European Geosciences Union

Committee on Education

GIFT - 2012

Water!

Geosciences Information for Teachers Workshop

Vienna, Austria, 23-25 April 2012

European Geosciences Union

GEOSCIENCES INFORMATION FOR TEACHERS (GIFT) WORKSHOP

Austria Center Vienna
22-25 April, 2012

Dear Teachers,

Welcome to the 10th GIFT workshop which this year will unite 81 teachers from 19 different countries. The general theme of the workshop is «Water!» and will be dedicated to the study of the hydrological challenges faced by our planet.

The water cycle, also known as the hydrological cycle, describes the continuous movement of water on, above and below the surface of the Earth. It also involves the exchange of energy, which leads to temperature changes. The water cycle significantly influences and shapes life, society and ecosystems on Earth. However, several problems are threatening water resources today, especially the unsustainable use of water and the lack of an adequate supply of usable/drinking water in many parts of the world. Such problems are complex caused by an ever increasing population, consumerism, political tensions, urbanization and changes in agricultural practice.

In addition, as the water cycle involves the exchange of heat, the effects of atmospheric global warming on the water cycle are significant: sea levels have risen, glaciers have retreated. The hydrological cycle is heavily affected by land use changes which in turn affect groundwater recharge. The problems mentioned above cause concerns in almost every sector of everyday life, and geo-engineers are seeking ways of mitigation. All water bodies are going to be affected by global warming, making knowledge of the water cycle essential for any kind of human activity. Entire regions on Earth will face extreme temperatures eventually associated with torrential rainfalls whilst other regions are likely to experience a scarcity of water and droughts.

In the two and a half days of the workshop we will have time to describe and discuss only the main aspects of the water cycle. First, of course, the crucial role that water, a key-molecule for life on Earth, has in metabolism and biodiversity on our planet. Talks will focus on global freshwater availability and distribution, overexploitation of water, strategies for sustainable use of water in the future and the threats by environmental changes. Floods in a changing world will also be described, as well as satellite observations specifically related to the water cycle

Regions where underground fresh water plays a particular role, such as Yucatan, will be described, as well as regions seriously affected by water scarcity and droughts. Finally, the use of naturally occurring isotopes to "fingerprint" sources of water in precipitation and rivers, and the presence of ‘ancient’ water beneath the deserts and other areas, will also be thoroughly discussed

A visit to the Isotope Hydrology Section laboratory at the United Nations is scheduled at the end of the workshop. And in the following afternoon, we have organized a visit to the Vienna Water treatment station, the most modern of Europe.

We hope that you will take seriously the GIFT agreement we have asked you to sign. The GIFT workshop is kindly sponsored by several science organizations. We would like to continue to offer teachers the opportunity to attend GIFT and similar workshops, but this depends upon us being able to show our sponsors that teachers have used the new GIFT information and science didactics in their daily teaching, or as inspiration for new ways to teach science in their schools.

Therefore, we ask you **1.** to fill out the evaluation forms as soon as possible and send them back to us, **2**. make a presentation of your experiences at GIFT to a group of your teaching colleagues sometime after you return from EGU, and **3**. send us reports and photographs about how you have used the GIFT information in your classrooms. We also encourage you to write reports on the GIFT workshop in publications specifically intended for geosciences teachers.

Information on past and future GIFT workshop is available on the EGU homepage. Look at
http://www.egu.eu/media-outreach/gift/gift-workshops.html

where you can find the brochures (pdf) and also the slides of the different presentations given at the GIFT workshops for the last 8 years. Beginning in 2009, we have also included web-TV presentations, which may be freely used in your classrooms.

We know that bringing together 80 teachers in Vienna is not enough to spread scientific information as widely as we would hope. For this reason, the EGU Committee on Education has inaugurated in 2012 an annual series of GIFT Distinguished Lectures, to be given by top scientists who have previously participated as speakers in GIFT workshops during the EGU General assemblies.

These lectures are to be included in a well-organized educational event for high school science teachers, in which a minimum of one hundred teachers will attend. High school teachers, high school directors, educators for teachers from the European area are welcome to request a lecture, for which the EGU Committee on Education will cover the travel and subsistence costs of the speaker. Lecturers and topics should be selected among the ones given in the past 5 years in EGU General Assembly GIFT Workshops

Even before we get « officially » started, you are in for our special yearly treat: our traditional visit to the Vienna Museum of Natural History, a courtesy of Mathias Harzhauser and Herbert Summesberger. Following this visit, we'll have an ice-breaker reception in the beautiful Museum.

We are looking forward to meeting you in Vienna!

The Committee on Education
European Geosciences Union

Acknowledgements

The GIFT-2011 workshop has been organized by the Committee on Education of the European Geosciences Union. EGU has supported the major share of the expenses, but the workshop has also benefited of the generous help of:

The European Space Agency

Commissariat à l'Energie Atomique et aux Energies Alternatives

Istituto Nazionale di Geofisica e Vulcanologia

The Associazione per la Geofisica « Licio Cernobori » in Trieste, Italy

The Institute of Geology and Geophysics, Chinese Academy of Sciences, China

University of Bergen
Department of Earth Sciences

National Science Foundation

Secretaría de Educación, Gobierno del Estado de Yucatan

Edugea and 2G Enterprises – William S. Goree Award

European Geosciences Union
Committee on Education

CHAIR

Carlo Laj
Laboratoire des Sciences du Climat et de l'Environnement (LSCE)
Avenue de la Terrasse,
91198 Gif-sur-Yvette cedex, France
Carlo.Laj@lsce.ipsl.fr

MEMBERS

Eve Arnold
Department of Geological Sciences
Stockholm University
S106 91 Stockholm, Sweden
emarnold@geo.su.se

Jean-Luc Berenguer
Centre International de Valbonne
BP 97 - 06902 Sophia Antipolis cedex, France
berenguer@unice.fr

Friedrich Barnikel
Fachkoordinator für Geographie
Landeshauptstadt München ,
Germany
friedrich.barnikel@awg.musin.de

Anita Bokwa
Jagiellonian University
Institute of Geography and Spatial Management
7 Gronostajowa St.
PL-30-387 Cracow, Poland
anita.bokwa@uj.edu.pl

Angelo Camerlenghi
ICREA, c/o Facultat de Geologia
Universitat de Barcelona
Martí i Franquès, s/n
E-08028 Barcelona, Spain
acamerlenghi@ub.edu

Francesca Cifelli
Dipartimento Scienze Geologiche
Università degli Studi Roma TRE
Largo San Leonardo Murialdo 1
00146 Roma, Italy
cifelli@uniroma3.it

Francesca Funiciello
Dipartimento Scienze Geologiche
Università degli Studi Roma TRE
Largo San Leonardo Murialdo 1
00146 Roma, Italy
ffunicie@uniroma3.it

Stephen A. Macko
Department of Environmental Sciences
University of Virginia
Charlottesville, VA 22903, USA
sam8f@virginia.edu

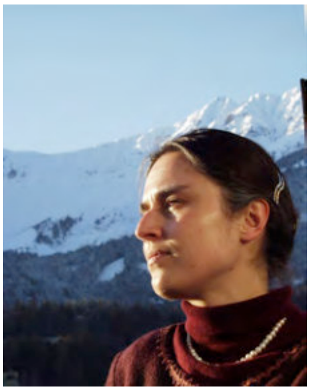
Phil Smith
Teacher Scientist Network (TSN)
John Innes Centre
Colney Lane
Norwich, NR4 7UH Great Britain
phil.smith@bbsrc.ac.uk

Annegret Schwarz
Gymnasium an der Stadtmauer,
Hospitalgasse 6,
55543 Bad Kreuznach,
Germany
aschwarz@stamaonline.de
Annegret.Schwarz@online.de

Herbert Summesberger
Natural History Museum
1010 Wien, Burgring 7
Austria
herbert.summesberger@ nhm-wien.ac.at

European Geosciences Union

Committee on Education



Anita Bokwa

Angelo Camerlenghi

Steve Macko

Francesca Cifelli

Eve Arnold

Carlo Laj

Annegret Schwarz

Friedrich Barnikel

Francesca Funiciello

Jean-Luc Berenguer

Phil Smith

Herbert Summesberger

Program

European Geosciences Union – General Assembly
GEOSCIENCE INFORMATION FOR TEACHERS (GIFT) WORKSHOP

Austria Center Vienna, 22-25 April 2012

Room 29

Water!

Programme

Sunday April 22, 2012

16:30 - 18:30 **GUIDED TOUR OF THE VIENNA MUSEUM OF NATURAL HISTORY** and ice breaker reception
Herbert Summesberger and Mathias Harzhauser
Vienna Museum of Natural History

Monday April 23, 2012

Chairperson: Carlo Laj

08:30 - 08:45 **WELCOME !**
Donald Bruce Dingwell and Günter Blöschl
President and President-Elect of EGU

PRACTICAL INSTRUCTIONS FOR THE WORKSHOP
Carlo Laj
EGU Committee on Education

08:45 – 09:15 **WATER CYCLE, FRESHWATER AVAILABILITY AND DISTRIBUTION: THE MAJOR CHALLENGES FOR WATER IN THE NEXT 100 YEARS**
Alberto Montanari
University of Bologna, Italy

09:15 – 10:00 **WATER, A KEY MOLECULE FOR LIVING: WATER IN METABOLISM AND BIODIVERSITY**
Gilles Boeuf
Museum National d'Histoire Naturelle, Paris
and Laboratoire Arago, Banyuls-sur-Mer
France

10:00 – 10:30 COFFEE BREAK

Chairperson: Annegret Schwarz

10:30 – 11.15 **WATER, WATER EVERYWHERE, NOT A DROP TO DRINK!**
Murugesu Sivapalan
University of Illinois
Urbana Illinois, USA

11:15 – 12:00 **FLOODS IN A CHANGING WORLD**
Günter Blöschl
Centre for Water Resource Systems
Vienna University of Technology (TU Wien) Vienna, Austria

12:00 – 14:00 LUNCH (SANDWICHES)

Chairperson: Anita Bokwa

14:00 –15:00 ***TEACHER-TO-TEACHERS COMMUNICATIONS***

LOW-COST AND EASY EXPERIMENTS ABOUT THE WATER IN THE ATMOSPHERE
Marcel Costa Vilas
IES Castellar, Castellar des Vallès, Spain

FRESH WATER ECOSYSTEMS – A CASE OF A SUBURBAN WATER STREAM
Anastasios Alevisos and Grigorios Zygouras
Chalandri and Melissia Lyceums, Greece

TELLING AND MEASURING URBAN FLOODS: EVENT RECONSTRUCTION BY MEANS OF PUBLIC-DOMAIN MEDIA
Stefano Macchia
Istituto Comprensivo "G. Arpino", Sommariva del Bosco (Cuneo), Italy

15:00 - 15 :30 COFFEE BREAK

Chairperson: Francesca Cifelli

15:30 –16:15 **ORIGIN AND FATE OF ATMOSPHERIC MOISTURE OVER CONTINENTS**
Hubert Savenije
Delft University of Technology
The Netherlands

16:15 – 16:30 **INFORMATION ON THE EDUCATIONAL PROGRAMS OF EGU**
Carlo Laj

16:30 – 16:45 **INSTRUCTIONS FOR THE POSTER SESSION EOS2**
Eve Arnold

16:45 – 18:00 **Tour of the General Assembly**
Expositions, posters, geocinema

Tuesday, April 24, 2012

Chairperson: Angelo Camerlenghi

08:30 – 09:15 **EARTH OBSERVATION FROM SPACE: QUANTIFYING WATER RESOURCES TO BETTER MANAGE THEM**
Pierre-Philippe Mathieu
European Space Agency (ESRIN – EOP/SE)
Frascati, Italy

9:15 – 10:00 **HYDROLOGY OF YUCATAN: AN EXEMPLE OF LARGE SCALE FRESHWATER RESERVOIR**
Mario Rebolledo
Unidad de Ciencia del Agua
CICY, Merida Yucatan
Mexico

10:00 – 10:30 COFFEE BREAK

Chairperson: Friedrich Barnikel

10:30 – 11:15 **MONITORING CLIMATE, DROUGHTS AND FLOODS: THE TRANS-AFRICAN HYDRO-METEOROLOGICAL OBSERVATORY**
Nick van de Giesen
Delft University of Technology
The Netherlands

11:15 – 12:45 **PIEZOMETRIC MAPPING, SIMULATION AND MODELING UNDERGROUND WATER (First group)**
François TILQUIN
High School Marie CURIE
Echirolles (near Grenoble), France

LUNCH (2 DIFFERENT GOOUPS))

13:30 - 15:00 **PIEZOMETRIC MAPPING, SIMULATION AND MODELING UNDERGROUND WATER (Second group)**
François TILQUIN

15:00- 15:30 COFFEE BREAK

Chairperson: Francesca Funiciello

15:30 – 16:30 **WATER FOOTPRINT – EDUCATION OF SUSTAINABLE DEVELOPMENT IN CLASS** (Room 29, first group, Splinter Room SPM2.8 second group)
Annegret Schwarz,
Head Gymnasium an der Stadtmauer
Bad Kreuznach, Germany

15:30 – 16: 30 **HANDS-ON ACTIVITIES – WATER** (Spilnter room SPM2.8 second group,
Room 29 first group)
.
Phil Smith
Coordinator,
Teacher Scientist Network (TSN)
Norwich,, UK

Chairperson: Eve Arnold

16:30 – 19:00 **EOS2 POSTER SESSION**

Wednesday April 25, 2012

Chairperson : Stephen Macko

08:30 – 10:00 **HOW MUCH WATER DO WE HAVE AND WHERE – USING NATURALLY OCCURRING ISOTOPES TO UNDERSTAND THE WATER CYCLE AND MAP GROUNDWATER RESOURCES**
Pradeep Aggarwal
Isotope Hydrology Section
International Atomic Energy Agency, Vienna, Austria

