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METHODOLOGY OF ANALYSIS OF BIOMASS POTENTIAL USING GIS IN THE CZECH REPUBLIC

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Abstract

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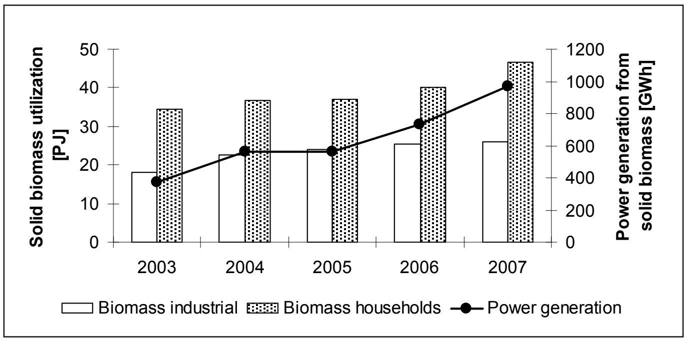
This article deals with the issue of a methodology for and analyzing biomass potential in the Czech Republic using a geographic information system. The biomass sources considered include cereal and rape straw, permanent grasslands and forest residuals. The process of assessing biomass potential from agricultural soils is based on assigning yields of individual biomass sources according to the production soil-ecological units (BPEJ) which were created for better agricultural planning in the Czech and Slovak Republics. The analysis of energy crop suitability is based on the evaluation of crop yields related to individual BPEJ's respectively to its component the main soil climate units (HPKJ). To ascertain the production potential of residual biomass (straw) from conventional agriculture, the wheat (grain) yield related to HPKJ was multiplied by the straw coefficient. The yield of the permanent grasslands in the main soil climate units was also multiplied by the coefficient of dry matter. The methodology for the analysis of biomass potential for forest land is based on forest management plans that describe the composition of all forest stands. Data from these forest management plans can be used to determine in detail the potential of the forest biomass in individual periods according to the plan for silvacultural treatment and major harvest of the wood. This detailed analysis is suitable only on the municipality level. On a higher government level, the forest management plan can be used to calculate a coefficient that determines the average yield from biomass in the form of forest residuals and in relation to the forest size for specific areas or levels of analysis. The energy potential of residual biomass is around 136 PJ from present area of conventional agriculture in the Czech Republic. Biomass consumption in animal production and harvest loses were deducted from this calculation.

biomass potential, soil-ecological units, forest residuals, permanent grasslands, straw

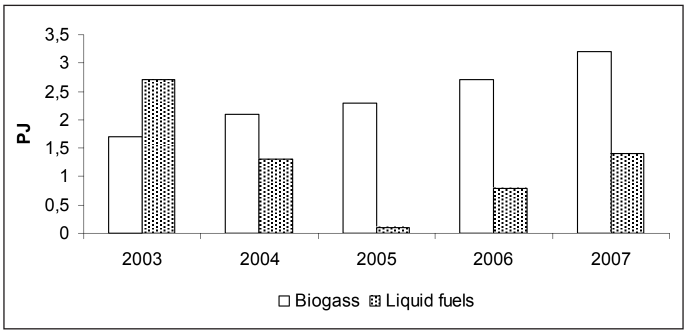
Today, biomass energy continues to be the main source of energy in many developing nations, particularly in its traditional forms, providing on average 35% of the energy needs of three-guarters of the worlds' population. Biomass covers between 60 and 90% of energy demand in the poorest developing countries. However, modern biomass energy applications are increasing rapidly both in the industrial and developing countries, so that they now account for 20–25% of total biomass energy use. For example, the United States obtains about 4% and Finland and Sweden 20% of their primary energy from biomass (Calle *et al.*, 2007).

Biomass features strongly in virtually all the major global energy supply scenarios, as biomass resources are potentially the world largest and most sustainable energy source. The annual bioenergy potential is about 2900 EJ (approximately 1700 EJ from forests, 850 EJ from grasslands and 350 EJ from agricultural areas) (Hall and Rao, 1999). In theory, at least, energy farming in current agricultural land alone could contribute over 800 EJ without affecting the worlds' food supply (Faaij *et al.*, 2002).

