15th Biennial Conference of the Euromediterranean Network of Experimental and Representative Basins

Advances in Hydrologic Research on Pristine, Rural and Urban Small Basins

BOOK OF ABSTRACTS

9-13 September, 2014
Colmbra, Portugal

Edited by:
M. Isabel P. de Lima
João L. M. P. de Lima

IMAR - Institute of Marine Research
Department of Civil Engineering, Faculty of Sciences and Technology of the University of Colmbra
15th Biennial Conference - Euromediterranean Network of Experimental and Representative Basins
Book of Abstracts
9-13 September 2014, Coimbra, Portugal

Faculdade de Ciências e Tecnologia da Universidade de Coimbra. Departamento de Engenharia Civil.
Editors: M. I. P. de Lima and J. L. M. P. de Lima


Printed version sponsored by Águas do Mondego, S.A.
# Table of Contents

- Welcome & Sponsoring: 5
- General Information: 7
- Programme Overview: 11
- Oral Programme: 12
  - Wednesday, 10 September 2014: 12
  - Thursday, 11 September 2014: 14
  - Friday, 12 September 2014: 15
- Poster Programme: 16
- Abstracts – Oral Communications: 19
- Abstracts – Poster Communications: 51
- Technical Visits Programme: 85
- Authors Index: 89
Welcome
Welcome address to Participants

Dear Participants of the 15th Biennial Conference ERB 2014,

It is our pleasure to welcome you in Coimbra and to this fifteenth gathering of the Euromediterranean Network of Experimental and Representative Basins Conference series, ERB 2014.

Over the years, the Euromediterranean Network of Experimental and Representative Basins (ERB) has stimulated the interdisciplinary exchange of ideas and expertise as a way of improving our understanding of hydrological processes, their observations, estimation, modelling and prediction. In particular, ERB gives special attention to operating and managing well instrumented experimental and representative basins for hydrological and environmental research on a long term basis.

Beginning with the first conference held in 1986 in Aix-en-Provence, France, the ERB conference series has been an important forum to discuss hydrological topics of common interest in small basin. Examples are: hydrological monitoring, runoff generation, hydrological and environmental modelling, biogeochemical processes, extremes, uncertainties in data and model concepts, effects of natural and man-made changes, erosion, sedimentation, hillslope processes, etc.

Changes affecting the hydrological cycle, resulting from climate forcing and human activities, give way to increased challenges related to the understanding of interactions between surface and groundwaters, hydrologic modelling and hydrologic forecasting in ungauged basins. In particular, hydrological extremes are drawing more and more attention due to the severe floods and low-flow events observed each year in many regions of the world. Improving monitoring, modelling and predicting hydrological extremes are important tasks for the scientific community, with repercussions to engineering practice. All of these issues will be discussed during the 15th Biennial Conference ERB 2014, with the special theme “Advances in Hydrologic Research on Pristine, Rural and Urban Small Basins” and with the objective of promoting a focused interdisciplinary exchange on the present state of knowledge. We hope the conference will provide an opportunity for the ERB community to reflect on the past accomplishments and discuss the future needs.

The conveners of this meeting wish all Participants a pleasant stay in Coimbra, a fruitful conference and stimulating discussions.

ERB 2014 Conveners
João de Lima
Isabel de Lima

General information on ERB

The Euromediterranean Network of Experimental and Representative Basins (ERB) is an open association of 20 European countries and was established in 1986. It promotes the exchange of basin information and the cooperation in international programs as FRIEND, HELP and PUB. Information is disseminated through Newsletters. The Steering Committee of ERB consists of National Correspondents nominated by the UNESCO-IHP National Committees.

The main objectives of ERB are:

- To increase relationships between members, research teams, universities and basin managers, through exchanges of hydrological information, data, research methods, models and to organise visits and biennial conferences;
- To enable joint studies of common interest;
- To make available and exchange data between research groups;
- To harmonize methods of data collection and processing.

Over the years ERB has organized fourteen biennial conferences with themes that reveal the convergence of hydrological topics of common interest in small basin research, despite the concern of the ERB community by a large diversity of hydrological problems. These conferences are very important occasions to present and discuss research and to exchange experiences, and have always attracted contributions from scientists of all member countries, among others. Especially young scientists can benefit from these meetings by presenting their (PhD) research, discussing their ideas and exchange data to test their hypotheses and model concepts.

List of previous ERB conferences:

- Aix en Provence [France], October 1986
- Perugia [Italy] - “Erosion and sediment tranport”, October 1988
- Wageningen [The Netherlands] - “Hydrological research basins and the environment”, September 1990
- Barcelona [Spain] - “Assessment of hydrological temporal variability and changes”, September 1994
- Ghent [Belgium] - “Monitoring and modelling catchment water quantity and quality”, September 2000
- Torino [Italy] - “Progress in surface and subsurface water studies at the plot and small basin scale”, October 2004
- Seggau Castle [Austria] - “Hydrological Responses of Small Basins to a Changing Environment”, September 2010
Organization

The conference is organized by IMAR - Institute of Marine Research and the Department of Civil Engineering of the Faculty of Sciences and Technology of the University of Coimbra, both located in Coimbra, Portugal.

Sponsorship

The conference has been sponsored by:

Águas do Mondego, S.A.

(Regional Water Company, Portugal)

Associação para o Desenvolvimento da Engenharia Civil – ACIV

(Association for the Development of Civil Engineering, Portugal)

Agência Portuguesa do Ambiente - Região Hidrográfica do Centro

(Hydrographic Region Authority – Centre, Portugal)

Águas de Coimbra, E.E.M.

(Coimbra Water Company, Portugal)

The conference secured the support of:

Associação Portuguesa de Recursos Hídricos

(Portuguese Water Resources Association)

International Association of Hydrological Sciences

International Hydrological Program, UNESCO

Ordem dos Engenheiros

(Engineers Association, Portugal)
General Information

Location and Conference Address
The 15th Biennial Conference ERB 2014 is being held at the Department of Civil Engineering of the University of Coimbra, Coimbra, Portugal. The history of the University of Coimbra dates back to the century following the one in which the Portuguese nation itself was founded, since the University was established in the 13th century, in 1290.

The conference is organized by IMAR - Institute of Marine Research and the Department of Civil Engineering of the Faculty of Sciences and Technology of the University of Coimbra, Portugal.

Conference Venue:
Department of Civil Engineering
Faculty of Science and Technology
Rua Luís Reis dos Santos - Pólo II Univ. Coimbra
3030-788 Coimbra, Portugal

Convener:
João de Lima, IMAR / University of Coimbra, Portugal
Isabel de Lima, IMAR / University of Coimbra, Portugal

International Scientific Committee
Hubert Holzmann, Austria (ERB coordinator)
Niko Verhoest, Belgium
Miroslav Tesar, Czech Republic
Daniel Viville, France
Sybille Schumann, Germany
Luca Brocca, Italy
Jurate Kriauciuniene, Lithuania
Laurent Pfister, Luxembourg
Piet Warmerdam, The Netherlands
Johannes Deelstra, Norway
Janusz Siwek, Poland
João de Lima, Portugal
Gianina Neculau, Romania
Sergey Zhuravin, Russia
Ladislav Holko, Slovakia
Mitja Brilly, Slovenia
Jérôme Latron, Spain
Manfred Spreefico, Switzerland
Liudmyla Gorbachova, Ukraine

Local Organising Committee
João Pedroso de Lima, IMAR / Universidade de Coimbra (team leader)
Isabel Pedroso de Lima, IMAR / Universidade de Coimbra (team leader)
Abelardo Montenegro, UFRPE, Brazil
Eugénio Santiago, CDRC
Jan Jacob Keizer, CESAM / Universidade de Aveiro
João Abrantes, IMAR (student)
Nuno Cruz Simões, IMAR / Universidade de Coimbra

Conference Themes
The objective of this fifteenth edition of the Euromediterranean Network of Experimental and Representative Basins Conference series is to continue promoting a focused interdisciplinary discussion of the present state of knowledge, and of the necessary advances in research and application disciplines related to the hydrology of small basins and related ecological issues, with a special theme:

Advances in Hydrologic Research on Pristine, Rural and Urban Small Basins.

The conference sessions will be on the following topics:
1. Hydrological modelling at different temporal and spatial scales
2. New instrumentation and monitoring developments
3. Effects of climate forcing and human activities on hydrological processes and prediction in ungauged basins
4. Transport processes in small basins
5. Uncertainties in surface and groundwater interactions
6. Reflections on the past, present and future of experimental basins’ networks
Registration & Information Desk

Information Desk
The Conference Information and Registration Desk is located in the Hall of the 4th floor of the Civil Engineering Department building (conference venue).

Pre-registration
Participants who have already fully registered for the conference can collect their badge and conference material at the registration desk.
Participants who have pre-registered for the conference can pay the registration fee at the registration desk and collect their badge and conference material there. On-site rates are charged.

On-site registration
On-site registration is possible, at the registration desk.

Registration fee of Participants includes:
- Full access to scientific sessions
- Book of the accepted Abstracts
- Conference documents, bag, certificate of attendance
- Refreshments, coffee and lunches during the conference
- Participation in the Ice Breaker Reception
- The Conference Dinner
- The Technical Visit

Registration of Accompanying Persons is also possible and includes:
- Participation in the Ice Breaker Reception
- Lunches during the conference
- Participation in the Reception at the Water Museum
- The Conference Dinner
- The Technical Visit

Registration & Information Desk opening time:

<table>
<thead>
<tr>
<th>Day</th>
<th>Opening time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuesday, 9 September</td>
<td>18:30-19:30</td>
</tr>
<tr>
<td>Wednesday, 10 September</td>
<td>9:00-17:30</td>
</tr>
<tr>
<td>Thursday, 11 September</td>
<td>9:00-13:00</td>
</tr>
<tr>
<td>Friday, 12 September</td>
<td>9:00-15:00</td>
</tr>
</tbody>
</table>

Participants should pick up their participation certificate at the registration desk.

Abstract & Programme Management

If you have any queries, please contact: erb2014@uc.pt

Conference Publications

A book of abstracts of oral and poster presentations will be available at the conference.
After the conference, selected full papers of oral presentations will be invited for publication in a special issue of Die Bodenkultur - Journal for Land Management, Food and Environment. Full papers of selected best posters will also be considered for publication.

Guidelines

Oral
Authors are kindly asked to upload their presentations in the 30 minutes preceding the actual time block of the session. A lecture room assistant will be available to help.

Poster
The general Display Time is from Wednesday, 9:00, to Friday, 15:30, during the conference hours. Authors are kindly asked to put up their posters as soon as possible.
The Authors in Attendance Time is when the authors’ posters must be on hand at their display for presentation. This will be on Wednesday, 10 September, 14:30-16:00.
Authors are kindly asked to take down their posters on Friday, before 15:30.
Special Events

All registered Participants of the 15th Biennial Conference ERB 2014 and Accompanying Persons are invited to join the following events:

- Ice Breaker Reception (Tuesday, 9 September)
- Lunches (Wednesday to Friday, 10-12 September)
- Reception at the Water Museum (Friday, 12 Sept.)
- Conference Dinner (Friday, 12 September)
- Technical Visit (Thursday, 11 September)

Ice Breaker Reception:
The Ice Breaker event will take place on Tuesday, 9 September, from 19:00 to 20:00, in the Conference Venue (Department of Civil Engineering, Campus II of the University of Coimbra – Hall, 4th floor).

Conference Venue:
Department of Civil Engineering
Faculty of Science and Technology
Rua Luis Reis dos Santos - Pólo II Univ. Coimbra
3030-788 Coimbra, Portugal

Lunches:
Lunches are offered from 13:00 to 14:00 in the University Restaurant “Casa da Pedra” - Campus II, Rua Silvio Lima (5 minutes walk from the Conference Venue).
Meal vouchers will be distributed beforehand to the Participants and Accompanying Persons.

Reception at the Water Museum:
This Reception is hosted by Águas de Coimbra, E.E.M. (Coimbra Water Company) and will take place after the conference closing session, on Friday, 12 September, from 16:00 to 17:00, at the Water Museum (Museu da Água - http://www.museuadaagua.com/).
The Museum is located about 100 m upstream of the Santa Clara Bridge, in the Green Park – Parque Verde Dr. Manuel Braga,– in downtown Coimbra (Avenida Emídio Navarro), on the right bank of the River Mondego.
This event will be an opportunity to relax and enjoy a glass of Port Wine with other conference participants, in the pleasant surroundings of the riverside.

Conference Dinner:
The Conference Dinner will be on Friday, 12 September, at 19:00. The Participants and Accompanying Persons should register for the Conference Dinner at the Registration Desk before it closes on Wednesday, 10 September.

Directions:
Restaurant “Piscinas”, Parque Verde do Mondego (left bank of the River Mondego, about 100 m upstream of the Pedestrian Bridge).

More details about the special events will be available at the Information Desk during the conference.
Technical Visits:
The Technical Visits’ programme include:

Visit 1 - Experimental drainage basins in wildfire affected rural lands in north-central Portugal
Thursday, 11 September.
Departure from Conference Venue, at 14:00
(approx. duration: 5 h).

Visit 2 - Insight into the fluvial environment of the River Mondego upstream of Coimbra
Saturday, 13 September.
Departure from city centre, at 9:30
(approx. duration: 4 h, kayak trip; additional 2 h for optional lunch).

Any participants who have not registered prior to the conference are kindly asked to register for these visits by Wednesday morning, 10 September, at the Conference help desk. Requests will be processed on a first come, first served basis.

The programme for these visits is included in this book.

About Coimbra
Coimbra has long held an important place in Portugal’s history since it was the first capital of the country from 1139 to about 1260; it is the birthplace of six Portuguese kings. The main part of Coimbra is essentially clustered on and around the hill overlooking the River Mondego, although newer parts of the town are spread out all around it below. Coimbra is a place full of tradition and beauty. It’s a cosmopolitan city that has developed into an important cultural centre, mainly because of the University of Coimbra, founded in 1290, and it has notable monuments from that era and beyond.

The university is one of the oldest in Europe and due to its monumental buildings and history attracts tourists from around the world. St Peter College (“Colégio de S. Pedro”), the delightful St. Michael Chapel (“Capela de S. Miguel”), the Rector’s Palace (“Reitoria”), The Grand Hall (“Sala dos Capelos”), the King John Library (“Biblioteca Joanina”), a magnificent Baroque building from the 18th century, profusely decorated with gilt carved wood and various exotic woods, and containing a collection of around 300 thousand volumes) are world-renowned landmarks situated on the main campus. The university town maintains its century-old academic traditions, as seen in the black-caped students and in the soulful tones of the “fado de Coimbra” (traditional songs sung by students to the accompaniment of guitars). The students’ houses and liveliness are present all over Coimbra and permeate its festivities and daily life.

With such a rich history, Coimbra has much to offer and see. Several monuments hark back to the beginnings of the Portuguese kingdom in the 12th century, such as the Old Cathedral (“Sé Velha”) and the São Tiago, São Salvador and Santa Cruz (with the tombs of the first two kings of Portugal) churches. But many other monuments evince the historical magnitude of Coimbra: the Santa-Clara-a-Velha and Santa-Clara-a-Nova Convents, the Santo António dos Olivais Church, Celas Monastery, the Manga Garden (or Cloister) and even the new Cathedral (“Sé Nova”). In Coimbra there are also pleasant green spaces, like the Parque Verde do Mondego, the beautiful Botanical Garden, the Dr. Manuel Braga Park and the romantic Penedo da Saudade Garden.

Coimbra is home to a fascinating historical heritage, and there are several important archaeological sites within a short distance of the city, which are well worth visiting.

UNESCO’s World Heritage Committee decided recently that the University of Coimbra has unquestionable exceptional universal value and that therefore deserved to be classed as World Heritage.
## Programme Overview

**Tuesday, 9 September:** *Ice Breaker Reception, 19:00-20:00*  
(Department of Civil Engineering, Campus II of the University of Coimbra – Hall, 4th floor)

<table>
<thead>
<tr>
<th>Time</th>
<th>Wednesday, 10 Sept</th>
<th>Thursday, 11 Sept</th>
<th>Friday, 12 Sept</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00-9:30</td>
<td>Registration and welcome to participants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9:30-9:45</td>
<td><strong>Opening session</strong></td>
<td><strong>Topic 3</strong> Effects of climate forcing and human activities on hydrological processes and prediction in ungauged basins (<em>PART 1</em>)</td>
<td><strong>Topic 4</strong> Transport processes in small basins</td>
</tr>
<tr>
<td>10:00-10:15</td>
<td><em>Topic 1</em> Hydrological modelling at different temporal and spatial scales (<em>PART 1</em>)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:30-10:45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:00-11:30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:30-11:45</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 12:00-12:15      | **Topic 1** (*PART 2*)                                                            | **Topic 3** (*PART 2*)                                                            | **ERB General Assembly**  
| 12:15-12:30      |                                                                                   |                                                                                  | Best Poster Award  
| 12:30-12:45      |                                                                                   |                                                                                  | Medal Award  
| 13:00-13:15      |                                                                                   |                                                                                  | Lecture ERB medal  
| 13:45-14:00      | **Poster session**                                                                | **Lunch** University Restaurant “Casa da Pedra”                                   |                                                                                  |
| 14:00-14:15      |                                                                                   |                                                                                  |                                                                                  |
| 14:15-14:30      |                                                                                   |                                                                                  |                                                                                  |
| 14:30-14:45      |                                                                                   |                                                                                  |                                                                                  |
| 14:45-15:00      |                                                                                   |                                                                                  |                                                                                  |
| 15:00-15:15      | **Topic 5** Uncertainties in surface and groundwater interactions                 |                                                                                   |                                                                                  |
| 15:15-15:30      |                                                                                   |                                                                                  |                                                                                  |
| 15:30-15:45      |                                                                                   |                                                                                  |                                                                                  |
| 15:45-16:00      | **Technical Visit**                                                               |                                                                                   |                                                                                  |
| 16:00-16:15      |                                                                                   |                                                                                  |                                                                                  |
| 16:15-16:30      |                                                                                   |                                                                                  |                                                                                  |
| 16:30-16:45      |                                                                                   |                                                                                  |                                                                                  |
| 16:45-17:00      |                                                                                   |                                                                                  |                                                                                  |
| 17:00-17:30      | **Coffee Break**                                                                  |                                                                                   |                                                                                  |
| 17:30-17:45      |                                                                                   |                                                                                  |                                                                                  |
| 18:00-18:15      | **Topic 6** Reflections on the past, present and future of experimental basins’ networks |                                                                                   |                                                                                  |
| 18:15-18:30      |                                                                                   |                                                                                  |                                                                                  |
| 18:30-18:45      |                                                                                   |                                                                                  |                                                                                  |
| 18:45-19:00      |                                                                                   |                                                                                  |                                                                                  |
| 19:00-22:00      |                                                                                   |                                                                                  | **Conference Dinner**                                                          |

**Session rooms:**

- Oral sessions: Auditório Laginha Serafim, 3rd Floor  
- Poster session: Hall, 4th Floor

---

15th Biennial Conference ERB2014
Wednesday, 10 September 2014

8:30-9:30
Registration and welcome to Participants

Opening Session
Room: Auditório Laginha Serafim
9:30-10:00
Director of the Department of Civil Engineering, Univ. Coimbra
President of IMAR - Institute of Marine Research
Director of the Laboratory of Hydraulics, Water Resources and Environment, Univ. Coimbra
Coordinator of ERB
ERB 2014 Conveners

Topic 1 Hydrological modelling at different temporal and spatial scales (PART 1)
Room: Auditório Laginha Serafim
Chairperson: João de Lima

10:00-10:15: ERB2014-38
Importance of ‘initial abstractions’ in the genesis of flash floods in mountainous basins: Venero Claro experimental basin
J.M. Bodoque, A. Díez-Herrero, V. Ruiz-Villanueva, E. Aroca-Jiménez

10:15-10:30: ERB2014-51
Assimilation of in situ soil moisture for improving rainfall and discharge prediction in small experimental basins
C. Massari, L. Brocca, A. Tarpanelli, T. Moramarco, D. Penna, M. Borga, P. Matgen, J. Martínez-Fernández

10:30-10:45: ERB2014-44
Spatio-temporal variability of throughfall and soil moisture at the plot scale in the Italian pre-Alps
D. Penna, G. Zuecco, O. Oliviero, H.J. van Meerveld, L. Hopp, G. Dalla Fontana, M. Borga

10:45-11:00: ERB2014-12
Influence of the riparian zone on the stream water export from a headwater Mediterranean catchment during the vegetative period
A. Lupon, S. Bernal, M. Erlandsson, S. Poblador, A. Wade, F. Sabater

Topic 1 Hydrological modelling at different temporal and spatial scales (PART 2)
Room: Auditório Laginha Serafim
Chairperson: Sybille Schumann

11:30-11:45: ERB2014-81
Hydrological response of a mountain catchment
L. Holko, M. Danko, J. Hlavèo, Z. Kostka

11:45-12:00: ERB2014-78
Runoff generation mechanisms in a Swiss pre-alpine catchment - results based on a blend of hydrological data at different spatio-temporal scales
B. Fischer, J. Seibert, M. Stähli

12:00-12:15: ERB2014-50
Influence of wind-driven-rain on the rainfall-runoff process in urban areas
J.M.G.P. Isidoro, J.L.M.P. de Lima

12:15-12:30: ERB2014-20
Methods of processing hydrometeorological data based on Tinoasa–Ciurea representative basin using GIS techniques
G. Neculau, C. Pricop

12:30-12:45: ERB2014-61
Physically-based and distributed models versus conceptual and lumped models: evaluation of performance and applicability in a case-study
P.G. Filianoti, D.A. Zema, C. Denisi, L. Gumari

END OF ORAL PROGRAMME TOPIC 1

13:00-14:30 Lunch break

14:30-16:00 POSTER SESSION
(see Poster Conference Programme)
Topic 6  Reflections on the past, present and future of experimental basins’ networks
Room: Auditório Laginha Serafim
Chairperson: Hubert Holzmann

16:00-16:15: ERB2014-39
The Venero Claro monitored basin and the web page of public distribution of hydrological and meteorological data

16:15-16:30: ERB2014-74
Hydrological studies in experimental and representative basins in Brazil: the experience of the REHIDRO network

16:30-16:45: ERB2014-48
What future for small research basins?
S. Chersich, F. Maraga, F. Zucca, L. Brocca

16:45-17:00: Discussion

END OF ORAL PROGRAMME  TOPIC 6

17:00-17:30  Coffee break

Topic 2  New instrumentation and monitoring developments
Room: Auditório Laginha Serafim
Chairperson: Andreas Herrmann

17:30-17:45: ERB2014-2
Combining stable isotopes and hydrometric data to investigate the stormflow response of a Mediterranean mountain catchment (Vallecebre Research Catchments, Spain)
J. Latron, M. Roig-Planasdemunt, P. Llorens

17:45-18:00: ERB2014-92
Can we use trace metals for tracing hydrological processes? Example of Rare Earth Elements for river basins heavily impacted by anthropogenic activities
C. Hissler, P. Stille, C. Guignard, J.F. Iffly, L. Pfister

18:00-18:15  ERB2014-30
Rainfall estimation from in situ soil moisture observations: is it feasible?

18:15-18:30: ERB2014-71
Infrared thermography as a heat tracer method for velocity estimation in shallow flows
R.L.P. de Lima, T.G. Cleveland, R.F. de Carvalho

18:30-18:45: ERB2014-26
TMS3: Temperature and moisture system for spatially distributed measurements
M. Šanda, T. Haase, J. Wild, J. Jankovec

18:45-19:00: ERB2014-25
Locating soil macropores with thermography
J.L.M.P. de Lima, J.R.C.B. Abrantes, V.P. Silva Jr., M.I.P. de Lima, A.A.A. Montenegro

END OF ORAL PROGRAMME  TOPIC 2
Thursday, 11 September 2014

Topic 3  Effects of climate forcing and human activities on hydrological processes and prediction in ungauged basins (PART 1)

Room: Auditório Laginha Serafim
Chairperson: Luca Brocca

9:30-9:45: ERB2014-76
Assessing changes in drought/wetness episodes in drainage basins, in Portugal, using the Standardized Precipitation Index
Á. Silva, M.I.P. de Lima, F. Espírito Santo, V. Pires

9:45-10:00: ERB2014-89
Assessment of the Floods Occurrence Potential in the Representative Basin of the Upper Teleajen River – Romania
M. Borcan, M. Retegan

10:00-10:15: ERB2014-5
Modelling and estimation of possible future changes of average annual runoff in the Rika River basin
L. Gorbachova

10:15-10:30: ERB2014-33
Changes in the river flow regime in the Raba Basin (Poland’s Western Carpathians)
M. Kędra

10:30-10:45: ERB2014-6
Description of a field experiment on the warming up of a mountain stream reach
J.L.M.P. de Lima, C. Canhoto

10:45-11:00: ERB2014-49
Testing a method to classify flow regime alterations in a temporary river
A.M. De Girolamo, A. Lo Porto, G. Pappagallo, F. Gallart

11:00-11:30  Coffee break

11:30-11:45 ERB2014-34
The influence of climatic, environmental and anthropogenic factors on flow regime changes in the Raba Basin (Poland’s Western Carpathians)
M. Kędra, J. Korpak

11:45-12:00: ERB2014-52
Monitoring of streamflow along a brook from natural forest to urban area
P. Kalicz, P. Csáfordi, G. Király, R. Szitá, A. Herceg, B.K. Szegedi, Z. Gribovszki

12:00-12:15: ERB2014-59
Modelling the impacts of climate change on a small basin under the influence of intensive vineyard culture
D. Serpa, J.P. Nunes, V. Silva, M.E. Rial-Rivas, J.J. Keizer, N. Abrantes

12:15-12:30: ERB2014-10
Impacts on surface hydrology and flow connectivity of land use changes in periurban small basin under Mediterranean climate

12:30-12:45: ERB2014-22
Contribution of forest road network to the flash flood in Píla village in June 2011 (first approximation)
T. Orfanus

END OF ORAL PROGRAMME  TOPIC 3

12:45-14:00 Lunch break

14:00 Departure to Technical Visit 1
(see Technical Visits’ Programme)
Friday, 12 September 2014

**Topic 4  Transport processes in small basins**
Room: Auditório Laginha Serafim  
Chairperson: Jérôme Latron

*9:30-9:45: ERB2014-7*
Experimental research and mathematical modeling of nutrients release in a small watershed  
N. Osadcha, V. Osadchyy, V. Lukovsky, Y. Luzovitska, V. Artemenko

*9:45-10:00: ERB2014-11*
Longitudinal dispersion coefficient in natural streams in Slovakia  
D. Halmova, P. Miklanek, J. Pekar, B. Pramuk, P. Pekarova

*10:00-10:15: ERB2014-66*
Organic carbon losses by runoff and erosion on biocrusts in a semiarid badlands microcatchment: consequences of their disturbance  
Y. Cantón, J.R. Román, S. Chamizo, E. Rodríguez-Caballero

*10:15-10:30: ERB2014-67*
Hydrologic behaviour and dynamics of pollutants in a small agro-forested basin in Portugal  
A.C. Duarte, L.M. Íñiguez, J.L.M.P. de Lima

*10:30-10:45: ERB2014-15*
Fully distributed (MOHID) and semi distributed (SWAT) modeling approaches for hydrology and nitrate transport simulation in an agricultural watershed  

*10:45-11:00: ERB2014-84*
Flow connectivity affects the main hydrological drivers that control runoff generation and water erosion  
E. Rodríguez-Caballero, Y.C. Castilla, S.C. de la Piedra, A.S. Benet

END OF ORAL PROGRAMME TOPIC 4

**Topic 5  Uncertainties in surface and groundwater interactions**
Room: Auditório Laginha Serafim  
Chairperson: Ladislav Holko

*14:30-14:45: ERB2014-1*
Groundwater flow paths in glacially affected areas: a hydrogeological investigation of flow in fluvio-glacial deposits  
R. Dijksma, S.H. Menkveld, G. Bier, A.T. Oosterhof

*14:45-15:00: ERB2014-21*
Riverbed groundwater interaction – how to estimate groundwater recharge  
H. Holzmann

*15:00-15:15: ERB2014-63*
Critical rainfall thresholds for debris flow initiation in a small catchment of Western Italian Alps  
L. Turconi, V. Coviello, M.R. Palladino, M. Arattano, G. Savio, D. Tropeano

*15:15-15:30: ERB2014-64*
Rainfall, Runoff and Soil Erosion Processes on Small Arable Catchment  
D. Zumr, J. Devaty, V. Klipa, P. Kavka, J. Dusek, T. Dosta

END OF ORAL PROGRAMME TOPIC 5

**Closing Session**
Room: Auditório Laginha Serafim  
15:30-15:45
Hubert Holzmann, ERB coordinator  
João de Lima, Convener  
Isabel de Lima, Convener

**Other events:**
Reception – Water Museum, 16:00-17:00  
Conference Dinner, 19:00-22:00  

**Saturday, 13 September 2014**
Departure to Technical Visit 2 from city center: 9:30  
(see Technical Visits’ Programme)
Poster Programme

Poster Exhibition Hall: 4th Floor

Display time:
Posters will be on display during the conference (from Wednesday, 9:30, to Friday, 15:30).

Authors in Attendance Time:
Wednesday, 10 September, 14:30-16:00.

Chairpersons: Abelardo Montenegro and Isabel de Lima

P1: ERB2014-3
Seasonal and storm dynamics of Dissolved Organic Carbon in a Mediterranean mountain catchment (Vallcebre Research Catchments, Spain)
M. Roig-Planasdemunt, P. Llorens, J. Latron

P2: ERB2014-4
Two adjacent experimental torrential watersheds in Slovenia
N. Bezak, S. Rusjan, A. Vidmar, M. Kogoj, M. Šraj, M. Mikloš

P3: ERB2014-8
Mulch effect on soil and water dynamics for rainfall bursts and long low intensity events
A.A.A. Montenegro, J.R.C.B. Abrantes, V.P. Silva Jr., J.L.M.P. de Lima

P4: ERB2014-9
Analysis of the components of soil water regime in the process of soil drought formation
M. Gomboš, B. Kandra, I. Vasiľová

P5: ERB2014-13
Modelling catchment behavior by streamflow component mixing approach
S. Rusjan, M. Mikloš

P6: ERB2014-14
Analysis of structural changes in hydrometeorological time series using a wavelet transform
P. Sleziak, Z. Studňová

P7: ERB2014-16
Biological indicators based on benthic macroinvertebrates traits: a good tool for assessing urban stream disturbance?
P. Isidoro, C. Canhoto, M. Abelho

P8: ERB2014-18
Using observations in the Hupsel Brook catchment and Cabauw polder (Netherlands) to develop the Wageningen Lowland Runoff Simulator (WALRUS), a new rainfall-runoff model for catchments with shallow groundwater
C.C. Brauer, P.J.J.F. Torfs, A.J. Teuling, R. Uijlenhoet

P9: ERB2014-19
Mapping soil permeability using infrared thermography
J.R.C.B. Abrantes, J.L.M.P. de Lima, V.P. Silva Jr., A.A.A. Montenegro

P10: ERB2014-23
Cartography of erosive status using a neuro-fuzzy technique: The Ria Formosa basin

P11: ERB2014-24
Projections of peak flow changes in 21st century in rural and urban parts of small Lithuanian catchment
E. Stonievičius

P12: ERB2014-27
TMS3: Calibration of soil moisture measurements on variety of soil classes and testing of temperature measurements in vast fields
J. Jankovec, M. Šanda, J. Wild

P13: ERB2014-28
Modelling and classification of geoforms: The Ria Formosa basin

P14: ERB2014-29
Water and energy fluxes of grasslands in representative basin in Pernambuco state - Brazil

P15: ERB2014-35
Spatial and seasonal variability of concentration and composition of suspended load in the Vistula river between Wyszogród and Chełmno (Poland)
M. Kaszubski

P16: ERB2014-37
The influence of modern and paleolakes on the outflow and chemical properties of river waters – an example from Pomerania, Poland
P. Gierszewski, D. Brykala, M. Kaszubski
P17: ERB2014-36
Human impact on the temporal and spatial conditions of the outflow from the Skrwa Lewa river basin (central Poland)
D. Brykala

P18: ERB2014-40
Antecedent moisture and rainfall thresholds for runoff generation in a humid rural catchment in NW Spain

P19: ERB2014-41
Analysis of climate change effects on the hydrology of a small headwater catchment in NW Spain using SWAT model

P20: ERB2014-42
Mercury mobilisation after wildfire and rainfall in eucalypt and pine forests
I. Campos, C. Vale, N. Abrantes, J.J. Keizer, P. Pereira

P21: ERB2014-43
Toxic effects of wildfires on aquatic ecosystems

P22: ERB2014-46
The hydrological research and related ecological issues in a Prealpine Italian small basin: the hydrological change related with soils, soil available water content, morphology and vegetation
S. Chersich, F. Maraga

P23: ERB2014-47
Educational experiences as enhancement of the environment in the Prealpine Gallina valley basin
S. Chersich, F. Maraga

P24: ERB2014-53
Effects of soil management on runoff, soil erosion and landslides occurrence in vineyards
M. Biddoccu, F. Opsi, S. Ferraris, L. Turconi, E. Cavallo

P25: ERB2014-54
Development of forest litter interception relationship
K.A. Zagyvainé-Kiss, Z. Gribovszki, P. Kalicz

P26: ERB2014-55
Morphometric characterization of a small drainage basin in Montouro (Cantanhede, Portugal) – surface and groundwater interactions

P27: ERB2014-56
Temporal changes of near-saturated hydraulic conductivity in a small arable catchment
D. Zumr, V. Klipa, M. Snehota, M. Dohnal

P28: ERB2014-57
Assessing the impact of climate change scenarios on water quality patterns on the Vouga catchment (Central Portugal)
J. Rocha, P. Roebeling, M.C. Cunha, J.P. Nunes, R. Jacinto

P29: ERB2014-58
The ground water component during snowmelt events in The Tatra Mountains (Poland)
J. Siwek, M. Zelazny

P30: ERB2014-60
Overland flow processes in eucalyptus plantations in north-central Portugal

P31: ERB2014-62
The importance of subsurface flow in streamflow generation in an eucalypt-dominated catchment in north-central Portugal

P32: ERB2014-63
Critical rainfall thresholds for debris flow initiation in a small catchment of Western Italian Alps
L. Turconi, V. Coviello, M.R. Palladino, M. Arattano, G. Savio, D. Tropeano

P33: ERB2014-65
Using SWMM to model surface runoff from intermittent rainfall patterns on soils covered with mulch: comparison with results from laboratory soil flume experiments
J.R.C.B. Abrantes, N.E. Simões, J.L.M.P. de Lima

P34: ERB2014-68
Kinetic energy of simulated rain resulting from combining nozzles and meshes
S.C.P. Carvalho, J.L.M.P. de Lima, M.I.P. de Lima

P35: ERB2014-70
Temporal and spatial behaviour of soil moisture in the experimental basin of Jatobá
V.P. Silva Jr., A.A.A. Montenegro, P.S. Duarte

P36: ERB2014-72
Assessment of the applicability of the SWAT model to simulate the streamflow in a small rural catchment in the Federal District (Brazil)
S. Ferrigo, R. Minoti, S. Koide

P37: ERB2014-77
Variability of extreme precipitation over mainland Portugal and its relationships with teleconnection patterns
M.I.P. de Lima, F. Espírito Santo, Á. Silva, S. Cunha

P38: ERB2014-79
Ice phenomena on a small stream in the zone of intermittently frozen ground
A.M. Tarbeeva, I.V. Krylenko, V.V. Surkov
P39: ERB2014-82
Evaluation of mulching as conservation technique for soil loss and soil moisture maintenance in plots under simulated rainfall

P40: ERB2014-83
Effect of conservation practices for reducing soil and nutrients losses on cassava cropping

P41: ERB2014-85
Variations in water availability as a consequence of run-off run-on processes that control vegetation dynamics in Drylands
E. Rodríguez-Caballero, M. García, A. Casas, S. Chamizo, Y. Cantón, D. Riaño, S. Ustin

P42: ERB2014-86
Generation of urban flood risk maps using a dual drainage model in SWMM
T.J. Paula, N.E. Simões, J.A. Sá Marques

P43: ERB2014-87
Development of a new device for continuous measurement of snow water equivalent
A. Kulasová, Z. Bagal, O. Špulák, V. Černohous, J. Souček, L. Daneš, Š. Blažková

P44: ERB2014-88
Impact of climate change in the drainage of a Portuguese urban catchment
S. Dias, D. Santos, N.E. Simões, J.A. Sá Marques, J.P. Leitão

P45: ERB2014-90
Urban floods of combined sewer systems: Hydraulic and quality modelling of an extreme rainfall event in Coimbra, Portugal
L. Girão, N.E. Simões, J.A. Sá Marques

P46: ERB2014-91
Revisiting the perceptual model of a schistous catchment (Weierbach, Attert River basin, Luxembourg)
J.F. Iffly, F. Barnich, L. Gourdol, C. Hissler, J. Juilleret, J. Klaus, N. Martinez-Carreras, L. Pfister

P47: ERB2014-93
The potential of a novel plastic optical fiber turbidity sensor to estimate sediment yields from recently burnt areas
J.J. Keizer, M. Martins, S. Prats, D. Vieira, R. Nogueira, L. Bilro

END OF POSTER PROGRAMME
Groundwater flow paths in glacially affected areas: a hydrogeological investigation of flow in fluvioglacial deposits

R. Dijksma (1), S.H. Menkveld (1), G. Bier (1) and A.T. Oosterhof (2)
(1) Wageningen University, the Netherlands
(2) Vitens Water Company, the Netherlands

During Elsterian (0.5 million year BP), glaciers cut a few km wide and up to 250 m deep gullies in pre-glacial sediments in the northern part of the Netherlands (Bosch et al., 2009; Huuse and Lykke-Andersen, 2000; Smit et al., 2012). At the end of this ice age, these gullies were filled by fluvioglacial sediments (lower part) and fine-grained glacio-lacustrine sediments (upper part). The elongated fluvioglacial sediments form significant aquifer systems, with a NS-orientation. These aquifers are covered by the glacio-lacustrine clay, acting as aquitard. This hydrogeological setting makes the gullies favourable locations for drinking water abstraction. However, well field Garyp was hampered by rapid salinization of the abstraction wells. In order to reveal the source of the salt water, the origin, distribution and properties of the hydrogeological formations was studied in detail. Furthermore, the origin and flow paths of brackish/salt water were investigated by using a detailed groundwater model.

The salinity of groundwater in the aquifers and aquitards in this region depends predominantly on the condition at the time of sedimentation. During Early Pleistocene (2.6 - 1.4 M years BP) marine sediments were deposited in the area, with brackish pore water (Custodio, 2010). Overlying Pleistocene fluvial formations can be considered as fresh water aquifers. Even though the brackish Early Pleistocene formations often are considered as the hydrological base, because of the low vertical hydraulic conductivity, significant flow from this layer could be the cause of drinking water well salinization.

GMS-MODFLOW is a well-known groundwater modelling package (Nguyen et al., 2005). A detailed groundwater model was constructed using this GMS-MODFLOW (Menkveld, 2013). This model was embedded in MIPWA, i.e. a 25x25 m² grid MODFLOW based hydrological model which covers the northern part of the Netherlands. All sources and sinks of water (canals, ditches, lakes, drains, wells) are embedded in this regional model. Firstly the effects of combining two modelling approaches (local schematization and regional MIPWA based schematization) were studied. Then the effects of three scenarios were tested: 1) shutting down some wells; 2) reducing overall extraction rate; and 3) reducing well screen length. It was concluded that all three scenarios do not show a positive effect regarding the attraction of saline water from the marine formations. It was found that glacial till from another glaciation (Saalian) acts as the main aquitard in the system. As a result, limited amounts of water can be abstracted from the upper layers. Given the abstraction rate, inevitably water will be abstracted from the brackish layers.

References:
Menkveld, S.H. (2013). Salinization of Garyp well field, Friesland: Hydrogeological investigation using GMS-MODFLOW to model the groundwater flow patterns and investigate measures to create sustainable drinking water extraction. MSc thesis, Wageningen University, the Netherlands, 90 pp.
Smit, F.W.H., E.P.H. Bregman (2012). Buried glacial valleys as drinking water reservoirs: an assessment on function and risks in their role as drinking water reservoirs in the ice-marginal landscape of northern Europe. ENCORE project record, Province of Drenthe, Netherlands and Århus University, Denmark.
ERB2014-2

Combining stable isotopes and hydrometric data to investigate the stormflow response of a Mediterranean mountain catchment (Vallcebre Research Catchments, Spain)

J. Latron, M. Roig-Planasdemunt and P. Llorens
Institute of Environmental Assessment and Water Research (IDAEA) CSIC, Barcelona, Spain

The hydrological behaviour of Mediterranean mountain catchments has been investigated in the last two decades in the Vallcebre Research Catchments (NE Spain, 42º 12’N, 1º 49’E) using a twofold approach based on hydrometric measurements and modelling. Results obtained have shown the complexity of the rainfall-runoff relationship as well as the strong non-linearity of the catchment’s hydrological response. The hydrological behaviour of the catchments is broadly similar to that observed in more humid regions during wet periods. On the contrary, during dry periods or during wetting up transitions, some hydrological processes characteristic of humid conditions are temporarily absent, activating a different combination of hydrological processes.

Water stable isotopes have been used in the last 3 years for determining the relative contribution of event and pre-event in the stormflow response, with the aim of improving the understanding of the hydrological behaviour of these catchments. Even if the use of stable isotopes in seasonal Mediterranean catchments has been relatively limited so far compared to humid temperate catchments, results obtained in the Vallcebre Research Catchments showed that the information they provide was very helpful, when used in combination with detailed hydrometric data.