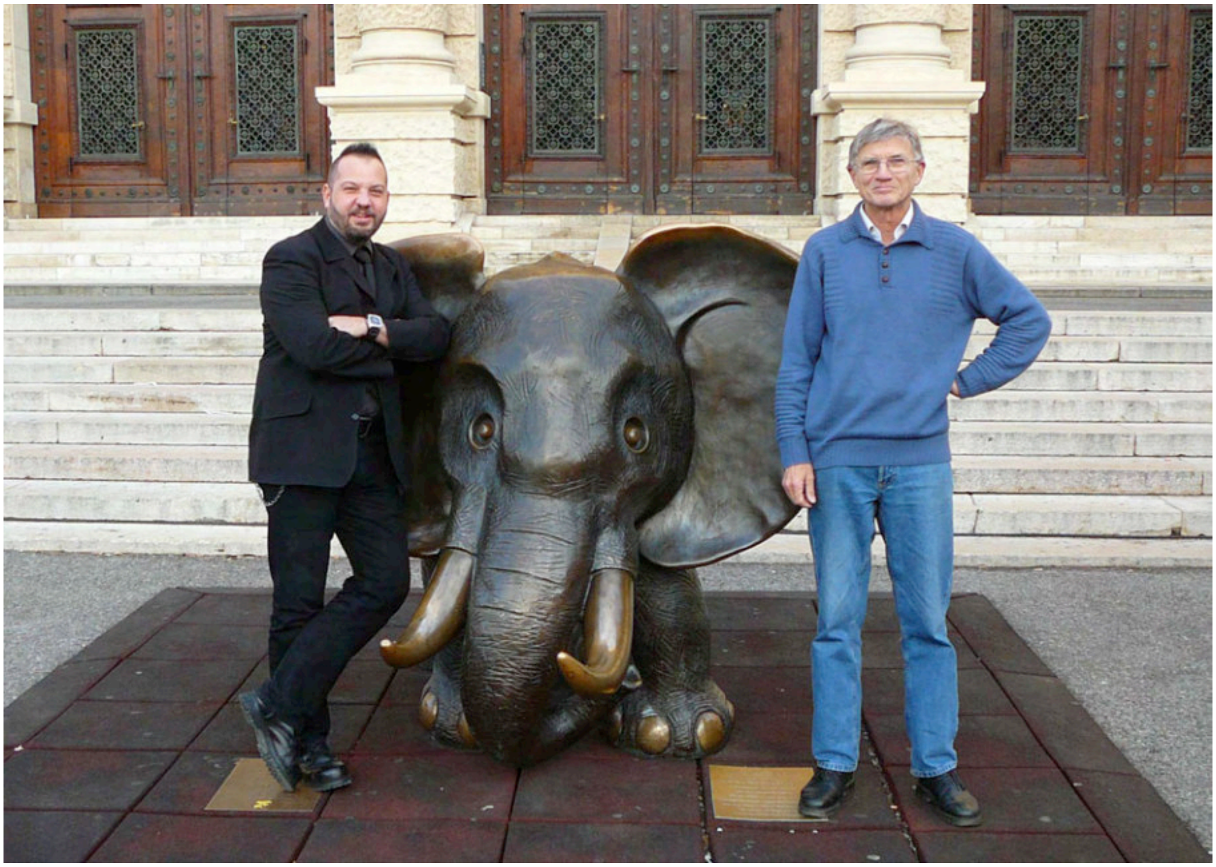
10:00 – 10:15 COFFEE BREAK

10:15 - 12:00 **VISIT OF THE ISOTOPE HYDROLOGY LABORATORY**

END OF THE GIFT – 2012 WORKSHOP

OPTIONAL VISIT TO THE VIENNA WATER TREATMENT PLAN

Speakers



Standing on each side of the bronze elephant (an artwork of the Viennese artist Gottfried Kumpf) in front of the entrance, our two hosts for the visit to the Vienna Museum of Natural History :

Mathias Harzhauser, on the left, Head of the Department of Geology and Palaentology, has earned his degrees from the University of Vienna and has been employed by the NHM after his Master's thesis. His PhD thesis deals with the « Paleoceanography of the Oligocene and Lower Miorece Gastropoda of the Eastern Mediterranean and the Western Indo-Pacific.

Herbert Summesberger, on the right, has earned his degrees from the University of Vienna. His PhD thesis deals with structural geology, stratigraphy and palaentology in the Northern Calcareaou Alps. He has organized several international symposia and is the leader of the Worksing Group on Geosciences, School and Public Relations of the Austrian Geologica Society. Retired since 2004, he is a member of the Board of the Friends of the Museum of Natural History, and organizes exhibitions and seminars for High School teachers. He has also written highschool books and a Vienna city guide for building and decoration stones.

The Museum of Natural History was established during the years 1872 to 1889 by emperor Franz Joseph I. In 1758 Francis Stephen of Lorraine, the husband of Maria Theresia bought the world's most famous natural history collection at his time from Johann Ritter von Baillou and is celebrated as the founder of the museum's collections. This was the basis of one of the largest Natural History Museums of the world equally important as a centre of natural sciences as well as a cornerstone of national education.

The Geological and Palaentological Department has about 20 millions of fossils in its scientific collections, only a small part of them is on display in the exhibition halls. Most important exhibits in the halls are the largest turtle of the world, a fine pterosaur collection and the famous collection of eocene fish from Bolca near Verona (Italy).

Also remarkable is the collection of the Department of Mineralogy and Petrology including famous gemstones and Austrian minerals from the « Hohen Tauern ». The most important specimen on display is the bouquet of flowers made of more than thousand diamonds and an equal number of coloured gemstones. Three easter eggs are made of topaze an citrine by Carl Fabergé, the Russian czar's jeweller. The meteorite collection including a 900 kg iron meteorite from Australia is among the most celebrated in the world. On display is also a piece of rock brought back from the moon by Apollo 17 astronauts.

In the Department of Prehistory several rooms are dedicated to excavations from Austria, dating from the Stone Age to the Early Middle Ages. One of the jewels is the world-famous statuette of the « Venus of Willendorf » dating from about 25,000 years B.C.

.

Address: 1, Maria-Theresien-Platz - Vienna 1010

Prof. Eng. Alberto Montanari
Alma Mater Studiorum – University of Bologna
Email: alberto.montanari@unibo.it
Web site: www.albertomontanari.it

Education
1985-1992: Master Degree studies in Civil Engineering
1993-1996: Ph.D. in Hydraulic Engineering and Hydrology
1997-1998: Post-Doctoral studies in Hydrology

Career
1992-1993: High School Teacher of Mechanical Technology at the IPSIA Lombardini Professional High School of Reggio Emilia (Italy)
1993-1998: Seminal lecturer in hydrology at the Faculty Engineering of Polytechnic of Milan and University of Bologna
1999-2000: Assistant Professor in Hydrology and Water Engineering at the Faculty of Engineering of the University of Bologna
2001-present: Associate Professor in Hydrology and Water Engineering at the Faculty of Engineering of the University of Bologna
2010: habilitated for full professorship
Presently teaching Advanced Hydrology and Water Resources Management, Water Resources Management and River Engineering Works at the University of Bologna

Academic and Scientific Positions
2007-2011: President of the Hydrological Sciences Division – European Geosciences Union
2009-present: Chair of the Union Awards and Medals Committee – European Geosciences Union
2004-present: Editor, Hydrology and Earth System Sciences
2005-present: Associate Editor, Water Resources Research
2010-present: Associate Editor, Survey in Geophysics
2010-present: Associate Editor, Hydrological Sciences Journal
2010-present: Chair of the Research Commission, Department DICAM, University of Bologna
2010-present: National Representative for Italy at the International Association of Hydrological Sciences

Other positions
2005-present: President of the Athletics Federation of the Emilia-Romagna Region (Italy)

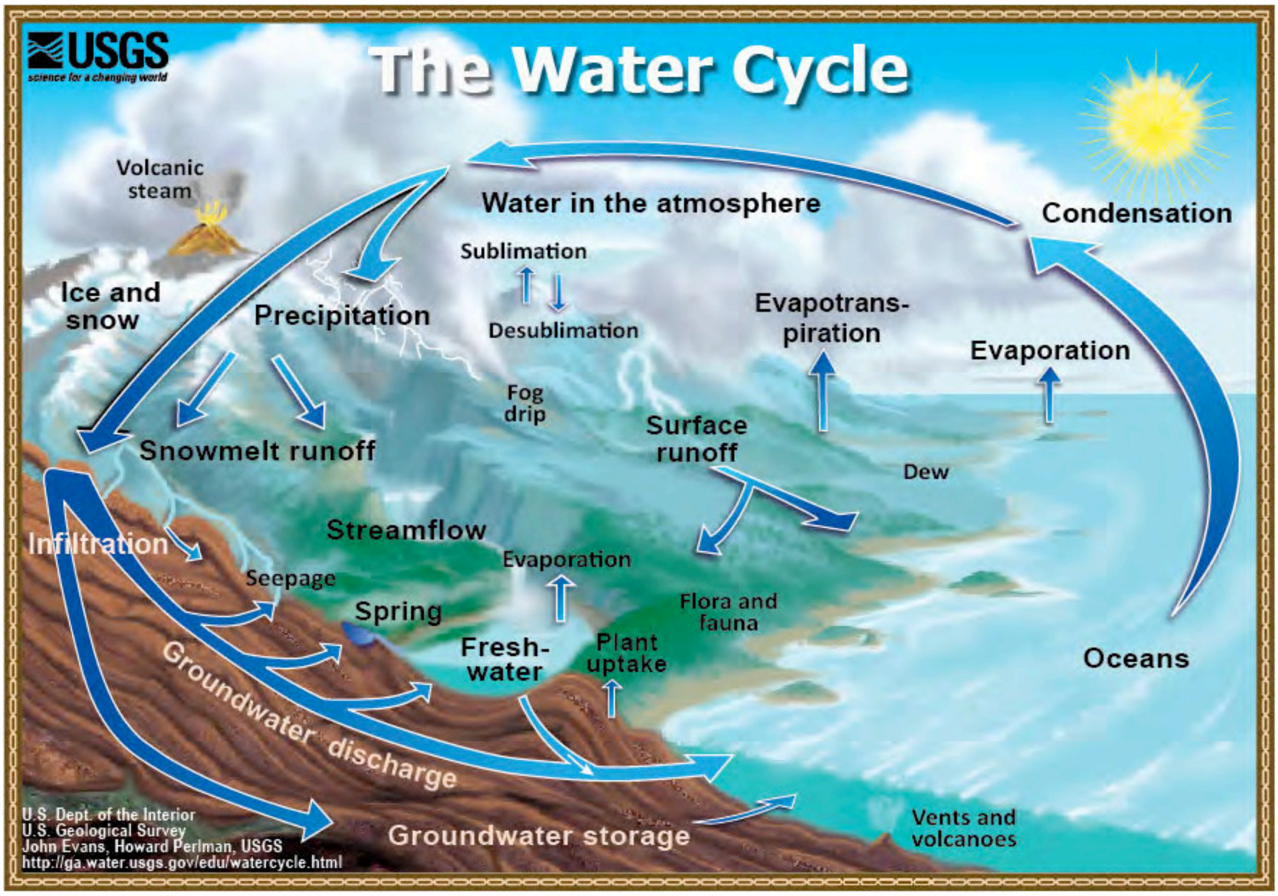
Alberto Montanari authored and co-authored 110 papers on international ISI scientific journals (57 contributions), conference proceedings or book chapters (53 papers) and edited special issues of scientific journals or monographs (8 contributions). Accordingly to the database of the ISI Web of Science Alberto Montanari's papers are currently 54. The total number of citations is 890. The average number of citations per paper is about 16, with a maximum of 94. The H index is 16.
He was invited to delivered 15 featured talks in hydrology at national and international scientific conferences. He was coordinator of two national research projects on Uncertainty

Estimation in Hydrology and coordinator of 12 Consulting Projects funded by Public Administrations, Water Managing Agencies and Professionals in Italy.

The Exciting Travel of a Drop Along the Water Cycle

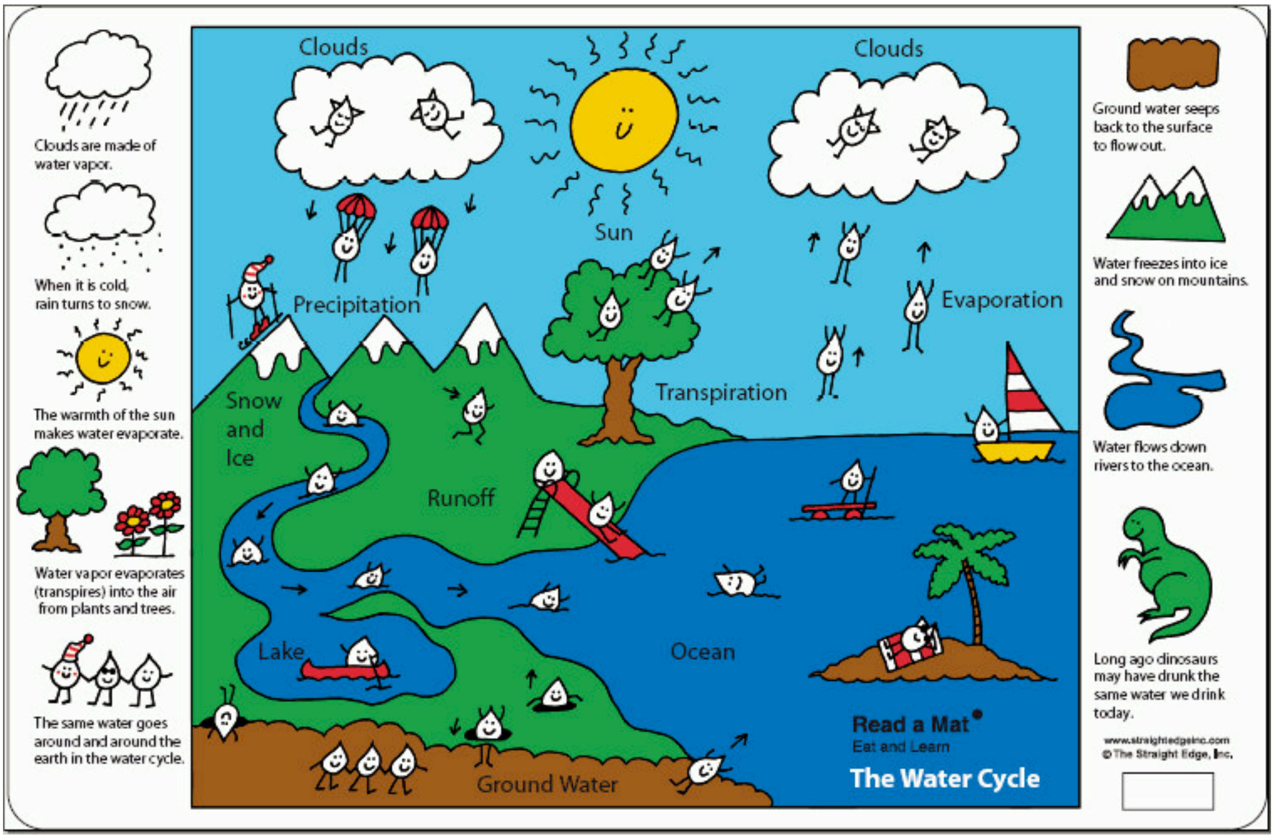
Alberto Montanari
University of Bologna ,
Bologna, Italy

We believe we are familiar with the water cycle. In fact, we were taught its basic principles in our childhood already. We also know that the world is experiencing water problems, related to water shortage, pollution and security. However, the truth is that humans still do not know what actually happens to a rain drop after it landed on the earth surface. We can see the final results of rainfall occurring, because we observe water in rivers, lakes and sea. But how a drop actually reaches such water bodies is still a mystery. This is one of the reasons why floods and droughts are difficult to predict and manage, and water resources management is still a challenge.
Hydrology is the science of the water cycle and hydrologists try to improve our knowledge of the travel of water through the earth system, for the sake of improving scientific understanding and supporting water resources engineering and water resources management.



