COST - Action ECHOES
Expected Climate Change and Options for European Silviculture

COUNTRY REPORT OF THE CZECH REPUBLIC

(Draft as of Oct. 2009)

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Introduction

Natural conditions of the Czech territory

Czech Republic is located in temperate climate zone and it is influenced by both oceanic and continental climatic systems. Despite the small surface area of the country (79 th. km^2), the climate varies substantially and has an increased continentality towards East. Climate variability is also determined by variable orography (115 – 1603 m a.s.l.). As a result, many evolutionary soil types occur in the Czech territory with a large diversity of plant communities. The country can be divided into three floristic areas, namely Central European forest flora, Pannonian, and West Carpatian flora. Increasing elevation determines successive vegetation levels – the oak, oak-beech, beech-fir, and spruce levels and sub-alpine level above the timberline (1350 m a.s.l.). Based on combination of above factors, there are specific natural forest areas delineated in the country that are also reflected in forest management planning (Fig. 1).

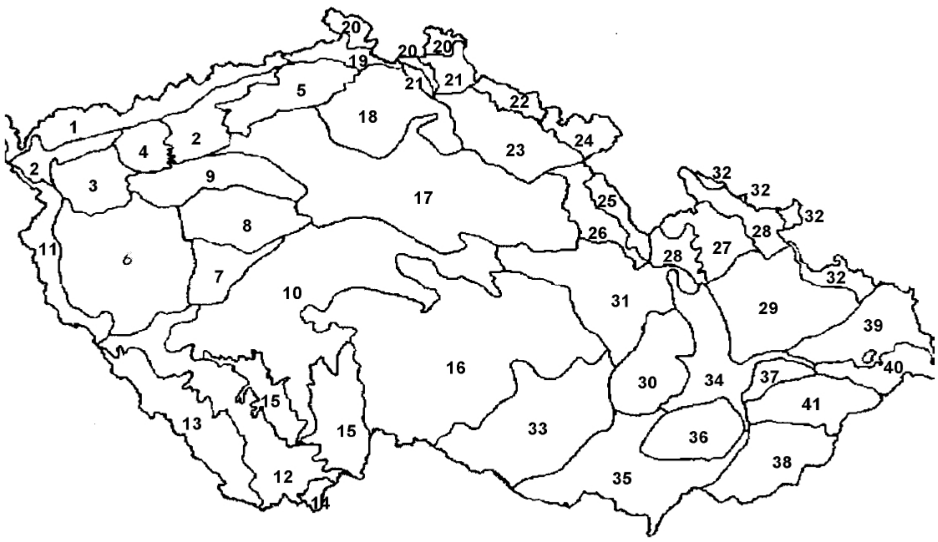


Fig. 1: Distribution of the Natural Forest Areas in the Czech Republic

Czech climate and its development since eighteen century

The trajectory of climatic parameters (temperature, precipitation) can be demonstrated on two selected meteorological stations for three different time intervals:

- The longest available meteorological time series in the country is from Prague-Klementinum and shows the courses of temperature and precipitation since mid eighteen and mid nineteen century, respectively (Fig. 2). The trend lines of annual average air temperature (Fig. 2a) and average air temperature for vegetation season (Fig. 2b) display a specific periodicity with a high variability among years and/or shorter periods (climatic episodes). Almost reciprocal variability, but with more linear trends show the annual sums of precipitation, both for entire years and for vegetation periods (Bagar 2003).

- The period of 1960-2000 focusing on climatic extremes observed at two climatically different locations. The fist (station RUZY) is situated in Prague to facilitate a comparison with data from Fig. 2 and Fig. 4 resp., and the second one (LYSA) at mountain top with highest a long–term annual precipitation in the Czech territory (Fig. 2 a-d; Dubrovský in Ač *et al*. 2009)
- Annual temperature and precipitation during the most recent period (1998-2008) and the linear trends compared with the average temperature and precipitation calculated for the period 1960-2000 (Fig. 3; CHMU www.chmu.cz)

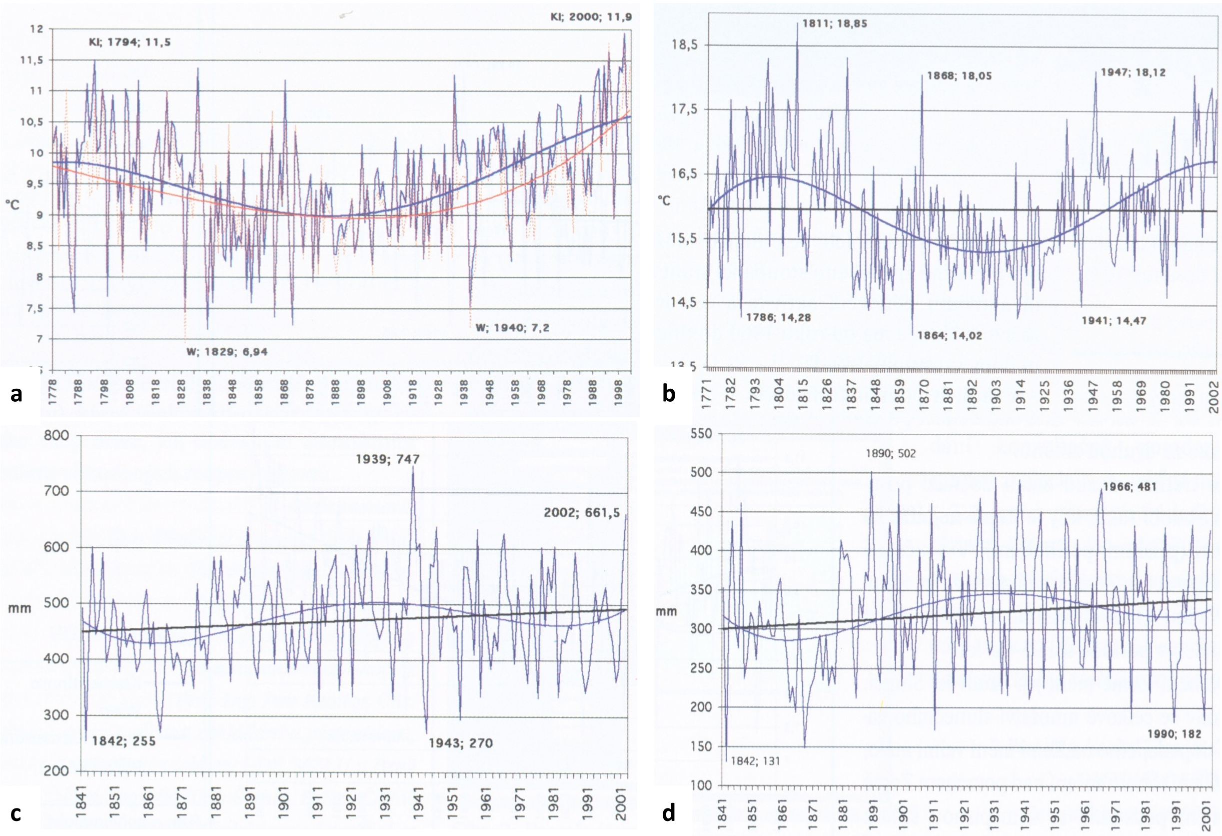


Fig. 2 (a-d): a - annual average air temperature, b- average air temperature for the period April-September, c- annual sums of precipitation, d- sums of precipitation for the period April-September. Reproduced from Bagar (2003).

