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Influence of weather conditions on waste biomass production

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Abstract

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A significant effect of weather conditions on crop biomass yields was observed in various production areas during the last decade. Starting with the municipality of Březník within the period of 2007–2011, the present article studies the relationship between weather conditions and the volume of municipal residue biomass (MRB). A statistically significant impact of rainfall level on MRB production has been demonstrated. The development of biodegradable municipal solid waste collection in the municipality of Březník has also been described and evaluated.

Keywords: biodegradable municipal solid waste collection; municipal residue biomass; weather conditions

Municipal Residual biomass (MRB), the source of which is biodegradable municipal solid waste (BMSW) or the biodegradable part of municipal solid waste (MSW) is considered a potential source of perennial bioenergy (Greg 2010). According to the aggregated indicator "Global human-appropriated biomass", it was estimated that up to one fifth of the total primary production is returned to the global ecosystem as a biodegradable component of MSW (Vitousek et al. 1986; Imhoff et al. 2004). Most of the biomass of this kind is collected and aggregated in population centres with high energy demands. The availability of this energy source increases together with the population growth rate and energy consumption per capita (Bogner et al. 2003). Implementation of equipment utilizing this potential requires significant investments (EIA 2009). Nevertheless, technologies using this type of biomass are improving and gradually displacing fossil energy. As a consequence, the formation of methane during storage of biological biodegradable components of MSW at dump areas can be reduced (Consonni et al. 2005). This may also decrease the need for waste dumps located near urban areas (Porteous 2005). Generally, environmental as well as economic aspects of different technological methods depend on some local conditions, such as population density, infrastructure and climate, separate collection and also developed markets for associated products (energy and composts). The most common technological method of its use is composting (Commission of the European Communities 2008). Composting is the highest form of recycling. An organic, discarded mate-

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Table 1. Summary of biodegradable municipal solid waste

Code No.*	Type of waste	Ratio**
20 01 01	paper and cardboard with the exception of highly glossing paper and the wallpaper waste	1.00
20 01 08	cafeteria biodegradable waste	1.00
20 01 10	clothing	0.60
20 01 11	textiles	0.50
20 01 38	wood not included in 20 01 37	1.00
20 02 01	biodegradable waste	1.00
20 03 01	rest municipal solid waste	0.54
20 03 02	marketplace waste	0.80
20 03 07	bulky waste	0.50

*Waste Catalogue of the Czech Republic; **biological component proportion in each type of waste

rial is converted for reuse. Compost can improve soil conditions and plant growth, and reduce the tendency for erosion, runoff, and non-source pollutions. Compost is an organic matter resource. Properly produced compost aids humus to soil (Epstein 1997).

Any type of BMSW is capable of aerobic and anaerobic decomposition. This in particular applies to the part of MSW composed of grass clippings, leaves, twigs, branches, and garden refuse. The decomposable part also includes separately collected biodegradable waste from residential areas, commercial establishments (e.g., restaurants) and institutions (e.g., schools), as well as waste paper (paper and paperboard products), wood, natural textiles and clothing made from these (Vrbová et al. 2009). Table 1 shows an overview of BMSW types and the biological component ratio in each type of waste (Kotoulová 2001).

The potential for the use of BMSW in the Czech Republic is based on an analysis of MSW potential (Ministry of Agriculture 2012). Table 2 presents the development and forecast of MSW production; the potential of the remaining municipal waste (RMSW) and yard waste in 2020 are forecasted to amount to 3.8 and 0.6 million tons, respectively (Pavlas et al. 2011).

The term "waste collection" includes not only the collection itself, but also the transfer of waste to places where collecting vehicles are unloaded and loaded (Tchobanoglous et al. 1993). The method of BMSW collection and its organization significantly affect the quality and quantity of the obtained material and have an impact on the required technical equipment (Váňa et al. 2005). Separate collection of BMSW can be classified based on several aspects (Altmann 2006):

(1) Based on collected BMSW:
- garden waste only,
- public green only,
- kitchen waste only,
- garden and kitchen waste,
- garden waste and public green,
- garden waste, public green and kitchen waste.