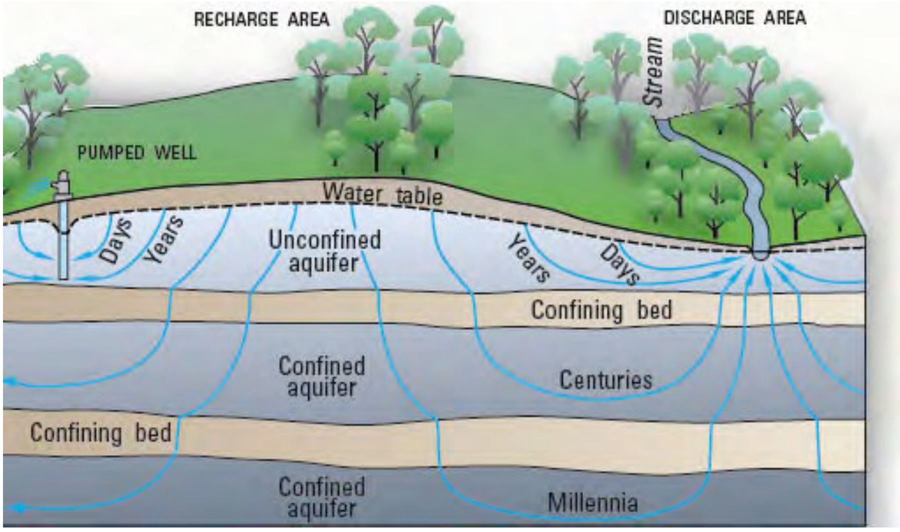
From: http://ga.water.usgs.gov/edu/watercycleprint.html

The water cycle is a circular trip that can be started everywhere. Classical hydrology assumes that the trip begins from the clouds, after water has condensed to form a drop. Earth's gravity pulls the drop down to the surface, but once it starts falling there are many places for the drop to go, depending also on wind direction. The drop can land on a leaf in a tree, in which case it would either evaporate or subsequently fall on the ground under the tree. If it evaporates, it heads to the clouds again. If the drop falls on the ground it starts moving downstream by flowing either on the earth surface or underground. Actually, how rain separates between surface water and groundwater is not fully known. Human action is likely to modify the trip of the drop through, for instance, river diversion, river flow withdrawal or groundwater pumping. Most of the human-used water is sprayed on crops, from where it mainly evaporates, therefore originating the so-called "blue-to-green flow diversion". Only a small amount of water is utilized for civil uses, therefore ending up in house water taps and other civil destinations. From these places the drop is likely to reach a sewer system, then a water sanitation plant and finally a receptor water body, from which it travels towards the ocean, to be ready to evaporate back in the sky.



From: http://ga.water.usgs.gov/edu/watercycleplacemat.html

River water is more convenient for human exploitation than groundwater because it does not need pumping. However, often there is the problem that river water availability does not match the water demands, and therefore humans started to build dams to store water when not needed, to be used during water scarcity.



Time scales of groundwater flow.
From http://ga.water.usgs.gov/edu/watercyclegwdischarge.html

Therefore, human activity induces river and groundwater depletion and is responsible for water degradation and pollution. There is a limit to the amount of water that can be used by humans without substantially compromising the quality of the environment. Estimation of such limit is needed if we want to make our societal development sustainable.

The above explanation clarifies the relevant role that humans may play in the water cycle. In fact, the study of the two way interaction between humans and water is ranking high in today's research agenda of hydrologists and social scientists. Humans are not only water users; they are rather becoming a fundamental part and a driver of the water cycle in many regions of the world.

The above described processes are partly random. In fact, the trip of the water drop in several instances develops by chance. The processes that bring the drop downstream are governed by physical laws, but these latter are however satisfied along several different pathways for the drop itself. Therefore, the trip direction is chosen randomly in many occurrences. It follows that inherent uncertainty affects hydrological processes, therefore limiting their predictability to varying extent. This is an important issue that must be considered when trying to understand and model hydrological processes.

This talk will focus on the travel of a drop along the water cycle and will emphasize what we know, what we do not know and what we guess. We will analyze the distribution of water in the earth and the most relevant challenges for water resources management. An overview will be presented of open research issues and modeling approaches in hydrology. Finally, a vision will be outlined for the future of hydrology and water, which is more and more requiring an interdisciplinary and coordinated research effort.

Information at:
http://water.usgs.gov/
http://water.usgs.gov/droplet/
http://www.albertomontanari.it

Gilles Boeuf

President of the Muséum national d'Histoire naturelle, in Paris.
Full Professor at the University Pierre & Marie Curie (UPMC),
Team UPMC/CNRS "Integrative biology of marine organisms",
Oceanological Observatory (Laboratoire Arago) in Banyuls-sur-Mer on the Mediterranean coast
gilles.boeuf@mnhn.fr

President of the Scientific Board of Agropolis International at Montpellier, since 2009,
Member of the French Commission of UNESCO, since 2010,
Member of the Advisory Board of the CIRAD (Research Centre for Agriculture for the Development), since 2010,
Member of the Advisory Board of the "Protected Marine Areas", since 2010,
Member of the Scientific Board of IFREMER (French Institute for the Exploitation of the Sea) since 2002,
Member of the Scientific Board of Natural Patrimony and Biodiversity at the Ministery of Ecology, Sustainable Development, transports and Housing (since 2005),
Member of the Scientific Board of WWF France, since 2011,
Member of the « Precaution and Ethic » Committee of INRA (National Institute of Agronomical Research) and CIRAD, since 2005,
Member of the Scientific Board of the Scientific Centre of the Sea in Monaco (since 2005),
President of the Natural Reserve of la Massane (Oriental Pyreneans), since 2006.

Education (briefly):
Thesis of University, Faculty of Science of the University Bordeaux 1; July, 1979.
Thesis of State, PhD, Faculty of Science of the University of Brest; February, 1985.
Three years of post-doctorate (on several stays) spent in different Universities in Chile between 1985 and 1998

Research Interests:
Specialized in environmental physiology and biodiversity. He has worked a long time on salmonid fish smoltification and migration and has studied fish development, growth and adaptation mechanisms through experimental physiology and endocrinology approaches. He has worked a lot on biological bases of aquaculture and on biodiversity, both terrestrial and marine. As the President of the National Natural History Museum, he was very implied in 2010, year dedicated to biodiversity, in all the related events, from the Meeting of Unesco in January to the Conference of Nagoya at last October. In 2010 and 2011, he opened the French Conference of Chamonix in May but also presented many talks in France and in the world.

Award:
Ordre National du Mérite (2008)

Summary of Publications (e.g., numbers of publications, H-factor):

More than 380 Publications in the area of environmental physiology, adaptation mechanisms, Fisheries and Biodiversitys. Out of these, 120 are ISI listed publications. More than 2 600 citations as per the ISI data base The H-factor is 30.

Among recent papers:

FALCON, J., L. BESSEAU, S. SAUZET and G. BOEUF. 2007. Melatonin effects on the hypothalamo-pituitary axis in fish.. **Trends in Endocrinology and Metabolism**, 18 (2), 81-88.
BOEUF, G. 2007. Ocean and bio-medical research. **Journal de la Société de Biologie**, 201 (1), 5-12.
MAGNANOU, E., J. ATTIA, R. FONS, G . BOEUF and J. FALCON. 2009. The timing of the shrew: continuous treatment with melatonin maintains youthful rhythmic activity in aging *Crocidura russula*. **PLoS one**,4 (6), e5904, 1-9.
BLONDEL, J., J. ARONSON, J.Y. BODIOU and G. BOEUF. 2010. The Mediterranean Region: biological diversity in space and time. **Oxford University Press**, 376 p.
BOEUF, G. 2010. Quelle Terre allons-nous laisser à nos enfants ? In « Aux origines de l'environnement », sous la direction de P Y Gouyon et H Leriche, **Fayard**, Paris, pp 432-445.
BOEUF, G. 2011. Water, a key molecule for living, water in metabolism and biodiversity. In "Water: the forgotten biological molecule", D. Le Bihan & H. Fukuyama, Eds., **Pan Stanford Publishing**, Singapore, pp 343-360. isbn 978-981-4267-52-6.
BOEUF, G. 2011. Specificities of the marine biodiversity. **Comptes rendus Biologies**, 334 (5-6), 435-440.

Water, a key-molecule for living: water in metabolism and biodiversity

Gilles Boeuf
President of the Muséum national d'Histoire naturelle, in Paris.
University Pierre & Marie Curie (UPMC),
UPMC/CNRS "Integrative biology of marine organisms",
Oceanological Observatory (Laboratoire Arago)
Banyuls-sur-Mer, France

Planet Earth is unique in our solar system, its size and the distance from the Sun allowing crucial significant range of temperature and the existence of both liquid water and vapor water. Solid water, as ice, also exists in cold conditions, mainly near the poles and in altitude but Earth is dominated by land masses between oceans and water vapor above them. Water, mainly represented by seas and oceans, currently covers more than 70 % of the surface of our planet. It offers more than 99 % of the available volume for the living. But such water is salted (average osmolarity of 1000-1100 $mOsm.l^{-1}$) with very strict and constant features. Water is actually the key molecule for the living. Life appeared and developed in water. Living beings are constituted by water. Without water, a land rapidly becomes a desert with very poor and specialized life, or without life. Water is life: take a look at the periphery of a north Chilean desert, which receives rainfall only every 10-12 years. In a matter of days it is covered by flowers (with the requisite cortege of insects!) that last for a few weeks, such a temporary ecosystem returning to its extreme arid state for the next years. So, life emerged in water and is constituted by water!
In the ancient seas, some events were crucial for the outcome of life and biodiversity: 1) the development of the nuclear membrane and the individual nucleus (transition from prokaryote to eukaryote status) around 2.2billion years (Byr) ago; 2) the emergence of multi-cellular organisms and metazoans around 2.1Byr ago, and 3) the capture of surrounding cyanobacteria that would become symbionts and cell organelles such as mitochondria and plastids with their own small DNA, around 2.1 Byr and 1.4 Byr ago, respectively. As well, something exceptional happened in this ancestral sea: the emergence of sexual reproduction, which would turn out to be extremely important for the development of biodiversity. The second great event in the same way was the getting out from the oceans, 450 million years ago for the animal metazoan organized life. Differences between life in water and in air are extremely strong (table 1), a lot of physical facts being essential, as fluid density and viscosity, thermal capacity, oxygen content, *etc.* and of course the presence/absence of aquatic system. Water is the universal biological solvent and organism water content may fluctuate from 60 % up to more than 98 % in some aquatic species (4 % or less for resistance forms, seeds in plants, anhydrobiosis stages in animals). Confronted to the physical osmosis law, animals developed during their evolution two strategies in terms of regulation of water and ion exchanges: isosmotic intracellular regulation (body fluids osmolarity is the same as in external water in sea water, SW, and brackish water, or a little higher in freshwater, FW, from the beginning in most groups and anisosmotic extracellular regulation (body fluids osmolarity is maintained in a narrow range, 250-350 $mOsm.l^{-1}$, not depending on the external water salinity) in a few arthropods and most vertebrates (Fig 1 and 2). If animal life emerged accidentally from the ocean to conquest lands, in several areas, under several forms, at several moments, only a few groups have been able to do it, independently. Water and ions exchanges between intracellular and extracellular media and between body fluids and the external environment are crucial, triggered by osmosis from one part, energetic costly living mechanisms from another.

Numerous new adaptations were developed in plants as well as in animals, because the shift to terrestrial life and air breathing was an exceptional development in the history of Life. After lichens and mosses, new vegetal forms develop roots able to search and absorb water and nutritive elements from the soil, cuticle against dehydration, lignin for the vertical carriage, stomates for transpiration and gas exchanges. The distinction between aquatic and aerial organisms is fundamental for the physiologist. Due to the specific density and viscosity of water, the energy required for ventilation is much higher for aquatic animals: it represents only 1 to 2% of the energetic budget of humans whereas it is 5 to more than 30% for fish, depending on species and conditions. Very oxyphilic species like huge pelagic fish *e.g.* are very high demanders. They are able to reach extremely rapid speeds in swimming (> 130 $km.h^{-1}$). Small animal species draw oxygen from the water by diffusion toward their deepest parts, while larger species (or stages) use gills. Sea water (SW), equilibrated with air, contains approximately 30 times less oxygen than the same volume of air. Aquatic animals maintaining a constant osmolarity cannot develop a very large surface area for exchange (gills) because of the inherent dangers of physical osmotic flow (water and electrolytes): the animal has the risk of losing its water in the salty ocean, or of being "drowned" in freshwater (FW). In fact, fish are constantly subjected to a delicate compromise between developing a maximum surface area for oxygen capture in a poorly oxygenated and changing environment, or a minimum surface area to avoid a severe loss or gain (depending on the environment) of water and mineral equilibrium. Aquatic animals secrete ammonia and the vast majority, as for terrestrial species, cannot regulate their body heat. Terrestrial animals on the other hand face with UV rays, dehydration, different weight-bearing requirements (requiring a heavier and more resistant skeleton and a consequently heavier muscle mass) and have to develop a different type of excreta with little or no toxicity (uric acid, urea). Today, water constitutes more than 60 % of animal bodies. The distribution of body water varies from 60 to more than 90 % depending on the phyla. Total water content varies between 79 and 92 % (extracellular, 6-65 %, intracellular, 27-76 %) for mollusks, and 60 to 81 % (extracellular, 6-65 %, intracellular tissues, 50-57 %, with also extracellular space) for vertebrates.

Today, 12 animal phyla (on the 31 recorded) are exclusively marine, and have never left the ocean (Echinoderms, Brachiopods, *Chaetognatha*, *etc*.). There are only two groups (and no complete phyla) that are exclusively terrestrial: myriapods and amphibians (apart one species). As well, the ocean biomass is considerable: bacteria from the sub-surface of the ocean alone represent 10% of the entire carbon-based biomass on the Earth. The marine environment has therefore played a determinant role in the history of life, and the current ocean preserves its primordial role in biological and climate evolution. Marine and terrestrial diversity are quite different from each other, including FW systems. Among the 1.9 million species described and deposited in Museums, less than 250 000 live in the oceanic environment.