On the contrary to long-term changes in temperature and precipitation affecting forest ecosystems in more or less gradual manner, windstorms can induce disturbances of extensive forest regions instantly. Some of the recent extreme events are documented below.

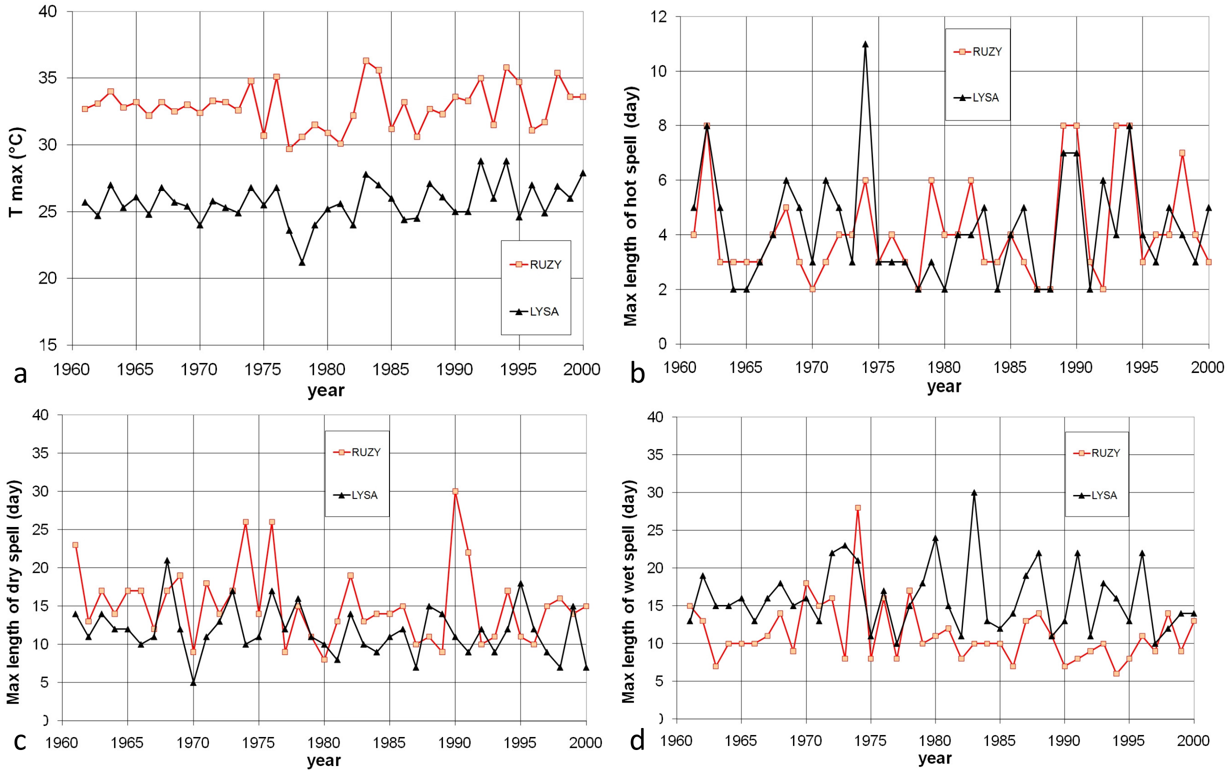


Fig. 3 a-d: Extreme climatic events during the period 1960-2000 observed in Prague (station RUZY) and Beskydy Mts. (station LYSA)

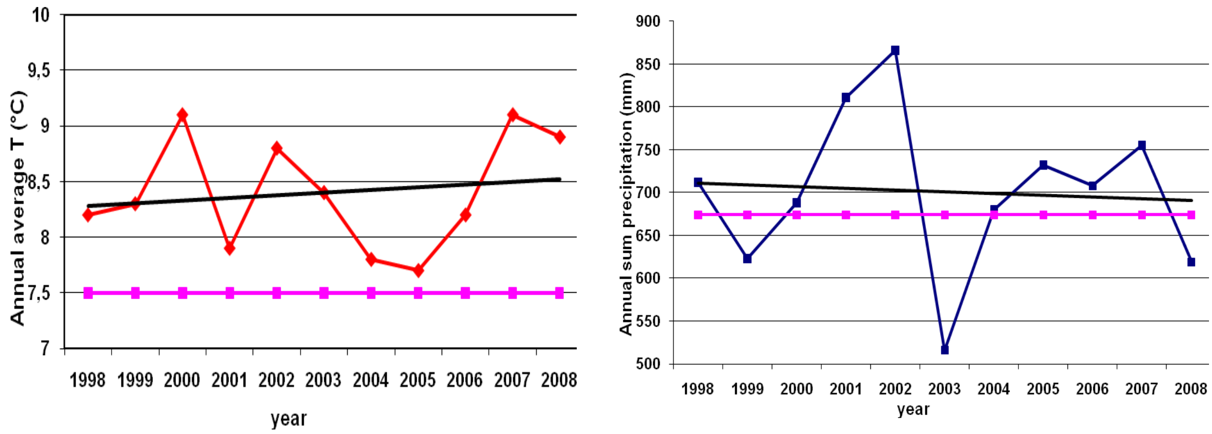


Fig. 4: Annual temperature (left) and precipitation (right) for the period of 1998-2008 with linear trends (black lines) compared with the average values calculated for the period 1960-2000 (pink horizontal lines).

What trends can be drawn from above data on temperature and precipitations?
Within 1870-2002 average temperature rose by more than 2°C as apparent from polynomial trend equalizer function. The same trend applies for temperature of vegetation season (April to September). Brázdil *et al.* (2009) confirmed a rising air temperature during 1961-2005, with a stronger trend since the 1980s.

There are no pronounced changes in precipitation totals in contrast to declining trends in relative air humidity and number of days with snow cover. The last decade confirms the trend with high oscillations. Precipitation shows particularly uneven distribution during the year, resulting in longer drought or wet periods, with consequences on forest health status.