Table 2. Development and forecast of municipal solid waste production (t)

	Index No.	2009	2010	2013	2020
Separate collection	20 01	527,316	515,206	568,503	663516
Yard waste	20 02	373,456	364,879	454,738	578,260
Other MSW*	20 03	3,893,894	3,720,340	4,145,916	4,791,298
Rest municipal solid waste	20 03 01	3,236,264	3,090,806	3,451,259	3,986,496
Bulky waste	20 03 07	506,482	486,444	540,124	623,889
Other components	20 03 XX*	151,148	143,090	154,533	180,913
Total MSW	20	4,794,665	4,684,550	5,169,157	6,033,074

*other municipal solid waste (MSW) with Code Nos 20 03 02, 20 03 03, 20 03 04, 20 03 04, 20 03 99; source: Ministry of Agriculture of the Czech Republic (2012)

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(2) Based on technical services:
  - through drop-off centers (DC),
  - large-sized containers (LSC – volumes of 6, 10, 12 and 18 m^3),
  - waste containers (C – volumes of 0.12, 0.24 and 0.77 m^3),
  - adjusted BMSW containers (C_{BMSW} – volumes of 0.12 and 0.24 m^3),
  - waste bag collection,
  - no-bin collection.

(3) Based on organization:
  - drop-off system,
  - pick-up system.

The basic objective of the presented study is an evaluation of separate collection data for BMSW in the rural municipality of Březník, covering the period of 2007–2011. Weather conditions of the same period and region are also analysed and compared to their actual impact on waste biomass production. Description of the impact on waste biomass production may reflect the influence of weather change as a possible limiting factor for the future continues reuse of biomass from the perspective of a local MSW composting system. The subobjectives were as follows: (1) acquisition of data concerning functionality and efficiency of BMSW separate collection (type of waste 20 02 01) in the municipality of Březník for the period of 2007–2011, (2) completion of data on weather conditions for the same region and period, (3) evaluation of the obtained data, and (4) discovering the context between local weather conditions and BMSW production in the researched rural municipality.

MATERIAL AND METHODS

Municipality of Březník – biodegradable municipal solid waste production. The rural municipality of Březník is situated at the foothills of the Czech-Moravian Highlands at the altitude of 367 m a.s.l. The village belongs to the Vysočina Region (Třebíč district); its municipal authority with extended powers resides in Náměšť nad Oslavou (about 6 km from

Table 3. Biodegradable municipal solid waste production (20 02 01) in Březník in 2007 and 2011

Month	Production (t)		Collected containers (pcs/month)			Collections (drives/month)		
	C_{BMSW} 0.24 m^{3*}	LSC 18 m^3	C_{BMSW} 0.24 m^3	C_{BMSW} 0.12 m^3	LSC 18 m^3	C_{BMSW} 0.24 m^3	C_{BMSW} 0.12 m^3	LSC 18m^3
2007								
March	–	8.15	–	–	4	–	–	1
April	2.20	9.84	33	5	4	2	2	1
May	1.30	–	33	5		2	2	–
June	2.92	13.08	33	5	4	2	2	1
July	4.40	8.98	33	5	4	3	3	1
August	3.14	18.34	33	5	4	2	2	1
September	4.30	0	33	5	–	2	2	–
October	1.89	18.41	33	5	4	2	2	1
November	1.60	–	33	5	–	2	2	–
2011								
March	–	20.80	–	–	4	–	–	1
April	3.20	–	95	5	–	1	1	–
May	22.22	12.34	96	5	4	2	2	1
June	8.88	–	96	5	–	2	2	–
July	6.96	14.90	96	5	4	2	2	1
August	9.98	18.33	96	5	4	2	2	1
September	9.94	–	96	5	–	2	2	–
October	10.74	24.07	96	5	4	2	2	1

C_{BMSW} – adjusted BMSW containers; LSC – large-sized containers; *included the collection of 0.12 m^3 C_{BMSW} containers; source: research ESKO-T s.r.o.