Results obtained using stable isotopes were generally in line with previous finding in these catchments, even if the contribution of pre-event water was higher than expected in some conditions. Using a set of 11 stormflow events with different characteristics (rainfall depth from 18 to 88 mm, stormflow coefficient from 0.02 to 0.57), two components hydrograph separations indicated that pre-event water accounted for 30% to almost 100% of the total runoff. The contribution of pre-event water depended on antecedent wetness conditions, on the extent of saturated areas within the catchment and on rainfall characteristics.

ERB2014-5

Modelling and estimation of possible future changes of average annual runoff in the Rika River basin

L. Gorbachova
Ukrainian Hydrometeorological Institute of the National Academy of Science of Ukraine and of the State Emergency Service of Ukraine, 37, Nauki Prospect, Kyiv-28, Ukraine, 03028

In the conditions of global and regional climate change, it is important to obtain quantitative and reliable values of the probable future runoff changes. A common method to evaluate climate change impact on water resources due to the global warming is by using the global and regional projections of Global Circulation Models (GCMs) of the atmosphere and ocean as input in the hydrological model. Despite that there are plenty of scientific publications dedicated to research on possible future changes in river runoff, however, only few of them were published in Ukraine. Moreover, detailed assessments have not been done for the Carpathian region’s rivers and the small basins. The goal of this paper is the modeling of average annual runoff in the Rika River Basin by using the Regional Climate Models (RCMs) data by means of various methods.

For this study, two water gauging stations of the Zakarpatska Water-balance Station (ZWBS) were selected, namely Studenyy River – Nizhny Student Village (25.4 km²) and Rika River – Mezhigirya Village (550 km²). The prospective estimations of changes of the average annual runoff were performed using the regional climate models data (REMO/ECHAM5, RCA3-E/ECHAM5, RCA3-B/BCM, RRCM/HadCM3Q0). These RCMs have the best verification of the rainfall in the Carpathian region of Ukraine. The period 1991-2010 was chosen as the base period, the period 2031-2050 was chosen as the forecast period and the optimal scenario of the society evolution (IPCC A1B) was also chosen. The hydrological module NAM of the Rainfall-Runoff model of the Mike 11 (Denmark, DHI) modelling system and the water-balance method were used to simulate and obtain possible future changes of average annual runoff.

Calibration of the NAM hydrological module was made by means of historical data (discharges, evaporation, air temperature and precipitation) for the three-year period. The Nash & Sutcliffe efficiency index was used as a quality criterion for calibration module NAM. For the Studenyy River – Nizhny Student Village gauging station the calibration was done for the 1971-1973 period. The Nash & Sutcliffe efficiency index was 0.73 for the 2007-2009 period. For the Rika River – Mezhigirya Village gauging station the Nash & Sutcliffe efficiency index was 0.78. For the Rika River – Mezhigirya Village gauging station the Nash & Sutcliffe efficiency index was 0.73 for the 2007-2009 period. Thus, these results allowed to model the average annual runoff by the NAM module by means of the RCMs data.

Datasets (temperature, precipitation, evaporation) for each river basin were prepared from the nodes of RCMs (Krakovska et al., 2013). It turned out that spatial resolution of the RCMs (25 km step) is insufficient for the Studenyy River – Nizhny Student Village gauging station, since its area is only 25.4 km². So, further research was performed only for the Rika River – Mezhigirya Village basin, which gauges the outlet of the ZWBS experimental basins. In our paper (Gorbachova and Bauzha, 2011) it was shown that the average annual runoff changes of the ZWBS streams are synchronous.

15th Biennial Conference ERB2014
For the gauging station Rika River – Mezhgirya Village the historical simulation (1991-2010 period) of the average annual runoff was performed by the NAM module, for achieving reliable results. The result of the analysis showed that the simulation quality by independent data fit in the category, which is fully consistent with the calibration quality. The statistical implementation of the water-balance method was performed for the period 1961-2010. In addition, the verification of the water-balance equations for the 1991-2010 base period has been done.

The ensemble approach was used to obtain more accurate estimation of the possible average annual runoff change. For the NAM RR Mike 11 module the ensembles were created based on calculations of such statistical parameters as: the mean value, the average Euclidean distance and the correlation coefficient. For the water-balance method, the ensembles were created by averaging the results of four RCMs. The analysis shows that assessing possible future changes of average annual runoff, the four RCMs have considerable uncertainty in the trends. Therefore, in such situation the ensemble averaging can show the approximate projection changes of the average annual runoff.

In conclusion, the results of calculations by two methods (NAM RR Mike 11 module and water balance method) showed similar results. The projections of average annual runoff of the Rika River at mid-XXI century with respect to the base period 1991-2010 for the A1B society evolution scenario, showed that, most likely, the possible future changes of average annual runoff will have the natural fluctuations.

References:


ERB2014-6
Description of a field experiment on the warming up of a mountain stream reach

J.L.M.P. de Lima (1,2) and C. Canhoto (1,3)

(1) Institute of Marine Research (IMAR), Marine and Environmental Sciences Centre (MARE), Portugal
(2) Department of Civil Engineering, Campus II, University of Coimbra, 3030-788 Coimbra, Portugal
(3) Department of Life Sciences, University of Coimbra, P.O. Box 3046, 3001-401 Coimbra, Portugal

Global warming will be reflected in an increase of water temperatures of streams and other water bodies, with direct consequences on these aquatic ecosystems. However, the effect of increased water temperature on stream function (vs. structure) has received comparatively little attention from the scientific community, especially of in situ field experiments. The main objective of this work is to describe a whole-stream manipulative experiment, focusing on the hydraulic design, to induce an increase in water temperature on a second order stream. The experiments took place from March 2010 to February 2012, in Ribeira do Candal stream, Lousã Mountain, Portugal (Canhoto et al., 2013; de Lima and Canhoto, 2014). A constant flow of stream water was controlled by a hydraulic setup consisting fundamentally of:

(1) a water intake and a transport system associated with a heating system;
(2) a manipulated stream reach (~22 m long; ~1.5 m width), subdivided into two parallel channels by a longitudinal divide made of a wall of schist stones.

The heating system relied on electrical power and was conceived to allow an instantaneous increase of water temperature, with minimum storage. One half channel of the study reach received heated water (~3°C above the other half), while the other half received water at stream ambient temperature. A constant flow was controlled with weirs and valves on both halves of the stream installed in the tanks of the heating system and upstream the study reach. A bypass channel guaranteed the drainage of the excess water not used by the two parallel channels. The system maintained a steady flow and similar abiotic conditions allowing the evaluation of the effects of the increase of temperature at several levels of biological organization. Investigation on biofilms composition and activity, fungal and invertebrate communities’ structure, trophic relationships, leaf litter decomposition and stream metabolism suggest that the effects of increased temperature in lotic environments can only be fully understood when using the realism of whole-stream manipulations and joining structural and functional approaches.

References:


The problem of water bodies eutrophication due to income of nitrogen (N) and phosphorus (P) compounds to the aquatic environment remains one of the most relevant from the point of view of water resources management [1]. The aim of this work was to study nutrients release in the reference basin and find the background values for mineral compounds of N (\(N_{\text{min}}\)) and P (\(P_{\text{min}}\)). The Holovesnya river (29.5 km\(^2\)) is representative water body for the mixed forest zone of Ukraine and included to the State Monitoring System. The hydrological response of the watershed is reflected in sharp spring floods, summer and winter low water.

The time series of nutrients content in the Holovesnya river were analyzed for period of 1956–2012. Obtained results showed considerable variation of \(N_{\text{min}}\). However, since 1995 until the present time mean values of \(N_{\text{min}}\) decrease and vary in narrower limits. A similar trend of \(N_{\text{min}}\) decrease also noted for the other rivers in Ukraine. This fact has been attributed to the sharp decline in agriculture production occurring after the Soviet Union collapse. Besides, the restructuring of economy has led to significant reduction in greenhouse gas emissions. Inflow of NO\(_3\) compounds to the atmosphere decreased from 2116 t/year in 1990 to 1153 t/year in 1995 and continues to decrease further [3].

The available data indicate that the distribution of dissolved N and P compound is uneven throughout the year. Extremely high nutrients losses from the watershed are closely related to snowmelt event. Unfortunately, having the only monitoring data it is very difficult to calculate the nutrients flux due to the low sampling frequency (4 times per year).

In 2012 the mechanism of water flow and nutrients release during snowmelt event was studied at the small plot scale (2 m\(^2\)). Previously surface layer of soil was removed to a depth of 35 cm, waterproof layer was laid and soil was brought fully back. Plastic tubes for runoff collecting were at the surface and confining layer. Thus, overland and subsurface runoff was physically separated.

The snow layer of 7 cm was accumulated on the plot during the winter. With temperature increasing snow began to melt and form a runoff, which takes 704 hours. Snowmelt water was collected continuously. Nutrients concentration (NH\(_4\)+, NO\(_2\), NO\(_3\), PO\(_4^{3-}\)) has been measured in a pre-filtered samples.

Runoff variability was depended on temperature increasing that determined snowmelt. The total runoff value was 1.1 m\(^2\). 11.7% of runoff was generated in the initial period of snowmelt before the temperature steadily moved over 0°C. The bulk of the flow formed with further warming. This phase, which took 88.3% of runoff, we considered as the basic. Distribution of water runoff between components was the following: 56% kept the overland flow and 44% - the subsurface one.

During the snowmelt event water delivered 456 mg of \(N_{\text{min}}\), of which 52% came with the overland flow and 48% with the subsurface flow. Nitrogen washout curve indicates that 111 mg of nitrogen (24% of the total flux) release at the initial flow period with low discharges. This could be explained by the peculiarities of nitrogen accumulation in soil. Ammonium, appearing as a result of the ammonification process, is strongly fixed by clay minerals. Opposite nitrification process favors the formation of NO\(_3\). Nitrate ions have high solubility that causes their geochemical mobility. The solubility of Ca(NO\(_3\))\(_2\) at 0°C is 2010 kg/kg H\(_2\)O, NaNO\(_3\) and KNO\(_3\) respectively 727 and 2795 kg/kg H\(_2\)O. Keeping in mind that dissolution process is limited by diffusion parameters, NO\(_3\) dissolution rate would be the maximum at the process beginning. Water flow increase at the basic phase causes reduction of NO\(_3\) concentrations because of dilution. Thus, the flush of nitrate compounds is mainly determined by hydrodynamic conditions.

Snowmelt waters washed out 44.4 mg of \(P_{\text{min}}\), what is 10 times less compared to nitrogen due to the low solubility of natural phosphates. The dominant part of \(P_{\text{min}}\) (67.7%) was delivered by subsurface flow. It is known that 10-20% of soil phosphates are mobile, while the others are quickly fixed by clay minerals through the sorption process. Soluble phosphates of calcium, sodium and ammonium are leached at the initial phase. They form about tenth (3.45 mg) of the total \(P_{\text{min}}\) flux. At the beginning of the main phase of runoff phosphates were absent at all what has been associated with desorption step. A subsequent delivery of phosphate is fully described by a diffusion process.

Taking into account that the main mechanisms of \(N_{\text{min}}\) and \(P_{\text{min}}\) transfer in the system "solid-water" are the physical processes of convective diffusion and desorption, removal of N and P during the experiment was described by calibrating the minimum number of parameters specified dynamic processes. The modeling exercise was based on transportation-box approach assumed that before the runoff a quasi-stable equilibrium was reached between solid and liquid phases of soil which then was disturbed by washing. Leaching of nutrients was represented as a consistently realized discharge phase [2]. The accuracy of \(N_{\text{min}}\) and \(P_{\text{min}}\) simulation was assessed on the basis of Nash–Sutcliffe efficiency coefficient. For \(N_{\text{min}}\) and \(P_{\text{min}}\) flow it was respectively 0.70 and 0.86.

This approach was applied to watershed scale for the Holovesnya river and gave the opportunity to calculate the nutrients release in different water phases as well as to establish their reference values.

References:


Impacts on surface hydrology and flow connectivity of land use changes in periurban small basin under Mediterranean climate

C.S.S. Ferreira (1,2), A.J.D. Ferreira (2), R.P.D. Walsh (3), T.S. Steenhuis (4), J.P. Nunes (1), J.L.M.P. de Lima (5,6) and C.O.A. Coelho (1)

(1) Centre for Environmental and Marine Studies (CESAM), Department of Environment and Planning, University of Aveiro, Aveiro, Portugal
(2) Research Centre on Natural Resources, Environment and Society (CERNAS), Coimbra Agrarian Technical School, Bencanta, Coimbra, Portugal
(3) Department of Geography, College of Science, Swansea University, Swansea, UK
(4) Department of Biological and Environmental Engineering, Cornell University, New York, USA
(5) Institute of Marine Research (IMAR), Marine and Environmental Sciences Centre (MARE), Portugal
(6) Department of Civil Engineering, Faculty of Sciences and Technology, University of Coimbra, Coimbra, Portugal

Impacts of human activities in urban environments on peak runoff and water availability has been investigated mostly by engineers. The complex interaction, however, between geology, climate, land use, type and size of human settlements and drainage systems, represents a challenge to understanding the hydrological changes. Limited information is available as regards to hydrological impacts that are expected to take place in a periurban landscape. The study, therefore aims to: 1) understand spatio-temporal variability of soil hydrological properties in different land uses; 2) identify the main runoff generation sources throughout the year; 3) evaluate the impact of landscape features promoted by various land-uses and geology on flow connectivity and streamflow response; and 4) discuss the importance of different urbanizing mosaic features on landscape management and urban planning.

The study focuses on the Ribeira dos Covões catchment (620 ha). Due to its proximity to Coimbra, the main city in central Portugal, most of the agricultural fields established in 1958 (representing 50% of the catchment area at that time) were converted into urban areas. In 2009, 30% of the catchment was urbanized, while agricultural land use was limited to 8% of the area. Despite the 62% forest cover in 2009, part of these areas is being used to build up infrastructures. Between 2009 and 2013, impermeable surfaces increased from 11.6% to 13.4%. The current urban settings consists of a discontinuous arrangement of buildings and roads with less than 25 inhabitants/km² and well-defined urban cores with 100,000 inhabitants/km² (Tavares et al., 2012). The catchment has a sub-humid Mediterranean climate (15°C and 892 mm of average annual precipitation), with long dry summers. The soil is deep (>3 m) overlaying sandstone but with some shallow soils (<0.4 m) under limestone lithology. Altimetry ranges between 30 m and 205 m a.s.l., and the average slope is 8°, with a few steep slopes reaching 47°. Methodology used to achieve the study objectives is based on a multi-scale approach, involving pedon scale measurements, plot experiments as well as catchment and subcatchments monitoring. A network of 31 sites, consisting of distinct landscape features characterized by land uses and geology, was established to measure surface soil moisture content (gravimetric method), hydrophobicity (molarity of an ethanol drop technique) and surface soil matrix infiltration capacity (minidisk tension infiltrometer, over 30 minutes). These experiments were carried out for one year during nine monitoring campaigns. Considering forest land use extent, its rainfall-runoff relationship has been measured since the 2010 Fall, throughout nine 8m×2m runoff plots. Three replicated plots were installed in the most representative forest areas: (i) eucalyptus and pine stands; (ii) dense shrub vegetation, with few eucalypt and pine trees encroachment; and (iii) oak forest. Overland flow (piped to collecting tanks), throughfall (manual gauges), surface soil moisture and hydrophobicity were measured after storm events. Catchment hydrological response has been measured since 2008, through a continuous-recording network including a weather station and a river water-level recorder at the outlet. This hydrological network was reinforced in Fall 2010, with 5 additional rain gauges and 8 water-level recorders, in order to provide continuous flow data on sub-catchments.

The results show that different landscape features have distinct and different mechanisms for generating overland flow while other may provide infiltration opportunities over the year. During the summer, the hydrophobic nature of forest areas (especially under eucalyptus and pine stands) and agricultural-limestone fields (mainly abandoned and under natural vegetation succession) exhibit low soil matrix infiltration capacity, inducing Hortonian overland flow. However, wettable and low hydrophobic agricultural soils overlaying sandstone and urban areas had greater matrix infiltration capacity of 14 and 10 mm/h, respectively, which is in excess of most rainfall intensities in the area, and served as infiltrating areas for uphill generated overland flow. Hydrophobicity breaks down throughout the wet periods, and matrix infiltration capacity increases under forest soils to 8 mm/h. Nevertheless, over agricultural and urban soil the increasing soil moisture through wet periods limited the infiltration capacity increase promoted by the absence of repellency.

A second runoff mechanism that occurred in the watershed was saturation excess runoff. Soil saturation was reached in topographic lows during the wet times of the years and on shallow limestone soils, mainly occupied by urban and agricultural fields. Despite widespread hydrophobicity under dry forest soils, runoff plots enlighten the great infiltration capacity of this land use with runoff coefficients <3%, indicating preferential flow paths on water infiltration, and limiting flow transfer downslope. Due to the generally sandy soils and limestone geology (in part of the area), as well as deep filled valley on which the catchment is located, annual runoff coefficient at the outlet of the 620 ha catchment did not exceed 20%, despite urbanization. However, the catchment showed a quick hydrological response (<1.5 h), associated with more extensive urban sites and limestone areas. Considering future increase trend in urbanization and the impermeable areas, it is expected a flood hazard increase when these areas are connected hydraulically with the outlet. Planning strategies should be implemented such that the mosaic of landscape units maximizes infiltration of the generated runoff from the impermeable urban areas.

References:
Longitudinal dispersion coefficient in natural streams in Slovakia

D. Halmova (1), P. Miklanek (1), J. Pekar (2), B. Pramuk (1) and P. Pekarova (1)
(1) Institute of Hydrology SAS, Racianska 75, 831 02 Bratislava, Slovakia
(2) Dept. of Applied Mathematics and Statistics, FMPI CU Bratislava, Slovakia

The paper deals with the estimation of the longitudinal dispersion coefficients and with the numerical simulation of transport and transformation of accidental pollution in the small natural streams. The paper briefly reviewed the theoretical background and the results of field experiments needed to determine the longitudinal dispersion coefficient. The use of models for simulation of pollution in the stream is encountered with the lack of information on the size of the mixing dispersion coefficient, either in the longitudinal or transverse direction. The values of the coefficients can influence the outcome of the calculations or simulations of leaking substances into the flow. Therefore, accurate determination of the values of these coefficients is an important part in solving the problems of pollution transport in the stream. In general, we can use the values of the mixing coefficients referred in the literature (approximate table values), or estimated using approximate empirical relationships, or determined on the basis of field measurements.

There are different ways of solving problems of pollution spreading in open channels, in natural rivers. One of them is the hydrodynamic approach, which endeavors to understand and quantify the spreading phenomenon in a stream. The hydrodynamic models are based on advection-diffusion equation and the majority of them are one-dimensional models. Their disadvantage is inability to simulate the spread of pollution until complete dispersion of pollutant across the stream section is finished. Two-dimensional mixing models do not suffer from these limitations. On the other hand, the one-dimensional models are simpler than two-dimensional ones, they need not so much input data and they are often swifter. Three-dimensional models under conditions of natural streams are applicable with difficulties (or inapplicable) for their complexity and demands on accuracy and amount of input data. As there was mentioned above the two-dimensional models can be used also until complete dispersion of pollutant across the stream section is not finished, so we decided to apply the two-dimensional model SIRENIE. This model can simulate dissemination of pollution in the stream. Through trial - error method, we have optimized longitudinal dispersion coefficients (Dx) so that the difference between measured and modeled values was minimal.

In this study, we summarized the results of our field experiments in the various streams on identifying the coefficient of longitudinal dispersion. From 1991 to 2014, we conducted a series of salt experiments at different flows for various hydrological and vegetation conditions in three regions:

- The Central Slovakia in Povazska Bystrica, in the experimental microbasins Rybarik and Lesny, the parts of the experimental Mostenik brook basin. The Field Hydrological Laboratory of IH SAS (Institute of Hydrology Slovak Academy of Science) was established in 1958 and since 1986 started a chemical program in the basin. The total area of the Rybarik basin is 0.119 km$^2$. The length of the stream from spring to closing profile is 256 m. The elevation is from 369 to 434 m above the sea level. The long-term annual discharge in Rybarik is 0.00087 m$^3$/s.

- The Western Slovakia in Bratislava, in protected area of the Little Carpathians, in Vydrica stream. Vydrica stream is designated by Natura 2000 as the Europe's most endangered habitats and species site, which in practice means that the area is protected with varying degrees of protection. The total flow length is 17 km; rises at an altitude of 505 m above sea level and the catchment area is 22.6 km$^2$. The average monthly flow during 1931–1960 at gauging station Cerveny Mos was 0.161 m$^3$/s (the minimum daily flow rate is 0.001 m$^3$/s$^{-1}$ and maximum daily discharge 7.5 m$^3$/s$^{-1}$). Specific conductivity was measured at a distance of 50 and 100 m from the site of the salt injection.

- The Northern Slovakia, in Western Tatra Mountains region, in experimental basin of Jalovecky stream. The catchment area is 45 km$^2$ and the average annual flow in 2008 was 0.91 m$^3$/s$^{-1}$. We have measured specific conductivity simultaneously on the left and right side of the stream at a distance of 220 m from the site of injection.

The measured coefficients $D_x$ during experiments are in the range 0.2 – 0.7 m$^3$/s$^{-1}$ in the Rybarik and Lesny streams, in the range of 0.4 – 0.6 m$^3$/s$^{-1}$ in the Vydrica stream, and in range 1.5 – 2.5 m$^3$/s$^{-1}$ in the Jalovecky stream. Dispersion coefficients are higher in unregulated streams and within the higher flow rates. These coefficients are widely used; it can be also used to simulate the dissemination of accidental pollution in the streams.

The environmental problems caused by the increasing of pollutant loads discharged into natural water bodies are very complex. For that reason the cognition of transport mechanism and mixing characteristics in natural streams is very important. The mathematical and numerical models have become very useful tools for solving the water management problems. The mathematical simulations based on numerical models of pollution mixing in streams can be used (for example) for prediction of spreading of accidental contaminant waves in rivers.

This publication is the result of the project implementation ITMS 26240120004 Centre of excellence for integrated flood protection of land supported by the Research & Development Operational Programme funded by the ERDF. This work was supported by project VEGA 0010/11.
ERB2014-12

Influence of the riparian zone on the stream water export from a headwater Mediterranean catchment during the vegetative period

A. Lupon (1), S. Bernal (2), M. Erlandsson (3), S. Poblador (1), A. Wade (3) and F. Sabater (1)

(1) Departament d’Ecologia, Facultat de Biologia, Universitat de Barcelona, Diagonal 643, 08028 Barcelona, Spain
(2) Department of Continental Ecology, Center for Advanced Studies of Blanes (CEAB-CSIC), Accés a la Cala Sant Francesc 14, 17390 Blanes, Girona, Spain
(3) School of Human and Environmental Science, University of Reading, Reading, UK

In Mediterranean regions, the annual water budget is mainly controlled by tree evapotranspiration (ET), which can occur almost all year around in evergreen forests. During the vegetative period, ET by deciduous riparian trees can also contribute to diminish the groundwater table and, further, Mediterranean streams can lose water towards the riparian zone especially during low flow periods. Thus, the riparian zone could be essential for understanding the temporal pattern of stream discharge during the vegetative period, and for predicting both, water and nutrient export to downstream ecosystems in regions where water is scarce. Here, we investigated the relevance of the riparian zone on regulating the temporal pattern of stream discharge and stream water export on a seasonal and an annual basis in a headwater Mediterranean catchment during 2 water years. We compared stream discharge between three nested catchments along which the basal area of riparian trees increased by 12-folds. Moreover, we estimated total daily ET by the riparian forest for each nested catchment based on the diel variation of instantaneous stream discharge, instantaneous sap flow rates, and riparian forest inventory data. Further, we used the PERSiST model, one of the few available hydrologic models including a riparian soil compartment (Futter et al., 2013), to explore whether the riparian zone was relevant for simulating stream water export from the upper and downstream sub-catchments on both a seasonal and annual scale. As expected for montane Mediterranean regions, the annual runoff coefficient was low (35%), and it decreased from the upper (38%) to the lower (28%) sub-catchment. Stream water export (area-specific) from the upper to the lower sub-catchment dropped by 17% and 40% during the dormant and vegetative period, respectively, suggesting lower ET during the former than during the latter season. During the vegetative period, instantaneous stream discharge exhibited a clear diel pattern, especially at the valley bottom, where discharge was 8-18% lower at noon than at midnight. This result suggests that riparian trees may be controlling the temporal pattern of stream water discharge, at least at daily time-scale. Finally, the simulation of the temporal pattern of stream discharge during the vegetative period at the valley bottom improved by 2% and 10% when either the soil riparian compartment or the riparian tree ET were included in the PERSiST model. Our results suggest that the activity of riparian trees during the vegetative period can influence the temporal pattern of stream discharge at different time scales, and thus, riparian ET may be a relevant component to consider if we are to predict stream water export and water availability in Mediterranean headwater catchments.

ERB2014-15

Fully distributed (MOHID) and semi distributed (SWAT) modeling approaches for hydrology and nitrate transport simulation in an agricultural watershed

A.M. Epelde (1), D. Brito (2), E. Jauch (2), R. Neves (2), L. Bernard-Jannin (3), S. Sauvage (3), J.M. Sánchez-Pérez (3) and I. Antigüedad (1)

(1) University of the Basque Country, Department of Geodynamics, Spain
(2) Technical University of Lisbon, IST/Maretec, Portugal
(3) University of Toulouse, Laboratoire Ecologie Fonctionnelle et Environnement (EcoLab), France

The coupling of different models is a common practice in agricultural pollution studies. Usually, hydrological, geological and crop models need to be coupled in order to study all the processes affecting the nitrogen dynamics. Rarely are found more complete models considering all the necessary processes which allow studying nitrogen pollution in agricultural watersheds. In this study, two different modeling approaches were used and strong points of each were highlighted. For this purpose, a semi distributed (SWAT) and a fully distributed (MOHID) models were applied in the Alegria River watershed (Northern Spain). This watershed is a lowland area predominated by an alluvial aquifer where the agricultural land use is the predominant one. In fact, it is a nitrate vulnerable zone that has suffered from agricultural nitrate related pollution since the decade of the 1990s. Although several environmental regulations led to the improvement of the pollution in the area, agricultural management practices still have a strong influence both on surface and groundwater quality.

SWAT is an agro-hydrological model which has been thoroughly used over different catchments along the world. Many reports describe it as one of the most useful and robust model for long term simulation of hydrology and nutrient losses in agricultural basins.

MOHID is an agro-hydrogeological model about which scarce publications have been published until date. Even though, it’s potential for simulating hydrology and nitrate migration within watersheds has to be emphasized. Although in theory, physically based distributed models don’t need any calibration process, their distributed nature implies the need of high amount of data. The variability of the physical characteristics in a basin and, in many cases, the lack of that kind of data, makes indispensable to establish acceptances in the model and to carry out the traditional calibration by comparing observed piezometers values and discharges at basin outlets with results provided by the model.

The main objectives of the paper are (i) to show each model’s performance on hydrology and nutrient dynamics simulation and (ii) to check SWAT simulated aquifer nitrate concentration by a physically based distributed model.

References:
For the setup of both models it is required meteorological information provided as time series (daily data for SWAT model and sub daily for MOHID) and spatially distributed data provided as different maps (Digital Elevation Model, Soil and Land Use maps). Each model reorganizes this data to its spatial distribution nature: Hydrologic Response Unit (HRU) in SWAT and grid cell in MOHID. Agricultural management practices have been maintained as similar as possible in both models.

Both models show good performance at simulating river discharge (Nash values are 0.74 and 0.73 for SWAT and MOHID, respectively, at daily time step). It must be considered that MOHID works at sub daily time step, so more precise results could be obtained with this model. The comparison between simulated and observed river discharge (Nash values are 0.74 and 0.73 for SWAT and MOHID, respectively, at daily time step) shows similar results for both models (at monthly time step they show $R^2$ of 0.96), MOHID model shows higher surface runoff contribution to the discharge.

Nitrogen cycle is simulated quite differently by the models. Whereas SWAT model is based on empirical equations for N cycle without modeling the carbon cycle, MOHID contemplates the soil organic matter decomposition from the microorganisms activity point of view, calculating for every time step, the microorganisms activity and also carbon, nitrogen and phosphorous fluxes. SWAT model has reproduced satisfactorily the nitrogen load exportation and also nitrate concentration in the river. The comparison between simulated and observed aquifer’s nitrate concentration suggests that SWAT is able to reproduce aquifer concentration in places where water table is shallow and the aquifer is the main contributor to river discharge. MOHID model also shows good performance on nitrogen load exportation and nitrate concentration both in the river and aquifer, proving SWAT ability for reproducing nitrate concentration in the Alegria river watershed.

Methods of processing hydrometeorological data based on Tinoasa–Ciurea representative basin using GIS techniques

G. Necula and C. Pricop
National Institute of Hydrology and Water Management
Administration of Prut – Barlad Water Basin, Romania

This paper summarizes data processing methods derived from observations and measurements at Ciurea Representative Basin for the year 2013. Tinoasa - Ciurea Representative Basin has an area of 4.17 km$^2$, is located in the eastern part of Romania, in Moldova Plateau, at the contact between the Moldavian Plains and the Central Moldavian Plateau. The site under study constitutes the upper part of the Nicolina river catchment area, which is part of Bahlui river basin, a tributary of the Prut River. This basin was chosen as a case study, in this paper, because it uses both classical and modern equipment (sensors for recording water level, solar radiation sensors and sensors for determining evaporation), in order to monitor hydrometeorological phenomena. Also, this basin is considered to be representative of all of the eastern plateau area of Romania.

The study aims at analyzing monitored meteorological parameters during the year 2013 within the basin and their influence on the formation of runoff, highlighting the main aspects of the flow (liquid and solid) and their role in the propagation and warning of dangerous hydrological phenomena. Working methodology was based on the use of G.I.S. technology and on numerical flow simulation models. G.I.S. data come in a variety of data formats and file types that are linked with descriptive information about spatial objects (stored in tables) and information about the datasets (their collection date, modification date and which is their accuracy). Using G.I.S. technology for characterizing and analyzing the study area brings forth its main software packages such as ArcGIS and the modalities for the implementation of this technology in small river basins. Flow modeling, both liquid and solid, drawing maps with isolines, developing forecasts and warnings are possible using this technology. The value of the results is given by the correctness and accuracy of the entry data in the program.

The results have highlighted the dominant role that the distribution of precipitation amounts plays in shaping the runoff considering the fact that there are completely forested and deforested basins and also the significant role of rainfall interception by forests (it being revealed with the drawing of rainfall and vegetation maps). Also, a specific phenomenon of the basin which is present more than half a year in 2013, is depletion, which is explained with geological mapping and soil mapping and also by determining the duration of sunshine, solar radiation and evaporation values. In 2013, evaporation values exceeded by far the multiannual average values (over 650 mm). Equipping this basin with automatic weather station (including all types of radiation sensors) and sensors for level determination makes this to be a warning basin in the case of dangerous hydrological phenomena occurrence.

In conclusion, the study targets the influence that the physico-geographical and generator factors (rainfall, temperatures, evaporation) have on the formation of runoff in small river basins.
ERB2014-21
Riverbed groundwater interaction – how to estimate groundwater recharge
H. Holzmann
University of Natural Resources and Life Sciences, Vienna, Austria

Groundwater and surface water interaction play an important role for groundwater recharge, drought management and water quality issues. Based on a case study in Lower Austria different techniques for estimation of riverbed infiltration were applied. The aim was to assess the impact of upstream release flow directives for the downstream water balance. Due to large streambed conductivities, infiltration losses considerably contribute to the water balance of the system. The applied methods dealt with empirical infiltration formulas based on sediment particle size distribution, soil physical analysis, difference discharge measurements along river branches and point measurements of infiltration by means of double ring infiltrometer, riverbed lysimeter and inverse groundwater modelling. Awaring the fact that the infiltration processes vary in space and time the gained results formed a basis for definition of potential values of infiltration. These findings were used as first estimates for the second order boundary condition (constant flux) in the groundwater modelling. It could be concluded that for the investigated environment the different methods exhibited comparable results with the exception of the empirical formulas, which tend to significantly overestimate the average values. The presentation will focus on the field observation techniques, like infiltrometer and riverbed lysimeter application. Furthermore the potential of spatial data analysis of groundwater level for the identification of riverbed leakage will be demonstrated.

ERB2014-22
Contribution of forest road network to the flash flood in Pila village in June 2011 (first approximation)
T. Orfanus
Institute of Hydrology, Slovak Academy of Sciences, Račianska 75, 831 02 Bratislava, Slovakia

The effect of wood harvesting on hydrological processes has become intensively discussed in Slovakia. Previous studies (monitoring and simulations) revealed no positive effect of forests on storm floods when compared to surrogate vegetation, i.e. grasslands, herbs or shrubs when the soil compaction and erosion were prevented. There was a destructive flood in Pila village in June 7, 2011, induced by 104 mm rainfall precipitation during 3 hours. The total flood discharge was estimated to 531 000 m$^3$. The 32 km$^2$ upper Gidra river catchment is forested by more than 95%, but the forest floor has been substantially disrupted by intensive logging activities during the last two decades. The forest road density in the left part of catchment reaches 10 km/km$^2$. About 25% of these linear compacted surfaces have been deepened down to the slightly permeable subsoil directly during their construction or by subsequent traffic and erosion. Direct surface runoff from the compacted surfaces was estimated to about 54 000 m$^3$ during the 2011 flood. HYDRUS-2D simulations revealed that drainage of the upward slopes by deeper wood-logging lines could transform the similar amount of subsurface water to the surface runoff, which contributes to the direct flood discharge, as well. The typical 100 cm deep soil profile was defined as input for the model. We considered 3 horizons: Ao (0-25 cm) – sandy loam ochric organomineral horizon, B (25-100 cm) – sandy clay loam cambic mineral horizon, C (100-more cm) – deluvial and proluvial substrate with very low permeability. The hydrophysical characteristics of particular soil horizons were measured by standard laboratory methods. The digital elevation model of Gidra catchment has been constructed in Grass GIS environment. Simulations were then performed for different inclinations and the results were weighed by occurrence frequency of various inclination classes in the catchment. New hydrological parameter has been defined; the critical hillslope length, which is the length of the upward slope above the forest road to which a continuous water table is created above the lowly permeable subsoil by specific rainfall and for specific slope.
ERB2014-25
Locating soil macropores with thermography
J.L.M.P. de Lima (1), J.R.C.B. Abrantes (1), V.P. Silva Jr. (2), M.I.P. de Lima (1) and A.A.A. Montenegro (2)
(1) Departamento de Engenharia Civil da Faculdade de Ciências e Tecnologia da Universidade de Coimbra (DEC-FCTUC), Portugal
(2) Departamento de Tecnologia Rural, Universidade Federal Rural de Pernambuco (DTR-UFRPE), Brasil

Water movement through soil macropores has significant impact on hydrological response. These structures affect infiltration, since they allow water to flow deeper and faster into the soil. Macropores also affect air flow into the soil and root growth, and enhance biological activity; their characterization has been attempted using different techniques (e.g. Perret et al., 1999; Luo et al., 2010).

This experimental study aimed to evaluate the performance of infrared thermography for mapping soil surface macroporosity and corresponding quantification of the number and size of different vertical macropores. It is a follow up of the work by de Lima and Abrantes (2014a, 2014b) on using infrared thermography in a controlled laboratory environment to study surface hydrological processes. Infrared thermography technology has experienced recently a great development, accompanied by a significant cost reduction, and is being used as a high resolution imaging tool for hydrological studies (e.g. Pfister et al., 2010; Schuetz et al., 2012); in particular, hand-portable infrared thermography devices show easy handling and scale adjustment.

The laboratory experiments were carried out using a rectangular free drainage soil flume with an area of 1.5x0.3 m² and a depth of 0.12 m. The soil flume, set at 10% slope, was filled with a sandy loam soil from the right bank of the Mondego River, in Coimbra (Portugal); vertical and inclined macropores were created in the soil by boring it with metal rods of different rectangular and circular sections.

The infrared thermography technique used to identify the macropores is based on applying a constant and uniform flow of hot water over the soil surface, using a feeder box installed at the upslope end of the flume. The water was heated to a temperature of around 80°C, and was applied with the lowest possible discharge in order to avoid damaging the structure of the macropores. As the heated water flows uniformly distributed over the soil surface, it concentrates in the macropores and infiltrates, yielding spots of higher temperature. Soil surface and macropores' temperatures were recorded with an Optris PI-160 portable infrared video camera (Optris GmbH, Germany); the output are thermograms (i.e. thermal imaging) that can be used to map the location of macropores, identify its geometry and estimate its size. The infrared technique allows to distinguishing the different sizes of the macropores, either by the size of the area of higher temperature or/and by the temperature gradient of these areas with respect to soil temperature. Macropores with smaller sectional areas show lower temperatures, since the amount of hot water flowing to these macropores is small, and are more difficult to characterize; thus, the macropore geometry is better defined for larger macropores. However, the technique does not allow to identify sharply the boundary of the macropores’ geometry, since it smoothes the edges due to thermal diffusion.

Results of this study show that the thermographic technique is easy to apply and can be useful to identify macropores at the soil surface and estimate its approximate size in a fast way. In field applications, it is expected that this technique allows also the mapping of macropores, even in the presence of mulching, which restricts their direct identification.

References:


ERB2014-26
TMS3: Temperature and moisture system for spatially distributed measurements
M. Šanda (1), T. Haase (2), J. Wild (3) and J. Jankovec (1)
(1) CTU in Prague, Faculty of Civil Engineering, Czech Republic
(2) TOMST s.r.o.
(3) Institute of Botany, AS CR

Third generation of combined thermal and soil moisture standalone field station made by TOMST s.r.o. (www.tomst.com) coded TMS3 is presented. The device combines three thermometers (MAXIM/DALLAS Semiconductor DS7505U with -55 to +125°C range and 0.0625°C resolution, 0.5°C precision in 0 to +70°C range and 2°C precision out of this range). Soil moisture measurement is performed based on time domain transmission (TDT) principle for the full range of soil moisture with 0.125% resolution within the full possible soil moisture span.

Principal compact version is designed for use approximately at heights -10, 0 and +12 cm relative to soil surface when installed vertically. Set of buriable/subsurface stations each with 2.2m extension cord and soil surface temperature measurement provides possibility to scan vertical soil profile for soil moisture and temperature at desired depths with soil and air temperature record. USB equipped station is designed for streamed direct data acquisition in laboratory use. Station is also equipped with the shock sensor indicating pre-manipulation. Presented version incorporates lifetime power supply for approximately 10 year operation and life time permanent data storage (0.5 million logs). Current sensor design aims towards improved durability in harsh outdoor environment with reliable functioning in wet
conditions withstanding mechanical or electric shock destruction. Insertion into the soil is possible by pressing with the use of a simple installation plastic shield.

Data are retrieved by TMD contact portable pocket collector (second generation) or by planned RFID wireless communication for hundreds meter distance (next generation for 2015). This option will allow online data harvesting and real time process control (e.g. optimized irrigation). Thanks to improved energy management of the unit, datasets are drafted in one minute interval for preliminary control on thermal and soil moisture status. User defined conditions (scanning for hydrological events with a 1 minute record interval and/or basic defined regimes (ca 1, 5, 10, 15 min - see Lolly manager software for details) is applied for the final stored record. Basic station diagnostics of the station is recorded daily, comprehensive record is performed monthly.

Last version of TMS3 station is being currently installed and used mostly in Czech Republic in mountainous and agricultural regions, but also at sites as e.g. Kenya or Ladakh bringing promising results in performance and durability. First analyses of water budget in the soil profile along vertical axis have been performed with good agreement with other commercial sensors (CS616 Campbell Scientific) as well as comparisons of soil moisture variability in the topsoil.

The research is supported by the Technology Agency of the Czech Republic projects No. TA01021283.

ERB2014-30
Rainfall estimation from in situ soil moisture observations: is it feasible?

L. Brocca (1), C. Massari (1), L. Ciabatta (1), T. Moramarco (1), D. Penna (2,3), G. Zuecco (3), L. Planezziola (3), P. Matgen (4) and J. Martinez-Fernández (5)

(1) Research Institute for Geo-Hydrological Protection, CNR, Perugia, Italy
(2) Department of Land and Agroforest Environments, University of Padova, Legnaro, Italy
(3) Department of Environmental Systems Science, ETH, Zurich, Switzerland
(4) Public Research Centre - Gabriel Lippmann, CRP, Belvaux, Luxembourg
(5) Centro Hispano Luso de Investigaciones Agrarias, USAL, Villamayor, Spain

Accurate estimates of rainfall are of vital importance for mitigation strategies of natural hazards such as floods and landslides as well as for disease and famine prevention and many other applications (Brocca et al., 2014). However, over many areas, ground-based observations of rainfall may be affected by significant errors mainly due to the spatial representativeness of the rain measurements, even in well-gauged experimental catchments. Due to the fundamental role played by rainfall in hydrological applications, the development of new techniques for improving its estimation is highly required. In this study, a "bottom-up" approach, named SM2RAIN, is applied, by doing "hydrology backwards", and using variations in soil moisture obtained from in situ sensors to infer preceding rainfall amounts. In other words, the soil is used as a natural raingauge and the soil moisture sensor is used for monitoring the water amount entering into the soil during a rainfall event. The SM2RAIN method is based on the inversion of the soil water balance equation and involves the estimation of only three parameters related to soil hydraulic properties (Brocca et al., 2013). The first application of the SM2RAIN method considered 1-year of in situ observations for only three locations in Italy, Spain and France (Brocca et al., 2013).

