

# Journal of Environmental Protection, Safety, Education and Management

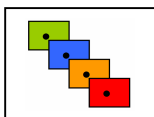


**Scientific Journal of the *Slovak Society of Environment Bratislava***  
the branch of Association of *Slovak Scientific and Technological Societies*

Journal published in cooperation with the *Slovak Association for the Club of Rome* and *Strix*

**2015**  
**Number 6**  
**Volume 3**

ISSN 1339-5270  
Code 9771339527001 52



# Journal of Environmental Protection, Safety, Education and Management

Scientific Journal of the *Slovak Society of Environment*, the branch of *Association of Slovak Scientific and Technological Societies*, Bratislava.

Journal published in cooperation with the *Slovak Association for the Club of Rome* and *Strix n.f.*



This journal publishes high quality original scientific papers, short communications, review papers and reviews of new books in the fields of science including Environmental Protection, Safety, Education and Management. Manuscripts are reviewed by two reviewers and the Ad hoc commissioned members of the Editorial Board of the Journal. The journal is published twice a year.

Name: Journal of Environmental Protection, Safety, Education and Management  
Periodicity: biannually. The issues are published on the 30<sup>th</sup> Juni and on the 30<sup>th</sup> November in particular calendar year.  
Publisher: Slovak Society of Environment  
1st Edition: 2015  
Date of issue: the 28<sup>th</sup> November 2015  
Copies printed: 50  
Number: 6/2015  
Volume: 3  
  
Code: 9771339527001 52  
ISSN: 1339-5270

Print: Kníhviazačstvo Binovec Trnava  
in cooperation with VeV, s.r.o., Harmincova 1B, 841 01 Bratislava  
Distributed: VeV, s.r.o., Harmincova 1B, 841 01 Bratislava - Dúbravka, Slovak Republic

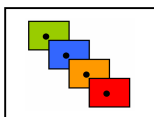
Copyright © Slovak Society of Environment, Koceľova 15, 815 94 Bratislava, Slovak Republic

The photo in the front page of cover: Vysoké Tatry. Author: Gabriela Rusková

Slovak Society of Environment, 15 Koceľova Str., 815 94 Bratislava, Slovak Republic

[www.sszp.eu](http://www.sszp.eu)

Bank name: Slovenská sporiteľňa, a. s.,  
Bank address: Tomášikova 48, 832 37 Bratislava, Slovak Republic  
Bank account name: Slovenská spoločnosť pre životné prostredie, Koceľova 15, 815 94 Bratislava  
Bank account number: 210454-019  
Bank branch code: 0900  
S.W.I.F.T.: GIBASKBX  
Company registration number: IČO 604 925



## EDITORIAL BOARD

### Chairman

Prof. Ing. Juraj HRAŠKO, DrSc., Academician of the Slovak Academy of Sciences,, Honorary Member of the Learned Society of SAS Bratislava, Slovak Republic

### Corresponding Editor

Assoc. prof., RNDr. Miroslav RUSKO, PhD., Slovak Society of Environment Bratislava / Slovak University of Technology in Bratislava, Trnava, Slovak Republic

### Scientific Editors

Prof. Ing. Ervin LUMNITZER, PhD., Technical University of Košice, Košice, Slovak Republic  
Assoc. prof., RNDr. Miroslav RUSKO, PhD., Slovak University of Technology in Bratislava, Trnava, Slovak Republic  
Prof. Ing. Vladimír ZAPLETAL, CSc., Slovak Society of Environment, Bratislava, Slovak Republic

