Introduction to Forest Ecology

INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

Tento projekt je spolufinancován Evropským sociálním fondem a Státním rozpočtem ČR InoBio – CZ.1.07/2.2.00/28.0018

Lesson content

- Forest Ecology- basic information on the course
- Main concepts and terminology, Importance of ecology
- Development of forests in Holocene
- Geographical distribution of forest in the world
- Structure and functions of forest ecosystems
- Ecological stability, Man and forest
- Ecological problems of present forestry

Basic information on the course

Prerequisites for registration:	completed State Bachelor Examination
Taught for the form of:	full-time
Form of teaching:	lecture, seminar
Mode of completion and credits:	**Exam (6 credits)**

Course lecturers:

prof. Ing. Jiří Kulhavý, CSc. (lecturer, examiner, instructor, administration)

doc. Ing. Josef Suchomel, Ph.D. (lecturer, examiner, instructor, administration)

doc. Ing. Luboš Purchart, Ph.D. (examiner, instructor, administration)

Study programme European Forestry

- The two-year MSc program in European Forestry is interesting in both its forms and content.
- It focuses not only on traditional forestry, but also on a number of **topics related to ecology**, nature conservation, and sustainable development, with particular emphasis on the latest progressive trends.
- The aim of the program is to provide students with a general overview of forestry and nature conservation and **develop them theoretical and practical management skills.**

What is Ecology

- Word comes from the Greek *oikos* =„home“
- Simply is defined as a study of the relationship between organisms and their environment
- *or* the study of the factors controlling the growth and distribution of population
- *or* the study how the nature works – including human activities *(Odum,1971)*
- *And many others definitions*

Subdisciplines of Ecology

Artficial distinction due to the fact that no single person can understand all (specialization) but important is to work together namely at ecosystem , landscapes or planet level!!)

- Physiological Ecology (ecophysiology)
- Population Ecology
- Community Ecology
- Evolutionary Ecology
- **Ecosystem Ecology (e.g. forest, river, ponds……,**
- Landscape Ecology
- Production ecology

Ecosystem Ecology

Aimed at: structural and functional attributes of the system as a whole:

- The reciprocal **influences between patterns and processes**
- **Conversion of solar energy** to plant biomass through photosynthesis (primary productivity)
- **Conversion of the energy and mass** in plants to energy and mass in animals (secondary production)
- The way in which energy is distributed among the organismsof the system (**Food webs)**
- **Cycling of matter** (CO_2,water) and biogeochemical cycling of nutrients
- **Stability (adaptation)** of the system – dynamic balance
- How one component of the system modifies another component that is acting on it or how influences its own behavior depending on the environmental context – **(negative or positive feedback)**

Ecosytem concept and methodology

(Eco)system concept needs: :

- Information how the system is **powered**
- Information what (which patterns) influences trajectory of the system over time (e.g. cycling of elements, enhanced, CO2concentration…)
- Application of matematic and modelling (system analyses)
- Holistic approach (structure and behaviour of ecosytem as a whole)
- Studying of complex intractions between positive and negative feedbecks rather than only reduction to different part of system (subsystem) – i.e. reductionism in ecology typical for nineteenh century

Hiearchy of nature

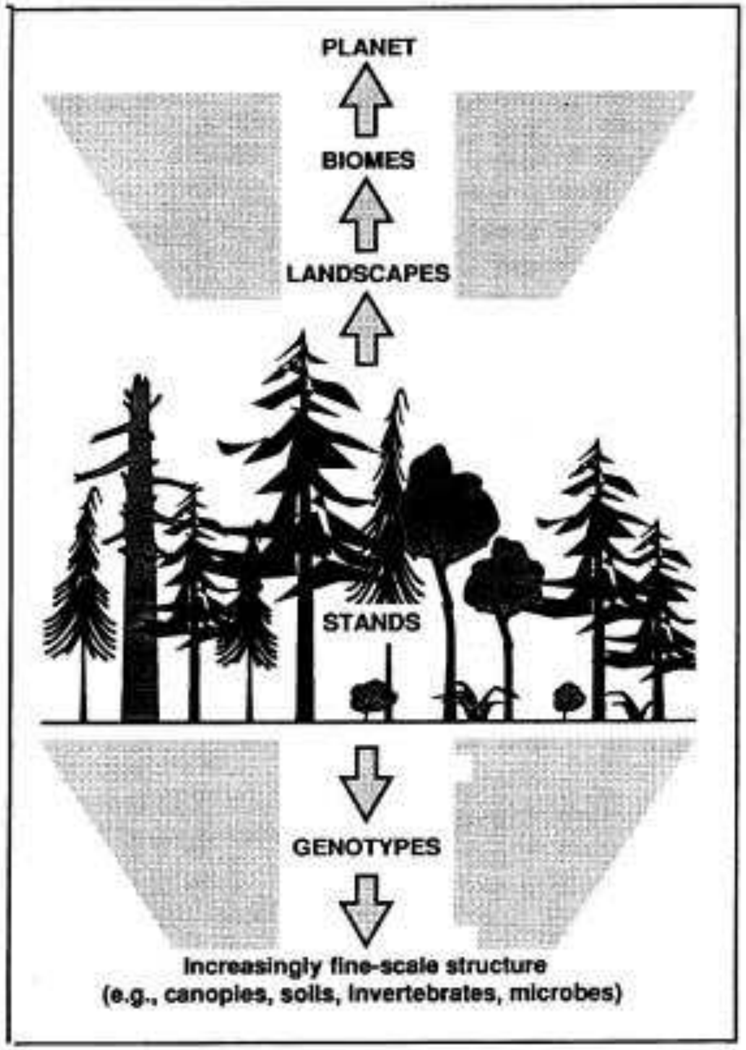


Figure 1.1. The hierarchy of nature. Every local ecosystem is part of a larger set of ecosystems that includes landscapes, regions, and ultimately the planet as a whole. Local ecosystems also comprise diversity at many scales, from individual plant and animal species and genotypes through microbes and the fine-scale structure of soils and canopies.

The influence of temperature an precipitation on type of vegetation

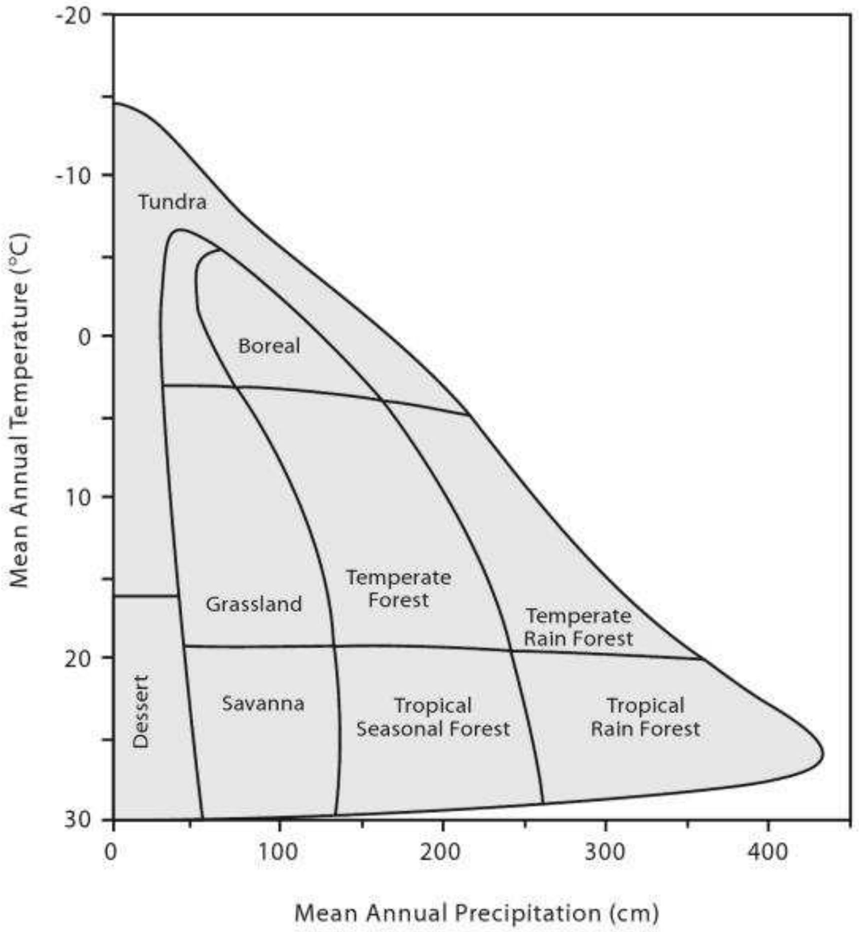


Figure 4.1. The influences of mean annual temperature and yearly precipitation on the type of vegetation. (Adapted from Whittaker 1975)