The main purpose of this study is to further develop the SM2RAIN method through its application over a number of experimental sites in Europe and Australia that are characterized by very different climatic and soil/land use conditions. Moreover, hourly (and sub-hourly) observations of soil moisture and rainfall over multiyear time periods are employed.

Firstly, the analysis of the SM2RAIN performance in calibration and validation periods is investigated by computing the different performance scores usually employed for analyzing rainfall data: correlation coefficient, r, root mean square error, RMSE, bias, probability of detection and false alarm ratio. The algorithm is found to perform satisfactorily over a variety of climatic, soil and land use conditions with r-values between observed and estimated rainfall, at daily time scale, ranging between 0.80 and 0.92 and average RMSE equal to ~3 mm/day. Secondly, the role played by different factors on the performance of the algorithm are investigated: (i) soil texture and land use, (ii) climatic conditions, (iii) depth of soil moisture sensor, and (iv) temporal resolution of soil moisture observations. Finally, several experiments with synthetic data obtained from physically-based hydrological models are carried out to test some possible improvements in the algorithm such as the addition of an explicit component for the runoff.

Overall, the obtained results clearly demonstrate the potential of soil moisture measurements to be employed as additional source of information including the improvement of rainfall estimation. Specifically, the integration of observed and estimated rainfall (through SM2RAIN) is envisaged even for improving hydrological applications such as flood modelling (Crow and Ryu, 2009; Massari et al., 2014).

References:

15th Biennial Conference ERB2014
Land use induced change of suspended sediment loads in the Petzenkirchen catchment, Lower Austria

C. Krammer and P. Strauss
Institute for Land and Water Management Research, Federal Agency for Water Management, Pollinbergstrasse 1, A-3252 Petzenkirchen, Austria

Streams in intensively used agricultural catchments are frequently characterised by increased transport of suspended sediments during rainfall events. This may affect stream water quality considerably (Eder et al., 2010; Bečvář, 2006). Since the beginning of the 1950’s, technological development in agriculture has received an unprecedented boost in terms of yields, use of agrochemicals and use of machinery. Alongside with this development negative side effects such as increased eutrophication, erosion or sediment delivery into streams are reported. Unfortunately sediment concentrations are event based and they vary considerably between events. This makes an evaluation of land use change on sediment behavior difficult (Lewis, 1996; Ulaga, 2005). Additionally, measurements of sediment concentrations in the ‘preindustrial era’ of agriculture are rare. The research watershed “Petzenkirchen” has been monitored from 1946 to 1954 and from 1990 on for water flow and sediment concentrations. Because two different measurement periods with distinct differences in land use have been observed, it thus offers the possibility to investigate if the change in land use influenced on sediment concentrations.

The aim of this study was therefore to determine if the changes in land use between the period 1945-1954 and 2002-2013 are reflected in suspended sediment concentrations and loads.

The Petzenkirchen catchment is situated in the prealpine area of Lower Austria with a mean annual precipitation of 716 mm. The catchment area extends 0.66 km$^2$ and has a medium length of 590 m and a slope of 2.4%. In the 1950s, the land use in the catchment was: arable land (72%), pasture (26%) and paved (2%). The main crops were winter wheat (18.9%), barley (4.4%), oats (15%), rye (10.8%), potatoes (13.6%), sugar beet (12.7%), maize (1.9%) and Lucerne (22.4%). At present 87% of the catchment area is arable land, 5% is pasture, 6% is forest and 2% is paved. The typical crops are winter wheat (43.2%), barley (11.5%), winter rape (10.7%), sunflower (12.8%) and maize (21.8%).

In the 1950s, the land use in the catchment was: arable land (72%), pasture (26%) and paved (2%). The main crops were winter wheat (18.9%), barley (4.4%), oats (15%), rye (10.8%), potatoes (13.6%), sugar beet (12.7%), maize (1.9%) and Lucerne (22.4%). At present 87% of the catchment area is arable land, 5% is pasture, 6% is forest and 2% is paved. The typical crops are winter wheat (43.2%), barley (11.5%), winter rape (10.7%), sunflower (12.8%) and maize (21.8%).

Discharge has been monitored between 1946 and 1954 and 2002-2013 using a Thomson weir combined with a limnigraph at a resolution of 1 min. For the period 2002 to present measurements were performed using an H-Flume combined with a water pressure sensor at a resolution of 1 min.

Suspended sediment concentrations and turbidity were measured during three different periods:

a) Between 1946 and 1954, water samples were taken regularly every 2 – 3 days at the beginning, and every 7 days near the end of that period. With a total number of 934 samples in 9 years this makes an average sampling interval of 3.5 days.

b) Between 2002 and 2005, the water samples were taken with an automatic suction sampler, this was mainly event based and resulted in a total number 389 samples.

c) From 2005 on, water samples were also taken during events using an automatic suction sampler. The total number of these samples is 2211. In addition, a continuous observation of turbidity (temporal resolution 1 min) has been performed (WTW: ViSolid 700 IQ).

To establish relationships between sediment concentration and water discharge for the different periods of interest we used several methods:

- Establishment of a sediment loading function between instantaneous discharge and suspended sediment concentration
- Aggregation of samples using water discharge and sediment concentration classes as well as duration curves

The samples of the different periods do not have the same statistical properties in a first approach. In an effort to obtain homogeneous data sets we therefore only took subsamples for the periods b) and c) for analysis. These subsamples were taken to resemble the data set in period a) with respect to rising/falling limb of the discharge and event flow rates.

The samples to calculate loading functions for the different periods of interest finally had the following characteristics:

- $n=943$, min flow $=0.40\ l\cdot s^{-1}$, max flow $=102\ l\cdot s^{-1}$, mean sediment concentration $=261\ \mathrm{mg}\cdot l^{-1}$ (period a);
- $n=1000$, min flow $=0.8\ l\cdot s^{-1}$, max flow $=120\ l\cdot s^{-1}$, mean sediment concentration $=1577\ \mathrm{mg}\cdot l^{-1}$ (period b and c).

In addition, calculation of sediment loading functions for the periods a) on the one hand and b) on the other hand revealed that substantial increase in sediment concentrations between periods a) and b) had occurred. Simultaneously with this change in sediment concentrations, a distinct change in land use took place. This can be seen from the conversion of grassland into cropland, a complete removal of fodder crops and a change of crop types. Change of crop types was mainly associated with removal of grain cereals to maize. This suggests that land use change between 1950 and present had a substantial effect on sediment production in the Petzenkirchen catchment.

References:


ERB2014-33
Changes in the river flow regime in the Raba Basin (Poland’s Western Carpathians)
M. Kędra
Cracow University of Technology, Institute of Engineering and Water Management, Warszawska 24, 31 151 Cracow, Poland

Alterations in a stream flow regime force the accommodated changes in a water management system. The identification and evaluation of the observed alterations in the hydrological regime is therefore of a great importance. Unfortunately, the lack of long continuous hydrometric records (e.g. in Poland) limits analyses to the last tens of years, and for that reason the distinction between the range of change in regime and the range of natural river flow variability can be difficult.

In Poland’s Western Carpathians, due to existing climatic and orographic conditions, the resulted river flow regimes for the long term have been characterised as so called nivo-pluvial or pluvio-nival, with two periods of high flows: in spring (in March or April) initiated by snow melting, and in summer (in June or July) caused by rainfall, with predominance of spring or summer flows, respectively (e.g. Chelnicki et al., 1999).

In the present study, an analysis and assessment of river flow variability in the selected mountainous catchment (of the Raba River) is performed for the period 1956–2012. Based on mean monthly discharge from the Raba River and a few its tributaries (with small basins), significant alterations in the characteristic features of the flow regime during the last 25–30 years or so have been identified. For all analysed catchments, the revealed changes pertain mainly to the summer half-year and involve alterations in the annual river flow pattern. Modifications in the distribution of mean monthly discharge follow towards the nival stream flow regime, with mainly one period of high flows in March–April, and weakly marked secondary culmination in June–July. Therefore, the alterations affect the magnitude of the culmination in June–July causing its noticeable decrease. The identified flow pattern for rivers belonging to the Raba Basin is atypical for that region, but similar to the pattern predetermined for streams in Poland’s Eastern Carpathians (e.g. Chelnicki et al., 1999).

References:

ERB2014-34
The influence of climatic, environmental and anthropogenic factors on flow regime changes in the Raba Basin (Poland’s Western Carpathians)
M. Kędra and J. Korpak
Cracow University of Technology, Institute of Engineering and Water Management, Warszawska 24, 31 151 Cracow, Poland

Every observed alteration in a hydrological regime should not only be recognized and estimated, but also thoroughly studied, explained and projected into future. The indication of the origins of the alterations in hydrological regimes can present a challenge, due to the difficulty in perceiving and assessing all of dynamical interactions between changes in climate and river environment followed in a particular time interval.

In the paper, various factors influencing the observed for the last 25–30 years significant changes in river flow regime in the Raba Basin are analysed in detail. The study is performed for several sub-catchments with the area ranging from 47 km² to 1470 km². The extended research involves the impact assessment of:
(a) climatic inputs (surface air temperature and precipitation),
(b) environmental factors (e.g. physiographic conditions, morphometric parameters of catchments and river channels, land cover), and
(c) anthropogenic influences (e.g. land-use, engineering works, river channel training, gravel mining) on temporal and spatial variability of river flows in the investigated catchment. The emphasis is put on the revealed changes in the hydrologic regime. The hydrometric records from Polish Institute of Meteorology and Water Management facilitate the evaluation of the hydrological inputs. In order to estimate and compare changes in channel morphometry and land cover, the archival air photos and maps are used from various years within the studied period of 1950-2012.

The conducted analyses allow one to assume that, among various factors considered, the climatic input plays the most important role in the observed alterations in the annual flow patterns in the Raba Basin. The identified shifts in the distribution of precipitation relate mainly to the summer half-year and they are consistent with the recognised changes in the flow regime for the last 25–30 years. The other considered factors differentiate the scale (intensity) of the observed alterations in flow regime in the particular catchments.
ERB2014-38

Importance of ‘initial abstractions’ in the genesis of flash floods in mountainous basins: Venero Claro experimental basin

J.M. Bodoque (1), A. Díez-Herrero (2), V. Ruiz-Villanueva (3) and E. Aroca-Jiménez (4)
(1) Facultad de Ciencias Ambientales y Bioquímica, Universidad de Castilla-La Mancha, Toledo, Spain
(2) Instituto Geológico y Minero de España (IGME), Ríos Rosas 23, 28003 Madrid, Spain
(3) Instituto de Ciencias Geológicas, Universidad de Berna, Switzerland
(4) Máster Universitario en Técnicas de Análisis, Evaluación y Gestión Sostenible de Procesos y Riesgos Naturales, Universidad de Cantabria, Spain

Flash floods constitute one of the hazards with the greatest capacity to generate risk, particularly with regard to society. The complexity of this process and its dependence on various factors related to basin and rainfall characteristics make flash floods difficult to characterize. To perform this task it is essential to conduct a proper analysis of the so-called ‘initial abstractions’. Among all of these processes, infiltration plays a crucial role in explaining the occurrence of floods in mountainous basins. The Green-Ampt model, which depends on the characteristics of rainfall and the physical properties of soil, will be used to characterize these abstractions. The method enables floods to be simulated in mountainous basins where hydrological response is sub-daily. However, it has the disadvantage that it is based on the physical properties of soil which have a high spatial variability. To address this difficulty, soil mapping units will be delineated based on geomorphological landforms and elements. They represent hydro-functional mapping units that are theoretically homogeneous from the perspective of the pedostructure parameters of the pedon. In addition, uncertainty associated with the parameterization of the Green-Ampt method will be estimated by implementing a Monte Carlo approach, which will require assignment of the proper distribution function to each parameter. The suitability of this method will be contrasted by calibrating and validating a hydrological model, in which the generation of the runoff hydrograph will be simulated using the SCS unit hydrograph, while flood wave routing will be characterized using the Muskingum-Cunge method. Calibration and validation of the model will be done with an automatic routine based on the search algorithm known as the univariate gradient, while the objective function to be used will be the percentage of error in the flow-peak of the hydrograph. The methodology proposed here will be implemented in the torrential Venero Claro basin, which is a tributary of the Alberche river on its right bank, located in the Sierra del Valle (eastern foothills of the Sierra de Gredos, Spanish Central System). Currently this basin has an active network of six rainfall gauges, one stream gauge, two complete weather stations and one X-band weather radar system. This hydroligic instrumentation makes this 15 km² basin one of the most densely instrumented basins from a hydrological and meteorological point of view in Spain.

ERB2014-39

The Venero Claro monitored basin and the web page of public distribution of hydrological and meteorological data

(1) Facultad de Ciencias Ambientales y Bioquímica, Universidad de Castilla-La Mancha (Toledo), Spain
(2) Instituto Geológico y Minero de España (IGME), Ríos Rosas 23, 28003 Madrid, Spain
(3) Instituto de Ciencias Geológicas, Universidad de Berna, Switzerland
(4) Escuela Universitaria de Ingeniería Técnica Forestal, Universidad Politécnica de Madrid, Spain
(5) Instituto de Diagnóstico Ambiental y Estudios del Agua, CSIC, Barcelona, Spain
(6) Texas A&M University, College Station, Texas, USA
(7) Master Universitario de Meteorología y Geofísica, Facultad de Ciencias Físicas, Universidad Complutense de Madrid, Spain

The Venero Claro experimental representative basin (Sierra de Gredos, Navaluenga, Ávila, Central Spain) is characterized by torrential behaviour, with flash floods, hyperconcentrated flows and debris flows taking place periodically. Since 2004, after the major known flow event in 1997, a very dense hydro-meteorological network was installed within the 15 km² catchment. This network is composed of 6 rain gauge stations (Hobo, Davis), 2 liminometers (Water Level), 1 weather radar station (Selex Rainscanner, X band), 2 complete weather stations (Vantage Vue, Davis) and 1 TDR soil moisture device (3 sensors). All these instruments are placed in representative positions in order to record the meteorological effects due to the elevation range (from 730 to 1940 m asl) and the hillslope aspect (from west to east). All the data recorded over these ten years (stream discharges, rainfall, soil moisture, detailed topography, geophysics and dendrogeomorphology) are now available to the international scientific community on a new website (http://veneroclaro.dendro-avenidas.es). It contains both general information about the Venero Claro basin (i.e. physiographic characteristics, 1997 flood event, projects, bibliography, etc.) and free access to data. Among the menus on this site is a 'Data Access' form where passwords will be provided to view or download all the data files collected by the hydrometeorological network from 2004 to the present. The hydro-meteorological information has been subject to processing and analysis during this decade: semi-distributed rainfall-runoff models for characterizing flood events; 1D-2D hydraulic models (critical depth method, HEC-RAS, Iber, MIKEFLOOD); determination of rainfall thresholds for triggering of landslides. Over the last year a special effort has been made to intensify hydrological analyses: fitting of frequency distribution functions of extreme values to precipitation and discharges; generalization of precipitation parameters (Generalized Pareto); geostatistical analysis of precipitation data; calculation of specific IDF curves; transforming reflectivity of radar in rainfall intensities by using geostatistics; modelling of the floating solid load and the associated hazardousness, and even isotopic analysis of precipitation in water and wood.
As a conclusion, this initiative enables others to use the collected data for calibration and validation of new hydrological methods and models. The dissemination of this type of information (not very common in Spain) may be of great interest for the technical and scientific community dedicated to geomorphological and hydrological processes and hazard analyses.

ERB2014-44

Spatio-temporal variability of throughfall and soil moisture at the plot scale in the Italian pre-Alps

D. Penna (1), G. Zuecco (2), O. Oliviero (2), H.J. van Meerveld (3), L. Hopp (4), G. Dalla Fontana (2) and M. Borga (2)

(1) Department of Environment Sciences System, Swiss Federal University of Technology (ETH), Zurich, Switzerland
(2) Department of Land, Environment, Agriculture and Forestry, University of Padova, Italy
(3) Critical Zone Hydrology Group, Faculty of Earth and Life Sciences, VU University Amsterdam, The Netherlands
(4) Department of Hydrology, University of Bayreuth, Bayreuth, Germany

Canopy interception determines the quantity and the spatial distribution of rain water infiltrating into the soil and affects many hydrological and biogeochemical processes. Many studies have focused on the quantification of throughfall but the controls on the spatial variability in throughfall at the plot scale and the temporal persistence of throughfall patterns are still poorly understood. Moreover, experimental evidence on the influence of throughfall patterns on the spatial and temporal variability of near-surface soil moisture patterns is still lacking. Therefore, in this study, we took advantage of a set of concurrent throughfall and soil moisture measurements at the plot scale in a pre-Alpine forested hillslope in Italy to address the following questions:

i) How much rainfall is intercepted by the canopy in different seasons?

ii) Do different collectors affect the final estimate of throughfall?

iii) How do throughfall patterns vary in space and time and what is their relation to canopy characteristics?

iv) What is the correlation between the spatial patterns of throughfall and near-surface soil moisture?

Throughfall and soil moisture measurements were taken from April to November 2013 in a 500 m² experimental plot on the hillslope of a small densely forested catchment (Ressi) in the Italian pre-Alps. The main tree species in the plot are beech and chestnut. The median diameter at breast height of the trees in the plot is 4 cm (range 1-61 cm). Two different throughfall collectors were used: buckets (collecting area: 556 cm²; capacity: 162 mm) and rain gauges (collecting area: 47 cm²; capacity: 80 mm). Fifty buckets were randomly distributed in the plot, while 40 rain gauges were installed on a regular grid (spacing 2.5x3 m²). A bucket and a rain gauge were installed in a nearby open area as well (approximately 150 m in a straight line from the experimental plot) to collect rainfall. Volumetric soil moisture content was measured at 50 points in the immediate vicinity (~30 cm upslope) of each bucket at two depths (0-7 and 0-12 cm) using portable TDR (Time Domain Reflectivity) probes. Rainfall and throughfall were measured for 20 events by manually emptying the collectors and measuring the volume of water in the collectors. Soil moisture measurements were taken before the events and after the events. In total, soil moisture was sampled 41 times for each depth. Canopy openness was determined by taking pictures with a 24 mm lens (covering an angle of 84°) upward from each bucket and rain gauge and selecting thresholds between dark (canopy) and light (sky) areas.

For the measured events, rainfall in the open area ranged from 4 mm to 122 mm. Plot-average throughfall for these events ranged between 69%-94% and 68%-100% of precipitation for the buckets and rain gauges, respectively. Throughfall measured by the two types of samplers was statistically similar (Mann-Whitney rank sum test, p>0.05). However, despite the smaller number of rain gauges than the buckets, the standard deviation and the coefficient of variation were typically higher for the rain gauges, likely due to their smaller collecting area. Measured throughfall in the plot ranged between 25%-178% and 13%-379% of the precipitation in open area for the bucket and the rain gauge measurements, respectively. This suggests an important role of dripping points in shaping plot-scale variability in throughfall, especially during small rainfall events, and underlines the greater variability in throughfall measured by the rain gauges than by the larger buckets. Throughfall as a percentage of precipitation tended to increase with increasing rainfall depth and rainfall intensity. The spatial variability of throughfall, expressed by the coefficient of variation, decreased asymptotically with increasing total rainfall and rainfall intensity.

Canopy openness (for the buckets) was poorly correlated with the mean relative difference of throughfall but significantly correlated (r=0.58, p<0.05) with the standard deviation of the relative difference. This suggests that canopy density and its heterogeneity exerts a weaker control on the spatial variability of throughfall than on the temporal persistence of throughfall patterns. Throughfall in the close canopy areas was more similar to the plot average than the throughfall in the gaps.

The soil moisture patterns were well correlated at the two depths (correlation coefficient ranged between 0.64 and 0.94, n=50), indicating a coupling between the patterns at two depths. Spearman rank correlation coefficient computed between the soil moisture pattern for a given sampling time and the pattern of the following sampling time ranged between 0.41 and 0.97 for 0-7 cm, and between 0.34 and 0.99 for 0-12 cm (n=50) revealing a high degree of temporal stability of soil moisture at the two depths. However, soil moisture spatial patterns were weakly or not significantly correlated with throughfall spatial patterns (maximum correlation was 0.35 at 0-7 cm depth and 0.38 at 0-12 depth), likely due to the lateral and vertical redistribution of water in the soil profile between the end of the rainfall event and the start of measurement (120-360 min). This also suggests that the spatial organization of soil moisture was dominated by soil properties rather than by the amount of throughfall.

In conclusions, this ongoing study contributes to gain more knowledge of the processes controlling the spatio-temporal variability of throughfall. However, our results also indicate the need to conduct further research to better understand the interrelationship between throughfall and soil moisture in forested catchments.
ERB2014-48

What future for small research basins?

S. Chersich (1,2), F. Maraga (3), F. Zucca (1) and L. Brocca (4)

(1) University of Pavia, Department of Earth Sciences, Pavia, Italy
(2) University of Milan Bicocca, Department of Earth and Environmental Sciences, Milan, Italy
(3) former Research Institute for Geo-Hydrological Protection, National Research Council, Turin, Italy
(4) Research Institute for Geo-Hydrological Protection, National Research Council, Perugia, Italy

The river basins represent the natural organizing scales of the terrestrial water ecosystem and are representative of the regional geologic, ecosystem and geomorphic environment on a long-term basis. Therefore, small experimental basins are fundamental for a significant advance in our understanding of the hydrological cycle but also of the energy, carbon and mass balances. Additionally, the research on small basins is expected to help in the understanding of the complex interactions that regulate the habitat and that determine the availability of life-sustaining resources, including water quality and food web. Notwithstanding the essential role of the research on small experimental basins, most of them suffer from the scarcity of funding thus being not possible to continue their hydro-meteorological monitoring through continuous sensor networks and ad hoc field campaigns. The main purpose of this study is to delineate some guidelines and suggestions for continuing the research on small basins in Italy.

A first inventory of the Italian experimental research basins has been carried out by Brocca (2013): the information for nine catchments, for which the experimental activity is still ongoing, has been collected and synthesized. Specifically, it was underlined that the research activity on small experimental basins in Italy started in '70s mainly focusing on runoff generation processes and the hydrologic response time of the catchments. Among these catchments, which are included in the ERB network, the Gallina and the Colorso basin are considered here as examples.

The Gallina basin (1.08 km²) belongs to the Po river system at the border of the Alpine range in north-western Italy presenting continental-Mediterranean climate. In the basin, a long-term (30 years) hydro-meteorological monitoring has been carried out also to understand the possible impact of climate changing on such a pristine environment (Anselmo et al., 2011). Besides a meteorological station, a hydro-sedimentary station at the outlet, where the sediment transport is prevailing bed load, is equipped by a sediment trap. The Colorso basin (12 km²) is located in central Italy and it is characterized by a Mediterranean climate. The basin was firstly equipped with rainfall and discharge stations and then a network of soil moisture stations was setup to study the role of soil moisture in the runoff generation processes (Brocca et al., 2011). The data collected in the Colorso basin were successively employed for a number of research activities as, for instance, the assessment of satellite soil moisture products accuracy (Brocca et al., 2010). For both basins, an important dataset has been collected that risks to be interrupted due to missing financial fund and technical personnel.

To overcome these issues, we propose here some possible ways forward. Regarding the research, we need to create a stronger network for the harmonization of the research activities in the different experimental basins in Italy also by sharing the collected data sets as well as measurement protocols. This will permit researchers to analyze a more extended database (both in time and in space) thus obtaining more robust results. Additionally, new research paths might be initiated. An ideal framework could be the Critical Zone (CZ) concept, which is related to a holistic framework for integrated studies of water with soil, rock, air, and biotic resources in the near-surface terrestrial environment (Lin, 2010).

For the near future, it is desirable to improve also the educational opportunities of the experimental catchments. Indeed, these basins are suitable to develop a focused and effective education of Earth sciences subjects at different levels; they can be considered as outdoor laboratories for a collaborative learning and research (see e.g. the United States Environmental Protection Agency, http://www2.epa.gov/learn-issues/learn-about-water). For instance, since 2008, educational scientific projects for students of primary schools have been undertaken in the Gallina basin and, in the following years, they will be extended to high school students. These educational activities have been funded by local communities and we are planning to use the municipality rooms for the development of a permanent scientific research Museum.

Another important aspect is related to the information and involvement of local people who live in the catchment area for making them understanding the relevance of the research activities that are carried out. Local people will become well aware and proud of the wealth of natural heritage and can be engaged for the maintenance and management of the equipment located within these areas (community engagement). Doing this, the experimental basins can become a sustainable resource for the territory from which the whole community (scientific and local) can obtain benefits.

So to come back to the question in the title: "what future for small research basins" in our vision it might became "how can we do better for the future activities of ERB community".

References:


Testing a method to classify flow regime alterations in a temporary river

A.M. De Girolamo (1), A. Lo Porto (1), G. Pappagallo (1) and F. Gallart (2)

(1) IRSA, CNR, 70132 Bari, Italy
(2) IDAEA, CSIC, Jordi Girona 18, 08034 Barcelona, Spain

The divergence of the actual hydrological regime from its natural condition may be responsible for the chemical and ecological status of a river. Anthropogenic pressures such as water abstractions, reservoirs, discharges of sewage may have a negative impact on biotic composition, structures and functioning of aquatic and riparian ecosystem. Hence, the evaluation of the hydrological alterations of a water body in a catchment is of the greatest importance in order to achieve the final objective of the European Water Framework Directive (WFD).

Hydrological status assessment is a difficult task especially in temporary rivers where the natural variability of streamflow may be confused with the effects of anthropogenic pressures. The WFD doesn’t provide recommendations on how the alterations should be evaluated and quantified. Some EU countries provide guidelines which are not specific for temporary rivers. Generally, hydrological alteration assessment is based on a comparison of hydrological indexes calculated on daily streamflow basis before and after impacts. In this paper, we tested a new approach to evaluate the hydrological alterations of a temporary river. In these rivers, it is expected that anthropogenic pressures largely modify low flow components with consequences on aquatic habitat and diversity in invertebrate species. For this reason, here the flow regime has been classified through the analysis of two metrics: the degree and the predictability of dry flow conditions, which were evaluated on monthly streamflow data. Both indexes were also used as indicators to assess the river’s natural flow regime and its alterations. We applied the methodology to the Salsola and Celone, two tributaries of the Candelaro river, located in Apulia region (Southern Italy). The drainage area is about 500 and 320 km², respectively. In the present study, the basins and river network have been fractionated in sub-units. Measured streamflow data over a long period (at least 15 years) were used to calculate the metrics in actual conditions. Given the lack of data from pristine conditions, simulated streamflow time series were used for calculating metrics in reference conditions. The SWAT model was run, which was calibrated and validated. The results of uncertainty analysis showed that parameter uncertainties were larger for low flow conditions than for floods and that extreme low flow tend to be overestimated by the model. This is a crucial point in simulating natural streamflow for temporary rivers, for which it is particularly important to understand if the extreme low flow predicted by the model is realistic or not. In this work a correction of flow series was elaborated for those river reaches recognized as temporary streams. By using the two metrics as coordinates in a plot a graphic representation of the regime can be visualized in a point. Hydrological perturbations associated with water abstractions, point discharges and the presence of a reservoir were assessed by comparing the position of the two points representing the regime before and after the impacts. A critical hydrological status was identified for some river reaches as a consequence of flow permanence change. The results show that the method is a useful tool when identifying river bodies under hydrological pressures and it can be used in defining the water quality status and in planning the “measures” towards the WFD goals.
ERB2014-50
Influence of wind-driven-rain on the rainfall-runoff process in urban areas

J.M.G.P. Isidoro (1,2) and J.L.M.P. de Lima (1,3)

(1) Institute of Marine Research (IMAR), Marine and Environmental Sciences Centre (MARE), Portugal
(2) Department of Civil Engineering, Institute of Engineering, University of Algarve, 8005-139 Faro, Portugal
(3) Department of Civil Engineering, Faculty of Sciences and Technology, University of Coimbra, 3030-788 Coimbra, Portugal

Runoff is an important component of the hydrological cycle, of the highest importance of hydrological studies of drainage basins, namely, urban basins. A deeper knowledge of the rainfall-runoff process is thus essential for a better design of urban drainage systems, water erosion, and soil and water conservation measures. The last decades showed that population growth and following urban expansion led to an increase in soil occupation, with severe changes of the natural hydrological cycle.

To assess the implications of these changes in urban areas, artificial rainfall laboratory tests were performed based on laboratory physical models. This work sums up several articles (e.g. Isidoro et al., 2012a, 2012b; Isidoro and de Lima, 2013). The rainfall simulator consisted of a movable structure with nozzles which could generate wind fields. The models have the ability to simulate the geometry and implantation of buildings on an impervious surface. These physical models represented different: a) building densities, b) rooftop connectivities, and c) building heights. A set of simulations of intense static and dynamic rainfall (moving storms), with and without wind action, were carried out.

The combined action of wind and rain significantly influences the rainfall-runoff process, leading to significant changes in the shape of the runoff hydrographs which will have influence on other processes (e.g. infiltration and transport of e.g. sediments, pollutants). The experiments have shown marked changes in the hydrograph, particularly in the peak flow, base time and slope of the limbs.

The results confirmed that, for the different simulated conditions of intense rainfall, the combined action of wind and rainfall and the geometry and implantation of buildings also have an influence on the rainfall-runoff process. This kind of physical modelling in laboratory setting can be used to assess some features of the built environment that influence runoff generation (e.g. less interception, altered depression storage, wetting of walls, changing of overland flow paths), reinforcing the importance of urban planning as a key tool in flood prevention and management.

References:

ERB2014-51
Assimilation of in situ soil moisture for improving rainfall and discharge prediction in small experimental basins

C. Massari (1), L. Brocca (1), A. Tarpanelli (1), T. Moramarco (1), D. Penna (2,3), M. Boga (2), P. Matgen (4) and J. Martinez-Fernández (5)

(1) Research Institute for Geo-Hydrological Protection, CNR, Perugia, Italy
(2) Department of Land and Agroforest Environments, University of Padova, Legnaro, Italy
(3) Department of Environmental Systems Science, ETH, Zurich, Switzerland
(4) Public Research Centre - Gabriel Lippmann, CRP, Belvaux, Luxembourg
(5) Centro Hispano Luso de Investigaciones Agrarias, USAL, Villamayor, Spain

Soil moisture (SM) is a key climate variable regulating energy and mass exchange between soil and atmosphere. In hydrology, SM plays an important role for floods, droughts and wildfires. As an example, in rainfall runoff modelling SM controls the rainfall-runoff partitioning by acting on many important hydrological processes such as evapotranspiration, infiltration and drainage. Although several studies have highlighted the potential of SM observations to improve flood modelling, much research has still to be done for fully exploiting the evident connection between SM and runoff. A number of studies in the last decade have highlighted the importance of SM for obtaining a reliable estimation of the catchment initial conditions before a storm event (e.g. Penna et al., 2011; Massari et al., 2014a). A confirmation of the high importance of SM has also derived from its use for correcting and estimating rainfall (Pellarin et al., 2008; Crow and Ryu, 2009; Brocca et al., 2013). By way of example, Brocca et al. (2013) proposed an innovative approach (SM2RAIN) that uses SM observations for directly estimating rainfall by inverting the soil-water-balance equation. In this respect, Crow and Ryu (2009) and Massari et al. (2014b) demonstrated that the assimilation of SM observations for both improving the quality of forcing data, i.e. rainfall observations, and enhancing the state estimation, might have a great benefit in flood simulation. However, the authors use synthetic data (Crow and Ryu, 2009) and only a small experimental catchment (Massari et al., 2014b) to prove their assumptions.

In this study, this methodology is extended to five European small experimental catchments having different hydrologic regimes and climate conditions considering the assimilation of different hydrologic quantities (e.g. SM, runoff etc.). The selected catchments have drainage areas in the range 1.0-15 km² and are located in central and north Italy (Resi and Colorso), Spain (Villamor), Luxembourg (Bibeschbach) and France (Valescure). For each catchment, high quality hourly in situ observations of soil moisture, rainfall and runoff (and other meteorological variables) have been collected for many years, thus establishing a remarkable and interesting case study for assessing the effectiveness of the assimilation exercise. The analysis is carried out by using the Ensemble Kalman filter for the assimilation of the states within the MISDc model ("Modello Idrologico Semidistribuito in continuo", Brocca et al., 2011). Rainfall correction is separately performed by the integration of the estimated rainfall via
SM2RAIN and the observed data. Different configurations of the assimilation experiment are analysed allowing to better understanding the benefits and the problems related to the jointly and the independently assimilation of the different observed hydrologic variables. Specifically, the assimilation of SM is found to improve runoff prediction for all the catchments. Moreover, the joint use of SM data for both correcting model states and rainfall significantly outperforms the situation where SM observations are used solely to initialize the hydrological model.

References:

ERB2014-52
Monitoring of streamflow along a brook from natural forest to urban area
P. Kalicz, P. Csáfordi, G. Király, R. Szita, A. Herceg, B.K. Szegedi and Z. Gribovszki
Institute of Geomatics and Civil Engineering, University of West Hungary, Sopron, Hungary

Runoff processes in natural catchments especially in forested ones are significantly different compared to urbanized areas. Pavements, channel control and canalisation reduce the surface roughness, the surface storage capacity, and the infiltration rate. The consequences are the increased surface runoff, the larger flood peaks, the shorter time of concentration, and the reduced travel time. These indices indicate the degree of human impacts on the runoff process and land use.

This study presents the results of a monitoring campaign of a small stream comparing runoff from natural, rural and urban sections. The pilot area of this research is the Rák Brook of town Sopron (western Hungary). The natural headwater catchment (6 km²) is the long-term research area of Hidegvíz Valley Project, therefore we had a good basis to extend the research catchment monitoring in the direction of urbanized lower part of the stream. The whole area of the extended drainage basin is 37.3 km². After some initial investigations seven sampling points were established along the Rák Brook. Each of them was monitored weekly and equipped with digital data loggers. The surface cover characteristics were analysed with GIS techniques. Four main categories were determined for each sub-basin, namely urban (artificially modified) area, agricultural land, grassland and finally forest and bushy area.

In this study three representative monitoring points are selected and compared along the longitudinal section of the stream. In each selected points the water stage is recorded continuously with pressure transducers, and the discharge is derived by rating curves. With the help of the specific discharge the different sections are well comparable. The differences between the natural and modified catchments are quantifiable with the slope of a regression line on the precipitation vs. specific discharge point clouds. The slope of the urbanized catchment line (9.11) is ten-times steeper then the slope of almost totally forested natural headwater (0.95) and rural (0.66) catchments regression lines. The difference indicates the stronger runoff response to precipitation.
ERB2014-59
Modelling the impacts of climate change on a small basin under the influence of intensive vineyard culture

D. Serpa, J.P. Nunes, V. Silva, M.E. Rial-Rivas, J.J. Keizer and N. Abrantes
CESAM & Departamento de Ambiente e Ordenamento da Universidade de Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal

Agricultural activities constitute one of the major causes of river water quality deterioration since large amounts of agrochemicals, namely fertilizers and phytopharmaceuticals, are supplied to the aquatic system. Although the impacts of agricultural pollution on freshwater systems have been widely investigated, there is a lack of fundamental understanding on how climate-induced changes in river flow, sediment transport and chemistry will affect the ecology of agriculture-impacted systems.

Taking into account the relevance of this topic within the context of the Water Framework Directive, a modelling approach was used in the present study to predict the impacts of climate change on the hydrological processes, sediment transport and chemical pollution of aquatic systems located nearby intensive vineyard areas. At a further stage, model results will be compared with those of microcosm bioassays to estimate the impacts of stream flow properties on these systems.

To ensure a detailed understanding of the processes occurring in the system, the model developed in the present study was calibrated and validated with data collected at a small experimental basin (6.2 km²) – São Lourenço.

Located within the Cértima River catchment (North-Central Portugal), the São Lourenço micro-basin is integrated in an important Portuguese winegrowing region – the Bairrada. Although vineyards are the dominant crop in the basin (35.0% of the total area), annual crops such as corn, pasture and potato, occupy a relevant area (17.2%). Aside from agricultural lands, the São Lourenço basin comprises large forest areas (33.9%), mainly of maritime pine and eucalypt plantations. Soils are typically Humic Cambisols (46.2%) however Chromic Luvisols (23.4%) and Calic Cambisols (18.4%) are also well represented in the basin. The climate in the region is described as sub-humid, with mild and wet winters and, dry and hot summers.

The São Lourenço’s experimental area, instrumented in October 2011, includes runoff and erosion plots in ploughed and non-ploughed vineyard lines, as well as a hydrometric station equipped with an automatic sampler, which allows for continuously records of water levels and the collection of stream samples during rainfall events. Rainfall gauges (two automatic and one totalizer) have also been installed in the area as well as Time Domain Reflectometry (TDR) probes to measure soil moisture in vineyards. As part of the monitoring program, runoff and stream samples are being collected on a weekly or bi-weekly basis, depending on the occurrence of rainfall events. Water samples are analysed for basic physicochemical parameters (pH, temperature, dissolved oxygen, electrical conductivity and total suspended solids) as well as for nutrients (nitrates, nitrites, phosphates, total nitrogen and phosphorus) and pesticides (15 in total).

For the modelling part of the work, the SWAT – Soil and Water Assessment Tool – model was selected largely because this has been widely applied in river basins worldwide to simulate hydrological and erosion processes as well as river water quality under changed climate conditions. Model performance was evaluated using the coefficient of determination ($R^2$), the Nash-Sutcliffe coefficient (NSE) and the percent of bias (PBIAS). Climate change scenarios, which included a “control” scenario (1971-2000) and two future scenarios for the period between 2071 and 2100, were simulated using the calibrated model. In the present study, future scenarios were derived from the outputs of a Global Circulation Model (GCM) driven by the A1b and B1 emission scenarios defined by the IPCC, which were dynamically downscaled with Regional Circulated Models (RCMs).

Based on the calibration results, the model developed in the present work is a powerful tool for simulating the water flow rates, sediment transport and chemical status of the São Lourenço stream. In what concerns the hydrological response, an excellent agreement was found between simulated and observed stream flow data ($R^2$=0.83; NSE=0.83; PBIAS=0.44%). As regards to sediment transport, model performance might be considered satisfactory ($R^2$=0.73; NSE=0.60), however there seems to be some underestimation of the daily amount of sediments exported from the basin, since a PBIAS of 46.4% was found. In terms of chemical response, an excellent agreement was found between simulated and observed daily phosphorus (P) loads ($R^2$=0.87; NSE=0.87; PBIAS=10.5%) unlike for nitrogen, for which model predictions were found to be satisfactory ($R^2$=0.63; NSE=0.32; PBIAS=-27.0%). For pesticides, namely the copper sulphate (CuSO$_4$) which is frequently used in vineyards, a satisfactory model performance was found between observed and simulated daily CuSO$_4$ loads ($R^2$=0.54, NSE=0.50; PBIAS=-19.1%)

Climate change scenarios revealed that a reduction of 11% in average annual rainfall as predicted for the period between 2071 and 2100, will lead to a 10% (Scenario A1b) to 12% (Scenario B1) in stream discharges. Soil erosion within the basin is also expected to decrease in the future since a 10% reduction in sediment transport was found in the São Lourenço stream, for both scenarios. As regards to the stream’s chemical status, an improvement is expected to occur as result of a decrease in nitrogen (8%) and phosphorus loads (9% to 11%), and a maintenance of CuSO$_4$ loads. Despite this amelioration in stream water quality, pollutants dilution is expected to be reduced as result of lower stream discharges, which may increase toxicity problems.

Future applications of the model include testing adaptations in agricultural practices to minimize the impacts of vineyard culture on water bodies under baseline and future climate change scenarios.
Physically-based and distributed models versus conceptual and lumped models: evaluation of performance and applicability in a case-study

P.G. Filianoti (1), D.A. Zema (2), C. Denisi (1) and L. Gurnari (3)

(1) Università degli Studi Mediterranea di Reggio Calabria - Dipartimento di Ingegneria Civile, Energia, Ambiente e Materiali (DICEAM), Italy
(2) Università degli Studi Mediterranea di Reggio Calabria – Dipartimento di Agraria – Località Feo di Vito, 89122 Reggio Calabria, Italy
(3) Università degli Studi di Palermo - Dipartimento di Ingegneria Civile, Ambientale, Aerospaziale, dei Materiali, Italy

Mathematical models simulating flood events in water courses result in a useful tool to plan possible mitigation measures against hydrogeological risks and prevent damages induced by low-frequency events.

As well known, in relation to the structure, hydrological models are classified into physically-based and conceptual models [1]. The first category is based on physical relationships (as, for instance, mass balance and dynamic equilibrium equations) in the hydrological and hydraulic processes, while the latter produces a theoretical and simple scheme of the physical phenomena.

In order to verify the efficacy of both model categories, two different models (both consisting of a rainfall-runoff submodel linked to a 1-D propagation submodel) for reconstructing flood events were compared: HEC – HMS (“Hydrologic Engineering Center’s Hydrologic Modeling System”), developed by the “US Army Corps of Engineers”; and SWMM (“Storm Water Management Model”), developed by the Water Supply and Water Resources Division of the U.S. Environmental Protection Agency (EPA). HEC-HMS is a hydrological, conceptual and lumped/semi-distributed model [2]; SWMM is a hydrological/hydraulic, physically-based and distributed model [3].

