The ATEAM land use change scenarios for Europe

Why this brochure?

This brochure is designed to provide an introduction to the ATEAM land-use scenarios. Its central questions are: 'What is a scenario?' 'What is the function of scenarios?' and 'How are scenarios used in ATEAM?'. It further draws your attention to the SRES scenarios of the Intergovernmental Panel on Climate Change (IPCC), which provide the global driving forces upon which the ATEAM scenarios are based.

What is a scenario?

The word 'scenario' is borrowed from performance theatre where it refers to the sequential elements of a screenplay. However, the concept did not remain exclusively in theatrical circles for very long. Other users in the military, political and scientific spheres, who needed to evaluate future developments under complex and uncertain conditions, soon began to apply it as well. In all of these applications, the term 'scenario' retained its essential meaning: 'scripting the future'.
Scenarios are thus alternative metaphors of how the future might unfold and are nowadays widely used in assessing the medium and long-term consequences of ongoing global environmental change. They are not predictions, to which likelihood can be attached. Rather they describe plausible futures as a function of changes in major *driving forces* (i.e. the main determinants of change in a scenario), such as population growth, economic development or technological change.

What is the function of scenarios?

When we consider the large temporal and spatial scales of global environmental change, scenarios provide an effective means to organise and structure an enormous amount of observational information, model results and personal insights. Scenarios can illustrate insights about future developments (for example, in technology, agriculture or ecology) in both qualitative and quantitative terms. Scenarios are a way *to assess the future, and in so doing they provide an opportunity to anticipate undesirable trends and to devise effective responses by modifying current policies and decision-making*. In other words: scenarios can offer a *bridge* between (environmental) science and policy.

How are scenarios used in ATEAM?

The main socio-economic drivers of environmental change such as population growth, economic and technological development, are global in scope and are inherently unpredictable. Given such uncertainties, future environmental conditions (i.e. the state of the atmosphere, hydrosphere, biosphere, lithosphere and cryosphere) can only roughly be approximated at regional and local scales. Therefore, in order to represent this uncertainty, ATEAM generates multiple scenarios. The ATEAM scenarios use the comprehensive global narratives or storylines developed for the IPCC Special Report on Emission Scenarios (SRES – and see below). These depict qualitatively different future directions in a world without explicit climate change policies. They also provide quantitative estimates (using integrated assessment models) of greenhouse gas and aerosol emissions from energy use, industrial activities and land use. The likely responses of the atmosphere to these emission estimates were described in the IPCC Third Assessment Report (TAR), and regional scenarios for Europe of atmospheric composition, climate change and nitrogen deposition have been developed for ATEAM on the basis of that assessment. All scenarios are quantified for and applied to the geographical area of ATEAM (EU, Switzerland and Norway), serving as input to the ATEAM analysis and synthesis of ecosystem vulnerability.

Developing the ATEAM land use scenarios

SRES provides the foundation for the development of ATEAM land use scenarios. SRES consists of a comprehensive set of narratives that define the local, regional and global socio-economic driving forces of environmental change (e.g. demography, economy, technology, energy, and agriculture – bottom of Figure).
The SRES scenarios are structured in four major 'families' labelled A1, A2, B1 and B2, each of which emphasises a largely different set of social and economic ideals. These ideals are organised along two axes. The vertical axis represents a distinction between more economically (A) and more environmentally (B) orientated futures. The horizontal axis represents the range between more global (1) and more regional developments (2). This can be represented as branches of a two-dimensional tree (Figure) where the two dimensions indicate the relative orientation of the different scenario storylines toward economic or environmental concerns and global or regional development, respectively.

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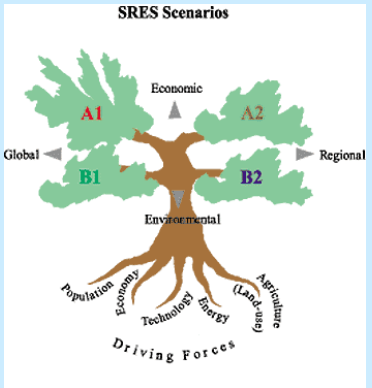
From the point of view of land use, the four scenario narratives define the future demand for energy, food, timber and many other commodities in different regions. The narratives explicate how this demand is met and so define energy use (including biomass as an energy source), trade patterns and intensity, agricultural intensification and extent, and deforestation and reforestation. Given the constraints imposed by the scenario narratives, a high-resolution, heuristic land-use model has been used in ATEAM to calculate the most likely location of the different land use types (agriculture, forestry, urban and nature conservation areas).



How is consistency guaranteed between local, regional and global drivers?

The procedure used for developing the ATEAM land-use scenarios distinguishes three steps. First, the global driving forces (GDF) in the selected scenarios are defined. Here we used the IMAGE 2.2 implementation of SRES (www.rivm.nl/ieweb). Second, the GDF are translated into sector-specific driving forces (SDF) for Europe, based either on an extension and refinement of the storylines or on a quantification of the relative changes in sector-specific driving forces. The final step consists of identifying and evaluating the impact of the SDF on land use, in order to quantify model input parameters or to estimate changes in land use areas directly for each land use type.

The ATEAM land use scenarios for Europe in the 21st century adopt the same notation as SRES, but provide a level of detail not available from the global SRES assessment. Associated with each of the narratives shown on the reverse side is a quantitative, spatially explicit description of the land use pattern under the scenario for the present day (ca. 2000), 2020s, 2050s and 2100s.