Czech forests

Forests currently occupy 33.6 % of the area of the country, i.e., about 2.6 mill. ha (MoA 2008). The tree species composition is dominated by conifers, which represent 75 % of the timberland area. The four most important tree species in this country are spruce, pine, beech and oak, which account for 52.8, 17.0, 6.7 and 6.9 % of the total cadastral forest area, respectively (MoA 2008). Broadleaved tree species have been favored in new afforestation since 1990. The proportion of broadleaved tree species increased from 21 % in 1990 to about 24 % in 2007. The total growing stock (merchantable wood volume) in forests in the country has increased from 564 mil. m^3 in 1990 to 673 mil. m^3 in 2007.

Specific conditions

Long-term air pollution coming mainly from coal-burning power stations ("Black Triangle": Czech Republic, Poland, former East Germany) that burn coal rich in sulphur, in combination with episodic climatic stress events (drought, severe winter, windstorms) resulted in extensive forest decline since 1960's, culminating in 1980's. Most heavily impacted were Norway spruce forests in Ore Mts., Giant Mts., Jizerske Mts. and weakened health status of forest stands was observed in other regions, e.g. Šumava Mts., Orlické Mts., Beskydy Mts. Fig. 5 shows average annual concentrations of SO_2 at selected mountain forest station 1973-2001 (Fabiánek *et al*. 2004). From 1990 the Czech emissions of greenhouse gases (GHG) have been decreasing from a 200 to a 150 mil. T CO_2 eq. in 1998 and they are relatively stable until recently http://www.chmi.cz/cc/acc/aindex.html.

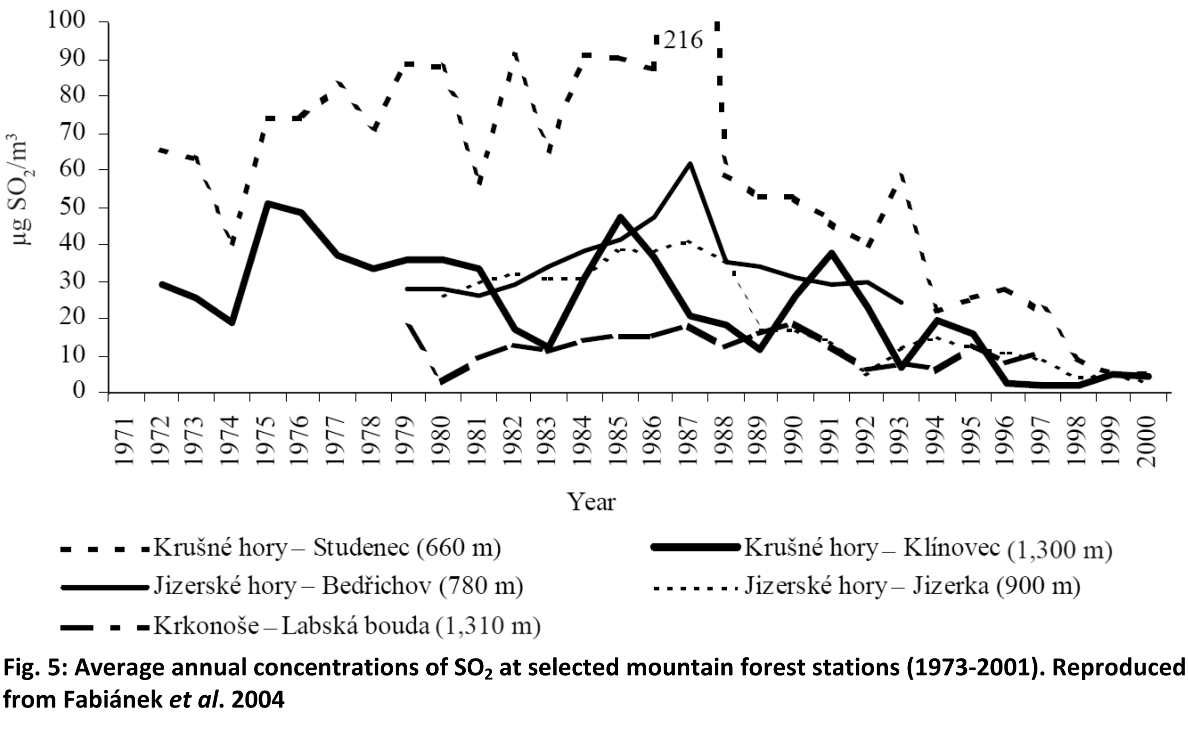


Fig. 5: Average annual concentrations of SO_2 at selected mountain forest stations (1973-2001). Reproduced from Fabiánek *et al*. 2004

Acid rain (rich in sulphur and nitrogen dioxides) had many direct impacts on forest vegetation (yellowing, defoliation mostly on spruce and pine, decline) and a long-term impact on functioning of forest ecosystems. Very significant were/are changes in soil properties resulting from acidification and nutrient degradation (Hruska and Cienciala 2001), changes in edaphon, water regime, species composition, etc. Different degree of such impacts was observed in most forests in the country with various synergic effects (weather, stand health condition, N deposition etc.) affecting forest growth. Moreover, former forest management significantly altered both tree species composition and spatial distribution of forest stands. Norway spruce monocultures, often even-aged stands, occupy more than 15 % of the former broad-leaved stands (Tomášková 2004). This has a crucial role in forest resistance to changing climatic and other factors.

I. Impacts

I.1 Observed impacts

Going back to historical records from the Czech chronicles since 1091, they depict climatic extremes in relation to their negative impact on crop yield, population, health, etc. Impact on forests was mostly mentioned when windstorms caused extended forest damages (storm-felled timber) and dry weather periods which brought forest fires (Kouba 2006).

Recently, when focusing on most extreme climatic evens, windstorms, snow and drought mostly impacted Czech forests in the last 15 years. The estimated salvage felling during this period ranges between 1.55 – 14,7 mil. m^3 (Rychtecká *et al.* 2008, MoA CZ 2009).

Windstorm was the most devastating climatic factor, with particular extremes in 2003 (resulting in 6,12 mil. m^3 of salvage logging), 2007 -hurricane Kyrill (14,7 mil. m^3) and 2008 - hurricane Emma (5,3 mil. m^3) (Hošek 2007, Knížek *et al.* 2008, Rychtecká *et al.* 2008).

