

A cura di **GIOVANNI VISCO**



CMA4CH



*Use of Multivariate
Analysis
and Chemometrics
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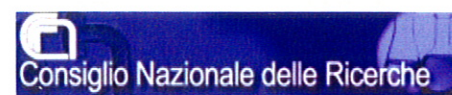
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A cura di Giovanni Visco

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Determining Anthropogenic Effects Using Principal Component Analysis on a Fluvial (E Hungary) and Two Lake Ecosystems (W Hungary, W Austria)

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Abstract

To be able to protect the water quality of any water system from the negative effects of urbanization and industrialization its main influencing processes should be understood. Principal component analysis was conducted on mainly chemical and biological parameters of the River Tisza (HU), Kis-Balaton Water Protection System (HU) and Lake Neusiedl (AU). Because of their different spatial structures the need to show spatial changes in the background processes and their factor scores, called for different interpretation methods. In each case PCA indicated a presumed anthropogenic influence and its exact location.

Introduction

In Central Europe -and generally in the world- with urbanization, along came the deterioration of surface waters. The negative effects of growing industrial and anthropogenic activity influence every water system be it a river a wetland or any other type.

The River Tisza stretches across five countries including Hungary. Its watershed area is 157,220 km² [1]. Despite the fact that in the last one and a half centuries numerous anthropogenic activities have influenced its watershed area, in comparison to Europe's other large rivers it is still considered to have one of the most natural river valleys in Europe [2]. The Kis-Balaton Water Protection System (KBWPS) is a so called mitigation wetland fulfilling the purpose of the once existing Kis-Balaton Wetland which used to filter the main water input (River Zala) of Lake Balaton protecting its water quality. Both Lake Balaton and the KBWPS are under de-jure protection of the Ramsar Convention. The KBWPS is an artificial lake system (with constant waterflow) consisting of two constructional phases Phase I (eutrophic pond) and Phase II a "classical" wetland habitat which receives extra inflow affecting it [3]. Lake Neusiedl the westernmost steppe lake in Eurasia. Its largest surface inflow is the River Wulka. In 2001 the lake gained World Heritage status; since 1979 both the Austrian, and Hungarian parts of the lake have been under UNESCO protection as a biosphere reserve and in 1989 it was brought under the de-jure protection of the Ramsar Convention [4]. Despite these steps over the decades a considerable area has been built-up around the lake which has affected and continues to affect its water quality.

The aim of this study is both to compare the utilization of PCA in determining the background processes of the River Tisza, KBWPS and Lake Neusiedl and to point out the presumed anthropogenic influences determining their processes.

Materials & Methods

The characteristics of the measured datasets can be found in Table 1. The method applied was PCA where the measured parameters were correlated, whereas the hypothetical variables (called principal components (PC)) are uncorrelated and are obtained as a linear combination of the original parameters. In the case of all the study areas summer data were analysed with a sufficient temporal gap between each sample ensuring the independence of the data from each other.

Table 1, characteristics of the analysed datasets from the three study areas

Study area	Time interval	Parameters used	Amount of data
River Tisza	1974-2005	27 chemical, biological and physical parameters	~175,000
KBWPS	1993-2009	22 chemical and biological parameters	~57,000
Lake Neusiedl	2000-2009	13 chemical and biological parameters	~15,000

Results

The River Tisza is considered to be a "linear system" in comparison to the KBWPS "with its two compartments" and Lake Neusiedl with its uniform water surface. Regarding the River Tisza, the composition of the first PC both changes and increases its explanatory power as we go downstream (Fig. 1). Two significant anomalies can be observed; one at its tributary coming from abroad and one at the water barrage system. In the case of the KBWPS, its inlet is described by processes determined by phosphorous forms, while significant differences can be observed between the two constructional phases and at the sampling location where it receives external loads. These excess loads cause the ions to have significant factor loading while other parameters which were significant throughout the system are forced into the background. In comparison to the first two cases Lake Neusiedl is a much more stable system. In all the years only the ions are present in the first PC, so changes in its processes can only be observed through spatial changes in the first PC's factor scores. There were certain areas with significant increase or decrease in the factor scores indicating anthropogenic activity.



Fig. 1, First PC's explanatory power at all sampling locations of the River Tisza (winters of 1974-2005)

Conclusions

In all three cases mostly anthropogenic influences lay behind the anomalies. At the Tisza its tributary brings extra loads while the water barrage system increases the water's retention time and together they locally change the pattern the processes follow. Inflows have a considerable effect on the KBWPS as well, where the processes in its inlet are determined by the diffuse agricultural phosphorous loads and in its wetland area by extra loads. In the case of Lake Neusiedl each extra treatment plant (NE) or the Hotel at the west shore. In all three cases because of their unique spatial structures and habitats the PCA results had to be interpreted and explained in different ways. In the case of the Tisza and the KBWPS only the factor loadings of different parameters, while at Lake Neusiedl -because of the constant composition of the first PC-, only the distribution of its factor scores turned out to be useful in interpreting the anthropogenic effects. In each case PCA assisted in determining the anthropogenic influences and in this way helped in the long term and complicated process of conserving our natural heritage.