Model prediction capability was evaluated by calibration/validation procedures. To this aim, a series of observed rainfall/runoff events was simulated. For a sample of these events the input parameters were setup in the calibration phase in order to achieve the best simulation of the observed flood hydrographs. In the validation phase the average value of the calibrated parameters was input into the model to simulate the observed flood hydrographs of the remaining events of the hydrological database.

On the basis of the results, the two studied models were compared by using a set of performance indexes able to take into account:

- how the physical processes are effectively reproduced (in other words whether the model is conceptual or physically-based, whether the spatial variability of the physical parameters are realistically predicted and whether groundwater and snow effects are simulated);
- the type and number of input data required (i.e. verifying whether the models need only rainfall height/intensity or also temperature, solar radiation and humidity data; quantifying the minimum number of parameters needed for simulation and calibration; and, finally, the need of detailed topographic and/or geomorphological information about the basin as those derived from a DEM/DTM);
- the interface utilised by the two software, which highlights the "open source" availability and the possibility to integrate into a GIS-environment;
- the model performance, verifying their prediction capability by evaluating the average difference between the simulated events and the corresponding observations (in terms of both cumulated runoff volume and peak flow); the computational costs by measuring the time required by the models to simulate an event of a given average duration; the time required to the modeller to implement and setup the software for an optimal simulation of the hydrological events; and, on the whole, the total complexity for model utilisation, given by the outcomes of the above mentioned evaluations.

The reported methodology was applied by implementing both models in the Mésima River (Calabria, southern Italy) assumed as case study. Six hydrological observations at the basin outlet were utilised for model evaluation. The studied basin covers 815 km² and the main stream is 51 km in length, with a mean slope of 1.5%. Although the coastal zones have a semi-arid climate, typical of the Mediterranean environment, in the headwater winters become very cold and summers are cool. The annual precipitation is on the average 900 mm, with heavy rainfalls mainly concentrated in winter. The soils, loamy sand [4], are rather homogenous, while the land uses are patchy, with prevalence of agricultural areas (mainly olive groves, intensive farms and orchards, according to the “Corine Land Cover 2006” classification).

The analysis of the prediction capability of six peak flow and cumulated runoff events by HEC – HMS has shown a mean error of 46% and 94%, respectively, compared to the corresponding observations at the basin outlet; the error increased up to 56% and 99% for peak flow and cumulated runoff simulations by SWMM.

References:


http://www.epa.gov/nrmrl/wswrd/wq/models/swmm

Critical rainfall thresholds for debris flow initiation in a small catchment of Western Italian Alps

L. Turconi, V. Coviello, M.R. Palladino, M. Arattano, G. Savio and D. Tropeano  
CNR IRPI, Strada delle Cacce 73, Torino, Italy

The present study aims at giving a contribution to the current state of knowledge concerning rainfall conditions able to activate debris flows in high-altitude mountain environments. To the purpose, the paper presents some findings deriving from the monitoring activity in the Marderello Torrent experimental basin. Marderello Torrent is a left tributary of Cenischia stream (NW Italian Alps), with a catchment area of 6.6 km². Since the early nineties, the Marderello catchment was chosen for study, chiefly because of its aptitude to generate muddy and debris flows with a relatively high frequency: 31 activations are known to have occurred during the last one hundred years and, according to the chronicles of the last three centuries, events with significant volumes are on the average liable to take place every 3-4 years; furthermore, minor events may occur even twice per year. Since 1994 the Marderello catchment was equipped with three meteorological stations, located at different elevations (3150, 2150 and 830 m a.s.l.), to collect rainfall and other meteorological data (air moisture, temperature, atmospheric pressure and wind). In most recent years, the monitoring network has been further improved and extended on the alluvial fan, with the installation of one ultrasonic device, two video-cameras and four geophones, in order to detect debris flow wave-fronts depth and time-to-arrival (Turconi et al., 2014). This equipment was installed in Spring 2013 and on the 17th July it already allowed to record a mud flow of Marderello Torrent (Coviello et al., 2014).

High-altitude experimental basins, equipped for debris flows monitoring and providing long time series of data, are not frequent in European Alps. Indeed, instrumentation is subjected to severe technical challenges in such environments, mainly related to the extreme weather conditions (e.g. temperature peaks down to -20°C, wind stroke, lightening). In such a context, the Marderello basin, with a twenty-year sequence of observations, represents a rare exception and enables to analyse and to compare different triggering conditions within M.I. Rocciamelone area.

The monitoring activity in the Marderello basin is devoted to investigate the soil erosion and flood discharge contribution to the sediment transport process along the hydrographic network. Based on the available observations, intense rainfalls, often corresponding with summer storm events, are the most frequent cause in debris flows activation. Hence it was necessary to assess the critical rainfall conditions able to trigger muddy-debris flows. To identify a kind of “critical rainfall thresholds”, in the present study an empirical approach has been used: empirical methods rely upon the analysis of past rainfall conditions responsible for landslides activation (Palladino et al., 2014).

Preliminary analysis of collected data highlights intense rainfall, with durations between 30 and 45 minutes, are able to activate both mud flows and debris flows processes in the Marderello catchment. Rainfall data deriving from rain gauges at different elevations within the basin, suggest the lead time of the Marderello catchment to a overhead cloudburst is about 45-50 minutes.

In order to identify rainfall conditions (duration-intensity combinations) proving to be critical for mass movements’ activation, rainfall time series were aggregated based on different time intervals, namely: 5, 10, 15, 20, 25 and 30 minutes. Data analysis allowed the identification of a minimum critical threshold, corresponding to the rainfall event occurred on August 2nd 2005: rainfall intensities recorded during this event (1.6 mm/5 min÷2 mm/20 min) mark the lower limit of rainfall conditions able to induce landslides activation in Marderello catchment.

Rainfall data analysis also draws attention on the peculiarity of some events:

1) On September 3rd 2011 a rainfall event activated concomitant multi-surge debris flows along all tributaries of the Cenischia Valley (Gioglio, Claretto, Bar and Marderello torrents); based on available historical information, only two cases with analogous concomitant activations are documented, in 1947 and 1868 (Turconi and Tropeano, 2008).

2) In the course of 2011 two activations (August 18 and September 3) were detected with associated rainfall intensities greater than 9 mm/5 min, never recorded before in the available time series.

3) On the other side, very important rainfall events, accounting for 100 mm in one day, have been recorded without debris flow occurrence.

Such situations put into evidence the complexity and variability of triggering mechanisms liable to occur in the same basin, do to the overlapping of different factors in the control of the activations. This suggests that triggering mechanisms need for further explanations. One of the most interesting aspects to take into account is the catchment capability as a source of debris, able to feed the mixture during the rainfall events. Currently, the “catchment-response” of the Marderello basin is surveyed through a number of devises, able to gain possible changes in its geo-structural set up, which is particularly developed at the catchment head (Turconi et al., 2010). Nevertheless, a bound sediment-source area has not been identified yet, and the whole catchment, together with the channel banks, are supposed to be the major contributors to sediment production.

References:
Rainfall, Runoff and Soil Erosion Processes on Small Arable Catchment

D. Zumr, J. Devaty, V. Klipa, P. Kavka, J. Dusek and T. Dosta
Czech Technical University in Prague, Faculty of Civil Engineering, Thákurova 7, 166 29 Prague 6, Czech Republic

Sediments and nutrients washed out from farmed catchments into rivers and reservoirs are one of the major environmental problems worldwide. Understanding the routing of the precipitated water and sediment, its pathways and residence time on the surface and in the subsurface are important prerequisites for water and soil management, floods and nutrient control. Different rainfall-runoff conceptual models are being used to estimate the hydrological response of a small catchment to storm events.

The infiltration regime and runoff routing depends on many factors of various scale and importance. Temporary variable properties of periodically cultivated soils are one of the crucial factors that must be taken into account to understand flow processes on agriculture catchments. Soil structure is a property that is often considered as a static rather than dynamic. This could be a reasonable assumption for compacted subsoil, but not for the regularly tilled soil layer. The anthropogenic effects and natural processes such as an overuse of heavy machinery, tillage, ploughing, harvest, rapid vegetation and root growth, edaphon activity, raindrops kinetic energy, freezing, thawing etc. cause recurrent cycles of the topsoil loosening, compaction and surface sealing. Gradual deformation of the soil structure within a vegetation season causes reduction of volume and connectivity of inter-aggregate voids, eroded fine particles clog the macropores and preferential pathways, the infiltration capacity decreases. Originally connected large pores normally serve as a quick bypass for infiltrating water, therefore, based on the state of the topsoil structure one can expect different runoff mechanisms ranging from hypodermic to surface flow.

The aim of the contribution is to examine the runoff dynamics on a small catchment scale with respect to variable hydraulic properties of the topsoil. The conceptual model assumes two possible mechanisms depending on the actual topsoil structure:

(a) After the tillage soil contains stable aggregates with hydraulically conductive inter-aggregate voids. Water percolates through the preferential pathways towards compacted subsoil layer, where lateral interflow is formed. The hypodermic runoff is the most common form of the catchment drainage during these periods.

(b) During summer when the topsoil is already compacted, ratio of the preferential pathways is small and surface soil crust is present, the catchment is prone to surface runoff.

To test the conceptual model we used a combination of physically based one dimensional macroscopic models S1D (simulation of infiltration and vertical percolation) and HYPO (lateral interflow). In the S1D the dual permeability approach with two coupled Richards equations is implemented to model the infiltration, the HYPO code simulates the shallow subsurface runoff as a diffusion wave (Boussinesq equation). To validate the one dimensional approximation of the runoff process, 2D simulation of a representative hillslope was performed. The surface runoff and sediment transport were simulated with use of E3D model.

The case study is based on monitoring of water regime and sediment transport on the cultivated experimental catchment Nucice (Central Bohemia, Czech Republic), which is situated in a moderately hilly region with the average altitude of 400 m asl. The catchment area is 53 ha, the land use is almost exclusively arable land, the maximal slope inclination is 11%, and the average is 4%. The soil at the catchment is classified as Dystric Cambisol, soil texture is loam with the content of clay particles around 8%. Soil has low inner aggregate hydraulic conductivity with values approximately 0.1 - 1 cm d\(^{-1}\). Soil is conservatively tilled till depth of approximately 17 cm below which a compacted subsoil was observed.

The research has been supported by the postdoctoral project by Czech Science Foundation 13-20388P "Dynamics of water runoff generation and soil erosion as a result of temporary variable soil structure and soil properties on a cultivated catchment" and Ministry of Interior of the Czech republic VG20122015092 "Erosion runoff - increased risk of the residents and the water quality exposure in the context of the expected climate change".
Organic carbon losses by runoff and erosion on biocrusts in a semiarid badlands microcatchment: consequences of their disturbance

Y. Cantón, J.R. Román, S. Chamizo and E. Rodríguez-Caballero
Departamento de Agronomía, Universidad de Almería, Ctra. de Sacramento, La Cañada de San Urbano, Spain

Arid and semiarid ecosystems are characterized by sparse vegetation where surface runoff is a dominant pathway of nutrient transfer. During rainstorms, patches of vegetation serve as surface obstructions that slow and trap runoff, sediments, and nutrients from open interpatch spaces. One particularly important component of these systems is the presence of biocrusts or biological soil crusts which are complex communities composed of cyanobacteria, algae, mosses, liverworts, fungi, bacteria and lichens that live in the uppermost millimeters of the soil surface. They are very frequent in dry and/or extremely cold environments, where they may compose up to 70% of the total biotic cover. These organisms play a wide recognized role in soil hydrology and fertility. They prevent erosion by water and wind, and supply large amounts of carbon and nitrogen to soils. Biocrusts usually act as sources of runoff and it has been highlighted that the distribution of water and nutrients provided by biocrusts via runoff may be essential in maintaining plant productivity. Numerous studies have dealt with the role of biocrusts in surface hydrology and erosional dynamics, but associated nutrient losses from biocrusts are understudied and poorly understood. Nutrients may be lost during water erosion as dissolved constituents in runoff and as associated elements in mobilized sediments reaching stream networks or harvested to plant-sinks exerting an important role in vascular plant survival and growth. Biocrust role in organic carbon losses or redistribution represent a critical aspect to understand nutrient and carbon cycles in arid and semiarid ecosystems.

On the other hand, biocrusts are not resilient to physical disturbances and increasing human activities in drylands such as livestock grazing, off-road vehicles, and trampling usually cause the loss of the biocrust or conversion of late-successional biocrusts into early ones. These crust disturbances have important consequences on infiltration and also on soil stability, dust emission, and nutrient losses. Explicit research to quantify the mobilization of organic carbon from biocrusts and subsequent redistribution has been hardly conducted.

The aim of this study is to ascertain the influence of biocrusts and their disturbance on dissolved and sediment organic carbon losses in a semiarid badlands microcatchment (SE Spain). The study was conducted at El Cautivo (Tabernas, Almería), a badlands catchment, developed on gypsiferous marls, where biocrusts appear as unique soil cover in many landforms, covering more than 80% of the soil surface. The climate is semiarid thermo-Mediterranean, with dry and hot summers and mild temperatures throughout the rest of the year (the average annual temperature is 17.9 °C). The mean annual rainfall is 235 mm, falling mostly in winter. This gully landscape is dominated by dissected NW-SW valleys with marked asymmetry between the NE and SW-facing slopes. NE-facing slopes have gradients of up to 30°, and their pediments are covered by scattered shrubs with cyanobacterial and lichen biocrusts among them, and a dense lichen crust on the top. SW-facing slopes have 30-70° gradients, and are mainly covered by physical soil crusts. Thus, the most representative soil crust types identified in the site were a structural crust over marls and two types of biocrusts: a cyanobacteria-dominated crust and a lichen-dominated crust. Two sets of runoff open plots were set up on the two biocrust types and three treatments were considered on each one (unaltered, in progress after crust removal since 2007 and in progress after crust removal since 2012). The first set of plots was integrated by 12 plots, with a size of about 1 m², which were set up over soils covered by unaltered cyanobacteria and lichen biocrusts and soils where these biocrusts were removed in 2007 and 2012. The second set of plots (8) covered almost complete hillslopes with about 10 m² of contributing area and in which the treatment of biocrust removed in 2012 was not considered. Moreover, organic carbon was analysed at the outlet of a microcatchment of 1.8 ha where biocrusts represent more than 70% of the surface cover and appear covering complete landforms and interplant spaces. During the last two hydrological years, runoff and erosion rates were monitored after each rainfall and water samples were collected for determination of dissolved and sediment organic carbon. Our results show that at the different spatial scales, higher organic carbon mobilization rates were observed during the first rainfall after the summer period and these rates were higher for plots covered by more developed biocrusts. With successive rainfalls, the pattern tended to change and organic carbon mobilization was higher in those plots with less developed biocrust cover because erosion rates were higher in those plots. Rainfall characteristics also played an important role in organic carbon mobilization for both fractions, dissolved and sediments. Respect the effects of disturbance, we found that during the first rain immediately after biocrust removal, dissolved organic carbon concentration was higher in biocrust-removed soils than in intact biocrusts, probably because organic carbon is more strongly retained by biocrust structures, but easily blown away in the soils devoid of them. However, sediment organic carbon concentration was higher in intact biocrusts than in biocrust-removed soils. Despite this higher sediment organic carbon concentration in soils with biocrusts, sediment organic carbon losses were higher in biocrust-removed plots due to their significantly higher erosion rates. After successive rains, both dissolved and sediment organic carbon concentrations decreased in biocrust-removed soils relative intact biocrusts, due to early colonization by cyanobacteria in biocrust-removed soils, which diminished sediment yield, and to less remaining organic carbon available in these disturbed soils. Annual dissolved organic carbon loss was up to 3-fold higher and annual sediment organic carbon loss up to 4-fold higher in biocrust-removed soils than intact biocrusts.
Hydrologic behaviour and dynamics of pollutants in a small agro-forested basin in Portugal

A.C. Duarte (1), L.M. Íñiguez (2) and J.L.M.P. de Lima (3,4)

(1) Escola Superior Agrária, Instituto Politécnico de Castelo Branco (IPCB), Portugal
(2) Instituto de Agricultura Sostenible (IAS), Consejo Superior de Investigaciones Científicas (CSIC), Córdoba, España
(3) Institute of Marine Research (IMAR), Marine and Environmental Sciences Centre (MARE), Portugal
(4) Department of Civil Engineering, Faculty of Sciences and Technology, University of Coimbra, Coimbra, Portugal

The non-point source pollution is closely related to the hydrologic behaviour of basins and has grown into a global environmental issue and a first cause of soil and water degradation in many parts of the world. In this context hydrologic basins are, at present, the basic unit of research, development and policy-making activities related to water. However, being hydrologic basins geographical dynamic units, their behaviour varies strongly both in space and time.

This study makes use of a small experimental basin, aiming at understanding the hydrologic behaviour during rainy and irrigation seasons. Special attention is given to the dynamic of pollutants, salts (electrical conductivity), sediments (turbidity) and nitrates. It is a follow up of the work done by Duarte (2006) and Duarte et al. (2007).

The studied basin is located within the Idanha Irrigation Scheme, Idanha-a-Nova, mainland Portugal, near the border with Spain and just north of the river Tagus. The study watershed is located within the Idanha Irrigation Scheme, Idanha-a-Nova County, Portugal, near the border with Spain and just north of the Tagus River. The study catchment covers an area of 189 ha and a perimeter of 6510 m, and presents a 3rd order hierarchy stream. The climate is typically Mediterranean with usually rainless summers and an average annual rainfall of 638 mm (Duarte, 2006). The main natural stream is 2300 m long and runs north-southwest. The drainage density of the perennial streams is 12.2 m ha⁻¹. Altitude varies from 212 m at the outlet of the basin to 248 m, and the slopes range from 0 to 4%; thus, the topography is flat to gently undulating. The predominant soil classes are Cambisols and Luvisols, originated from deposits of the tributaries of the river Tagus. A hydrometric station was constructed and installed at the outlet of the basin (39°50′48″ N, 7°10′00″ W). The station consisted of i) a long-throated flume, with a triangular control section for small water depths and a triangular/trapezoidal section for larger discharges, and ii) an ultrasonic sensor connected to a datalogger continuously measured and recorded the water level at the flume every 15 minutes. The concentration of the pollutants in water is evaluated with a multiparameter probe for monitoring water quality and recorded in the same time interval. Agricultural practices were recorded by farmers and verified by direct observations during visits to the basin.

This work presents the analysis of transport processes on a small hydrologic basin using a hydrometric station and a multiparameter probe. Most runoff events showed a clockwise sediment graphs (positive hysteresis), indicating that the sediments arrive fast to the hydrometric station and are originated mainly from the nearby sites (e.g. Soler et al., 2008). A negative hysteresis would be indicative that the sediments have originated in more remote locations in the basin (e.g. García Ruiz et al., 2000). On the other hand, the pollution load of sediments does not seem dependent on the total runoff volume of a certain event, except when flow has enough power to detach and load the particles outside of the drainage network (e.g. sheet and rill erosion on the slopes); therefore, the amount of sediment load along the rainy season is mainly associated with extremes rainfall-runoff events. The dynamic of salts in the basin shows the effect of dilution in events with high return periods, and more evident in the extreme events. The electrical conductivity before an extreme event, after a long dry period, remains high, followed by lower values for some days. The same behaviour is also observed with respect to nitrates, due to its high solubility.

As a final conclusion the dynamics of contaminants at basin level appears to be dependent on the hydrologic behaviour in this territorial unit, also depending on the nature of the contaminants and magnitude of hydrologic events.

References:

15th Biennial Conference ERB2014
Infrared thermography as a heat tracer method for velocity estimation in shallow flows

R.L.P. de Lima (1,2), T.G. Cleveland (3) and R.F. de Carvalho (1,4)

(1) Institute of Marine Research (IMAR), Marine and Environmental Sciences Centre (MARE), Portugal
(2) Deltasync, Delta, The Netherlands
(3) Texas Tech University, Lubbock, USA
(4) Civil Engineering Department, University of Coimbra, Coimbra, Portugal

Shallow flows can be observed in many different situations such as in lakes, estuaries, stratified water bodies, coastal areas, lowland rivers, overland flows or urban basins. The determination of velocity fields in these flows, which is affected by factors such as channel slope and roughness, is relevant for the success of sediment erosion, river morphology or contaminant transport models. Therefore, development of accurate and versatile flow measurement techniques is of crucial importance for general hydraulics, hydrology and water resources applications. Over the last 30 years, significant improvements and developments were accomplished, not only resulting in higher accuracy and quality of the obtained data, but also with the emergence of powerful new techniques with new capabilities and characteristics, benefiting from the great development of technology in other areas of knowledge. Nowadays, there is a wide range of options available for velocity and discharge measurements that provide good results even under unfavorable conditions (Boiten, 2000). Measurement instruments have to deal with problems such as variability of bed conditions, presence of sediments, accretion and erosion problems, tidal effects, confluence of water masses, or even the presence of vegetation or air entrainment. Measurements in shallow water depths are inherently complicated, often colliding with minimum working depths of equipment (e.g. mechanical current meters), vegetation interference, sand deposition, temporal and spatial changes, or even the inevitable interference of boundary conditions (e.g. reflection of waves of ADCPs). All of these factors contribute for inaccurate measurements and complicate this important task of quantifying the flow and obtaining velocity profiles and fields. Tracer methods contribute to surpass some of these limitations; however, they still raise some environmental concerns, namely the impact caused by the use of dyes.

Infrared technology is a powerful method to monitor surface temperature distribution and has been occasionally used in hydraulic studies. Due to the recent reduction of costs and increased portability of these cameras, its applications in water resources, hydrology and soil and water preservation have increased in the last years. The use of IR thermography for quantitative flow measurements has not been extensively explored yet and its capabilities have yet to be studied, but some successful examples can already be found in the literature (Chung and Grigoropoulos, 2003; Liu et al., 2005; Liang and Chong, 2011; Schuetz et al., 2012).

This work presents a novel technique for velocity estimation that uses infrared thermography to estimate mean flow velocity, based on time of travel. The experimental setup consists in an IR camera hanged (pointing downwards) above a flume, continuously recording the flow. Several methods were then used to heat the flow, and the hot water acted as a heat tracer, visible through thermography. The recorded images were digitally analyzed to compute velocity. The flume provided a channel 0.3 m wide and 4.5 m long and the camera was hanged 1.5 m above the flume, resulting in a recording area of 42×55 cm². The camera was connected to a Digital Video Recorder (DVR) system, which allowed the recording of a 30 frames per second footage of 320×240=76800 pixel images. The resulting footages from the thermographic camera are sequences of greyscale images (temperature maps) where higher temperatures are usually represented by brighter colors and lower temperatures by darker colors. Thus, the heated mass of water is clearly visible as a bright mass moving downstream, allowing flow visualization and quantification of the motion of the induced heated mass of water. For comparison purposes, a SonTek/YSI 16-MHz MicroADV (Acoustic Doppler Velocimeter), a well-established velocity measurement technique, was installed. A 2D side-looking probe was used, since it’s the most adequate for measurements in shallow water depths.

Proof of principle experiments were performed and results are in accordance with the data provided by the ADV. Other initial tests were also performed to infer about the most efficient procedures, such as comparing the effect of the addition to the flow of different quantities of hot water, and the influence of the addition of hot water from different distances upstream. The main advantage of the technique relies in the fact that the used tracer is the same as the initial fluid in the flow, thus sharing most of its properties, what is crucial for the success of a tracer. In addition, the formation of conglomerates on the water surface is avoided and no chemicals are added to the flow (few problems environmental concerns). The portability of thermographic cameras is also an advantage as it opens good prospects for uses in the field. This technique can be particularly useful when dealing with shallow water depths, and has no constraints regarding the use in the presence of sediments, debris or rocks, which are usually limitations for other methods. Therefore, this technique might have an important role in the future in the measurement and monitoring of shallow flows in hydrological basins.

References:
HYDROBOD, a GIS-based hydrological soil information system for Lower Austria

Ch. Krammer (1), K. Klebinder (2), A. Eder (3), B. Solier (2), Th. Bauer (3), G. Markart (2) and P. Strauss (3)

(1) Department of Hydrology, Lower Austrian State Administration, St. Pölten, Austria
(2) Institute for Natural Hazards, Innsbruck, Austria
(3) Institute for Land and Water Management Research, Petzenkirchen, Austria

Lower Austria is Austria’s largest state, covering a total area of more than 19,000 km², with surface elevations between 150 and 2,000 m above sea level. Climate ranges from semi-arid to semi-humid.

Different questions of hydrology and water management require some soil parameters, which were not available coherently throughout the whole area before this study. A special interest was to obtain a database which should allow to estimate runoff coefficients in a further step. However, this database should also assist to solve questions of water balance, like evapotranspiration, on a catchment scale. The desired parameters include for instance soil layer depth (down to the rocky base), storage capacity, saturated vertical conductivity, and surface roughness.

The actual project should provide a continuous data set of these soil parameters on a GIS base, using a grid of 50 x 50 m², in three layers down to 1 m below surface level. The frame of the study was defined as the whole area of the state, plus a buffer of 1 km beyond the boundary. This area was extended in some parts, in order to include smaller catchments which exceed the buffer.

Different base data sets are available for this study, such as a highly resolved elevation grid, a GIS layer which assigns land use, or a geological map with quite good resolution, and soil maps for arable land.

Transfer functions were defined for arable land and forests, which allowed to estimate the percentage of different grain size classes and of humus, and they were calibrated and validated using data from monitoring networks. These estimations were the basis for further calculations to obtain the desired data. While arable land is very well classified in Austria, a special challenge was the fact that in forest land monitoring points were available only very scarcely, and neither was a coherent mapping of forest soils available. Another problem was encountered because Lower Austria has a common border with Czech Republic, where the buffer also had to be filled up with parameters, so the Czech classification of soil properties had to be “translated” into the own classification.

Among the results of this study, there are different grids and maps with the required parameters. Moreover, by using the above mentioned parameters and a cell-by-cell calculation model, a classification was made to classify different soil reaction types with regard to heavy rainfall.

Hydrological studies in experimental and representative basins in Brazil: the experience of the REHIDRO network

A.A.A. Montenegro (1), S.M.G.L. Montenegro (2), J.E.F.W. Lima (3), S. Koide (4), R. Aragão (5), C. Souza (6) and M.A.S. Cruz (7)

(1) Federal Rural University of Pernambuco State- Recife, Brazil
(2) Federal University of Pernambuco State- Recife, Brazil
(3) Embrapa Cerrados, Brasilia-DF, Brazil
(4) Federal University of Brasilia, Brasilia-DF, Brazil
(5) Federal University of Sergipe State, Aracaju-SE, Brazil
(6) Federal University of Alagoas State, Maceió-AL, Brazil
(7) Pesquisador Embrapa Tabuleiros Costeiros, Avenida Beira Mar 3250, Jardins, Aracaju,SE, CEP 49025-040, Brazil

Experimental and numerical studies in Experimental and Representative Basins are essential for a proper understanding of hydrological processes at different scales, in particular in semiarid environments, allowing the generation of knowledge and water resources planning. This work presents comparative analysis among different basins in the Brazilian semiarid, and the Cerrado Biome. The Hydrological Network REHIDRO has been focused on developing joint hydrological studies, involving the Federal Rural University of Pernambuco State (UFPR), the Federal University of Pernambuco State (UFPE), the University of Brasilia (UnB), the Federal University of Alagoas State (UFAL), the Federal University of Sergipe State (UFS) and the Brazilian Corporation for Agricultural Research (EMBRAPA Cerrados and EMBRAPA Tabuleiros).

Advances in network performing a comparison between the basins and instrumentation employed in their respective monitoring procedures will be discussed, and the perspectives toward joint investigations upon hydrological experimentation and modeling. The Tapacurá Representative Catchment has been studied by UFPE. It is one of the main sub-catchments that supply the Recife Metropolitan Region, northeastern Brazil. The Tapacurá catchment covers an area of about 470 km². Monitoring and modeling studies have been carried out on stream flow data from January 1997, using the data from a gauging station. The results show that the most sensitive hydrological parameters are the base flow, time of concentration and soil evaporation, which affect the catchment hydrology. The Tapacurá Representative Catchment involves the Gameleira Experimental Basin, where stream flow, sediment transport, and moisture dynamics have been monitored.

The Ipanema catchment is part of the São Francisco River basin, and it is located in the Brazilian drought polygon. The São Francisco Basin has an area representing 8% of Brazilian territory. An experimental (Jatobá) and representative (Mimoso) catchments have been monitored as part of the network by the UFRPE, both in the Pernambuco State. Those catchments are part of the Ipanema River basin. The Mimoso representative catchment has an area of 149 km², comprising non perennial rivulets, and an alluvial valley which is exploited for small scale irrigation in the area, mainly for vegetables. The upper catchment is partially covered by dense caatinga forest. Demonstrative experimental plots have been instrumented and studies related to irrigation management techniques and soil conservation alternatives were carried out. A network of 86 piezometers.
has been monitored both for water levels and salinity, since 1994. Stream flow and sediment transport has been monitored since 2002. Emphasis has been also placed on investigating the spatio-temporal structures of variation of soil moisture, under different soil use scenarios. The Olho D’água creek is also a São Francisco River tributary, draining a smaller catchment (83.1 km²) in the Brazilian semiarid region. Part of such catchment is under the establishment of an experimental hydrological monitoring network in order to assess hydrological processes in a catchment that represents 45% (12689 km²) of Alagoas state (c. 839000 inhab.). Hydrometeorological and fluvial processes have been estimated in order to assess water balance and remote rainfall data quality, by the UFAL research Group.

The Japaratuba river basin (1700 km²) is one of the six main river basins in the State of Sergipe, Northeastern Brazil. In this basin several activities have been put into practice over the last two centuries such as mining, cattle rising, pasture, and sugar cane cultivation. These activities have been impacting the water resources in the region, particularly in the Siriri river sub-basin (308 km²). As a consequence, the natural vegetation has been removed affecting the hydrologic processes, bank interactions and flood plains. The bank vegetation not only increases the groundwater recharge, but also helps in the reduction of the pollutant and sediment load reaching the river. Hence, an evaluation of the influence of bank vegetation on runoff and sediment load of the Siriri river basin would be of great help in the process of preserving the bank vegetation, and avoiding river sedimentation. In addition, the identification of the impacts on the processes of soil erosion and transport would help the research group from UFS and Embrapa Tabuleiros to figure out adequate land use scenarios for this basin. Water samples have also been collected over the past two years at five sites for water quality verification. Flow discharge and total rainfall have been registered at daily basis (1983-2013), land use and land cover have also been monitored over time.

The study area of UnB research Group is part of the contribution area of the Descoberto reservoir. The Descoberto reservoir is responsible for 63% of the urban water supply of the Brazilian Federal District. The Descoberto reservoir basin has an area of about 420 km² and the main tributary river has an area of about 114 km². Flow, rainfall, sediments and nutrient loads has been collected at the main tributary rivers. Six sub-basins have been investigated and monitored, with areas ranging from 16 km² to 114 km².

The Upper Jardim Experimental River Basin covers an area of about 105 km², and is located in a rural zone of the Federal District, Brazil, in the core region of the Cerrado biome (Brazilian savanna). Since 2001, in order to generate a database to support hydrological studies in a typical rural catchment of the Brazilian savanna, EMBRAPA Cerrados (Savannas Agricultural Research Center), in partnership with the University of Brasilia (UNB), and other institutions, has intensively characterized and monitored this area. Moreover, the water table variation is monthly monitored by using 56 piezometric wells distributed all over the area.

### Assessing changes in drought/wetness episodes in drainage basins, in Portugal, using the Standardized Precipitation Index

A. Silva (1), M.I.P. de Lima (2,3), F. Espírito Santo (1) and V. Pires (1)

(1) The Portuguese Institute for the Sea and the Atmosphere, Lisbon, Portugal
(2) Institute of Marine Research (IMAR); Marine and Environmental Sciences Centre (MARE), Portugal
(3) Department of Civil Engineering, Faculty of Science and Technology, University of Coimbra, Coimbra, Portugal

The nature of the precipitation regime, the uncertainties in trends in hydrological variables, and the increasing demand for water for different uses, give way to different studies of the distribution of precipitation in time and space, and consequences for the availability and management of water resources and water related events, such as droughts and floods. Moreover, it is sometimes important to apply simple tools that can provide insight into the temporal and spatial variability of precipitation deficits and surpluses which might affect in a different way the society, the environment and the economy at the local and regional scales, depending on specific conditions.

The location of mainland Portugal on the Northeast Atlantic region, in South-western Europe, together with other geographical features, makes this territory vulnerable to extreme dry/wet hydro-meteorological events, driven by the strong variability in precipitation. Thus, this study focuses mainly on using the Standardized Precipitation Index (SPI) to analyzing drought/wetness episodes at the drainage basin scale, for mainland Portugal. This index’s main advantages are related with its versatility and capacity for monitoring the development and persistence of dry and wet hydro-meteorological situations on various time scales that are pertinent to assess e.g. water availability for agriculture, streamflow, reservoir storage and groundwater supplies.

In this work the SPI was calculated from monthly precipitation data, recorded in the period 1941-2012 at 53 precipitation stations scattered across the country. The SPI series were calculated at short (3 and 6-month) and long (12 and 24-month) time scales, on which precipitation deficits/surpluses which might affect in a different way the society, the environment and the economy at the local and regional scales, depending on specific conditions. The SPI values, spatial grids were obtained for all the months and main time scales (SPI-3, SPI-6, SPI-9, SPI-12 and SPI-24). These grids were used to obtain the statistics for selected drainage basins, using a zonal statistics function; the dry and wet episodes were classified (moderate to extreme), based on the SPI values. The variability and trends in the SPI time series and in the areas affected by dryness and wetness were studied. The main drought and flood episodes were also assessed. The annual SPI shows a significant increase in the extent of dry extremes and a non-significant decrease in the extent of wet extremes. For shorter time scales, the behavior depends on the season. Nevertheless, some drought episodes were restricted to the southern regions while others affected the whole territory.

The understanding of changes (in time and space) observed in many hydrological variables, and their impact...
on water balances and transport processes at the basin scale and for different time scales, need sometimes to be supported by simple and standardized ways to quantifying and expressing the spatial-temporal variability of the rain input. Results confirm that the SPI is an efficient and simple tool to identifying abnormal dry and wet periods and to understanding its spatial patterns. Moreover, this study illustrates that this approach can be implemented at the basin scale, namely for small basins, and can therefore play specifically an important role in hydrological studies, in particular in basins missing detailed information on precipitation.

ERB2014-78

Runoff generation mechanisms in a Swiss pre-alpine catchment - results based on a blend of hydrological data at different spatio-temporal scales

B. Fischer (1), J. Seibert (1,2) and M. Stähli (3)
(1) University of Zurich, Department of Geography - Hydrology and Climate, Winterthurerstrasse 190, 8057 Zürich, Switzerland
(2) Uppsala University, Department of Earth Sciences, Uppsala, Sweden
(3) Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Birmensdorf, Switzerland

Mountainous headwaters are dynamic and heterogeneous hydrological systems of different landscape elements in terms of topography, geology, wetlands, land use and land cover. Within a catchment these different elements are in some order spatially arranged and connected. In mountainous catchments long term detailed data are generally sparse and even when they exist, its role in a wider region is unknown and internal data such as groundwater or isotopic data are usually lacking. This makes it difficult to identify runoff generation processes of both hydrological extremes states of low flow and high flow. Additionally at catchment scale it is difficult to judge the value of the data due to the lack of information of internal organization and dominant processes.

Here we present results from a new data set collected in the Zwäckentobel, a 4.3 km² Swiss pre-alpine catchment. The high annual precipitation input, flashy character of streams and dominant wet conditions, make this catchment an exciting study area for hydrologists. However the contribution and response of streams to storm flow state in space and time we got a dynamic character. By using different sources of data for runoff generation mechanisms in a Swiss pre-alpine catchment - results based on a blend of hydrological data at different spatio-temporal scales

whether spatial patterns can be detected. We tried to link these patterns to the physical properties of the respective sub catchments and studied whether the observed patterns remained stable in time. Then we tried to identify runoff generation processes by using a combination of hydrometric measurements with stable isotope information. Instead of studying only one catchment with only a few storm events, we compared five parallel subcatchments, to learn from their mutual differences and at different scales for different hydrological antecedent conditions. The question was: are the six subcatchments responding differently to rainfall with different runoff contribution processes? Can this be linked to catchment characteristic? Does a high rainfall catchment respond different during different antecedent conditions? The rainfall, runoff and isotope concentrations of the snow free season 2010 and 2011 were measured for 14 rainfall events and compared with long-term observations.

Results of the low flow state showed that the collected water samples actually do contain information about the structure and represented the local physical system with differences between different sub catchments as well as between smaller hydrological units. One surprising outcome was that the chemical signal from springs near the water divide could be detected even at the catchment outlet. Overall the results showed that the snapshot sampling approach is a valuable tool for assessing hydrological organisation.

For storm flows we could identify for all streams their dominant runoff generating mechanisms. Antecedent conditions and storm size have influence on the stream response; all streams are fast responding where big rainfall events tend to have larger event water contribution while smaller events have larger pre-event contribution to stream flow. Small catchment are generally expected to react similar to storm flow, while from this study it emerges that mountainous headwaters have spatial and temporal difference in input as well as in the response of the different streams. The mixture of hydrometric short term and the indispensable log-term observations in combination with stable isotope were valuable to increase our knowledge of hydrological processes of pre alpine headwater catchments with high precipitation input and a dynamic character. By using different sources of data for base and storm flow state in space and time we got a different picture of this wet pre alpine study site. Going beyond the catchment scale contributed in a better understanding of the hydrological signal and value of the data for the snow free season 2010-2011 and the long-term reference subcatchment. This helps in a better process understanding of both low and high flow and can serve as base for a better water management in these hydrological complex regions.
Mountains are important sources of water for the downstream areas. Complex topography results in high spatial variability of the hydrological cycle. We present results of spatial variability of rainfall, runoff, soil moisture and modelled evapotranspiration and soil moisture from the mountain catchment of the Jalovecký creek (area 22.2 km², mean altitude 1500 m a.s.l., altitude range 820-2178 m a.s.l., mean slope 30°) and warm half of the years 2013 and 2014. The catchment is representative for mountain catchments of the highest part of the Western Carpathians.

Earlier analyses of the rainfall-runoff events based on the 10-minutes data revealed that the hydrological response of the catchment is fast. The lag time (between maximum rainfall and peakflow) is about 2.3 hours, the rising limb of the hydrograph lasts less than 0.7 hour and the falling limb lasts about 6.2 hours. Observed hydrographs frequently document presence of delayed subsurface flow and isotopic separations indicate that most runoff events are dominantly composed of the pre-event water. In this study we employ data from an extended precipitation and runoff network to shed more light on spatial differences that occur in the catchment. The objectives are to answer the following questions:
- what is the influence of altitude on rainfall amounts at different time scales?
- how frequently could the overland flow occur?
- what are the differences in runoff response of the main subcatchments?
- is the runoff response influenced by differences in spatial occurrence of the rainfall?

Precipitation is measured by 13 rain gauges (tipping bucket, weighting) located at altitudes 820 to 1900 m a.s.l. The data show that despite larger catchment area, rainfalls that hit only a small part of the catchment area are rare. Rainfall characteristics such as monthly, daily or event totals and rainfall intensity mostly do not exhibit clear relationships with the altitude. When a good altitude gradient occurs, higher rainfall totals are typically connected with higher altitude gradients. Although rainfall intensities may be rather high, they rarely exceed infiltration capacity characterized by saturated hydraulic conductivity of the soil surface.

Runoff response of the two main subcatchments of the Jalovecký creek differs only under drier conditions. Contribution of the subcatchment downstream from the confluence of the two main tributaries reaches about 30% during the peakflow, but becomes small during the low flow periods. Runoff response to similar, relatively high rainfall events (up to about 100 mm of rainfall) differs. Soil moisture measured at several different locations (open area, forest) show similar temporal variability. Catchment runoff occurs after exceeding certain soil moisture threshold.

Rainfall-runoff modelling is performed with the MikeShe model at daily time step.

---

**Flow connectivity affects the main hydrological drivers that control runoff generation and water erosion**

E. Rodríguez-Caballero (1), Y.C. Castilla (1), S.C. de la Piedra (1) and A.S. Benet (2)

(1) Departamento de Agronomía, Universidad de Almería, Almería, Spain
(2) Estación Experimental de Zonas Aridas (CSIC), Almería, Spain

Water erosion is the principal form of land degradation in drylands. Thus, it is completely necessary to advance in the knowledge about the main hydrological drivers that control runoff generation and water erosion in these systems. Drylands are characterized by a low precipitation and high evapotranspiration, which results in a sparse vegetation cover interspersed over a bare open matrix. During the few rainfall events, runoff is generated in bare soil areas and exported out of the catchment or redistributed towards vegetation, which acts as surface obstruction for water, sediments and nutrients, reducing water and sediment loss. However, the capacity of vegetation to trap runoff is limited, and varies depending on rainfall properties, previous surface conditions and eco-physiological state of vegetation. Once the capacity of vegetated buffers to trap runoff and sediments has been exceeded, they act as runoff sources by increasing flow connection. At this point, the main hydrological drivers that control runoff generation and water erosion vary from the standard conditions increasing the total amount of water and sediment losses. The main goal of this study was to identify possible thresholds in the hydrological and erosive response of a small catchment that could modify catchment connectivity, and if existing, to analyze the main drivers controlling at different stages of catchment connection (whenever rainfall is below or above the identified threshold). Our dataset consisted of all runoff events recorded from 1991 to 2011, in a catchment (El Cautivo, Tabernas Desert) of approximately 1.8 ha, located in SE Spain, in the province of Almería. Climate at El Cautivo is semiarid thermo-Mediterranean with an average temperature of 18.5°C and an annual precipitation of 235 mm, with a high intra and inter-annual variability. The main soil types are Leptosols, Regosols and Gypsisols, with a silty loam texture. The whole landscape shows a very marked asymmetry. S and SW orientations show almost no vegetation and shallow soils covered by physical soil crust (PSC) and directly connected with the channel network. N and NE hillslopes are mainly covered by biological soil crusts (BSCs) covering the upper part of these hillslopes. BSC cover gradually decreases downstream, increasing the cover of annual plants and shrubs. The headwaters are mainly covered by tussocks of perennial grasses and some BSCs in the interplant spaces.

