration	true
21 Planet Earth	Wallois, 6,370 km	true
22 Air pressure	100 kPa	true
23 Avogadro's number	The number of molecules in one mol of a substance	true
24 Carbon monoxide	incomplete fuel combustion	true
25 Catalytic converter	nitrogen oxides	true
26 Catalytic converter	carbon monoxide	true
27 Concentration	1 liter	true
28 Concentration maximum	Wash height	true
29 Concentration maximum	atmospheric turbulence	true
30 Gaussian model	symmetric, normal distributions	true
31 Groundlevel ozone	on hot, sunny summer days	true
32 molecular diffusion	1 - 10	true
33 Ozone	NOx and VOCs	true
34 Photochemistry	ozone (O3)	true
35 Solar radiation	1,360 W	true
36 steady-state models	constant emissions	true

For any test, answers and the time spent on each question are logged for later evaluation within a lecture. A special function "read-test(TEST_ID)" is used to load these variables in lecture's dynamic knowledge base for processing in the rule-based inference. A common construct is to offer a student to repeat part or all of a lecture, when a subsequent embedded test yielded poor results or failed completely.

5. Discussion forum

Every course can have a dedicated forum assigned at the generic web-based discussion board (an implementation of the widely used, public domain, Open Source phpBB discussion board).

Students register directly at the board (registrations are confirmed by the tutor).

Basic, introductory topics are prepared by the tutor with appropriate welcome messages, and first posts to start off the discussions.

The forum and its topics are integrated with the lectures: individual units that introduce any concepts that are complex and/or controversial include an invitation (and direct link from the body of the lecture) to visit the forum and follow the discussions, browse the topic, create a new topic, or contribute a response to a topic.

Properly registered users receive near instant email notification about new posts to fora and topics they are subscribed to.



Measuring participation

To evaluate activity and contribution to the discussion, the logs and data bases of the discussion forum are analyzed as part of the [student evaluation](#).

The first step monitored in registration at the discussion forum.

CourseWare then monitors and evaluates:

- the number of topics created
- the number of posts;
- the number of replies a given post generates, as an indication of the attractiveness of the topic;
- one or more optional manual bonus points for innovative, well researched, high quality contributions.

The screenshot shows a table titled 'Urban Ecology - Student evaluation'. The table lists 27 students with columns for 'Matrikelnummer', 'Semester', 'Last activity', and 'Points'. The 'Points' column shows scores ranging from 0 to 100. A '27 objects' label is visible on the right side of the table.

Matrikelnummer	Semester	Last activity	Points
013308	WS2011/12	2011-11-26	100
0817070	WS2011/12	2011-11-20	940
0410480	WS2011/12	2011-11-20	100
0412773	WS2011/12	2011-11-24	100
0138401	WS2011/12	2011-11-24	100
1118739	WS2011/12	2011-11-26	80
0715708	WS2011/12	2011-11-29	75
0412046	WS2011/12	2011-11-29	100
0810819	WS2011/12	2011-11-20	75
0110051	WS2011/12	2011-11-20	100
0710081	WS2011/12	2011-11-21	100
0714480	WS2011/12	2011-11-26	100
0418110	WS2011/12	2011-11-26	100
0118629	WS2011/12	2011-11-24	100
0410411	WS2011/12	2011-11-29	100
0817070	WS2011/12	2011-11-20	47
1118739	WS2011/12	2011-11-26	100
0810819	WS2011/12	2011-11-20	100
0418006	WS2011/12	2011-11-27	17
0410010	WS2011/12	2011-11-20	100

6.Embedded simulation models

CourseWare integrates a range of web-based simulation models, that can be used as student assignments, experiments, or a simulated laboratory. Scenarios or model application cases are formulated as part of e lecture, the model being used to find the answer, in analogy to the multiple-choice tests.

CourseWare uses an open client-server architecture and a standard interface through a relational data base engine (RDBMS) and standard SQL.,

Available simulation cover application domains such as:

- air quality , emissions, dispersion
- water resources and quality
- coastal water quality

- land use dynamics
- technological risk assessment.