Overview of scenarios used in ATEAM

All scenarios cover a time horizon out to 2100.

- *Land use change scenarios*
  Four main land use types are identified: agriculture, forestry, and urban and protected areas. Scenarios for these are described in more detail in this brochure
- *Climate scenarios*
  These include estimates of mean monthly temperature, precipitation, vapour pressure and cloud cover over a 10' x 10' regular grid. The climate scenarios are chosen to embrace a wide range of variability and uncertainty, accounting both for differences between climate model estimates (results from five different general circulation models) and for differences in the scenarios of emissions.
- *Atmospheric composition scenarios*
  Estimates of global CO_2 concentration (CO_2 is well mixed throughout the global atmosphere) under alternative SRES emissions scenarios, taken from the IPCC TAR.
- *Nitrogen deposition scenarios*
  These include gridded values for Europe of wet and dry atmospheric nitrogen (N) deposition under alternative SRES emissions scenarios, based on information generated in an earlier EC-funded project: AIRCLIM.

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The four ATEAM land use change scenarios

Economic

Global

Regional

Environmental

A1

Storyline

The A1 narrative describes a globally oriented future world of rapid economic growth with emphasis on material assets, a stabilising global population (after 2050), and a rapid introduction worldwide of new and more efficient technologies. The social and political climate is stable, and the wealth gap between countries rapidly declines.

Driving forces for Europe

- slight population increase until 2050, then decrease
- very rapid economic growth
- increase in income
- emphasis on market-oriented solutions (free trade)
- environmental amenities are valued with increasing economic growth
- focus on local environmental problems (urban pollution, noise, etc)

Sectoral driving forces for Europe

- rural development policies decline in importance
- rapid enlargement of EU results in competition from CEE countries
- trends in demand and supply of agricultural products become more important

- timber demand and production increase
- forest area decreases as result of competition with other land uses
- recreational use of forests increases, strict protection of forests decreases
- forest fires increase in Mediterranean countries

- rising demand of housing and immigration causes urban land use to increase
- spatial planning is less restrictive
- significant increase of large cities (capitals) and slow increase of smaller cities

- conservation sites are maintained, and slowly expand
- more emphasis on the function of recreation
- less emphasis on the protection of biodiversity

A2

Storyline

The A2 narrative describes a very heterogeneous world with increasing global population. Economic development is regionally oriented and economic growth and technological change are fragmented and slow. Social and political institutions diversify. The wealth gap between countries remains.

Driving forces for Europe

- population increase
- slow economic growth
- economic development is primarily regionally oriented and uneven
- regional self-reliance in terms of resources
- weak global environmental concern. Environmental policy focuses on regional pollution.

Sectoral driving forces for Europe

- substantial food requirements result in an increase of land for agriculture
- EU enlargement is not significant
- trends in supply and demand of agricultural products become less important

- timber production increases mainly through increased growth rate
- forest area decreases as a result of increased agriculture
- recreational function of forests is valued
- slight increase of forest fires

- urban areas grow over time
- heterogeneous spatial planning
- counter urbanisation: growth of small and medium-sized towns

- weak nature conservation policy
- current level of protection might decline due to expansion of urban areas and agriculture
- strongly fragmented network of nature reserves

B1

Storyline

The B1 narrative describes a convergent world with a stabilising global population. There is a swift shift in economic structures towards a service and information economy with resource-efficient technologies. High environmental and social consciousness. Emphasis is on global solutions, including improved equity among people and nations.

Driving forces for Europe

- increase in population until 2050, then decrease
- economic growth continues
- technological change plays an important role
- maintenance of biodiversity, protection of global commons and resource efficiency

Sectoral driving forces for Europe

- strict environmental policies and intensive agricultural practise
- effect of EU enlargement not important, due to adequate protection of EU agriculture
- trends in supply and demand of agricultural products are closely linked

- timber demand increases slightly until 2010, then decreases
- increase in forest area
- multifunctionality of forests
- slight decrease in forest fires

- urban areas grow little and stabilise after some time
- restrictive and homogenous spatial planning
- compact settlements for each size of city
- urban green spaces

- strict protection of areas with high biodiversity
- European ecological networks is accomplished and maintained
- large nature conservation areas over Europe

B2

Storyline

In the B2 narrative, describes a future world with significant concern for environmental and social sustainability at local and regional level. Human welfare, equality and environmental protection have high priority. Stable population, slow economic growth. Technological change and innovations are unevenly distributed among the region.

Driving forces for Europe

- stable population
- relatively slow economic development
- global markets decline, focus on local and regional markets
- self reliance of regions in terms of resources
- regionally and locally oriented environmental policies are successful

Sectoral driving forces for Europe

- rural development policies become more important
- strict environmental policies, move to multi-functional agriculture
- EU enlargement is not significant, because of adequate protection
- trends in supply and demand of agricultural products are less important

- increase in demand of timber until 2030, then decrease
- increase in timber production
- increase in forest area
- forest protection is of high priority
- slight decrease in forest fires

- small increase in urban area
- restrictive and heterogeneous spatial planning
- compact settlements in small and medium-sized cities
- urban green spaces

- much attention to preserve biodiversity and wildlife at local level
- increase in total area of protected sites
- increase in number of small protected sites