To achieve our objective, a piecewise regression analysis was applied to identify any possible threshold in the hydrological response of the catchment. Based on this result, the database was divided in two sub-databases: i) Events below the hydrological threshold (low magnitude events) and ii) Events in which the hydrological threshold have been exceeded (high magnitude events); and, we built two structural equation models (SEM), one for each dataset, to identify the main hydrological drivers acting at each stage of catchment connection. Structural equation
models have been demonstrated to be very useful for distinguishing complex causal relationships in hydrological studies, and so we proposed an a priori model that included the interactive effects of rainfall properties (rainfall amount, \( P \), and intensity, \( I \)), system hydrological response (runoff rate, RR, and maximum peak discharge, \( Q_{\text{max}} \)) and sediment yield (SY), to identify the main hydrological drivers that control runoff generation and water erosion and to separate direct and indirect causal effects between drivers.

Analysis by piecewise regression showed a sharp threshold in the relationship between runoff rate and total rainfall at about 21 mm. Whenever \( P \) was lower than this threshold, runoff increased linearly with the amount of rainfall, and above it, the rainfall-runoff slope was considerably stronger than for low-magnitude events. This threshold is the result of variations in the main hydrological drivers as consequence of cross-scale interactions between the different hydrological units. As a consequence of these differences in flow connectivity, a different structural equation model was obtained from each dataset (low and high-magnitude events). In both models RR was controlled by \( P \), according to previous studies, but some differences have been observed between them. In low-magnitude rainfall events, \( Q_{\text{max}} \) was only affected by maximum \( I \), since runoff starts when the rainfall intensity exceed the limited infiltration capacity of PSC areas directly connected to the channel network and most of the runoff generated in BSC areas were re-infiltrated in downstream vegetation. Under high-magnitude rainfall events, \( Q_{\text{max}} \) and the RR were also affected by \( P \). These results indicate that a minimum rainfall amount was necessary to fill the soil under vegetation. At that moment, upslope BSC source areas were connected directly with the catchment outlet, increasing the amount of water reaching the catchment outlet at the same time. The erosive response, on the contrary, was only controlled by the reduced infiltration capacity and high erodibility of PSCs areas, and no additional SY was measured when runoff generated in areas with BSCs reached the drainage network. These results indicate that sediment connectivity is not always linked to runoff generation, especially in areas covered by BSCs, which act as runoff sources but exert a strong protective effect against water erosion.

Based on these results, we can conclude the need for considering both direct and indirect interactions among the main hydrological drivers that control runoff generation and water erosion to completely understand the hydrological and erosive behavior of dryland catchments. Moreover, these drivers vary depending on rainfall properties, generating thresholds in the hydrological response of the catchment, fact that needs to be considered in hydrological studies to correctly characterize the variables that act controlling runoff generation and water erosion.

ERB2014-89
Assessment of the Floods Occurrence Potential in the Representative Basin of the Upper Teleajen River – Romania

M. Borcan and M. Retegan
National Institute of Hydrology and Water Management, 97 Bucuresti - Ploiesti Road, Bucharest, Romania

Since over the last four decades the Ialomiţa River Basin has been affected by several catastrophic hydrological events, of which the most important were the ones in 1975, 2001 and 2005, for a better management of the extreme situations generated by such episodes, we propose a new methodology regarding the estimation of the flash-flood occurrence potential in this particular river basin.

The area we have chosen to study is the upper basin of the Teleajen River, which is located on the southern slopes of the Eastern Carpathian Mountains, in Southern Romania, comprising much of the formation area of the Teleajen River. The river basin has an area of 41.3 km² and relies entirely on the southern slopes of the Ciucăş Massif (1956 m a.a.), ending at approximately 250 m downstream the confluence of the Cheiţa and Tâmpa streams, which thus form the Teleajen River itself. The basin comprises 8 sub-basins, with an area between 1.51 km² (the smallest) and 21 km² (the largest) and is monitored by four river stations that provide level and discharge measurements (Cheiţa, Cucu, Ciobanu and Tâmpa river gauges). The river network is represented by two main streams, Cheiţa and Tâmpa, with a multitude of creeks and torrents.

In order to identify the vulnerable areas to runoff erosion processes developing on the slopes, we have used the PIFT method (Potential Index of Flood Transmission), proposed by Smith (2003) in “Western Region Flash Flood Project” (WRFFP) and used in Romania by Minea (2011) and Mătreaţă (2011).

The database we have used in order to apply the above mentioned method refers to the slope thematic layer with a 30 m spatial resolution, the soil texture thematic layer (***1980), the Corine Land Cover 2006 Data Set (***2006; http://www.eea.europa.eu/publications/COR0-landcover) as well as the maximum amount of rainfall recorded in a 24-hour period.

The main objective of the method is represented by the assessment of an index which synthetically expresses the floods potential occurrence for both small and large river basins. The impact quantification of the main physical – geographic factors (land slope, soil texture and land use manner) and of the main factor which generates the runoff (rainfalls) determines the size of this potential index of flood transmission.

The generation in GIS environment of the thematically layers specific to the above mentioned factors allows the identification of the critical areas with rapid runoff potential and favorable to floods occurrence, areas which can be framed in four risk classes (high, average, low, minimum).

The PIFT method was applied as case study at the major flood (1975) which affected the entire Ialomița, including the Upper Teleajen River Basin, offering ideal conditions for the methodology verification.
This article aims to delimit the areas with maximum risk to potential flash-floods in the Upper Teleajen River Basin from South-Eastern Romania.

References:
Smith, G. (2003). Western region flash flood project, AMS Conference, Session 6 GIS Applications

ERB2014-92
Can we use trace metals for tracing hydrological processes? Example of Rare Earth Elements for river basins heavily impacted by anthropogenic activities

C. Hissler (1), P. Stille (2), C. Guignard (1), J.F. Iffly (1) and L. Pfister (1)

(1) GEOSAT/EVA/CRP – GL, 41 rue du Brill, L-4422 Belvaux, Luxembourg
(2) LHyGeS - UMR 7517 CNRS - EOST/UdS, 1 rue Blessig F-67084 Strasbourg cedex, France

Over the past decades, geochemical tracers have been used to study hydrological processes based on the assumption of their conservative behaviour in the ecosystem. Recent geochemical studies have highlighted that some of these hydrological tracers could in the end not be considered as conservative. In this context, the cases of Si and Cl concentrations in the water of pristine river basins were more specifically pinpointed. The important questions experimental hydrologists have to take into account are: i) Are there any conservative tracers in natural river systems? and ii) What potential could present tracers that are not conservative in order to progress in the understanding of hydrological processes?

Here, we propose to introduce the potential for trace metals to trace hydrological processes in river systems impacted by anthropogenic activities. For instance, the Rare Earth Elements (REE), considered for a long time as being undisturbed by human activities, were commonly used as tracers of continental crust derived material. However, they become more and more used in industrial, urban or agricultural processes. The global production of lanthanides (REE), used in industry, medicine and agriculture, for instance, has increased exponentially from a few tons in 1950 to projected 185 kt in 2015. Consequently, these new anthropogenic contributions impact the natural cycle of the REE.

Our objective is to present the potential that such chemical elements could have to improve the understanding of hydrological processes at watershed scale. Therefore, we monitored water quality and discharge of the upper Alzette River (Luxembourg, Europe) over two complete hydrological cycles (2010-2013). The river water was characterized using a multitrajectory approach (standard parameters for water quality including REE concentrations, Pb, Sr, Nd radiogenic isotopes) with two complementary sampling setups (bi-weekly and flood event based sampling). This extensive sampling design allowed quantifying the annual budget of the REE in the dissolved and colloidal fractions of the river water and the waste water treatment plant effluents.

Enrichments in Gadolinium (Gd, one of the REE) have been observed for the dissolved fraction of the water during low flow. This enrichment has not been detected in the surrounding soils of the basin and can be related to the effluents of the waste water treatment plants, which control the REE chemistry of this fraction. When flood events occur, the Gd anomaly progressively disappears and gives way to the chemical signature of the basin’s soils. These results document the real conservative behaviour of the anthropogenic Gd in river water. Gd has the potential for serving as a real alternative to conventional tracers to study hydrological processes in river basins impacted by anthropogenic activities.
ERB2014-3
Seasonal and storm dynamics of Dissolved Organic Carbon in a Mediterranean mountain catchment (Vallecebre Research Catchments, Spain)

M. Roig-Planasdemunt, P. Llorens and J. Latron
Institute of Environmental Assessment and Water Research (IDAEA) CSIC, Barcelona, Spain

An improved understanding of the catchment hydrological functioning can be obtained from the analysis of Dissolved Organic Carbon (DOC) dynamics in rainfall, streamwater, soil water and groundwater. DOC dynamics at the catchment scale has been studied in many environments, but there are relatively few studies in Mediterranean mountain regions. In these environments, water solutes dynamics is often complex and difficult to predict because of the strong intra- and inter-annual precipitation variability and the strong climatic seasonality that lead to a very contrasted hydrological response along the year.

With the objective of improving the knowledge of DOC dynamics in seasonal Mediterranean environments, rainfall, soil water, groundwater and stream water samples were taken on a regular basis, as well as during storm events along a 27 month period in the Can Vila research catchment (NE Spain, 42° 12'N, 1° 49'E). Detailed distributed hydrometric measurements (precipitation, discharge, soil water content, soil temperature and water table level) were obtained during the same period. Using these data we characterized the DOC dynamics in the different hydrological compartments and analyzed the factors which affect them. We also analyzed the DOC dynamics during storm events and the factors that control DOC delivery to the stream to assess possible differences in the hydrological functioning of the catchment along the year. Preliminary results showed that DOC dynamics of rainwater and soil water presented some marked seasonality, while no clear seasonality was observed in stream water and groundwater, where DOC dynamics was strongly related to discharge and water table variations. During storm events, streamwater DOC concentration strongly followed the discharge pattern for all observed events along the year. For storm events with several discharge peaks, the slope of the discharge/DOC concentration relationship was higher for the first peak and decrease progressively along successive peaks.

ERB2014-4
Two adjacent experimental torrential watersheds in Slovenia

N. Bezak, S. Rusjan, A. Vidmar, M. Kogoj, M. Šraj and M. Mikoš
University of Ljubljana, Faculty of Civil and Geodetic Engineering, Jamova 2, SI-1000 Ljubljana, Slovenia

The aim of the study was to observe different hydro-meteorological variables in two adjacent experimental torrential watersheds in Slovenia. Watersheds, named Kuzlovec and Mačkov graben are located approximately 15 km west of the capital city Ljubljana. Two small torrential watersheds were selected because relatively homogeneous land use, soil type and geological conditions in the experimental watersheds. The drainage area of Kuzlovec and Mačkov graben research watersheds are 0.71 km² and 2.33 km², respectively. Kuzlovec is almost completely covered with forest (about 85%), however for the Mačkov graben watershed this percentage is a little smaller, approximately 65–75%. In the Kuzlovec there are no major anthropogenic influences, on the other hand Mačkov graben is exposed to some human effects. Furthermore, slopes in both watersheds are high (mean slope for Mačkov graben and Kuzlovec are 58.5° and 46.5°, respectively), meaning that both streams can be classified as flashy streams.

Various hydrological and meteorological variables are being observed in the both adjacent experimental watersheds. Water levels are observed with pressure probes, relatively dense network of rain gauges were established (6 tipping buckets were placed around both experimental watersheds), in-stream turbidity measurements (Hydrolab MS5 sonde) are performed during extreme hydrological and meteorological events, disdrometer is located in the capital city of Ljubljana. Furthermore, at extreme events (high and low flows) at-point discharge measurements are performed using Flo-tracer (dilution of salt) and FlowTracker (Doppler) in order to obtain rating curves for both research watersheds.

The idea behind measurements is to get more information about the dynamic of suspended sediment transport during extreme events. Therefore, measurements are carried out with 10 or 20 minutes time step, which gives us possibility to analyse relationship between discharge, rainfall intensity and suspended sediment concentrations. Investigations of time lag among peak discharges, suspended sediment concentrations peak and maximum rainfall intensities can be performed using measured data from two torrential experimental watersheds.
Mulching cover has been used as a common management practice to improve water use efficiency and soil conservation in agricultural lands of semiarid regions. These regions are characterized by soils with low infiltration rates and irregular storm patterns, with high intensity rainfall events occurring mainly in the beginning of the rainy season when soil is more susceptible to evaporation and erosion (e.g. Carvalho et al., 2002; Cantón et al., 2011; de Lima et al., 2012). This has implications on the hydrologic response of small basins. On the other hand, mulching can adversely increase rainfall interception and water retention, when mulch thickness and cover density is too high. So, it is expected that the type of mulch and cover density would have distinct influences, depending on the crop stage, soil type, and climate conditions (e.g. rainfall characteristics).

The main purpose of this study was to study the temporal dynamics of several relevant hydrological processes (e.g. runoff, soil moisture, sediment transport) in the presence of interception and water retention by mulch cover. Two distinct rainfall events were compared: a short duration high intensity rainfall event and a long and low intensity rainfall event.

Laboratory experiments were conducted using a 2.00 m long, 0.30 m wide and 0.12 m deep rectangular soil flume, with free drainage, set at 10% slope gradient. Two full-cone nozzles positioned at different distances from the soil flume have been selected for the experiments. A sandy-loam soil from the left bank of River Mondego, near Coimbra, Portugal, was used in the experiments, and different initial soil moisture contents were considered. Two soil cover conditions were evaluated: i) Bare soil (i.e. without mulch); and ii) Mulch cover with 4 t/ha density of rice straw.

Runoff hydrographs were monitored at the downstream end of the flume, during the rainfall simulations and runoff recessions. Runoff volume samples were collected at regular time intervals and then were placed in a low temperature oven to dry, allowing sediment loss to be evaluated. Soil moisture was measured throughout the experiments, at depths of 25, 50 and 75 mm using several soil moisture sensors.

The results clearly show that mulching and the characteristics of the rainfall events strongly affected infiltration, surface runoff and erosion. In general, mulching reduced runoff generation. Mulch protects the soil surface from the direct impact of raindrops and promotes the dispersion of the kinetic energy of the raindrops, preventing the compaction of the soil surface layer. For low intensity rainfall events, mulching retards infiltration. For this low rainfall intensity no soil crust was produced in the bare soil condition and relative infiltration was higher. However, at the end of the rainfall event, soil moisture was higher for the mulch cover condition.

References:
Modelling catchment behavior by streamflow component mixing approach

S. Rusjan and M. Mikos
University of Ljubljana, Faculty of Civil and Geodetic Engineering, Chair of Hydrology and Hydraulic Engineering, Jamova 2, SI-1000 Ljubljana, Slovenia

Catchments are spatial landscape elements that control water fluxes through a variety of topographic, physical and geological properties. At the most basic level, a catchment's function might be defined as the collection, storage and release of water. However, knowing the hydrological outcome of the catchment response to the atmospheric inputs gives us only a blurred and unclear picture of the hydrological processes that result in a stream hydrograph change. Traditionally, hydrological models have been developed around the central assumption that the functional behavior of hydrological systems can be predicted from the physical properties of the system combined with the governing flow equations and the initial and boundary conditions. Based on many hydrological modeling efforts, it became evident that it is extremely difficult to determine system properties at the selected scale in advance by manipulating numerous model parameters to achieve a satisfactory correspondence between the observed and simulated fluxes. Therefore, the conceptualization of streamflow generation processes and their integration into rainfall-runoff models remains one of the major research challenges in catchment hydrology. Kirchner (2009) demonstrated how streamflow time series can be used to construct a storage–discharge relationship that can be applied to simulate a full range of streamflow conditions when combined with precipitation and evapotranspiration measurements. The model structure was conceptualized on the system properties, which were directly inferred from observed changes during streamflow recession. Other recent research studies (e.g. Harman et al., 2009; Teuling et al., 2010) have increased confidence in the belief that streamflow recession does not necessarily solely reflect aquifer characteristics but instead provides a broader measure of the system-wide storage–discharge or geomorphological characteristics within the catchment.

At our experimental Padež stream catchment, the simple dynamical system approach proposed by Kirchner (2009) was modified and implemented to analyze, explain and simulate streamflow fluxes in diverse seasonal hydrological conditions. The catchment is characterized by the flushing, torrential hydrological response conditioned by the flysch geological settings of a low hydraulic conductivity. Consequently, the streamflow formation is not controlled solely by the subsurface catchment storage but is also strongly influenced by the rainfall-runoff that bypasses the subsurface part of the total catchment storage. Therefore, two components of the streamflow are described by separate sensitivity functions, and the components' exchange dynamics are identified using two-component hydrograph separation and combined through a simple model to simulate the streamflow. According to the simulation results, the Padež stream catchment behaves primarily like a subsurface storage-dependent simple dynamical system under conditions of low to moderate antecedent catchment wetness and rainfall intensities (up to 5 mm/h), when the subsurface storage flow sensitivity function was generally able to simulate streamflows. In contrast, when rainfall intensities increase (exceed approximately 5 mm/h), a secondary streamflow formation mechanism, described by the subsurface storage bypassing flow sensitivity function, is triggered and is responsible for the fast hydrograph formation with steeply rising and falling limbs. To be able to implement the modeling concept for streamflow predictions, the rainfall losses, most likely associated with interception losses not covered under the potential evapotranspiration calculation, would have to be more thoroughly analyzed through rainfall interception measurements. Our study shows the possible way that two hydrological concepts, the streamflow recession analysis and the two-component hydrograph separation based on relatively easily measurable tracers, such as electrical conductivity, could be combined for analyzing streamflow fluxes.

References:
Analysis of structural changes in hydrometeorological time series using a wavelet transform

P. Sleziak, K. Hlavčová and J. Szolgay
Slovak University of Technology in Bratislava, Faculty of Civil Engineering, Department of Land and Water Resources Management, Radlinského 11, 813 68 Bratislava, Slovakia

The determination of the temporal variability of water resources is of high importance with respect to long-term water policy. Policy-makers are calling for regional and country-level responses on ‘how to’ adapt to hydrological change. Integrating information about the risks associated with climate change in the planning of adaptive measures is also a high priority for international organizations, financial institutions and environmental agencies. This implies a need for the development of scenario tools, methods, models and data sets that can capture impacts and incremental changes in risk concerning the measures needed for adaptation planning in specific regions. Successful adaptation to global change in water management should, among other things, be based on high-quality meteorological and hydrological data and innovative descriptions of climate variability and hydrological regimes. This requires the development of adequate methods and models for analysing fluctuations and changes in the natural and anthropogenic variations of longer hydrometeorological series. The study of such changes must be based on statistical analyses of the time series of recorded history and data series with adequate lengths and quality.

The poster intends to present an analysis of changes in the structure of longer discharge time series from small catchments (mean annual and seasonal discharges) covering different runoff generation conditions in Slovakia. Ten small basins with areas of 100 km² and with lengths of time series from 1930 to 2013 were analysed. An introduction to the spectral analysis of time series with wavelet transform (WT) was given. The major advantage of this method over others (for example, Fourier analysis) is that it does not require a strict assumption of the stationarity of the time series, and it can detect periods in specific time frames, making it particularly interesting for the detection of potential changes in the behaviour of climatic and hydrological systems. Subsequently, models for the detection of potential changes in the structure of the analysed series were created with the aim of capturing changes in the relationship between the frequency components and the structure of the time series. The main aim of the study was to detect changes in the cyclical components and the multiannual variability of time series in small basins in selected regions of Slovakia by wavelet and cross wavelet analyses. The changes detected will be contrasted with the results from studies of experimental hydrologic basins in the regions analysed. The results showed that the WT method is appropriate for the analysis of long-term hydrological time series in small basins. The methodology developed during this work will also serve as a model for other similar research changes in the structure of hydrological time series with shorter sampling intervals.

Urbanization has deep impacts in streams affecting all aspects of the ecosystem. The distinctive impacts of urbanization include the increase in impervious surfaces which in turn alters the hydrology and geomorphology of streams. Thus, urbanization affects not only water quality but also habitat characteristics. Biological indicators may reveal spatial-temporal effects of stressors and their cumulative effects on stream biota, and biotic indices based on intolerance to disturbance and taxonomic richness are effective and widely used to assess ecological health. But the multiple, co-occurring and interacting stressors of urban streams, namely habitat alterations, may be better revealed by macroinvertebrate traits - the species adaptations to environmental conditions. The aim of this study is to develop a broadly applicable and easy to use multi-trait biotic index based on macroinvertebrate adaptations to environmental conditions to evaluate urban stream health. The preliminary results obtained during four sampling occasions in Ribeira dos Covões, a small peri-urban stream in Coimbra suggest that macroinvertebrate traits - the species adaptations to environmental conditions. The aim of this study is to develop a broadly applicable and easy to use multi-trait biotic index based on macroinvertebrate adaptations to environmental conditions to evaluate urban stream health. The preliminary results obtained during four sampling occasions in Ribeira dos Covões, a small peri-urban stream in Coimbra suggest that macroinvertebrate biological, physiological and ecological traits can be a very promising tool to monitor the urban stream degree of disturbance. We found a response of the macroinvertebrate traits along the longitudinal profile, denoting a degree of disturbance similar to that obtained with biotic indices. These results will be compared with physico-chemical parameters, habitat and riparian quality, in order to establish a multi-trait index capable of assessing the urban stream environmental stress.

This work was supported by the Slovak Research and Development Agency under Contract No. APVV-0303-11 and APVV-0496-10 and a Grant for Support of Young Researchers at the Slovak University of Technology in Bratislava.
Hydrology and Quantitative Water Management Group, 2
The slightly sloping, freely draining Hupsel Brook catchment is located in the east of The Netherlands.

The Netherlands.

The Wageningen Lowland Runoff Simulator (WALRUS), a new rainfall-runoff model for catchments with shallow groundwater.

C.C. Brauer, P.J.J.F. Torfs, A.J. Teuling and R. Uijlenhoet

Hydrology and Quantitative Water Management Group, Wageningen University, The Netherlands

Rainfall-runoff models are often designed using experience gained in experimental basins. Here we present the Wageningen Lowland Runoff Simulator (WALRUS), which has recently been developed using observations from two contrasting experimental basins in The Netherlands.

The slightly sloping, freely draining Hupsel Brook catchment is located in the east of The Netherlands (6.5 km², 22-35 m above mean sea level) and has been an experimental catchment employed by Wageningen University since 1965. The flat Cabauw polder with controlled water levels is located in the west of The Netherlands (0.5 km², 1 m below sea level) and is part of the Cabauw Experimental Site for Atmospheric Research (CESAR), which is well known in the meteorological community.

Lowlands comparable to the Hupsel Brook catchment and Cabauw polder exist all over the world (often in river deltas), and are characterized by shallow water tables. These shallow water tables affect both runoff generation and evapotranspiration. Based on observations, we identified several characteristics which affect hydrological processes in lowland catchments, but are often not taken into account in rainfall-runoff models: (1) groundwater and unsaturated zone are coupled, (2) plant water stress is limited, (3) the catchment wetness determines which routes the water takes to the surface water, (4) feedbacks exist between groundwater and surface water, and (5) seepage and surface water supply and extraction are common.

Using these characteristics, we developed WALRUS to fill the gap between complex, spatially distributed models which are often used in lowland catchments and simple, parametric models which have mostly been developed for mountainous catchments (Brauer, 2014a, 2014b). This lumped, parametric rainfall-runoff model can be used all over the world in both freely draining lowland catchments and polders with controlled water levels.

In both catchments, WALRUS performs well during the years used for calibration and validation. The model also performs well during extremely wet periods (flash flood in the Hupsel Brook catchment in August 2010) and extremely dry periods (summer 1976). WALRUS is computationally efficient, which allows operational forecasting and uncertainty estimation by creating ensembles. An approach for flexible time steps increases numerical stability and makes model parameter values independent of time step size, which facilitates use of the model with the same parameter set for multi-year water balance studies as well as detailed analyses of individual flood peaks.

References:


Mapping soil permeability using infrared thermography

J.R.C.B. Abrantes (1), J.L.M.P. de Lima (1,2), V.P. Silva Jr. (3) and A.A.A. Montenegro (3)

(1) Department of Civil Engineering, Faculty of Science and Technology, University of Coimbra, Coimbra, Portugal
(2) Department of Rural Technology, Rural Federal University of Pernambuco, Recife, Brazil

Permeability is the measure of the soil’s ability to allow water to flow through its pores or voids. In general, small scale measurement techniques (e.g. double-ring infiltrometer, Guelph permeameter) rely on precise and time-consuming experimental procedures. Also, permeability is highly variable over different spatial scales, strongly influencing hydrological processes. Hence, local scale traditional permeability tests need to be grouped or scaled to bring out spatial coherence (e.g. Wang et al., 2001) in order to properly represent distributed patterns of variation and for distributed spatial analysis. Recently, several experimental research have been carried out aiming to develop measurement techniques for estimating soil hydraulic characteristics (e.g. Reynolds and Elrick, 1985; Haverkamp et al., 2006; Vereeken et al., 2007).

The main goal of this study was to verify if infrared thermography can be used to identify preferential infiltration fluxes, at the soil surface, which would allow to map areas of lower and higher skin surface soil permeability. This study follows other articles that also made use of infrared thermography in a controlled laboratory environment to study surface hydrological processes (de Lima and Abrantes, 2014a, 2014b).

Experiments were carried out using a 3.00 m long, 0.30 m wide and 0.12 m deep free drainage laboratory soil flume with a hot water feeder box installed at the upslope end of the flume. Different skin soil surface permeability scenarios were tested in a defined section of the flume, using different soil materials (e.g. sandy loam soil, sieved sand). Skin soil surface temperature distributions of the section were surveyed by an infrared video camera (PI160 from Optris GmbH).

The technique starts by applying heated water to the soil surface, using the feeder box, at a temperature of around 80°C. As the heated water flows along the flume, approximately uniformly distributed, it infiltrates and preferentially penetrates the soil in the higher permeability areas which, consequently, present higher temperatures. Temperature data was then converted into permeability data to generate soil surface permeability maps. The conversion method consists in transforming the temperature data of the thermograms into permeability data using linear regressions comparing the a priori known permeability of different spots of the soil surface with their corresponding temperatures extracted from the thermograms.

Thus, the technique enables mapping of the soil surface permeability. Although small differences in permeability or small patches of soil with other characteristics are not easily detected, thermograms allow the identification of areas with higher permeability, perceptible by the higher temperatures.

References:


To assure the quality of the erosive status classification obtained using the Fuzzy ARTMAP neural network technique, a comparison with the PAP/RAC criteria was held (PAP/RAC is a widely used criteria for environmental mapping). The differences found in the results obtained by the two methods were of about only 779 ha, i.e., less than 1% of the total area.

The attained values show a good choice of polygons in the training phase. This Fuzzy ARTMAP neural network can thus be used for classification of the neighbouring area of the Ria Formosa basin, as long as similar slopes, lithofacies, land use, soil type and forestry index are present.

References:

ERB2014-24

Projections of peak flow changes in 21st century in rural and urban parts of small Lithuanian catchment

E. Stonievicius

Vilnius University, Lithuania

The increase of extreme rainfall events is likely in the 21st century. Climate predictions based on A1B and B1 emission scenarios show that heavy showers (20 mm/day) in western part of Lithuania will be ~ 50% more frequent. More intensive rainfall is likely to produce the higher peak flow. Especially in small rivers, there the runoff concentration times are shorter.

In this study the projections of small Smeltale river (catchment area 120 km$^2$) peak flow changes according to various climate change scenarios are presented. Smeltale is situated in the western part of Lithuania. More than 80% of catchment area is rural and dominated by agricultural land. The rest 20% of catchment is in Klaipeda city where the majority of runoff reaches the river by the rain drainage system. The changes of peak flow in the rural part were estimated with Technical Release 20 (TR-20) model, which presents simplified procedures to calculate storm runoff volume and peak rate of discharge. In the urban part the discharge was calculated according to the method described in the Lithuanian Technical Regulation in Construction of Storm Water Drainage Systems.

The study results showed that the peak flow from the smaller urban part of the catchment is large than flow from the rural part during extreme rainfall events. With more intensive rainfall being projected for the 21st century, the peak flow is likely to increase up to 40% in the rural part of the catchment and up to 10% in the urban part. Planned land use changes also are expected to increase the peak flow of both parts of catchment.

ERB2014-23

Cartography of erosive status using a neuro-fuzzy technique: The Ria Formosa basin

F.M.G. Martins (1,2,4,5), H.M.N.P.V. Fernandez (1,2,4,5), J.M.G.P. Isidoro (3,5), A. Jordán (4) and L.M. Zavala (4)

(1) CIEO, Research Centre for Spatial and Organizational Dynamics, University of Algarve, 8005-139 Faro, Portugal
(2) CERENA, Centre for Natural Resources and the Environment, Instituto Superior Técnico, University of Lisbon, 1049-001 Lisbon, Portugal
(3) Institute of Marine Research (IMAR); Marine and Environmental Sciences Centre (MARE), Portugal
(4) MED_Soil Research Group, Department of Crystallography, Mineralogy and Agricultural Chemistry, University of Seville, Seville, Spain
(5) Department of Civil Engineering, Institute of Engineering, University of Algarve, 8005-139 Faro, Portugal

Geographical Information Systems (GIS) are a powerful tool for the assessment of local natural resources. GIS allow a rapid integration, representation and analysis of biophysical attributes from assorted origins, for instance, topographic, cartographic and remote sensing. In this work, neuro-fuzzy technique - Fuzzy ARTMAP technique (Carpenter et al., 1992) -, embedded in a GIS environment was used to build a cartographic representation of the erosive status of the Ria Formosa basin (Portugal). Mapping the erosive status of a given area allows for a higher awareness of the potential soil erosion risks of that area; the erosive status is thus a key-index for the assessment of soil erosion risk.

The erosive status map of the Ria Formosa basin was obtained by crossing erodibility and soil protection maps. The erodibility map was obtained from the slope and lithofacies maps and the soil protection map from the land use and the vegetation coverage maps.

The Fuzzy ARTMAP technique is a generalized version of ARTMAP architecture that incorporates fuzzy-logic with ART methodology. The Adaptive Resonance Theory (ART) evolved from the biological theory of cognitive information processing and has been used for pattern classification. From this theory many models of neural networks capable of learning for unsupervised classification standards were developed. The ARTMAP networks have a hierarchical architecture for parallel multi-layers. The first layer is the input, the intermediate layers are hidden-layers and the last layer is the output. These networks use two ART modules (ARTa and ARTb) linked by weighted-connections. ARTa module receives an input information vector representing a pattern. ARTb module receives an output information vector representing the class-target for the same input pattern. These two modules are bonded by a bonding layer called "map field".

Ria Formosa is a shallow coastal lagoon covering an area of about 16000 ha in the south of Portugal and the Ria Formosa basin totals an area of 86426 ha. Initially, polygons were digitized to train the neural network. These small areas, which represent only 1% of the basin area, were chosen because they give a good representation of the different topographic, lithologic, land use, soil type and forestry index typologies of the Ria Formosa basin. After this initial phase the erosive status classification was carried out, resulting in 5 different classes of erosive status: very low, low, moderate, high and very high.
Testing of third generation of combined thermal and soil moisture standalone field station made by TOMST s.r.o. (www.tomst.com) coded TMS3 is presented.

The TMS3 underwent calibration on sets of soils. Disturbed and packed cylindrical soil samples (approx. 20 liter) were subject investigation. Database of soil-specific calibration curves is being built for various soil samples. TMS3 station has been calibrated for soil materials: sandy loam, quartz sand, loamy sand, loam and peat. Calibration on selected undisturbed 7 liter samples previously CT scanned for correct sensor is also completed. Temperature and salinity influence on the soil moisture results in drift of 0.05%/°C and 7%/in full range of 0 to 10 miliSiemens/cm) and additional 2%/in additional range of 10 to 20 miliSiemens/cm) as found in 100% moisture (water based solution). There is a TMS3Calibr software released as a user friendly tool to convert raw measurements to volumetric soil moisture.

Extended testing of temperature measurements TMS1, TMS2 and TMS3 generations is successfully performed in variety of field locations (central Europe, southern Africa, Himalaya region). Results of long-term temperature measurements at hundreds of localities are successfully used for i) evaluation of species-specific environmental requirements (for different species of plants, bryophytes and fungi) and ii) extrapolation of microclimatic conditions over large areas of rugged sandstone relief with assistance of accurate, LiDAR based, digital terrain model. TMS units are e.g. also applied for continuous measurement of temperature and moisture of coarse woody debris, which serves as an important substrate for establishment and growth of seedlings and is thus crucial for natural regeneration of many forest ecosystems. User friendly software ViewTMS allows merging of data from different time blocks and difference sensors for comprehensiv statistical analysis.

The research is supported by the Technology Agency of the Czech Republic projects No. TA01021293

ERB2014-27
TMS3: Calibration of soil moisture measurements on variety of soil classes and testing of temperature measurements in vast fields

J. Jankovec (1), M. Šanda, (1) and J. Wild (2)
(1) CTU in Prague, Faculty of Civil Engineering, Czech Republic
(2) Institute of Botany, AS CR

Environmental geomorphic events may represent threats to people and economical activities. A deeper knowledge of the genesis of these events is thus crucial for finding the adequate tools that are able to mitigate those threats. Geographic Information Systems (GIS) based on the Digital Elevation Models (DEM) have a marked importance in environmental and land management. DEM are also important tools for the identification and modelling of geomorphs.

In this work a hierarchical method based on a DEM was used to classify geomorphs in the Ria Formosa basin (south of mainland Portugal). The derivate models of DEM (e.g. slope, curvature, profile, local relief) were considered in order to obtain a cartographic representation of the geomorphs existent in this basin, which may have importance on the hydrologic behaviour of the basin and also of sub-basins of different sizes and with different physiographic characteristics.

Data analysis and mapping were performed using IDRISI Taiga software. The Ria Formosa basin is limited by coordinates WGS84: 37° 15′ N to 36° 57′ N and 7° 28′ W to 8° 4′ W. The area and perimeter of this basin are, respectively, 864 km² and 166 km, including a coastal lagoon with an area of about 160 km². Land use and cover of the Ria Formosa basin are mainly agriculture (49%), sclerophyllous vegetation (17%) and saltmarsh (8%). The topography of the region is regular and continuous, without sudden changes in altitude. Average slope of the basin is 11% with an altitude range from 0 to 530 m above mean sea level. Average length of the main streams that drain into the Ria Formosa is 26.1 km. The annual rainfall varies between 400 and 800 mm and the annual average temperature is 17°C. This coastal lagoon is protected by the European Union (EU) and by Portuguese law, being classified as a Wetland of International Importance by the Ramsar Convention (Ramsar Site PORTUGAL 212). The Ria Formosa basin overlaps 7 municipalities (Faro, Tavira, Olhão, São Brás, Loulé, Vila Real de Santo António and Castro Marim).

The automatic method for classification of the Ria Formosa basin was implemented in GIS environment with the Crosstab module (IDRISI Andes). Using filtering techniques within a moving window, this module allowed the cross analysis of different local terrain parameters derived from the DEM. This automatic method for hierarchical classification of the Ria Formosa basin

ERB2014-28
Modelling and classification of geomorphs: The Ria Formosa basin

F.M.G. Martins (1,2,4,5), H.M.N.P.V. Fernandez (1,2,4,5), J.M.G.P. Isidoro (3,5), J.L.M.P. de Lima (3,6), A. Jordán (4) and L.M. Zavala (4)
(1) CIEO, Research Centre for Spatial and Organizational Dynamics, University of Algarve, 8005-139 Faro, Portugal
(2) CERENA, Centre for Natural Resources and the Environment, University of Lisbon, 1049-001 Lisbon, Portugal
(3) Institute of Marine Research (IMAR); Marine and Environmental Sciences Centre (MARE), Portugal
(4) MED_Soil Research Group, Department of Crystallography, Mineralogy and Agricultural Chemistry, University of Seville, Seville, Spain
(5) Department of Civil Engineering, Institute of Engineering, University of Algarve, 8005-139 Faro, Portugal
(6) Department of Civil Engineering, Faculty of Sciences and Technology, University of Coimbra, 3030-788 Coimbra, Portugal

Environmental geomorphic events may represent threats to people and economical activities. A deeper knowledge of the genesis of these events is thus crucial for finding the adequate tools that are able to mitigate those threats. Geographic Information Systems (GIS) based on the Digital Elevation Models (DEM) have a marked importance in environmental and land management. DEM are also important tools for the identification and modelling of geomorphs.

In this work a hierarchical method based on a DEM was used to classify geomorphs in the Ria Formosa basin (south of mainland Portugal). The derivate models of DEM (e.g. slope, curvature, profile, local relief) were considered in order to obtain a cartographic representation of the geomorphs existent in this basin, which may have importance on the hydrologic behaviour of the basin and also of sub-basins of different sizes and with different physiographic characteristics.

Data analysis and mapping were performed using IDRISI Taiga software. The Ria Formosa basin is limited by coordinates WGS84: 37° 15′ N to 36° 57′ N and 7° 28′ W to 8° 4′ W. The area and perimeter of this basin are, respectively, 864 km² and 166 km, including a coastal lagoon with an area of about 160 km². Land use and cover of the Ria Formosa basin are mainly agriculture (49%), sclerophyllous vegetation (17%) and saltmarsh (8%). The topography of the region is regular and continuous, without sudden changes in altitude. Average slope of the basin is 11% with an altitude range from 0 to 530 m above mean sea level. Average length of the main streams that drain into the Ria Formosa is 26.1 km. The annual rainfall varies between 400 and 800 mm and the annual average temperature is 17°C. This coastal lagoon is protected by the European Union (EU) and by Portuguese law, being classified as a Wetland of International Importance by the Ramsar Convention (Ramsar Site PORTUGAL 212). The Ria Formosa basin overlaps 7 municipalities (Faro, Tavira, Olhão, São Brás, Loulé, Vila Real de Santo António and Castro Marim).

The automatic method for classification of the Ria Formosa basin was implemented in GIS environment with the Crosstab module (IDRISI Andes). Using filtering techniques within a moving window, this module allowed the cross analysis of different local terrain parameters derived from the DEM. This automatic method for hierarchical classification of the Ria Formosa basin
The main objectives of the present study were therefore: partitioning and balance water over this ecosystem. The eastern Brazil, semiarid region, from March to December was established in the centre of the representative basin. Considering the above-mentioned, a micro-meteorological tower was installed for measuring soil moisture at depths of 0.10, 0.20, 0.30 and 0.40 m using water content reflectometers, and soil water storage was calculated for the 0-0.40 m soil layer. Infiltration tests were performed in soil surface and 0.20 and 0.40 m depth for the determination of the saturated soil hydraulic conductivity and the soil-water retention curve was determined in the laboratory. The deep soil drainage and/or capillary rise were calculated by Darcy’s law. The reference evapotranspiration (ET), was also assessed, by Penman-Monteith method. It was verified that rainfall during the experimental period (194.8 mm) was significantly lower than average (about 560 mm), reducing the soil water storage. Sensible heat flux dominated the energy budget over the whole experimental period, accounting for 72% of net radiation, being that in wetter period (July-August), latent heat flux was mainly a consumption resource for net radiation, accounting for 58% of net radiation. In relation to water balance components it was verified that the flux of water crossing the bottom of the soil layer (capillarity rise or drainage) had very small values. The total evapotranspiration and its daily average, obtained by eddy covariance method (ET_EC), were 263.8 mm and 0.86 mm day⁻¹. The total and average ET, obtained by water balance method (ET_WB), were 194.4 mm and 0.63 mm day⁻¹, respectively. The agreement between the two measures of ET was generally better in wetter periods, indicating that, in drier periods (from September to December), the ET was underestimated by the water balance method. The grassland must have suffered water stress, in almost all experimental period, due the values of the ratio ET/ETo being much lower than 1 (ET_EC/ETo = 0.30 and ET_WB/ETo = 0.24). In this study, it was verified that the seasonal and diurnal variation in energy partitioning was primarily controlled by the soil water availability and ET was strongly controlled by the vapour pressure deficit (VPD) of the air during the periods with limited soil moisture. The water balance method can be used for estimating ET of grasslands in similar environmental conditions.