Major compatible systems that can link CourseWare include:

1. Urban and Industrial Air Quality Assessment and Management (<http://www.ess.co.at/AIRWARE/>) , including emission inventories, monitoring data management and analysis, simulation and optimization models, scenario analysis and real-time modeling and forecasting, public information systems and reporting.
2. Technological and Environmental Risk Analysis (<http://www.ess.co.at/RISK/>) , primarily for the chemical process industry and the transportation of hazardous goods, including internal and external safety reports and emergency management as well as training.
3. Environmental Impact Assessment (EIAxpert, <http://www.ess.co.at/EIA/>) covering all environmental domains including industrial installations and urban and regional development.
4. Water resources management, using the WaterWare (<http://www.ess.co.at/WATERWARE/>) river basin management information system, including multi-criteria optimization of water allocation, economics of use/distribution, investment projects, surface and groundwater pollution control, wastewater management.



Related application domains and model systems include dynamic land use change, regional development, waste management, land reclamation, multi-criteria ranking and benchmarking, site suitability analysis, integrated coastal zone management, vulnerability analysis, computer assisted technical training.

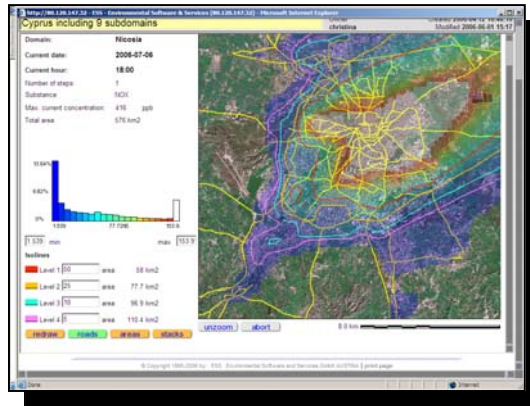
The systems described below are only examples of possible configurations and use of the underlying tools and models, which can be adapted, extended and customized due to their open and modular architecture for any conceivable environmental problem and application.

Detailed information on products and projects is available on-line

<http://www.ess.co.at/>
<http://www.ess.co.at/DEMOS>

Urban and Industrial Air Quality Assessment and Management

(<http://www.ess.co.at/AIRWARE/>) , including emission inventories, real-time monitoring data management and analysis, simulation and optimization models, scenario analysis and real-modeling (now-casting) and forecasting, public information systems and reporting.



time

grid

AirWare includes several state-of-the-art models including 3D non-hydrostatic meteorological model MM5, 3D DWM diagnostic wind field model, 3D nested dynamic photochemical model CAMx, regulatory model AERMOD, dynamic multi-puff model MPUFF for transient (accidental) release scenarios, high-resolution 3D CFD model TIMES. The system is fully web based for easy distributed remote access and use.

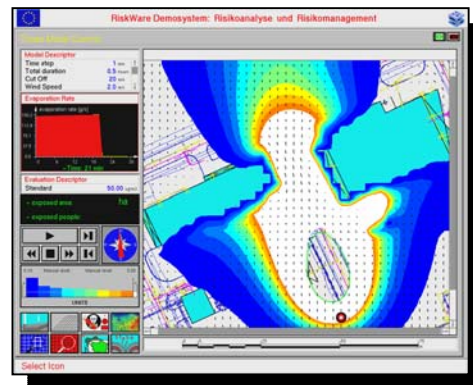
Technological and Environmental Risk Analysis

(<http://www.ess.co.at/RISK/>) , primarily for chemical process industry and the transportation of hazardous goods, including internal and external safety reports and emergency management as well as training.



the

RiskWare includes a set of data bases for hazardous installations from national to local scale, linked to several models for release, evaporation, fire, BLEVE, explosion, atmospheric dispersion, soil contamination, surface and costal water spills and corresponding exposure and impact analysis. Models can be used for scenario analysis, risk assessment (stochastic), and risk management in real-time.