Biomass is the most important renewable energy source (RES) in the conditions of the Czech Republic and contributes about 82% to the total RES contribution to the primary energy sources (74 PJ of 91 PJ in the year 2007). Solid biomass utilization grows since beginning of last decades as the result of the two factors: continuously increasing prices of electricity as well as natural gas and state support of biomass utilization in power generation (Fig. 1).



1: *Development of biomass utilization in the Czech Republic (MPO, 2008)*



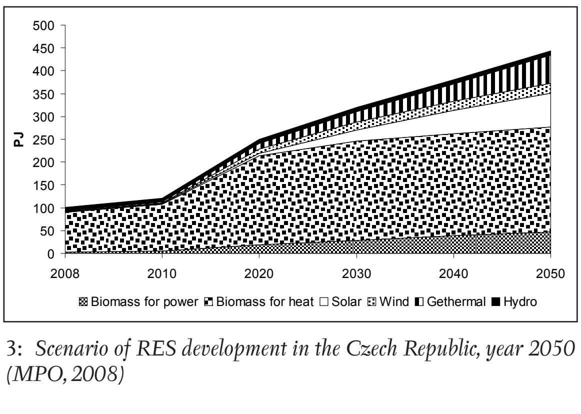
2: *Development of biogas production and domestic consumption of liquid fuels in the Czech Republic (MPO, 2008)*

Power generation based on biomass utilization reached almost 1 TWh_e (968 GWh_e) in the year 2007. Significant part of solid biomass was consumed by households for space heating, cooking a hot water preparation – 46.6 PJ (app. 3 million tones) in the same year. It is expected that significant part of currently used coal will be substituted by biomass during this decade. Liquid bioefuels consumption and biogas contribution is significantly lower compared with the contribution of solid biomass (Fig. 2). Utilization of solid biofuels (biomass pellets and briquettes) is almost negligible at the moment – 54 000 tones of briquettes and 16 000 tones of pellets (MPO, 2008).

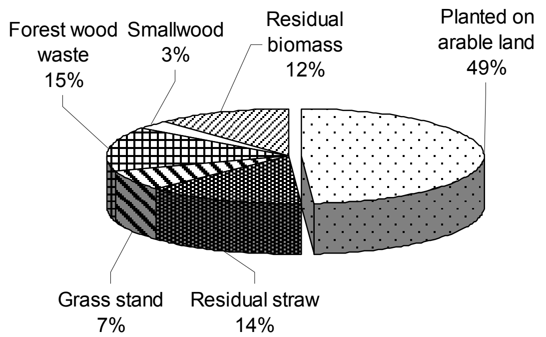
Sources of biomass

Biomass is the decisive RES in long-run (horizon 2020–2050) in the condition of the Czech Republic. But easily available sources of residual biomass (namely residuals from wood processing industry) are already utilized to the major extent. It is not possible to meet future needs for biomass without rapid development of biomass planting for energy purposes on agriculture land. Long-run perspective of RES utilization (Fig. 3) was published in the year 2008 (MPO, 2008).

As mentioned above, sources of relatively cheap biomass are already utilized to the significant extent, namely wood residuals from wood and paper industry. Sources of additional biomass are especially:



3: *Scenario of RES development in the Czech Republic, year 2050 (MPO, 2008)*



4: *Scenario of structure of biomass sources in the Czech Republic, year 2050 (source: MPO, 2008)*

- Higher utilization of residual biomass from agriculture – esp. straw and grass from permanent grasslands.
- Utilization of small wood – residuals from timber felling.
- Intentionally planted biomass on agriculture land (energy crops).

First two sources are limited and their contribution to the future biomass delivery is less significant (Fig. 4) according to MPO (2008). The decisive role will be played by (energy crops) intentionally planted biomass from agriculture land for several different purposes.

There are not only different types of biomass competing each other, but also different biomass users competing for biomass. But the primary bounding factor here is the agriculture land utilization. The area of agriculture land is limited and one should respect the fact that from environmental reasons the requirements to reduce intensity of land utilization will have higher importance. This can be seen at present in the case of forest residuals. Environmental protection calls for smaller areas of forest harvest, but in contrary it limits (economic) effectiveness of residuals collection and processing to the wood chips.

Up to 1 million hectares of agricultural land (of total 3.6 mil. hectares of agriculture land) is assumed to be used for energy purposes in the long-run according to most recent studies (CZ Biom, 2009). Fast-growing trees (poplar and willow), reed canary grass, miscanthus, rescue grass, tall oat-grass, sorrel hybrid, and cocksfoot are among the most promising energy crops to be grown on these lands.