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Table 4. Monthly average air temperatures and total precipitation

Year	Month											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Monthly average air temperatures (°C)											
2007	3.0	2.6	5.7	11.5	15.0	19.2	19.4	19.0	12.2	7.7	1.3	–1.5
2008	0.7	2.3	3.4	8.9	14.7	18.8	19.1	18.9	13.0	8.9	5.2	0.8
2009	–3.3	–0.8	3.5	13.2	13.9	15.6	18.9	19.4	15.9	7.9	5.2	–0.8
2010	–4.2	–1.5	3.5	8.8	12.2	17.0	20.4	17.6	12.2	6.3	5.1	–4.8
2011	–1.2	–1.4	4.8	11.1	14.1	17.6	17.3	19.4	16.0	8.4	2.2	1.3
	Monthly total precipitation (mm)											
2007	1.9	2.2	6.3	2.6	2.5	4.2	4.8	3.9	3.6	1.2	3.3	0.9
2008	1.0	1.5	2.3	2.8	2.4	4.2	2.9	3.1	2.5	1.0	1.8	1.6
2009	1.7	2.3	3.3	2.1	3.4	5.4	7.0	2.4	2.0	1.8	2.4	2.2
2010	2.6	1.4	1.0	5.0	5.7	10.7	8.0	6.7	5.6	1.3	1.9	1.9
2011	1.4	0.7	4.8	2.7	7.4	6.2	4.5	3.8	6.3	2.9	0.3	1.0

source: CHMI

Březník). Its territory mostly constitutes agricultural and forest land (693 and 579 ha, respectively). The built-up area spans 18 ha with 19 ha of gardens. 627 permanent residents live in 233 family houses and 10 blocks of flats. Gas is the most common heating medium. Separate collection of BMSW can be considered fully developed, with good access throughout the territory of municipality. Both drop-off and pick-up systems are applied. 0.12 m^3 and 0.24 m^3 containers, as well as large volume containers (18 m^3) are placed in the municipality.

Tables 3 specifies, on a month-by-month basis, the BMSW production in Březník in 2007 and 2011 (peripheral input data). These tables summarize also the real number of containers/month, available per collection drive.

Municipality of Březník – long-term climate normal. The Czech Hydrometeorological Institute (CHMI) conducts regular meteorological observations at more stations within the concerned region. Manually measured data used for this study cover long term monthly average air temperatures (°C), measured at the Sedlec station, and long term monthly total precipitation (mm) at Náměšť nad Oslavou, both for the period of 2007–2011 (Table 4).

Partial correlation methodology. When working simultaneously with several variables, we need to assess the mutual dependence of their pairs

Table 5. ANOVA

Source of variability	Sums of squares	*Df*	Mean squares	*F*	*P* – value
Model	$SS_{\hat{Y}_i} = \sum_{i=0}^{n} \left(\hat{Y}_i - \bar{Y}\right)^2$	1	$MS_{\hat{Y}_i} = SS_{\hat{Y}_i}$	$\frac{MS_{\hat{Y}_i}}{MS_E} = F_{1,n-2}$	$Pr(F > F_{1, n-2})$
Residual	$SS_E = \sum_{i=0}^{n} (e_i)^2 = \sum_{i=0}^{n} (Y_i - \hat{Y}_i)^2$	$n - 2$	$MS_E = \frac{SS_E}{n-2}$		
Total	$SS_Y = \sum_{i=0}^{n} (Y_i - \bar{Y})^2$	$n - 1$	$MS_Y = \frac{SS_Y}{n-1}$		