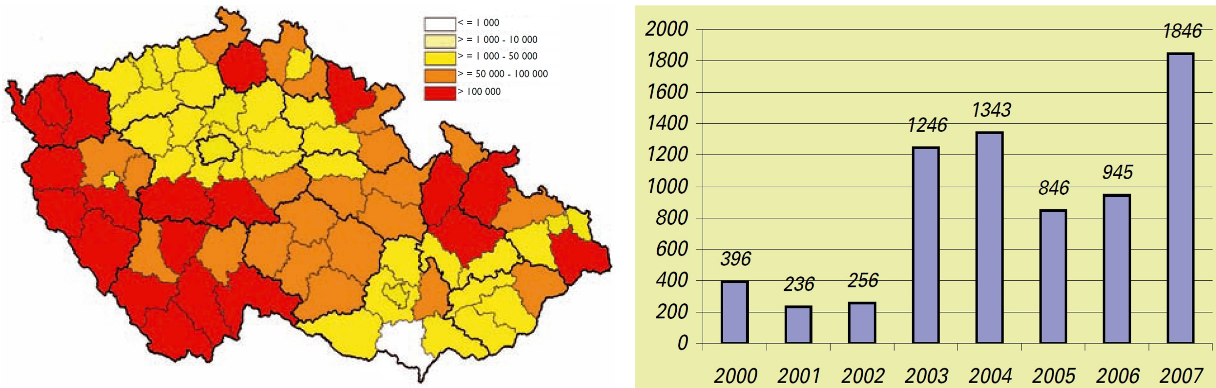


Fig. 6: Damage to forest stands by wind, snow and frost (left); timber damaged by bark beetle in Norway spruce stands (right). Reproduced from MoA (2008).

Because of severe winters in 1996 and 2006, frost was responsible for 2 mil. m^3 of salvage logging in 1996, while snow for 2,9 mil. m^3 of salvage logging in 2006 (Rychtecká *et al.* 2008).

The annual average temperature in 2007 was the highest since the beginning of instrumental measurements in the Czech Republic. This contributed to severe outbreaks of bark beetle in Norway spruce (*Ips typographus*, *I. duplicatus, Pityogenes chalcographus*) and Scotch pine forests (*Ips acuminatus*, *I. sexdentatus*). In 2007, the damage in Norway spruce stands reached almost 1,9 mil. m^3 (Fig. 7, right) and similar extent was observed in the following year of 2008, namely 1,8 mil. m^3 (Knížek *et al*. 2009, MoA CZ 2009).

Despite no significant trend in annual sums of precipitations during last decade, we can notice a high oscillation among years and uneven temporal and spatial distribution of rainfalls within a year. Local floods occurred in 1997and 1998 in the upper part of Morava river watershed and the whole Czech territory faced to severe floods in 2002. These events did not result in any significant damage to forests, but the stands suffered from infrastructure damage (e.g. forest roads), soil erosion, changes in nutrient regime and decline of some riparian vegetation such as alders (Strnadová *et al.* 2008).

Complementary to unevenly distributed rainfalls, longer dry periods accelerated already existing forest decline in some regions and increased effects of other harmful factors in forest stands. This concerned e.g. the Moravia-Silesian region with rapidly growing dieback of allochtonous Norway spruce stands after drought in 2003 (Holuša *et al*. 2002, Šrámek *et al*. 2009). In the Šumava Mts., suffering since 1980s from intensive bark beetle attacks, the last enclaves of waterlogged spruce stands, so far resisting to the bark beetle pressure, also started to decline after 2003 (Jonášová *et al*. 2008).

I.2 Impact monitoring

The recent systematic forest health status monitoring in the country started in 1950s and was induced partially by the impact of air pollution on forests. Since 1986, European ICP Forest (Forest Focus after 2004) monitoring has been adopted and nowadays it covers more than 300 forest stands of different category size and information levels all over the country. The annual reports present trends in forest stand yellowing, defoliation, dieback and their relationships to factors like air pollution, weather, pest, diseases, etc. (e.g. Fabiánek *et al*. 1998, 2004, 2007). Except of collecting data and information from field measurements about single trees or forest stands, assessment from remotely sensed data (satellite Landsat TM and ETM+) of the whole Czech forest cover and reporting about general forest health status and its spatial distribution have been running since 1990's. All these activities are recently coordinated by the Ministry of Agriculture (MoA CZ) and many national and private research bodies are being involved in forest monitoring and forestry research (e.g. Forest Management Institute - www.uhul.cz, Forestry and Game Management Research Institute - www.vulhm.cz, IFER - Institute of Forest Ecosystem Research, Ltd. - www.ifer.cz, Stoklasa tech., etc.). Annual "Green Report" is summing up results from the monitoring and forestry management/measures.

The Ministry of Environment (MoE) is the national entity with overall responsibility for the National Emission Inventory System and Climate Change. The Czech Hydrometeorological Institute (CHMI), founded by the MoE, is designated as the coordinating and managing body responsible for the compilation of the national greenhouse gas inventory and reporting its results (www.chmi.cz/cc/). Other national level forest research activities are carried out by research and academic institutions, largely on EU/national projects bases. As an example, the ISBE AVCR (www.usbe.cas.cz) is a member the Integrated Carbon Observation System (ICOS - www.icos-infrastructure.eu/), research infrastructure the main objective of which is to decipher the greenhouse gas balance of Europe and adjacent regions. Within this program, the ISBE AVCR is running experimental research site Bílý Kříž in the Beskydy Mts. (www.usbe.cas.cz/lefr/en_bily_kriz.htm) where, equipped with open-top chambers, glass dome, and UV-B illumination bank, is focusing on monitoring of the impacts of global climate changes on forest ecosystems.

I.3 Expected impacts

Most of the impact studies are run in phytotrons, open-top chambers, glass domes with a controlled environment facility and these results refer to relationships between changes in temperature, water conditions, concentration of CO_2, etc. (e.g. www.usbe.cas.cz/lefr) and physiological responses of trees. The results from such experiments do not bring clear answers and their interpretation for the scale of forest stands and regions is even more problematic. There is a high probability that rising temperature and concentration of CO_2 would further increase growth rates of some tree species (e.g. pine, beech) in temperate deciduous forest and would shift up altitudinal vegetation zones.

