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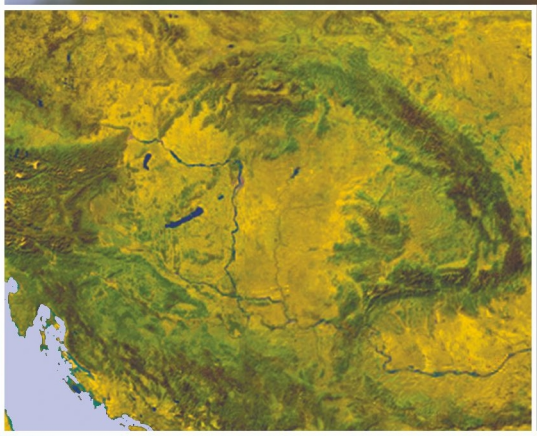

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Soil organic matter characterisation by photometric indices or photon correlation spectroscopy: are they comparable?

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Abstract

Soil organic matter (SOM) is a complex component of soil that acts as basis for most of the soil forming processes. SOM characteristics, including quantity, spatial distribution, molecular size and composition, are the results of environmental effects. SOM is definitely hard to be measured *in situ*, therefore most investigations are based on incomplete SOM extractions or other proxies. Even though, the traditional humus concept that polymerisation degree of SOM molecules are proportional to their stability are refuted, the concerning proxies for SOM composition predictions are still in use. These are mainly based on the photometric investigations of alkali extractions. However, this extraction method received many rightful critiques, it still could be a possible alternative, since it is quite simple, cheap and represented much more SOM than water extractions. This study aimed to compare SOM composition results based on carbon-nitrogen ratio and alkali extractions measured by UV-vis spectrometry and photon correlation spectrometry on the same soil used as forest and crop field. SOM composition proxies provided inconsistent results using the NaOH extraction method compared with photon correlation. Therefore, the application of organo-mineral SOM protection theory in association with the photometric proxies seems to be difficult in the case of the investigated Luvisol. On the other hand, photon correlation spectroscopy provided results in line with the published results of the organo-mineral stabilization theory that suggested alkali extraction with special care could be a useful alternative. However, due to the known imperfections of it, the application of in situ measurement methods would be preferable.

Keywords: organic matter composition, tillage, soil carbon, dynamic light scattering

Introduction

Soil organic matter (SOM) is an important component of soil. As a result of input (mainly plant residuals) and output (mineralization) SOM is an ever-changing holistic system that is complex and spatially diverse, therefore cannot be described or modelled adequately still today even though it is a key parameter of sustainability (Jancsovszka, P. 2016). The first, widely accepted theory was the humus concept (Kononova, M.M. 1966), which separated SOM to single molecules based on their extent and polymerization. Main components were classified as humic, fulvic substances and humin that belonged to colloid size and polymerisation range of an increasing order respectively (Stevenson, F.J. 1982). According to this theory the stability of a certain SOM molecule is proportional of molecular extent, polymerisation and aromaticity. This way the process of humification was presumed to be constructed more complex molecular structures to be more resistant against mineralisation. The proxies applied to measure SOM composition, therefore based on humic substance solubility in various solvents (Kononova, M.M. 1966).

In recent times studies proved that SOM highly interacted with the mineral phase of the soil, creating various types of complexes that affected SOM stability more than mo-

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lecular composition alone (Zimmermann, M. *et al.* 2007; Schmidt, M.W.I. *et al.* 2011). Accordingly, SOM could not be clearly classified on the basis of the humus concept (Lehman, J. and Kleber, M. 2015). However, according to this theory stable SOM was directly related to the fine particles of the soil (Hassink, J. 1997; Wiesmeier, M. *et al.* 2014) the role of aggregates was less clear. Six, J. *et al*. (2002) revealed that SOM takes a major role in forming and stabilizing these aggregates, which are thus considered to be storage vessels for SOM by protecting it from decomposition (Meng-Yun, L. *et al*. 2014; Jakab, G. *et al.* 2016). Therefore, in general, SOM is classified to *i)* mineral phase associated, recalcitrant pool with long turnover time; *ii)* aggregate associated chemically and biologically active pool with short turnover time; *iii)* particulate organic matter (often called light fraction), which consists slightly degraded plant tissue and iv.) water soluble pool (Filep, T. *et al.* 2015). Moreover, nowadays, the application of highly intact biochar in soils is coming to the focus (Kása, I. *et al.* 2016; Dencső, M. *et al*. 2017).

Natural SOM systems can be disturbed by physical and chemical effects, such as agricultural land use. Many studies have shown that cultivation can change the structure of SOM by affecting aggregate size and stability (Spaccini, R. and Piccolo, A. 2013), carbon/nitrogen (C/N) ratios (John, B. *et al*. 2005; Rieder, Á. *et al.* 2018) and soil organic carbon (SOC) quantity and distribution (Falkengren-Gerup, U. *et al*. 2006). Meng-Yun, L. *et al*. (2014) demonstrated that easily oxidisable organic carbon tended to be enriched in macro-aggregates instead of within micro-aggregates, and in addition their data confirmed aggregate breakdown in farmlands. These combined effects can lead to massive SOC loss in regions of cultivated land (Plaza-Bonilla, D. *et al*. 2014; Bilandžija, D. *et al.* 2017). In contrast, Rabbi, F.S.M. *et al*. (2014) demonstrated that SOC mineralization rates and protection was irrespective of aggregate size. The effect is clearer under tropical conditions while not always so obvious in the temperate zone, where the influence of global warming (Mika, J. and Farkas, A. 2017) makes the picture more complex.

Zimmermann, M. *et al*. (2007) published a fast procedure to separate SOM pools, that combines physical and chemical fractionation techniques, such as density separation and NaOCl oxidation. As Poeplau, C. *et al*. (2013) pointed out in their study, this method is likely to become widely used.

Parallel with the conceptual development, the investigation methods and technics were also improved. X-ray spectromicroscopy as an important part of *in situ* investigations of organo-mineral interactions became more available (Lehman, J. *et al.* 2008). Increasing number of published studies are based on other *in situ* technics such as Raman spectroscopy and Fourier transform infrared spectroscopy, nano scale secondary ion mass spectrometry (Mueller, C.W. *et al.* 2017) even though they are less widespread for routine measurements because of financial reasons. This could be the reason why humus concept proxies based on SOM solubility are still in progress. Moreover, using these extractions, more up-to-date analytical methods such as static (SLS) and dynamic light scattering (DLS) can be used to measure molecular weight and size values of SOM. Despite its efficiency, only a few studies (Palmer, N.E. and Wandruszka, R. 2001; Esfahani, M.R. *et al*. 2015) have applied this method. However, NaOH extraction method has received many critiques (Rice, J.A. 2001; Lehman, J. and Kleber, M. 2015) it is still widely applied (Wang, K. and Xing, B. 2005; Chaudhuri, S. *et al.* 2013; Reddy, S. *et al.* 2014). Therefore, it is still a question whether the NaOH extraction based photometric proxies developed for the humus concept are applicable in combination with the organo-mineral theory.

This study aims to compare SOM composition results gained by the fractionation method of Zimmermann, M. *et al*. (2007) in combination with alkali extraction as a proxy of the humus concept. Our hypothesis is that traditional photometry based results are comparable to those received using photon

correlation spectroscopy. Reaching this aim the same soil under different land uses were investigated in order to determine how land use change affects SOC content and SOM composition of the various pools.

Materials and methods

Study site

Soil samples were taken in 2015 near Kisbárkány, Hungary 48°00′55.3″N; 19°40′24.5″E *(Figure 1),* where the mean annual temperature is between 9–12 °C and precipitation is 600 mm (Dövényi, Z. 2010). This site was a typical example of forest clearance during the 18th century as it was widespread in the hilly parts of Hungary at that time (Szalai, Z. *et al*. 2016). Two quite similar, slightly eroded soil profiles were sampled and described as a haplic Luvisol (IUSS WG WRB, 2015) on Oligocene siltstone *(Table 1).*

*Table 1. Main parameters of the investigated topsoil**

Parameter	Forest	Arable
Size, μm v/v		
>200.0	0.0	0.0
70.0–200.0	2.1	2.3
63.0–70.0	1.5	1.7
20.0–63.0	28.5	26.9
2.0–20.0	53.2	51.8
0.5–2.0	12.6	14.7
0.5>	1.8	2.3
Sesquioxides, m/m	14.2	–
pH_{dw}	6.3	6.8
Depth of humic horizon, cm	40.0	42.0
$CaCO_3$, m/m	0.0	0.0
Munsell color	10YR4/2	

*Partly based on Németh, T. and Sipos, P. 2006.

Sampling sites were chosen on flat areas (slope steepness < 3%). Mineralogy of the soil was characterised by 40–70 per cent quartz and 5–15 per cent feldspars (Sipos, P. 2004). The predominating clay mineral was smectite (Németh, T. and Sipos, P. 2006).

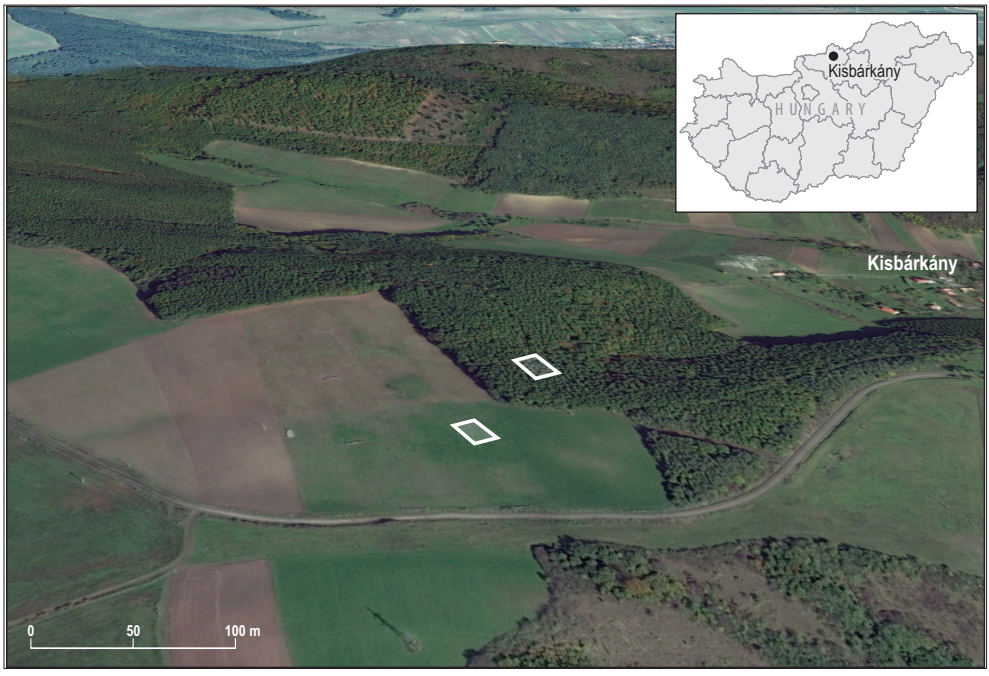

Fig. 1. Location of the sampling sites under forest and arable field Google Earth

The first profile was situated in a forest which has existed for more than 120 years, while the second was in an area which had been converted to an arable field before the 19th century according to the Third Military Survey of Hungary (1869–1887). Forest was dominated by *Quercus robur* with the appearance of *Ulmus campestris* < 10 per cent. Crop production on the arable field was based on autumn ploughing tillage with < 5 kg ha per year nitrogen fertilizer application in spring as an average of 20 years. Main crops were wheat, maize, rape and sunflower.

Sampling

One sample from the forest and one sample from the crop field as composites of 9 subsamples taken from the diagonals of two 100 m^2 squares were collected from the 0–10 cm layer of the topsoil (Rowel, D.L. 1994). Subsamples were mixed in order to create a spatially representative sample. Samples were dried and crushed, after which the > 2,000 μm particles were removed by dry-sieving.

Soil fractionation

The Zimmermann fractionation method was improved by Poeplau, C. *et al.* (2013) and in its present form widely used and accepted. The authors decided to use this method for compatibility reasons to the RothC model (Coleman, K. and Jenkinson, D.S. 1996) for possible further application. Fractionation procedures were as follows, 30 g of each sample were taken to 150 ml of distilled water then ultrasonic dispersion with 22 J/ml was applied. Then the samples were wet-sieved over a 63 μm screen in order to separate the sand, aggregate and particulate organic matter (POM) fraction from the rest of the sample. Particles < 63 mm were centrifuged (at 3,500 RPM for 15 min) in order to separate the silt and clay (s+c) and the dissolved (DOC < 0.45 mm) fraction (Popleau, C. *et al*. 2013). After the centrifugation the liquid component including DOC was decanted, whereas the solid phase was considered as s+c fraction. 1 g of the s+c fraction was oxidized with 6 per cent NaOCl in order to determine the resistant SOC (rSOC) content. Finally, the >63 mm fraction was separated by density. The heavy fraction (> 1.8 g cm^{-3}) contained the sand and aggregates (S+A), while the light fraction (< 1.8 g per cm^3) was POM.

UV-Vis spectroscopy

For SOM extraction the most traditional alkali solution method was applied since this was quite simple and therefore, still in use in recent studies (Nierop, K.G.J. *et al*. 2001). 40 mL 0.5 M NaOH were added to 4 g of sample, which were then shaken for 24 h according to the method of Galantini, J. A. *et al*. (2004) under non reductive conditions. Following this step, the solvent was centrifuged at 3,500 RPM for 15 min (Szalai, Z. *et al*. 2016) and right after that measured by photometry in order to avoid oxidation and recombination.

A Shimadzu UV-3,600 spectrophotometer was used to measure the absorbance values of the extractions depending on the wavelength. The total spectrum was recorded from 180 nm to 1,000 nm wherein the E_2/E_3 (245/265 nm), E_4/E_6 (400/600 nm) and Ultraviolet Absorbance Ratio Index URI (210/254 nm) ratios were calculated as they are in connection with SOM composition (Tan, K.H. 2003; Guo, M. and Chorover, J. 2003; Her, N.G. *et al.* 2008; Nadi, M. *et al.* 2012).

Dynamic light scattering

This method was chosen since it needed the same alkali SOM extraction as the photometric method did, therefore independently from extraction method the results were directly comparable with each other. DLS measurements were made using a Malvern Zetasizer Nano instrument where 0.5 M NaOH was determined as the solvent and extracted SOM was determined as the

substance. Measurements were carried out right after the extraction process as it was described at photometric measurements. The resulting histograms are based on volumetric percentage of the averages of at least three repetitions. (In case of high diversity two additional repetitions were created.)

SOC, particle size and pH measurement

Soil organic carbon (SOC) and total nitrogen TN data were achieved applying a Tekmar Dohrmann Apollo 9,000N instrument, which used dry combustion at 800 °C (Szalai, Z. *et al.* 2016). This instrument is additionally capable of measuring solid state samples, and so there was no need for prior sample preparation (Buurman, P. *et al.* 1996). Particle sizes of the bulk samples were determined in a range of 0.2-2000 μm using a Fritch Analysette 22 Microtech laser diffractometer by applying 0.5 M sodium pyrophosphate and 15 min ultrasonic treatment for disaggregation (Centeri, Cs. *et al.* 2015). The device provided 105 size classes those were grouped to 10 according to the USDA system *(Table 1).* pH values were determined using a potentiometer according to Buurman, P. *et al.* (1996).

Statistical analysis

SOC, DOC and TN values were determined as three repetitions at least. If SD exceeded 10 per cent additional measurements were carried out. Normality of the data was checked using Shapiro-Wilks test and transformation was carried out if that was needed. Differences among the averages were tested using one-way ANOVA with post hoc Tukey test. Since POM had one order higher values this fraction was excluded from the ANOVA for SOC and TN.

Results and discussion

Sand + Aggregate fractions and SOC distribution

The most relevant component of the bulk soil was in aggregated form and was classified as S+A by the fractionation under both land uses. The ratio of aggregates was higher under forest vegetation *(Table 2).* This ~ 10% difference did not highlight relevant changes so we cannot conclude that it was generated by land use conversion. In contrast, there was a difference between the SOC concentration of S+A, POM and bulk soil under forest and arable land, as under forest the SOC concentration is twice as much as under arable land use in all these fractions.

It is in accordance with the results of Falkengren-Grerup, U. *et al.* (2006) approximately 48 per cent of the SOC has mineralized under arable use due to intensive cultivation during the last ~200 years *(Table 2).*

Moreover, SOC distribution among fractions has also varied substantially between

Table 2. Carbon content and fractional distribution of the samples fractionated by the Zimmermann, M. et al. (2007) method

Soil fraction	Forest			Arable		
	Soil mass, %	SOC, g/kg	Proportion of SOC weighted with soil mass, %	Soil mass, %	SOC, g/kg	Proportion of SOC weighted with soil mass, %
S+A[1]	83.8	18.8	76.0	71.7	9.0	39.6
POM[2]	1.8	182.8	15.8	8.8	94.2	50.7
s+c[3] (rSOC)[4]	7.2	19.7 (4.8)	6.8	7.2	17.7 (10.7)	7.8
DOC[5]+ (loss)	0.0 (7.3)	0.005 (n. a.)	0.0 (1.4)	0.0 (12.3)	0.005 (n. a.)	1.9
Bulk soil	–	25.4	–	–	13.3	–

[1]Sand and Aggregates, [2]Particulate Organic Matter, [3]silt and clay; [4]resistant Soil Organic Carbon; [5]Dissolved Organic Carbon; n. a. = no data.

the two land use types. Both S+A and POM fractions contained approximately half of their SOC content under arable field compared to the forest soil.

This changes could be the result of both mineralization and a lower degree of formation (John, B. *et al*. 2005) beyond the potential soil erosion under both land uses. S+A had a much higher SOC loss than might be predicted on the basis of decreasing aggregate stability (lower ratio of S+A), which consequently implies that there might be some additional/secondary aggregating agent besides SOM, such as sesquioxides (Barthes, B.G. *et al*. 2008). SOC content of the finest fraction (s+c) seemed to be decreasing as well because of tillage operations, even though this change was not significant *(Figure 2).*

In contrast, in this fraction, the volume of resistant SOC increased significantly, which suggested the overrepresentation of chemically active SOC in mineralization. Moreover, tillage could improve SOM conservation on the mineral phase as it was reported by Fortuna, A. *et al.* (2003). SOC solubility did not change, and DOC presented less than 1 per cent under both land uses.

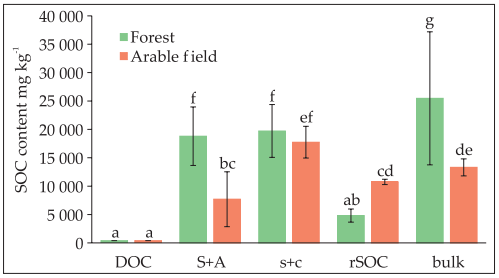

Fig. 2. Differences among SOM fractionated by the Zimmermann, M. *et al*. (2007) method concerning soil organic carbon (SOC) content. Whiskers indicate standard deviation. Same letters indicate groups with no difference at p < 0.05 level. – s+c = silt and clay; rSOC = resistant soil organic carbon; DOC = dissolved organic carbon; S+A = sand and aggregates; bulk = bulk soil; Particulate organic matter (POM) is excluded from this figure because of a higher magnitude value.

TN content of the fractions

TN distribution compared to that of SOC revealed the higher proportion (~ 40%) of dissolved component under both land uses *(Table 3).* The high volume of water soluble N content in topsoil of the forest does not necessarily indicate inorganic N but could be the result of increased microbiological activity (Chatigny, M.H. 2003).

TN content of the bulk soils decreased ($p<0.01$) under cultivation, although TN related to the finest size fractions (s+c, rSOC) did not changed significantly *(Figure 3).* This was in line with the classic SOM saturation theory of Hassink, J. (1997) and Wiesmeier, M. *et al*. (2014) who emphasized the role of <20μm fraction in SOM conservation. Therefore, the TN difference of the bulk soils was solely due to the TN loss of aggregates under cultivation *(Table 3)* (Goebel, M. *et al.* 2005). The proportion of POM N increased by 5 times under cultivation, which increase is 3 times higher compared to carbon.

An additional SOM loss opportunity was detected wherein SOM was dissolved in sodium polytungstate (SPT). The potential error caused by this process is relatively unknown, although Crow, S.E. *et al*. (2007) estimated it to be up to 26 per cent.

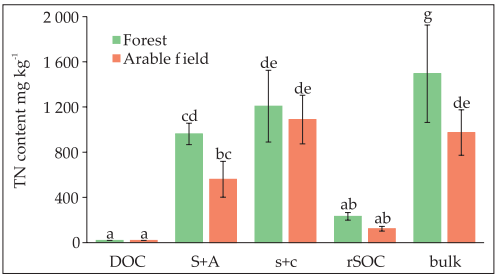

Fig. 3. Differences among SOM fractionated by the Zimmermann, M. *et al*. (2007) method concerning total nitrogen (TN) content. Whiskers indicate standard deviation. Same letters indicate groups with no difference at p < 0.05 level. – s+c, rSOC, DOC, S+A, POM, bulk = For explanation see *Fig. 2.* POM is excluded from this figure because of a higher magnitude value.

Table 3. Nitrogen content and fractional distribution of the samples fractionated by the Zimmermann, M. et al. (2007) method

Soil fraction	Forest			Arable		
	Soil mass, %	TN, g/kg	Proportion of TN weighted with soil mass, %	Soil mass, %	TN, g/kg	Proportion of TN weighted with soil mass, %
S+A[1]	83.8	0.9	51.7	71.7	0.5	27.7
POM[2]	1.8	4.5	5.2	8.8	4.1	24.8
s+c[3] (rSOC)[4]	7.2	1.2 (0.2)	5.6	7.2	1.1 (0.1)	5.4
DOC[5]+ (loss)	0.0 (7.3)	0.1 (n. a.)	0.0 (37.7)	0.0 (12.3)	0.1 (n. a.)	42.1
Bulk soil	–	1.4	–	–	1.0	–

[1]Sand and Aggregates, [2]Particulate Organic Matter, [3]silt and clay; [4]resistant Soil Organic Carbon; [5]Dissolved Organic Carbon; n. a. = no data.

C/N ratios of the fractions

Most fractions had a C/N ratio between 10 and 20, which is usual for temperate SOM (Bronick, C.J. and Lal, R. 2005). As it was expected lowest values were related to the water soluble components, while outstanding high C/N values were found in the POM (of forest's soil) and rSOC (of arable field's soil) fractions *(Figure 4)*, even though significant differences at $p<0.05$ were only found under forest.

Due to the lower C/N values of crops compared to those of the forest litter (Cools, N. *et al.* 2014), C/N arable field POM was lower, since this fraction referred to the most recent non degraded SOM. The most extreme value was found in the rSOC fraction of the arable field, which could not be interpreted adequately.

Photometric indexes

The absorbance value at 280 nm revealed a consistent pattern that highlighted only the quantitative difference between each pair *(Figure 5)*. Absorbance values normalized to SOC content prove that absorbance is not a direct function of SOC content. Since this property would be a proxy of aromaticity, the results suggested the same order of fractions under both land use types which was in contrast with both the results of C/N ratio of

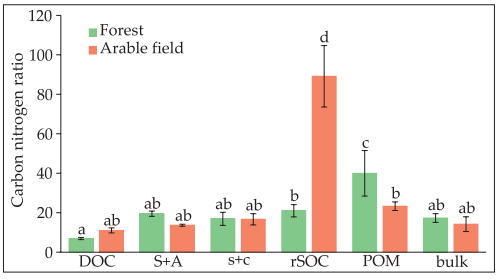

Fig. 4. C/N values of the SOM fractionated by the Zimmermann, M. *et al.* (2007) method under various land uses. Same letters indicate groups with no difference at $p < 0.05$ level. – s+c, rSOC, DOC, S+A, bulk, POM = For explanation see *Fig. 2.*

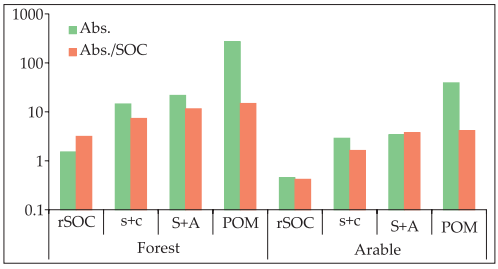

Fig. 5. Absorbance values of SOM solutions (in 0.5 M NaOH) at 280 nm fractionated by the Zimmermann, M. *et al.* (2007) method. Abs/SOC is the absorbance value normalized to the SOC content of the sample. – s+c, rSOC, S+A, POM = For explanation see *Fig. 2.*

this study and the SOM stabilization theory of Schmidt, M.W.I. *et al*. (2011) and Lehmann, J. and Kleber, M. (2015). Moreover, Lützow, M. *et al.* (2006) pointed out that aromaticity is not necessarily indicative of higher resistance against degradation, especially in the most resistant clay associated fraction.

URI revealed different results compared to the E_2/E_3 and E_4/E_6 indexes. The only significant tendency regarding the URI is that the S+A fraction has the highest value under both land uses, which could refer to the higher proportion of aliphatic SOM components within the aggregates *(Figure 6).* The reason of extremely high value at arable S+A is unknown.

The trend of E_2/E_3 and E_4/E_6 were different, even though both of them were presumed to be a proxy of SOM polymerisation degree. E_4/E_6 indicated that the average polymerization degree of SOM is the highest in POM and lowest in the finest mineralogical fraction. This is in accordance with the traditional humus concept (Kononova, M.M. 1966), but contradicts the results of Chaudhuri, S. *et al.* (2013) who reported a tendentious decrease in E_4/E_6 value with maturation. Almost similar but they have got different values, which was also reported by Nadi, M. *et al.* (2012). E_2/E_3 did not indicate relevant differences among the fractions. Moreover, there was no considerable difference between the two land use types either.

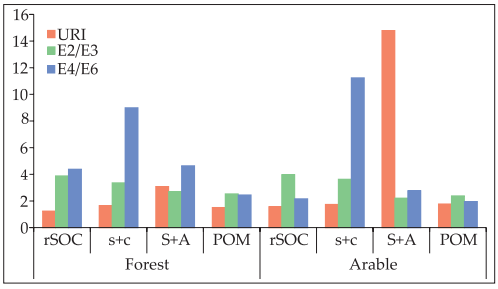

Fig. 6. Photometric index values of SOM fractionated by the Zimmermann, M. *et al*. (2007) method under different land uses URI = Ultraviolet Ratio Index; E_2/E_3 = ratio between absorbance values at 254 and 365 nm; E_4/E_6 = ratio between absorbance values at 465 and 665 nm; s+c, rSOC, S+A, POM = For explanation see *Fig. 2.*

Results of molecular size distribution

Most investigated organic substances had a polydisperse molecular size distribution. The histograms were bi-, trimodal or possessed even more peaks that referred to the heterogeneous compositions of SOM in each fraction *(Figure 7).*

There were trimodal distribution at both land uses concerning the POM fraction. The two higher molecular sized peaks were situated at the same size under both forest and crop field, whereas the lowest peak that dominated the forest sample was shifted upward under crop field. In general, this comparison implied that the forest had the relatively lower molecular-sized POM composition; however, there was no relevant difference measured by the photometric indexes.

In the aggregate fraction (S+A), the size difference between the forest and arable samples was the highest with a very wide range of large molecular sizes under the forest. Moreover, under forest, as it was expected, this fraction had the highest molecular size values compared to the others as was also reported by (Tan, K.H. *et al*. 2003). In case of S+A, the average molecular size was significantly lower under the arable land, even though photometric indexes revealed the opposite tendency.

However, the highest peaks indicated nearly the same modulus value in both cases at approximately 550–600 nm, though the distribution is obviously different regarding the s+c fraction. The arable sample seemed to be much more diverse, and was shifted to the lower size direction, although no changes were indicated by C/N ratio.

Concerning the rSOC in either case, the main peak was shifted downwards and became narrower compared with those of the whole s+c fraction. This suggested that oxidation (hypochlorite treatment for labile fraction removal) diminished the molecular size in both cases, however, the more intensive degradation occurred under the forest. Accordingly, *i)* oxidization could degrade SOM molecules in a wide size range; *ii)* molecular sizes rang-

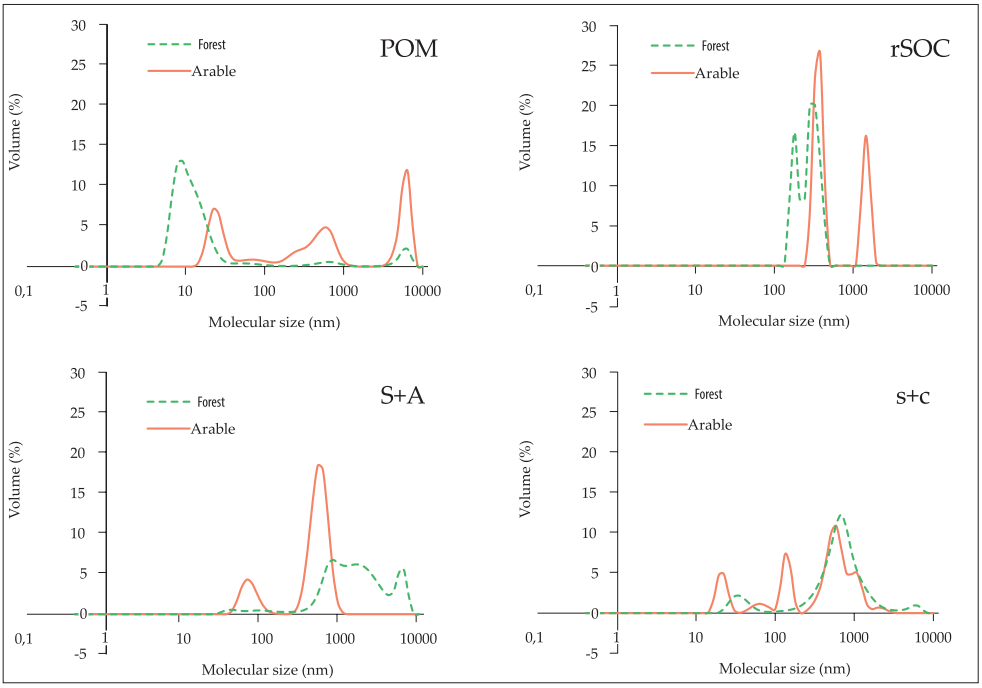

Fig. 7. Soil organic matter molecular size distributions of the studied fractions (Zimmermann, M. *et al*. 2007) under different land uses. Spectra are averages. – s+c, rSOC, S+A, POM = For explanation see *Fig. 2*.

ing from 300–350 nm seemed to be more resistant, although other narrow peaks appeared depending on land use variations.