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Authors List

Author name	Country	Page
T. Albanis	Greece	22
I. Alfieri	Italy	14
V. Andrić	Serbia	50
P. Avino	Italy	16
A. Baci	Romania	18, 60
P. Baldassarri	Italy	20
G. Barone	Italy	14
M. Benamor	Italy	40
L. Bergamonti	Italy	14
M. Bevilacqua	Italy	42
C. Bibire	Romania	18
G. Bocchinfuso	Italy	42
V. Boti	Greece	22
I. Bratu	Romania	38, 60, 64
R.G. Brereton	UK	6
L. Campanella	Italy	66, 68
G. Capannesi	Italy	16
M. Castrucci	Italy	64
T. Černohorský	Czech Republic	34
A. Coppa	Italy	68
L. D'Alessio	Italy	24
M. Dimitrijević	Serbia	36
S. Dreve	Romania	60
J.B. Ghasemi	Iran	58
T. Gatta	Italy	26, 46
G. de Gennaro	Italy	32
G.E. Gigante	Italy	10, 28
S.P. Grapini	Romania	60
E. Gregori	Italy	26
G. Guida	Italy	10, 52
I.G. Hatvani	Hungary	30, 62
A. Herzig	Austria	30
R. Jančić-Heinemann	Serbia	36
P. Ielpo	Italy	32
L. Jäntschi	Romania	38, 64
J. Jičínská	Czech Republic	34
A. Kachbi	Algeria	40
I. Kacso	Romania	60
J. Korponai	Hungary	30, 62
J. Kovács	Hungary	30, 62
A. Krejčová	Czech Republic	34
M. Gajić-Kvašček	Serbia	36, 50
A. Lorenzi	Italy	14
P.P. Lottici	Italy	14
F. Langerame	Italy	46

N. Magyar	Hungary	30
M. Manigrasso	Italy	16
A. Mannaioli	Italy	42
L. Saidi-Mansouri	Algeria	40
M. Marabelli	Italy	42
F. Marini	Italy	8, 26, 44, 68
C. Măruțoiu	Romania	38, 60, 64
O.F. Măruțoiu	Romania	38, 64
V.C. Măruțoiu	Romania	38, 60, 64
P. Mazzoleni	Italy	14
C. Mazzuca	Italy	44
L. Micheli	Italy	44
M. Miclăuș	Romania	60
D. Milovanović	Serbia	36
A. Montenero	Italy	14
S. Ruiz-Moreno	Spain	54
J. Návesník	Czech Republic	34
L.C. Nicolae	Romania	38
A. Palleschi	Italy	44
G. Palleschi	Italy	44
V. Paolillo	Italy	32
S. Pasquale	Italy	14
I. Petrovická	Czech Republic	34
S. Pirhadi	Iran	58
S.H. Plattner	Italy	10, 48
S. Polić-Radovanović	Serbia	36
M. Pouzar	Czech Republic	34
G. Predieri	Italy	14
R. Pérez-Pueyo	Spain	54
R. Reale	Italy	48
M.N. Reskóné	Hungary	62
S. Ridolfi	Italy	10, 28, 42
A. Rosada	Italy	16
D. Rui	Italy	66
M.V. Russo	Italy	16
V. Sakkas	Greece	22
A.M. Salvi	Italy	46
M.P. Sammartino	Italy	42, 46, 48, 52
O. Kebiche-Senhadi	Algeria	40
M. Eremić-Savković	Serbia	50
M. J. Soneira	Serbia	54
V. Svoboda	Serbia	36
I.K. Székely	Hungary	30, 62
P. Tanos	Hungary	30, 62
M. Tecla	Romania	64
M. Tomassetti	Italy	26, 68
M.G. Tortora	Italy	52
J. J. González-Vidal	Spain	54
G. Visco	Italy	10, 26, 48, 66
N. Vornicu	Romania	18



Index

Scientific and Organizing Committee	pag. 1
Patroniser	1
Prizes	2
Preface and Acknowledgements	3
Richard G. Brereton, Quantitative Application of Self Organising Maps	6
F. Marini, Coupling Chemometrics and NIR Spectroscopy for Food and Drug Authentication	8
G. Visco, S.H. Plattner, G. Guida, S. Ridolfi and G.E. Gigante, Daggers, Rings, Axes or Fibulae Have Different Composition? A Multivariate Study on Central Italy Bronzes from Eneolithic to Early Iron Age	10
I. Alfieri, G. Barone, L. Bergamonti, A. Lorenzi, P.P. Lottici, P. Mazzoleni, A. Montenero, S. Pasquale, G. Predieri, Characterization and Photocatalytic Activity of TiO ₂ Nanoparticles on Modica and Comiso Stones	14
P. Avino, G. Capannesi, M. Manigrasso, A. Rosada, M.V. Russo, Deep Investigation on Inorganic Fraction of Atmospheric PM in Mediterranean Area by Neutron and Photon Activation Analysis	16
A. Baciú, N. Vornicu, C. Bibire, XRF and FT-IR Spectroscopy Analysis for Identification of Pigments and Binders Found on Wall Paintings From the Three Hierarchs Church, Iasi	18
P. Baldassarri, Palazzo Valentini (Rome, Italy) - Archaeological Investigations and Preservation	20
V. Boti, V. Sakkas and T. Albanis, Measurement Uncertainty of a Matrix Solid Phase Dispersion Analysis Method of Endocrine Disruptors in Different Food Commodities	22
L. D'Alessio, Everything is fractal	24
T. Gatta, E. Gregori, F. Marini, M. Tomassetti, G. Visco, Different Types of Marble Classification Using Thermal Analysis and Chemometry in Order to Identify Provenance	26
G.E. Gigante, S. Ridolfi, Multivariate Analyses as a Necessary Tool to Improve the XRF Data Treatment	28
I. G. Hatvani, N. Magyar, P. Tanos, J. Korponai, I. K. Székely, A. Herzig, J. Kovács, Determining Anthropogenic Effects Using Principal Component Analysis	30