Df – degrees of freedom; MS_E – mean squared error = sum of squared residuals; MS_Y – total mean square – $SS_{Y/(n-1)}$ – S_y^2 – total variance of the *y*'s; $MS_{\hat{Y}_i}$ – mean square for the regression – $SS_{\hat{Y}_i}/1$; $F = t^2$ for Simple Linear Regression. *Pr* – probability, the exact *P*-value is given by $Pr(F > F_{1, n-2})$. The larger the *F* (the smaller the *P*-value) the more of *y*'s variation the line explained so the less likely H_0 is true. We reject when the *P*-value < α. Especially the *P*-value is the probability of being greater than the *F*-statistic or simply the area to the right of the *F*-statistic, with the corresponding degrees of freedom for the group and error (Litschmannová 2011)

Table 6. Standard transformation

Years	Quarters	Average BMSW production per one drive of collection (t)	Average monthly temperature (°C)	Average monthly precipitation (mm)
2007	1Q	$\frac{1}{3}\left(\frac{1}{n}\sum_{i=1}^{n} x_{i(0.12;\,0.24)} + \frac{1}{n}\sum_{i=1}^{n} x_{i(0.12;\,0.24)} + \frac{1}{n}\sum_{i=1}^{n} x_{i(0.12;\,0,.24)}\right)$	$\frac{t_1 + t_2 + t_3}{3}$	$\frac{p_1 + p_2 + p_3}{3}$
…	…	…	…	…
2011	4Q	…	…	…

$x_{i(0.12;\,0.23)}$ – amount of biodegradable municipal solid waste in C_{BMSW} – adjusted BMSW containers in C_{BMSW} containers (0.12 and 0.24 m^3)/drive of collection; n – number of collection (drive of collection); t_1, t_2, t_3 – monthly average air temperatures of the relevant quarter; p_1, p_2, p_3 – monthly total precipitation of the relevant quarter

without the influence of the others. The first option is to calculate correlation coefficients for all pairs of variables and establish the so-called correlation matrix. Calculation of correlation coefficients for the pairs, however, cannot capture higher-level interactions. To obtain these, we can use partial correlation coefficients. These express an interdependence of two variables, provided that other variable does not change. For example $r_{\text{i,j,k}}$ expresses the interdependence of variables X_i and X_j, provided that X_k does not change (Lepš, Šmilauer 2014).

Regression model of the relation between weather conditions and production of biodegradable municipal solid waste (20 02 01). The simplest regression method is the linear model of regression, i.e. a straight line, where the relation between two quantitatively measured characteristics (Y and X) is represented by the equation the $Y = a + b \times X + \varepsilon$. The parameters (regression coefficients) a and b have specific numerical values that we try to estimate based on the collected data (sample data); the symbol ε represents the stochastic (nondeterministic) part of the model (Šmilauer 2007).

Simple regression:

$$Y_i = \beta_0 + \beta_1 \times X_i + \varepsilon_i \tag{1}$$

where:

Y_i – production of BMSW (t)
X_i – independent variables (°C; mm)
$\beta_{0,1}$ – regression coefficients
ε_i – all other unstated impacts (regression residuals)
i – 1, …, n
n – total number of observations

Analysis of variance is a part of regression analysis. Through this analysis, we determine the suitability of the selected regression model by using the F-test (ANOVA in regression). In this decomposition, we describe how a large part of the total variability in the values of the given variable can be explained by the chosen model and how significant the remaining (unexplained) part is. This analysis is based on the relation (Litschmannová 2011):

Analysis of variance:

$$SS_Y = SS_{\hat{Y}} + SS_E \tag{2}$$

where:

Y_i – observed value
$\bar{Y}$ – mean (average) of the observed value
$\hat{Y}$ – estimate of the mean value
e_i – difference between the two values (residual)
i – 1, …, n
n – total number of observations
s – sample standard deviation of quantile variable for entire data set
σ – population standard deviation