These spectra did not substantiate the results obtained from the photometric indexes, even though they were in line with the results of organo-mineral theory (i.e., POM is the direct function of plant cover, and aggregates contain the largest SOM molecules – Manzoni, S. and Porporato, A. 2009; Burd, A.B. *et al.* 2015).

SOM compositions of the soil fractions under arable land and forest were comparable, but quite different *(Figure 8).* SOM of the crop field demonstrated substantial diversity, both the highest-and lowest-sized SOM molecules were associated with POM. In this case SOM molecules were found to have a more or less continuous size distribution, whereas under forest the fractions seemed to be clustered around certain size values.

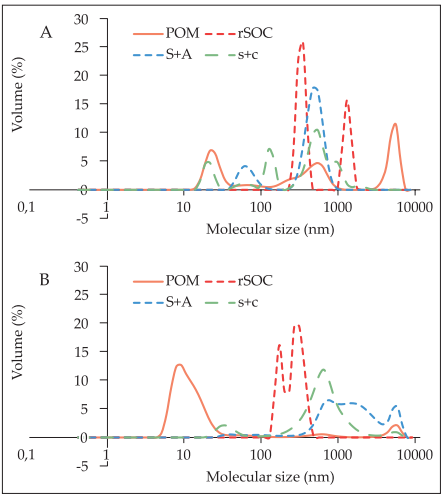

Fig. 8. SOM molecular size distribution of different fractions (Zimmermann, M. *et al*. 2007) under arable (A) and forest (B) land uses. – s+c, rSOC, S+A, POM = For explanation see *Fig. 2*.

Conclusions

Even though OM input and land use are presumed to be the primary driving forces of soil aggregation and SOM composition, no relevant difference was found in the volume of aggregation and aggregate stability due to former forest clearance and cultivation, however SOC and TN concentrations decreased significantly in the investigated smectite rich Luvisol. Therefore, the binding capability of this particular soil was presumed to be the function of rather SOM composition than SOC content. In contrast silt and clay associated SOM quantity did not change significantly. SOM composition proxies provided inconsistent results using the NaOH extraction method. Therefore, the application of organo-mineral SOM protection theory in association with the photometric proxies seems to be difficult in the present case.

On the other hand, photon correlation spectroscopy provided results in line with the published results of the organo-mineral stabilization theory that suggested alkali extraction with special care could be a useful alternative for such soils. However, due to the known imperfections of it, the application of in situ measurement methods would be preferable.

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Identification of Saharan dust particles in Pleistocene dune sand-paleosol sequences of Fuerteventura (Canary Islands)

György VARGA[1] and Cristopher-Bastian ROETTIG[2]

Abstract

Automated static image analysis and newly introduced evaluation techniques were applied in this paper to identify Saharan dust material in the unique sand-paleosol sequence of Fuerteventura (Canary Islands). Measurements of ~50,000 individual mineral particles per samples provided huge amount of granulometric data on the investigated sedimentary units. In contrast to simple grain size and shape parameters of bulk samples, (1) parametric curve-fitting allowed the separation of different sedimentary populations suggesting the presence of more than one key depositional mechanisms. Additional (2) Raman-spectroscopy of manually targeted individual particles revealed a general relationship among grain size, grayscale intensity and mineralogy. This observation was used to introduce the (3) intensity based assessment technique for identification of large number of quartz particles. The (4) cluster and (5) network analyses showed that only joint analysis of size, shape and grayscale intensity properties provided suitable results, there is no specific granulometric parameter to distinguish Saharan dust due to their irregular shape characteristics. The presented methods allowed the separation of Saharan dust-related quartz grains from local sedimentary deposits, but due to the lack of robust granulometric characterization of coarsest fractions and due to the diverse geochemical properties of North African sources, exact volumetric amount of deposited dust material and sedimentation rates could not be determined from these data.

Keywords: Saharan dust; Canary Islands; grain size; grain shape; automated image analysis

Introduction

Global mineral dust particle emission from arid-semiarid areas can be set into the range between 2 and 3 billion tons per year. Wind-blown particles are playing important role in several climatic and other environmental processes, while the accumulated eolian dust deposits are valuable climatic archives (Harrison, S.P. *et al.* 2001; Kohfeld, K. and Tegen, I. 2007; Maher, B.A. *et al.* 2010; Pósfai, M. and Buseck, P.R. 2010; Shao, Y. *et al.* 2011). Huge amount of dust is deposited far from the source area, contributing to local sedimentary units as exotic mineral material and has an influence on parent material for soils. Examples for atmospheric dust addition with significantly different geochemical fingerprint were reported from several places, e.g. quartz-rich dust addition to basaltic environments: Hawaii (Jackson, M.L. *et al.* 1971); Cheju (Lim, J. *et al.* 2005); San Clemente Island (Muhs, D.R. *et al.* 2007b); Canary Islands (Coude-Gaussen, G. *et al.* 1987); clay-rich dust delivery to Caribbean soils (Prospero, J.M. and Lamb, P.J. 2003) and Florida (Muhs, D.R. *et al.* 2007a) and dust contribution to the formation of red soils in the Medi-

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terranean (Yaalon, D.H. and Ganor, E. 1973; MacLeod, D.A. 1980; Yaalon, D.H. 1997) or in Australia (Mee, A.C. *et al.* 2004).

North African regions are responsible for 50–70 per cent of the global dust budget and are regarded as the most intense and dominant sources of atmospheric eolian dust (Tegen, I. *et al.* 1996; Mahowald, N.M. *et al.* 1999, 2006; Ginoux, P.M. *et al.* 2001; Miller, R.L. *et al.* 2004). This dust is transported into the direction of Europe, Middle East and the Atlantic Ocean (Israelevich, P.L. *et al.* 2002; Barkan, J. *et al.* 2005; Engelstaedter, S. *et al.* 2006; Stuut, J.-B.W. *et al.* 2009). The largest amount is transported westward by high altitude Saharan Air Layer towards the Canary Islands, Caribbean and North America, and by the so-called 'Harmattan' winds of the northeasterly trade winds to South Atlantic and South America (Prospero, J.M. *et al.* 1970; Swap, R. *et al.* 1992; Prospero, J.M. 1996).

Fuerteventura is the second largest member of the archipelago of the Canary Islands located closest to the African continent, 100 kilometres west of Morocco. The basaltic Eastern Canary Islands are influenced by Saharan dust events, locally called 'Calima' *(Figure 1).* The silt, clay and very fine-sand sized mineral particles are deposited on the widespread, shelf-originated carbonate eolianites of the island. Cyclic nature of Quaternary climates, changing amount of transported mineral dust, sea-level variations and related sand availability created a unique carbonate sand dune-paleosol sequence on the basaltic island, making it an excellent natural laboratory to study the complex Quaternary eolian dynamics (Roettig, C-B. *et al.* 2017). The sedimentary deposits are excellent archives of past environmental changes and landscape evolution history. It is especially true for relatively isolated areas, where to some extent limited transport and depositional mechanisms have played a role in the formation of sedimentary deposits.

The present study aims to (1) provide information on granulometric character of various windblown deposits of Fuerteventura; (2) present a set of new methods to identify Saharan dust material in the carbonate eolianite-paleosol sequences of the island. Both of these proposed aims will be discussed by using the results of automated static image analysis technique. Determination of granulometric parameters is standing in the focal point of sedimentary studies and it is of growing interest in the Earth sciences. Accurate grain size and shape data of sedimentary deposits provide valuable information on entrainment, transport and accumu-

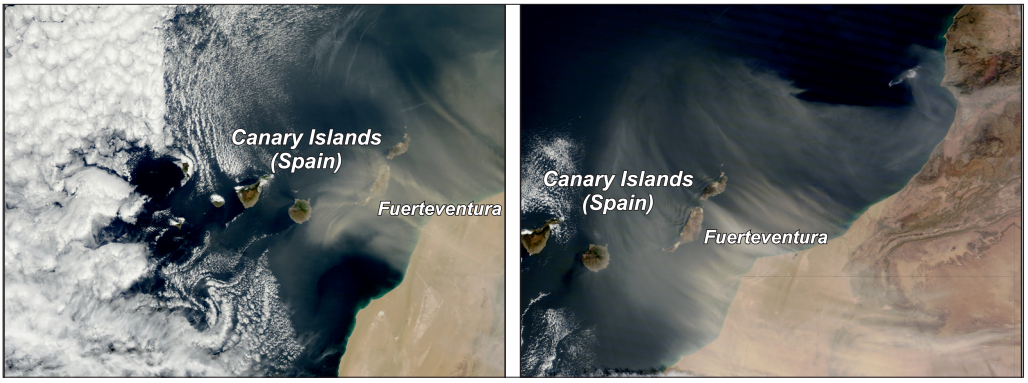


Fig.1. Location of Fuerteventura (Canary Islands) and satellite images of Saharan dust events on 4th February 2013 (NASA Aqua MODIS) (on the left), and on 8th March 2012 (NASA Terra MODIS) (on the right). *Source*: https://worldview.earthdata.nasa.gov/

lation mechanisms of sedimentary particles, and makes us able to gain insights into soil erodibility (Centeri, Cs. *et al.* 2015).

Investigation area

Geological setting of Fuerteventura can be characterized by the products of Neogene and Quaternary alkali basaltic volcanism, unconsolidated carbonate eolianites delivered from exposed shelf areas of the island and admixtured Saharan dust material. Paleo-dune fields and sand sheets of coarse grained biogenetic sandy shelf material with intercalated silty paleosols provide insight into the complex eolian dynamics of the Quaternary. Main phases of sand accumulation are dependent on sand availability and geomorphic stability determined by humidity-driven soil formation. However, as it was reported by Criado, C. *et al.* (2012), not all reddish layers are in-situ soils, but rather they are formed by higher admixture of silt-sized Saharan dust material with quartz and calcite with some additional feldspar, illite, kaolinite and hematite during periods of reduced sand supply (Roettig, C-B. *et al.* in press). Nowadays, sand availability has also been a key-issue at the island as the demand for sand has grown tremendously by road and building constructions

The identification of past Saharan dust particles and the assessment of their admixture into terrestrial archives play a key role in (1) the understanding of past climate-driven atmospheric circulations; (2) recognition of periods with stable geomorphic evolution and soil formation. Recent observations and measurements allow us to get an overview on dust transportation, deposition and general characteristics of Saharan dust particles. Three different synoptic meteorological situations have to be taken into account regarding the dust availability on Fuerteventura: (1) low altitude easterly winds dominant all year long with winter-spring maximum; (2) summertime dust-bearing Saharan Air Layer as a results of northward migration of the inter-tropical convergence zone (although the main dust transport route is between N15°-21°, a southerly component of flow occur in the lee of the easterly wave); (3) low-level continental trade winds. Modern annual Saharan dust deposition rate is around 20 to 80 g/m^2/year in the region, the reported grain sizes are primarily in the medium and coarse silt fractions (Menéndez, I. *et al.* 2007). The amount of deposited dust in the past could even be significantly higher (Tsoar, H. and Pye, K. 1987).

Methods

Granulometric characterization of eolian deposits

Samples were taken from 24 silty units considered as paleo-surfaces of stable geomorphic periods with reduced sand movements and relatively enhanced Saharan dust influence, additional dune sand and sand sheet samples were also investigated as references for intense sand transportation intervals. Detailed description of the units and stratigraphic analysis of selected sites can be found in the works of Faust, D. *et al.* (2015) and Roettig, C-B. *et al.* (2017, in press). Air-dried and 2 mm sieved samples were measured by Malvern Morphologi G3-ID instrument in the Laboratory for Sediment and Soil Analysis (Geographical Institute, Research Centre for Astronomy and Earth Sciences, Hungarian Academy of Sciences).

The applied automated static image analysis technique is a new, innovative mode of grain size and shape analyses completed with chemical identity assessments of Raman spectrometry. In contrast to widely used laser diffraction measurements, image analysis provides direct observational data of particle size, and due to the automatic measurement technique large number of particles are characterized allowing us a more robust and objective granulometric description of particles compared to manual microscopic approaches *(Figure 2).*

7 mm^3 of mineral particles per samples were dispersed by 4 bar compressed air onto a glass slide with 60 s settling time. The used

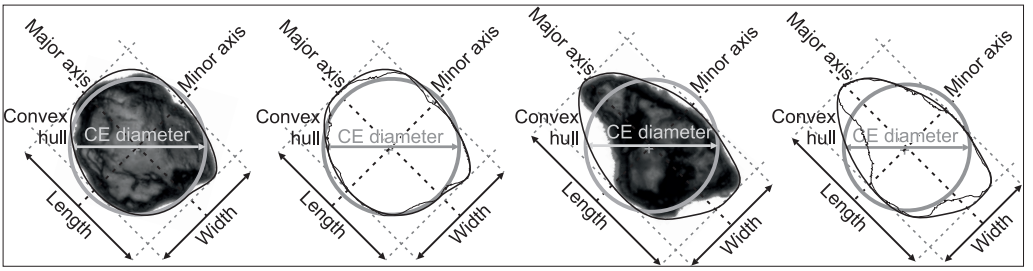


Fig. 2. Key grain size and shape parameters of mineral particles (modified after Varga, Gy. *et al.* 2018). – Aspect Ratio = Width/Length; CE Diameter = diameter of a circle with the same area as the projected 2D particle image; Circularity = $(2 \times \Pi^{0.5} \times \text{Area}^{0.5})$/Perimeter; Convexity = $\text{Perimeter}_{\text{Convex hull}}$/Perimeter; Elongation = 1 – Width/Length, the same as 1 – Aspect Ratio; SE Volume = volume of a sphere with the same CE Diameter as the projected 2D particle image; Solidity = $\text{Area}_{\text{Convex hull}}$/Area

20 x objective lens provide a 960 x magnification, suitable for detailed characterization of particles in the size range between fine silt and fine sand fractions. Two-dimensional imaging was completed with the usage of additional vertical focal planes, two additional layers were applied above and two other ones below the focus, equivalent to a total of 27.5 μm.

The captured high-resolution grayscale images of ~50,000 individual mineral particles were automatically analysed by the device software to get a raw granulometric data-matrix. Each row of the table represents one sedimentary particle (with its own identity number), while the columns are various size and shape parameters, completed with light transmissivity data and Raman correlation scores.

Circle-equivalent (CE) diameter is the key size descriptor, calculated as the diameter of a circle with the same area as the projected two-dimensional image of a given mineral grain. Beside several other simple size properties (e.g. length, width, perimeter, sphere-equivalent volume), various shape parameters are derived from these sizes. Aspect ratio is the ratio of width and length, circularity describes the proportional relationship between circumference of a circle equal to the projected area of the particle and perimeter. Convexity (and solidity) parameters are measures of edge roughness by using the ratio of particle and convex hull perimeter (and area). Circularity and convexity values are also suitable to filter out stacked particles and aggregated particles, in this study particles with lower than 0.65 circularity and convexity values were excluded from further calculations.

Intensity mean and standard deviation parameters are determined from the grayscale images as a results of light transmissivity of particles. These values are dependent on mineralogy, particle thickness, chemical homogeneity and surface roughness (for detailed description of the method, see: Varga, Gy. *et al.* 2018). Intensity values together with chemical identity analyses of the build-in Raman spectrometer provide useful additional information for separation of granulometrically similar particles.

Identification of Saharan dust material

Based on the fact that the Saharan dust deposited at Fuerteventura is mainly (1) silt-sized and (2) contains a lot of quartz particles (regarded as exotic in the basaltic and carbonate-rich environment of the island), these two deterministic factors were evaluated separately to identify North African dust particles. Three different assessment methods were applied to determine the amount of Saharan dust material of the samples.

An indirect approach was applied to theoretically discriminate the silt-sized sedimen-

tary subpopulations which were mathematically separated. The polymodal grain size distribution curves were partitioned into several unimodal Weibull-distributions by applying parametric curve-fitting technique (Sun, D. *et al.* 2002, 2004; Varga, Gy. *et al.* in press). According to the applied parametric curve fitting technique the polymodal particle size curves can be interpreted as sum of several, in this case three overlapping Weibull-functions which represent three sediment populations:

$$W_1 + W_2 + W_3 = c_1 \cdot \left(\frac{\alpha_1}{\beta_1^{\alpha_1}}\right) \cdot x^{\alpha_1 - 1} \cdot e^{-\left(\frac{x}{\beta_1}\right)^{\alpha_1}} + c_2 \cdot \left(\frac{\alpha_2}{\beta_2^{\alpha_2}}\right) \cdot x^{\alpha_2 - 1} \cdot e^{-\left(\frac{x}{\beta_2}\right)^{\alpha_2}} + c_3 \cdot \left(\frac{\alpha_3}{\beta_3^{\alpha_3}}\right) \cdot x^{\alpha_3 - 1} \cdot e^{-\left(\frac{x}{\beta_3}\right)^{\alpha_3}},$$

where, shape ($\alpha_{1\text{-}3}$), location ($\beta_{1\text{-}3}$) and weighting ($c_{1\text{-}3}$) parameters of the three Weibull-functions were modified by an iterative numerical method as a least-square problem to assess the appropriate goodness of fit of measured data and calculated size distributions of constructed subpopulations (Varga, Gy. *et al.* 2012, in press). According to published data on recent dust events from the area (Criado, C. and Dorta, P. 2003; von Suchodoletz, H. *et al.* 2009; Menéndez, I. *et al.* 2013) and measurements of other far-travelled North African dust material (Varga, Gy. *et al.* 2016), the subpopulation with smallest particles are regarded as the product of long-ranged dust transport.

Raman-spectroscopy (at 785 nm wavelength with 3 μm spot) was also applied to directly identify the quartz grains as an indicator of Saharan dust contribution. The acquired spectra of targeted particles were compared to Raman spectral reference libraries using KnowitAll® software from Bio-Rad to identify the minerals present.

The third applied technique was based on the grayscale intensity mean values of particles, the relatively high values were used as a proxy for quartz grains as it was found that there is a strong correlation between light transmissivity and chemical identity (especially in this special case of an environment characterized with the overwhelming majority of carbonate and quartz particles).

Cluster and networks analysis techniques were also applied to differentiate various mineral particle populations based on their general normalized shape (aspect ratio, circularity, convexity, solidity) and grayscale intensity (mean, standard deviation) values. Hierarchical cluster trees were created by using the Euclidean distance pairs of the selected parameters of separated quartz and carbonate size fractions (fine, medium, coarse silt and sand).

For network analysis 192 x 192 ([24 samples x 2 minerals x 4 size fractions] x [24 x 2 x 4]) matrix was compiled, where coefficient of determination was calculated for each pair of records based on the normalized shape and grayscale intensity parameters. This matrix was transformed into an adjacency matrix with values of 0, if $r^2 < 0.99$ and 1, if $r^2 \geq 0.99$, in this way all of the similar mineral grains were coupled and the whole database can be handled as a network or a finite graph, where the similar records (nodes) are connected (edges) to each other. The Gephi network visualization software was used to analyse the compiled network by applying the ForceAtlas2 continuous graph layout algorithm (Jacomy, M. *et al.* 2014).

Results

General granulometric character of sedimentary samples from Fuerteventura

Grain size distribution curves of samples from the paleo surface units were polymodal, mostly with two-three distinct peaks in coarse silt, fine sand and medium sand fractions. Samples taken additionally from sand members of the sedimentary sequence showed a pure unimodal distribution almost entirely in the sand fractions. It is also worth noting, that even these medium and coarse

sand dominated samples contained small amount (< 0.5 vol.%) of silt-sized particles.

General granulometric characteristics by size fractions are presented in *Table 1.* and *Figure 3.* The dominance of sand-sized fraction is clearly visible on circle-equivalent diameter, length and width box-plots; this fraction determines also the bulk grain size values. Shape parameters of samples showed a more diverse picture. Mean aspect ratio values were between 0.75 and 0.80 for all fractions, but higher standard deviation scores could be observed in case of sand-sized particles. Circularity and convexity parameters of silt grains were relatively high, especially compared to sand particles, which had a more irregular shape character. Particles with highest solidity values were from the medium and coarse silt-sized fractions, solidity parameters of fine silt- and sand-sized grains were lower, but in case of clay particles it could be the result of the small number of pixels on the acquired images of individual clay-sized grains.

Parametric curve-fitting: the mathematical-statistical approach

All of the measured volume-based grain size distribution curves of the measured samples showed a polymodal character. Beside the sand-sized modes, a clear medium and coarse silt-sized peak is present on the diagrams. By using three three-parameter Weibull-distribution functions, proper goodness-of-fit values were reached among the constructed and measured distributions (r^2 values were 0.98±0.2) during the parametric curve-fitting *(Figure 4).*

Samples could be represented by diverse grain size distributions; the amount of the coarsest fraction was especially various. During the measurements an average of ~50,000 individual mineral particles were scanned, so even a few sand-sized grains could have a significant effect on volume-based grain size distributions. As the result of polydisperse grain size of samples (particle sizes covering several orders of magnitude: submicron to some few hundred microns) to get a more robust representation several millions of scanned mineral particles would be necessary (Varga, Gy. *et al.* 2018).

Mean modal value of circle-equivalent diameter was 62.3 μm (±12.1 μm standard deviation), while the average median was calculated as 49.2 μm (±9.5 μm standard deviation) for the 24 samples.

Direct differentiation of quartz grains via Raman-spectroscopy

The applied measurement system of Malvern Morphology G3-ID enables the chemical characterization of dispersed mineral particles with the use of integrated Raman probe. Due to the relatively low number of interpretable spectra, special focus was given to the medium silt to fine sand-sized components of the samples studied. Only few hundreds of 30–120 μm quartz (Raman shift ~464 cm^{-1} and carbonate (Raman shift ~1,086 cm^{-1}) grains were identified, and this low number of particles did not allow a mathematically robust, quantitative determination of quartz content.

However, some general, broad conclusions could be drawn based on the whole mass of measured samples. Two distinct clusters of quartz and carbonate particles were visible on the circle-equivalent diameter and mean grayscale intensity scatterplots. As mean intensity scores are primarily dependent on particle thickness and mineralogy, with the assumptions of high proportion of isotropic particles, lower circle-equivalent diameter results a higher mean grayscale intensity values *(Figure 5).* This relationship is clearly visible in case of carbonate particles, but quartz grains are lighter in colour, these can be characterized by higher grayscale intensity values.

General grain size properties of the identified quartz and carbonate particles are also presented. As the selection of mineral grains for manually targeted chemical identity analysis cannot be regarded as representative due to the relatively high number of not

Table 1. Mean grain size and shape parameters of investigated samples

Sample name	CE, μm	Fine silt	Medium silt	Coarse silt	Sand	Length	Width	Perimeter	Aspect ratio	Circularity	Convexity	Solidity	Intensity mean	Intensity STD
		vol. %				μm								
ID-Enc-1	150.70	0.08046	1.784	25.610	72.53	187.8	140.1	453.9	0.7930	0.8666	0.9391	0.9548	27.64	25.02
ID-Enc-2	229.30	0.04735	1.020	14.820	84.11	281.0	204.9	769.1	0.7488	0.8565	0.9292	0.9592	24.62	24.07
ID-Enc-3	183.90	0.04337	2.036	21.120	76.80	236.1	167.5	459.3	0.8058	0.8689	0.9243	0.9720	26.11	25.88
ID-Enc-4	286.60	0.01920	0.260	6.178	93.54	361.5	268.0	980.9	0.7731	0.8342	0.8828	0.9624	22.53	24.44
ID-Enc-5	177.00	0.04310	1.348	24.120	74.49	217.0	154.8	654.6	0.8105	0.867	0.9421	0.9713	26.84	25.65
ID-Enc-6	227.40	0.06085	1.247	14.320	84.38	256.3	215.3	808.5	0.8068	0.8259	0.8730	0.9618	29.57	28.27
ID-Enc-7	204.10	0.03401	0.977	18.370	80.62	246.8	186.4	637.9	0.7495	0.8287	0.8963	0.9532	29.08	27.05
ID-Enc-8	95.96	0.16380	3.786	24.910	71.14	112.7	89.4	337.9	0.7805	0.9062	0.9518	0.9752	37.20	26.91
ID-Enc-9	178.10	0.05210	0.345	9.006	90.60	208.1	161.8	671.9	0.7871	0.8407	0.8966	0.9560	29.40	27.38
ID-Enc-10	197.40	0.26670	1.708	9.864	88.16	240.9	186.1	601.6	0.8032	0.8219	0.8765	0.9611	29.83	28.25
ID-Enc-11	198.30	0.05103	0.595	8.280	91.07	240.2	187.6	635.1	0.7769	0.8198	0.8789	0.9573	29.06	28.32
ID-Enc-12	197.70	0.12900	1.690	12.450	85.73	255.4	178.8	777.4	0.7782	0.8110	0.8767	0.9469	29.21	27.42
ID-Enc-13	148.20	0.04126	0.646	12.530	86.78	179.6	137.7	472.6	0.7830	0.8430	0.9068	0.9608	32.29	27.67
ID-Enc-14	220.30	0.09192	1.015	15.920	82.97	260.2	208.0	683.6	0.7640	0.8229	0.8726	0.9568	28.21	28.07
ID-Enc-15	106.10	0.13030	1.577	21.240	77.05	128.8	99.14	391.1	0.7897	0.8742	0.9324	0.9624	36.09	27.61
ID-Enc-16	150.50	0.16050	1.441	15.160	83.24	180.1	144.0	558.3	0.7757	0.8475	0.9068	0.9586	32.02	27.28
ID-Enc-17	250.80	0.13630	1.711	10.040	88.11	333.5	227.6	846.5	0.7862	0.8459	0.9154	0.9745	24.99	24.36
ID-Enc-18	165.00	0.23430	2.468	21.400	75.90	193.4	145.0	599.6	0.7387	0.8889	0.9326	0.9777	30.30	26.18
ID-Enc-19	206.20	0.45110	3.669	18.290	77.59	245.8	178.5	784.4	0.7337	0.8570	0.9066	0.9770	27.68	26.39
ID-Enc-20	155.90	0.19410	0.570	9.399	89.84	195.9	136.1	596.2	0.7337	0.8392	0.9145	0.9496	32.20	26.97
ID-Enc-21	98.39	0.13860	2.210	27.000	70.65	122.8	91.5	360.6	0.7509	0.8551	0.9246	0.9634	37.10	28.02
ID-Enc-22	154.70	0.12260	1.759	16.500	81.61	189.8	140.6	503.2	0.7871	0.8314	0.8955	0.9671	31.15	27.66
ID-Enc-23	191.50	0.29800	3.297	19.760	76.65	237.5	184.0	367.7	0.7714	0.7854	0.8869	0.9048	27.09	25.08
ID-Enc-24	145.50	0.28090	3.763	20.290	75.67	186.7	136.4	540.7	0.7093	0.8467	0.9216	0.9610	31.40	25.90

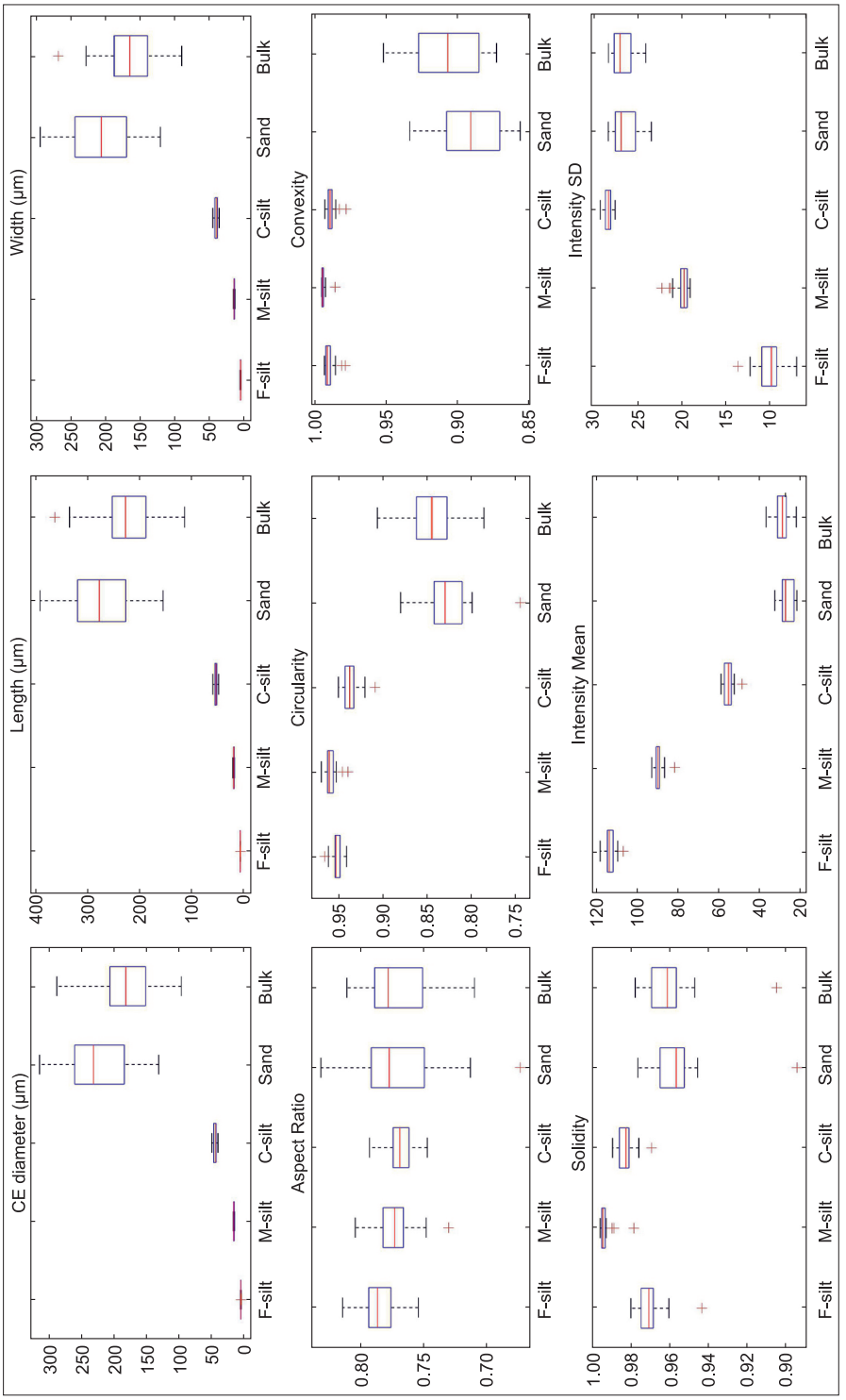


Fig. 3. Box-plots of various granulometric parameters by size fractions. – CE diameter = circle-equivalent diameter; F-silt = fine silt (2.0–6.5 μm); M-silt = medium silt (6.5–20.0 μm); C-silt = coarse silt (20.0–62.5 μm).