**ERB2014-29**

**Water and energy fluxes of grasslands in representative basin in Pernambuco state - Brazil**

E.M. Alves (1), A.C.D. Antonino (1), J.R.S. Lima (2), S.M.G.L. Montenegro (1), E.S. Souza (3), C.B. Machado (1), A.A. Ribeiro (2) and R.M.S. Souza (3)

1) Federal University of Pernambuco – UFPE, Brazil
2) Federal Rural University of Pernambuco, Garanhuns, UFRPE, Brazil
3) Federal Rural University of Pernambuco, Serra Talhada, UFRPE, Brazil

Energy and water fluxes (evapotranspiration) and environmental factors regulate carbon flux of terrestrial ecosystems especially in arid and semi-arid grasslands. Grassland is one of the globally widespread biome types, and plays an important role in the terrestrial carbon cycle. Evapotranspiration (ET), linking the cycles of water and energy is one of the major components of the water balance for terrestrial ecosystems and food crops. The accurate estimation of water loss by ET is very important for assessing water availability and requirements of terrestrial ecosystems, and making adequate use of water resources. There are various methods for measuring ET, being that the eddy covariance technique is a widely used and accepted method to quantify ecosystem-scale mass and energy fluxes, while water balance method is widely used due their simplicity, robustness and low cost. Considering the above-mentioned, a micro-meteorological experiment over grasslands was conducted in an experimental basin within a representative basin of northeastern Brazil, semiarid region, from March to December 2012, to improve the current understanding of energy partitioning and balance water over this ecosystem. The main objectives of the present study were therefore:

1) to quantify the seasonal and diurnal variations in the energy exchanges over the grasslands using the eddy covariance method;
2) to quantify the different fluxes of water in the grassland ecosystem using the water balance method and
3) to compare the ET obtained by eddy covariance and water balance methods.

The study area, located at Mundaú representative basin, county São João (8° 52’ 30” S, 36° 22’ 00” W, elevation 705 m), Brazil, is covered by pasture. In order to estimate ET by eddy covariance method (ET_EC), a micro-meteorological tower was established in the centre of the experimental field instrumented with a rain gauge, a pyranometer, a net radiometer, and a system consisting of a 3-D sonic anemometer and an open-path and fast response infrared CO₂/H₂O analyzer. In order to determine the ET by water balance method (ET_WB), sensors were installed for measuring soil moisture at depths of 0.10, 0.20, 0.30 and 0.40 m using water content reflectometers, and soil water storage was calculated for the 0-0.40 m soil layer. Infiltration tests were performed in soil surface and 0.20 and 0.40 m depth for the determination of the saturated soil hydraulic conductivity and the soil-water retention curve was determined in the laboratory. The deep soil drainage and/or capillary rise were calculated by Darcy’s law. The reference evapotranspiration (ET), was also assessed, by Penman-Monteith method. It was verified that rainfall during the experimental period (194.8 mm) was significantly lower than average (about 560 mm), reducing the soil water storage. Sensible heat flux dominated the energy budget over the whole experimental period, accounting for 72% of net radiation, being that in wetter period (July-August), latent heat flux was mainly a consumption resource for net radiation, accounting for 58% of net radiation. In relation to water balance components it was verified that the flux of water crossing the bottom of the soil layer (capillarity rise or drainage) had very small values. The total evapotranspiration and its daily average, obtained by eddy covariance method (ET_EC), were 263.8 mm and 0.86 mm day⁻¹. The total and average ET, obtained by water balance method (ET_WB), were 194.4 mm and 0.63 mm day⁻¹, respectively. The agreement between the two measures of ET was generally better in wetter periods, indicating that, in drier periods (from September to December), the ET was underestimated by the water balance method. The grassland must have suffered water stress, in almost all experimental period, due the values of the ratio ET/ETo being much lower than 1 (ET_EC/ETo = 0.30 and ET_WB/ETo = 0.24). In this study, it was verified that the seasonal and diurnal variation in energy partitioning was primarily controlled by the soil water availability and ET was strongly controlled by the vapour pressure deficit (VPD) of the air during the periods with limited soil moisture. The water balance method can be used for estimating ET of grasslands in similar environmental conditions.
Relation between characteristic flood discharges of different return period; a study from Lower Austria

C. Krammer
Department of Hydrology, Lower Austrian state administration, Austria

The goal of this study is to find predictors to estimate the magnitude of rare events if one knows only data from short time series, and to estimate relations between characteristic flood discharges of different return periods for a given catchment.

Lower Austria, with its area of more than 19,000 km², includes regions ranging from lowlands (down to less than 200 m above sea level) up to higher mountains (2000 m), and climatic zones from semi-arid (below 500 mm precipitation per year) to humid (over 2000 mm/year).

For this study, data from more than 80 gauging stations were used to calculate characteristic flood discharges of different return periods, measuring discharges from catchments of less than 20 km² up to more than 1400 km².

Since quite a few of the empiric distributions, which had been obtained from gauged data, show a typical S-shape instead of a simple curve, they could not always be approximated well by theoretical distribution functions known from literature. Therefore, it was not possible to underlay one theoretical distribution under all the different data sets and just find predictors for the parameters of this one function. This led to the idea to use just relations within the empiric distributions (for instance Q1/Q10, and also Q10/Q100 where data allowed this estimation). The further analysis served to find predicting variables and establish a formula that should give a good estimation of these quotients. Tested variables include climatic, hydrologic, orographic, shape and land use parameters as well as catchment size.

Spatial and seasonal variability of concentration and composition of suspended load in the Vistula river between Wyszogród and Chełmno (Poland)

M. Kaszubski
Institute of Geography and Spatial Organization Polish Academy of Sciences, Department of Environmental Resources and Geohazards, Kopernika 19, 87-100 Toruń, Poland

The main objective of the study is to explain causes of variations of concentration, particle size distribution and composition of suspended load in the riverbed of the lower Vistula between Wyszogród and Chełmno. The study was conducted in seven bridge cross-sections (three above and four below the Włocławek reservoir).

In each cross-section, three water samples were collected in the characteristic parts of the riverbed. Since July 2012 fifteen measurement series were carried out. During each measurement series 22 samples of water were collected. In each sample the overall concentration of suspended load, the proportion of the organic matter and particle size distribution of the mineral fraction were measured.

Variation of concentration and characteristics of suspended load were studied both in the cross-sections of the Vistula riverbed and along its longitudinal profile. The study focus primarily on determining the qualitative and quantitative variation in the properties of suspended load in the cross-sections located in different morphological riverbed type, various level of its hydrotechnical management, including the operation on the Włocławek reservoir, and the diversity of the water flow conditions. The author tested the correlation occurring between the size of suspended load concentration as well as the flow rate and flow velocity at the water sampling sites. Moreover, the effect of morphological variation of the Vistula riverbed (the riverbed depth and the location of points of collecting water samples relative to the riverbed mesoforms) on the concentration size, composition structure and the particle size distribution of suspended load were determined. Measurement sessions were chosen in such a way as to cover the widest possible spectrum of the water flow conditions in the riverbed of the Vistula. In addition to the low and medium flow the variability in concentration during flood flows of various types (ice jam, snowmelt and rainfall) were determined.

The results showed that the variation of the concentration of suspended load in the longitudinal profile is primarily associated with the operation of the barrage in Włocławek. During the study period the reduction of concentration of suspension in the Włocławek reservoir averaged to 70%. As the results indicate, the average concentration of suspended load in the bridge cross-section in Chełmno did not reach even once the turbidity level of the section above the Włocławek reservoir. The problem of the variation of concentration of suspended load in the cross-sections of the Vistula was not previously the subject of a more detailed study. The observations performed by the author revealed that the variation of concentration, composition and grain size distribution of suspended load in the cross-sections were often higher than on the entire analysed section of the Vistula. During the study period the following turbidity variations in the cross-sections were recorded: 83% in Wyszogród, 74% in Płock, 40% in Włocławek, 53% in Toruń, 35% in Bydgoszcz, and 34% in Chełmno.
Human impact on the temporal and spatial conditions of the outflow from the Skrwa Lewa river basin (central Poland)

D. Brykala
Polish Academy of Sciences, Institute of Geography and Spatial Organization, Poland

The subject of research is the Skrwa Lewa river basin which is the left-bank tributary of the lower Vistula River, the largest Polish river. Its length is 48.5 km, it has an average gradient of 1.53% and its largest tributary is the Osetnica river - 17.3 km long. The total area of basin is 400.4 km². The defining land use in the Skrwa Lewa basin, in comparison to neighboring basins, is the significant percentage of forest (40%) while agricultural land takes up 57% (of which 78% is arable land). The only town - Gostynin (20,000 inhabitants) - occupies just 1% of the area.

The terrain studies ran since 2000 and was set against a multi-year background (since 1961) based on the results of hydro-meteorological observations conducted by the Institute of Meteorology and Water Management (IMGW) in the catchment. In addition, the impact of human activity on this hydrographic system has been well researched from medieval to modern times.

Until the Middle Ages, man had little influence on changes to the hydrographic network and run-off. The significant improvement in farming techniques which then took place increased the area of arable land at the expense of forested areas. With the increase in cereal yields, a search for new methods of milling became indispensable and in the mid-14th c. mills emerged using energy from the river at 30 locations in the river basin. They were the first hydro-technical constructions for damming water and, until the beginning of the 20th century, they constituted the main element in river management. In the 20th century almost all stream channels have been regulated in the upland zone of the river basin.

Land melioration is another manifestation of human impact in the river basin. The first, from 1796, concerned the draining of meadows near Lake Lucientskie. However, until the mid-20th century, land melioration was carried out only on a small scale and in small areas, mainly in the Płock Basin. In 1961-2005 24% of the basin was affected by improvements reaching a. maximum in the 1980's. At that time more than 2000 hectares of agricultural land were drained, mainly in the upland part of the Osetnica basin. It should be noted that nearly all the land improvement works carried out consisted of drainage, and in the upland part, as much as 81% of the total arable land has been affected.

Sequences of average annual discharge and average annual groundwater-levels for the period 1961-2005 are statistically heterogeneous. This can be evidence for the impact of factors other than precipitation on these changes. The analysis of the double-mass curve for annual cumulative precipitation and discharge helped to define the date from which a deviation of the double-mass curve from a straight line becomes visible. Until 1978 points of cumulative precipitation and discharge imitate a straight line. From 1979 to 1982, there is an increase in discharge relative to precipitation, while from 1983 the relationship between discharge and precipitation is becoming smaller. After 1982 there was a permanent change in the angle of inclination of the straight line. Retrial tests for homogeneity show that the sequences of average annual discharge of the Skrwa Lewa river at Klusek and of average annual groundwater-levels are statistically homogeneous in years: 1961-1982 (period A) and in years: 1983-2005 (period B).

With the help of selected parameters for floods and low flows (start, duration, depth), differences between periods A and B have been illustrated. In 1983-2005 the floods waves of the summer half-year were formed on average two weeks earlier than in period A. Levels of peak flow (two-fold) and duration (three-fold) have been substantially reduced. The low flows of the summer half-year in period B have begun to appear three weeks earlier and have lasted until the beginning of October, about a month longer than on average in years 1961-82.

The main conclusions are:
1. The process of human-modifying the conditions of discharge in the Skrwa Lewa river basin has progressed through three stages:
   - In the first phase changes were caused by settlement in the area and were due to the conversion of forest to agricultural land.
   - In the second stage, the hydrographic system was modified by regulation of river channels and the hydro-technical management of rivers.
   - The third stage is associated with land melioration.
2. Major changes in the discharge of the Skrwa Lewa River were related to the summer half-year. They revealed primarily a two-fold increase in irregularities in the discharge, while reducing by half the levels of maximum and minimum flows. The duration of low flows increased three-fold while the duration of floods was reduced three-fold.
3. On the volume of water resources available during the growing season, precipitation in winter (as snow) has a decisive influence. A pattern can be observed that in years in which the groundwater retention did not recover, in the summer half-year very low flows occurred (1989-1992). Thus, the restoration of storage in small reservoirs could contribute to the prolongation of increased discharge from the thaw period up to the period of droughts.
4. Theoretically, the restoration of mill dams in the Skrwa Lewa river basin in places where they have operated for centuries would increase (recover) retention in through reservoirs of about 2-3% of the average annual discharge from the basin. Such a step would also entail an increase in other forms of retention.

Basic research for the results presented in this work was made possible particularly by project funded by the National Science Centre (NCN - grant: UMO-2011/03/D/HS3/03631).

15th Biennial Conference ERB2014
ERB2014-37

The influence of modern and paleolakes on the outflow and chemical properties of river waters – an example from Pomerania, Poland

P. Gierszewski, D. Brykala and M. Kaszubski
Institute of Geography and Spatial Organization, Polish Academy of Sciences, Poland

The studies on the conditions of the water and dissolved matter circulation in the young-glacial catchment of the Czechowskie lake (Tuchola Pinewood Forest, Pomerania, Poland) have been conducted since 2012. They are implemented on the basis of an organised network of monitoring surface water and groundwater. An important aim of the study is to assess the impact of both modern and former lakes (paleolakes) on the regime of the outflow and the transformation of the water chemical properties.

The hydrological and hydrochemical monitoring of surface water and groundwater was conducted on the basis of a network of piezometers and gauging stations. The results of investigation show the small variation of the first groundwater level. Between May 2012 and March 2014 it ranged from 0.17 to 0.92 m. The smallest variation of the groundwater levels was observed in the deepest piezometers located in the watershed zone, while the greatest – in the shallow waters within the lake terrace used for farming. The insignificant dynamics of the groundwater table corresponds to a small variation of water level in the Czechowskie lake, which was 0.33 m.

The measurements of the discharge showed that its average value at the outflow from the Czechowskie lake is 30 dm³ s⁻¹. It almost equals the total amount of water flowing into the lake through watercourses. The average specific runoff from the whole basin was 6 dm³ s⁻¹ km⁻². This is typical value for young glacial catchments of the outwash plain areas in Pomerania.

Hydrochemical studies have shown large diversity of total mineralization both surface water and groundwater, but large similarity their ionic composition. The value of specific conductivity of water ranges from approximately 80 to 800 µS cm⁻¹. The most mineralised (700-800 µS cm⁻¹) is the shallow groundwater in the mineral-organic-carbonate deposits of paleolakes and in the watercourses draining them. The lowest mineralisation was recorded in shallow groundwater of the sandy outwash plains. Both surface water and groundwater represent a bicarbonate-calcium-sulphate type characteristic of the young glacial environment. The zones of water enrichment in salts are associated with fossil lake basins filled with the organic-carbonate sediment, while the salt precipitation zones with the modern lakes. This situation creates a specific, cascade model of the transformation of chemical properties of the water circulating in the catchment.

ERB2014-40

Antecedent moisture and rainfall thresholds for runoff generation in a humid rural catchment in NW Spain

M.L. Rodríguez-Blanco, M.M. Taboada-Castro and M.T. Taboada-Castro
Centro de Investigaciones Científicas Avanzadas (CICA), Facultade de Ciencias, Universidade da Coruña, Campus de A Coruña, 15017 A Coruña, Spain

The antecedent moisture state is one of the most important environments controllers of storm runoff in humid catchments. However, field-scale soil moisture data are available for only a few localisations and are lacking for large areas and for multiyear period. Owing to these difficulties, antecedent soil moisture conditions (AMCs) are typically estimated from measured variables such as antecedent rainfall for several days before the events (e.g. AP1, 3, 5, 7, 15 and 21 days), antecedent precipitation index (API), discharge, groundwater elevation, etc. This study evaluates the role exerted by the antecedent moisture conditions and rainfall depth on runoff generation in a humid rural headwater catchment located in NW Spain. For this purpose, 228 rainfall-runoff events occurred in the Corbeira catchment between 2004 and 2012 were examined. Discharge at the beginning of the event, AP1, 3, 5, 7, 15 and 21 days, API and soil moisture data, predicted by the SWAT model, are used as proxies of AMCs in order to identify the surrogates for AMCs that best suited to characterise the hydrological response of the catchment. The ability of the model to simulate soil moisture was not directly validated by comparing with actual measurement due to the lack of available data. However, the reasonable estimation of other hydrological parameters demonstrates the ability of the model to simulate the hydrological response of the catchment through the prediction of hydrological process. Therefore, the SWAT model could be a good alternative for getting a reliable estimation of soil moisture at catchment scale in this catchment. The results of this study provide a wide overview of the hydrological response of the Corbeira catchment. They show evidences of a non-linear response in runoff generation, and allow the identification of antecedent moisture thresholds above which runoff significant increases. The results also indicate that discharge at the beginning of the event and the soil moisture data calculated by SWAT model best predict the runoff variability runoff than antecedent rainfall.

This study is a contribution to the Virtual Institute of Integrated Climate and Landscape Evolution (ICLEA) of the Helmholtz Association.
**ERB2014-41**

Analysis of climate change effects on the hydrology of a small headwater catchment in NW Spain using SWAT model

M.L. Rodríguez-Blanco (1), M.M. Taboada-Castro (1), M.T. Taboada-Castro (1), J.P. Nunes (2), M.E. Rial-Rivas (2) and J.J. Keizer (2)

(1) Centro de Investigaciones Científicas Avanzadas (CICA), Facultade de Ciencias, Universidade da Coruña, Campus de A Coruña, 15071 A Coruña, Spain
(2) CESAM and Dept. Environment & Planning, University of Aveiro, 3810-193 Aveiro, Portugal

Climate changes such as changes in precipitation, temperature and atmospheric CO$_2$ concentration are expect to impact all aspects of the hydrological cycle, thereby changing the availability of fresh water. An assessment of the effects of long-term climate change on water resources is essential to the development of water quality improvement programs. In this study, the potential impact of climate change on the hydrology of the Corbeira catchment, a small rural headwater catchment of 16 km$^2$ located in NW Spain is investigated using the Soil and Water Assessment Tool (SWAT). The model was calibrated (October 2005 to September 2008) and validated (October 2008 to September 2010) using daily measured streamflow data at the catchment outlet. The model calibration and validation results were rated as satisfactory, indicating that SWAT model is an appropriate tool for water resource investigation in this area and therefore it can provide a useful tool for further analysis.

The calibrated model was used to simulate the impact of climate change on streamflow for the periods 2031-2060 and 2069-2098, based on existing regional climate models. Overall, the simulation results predict that streamflow would decrease compared with the current data. Climate change could reduce the water resources by an average of 16% and 35% for the 2031-2060 and 2068-2098 periods, respectively. These results indicate that hydrology of the Corbeira catchment is very sensitive to potential climate change. The marked reduction in water availability in the catchment should be considered by water managers to develop a responsible management in the reservoir situated downstream, which supplies drinking water to a population of 400,000 inhabitants.

**ERB2014-42**

Mercury mobilisation after wildfire and rainfall in eucalypt and pine forests

I. Campos (1,2), C. Vale (2,3), N. Abrantes (1), J.J. Keizer (1) and P. Pereira (2,4)

(1) Department of Environment and CESAM, Aveiro University, 3810-193 Aveiro, Portugal
(2) IPMA - Portuguese Institute for the Sea and Atmosphere, Av. Brasília, 1449-006 Lisboa, Portugal
(3) CIIMAR, Rua dos Bragas, 4050-123 Porto, Portugal
(4) Department of Biology and CESAM, University of Aveiro, 3810-193 Aveiro, Portugal

Wildfires and subsequent rainfall play an important role in the redistribution of trace elements. In particular, the fire-induced release of mercury (Hg) into the environment is of special concern due to its volatilisation and toxicity. Hence, the present study addresses this concerning issue by comparing the concentrations of Hg in topsoil (0-2 cm) and ash in burnt (Ermida and São Pedro do Sul, centre of Portugal) and long-unburnt pine and eucalypt plantations, for being the two principal and, at the same time, the most fine prone forest types in north-central Portugal. Sampling collection was immediately after fire and 4 months after fire, following an episode of heavy rainfall. The principal results obtained in this study were the following:

1. 30% of the Hg retained in eucalypt soils was released by the fire, corresponding to a loss of 1.0-1.1 g Hg per hectare of burnt soil;
2. levels of Hg in burnt eucalypt soils doubled the values registered in burnt pine soils for both areas; the Hg concentrations in ash revealed a similar pattern;
3. Hg concentrations in both soils and ashes differed significantly between the two burnt areas, possibly due to differences in fire severity;
4. the heavy rainfall occurred 4 months after the fire caused a loss of 1.0 g Hg per hectare from ashes. Part of this amount was mobilised to the soil, which explain the increment of 0.5 g Hg per hectare in the soils. The remainder, 0.5 g Hg per hectare, could be exported to the surrounding areas or eventually introduced into aquatic systems.

Our results highlight that wildfires and subsequent rainfall play key roles in the mobilisation of mercury in the environment.
Toxic effects of wildfires on aquatic ecosystems

N. Abrantes (1), P. Kowalski (2, 4), V. Silva (4), J. Campos (4), J. Pereira (4), A. Micaelo (2), B. Nunes (4), J. Pimenta (2), S. Estrela (1), P. Narcis (5), F. Cássio (6), M.C. Pascoal (6), F. Gonçalves (4), C. Vale (2, 3) and J.J. Keizer (1)

(1) Department of Environment and CESAM, Aveiro University, Aveiro, Portugal
(2) IPMA - Portuguese Institute for the Sea and Atmosphere, Lisboa, Portugal
(3) CIIMAR, Porto, Portugal
(4) Department of Biology and CESAM, University of Aveiro, Aveiro, Portugal
(5) Freshwater Ecology and Management, Department of Ecology, University of Barcelona, Barcelona, Spain
(6) Department of Biology, Centre of Molecular and Environmental Biology, University of Minho, Braga, Portugal

Wildfire is the major disturbance in Mediterranean forests, posing an important threat to life, human goods, and natural resources in fire-prone forest areas. In the case of Portugal, wildfires devastate in the last decade an average of 140,000 ha per year. Fire frequency in Portugal is also not expected to decrease in the foreseeable future, not just because of the likely increase in fire-propitious meteorological conditions due to climate change but also because of the nature of the country’s forestry activities. A key environmental concern in relation to wildfires is that they constitute a diffuse source of contamination of the aquatic systems affecting the water quality, namely through the production and subsequent exportation of deleterious pyrolytic substances, such as polycyclic aromatic hydrocarbons (PAHs), and also through the input of metals associated to ash/soil loads. Concern about PAHs relates to their toxicity, carcinogenicity, environmental persistence, and tendency to bioaccumulate. Contamination of water bodies by postfire inputs of various metals may constitute also an environmental problem, as some of them are poisonous at high concentrations, are persistence in the environment and tend to bioaccumulate. A substantial part of the PAHs and metals can end up in downstream aquatic habitats, since wildfires can also enhance greatly runoff generation and the associated transport of sediments. In fact, preliminary results yielded by the proponent team showed the presence of distinct PAHs in runoff and water samples from a burnt area and concerning toxic effects in organisms exposed to them (Campos et al., 2012), which emphasizes the urgently needed to provide a sound scientific basis for assessing, monitoring and predicting the risks of surface water pollution by recently burnt areas. Moreover, both PAHs and metals constitute a concerning risk to human health, either by direct consumption of water with concentrations exceeding guideline values, or by using water for recreational activities as fishing and swimming. Whilst the effects of wildfire on hydrological and erosion processes have received considerably research attention, the information on post-fire exports of PAHs and metals from recently burnt areas has been poorly studied so far. Also the toxic effects of this ash-loaded runoff on aquatic biota and human health remain an important research gap. FIRETOX, a recently FCT funded project (PTDC/AAG-GLO/4176/2012) addresses this urgent need for a better understanding of the toxic effects that wildfires can cause in downstream aquatic ecosystems. It therefore aims at: assessing the production and exportation of PAHs and metals by runoff in burnt areas at plot-to-catchment scale; determining the toxicity of runoff and sediment samples from burnt areas on aquatic organisms from different trophic-functional groups, and relate it to the samples’ PAH and metal contents; evaluating the potential of fire-produced PAHs and metals for bio-amplification and bio-accumulation in aquatic biota (pelagic and benthic organisms); developing and testing in situ assays for field validation in additional burnt areas; elaborating a protocol that uses one or more of parameters studied by for a rapid and reliable assessment of the potential risks that recently burnt areas pose for aquatic biota and human health due to pollution of downstream surface water bodies with PAHs and metals. The knowledge gap that FIRETOX addresses is of special and urgent importance for the implementation of the Water Frame Directive (WFD). Namely, the WFD established the obligation to characterize the various sources of point and diffuse pollution of water bodies. In this context, also FIRETOX’s contribution to the knowledge about the eco-toxicological response of pelagic and benthic species to runoff from burnt slopes and catchments deserves special mention.

References:
The hydrological research and related ecological issues in a Prealpine Italian small basin: the hydrological change related with soils, soil available water content, morphology and vegetation

S. Chersich (1,2) and F. Maraga (3)
(1) University of Pavia, Department of Earth and Environmental Sciences, Via Ferrata, 1. 27100. Pavia, Italy
(2) University of Milan Bicocca, Department of Earth and Environmental Sciences, Piazza della Scienza 1, 20126 Milan, Italy
(3) former Italian National Research Council (Cnr), Department of Earth and Environment, Research Institute for geo-hydrological Protection (IRPI), Section of Turin, Italy

The study area, the Marchiazza upper basin, is located in the Pre Alpine environment at the border of the northwestern Italian Alps in the upper Po river basin. It is representative of homogeneous ryolithic bedrock presenting continental-Mediterranean climate. The small Gallina Valley basin (1.08 km$^2$ area; 522 m max, 330 m min a.s.l. altitude) is equipped with a meteorological station at divide line and hydro-sedimentary station at the outlet. Sediment transport is prevailing bed load. Sediment surveys relates to the experimental reach 120 m long, upstream of the mouth, equipped with a trap. Flash floods occur higher than 1 m$^3$ s$^{-1}$ referred to mean/ year discharge 0.2 m$^3$ s$^{-1}$ (maximum: 6.4 m$^3$ s$^{-1}$ in 1995). Sediment release ranges between zero and 74 m$^3$ with a mean value of 34 m$^3$ year.

The understanding and definition of the hydrological processes has to be accomplished by appropriate and careful observation of the soil that is a primary component of the hydrological cycle. The rainfall that infiltrates into the soil forms part of the soil water, some may return to the atmosphere through evaporation from the soil surface of which some may be used by plants for transpiration, another part runs off the land and moves rapidly downhill towards river courses, contributing to peak flows. Runoff contributes to erode soil that is redeposited in river courses and downstream.

The recent response by water and sediment decreases that we recorded in the sediment trap can be linked with the soils’ type but also with land use change, afforestation spread that are modifying the hydrological cycle, favouring rain water infiltration rather than sheet flows, and water retention in the soils with its progressive release following the peak, which explains the bedrock exposition in the bed river of the main channel.

Along the bank river, after 2010 we did not observe sand associated with channel incision and consequently there isn’t a overbank sedimentation.

During the beginning of the 20$^{th}$ century the environment was more sensitive to erosion and to runoff because the forest was used for firewood and there was soil exposed by the vineyard cultivation near the Marchiazza confluence (on the downstream reaches). After the World War II (1940) the vineyards have been abandoned and natural forest regeneration started. Natural plant colonisation in the landscapes has prevented soil erosion and consequently colluvial flux in the channel network and sediment feeding from the mountain research basin.

To study the soils’ type we have focused our research on the characteristics of twelve soil profiles obtained from two different surveys where we have investigated the Soil Available Water Capacity, the geo-morphological and topographycal aspects and the vegetation on formations along a toposequence. These surveys have allowed us to identify a spatial variability of the Entisols, to analyse soil water and its relationships with the surface features, the soil erosion and the vegetation cover and to derive hypothesis on soil evolution.

Using physical and chemical analysis and the morphology, the soils have been classified according to Keys to Soil Taxonomy (USDA-NRCS, 2010) and the World Reference Base for soil resources (WRB, 1999).

The studies show that the Entisols have an evolution to Inceptisols on the watershed slopes. The Soil Available Water Capacity (AWC) is a parameter which is related with the type of soil, humus and vegetation. The AWC has a relevant influence on the development of the vegetation and that it is correlated with specific Entisols.

The Typic Udorthents that are more evolved (because an umbic horizon is forming) are on colluvium morphology with Quercus robur forest or very well developed Castanea sativa trees associated with the heath vegetation. Typic Udiorthents can be found close to the channel network on the rare alluvium deposits. Typic Udorthents and Typic Udiorthents have an available water capacity that ranges from low (35 mm) to moderate (150 mm).

On the watershed divide lines with the Prealpine high heath vegetation (with Calluna vulgaris, Ulex europaeus), there are Lithic Udorthents that have a frequent skeleton and a very low average Soil Available Water Capacity (ranging from 5 to 35 mm).
ERB2014-47

Educational experiences as enhancement of the environment in the Prealpine Gallina valley basin

S. Chersich (1,2) and F. Maraga (3)

(1) University of Pavia, Department of Earth and Environmental Sciences, Via Ferrata, 1. 27100. Pavia, Italy
(2) University of Milan Bicocca, Department of Earth and Environmental Sciences, Piazza della Scienza 1, 20126 Milan, Italy
(3) former Italian National Research Council (Cnr), Department of Earth and Environment, Research Institute for geo-hydrological Protection (IRPI), Section of Turin, Italy

The educational experiences related to the basin of the Gallina Valley began in 2008 with the project "Air of rain." The project was aimed at a diverse audience, educating, both on what the nature of the rainfall is and its change induced by pollution, meaning the latter factor as a cause of environmental risk and potential consequences of hydro-geological risk. The project has also brought education to the knowledge of the rain and the effects that human activities can induce on it, considering the associated risk that you may have, by facilitating the recruitment of sustainable and eco-conscious behavior. In conclusion, this project has been made on thematic publications aimed at a wide audience. Subsequently, we embarked on a journey that ended with the construction of three educational projects in for three years from 2010 to 2013, aimed first at the primary schools and then to the higher schools involving a total of 11 classes with about 240 students and thirty teachers. These projects have involved three entities: the IRPI Institute (researchers, staff and external staff for research), the schools (teachers and students) and local authorities (municipalities and associations).

The IRPI research manager, Franca Maraga, has promoted educational events to project closure Cnr RSTL560 recognizing the opportunity to give educational outreach to the research conducted in the field of mountain territory of the River Marchiazz, concerning the hydrological processes of surface waters.

The idea was to enhance the search basin of Gallina Valley, representative of Alpine Piedmont North-western, belonging to the European network of representative and experimental basins (Experimental and Representative Basins - UNESCO - IHP) sensitizing the local population (particularly the students) on "water and soil environment" promoting the development of interest for local search to the applied hydrology and the collective knowledge of the geographical areas to which they belong.

In the 1980s the research of the basin of the Gallina Valley of in Val Marchiazz started for the monitoring of the water balance and sediment with a weather station (for measurement of rainwater, temperature and humidity), with a hydrometric station (for measurement of the height of river water) and with a sedimentary station (for the measurement of sediment). The site is particularly suited to enhance teaching because it is easily accessible by a dirt road and it is nearby a picnic area with tables and seats that can accommodate the students and make easy the work of observation or tabulation of data.

The educational aims of the education projects are both to promote the knowledge of the mode of collection of environmental data sharing issues hydrogeological and environmental problems and to introduce students to the topics of research in order to understand their utility and to encourage the participation of students in initiatives related to the environment and to promote actions consistent with the adoption of responsible behavior from an ecological point of view.

Specifically we wanted to develop the knowledge of the environment and its resources but also the construction of a sense of identity, belonging and respect for their territory through the knowledge of the environmental heritage (regarding landscape, morphology, hydrology, geology, soil, vegetation,...). For this reason we involved the municipalities and local authorities (local associations and consortia) on educational intervention. Issues have been examined related to the water cycle (age, quantity and quality), ecosystem (in particular the aquatic environment), and the relations between the different elements of natural biodiversity and the bio-indicators. They also concerned the measuring instruments used in the research basin (how they work and what data they provide) focusing on the utility of experimental research and on the concept of variability and reliability of data. In the students’ class, thanks to the suggestions of the experts, with a problem solving approach we have begun to collect climate data by building it with the students’ simple tools.

The students, with a learning-by-doing and a reflective learning approach, have understood to be able to protect the water resource by themselves and the environment through everyday actions and behave responsibly towards the respect of water resources and nature protection.

Depending on the age of the students, the different results and products have been obtained but in all cases the students have shown great interest in the scientific research. This approach has proved to be very positive for the development of an attitude of respect and preservation of the environment. The students’ participation has been remarkable and has spread their enthusiasm for the "value of water" researchers, teachers and parents. The basin of research "came to life" thanks to school education, by inserting it in the context of the local community as a perceived reality useful for the community.

We thank the personnel who took part in this project: Franca Maraga (formerly Senior Researcher) and Renato Massobrio (Associate Research Institutes), the external staff of the project: Silvia Chersich, Chiara Pelissero and Marco Casazza. We thank the students and teachers of comprehensive schools of Arborio and Gattinara (elementary school Rovasenda, Olicenengo and Lozzolo) and IPSSAR Institute of Gattinara, the municipality of Lozzolo, Villa del Bosco, Rovasenda, Olicenengo and the Pro Loco of Lozzolo, the Community Valuable Hilly Areas of Nebbiolo and Porzini.
Effects of soil management on runoff, soil erosion and landslides occurrence in vineyards

M. Biddoccu (1,2), F. Opsi (1), S. Ferraris (2), L. Turconi (3) and E. Cavallo (1)
(1) IMAMOTER - Institute for Agricultural and Earthmoving Machines, Italian National Research Council, Strada delle Cacce 73, 10135 Torino, Italy
(2) Interuniversity Department of Regional and Urban Studies and Planning, Politecnico e Università di Torino, Viale Mattioli 39, 10125 Torino, Italy
(3) IRPI - Institute for Hydrogeological Protection, Italian National Research Council, Strada delle Cacce 73, 10135 Torino, Italy

Erosion and landslides have been identified as two of the major threats that affect European soils. In Italy vineyards cultivated on hill and mountain slopes are frequently affected by intense soil erosion processes and landslides, especially during extreme rainfall events. The management practices adopted in vine cultivation are strictly related with hydrological processes and land conservation in vine-growing areas. The disturbance of the soil profile and land leveling works during the vineyard plantation, the orientation of the vine-rows along the slope, tillage and maintenance of bare soil in the inter-rows affect strongly water infiltration and runoff formation and expose the soil to degradation processes, such as soil erosion, decrease of carbon content and compaction. Furthermore intense runoff and gully erosion processes in vineyards are often related to the occurrence of soil-slips and mud flows, as documented by historical data on landslides collected by IRPI.

The first soil erosion measurements in vineyards from Piedmont were carried out for about 2 years by IMAMOTER and IRPI at beginning of ‘80s, in the Alto Monferrato vine production area. Long-term data have then been collected by IMAMOTER from field-scale vineyard plots within the Tenuta Cannona Vine and Wine Experimental Centre of Regionale Piemonte, which is also located in Alto Monferrato. Since 2000, rainfall, runoff and soil erosion monitoring has been carried out under natural rainfall conditions on three parallel field plots (75 m long and 16.5 m wide, slope gradient about 15%) that are conducted with different inter-rows soil management techniques (conventional tillage, reduced tillage, controlled grass cover), with vines aligned along the slope. Experimental plots are part of a 16-hectars experimental vineyard, managed in according to conventional farming for wine production. The primary intent of the program was to evaluate the effects of agricultural management practices and tractor traffic on the hydrologic, soil erosion and land degradation processes in vineyards. The dataset include measurements for more than 200 runoff events and over 70 soil loss events; moreover, periodic measurements for soil physical and hydrological characteristics are included for the three plots.

The analysis of data collected over more than a decade in the Cannona Experimental Site showed that the use of permanent grass cover in the inter-rows reduces runoff and especially soil losses at yearly and seasonal scale. The worst soil management was the reduced tillage, which produced the highest water and soil losses. The use of permanent grass cover in the inter-rows improved water infiltration and reduced runoff and especially soil losses, even if it was not very effective in the first three years of installation. The best performance of grass cover reducing runoff and soil erosion was shown during summer storms, while it was less effective during autumn, which is the season where extraordinary meteorological events have stroked Piedmont during last decades. The soil and water conservation in the vine-growing systems will be more and more relevant, taking in account climate changes that predict increase in rainfall intensity and erosivity. The monitoring activities at the Cannona Experimental Site are currently carried out and implemented in order to improve the understanding of the soil management effects on soil hydrology, erosion and landslides triggering in sloping vineyards. The results obtained from the Cannona long-term monitoring program could be useful in a multidisciplinary approach to investigate interactions among land use/ soil management and natural processes at different scales, rising up from hillslope to small basin scale and to address the adoption of adequate water and soil conservation practices.

Development of forest litter interception relationship

K.A. Zagyvainé-Kiss, Z. Gribovszki and P. Kalicz
Institute of Geomatics and Civil Engineering, University of West Hungary, Sopron, Hungary

The climate modifier and water storage effects of forests have been published for decades in scientific literature. There are also a largely lot paper can be found in the theme of forest crown interception, but hardly any publications analyse in detail forest litter interception, through depending on mainly the mass of the forest litter it can be a non negligible part of forest water budget. With the advent of the continuous cover forestry the water budget calculations have increasing demand for sophisticated estimation of litter interception. It is important to take into account the high spatial variability of uneven-aged forests. To develop these methods it is necessary to maintain long-term monitoring plots.

The plots of the forest litter investigations are located in the Hidévolgy Valley Research Catchment in western Hungary near town of Sopron. In this paper we present the results of a four years long forest litter interception investigation. In the frame of this research three monitoring plots are selected each have different more-or-less homogeneous tree species composition. Two of them are broad-leaved (sessile oak and beech) and one coniferous (spruce) forest. Each plot is equipped with troughfall measurement funnels and a micro-meteorological station is located in the beech plot. The undisturbed litter samples were collected into a wireframed lysimeters with screen cover in each forest stand and weighted with digital hook scale generally once a day.

On the basis of the dataset we analyzed the composition of forest litter from moisture characteristic point of view. We determined the factors most affecting the water uptake and the storage capacity of forest litter. Interception loss equations and desiccation curves had also been outworked successfully in case of the above mentioned three ecosystems.
The main purpose of this study is the characterization of the interactions between surface and groundwater within a small (local scale) watershed taking into account: the topography, the geology, the local and regional tectonics and the morphometry of the drainage system. It is also an objective to identify the main recharge area of the shallow unconfined aquifer and to express the relations between surface and groundwater flow. The studied watershed is close to Montouro village (Cantanhede County, Coimbra District, Portugal).

The methodology implemented in this work was the following:

1. delimitation of the watershed;
2. determination of the morphometric parameter for the characterization of the basin geometry;
3. analysis of the digital elevation model to quantify the slopes and to detect possible structural alignments that influence the surface and groundwater flow;
4. inventory of the wells across the basin creating a database with information of identification, location and characterization (diameter, depth and wellhead);
5. realization of campaigns to measure water levels;
6. elaboration of piezometric maps to identify the direction of groundwater flow.

The ArcGis and Surfer software were used during the performance of some of the tasks.

This small-scale drainage basin has an area of about 6.4 km², a perimeter of 14.2 km and is located on a rural area, within the Vouga hydrographic basin. This natural basin drainage network, according to the Horton–Strahler method, has forty-nine first-order streams, nine second-order streams, two third-order streams, and one fourth-order stream. The total length of streams equals 23.3 km and the basin is moderately drained (with a drainage density of 3.6 km km⁻²). The main watercourse has an extension of about 4.8 km, exhibits a SE-NW orientation and is a tributary of the Mesas streamlet, which runs to the Boco river. The main watercourse evidences a perennial regime with seasonal evolution. The streams are characterized by a dendritic drainage pattern.

The watershed has low irregularity (compactness coefficient of 1.57), elongated shape (with a form factor of 0.27) indicating flow for longer duration, denotes moderately sharp relief (elongation ratio of around 0.33) and the relief ratio equals 0.012. The ellipsoidal height in the basin varies from 74 m to 146 m, with a medium altitude of 110 m. The upstream domains of the basin are flattened and are filled by quaternary deposits of old beaches, the valleys are relatively underemphasized and have moderate slopes. The topography imposes a slow drainage regime with frequent retention areas and it also influences the groundwater flow within the phreatic aquifer.
Temporal changes of near-saturated hydraulic conductivity in a small arable catchment

D. Zumr, V. Klipa, M. Snehota and M. Dohnal
Czech Technical University in Prague, Faculty of Civil Engineering, Thákurova 7, 166 29 Prague, Czech Republic

Unsaturated hydraulic conductivity $K(h)$ is key parameter for numerical modeling of water flow and solute transport in the vadose zone. Tension infiltrometer is advantageous tool to conduct the measurement of unsaturated hydraulic conductivity in the field under near saturated conditions. Manually operated minidisk infiltrometers are often used for performing infiltration experiments, but their disadvantage is that permanent attendance is needed during experiments. Therefore automatization of the tension infiltrometer is desirable.

A new automated multi-disk tension infiltrometer has been developed and tested at the Faculty of Civil Engineering (Czech Technical University in Prague) in cooperation with DHI and CS Plasting Company to facilitate the measurements of near-saturated hydraulic conductivity. Proposed device is divided into the two groups of three tension mini-disk infiltrometer modules. Each group is held in its own lightweight aluminum frame with fixed matrix of infiltrometer modules and is controlled by Mariotte’s bottle. Therefore it is possible to conduct six infiltration experiments simultaneously at two different pressure heads.

Amount of infiltrated water is registered via changes of buoyant force of vertical bar attached to the weighing sensor in each infiltrometer module and recorded automatically using datalogger. Cumulative infiltration and volumetric flux of water are calculated and displayed in real time. Near saturated hydraulic conductivity is determined from cumulative infiltration data using nonlinear optimization and improved procedure of Zhang.

Multidisk infiltrometer have been tested on four experimental locations. Two sites were situated at arable land (Nucice and Kopaninsky stream) and two located in headwater catchments Bohemian Forest and Jizera Mountains). Soils at experimental sites were classified as Dystric Cambisols, Cryptopodzols and Podzols (empirical textures ranges from loam to clay loam classes. Soil is conservatively tilled till depth of approximately 17 cm, below the topsoil a compacted subsoil is present.