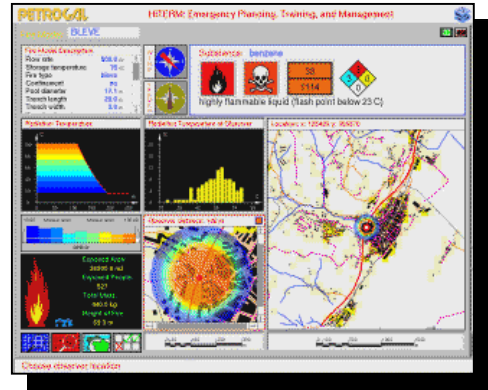


For an overview, see:

<http://www.ess.co.at/RISK/IMAGES/images.html>
<http://www.ess.co.at/EMIS>

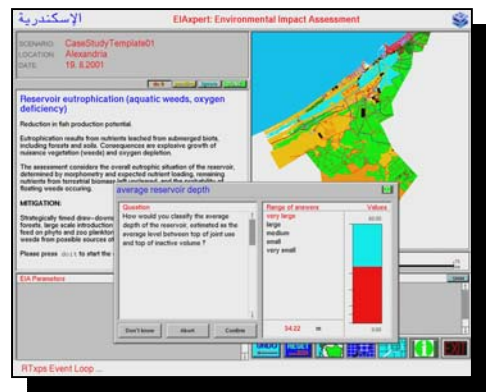
Environmental Impact Assessment

(EIAxpert, <http://www.ess.co.at/EIA>) covering all environmental domains including industrial installations and urban and regional development, originally developed for water resources projects for the Mekong Secretariat, Thailand, then extended to cover all environmental domains and linked with several simulation models for impact computations and the embedded data base and GIS functionality



The underlying rule-based expert system for assessment and estimation is integrated in all ESS data base application to provide default values and for embedded quality assurance (testing completeness, consistency, and plausibility of all user defined or automatically obtained (e.g., sensors) data.

The assessment system uses a set of hierarchical, project specific checklists.



Integrated Water Resources Management

using the WaterWare river basin management information system, including water allocation, economics of use/distribution, surface and groundwater pollution control, wastewater management.

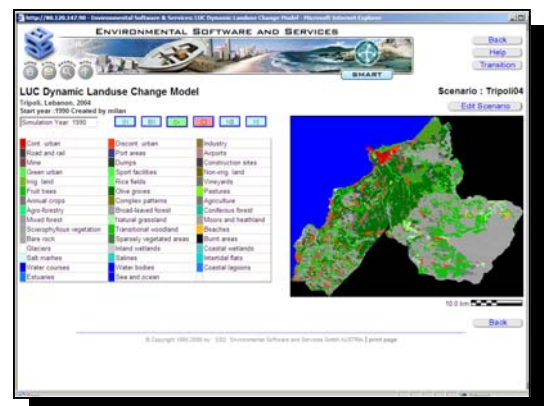
<http://www.ess.co.at/WATERWARE/>

WaterWare integrates dynamic mass budget models driven by prognostic numerical meteorology with economic assessment and multi-criteria optimization for optimal water allocation and efficient use, conjunctive use of surface water, desalination, and groundwater, including water quality and wastewater management, also links to coastal water quality (see also: ICZM).

WaterWare also features a real-time operational control version of the multi-criteria optimization, e.g., for high-efficiency precision irrigation water management.

Dynamic Land use change modeling:

An optional dynamic land use change model to process the LUC data and predict land use change, in particular in the coastal zone. The model uses a basic matrix of transition probabilities (Markov model) that can be controlled by a set of rules that reflect spatial and



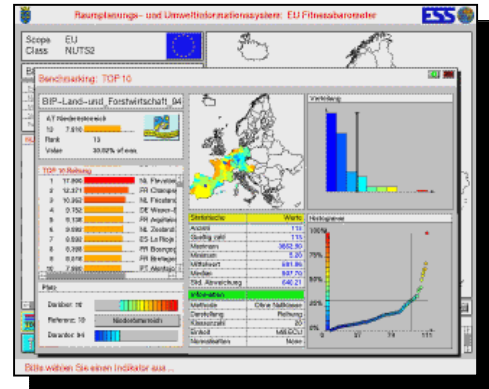
temporal context.

The land use change model was originally developed in the SMART project and applied to several coastal zones around the Mediterranean and the Gulf of Aqaba, Red Sea,

Site suitability Analysis, ranking and benchmarking:

A tool for geo-referenced multi-criteria analysis, used to determine ranking positions of regions across Europe (comparative analysis) and optimal location for specific activities (site suitability).

Development funded by the Province of Lower Austria for its Statistical Bureau and Environmental Divisions.