Photosynthesis

(*Feed back princip in ecosystem* level)

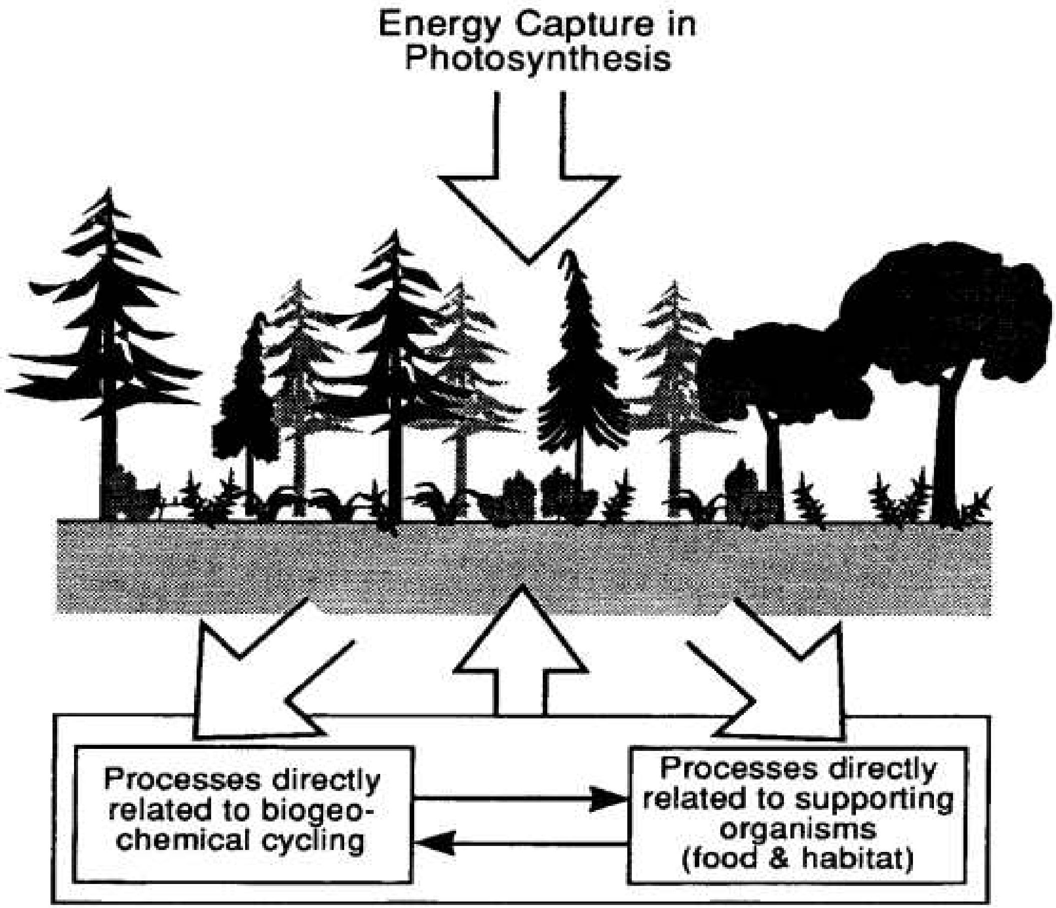


Figure 3.6. The energy captured by green plants in photosynthesis drives processes that feed back to support more photosynthesis.

Water balance in rain forest

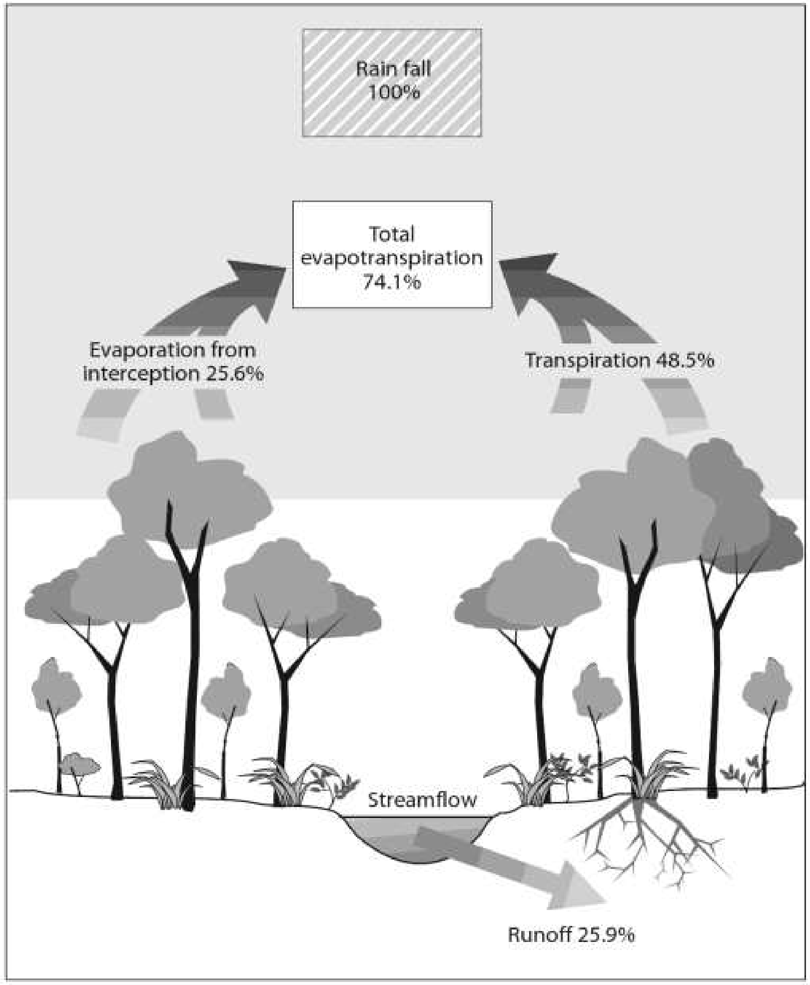


Figure 3.5. The water balance of an Amazon rain forest. (Salati 1987. Copyright © 1987. Reprinted by permission of John Wiley and Sons, Inc.)