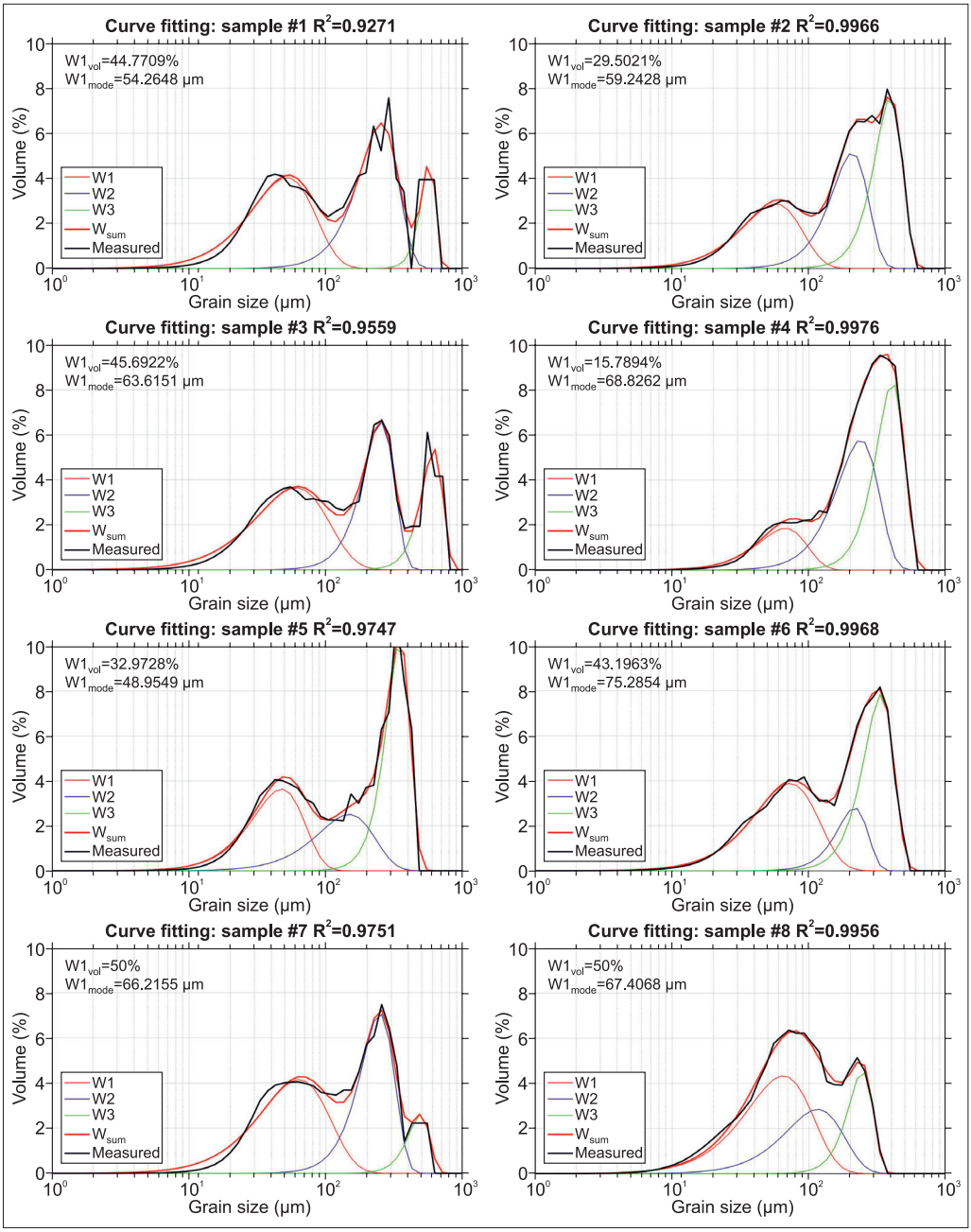


Fig. 4. Results of parametric curve-fitting of the measured grain size distributions

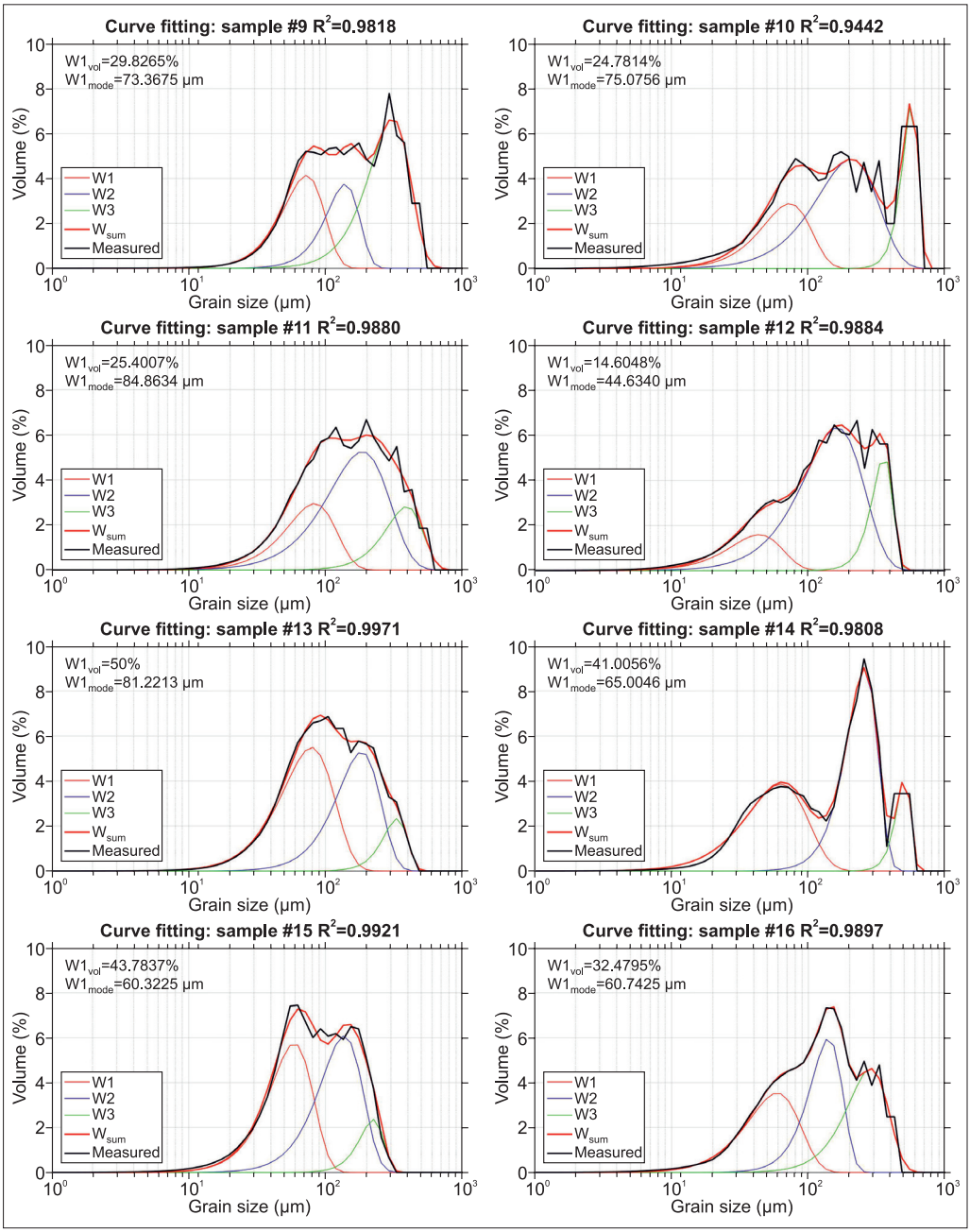
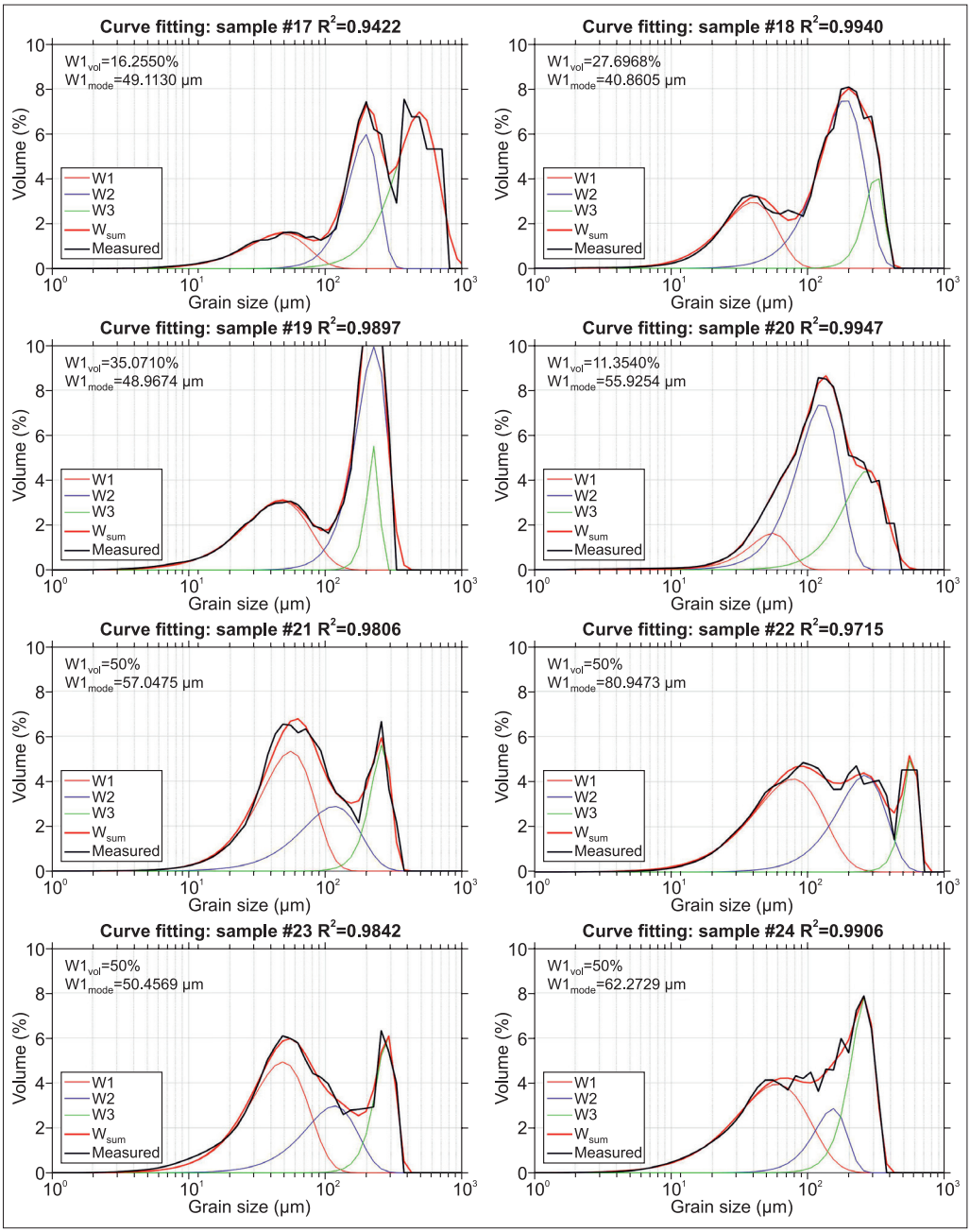


Fig. 4. Continued



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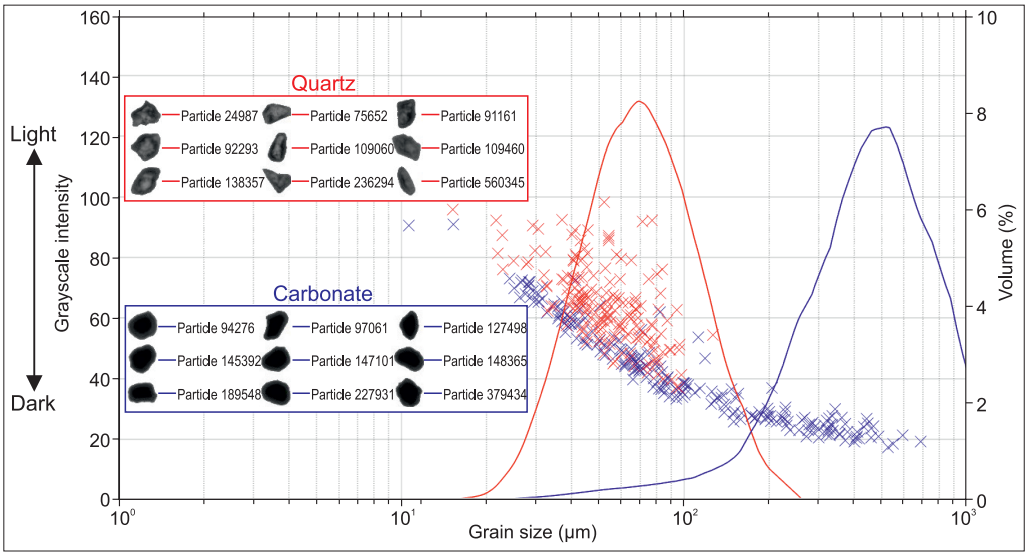


Fig. 5. Relationship among grain size, grayscale intensity and mineral composition of particles on a grains size vs. intensity scatter plot of quartz and carbonate particles.

interpretable acquired Raman spectra, it is assumed that the grain size distributions are somewhat higher (quartz mode: ~70 μm, median: 68.5 μm; carbonate mode: ~520 μm, median: ~460 μm) than the real particle sizes.

Grayscale intensity-based indirect assessment of quartz particles

The automatically recorded dimensionless grayscale intensity values served as proxies of optical properties of mineral grains. As it was above shown above, two distinct groups of particles could be separated on the grain size - grayscale intensity scatter plots, and the acquired Raman spectra confirmed our hypothesis that in a given size-class the grayscale intensities of quartz particles were higher, meaning brighter (lighter in colour) grains.

By using this observation, we applied specific grayscale intensity threshold values (+5%; +1σ [standard deviation] above size-class mean intensities) for every size-classes to identify possible quartz particles *(Figure 6).* While +1σ thresholds provided too many outliers (probably caused by the low number of scanned particles), the + 5 per cent filtering resulted an average of modal value around 65.1 μm (± 12.7 μm standard deviation) and mean median of the 24 samples was 48.3 μm (± 6.7 μm standard deviation). These values were very similar to the results of fine-grained populations of parametric curve-fittings (W1s), but grain size mode and median of the directly identified quartz particles were slightly higher.

Discussion

Irregular shape character of the quartz particles

The obtained results of the applied various methods demonstrated that quartz and carbonate particles could be distinguished by simultaneous analysis of size, shape and grayscale intensity values of the investigated samples. Cluster analysis of shape parameters of medium and coarse silt-sized quartz and carbonate particles showed that the two

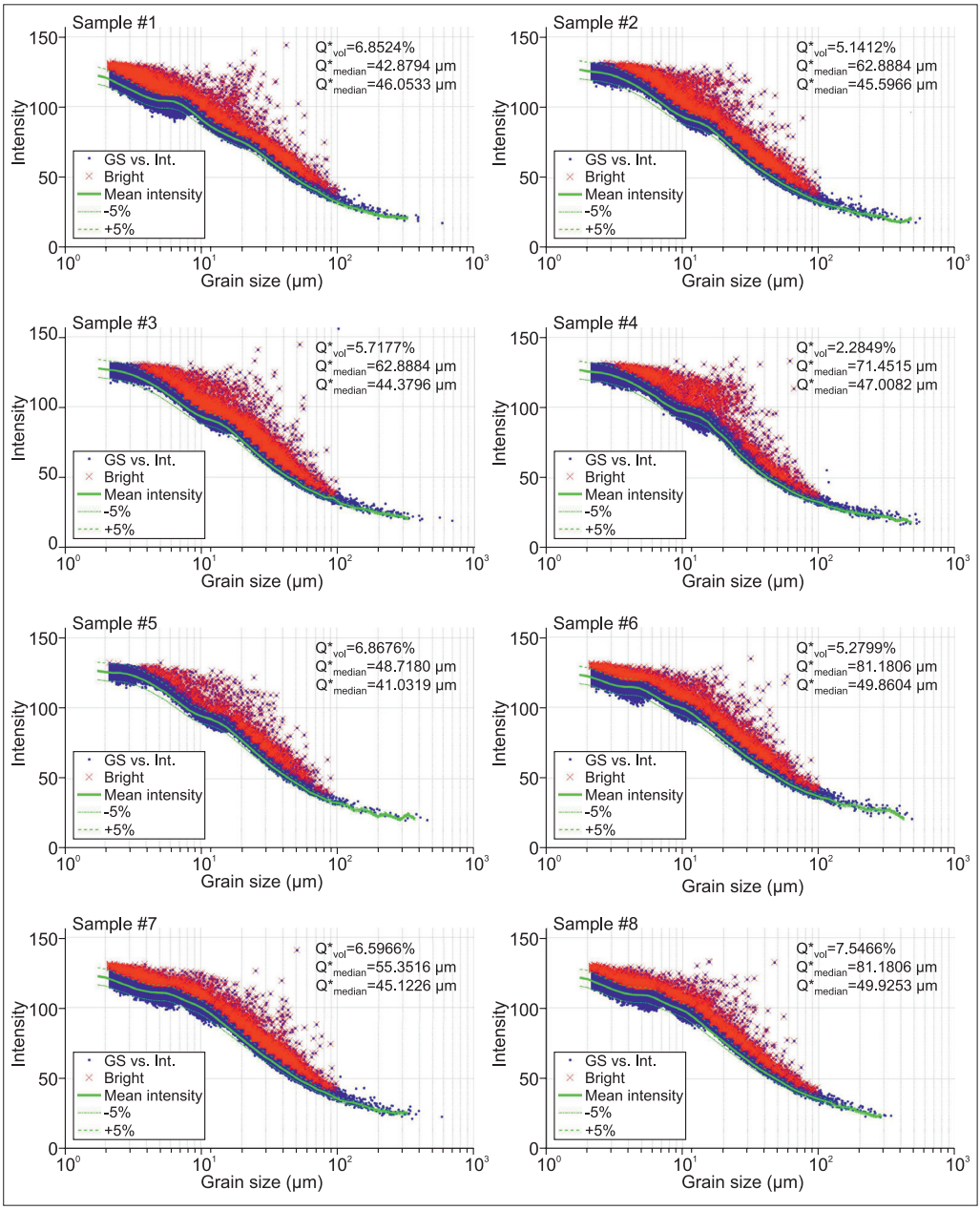
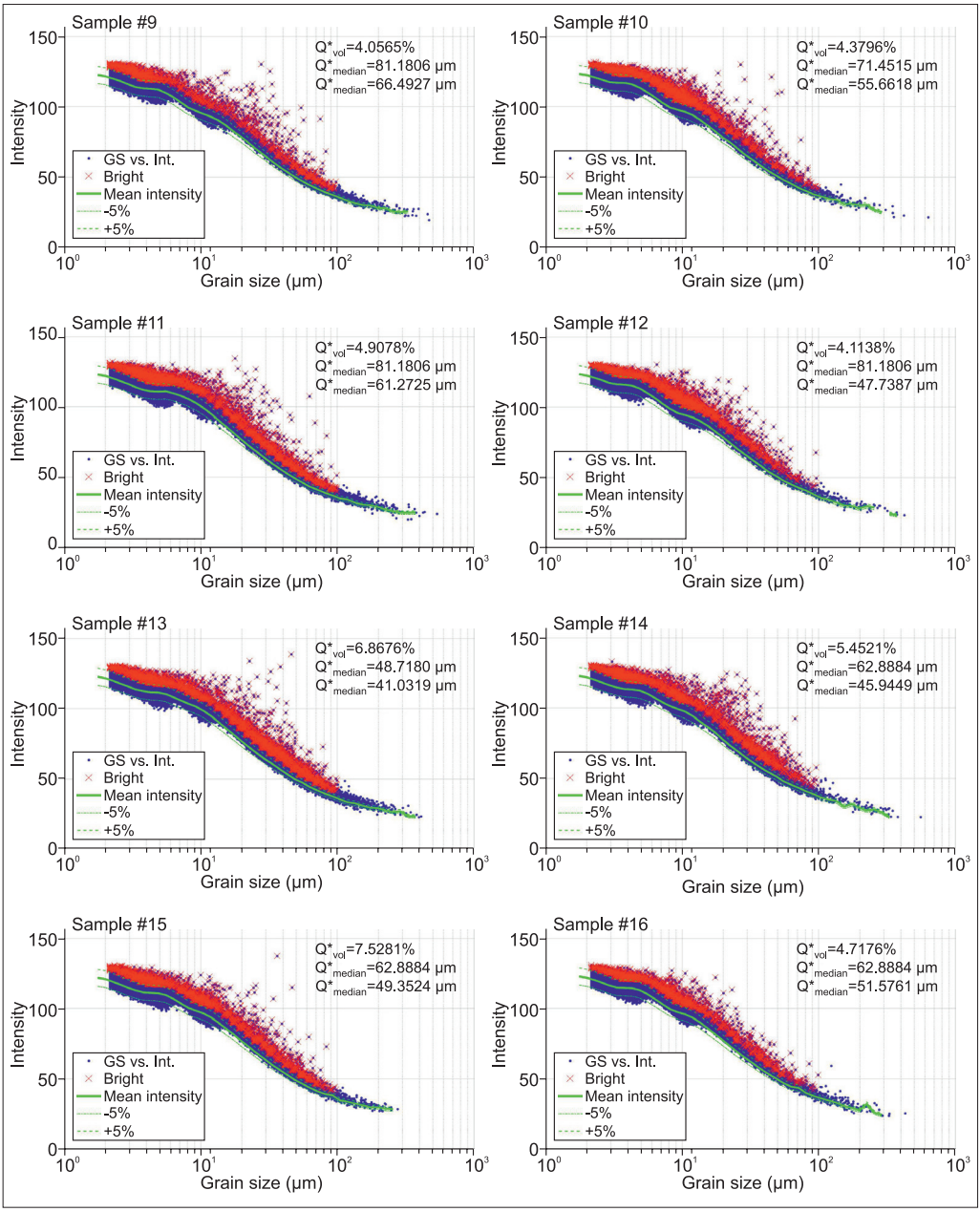


Fig. 6. Intensity-based assessment of quartz particles based on filtering of + 5 per cent above size-class means of intensity

populations were well separated from each other, suggesting main shape properties of the two clusters could be determined to serve as granulometric fingerprint to identify external quartz particles in the investigated depositional environment *(Figure 7)*. However, detailed



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analysis of different parameters indicated that the homogeneous-inhomogeneous shape characters of carbonate and quartz particles were the main drivers of clustering. All shape parameters in all size fractions were falling into a wider range in case of quartz particles,

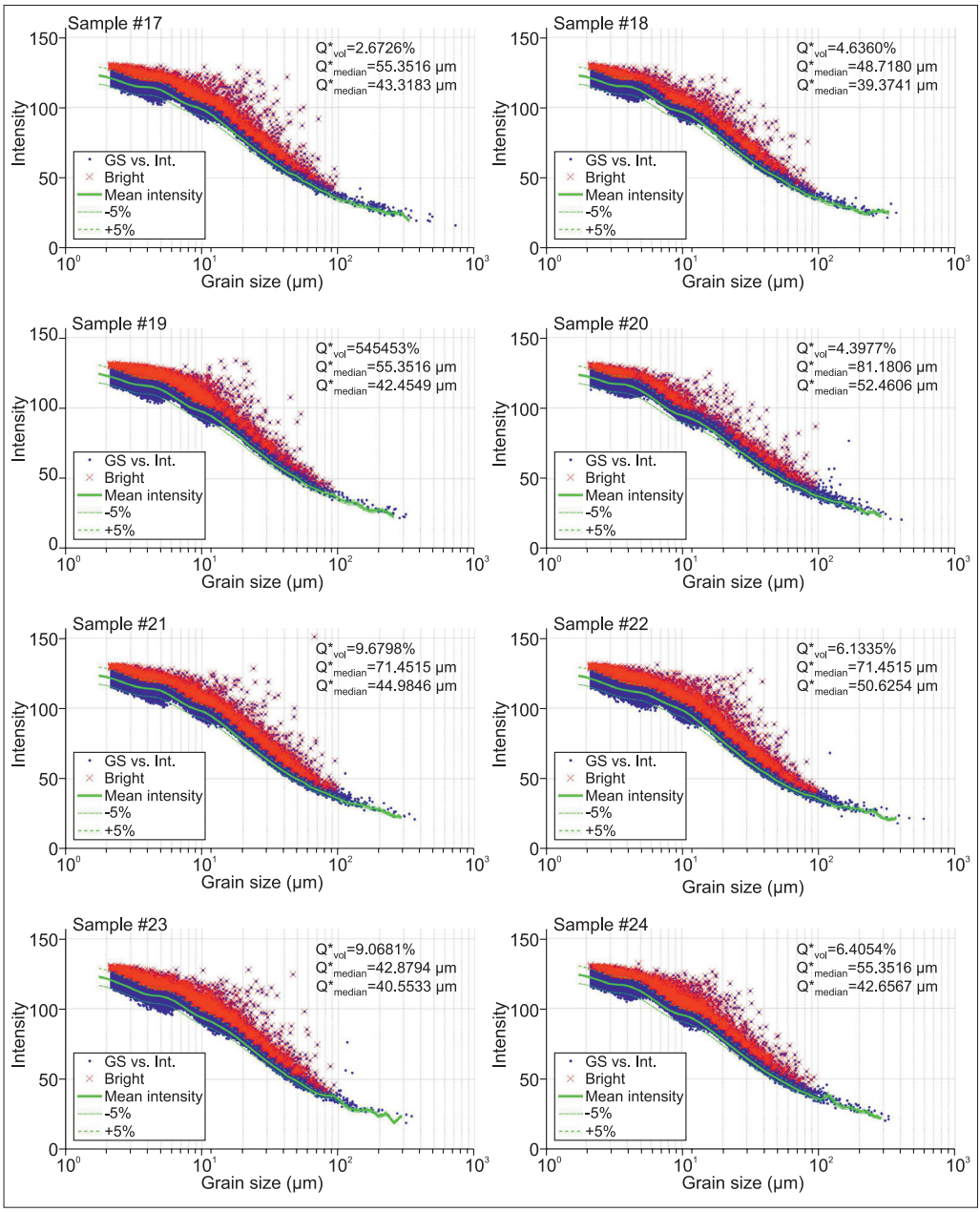

Fig. 6. Continued

while the standard deviation of shape values of carbonates were significantly smaller *(Table 2).* These phenomena were also recognizable on the more platy shape distribution curves of quartz particles compared to the leptokurtic carbonate shape distrubutions.