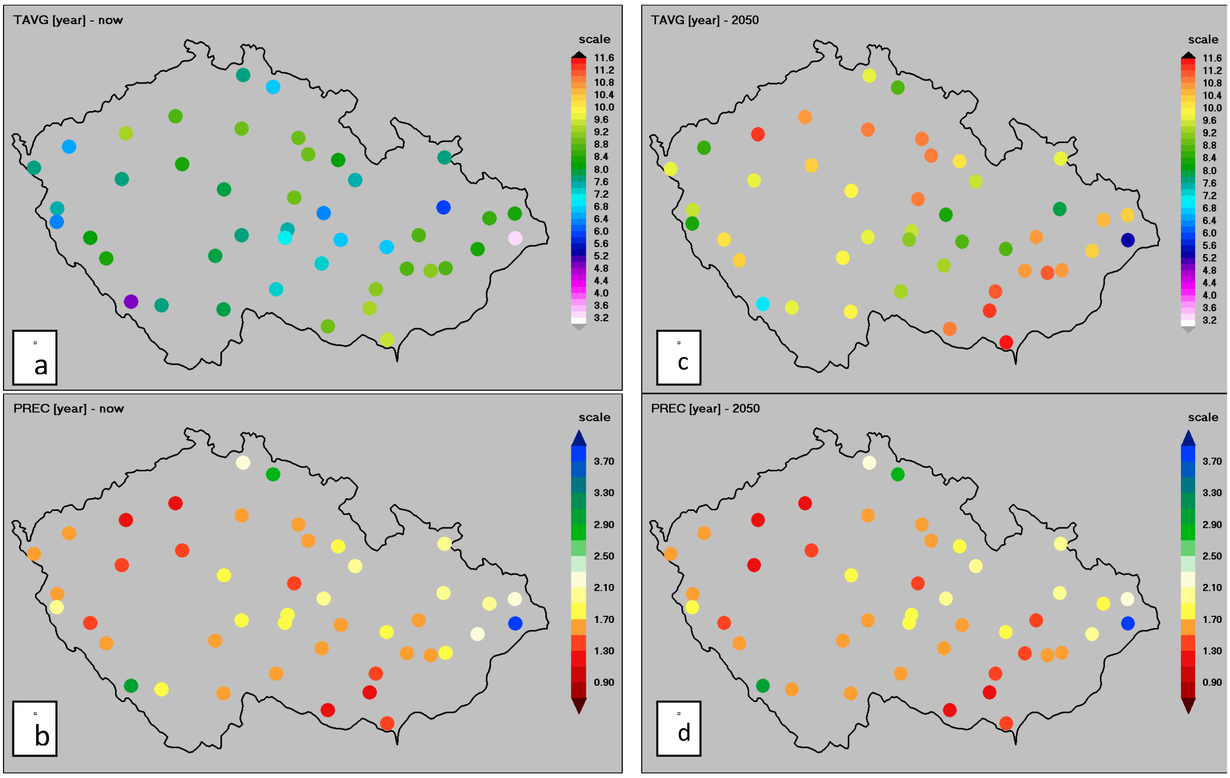


Fig. 7: Contemporary annual average temperatures TAVG (a), daily precipitations PREC (b) and in 2050, resp. (c, d). Reproduced from Dubrovský in Ač *et al.* (2009)

The temperature and precipitation trends (medium emissions scenarios IS92a) projected for the Czech territory to 2050 from the GCM models (MAGICC - www.cru.uea.ac.uk, ECHAM and HADCM - http://ipcc-ddc.cru.uea.ac.uk) display similar trends to those from the last decade, i.e., an increase in temperature and a slight decrease in precipitations (Fig. 7), (Dubrovský *et al*. 2005; Dubrovský in Ač 2009).

Regardless of a high uncertainty in simulations of climate changes, especially with respect to bulk precipitation and its spatial distribution, there is some common agreement on potential response of the Czech forests to changing conditions and on the measures that should be adopted in future forest management.

The recently observed calamities from pests and fungal diseases, affecting mainly Norway spruce, are perhaps the most actual peril resulting from climate change in the Czech forests. This is a consequence of hundred years lasting forest management heavily promoting Norway spruce plantations. Increasing temperature should invoke shifts in altitudinal vegetation zones that would further support a stronger representation of broadleaved tree species (notably beech) on account of currently dominating spruce.

Changes in species composition are closely related to changes in soil regime. Higher temperature and lower C/N ratio of deciduous tree litter will increase microbial activity and accelerate decomposition processes of organic matter. Hence, rising CO_2 concentration and increased amount of litter may result in more intensive humus accumulation.. Successively, decomposition processes may release more N and other nutrition elements and supportgrowth (Klimo *et al.* 2002, Kulhavý 2002).

I.4 Case studies

To be elaborated

II. Adaptation

Two different fields of adaptation measures can be distinguished:

- Activities focusing at trees and stands (incl. soils),
- Activities changing the socio-economic and political frame of forest management.

Adaptation measures ultimately aim at reducing the vulnerability to climate change. Measures relative to impact management are actions taken as immediate response to sudden impacts (see I.4 impact management).

Beyond immediate response actions to disturbance events (e.g. wind throw) there is the option to adapt current management practices and concepts, notably in order to reduce future impacts on forest stands and trees. Adaptation strategies may be elaborated as a general framework for all sectors at the country level. They may be stated for the forest sector, parts of the country or for specific forest types.

II.1. Vulnerability of forests and forestry

Relatively high vulnerability of the forests in the Czech Republic is given by its species composition, especially proportion of the Norway spruce. The potential natural share of spruce forests was about 11 %. The recent share of spruce forests is about 53 %. The spruce forests are mostly managed as a monocultures using blocks of clearcuts of maximum 1 ha with rotation period of 80 years. These types of forests are especially vulnerable to abiotic damaged by windstorms and snow and biotic damages by bark beetle and other pets. In 2007 windstorm Kyrill for example damaged about 15 mil. m^3 of wood, mostly in spruce forests. In 2008 windstorm Emma damaged about 5 mil. m^3 of wood, mostly again in spruce forests. In the following years (2008 and recent 2009) reasonable parts of spruce forests are affected by bark beetle as a results of the previous storm damage. In the 2008, about 2.5 mil. m^3 of wood was cut because of the bark beetle attack. If the frequency of such storms will increase in the future, the vulnerability of the spruce forests will also increase. Spruce forests in the low altitude (below 400 – 500 a.s.l) are especially vulnerable to drought stress. If the threat of the drought stress will increase in the future, these forests will be even more vulnerable to bark beetle and other pest than they are recently. In some region of the Czech Republic, there are enormous problems with management of spruce forests planted out of their natural range because of their general dieback (Beskydy Mts.). This dieback is probably a result of several factors (pest attack, drought stress, and others).

The Norway spruce is economically most important species for forestry and related wood industry. If the vulnerability of the spruce forests will increase in the future, it will have ultimate effect on the wood industry and related areas.

The expert opinion on forest vulnerability is as follows:

1. **until 2020**, increased impacts of the windstorms and related bark beetle attacks and other pest on the spruce forests, increased amount of wood from unplanned salvage fellings and loggings,
2. **until 2050**, increased impacts of the windstorms and related bar beetle attacks and other pest on the spruce forests, increased amount of wood from unplanned salvage fellings and loggings, potential improvement of situation if the planned adaptation measured will be implemented
3. **until 2100**, increased impacts of the windstorms and related bar beetle attacks and other pest on the spruce forests, increased amount of wood from unplanned salvage fellings and loggings, potential improvement of situation if the planned adaptation measured will be implemented.

The forestry in general in the Czech Republic will be highly affected if the projected climate change scenarios will fulfil. It will be a result of the high vulnerability of the spruce forests. The extent of these effects will depends on the future course of climate and the ability of the forestry in the Czech Republic to adapt to the climate change.