The global cycles

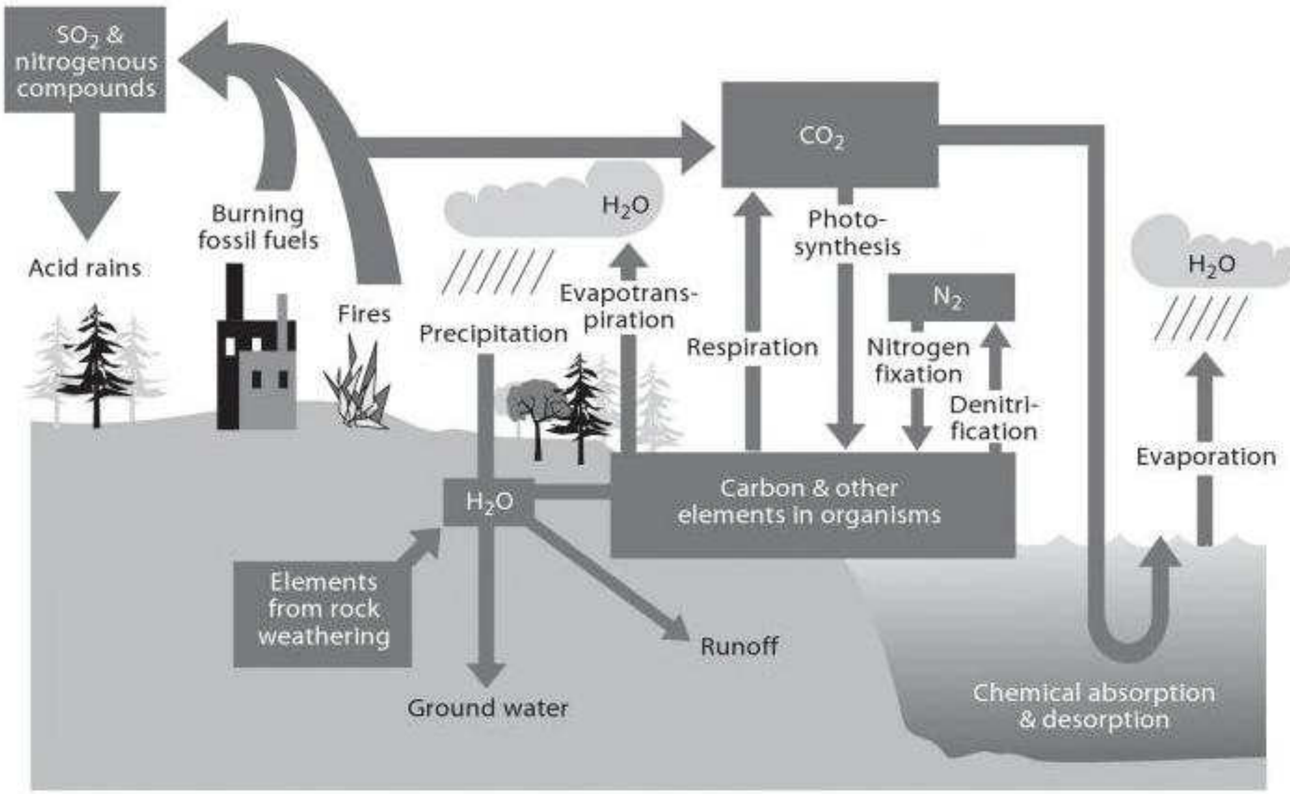


Figure 3.1. The global cycles of some biologically important elements. (NASA 1988)

Global carbon pools

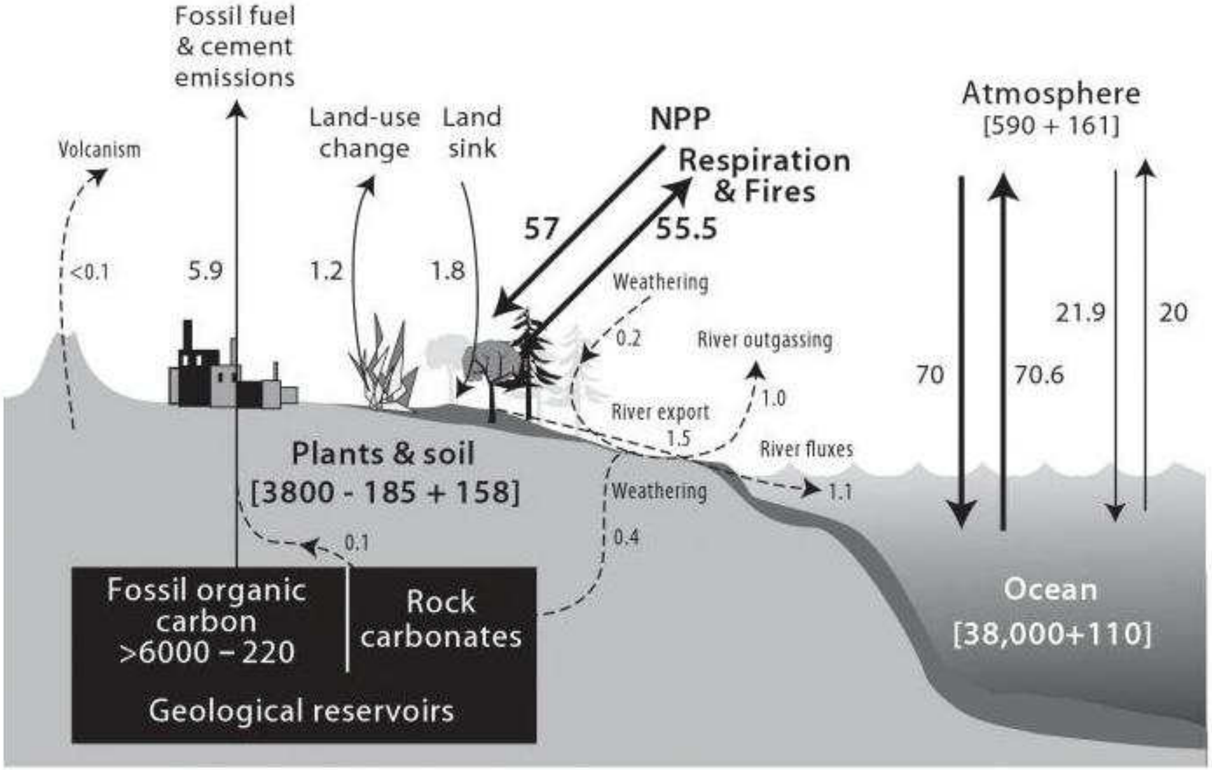


Figure 3.2. Global carbon pools and fluxes (pools in Pg and fluxes in Pg/y; 1 Pg = 10^{15} g). For pools, the first number represents the estimated preanthropogenic value, while additions or subtractions represent human perturbations. For example, 185 Pg is estimated to have been lost and 158 Pg added to the plant-soil pool due to human activities. For fluxes, dark arrows denote preanthropogenic and light arrows human perturbations. Of the total soil-plant pool, nearly 80 percent is in soils. Of the total flux due to heterotrophic respiration and natural fires, more than 90 percent is respiration. Values are averages over the 1980s and 1990s. (Estimates for most values may vary among authors). NPP, net primary productivity. (Adapted from Field and Raupach 2004)

Global nitrogen cycle

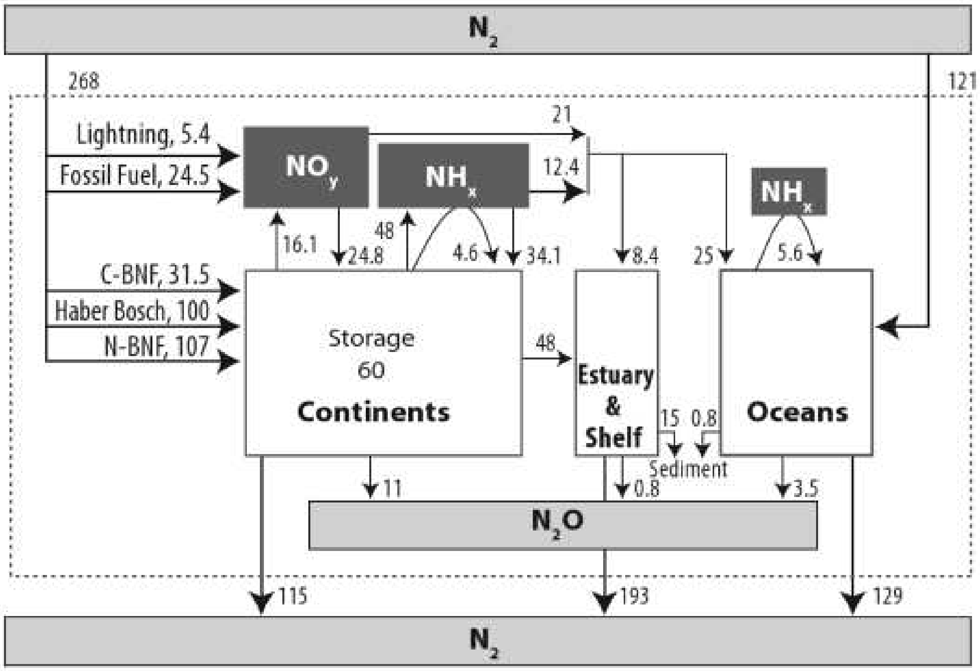


Figure 3.3. Components of the global nitrogen cycle for the early 1990s (Tg N/y). All shaded boxes represent reservoirs of nitrogen species in the atmosphere. Creation of reduced nitrogen (N_r) is depicted with bold arrows from the N_2 reservoir to the N_r reservoir (depicted by the dotted box). Denitrification, the creation of N_2 from N_r, is also shown with bold arrows. All arrows that do not leave the dotted box represent interreservoir exchanges of N_r. The dashed arrows within the dotted box associated with NH_x represent natural emissions of NH_3 that are redeposited on fast time scales to the oceans and continents. N-BNF, biological nitrogen fixation within natural ecosystems; C-BNF, biological nitrogen fixation within agroecosystems; Haber Bosch, an industrial process. (Adapted from Galloway et al. 2004, with kind permission of Springer Science and Business Media)