Table 1: major differences between life in water and air (adapted from Willmer *et al*., 2000)

Property	Water/aquatic	Air/terrestrial	Approx ratio water/air
Density	1.00 g/ml	0.0012	850
Viscosity	1.00 kg/m/sec	0.02	50
Thermal capacity	1.00 J/ml/°C	0.0003	3300
Velocity of sound	1485 m/sec	343	4.33
Refractive index	1.33	1.00	1.33
Oxygen content	4-7 ml/l	210	1/30
O_2 diffusion ratio			1/300 000
Carbon dioxide	0.4	46	1/115
Salts	Freely available	No directly available	
Water	Abundant but may be osmotically unavailable	Rare, always hard to find and keep	

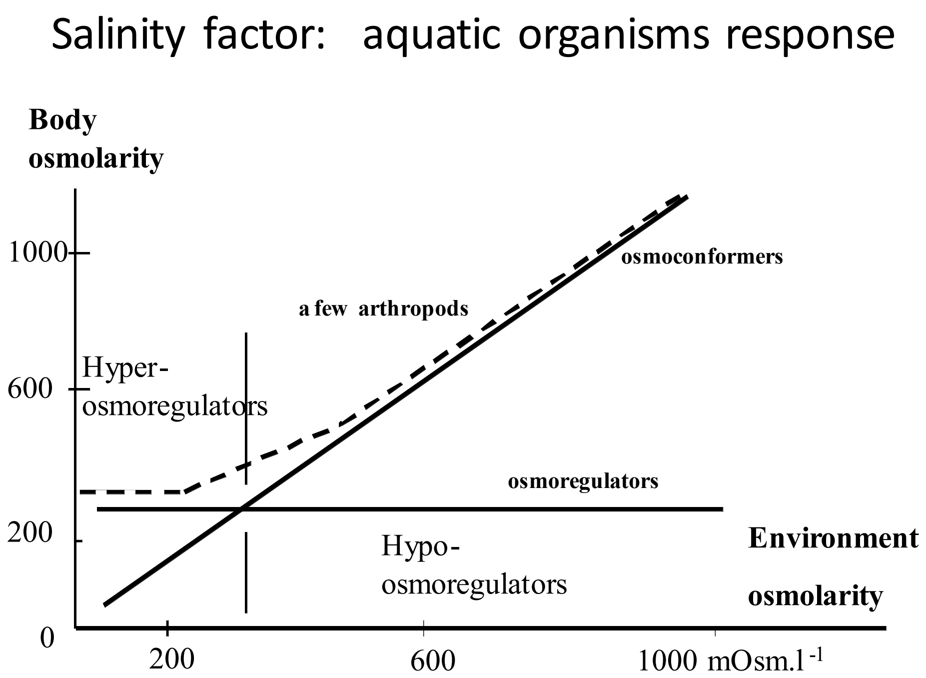


Figure 1: Ionic and osmotic strategies in aquatic animals. Osmoconformers have the same osmolarity as the environment; osmoregulators are independent; a few arthropods (dotted line), *e.g*. crabs, are intermediary, able to maintain an independent osmolarity only in a limited salinity range.

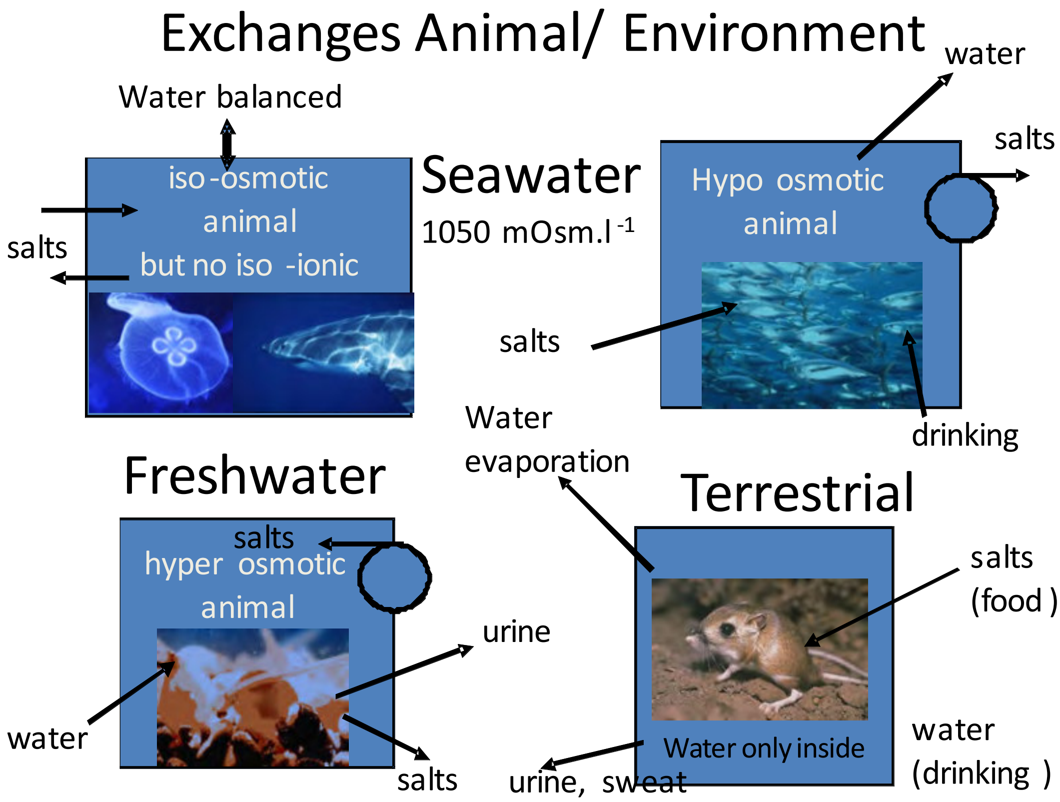


Figure 2: major situations and strategies developed by animals for water and ionic exchanges

In an entire life, a human being needs about 75 m^3 of water only for his physiological needs. According to sex and age, the human water content varies between 60 and 75 % of body weight, females and old people having less water. A new-born is constituted by 75 % of water with extremely fast fluxes between different compartments.

One of the most worrying problems, humans are facing now is the lack of good quality water enhanced by the global climatic change. As all terrestrial species, human needs water and cannot live without it. Million persons die every year for lack of water or by drinking polluted water. Water development underpins food security, people’s livelihoods, industrial growth, and environmental sustainability throughout the world. In 1995 the world withdrew 3906 cubic kilometers (km3) of water for these purposes. By 2025 water withdrawal for most uses (domestic, industrial, and livestock) is projected to increase by at least 50 percent. This will severely limit irrigation water withdrawal, which will increase by only 4 percent, constraining food production in turn.

So, we have to highlight how life is totally linked with this apparently so simple and so-abundant molecule, from the general physiology to the intimate functioning of the brain. Tomorrow, wars could be triggered for water. It has been often in the past the most protected resource for many peoples. It is extremely unequally shared and wasted today. Hasn’t water, so vital, became the forgotten molecule?

CURRICULUM VITAE

Murugesu Sivapalan

Professor of Civil and Environmental Engineering & Professor of Geography

Date of Birth: April 19, 1953. Sri Lanka
Nationality: Australian Citizen & United States Permanent Resident
Address: Department of Geography & Department of Civil and Environmental Engineering, University of Illinois at Urbana-Champaign, 220 Davenport Hall, 607 S. Mathews Avenue, Urbana, IL 61801, USA. Phone: +1 (217) 333 2675/1844 Fax: +1 (217) 244 1785

E-mail: sivapala@illinois.edu Website: http://www.geog.uiuc.edu

Education

Ph.D., Civil Engineering, *Princeton University* 1986
M. A., Civil Engineering, *Princeton University* 1983
M. Eng., Water Resources Engineering, *Asian Institute of Technology, Thailand* 1977
B. Sc. Eng. (Hons), Civil Engineering, *University of Ceylon, Peradeniya, Sri Lanka* 1975

Prizes, Awards and Honors

Doctores *Honoris Causa*: *Delft University of Technology, The Netherlands* 2012
Robert E. Horton Medal: *American Geophysical Union (AGU)* 2011
Hydrological Sciences Award (HSA): *American Geophysical Union (AGU)* 2010
International Hydrology Prize (IHP): *International Association of Hydrologic Sciences (IAHS)* 2010
Centenary Medal: *Commonwealth Government of Australia* 2003
John Dalton Medal: *European Geophysical Society (EGS, now EGU)* 2003
Fellow: *American Geophysical Union (AGU)* 2003
Fellow: *Australian Academy of Technological Sciences and Engineering (FTSE)* 2001
Fellow: *Modelling and Simulation Society of Australia and New Zealand (MSSANZ)* 2001
Biennial Medal (Natural Systems): *Modelling and Simulation Society of Australia and New Zealand* 2001
Life Member/Fellow: *The International Water Academy (TIWA), Oslo, Norway* 2000

Other Recognition

Executive Editor: *Hydrology and Earth System Sciences Journal* (European Geosciences Union) 2004–present
Founding Section Editor (Hydrology and Water Resources): *Geography Compass* (John Wiley) 2006-2009
Founding Chair: *IAHS Decade on Predictions in Ungauged Basins* 2002–2005

Employment Record

August 16, 2005 – to present **Professor of Civil and Environmental Engineering & Geography**
University of Illinois, Urbana-Champaign

November 23, 1999 – August 15, 2005 **Professor of Environmental Engineering**
Centre for Water Research, University of Western Australia

June 1, 1996 – June 30, 1997 **Head, Department of Environmental Engineering**
Centre for Water Research, University of Western Australia

August 15, 1995 – November 22, 1999 **Associate Professor (with tenure) of Environmental Engineering**
Centre for Water Research, University of Western Australia

September 1, 1988 – August 15, 1995 **Lecturer and Senior Lecturer**
Centre for Water Research, University of Western Australia

July 1978 – June 1981 **Civil Engineer/Senior Consultant**
Rocks & Stones (Nig) Ltd., Ibadan, Nigeria

Research Interests

The main focus of my research is on making predictions of hydrological responses in *ungauged* and *changing* catchments (i.e., catchments devoid of any response measurements) subject to human impacts (climate change, land use and land cover changes), avoiding the reliance on calibration. A basic aim of the research therefore is to understand observed space-time variabilities of and changes in a variety of hydrological responses, including extremes (within and between catchments), across spatial and temporal gradients and interpret these in terms of the underlying climate-soil-vegetation-topography- human interactions.

Water, water everywhere, not a drop to drink!

Murugesu Sivapalan
University of Illinois at Urbana-Champaign

Abstract: *This talk will cover the critical issues underpinning the world water crisis. It will help to gain a good understanding of the causes of the water crisis and why it may yet worsen, analyzing the connections between the size and behavior of human populations and associated freshwater problems, in the context of a changing world, and exploring the avenues left to prevent and possibly reverse the worsening trends. The talk will outline the roles that science and technology can play, but also the critical role that humanity can and should play through changing their attitudes towards sustainable development, valuing both water and nature equally, and exercising leadership and stewardship at all levels: households, communities, cities, nations, and the whole world.*

Earth is the "blue planet", with more than two thirds of its surface covered by water. Yet, the amount of fresh water actually available for human consumption is incredibly small and is becoming increasingly scarce. Even the small fraction of fresh water that is found on earth is very unevenly distributed in space and time, especially in relation to the distribution of human populations. Many parts of the world do not have enough water now to produce food for their growing populations. A lack of access to drinking water and sanitation perpetuates the cycle of poverty and instability.

As population pressures increase on land, invariably we find that humans are beginning to degrade the very sources of water that they drink and use for food production, and in this way they adversely impact water availability. Dams that supply drinking water to cities are in danger of being polluted by nutrient exports from upstream watersheds and heavy metals from industrial sites. Large scale irrigation schemes in many countries, such as India and Australia, are giving rise to land salinization and water-logging, effectively eliminating land from any further production. Elsewhere, in the US, China, India and Egypt, countries are pumping groundwater for irrigation in excess of natural recharge rates. Clearly the world is facing a water crisis, but much of it is self-imposed. It arises through a long and entrenched legacy of unsustainable practices that have their origins, first, in our undervaluing water as a resource and our proliferation of waste, our inefficiencies in water use and our degradation of the natural environment.

The good news is that this crisis of water management need not intensify, and it can be reversed through concerted action at several levels. Water prices must rise in the future, and price structures must include the real costs of water, i.e., the cost of accessing the water, the cost to the environment through the extraction and the cost of any pollution introduced through return flows. Higher water prices will not only encourage all users to use water more efficiently, but also could generate the funds to maintain existing infrastructure and build new infrastructure. Such pricing will also save significant amounts of water to be left in-stream for environmental uses.

The water crisis is really a crisis of water for food. Engineers, managers, politicians and funding agencies have all shown a preference for large irrigation schemes to bring about substantial growth in food production. By contrast, rain-fed agriculture, more than 60% of worldwide food production, does not require major engineering works, and can be handled through small-scale land-use planning and watershed management. Rapid growth in rain-fed agriculture could be spurred through intensive research on crop breeding for rain-fed environments. Since rain-fed agriculture can be practiced with localized water management – harvesting and storing water where it falls – it is very cost-effective.

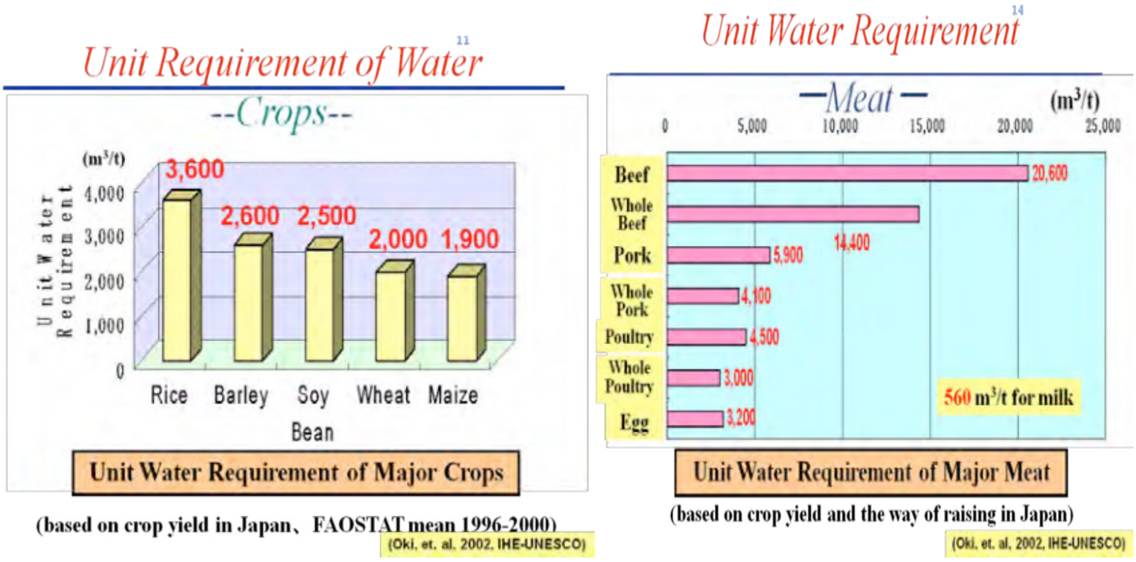


Figure 1: Unit water requirement of water for several crops, and for several types of meat (taken from Oki et al., 2003).