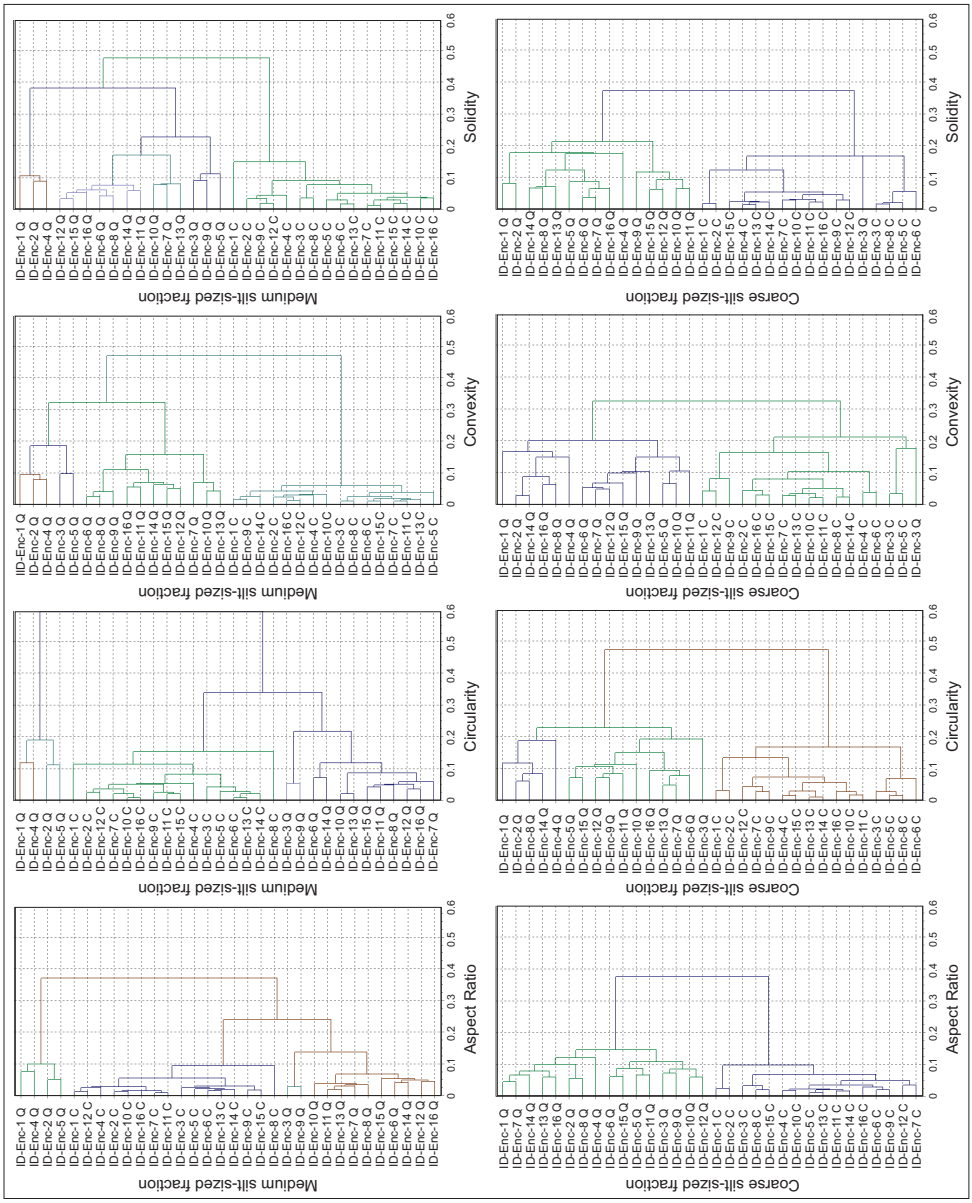

Fig. 7. Cluster analysis of medium and coarse silt-sized quartz and carbonate particles of the samples based on different shape parameters

*Table 2. Shape and grayscale intensity means and standard deviations of quartz (Q) and carbonate (C) particles by size fractions**

Indicator	Aspect ratio		Circularity		Convexity		Solidity		Mean intensity		Intensity Standard deviation	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
FS (C)	0.809	0.019	0.958	0.008	0.993	0.002	0.978	0.006	110.742	2.103	11.413	1.051
FS (Q)	0.760	0.038	0.944	0.021	0.988	0.004	0.971	0.006	115.442	1.403	8.764	0.899
MS (C)	0.782	0.012	0.962	0.005	0.995	0.001	0.995	0.001	88.396	2.005	20.408	0.786
MS (Q)	0.680	0.041	0.907	0.038	0.986	0.005	0.976	0.014	105.138	1.568	13.067	0.502
CS (C)	0.777	0.011	0.940	0.009	0.989	0.003	0.983	0.004	54.708	2.322	28.510	0.405
CS (Q)	0.655	0.029	0.876	0.023	0.981	0.007	0.961	0.013	65.239	2.409	24.571	0.797
Sd(C)	0.777	0.037	0.828	0.027	0.892	0.021	0.957	0.015	26.873	3.288	26.440	1.538
Sd (Q)	0.640	0.049	0.806	0.041	0.937	0.021	0.913	0.027	49.395	1.694	26.810	1.241

*FS = fine silt; MS = medium silt; CS = coarse silt; Sd = sand.

Network analysis showed similar results. More connections among different size fractions of different particle groups marked similar shape properties in *Figure 8.* It is clearly visible that majority of carbonates were clustered into distinct groups, except for fine silt-sized particles as a result of analogous shapes of smallest particles caused by the relatively low-resolution of the acquired images in this scale.

Medium silt-sized quartz particles showed some clustering in case of more than a half of the samples, but overwhelming majority of coarse sized fractions of quartzes appeared as individual samples without any connection to other ones. As the largest volumetric proportion of supposed Saharan dust material is falling into the coarse silt-sized fraction and even this size population showed the least clustered shape-determined structure, it could be ascertained, that we were not able to find any simple shape parameters to distinguish Saharan dust-related sedimentary populations. However, the joint characterization of size, shape and grayscale intensity properties allowed us to differentiate the North African dust material from local carbonates.

Potential source areas of identified dust particles

The lack of specific shape properties of deposited Saharan dust particles in Fuerteventura can be traced back to diverse geological and pedological character of dust source areas. Previous satellite based studies (e.g. Prospero, J.M. *et al.* 2002; Washington, R. *et al.* 2003; Engelstaedter, S. *et al.* 2006; Goudie, A.S. and Middleton, N.J. 2006; Varga, Gy. 2012) on Saharan dust source areas allowed us to identify potential source areas of mineral dust particles deposited on Fuerteventura. While comprehensive reviews on geochemical characteristics of North African sources provided information on geochemical, mineralogical and isotopic composition of the dust material (Scheuvens, D. *et al.* 2013).

One of the potential source areas is located in the southern part of the Taoudenni Basin

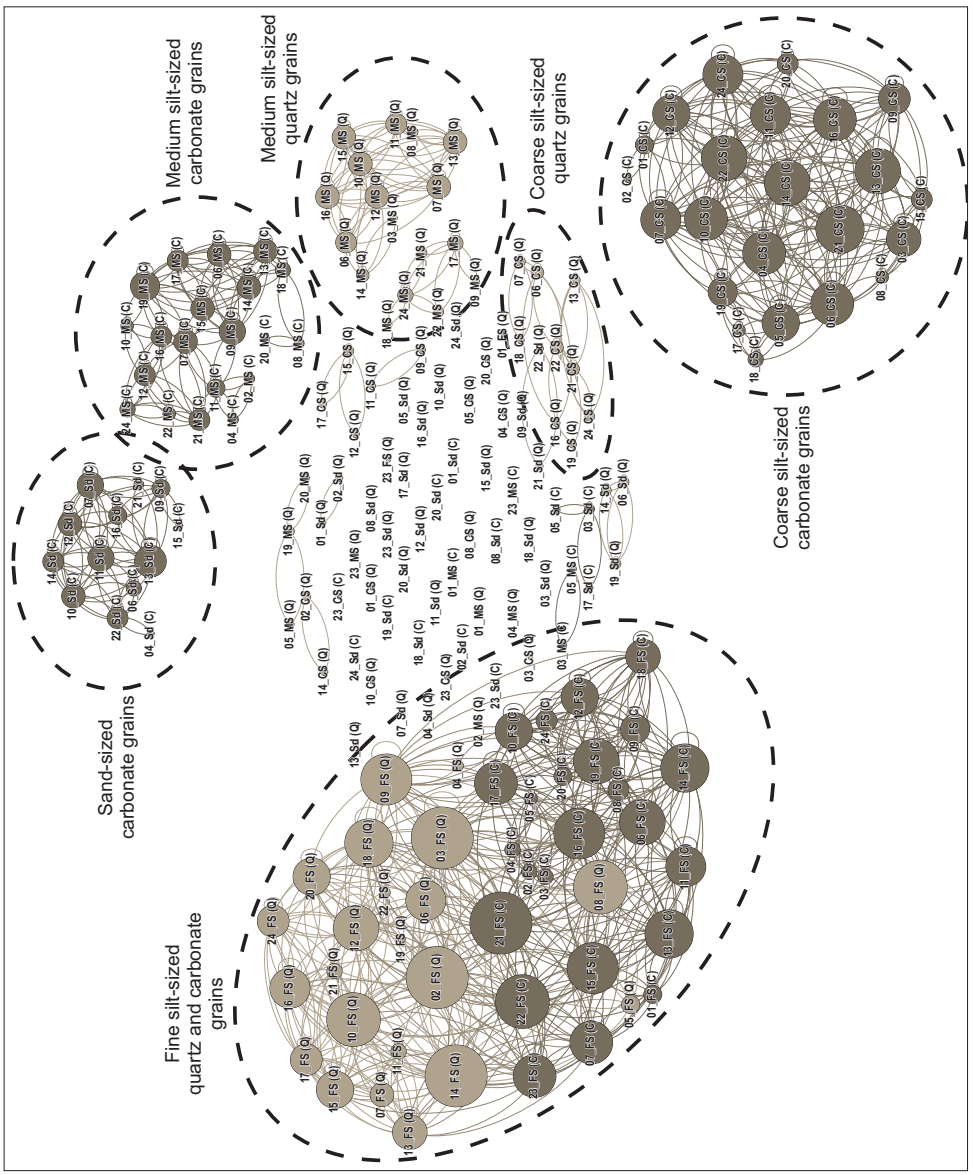

Fig. 8. Network analysis of quartz (Q) and carbonate (C) particles by samples and size fractions. – FS = fine silt; MS = medium silt; CS = coarse silt; Sd = sand

NW from the large bend of Niger River and west from the Adrar des Ifoghas. This area is covered by the deposits of Pleistocene Lake Araouane, one of the largest pluvial lakes in Africa (Bridges, E.M. 1990). The salt and diatomite deposits of the enclosed basin are visible also on satellite images. The prevailing NE trade winds formed an extensive system of barchanoid dunes, partly covering the surface of the ancient lakebed. The dust emission mechanism of the region and intensive deflation of fine-grained particles of lacustrine deposits are enhanced by the bombardment energy of saltating sand particles.

A long narrow band of dust sources is located at the western part of the Sahara at the eastern slopes of gently rolling hills running parallel to the Atlantic coast. Couple of seasonal streams (with frequent flash floods in the spring) and sebkhas (e.g. Sebkha Ijil) lying on the pedimented surface of the Adrar Souttouf and Zemmour Massif are the main sources of fine-grained material in this region.

Several other sources are associated with the large alluvial fans and extensive wadi-system located at the western and northwestern slopes of the Ahaggar. The Tidikelt Depression at northern part of the region, surrounded by plateaus (the Tanezrouft to the south and Plateau du Tademait to the north), by mountains (Ahaggar and Tassili-n-Ajjer to the east) and by the sand sea of Erg Chech to the west has an extensive ephemeral drainage system including several wadis from elevated regions, seasonal marshes and mud flats (Glaccum, R.A. and Prospero, J.M. 1980).

Conclusions

Automated static image analysis provided huge amount of granulometric (size and shape) data on sedimentary deposits of Fuerteventura. The presented set of methods provided new data on the granulometric character, depositional mechanisms and admixture of dust material to sandy units. Parametric curve-fitting suggested the presence of more than one key depositional mechanisms, Raman-spectroscopy of manually targeted individual particles revealed a general relationship among grain size, grayscale intensity and mineralogy, while intensity based assessment technique was introduced for identification of large number of quartz particles. All three presented evaluation methods have their own advantages and drawbacks. Parametric curve fitting is a relatively fast technique, it is only based on single one grain size distribution, but it does not take any shape or mineralogy-related information into consideration. Raman spectroscopy provide direct chemical identity data on the selected particles, but generally the number of characterized grains is several orders of magnitude smaller than the whole investigated particle population. The grayscale intensity-based assessment is an indirect technique, but it is suitable for identification of large number of exotic particles.

According to our results, there is no specific granulometric fingerprint parameter for identification of Saharan dust material in the deposits of Fuerteventura, but joint applications of several size, shape and grayscale intensity values and mathematical techniques allowed the separation of quartz particles from other local sedimentary units.

However, the lack of robust granulometric characterization of largest fractions, caused by the wide polydispersity of the mineral deposits, did not allow a stable quantitative assessment of volumetric amount of quartz material. Determination of the total mass of deposited Saharan dust material is a more difficult question in the area, as in most of dust and sediment samples from North African source areas, quartz was found to be the most dominant mineral, but the carbonate-content of dust is also relevant, what can be also interesting in case of Fuerteventura. The calcite content and consequently the (Ca+Mg)/Fe ratio of western sources are among the highest in North Africa. The reason for high carbonate content of other mentioned sources is unclear at the moment, but it can be stated that almost all discussed emission regions had relatively high carbonate content.

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Evaluation of the diversification of rural landscape in Slovakia after 1989 with a focus on the built-up area of municipalities: a case study of Podhájska municipality

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Abstract

The rural landscape in Slovakia was a synonym of agricultural production until 1989 and countryside has fulfilled specifically a productive function. Agriculture still plays a very important role in the Slovak countryside, but after 1989 there have been socio-economic changes in Slovak economy, which has reoriented to the market economy, resulting in changes of the ownership of enterprises, production processes and competition in the market. Countryside has been looking for new poles of development, what can be termed as the diversification of the functions of the countryside, i.e. the transformation of a mono-functional space into a multifunctional space. However, the increase in the amount of rural functions also results in changes of the land cover structure, which are most evident in built-up areas of municipalities. The aim of the paper is to evaluate the changes of the land cover structure of the rural landscape in Slovakia, focusing on the built-up area of the monitored municipality. The municipality of Podhájska, which is the centre of the Termál micro-region, was selected as the model territory and was researched as a case study. In this region, there is a constantly developing tourism, services and business instead of focusing only on agriculture. Changes in the land cover structure were monitored using aerial images from 1987 and 2014 (updated by field research) and the extent and nature of these changes were then analysed by Analysis tools in ArcGIS 10.2. The changes occurred in almost a quarter of the monitored area. Particularly, the use of gardens around houses has changed and they transformed from production to recreation area. The built-up area is also thickened and expanded under the influence of an increase of the tourism importance, especially in the area of former vineyards that had a long tradition in the municipality. The results of the research point to the loss of rural identity in case of increasing amount of function. Similar case studies should serve as base material for documents dealing with the sustainable development of rural areas.

Keywords: rural landscape, GIS, diversification, land cover structure, landscape changes

Development of countryside in Slovakia – an introduction

The rural space in Slovakia was influenced by several development periods before 1989, which shaped its function and visual aspect. Agriculture in the countryside advanced at the turn of the 19th and 20th century due to foundation of first agricultural cooperatives. After World War II the countryside was a synonym of agricultural production that provided food for the population. Since the 1950s the agricultural landscape has undergone radical changes. Löw, J. and Míchal, I. (2003) mention the term of "communism in the landscape" and they see the main negatives in the central management. This period was characterized by a strong use of chemicals, mechanization and intensification in agriculture. United agricultural cooperatives have arisen, the mosaic of the landscape has been changed and the land was unified. In the 1960s, under the influence of industrialization, the young rural population has

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been moving out to towns and cities for a better quality of life. The rural population was, thus, very old (Burian, J. *et al.* 2013). In the 1970s and 1980s, the main well-developed catchment municipalities were formed, where all the activities and services were concentrated. The surrounding municipalities were on the downgrade.

After the collapse of communism, in 1989, the economy transformed from a centrally planned economy into a market economy (transition economy) in Central Europe. These countries have opted for a market mechanism, with the main elements of privatization, enterprise restructuring, market liberalization (Roland, G. 2000). The return of land and the increase of land trade have allowed the return of private farmers. Social development has resulted in the extinction of many agricultural cooperatives and businesses in rural areas and their insufficient use and dilapidation of agricultural buildings has been linked to the formation of brownfields. One of the most important elements of the transformation in the countryside was the restitution of land to the original owners. This change has not had a very powerful landscape manifestation, because the expected effect of the increase in private farming on land was not met due to the loss of bond of man to the soil, lack of domestic capital, aggravated conditions for agricultural business and especially legislative and administrative barriers (Izakovičová, Z. 2012). Because of these barriers land owners can in many cases just rent their land to large-scale farmers or the land owners are still unknown.

Rural settlements are looking for resources for further development and want to gain the most of their potential. Their aim is, on the one hand, to maintain agricultural production and on the other hand to enable diversification into other activities, e.g. rural development towards a recreation and tourism and improvement of the lives of rural inhabitants (Pělucha, M. *et al.* 2009). Negative is the loss of agricultural land as a result of the construction of new buildings (family houses, recreational complexes, manufacturing enterprises), which often do not respect the environmental and visual aspects of the countryside. Unharmed remains of rural decline are also agricultural, state, residential or industrial and other brownfields. Of the positive phenomena of the transitive economy, it is worth mentioning environmental measures aimed at eliminating sources of environmental pollution.

In the last decade, there has been a focus on drawing the funds for revitalizing dilapidated and unused land and brownfields in the countryside. Revitalization (revival, return of life) means the correction of an anthropogenically affected landscape or its part into a state connected with nature, a state approaching the original state.

Multifunctional countryside

At present, new terms associated with land use, as well as land use in the countryside multifunctional land use (Némethová, J. 2010), integrated land use (Spišiak, P. 2005) are being used. In the document The Future and Rural Society (1988), a "new rural model" was presented and demonstrated. The countryside is not only perceived as a place for agricultural production, but it also becomes a place for small and medium-sized enterprises of a non-agricultural nature. Also, the countryside becomes a place for recreation and also becomes a basis for the ecological stability of the environment. The production function is receding and is replaced by consumption (land purchase, home, tourism associated with the consumption of traditional meals and drinks in local restaurants, visits of organized events, etc.) (Hruška, V. 2013).

The concept of multi-functionality has been gradually applied not only to agriculture but also to the countryside as a whole. Holmes, J. (2006, 2012) regards the multifunctional transition as a transition from production to consumer and conservation functions. There is also a new strong political force in the countryside-environmentalism.

Multi-functionality and environmentalism included in concept of "green infrastructure" are becoming highly relevant for rural areas and landscapes. A significant impact on the development of the countryside and its renewal was the entry of Slovakia into the European Union in 2004.

Rural landscape as an object of research

Woods, M. (2011) argues that from the perspective of geography is viewed mainly the agriculture, the impact of human activity on rural areas, rural studies and land use. The benefit of this view on the countryside lies mainly in placing emphasis on spatial differentiation and exploration of the landscape and its interaction with the human factor. The impact of the human factor as the main actor of agricultural activity in the countryside is the subject of many studies, but the emphasis is put largely on the non-built-up area where this agricultural activity predominantly takes place. In scientific papers dealing with the rural landscape in Slovakia, we can find studies focusing mainly on the change of the land cover structure (Kanianska, R. *et al*. 2014), the impact of tourism on the landscape (Klaučo, M. *et al*. 2017), diversification of the rural landscape (Máliková, L. and Klobučník, M. 2017), function of agriculture in countryside (Bazik, J. and Muchová, Z. 2016; Špulerová, J. *et al.* 2017), rural population (Simpach, O. and Pechrová, M. 2016), green infrastructure and sustainable countryside (Tóth, A. *et al.* 2016), the potential of the rural landscape (Štěpánková, R. and Bihuňová, M. 2012) or multi-functionality of the countryside (Bezák, P. and Mitchley, J. 2014; Bohátová, Z. *et al.* 2015).

The change of rural functionality is evident mainly in built-up areas of municipalities, where new buildings, a change in the image of the countryside, revitalization, concentration of services connected with new functions are noticeable (Nováková, G. and Šebo, D. 2016). Not only in Slovakia, but almost in every European country is tourism one of the most significant driving forces in countryside. People want to spend time "close to nature" or they just want to "enjoy the countryside" (Kulcsár, N. 2015). These all research point out to gradually increasing multi-functionality of countryside.

The main research question is how the multi-functionality of countryside caused by socio-economic changes after 1989 in Slovakia has influenced land cover structure of built-up area of countryside. The aim of this paper is research the changes in the land cover structure in the built-up area under the influence of functional changes in the countryside after 1989, pointing to the fact that the mono-functional countryside is becoming a multifunctional countryside and how the landscape diversifies and how new functions enter into it. For this research we need to make comparison of land cover structure between two periods – before 1989 and current state. Therefore, the goal is to create maps of land cover structure using aerial images and then to assess the most significant changes in landscape.

Study area

The municipality of Podhájska is located in western Slovakia, in the Nitra self-governing region, in the district of Nové Zámky *(Figure 1).* The total area of the municipality in 2017 was 11,116.3 ha and the number of inhabitants reached 1019 (31.12.2017). Podhájska is a centre of Termal microregion, which consists of 13 municipalities: Bardoňovo, Čechy, Dedinka, Dolný Ohaj, Hul, Kolta, Maňa, Podhájska, Pozba, Radava, Trávnica, Veľké Lovce and Vlkas. Podhájska was founded in 1960 by the unification of two municipalities – Belek and Svätuša, whose history dates back to the 11th and 12th centuries.

This municipality was selected as the model territory and case study on the basis of the results of the multi-criteria analysis in which it ranked first and reached the highest level of diversification among the 13 municipalities of the micro-region (Žoncová, M. 2017)

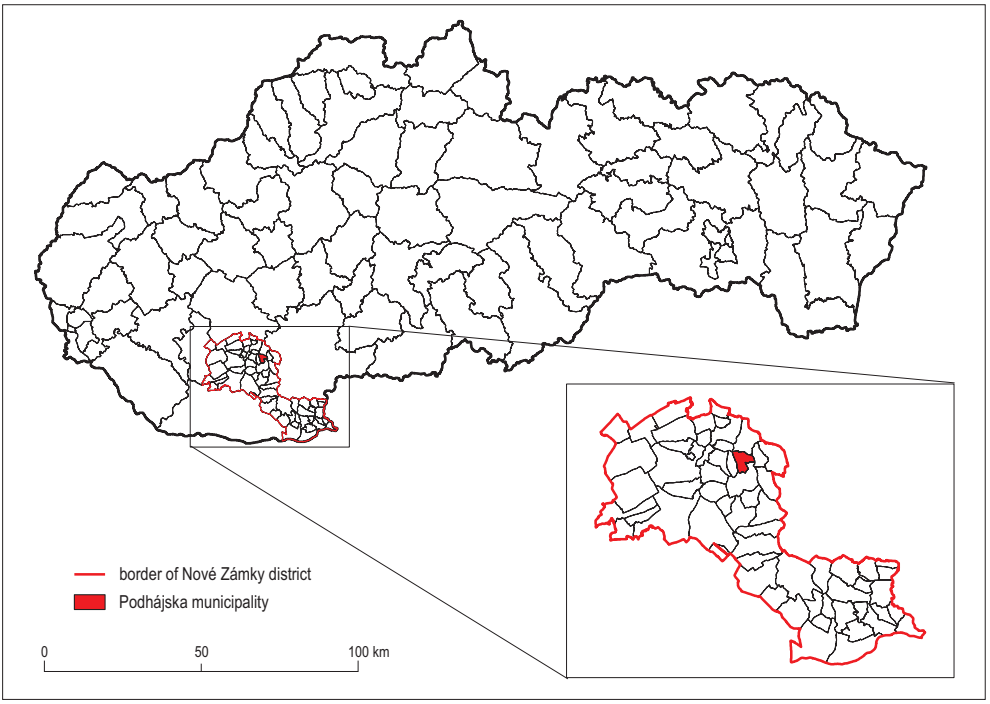

Fig. 1. Localisation of interested area of Podhájska municipality in Slovakia. *Source*: Žoncová, M. by ArcGIS 10.1

and also because of the increasing importance of another function (non-agricultural). Nowadays, the landscape in this area is partly formed by the development of tourism, which is developing thanks to the ever-growing popularity of the thermal aquapark in Podhájska. Podhájska is well-known for the thermal aquapark and thanks to it, the TREND journal ranked this aquapark on the 5th position in the most visited places in Slovakia in 2005 (TREND, 2006) and on the 52th position in the ranking of the most profitable companies in Slovakia in period 2012–2016 (Haluza, I. 2017). The municipality of Podhájska has a hilly relief, which is largely used for agricultural activity. The territory is rich in mineral and thermal waters with the most important locality in Podhájska, where water is used for treatment of the locomotive system, the respiratory system and skin eczema. Tourism has begun to build its prominent position in 1973 when workers of Nafta Gbely Company began drilling under the vineyards behind the Liska stream and after reaching a depth of 1,900 meters, 90 °C of hot water was fired. The citizens built here in 20 days two swimming pools, which are in function until today. This rural municipality has looked for new poles of development after 1989 because of decline of agriculture and increase of unemployment.

Data

Land cover structure can be interpreted in orthophoto images in different ways. In European countries, the most widespread interpretation is currently based on CORINE Land Cover methodology (Feranec, J. and Oťahel, J. 2001) or Urban Atlas data (Pazúr, R. *et al.* 2017). We were able to ob-

serve changes in the landscape structure using aerial images in software ArcGIS 10.1 by creating maps of land cover structure from two observed years:

– 1987 – for creating map of land cover structure, we used panchromatic (black and white) aerial photos provided by Topography Institute of Colonel Jan Lipsky in Banská Bystrica (TICJL) with resolution 58 cm/1px.
– 2016 – for creating map of current land cover structure, we used the newest aerial photos (from 2014) provided by web portal "mapy.cz" with resolution 25 cm/1px. We also checked and updated land cover structure on these photos with field research, which took place in 2016. Although the latest available satellite imagery is available on Google Maps, these images do not match the quality level needed to get close to the built-up areas of the municipalities.

Methods

Creating maps of land cover structure in 1987 and 2016

For comparing and analysis of changes in built-up area of Podhájska, we made maps of land cover structure in 1987 and 2016 using the aerial images. The next step in processing aerial images is their geo-referencing, digitization and subsequent vectoring of landscape elements in ArcGIS 10.1 over the reference periods. The mapping of the landscape structure in the *built-up area of Podhájska* was implemented in detail into the level of *landscape elements*, which are grouped into eight *groups of landscape elements* (Feranec, J. *et al.* 1996; Ružička, M. 2000; Vojteková, J. 2013):

– Elements of forest vegetation (monitored landscape elements: groves);
– Elements of grasslands and pastures (occurrence in the observed area was not recorded);
– Elements of agricultural lands (monitored landscape elements: fields; vineyards);
– Elements of rocks and raw soils (occurrence in the observed area was not recorded);
– Elements of water courses and water bodies (rivers, streams);
– Elements of settlement and recreational areas (individual housing area; collective housing area; gardens of houses (production); gardens of houses (recreational); churches, chapels, bell towers; cemeteries; statues, crosses, sculptures; sport fields; swimming pools and aquaparks; playgrounds; buildings of public administration; preschool and school facilities; retail trade facilities; medical facilities; restaurants; cafes and pubs; cinema; paved sidewalks; parks, residential grasslands woods and scrubs; hotels, guesthouses; private accommodation; apartment houses; campsites; other unused areas);
– Elements of technical structures (industrial areas; farms, agricultural yards);
– Elements of transportation (main roads; other roads; railway line; parking; bus stop and station; gas station; railway station).

When mapping accommodation facilities, we combined a number of information sources available information from the internet (www.ubytovanienaslovensku.sk), from the municipal websites as well as from field research. Subsequently, we have categorized accommodation facilities according to their equipment (hotel, pension, apartment house, private accommodation, etc.). We also distinguish two types of gardens – *recreational* and *production* gardens. The main difference was visible on aerial images, where in recreational gardens were visible pools, lawn, parking places, gazeboes, etc. and their function consists in aesthetic, relax and fun. On the other hand, in the production garden was considerably visible a segmentation into small zones, where people grown their own vegetable and fruit. Based on the predominance of one function, the garden was included in the one of these categories.

From aerial images, only *size, localization*, but not the *function* of the building, can be seen. Oťahel, J. and Feranec, J. (1997) high-

light the importance of field research in determining the function of objects and detailed mapping of the territory over a longer period of time with a maximum of information. Since the function of an object is not readily recognizable from an aerial image, it is important field research to determine the functionality of each object and its localization. When creating a map of the secondary landscape structure in 1987, we consulted the function of the buildings in this period with the mayor, the employees of the information office, but also with the inhabitants of the municipality. We also studied archive records where we found out, for example, when the building of a shop, a cooperative, a general office, schools were built. We also reached statistical database of accommodation facilities from Statistical Office of Slovak republic and municipal databases.