II.2. General adaptation strategy or policy

In the Czech Republic, National Climate Policy Program (2009-2020) is supposed to be launched in 2009 by the Ministry of Environment. The program follows the National Program to Abate the Climate Change Impacts. The forestry is important part of the recent and previous program in terms of impact, adaptation and mitigation. The recent National Climate Policy Program describes the past adaptation measures and also the recently discussed adaptation measures, which are part of the recently launched National Forestry Program

(2008 – 2013). National Forestry Program was launched in 2008, agreed by the Czech government and it describes general adaptation strategy of forestry in Czech. Recently there is ongoing negotiation about implementation of the particular adaptation measures into the forest management practice.

II.3. Forest adaptation measures

In 2008, a new National Forestry Program was launched. It includes general adaptation recommendations for the forest types of the whole country. Recently there is ongoing process of negotiation and discussion between different stakeholders about implementation of the particular adaptation measures into the forest management practice. This process should end up with selecting specific measures, which should be implemented in the forest management in the state and private forests in the whole country.

The main recommendations of recent National Forestry Program include measures in the following areas:

1. Silviculture – forest regeneration, silvicultural systems, species composition.
2. Management of carbon in the forests soils.
3. Subsidies of specific types of forest management practices.
4. Afforestation of agriculture fields with fast growing tree species.

The National Forestry Program launched in 2008 does not distinguish between the public and private forests. There is only one general strategy. However it is possible that during the process of implementation of the National Forestry Program specific adaptation measures may differ based on the ownerships of the forests. In the Czech Republic about 60 % of the forest land is owned by the state. This might be one of the big advantages of the forestry while deriving and implementing adaptation strategy and measures.

The National Forestry Program of Czech Republic includes following adaptation strategies and measures:

1. To grow diversified forest stands with the greatest possible employment of natural processes, varied species composition, natural regeneration and variability of silvicultural practices.
2. To prevent soil degradation and thus maximize the amount of carbon fixed in the soil.
3. To promote forest species and ecotypes resistant to climate changes.
4. To optimize carbon cycling in soil horizons, growing stock and wood products.
5. To apply measures maintaining high and stable wood mass production.
6. To extend legal time limits for the afforestation and establishment of stands in line with the natural forest regeneration.
7. In respect of forest typology, to assess possible changes of forest altitudinal vegetation zones (FAVZ).
8. To focus the rules of public aid on the support of adaptive measures mitigating the impacts of climate change.
9. To foster the environment-friendly afforestation of farmlands.
10. To shorten the rotation period in woody species most jeopardized by climate change.

11. To support cultivation of stands with fast growing tree species on agricultural land with regard to the draft amendment to Government Decrees No. 239/2007 Coll. and No. 308/2004 Coll. as amended by Government Decree No. 512/2006 Coll. concerning, among others, the fast growing tree species grown on farmlands for energy purposes, approved by Government Resolution No. 402 of 16 April 2008.
12. To provide for the management of low forest and coppice-with-standards.

II.4. Research studies of forest adaptation

Till now there were no specific projects focusing on forest adaptations. Most of the projects still focus on the impact and mitigation. Forest adaptation is still mostly discussed in the scientific and professional journals.

From the ongoing projects, these are connected with the forest adaptation:

1. Project SP/1A6/108/07 (Ministry of Environment) - Specification of existing estimates of climate change impacts in hydrology, water management, agriculture and forestry sectors and proposals for adaptation options (2007-2011, MZP/SP). No results concerning forest adaptation available yet.
2. Project “Forest adaptation strategy for the changing environment in the Moravian-Silesian Beskids” (LASPROBES), funded by the Czech Forests, s.a. This project was initiated in response to rapidly worsening conditions of spruce stands in the Jablunkov region in the North-East part of the Czech Republic. The project aim is to formulate adequate forest management adaptation strategy. To start in Nov. 2009, no results available yet.

III. Mitigation

III.1 Carbon accounts

The greenhouse-gas reporting of the Land Use, Land-Use Change and Forestry (LULUCF) sector in the Czech Republic is under the technical responsibility of IFER – Institute of Forest Ecosystem Research. IFER is a part of the National Inventory System, coordinated by the Czech Hydrometeorological Institute and under the formal responsibility of the Czech Ministry of Environment.

Since 1990, the LULUCF sector represented a net sink of emissions in the Czech Republic. In average for the period of 1990 to 2007, it reached about 5 % of the total emissions of the country. However, the actual contribution of the sector varies annually (Fig. 8).

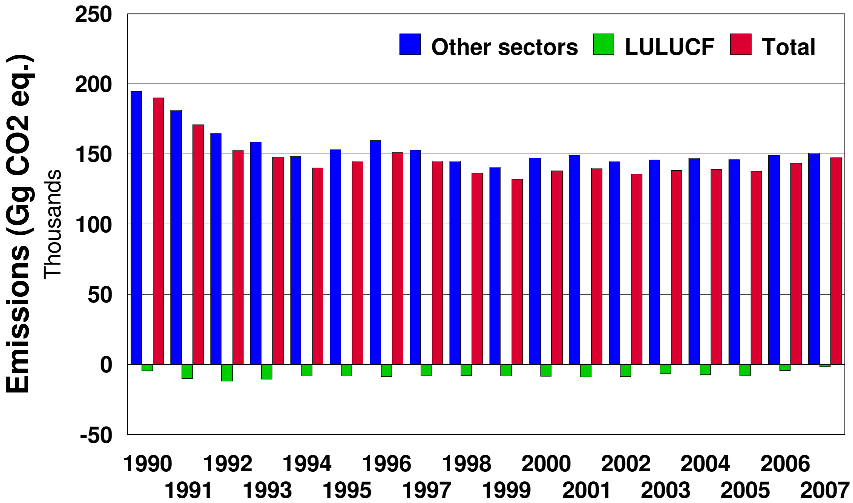
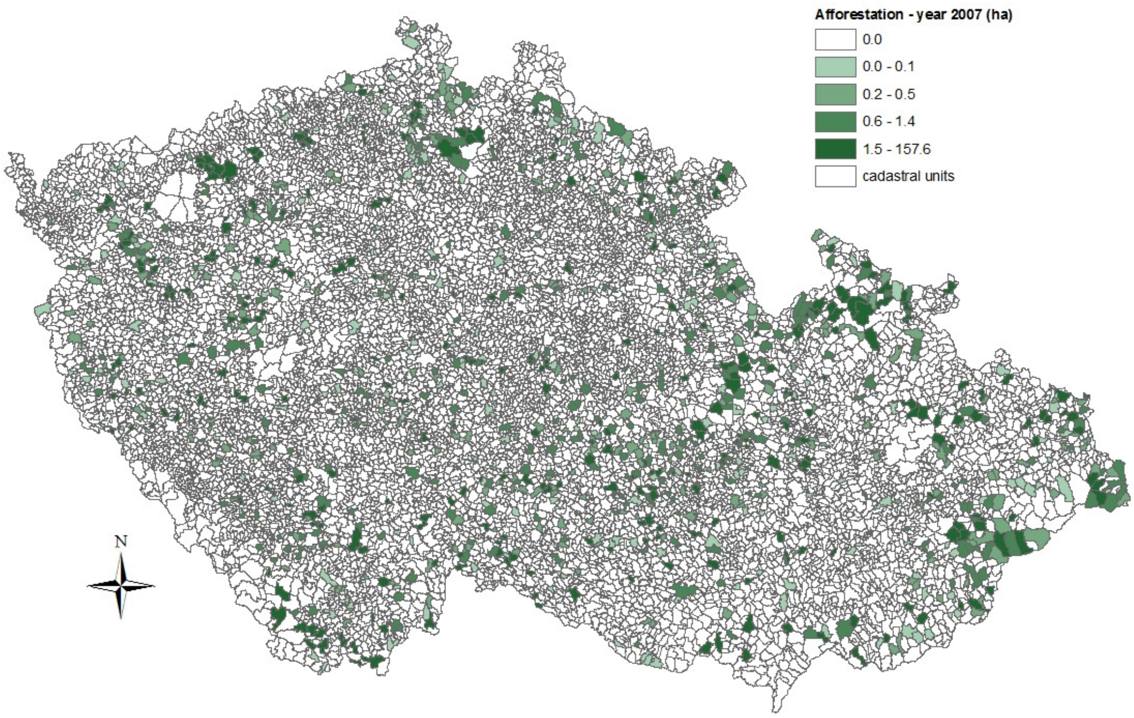