The amount of water consumed in the production process of a product is labeled the 'virtual water' in a product. For example, to produce one kilogram of wheat we need about 1000 liters of water. For meat we need about five to ten times as much! So when we trade goods, especially food products, there is a virtual flow of global water (or across regions) of countries that export food (see Figure 2). Instead of producing this food themselves, and using water for the production of rice or meat, the importing country or region can utilize their water for other purposes. This results in real water savings, relieving the pressure on scarce water resources. Conversely, water-rich countries could profit from the abundance of water resources by producing water-intensive products for export.

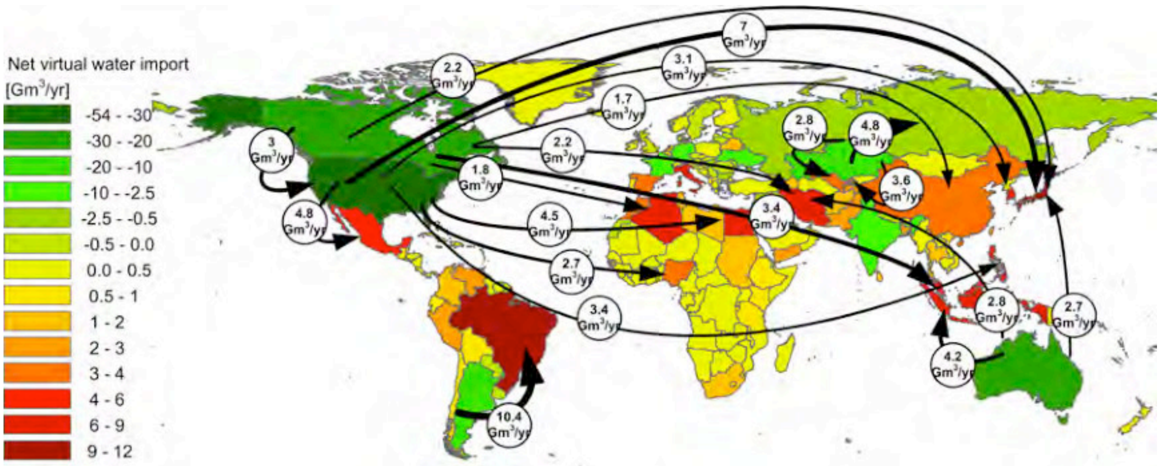


Figure 2: National virtual water balances and net virtual water flows related to trade in wheat products in the period 1996–2005. Only the largest net flows (>2Gm³/yr) are shown (taken from Mekonnen and Hoekstra, 2010).

Global policies on use of water need to build on (i) the equitable pricing of water, (ii) its localized management and control, and (iii) virtual water trade, and must be underpinned by the transfer of rights and responsibilities for operations of water management to communities that live on or close to the land. The biggest problem in arriving at such policies is our lack of information about the magnitude and distribution of accessible water resources, at all levels. Nor do we have good projections on how these will change with future climatic and land use changes. The lack of data is most severe in developing countries of the world. In our current information era, governments are cutting back on routine gauging of hydrological quantities as an unnecessary expense. Water is a billion dollar industry, and there is no justification for not investing a few millions of dollars for monitoring and developing a predictive understanding of the space-time distribution of our most basic and valuable resource. The expansion of the virtual water trade requires not only information on the space-time distribution of water resources across the globe, but also the integration of such information with global and regional economic models to guide inter-regional and international transfers of virtual water.

The way forward is therefore clear – our hopes to prevent, even reverse, the water crisis, requires us to make stark choices, along with associated sacrifices, through raising the price of water and the removal of all subsidies, encouraging the use of rain-fed agriculture and localized water management, investing the returns from higher prices into existing and new infrastructure to increase water supply, new science and technology to increase crop productivity and land and water management, and new schemes to rehabilitate and sustain degraded environments, encouraging the utilization of virtual water trade, and reforming the system of water rights on the basis of equitable allocation of water to different sectors, including especially the environment. These require strong leadership, a global vision, and a stewardship of nature, simultaneously at many levels. This is the most fundamental challenge facing humanity.

References

Mekonnen, M. M. and A. Y. Hoekstra (2010) A global and high-resolution assessment of the green, blue and grey water footprint of wheat. *Hydrol. Earth Syst. Sci.*, 14, 1259-1276.

Oki, T., Sato, M., Kawamura, A., Miyake, M., Kanae, S. and Musiake, K. (2003) Virtual water trade to Japan and in the world, In: Hoekstra, A.Y. (ed.) Virtual water trade: Proceedings of the International Expert Meeting on Virtual Water Trade, Value of Water Research Report Series No. 12, UNESCO-IHE, Delft, the Netherlands.

Prof. Günter Blöschl

Chair of Hydrology and Water Resources Management
Director, Centre for Water Resource Systems
Head, Institute of Hydraulic Engineering and Water Resources Management
Vienna University of Technology (TU Wien)
Vienna, Austria
email: bloeschl@hydro.tuwien.ac.at
www.hydro.tuwien.ac.at www.waterresources.at

Education (briefly):
Senior doctorate (1997)
PhD, Vienna University of Technology (in Hydrology, 1990)
Diploma (Dipl.-Ing.) Vienna University of Technology (in Civil Engineering, 1985)

Research Interests:
Research on Hydrology and earth system sciences, interdisciplinary water sciences, water resource systems, floods and droughts, hydrological modelling, field experiments.
Director of the Doctoral Programme on Water Resource Systems, a multi-year inter-disciplinary PhD programme at TU Vienna on water, focusing on connecting biogeochemical and ecological processes impacting on water quality.

Summary of Publications (e.g., numbers of publications, H-factor):
More than 300 Publications in the area of hydrology and water resource sciences. Out of these, 110 are ISI listed publications. More than 3000 citations as per the ISI data base which are exponentially increasing (almost 600 citations in 2010 alone). Some of the papers are cited in 40 different disciplines. The H-factor is 32.

Recent honours:
Leonardo lecturer: EGU Leonardo conference, Bratislava (2011)
Fellow: German Academy of Science and Engineering, acatech (2010)
Union Service Award: European Geosciences Union, EGU (2009)
Fellow: American Geophysical Union, AGU (2006)
Fellow: The International Water Academy (2003)

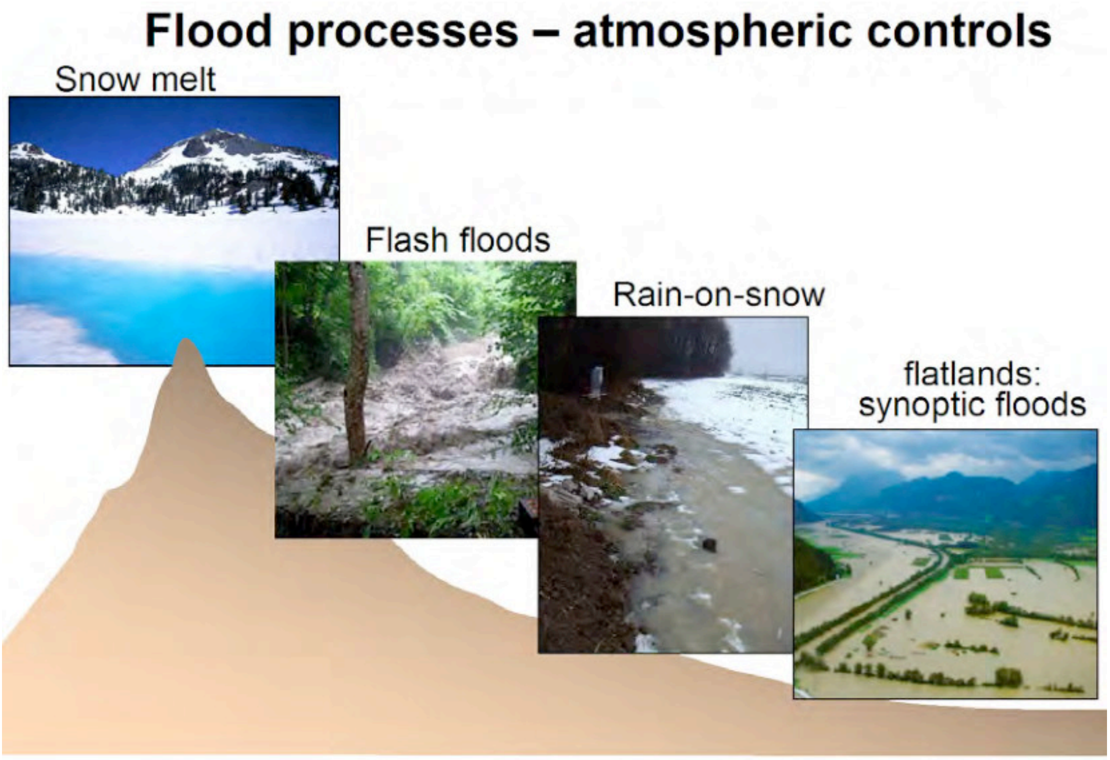
Service to the community:
President Elect of the European Geosciences Union (2012-2013)
President of the Hydrological Sciences (HS) division of EGU from 2004-2008
Established the hydrology journal HESS as an open access journal
Established the Young Scientist Poster award.
Editor: Hydrology and Earth Systems Sciences (HESS) of the EGU (present)
Chair: Alexander von Humboldt Medal Committee, EGU (present)
Chair: Henry Darcy and John Dalton Medal Committees, EGU (past)

Floods in a changing world

Günter Blöschl
Centre for Water Resource Systems
Institute of Hydraulic Engineering and Water Resources Management
Vienna University of Technology (TU Wien)

Floods occur when land that is normally dry is inundated by water. Floods can occur at the coast when an earthquake produces huge waves which we call a Tsunami. Floods can occur in a valley when the dam of a lake or reservoir breaks which we call a dam breach flood. A similar type of flood occurs when a glacier lake bursts, a glacier outbreak flood. Floods can occur at rivers as a result of ice jams, i.e. ice blocking the path of the water which we call ice jam floods. And floods can occur at rivers as a result of heavy rainfall and snowmelt which we call rainfall and snow melt floods. This presentation will focus on rainfall and snowmelt floods at rivers.

August 2005 flood in Tirol, Austria
http://alpinesicherheit.wordpress.com/2005/08/27/hochwasser-2005/



Processes of river floods © TU Wien. www.tuwien.ac.at

Rainfall and snowmelt floods at rivers can be produced by a mix of hydrological processes (see schematic of processes above). In mountainous areas, snowmelt is an important cause of flooding because of warm weather and the sun's radiation. Flash floods are produced by heavy, localised rainstorms (thunderstorms). They occur, for example, in cities and in small catchment areas. A 15 min rainstorm can produce a large local flood in a city. But such a storm does not produce a flood in a big river catchment. For the large catchments (in the flatlands) synoptic rainfall is an important cause, i.e. when it rains over an area of thousands of square kilometres, often during a period of a day or two. Finally, an important mechanism is when it rains on an existing snow pack. The rain on the snow can lead to large floods, eg. in December and January when the soils are wet. In fact, whether soils are wet of dry is very important for whether a given rainstorm (or snowmelt event) actually produces a flood. If the soils are dry most of the rainwater infiltrates and no flood occurs, but if the soils are wet a moderate rainstorm can produce a big flood.

Recently there have been major rainfall induced floods at the rivers around the world and it certainly seems as if they had increased in number and magnitude. The Danube and Elbe flooded in 2002, Floods in Western Austria and in Switzerland in 2005 (see photo above), Central European rivers in 2010, and Australian rivers in 2011. In many catchments the recent floods are much larger than those that have been observed before. The newspapers therefore sometimes report that the floods have indeed increased in recent years. But is this actually the case? Have floods increased in the past decades, and if so, why?

To answer this question one needs to look at what can cause *changes* of river floods. The main, drivers of changes in floods are river regulations, changes in land use and changes in climate.

River regulations: Rivers have been regulated mainly to protect people locally against floods. But this reduces retention area in the flood plain (the area next to the river). Before a regulation, part of the flood waters are retained in the flood plain which lowers water levels downstream. After a regulation there is no such retention, so river regulations can increase the floods *downstream*. The interesting thing is that river regulations help reduce the flood risk at the place where the river is regulated but a couple of kilometres downstream the regulations can actually increase the flood risk.

Changes in land use: When one develops agricultural land into urban land, most of the surface area is sealed, which means the water can no longer infiltrate. Urbanisation therefore tends to increase the flood risk. However, this is a very local effect. It only applies for the small urban catchments, not so for larger river basins. Other land use change effects are changes from forest to agricultural land which may increase erosion. And the erosion in turn leads to a loss in soil and therefore retention volume which may increase the flooding. This is an important effect in tropic and arid regions, but less important in humid regions. There are numerous field studies indicating significant flood increases as a result of deforestation. This is attributed to decreased interception storage in the forest canopy, decreased litter storage on the ground, as well as changes in soil related to infiltration capacity and macropores. Land management (eg. different tillage practices) can also significantly affect flow paths and consequently floods.

Changes in climate: In some years there are bigger rainstorms than in other years. This has to do with our climate system. Some very big rainstorms only occur rarely. For example, some of the biggest floods in the Danube catchment occurred in 1897 and 1899. If rainstorms occur more frequently or with higher intensities one would also expect that the flooding is more frequent or more intense when all the other factors remain the same. We did observe that the weather patterns in Europe have changed recently. This can produce changed intensities and frequencies of storms. It is also possible that in a warmer climate there is a larger number of convective storms. Changes in floods have been found to be correlated with climate characteristics such as precipitation and atmospheric circulation patterns but the exact mechanisms of flood changes due to climate fluctuations are an active area of research.