Poplar and willow (short rotation coppice)

A short rotation coppice (SRC) with fast-growing trees – poplar and willow – is a promising lignocelulose crop system in the Czech Republic. Length of rotation in a Czech SRC ranges between 3–6 years, which can be repeated 4–7 times on same stump (Havlíčková a kol. 2008). The actual acreage of SRC, however, is small, only about 300 ha. This slow growth has been caused by different reasons including an inconsistent subsidy system and some legal barriers (nature protection). Yields vary between 7–12 t(dry)/ha/year depending mainly on site quality.

Sorrel hybrid schavnat (*Rumex patientia* L. × *Rumex tianshanicus* A. Los.)

Sorrel is a perennial crop, which can be partially or fully used for biomass production (direct burning, biogas production). Moreover it is a very perspective crop for producing high quality forage, specialized food products and biologically active food and feed additives. Dry stalks can be harvested for energy in the summer continuously for more than 10 years according to Ust'ak and Ust'akova (2004). It has very few requirements for soil, fertilization and climate. It is registered as an agricultural crop 'Rumex OK-2' in the Czech Republic. The actual acreage of schavnat is about 1200 ha, which is relatively small, but it is the largest out of all lignocelluloses energy crops. Yields of dry stalks vary between 5–9 tDM/ha/year depending on site conditions and the quality of the agrotechnolgy.

Miscanthus (*Miscanthus* × *giganteus* J. M. Greef et Deuter)

Another promising biomass producing crop is *Miscanthus* × *giganteus*. It is a large perennial grass with high water efficiency usage (C4 type of photosynthesis), which can be used for energy production. Currently it is grown only on very small area in the Czech Republic. The main reason is the high cost of the planting material and the little knowledge about methods of growing and utilisation among farmers (Havlíčková *et al*., 2008).

Approaches to assessment of biomass potential

Several studies were carried out of biomass potential assessments in the Czech Republic in last 13 years (Sladký, 1996; Scholes, Manning, Markvart, 1997; SRCI CS, 1999; Lewandowski *et al*., 2006; Report of independent expert commission, 2008; CZ Biom, 2009). Total biomass potential ranges between 151–276 PJ/year for long-term assessments (2030–2050) in these studies. Authors were using different approaches and methodologies which have led to different results not only in total potential, but also in distribution of potential among different biomass sources, time horizons and geographical areas. Regarding composition of biomass potential we can find that in earlier studies (Sladký, 1996; Scholes, 1997) 3 main biomass sources – forest residues, straw and energy crops – have had approximately equal contribution to overall biomass potential. In most current studies (Report of independent expert commission, 2008; CZ Biom, 2009) contribution of residual biomass from forest and agriculture has decreased significantly to 18% and 12%. The importance of intentionally grown biomass (energy crops) is confirmed in all recent studies with energy potential ranging between 63 and 79% of total biomass potentials.

Definition of type of biomass potential and especially its barriers and limits for biomass utilisation are also applied differently in these studies. Most of the studies are assessing realisable biomass potential, but they differ quite much definition of its barriers (especially technical, environmental). Most of the studies also do not consider more scenarios of biomass development. The Action plan for biomass (CZ Biom, 2009) is the only domestic study which defines two scenarios of biomass development – "food security scenario" and "energy biomass scenario" which differ in respect to national strategy of food supply. Total biomass potential according to these scenarios is 151,3 PJ and 201,9 PJ/year. Six scenarios of biomass development were analysed in EU project VIEWLS (Lewandowski *et al*., 2006) which included different crop-yield levels (actual, optimal), conversion efficiencies and different land allocation procedures.

Used methodologies aren't often described in published reports which makes comparison and validation of results quite difficult. Some assessments were using only statistical data of biomass production, land availability and yields of (energy) crops to calculate biomass potential using simple formulas and indexes (Sladký, 1996; SRCI CS, 1999, Report of independent expert commission, 2008; CZ Biom, 2009). These studies are typically providing only overall biomass assessments for whole the Czech Republic without more detailed information about its geographical distribution. These studies therefore cannot consider some important factors in details as change of yields according to site conditions and distribution of agricultural land.