Tension infiltration experiments were performed repeatedly in order to determine the unsaturated hydraulic conductivity of the topsoil at single location. So far five tension infiltration campaigns were carried out under tension $h_0$=-3.0 cm with different soil cultivating and actual crop development phases: (i) young winter barley (October 2012), (ii) period between post harvest stubble management and sowing (April 2013), (iii) full-grown oat (June 2013), (iv) after fresh post harvest stubble management (October 2013) and (v) stubble breaking sowed with young winter wheat (March 2014). All experiments were performed on the levelled soil surface after removing upper soil layer (1 to 3 cm). A thin layer of quartz sand (thickness 1 - 2 mm, grain size 0.1 - 0.6 mm) was applied to improve contact between the infiltrimeter and the soil surface. Each infiltration campaign consisted of six tension infiltration experiments; the total number of 30 infiltration data sets was obtained.

Up to now results indicate that unsaturated hydraulic conductivity is significantly lower in April and March (i.e. after winter), but rather the same in the remaining periods. Based on the monitoring of the water regime on the catchment, the infiltration capacity of the soil profile is decreasing during the season due to gradual topsoil compaction. The compaction causes tightening and disconnecting of the preferential pathways. Results of the tension infiltration experiments indicate that the hydraulic properties of the aggregates are stable. The limited infiltration is caused by the changing ratio of the inter-aggregate voids and the soil crusting. Measured data are part of a broader data base which is formed in order to study the runoff formation and erosion processes in the agriculturally managed catchment.

The research was performed within the framework of projects granted by: Technology agency of Czech Republic No.: TA01021844, Czech Science Foundation No.: 13-20388P and 14-03691S and internal CTU student grant No.: SGS14/131/OHK1/2T/11.
ERB2014-57
Assessing the impact of climate change scenarios on water quality patterns on the Vouga catchment (Central Portugal)

J. Rocha (1), P. Roebeling (2), M.C. Cunha (1), J.P. Nunes (2) and R. Jacinto (2)
(1) Laboratory of Hydraulics, Water Resources and Environment. Department of Civil Engineering. University of Coimbra, Portugal
(2) Department of Environment and Planning (DAO) and Centre for Environmental and Marine Studies (CESAM), University of Aveiro, Portugal

Worldwide river catchment territories have been progressively occupied by human activities which, in turn, lead to the destruction of natural areas and environmental values. The development of unplanned and unsustainable human activities, resulted on increased rates of water pollution delivers even though major human settlements are confined within those areas and they are considered to encompass major importance from the environmental, social and economic perspective. The sustainable socio-environmental and economic development of catchments and linked coastal regions must be balanced with strategies aiming water quality improvement and water pollution reduction within the adoption of best management (agricultural) practices (BMP’s).

The Water Framework Directive (WFD-2000/60/EC) requires the identification and quantification of water pollution delivers, therefore the implementation of sustainable agricultural practices is one of the key challenges towards water quality improvements and to achieve the WFD water status milestones: achieving good status for all waters bodies. To this end, the assessment of water pollution deliveries under climate change scenarios must be implemented on future River Basin Management Plans.

This study aims to assess the impact of induced climate changes on Dissolved Inorganic Nitrogen (DIN) water pollution delivery by the key agricultural land use categories. For this study the Soil and Water Assessment Tool (SWAT) was used to assess the effects of potential future climate scenarios on DIN water pollution delivers on the Vouga catchment, central Portugal. The SWAT model was chosen due to the ability to simulate continuous time landscape processes (e.g. hydrological patterns processes, water balance, water quality, nutrient exportation) and to estimate crop growth and crop yields under climate change scenarios. The baseline (SWAT-calibrated) scenario is used to establish the normal (actual) Vouga catchment conditions and crop yields (e.g. corn, vine, potatoes, oats, pastures) and linked DIN delivery rates within a range of meteorological conditions.

A set of induced climate changes was considered for the 2015-2098 in order to simulated different crop growth and yields and to assess diffuse-source water pollution supplies. To this end, it was simulated a variation on both temperature (2°C, 4°C) and precipitation (30%, 45%) values, according to the Intergovernmental Panel on Climate Change (IPCC) projections.

Preliminary SWAT and Climate Assessment Tool (CAT) results, suggest that a temperature variation will have a significant impact on crop yield rather than on flow and exportation rates. An increase of 2°C will have higher expression on the flow values rather than on DIN exportation and crop yields. An increase of 4°C will result on the lowest flow and DIN simulated values, and on the highest crop yield results, due to the increase on the vegetative plant cycles. An increase on the precipitation rates will result on progressively higher values for both flow and exportation rates with the highest obtained values linked with the 30% precipitation increase, hence major water quantity will be available and more nutrients will be leached and transported to the stream network. On the other hand the baseline scenario registers the highest crop yield values and the lowest was obtained for the 30% precipitation increase.
The ground water component during snowmelt events in The Tatra Mountains (Poland)

J. Siwek and M. Zelazny
Jagiellonian University, Institute of Geography and Spatial Management, ul. Gronostajowa 7, 30-387 Cracow, Poland

The dynamic of river runoff during high flow events is usually accompanied by the changes of stream-water chemical composition, which is a result of individual properties of water supplying the stream from different flow paths (Walling and Foster, 1975; Caissie et al., 1996; Suzuki, 2003; Holko et al., 2006; Siwek et al., 2012). The detailed information about the role of particular runoff components can be obtained only with the combination of isotopic and chemical tracer-based approaches. The hydrochemical data are especially useful for elucidating water flow paths in the drainage basin. However, hydrograph separation based on hydrochemical data sometimes may lead to overestimating the base flow component; it gives the information about the upper limit of its contribution (Sklash and Farvolden, 1979).

The studies where carried out in the catchments of Lejowy (6.95 km², 879–1794 m a.s.l.) and Starorobocianski (8.54 km², 1042–216 m a.s.l.) streams in The Tatra National park (southern Poland). The catchments are located in close proximity and are characterized by significant geological differences. Therefore, they are the excellent polygons for experimental studies concerning water circulation in the pristine catchments with different environmental characteristics but in the similar hydro-meteorological conditions. The catchment of the Starorobocianski is a part of the main Tatra crystalline core, which is formed of gneiss, alaskite, mylonite, and crystalline shale. Lejowy stream drains the karstic part of Tatra, with the bedrock composed of sedimentary rocks – primarily limestones, dolomites, shales and marls.

The sampling was performed during snowmelt events in 2009 and 2010 with autosamplers (ISCO) with the sampling interval ranging from 2 to 12 h. The snow samples were collected irregularly. The concentration of main ions was determined using an ion chromatography system – DIONEX ICS 2000. The role of base flow was estimated with a mass balance approach with the two-component mixing model concerning the ion concentration ratio in pre-event and event water (Pinder and Jones, 1969; Ogunkoya and Jenkins, 1993).

Due to different geology the streams are characterized with individual chemical properties – the mean annual mineralization of water in the crystalline catchment (45.9 mg/L, n=644) was clearly lower than in the karstic (262.5 mg/L, n=689). During the snowmelt events the dilution of pre-event water with snowmelt was observed in both streams; however, it was more evidenced in the stream draining the karstic catchment.

The chemical composition of stream water in the karstic catchment indicated that the contribution of pre-event water was up to 88% of the total runoff. Also the absence of increase (or even slight decrease) of nitrate concentration suggest minor role of snowmelt in the total runoff during analyzed events. The crystalline catchment showed lower pre-event water contribution (75%); however, during short-time lasting snow-melt events in the beginning of winter, it came up to 85%. The characteristic phenomenon was the increasing nitrates and ammonium concentrations which reflects the influx of snowmelt water into the stream.

Despite of the alpine character of the catchments, the pre-event water may have an important contribution in the total runoff. In both catchments the concentration of calcium and carbonates were found as the best tracers of ground water component. Due to low difference in mineralization of snow water and stream water in crystalline catchment the mass balance estimation of pre-event water may be significantly overestimated.

References:

Abstracts - Poster Communications 71
Overland flow processes in eucalyptus plantations in north-central Portugal

A.K. Boulet (1), M.E. Rial-Rivas (1), S. Prats (1), J. Santos, (1), C.O.A. Coelho (1), A.J.D. Ferreira (2) and J.J. Keizer (1)

(1) Centro de Estudos do Ambiente e do Mar (CESAM), Departamento de Ambiente e Ordenamento, Universidade de Aveiro, 3810-193 Aveiro, Portugal
(2) Departamento de Ambiente, Escola Superior Agrária de Coimbra, Bencanta, 3040-318 Coimbra, Portugal

Forests currently occupy about 35% of mainland Portugal. Eucalyptus plantations were introduced in Portugal in the middle of the twentieth century and have thereafter seen an effulgent expansion. In 2010, the last forest inventory results corroborated that eucalypt had become the predominant tree species in Portugal, covering 26% of the total forested area.

Eucalyptus stands present a large interest in economical term. Eucalypt timber is used as the principal raw material for paper pulp production, one of Portugal’s leading industries. In the Baixo Vouga region of north-central Portugal, boosted by the paper pulp industry, forests now occupy as much as nearly 50% of the territory, of which 2/3 is covered by Eucalyptus plantations.

The hydrological consequences of such a large-scale afforestation with eucalypt monocultures area is currently being studied in the upstream, mountainous part of the Baixo Vouga region. The present work focuses on overland flow processes and aims to study the influence of eucalypt afforestation on overland flow production, by (i) determining the overall differences between three subsequent rotation cycles; (ii) analysing the inter-annual patterns of these three rotation cycles; (iii) analyzing the seasonal variations.

The study was carried out in the west-facing foothills of the Caramulo Mountains. The climate is temperate with moist winters and dry soft summers, with long-term mean annual rainfall ranging from 1400 to 1600 mm. Soils are an association of shallow and stony Umbric Leptosol and Cambic Umbrisols (WRB, 2006), developed from schists. Slopes are typically convex rectilinear and steep, with angles of 20º and more.

The vegetation of the study area is mainly composed of *Eucalyptus globulus* plantations, which provides a commercial crop in only 10-12 years. As Eucalyptus species regrow from stumps after cutting, 3 consecutive rotation cycles are typical. Shrub understory is characterized by broom (*Pterospartum tridentatum*), heathers (*Erica spp.*) and gorse (*Ulex spp* and *Genista spp.*).

A monitoring network was installed in 2003 in 3 eucalyptus stands representatives of the 3 consecutive rotations cycles (R1, R2, R3) in Portugal.

It comprised a total of 9 bounded plots of 16 m². 3 plots for each rotation cycle. In 2007, 6 of the plots were equipped with data-loggers to provide hydrograms of overland flow generation. Rainfall amount and intensity were recorded using 2 automatic rainfall gauges. Soil properties such as bulk density, stone percentage, and organic matter content were sampled at one occasion and determined in the laboratory. Soil moisture measurements were performed weekly for 9 soil profiles, using a soil moisture profile probe (Delta T, PR2/4) with measurement points at 4 depths (0 to 40 cm). Soil water repellence was measured monthly in the field by means of the Molarity of Ethanol Droplets test. Vegetation characteristics evolution was measured every 2 months for tree DBH and annually for crown height. Shrub surveys identified species, shrub crown cover and height.

Analyse of key parameters showed a greater soil density at the surface layer of the plantation R1, which presented a large bare area that was more vulnerable to compaction. Plantations R2 and R3 presented a thick litter layer of up to 10 cm, providing a strong buffering effect. Soil presents stone contents surrounding 50%. The seasonal variation of soil water repellency (SWR) was extremely high; the SWR was more severe during the dry season, it decreased throughout the wet season.

Eucalypt basal area growth was extremely fast at R1, about 2.7 m²/ha/year, whereas it was 1.2 m²/ha/year at R3. Shrub understory cover was high at R2 and R3, ranging from 50 to 60% and shrubs had a height until 80 cm.

Results showed a decrease on the annual overland flow rate following the rotation stage. Annual overland flow median declined strongly between the first and the second rotation cycle from 3.8% (R1) to 0.7% (R2), and was 0.5% at the third rotation (R3).

A large inter annual variability existed in overland flow production, related to climatic factors such as rainfall amount and antecedent soil moisture but unrelated to eucalypt growth in terms of, for example, DBH. In general, there was no clear tendency in terms of intra-rotation evolution, i.e. during the 11 years of a rotation cycle.

There existed a clear seasonal pattern in overland flow production. The lowest overland flow coefficients were observed during winter, from January to March. Overland flow coefficients were somewhat higher during the spring and summer seasons, but reached maximum values at the start of the autumn, in particular during September (up to 30% for R1), being again lower during the rest of the autums. A strong correlation existed between soil moisture content and overland flow rate, but it was negative, contrary to what many authors reported for wettable soils.

The seasonal patterns in overland flow coefficients could not be directly related with the seasonal variations in overland flow amounts. Especially the high overland flow coefficients that were observed at the end of spring or summer did not coincide with large amounts of overland flow, as rainfall amounts were reduced. Important amounts of overland flow were produced in two types of situations cases: (i) during autumn, as hortonian flow, when two key conditions were combined: high precipitation amounts and strong to extreme water repellency; (ii) during winter, as saturation overland flow, when large rainfall events coincided with wet antecedent soil moisture conditions. In some cases of the saturation overland flow, runoff coefficients equalled 100%.

References:

The importance of subsurface flow in streamflow generation in an eucalypt-dominated catchment in north-central Portugal

A.K. Boulet (1), M.E. Rial-Rivas (1), J. Santos (1), S. Prats (1), O. González-Pelayo (1), C.O.A. Coelho (1), A.J.D. Ferreira (2) and J.J. Keizer (1)

(1) Centro de Estudos do Ambiente e do Mar (CESAM), Departamento de Ambiente e Ordenamento, Universidade de Aveiro, 3810-193 Aveiro, Portugal
(2) Departamento de Ambiente, Escola Superior Agrária de Coimbra, Bencanta, 3040-316 Coimbra, Portugal

Eucalypt stands were first introduced in Portugal during the mid-20th century but have since then been widely planted and, in 2010, covered 26% of the country’s forested area. This expansion reflects first and foremost the economic importance of eucalypt wood for the production of paper pulp by what is one of Portugal’s leading industries. The Baixo Vouga study region, north-central Portugal, is nowadays covered for 50% by forests, 2/3 of which 2/3 consist of eucalypt plantations. This large-scale afforestation with eucalypt plantations is widely perceived to have important hydrological consequences but it has been poorly quantified so far.

This research gap is being addressed through a combined measurement-modelling approach that is being applied in two experimental headwater catchments with contrasting land covers, being dominated by eucalypt plantations and by Maritime Pine stands (that the eucalypt plantations have come to substitute in many places).

Initial modeling work using SWAT clearly demonstrated the need for a better understanding of the principal stream flow generating processes (Rial-Rivas et al., 2011). Overland flow is being monitored quite extensively during the past few years, using various runoff plots in a Maritime Pine stand and in three eucalypt stands in different rotation cycles. By contrast, subsurface flow had never been measured till the start of the current study. The objectives of the present study were therefore the following: (i) to quantify subsurface flow; (ii) to determine its principal processes, i.e. pipe or matrix flow; (iii) to identify the main factors influencing subsurface flow; (iv) to relate subsurface flow with stream flow, in terms of timing as well as quantities.

This study was carried out in an experimental catchment of 0.52 km² located in the west-facing foothills of the Caramulo Mountains that is dominated by Eucalyptus globulus plantations. The climate of the area is of a transitional Atlantic-Mediterranean type, with wet winters and dry summers and a long-term mean annual rainfall in the order of 1400 to 1600 mm. The area’s soils are generally shallow and stony, and consist of a complex of Umbric Leptosol and Cambic Umbrisols (WRB, 2006), developed over Precambrian schists. Its slopes are typically convex rectilinear and steep, with angles of 20° and more. Within the experimental catchment, a mature eucalypt plantation that was already equipped with 3 runoff plots was selected to measure subsurface flow. To this end, three trenches of roughly 3 m wide and 1 m high were excavated down to the bedrock along the side of a forest trail. The subsurface flow captured by each of these trenches was then measured by routing it to a tipping-bucket gauge that was equipped with an event data logger. In addition, the excavated soil profiles were instrumented with soil moisture sensors (EC-5, Decagon Devices, Inc.) installed at 4 depths between 0 to 80 cm. Rainfall was measured using an automatic rainfall gauge installed at 1 km from the site, whereas stream flow at the catchment outlet and its electrical conductivity were monitored using a pressure and an EC sensor (Campbell Scientific CS450 and CS547A) installed in a H-flume. The results presented here concerned the initial monitoring period between October 2013 and April 2014.

Subsurface flow generation differed markedly between the three trenches. The central trench that drained a convergent slope area of some 1.9 ha, exclusively produced pipe flow. Pipe flow mainly originated from 7 large macro-pores that were situated close to the soil-bedrock interface and ranged in diameter from 3 to 8 cm. However, with increasing amounts of pipe flow also several smaller macro-pores situated at lower depths started to contribute. By contrast, the other two trenches that drained non-convergent slope area mainly produced matrix flow at the soil-bedrock interface. In agreement with the differences in type of subsurface flow, the central trench also produced markedly more subsurface flow than the two lateral trenches. During extreme rainfall events, pipe flow was at least an order of a magnitude higher than matrix flow.

Matrix flow was closely linked to soil moisture contents in the sense that it started and ended when soil moisture layer contents reached certain threshold values. Matrix flow was found to begin within as little as a few minutes after the onset of the rainfall event and to continue as long as up 40 hours after the end of the rainfall. The matrix flow response, however, depended strongly on antecedent moisture contents, as was evidenced by a high linear correlation coefficient.

Subsurface flow appeared to have a strong influence on the stream flow response at the catchment outlet. For example, an extreme rainfall event with a daily rainfall amount of 51.6 mm and an I30 of 27.2 mm h⁻¹ produced a peak stream flow of 1.16 mm h⁻¹ with an electric conductivity of 21 µS, which approximates the conductivity of rainfall. At the same time, however, the event hardly generated any overland flow but caused a maximum pipe flow of 0.93 mm h⁻¹. Worth stressing is furthermore that the timing of the peaks in stream flow closely coincided with that of the peaks in subsurface flow.

References:
Using SWMM to model surface runoff from intermittent rainfall patterns on soils covered with mulch: comparison with results from laboratory soil flume experiments

J.R.C.B. Abrantes, N.E. Simões and J.L.M.P. de Lima

Institute of Marine Research (IMAR) / Marine and Environmental Sciences Centre (MARE); Department of Civil Engineering, Faculty of Science and Technology of the University of Coimbra, Rua Luís Reis Santos, Campus II - University of Coimbra, 3030-788 Coimbra, Portugal

Mulching is an important management practice for surface runoff and soil erosion control, particularly in hillslopes at semiarid areas of the world. Antecedent soil moisture conditions, rainfall patterns, and soil cover play an important role in the detachment and transport of soil particles and runoff generation (e.g. Montenegro et al., 2013). This study evaluates, based on laboratory soil flume experiments, the performance of the software SWMM (Storm Water Management Model) in modelling surface runoff from intermittent rainfall events on soils covered with distinct mulch densities.

SWMM is a dynamic rainfall-runoff model (Rossman, 2010) that has been widely used for simulating runoff quantity and quality, especially from urban areas. The runoff component of SWMM uses the semi-distributed non-linear reservoir model method where a set of subcatchment areas transform precipitation in runoff. The routing module of SWMM transports this runoff and uses the full or simplified version of 1D Saint-Venant equations. However, the application of SWMM in modelling surface runoff at the field plot and laboratory flume scale is yet understudied. Also, the ability of the model to simulate surface runoff from intermittent rainfall events on soils covered with mulch has not been evaluated yet.

Laboratory experiments were conducted using a 2.00 m long, 0.30 m wide and 0.12 m deep free drainage rectangular soil flume, set at a slope of 10%, with a sandy loam soil from the right bank of Mondego River, in Coimbra (Portugal). Three soil surface conditions were considered: i) Bare soil; ii) Low mulch cover of 2 ton/ha density; and iii) High mulch cover of 4 ton/ha density. A rainfall simulator comprised of a single downward oriented full-cone nozzle, positioned 2.2 m above the geometric centre of the soil flume surface, was used to simulate a sequence of five rainfall events, with different intensities and patterns, in an intermittent way. A submerged pump, installed in a constant head reservoir and an electric retention valve, allowed a steady operating pressure at the nozzle. More information on the laboratory experiments and measured hydrographs used in this study can be found in Montenegro et al. (2013). Also, both the rainfall simulator and soil flume have been used in several research projects in the last years (e.g. de Lima et al., 2011; de Lima and Abrantes 2014a, 2014b).

The laboratory experiments clearly show that the mulching, the intermittency and characteristics of the sequential rainfall events strongly affect surface runoff. Numerical simulations for all studied cases showed that SWMM predicted efficiently surface runoff on the soil flume, showing the applicability potential of the model to small areas. In general, Nash-Sutcliffe coefficients for discharge were higher than 0.5 and determination coefficients were higher than 0.75, for all cover conditions.

References:

Kinetic energy of simulated rain resulting from combining nozzles and meshes

S.C.P. Carvalho, J.L.M.P. de Lima and M.I.P. de Lima
Institute of Marine Research (IMAR) / Marine and Environmental Sciences Centre (MARE); Department of Civil Engineering, Faculty of Science and Technology, Campus II – University of Coimbra, 3030-788 Coimbra, Portugal

The capacity of reproducing natural raindrop characteristic through simulations is a major concern in soil water erosion studies. In particular, the size and fall speed are key variables affecting the kinetic energy of individual drops that enhance soil detachment.

This study examines, in controlled laboratory conditions, the rainfall kinetic energy produced by a spray nozzle type rainfall simulator comprising a mesh, which intercepts the drops sprayed out by the pressurised drop formers. The main aim of the study is to explore the adaptation of nozzle simulators through the inclusion of meshes, which are expected to change the properties of the simulated rain from mesh-free simulations, in particular its kinetic energy. Presently, there are hardly any studies on this specific topic, although meshes have already been used in combination with non-pressurized simulators, mainly aiming at randomizing the raindrops' landing position.

In the experimental setup, the mesh, with a 20 mm square aperture, was suspended at three vertical distances (0.20, 0.40 and 0.60 m) below the four types of spray nozzles tested. The nozzles were manufactured by Spraying Systems Co. and included three single full-cone nozzles (HH-22, HH-14W and HH-4.3W) and a multiple full-cone nozzle (7G-1). The simulated rainfall, with and without the presence of the mesh, was measured under the nozzles using a Laser Precipitation Monitor from Thies Clima that yields information on the diameter and fall speed of the raindrops.

Results show that the mesh affected the kinetic energy of the simulated rainfall in comparison to the mesh-free simulations. This was observed from the distribution of the kinetic energy of the rainfall as a function of drop size and fall speed. The kinetic energy increased when the mesh was used; however, this increase differed according to the spray nozzle used. Nevertheless, the shorter the distance between the mesh and the nozzle, the stronger this effect. The contribution to the total kinetic energy of a small number of big drops with high fall speeds was relevant when meshes were used.

Further investigation is needed to understand how useful and practical can be the adaptation of nozzle simulators, by incorporating meshes, in particular for experimental field work related to soil loss studies.
ERB2014-72

Assessment of the applicability of the SWAT model to simulate the streamflow in a small rural catchment in the Federal District (Brazil)

S. Ferrigo (1), R. Minoti and S. Koide (1)
(1) University of Brasilia, Brazil

Hydrological modeling can help the understanding of physical processes and assessment of impacts on water resources and the environment caused by rural development and urban expansion in watersheds. However, modeling water systems requires essential steps for obtaining consistent and reliable results.

This study aims to evaluate the applicability of the SWAT (Soil and Water Assessment Tool) to simulate the streamflow in a small rural catchment in the Federal District, Center West of Brazil, including the analysis of hydrological dynamics simulation during the dry and rainy seasons.

The Descoberto Lake is responsible for 63% of the public water supply in the Federal District, located in the center west of Brazil. The sub-basin Descoberto River flows in the lake, and is one of the main drainage areas with about 114 km². SWAT model was applied and automatically calibrated by SWAT-CUP in the sub-basin Descoberto. Sensitivity analysis of the model was performed for 14 parameters chosen by degree of importance during the initial simulation and the observed difficulties in simulating the flows. The model was mainly sensitive to the saturated hydraulic conductivity of the soil, curve number, and available water capacity in the soil. The parameter calibration at daily basis for the hydrological years 2005 to 2010 for the River Descoberto was considered satisfactory. It led to a Nash-Sutcliffe Efficiency (NSE) of 0.40 and a coefficient of determination (R²) of 0.44. The validation for the period 2010 to 2013 led to NSE of 0.48 and a R² of 0.46. In the rainy season (November to March), the NSE and R² coefficients were 0.28 and 0.42 respectively, indicating an unsatisfactory simulation when analyzing the statistical coefficients. During the dry season (June to September) the NSE and R² coefficients were 0.39 and 0.74, indicating a satisfactory simulation. However, the percentage errors between the observed and simulated flow values, during the hydrological years of 2005 to 2010, were 35% and 56% at the rainy and dry seasons, respectively. It was found difficulties to simulate the base flow during the dry season.

ERB2014-75

The runoff generation mechanisms investigation at small Pacific catchments based on chemical tracers

V.V. Shamov (1), T.S. Gubareva (1), B.I. Gartsman (2), A.G. Boldeskul (1), N.K. Kozhevkina (3) and T.N. Lutsenko (1)
(1) Pacific Geographical Institute, Vladivostok, Russia
(2) REA-Primorye Co. Ltd, Vladivostok, Russia
(3) Institute of Biology and Soil Sciences, Vladivostok, Russia

The investigation has been performed in warm periods in 2011-2013 at representative small catchments in the monsoon climate zone in the Pacific Asia, Russia (N 44°01’, E 134°11’). The studied area is consider ed a typical low-mountain south taiga landscape. The broad-leaved-coniferous and coniferous (spruce-fir) forests dominate here at the elevations of 300-600 and 600-1100 m a.s.l., accordingly. The observations involved the continuous registration of stream water level and temperature, precipitation rate, air temperature and humidity, net radiation to cover several conspicuous flood events; frequent precise measurement of streamflow discharge; frequent atmosphere, stream and talus water sampling for chemical analysis and in-situ and lab analyses for dissolved compounds in atmospheric, talus and stream water. The observations are going on.

Conservative tracers and the set of end-members that contribute to the stream flow were identified from the stream chemical data using the diagnostic tools described by Hooper (2003). The key procedure of this is the principal component analysis (PCA) to estimate an appropriate rank of streamflow chemistry dataset. The PCA fits the streamflow chemistry to a lower dimensional mixing subspace (Euclidean U-space) and, then, the residuals between projected and original data were estimated.

Diagnostic plots are made by plotting the residuals against the observed concentrations for each dissolved compound. The dimension of the mixing subspace should be the smallest possible such that the residuals exhibit no structure, that is, the residuals appear to be a random noise. The coefficient of determination R² is used as a randomness degree measure. Appropriate rank (the smallest mixing subspace) is directly related to the number of end-members in the mixing mode – one more end-member than the rank is required. Curvature in the residuals could indicate chemical reactions of variable end-members concentrations.

In a first step, on the stage of the preliminary analysis, 12 chemical compounds were subjected to the EMMA procedure to evaluate the potential tracers for the three small representative catchments: 1) Elovyi Creek – weir (area of 0.82 km²) (2011–2013); 2) Rezervny Creek – outfall (area of 1.25 km²) (2012–2013); and 3) Elovyi Creek – outfall (area of 3.52 km²) (2013). This procedure has provided the potential chemical tracers as following: $\text{M}^+ –$ ion total, $\text{TO}_c^c$ – total dissolved organic carbon, Si – dissolved silica, $\text{H}^+$ – hydrogen ion; major anions $\text{HCO}_3^–$, $\text{Cl}^–$, $\text{SO}_4^{2–}$, $\text{NO}_3^–$, and major cations $\text{Ca}^{2+}$, $\text{Mg}^{2+}$, $\text{K}^+$, $\text{Na}^+$.

In a second step, only 4 to 6 chemical tracers were selected as the parameters in the EMMA model. This analysis is undertaken to accept/reject the hypothesis about conservativeness of the tracers and to make an objective decision about the rank of mixing subspace, and
therefore about the number of end-members for the hydrograph separation, based on the EMMA.

In a third step, the hydrograph separation was performed to evaluate e.g. the proportions of the event, the talus and the basic flows in the creek taking into account the rain character/genesis, phase and strength of the flood, the catchment area.

We preliminarily found some interesting features in the hydrological regime of small creeks such as: 1) a double-pick ("camel") form of the flood hydrographs that indicates about at least 2 different sources of stream flow – surface water and, after, subsurface water; 2) non-linear character of relation of the upper catchment runoff percentage to the discharge at stream outfall that obviously demonstrates more significant contribution of headwaters in extreme – driest and wettest – conditions in elementary streams; 3) evident diurnal oscillations in the creek discharge in rain-free low water periods: probably, due to the tree roots suction in day light, some talus water amount is retarded till the night; 4) in case of subsurface generation (weak) flood, the basic flow proportion is much higher against strength floods of predominantly surface generation – this seems like a short-term "event shutter" to prevent the groundwater to penetrate to the stream after heavy cyclonic rainfalls. Moreover, the dissolved organic carbon, nitrate and suspended matter transport rates were estimated in widely-varied hydrological conditions in 2012.

References:

ERB2014-77
Variability of extreme precipitation over mainland Portugal and its relationships with teleconnection patterns

M.I.P. de Lima (1,2), F. Espírito Santo (3), Á. Silva (3) and S. Cunha (3)
(1) Institute of Marine Research (IMAR); Marine and Environmental Sciences Centre (MARE), Portugal
(2) Department of Civil Engineering, Faculty of Science and Technology, University of Coimbra, Coimbra, Portugal
(3) The Portuguese Institute for the Sea and the Atmosphere, Lisbon, Portugal

The increase in the intensity and/or frequency of weather and climate extremes is expected to have environmental and socio-economic impact, which depends largely on the local and regional development, organization and existing infrastructures to minimize its effects. Due to its geographical situation, mainland Portugal shows irregular precipitation temporal distribution and important spatial gradients in precipitation and air temperature; furthermore, the area is prone to heat waves, droughts and floods. Thus, in general, the intensification of the climate signal in mainland Portugal is expected to have negative impacts on soil, water resources and ecosystems, which are already motive of concern in some regions. The dense perennial drainage network of the territory is associated with a large number of small basins. In some of them, the strong relief, shallow stony soils and sparse vegetation cover give way to large surface runoff and sediment flows, resulting from water erosion, which pose a threat for water storage, soil conservation and ecosystems.

In this study we investigate trends in selected precipitation-related indices of "moderate" extremes that include duration, threshold, absolute and percentile indices. These indices were calculated from daily precipitation data (1941-2012) from 27 meteorological stations scattered across the area. The precipitation indices were assessed at the annual and seasonal scales and calculated at both the station and regional scales. Additionally, we have also investigated the correlations between these indices and several modes of low frequency variability over the area.

Overall, results show regional differences in the indices’ trends and also point out to a greater asymmetry in the temporal distribution of precipitation and variations in the intensity, persistence and frequency of extreme events at various scales. Results highlight sometimes marked changes in seasonal indices; in particular, they show that, in spring, significant drying trends are accompanied by a reduction in extremes and, in autumn, wetting trends are detected for all indices. Nevertheless, since the 1980s there was a tendency towards more extreme precipitation events: it is notable the occurrence of long drought spells, as well as the more intense precipitation events on record; these events distressed more the centre and southern regions of mainland Portugal, which are the most vulnerable and the more affected by these types of events.

In addition, the observed relationship between extreme precipitation indices and atmospheric large scale modes of low frequency variability confirm that, over mainland Portugal, the North Atlantic Oscillation is one of the most important teleconnection patterns and the mode of variability that has the greatest influence on precipitation extremes in the area, particularly in winter and autumn. Thus, there is evidence that the local and regional specificities in the study area should be carefully considered in hydrological and environmental studies and definition of adaptation and mitigation measures to climate change. This general concern applies also to other regions of the globe.

Moreover, regardless of the trends observed in annual precipitation and of the scenarios predicted by climate models, the time and space scales supporting such studies do not match the temporal and spatial resolutions required for the hydrological modeling in small basins. Therefore, the understanding of the behavior in precipitation at the daily scale, and the examination of the intra-annual precipitation variability is, in general, an important issue in research in different areas.
In the zone of intermittently frozen ground, outside the permafrost zone, which also includes the southern part of forest zone of the East European plain, the first order streams hold a special position in the hydrographical network. Because of low groundwater supply, the channels can be either dry or frozen to the bed during strong cold snaps in winter period. It doesn’t occur on larger watercourses. Also, unlike the rivers, formation of icing – a sheet-like mass of layered ice – can occur in small channels in this area. It leads to certain consequences for their hydrologic regime, channel and flood plain morphology, and also structure of the bottomland landscape.

The processes of freezing of the channel and formation of the icings don’t happen in all of the small channels and are not annually. These processes need special combination of ground water supplies, air temperature conditions in winter, snow depth, and so on. To identify these conditions observations were organized on the stream Yazvizy – the 3rd-order watercourse. The stream is located in the basin of the middle course of the Protva-river (a tributary of the Oka in Kaluga region). The catchment area of the stream is 7.6 km², the length of the stream bed is 3.5 km. A large part of the basin of the stream is in a natural state (is occupied by mixed forest), only 22% of the catchment area is occupied by an abandoned farmland. A stream bed throughout is intact.

The streams watershed has a complex geological structure. There are two horizons Middle Pleistocene moraine (bouldery loams), with lenses of fluvioglacial sandy sediments and Late Pleistocene alluvial sediments in the middle course of the stream. The estuary area of the stream is located on the flood plain of the parent river. Complex geological structure predetermined the unevenly location of the springs that feed the stream flow during drought period. It’s a cause of the absence of a continuous flow in some parts of the middle and downstream. Discharge of water during high water events, which is observed in the early to mid-April, is 0.2-0.3 m³/sec.

The observations on the Yazvizy-basin have been held since 2004 and initially consisted of only visual observation of the icings formation. During the period from 2004 to 2014 icings are formed annually, except in unusually warm winters (in the years 2005/2006 and 2007/2008). Especially thick icing was observed in the winter of 2004/2005, 2009/2010 and 2011/2012 years. In the other years, the icing had a local character.

The analysis of meteorological data for this period on the weather station Maloyaroslavets, situated in 25 km to the South from the experimental basin, shows that the most thick icing forms in the years when in the second half of winter (January-February) there are significant (below 0-20 degrees) and long (not less than two weeks) lowering of the air temperature. The decrease of the air temperature in the first half of winter does not lead to the formation of ice accumulation and the freezing of the channel, because during this period there are huge reserves of groundwater. It distinguishes the icings of the intermittently frozen ground zone from icings in permafrost zone, where the ice accumulation occurs mainly in the first half of winter, before the underground water dried up (Alekseev, 1987). The formation of icing doesn’t happen along the entire length of the stream, but only in the middle course, downstream of springs, at some distance from them. The formation of the thickest icing occurs near the debris jams. They often become the centers of freezing and dams for the accumulation of ice in the channel.

Since 2011 on the Yazvizy-stream we started monitoring the temperature of the ground in the stream bed. Temperature sensor was installed in the place of the regular forming of icing. At the same time we carried out the measurements of the rate of ice accumulation and carried out the drilling of the ice thickness, freezing banks have been also estimated. During the period of the observations the formation of significant ice accumulation was observed only in winter 2011/2012. The observations in winter 2011/2012 showed that the formation of icing in the channel occurred after the freezing of the stream bed material on one of the riches, when air temperature dropped to approximately minus 15°C. At the same time the groundwater inflow remained from the banks and from the upper sections of the stream channel. Entering the channel groundwater froze and formed an icing with an uneven surface. A further decrease in the average daily air temperature to minus 27°C led to the freezing-up of banks and blocking of ground water sources. As a consequence of this the growth of icing ceased for some time. The water in the channel covered with ice upstream the freezing area and in the banks was in pressurized condition. The temperature of the bed ground at that time amounted to minus 6.9°C. Further warming led to releasing of the groundwater and increased the volumes of their entry into the stream channel, despite negative temperatures. The water injected into the channel stream spread evenly and freezing formed flat and smooth surface. Icings keeping in the channel for a long time, affect the flow regulating effect, reducing the peak water discharge and increasing the volume of its decline. Inasmuch as a channel filled with ice, flood runoff takes place at very high levels. This contributes to the sediment supply on the floodplain, which floods only in the years with icing formation. The formation of icing on small streams leads to blockage of the channel, so during the high water stream rushes along the flood plain and scours the banks in the contact with ice, which leads to the formation of new branches and channel widening. These phenomena are forming a special structure of landscapes ice valleys.

References:
Estimation of the possibility to use remote sensing data to characterize snow cover of Pribaikalye

E. Istomina and E. Maksyutova
V.B. Sochava Institute of Geography SB RAS, Russia

To investigate the spatial structure of the snow cover at the regional level, weather stations data are traditionally used. However, these data are not enough in mountain areas due to the large variety of climatic conditions. For this reason methods for studying snow cover using space images are actively developed recently.

Over the last twenty years a large number of maps of the planetary level, based on remote sensing data and reflecting the characteristics of the snow cover have appeared. The purpose of this study is the selection and validation of remote sensing data for the study of snow cover of the Baikal region at the regional level. Validation of the MODIS «snow cover» data was made based on weather station observation data of snow depth for winters of 2000-2001, 2007-2008 and 2008-2009, which are different in terms of snowiness. It’s shown that precision of measurements of «Snow cover» MODIS and weather station data are 80% for snow cover depth more than 2 cm. Most of mistakes and uncertainties are observed in May and October when snow cover is unstable. Satellite imagery data complement and extend the point information of weather stations network for investigation of the spatial distribution of snow cover especially for the mountain areas of the Baikal region not covered by in-situ data. Remote sensing data allows to identify that the snow comes early and melts later on the mountain parts of the territory. Basins and plains areas are characterized by the later appearance and early snow melting.

This work is the initial stage of the investigation, testing the possibility of using satellite imagery in combination with weather station data for analysis of snow cover borders. We plan to expand the observation period, as well as using a wider range of remote sensing data, including radar data, which contain information about the depth of snow cover for the study of current spatio-temporal dynamics of snow cover of Baikal region.

Research was done with financial support of the RFBR (№14-45-04106).

Evaluation of mulching as conservation technique for soil loss and soil moisture maintenance in plots under simulated rainfall

H.V.G. Alvares (1), A.A.A. Montenegro (1), A.L. Normandia Monteiro (1) and J.L.M.P. de Lima (2,3)
(1) Federal Rural University of Pernambuco State, Brazil
(2) Department of Civil Engineering, University of Coimbra, Portugal
(3) Institute of Marine Research (IMAR); Marine and Environmental Sciences Centre (MARE), Portugal

In several areas of Brazil tons of soils are lost every year due to erosion, being one of the biggest environmental problems in the region, reducing soil quality and polluting water resources. Techniques that minimize the effects of runoff and soil losses are essential for agricultural areas, particularly in the Brazilian semiarid region. In the Pernambuco state, rainfall of high intensity and short duration are responsible for high erosion rates. One of the conservation methods widely used is the implementation of vegetable mulch on the soil surface. A bare soil is more affected by rainfall, due to the impact of rain drops, increasing runoff, soil and nutrient losses. Besides, mulching also contributes for the soil moisture maintenance, by reducing evaporation.

This study aimed to analyze the effects of mulch on an Ultisol from the Pernambuco State semiarid, Brazil. Two experiments, each one with three replicates, used an oscillating rainfall simulator with VeeJet “80-100” nozzle, 2.8 m above the geometric center of a wood plot with a 12% slope. Soil was repacked at a depth of 20 cm, reproducing field density of 1.73 g/cm³. In one plot soil was covered with powder coconut, with a cover density of 6 t/ha. The other plot was simulated with bare soil.

Furthermore, complementary investigation was carried out to evaluate high cover percentage mulching performance for low intensity rainfall. Such conditions might reduce infiltration and wetting process along soil profile, when compared to bare soil conditions. Soil moisture measurements were conducted at three points along the plots, in three moments: (a) before the experiment start; (b) at the end of the experiment; and (c) after ceasing runoff and 60 minutes after ceasing recession, to verify the soil moisture dynamics along the plots. Additionally, runoff was monitored. Rainfall event with intensity of 40 mm/h for 40 min and 60 mm/h for 20 minutes was adopted. Additional simulations were performed considering constant intensity rainfall of 10 mm/h for 30 minutes. The work discusses the effect of mulching on runoff, and moisture, under different rainfall scenarios.
ERB2014-83

Effect of conservation practices for reducing soil and nutrients losses on cassava cropping

C.A. Lima (1), A.A.A. Montenegro (1), T.E.M. Santos (2), A.L. Normandia Monteiro (1) and E.G. Pereira (3)
(1) Federal Rural University of Pernambuco State- Recife, Brazil
(2) Federal University of Pernambuco State- Recife, Brazil
(3) Federal University of Bahia Reconcavo- Cruz das Almas, Brazil

Experimental studies using management practices have been intensified in recent years, mainly to reduce the effects of erosion. Management tillage systems with the use of mulch are alternatives to soil conservation, in order to protect the surface against the erosion agents and preserve soil organic matter and nutrients, aiming to soil sustainability and agriculture development. In particular cassava plants investigated in this study are commonly grown in semi-arid regions, playing an important role as human food in the fresh form or as flour, animals feeding and being a major source of financial income for small and medium farmers. However, it has contributed to the acceleration of soil losses by erosion, due to some characteristics of plant: slow initial growth, leaving the soil uncovered and unprotected for 2 to 3 months after cropping, large spacing between plants in the initial phase and moving soil at planting and harvesting.