$SS_Y = \sum_{i=0}^{n}(Y_i - \bar{Y})^2$ – total sum of squared deviations from the mean
$SS_{\hat{Y}_i} = \sum_{i=0}^{n}\left(\hat{Y}_i - \bar{Y}\right)^2$ – regressive (explained) sum of squares of the model
$SS_E = \sum_{i=0}^{n}(e_i)^2 = \sum_{i=0}^{n}(Y_i - \hat{Y}_i)^2$ – unexplained residual sum of squares

A suitable regression model must contain a sum of explained squares which is greater than the residual sum of squares. When testing this assumption, we verify the null hypothesis (H_0: the selected functional relation between the dependent and independent variable does not exist). The results are presented in Table 5.

Standard transformation of the regression model data. In order to obtain a more precise interpretation of the described data, a standardized transformation has been applied. This eliminates

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Table 7. Number of biodegradable municipal solid waste containers and number of collected containers per month in the municipality of Březník (total/collected containers per month)

Year	C_{BMSW} 0.12 m^3	C_{BMSW} 0.24 m^3	LSC 18 m^3
2007	5/11	33/70	4/4
2008	5/11	45/88	4/4
2009	5/10	86/170	4/4
2010	5/11	86/170	4/4
2011	5/11	96/178	4/4

C_{BMSW} – adjusted BMSW containers; LSC – large-sized containers

possible interruptions in the continuous measurement conducted by CHMI (unmeasured precipitation). This model, which is also more suitable for handling winter months without BMSW (20 02 01) collection in the municipality, is depicted in Table 6.

RESULTS AND DISCUSSION

The municipality placed three types of BMSW containers in the built-up area already in 2004: C_{BMSW} containers 0.12 m^3 and 0.24 m^3 for BMSW from residences, and LSC containers 18 m^3 for BMSW from public green areas.

The year-by-year development of the number of BMSW containers and their collection is presented in Table 7.

Increasing the number of C_{BMSW} 0.24 m^3 containers (and the associated increase of the number of participating residences) influenced the total volume of collected BMSW between 2007 and 2011. This trend, recalculated to BMSW production per

Table 8. Average values from data obtained for individual quarters of the years 2007–2011 (standard transformation)

Quarter	Year	Average BMSW production/ collection drive (t)*	Average monthly temperature (°C)	Average monthly precipitation (mm)
1Q	2007	0	0	0
	2008	0	0	0
	2009	0	0	0
	2010	0	0	0
	2011	0	0	0
2Q	2007	1.07	13.82	2.56
	2008	1.60	14.12	3.13
	2009	2.26	14.21	3.64
	2010	3.41	12.65	7.15**
	2011	3.64	14.29	5.42
3Q	2007	1.73	16.85	4.12
	2008	2.41	17.00	2.80
	2009	3.87	18.08	3.78
	2010	4.52	16.76	6.76
	2011	4.48	17.56	4.87
4Q	2007	0.58	3.85	2.24
	2008	1.68	4.97	1.44
	2009	2.05	4.11	2.13
	2010	1.00	2.18	1.68
	2011	1.79	3.94	1.38

*collection of C_{BMSW} containers (0.12 and 0.24 m^3); **high leverage point, extreme precipitation in June

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Table 9. Correlation values

Correlations (Table 8) Marked correlations are significant at $P < 0.05000$ $N = 20$ (case deletion of missing data)		
Variable	Temperature	Precipitation
Tons	0.8307	0.9105
	$P = 0.000$	$P = 0.000$
Partial correlations (Table 8) Marked correlations are significant at $P < 0.05000$ $N = 20$ (case deletion of missing data)		
Variable	Temperature	Precipitation
Temperature	1.0000	0.5707
	P = --- ???	$P = 0.011$
Precipitation	0.5707	1.0000
	$P = 0.011$	P = --- ???

N – total number of observatios

one collection drive, is presented in Table 8. This table also represents the standard data transformation for the regression model.