Other group of studies is using GIS (digital maps and databases) for analysis of biomass resources (Scholes, Manning, Markvart, 1997; Havlíčková *et al.*, 2008). Corine Database is often used on the continental (EU) or national level. On national or regional level other GIS sources are used as actual crops maps, agricultural land valuation maps, forest management plans and different atlases. Most detailed methodologies of biomass potential assessment (Havlíčková *et al.*, 2008) combine GIS sources with statistical data and results of research on new energy crops.

METHODS AND MATERIALS

For the analysis to fulfill its goals, it must go through a certain process that can basically be characterized on an axis: defining the task – selection of a methodology, processing instruments and data sources – data processing – interpretation of the results. Following the given approach and principles allows for the attainment of reliable results that enable rational strategic decision-making about the utilization of biomass in the area considered. The methodology can contribute to the economically efficient and environmentally acceptable development of bioenergy in regions of the Czech Republic (Havlíčková *et al.*, 2006).

Defining the task

Defining the task is an important step in the process because it enables the selection of a methodology, the completion of concrete analysis and obtainment of suitable accuracy in the resulting data. The task is specified by the applicant and must obtain the following basic parameters:

- Quantification of the scope of the analysis or from which interested area is biomass to be utilized or how much energy potential from biomass is needed for the considered source.
- Determination of the required biomass sources or which form of biomass is to be used and under which parameters and eventually which technology is to be used.
- Definition of the type of biomass potential or what potential do we want to know – e.g., technical exploitable usable, available or economic.
- Determination of the time horizon or when, eventually in which period do we want to start using the potential.

Methodological approach using GIS

The biomass sources considered include cereal straw, permanent grasslands, forest residuals and fast-growing trees. The process of assessing biomass potential from agricultural soils is based on assigning yields of individual biomass sources according to the production soil-ecological units (BPEJ) or the main soil climate units (HPKJ – a part of the BPEJ), which were created for better agricultural planning in the Czech and Slovak Republics during 1980s and 1990s (Havlíčková *et al.*, 2006).

The methodology for the analysis of biomass potential for forest land is based on a different principle than the assignment of yields according to the BPEJ. Forest management plans that describe the composition of all forest stands have been completed and are regularly updated. Data from these forest management plans can be used to determine in detail the potential of the forest in individual periods according to the plan for silvacultural treatment and major harvest of the wood. This detailed analysis is suitable only on the municipality level.

Zoning of agricultural land for energy crops

Despite the Czech Republic's relatively small size, it has a wide range of climatic and soil conditions. The diversity of conditions here stems mainly from the quite mountainous surfaces (altitudes 180–1600 m) and the republic's position in the transitional zone between the oceanic and continental types of climate. The average yearly temperature ranges between 5–10 °C and annual precipitation between 400–900 (1500) mm.

Therefore a new agricultural land valuation was created for better agricultural planning in the Czech and Slovak Republics during 1980s and 1990s, based on an extensive land and climatic overview. The base units of the system are the production soil-ecological units (BPEJ) from which the main soil climate units (HPKJ) can be derived. There are 10 agroclimatic regions and also 10 main soil types that are further divided into 73 sub-types (Havlíčková *et al.*, 2006).

Results of willow and poplar and other new energy crops field testing showed that the factor of locality – its climatic and soil conditions – had the most statistically conclusive influence on yields and also other growth parameters. Therefore zoning of agriculture land was created to identify areas suitable, unsuitable or environmentally risky for biomass production using willow and poplar SRC (Weger *et al.*, 2007). Zoning of agriculture land for other crops has been created in the last year (e.g., for canary grass, miscanthus, rescue grass, tall oat-grass, sorrel hybrid, and cocksfoot) to assess biomass potential in the Czech Republic.

Main data sources and instruments

- Maps (SMO 5 in Czech) on a scale of 1 : 5000.
- Another map base is the LPIS that also includes actual grown crops.
- Maps and databases of BPEJ, LHP.
- Site specification and the yield curves of selected energy crops (willow, poplar reed canary grass, miscanthus, rescue grass, tall oat-grass, sorrel hybrid, and cocksfoot) in the BPEJ system from the results of field testing and research projects.

The main instruments for processing these data include the following:

- SW TopoL
- SW ArcGIS Desktop version 9.2,
- Microsoft Excel.