### Members of the Editorial Board from academic sphere

Assoc. prof., Ing. Peter ADAMIŠIN, PhD., University of Prešov, Prešov, Slovak Republic  
Prof. RNDr. Peter ANDRÁŠ, PhD., Matej Bel University, Banská Bystrica, Slovak Republic  
Ing. Dušan BEVILAQUA, PhD., Slovak Society of Environment, Bratislava, Slovak Republic  
Assoc. prof., Ing. Peter BLIŠŤAN, PhD., Technical University of Košice, Košice, Slovak Republic  
Dr.h.c. prof. Ing. Miroslav BADIDA, PhD., Technical University of Košice, Košice, Slovak Republic  
Assoc. prof., Ing. Lucia BEDNÁROVÁ, PhD., Politechnika Rzeszow, Wydział Zaradzania, Poland  
Prof. Jesper BRANDT, Roskilde University Center, Denmark  
Prof. Jürgen BREUSTE, Paris Lodron Universität, Salzburg, Austria  
Prof. Thomas COOK, M.S., Ph.D., College of Public Health, The University of Iowa, USA  
Prof. Péter CSORBA, Univerzity L. Kossuth, Debrecen, Hungary  
RNDr. Jana DADOVÁ, PhD., VŠB-Technical University of Ostrava, Ostrava-Poruba, Czech Republic  
Prof. Ing. Vojtech DIRNER, CSc., VŠB-Technical University of Ostrava, Ostrava-Poruba, Czech Republic  
Prof. György HELTAI, St. Stephen University, Gödöllő, Hungary  
Ing. Jana CHOVANCOVÁ, PhD., University of Prešov, Prešov, Slovak Republic  
RNDr. Zita IZAKOVIČOVÁ, PhD., Slovak Academy of Sciences, Bratislava, Slovak Republic  
RNDr. Jozef KLINDA, The Ministry of the Environment of the Slovak Republic, Bratislava, Slovak Republic  
Ing. Ivan KLINEC, Slovak Academy of Sciences, Bratislava, Slovak Republic  
Assoc. prof., Ing. Vladimír KOČÍ, Ph.D., Institute of Chemical Technology, Prague, Czech Republic  
Prof. Ing. Vojtech KOLLÁR, PhD., School of Economics and Management in Public Administration, Bratislava, Slovak Republic  
Prof. RNDr. Oľga KONTRIŠOVÁ, Technical University in Zvolen, Zvolen, Slovak Republic  
Ing. Anton KORAUS, PhD., LL.M.,MBA, School of Economics and Management in Public Administration, Bratislava, Slovak Republic  
Assoc. prof., RNDr. Jana KOTOVICOVÁ, Ph.D., Mendel University in Brno, Brno, Czech Republic  
Assoc. prof., Ing. Ružena KRÁLIKOVÁ, PhD., Technical University of Košice, Košice, Slovak Republic  
Ing. Gabriel KUCZMAN, PhD., Slovak University of Agriculture in Nitra, Nitra, Slovak Republic  
Assoc. prof., Dr. Ing. Radmila KUČEROVÁ, VŠB-Technical University of Ostrava, Ostrava-Poruba, Czech Republic  
Prof. Dr. Ing. Miroslav KYNCL, VŠB-Technical University of Ostrava, Czech Republic  
Prof. Ing. Ján LABUDA, DrSc., Slovak University of Technology in Bratislava, Slovak Republic  
RNDr. Anna LACKOVIČOVÁ, CSc., Slovak Academy of Sciences, Bratislava, Slovak Republic  
Prof. Ing. Ervin LUMNITZER, PhD., Technical University of Košice, Košice, Slovak Republic  
Ing. Alena MANOVÁ, PhD., Slovak University of Technology in Bratislava, Slovak Republic  
Prof. PaedDr. Marián MERICA, PhD., University of Sts. Cyril and Methodius in Trnava, Slovak Republic  
Dr.h.c. mult. prof. Ing. Jozef MIHOK, PhD., Slovak Office of Standards, Metrology and Testing, Bratislava, Slovak Republic  
Assoc. prof., Ing. Eva MICHALKOVÁ, CSc., Technical University in Zvolen, Zvolen, Slovak Republic  
Prof. RNDr. Ladislav MIKLÓS, DrSc., Technical University in Zvolen, Zvolen, Slovak Republic  
Assoc. prof., Ing. Mikuláš MONOŠI, PhD., University of Žilina, Žilina, Slovak Republic  
Assoc. prof., RNDr. Karol NEMOGA, CSc., Slovak Academy of Sciences, Bratislava, Slovak Republic / Slovak Association for the Club of Rome  
Prof. Ing. Milan ORAVEC, PhD., Technical University of Košice, Slovak Republic  
Prof. Ing. Anton OSVALD, PhD., University of Žilina, Slovak Republic  
Assoc. prof., Ing. Iveta PAULOVÁ, PhD., The School of Management/Vysoká škola manažmentu, Bratislava, Slovak Republic  
Ing. Witalis PELLOWSKI, PhD., Military Academy, Wrocław, Poland  
Prof. Ing. Milan PIATRIK, PhD., Slovak Society of Environment, Bratislava, Slovak Republic  
Assoc. prof., Ing. Peter PODHORANSKÝ, PhD., Slovak University of Technology in Bratislava, Bratislava, Slovak Republic  
Assoc. prof., Ing. Miloš POLIAK, PhD., University of Žilina, Žilina, Slovak Republic  
Assoc. prof., RNDr. Dana PROCHÁZKOVÁ, PhD., DrSc., Czech Technical University in Prague, Prague, Czech Republic  
Assoc. prof., RNDr. Miroslav RUSKO, PhD., Slovak University of Technology in Bratislava, Bratislava, Slovak Republic  
Ing. Peter SABO, CSc., Matej Bel University, Banská Bystrica, Slovak Republic