This talk will discuss the various processes of floods in Europe. It will also discuss what are the possible reasons for changes in floods and the consequences for damage to property and life, and outline ways of minimising the flood risk for all people concerned.

Prof. H.H.G. Savenije

Delft University of Technology
The Netherlands

Email: h.h.g.savenije@tudelft.nl
Telephone: +31 15 2781433

Prof. Savenije studied at the Delft University of Technology, in the Netherlands, where he obtained his MSc in 1977 in Hydrology. As a young graduate hydrologist he worked for six years in Mozambique where he developed a theory on salt intrusion in estuaries and studied the hydrology of international rivers.
From 1985-1990 he worked as an international consultant mostly in Asia and Africa. He joined academia in 1990 to complete his PhD in 1992. In 1994 he was appointed Professor of Water Resources Management at the IHE (now UNESCO-IHE, Institute for Water Education) in Delft, the Netherlands. Since 1999, he is Professor of Hydrology at the Delft University of Technology, where he is the head of the Water Resources Section.

In 2008 he received the Henry Darcy Medal of the European Geosciences Union for outstanding contributions to Hydrology and Water Resources Management.
In 2010 he received the 'Leermeesterprijs' (Master Award) of the TU Delft, which is an annual award for the most distinguished teacher.

Prof. Savenije has published widely in the fields of hydrology, estuary hydraulics and water resource management. Recently he published a book on "Salinity and Tides in Alluvial Estuaries". He is chief executive editor of Hydrology and Earth System Sciences (HESS) and editor in chief of Physics and Chemistry of the Earth. He is the incoming President of IAHS (the International Association for Hydrological Sciences) and was President of Hydrological Sciences of the European Geosciences Union (EGU), and Past-President of the International Commission on Water Resources Systems of IAHS. He has organised several regional and international water conferences, and has wide-ranging experience in Africa, Asia and South America.

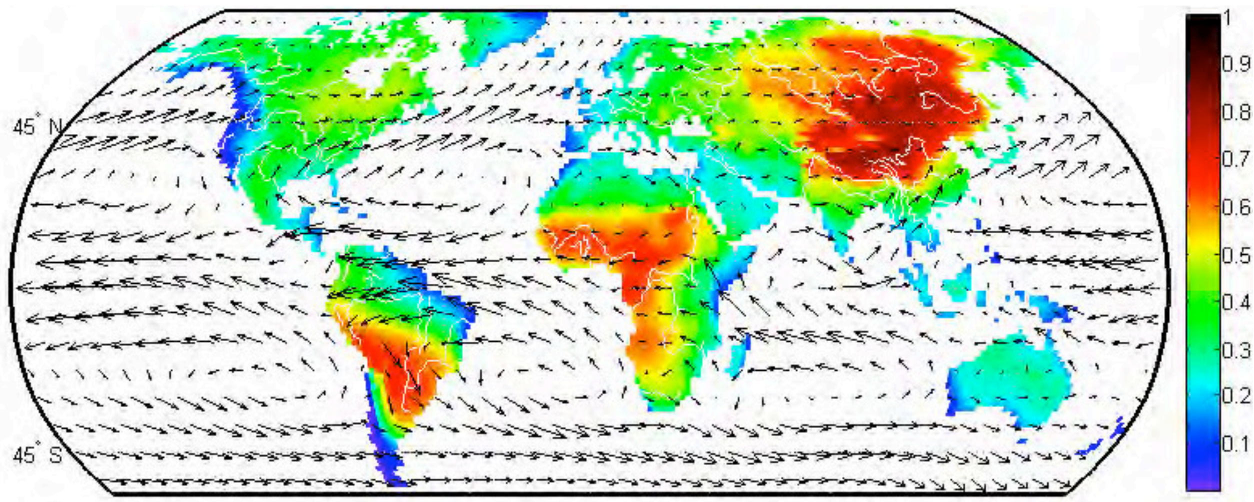
He (co-)authored 145 scientific articles in international journals and has graduated more than 150 MSc students and 25 PhD students in the fields of hydrology and water resources management.

Origin and fate of atmospheric moisture over continents

Hubert H.G. Savenije
Delft University of Technology
The Netherlands

There has been a longstanding debate on the extent to which terrestrial precipitation relies on terrestrial evaporation (moisture recycling). Where does the moisture go that we evaporate, and to what extent does rainfall depend on evaporation from land? In this paper I shall show how important the moisture recycling is to sustain rainfall in different parts of the world. I shall present global maps that indicate regions that rely heavily on recycled moisture, as well as those that are supplying the moisture. An accounting procedure, based on readily available information from ERA□Interim reanalysis data, is used to calculate moisture recycling ratios. We show that, on average, 40% of the terrestrial precipitation originates from land evaporation and that 57% of all terrestrial evaporation returns as precipitation over land. Moisture evaporating from the Eurasian continent is responsible for 80% of China's water resources. In South America, the Río de la Plata basin depends on evaporation from the Amazon forest for 70% of its water resources. The main source of rainfall in the Congo basin is moisture evaporated over East Africa, particularly the Great Lakes region. The Congo basin in its turn is a major source of moisture for rainfall in the Sahel. Furthermore, it is demonstrated that due to the local orography, local moisture recycling is a key process near the Andes and the Tibetan Plateau. Overall, this paper demonstrates the important role of global wind patterns, topography and land cover in continental moisture recycling patterns and the distribution of global water resources. Finally I'll show in which parts of the world land use changes have led to changing rainfall patterns, particularly in vulnerable areas.

This work has been carried in cooperation with my students Ruud van der Ent and Revekka Nikoli. Ruud van der Ent received the Young Scientist Award from WMO for this work.



The colours indicate the percentage of the atmospheric moisture that is of continental origin

Pierre-Philippe MATHIEU

European Space Agency (ESRIN - EOP/SE) –
Earth Observation Science & Applications
Via Galileo Galilei - Casella Postale 64 –
00044 Frascati (Rm) - ITALY
Tel: +39 - 06 941 80 568
pierre.philippe.mathieu@esa.int

Pierre-Philippe received its Master in Environmental Sciences in 1996 from the "University of Liège" (Belgium) and its Ph.D. in oceanography from the "University of Louvain" (Belgium) in 1998.

PP then started to work on the development of advanced data assimilation techniques for integration of satellite data into ocean models at the "Joint Research Centre" (Italy) and the " Netherlands Institute of Ecology" (Holland).

In 2000, PP moved to the "University of Reading" (UK), where he worked as a senior research fellow of the "National Environment Research Council". His main research interest lied in the modelling and prediction of the climate system as well as in the use of climate information to support decision-making. During that time, PP got a degree in Management from the "University of Reading Business School" and worked as a consultant in Weather Risk Management for a small private company.

Since 2003, PP works as an "Earth Observation Applications Engineer" within the "European Space Agency" in ESRIN (Italy). He is in charge of fostering the use of EO information and managing a variety of EO application activities, including energy management, risk assessment, corporate sustainable development, climate change and the "Global Monitoring for the Environment & Security" (GMES).

PP is member of the GEO energy expert group, SCAR/SCOR expert group on oceanography, co-chair of the COSPAR panel on Capacity Building and co-editor of the IEEE "Journal of Selected Topics in Applied Earth Observations and Remote Sensing".

Earth Observation from space: Quantifying Water resources to better Manage them.

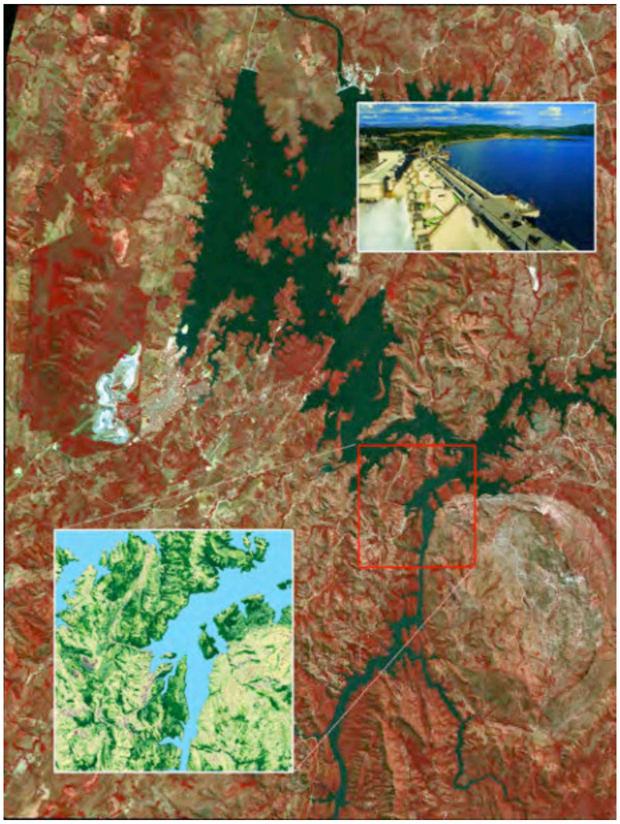
Pierre-Philippe Mathieu
European Space Agency (ESRIN - EOP/SE)
Earth Observation Science & Applications
Via Galileo Galilei
Casella Postale 64
00044 Frascati (Rm) – ITALY

One of the major environmental and societal challenges of the 21st century is to better manage our (limited) water resources. Water is indeed central to many of the core economic, social, and political issues, from the local to the global scale, such as poverty, health, wars, economic and sustainable development.

Better *management* of water requires better *measurement* of its resources and associated stresses (natural and human-induced). It also requires a better understanding of the complex flow of water through the global hydrological cycle and its interactions with climate, ecosystems and human activities.

Satellite can play a key role in this endeavor as they have a unique global view of our planet, providing us with consistent and frequent information on the state of our environment at the regional and global scale.

This talk will present some of the capabilities of current and future satellite missions, in particular from ESA, highlighting the information that can be used to understand the water cycle in a changing climate context and quantify its impact on natural resources. It will illustrate how satellite data can be used to better manage water-related resources (e.g. provision and transport of safe drinking water, irrigation development, hydropower energy), water related-risks (e.g. flood prediction), and better understand the global water cycle and its links to climate and ecosystems. The talk will then discuss the scientific and technical challenges we face to address the water monitoring issues, from building a suitable system to gather, share and make sense of all kinds of water data to better understanding and forecasting of the water cycle.



Land Cover map of the Cana Brava Hydroelectric Power Plant

Snow Cover over the Alps as seen by MERIS onboard Envisat

Mario Rebolledo Vieyra
Senior Scientist
Center for Studies on Water.
Centro de Investigación Científica de
Yucatán, A.C., Unidad Quintana Roo.

Education

- Undergraduate:
    - Bachelor of Science: Oceanology, Facultad de Ciencias Marinas, Universidad Autónoma de Baja California, Mexico. March, 1991.
- Graduate
    - MSc, Seismology, División de Ciencias de la Tierra, Centro de Investigación Científica y Educación Superior de Ensenada. December 1994.
    - PhD. Geophysics, Instituto de Geofísica, UNAM, March 2002. With honors.

Grants and Awards

- Post-doctoral grant, Paris, France, UNAM, Sept. 2003 to May 2004
- Post-doctoral grant, Paris, France, CONACYT, Oct. 2002 to August, 2003
- Alfonso Caso Medal, to the best PhD thesis of the 2002 promotion.
- PhD Grant, Mexico, CONACYT, 2000-2002
- PhD Grant, Mexico DGEP, UNAM, 2001-2002
- PhD Thesis Grant, Mexican Institute on Petroleum, 2000-2001
- Researcher Assistant, to Dra. Joann Stock, Geophysical and Planetary Science Division, California Institute of Technology, 1997.
- MSc Grant, Mexico, CONACYT, Sept. 1991 to August, 1993
- Top Senior, GSA Annual Meeting, San Diego, CA., 1991.
- Teacher Assistant, Marine Sciences Faculty, U.A.B.C., 1988-1990.

Experience

- Director of the Center for the Studies on Water, CICY, A.C., January, 2005 to September 2009.
- Post-doctoral fellow at Laboratoire des Sciences du Climat et de l'Environnement, Unité Mixte de Recherche CNRS-CEA, Gif-sur-Yvette, Francia. October 2002 to April 2004.
- Post-doctoral fellow, Instituto de Geofísica, UNAM, March 2002 to September 2002.
- Chief of the Digital Documentation laboratory of the Core Respository fo the Chicxulub Scientific Drilling Project. December 2001 to March 2002.
- Chief of the Digital Documentation laboratory of the Core Respository fo the UNAM Scientific Drilling Project. 2001.

- Responsible of the Chicxulub Shallow Drilling Project Core Repository, UNAM, 2000 to 2002.

Oceanographic campaigns

- Picasso, Leg 2, R/V Marion Dufresne, IFEP, June, 2003.
- FAMEX, Leg 1, R/V l'Atalante, IFREMER-UNAM, March, 2002.
- Seeps, R/V Atlantis, Univ. Of Oregon, April, 2001.
- Sedimentos III, R/V El Puma, UNAM, April, 2000.
- Plume, Leg 3, R/V Thomas Washington, SCRIPPS-CICESE, July, 1991.

Teaching experience

- Teacher, Marine Geology, Graduate Program, Instituto de Ciencias del Mar y Limnología, UNAM, 2009 to present.
- Teacher assistant to Dr. Avto Gogichaisvili, course: Paleomagnetism and environmental magnetism, Posgrado en Ciencias de la Tierra, UNAM, 2000 to 2001.
- Teacher, Physics, "Curso de Introducción a las Ciencias de la Salud", Medicine School, Universidad Anáhuac, 1999.
- Instructor, Topography, Facultad de Ciencias Marinas, U.A.B.C., 1997
- Teacher, Non-renewable marine resources, Facultad de Ciencias Marinas, U.A.B.C., 1994
- Teacher, Structural Geology, Facultad de Ciencias Marinas, U.A.B.C., 1993

Oceanographic campaigns

• Picasso, Leg 2, R/V Marion Dufresne, IFEP, June, 2003.
• FAMEX, Leg 1, R/V l'Atalante, IFREMER-UNAM, March, 2002.
• Seeps, R/V Atlantis, Univ. Of Oregon, April, 2001.
• Sedimentos III, R/V El Puma, UNAM, April, 2000.
• Plume, Leg 3, R/V Thomas Washington, SCRIPPS-CICESE, July, 1991.