The present study aimed to evaluate the effect of management practices in reducing soil and nutrients losses in cassava planting under simulated rainfall of varying intensity. The experiment was conducted at the Campus of the Federal University of Bahia Reconcavo, in the municipality of Cruz das Almas, Brazil in an experimental area of 240 m² and 7% slope, in Alic and cohesive yellow Latosol, sandy clay loam texture. The experiment was conducted in a completely randomized design, with three replications, in plots with erosion area of 3 m², bounded by metal plates under different conditions of land use: Cassava downhill (planted spaced 0.9x0.9 m² single rows following the slope of the land); cassava downhill with mulch cover (Brachiaria decumbens) density of 8 Mg ha⁻¹; cassava in contour lines associated with cowpea (Phaseolus vulgaris) plus mulch cover (planted spaced 2x0.6x0.6 m² for cassava and dual row 0.5x0.2 m² for beans), and cassava in contour lines associated to cowpea.

A simulated rainfall simulator with an oscillating sprinkler nozzle type "VeeJet 80-100", located in the center of the frame 2.87 m above the ground was adopted. Rainfall was set as 40 mm h⁻¹, during the first 90 minutes, and then increased to 90 mm during 30 min for a total of 2 hours rainfall, 57 days after Cassava planting. Soil losses were determined by weighing the collected soil material for 10 seconds in plastic pots at 3 minutes intervals. Soil samples were allowed to stand and later dried in an oven for 72 hours, to determine the soil mass lost. Loss of nutrients in the sediment (kg ha⁻¹) was calculated as the product of the elements concentrations in the sediment and the total mass lost per unit area.

It can be seen that the rainfall of late profile, with higher intensities in the last third of the total time, was not able to generate runoff in presence of mulch. Residues on the soil surface acted as a sink of rainfall kinetic energy, increasing infiltration, then providing no soil loss. On the other hand, cassava in contour lines associated with cowpea reduced soil loss in 89.2% and, for the nutrients losses, 98.17% reduction for Ca, 97.71% for Mg, 96.45% for K and 72.14% for P, compared to cassava downhill. Results point out that mulching and crop consortium were effective conservation practices in reducing soil and nutrients losses by erosion, thus enhancing soil conservation.

ERB2014-85

Variations in water availability as a consequence of run-off run-on processes that control vegetation dynamics in Drylands

E. Rodríguez-Caballero (1), M. García (2), A. Casas (2), S. Chamizo (1), Y. Cantón (1), D. Riaño (2) and S. Ustin (2)
(1) Departamento de Agronomía, Universidad de Almería, Almería, Spain
(2) Center for Spatial Technologies and Remote Sensing (CSTARS), University of Davis, Davis (CA), USA

Arid and semiarid ecosystems are characterized by low precipitation amounts and high potential evapotranspiration, which makes water the main limiting resource controlling ecosystem functioning and productivity. However, the precipitation regime, by itself, does not explain the high spatial and temporal heterogeneity in surface cover patterns observed in these landscapes. Due to water scarcity and historical human pressure, arid and semiarid landscapes usually show a patchy distribution in which sparse vegetation interperses over a bare soil open matrix. During the few rainfall events, runoff is generated in bare soil areas and redistributed through vegetation, which acts as surface obstruction and sink for water, sediments and nutrients. Thus, any semiarid ecosystem is strongly affected by water redistribution from bare soil to vegetated areas. This process increases plant water availability and reduces drought stress, which affects numerous fundamental plant processes with strong implications to predict long-term ecosystem functioning and stability. Traditional methods to measure vegetation water status, dynamic and productivity rely on very local and costly field sampling measurements, which do not reflect the high spatiotemporal heterogeneity inherent to arid and semiarid areas. Multitemporal airborne hyperspectral optical sensors provide detailed contiguous spectral information to better quantify physicochemical properties of vegetation which may improve the knowledge on vegetation dynamics. The aim of this study was to analyze how vegetation dynamics are controlled by water availability. Particular attention was paid to the effect of water redistribution due to run-off and spatial variations in water stress estimated from the hyperspectral sensor Airborne Visible-infrared Spectroradiometer (AVIRIS). The study area was Jasper Ridge Biological Preserve (Jasper Ridge), which is located in the northeastern foothills of the Santa Cruz mountains, California, USA. It has a Mediterranean climate with 652 mm mean annual precipitation concentrated in winter and autumn and hot and dry summers, which makes water one of the main limiting factors.

To analyze how run-off redistribution affects water canopy content, vegetation dynamics and productivity, a soil
water balance model was applied using as water inputs the rainfall and subsequent run-off generation and re-infiltration and using as water loss the water evapotranspiration (ETP). Run-off was modeled in a pure source sink system, in which bare areas act as run-off sources and vegetation as sinks. ETP was modeled using the Hardgrees equation and spatial variation in solar radiation due to topographic shadows. This model was applied daily throughout two hydrological years: 2005-2006 and 2006-2007. From AVIRIS images acquired on two different dates, the Normalized Difference Infrared Index (NDII), the variation of the sub-pixel fraction of photosynthetic vegetation (PV) and the Normalized Difference Vegetation Index (NDVI) were calculated as indicators of vegetation canopy water content (CWC), vegetation dynamics and productivity, respectively. The first image was acquired just after the rainy season on 2006/May/12 and the second one at the end of the summer of an unusual dry year on 2007/Aug/13.

Just after the rainfall period, the study area showed high water availability, which results in high values of NDII, PV and NDVI. Nevertheless, these values are not homogenous for the whole area and significant differences were observed among the main surface covers. This highlights the effect of water redistribution in an arid and semiarid landscape configuration. Grasslands covered the driest areas with high ETP and very low water inputs, which results in a low amount of CWC (NDII=0.03), PV (60%) and productivity (NDVI=0.58). The chaparral located in the south slopes, with very high ETP but an important water input, results in higher CWC (NDII=0.11), PV (70%) and productivity (NDVI=0.75) than grassland. Forest areas showed the highest water inputs, with high CWC (NDII=0.26), PV (93%) and productivity (NDVI=0.77). Riparian vegetation showed less water availability than forest areas but similar PV (93%) and higher productivity (NDVI=0.80), as a consequence of their capability to extract water from deeper layers and their proximity to water courses. However; lower values of CWC have been observed in these areas (NDII=0.21) than in forest areas, probably due to differences in water economy between riparian vegetation and broadleaf trees. In comparison, a strong decrease in NDII, PV and NDVI was observed on to 2007/Aug/13 as a consequence of the drought stress.

When we analyzed the effect of water availability on CWC, vegetation dynamics and productivity for the different surface covers separately, a strong linear relationship between water availability and NDII, PV and NDVI was observed for grassland, chaparral and forest. Weaker relationships were obtained in riparian vegetation, which showed lower water redistribution dependence due to their proximity to water courses and their capability to capture water from deeper layers. Based on these results we can conclude that run-off generation and water redistribution constitute one of the principal ecosystem processes controlling landscape configuration, CWC, vegetation dynamics and productivity in arid and semiarid ecosystems.

ERB2014-86
Generation of urban flood risk maps using a dual drainage model in SWMM
T.J. Paula, N.E. Simões and J.A. Sá Marques
University of Coimbra, Coimbra, Portugal

Urban floods are currently a problem all over the world. The damage can be enormous, thus it is necessary to implement preventive measures to mitigate this problem. The increasing urbanization of permeable surfaces and climate changes can lead to the occurrence of flooding and drainage systems may not be prepared to the increasing of flow caused by these phenomena. Flood risk maps are used to classify the likelihood of flooding and quantify its consequence. In 2007 the European Union issued Directive 2007/60/CE that requires Member states to assess if there are any risks of flooding.

A methodology to generate urban floods risk maps is presented in this work. An approach to model a 1D/1D dual drainage system (Simões, 2012) using SWMM, controlling input and output flow between the surface and the sewer systems, is presented (see Paula, 2013). Several rainfall events are simulated in SWMM and, based on water depths of the floodable areas, maps of floodable areas are created. Using water depth vs. damage cost functions, flood risk maps are also produced for the area of Praça 8 de Maio, in Zona Central catchment, in Coimbra, Portugal.

This methodology allows generating maps of the floodable areas and flooding risk maps for different return periods. The results obtained show that the developed framework gives a clear indication about what areas and buildings are most likely to suffer considerable damages. The produced maps can be an extremely useful planning tool.

References:
Development of a new device for continuous measurement of snow water equivalent

A. Kulasová (1), Z. Bagal (1), O. Špulák (2), V. Černohous (2), J. Souček (2), L. Daneš and Š. Blažková (1)

(1) T.G. Masaryk Water Research Institute, Podbabská 30, Praha 6, Czech Republic
(2) Forestry and Game Management Research Institute, research station Opočno, Na Olívě 55 Opočno, Czech Republic
(3) Libor Daneš, Masarykova 885, Roztoky u Prahy, Czech Republic

In the northern mountains of the Czech Republic and their foothills winter precipitation is roughly a half of yearly precipitation totals. Gradual accumulation and melting of snow depends on the character of the winter period, relief and type of vegetation. Snow covers with the same depth can have quite different snow water equivalents, i.e. the amounts of water contained within snow, depending on the snow structure and its stratification. During winter the snow water equivalent is influenced by the variability of falling precipitation, radiation, air and soil temperatures and wind. Quick snowmelt is likely to occur on non-forested slopes oriented to the South, while gradual slower melt usually occurs in the locations turned to the North and within forest. Melting snow replenishes the groundwater storage and affects in an important way water quality.

In the case of extreme situations the monitoring of snowmelt is important for the flood protection of population and property. From this point of view the immediate information on water storage in snow is very important. The obvious way to get this information is the continuous measurement of snow water equivalent.

A number of methods of automatic measurement of snow water equivalent have been tested worldwide. In the Czech Republic the snow water equivalent is at present measured manually and with the help of snow pillows. Manual measurement of the snow water equivalent is done weekly in the network of climatic stations CHMI and in experimental catchments. Data is transferred to the forecasting centre of CHMI in Prague (CPP) and to regional forecasting branches of CHMI (RPP).

Automatic measurements of snow water equivalent with snow pillows uses the principle of monitoring the mass of the snow layer with the help of pressure transducer. A disadvantage is beside other things a potential risk for the environment caused by the presence of the non-freezing mixture within the snow pillow. Cumulating mass is registered with weight sensors. For monitoring the snow depth most often ultrasonic sensor is used. Because of the variable snow quality, the snowbridging and also the variable accuracy of the sensors, it is necessary to check all automatic systems by manual measurements, which is a physically demanding fieldwork.

The need for improving the reliability of continuous monitoring of snow water equivalent brought about the project “The development of a device and methodology for continuous measurement of snow water equivalent (2011-2014). The aim of the project is to design a device suitable for any terrain, easily installable and also easily removable and transportable, which would monitor continuously the snow water equivalent. Three partners cooperate on the project: T.G. Masaryk Water Research Institute (coordinator), Research Institute of Forest Management, Hunting and Game-keeping (VULHM) and the firm Ing. Libor Daneš.

Direct registration of snow water equivalent is possible only under the assumption of technical limitation of errors brought about by snowbridging. In 2012 the first prototype was produced and tested in the laboratory of TGM WRI. A novel device precluding the snowbridging has been registered as a protected design.

Based on the experience a second prototype of snow weight was produced. The new prototype has been installed in the field conditions on the experimental catchment of VULHM in the Orlice Mountains. The system monitored the winter period 2012-2013. During winter manual observation in weekly time interval has been carried out. Based on the results from 2012-13 the documentation has been modified and a new prototype was produced. Prototypes were in 2013 gradually installed on selected representative locations in various elevations.

The new prototypes III have been placed on the experimental catchment U Dvou loucek in the Orlice Mountains (890 m a.s.l. in the vicinity of the prototype II), on the research plot Ceska Cermna (450 m a.s.l.) and on the location at the climatic station CHMI in the municipality Sindelova (565 m a.s.l.). The tested prototype I was installed on the experimental catchment Jezdecka in the Jizera Mountains at the elevation 769 m a.s.l.

In the 2013-14 winter period 5 devices have been tested in the field. The data are recorded in hourly intervals and transferred to a server. Also information on meteorological characteristics important for checking the functioning of the system, such as air and soil temperatures and radiation, are available from each location. Also various types of sensors for the depth of snow have been tested. At the same time manual measurements have been carried out as a check. Unfortunately, the winter period 2013-14 made it possible to test instruments only during small depths of snow and the behaviour of the system during fluctuations of temperatures. At some sites there were shorter or longer periods without snow. Durable snow cover occurred only on the station Jezdecka in the Jizera Mountains and U Dvou loucek in the Orlice Mountains.

Measurement of the snow water equivalent with the prototype I at the Jezdecka site agreed with manual measurement. Fluctuations happened when temperature dropped under -7 °C. The device precluding snowbridging worked correctly during both winters. At present modifications of the system, such as air and soil temperatures and radiation, are available from each location. Also various types of sensors for the depth of snow have been tested. At the same time manual measurements have been carried out as a check. Unfortunately, the winter period 2013-14 made it possible to test instruments only during small depths of snow and the behaviour of the system during fluctuations of temperatures. At some sites there were shorter or longer periods without snow. Durable snow cover occurred only on the station Jezdecka in the Jizera Mountains and U Dvou loucek in the Orlice Mountains.

The project is supported by the Czech Technological Agency (TA01020673).
Impact of climate change in the drainage of a Portuguese urban catchment

S. Dias (1), D. Santos (1), N.E. Simões (2), J.A. Sá Marques (2), J.P. Leitão (3) and T.J. Paula (4)

(1) Department of Civil Engineering, University of Coimbra, Portugal
(2) Institute of Marine Research (IMAR), Marine and Environmental Sciences Centre (MARE), Portugal
(3) Eawag: Swiss Federal Institute of Aquatic Science and Technology, Dübendorf, Switzerland
(4) AC, Águas de Coimbra, EM, Coimbra, Portugal

Recent floods all over the world show the vulnerability of urban environment to the extreme hydrological conditions. Floods in urban environment occur mainly due to heavy rain and the inability of the drainage system to drain all the water resulting from precipitation. The recent increase of urban floods results from the combined effect of climate change and urbanization and its consequences are devastating and costly (Butler et al., 2011). Concerned with this problem, the European Union created the directive 2007/60/CE on the assessment and management of flood risks and recently, it was published a document that defines the Portuguese strategy for adaptation to climate change (Paulino et al., 2013).

According to IPCC 2013 in Portugal, the frequency of extreme weather events will increase, especially in winter. It is expected that a rainfall with a current return period of 20 years will have a frequency between 15 and 18 years in all climate scenarios. On the other hand, its intensity will increase about 10% to 20% in winter period.

This poster shows a methodology to quantify the impact of climate changes in urban drainage systems. This work uses the method proposed by Casas-Castillo and Rodriguez-Solà (2014) and IPCC 2013 scenarios to access the impact of climate changes in IDF curves. With the new IDF curves, the alternating block method was used to generate the design storms. The effect of the storms is evaluated using a SWMM dual-drainage model. The impact of floods is evaluated with flood risk maps based on depth/cost curves and sustainable drainage solutions are used in order to attenuate the flood peaks and consequent risks.

The methodology is applied to Zona Central case study in Coimbra, Portugal. This catchment has suffered several flood events recently (e.g. 9/06/2006, 25/10/2006, 21/09/2008 and 24/12/2013). The catchment has a total area of approximately 1.5 km² and it is highly urbanised.

References:
Casas-Castillo, M.C., R. Rodríguez-Solà, personal communication, May 23, 2014.

Urban floods of combined sewer systems: Hydraulic and quality modelling of an extreme rainfall event in Coimbra, Portugal

L. Girão (1), N.E. Simões (1,2) and J.A. Sá Marques (1,2)

(1) Department of Civil Engineering, University of Coimbra, Portugal
(2) Institute of Marine Research (IMAR), Marine and Environmental Sciences Centre (MARE), Portugal

Due to climate change and the increase of urbanization, the number of urban floods is becoming more frequent (Butler et al., 2011). The European Union published the directive 2007/60/CE on the assessment and management of flood risks to mitigate and decrease costs related with this phenomenon. On the other hand, for the management and protection of water resources, the European Union adopted in 2000 the Water Framework Directive (WFD). It pretends to ensure good chemical status of water (groundwater or surface) across Europe, imposing limits on the concentration of pollutants.

Floods occur mainly in urban areas due to heavy rain and the inability of the drainage system to drain all the storm water. Many cities have combined sewers systems and during extreme events, the number of discharges from Combined Sewer Overflows (CSOs) increases, jeopardising water quality and habitats where such discharges occurs.

This poster shows a methodology to study the quality of water in urban drainage systems and its impacts during a flood event. A dual drainage network (1D-1D) is used in the Storm Water Management Model (SWMM), and based on recorded rainfall events and population water consumption patterns, the concentration of pollutants is calculated, its behaviour is analysed and the impact on water bodies and surface waters in verified. Measures to reduce the impact of pollutants during a flood event are also presented.

The study area is Zona Central in Coimbra, Portugal (Simões, 2012). It is a 1.5 km² highly urbanized area with a combined sewer system. Recently, this catchment has suffered several flood events (e.g. 9/06/2006, 25/10/2006, 21/09/2008 and 24/12/2013) and the discharges to water bodies are also frequent.

The results obtained show the ability of the model to predict the water quality on surface waters during flood events and consequently shows the importance of the use of dual drainage networks to water quality studies in urban areas.

References:
In recent years, new combinations of exploration techniques have been tested in order to improve our understandings on hydrological processes. For instance, the combined use of hydrological monitoring, geochemistry (element concentrations, isotopic ratios), ecological indicators, remote sensing or geophysics demonstrates how these complementary tools help significantly defining the perception that experimental hydrologists have on the functioning of the watersheds. Nevertheless, the application of appropriate techniques still presents some limitations due to the study site characteristics. However, due to the complex hydrological response of a little forested catchment composed of schist substratum overlaying by loamy periglacial deposits, we decided, a few years ago, to concentrate our energy applying such a multidisciplinary approach. In the framework of different projects, we realized a monitoring of soil physical parameters, stable isotopes, trace elements and other classical geochemistry parameters, ERT measurements, diatom identifications, thermal IR imagery. We are now able to present the gain of information we obtained for the Weierbach experimental catchment (0.47 km²), which is monitored continuously for hydro-meteorological and standard geochemical parameters since 2002.

The geological map first indicates coarse, compact and badly stratified schist that induces only a low storage capacity and feeds only poorly baseflow. The hydro-meteorological data strengthened this first perception. Indeed, the results of the hydrological monitoring present the predominance of rapid surface and sub-surface processes, triggering exceptionally high runoff coefficients.

Geochemical and isotope tracers data refined this process representation, with a dual seasonal behaviour: almost exclusive surface runoff contributions from the riparian zone in dry period, shifting toward a delayed contribution from the soil and subsoil layering over the schist bedrock during the wet period. Our results exhibit the key role that play the combination of periglacial deposits and weathered schist in the seasonal dynamic of the catchment. This complex geomorphologic structure is composed of 2 layers that reach 5 m depth until the unweathered schist. The presence of this structure in all the catchment was demonstrated by an intense ERT survey.

Recent investigations with thermal IR imagery have brought further evidence on the importance of the contribution of those soil deposits, in addition to the spatial and temporal variability of those generated by the riparian saturated area.

The potential of a novel plastic optical fiber turbidity sensor to estimate sediment yields from recently burnt areas

J.J. Keizer (1), M. Martins (1), S. Prats (1), D. Vieira (1), R. Nogueira (2) and L. Bilro (2)

(1) CESAM, University of Aveiro, Environment&Planning, Aveiro, Portugal
(2) IT-Aveiro, Aveiro, Portugal

It is well-established that wildfires can play an important role in the hydrological and erosion response of forested catchments. Overland as well as stream flow and the associated sediment yield can be markedly enhanced during the earlier stages of the window-of-disturbance. Nonetheless, it continues to be a major challenge to quantify post-fire erosion rates and their evolution with time-since-fire, not only for catchment outlets but especially also for plots. This constraint could, at least in part, be overcome by low-cost turbidity sensors, placing them in runoff collection tanks and at multiple points across stream flow sections. Especially plastic optical fibre turbidity sensors (POF) have an elevated potential, because they have reduced costs, are suitable for multiplexing and are robustness under adverse monitoring conditions. The present study explored this potential for recently burnt areas, which present a special challenge for turbidity monitoring since the characteristics of the transported sediments can be expected to change markedly over time due to exhaustion of ashes. To this end, a large number of runoff samples were analyzed that had been collected from various plots and one catchment outlet in a recently burnt study area in north-central Portugal. Comparison of the sediment and organic matter contents of these samples with the turbidity suggested that the novel POF sensor would greatly facilitate obtaining rough estimates of post-fire erosion rates. However, the results also suggested that the sensor would need regular calibration to accommodate changes in the characteristics of the transported sediments.
Technical Visits

Technical Visit 1
Thursday, 11 September: 14:00-19:00

Experimental drainage basins in wildfire affected rural lands in north-central Portugal

A five hours visit to two experimental drainage basins monitored by the Earth Surface Processes team of CESAM, University of Aveiro.

HIGHLIGHTS:
Two areas will be visited where the hydrological and erosion effects of wildfires are/were studied across spatial scales.
The first area is one of the first in the world where the export of fire-induced contaminants is being monitored.
The second area is rather unique for assessing the effectiveness of two novel measures of post-fire erosion control and employing both micro- and field-scale plots.

SHORT DESCRIPTION:
The technical visit will be to two experimental drainage basins located north of Coimbra, in the river Vouga catchment (Fig. 1), and will focus mainly on runoff generation and the associated transport processes in recently burned areas.

It is well-established that wildfires can lead to strong and, sometimes, extreme responses in hydrological and erosion processes. The same is true for certain post-fire forestry operations, for example, ploughing in downslope direction. Nonetheless, there continues to exist various research gaps hampering an integrated assessment of the on- and off-site impacts of wildfires and post-fire land management. They include the role of fire severity and repeated fires, the responses beyond the plot scale, the losses of nutrients (C, N, P), the export of contaminants [e.g., metals, polycyclic aromatic hydrocarbons (PAHs)], and the effects of typical forestry operations as well as post-fire emergency land stabilization measures.

Since the dramatic summers of 2003 and 2005, when wildfires consumed more than 300,000 ha of rural lands across mainland Portugal, the Earth Surface Processes team of CESAM (University of Aveiro) has increasingly been addressing some of the above-mentioned knowledge gaps for north-central Portugal. The technical visit concerns two of this team’s study areas (Fig. 2).

Acknowledgement: This visit was organized with the collaboration of Nelson Abrantes, Sérgio Prats Alegre and Jan Jacob Keiser, of CESAM, University of Aveiro, who kindly guided the visit and provided the photographs from the sites to be visited.
The **Macida** study area of the FIRETOX research project (Fig. 3) comprises six study sites that were instrumented with slope-scale runoff plots and with slope-scale sediment fences. Two of the sites were long-unburnt, one being covered by a *Eucalyptus globulus* plantation and the other by a *Pinus pinaster* plantation. In addition to these two control sites, two other sites had suffered a low-severity fire during the summer of 2013 and another two sites a high-severity fire, in both cases involving eucalypt as well as pine plantations. The study area was instrumented with two hydrometric stations (Fig. 3) to study the off-site effects of the wildfire on downstream aquatic systems.

In this study area two sites will be visited (Fig. 4):

1) the pine plantation that burned at low severity and which was logged in the meantime;

2) the hydrometric station of the largest experimental basin (210 ha), where the export of contaminants (metals and PAHs) is being measured.

The **Ernida** study area of the FIRECNUTS research project (Fig. 5) comprised six study sites with a similar experimental set-up as the FIRETOX sites, where the export of carbon and key nutrients (N, P) by overland flow was monitored during the first three years after a wildfire in August 2010. In addition, a seventh site was selected to test the effectiveness of two post-fire emergency land stabilization measures that, hitherto, had been poorly tested under field conditions, not only in Portugal but also in the rest of the world, *i.e.* mulching with commercially-available forest residues and application of polyacrylamide (PAM). The effectiveness of both measures was tested at the micro-plot scale during the first year after the wildfire; but the effectiveness of mulching was also tested at the field scale and during the three subsequent years after the fire. Figure 6 shows the site and, more specifically, five of the six field-scale plots immediately after the fire and after the mulch application.

In the site where treatment effectiveness is being tested, the conditions illustrate how post-fire vegetation recovery looks like four years after a wildfire, by contrast to the field conditions observed only one year after a fire (*e.g.* at the Macida pine site).
Technical Visit 2
Saturday, 13 September: 10:00-16:00

Insight into the fluvial environment of the River Mondego upstream of Coimbra

A kayak trip down a stretch of the River Mondego, upstream of Coimbra.

SHORT DESCRIPTION:
The River Mondego catchment has a dominant NE-SW orientation and an area of 6644 km²; this catchment is the second largest in area of those that are located entirely in Portuguese territory. The river is 234 km long: the source is in Serra da Estrela, at an altitude of 1425 m a.s.l., and its mouth is near Figueira da Foz, on the Atlantic Ocean. In its first 50 km the river descends to 750 m; the last 80 km section of the river has a gentle slope. The main geological formations are granites and schist of the Iberian Meseta, changing downstream to sandstones and marl and, closer to the mouth, to recent sedimentary formations.

Descending 15 km down the River Mondego in a kayak will be a relaxing activity, combining physical activity and the opportunity to see the beautiful environment and the ecosystem characteristics of one section of the river. The selected section of the river is upstream of Coimbra and stretches from Penacova to Praia fluvial de Palheiros e Zorro (left bank). In the first part the river runs through a deep, narrow valley, with a meandering course and enclosed by steep slopes that are covered mainly by pine and eucalyptus forests. The soils are derived from schist. Closer to Coimbra the river opens out to its lower course, running through a vast alluvial plain for the last 40 km of its course. The trip will end at the fluvial beach Praia fluvial de Palheiros e Zorro.

The descent will be guided by professionals. Safety requirements are met. The kayaks are for two persons. Transportation by bus from the Coimbra to the departure and pick-up points will be provided.

At the end of the trip, it will be possible to have lunch next to the river, in a relaxing environment, prior to transportation to Coimbra by bus, at Casal da Misarela, in front of the Praia fluvial de Palheiros e Zorro.
Author’s Index

Abelho, M. 16, 54
Abrantes, J.R.C.B. 13, 16, 17, 28, 52, 56, 74
Abrantes, N. 14, 17, 38, 63, 64
Alvaraes, H.V.G. 18, 79
Alves, E.M. 16, 59
Antíguedad, I. 15, 25, 55
Antonino, A.C.D. 16, 59
Aragão, R. 13, 45
Arattano, M. 15, 17, 40
Aroca-Jiménez, E. 12, 32
Artemenko, V. 15, 22
Azevedo, J.M. 17, 68
Bayón, Z. 18, 82
Ballesteros, J.A. 13, 32
Barnich, F. 18, 84
Bauer, Th. 45
Benet, A.S. 15, 48
Bernal, S. 12, 25
Bernard-Jannin, L. 15, 25
Berta, N. 12, 13, 29, 36
Berti, A.C.D. 16, 59
Bispo, N. 16, 59
Blažková, Š. 18, 82
Blázová, K. 54
Bledsoe, J.G. 14, 17, 23, 28, 36, 43, 52, 56, 58, 74, 75
Bledsoe, J.G. 14, 17, 28, 46, 75, 77
de Lima, R.L.P. 13, 44
de Salas, L. 13, 32
Denisi, C. 12, 39
Devaty, J. 15, 41
Dias, S. 18, 83
Díez-Herrero, A. 12, 13, 32
Dijkema, R. 15, 19
Dohnal, M. 17, 69
Dosta, T. 15, 41
Duarte, A.C. 15, 43
Duarte, P.S. 17, 75
Dusek, J. 15, 41
Eder, A. 45
Eipelde, A.M. 15, 25
Erlandsson, M. 12, 25
Espírito Santo, F. 14, 17, 46, 77
Estrela, S. 17, 64
Fernandez, H.M.M.N.P.V. 16, 57, 58
Fernández, J.A. 13, 32
Ferrari, S. 17, 67
Ferreira, A.J.D. 14, 17, 23, 72, 73
Ferreira, C.S.S. 14, 23
Ferrigo, L. 17, 76
Figueiredo, F.P.O. 17, 68
Filianoti, P.G. 12, 39
Fischer, B. 12, 47
Gallart, F. 13, 14, 32, 35
García, M. 18, 80
Garrote, J. 13, 32
Gartsman, B.I. 76
Gierszewski, P. 17, 62
Girão, L. 18, 83
Gombos, M. 16, 52
Gonzáles-Pelayo, O. 17, 73
Gorbachova, L. 14, 20
Gourdol, L. 18, 84
Gribovskiz, Z. 14, 17, 37, 67
Guardiola-Albert, C. 13, 32
Gubareva, T.S. 76
Guignard, C. 13, 50
Gunari, L. 17, 67
Haase, T. 13, 28
Halmova, D. 15, 24
Hercog, A. 14, 37
Hernández, M. 13, 32
Hissler, C. 12, 18, 50, 84
Hlavčová, K. 54
Hlavě, J. 12, 48
Holko, L. 12, 48
Holzmann, H. 15, 27
Hopp, L. 12, 33
Iffly, J.F. 13, 18, 50, 84
Iríguiez, L.M. 15, 43
Isidoro, J.M.G.P. 12, 16, 36, 57, 58
Isidoro, P. 16, 54
Istomin, E. 79
Jacinto, R. 17, 70
Jankovec, J. 13, 16, 28, 58
Jauch, E. 15, 25
Jordan, A. 16, 57, 58
Juilleret, J. 18, 84
Kaczk, P. 14, 17, 37, 67
Kandra, B. 16, 52
Kaszubski, M. 16, 17, 60, 62
Kavka, P. 15, 41
Kędra, M. 14, 31
Keizer, J.J. 14, 17, 18, 38, 63, 64, 72, 73, 84
Király, G. 14, 37
Klaus, J. 18, 84
Kleibinder, K. 45
Klipa, V. 15, 17, 41, 69
Kogoj, M. 16, 51
Koide, S. 13, 17, 45, 76
Korpak, J. 14, 31
Kostka, Z. 12, 48
Kozielski, W. 17, 64
Kozhevnikova, N.K. 76
Krammer, C. 30, 60
Krammer, Ch. 45
Krylenko, I.V. 17, 78
Kulasová, A. 18, 82
Lain, L. 13, 32
Lator, J. 13, 16, 20, 51
Leitão, P. 18, 83
Lima, C.A. 18, 80
Lima, J.E.F.W. 13, 45
Lima, J.R.S. 16, 59
Llorens, P. 13, 16, 20, 51
Llorente, M. 13, 32
Lo Porto, A. 14, 35
Lozano, M.E. 13, 32
Lupon, A. 12, 25
Lukovsky, V. 15, 22
Lutsenko, T.N. 76
Luzovitska, Y. 15, 22
Machado, C.B. 16, 59
Maksyutova, E. 79
Mancebo, M.J. 13, 32
Maraga, F. 13, 17, 34, 65, 66
Markart, G. 45
Martinez-Carreras, N. 18, 84
Martinez-Fernández, J. 12, 29, 36
Martins, F.M.G. 16, 57, 58
Martins, M. 18, 84
Massari, C. 12, 13, 29, 36
Matgen, P. 12, 13, 29, 36
Meaurio, M. 55
Menkveld, S.H. 15, 19
Micaelo, A. 17, 64
Miklanek, P. 15, 24
Mikos, M. 16, 51, 53
Minoti, R. 17, 76
Montenegro, A.A.A. 13, 16, 17, 18, 28, 45, 52, 56, 75, 79, 80
Montenegro, S.M.G.L. 13, 16, 45, 59
Moraramaro, T. 12, 13, 29, 36
Narcis, P. 17, 64
Neculau, G. 12, 26
Nieves, P. 18, 83
Nogueira, R. 18, 84
Normandia Monteiro, A.L. 18, 79
Nunes, B. 17, 64
Nunes, J.P. 14, 17, 23, 38, 63, 70
Olivera, F. 13, 32
Olivero, O. 12, 33
Oosterveld, J.B. 15, 19
Opsi, F. 17, 67

15th Biennial Conference ER2014

Authors Index 89
<table>
<thead>
<tr>
<th>Authors</th>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orfanus, T.</td>
<td>14, 27</td>
</tr>
<tr>
<td>Osadcha, N.</td>
<td>15, 22</td>
</tr>
<tr>
<td>Osadchyy, V.</td>
<td>15, 22</td>
</tr>
<tr>
<td>Palladino, M.R.</td>
<td>15, 17, 40</td>
</tr>
<tr>
<td>Pappagallo, G.</td>
<td>14, 35</td>
</tr>
<tr>
<td>Pardo Iguzquiza, E.</td>
<td>13, 32</td>
</tr>
<tr>
<td>Pascoal, M.C.</td>
<td>17, 64</td>
</tr>
<tr>
<td>Paula, T.J.</td>
<td>18, 81, 83</td>
</tr>
<tr>
<td>Pekar, J.</td>
<td>15, 24</td>
</tr>
<tr>
<td>Pekarova, P.</td>
<td>15, 24</td>
</tr>
<tr>
<td>Penna, D.</td>
<td>12, 13, 29, 33, 36</td>
</tr>
<tr>
<td>Pereira, E.G.</td>
<td>18, 80</td>
</tr>
<tr>
<td>Pereira, J.</td>
<td>17, 64</td>
</tr>
<tr>
<td>Pereira, P.</td>
<td>17, 63</td>
</tr>
<tr>
<td>Pérez-Cerdán, F.</td>
<td>13, 32</td>
</tr>
<tr>
<td>Perucha, M.A.</td>
<td>13, 32</td>
</tr>
<tr>
<td>Pfister, L.</td>
<td>13, 18, 50, 84</td>
</tr>
<tr>
<td>Planezziola, L.</td>
<td>13, 29</td>
</tr>
<tr>
<td>Pimenta, J.</td>
<td>17, 64</td>
</tr>
<tr>
<td>Pires, V.</td>
<td>14, 46</td>
</tr>
<tr>
<td>Poblador, S.</td>
<td>12, 25</td>
</tr>
<tr>
<td>Pramuk, B.</td>
<td>15, 24</td>
</tr>
<tr>
<td>Prats, S.</td>
<td>17, 18, 72, 73, 84</td>
</tr>
<tr>
<td>Prícop, C.</td>
<td>12, 26</td>
</tr>
<tr>
<td>Retegan, M.</td>
<td>14, 49</td>
</tr>
<tr>
<td>Rial-Rivas, M.E.</td>
<td>14, 17, 38, 63, 72, 73</td>
</tr>
<tr>
<td>Riaño, D.</td>
<td>18, 80</td>
</tr>
<tr>
<td>Ribeiro, A.A.</td>
<td>16, 59</td>
</tr>
<tr>
<td>Rivero-Honegger, C.</td>
<td>13, 32</td>
</tr>
<tr>
<td>Rocha, J.</td>
<td>17, 70</td>
</tr>
<tr>
<td>Rodrigues, N.V.</td>
<td>17, 68</td>
</tr>
<tr>
<td>Rodríguez-Bianco, M.L.</td>
<td>17, 62, 63</td>
</tr>
<tr>
<td>Rodríguez-Caballero, E.</td>
<td>15, 18, 42, 48, 80</td>
</tr>
<tr>
<td>Roebeling, P.</td>
<td>17, 70</td>
</tr>
<tr>
<td>Roig-Planasdemunt, M.</td>
<td>13, 16, 20, 51</td>
</tr>
<tr>
<td>Román, J.R.</td>
<td>15, 42</td>
</tr>
<tr>
<td>Ruiz-Villanueva, V.</td>
<td>12</td>
</tr>
<tr>
<td>Ruiz-Villanueva, V.</td>
<td>13, 32</td>
</tr>
<tr>
<td>Rusjan, S.</td>
<td>16, 51, 53</td>
</tr>
<tr>
<td>Sá Marques, J.A.</td>
<td>18, 81, 83</td>
</tr>
<tr>
<td>Sabater, F.</td>
<td>12, 25</td>
</tr>
<tr>
<td>Sánchez Pérez, J.M.</td>
<td>15</td>
</tr>
<tr>
<td>Šanda, M.</td>
<td>13, 16, 28, 58</td>
</tr>
<tr>
<td>Santos, D.</td>
<td>18, 83</td>
</tr>
<tr>
<td>Santos, J.</td>
<td>17, 72, 73</td>
</tr>
<tr>
<td>Santos, T.E.M.</td>
<td>18, 80</td>
</tr>
<tr>
<td>Sauvage, S.</td>
<td>15, 25</td>
</tr>
<tr>
<td>Savio, G.</td>
<td>15, 17, 40</td>
</tr>
<tr>
<td>Seibert, J.</td>
<td>12, 47</td>
</tr>
<tr>
<td>Serpa, D.</td>
<td>14, 38</td>
</tr>
<tr>
<td>Shamov, V.V.</td>
<td>76</td>
</tr>
<tr>
<td>Silva Jr., V.P.</td>
<td>13, 16, 17, 28, 52, 56, 75</td>
</tr>
<tr>
<td>Silva, À.</td>
<td>14, 17, 46, 77</td>
</tr>
<tr>
<td>Silva, V.</td>
<td>14, 17, 38, 64</td>
</tr>
<tr>
<td>Simões, N.E.</td>
<td>17, 18, 74, 81, 83</td>
</tr>
<tr>
<td>Siwek, J.</td>
<td>17, 71</td>
</tr>
<tr>
<td>Sléziak, P.</td>
<td>16, 54</td>
</tr>
<tr>
<td>Snehota, M.</td>
<td>17, 69</td>
</tr>
<tr>
<td>Sotier, B.</td>
<td>45</td>
</tr>
<tr>
<td>Souček, J.</td>
<td>18, 82</td>
</tr>
<tr>
<td>Souza, C.</td>
<td>13, 45</td>
</tr>
<tr>
<td>Souza, E.S.</td>
<td>16, 59</td>
</tr>
<tr>
<td>Souza, R.M.S.</td>
<td>16, 59</td>
</tr>
<tr>
<td>Špulák, O.</td>
<td>18, 82</td>
</tr>
<tr>
<td>Šrák, M.</td>
<td>16, 51</td>
</tr>
<tr>
<td>Stähl, M.</td>
<td>12, 47</td>
</tr>
<tr>
<td>Steenhuis, T.S.</td>
<td>14, 23</td>
</tr>
<tr>
<td>Stille, P.</td>
<td>13, 50</td>
</tr>
<tr>
<td>Stonevicius, E.</td>
<td>16, 57</td>
</tr>
<tr>
<td>Strauss, P.</td>
<td>30, 45</td>
</tr>
<tr>
<td>Studnova, Z.</td>
<td>16</td>
</tr>
<tr>
<td>Surkov, V.V.</td>
<td>17, 78</td>
</tr>
<tr>
<td>Szegedi, B.K.</td>
<td>14, 37</td>
</tr>
<tr>
<td>Szita, R.</td>
<td>14, 37</td>
</tr>
<tr>
<td>Szolgay, J.</td>
<td>54</td>
</tr>
<tr>
<td>Taboada-Castro, M.M.</td>
<td>17, 62, 63</td>
</tr>
<tr>
<td>Taboada-Castro, M.T.</td>
<td>17, 62, 63</td>
</tr>
<tr>
<td>Tapiador, F.J.</td>
<td>13, 32</td>
</tr>
<tr>
<td>Tarbenev, A.M.</td>
<td>17, 78</td>
</tr>
<tr>
<td>Tarpanelli, A.</td>
<td>12, 36</td>
</tr>
<tr>
<td>Teuling, A.J.</td>
<td>16, 55</td>
</tr>
<tr>
<td>Torfs, P.J.J.F.</td>
<td>16, 55</td>
</tr>
<tr>
<td>Tropeano, D.</td>
<td>15, 17, 40</td>
</tr>
<tr>
<td>Turconi, L.</td>
<td>15, 17, 40, 67</td>
</tr>
<tr>
<td>Uijlenhoet, R.</td>
<td>16, 55</td>
</tr>
<tr>
<td>Ustin, S.</td>
<td>18, 80</td>
</tr>
<tr>
<td>Vale, C.</td>
<td>17, 63, 64</td>
</tr>
<tr>
<td>van Meerfeld, H.J.</td>
<td>12, 33</td>
</tr>
<tr>
<td>Vasílová, I.</td>
<td>16, 52</td>
</tr>
<tr>
<td>Vidmar, A.</td>
<td>16, 51</td>
</tr>
<tr>
<td>Vieira, D.</td>
<td>18, 84</td>
</tr>
<tr>
<td>Wade, A.</td>
<td>12, 25</td>
</tr>
<tr>
<td>Walsh, R.P.D.</td>
<td>14, 23</td>
</tr>
<tr>
<td>Wild, J.</td>
<td>13, 16, 28, 58</td>
</tr>
<tr>
<td>Zabaleta, A.</td>
<td>55</td>
</tr>
<tr>
<td>Zagyvainé-Kiss, K.A.</td>
<td>17, 67</td>
</tr>
<tr>
<td>Zavala, L.M.</td>
<td>16, 57, 58</td>
</tr>
<tr>
<td>Zelazny, M.</td>
<td>17, 71</td>
</tr>
<tr>
<td>Zema, D.A.</td>
<td>12, 39</td>
</tr>
<tr>
<td>Zucca, F.</td>
<td>13, 34</td>
</tr>
<tr>
<td>Zuecco, G.</td>
<td>12, 13, 29, 33</td>
</tr>
<tr>
<td>Zumr, D.</td>
<td>15, 17, 41, 69</td>
</tr>
</tbody>
</table>