RESULTS

Potential of individual biomass resources

Residual straw

To geographically analyze the potential of grain straw from conventional agriculture, yield tables are used for grain for individual production and ecological soil units (BPEJ). To ensure that straw yields are calculated only for arable lands it is necessary to check overlapping of grain yield maps and the map of actually grown crops (LPIS in Czech). In the next step straw yields are calculated from grain yields using the coefficient of the straw share (Ks) that according to experts e.g., for wheat ranges between 0.8–1.0, barley 0.7, rape 0.8.

Finally, it is necessary to deduct the amount of straw needed for farm animals (cattle, sheep, rams, horses). In the final step, straw residuals that have the required amount for animal production deducted should be multiplied by the heating value. The energy potential for burning from conventional agriculture is the sum of the residual grain straw and rapeseed (Tab. I).

I: *Energy potential in the Czech Republic for burning from conventional agriculture*

	in t	in GJ
Residual grain straw	5057443.75	79401866.86
Rape	620249.12	10854359.6
Total	5677692.87	90256226.46

Permanent grasslands (TTP in Czech)

To determine the biomass potential of grassland areas, grass yields from tables are used similarly as with the grain straw. In the first step, grassland yields are assigned to each BPEJ unit and then entered into a GIS database. These tabular yields include "raw" grass yields, therefore they must be corrected to dry mass using a coefficient of 0.20 (20% dry mass). In the second step, the overlapping of the yield layer and the map of actually grown crops (LPIS) ensures that the grass yields are determined only on grasslands.

Energy potential from biogas stations takes into consideration the following sources: silage corn silage and permanent grasslands (Tab. II.). The calculation of energy potential for silage corn is counted with 60% harvest humidity One ton of 35% dry corn silage can produce about 240 m^3 bioethanol, i.e., it has an energy potential of 4.5 GJ.

To calculate the energy potential of permanent grasslands, a coefficient is needed to correct the yields in tons/hectare because yields include "raw" yields per hectare (20% dry matter). One ton of 35% dry material from these grasslands can produce 175 m^3 biogas, i.e., it has an energy potential of 3.3 GJ.

II: *Energy potential from conventional agriculture biogas production in the Czech Republic*

	in t	in GJ
Corn for silage and permanent grasslands	14022121.64	45696915.83

Forest residuals

Analysis of biomass potential of forest stands is based on a similar principle as the agro systems – thus on the site values, but not using the BPEJ and LPIS. In the Czech Republic, forest management plants based on forest types (SLT in Czech) provide expected yields (reserves) of wood biomass. From these data, forest biomass potential can be determined in detail for individual periods according to the planned forest management (silviculture – thinning and felling) and to harvest, not only to the actual date, but also on a 10-year or longer horizon. This detailed determination of forest potential is appropriate for analyzing at the municipality level.

For higher administrative levels, the calculation of potential is very difficult to process, therefore in the project LHP analysis of selected areas was completed and a coefficient for forest logging residuals (KLZ) was calculated to quantify total amount and distribution of potential at the regional and district levels. The coefficient value is 0.63 t/ha at 60% water content and gives the average biomass yield for forest exploitation residuals related to forest area.

When completing an economic assessment of the utilizable potential to determine the cost of 1 GJ of heat in fuel, the above-mentioned layer is integrated with another layer that includes the results of the economic calculation aimed at determining an estimate price of the corresponding biomass forms. The estimate of biomass prices was created on the basis of an economic model that represents all steps needed for processing forest harvest residuals after logging. The resulting price of wood chips ranges from 90–105 CZK/GJ of heat in fuel and depends on the salaries of the workers participating in the processing.

Energy crops

To determine the potential of selected energy crops, the yield potential of these crops related to the site value, preferably to the BPEJ or HPKJ, must be known.

Energy crops used in the model include fast-growing trees, reed canary grass, miscanthus, rescue grass, tall oat-grass, sorrel hybrid, and cocksfoot. Basic site specification that gives expected yields in the HPKJ system was created for these energy crops. For computer analysis, these expected energy crop yields were entered into a database and assigned to each BPEJ unit, therefore creating the field layer for the GIS model, i.e., energy crop yields. In the next step energy crop potential can then be done by filtering through the yield layers with the suitable soil types. The figure 5 demonstrates yields of miscanthus in NUTS3 – Královehradecký region.