Dr.h.c. Prof. Ing. Ján SUPUKA, DrSc., Slovak University of Agriculture in Nitra, Nitra, Slovak Republic  
RNDr. Anna ŠPINEROVÁ, PhD., Technical University in Zvolen, Zvolen, Slovak Republic  
Prof. dr. sc. Nives ŠTAMBUK- GILJANOVIĆ, University of Split, School of Medicine, Split, Croatia  
Assoc. prof., Ing. Peter TREBUŇA, PhD., Technical University of Košice, Košice, Slovak Republic  
Prof. Dr. Štefan Volner, CSc., Alexander Dubček University of Trenčín in Trenčín, Slovak Republic  
Prof. Ing. Ivan VOLOŠČUK, DrSc., Matej Bel University, Banská Bystrica, Slovak Republic  
Prof. Ing. Jaroslava VRÁBLIKOVÁ, CSc., University of Jan Evangelista Purkyně in Ústí nad Labem, Czech Republic  
Assoc. prof., Ing. Ladislav WELWARD, PhD., Slovak Society of Environment, Bratislava/Banská Štiavnica, Slovak Republic  
Assoc. prof., Ing. Viktor WITTLINGER, PhD., Slovak Society of Environment, Bratislava/Pezinok, Slovak Republic  
Prof. Ing. Vladimír ZAPLETAL, CSc., Slovak Society of Environment, Bratislava, Slovak Republic

#### **Members of the Editorial Board from economic sphere**

Dipl.- Ing. Hans-Dieter PIETRUCHA, Iotronic Process Monitoring, Langenargen am Bodensee, Bundesrepublik Deutschland  
Ing. Katarína SRDOŠOVÁ, PhD., 3EC International, Bratislava, Slovak Republic / Prague, Czech Republic  
Ing. Ivan ŠIMKO, PhD., Slovak Society of Environment, Bratislava/Žilina, Slovak Republic  
Ing. Mark TOMIN, PhD., MJT Associates, Canada  
Ing. Tatiana TRECÁKOVÁ, Ph.D., Prague, Czech Republic

#### **Co-editors**

RNDr. Ján BENCÚR, Slovak Society of Environment, Bratislava/Dolný Kubín, Slovak Republic  
Ing. Róbert BRŇÁK, The Ministry of the Environment of the Slovak Republic, Bratislava, Slovak Republic  
RNDr. Peter DEBNÁR, Slovak Society of Environment, Bratislava/Trnava, Slovak Republic  
Ing. Ján ILKO, Wien, Republik Österreich  
Ing. Ivan JUHAS, Ottawa, Canada  
MUDr. Vladimír KARVAJ, Slovak Society of Environment, Bratislava/Nové Zámky, Slovak Republic  
Ing. Gabriela RUSKOVÁ, Slovak Society of Environment, Bratislava/Šúrovce, Slovak Republic  
RNDr. Ján ŠAVRNOCH, Slovak Society of Environment, Bratislava/Ružomberok, Slovak Republic  
Ing. Michal VANÁK, Slovak Society of Environment, Bratislava/Trnava, Slovak Republic

#### **Technical Editors**

Ing. Július HORNICKÝ, Slovak Society of Environment, Bratislava/Nové Zámky, Slovak Republic  
Bc. Peter KLEŠTINEC, Slovak Society of Environment, Bratislava/Ratkovce, Slovak Republic  
Ing. Lukáš KRÁL, Slovak Society of Environment, Bratislava/Žiar nad Hronom, Slovak Republic  
Ing. Viliam NOVÁK, Slovak Society of Environment, Bratislava/Trakovice, Slovak Republic  
Mgr. Pavol SEDLÁK, Slovak Society of Environment, Bratislava, Slovak Republic  
Ing. Michal VEREŠ, Railway company Slovakia, Bratislava, Slovak Republic

#### **It was of a great honour for the Editorial Board of our Journal to have such excellent members like**

† prof. RNDr. Jozef ŠTEFFEK, PhD., Technical University in Zvolen, Zvolen, Slovak Republic  
† prof. Dr.h.c. Juraj TÖLGYESSY, Ing., PhD., DrSc., Member of the European Academy of Sciences and Arts / University Professor Emeritus of nuclear and environmental chemistry / Matej Bel University, Banská Bystrica, Slovak Republic

#### **Contact addresses**

Slovak Society of Environment Bratislava, 15 Kocel'ova Str., 815 94 Bratislava, Slovak Republic  
e-mail: journal.jepsem@centrum.sk  
e-mail: sszp@centrum.sk

www.sszp.eu