The global water cycle

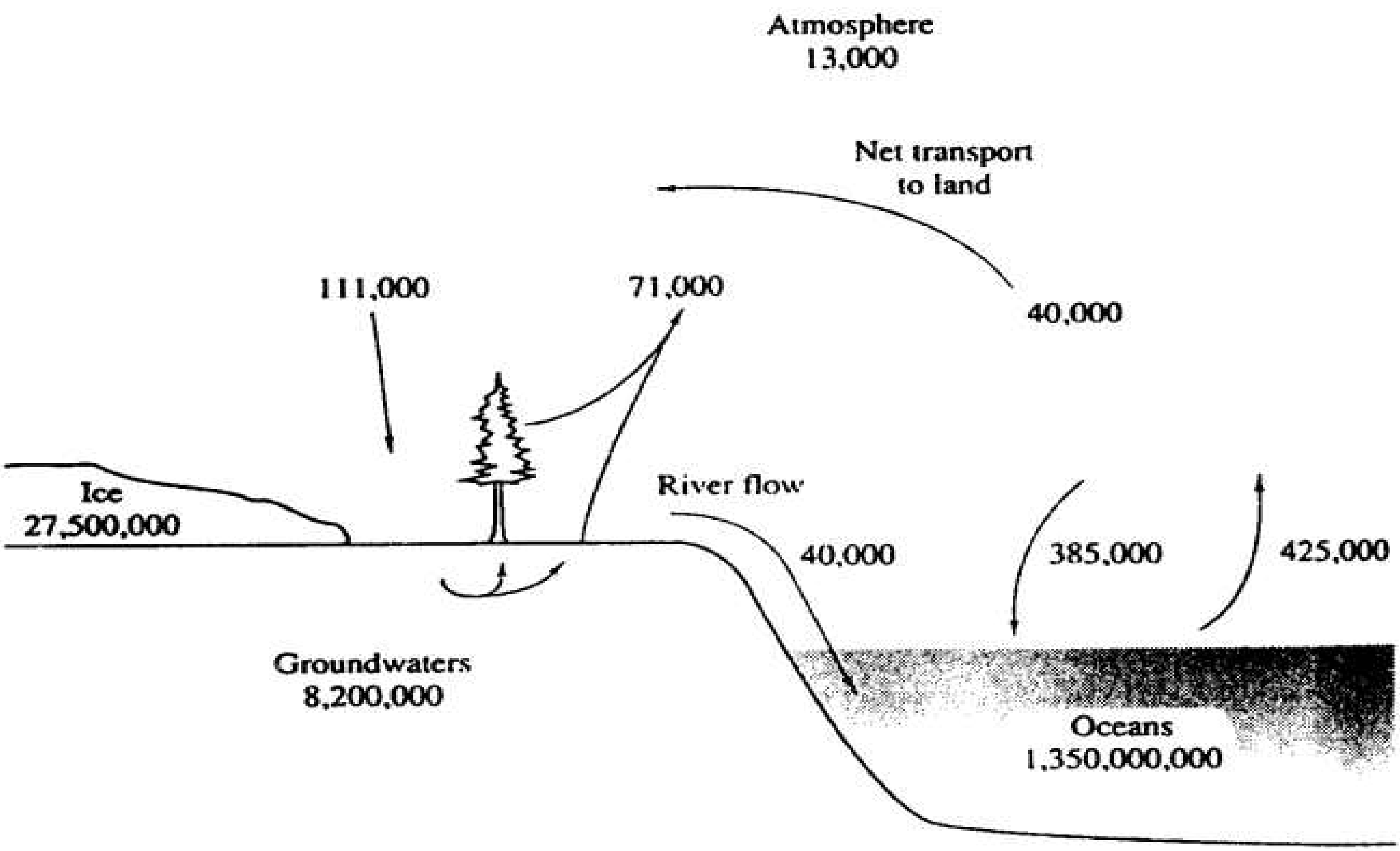


Figure 3.4. The global water cycle. Values are in cubic kilometers for pools and cubic kilometers per year for fluxes (1 $km^3 = 10^{15}$ g). (Schelsinger 1991)

Water balance in rain forest

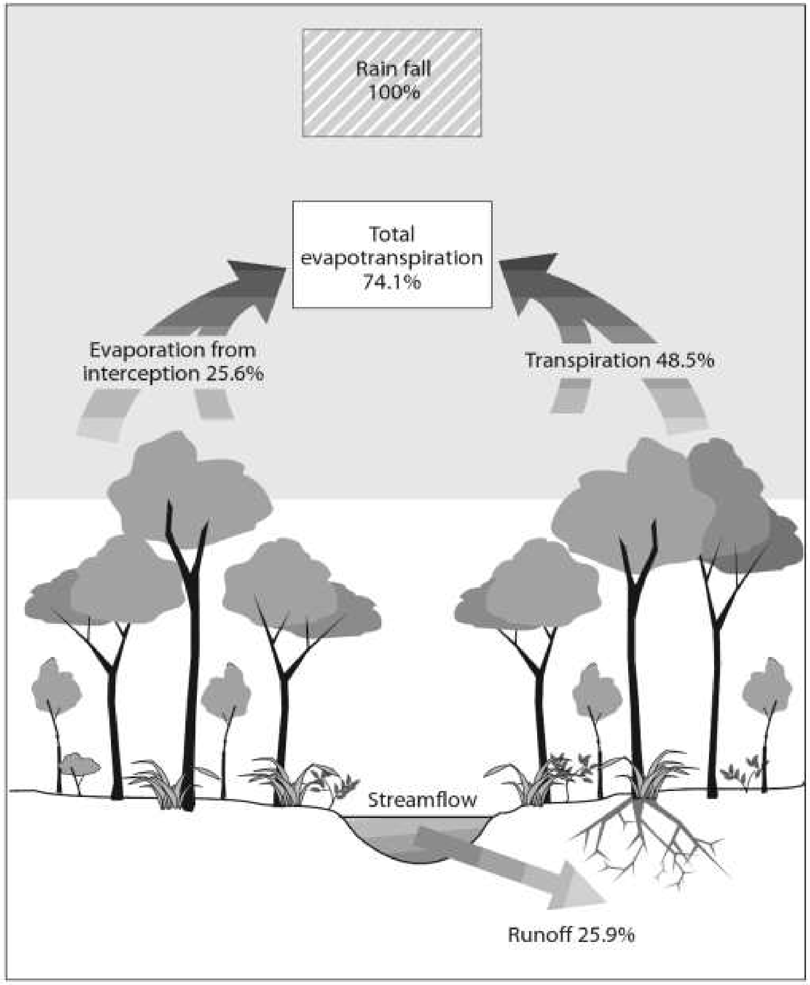


Figure 3.5. The water balance of an Amazon rain forest. (Salati 1987. Copyright © 1987. Reprinted by permission of John Wiley and Sons, Inc.)