Teaching Experience

• Teacher assitante to Dr. Avto Gogichaisvili, course: Paleomagnetisme and environmental magnetism, Posgrado en Ciencias de la Tierra, UNAM, 2000 to 2001.
• Teacher, Physics, "Curso de Introducción a las Ciencias de la Salud", Medicine School, Universidad Anáhuac, 1999.
• Instructor, Topography, Facultad de Ciencias Marinas, U.A.B.C., 1997
• Teacher, Non-renewable marine resources, Facultad de Ciencias Marinas, U.A.B.C., 1994
• Teacher, Structural Geology, Facultad de Ciencias Marinas, U.A.B.C., 1993

The hydrogeology of the Yucatán Peninsula

Mario Rebolledo-Vieyra
CICY, A,C.
GIFT Workshop, Vienna, Austria, 2012

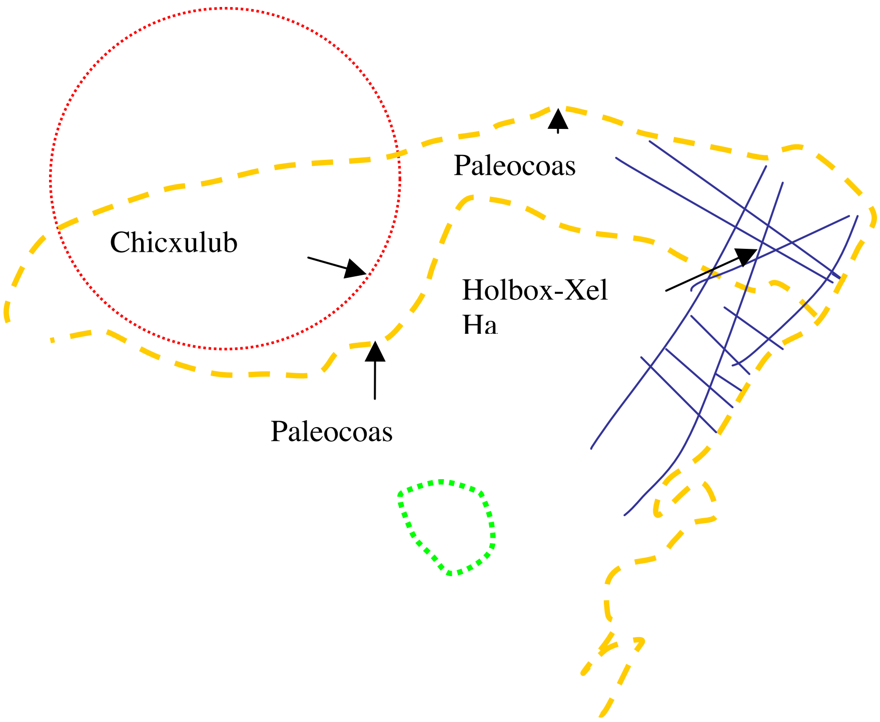
Karstic terrains around the planet have proven to be important water reservoirs. In this contribution we will present a study case in Yucatan, Mexico, to explain the main characteristics of a coastal karstic aquifer: origin, structure and secondary porosity, secondary permeability, hydraulic conductivity, saline intrusion, etc.

The only surface expression of the Chicxulub Impact Crater is a Ring of Sinkholes (locally called Cenotes) (Figure 1). The density of the cenotes varies from several cenotes per kilometer, to several kilometers between each cenote. This ring has a radius of approximately 90 km and it is centered at Chicxulub Puerto. The hydrogeological significance of the Ring was investigated by scientist since 1990. It is not known today whether the Ring of Cenotes is the surface expression of the transient cavity as some authors have suggested, or whether it is the outer rim of the impact structure as other authors have suggested. The center of the ring is approximately coincident with the center of the Chicxulub Impact Crater. Reactivation of K/T rim faults had been suggested by Hildebrand et al., (1991), and Pope et al. (1996) as associated to the formation of the Ring of Cenotes. Several seismic reflection surveys have shown the limits of the Chicxulub impact basin as marked by a system of normal faults. British scientits conducted a seismic experiment that complemented the seismic lines from PEMEX. From their model, we can see that the cenote ring is coupled with one of these fault systems. However, none of these models project such faults to the Tertiary sedimentary sequence; therefore we can only infer that the cenotes are associated to these faults.

Other hypotheses include "post impact subsidence induced by slumping and viscous relaxation in the rim" and "slumping in the rim of the buried crater, differential thickness in the rocks overlying the crater, or solution collapse within porous impact deposits". Some researchers suggested a long duration of subaerial exposure and weathering as a principal reason both for difference in permeability and cenote density inside and outside the Ring. This is consistent with the evolution of surface features reported by Pope et al (1996). While sedimentation occurred in the basin outlined by the Ring, erosion and karst weathering were taking place outside the ring.

Other researchers report that the karst features are associated with gravity gradients, which others interpreted as corresponding to peripheral faults of the buried crater. From this model, we interpret the faults as weakness zones with high permeability. This fault system probably generates a secondary porosity with high permeability that allows the circulation of water, which, in turn, will dissolve the carbonates of the roof and hanging walls of the faults. However, this model implies that the late Tertiary geomorphic feature can retain a memory of a Cretaceous-Tertiary boundary event. The absence of any seismic activity at present, associated to these “active fault zones”, does not support this hypothesis; nonetheless another array of cenotes, that is not related to the ring of cenotes, is the alignment of >100 km long chains of elongated solution depressions locally known as sabanas along the Holbox fracture zone-Xel-Ha zone; these alignments support the hypothesis of the origin of karst features associated to weakness zones in major fractures zones, such as Holbox fracture zone-Xel-Ha zone and the Chicxulub crater rim. Perry et al. (1992) also proposed that a circular reef complex may have formed in the Paleocene sea above ejecta material at the crater rim and that this later became a favored ground-water flow channel; however, no direct evidence supports this model.

The scientific activity, prompted by the discovery of the Chicxulub Impact Crater in the Northern Yucatan Peninsula, covers a wide range of disciplines, from geochemistry and



planetary sciences, to paleontology and hydrology. Today, the Northern Yucatan, is the region with the most hydrologic studies in the Peninsula. The study of the structure and morphology of the crater has allowed researchers to understand the key role of the crater in the Yucatan hydrogeology. Now we know that the Ring of Cenotes, produced by the gravitational deformation of the Tertiary sedimentary sequence within the crater, controls the groundwater in Northern Yucatan. Today, more than half a million persons live within the crater, therefore, understanding the role of the crater on the local hydrogeology and its implication on the management of the aquifer, gives a new importance to continue the studies on the Chicxulub Impact Crater.

Figure 1.- Interferometry radar image from NASA (2000), showing the main topographic features of the northern portion of the Yucatan Peninsula. The southern portion of the Chicxulub crater is correlated with the ring of cenotes, on the eastern portion of the Peninsula, within the Holbox-Xel Ha fracture zone is also correlated with a large number of cenotes.

Literature Cited

Hildebrand, A.R., G.T. Penfield, D.A. Kring, M. Pilkington, A. Camargo Z., S.B. Jacobsen and W.V. Boynton (1991) Chicxulub Crater: A possible Cretaceous/Tertiary boundary impact crater on the Yucatán Peninsula, Mexico, Geology, Vol. 19, p. 867-871.

Perry, E., D.J. Winter, B. Sagar and B. Wu (1992) The Chicxulub structure: Surface manifestation and possible isotope signature. Lunar and Planetary Science Conference, 23rd, Abstracts, pp. 1057-1058.

Perry, E., G. Velazquez and L. Marin (2002) The Hydrogeochemistry of the Karst Aquifer System of the Northern Yucatan Peninsula, Mexico, International Geology Review, No. 3, pp. 191-221.

Pope, K. O., A. C. Ocampo, G.L. Kinsland, R. Smith (1996) Surface expresion of th Chicxulub crater. Geology, V. 24, p. 527-530.

Prof. Dr. Nick van de Giesen

Delft University of Technology
Faculty of Civil Engineering and Geosciences
n.c.vandegiesen@tudelft.nl
P.O. Box 5048, 2600 GA Delft
Netherlands

Since July 2004, Nick van de Giesen has held the Van Kuffeler Chair of Water Resources Management of the Faculty of Civil Engineering and Geosciences. He teaches Integrated Water Resources Management (CT4450) and Water Management (CT3011, 2005). His main interests are the modeling of complex water resources systems and the development of science-based decision support systems. The interaction between water systems and their users is the core theme in both research portfolio and teaching curriculum. Since 1 April 2009, he is chairman of the Delft Research Initiative Environment (www.environment.tudelft.nl).

Before coming to Delft University, he worked from 1998 to 2004, at the Center for Development Research of Bonn University, with as main activity the scientific coordination of the GLOWA Volta Project. From 1994 to 1998, he did Post-Doctoral research on the hydrology and management of inland valleys at WARDA, Cote d'Ivoire. He received his Ph.D. from Cornell University for his work on wetland development in Rwanda. At Wageningen University, he did his M.Sc. in irrigation engineering.

Main research projects

Distributed Temperature Sensing: An important focus of recent research concerns the application of Distributed Temperature sensing (DTS) to water management problems. DTS allows for precise measurement of temperature along a fiber optic cable. The length of the cable may go up to 10 km and temperature will be measured at each meter. Accuracy will increase with the duration of the measurement. For measurements of 30 seconds, an accuracy of 0.1 K can be obtained, improving to 0.02 K for measurements of 30 minutes.

The applications have been numerous, leading to many scientific publications in recent years (see below). The first application concerned groundwater inflow into a small stream in Luxembourg. Subsequent applications include finding illicit sewer connections, finding seepage zones in canals, determining soil moisture content, and determining atmospheric temperature profiles. Important partners are Oregon State University, University of Nevada Reno, and Ecole Poltychnique Fédérale de Lausanne. Regular workshops are organized to help scientists become familiar with this interesting technique (see ctemps.org).

Small Reservoirs Project: This project seeks to develop planning tools for the siting, construction, and management of ensembles of small reservoirs in the Volta basin (Ghana and Burkina Faso), the Limpopo basin (Zimbabwe), and the Sao Francisco basin (Brazil). The basic idea is to determine the optimal density of small reservoirs from a hydrological, marketing, and environmental point of view (see www.smallreservoirs.org).

Monitoring Climate, Droughts and Floods: The Trans-African Hydro-Meteorological Observatory

Nick van de Giesen
Water Resources Management
Delft University of Technology
Netherlands
n.c.vandegiesen@tudelft.nl

Climate variability and change will, most likely, have major impacts in Africa. Droughts are widely recognized to be a major problem in Africa and climate change may exacerbate this burden. Unfortunately, the science base for climate research is very meager. The number of stations that measure climate and weather variables is very limited and not improving. The Trans-African Hydro-Meteorological Observatory (www.tahmo.org) is an initiative to design, build, deploy, and operate 20,000 measurement stations in sub-Saharan Africa. Design follows a set of rules that serve easy deployment and operation, such as absence of moving parts and cavities, self- and cross calibration of sensors, and low cost (€ 200-300 per station). The idea is that stations will be deployed at high schools and that educational material will be developed for the science curriculum. This approach will ensure good social embedding and acceptance as well as help create a generation of scientists and technicians with hands-on environmental monitoring experience. Operation focuses on the long-term financial sustainability of the network. Raw data will be made available for scientific use but value added products will be produced to finance maintenance and operation. The project is still in its early phases of development. Three important parts are distinguished: Design, Operation, and Education.

Acoustic disdrometer

Design
Design of the station is mainly governed by operational requirements. The station should be:

- Robust
- Cheap (<€300)
- Self calibrating
- Cross calibrating

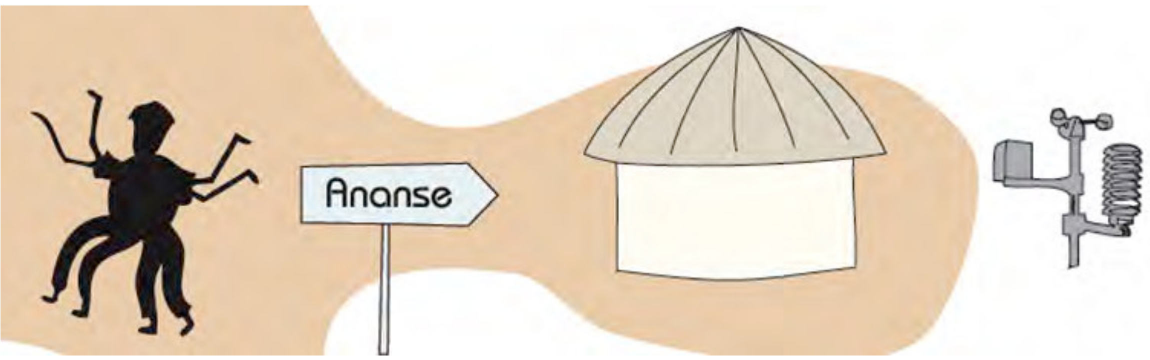
And have:

- No moving parts
- No cavities

The African environment is rather unforgiving due to extreme heat, dust, insects and birds. In addition, the technical infrastructure to maintain weather stations is also very limited. The idea is to make the station sufficiently cheap to simply be able to replace them when they would fail. The average life span should be five years or more.

An interesting first example of a new sensor was the development of an acoustic raingauge (see picture). This raingauge measures the impact of individual raindrops. Because the relation between the terminal speed and size of raindrops is well known, one can derive drop size from the energy in the acoustic signal. The sensor is very robust and has no moving parts. At the moment, this sensor has been tested in Tanzania and Zambia.

Operation
In the 2012 summer, several field trials will take place to test some important aspects of the project. The objectives of the trials are twofold. First, we want to know what problems will be encountered in the field under African conditions of a very robust weather station. Special attention will be given to the impact of insects, birds, and extreme solar radiation. Second, hands-on experience is to be gained with data communication protocols and GPRS availability. In principle, cell phone coverage in Africa is very good and in some ways the services offered, such as micro-payments through SMS, are ahead of services at other continents. Also in remote areas there tends to be coverage but a single provider often does not cover the complete country, causing additional complications in terms of contracts, etc. Network outages and poor signal strength during rainstorms are additional challenges. Finally, although within-country data collection normally is unproblematic from a legal point of view, use and communication of these data outside the country of origin is still often subject to complicated rules and arrangements.