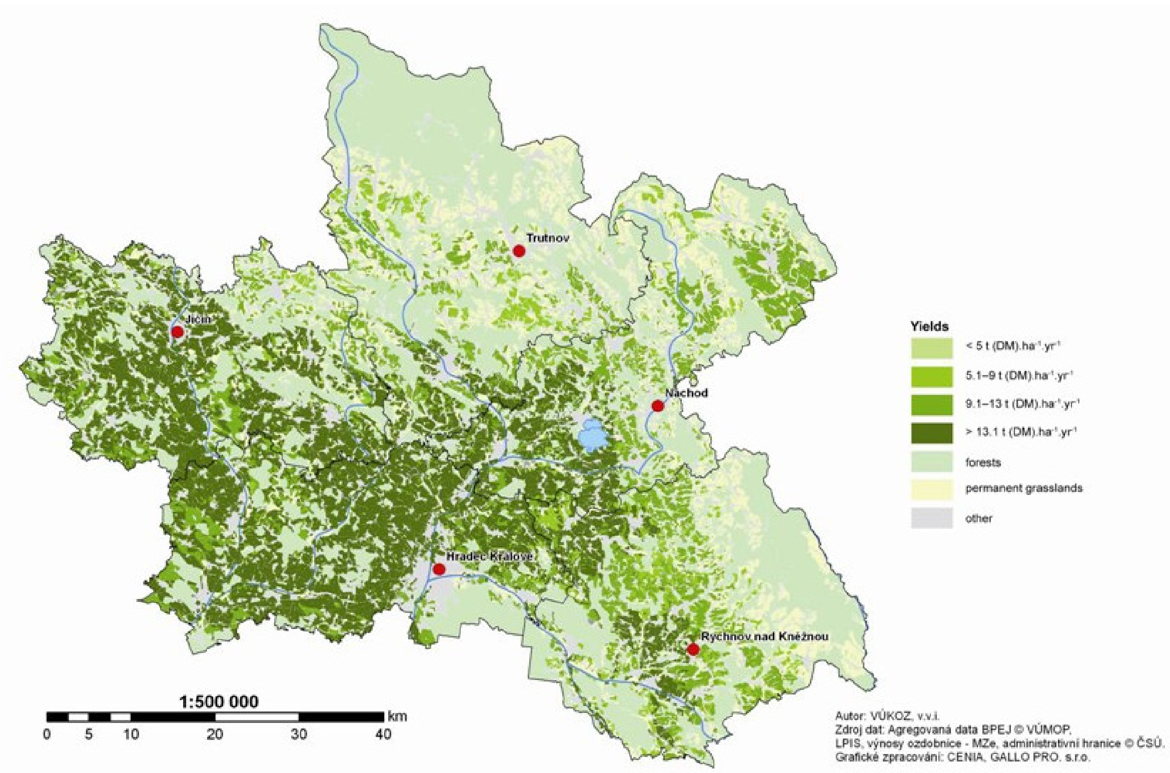
In the model, the variant using 10% of Czech agriculture lands that included mainly soils with the lowest production potential for cereal grains and other conventional agricultural crops, was selected. Here, the tabular yields are the lowest because we are dealing with permanent grassland areas.

DISCUSSION

First results of our work show that proposed methodology for analysis of biomass potential can produce very detailed geographical data about distribution and amount of different biomass sources in landscape down to the NUTS-4 level. The methodology can be also used for calculating and evaluation different scenarios and tasks respecting different land use patterns, preventing land use conflicts with food crops or nature protection. It can be also used for analysis in wide time scale from analysis of current biomass potential up to few decades horizon. The methodology created is far more detailed and flexible than those used up to now for assessment of biomass potential in the Czech Republic (Sladký, 1996; Scholes, Manning, Markvart, 1997; SRCI CS, 1999; Lewandowski *et al.*, 2006; MPO, 2008; CZ Biom, 2009).

From preliminary results of biomass potential assessment (agricultural residuals and some energy crops) it can be also concluded that biomass sources can be mobilized to fulfill national goals in consumption of biofuels and that biomass can be the dominant renewable source in the Czech Republic. The decision to use biomass for energy purposes should always be preceded by an analysis of the biomass potential for the area being considered.