Analysis of changes in land cover structure

To analyse changes in the landscape in ArcGis 10.1, several methods have been developed that are engaged in detail by Singh (1989). In our research, we have used the *Intersect* tool in ArcToolbox (Analysis Tools → Overlay → Intersect) to create intersections of existing layers (in our case, the two monitored years) and a new layer is created with an attribute table with data from both layers. The "Intersect" tool for analysing changes in the landscape structure was also used by Mackenzie, J. (2009), Benini, L. *et al.* (2010), Chirici, G. *et al.* (2006) and Coughlan, M.R. (2014). In the newly created layer which is created with the Intersect function, we can then select polygons in the attribute table that have the same code of landscape element group in both observed years.

Subsequently, the selected polygons are exported to the new layer that characterizes the areas in which the changes occurred in the two observed years from one landscape elements to another. In this way are identified areas in the landscape that were subject to change. Because we have linked two attribute tables using Intersect function, we can also identify the nature (character) of the change, i.e. to determine changes from one landscape elements to another landscape element. To analyse the nature of the changes, we calculated the extent of all existing polygons (areas). Subsequently, we calculated the percentage of landscape elements in year *x* changed to landscape elements in year *y* from the total area of the changed landscape structure in the observed area in the time horizon of years *x–y*. Based on the results, it is possible to create scenarios for the future development of the landscape of the monitored area.

Results

On the basis of the map comparison, we found out that the changes were observed on an area of 367,145.7 m^2 of the total area of built-up area of 1,670,420.4 m^2, which is nearly 22 per cent change *(Figure 2, Table 1).* Changes

Table 1. Change of the area of different landscape elements in the municipality of Podhájska between 1987 and 2016

Indicators*		Change of the area of landscape elements in %, 2016				
		F	A	U	Ts	Tr
Change of the area of landscape elements in %, 1987	F	0.00	0.84	2.03	0.00	0.00
	A	1.85	3.50	32.25	0.00	3.34
	U	0.00	0.73	37.04	0.00	3.93
	Ts	0.49	0.00	1.05	11.52	0.18
	Tr	0.83	0.00	0.40	0.00	0.03

*Elements of: F = forest vegetation; A = agricultural land; U = urban and recreational areas; Ts = technical structures; Tr = transportation

Fig. 2. Localisation of landscape structure changes in built-up area of municipality of Podhájska. – F, A, U, Ts and Tr = for explanation see *Table 1. Source:* Žoncová, M. by ArcGIS 10.1

also occurred in the percentage representation of individual *groups of landscape elements (Figure 3).* The most visible is the decline in the area of the group of agricultural land elements and the increase in the area of the group of settlements and recreational areas.

In terms of the number of changed landscape elements *(Table 2),* the number of landscape elements has increased from 1987 to 2016. During this period, 14 landscape elements were transformed into 27 landscape elements. Based on this result, we can claim that the country has diversified considerably and that the observed built-up area becomes more multifunctional

Transformation of gardens

Approximately one fifth of changes in the observed built-up area consisted in the transformation of the house gardens. In creating a map of the current landscape structure, we have included a new landscape element "recreational garden" in the list of landscape elements. We considered it important to define this landscape element, because these areas form a considerable area of the built-up area of municipality (recreational gardens [7.6%] and production gardens [35.9%] in 2016) and therefore it is necessary to pay increased attention to this type of land cover.

The original (former) functional use of houses gardens for growing their own crops, fruit and vegetable gradually disappears and the gardens are transformed into recreational purposes. In such gardens, new features are visible, which was not seen in 1987 (swimming pools, trampolines, large parking spaces, playgrounds, sports grounds, grassy areas, gazebos, fire rings, ponds, ornamental plantings, etc.) *(Photo 1).*

In contrast to the recreational garden, the production garden is on aerial picture characterized by a miscellaneous structure, space division, more regular mosaic. There is also a higher occurrence of trees in a regular mosaic, which suggests a possible fruit planting. In these gardens, there have also sometimes been farm buildings, which are related to self-sufficiency and work in the garden. However, in many gardens there is also a change of structure, which means that the aerial view on the garden appears to be cultivated only in a certain part, the rest of the land is unused.

This change is also related to the growing importance of tourism in the municipality and, consequently, to the growing number of accommodation facilities. Owners of accommodation want to satisfy all the needs of the tourist and create the most pleasing, visually attractive and clean environment for them. In many cases, it is a redevelopment of existing family houses to accommodation facilities. Individual hous-

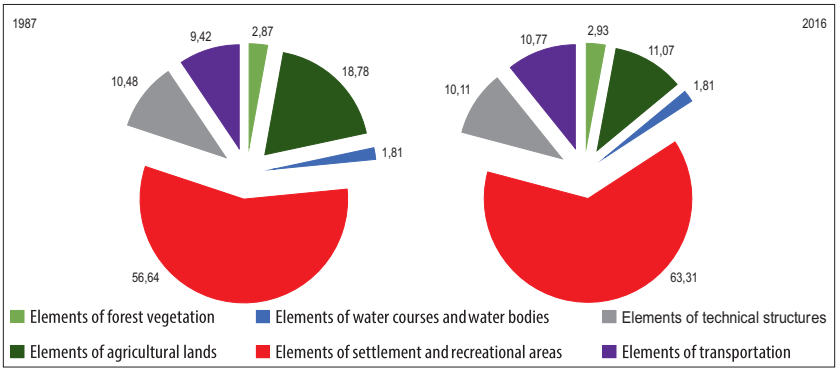

Fig. 3. Landscape structure of built-up area in municipality of Podhájska in 1987 and 2016 in per cent.
Source: Authors' own research

Table 2. Percentage change of the secondary landscape structure in the municipality of Podhájska in 1987 and 2016

Indicators	Landscape elements* in 1987	Landscape elements* in 2016																							Sum
		L1	P1	P2	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	T1	D1	D2	D3	D4	D5	
	L1	–	0.84	–	0.11	–	–	–	–	–	–	–	–	0.05	–	–	0.12	0.01	1.74	–	–	–	–	–	<0.01	–	–	–	2.87
	P1	0.88	–	*3.50*	0.53	0.12	–	0.05	0.02	–	0.09	–	0.99	0.03	0.48	–	3.05	*9.03*	*7.14*	–	–	–	–	–	0.30	*2.99*	–	–	29.20
	P2	0.97	–	–	0.33	–	–	–	–	–	–	–	0.20	0.14	–	*2.76*	*2.02*	1.65	*3.61*	–	–	–	–	–	0.05	–	–	–	11.74
	S1	–	–	–	–	–	–	0.11	–	–	0.02	–	0.23	1.28	–	–	–	0.11	0.07	–	0.03	–	–	–	–	–	–	–	1.85
	S3	–	–	–	–	0.21	–	–	0.71	–	–	–	0.32	–	0.25	–	–	–	–	–	–	–	–	–	0.05	0.69	–	–	2.23
	S7	–	–	–	–	–	–	–	–	–	–	0.06	–	–	–	–	–	–	–	0.31	–	–	–	–	<0.01	–	–	–	0.06
	S8	–	–	–	0.12	–	–	–	–	–	0.07	–	0.09	1.69	0.06	–	<0.01	0.13	0.57	–	–	0.20	–	<0.01	0.38	0.81	<0.01	–	2.66
	S13	–	–	–	–	–	–	–	–	0.11	0.09	1.69	0.24	–	–	–	–	0.45	0.89	–	–	–	–	–	–	0.79	0.64	–	4.89
	S14	–	0.73	–	1.81	0.19	–	0.02	0.03	–	0.04	0.30	1.33	*3.18*	0.46	–	1.00	–	*20.24*	–	0.11	0.02	–	–	0.32	0.24	–	–	30.02
	T2	0.49	–	–	–	–	–	0.57	–	–	–	0.22	0.18	–	–	–	–	–	0.09	–	–	–	*11.52*	–	–	0.18	–	–	13.23
	D1	–	–	–	–	–	–	–	–	–	–	<0.01	–	–	–	–	–	–	<0.01	–	–	–	–	–	–	–	–	–	<0.01
	D2	–	–	–	–	–	<0.01	–	–	–	–	0.34	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.34
	D3	0.83	–	–	–	–	0.02	–	–	–	–	0.01	–	0.04	–	–	–	–	–	–	–	–	–	–	–	–	–	0.01	0.90
	D5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.01	–	–	0.01
	Sum	3.17	1.57	3.50	2.91	0.51	0.02	0.75	0.77	0.11	0.31	2.62	3.47	4.72	1.25	2.76	6.19	11.37	34.35	0.31	0.14	0.22	11.52	<0.01	1.10	5.71	0.65	0.01	100.00

*L1 = groves; P1 = fields; P2 = vineyards; S1 = individual housing area; S2 = sport fields; S3 = swimming pools, aquaparks; S4 = retail trade facilities; S5 = restaurants; S6 = collective housing area; S7 = paved sidewalks; S8 = parks, residential grasslands, woods and scrubs; S9 = hotels, guesthouses; S10 = private accommodation; S11 = apartment houses; S12 = campsites; S13 = other unused areas; S14 = production gardens of houses; S15 = recreational gardens of houses; S16 = cinema; S17 = playgrounds; S18 = cafés and pubs; T1 = industrial areas; T2 = farms, agricultural yards; D1 = main roads; D2 = other roads; D3 = parking; D4 = gas station; D5 = railway stop and station. – Highest values in *italics*.

ing areas were transformed into accommodation facilities, namely private accommodation (1.3%) or hotels, guesthouses (0.2%).

The accommodation capacities were also created by the addition of new buildings in the rear parts of the gardens. This method of transforming house gardens into accommodation (hotels, guesthouses, private accommodation, apartment houses) represented almost 5 per cent of the total area of the changed landscape structure. In this case, part of the garden is often used for the original purpose (growing crops) and the second part of the garden for recreation.

Another significant part of the changes (16.2%) was the transformation of arable land into house gardens. Most of them were converted into functional house gardens (9.0%) and rest into recreational house gardens (7.1%). This phenomenon is related to the building of new houses and also gardens. The new houses were mostly created for the residential function of the domestic population as well as for accommodation for tourists. Agricultural land has reduced its area to the detriment of the increase of parking space.

Development of tourism

As the private business in Slovakia started only after 1989, there was no accommodation capacity in the municipality before that year. However, according to the data from the website ubytovanienaslovensku.sk and the Business register of Slovak republic, accommodation capacities increased significantly after year 2000.

In the former vineyards, a new urban area is created, which fulfils the recreational-residential function. There are new large accommodation facilities such as guesthouse Quatro IV, guesthouse Andrejka, guesthouse MeryJan *(Photo 2)*. Large-capacity guesthouses were also built in other parts of the municipality, but not so many *(Photo 3)*.

Private accommodation prevails in the local area of Svätuša. Local residents provide their houses, parts of their houses, separate outbuildings, or separate cottages in their

Photo 1. Example of recreational garden (A) and production garden (B) on aerial photo. *Source:* mapy.cz, 2017

gardens. Most of private accommodation facilities are located in the north of the built-up area of municipality. Around the private facilities, the functional gardens are transformed into recreational gardens. With this way were created several new recreational gardens, representing 3.6 per cent of the total changes.

Part of the agricultural land was transformed into a camping site (2.8% of the changes), which was built south of the thermal swimming pool to increase the accommodation capacities in the municipality.

The changes took place also in the area of the thermal swimming pool. The area did not

Photo 2. Accommodation facilities in the vineyards area. *Source:* ubytovanienaslovensku.sk

Photo 3. Large-capacity guesthouses beyond the vineyards area. *Source:* ubytovanienaslovensku.sk

grow, but it was thickened. In the area of the swimming pool there are new accommodation facilities connected directly to the swimming pool area, new parking areas, new restaurants, sports fields, swimming pools. In 2007 the hotel Borinka was renovated in the area of the swimming pool and the capacity of the hotel was increased. A new Aquamarin wellness center was also completed in 2012.

Multifunctionality of Podhájska

A spatially large change, but only in one location, was the change in the use of the former agricultural complex in the local part of Belek, where this facility is exploited by Kraintek company since 1990. There was a transformation from the area of the agricultural cooperative to the *business area*. New buildings have been built in the area and decorative surrounding greenery has been planted. The whole area was so completely revitalized. The transformation of the former agricultural area also took place in the western part of the municipality, where part of the area is currently used as a shop of building material. The rest of the built-up area still functions as an agricultural cooperative and part of the area comes into brownfield.

New landscape elements are also coming to the countryside, not very typical for this environment. In Podhájska is a *cinema* with an outdoor projection. In 2016, the cinema started its year-round operation in the interior, where is a *café,* too. In the summer, various cultural events are organized.

The new landscape element in the village is also the P-Petrol *gas station* on the main road, which originated on an area that had not previously been used.

However, it is important to note that there are not only changes in the area but also *functional changes* in the municipality of Podhájska. For example, this situation is reflected in the use of the building of the General Office, but also in the use of residential buildings for small and medium-sized enterprises. In the past there was only a municipal office, currently a municipal office, a library, an information centre as well as a cultural and social centre are housed in the building. A similar situation also occurs in the building on Senčianska Street, where there are groceries, a beer house and the accommodation was completed on the floor.

Discussion

The monitoring of changes in the landscape structure of the countryside in Slovakia, influenced by natural or anthropogenic factors is also the main object of the research in scientific studies by Malenová, P. (2007), Šolcová, L. (2012) and Vojteková, J. (2013). They also use aerial photos for detecting changes in landscape. Boltižiar, M. (2008) claims that the highest advantage of using aerial images is the presentation of the Earth's surface and providing a number of quantitative but especially qualitative information about the individual objects of the landscape whose dynamics can be monitored at different time horizons.

In the Corine Land Cover methodology, a more detailed legend was used to map the landscape cover at a scale of 1:50,000, used by many authors in their works (Svicek, M. 2000; Cebecauerová, M. 2004). We agree with the opinion of Kopecká, M. (2006), which states that the Corine Land Cover legend does not allow to interpret changes that are important especially in terms of local ecosystem biodiversity (for example, to quantitative reduction of forest vegetation or loss of gardens to the detriment of dissemination of built-up area, evaluate the revitalization of municipalities, etc.), which we also consider to be its main disadvantage.

Based on the map comparison, we found that the changes occurred on an area of 367,145.7 m^2 of the total area of the built-up area with area of 1,670,420.4 m^2, which represents 22 per cent change. The most visible is the decline in the area of the group of agricultural elements and the increase in the area of the group of settlements and recreational areas.

When we researched the changes in the landscape structure of the municipality of Podhájska, we have spatially and on a percentage basis analysed the landscape structure in 1987 and 2016. In creating the maps in 2016, we set out a new landscape element – recreational garden. Currently, more than 7.5 per cent of the area is covered by recreational gardens in Podhájska. Changes in the use of gardens are also analysed in research of Supuka, J. *et al.* (2013), who have observed gardens in the municipality of Tvrdošovce, where up to 25 per cent of gardens are recreational gardens.

When we analysed types of accommodation facilities, there was problem to categorize them according to their quality classification. In this categorization, we found out inaccuracies when accommodation facilities use a different nomenclature of facility in their name, but they do not actually meet the conditions (e.g. they are referred as a guest house and do not meet the conditions). Bučeková, I. (2007) points out this problem, when she examined the network of accommodation facilities in Bratislava. We also consider alarming that accommodation facilities are glutted and concentrated in one municipality.

This enormous increase of commercial and private accommodation facilities also occurs in spa town Mórahalom in Southeast Hungary, where in 2000 only 3 families offered accommodation and in 2009 nearly 80 did. The changes caused only smaller conflicts according to the questionnaire because of tourists parking everywhere. Tourism in general is a fragile business, which depends on many internal and external factor, therefore, a regional economy based only on tourism will never be sustainable (Martyin, Z. 2015). Accommodation facilities should also concentrate to surrounding municipalities and focus attention on traffic services. According to Kulusjärvi, O. (2016), a move from "a resort-oriented tourism" towards "a region-based tourism" should be made to achieve long-term business success and sustainable regional development.

Conclusion

Changing the socio-economic and political conditions after 1989 has resulted in rapid changes in the economy, the way of life of the population, which was reflected mainly in the change of the landscape structure. Based on the research of changes in the landscape structure in Podhájska municipality, we can assess the impacts of the transitory economy on the landscape and identify their positive and negative aspects.

Based on the results of the research, we can identify *five basic trends* in the development of the observed area, i.e. to define the basic processes that are characteristic for the current countryside: new building, expansion of built-up area of municipality, thickening of the built-up area, change of the function of the areas, revitalization. Countryside is thus becoming a multifunctional space that does not provide only an agricultural function. For this reason, the relationship of the population to the land is often lost, what can be caused also by the fact, that inhabitants are originally from a city and have urban style of life. An emphasis should therefore be placed, on the one hand, on deepening the relationship between man and the countryside, and, on the other hand, on keeping the "genius loci" through the protection of the natural and cultural heritage.

We consider it important to study the changes in the gardens (around the houses), because they form a large part of the built-up area of municipality. The use of gardens is closely related to the intensity of the relationship of the population to the land, which could lead to increased awareness of the growing of own crops on their own parcels. In this way, the relationship of the population to the soil could be revitalized. Attention should also be paid to the disappearance of vineyards around the swimming pool and their transformation into area with accommodation facilities. The vineyards form an integral part of the landscape and increase its heterogeneity, create the landscape image for a long time in the municipality of Podhájska. The direction of the municipality develop-

ment should also be focused on the support of viticulture or the development of tourism associated with wine tourism.

This work can serve as an example for exploring the changes of rural municipalities and can be used as a basis for further research, for example, for comparing rural changes in other regions or countries, or creation scenarios of future development. These findings can also serve as a base material for further spatial planning of the surrounding municipalities of the Termál micro-region. Then, tourism development would better contribute to socioeconomic development and well-being in local communities. In the next research, it would be interesting to compare the diversification of the rural landscape of a similar micro-region or with other regions or countries of Central Europe (e.g. with regions from the Czech Republic, Hungary or Poland).

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Perception, understanding, and action: attitudes of climate change in the Hungarian population

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Abstract

This study is based on a non-representative, national level survey sample whose main purpose is to interpret the general population's understanding of climate change. The study also provides an examination of correlations between climate change concerns and the taking of individual action as well as the relationship between pro-environmental thinking and climate change scepticism. Our results show a moderate correlation between the general population's concerns and the professional views on the subject, known in the literature as the New Environmental Paradigm scale and Scepticism scale, but a significantly weaker correlation when it comes to taking action against climate change. Factors relating to the respondents, such as residence settlement type, education level, gender, age, personal and social values, or casual attributions in relation to climate change heavily influence this weaker correlation. Most respondents assessed climate change as a current (urgent), but geographically remote phenomenon. This is a clear indication of problems associated with cognitive conceptualization and the localization of climate change in communication. The target audience must be taken into account when designing climate change communications because interpretations of climate change can vary widely and cover a broad range attitudes ranging from concern about to issue all the way to climate change scepticism. This also applies to views concerning responsibility for climate change with some believing it is a political responsibility and others believing it is a scientific responsibility.

Keywords: climate change, perception, responsibility, climate adaptation, climate change denial, Hungary

Introduction

Public understanding of climate change in the context of the surrounding public-political discussions has become an essential subject of social science research papers. Beyond the territory of physical science, several societal aspects of climate change have also been brought into the focus of research, thus, similar activities in the topic have begun in Hungary with varying intensity and scope from the mid' 2000s. While extended research on Hungarian climate change futures (e.g. Bartholy, J. *et al.* 2014) forms the context, recent scholarship focused on the knowledge of climate change in society (Mosoni-Fried, J. *et al.* 2007; TÁRKI 2007; Szirmai, V. *et al.* 2008; Baranyai, N. and Varjú, V. 2015), on adaptation issues and impact on society (Salamin, G. *et al.* 2011; Bajmóczy, P. *et al.* 2012; Mesterházy, I. *et al.* 2014; Antal, Z.L. 2015; Bobvos, J. *et al.* 2017; Farkas, J.Zs. *et al.* 2017; Kajner, P. *et al.* 2017; Király, G. *et al.* 2017), or on climate discourses and controversies (Jankó, F. *et al.* 2010, 2011; Bereczki, B.H. 2012; Kőszegi, M. *et al.* 2015). However, we do not know enough about climate and climate change. As Hulme, M. (2008) argues, geography should unfold

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the social meanings of climate and the effect of geographical scales i.e. localization in the understanding of climate change. Our study aims to develop our knowledge in this direction.

The following questions guided our investigation: What kind of relationships are there between the concerns about and experiences of climate change and green actions? Which factors tend to influence people's readiness to act? Is there any correlation between the place of residence and the experiences and evaluation of climate change? What kind of role does the proximity or, conversely, the remoteness of the phenomenon in terms of geography and time play in the perception of the problem? How vital is the topic of climate change? Who or what is the primary cause of the problem and, in the opinion of the people questioned in our survey, whose responsibility is to find the solution? In line with the questions we raised, we assumed that concern and experience are strongly correlated to actions; moreover, we assumed that the level of concern is inversely proportionate to the intensity of actions ('it's all the same anyhow' attitude) (Searle, K. and Gow, K. 2010). Additionally, we hypothesized that opinions on the topic will most probably be divided even though respondents believe climate change to be a significant problem, and that the issue of climate change will be identified as something remote from Hungary from a geographical point of view (contrary to the scientific forecasts).

Literature review

A wide range of various social sciences is currently interested in climate change research. From our study's point of view, the analyses focusing on the questions of perception, the formation of attitudes and communication have relevance and determine public action, inaction and engagement. Therefore, we emphasize the fields of sociology and psychology (Lorenzoni, I. and Pidgeon, N.F. 2006; Formádi, K. 2013), working real close to geography here. In addition, as the result of successful integrating efforts of Anglo-Saxon social geography, an independent field of research is slowly shaping around the social understanding of climate change (Demeritt, D. 2001; Hulme, M. 2008, 2009), however, this approach is still marginal in Hungary (Jankó, F. *et al.* 2010). In the USA, a whole series of studies focus on the opposing views of climate change that exists between the high level of consensus within the scientific community and the balanced or otherwise polarized opinions of the civil society, or of those presented in the media (Farmer, G.T. and Cook, J. 2013). The related problems and the reasons for such contradictions are identified, on the one hand, as the cognitive bias towards climate change (Whitmarsh, L. 2011; Stoknes, P.E. 2014), the limits of perception and visibility (Hulme, M. 2014), the processing of risks and direct concern, and the differences between personal values (Weber, E.U. and Stern, P.C. 2011; Donner, S.D. 2011). On the other hand, the complex and politicized nature of the topic and the successful operation of well-organized, climate change sceptic 'denial machine' are emphasized (Dunlap, R.E. and McCright, A.M. 2011; Farmer, G.T. and Cook, J. 2013).

Upon the examination of five factors (extreme weather events, public access to accurate scientific information, media coverage, elite (political) cues and the movement and countermovement advocacy), Brulle, R.J. *et al.* (2012) established that changes in concerns about climate change are primarily influenced by elite political cues and related economic factors as well as by the media. Not surprisingly, climate scepticism and the relations thereof to values and experiences are also in the focus of several studies (Whitmarsh, L. 2011).

The research papers that concentrate on the relationship between personal experience and the reality of climate change clearly indicate the profundity of the experience and perception theme. The studies of Egan, P.J. and Mullin, M. (2012), Akerlof, K. *et al.* (2013), Hamilton, L.C. and Stampone, M.D. (2013) compare the experiences of respondents to actual climate data, while Myers, T.A. *et al.* (2013) demonstrate both learning-by-expe-

rience (where personal exposure leads to an increasing belief in climate change) and motivated reasoning (where the prior, firm conviction manipulates perception and experience). Several studies emphasize the correlation between personal experience and motivation to act (Lorenzoni, I. and Pidgeon, N.F. 2006; Broomell, S.B. *et al.* 2015), while social-geographic approaches also underscore the role of locality and temporality in this respect (Brace, C. and Georghegan, H. 2010).

Communication must also be emphasized, as various governmental and non-governmental campaigns aspire to influence the engagement towards and actions related to climate change. The core question of communication is how can attention be raised authentically by transmitting a consistent, valid, and true interpretation of climate change. (We should only think about the catastrophe-focused language of our colonial attitudes related to developing countries in the communication panels.) In addition, how can we, through the internet primarily, give precise information and instructions to people concerning the complex problem of climate change (Manzo, K. 2010, 2012; Moser, S.C. 2010; Nerlich, B. *et al.* 2010; Schäfer, M.S. 2012; Stoknes, P.E. 2014; Jankó, F. 2015).

Methodology

Our survey took place between February 2013 and October 2015. The questionnaires were distributed in hard copies and electronic form via e-mail using the snowball sampling method; as a result, we attained a non-representative 'convenience' sample of the national coverage comprising 545 respondents. Of the respondents, 58 per cent was female, while in the age structure, young adults and persons of tertiary-level education were overrepresented (the questionnaire targeted the 14-year-old and above age group) compared to the Hungarian population. Due to the geographic origin points of the snowball, the majority of respondents were residents of Western Hungary; however, the sample represented all counties to a greater or lesser extent. Resident distribution according to settlement size turned out to be statistically adequate as Budapest represented a 16.9 per cent share and the distribution of further population clusters conforms to the national data. Otherwise, due mainly to sampling through the internet, families with kids, households with above average net incomes, persons of tertiary-level education (nearly 68%, while national data is 15%) and, thereby, people belonging to labour market groups requiring higher education levels were overrepresented in the sample. Hence, our questionnaire is unsuitable for describing the general approach of the entire country concerning environmental awareness, but it is satisfactory for the examination of correlations between the factors mentioned in the title.

The questionnaire was divided into six parts. Nine questions in the introductory section focused on the personal data of the respondents (gender, age, level of education, residence, household type and income per capita, labour market position). In the second block, respondents had decided which one of seven cartoons most fits their perceived conception of climate change *(Figure 1).*

Some of the pictures are presented in Manzo, K. (2012) and they analyse the geopolitical aspects of climate communication as part of a cartoon competition organized by Ken Sprague Foundation. In addition, we collected more cartoons from the internet that matched our conception. Our aim was to examine observations on climate change in the mirror of visuality, to explore which interpretations are most effective at catching the attention of respondents, and to make the questionnaire interesting for respondents. These cartoons provided a sophisticated reference to the question of the perception, and the understanding of and responsibility for climate change; we positioned them at the beginning of the questionnaire to avoid any biasing of the evaluation through upcoming questions. Cartoons represented seven different ways of interpretation, and the study enabled the testing of the correctness of these associations.

Fig. 1. Cartoons in the questionnaire. – a–g = for explanation see the text. *Sources*: http://www.transitionpenwith.org.uk (a); http://www.sfchronicle.com (b); www.kenspraguefund.org (c, d, e, f); www.caglecartoons.com (g)

Climate change as a scientific problem (a), a geopolitical issue (b), a climate-catastrophe (c), a conflict of renewable energies (d), wasting (e), a conflict of nature and humanity (f) and sustainable development (g).

The following block of questions are related to problem perception addressing its psychological, geographical and temporal factors: we asked first the respondents to prioritize global problems; after that, they had to do the same with environmental issues. By using the Likert scale, we formulated a series consisting of six questions focusing on concern (3–3 in positive and negative tone – e.g. "I am afraid of the future climate catastrophes" or "I do not care what happens to the Earth and mankind after me"), the aggregation of what provided us with a concern-index, the values of which varied on a scale between 5 and 30 (the average score was 23.23). In further questions, we tested different sectors from the aspect of their level of exposure to climate change; we also raised several questions regarding the evaluation of distance from climate change. One of these questions concentrates on the subject in terms of time: respondents had to evaluate the effects of climate change in the past, in the present, and in the future. Two questions were formulated to examine the issue of geographic distances: based on the imagined-believed climate threat, respondents were asked to rank the listed territories of different climatic conditions and continental regions.

The fourth block focuses on the issue of responsibility: through different approaches, the questions targeted the origins of climate change and the identification of those origins as well as who should be primarily responsible for finding a solution. The fifth block includes two Likert scale-based groups of

questions, one comprising 15, the other 17 points. The former New Ecological Paradigm index ("NEP index") aimed to evaluate the level of relations between nature and humanity, i.e. pro-environmentalist thinking (on a scale ranging from 15 and 75, where the average value was 55.59), while the latter ("Scepticism index") examined the degree of scepticism (on a scale ranging from 17 and 85, where the average was 42.92). The first group of questions is known in the international scientific literature as New Ecological Paradigm (NEP) and was developed by Dunlap, R.E. *et al.* (2000). More precisely, Dunlap updated the scale from 1978, replacing the ecologic-economic *termini technici*, which were widely known to the public in the USA back then but became obsolete in the meantime, similar to terms like steady-state economics, limits of growth, Spaceship Earth (Dunlap, R.E. and van Liere, K.D. 1978 – see the lists there). The scepticism scale was developed by Whitmarsh, L. (2011) and was supplemented by Corner, A. *et al.* (2012). We adapted the Hungarian translation of both scales to the aims of the current research. According to international precedents, these scales are suitable to serve as the basis of development of a consistent aggregate index, though there are several issues we must acknowledge in connection with the application of the initial version of NEP (Dunlap, R.E. *et al.* 2000).