Functions and services provided by a forest

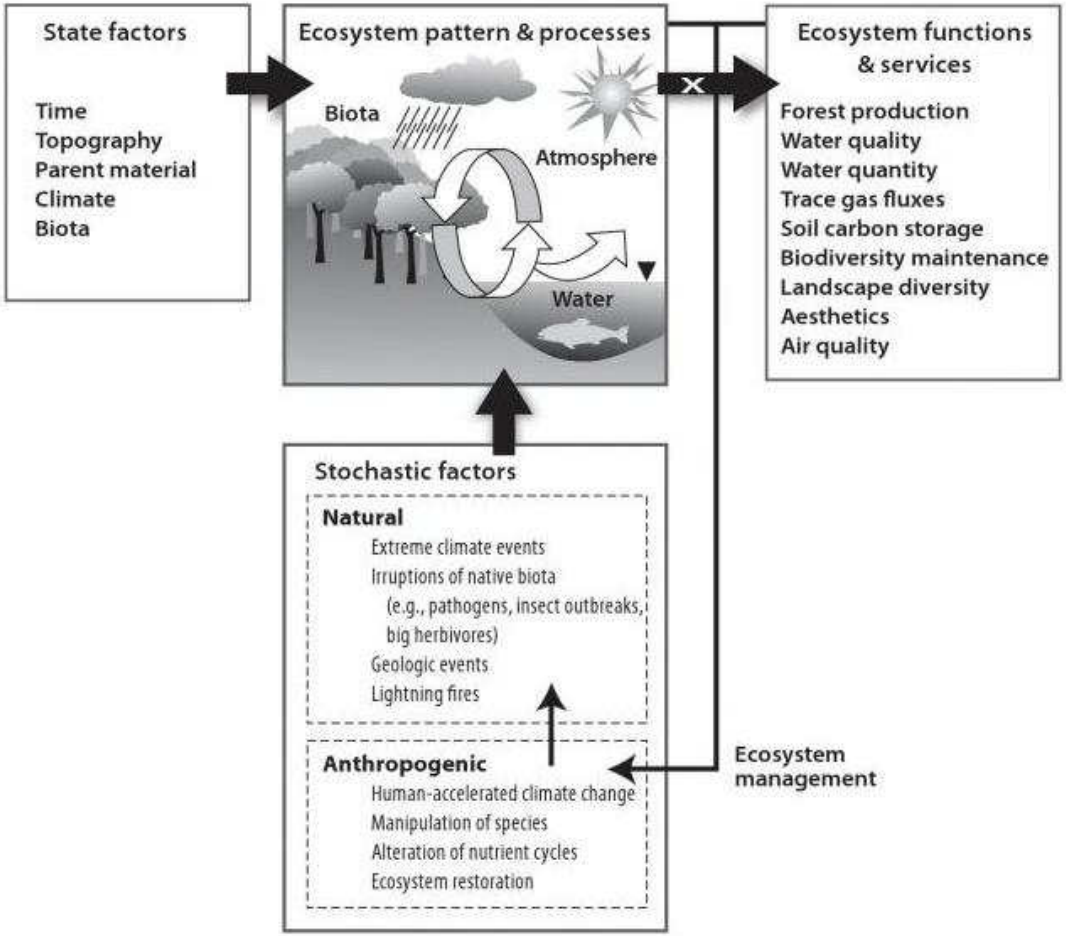


Figure 3.7. A conceptual diagram showing how state factors and stochastic factors influence functions and services provided by a northern hardwood forest, Hubbard Brook Experimental Forest, New Hampshire. (Adapted from Groffman et al. 2004)

Why Forest Ecology

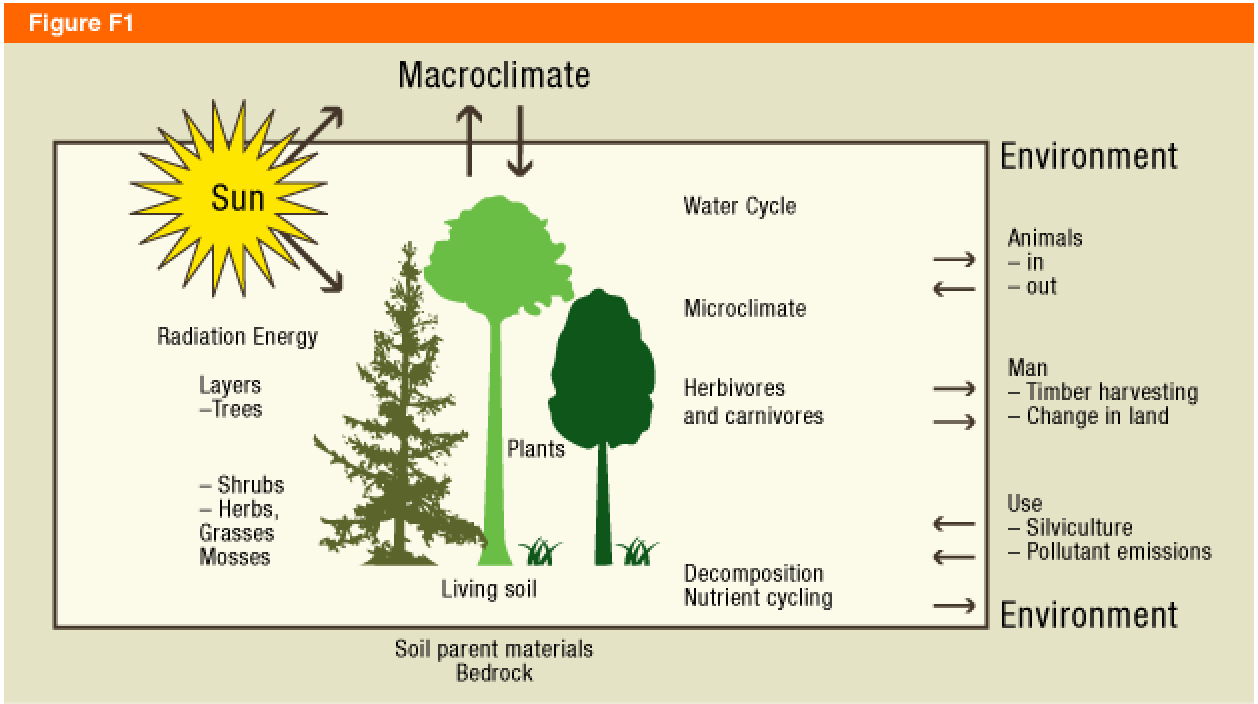
Need to acquire knowledge of:

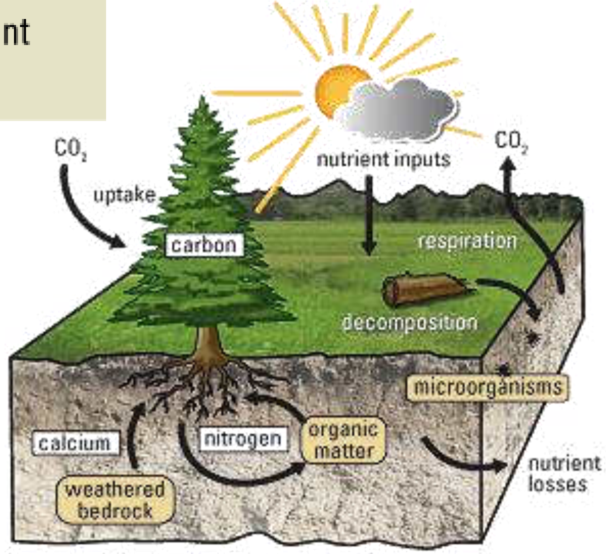
- Structure, processes and functioning in natural and managed forests
- Role of soil and climat for cenoses behaviour (functioning of ecosystem)
- Cycling of matter and nutrients
- Trophic relations (food web), energy flow and primary and secondary production
- Biodiversity and biotic interactions in forest ecosystem,
- Ecological impacts of human activities on forest ecosystems
- Stress theory, principles of ecological stability
- Global aspects of forest protection