Fig. 8: The contribution of the LULUCF sector (green bars) in relation to the other sectors (blue bars) of the Czech emission inventory. The negative emission values by the LULUCF sector represent a sink of emissions for the entire reporting period, hence somewhat decreasing the emission total (red bars).

The methodology of the emission inventory for the LULUCF sector is guided by the IPCC Good Practice Guidance for LULUCF (IPCC 2003), while the elements of the IPCC Guidelines (IPCC 2006) are also gradually implemented. The Czech emission inventory of the LULUCF sector is based on the cadastral data on land use and a specific land-use change detection, which is elaborated on a level of about 13 thousand cadastral units. This system is also used for detection of the LULUCF activities under the Kyoto Protocol, i.e., for afforestation/reforestation and deforestation activities under Art. 3.3 and for Forest Management, the only voluntary activity of Art. 3.4 elected by the Czech Republic (Fig. 9).



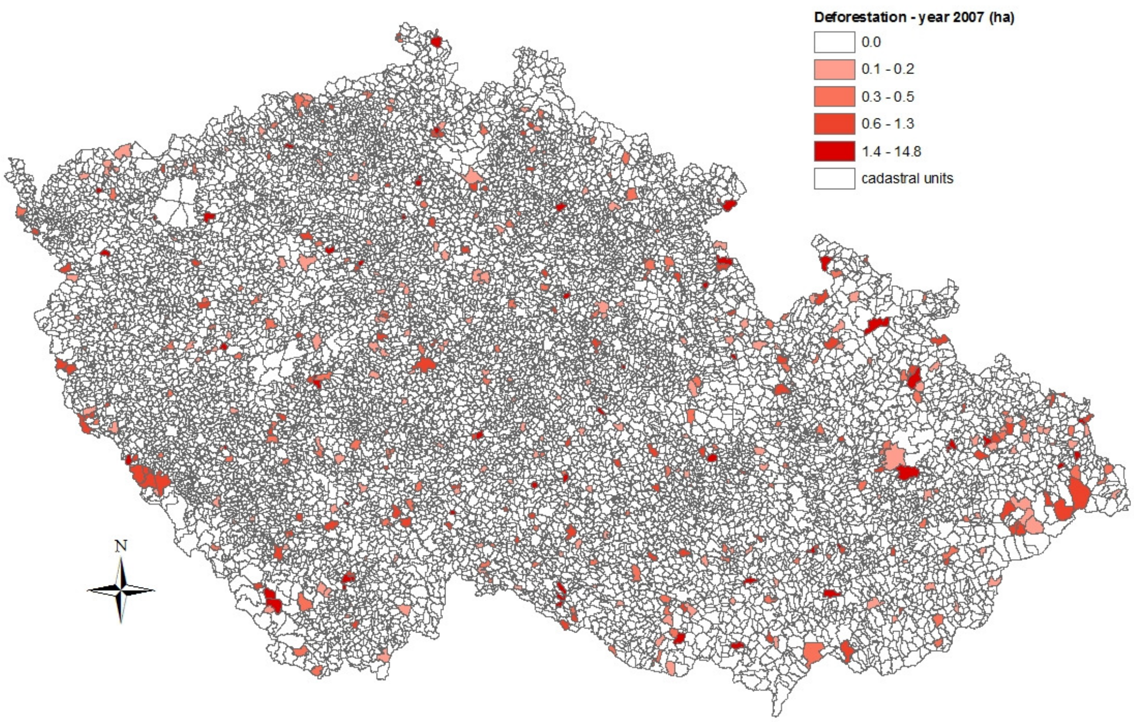


Fig. 9 Spatial identification of afforestation/reforestation (AR; green patches, above) and deforestation (D; red patches, below) activities for the year 2007. Each cadastral unit with non-zero occurrence of AR or D activity is identified and marked using the color scales in ha units.

Table 1: GHG estimates in Sector 5 (LULUCF) and its categories in 1990 (base year) and 2007.

Sector/category	Emissions 1990 Gg CO_2 eq.	Emissions 2007 Gg CO_2 eq.
5 Total LULUCF	-4 565	-1 720
5A Forest Land	-5 880	-1 583
5A1 Forest Land remaining Forest Land	5 473	-1 155
5A2 Land converted to Forest Land	-407	-428
5B Cropland	1 336	134
5B1 Cropland remaining Cropland	1089	55
5B2 Land converted to Cropland	247	79
5C Grassland	128	383
5C1 Grassland remaining Grassland	59	4
5C2 Land converted to Grassland	-187	-387
5D Wetlands	22	19
5D1 Wetlands remaining Wetlands	(0)	(0)
5D2 Land converted to Wetlands	22	19
5E Settlements	85	93
5E1 Settlements remaining Settlements	(0)	(0)
5E2 Land converted to Settlements	85	93
5F Other Land	(0)	(0)

Note: Emissions of non-CO_2 gases (CH_4 and N_2O) are also included.