We dedicated the final block to actions intended to measure the level of readiness for action and activity volume. The scale included twelve partially positive and partially negative statements, from which we developed an index using the aggregation method (on a scale ranging between 12 and 60, where the average was 43.12).

Results and discussion

Perception of the problem

Among global problems, respondents ranked environmental issues as the most important (regarding the average of ranking points [2.8], and the absolute first place as well). Here we must mention the Eurobarometer surveys that focus on the same topic and are prepared occasionally in the European Union. Within the frames of these investigations, members of the European population are requested to rank global problems. The problems identified as the most important have remained unchanged since the very beginning of these surveys (though their respective scores show a decreasing trend): these issues are poverty, lack of food, and potable water. With respect to the second and third positions, we notice a bit more motion: after 2009, climate change was forced from second into third place by the global financial crisis while international terrorism climbed into second place in 2015. The data measured in Hungary fit into this trend more or less; however, climate-related issues are less significant in general (TNS 2009, 2011, 2014, 2017). Our methodology and the way of we formulated our questions were partially different from that of the Eurobarometer survey as we 'weighed environmental problems against other global issues': differences in results may arise partly from this fact and partly from the different sample we used.

On our scale, therefore, poverty, and lack of food and potable water reached second place in the aggregate (av. ranking points: 3.2), showing a curve sloping downwards to the right; the same applies to the problem of increasing global population (3.9). The functions of three of the listed global issues – the depletion of fossil fuel dependent energy resources (4.4), armed conflicts (4.7), and the financial crisis (5.1) – form an inverted U curve. Worldwide epidemics (5.6) and international migration (6.3) show a curve sloping downwards to the left; most probably, results would be completely different if the survey were completed today *(Figure 2).*

The question aimed at differentiation between environmental problems allowed the specific weighing of climate change – and came up with a surprising result. First place was divided between the issues of waste (4.4) and climate (4.9), but, on average, the highest

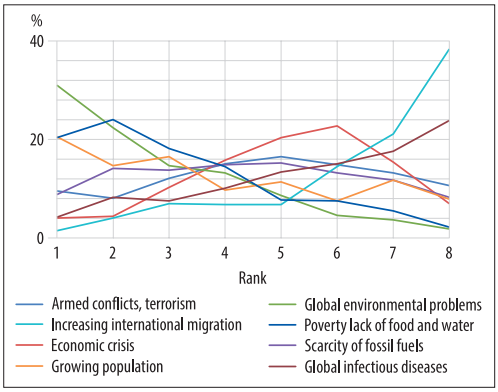

Fig. 2. Ranking of global problems

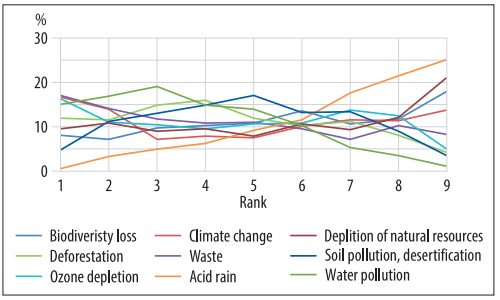

Fig. 3. Ranking of environmental problems

number of ranking points were awarded to water pollution (3.7). According to the visual demonstration of results, the problems of waste and water pollution show asymmetric inverted U curves (the former slightly, while the latter significantly sloping to the right); the issue of climate change draws a U curve demonstrating a strongly polarized evaluation of this topic in the sample*(Figure 3)*[4]. Thus, on average, the issue of climate change is surpassed by deforestation and forest degradation (4.5 – inverted U curve) (in this respect, the questionnaire refers to tropical areas and the flora of taiga) by destruction of the ozone layer (4.7 – waving curve) and by the problems of soil contamination and soil destruction (4.9 – inverted U curve) as well. In this hierarchy, three issues with curves sloping to the left follow climate change: scarcity of natural resources (5.5), biodiversity loss (5.6), and acid rain (6.8 – the latter is practically excluded from environmental discourses today).

We questioned the respondents about the expectable positive and adverse effects of climate change on different sectors by using a Likert scale. With respect to agriculture, 78.5 per cent of respondents answered that the expected outcome of climate change is rather negative; the same answer was given by 78 per cent of respondents in connection with natural environment, and by 74 per cent in connection with the standard of living; however, regarding the industry sector, the most frequent response was „I don't know".

Several studies have already demonstrated the high level of perception of signs of climate change within the Hungarian population (TÁRKI 2007; Baranyai, N. and Varjú, V. 2015).

We measured the experiences in and the distance of climate change in terms of time with an absolute multiple-choice question. Almost 47 per cent of respondents answered that the effects of climate change are already directly perceivable and visible, while 40 per cent chose the following among the possible answers: 'Climate change has been and is still affecting humanity and this is not expected to change in the future either.' The number of votes cast for the other options is insignificant: 9 per cent of respondents think the climate change effects will only be perceivable in the lives of their children or grandchildren; 3 per cent voted for the option of 'perceivable only in the distant future'; and 3 respondents opted for the absolute sceptical answer (there are no, and there will be no significant effects). These results correspond entirely to the statistics of TÁRKI (2007).

The answers to the questions measuring the geographical distance of the climate change problem justified our preliminary assumptions. Media influence on the ideas about climate change is clearly demonstrated in the

[4] We should note that no similar result is presented with respect to any of the other problems measured by the survey.

case of questions approaching the problem from a climate point of view. In questions like these, respondents ranked polar regions almost unanimously in the first position (average ranking point: 2.1); islands are listed as second (3.8), while coastal countries are in third place (3.8). When applying the approach to continental regions, the first ranked territories were Australia and Oceania (3.4 – most probably because of the latter), while South and East Asia (3.8), Africa and the Middle East (4.0) were listed as second and third. Areas of continental climate (6.4) and Eastern Europe (5.7) are ranked last from the aspect of average ranking points *(Figures 4* and *5)*.

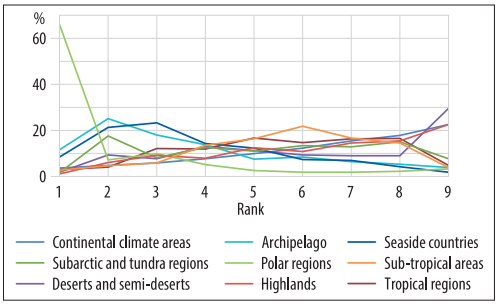

Fig. 4. Ranking of geographic-climatic regions from the point of view of their exposedness to climate change

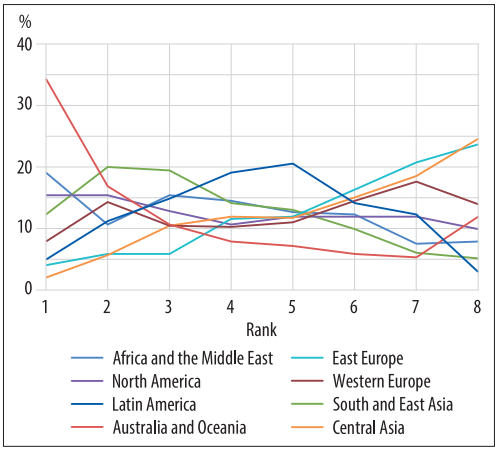

Fig. 5. Ranking of continental regions from the point of view of their exposedness to climate change

The causes of climate change and the responsibility for action

The first approach led us to the conclusion that more than half of the respondents (54%) thinks that consumer society is responsible for climate change. This was followed by globalization (20%), failure of environmental policies, and the progress of science and technology. From a rather sectoral approach, industry and the industrial revolution were ranked first (34%), followed by the change in the land use and the reduction natural habitat territories (27% ≈agriculture), and fossil fuel based energy production (26%). Transport and oil-industry were chosen by 6–6 per cent of the respondents. (Compared to international data we see that industry is over-, transport is underestimated here.) However, if we create an aggregate score from the votes cast for fossil fuel based energy production and the companies interested in the oil industry, their share in responsibility is almost 33 per cent. A third approach offered the possibility to choose between developed and developing countries: two-thirds of respondents cited the responsibility of the former, while one-third were for that of the latter. However, the respondents were presumably unclear about the group to which Hungary belongs.

Our next question was: 'In your opinion, which entity is primarily responsible for the solving of problems arising from climate change?' We applied three different approaches here as well. According to the results, respondents would shift the responsibility to developed countries, economy and politics. Regarding the latter, international negotiations turned out to be more critical than national governments, but in between the two, there is the opinion considering individuals as key factors. Baranyai, N. and Varjú, V. (2015) came to a different conclusion: in response to their question, which was similar to ours, science ranked first; however, they included the similar options into one question and used the Liker scale for evaluation.

When we involved the cartoons into the examination, we got a bit more complex view of the problem of perception *(Table 1)*. Those

Table 1. Relationship between cartoons and responses on the causes and responsibility, %

Groups	Causes and responsible factors	'Science' N = 115	'Politics' N = 135	'Climate catastrophe' N = 59	'Bio-fuel' N = 35	'Wasting' N = 116	'Nature and mankind'N = 62	'Sustainable development' N = 23
What is the cause of climate change? – In three groups								
Group 1	Consumer society and the well-being of the developed, Western world	43.5	57.8	47.5	48.6	*63.8*	56.5	*60.9*
	The process of globalization	*30.4*	13.3	28.8	*31.4*	17.2	14.5	8.7
	The failure of environmental policy	14.8	*22.2*	13.6	8.6	13.8	16.1	21.7
	The progress of science and technology	*11.3*	6.7	10.2	*11.4*	5.2	*12.9*	8.7
Group 2	Fossil-fuel dependent energy production	20.9	31.1	23.7	17.1	*35.3*	21.0	17.4
	Land use change, natural habitat loss	35.7	22.2	27.1	*37.1*	19.0	25.8	*39.1*
	Motorized traffic	9.6	4.4	*11.9*	*11.4*	3.4	1.6	*13.0*
	Industry and industrial revolution	27.0	*37.8*	33.9	22.9	36.2	*40.3*	30.4
	Oil industry companies	7.0	4.4	3.4	*11.4*	6.0	*11.3*	0.0
Group 3	The developed, Western countries	61.7	73.3	64.4	65.7	69.8	72.6	*78.3*
	The developing countries	*38.3*	26.7	35.6	34.3	30.2	27.4	21.7
Who are primarily responsible for the solution of the problem? – In two groups								
Group 1	National governments	37.4	25.2	*28.8*	17.1	21.6	*29.0*	4.3
	Politicians involved in international negotiations	39.1	40.7	45.8	*60.0*	31.9	37.1	*60.9*
	Local municipalities	5.2	0.0	*6.8*	0.0	1.7	1.6	4.3
	The individuals	18.3	34.1	18.6	22.9	*44.8*	32.3	30.4
Group 2	Environmental organizations and institutions	7.8	3.7	11.9	*17.1*	3.4	8.1	4.3
	Market mechanisms, market operation, economy	20.9	23.7	20.3	*37.1*	27.6	25.8	21.7
	Politics	29.6	*36.3*	27.1	20.0	30.2	24.2	30.4
	Society, civil movements	11.3	8.9	8.5	11.4	13.8	3.2	*21.7*
	The progress of technology	14.8	16.3	18.6	2.9	16.4	*22.6*	8.7
	Science	*15.7*	11.1	13.6	11.4	8.6	*16.1*	13.0

Note: Column data of groups make 100 per cent, numbers in italics indicate characterizing data.

respondents who chose the picture implying the role and duties of science tended to think that science and technological progress are the reasons behind and are responsible for the solution of climate change. Nevertheless, even more surprisingly, they were represented in the highest rate among those who identified the developing countries as the cause of the problem. A considerable proportion of students chose this cartoon.

Those respondents (mainly people of tertiary-level education living in Budapest working as white-collar executives) who decided to select the politics-related picture marked the failure of environmental policy as the reason for the problems and (accordingly) politics as the key to problem solving. Those who blame industry and traffic for climate change chose the cartoon 'climate catastrophe in the desert,' a decision that is traceable to the basic antagonism between the environment and humanity. On the other hand, a significant number of these respondents marked national governments and local municipalities as key factors to finding a solution for a phenomenon that has no such clean-cut explanation.

Respondents identified technological progress and science, land use changes, traffic, and oil companies as the main causes of climate change in the cartoon concerning the problems associated with biofuels. This cartoon indirectly visualizes the conflict between developed and developing countries and the choices the respondents made properly fit into the visual and contextual world of this cartoon. The respondents who chose this cartoon emphasized the role of international politics, environmental organizations, and the market in problem solving. A higher number of older respondents (those above 60 years) chose this cartoon.

The 'wasting' cartoon was the most popular among people who live in Budapest, have relatively lower salaries, and work in offices or in the trade industry. These respondents identified consumer society and fossil fuel based energy resources as the leading causes of climate change, while, in their opinion, the primary responsibility for solving this problem lies with individuals. The choice of the cartoon visualizing the battle between nature and humanity involved the determination of scientific and technological progress, industry and oil companies as leading causes, and national governments, science and technology as those responsible for finding a solution to climate change (students were overrepresented in this group).

The cartoon about sustainable development (though it was rarely chosen, was picked mainly by respondents of higher education level) also fits into the idea of consumer society. The failure of environmental policy, land use change, natural habitat loss, traffic and developed countries were identified as main cause, and international politics and non-governmental, civil movements were identified as key factors of solving the problem of climate change. In summary, we think cartoons were useful tools in the survey: they gave a proper synthesis of different readings of climate change from which conclusions regarding actions could be drawn as well (see details below).

Concern, environmental awareness, action

Hereunder we examine the factors influencing actions, the mode of action and correlations between the level of concern, pro-environmental thinking and climate scepticism. We used four indicators for these analyses. After having the indexes correlated, we first received medium and weak correlations: correlation coefficients between index of concern, NEP and scepticism were 0.50, –0.57 and –0.53. The correlation coefficients between the indicator of actions and the three mentioned factors were 0.24, 0.31 and –0.26 (as for scepticism, correlations were ordinarily negative). That is to say that there is a medium-level relation among concern about climate change, pro-environmental thinking, and scepticism, but these factors rarely explain the differences of action indicator values. Paralleled, the respondents who chose

'wasting' and 'battle between nature and humanity' cartoons demonstrated a higher level of concern, pro-environmental thinking, and readiness to act.

As a further approach, we clustered the respondents depending on the rank they gave to climate change among environmental problems as well as on the level of their concern. In the former case, we observed the same correlations and trends as described hereinabove, while in the latter case the correlation between the higher level of concern and the higher level of willingness to act was more obvious. Nevertheless, there are no signs that would demonstrate a paralyzed condition (inability to act) at an outstanding level of concern; namely, we could not verify our preliminary assumption in this regard.

What factors influence the actions and the values of other indicators? With respect to gender, women are more active in the field of actions, and they are more inclined to concern (the same result: TÁRKI 2007; Searle, K. and Gow, K. 2010) than men; in parallel, they have a more developed environmental thinking, and they are less sceptic. The harmonic change in indicators is also traceable among the values of age groups: the youngest and the oldest respondents are the less concerned, the less active, the less environment-friendly and the most sceptic, which is quite understandable.

Nevertheless, the examined four dimensions are more influenced by the type/size of the settlement and the level of education. Regarding the former, the NEP index shows a U-shape; while in the latter case, higher education level entrained, to a certain extent, higher average values (the scores were lower regarding scepticism) (*Figure 6.* – cf. Baranyai, N. and Varjú, V. 2015).

Furthermore, we should mention the fact of living in a 'standard family model' (parents with kids) also seemed to have determinant power on the above-mentioned indicators. We could not demonstrate an obvious correlation between the indicators and the income per capita: the respondents in the second and fifth income clusters were the most concerned and the readiest to act. Neither could we identify a correlation between the indicators and labour market clusters: respondents employed in executive and white collar jobs, the large- and medium-size entrepreneurs, qualified office workers, trade industry employees and service providers were more typified by stronger concerns, a higher level of pro-environmental thinking and readiness to act, and less climate scepticism. Furthermore, it is a valuable sign that the index of concern and the index of activity was the highest among those respondents, who chose the cartoons 'waste' and 'battle between nature and humanity', and climate scepticism was the lowest among those who chose the cartoon visualizing the climate catastrophe.

Certain correlations in the fields of experience and responsibility seem to be quite obvious. Those who have direct knowledge of the problem are more concerned, more aware of environmental issues, less sceptic, and more ready to act; the same applies to those who identified the individual people as responsible for solving climate change. The midline is more or less represented by those respondents (diverting, however, downwards from the median in each case) who considered climate change as a factor influencing the past and the future as well. That is to say, the choice of the above answer also showed a certain level of scepticism in the sample. We also examined the daily logs of extreme weather events to check if those persons who filled out the questionnaire after such an extremity (within a one-week period) are more concerned about climate change or not. According to the results, there was no sign of any evidence (except that on the level of average values); however, on this scale, at least the direction of the correlation was the expected.

We examined the place of residence of respondents also, both in the relation of experience and the above four indicators. As for the direct experience of climate change, the average scores of respondents from Northern Hungary (*Észak-Magyarország*), Rim of the Alps (*Alpokalja*), and Budapest were the highest (they directly experience climate change).

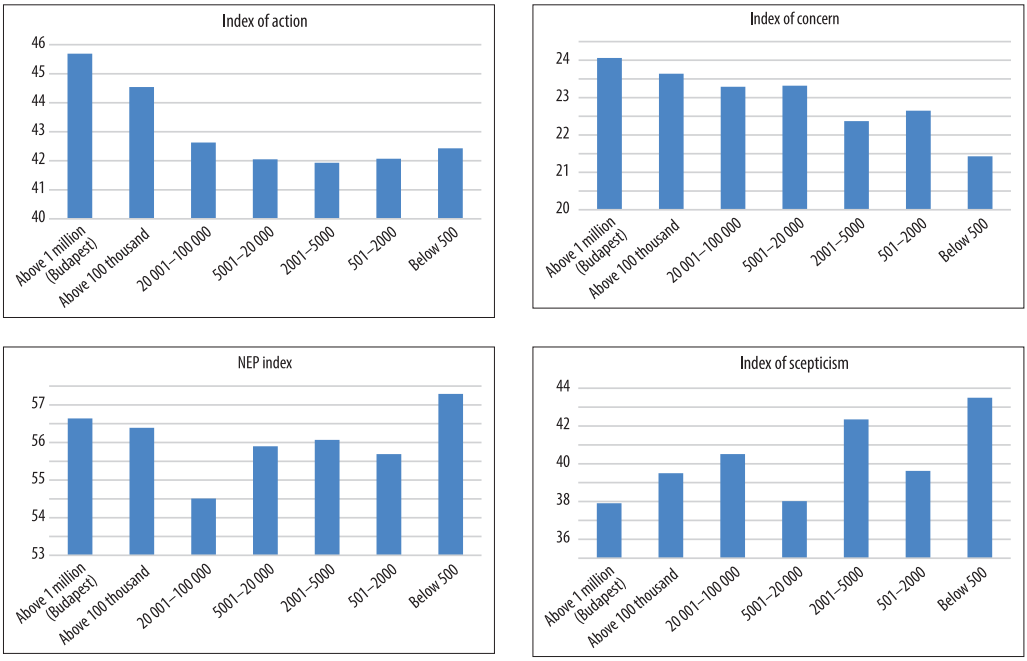

Fig. 6. Correlations between the category of settlement size and the four dimensions

This result contradicts our preliminary assumption: we expected a higher level of sensitivity in the region of the Great Hungarian Plain (*Alföld*). This finding suggests that direct experience is a stronger influencing factor in areas where people are unaccustomed to extremities. However, this is only one segment of correlations within the four examined dimensions. The index of concern reflects more or less the same results as the above correlation, but concerning the other indicators, Rim of the Alps provides the only outstanding scores while Great Hungarian Plain and Little Plain (*Kisalföld*) regions are presented more significantly instead of Northern Hungary.

Summary and conclusions

A core conclusion of our examinations is that climate change is a very complex issue with several possibilities of interpretation and differentiated understanding: the topic divides people. This is the reason for the argument that climate change is not the proper issue to activate people (Stoknes, P.E. 2014) We offered several approaches in our study, but some of our questions remained open or were only partially verified. Our results reflect a moderate correlation between concerns and thoughts about climate change (pro-environmental thinking and climate scepticism), and a significantly weaker one between concerns and the intensity and consciousness of our actions. This is because the latter are more exposed to the influence of many other factors like settlement type, education level, gender, age, life values, or casual attributions in relation to climate change.

Another valuable result of the study is the demonstration that most of the respondents evaluated climate change as a phenomenon that is near in time, but geographically remote (cf. Hulme, M. 2008; Stoknes, P.E. 2014). This is a clear indication of cognitive

conceptualization and problems with the localization of climate change in communication. The answers we received to our questionnaire also verified the existence of climate scepticism in Hungarian society, beyond temporality and geography it is also a fact that should be taken into consideration in the course of climate communication planning. Furthermore, we managed to identify several different clusters of respondents based on visualization of the problem, which verifies the thesis that the target group should always be considered carefully in communication projects.

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Nomen est omen – Tourist image of the Balkans

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Abstract

The regime change, the South Slavic civil war, global recession and their political, economic and social consequences had a significant impact on the tourism market of South-east Europe and the Balkan region. Many potential visitors to the region were affected by their negative associations with past events, even those that happened many years ago. The image of the Balkan region has become at times almost synonymous with conflict, turmoil and unrest. However, these perceptions may be changing and are therefore worthy of exploration. The article provides a tourism oriented analysis of the area's image as a tourism destination. In accordance with the literature, the perceptions are measured by using a customer-based approach. Internet-based social media encourages the sharing of recent tourism experiences which can confirm or change associations with destinations. This study provides a content analysis of comments from one of the most popular travel portals (TripAdvisor) including key elements of the Balkan region's image. The results of the research show theoretical implications like the importance of emotional image elements, the role of locals, or the complexity of tourism experience. From a practical point of view, the conclusions can induce long term thinking about the selected destination's branding, and motivation for further research, as well.

Keywords: Balkans, tourism, image, brand, TripAdvisor, customer-based, content analysis

Introduction

Places around the world seek to attract visitors, inhabitants and investment by dedicating significant resources for those activities. In the competitive, globalized world, it is fundamental to be different, to find the unique selling points (USP) of a certain area. In theory, this needs considerable funds and a long time for realization. However, from a practical point of view, those places that know their own values and can communicate it in a consistent way are successful in the longer term, providing a sustainable future for their inhabitants, investors and visitors. The administrative boundaries and borders often do not coincide with the perceptions of the target groups (e.g. destination in the mental map of a visitor). Acknowledging this complexity, this article seeks to map a geographical area, namely the Balkans, rather than an administrative area (like a country or a city). In the present-day world, technological advancement affects the image and perceptions of places and image is no longer a one-way communication (Govers, R. and Go, F. 2009).

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Our study has a dual purpose. On the one hand, it explores the particularities of a selected area's (the Balkans) offer by analysing consumer opinions related to tourism service providers using the Balkan name in non-Balkan countries or those generating Balkan experiences. In line with current advances in tourism research, the study is based on content analysis that has become more and more popular among tourism researchers. On the other hand, the study proposes exploring the tourism-related substance of the term 'Balkan' i.e. what makes a service Balkan in the visitors' opinion, by analysing experiences related to the tourist services used in Balkan countries. Thus, the study seeks an answer to the question of whether the particularities of Balkan-related tourist services perceived as Balkan by the consumer carry any characteristic signs which can be used to develop a product with the *Balkan* brand name which could be sold successfully in tourism.

Branding in tourism

A successful brand is undoubtedly a powerful tool for differentiation, providing a competitive advantage (Tasci, A.D.A. *et al.* 2007; Boo, S. *et al.* 2009; ETC–UNWTO 2009). A brand has four dimensions, namely awareness, image, quality and loyalty (Konecnik, M. and Gartner, W.C. 2007), that can be extended by value and experience (Boo, S. *et al.* 2009). Tourism researchers agree that image plays the main role (Lee, G. *et al.* 2006; Konecnik, M. and Gartner, W.C. 2007) in destination branding, so the image is also at the forefront of tourism researchers. Brand image (also using the terms brand identity or brand equity in the literature) has its origin in destination image (Gartner, W.C. 2014). Besides the rational attributes, the emotional level of the brand is widely accepted (Laitamäki, J.M. and Hämäläinen, T.J. 2008; ETC–UNWTO 2009; Moilanen, T. and Rainisto, S. 2009; Saraniemi, S. 2010; Usakli, A. and Baloglu, S. 2011), extended by personality characteristics (Usakli, A. and Baloglu, S. 2011) which means the human dimension enabling a better involvement of the travellers (Kumar, V. and Najak, V.K. 2014). The brand has furthermore a strong connection with the travellers' lifestyle and ideal self-congruence (Nam, J. *et al.* 2011; Usakli, A. and Baloglu, S. 2011; Barnes, S.J. *et al.* 2014). The brand personality is strongly linked to the residents and hosts of the destination, i.e. residents' identity influences their attitudes towards tourism/tourists (Wang, S. and Xu, H. 2015), and locals can also be involved in advocacy activities (Palmer, A. *et al.* 2013).

In the case of the Balkans, the question is whether the very wide array of different countries could come together under the umbrella of the term 'Balkan'? The national stereotypes, which are often unpopular with the locals themselves, even if they are positive (ETC–UNWTO 2009) – can be a limitation in this process. Taking a look at some 'success stories', like European Quartet (Visegrad 4 countries), the Baltic countries, Europe's marketing overseas or US branding out of the USA, we can see a strong emphasis on promotion rather than on – the very complex – branding. This takes us to the brand architecture. Meanwhile, sub-national branding is more effective (ETC–UNWTO 2009) (e.g. Andalusia in Spain, Provence in France or Toscana in Italy), supra-national brands can have an impact on visitor flows if the countries are quite similar and small, or when they are relatively unknown which can be the case in the Balkans.

Tourism service providers and marketing organizations of various tourist destinations have a great propensity for using attractive-sounding geographical names to emphasize the regional relevance and/or particularities of the various offers (Kozma, G. and Ashworth, G. 1993; Kavaratzis, M. and Ashworth, G. 2005). The geographical name can even represent the service itself, i.e. it becomes a symbiotic brand (Kozma, G. 1995; Papp-Váry, A. 2013; Kavaratzis, M. *et al.* 2015). Geographically relevant brands gain more significance with distance, which means they orientate the consumers from

more distant places (ETC–UNWTO 2009). Even if 'places' are at the forefront of branding today, the available literature mainly focuses on administrative areas which raises the challenge of which administrative areas destinations (like the Balkan countries) belong. In the case of the Balkans, the situation is quite negative (*Photo 1*).

While the geographical associations with other so-called regional brand names which are quite well known in European tourism (such as *Alpine wellness*, *Carpatair*, *Mediterranean Hotels*, *Nordic wellbeing*, *Scandinavian Airlines*) trigger positive or at most, neutral conceptual associations.

Conceptual associations related to a tourist destination affect its competitiveness (Qu, H. *et al.* 2011; Pike, S. and Page, S. 2014). In spite of the fact that the geographical names which embody tourist destinations can create negative images and generate negative conceptual associations, astute product development and marketing communication could shape that fame or notoriety into a competitive edge (Tasci, A.D.A. *et al.* 2007; Cakmak, E. and Isaac, R. 2012). Glasgow, formerly an embodiment of Scottish coal mining, acquired the title 'European Cultural Capital' (1990) and Essen, the German centre of heavy industry and a citadel of the Ruhr region, was declared part of the UNESCO World Heritage (2001). These events helped both take major steps towards leveraging their popularity in tourism (Rátz, T. 2006).

These examples prove that inherent negative associations can be converted into positive ones by transforming the geographical names into brand names used in tourism. This is largely facilitated by the fact that tourism is one of the economic sectors associated with the highest number and most favourable pieces of news (WTO 2002).

Photo 1. Hotel Balkan in Belgrade: where tourists can be positively disappointed too (Photo by Michalkó, G.)

The 'power' of the travellers

Although acknowledging its complexity (García, J.A. *et al.* 2012), many brand studies focus on a narrow aspect of branding (Pike, S. 2002). Reflecting the 'power of the travellers', consumer (or customer)-based analysis (e.g. Konecnik, M. and Gartner, W.C. 2007; Tasci, A.D.A. *et al.* 2007; Boo, S. *et al.* 2009) are mostly used. Recently, stakeholders' dimensions (Marzano, G. and Scott, N. 2009; dos Santos, E.R.M. 2014) also came into focus, including host communities (dos Santos, E.R.M. 2014) or the analysis of official communication messages (e.g. promotional brochures) (Brito, P.Q. and Pratas, J. 2015). The stakeholder perspective of branding considers the actors as decision-makers, accepting that the destination brand is the 'outcome of the achievement of unity and collaboration among the stakeholders' (Marzano, G. and Scott, N. 2009, 249). At the same time, there are valuable case studies focusing on a mixture of stakeholders (García, J.A. *et al.* 2012) or a special segment like attendees of conferences (Lee, J.S. and Back, K.J. 2010). Although the intermediary stakeholders (marketing, media) play a fundamental role in tourism, the branding literature gives less attention to them (e.g. among the reviewed studies by Pike, S. [2002, 2009] there were no media targeted).