The program Statistica 8 was used to analyse the data and obtain the necessary characteristics of selected statistical methods. The results of the analysis, presented in the Table 8, first focused on determining the correlation coefficient (the correlations matrices function) between the average BMSW production per one collection drive in the given quarter (t) and other variables, namely the average monthly temperature (°C) and the average monthly precipitation (mm). The results, presented in Table 9, confirm an individual linear dependence. The partial coefficient 0.5707 demonstrated a high correlation between the average daily temperatures and average daily precipitation (Table 9). Therefore only the more significant variable (average monthly precipitation) was used for the next calculation.

The simple regression summary is presented in Table 10. The coefficient of determination R^2 can be considered as a percentage of the total variability of the response variable, as explained by the regression model. However, the use of the adjusted coefficient of determination R^2 is recommended (Šmilauer 2007).

"F statistics", resulting from the analysis of the variance regression model, was carried out as an intermediate step of the selected regression function (Table 11).

Values of the mean squares in Table 11 were used for testing the significance of the regression model, whereas the key value used was the ratio of the model mean square and the residual mean square. In the case of the null hypothesis, the value of this ratio should be relatively close to 1 (i.e., the explained and unexplained variability should be of a similar size). More precisely (for this particular model), it should originate from the F disturbance with a parameter value of 1.18 (for the presented model). Nevertheless, the probability that the true value of this ratio, i.e. the F statistic (with a value

Table 10. Regression summary for average development of biodegradable municipal solid waste production per one collection drive

$n = 20$	Regression summary for dependent variable: Tons (Table 8) $R = 0.91052733$, $R^2 = 0.82906002$, adjusted $R^2 = 0.81956336$ $F(1.18) = 87.300$, $P < 0.00000$, standard error of estimate = 0.65022					
	Beta	Std. Err. of Beta	B	Std. Err. of B	$t(18)$	P-level
Intercept			0.056065	0.222855	0.251577	0.804218
Precipitation	0.910527	0.097451	0.686689	0.073494	9.343453	0.000000

R – value/field represents the simple correlation, which indicates a high degree of correlation; R^2 – field contains the coefficient of determination, which measures the reduction in the total variation of the dependent variable due to the independent variables ($R^2 = 1 - SS_E/SS_Y$). The adjusted R^2 is interpreted similarly to the R^2 value except the adjusted R^2 which takes into consideration the number of degrees of freedom. The F-value, and resulting P-value is used as an overall F-test of the relationship between the dependent variable and the set in independent variables. The Standard error of estimate measures the dispersion of the observed values about the regression line. The Intercept field contains the intercept value if you selected to include the intercept in the model on the Model Definition – Advanced. The Standard error field contains the standard error of the intercept. The t-value with the resulting of P-value are used to test the hypothesis that the intercept is equal to 0. The beta (B) regression coefficient is computed to allow you to make such comparisons and to assess the strength of the relationship between each predictor variable to the criterion variable. Beta (standardised regression coefficients) is a measure value of how strongly each predictor variable influences the criterion (dependent) variable. The beta is measured in units of standard deviation. The n is total number of observations.

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Table 11. ANOVA results

n = 20	Analysis of variance; *DV*: tons (Table 10)				
	Sums of squares	*Df*	Mean squares	*F*	*P*-level
Regress	36.90877	1	36.90877	87.30012	0.000000
Residual	7.61005	18	0.42278		
Total	44.51881				

n – total number of observations; *DV* – dependet variable; *Df* – degrees of freedom; F – F-value is actually the quotient of the following ratio effect variance/error variance

of 87.30012), originates from this F disturbance is less than 0.000001 or equal to 0^6, as confirmed by the values in the "p-level" column. Hence H_0 can be rejected with this probability of a Type I error (at the concerned level of significance).

Graphical representation of the regression line, including the confidence interval is presented in Fig. 1.