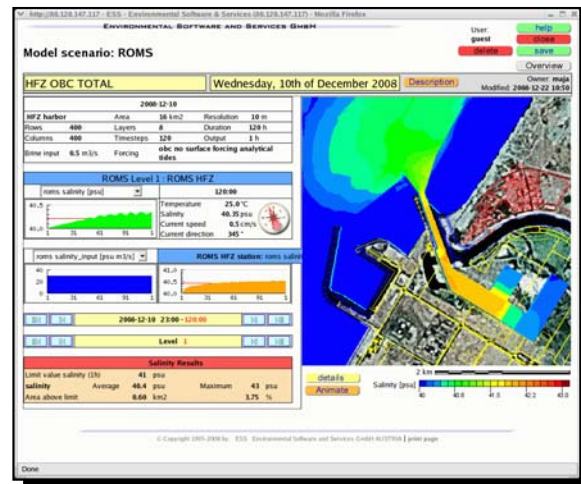


Integrated Coastal Zone Management:

Combination of tools with embedded GIS, EIA expert system, dynamic land use change model, water resources, site suitability, multi-criteria assessment, coastal zone vulnerability, coastal water quality, spill tracking, etc.

Waste outfalls, oil spills, sediment erosion and transport

Pollution from terrestrial or marine sources, including waste outfalls, accidental spills, oil spills, from shipping, harbor operations, off-shore activities using dynamic 3D simulation models such as POM (Princeton Ocean Model) or ROMS (Regional Ocean Modeling System) and similar, coupled to the 3D nested grid prognostic meteorological models MM5 or WRF for high-resolution surface dynamic BC.



Options include scenario analysis, environmental impact assessment (EIA) as well as real-time modeling and forecasting with integrated remote sensing data for emergency management, using numerical weather forecasts over several days (MM5 prognostic meteorological model) for dynamic and distributed wind, temperature and radiation data

7. Authoring tools

To support course content developers, CourseWare currently offers:

- detailed dynamic logs and syntax checking;
- an interactive test editor.

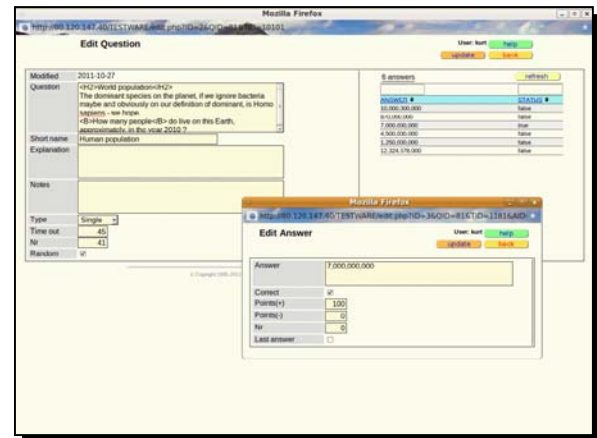
Multiple-choice test editor

The multiple choice tests can be designed and compiled with an interactive, on-line editor. The test consists of:

- an (optional) start page that provides introductory information for larger tests;
- a sequence of questions, for each of which
- a set of answers are defined, together with the score (positive or negative) for selecting any one of these answers.

After defining the test OBJECT (giving it a name, description, and setting any global test parameters such as a fixed or random sequence of questions), a list of questions can be defined and linked to the tests; there is also the option to link questions from other tests in the repertoire. Questions are described in plain HTML, and can include optional imagery. Questions are given a maximum time available to provide an answer. Questions can be defined to offer multiple answers, or only a single, exclusive answer. The answer can again be offered in a fixed, predefined sequence, or randomized. For each of the questions, a set of possible answer to be offered to the students are defined. For each of these answers, we define their status (TRUE or FALSE), and assign points (positive or negative) to each possible selection.

To combine a random sequence of answers with some fixed position (the last answer and thus position, e.g., "all of the above", a "last answer" can also be defined.



Available Courses

- Urban Ecology (currently offered at the University of Innsbruck)

Content available for integration:

- Environmental Geomatic, Water Resources Management, DSS, Air quality assessment and management, Environmental Impact Assessment

<http://www.ess.co.at/CourseWare>