A unique feature of presented methodology is a possibility to analyze land competition between food and energy crops under different scenarios of biomass utilization in the Czech Republic. It is important because production and use especially so-



5: *Yield map of miscanthus – NUTS3, Královehradecký region* called first-generation biofuels, have been criticized and debated recently in the scientific and non-scientific literature (Henke *et al.*, 2005; Patzek *et al.*, 2005; Moore, 2008; Rabbinge, 2008a). Food commodity prices increased sharply between 2004 and the summer of 2008, and many analysts and commentators pinpoint the market development of biofuels as one of the main causes (BBC, 2007; Wroughton, 2008), a key factor allegedly being the subsidized production of biofuels in the European Union and the United States.

Biomass for energy has the potential to reduce GHG emissions, but only if the biomass is sustainably produced (Dornburg *et al.*, 2008). The methodology can be also used for selection of most suitable regions or sites where biomass production of different energy crops can be economically and environmental sustainable. For instance water-logged floodplains with arable lands can be identified and recommended for poplar and willow SRC which are not suitable for conventional agriculture.

CONCLUSION

Presented methodology can be used for thorough mapping of all important biomass sources and biomass potential in the Czech Republic. It can help to create a state and regional strategies for the utilization of biomass in much more detailed level (NUTS-4) than previously used methodologies. Results of the analysis would enable efficient decision-making not only for the investor but also for the state and regional governments when realizing projects on biomass utilization and when setting up an efficient support system. Various barriers hinder the current development of biomass, especially the absence of a reliable databases and maps of biomass potential of individual biomass forms. Solving these issues would enable the formulation of a strategy for the utilization of biomass and serve as a basis for the revision of the Czech Energy Policy and to update the subsidy system.

The potential of residual biomass from agriculture (straw) for direct burning is around 90 PJ from current growing area of conventional agricultural crops. Wheat and rape straw were considered for calculation. The biomass potential for biogas production is around 46 PJ. Biomass from permanent grasslands and corn silage was considered for calculation. Biomass consumption in animal production and harvest loses were deducted from both calculations.

SUMMARY

The article deals with the methodology and analysis of biomass potential in the Czech Republic using geographical informative system (GIS). The process of assessing biomass potential from agricultural soils is based on assigning yields of individual biomass sources to individual production soil-ecological units (BPEJ) respectively to its component the main soil climate units (HPKJ).

Table yields of cereals and rape on each possible HPKJs' are used for the geographical analysis of straw potential. Straw yields were first calculated from grain yields using coefficients of straw contend. Map of actually grown crops (LPIS) was used to extract HPKJs on arable land. Finally it is necessary to deduct the amount of cereals straws needed for animal production from calculation. On the contrary all rapeseed straw can be used for energy. Harvest and transport loses can be up to 10% of harvested straw. In the final step, straw residuals that have the required amount for animal production deducted should be multiplied by the heating value of straw of individual crop.

To determine the biomass potential of grassland areas, grass yields from tables are used similarly as with the grain straw. In the first step, grassland yields are assigned to each HPKJ unit and then entered into a GIS database. These tabular yields include "raw" grass yields, therefore they must be corrected to dry mass using a coefficient of 0.20 (20% dry mass). In the second step, the overlapping of the yield layer and the map of actually grown crops (LPIS) ensures that the grass yields are determined only on grasslands.

Energy crops used in the GIS model include fast-growing trees (poplar, willow), reed canary grass, miscanthus, rescue grass, tall oat-grass, sorrel hybrid, and cocksfoot. To determine the potential of these energy crops, the potential yield must be known of these crops related to the site productivity value, preferably on HPKJ. Therefore zoning of agriculture land was created for these energy crops that give their expected yields on relevant HPKJs. For GIS analysis, these yields were entered than into a database creating the map layer "energy crop yields". In the next step the maps were intersect with layers of the suitable soil types.

Analysis of biomass potential of forest stands is based on a similar principle as the agro systems – thus on the site values, but not using the BPEJ and LPIS. In the Czech Republic, forest management plants based on forest types (SLT in Czech) provide expected yields (reserves) of wood biomass. Analysis of LHP in selected areas was completed and a coefficient for forest logging residuals (KLZ) was calculated to quantify total amount and distribution of potential in relation to forest stand area at the regional and district levels.

Only straw from cereals and rapeseed was considered for analysis of agricultural biomass potential for direct burning. Straw needed for forage and bedding in animal production was deducted from total amount of cereals straws.
The total calculated potential of straw for direct burning was 5 677 693 tones which equals approximately 90 PJ. Biomass from permanent grasslands and corn silage was used in calculation of potential for biogas production. Hay and corn silage needed for animal production (cattle) was deducted from total amount. The total calculated potential for biogas was 5 677 693 tones of biomass which equals approximately 46 PJ.