On the other hand, opinions of tourists who have previously visited the desired destination play a significant role in the decisions made by potential tourists, which was known as word of mouth in the old days (Oh, H. 1999; Kozak, M. 2010; Martin, W. and Lueg, J. 2013) and 'word of mouse' or similar today. *(Table 1)* The current reviews and comments posted on various internet forums can influence demand behaviour (Jacobsen, J.K.S. and Munar, A.M. 2012; Munar, A.M. and Jacobsen, J.K.S. 2014; Ladhari, R. and Michaud, M. 2015).

Controlling word of mouth is extremely difficult, for example, in the case of hotels, it is a common practice that only 'real' guests who booked and stayed can share their views. However, the online reviews are available to the service providers who can use them to shape their offers (Chaves, M. *et al.* 2012; Mauri, A. and Minazzi, R. 2013; Luo, Q. and Zhong, D. 2015). As it is the primary interest of tourist service providers to have up-to-date information about their customers' satisfaction, they try to follow up on the online reviews they receive, which are also factored into the shaping of their brand (Grewal, R. *et al.* 2003; Vermeulen, I. and Seegers, D. 2009; Torres, E. *et al.* 2014).

Among the available portals for providing feedback from travellers, TripAdvisor is the leading source. With over 630 million reviews and opinions covering the world's largest selection of travel listings worldwide – covering approximately 7.5 million accommodations, airlines, attractions, and restaurants – TripAdvisor provides travellers with the wisdom of the crowds to help them de-

*Table 1. Which of the following information sources do you think are most important when you make a decision about your travel plans?**

Information source	EU 28, %
Recommendations of friends, colleagues or relatives	51
Websites collecting and presenting comments, reviews and ratings from travellers	*34*
Personal experience	33
Websites run by service provider or by destination	17
Counters of travel agencies and tourism offices	13
Social media pages (for accommodation, restaurants, transport companies, etc.)	12
Newspaper, radio, TV	11
Paid for guidebooks and magazines	9
Other	3

*Maximum 3 answers were accepted. *Source*: Flash Eurobarometer 432: Preferences of Europeans towards tourism. Own editing.

cide where to stay, how to fly, what to do and where to eat. TripAdvisor-branded sites are available in 49 markets, and are home to the world's largest travel community of 455 million average monthly unique visitors[6].

From the research point of view, TripAdvisor is used in most of the tourism-related case studies and academic articles dealing with content analysis. Over 100 papers used it as source for research since 2016 (Gal-Tzur, A. *et al.* 2018). In the case of hotels, other portals (e.g. booking.com or Airbnb) are also used regularly by tourism researchers. When talking about a destination such as the Balkan area, the selection of the TripAdvisor data is appropriate to map the image elements or the destination *(Table 2.)*

Taking a closer look at the selected social media-oriented and content analysis method-based tourism research, the usefulness is evident both from the theoretical and from the practical point of view. The social media content (including review sites) is an appropriate tool for tracking image elements (Govers, R. and Go, F. 2009; Kladou, S. and Mavragani, E. 2015; Marine-Roig, E. and Anton Clavé, S. 2015), and also a very valuable input for identifying brand equity (Marine-Roig, E. and Anton Clavé, S. 2015; Malenkina, N. and Ivanov, S. 2018; Thanh, T.V. and Kirova, V. 2018). This kind of information is in line with tourism knowledge like tourism image main dimensions (cognitive, affective, conative) (Kladou, S. and Mavragani, E. 2015), the AIDA model (Malenkina, N. and Ivanov, S. 2018) or the experience model (Thanh, T.V. and Kirova, V. 2018). Simply by just being there on a review portal can help potential visitors to reduce uncertainty (Raguseo, E. *et al.* 2017). Tracking visitors' feedback can support understanding their needs, expectations and behaviour (Ganzaroli, A. *et al.* 2017; Rodrigues, H. *et al.* 2017; Gal-Tzur, A. *et al.* 2018; Malenkina, N. and Ivanov, S. 2018), and also the effects of tourism trends can be monitored (Marine-Roig, E. and Anton Clavé, S. 2015).

[6] Information from TripAdvisor (www.tripadvisor.com, retrieved in April 2018).

Table 2. Selected tourism-related academic articles with content analysis

Authors, year	Methodology*	Source	Target destination/segment
Banerjee, S. and Chua, A.Y.K. 2016.	QT	TripAdvisor	Hotels (worldwide)
Cenni, I. and Goethals, P. 2017.	QL, QT	TripAdvisor	Negative hotel reviews
Galí, N. *et al.* 2017.	QL, QT	official tourism slogans	TOP50 tourism destinations (worldwide)
Gal-Tzur, A. *et al.* 2018.	QL, QT	TripAdvisor Q&A section	Cities (Tel Aviv, Haifa, Stuttgart, Athens)
Ganzaroli, A. *et al.* 2017.	QL, QT	TripAdvisor	Restaurants in Venice (Italy)
Kladou, S. and Mavragani, E. 2015.	QL, QT	TripAdvisor	Istanbul
Malenkina, N. and Ivanov, S. 2018.	QL, QT	official tourism websites	Spain
Marine-Roig, E. and Anton Clavé, S. 2015.	QT	social media sites	Barcelona
Raguseo, E. *et al.* 2017.	QT	TripAdvisor, OTAs	Italian hotels
Rodrigues, H. *et al.* 2017.	QL, QT	Treatment Abroad	Medical tourism
Thanh, T.V. and Kirova, V. 2018.	QL, QT	TripAdvisor	Wine tourists to Cognac (France)

*QT = Quantitative, QL = Qualitative methods. *Source:* own editing.

Another important aspect is that content analysis is appropriate for mapping differences between segments (Banerjee, S. and Chua, A.Y.K. 2016; Rodrigues, H. *et al.* 2017), and the geographical location can also influence the ratings (Banerjee, S. and Chua, A.Y.K. 2016). From the practical point of view, the results can support future developments and marketing communication (Kladou, S. and Mavragani, E. 2015; Banerjee, S. and Chua, A.Y.K. 2016; Marine-Roig, E. and Anton Clavé, S. 2015; Gal-Tzur, A. *et al.* 2018), or just simply identify need for intervention (e.g. transportation).

The Balkans as a destination

Balkan Airlines which operated from 1947 to 2002 can now be seen as one of the success stories in terms of using the Balkans as a geographical name in tourism (Erdősi, F. 2007). The Bulgarian national airline flew the Balkans name to fifty countries on four continents for five decades, contributing (consciously or unconsciously) to associations with the term Balkans in the context of tourism. At the same time, the Balkan region, which was named after the Balkan Mountains located in Bulgaria and has often been associated with Southeast Europe (Kocsis, K. 2007), encouraged other tourism businesses to offer their services under this well-known geographical name. One prominent example is the *Sofia Hotel Balkan* located in the heart of the Bulgarian capital, currently operated by the world-famous *Sheraton* chain of luxury hotels. But just as the geographical interpretation of the Balkans extends well beyond the boundaries of Bulgaria (Pap, N. 2013; Pap, N. and Reményi, P. 2017), travellers can see tourism services offered under the Balkans name everywhere in the world.

However, due to some of the more negative associations which developed during periods of conflict and war, the use of the geographical name Balkans as a tourism-oriented brand in the future requires a broader examination of the term and its inherent associations. Tamminen, T. (2004) suggests that the term 'Balkanization' alludes to instability and conflict, whereas 'Europeanization' is understood as the adoption of 'Western norms' and 'European' values and practices. Matanov, A. *et al.* (2013) describe how the collapse of Yugoslavia in the early 1990s precipitated the worst armed conflict in Europe since WWII with war activities spanning ten years, and Akova, S. and Demirkiran, C. (2013) refer to a multitude of historical conflicts and civil wars, as well as an unstable environment. O' Brennan, J. (2014, 239) states that the Western Balkans in particular still remains „a region of great fragility, defined by inter-ethnic contestation for territory and power and „mutually antagonistic nationalisms". Rightly or wrongly, therefore, the image of the region has often become synonymous with conflict. As stated by Vitic, A. and Ringer, G. (2008, 128) „perhaps the most pervasive – and disruptive to tourism's revival in the Balkan states – are the dated, and often inaccurate, misperceptions and images of the civil wars and ethnic barriers that prevailed throughout the 1980s and early 1990s, yet still define the region for many international visitors and tour operators". Whether this is still the case is a subject worthy of further exploration.

The term Balkans and the content and quality of the services provided by tourism businesses using it are in close relationship, and other associations related to the Balkans (external ones i.e. not those generated by tourism) inevitably shape tourists' attitudes to the Balkan name. However, it should be noted here that it is deeply contested as to which countries form part of the Balkans, and the authors acknowledge that there are huge variations within the countries which are said to be located in the Balkans. On the other hand, tourists' knowledge of the history, geography and politics of the region may be sketchy at best, but they may still have some associations with the Balkans as a concept, region or even destination.

The Balkans can be seen as a geographical name which is more or less known as a destination for the average person and is likely

to evoke various tourism-related references (Ábrahám, B. 2007; Seben, G. 2007). If the Balkans as a geographical name became a successful tourism brand, it could facilitate not only the socio-economic development of the region and its geopolitical stability, but also the process of the European Union's expansion and achievement of its security policy objectives (Anastasakis, O. 2000). This could be enhanced by the fact that the Balkans has become a relatively positive brand name both in fashion and music; for example, bags and wallets made of recycled bicycle tyres are sold by a Hungarian-Swiss company under the brand name *Balkan-Tango*, while *The Balkan Fanatik* music band enjoys international recognition, too.

The term Balkans has taken on geopolitical dimensions in addition to locational ones. The Balkan Peninsula which provides the physical geographical boundaries was named after the Balkan Mountains located in Bulgaria (Székely, A. 1970). The physical delimitation of the Balkan Peninsula itself is a topic of professional debates; literature reports 17 different boundaries, while researchers agree that the Danube–Sava–Kupa rivers create a fairly clear line (Pap, N. 2013). For centuries, knowing and understanding the Balkans have been the objective of travellers, thinkers and researchers from various fields of science (Hajdú, Z. 2003; Bracewell, W. and Drace-Francis, A. 2009; Kőszegi, M. 2010; Sanguin, A. 2011; Nagy, M. 2012).

As mentioned, the Balkans is a geographical name with negative connotations, so as a result, associations with and perceptions of the region also incorporate elements which represent the darker side of life (Carter, F.W. and Norris, H.T. 1996; Redepenning, M. 2002; Garde, P. 2007; Császár, M.Zs. and Pap, N. 2011). In connection with its role in the history of Europe, in particular on account of the wars and delayed development as a result of them, the Balkans is a geographical term which does not tend to reflect many positive aspects of life (Newman, B. 1945; Kaplan, R. 1994; Arday, L. 2002; Bideleux, R. and Jeffries, I. 2007). The images which characterized the Balkans at the turn of the 19th/20th century (e.g. "sick man of Europe", "powder keg of Europe") are still present in public opinion related to this region (Rutar, S. 2004; Hajdú, Z. 2007; Petrovic, M. 2008). The late modern and postmodern eras in the Balkan region were characterized by destructive nationalism, ethnic conflicts, wars and ongoing instability (Bottlik, Zs. 2009; Clemens, V. 2010; Pap, N. 2013; Iov, C.A. and Ivan, A.L. 2014; Jovanović, S. *et al.* 2015; Kadiu, F. 2015).

The negative connotations of the Balkans are magnified by the term *balkanization*, which is widespread in British-American social scientific literature as a description of the fragmentation and division of a community or a nation (Ellis, M. and Wright, R. 1998). From the branding point of view, the Balkans name's negative connotations can be a paradox when emphasizing the positive effect of branding on place identity (ETC-UNWTO 2009), on diminishing negative effects of crisis (ETC-UNWTO 2009; Moilanen, T. and Rainisto, S. 2009) or on transmitting value (Moilanen, T. and Rainisto, S. 2009; Saraniemi, S. 2010).

Methodology

After considering some acknowledged methods for tourism destination image research, including netnography, big data and content analysis, for this analysis content analysis was chosen. This meant the systematic evaluation of content, which was the texts written by tourists in this case. The research process follows the traditional method of content analysis, namely information-processing where the preselected texts are transformed through systematic categorization into data that can be analysed further (Camprubí, R. and Coromina, L. 2016).

One of the key stages in the study is identifying the content and meanings inherent in the word Balkans/Balkan. Knowing which elements are described in the travel experiences of visitors to Balkan countries as being typically Balkan, could be used to change the image of the Balkans which people have formed.

For this, we used the database of one of the most popular travel portals, TripAdvisor. TripAdvisor is a platform for tourists to rate or review destinations and services used by tourists, to create a place of dialogue or forum for the stakeholders and interested parties. It has excellent search capabilities, but also involves many factors which limit the validity of scientific results (Ayeh, J. *et al.* 2013). Our analysis was performed based on a database created from information posted on TripAdvisor and downloaded before March 7th 2014.

To collect the phrases including the word 'Balkans/Balkan' from descriptions of tourist experiences, a relatively simple Excel database was created from the set of results using the search terms. The basic sample was created from 3,860 reviews which included the word 'Balkans/Balkan' either in the name of the reviewed facility, the brief title of the review or the body of the review itself *(Table 3)*.

As our study focuses on the international dimension of the tourism-related aspects of the term 'Balkan', we restricted our analysis to reviews of citizens from countries lying outside the studied area (i.e. clearly non-Balkan), while reviews of posts with unidentified nationality were excluded from start. The database obtained was suitable for grouping reviews by country for the purposes of our analysis, breaking down the experiences related to countries lying in the studied area (1,861 reviews) and those outside (1,999 reviews). In addition to this essential categorization, we used a database suitable for filtering the following information:

– Exact name of the reviewed place;
– Type of the reviewed place (accommodation, catering, tourist attraction);
– Brief informative title of the review.

Although 22 per cent of the reviews were initially posted on TripAdvisor in another language than English, the various longer or shorter reviews and additional pieces of information were available in English thanks to the English language function of the portal. We searched the terms *Balkan/Balkans* with British spelling, making sure that information would not be left out of our database because of any misspelling by the reviewers (e.g. missing letters).

Using the database compiled above, we conducted a content analysis. As part of this, we focused on phrases which included the terms *Balkan/Balkans* in the reviews, as well as the words directly associated with them and grouped them according to the content. We applied two approaches in the analysis. Firstly, we analysed the Balkan particularities of tourist services available in countries outside the studied area. Secondly, we dissected the elements of what 'Balkan' means in the experiences which took place in Balkan countries *(Figure 1)*.

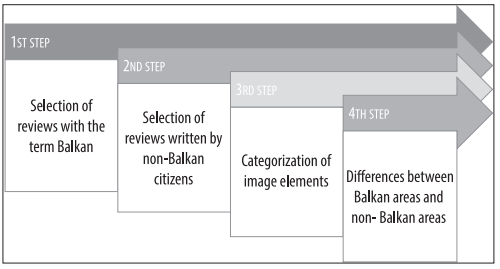

Fig.1. Data analysis process – main research steps. *Source*: Authors' research

Table 3. Study sample with the number of opinions in units

Number of reviews related to the facility located	The word 'Balkan' in the			Together
	name of the facility	title of the review about the facility	body of the review about the facility	
in the Balkans	566	113	1,182	1,861
outside the Balkans	904	162	933	1,999
Total reviews	*1,470*	*275*	*2,115*	*3,860*

Source: Own research.

Results

Quantitative results

In line with the consulted literature, the database enabled some quantitative analysis. The geographical location of the facility (in the Balkan countries or outside) has an effect of the general evaluation: the average rating for the facilities in the Balkan countries is 3.90 (standard deviation: 1.218), and 4.05 (standard deviation 1.119) for the ones outside of the region.

The reviewer place of origin also influences the perceptions that can be traced in the general evaluation. Those reviewers who live in the Balkan area, are more positive (average rating of 4.18 with standard deviation of 1.034) than non-Balkan people (average rating of 3.95 with standard deviation of 1.185). Among the source markets with at least 100 comments, Russians (4.46), Spanish (4.43), Canadian (4.25) and US (4.24) visitors were the most satisfied, whereas the most 'critical' were the reviewers from England (with an average evaluation of 2.86).

According to the facility type, there are also some important outcomes. The attractions showed the best performance (in this case, the std. deviation is the lowest, as well). At the same time, accommodation – especially hotels – had the weakest performance, which definitely need some developments in the future *(Table 4).*

Table 4. Average rating by facility type

Facility type	Mean	Standard deviation
Attraction	4.58	0.722
B&B / Inn	3.92	1.275
Hotel	3.55	1.285
Restaurant	4.19	1.012
Speciality Lodging	4.09	1.385
Total	*3.97*	*1.178*

Source: Own research.

Services with the word Balkan in their names

The database of 3,860 elements processed as part of our study included 1,470 reviews where the word Balkans appeared in the name of the reviewed service. We noticed the word Balkan was used most often in reviews related to names of restaurants (854 reviews) and hotels (544 reviews). Most reviews (904 reviews) commented on service providers located outside the studied Balkan countries.

We identified 22 non-Balkan countries whose tourist services were referenced in reviews with the word Balkan in the title. Clearly experiences perceived as being Balkan can be acquired also when using services of tourism businesses in non-Balkan countries, and this may influence global perceptions of the Balkan region. However, geographical misunderstandings are not uncommon. For example, it transpires from the reviews that in some cases the Balkan atmosphere is associated with the Mediterranean region and the Balkan cuisine with the Turkish one. This data shows that from the image elements of the Balkan, the gastronomy has the strongest appeal and potential for 'export' *(Table 5).*

The 'Balkan' element in the tourism experience

From the qualitative point of view, in the tourist opinions on experiences in Balkan countries shared on the TripAdvisor travel portal, the terms *Balkan/Balkans* in the review body can be grouped into five categories based on the main themes of their content (1,182 reviews). Geographical location (180 reviews), cuisine (136 reviews), travel (626 reviews), culture (183 reviews), and atmosphere (57 reviews). Although the themes outlined were sometimes overlapping in the bodies of the various reviews, they were limited based on the keyword or main theme of the review *(Figure 2).*

Tourists visiting the Balkans often localize their experiences using the word Balkans instead of the geographical name of the country, region, city or territory of their destination. Identifying a destination or a service provider as being Balkan during a trip to a Balkan country means that the tourist has a certain understanding of the geographical scope of the Balkans (i.e. a mental map) and is certain about being in the Balkans.

Table 5. Use of the word 'Balkan' in titles of reviews on the tourist restaurants of countries lying outside the Balkans

Country	Number of reviews	Names in the description of the service reviewed	Occurrences of the word 'Balkan' in the review titles
Denmark	4	Herzegovina Ankara	Balkan atmosphere Balkan food
South Korea	1	Zelen	Balkan food
Israel	4	Montenegro Nanuchka Arnold	Balkan food Balkanian (sic) touch
Colombia	1	Bukara	Balkan cuisine
Poland	11	Paros Banja Luka Maly Belgrad Bulgaria Magica Balbinka	Balkan night Balkan cuisine Balkan food Balkan and Turkish cuisine
Hungary	2	Montenegro	Balkan food Taste of the Balkans
Malta	1	Transylvania	Balkan style

Source: Authors' data collection based on TripAdvisor.

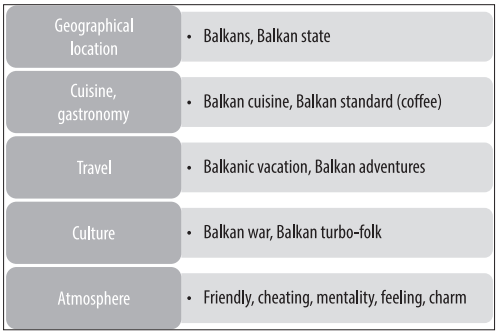

Fig. 2. Dimensions of the Balkan image with some examples. *Source*: Authors' data collection based on TripAdvisor

For example, a Dutch tourist who visited Albania praises the hotel where he stayed by saying: *"This is one of the best hotels in the Balkans."*

Reviews often identify the geographical location of a country, stating that it is part of the Balkans, as did a British tourist visiting Montenegro: *"Montenegro is a new Balkan state born out of the wars of the 90s."*

Dedicating a separate category to travel in our discussion was necessary because the word Balkan tends to emphasise the importance of the Balkans as a region, and not only of the individual countries in which the tourists find themselves.

For example, a Swedish tourist who spent the holidays in Montenegro reported his experience at the given destination as being specifically Balkanic (sic!) rather than Montenegrin. He felt that the observations made during the vacation apply to the Balkans as a whole and can be replicated in any Balkan country: *"This is the perfect place for an excellent Balkanic vacation."*

When an Israeli tourist who visited Slovenia recommended a hotel in Ljubljana, he presented the travel as a Balkan trip: *"If you're beginning your Balkan adventures in Ljubljana and want to start in confidence, may I recommend the Austria Trend Hotel?"*

When describing the gastronomy, tourists tend to label the offer of a given catering facility as being typically Balkan. The meals most frequently mentioned include grilled meat (mutton), fresh vegetables, enticing sweets, tasty wines and home-made liqueurs. The specific offers are hallmarked by *cevapcici*, *kebab*, *lepinja*, *rakia* and *shopska salad*.

Reviews from tourists who mention the Balkan cuisine are generally appreciative, as seen in the post of a Polish tourist who visited Serbia: *"After a whole day of visiting Belgrade, it is a perfect place to enjoy delicious Balkan cuisine."*

A British guest in Bosnia-Herzegovina complained about the quality of coffee served there, but also implies that standards of Balkan cuisine tend to be usually high: *"The only let down for me has been the coffee, which on at least 2 occasions is not up to Balkan standard."*

The reviews described culture as a specific Balkan attraction with a regional dimension that crosses borders. However, the legacy of wars is mentioned frequently.

For example, a British tourist visiting Mostar in Bosnia-Herzegovina to see the rebuilt Old Bridge stated that: *"We felt making the effort to visit Mostar was well worth it, after watching its demise in the Balkan War."*

Music is another element of culture which is described often and usually positively.

A German tourist reporting on his visit to Serbia mentions a specific musical trend, turbo folk, a popular music rooted in folk music: *"The evening started with international music with a Spanish theme and ended with Balkan turbo-folk."*

Atmosphere proves to be a more ambivalent category, with both positive and negative comments. The heritage environment is viewed positively, whereas the infrastructure is frequently not. Balkan people are seen as friendly and hospitable by many, but service levels and attitudes are also viewed less favourably. Cheating and scams are also mentioned on several occasions.

If a tourist feels he does not get the quality of service he paid for, he feels defrauded and sometimes rates the experience 'Balkan', as an Indian customer visiting Croatia did: *"Middle-class hotel with Balkan mentality, at Monaco prices. No real service. [...] Huge disappointment, first (and last) time I was in Croatia, cheat other people from now on instead of us."*

However, a German citizen's review about Montenegro implies that Balkan 'atmosphere' can be positive: *"Budva is definitely a nice party city, Balkan feeling is in the air."*

Summary of results

The brief analysis and examples above show that the meaning behind the Balkan attribute can be understood relatively easily in the case of tourists who shared their experiences of the Balkan countries through the TripAdvisor travel portal. The existence of the 'Balkan' in travellers' experiences (demand side) could be integrated into the stakeholders' view, taking advantage of perceptions already measurable. The geographical context of the selected area can be tracked in the database involved in the research. Travel experiences were reported as typically Balkan probably because the visitors could personally engage in the various elements of the image of the Balkans they had (fixed) in their minds. From the main image elements arising in the analysis (based on the categorization of the texts' content), the gastronomy has the best potential in showcasing 'Balkan experience' outside of the region itself. Gastronomy – namely restaurants – are also in the forefront of image shaping outside of the researched area, as these are the most common facilities, and those with the most positive image.

Evaluating the results, it seems that the term Balkan can be construed as an umbrella concept of two experiences which occasionally overlap: the first is meant to express the simplified geographical identification of experiences from Balkan countries on the experiencing parties' mental map; the second (partially related to the first one) is a rating with an axiological substance, too, which is positive in some cases, contrary to common myths that all associations with the Balkans tend to be negative. From the residents' point of view, the Balkans has also an important role in the local identity, as reviewers from the areas tend to be more positive, proud of their values that is reflected also in the general scores.

The fact that a tourist rates something as Balkan in a TripAdvisor post is an expression of the expected experience in most cases. This means that it can be construed as a manifestation of an experience in a Balkan country corresponding to the pre-existing expectations (this can be positive, too, for example when tasting Balkan cuisine, or negative, for example regarding the facilities or cleanliness in a Balkan hotel). But there are cases where the experiences of the tourist acquire a Balkan attribute not in the light of expectations, but experiences i.e. the negative ideas about the region in their minds are connected with a case experienced in a heightened state of emotion (e.g. being cheated or being the

victim of rudeness). Although being a crucial element for tourism mobility, among the elements of the tourism value chain, accommodation has the weakest performance.

The tourist dimension of 'Balkan' was expressed best perhaps by a British tourist visiting Romania: *"This is a Balkan country and if you don't know what this means from a cultural point of view you are missing the charm of visiting foreign places."*

The term *charm* encapsulates well the complex nature of Balkan experiences. It implies that visiting a Balkan country will be enriched with an unparalleled experience of life and impressions which, as our study confirms, are nourished by becoming aware of the geographical location, the regional character of the territory which transcends the country boundaries, the cuisine, a tourist offer full of challenges, as well as joy, the cultural traditions rooted deeply in history, but also conflict, and the atmosphere. Perhaps unexpectedly, experiences rated as being Balkan appear mostly in a context where satisfaction is the dominant feeling, therefore, the term Balkan does not necessarily carry unfavourable connotations.

Conclusions

This study in no way expresses the complexity of interpretations which abound in relation to the Balkans as a geographical or political entity. However, the results of the analysis show important theoretical and practical implications. From the theoretical point of view, the selected methodology in line with recent academic literature (e.g. Kladou, S. and Mavragani, E. 2015; Marine-Roig, E. and Anton Clavé, S. 2015) enables the measurement of a realistic image dimension of the selected destination. It is recognized that image creation and brand building are exceptionally complex in tourism and can take many years, if not decades.

Revisiting the tourism branding literature, regional branding is even less common than national or city level branding. However, the study does underpin the relevance of geographical dimensions of branding, as the term 'Balkan' is still used quite widely by international visitors to the region, regardless of the country that they are visiting. Thus, the results of the content analysis can support the identification of the area's brand equity (Marine-Roig, E. and Anton Clavé, S. 2015; Malenkina, N. and Ivanov, S. 2018; Thanh, T.V. and Kirova, V. 2018). Regarding the image elements, the study underpins the importance of emotional dimensions, furthermore the need for involvement of the residents (who are the 'service providers' meeting the visitors) shaping the environment and communicating through their behaviour (Wang, S. and Xu, H. 2015). In the case of the researched area, we can also conclude that locals have a strong identity that can be seen as a positive element (reflected in the scores given). The study, also in line with the reviewed literature (Banerjee, S. and Chua, A.Y.K. 2016; Rodrigues, H. *et al.* 2017) underpins the difference between certain segments (e.g. according to reviewers' place of residence) in the perceptions of the Balkans.

From a practical point of view, the paper acknowledges the rich national variations which clearly exist in terms of development levels, resources, facilities, services or attractions in tourism. However, accommodation clearly has the weakest performance, meanwhile attractions and restaurants can be a good starting point for communicating 'Balkan' experience. Also from the demand point of view, the analysis underpins the difference of segments, the role of residence (country), and thus, socio-cultural background in perception building. In this regard, the research can be seen as the starting point for new discussions about the Balkans as a tourist region, especially for international tourists, many of whom will be too young to personally remember many of the past conflicts in the region. Opinions about tourist services using the geographical name Balkans can shape the region's tourism-related image not only by transfers associated with the given location or other service providers (e.g.

media, internet, word of mouth marketing), but also because of the general economic, political and cultural conceptual associations related to the Balkans. The use of the term 'Balkan' in reviews is still somewhat mixed in terms of positive and negative connotations, but the predominance of positive comments is perhaps a hopeful sign of changing attitudes and perceptions to this exciting but as yet, still relatively under-visited region.

The results of the research can provide valuable input for future developments and marketing communication (Kladou, S. and Mavragani, E. 2015; Marine-Roig, E. and Anton Clavé, S. 2015; Banerjee, S. and Chua, A.Y.K. 2016; Gal-Tzur, A. *et al*. 2018) of the Balkan region as a tourism destination. The negative comments in areas that need intervention can help destination managers and service providers in meeting expectations of travellers and in providing good quality service and experiences.

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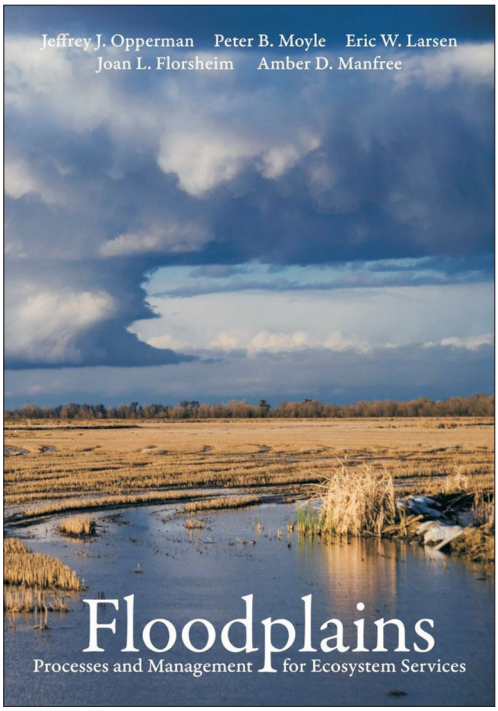
BOOK REVIEW SECTION

Opperman, J.J., Moyle, P.B., Larsen, E.W., Florsheim, J.L. and Manfree, A.D.: Floodplains: Processes and Management for Ecosystem Services. Oakland, University of California Press, 2017. 258 p.