Forest ecosystem

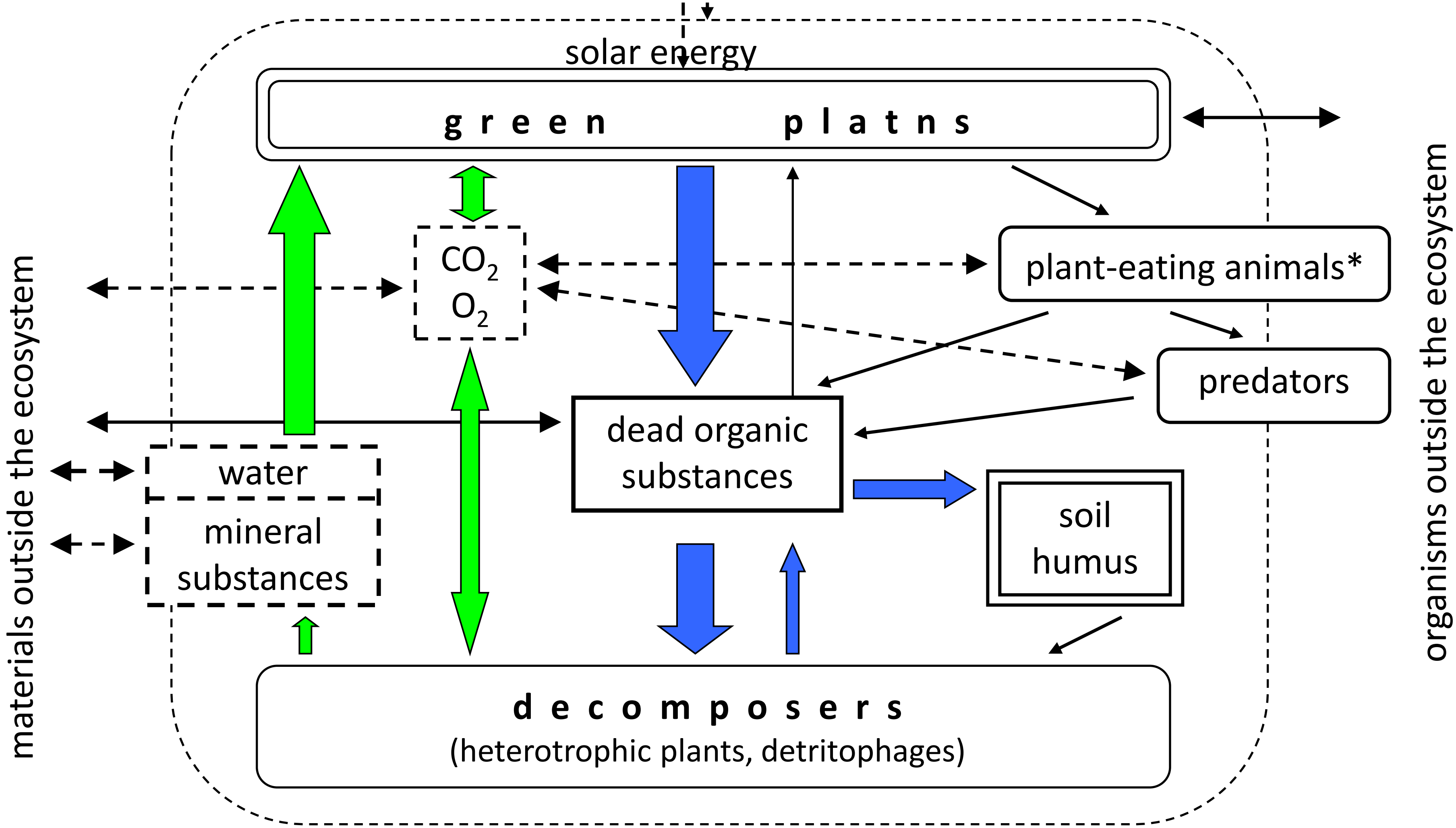
- **Forest ecosystem – a community of species interacting among themselves and with the physical environment**
- Ecosystem may be used **concretely** for desribing a particular place on the ground or **abstractly** to decribe a type (e.g. Norway spruce ecosystem)
- **Biogeocenosis** is an equivalent (mostly in Europe)
- Main attributes are: **source of energy**, a **supply** (inputs) of row materials (e.g. nutrients in rainfall), **mechanisms for storing and recycling (cycling of matter and nutrients)**, **mechanisms** that allow it **to persist** (e.g. climatic fluctuations, periodic disturbance..)
- Ecosystem **is dynamic rather than static** (time and space dynamic - **succession**)
- **Synergy** – *the whole is greater than sum of the parts*
- **Stability** – it doesnt mean „*no change*“. Rather is analogous to the dynamic balance

Structure of forest ecosystems





ECOSYSTEM STRUCTURE AND FUNCTIONING



primary produces

secondary producers (phytophages, predators, reducers)

easily decomposable dead organic substances

not decomposable dead organic substances

mineral substances

movements of organic substances

movements of mineral substances or energy

limits of the ecosystem

The influence of disturbances to hydrologic functions

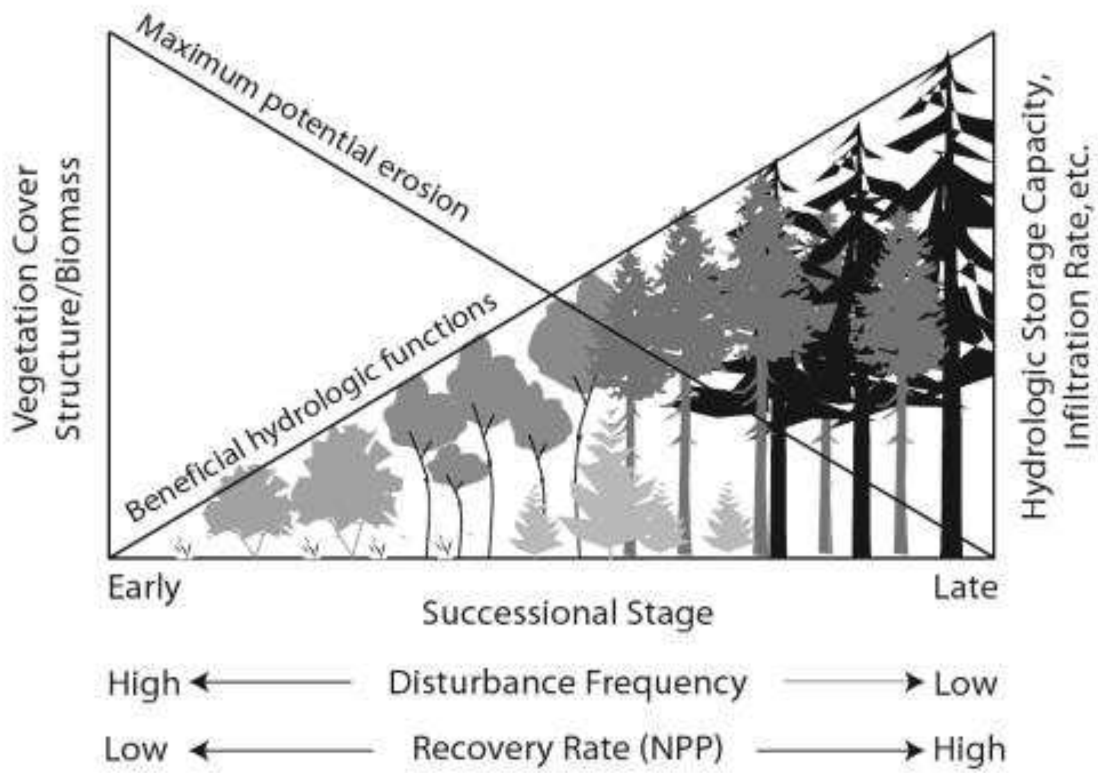


Figure 3.9. The influence of disturbance frequency on hydrologic function. NPP, net primary productivity. (Huston et al. 2004)

Water balance in rain forest

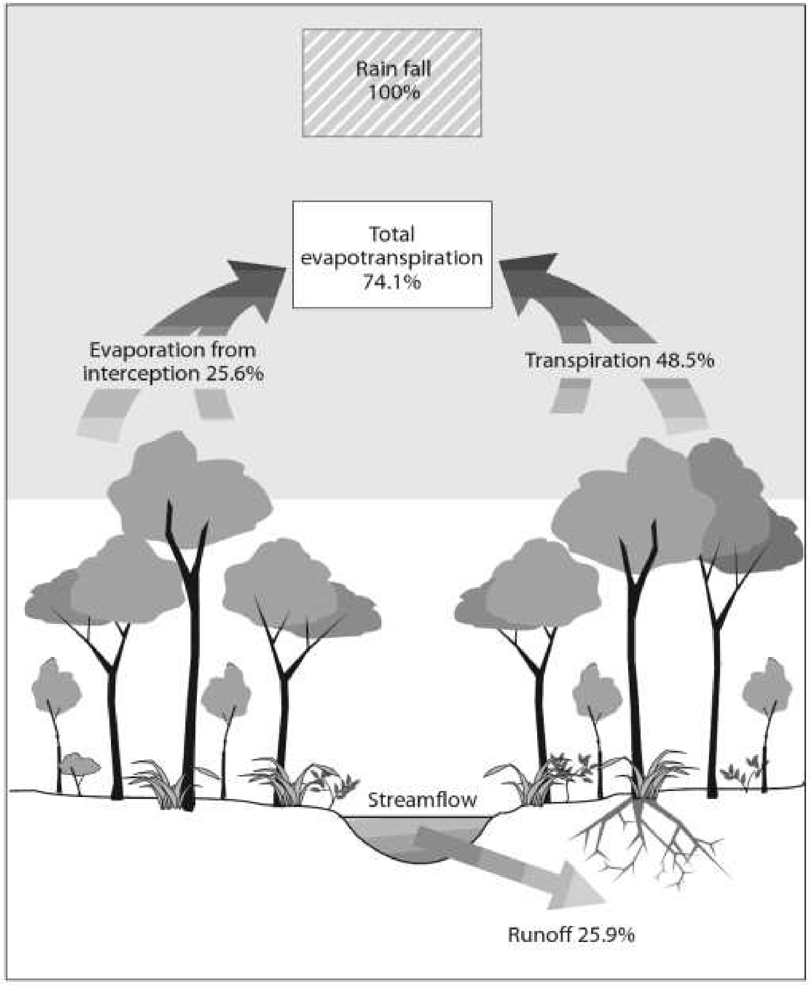


Figure 3.5. The water balance of an Amazon rain forest. (Salati 1987. Copyright © 1987. Reprinted by permission of John Wiley and Sons, Inc.)