SOUHRN

Metodika a analýza potenciálu biomasy s využitím GIS v České republice

Článek se zabývá problematikou metodiky a analýzy potenciálu biomasy v ČR s využitím geografického informačního systému. Postup při stanovení potenciálu biomasy je založen na přiřazování výnosů jednotlivých zdrojů biomasy ze zemědělské půdy (druhů plodin) podle bonitačních půdně ekologických jednotek (BPEJ).
Pro geografickou analýzu potenciálu slámy z tzv. konvenčního zemědělství se používají tabulkové výnosy obilovin a řepky udávané k jednotlivým hodnotám hlavních půdně klimatických jednotek (HPKJ). Pro zajištění výnosů pouze na orné půdě je potřeba provést průnik dat HPKJ a LPIS (mapa druhů kultur). Tím je zaručené určení výnosu pouze na orné půdě. V druhém kroku jsou přiřazeny údaje výnosů zrna a vynásobeny koeficientem podílu slámy ke každé HPKJ. Využitelný potenciál obilné slámy pro energetiku je však menší – je nutno odečíst slámu využívanou pro živočišnou výrobu (skot, ovce, berani a koně). U řepky se může využít veškerá reziduální sláma pro energetické účely. Uvažovat je také třeba technologické ztráty při sklizni a transportu (až 10 %). V posledním kroku je třeba zbytkovou slámu po odečtení spotřeby živočišné výroby vynásobit hodnotou výhřevnosti pro jednotlivou plodinu.
Pro zjištění potenciálu biomasy trvalých travních porostů se používají tabulkové výnosy TTP přiřazené hodnotám HPKJ podobně jako u slámy. V prvním kroku se výnosy TTP převádějí do databáze GIS s přiřazenými hodnotami výnosů každé HPKJ. Tyto tabulkové výnosy TTP obsahují „surový“ výnos na 1 ha, takže pro posuzování výnosu sušiny je nutno hodnoty opravit koeficientem sušiny 0,20 (20 % sušiny). Ve druhém kroku se provádí průnik dat HPKJ a LPIS. Tím je zaručeno určení výnosů TTP pouze na půdě TTP.
Pro zjištění potenciálu vybraných energetických plodin je potřeba znát výnosový potenciál těchto plodin vztažený k bonitě stanoviště (HPKJ). Pro jednotlivé energetické plodiny byla vytvořena tzv. rámcová rajonizace, která udává očekávaný výnos v systému HPKJ. Pro GIS analýzu se očekávané výnosy energetických plodin převedly do databáze a přiřadily se ke každé jednotce HPKJ. Tím vznikly oborové hladiny jednotlivých energetických plodin, které se v dalším kroku protnuly s ornou půdou a v případě rychle rostoucích dřevin tak i s půdou TTP.
Metodika potenciálu biomasy pro lesní pozemky je založena na jiném principu než přiřazování výnosy dle BPEJ. Pro lesní komplexy jsou zpracovány a pravidelně aktualizovány lesní hospodářské plány (LHP), které popisují skladbu každého lesního porostu. Na základě analýzy LHP je možné vypočíst koeficient, který určuje průměrný výnos biomasy ve formě lesních těžebních zbytků a ve vazbě na rozlohu lesa.
Při analýze potenciálu biomasy bylo uvažováno pro spalování pouze se zbytkovou slámou obilnin a slámou z řepky. Od celkového množství obilné slámy v tunách se odečetla spotřeba slámy na podestýlku a krmení pro živočišnou výrobu. Celkově potenciál pro spalování dosahoval hodnoty 5 677 693 tun, což v přepočtu na energii odpovídá 90 PJ. K produkci bioplynu se uvažovala biomasa z TTP a kukuřice ve formě siláže, kdy se od celkového množství odečetla spotřeba kukuřičné siláže a TTP pro skot. Hodnota potenciálu pak celkově dosahuje hodnoty 14 022 122 tun, což je po přepočtu na energii 46 PJ.

potenciál biomasy, bonitovaná půdně ekologická jednotka, lesní zbytky, trvalé travní porosty, sláma

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