An assessment of the mean values of weather data proves a statistically significant relation between the average BMSW production per collection and the average monthly precipitation (r = 0.91, α = 0.05, n = 20), as well as between the BMSW production and the average monthly temperature (r = 0.83, α = 0.05, n = 20). In other words, the biomass waste production in the municipality of Březník depends on the weather conditions of the growing season. The positive relationship was furthermore enriched by linear regression; however this does not necessarily reflect a causal relation (in fact, only non-manipulated areas were observed). Thus, BMSW production could have been influenced by non-measured factors. Furthermore, as the distribution of regression residuals around the x-axis shows, there exist some differences between the real (observed) and predicted (fitted by the regression model) values of the variables in the regression equation.

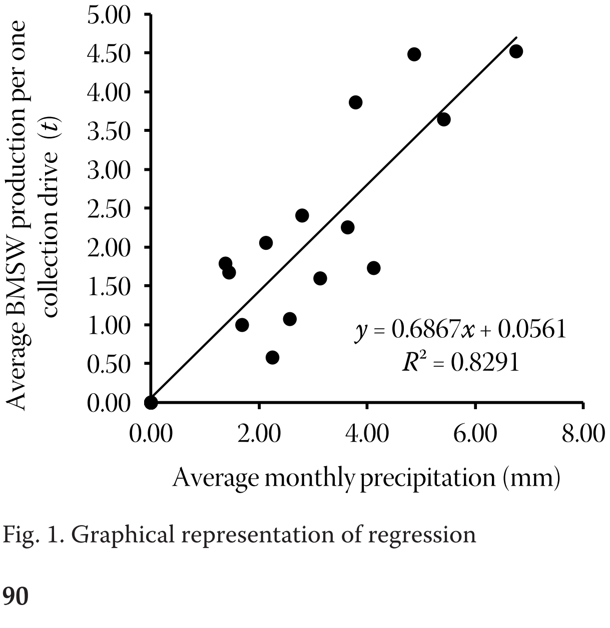

Fig. 1. Graphical representation of regression

An increasing number of C_{BMSW} 0.24 m^3 containers may influence unexplained points of the analysed components; additionally, extreme fluctuations of both analysed climate data probably also played a role.

Mužíková et al. (2013) describe similar statistically conclusive results concerning the influence of weather conditions (dry and wet years); they proved a close relation between the values of available water capacity and biomass production of selected crops in the Czech Republic (in 1976–2010). Středová et al. (2011) published an analysis of several temperature and precipitation indexes and their changes, with an emphasis on the increase of above-normal temperature months and the loss of normal rainfall months. Mužíková et al. (2011) also documented the future increase of extremities in the weather conditions across the Czech Republic

CONCLUSION

The principal objective of the present study was an evaluation of BMSW in the municipality of Březník in the period of 2007–2011. The influence of selected weather factors on BMSW production of a rural municipality was also studied.

The study proves that weather conditions influence BMSW production and mathematically defines this dependence; this should be taken into consideration when developing BMSW collection processes. Available data for individual quarters of 2007–2011 confirm the following regression compensation straight line of average monthly precipitation p (mm) and the average BMSW production per one collection T (t) in the municipality of Březník: $T = 0.056 + 0.687p$.

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Compost utilization depends on a number of factors including its benefits to soil-plant systems. Compost can be used also in other non-agricultural and landscape ecosystems, especially as an output material of the system of the municipal BMSW management. Important is the realization of composting by local authorities in natural and agro ecosystems as an integral part of the entire waste management system of BMSW. Thus, a systems perspective that includes full cost accounting of separete collection, handling, and processing must incorporate marketing, distributing, and recycling in a life cycle analysis that reflects external costs and societal benefits for composting-based solid waste systems to be competitive. In terms of the actual perspective, weather effects and their frequent regional fluctuations may become a new, complementary, approach to flowing the costs of waste management system of BMSW, because these effects may reflect an impact on the balance of input municipal residue biomass for re-usage. It might work as a guideline for local authorities.

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