Driving forces in forest ecosystems dynamic

- Soil and climat (solar radiation, water..)
- Air pollution (SO_2, NOx, Ozon)
- Acid rain
- Global warming
- Volcano eruption
- Man activity and forest management
- …

Interrelationship between ecosytem services and human health

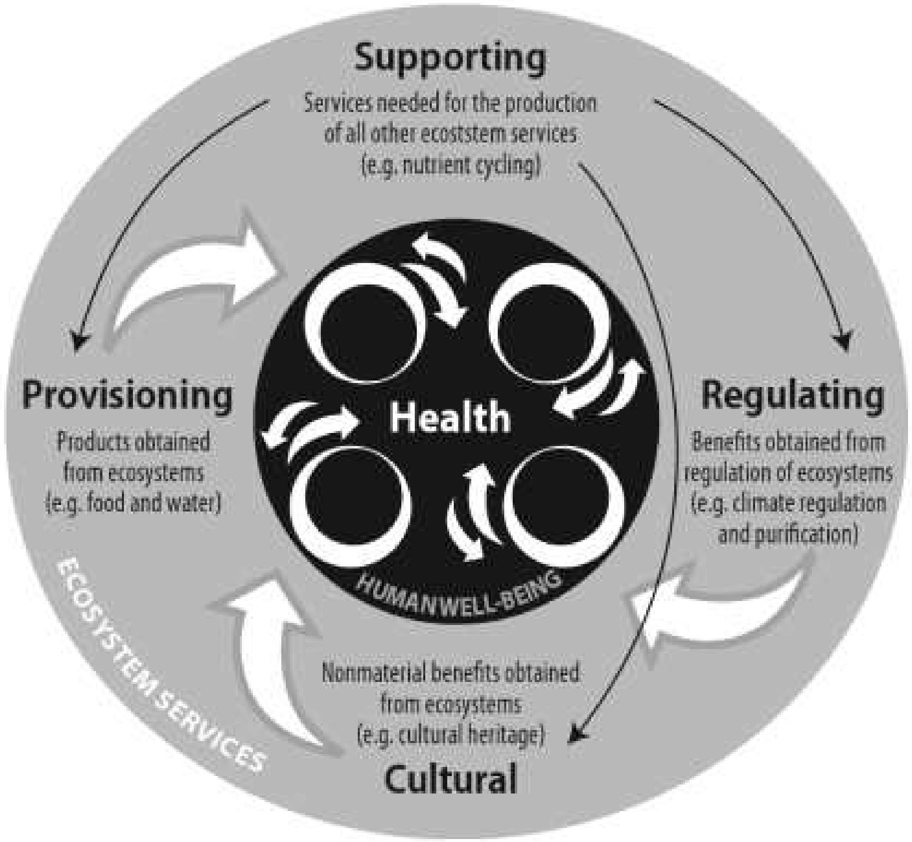
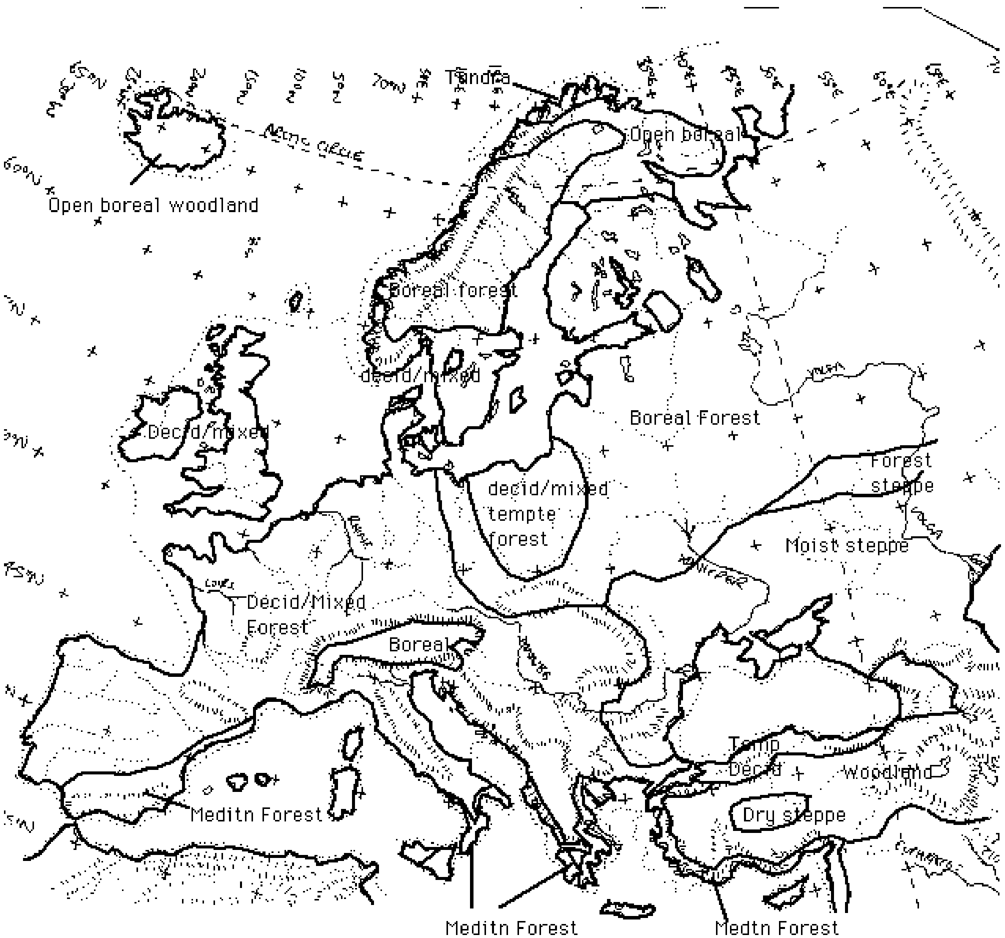


Figure 3.12. Interrelationship between ecosystems services, aspects of human well-being, and human health. (Millenium Ecosystem Assessment 2005a)