Floodplains are usually treated subordinate to channels in geomorphological and environmental research. This book brings a wealth of arguments for the joint presentation of river channels and their floodplains. (In Hungary, where morphological floodplains make up almost two-thirds of the territory, this approach should be just natural.) From a geomorphological aspect, the importance of floodplain connectivity is underlined throughout. In the biogeochemical section we read, for instance, that the densities of zooplankton and aquatic macroinvertebrates are much (15 and 30 times, respectively) higher in backwaters or floodplain lakes than in the main Danube channel.

It can be anticipated from the background of authors that the comparison of floodplain definitions will be followed by the presentation of the geomorphic processes which shape floodplains. The distinction between braided and anastomosing channel types (often rather vague in literature) is clearly drawn here: braided channels are divided by unstable mid-channel bars, while anastomosing channels by fairly stable, vegetated islands. Throughout the book the modern concept is adhered to that vegetation growth is a principal agent of the geomorphic evolution of floodplains. Floodplain erosion during floods is another important issue in fluvial geomorphology. The authors point out that it is equally possibly associated with scour at the site where floodwater breaches the natural levee and further away on splay deposits.



Much more space is devoted, however, to the other side of the coin, i.e. how geomorphology influences floodplain ecology. Although numerous arguments are cited for the importance of this control, the reviewer feels that the ecological classification of wetlands (into eupotamon, parapotamon etc.) could have been better integrated with that of floodplain landforms. On the other hand, some of the main topics of the book (floodplain connectivity, the duration and frequency of floods, predictability of peak flows) appear in this chapter and related to biogeochemical processes such as nutrient retention. The main idea is that floods (not only the major floods but a series of moderate inundations, too) create a landscape mosaic, a dynamically changing pattern of wetlands with constant properties, which ensure high levels of biodiversity (Shifting Habitat Mosaic concept). The hydrarch succession is directed towards landscape homogeneity, but floods reset the stage of this succession and maintain a heterogeneous floodplain pattern.

The basic conceptual frameworks of river/floodplain ecology (the River Continuum Concept, the Flood Pulse Concept, the Riverine Productivity Model) are described, assessed and the need for their integration is pointed out. A crucial issue concerns the turnover of nutrients between the river and the floodplain water bodies. Some observations indicate that local autochtonous sources supply abundant and easily available nutrients. Floodplain forests with trees of rapid growth rate, well adapted to inundation (like cottonwood), contribute to carbon cycling. Recent findings, however, point to the role of algae in sustaining the floodplain food web. Floating algal mats in standing water (well-known from the Danube Delta) as well as floodplain soils and sediments are important carbon reservoirs. Fish species are classified according to their use of the floodplain

and for most of the classes (for floodplain spawners, floodplain foragers and pond fishes) both permanent wetlands and seasonal floodplains are vital habitats.

The importance of floodplains is measured by the provision of ecosystem services by them. The main services described in the book are sediment and nutrient (mostly nitrogen and phosphorus) storage, carbon sequestration in soil and vegetation, groundwater recharge (drought mitigation), fish productivity due to variable habitats, recreation (hunting, fishing, bird watching), the maintenance of biodiversity and allowing some agricultural activities (on condition that they are compatible with inundation). Unfortunately, little mention is made of the scientific assessment of water-based ecosystem services (see e.g. Martin-Ortega, J. *et al.* 2015).

The first part focused on natural processes, while the second acknowledges that the overwhelming majority of the world's rivers and floodplains are heavily transformed by human society. The book uses the term 'novel ecosystem' for these modified conditions. Ample evidence is cited for the homogenisation of flow regimes which leads to homogenised aquatic flora and fauna (generalist species becoming more and more abundant) as well as microbial life. In addition, the loss of floodplain connectivity can slow down, but in some cases speeds up the spreading of alien species. Novel ecosystem requires a new approach to restoration, which is called by the authors 'reconciliation', because management should reconcile competing demands for land and water. The emphasis here is improving the provision of ecosystem services and resilience through active management. This compromising approach means that human impact is not excluded from the floodplain and even alien (but non-invasive) species are tolerated to some extent. (Think of the debate about the benefits and risks of black locust in the Hungarian floodplains.)

The next chapters of the book focus on flood management (the term preferred to 'flood control'), where traditional structural techniques of flood hazard reduction are presented and criticised. Instead, 'green infrastructure' solutions are proposed which can be integrated with 'soft engineering' techniques. It is emphasised that the flood hazard should be viewed in the river-basin perspective: floodwater retention upstream of sites with high flood hazard has to have priority. In addition, in certain case structural solutions (levee setback, floodways only inundated during high floods, flood by-passes) are to be considered.

In spite of the similarity in their main hydrological properties, they are very different from each other. This means that general conclusions for their restoration/rehabilitation are rather risky to draw. Consequently, authors had decided to present floodplain management strategies on case studies. The case studies include the Room for the River project in the Netherlands, the Danube restoration in Bavaria, the Ebro River in Spain, the Mississippi floodways (the New Madrid and Atchafalaya floodway system), the Napa River in California and the Murray-Darling river system in Australia. Naturally, the book would have profited from the analysis of some other rehabilitation projects outside the United States, for instance, from Australia (referring to the works of Gary Brierley and Kirstie Fryirs) and France (based on papers by Hervé Piégay). This would have reduced the bias to US rivers. Instead, a detailed study of the flood risk in the Central Valley of California follows and allows authors to assess the benefits of the floodplain reconciliation model proposed by them.

The conclusions summarise the basic principles of floodplain management which are assumed to be valid worldwide. For the maintenance of novel floodplain ecosystems, too, inundations allowed by floodplain connectivity, are inevitably necessary. Floods predictable in timing are needed for geomorphic and biological diversity. Flood-risk management should be designed with the entire drainage basin in site and a flexible comprise of the combination of both structural and non-structural measures. The message engineers can learn from the geomorphologist and ecologist authors of the book is that with careful floodplain management it is possible to reconcile human interests and environmental values.

Dénes Lóczy[1]

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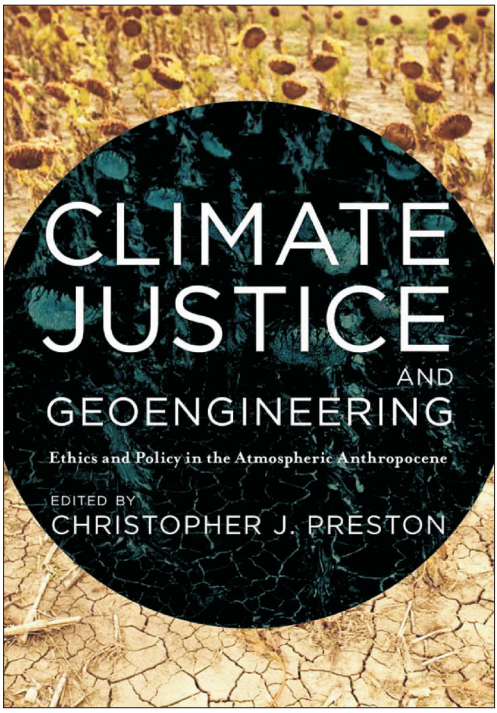
Preston, C.J. (ed.): Climate Justice and Geoengineering: Ethics and Policy in the Atmospheric Anthropocene. London–New York, Rowman & Littlefield International. 2016. 209 p.

A great many researches have been addressing the issue of global climate change for decades. The Intergovernmental Panel on Climate Change (IPCC) in its fifth Assessment Report significantly expanded its focus to climate engineering compared to previous reports. Adaptation to climate change is not optimal, as countries most in need of adaptation have the least amount of resources. In response, and as the planet is already locked in the future warming caused by past emissions, geoengineering is suggested as a possible tool of further mitigation. Geoengineering, also known as climate engineering, describes methods and technologies for 'manipulating' the climate in order to mitigate or prevent the effects of climate change.

Christopher Preston, professor of philosophy at the University of Montana and a leading philosopher of the ethics of climate engineering, has brought together an impressive group of thinkers and researchers to reflect on the complex topic of "Climate Justice and Geoengineering: Ethics and Policy in the Atmospheric Anthropocene" in the current volume. There is an extensive literature nowadays on the ethics of geoengineering which offers several important observations. One of the main ethical issues this volume indirectly draws attention to is the thought of intentionally manipulating the whole planet challenges the whole domain of environmental thinking. The current edited volume is a remarkable initiative to provide a comprehensive and comparative overview of climatic technologies and ethical issues in their interrelations. It gives us the opportunity to evaluate technologies while taking into consideration key ethical challenges, and to gain a better understanding of alternative climate policies. Thanks to the fairness approach the list of contributors includes both advocates of climate intervention research and its sceptics.



This cross-disciplinary collection contains a second-generation of analyses which state that the portrayal of the problems identified in first generation studies of climate engineering can start to take on a different hue when put into a more realistic context. While significant ethical challenges are still clearly surrounding climate engineering, the arguments of several authors do not preclude the possibility that some form of climate engineering will make some contribution to climate justice in the future under certain highly constrained circumstances.

The volume includes 13 studies written by economists, geographers, philosophers, policy experts, climate experts and sustainable development theorists. Diversity is not only presented in terms of disciplinary background, but also as regarding the nationality of the authors. Contributors originate from Canada, Finland, Germany, Italy, Kenya, the Netherlands, Nigeria, Sweden, Switzerland, the United Kingdom and the United States. The articles take up theoretical and practical aspects as well. The book consists of three parts.

Part I (*Geoengineering Justice in Theory*) is oriented primarily towards philosophical and ethical theory. Geoengineering means deliberate large scale intervention into the Earth's natural systems in order to counteract climate change. Generally, geoengineering techniques can be grouped in two categories: Carbon Dioxide Removal (CDR) and Solar Radiation Management (SRM). CDR techniques aim to remove carbon dioxide from the atmosphere, directly counteracting the increased greenhouse effect and ocean acidification. These techniques (e.g. afforestation, biochar, bio energy with carbon capture and sequestration, ambient air capture, ocean fertilisation, enhanced weathering, ocean alkalinity enhancement) should be implemented on a global scale to make a significant impact on carbon dioxide levels in the atmosphere. SRM techniques aim to reflect a small proportion of the Sun's energy back to space, counteracting an increasing level of greenhouse gases in the atmosphere which absorb energy and raise temperature. Some SRM techniques are albedo enhancement, and the

use of either space reflectors or stratospheric aerosols through stratospheric sulphate injection (SSI).

Toby Svoboda argues in Chapter 1 that, although SRM may impose distributive injustice in general, certain uses of SRM might nonetheless be distributively just. According to Preston, SRM could have the morally contestable outcome of increasing the vulnerability of some parties to climate related burdens, yet on the whole a policy involving SRM might be more just than its alternatives, given SRM's potential to manage climate risk and buy time for mitigation, development, adaptation and, possibly, CDR. As Svoboda puts it: "Accordingly, SRM might be permissible in light of our duties of justice, despite its potential to bring unjust burdens to some parties. To be clear, I am not advocating SRM deployment, but it is time for ethicists to begin broadening their consideration of SRM, attending not just to its potential ethical problems but also to its potential ethical merits" (p. 13).

Employing geoengineering to struggle with climate change is often identified as 'Plan B'. Chapter 2 argues against the common Plan B framing of SSI. According to Augustin Fragnière and Stephen M. Gardiner, Plan B framing presupposes distinctness, independence, exclusiveness, attractiveness and relative feasibility. In general, it claims that the framing encourages distortions of the ethical judgement by unnecessarily narrowing down the variety of options available to future climate policy and underestimating the relevance of past moral failures. According to the authors, rather than a comparative assessment of mitigation and geoengineering, we should encourage a more integrative assessment that situates SSI within the wider context of climate policy as a potential part of more general schemes of action. Another lesson learnt from this chapter is that ethics is premier to this task.

Chapter 3 addresses the problem that the debate surrounding climate change and climate justice mostly focuses on emission reduction. The aim of this chapter is to argue that the concept of recognition plays an important role in evaluation and improvement of participatory processes. The main conclusion of the authors is that using SRM without ensuring participatory justice for all actors concerned we risk endangering the trust and social capital.

In Chapter 4 Patrik Baard and Per Wikman-Svahn try to figure out whether we have a residual obligation to engineer the climate as a matter of justice. The theory of residual obligation was first discussed by Bernard Williams. The concept pointed out that if an agent has more than one obligation, fulfilling one of them does not cancel out the moral importance of the others. The authors critically examine the thesis that we have a residual obligation of solar geoengineering. Furthermore, geoengineering exposes individuals to new risks. Concluding alternative residual obligations should thus be more seriously considered in climate policy.

The last topic of Part I is intergenerational justice of climate change (Chapter 5). The problem is that earlier generations' emissions cause loss to the future generations by climate change which must be compensated. According to Frank Jankunis and Allen Habib further investigations about geoengineering as a potential compensatory mechanism are necessary.

In Part II (*Geoengineering Justice in Practice*) four theoretical questions are addressed. The first one is that the solar geoengineering has obligations to the global poor (Chapter 6). There is a broad consensus that the effects of climate change will disproportionately affect the poor, for the simple reason that poorer people will have less resources compared to wealthier ones to manage climate risks and adapt to unavoidable changes. The other most significant criticism against solar geoengineering is that it could shrink responsibility by postponing the harmful effects of climate change.

The second question is why aggressive mitigation must be part of any pathway to climate justice (Chapter 7). Reflecting on it, countries' representatives are obliged to ensure that their citizens' total fair share (FS) of emission entitlement is not exceeded and to promote the establishment of adequate global institutions. Also, wealthy countries ought to undertake fast and far reaching mitigation. The possibility to research and deploy climate engineering (CE) technologies and to undertake adaptation does not diminish the original obligation with respect to mitigation. In conclusion, different strategies of how meaningful policies can evolve over time are suggested, for example carbon pricing as well as low carbon research and development.

Chapter 8 discusses the energy and climate context that shapes the possible roles of climate engineering, the way CE might be used as a part of a strategic portfolio to control climate impacts, cultural issues associated with starting research on this topic, and some thoughts about moving towards the international control of CE. The author's main conclusions are that geoengineering may be needed in the future, but one needs further research to prove its potential. As the problem of climate change grows, the need for international interaction and coordination will also increase. Here, early and smaller scale interventions can provide an alternative to build the institutions required.

The last topic in this part of the volume analyses the ethical challenges, risks and opportunities that result from the complex relations between food systems and climate engineering. Important and difficult questions arise from interactions between climate engineering, climate mitigation, and food production and consumption. It is necessary to find the ways to resolve or manage the risks related to non-agricultural SRM techniques. Considering how significantly climate change threatens food justice and food security, there are good reasons for being cautiously positive towards those climate engineering strategies that are safe in terms of food justice and food security.

Part III (*Geoengineering Justice in Frames, Scenarios, and Models*) employs four individual models and case studies. The first topic addressed here is "Framing out Justice: The Post-politics of Climate Engineering Discourses" (Chapter 10). It compares climate engineering to climate change in terms of how they are framed in media discourses. The chapter begins with a brief introduction to the existing climate change discourses. Three competing theories, 'Prometheanism', 'eco-modernisation' and 'green radicalism', are presented in this part of the book. According to the author three explicit master framings can be identified in the discourses: technological optimism, political realism and 'avoiding catastrophe' framings. The researches presented here focus on explicit aspects of the debate, also analysing separately the framings of the two main techniques, CDR and SRM. In general, media framings typically imply that geoengineering would be practical and controllable, and describe it as a decision to be made to avoid potentially catastrophic levels of climate change. Duncan McLaren also emphasises the possibility of cancelling the domination of the climate debate by discourses sustaining existing injustices.

Chapter 11 presents a case study which focuses on solar geoengineering. It investigates "Technology-Based Climate Intervention and Compromising Social Justice in Africa". According to the authors, Africa is likely to experience catastrophic climate impacts if the current trajectory of climate policies is maintained. In consequence, this study shows that under certain climatic conditions and a specific climate intervention regime, African policymakers often decide to prioritise one group of stakeholders over others, depending on this group's social influence and its firm interest in the outcome of climate policy, which has significant implications for climate justice. Furthermore, the implementation of such systems requires sustainable, socially equitable and affordable infrastructure. Therefore, African leaders need to become self-determined 'climate pro actors' by developing consistent climate protection mechanisms.

The next chapter (Chapter 12) presents integrated assessment models (IAMs) which are analysing trade-offs and synergies as foreseen. As the authors, Johannes Emmerling and Massimo Tavoni point out, "Achieving climate stabilization is the ultimate goal of climate change policies" (p. 175). According to the authors the main question is even if countries were to agree on a long term temperature goal, how could it be translated into climate change strategies. IAMs have already been used as a respond to this policy request. Geoengineering technologies, namely CDR and SRM, have been incorporated into IAMs, though in much different degrees. Both of them raise many concerns with important consequences for equity and justice, but these are fundamentally different from each other. In the case of CDR, the benefits of reduced economic costs must be compared with the temporal and geographical repartition of effort, and the risks can be mitigated by setting appropriate measurement and introducing the right policies. On the other hand, SRM embodies a series of risks which are not easily mitigated.

The last chapter (Chapter 13) computes the Kaldor-Hicks optimal level of geoengineering and shows there is actually no Pareto optimal level in this case. The author, Richard Tol, considers two sets of transfers. The first set assumes that people are exposed to unbridled climate change and compensates those who would prefer less-than-globally-optimal geoengineering. The other set favours climate change and compensates those who would prefer more-than-globally-optimal geoengineering. Although the presented analysis is really simple, it provides a valuable overview of the main inequities that come with geoengineering. On the other hand, it has many limitations. For example, the analysis is static, but the problem is dynamic. Hence, this macroeconomic analysis is very useful to evaluate the process, but further development should be taken.

In conclusion, achieving climate stabilisation is the ultimate goal of climate change policies. Over the last decades, such approaches have considerably increased their legitimacy among scientists, policy makers and environmental groups. The most important question is even if the representatives of countries were to agree on a long term temperature goal, how could it be translated into climate change strategies? More specifically, how would the development of such strategies complement or weaken efforts aimed at mitigation and adaptation. The technologies discussed above may target different areas of the climate system with different concerns, diverse social impacts and environmental effects. In the end of the volume, we have an overall view about how to evaluate technologies while taking into consideration their ethical challenges, and how to gain a better understanding of alternative climate policies.

In light of these, the most outstanding message of the volume is that geoengineering intersects with other sectors and trends in all geographical regions and at all levels of governance (all scales). In order to determine whether any geoengineering approach is appropriate to address climate change, we must first turn to critical global discussions. According to Christopher J. Preston, matters of justice are perhaps the primary consideration that should drive any discussion of climate change.

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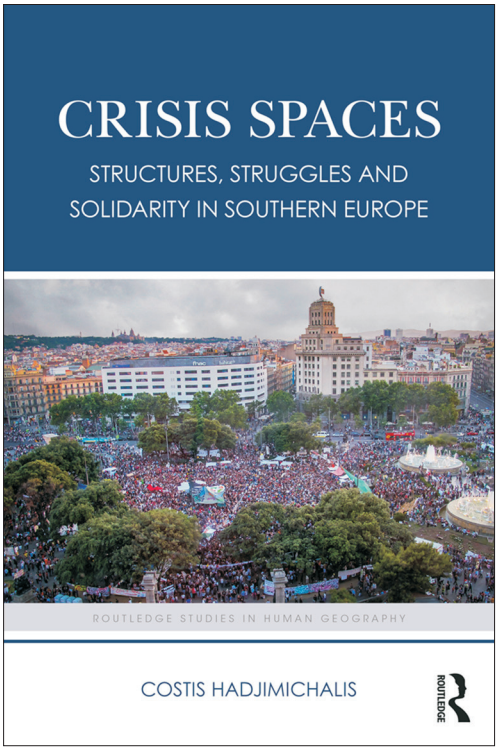
Hadjimichalis, C.: Crisis Spaces: Structures, Struggles and Solidarity in Southern Europe. London–New York, Routledge, 2018. 217 p.

Although almost ten years have passed since the financial breakdown that launched the latest structural and financial crisis of capitalism, its socio-spatial consequences are still with us and subjects to public and academic debates. While the former are revolving around sluggish economic recovery, geopolitical shifts, migration and rising political extremes, academics grew concerned also with the complexity and multiplicity of crisis mechanisms spreading at all spatial scales. These mechanisms are limiting national sovereignty, destroying local communities, subjecting households to the turmoil of financial markets, and polarising societies by class, gender, ethnicity, family, and place of living (Christophers, B. 2015; Pike, A. *et al.* 2017). Critical scholars interpreted the crisis as a driver of re-distributing wealth under capitalism, taking the post-2008 downturn particularly devastating and widespread – as it unfolded in the context of the polarising mechanisms of neoliberal capitalism such as the privatisation of public goods, shrinking systems of collective consumption, and the financialisation of state affairs and the processes of social reproduction (e.g. through rising public and private debts) (Harvey, D. 2006; Aalbers, M.D. 2009; Hadjimichalis, C. 2011).



Researching the structures, practices, and discourses reproducing unevenness and subsequent crises has led scholars to re-thinking key concepts explaining socio-spatial inequalities, such as uneven development, the central idea of the book "Crisis Spaces". The concept traditionally has a strong macro-focus, considering unevenness (social and spatial) as well as the propensity to crisis inherent to capitalism. Yet, political economists and economic geographers grew increasingly sensitive to socio-cultural diversity of institutions and social practices, and the entanglement of macro-structural changes and local/institutional contexts that produced new polarities and marginalities in the last two decades. This re-focusing rested on a growing body of research on the complexity of economic links and power relations, new forms of exploitation and the effects of financialisation facilitated by new technologies and changing state policies (Hudson, R. 2016; Peck, J. 2016). Consequently, in current debates on uneven development, there has been a shift to looking at macro and local processes relationally. As Jamie Peck puts it, it's time to "displace centric, prototypical theorizing with alternatives that are not just polycentric in an unprincipled way, but which carry the responsibility of actively confronting situation, position, location and relational context" (Peck, J. 2016, 14). Such ideas are resonating with the rising critiques of European development policies and the theoretical grounds they rest on as they failed to address socio-spatial polarisation (Pike, A. *et al.* 2017) and with arguments for re-politicising development policies articulated by critical scholars (e.g. by Massey, D. 2005; Hadjimichalis, C. and Hudson, R. 2014).

Costis Hadjimichalis' book is embedded in, and it puts forward, such debates in various ways. His systematic analysis of the causal mechanisms of the recent crisis highlights the major structural processes that reproduced the vulnerable position of South European (SE) economies within the EU (politically and economically) and the entanglement of such processes with the financialisation that made SE states, firms and households dependent on global financial markets. Although the argumentation is grounded in critical political economy, the author goes beyond the macro-focus. By adopting a consequent cross-scalar approach, he discusses recent SE processes of dispossession, socio-spatial polarisation and marginalisation relationally in the context of global finance,

European division of labour and power relations, national institutional practices, regional economic restructuring and households' changing position. Moreover, the book enriches the uneven development debates by analysing the construction of the 'South Question' in European public discourses from a critical-and-South-European perspective. It highlights the ways the spatial narratives of the crisis were (and still are being) created, embedded in ahistorical and partial explanations of the meltdown, and employed to justify the highly unequal spread of the consequences of the crisis. The author links such discourses to macro processes fuelled by institutional restructuring and practices in the post-Maastricht era gearing the governance and development policies toward neo-liberalisation in the EU, along with the de-politicisation of the interventions and their outcomes (i.e. the reproduction of inequalities). Finally, discussing multiple spatial processes (re)producing inequalities from this very (SE) position, the author is also searching for a way out for the weak and marginalised through institutional change and emerging new political subjectivities.

The argumentation follows a clear logic, from the analysis of the changes in the spatial division of labour and the uneven emergence of the European common market processes (Chapters 2 and 3), through discussing how uneven development was depoliticised discursively and through institutional practices (Chapters 4 and 5) to finding alternatives and arguing for more democratic and just European and national policies (Chapters 6 and 7). The analysis is richly illustrated by figures, and supplementary information (brief overviews of key documents, events and case studies) inserted in boxes helps the reader get a comprehensive view of the processes without losing the track of argumentation. Yet, this brief overview would be superficial without discussing the author's positionality. He is a critical scholar and a South European confronting the everyday reality of crisis and marginality as well as the 'South Question' in various discursive contexts. A major question is how this position raised new ideas and lessons to the academic community and policymakers, and to Central and Eastern Europeans (likely, the majority of readers of Hungarian Geographical Bulletin) in particular.

A key argument of the book is to understand uneven development as an outcome of interrelated external and endogenous processes and factors operating at various scales. *Scalar approach* is employed in the book as an analytical tool for revealing power relations that are shaping socio-spatial processes. One key point discussed is the ways the ambiguously and one-sidedly emerged European institutional frameworks were employed to push forward neo-liberalisation homogenising institutional practices (privatisation, export orientation along with deflatory regimes and fiscal discipline), to exploit internal differences within the common market along national and private elite (capitalist) groups' interests. Thus, the author argues for understanding apparent and less visible mechanisms and agencies behind economic, and the related political, dominance that operates across scales, from unequal state relations manifesting in supranational institutional practices (e.g. imposing the principles of German 'ordoliberalism' on the euro zone), to the manoeuvring of the capitalist elite groups in a multi-scalar space to get a tighter control over labour and resources across Europe. This approach is employed also to highlight how such interests and institutional practices produced inequalities at various scales and deepened national, regional and local dependencies across South Europe.

Everyday life and social reproduction as a scene to crisis and a source of resistance as well are also central issues in the book that links the argumentation to recent debates on uneven development. The author discusses the organisational structure of SE economies and its specifies (i.e. informality, flexible employment forms, and entanglement of small family businesses and households as scenes to social reproduction) in a historical perspective. He highlights the destructive nature of homogenising neoliberal regulations that neglect such socio-cultural peculiarities and undermine the pillars of local and regional economies as the frameworks of everyday life – from local SMEs to community and family ties. Such processes, along with financialisation (emerging property market bubbles and growing debt), made SE economies highly vulnerable and the 2008 crisis devastating to businesses as well as to households, endangering the daily survival of many. This is a heavy argument against "centric, prototypical theorizing" of spatial processes (see Peck, J. 2016, 14) and policy making focused on growth and based on model regions (best practices) that failed to manage socio-spatial polarisation in Europe during the crisis and thereafter.

Nevertheless, as a critical scholar, the author considers everyday life also as a source for new political activism. SE social movements addressed the consequences of the crisis and related austerity schemes that destroyed the existing frameworks of social reproduction (through housing crisis, growing poverty and need for food, and a rising number of citizens marginalised within the shrinking system of public health care). Although various forms of political activism are highly diverse by aims, social basis and organisation, they manifested a new political subjectivity against the corrupt (and failing) state and the global capitalist elite, representing alternatives in political life. Going further, the author considers social movements as potential sources of political change in times of crisis and post-crisis, for several reasons. They are being grounded in everyday life, they ex-

hibit and address fundamental problems of social reproduction and the diverse aspects of inequalities (class, gender, ethnicity, race, religion, age, etc.), and they raised international recognition and solidarity). Thus, they might support the renewal of leftist politics through re-thinking key issues such as sovereignty, citizenship, state roles and socio-spatial justice across Europe. Still, the central ideas here are the related processes of spatialisation of politics (linking abstract mechanisms and policies to everyday life) and of the emergence of new political subjectivities (involving people in the former process) that might produce an alternative to the recent political regime.

This argumentation raises fundamental questions on the diverse trajectories of European (semi) peripheries and, thus, on uneven development – i.e. the structural contexts of the scarcity and weakness of such movements in the East. These questions include the lack of leftist political forces (and, generally, of organised political articulation of interests of powerless and vulnerable social groups), the colonisation of civil grassroots initiatives by party politics and/or the state, and the dominance of state-capital alliance over alternative organisations in the economy (e.g. linking consumers and producers to favour domestic capital against major transnational retail corporations). Getting further, it is a matter of debate whether a better, just Europe could be forged in the SE 'laboratory' of emerging grassroots/spatialised politics, if the rest of the (semi)periphery of the EU is divided and faces emerging oppression.

The position of the author (a South European/Greek critical scholar), from which he discusses crisis mechanisms and its consequences, opened up the argumentation anchored in critical political economy to discursive aspects of unevenness, to everyday life, to socio-cultural diversity and its historical roots. This position was a source of knowledge about the everyday reality of the crisis, social relations and practices in the European (semi)periphery, and also a source for inspiration to get engaged in social movements. It was constantly challenged, however, through confrontations in public and academic discourses. This position also has made the author bring his theoretical argumentation to the ground, place it in a non-core context and translate his findings into political alternatives. By doing so, the author is challenging core-biased theories and concepts in knowledge production as well as the neoliberal hegemony in political discourses. I think a powerful lesson of the book for CEE scholars is the need to place ourselves and our academic work in a wider non-academic context to do meaningful work, in order to reveal and address apparent and also hidden social problems and needs. It is also indispensable to learn more about socio-spatial processes in the (semi)peripheries beyond CEE and Europe as a whole, and reconsider the relevance of concepts and theories coming from the global centres of knowledge production, driving our research practices, institutions and everyday lives.

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