on a Fluvial (E Hungary) and Two Lake Ecosystems (W Hungary, W Austria)

P. Ielpo, V. Paolillo and G. de Gennaro, Gaseous Pollutants and PM10 Trends From Monitoring Networks in Bari Province: PCA and APCS Applications on a Two Years and Half Data Set	32
A. Krejčová, I. Petrovická, J. Návesník, T. Černohorský, M. Pouzar, J. Jičínská, Are There Significant Differences in the Quality of "Organic" and "Conventional" Vegetable?	34
M. Gajić-Kvašček, V. Svoboda, R. Jančić-Heinemann, M. Dimitrijević, D. Milovanović, S. Polić-Radovanović, Classification of Neolithic Ceramics and Clays According to Their Morphological Characteristics	36
V.C. Măruțoiu, L.C. Nicolae, O.F. Măruțoiu, I. Bratu, C. Măruțoiu, L. Jäntschi, Painting Materials Analysis of the "Sf. Nicolae" Church-Farcasesti, Gorj, Romania	38
L. Saidi-Mansouri, A. Kachbi, O. Kebiche-Senhadj, M. Benamor, Characterization and Stability Of CTA-Based Polymer Inclusion Membranes Using 2-NPOE as Plasticizer and BMIMPF ₆ as Ionic Liquid	40
M. Marabelli, A. Mannaoli, S. Ridolfi, M.P. Sammartino, Diagnostics Applied to an Easel Painting by Ferraù Fenzoni (Cathedral of Todi)	42
C. Mazzuca, L. Micheli, F. Marini, M. Bevilacqua, G. Bocchinfuso, G. Palleschi, A. Palleschi, Multifunctional Hydrogels for the Cleaning of Paper Samples	44
A.M. Salvi, F. Langerame, T. Gatta, M.P. Sammartino, Surface Degradation of Indoor Stonework in an Ancient Roman Church: XPS and SEM/EDS Investigation	46
M.P. Sammartino, R. Reale, S.H. Plattner, G. Visco, The Old Italian Technical Normative NORMAL 07-81 Can Be Improved? A Possible Accurate Measurement of Water Absorption by Stone	48
M. Eremić-Savković, M. Gajić-Kvašček, V. Andrić, Multivariate Analysis of Eight Radionuclides Using the Soil Monitoring Network Data	50
M. Tortora, G. Guida, M. P. Sammartino, Metallographic, XRF and SEM/EDS Analyses of Probable Roman Surgical Instruments	52
J. J. González-Vidal, R. Pérez-Pueyo, M. J. Soneira and S. Ruiz-Moreno, Pattern Recognition Based on Principal Component Analysis in Raman Spectroscopy Applied to Artistic Pigments	54
J. B. Ghasemi, S. Pirhadi, Molecular Docking, Pharmacophore Modeling, and Virtual Screening for the Discovery of New Reverse Transcriptase Inhibitors	58
S.P. Grapini, A. Baciú, C. Măruțoiu, M. Miclăuș, V.C. Măruțoiu, S. Dreve, I. Kacso and I. Bratu, Scientific Investigations of a 16th Century Stall Belonging to the Evangelic Church from Bistrita, Bistrita-Nasaud County, Romania	60
I. G. Hatvani, M. N. Reskóné, I. K. Székely, P. Tanos, J. Korponai, J. Kovács,	62



Determining the Temporal Sampling Frequency of Kis-Balaton and the Spatial
Sampling Frequency of Lake Velence (W Hungary) Using Variograms

C. Măruțoiu, M. Tecla, O.F. Măruțoiu, I. Bratu, V.C. Măruțoiu, L. Jäntschi, 64
Identification of Painting Materials From the Main Church of Polovragi Monastery

D. Ruiu, M. Castrucci, G. Visco and L. Campanella, Efficiency Evaluation of 66
Different Types of Packaging In The Protection of Three Drugs Using
Photostability Tests

M. Tomassetti, F. Marini, L. Campanella, A. Coppa, Inductively Coupled Plasma 68
(ICP), Thermogravimetric (TG), Derivative Thermogravimetric (DTG) and
Chemometric Study of Fossil Bones From an Archaeological Site

Author list 70