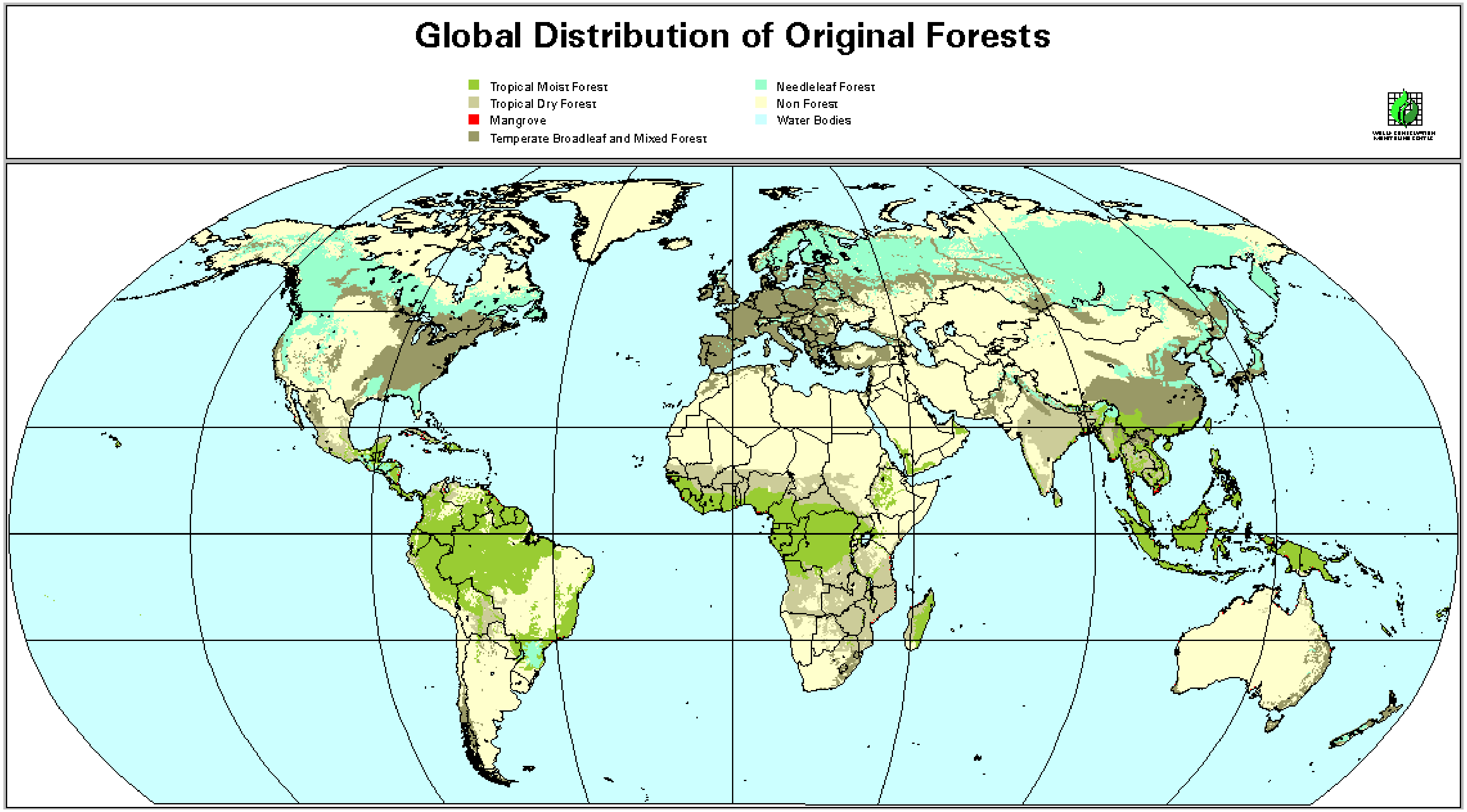
Development of forests in Holocene

The **Holocene** is a geological epoch which began at the end of the Pleistocene[1] (at 11,700 calendar years BP) [2] and continues to the present. The Holocene is part of the Quaternary period. Its name comes from the Greek words ὅλος (*holos*, whole or entire) and καινός (*kainos*, new), meaning "entirely recent".[3] It has been identified with the current warm period, known as MIS 1 and based on that past evidence, can be considered an interglacial in the current ice age.



9,000-8,000 14C years ago; forest had by now returned to most of Europe after the end of the cold Younger Dryas at 10 kyr. At 9 ka, however, the forest cover was rather more open than at present with more herbaceous glades. By 8 kyr the forest was closed, but with conifers more abundant than at present in eastern Europe.

Geographical distribution of forest in the world



Basic terminology and definitions, importance of ecology

- Abiotic factors
- Atmospheric deposition
- Autotrophic respiration
- Biodiversity
- Biogeochemical cycling
- Biomass
- Biotic factors
- Carbon allocation
- Climate change
- Climax
- Decomposition
- Defoliation
- Disturbance
- Ecological stability
- Elasticity
- Energy balance
- Evapotranspiration
- Fire and forests
- Food web
- Forest certification
- Forest ecology
- Forest ecosystem
- Global ecology
- Gross primary production
- Heterotrophic respiration
- Immobilization
- Infiltration
- Leaf area index
- Litterfall
- Lyzimetric waters
- Mineralization
- Modelling
- Net ecosystem exchange
- Net primary production
- Nutrient leaching
- Photosynhesis
- Primary productivity
- Resilience
- Sapwood
- Secondary productivity
- Simulation
- Solar radiation
- Stress factors
- Succcession
- Surface runoff
- Sustainability
- System analyses
- Throughfall
- Transpiration
- Volatilization
- Water balance

Ecological problems of present forestry Czech Republic

- **Problem area 1**: The reconstruction of a pure Norway spruce forest stands on sites outside of its natural area.
- **Problem area 2**: To stop soil degradation and necessity of rehabilitation of the forest area heavily affected by air-pollutatns
- **Problem area 3:** The uniform age structure of forest stands.
- **Problem area 4**: Sustainable management and protection of forest ecosystem which needs special interests – e.g. Floodplain forest ecosystem, National parks, Protected area..

Literature

Basic reading list:

WARING, R H. - RUNNING, S W. ***Forest ecosystems : analysis at multiple scales.*** 3. vyd. Amsterdam: Elsevier/Academic Press, 2007. 420 s. ISBN 978-0-12-370605-8.

TOWNSEND, C R. - BEGON, M. - HARPER, J L. ***Essentials of ecology.*** 3. vyd. Malden, MA: Blackwell Pub., 2008. 510 s. ISBN 978-1-4051-5658-5.

AGREN, G I. - ANDERSSON , F O. ***Terrestrial Ecosystem Ecology***. Cambridge University Press, New York, USA: Cambridge University Press, 2012. 330 s. ISBN 978-1-107-64825-8.

PERRY, David A, Ram OREN a Stephen C HART. ***Forest ecosystems***. 2nd ed. Baltimore: Johns Hopkins University Press, c2008. ISBN 978-0-8018-8840-3.

SCHULZE, Ernst-Detlef, Erwin BECK a Klaus MÜLLER-HOHENSTEIN. ***Plant ecology***. Berlin: Springer, c2005, 702 s. ISBN 3-540-20833-x.

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VALENTINI, R. ***Fluxes of carbon, water, and energy of European forests***. Berlin: Springer, c2003, 270 s. ISBN 3-540-43791-6.

FÜHRER, E. ***Pathways to the Wise Management of Forests in Europe***. Amsterdam: Elsevier, 2000, 119 s.

Recommended reading list:

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Other recommended literature (part 1)

- Apps, M.J. , Price, T.D.: Forest Ecosystems, Forest Management and the Global Carbon Cycle. NATO ASI Series, Vol. 40, Springer-Verlag, 1996. 452 p.
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- Maser, Chris.: Sustainable Forestry. Philosophy,Science and Economics, St. Lucie Press, 2000. 371 p.
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Actual case studies in Europe

New Book: Adapting to climate change in European forests – results of the project -Joanne Fitzgerald and Marcus Lindner (editors) – available for public on www.efi.fi

COST project EuMixFor – 2013-2016 (good discussion on Internet)

Forest Condition monitoring in Europe –ICP, FOOTMON..

Articles on Web

- http://www.eea.europa.eu/publications/eea_report_2008_3

Book: Forest Ecosystems (Perry et al. 2008) - http://books.google.cz/books?id=rNfoL3zH6NkC&printsec=frontcover&dq=bibliogroup:%22Forest+Ecosystems%22&hl=cs&sa=X&ei=KvE_Us-nJ4LZtAaO8oDAAw&ved=0CDMQ6AEwAA#v=onepage&q&f=false

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- http://www.efi.int/portal/
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- **Book: Carbon and Nitrogen Cycling … (Schulze et al. 2000)** - http://books.google.cz/books?id=ku6QwSTDsvEC&printsec=frontcover&hl=cs&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false
- **Book: Spruce Monocultures in Central Europe (Klimo et al. 2000)** - http://fefr.org/files/attachments/publications/proc33_net.pdf
- Book: **Functioning and Management of European Beech Ecosystems (Brumme et aa. 200) -** http://books.google.cz/books?id=YIkEZwZcrxwC&printsec=frontcover&hl=cs&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false
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- **Book: Causes and Consequences of Forest Growth Trends in Europe (Kahle et al. 2008) -** http://books.google.cz/books?id=gSFKtxtv1kEC&printsec=frontcover&dq=Causes+and+Consequences+of+Forest+Growth&hl=cs&sa=X&ei=avg_Ura7DojesgbnuICoAw&ved=0CDEQ6AEwAA#v=onepage&q=Causes%20and%20Consequences%20of%20Forest%20Growth&f=false

- **Book: Ecology of Woodlands and Forests: Description, Dynamics and Diversity (Thomas et al. 2007) -** http://books.google.cz/books?id=0Ntvos9aaC8C&printsec=frontcover&dq=Ecology+of+Woodlands&hl=cs&sa=X&ei=Lvk_UrTHLYKctQa0oICICg&ved=0CDMQ6AEwAA#v=onepage&q=Ecology%20of%20Woodlands&f=false