In 2007, the net GHG flux for the LULUCF sector, estimated as the sum of emissions and removals, equalled -1.72 Mt CO_2 eq. These removals realized within the LULUCF sector decrease the GHG emissions generated in other sectors by 1.1 %, which is the smallest contribution since 1990. The contribution of the LULUCF sector in 1990 and in 2007 with individual land-use categories is shown in Table 1.

The emission inventory of the Czech Republic is periodically reviewed by the UNFCCC review teams. The most recent in-country review was held in October 2009.

III.2. Forestry as a source of bioenergy

Biomass has a dominant position among the renewable energy sources in the Czech Energy Policy (2004). It is expected that it will contribute up to 85 % (from current app. 66 %) of the whole share of renewable energy sources on primary energy consumption in 2030, the target year of the Czech Energy Policy. Within renewable resources, biomass plays also an important role in power generation – the share of biomass is expected to increase up to app. 80 % at 2030 from a current share of app. 50 %.

Sources of biomass for energy in the Czech Republic can be divided into main two groups – residual biomass and biomass intentionally produced from energy crops. A list of the relevant sources is given below:

Residual biomass:

- Waste wood, woodchips, wood shavings and sawdust from sawmills, wood-processing and paper industry
- Organic residues and plant residues from food industry esp. milk and oil/fat factories e.g. shells and skins from seeds
- Branches and other residues from forest felling and thinnings including fire wood
- Residual straw from harvest of cereals and rape
- Wood biomass from pruning of fruit orchards and maintenance of river banks, parks, alleys and other greenery
- Recycled wood from buildings and house construction

Biomass from energy crops:

- Fast growing trees: short rotation coppice of mainly willow and poplar on agriculture land
- Perennial and herbaceous crops: Sorrel-Dock hybrid, Miscanthus, Reed Canary grass, energy triticale, etc.

In present, mainly residual and waste biomass from wood-processing industry is utilised and covers most of the total biomass utilisation in the Czech Republic (Fig. 10). Other slowly increasing resource with a large potential is forest felling residues, which can be now produced for competitive price due to increasing price of waste wood from wood-processing industry. Total forest area in the country is 2,65 mil. ha. A theoretical potential of forest residuals (residuals from timber felling and thinning) is about 0,9 t/ha/year, but it varies significantly depending on local conditions and barriers.

Currently there are three projects focussing on assessment and evaluation of the potential of biomass sources in the Czech Republic, including forest residues. Their results will be available in 2010.

Sources of residual biomass are rather limited in the Czech Republic. Energy crops on potentially available land are expected to play the major role as of 2030 (Fig. 10).

It is expected that energy crops will be planted preferably in regions with limited suitable conditions for classical intensive agricultural production – so called Less Favorable Areas (LFA). LFA in principle are areas with climatic and soil conditions that do not allow economically profitable production of food crops. It is estimated that the planted area of non-woody energy crops is currently 1200 ha. Growing area of short rotation coppices with poplar and willow is about 250 ha.

Biomass market is still undeveloped in the Czech Republic and has mainly a local character. Biomass in the form of wood residuals from timber felling is expected to play important role in midterm. But in longer term the major role of intentionally planted biomass is expected.

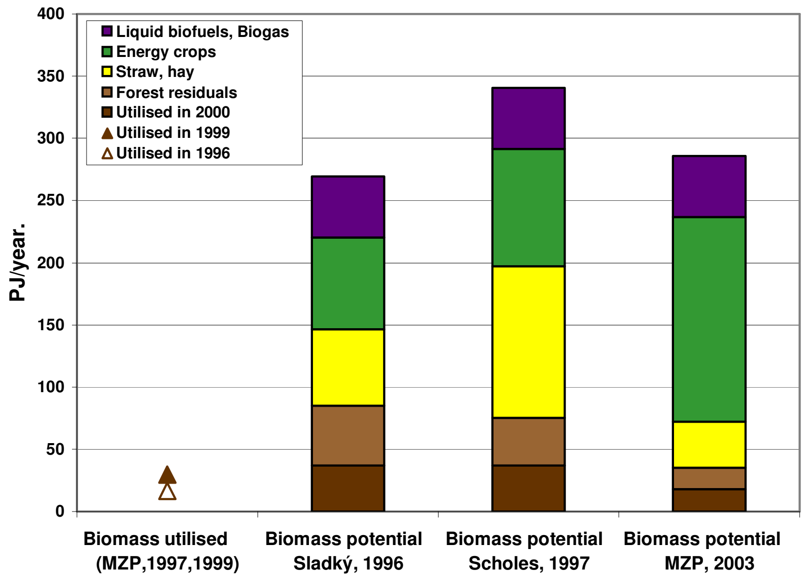


Fig. 10: Solid biomass utilization in the Czech Republic and biomass realizable potential up to year 2030 according to different analyses (see Knápek *et al*. 2005).

III.3. Processes, instruments and strategies

There are no specific forest mitigation strategies implemented in the country. The most recent strategic documents (currently being prepared in the country) stress afforestation of abandoned agricultural land. The potential for afforestation is, however, rather limited. As for the current forest land and forest management, mitigation is considered to be tightly linked to adaptation strategies. The key adaptation measure applicable for the Czech forestry is to strengthen the resilience of the current forest stands. This in practice means increasing the share of broadleaved species, creating structurally rich forest stands and decreasing the share of spruce monocultures in the country, which are for several reasons sensitive to climate change effects and extreme weather events. Such adaptation measures may mean some reduction of growing stock, i.e., carbon held in biomass. However, this strategy is also considered as a suitable mitigation measure for forestry, as it presumably ensures a long-term stability of carbon stocks in forests, preventing emissions due to various disturbances.

III.4. Research studies on mitigation

Several studies and projects focused on carbon and carbon balance have been conducted in the country during recent years. The most important national projects to mention are CzechCarbo (2003-2007) and CzechTerra (2008- 2011), supported by the Czech Ministry of Environment and coordinated by the Institute of Systems Biology and Ecology, Czech Academy of Sciences, České Budějovice.

The CzechCarbo project contributed, among others, to the methodological development of the Czech LULUCF emission inventory and outlined the specific adaptation and mitigation strategies and recommendations for the Czech forestry.

The currently running project CzechTerra contains several important elements supporting adaptation and mitigation strategies in the country. CzechTerra established a new statistical landscape inventory in the country. It is designed to effectively provide fundamental information on landscape and forestry at country level for the needs of international reporting, such as UNFCCC and CBD.

A mitigation potential in the Czech forestry was recently analyzed by the EFISCEN model (Cienciala *et al*. 2008). This tool was previously also used to analyze growing stock development under different management strategies for several European countries, including Czech Republic (Schelhaas *et al*. 2004).

IV. Case studies and references

At this moment we do not elaborate on case studies.

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