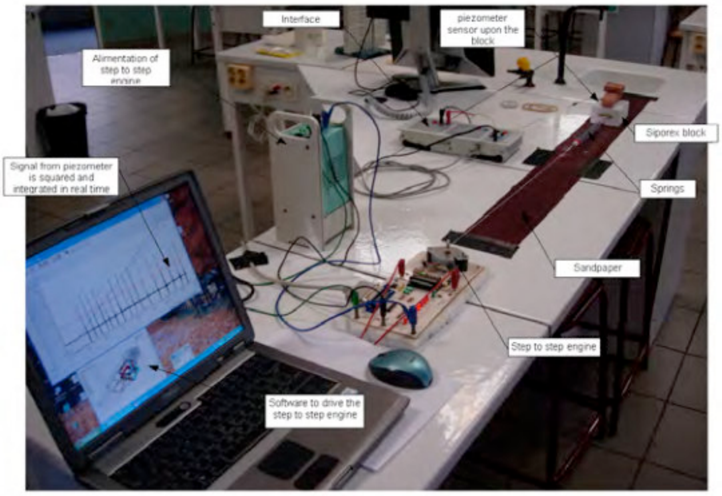
Education
Perhaps most interesting for the GIFT workshop is the educational side of the project, and feedback from the teachers would be much appreciated. In the short term, we try to develop a crowd sourcing activity at African university campuses to support the *Design* part of the

project. More directly relevant is the idea to deploy the stations at high schools. The main reason is to ensure continued functioning of the weather station through good social embedding but the additional benefit would be to educate a generation of students with an affinity for measuring environmental parameters.

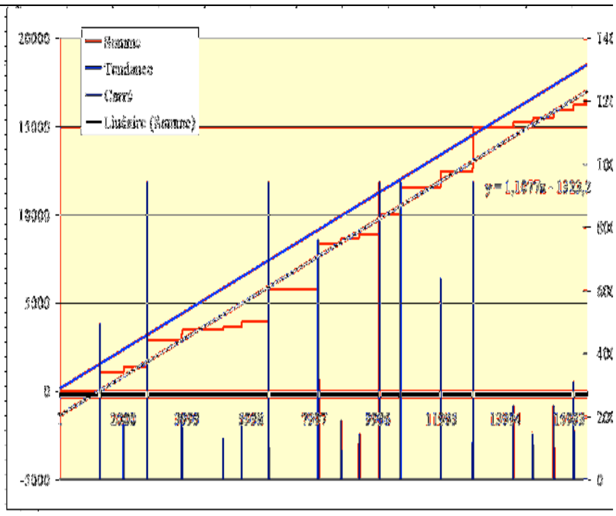
A companion curriculum for environmental sciences would be an important part of the program. A first study was performed at two Junior High Schools in Ghana in 2011 (http://tahmo.org/TAHMO_Report_Miranda_Pieron.pdf). This study made clear that there have to be very direct links between the measurements and the daily context of students and citizens. An interesting dilemma, open for discussion, is that from an operational point of view, one would like to have a monolithic untouchable station, whereas, from an educational point of view, one would like to have a transparent and touch-inviting design. To be discussed during the GIFT workshop would be the question to what extent and how one can combine a robust design with an inspiring educational package.

François TILQUIN
Lycée Marie CURIE
av. du 8 mai 1945
BP 348
38435 ECHIROLLES cedex
FRANCE
francois.tilquin@ac-grenoble.fr

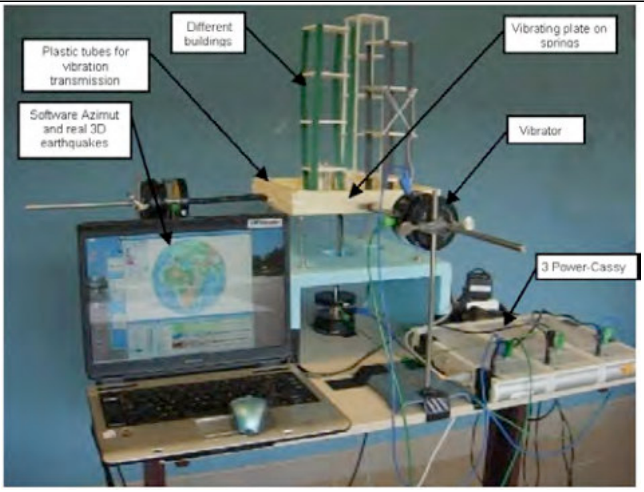
I am a biology and geology teacher in a high school near Grenoble. My students are 15 -18 years old. I am the author of various teaching software and pedagogical applications: data acquisition with interface, simulations, numerical and analogical modeling in biology and geology.



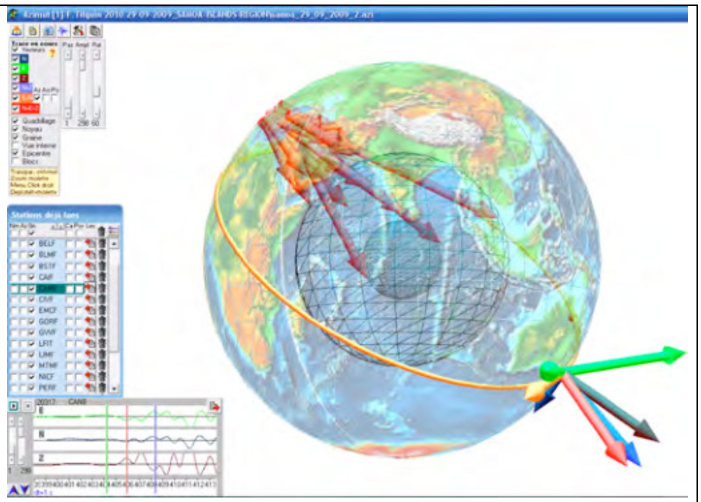
Stick-slip experiments: block is pulled by a small step to step engine. Slipping are recorded by piezometer on block.



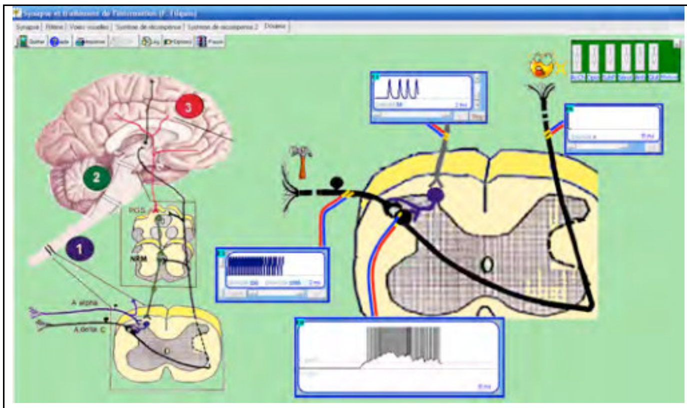
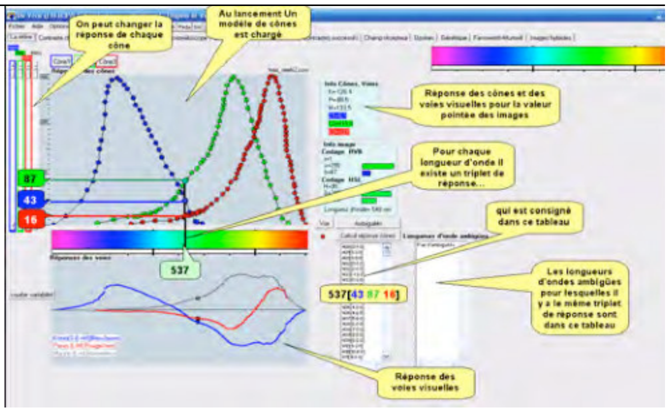
Results of slipping experiment: No possibility to predict neither the moment of slipping , nor the intensity of it.



Pedagogical 3D Shake-table, and cartoon buildings.



Azimut©$_{FT}$ software: 3D vectors of ground's movements

	
Synapse©$_{FT}$ Free software for nervous simulation.	**De Visu©$_{FT\ INRP}$ Free software for the color vision modeling.**

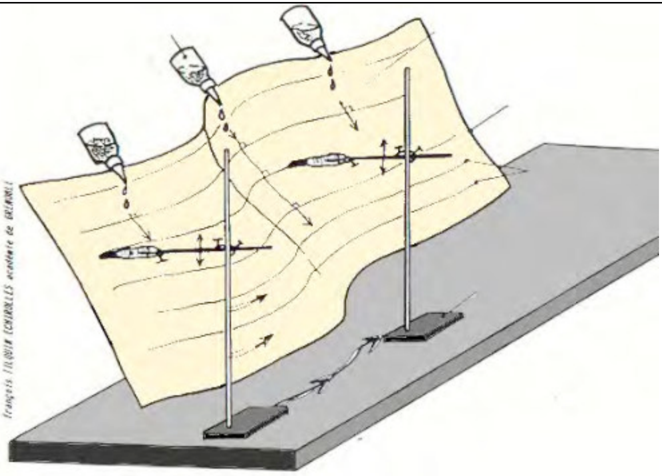
I have created create software in the last 35 years, and my students are the first users of them. These software are free and downloading at http://www.ac-grenoble.fr/webcurie/ft

Piezometric mapping, simulation and modeling underground water

By François TILQUIN
francois.tilquin@ac-grenoble.fr
High School Marie CURIE ECHIROLLES (near Grenoble)

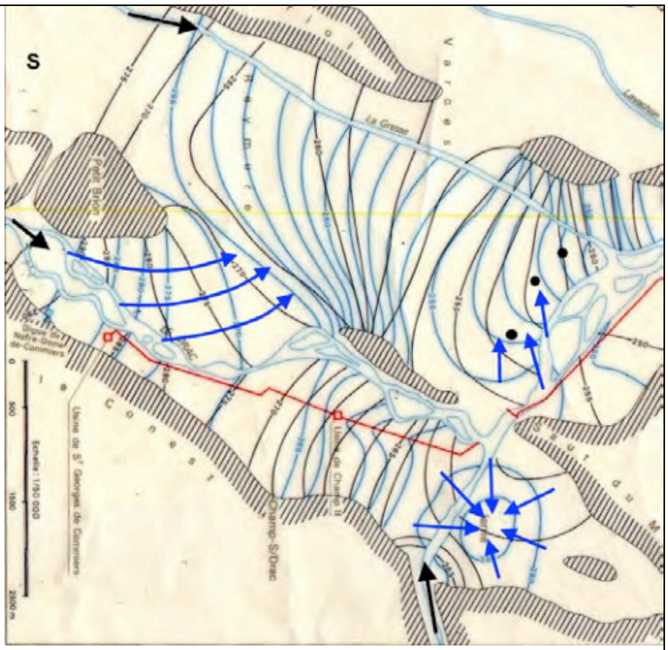
How to build and use a piezometric map

A piezometric map is a tool that shows the underground water surface, built from many wells dug into the ground. It allows drawing underground water flows and illustrates the relationships between surface water and underground water.



Learning how to make a piezometric map.

This classroom experiment shows how to build a piezometric map.
A student holds a piece of cardboard and forms various bends and slopes. This simulates the upper surface of the underground water, which is not horizontal.
The other student draws lines at different heights on the cardboard using a T-square, creating a piezometric map.
Of course the water will flow down slope, but to see how the water will actually flow, the student puts some colored water on the top of the cardboard. The flow pattern demonstrates two principles: water flows from top to bottom and perpendicular to the piezometric contours.



Piezometric map of the Drac river at two different times

The source of the underground water is from the South (left side of map) where the Drac river surface water filters into the alluvium and disappears completely.
This double piezometric map of Grenoble shows underground water before restrictions on industrial use of water (blue lines), and after pumping was restricted (black lines).
The map shows a big pumping cone on the North (bottom-right) of the map and shows the consequences on the piezometric lines just above (middle-right) where the water flows out of the river, toward the pumping station. This is a demonstrative example of the necessity of water management.

Analogue model of underground water

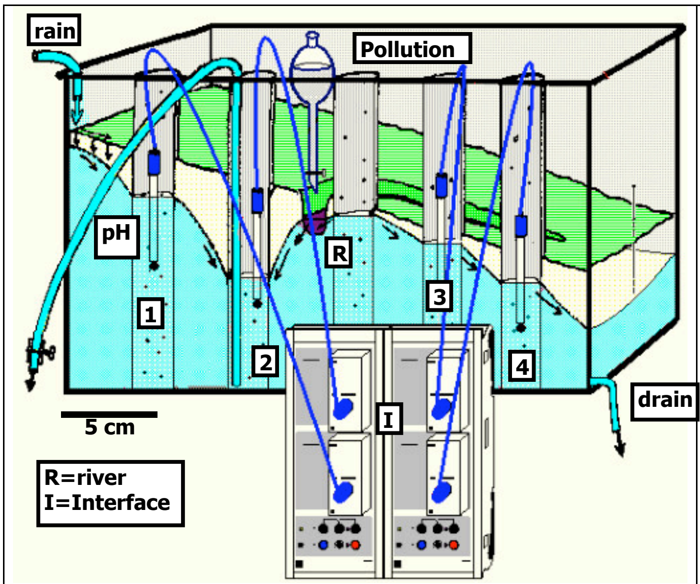
This analogue model is made with a plastic aquarium filled with sand, fed with water at the top-left and drained at the bottom-right. Wells along the front of the tank show the piezometer level.

Students can simulate relationships between river and underground water, origin of the water source, dry or flood periods, relationships between the surface and subsurface topography and geology which highlights the fundamental role of the geology in controlling surface water flow speed and erosion.

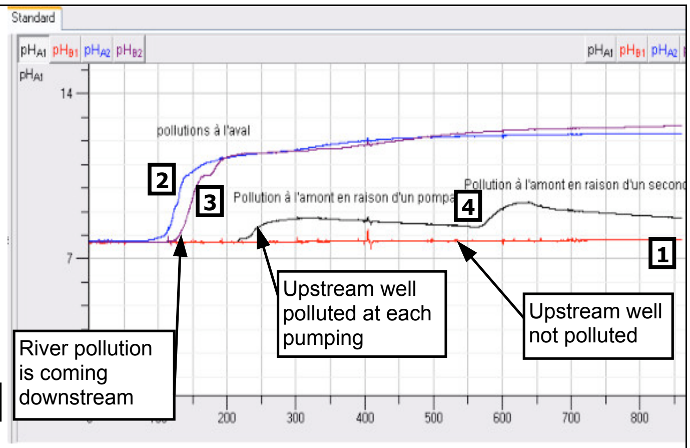
Students can also simulate pollution with soda or hot water. Pollution can be measured with an automatic system or simple sensors upstream or downstream of the pollution and before and after pumping underground water.

Karst streaming can also be simulated with pipes put in the sand.

This model is very easy to make by your self, with an aquarium, plastic tubes cut in half and drilled, silicone glue and sand.



Analogue underground model and system to record pollution.
1-2 upstream well **3-4** downstream well **2**-pumping well



Pollution simulations:
When a river is polluted, contamination flows downstream, but it can flow upstream only after pumping. The upstream well 1 is too far from the pollution source and its water level is too high to be contaminated.

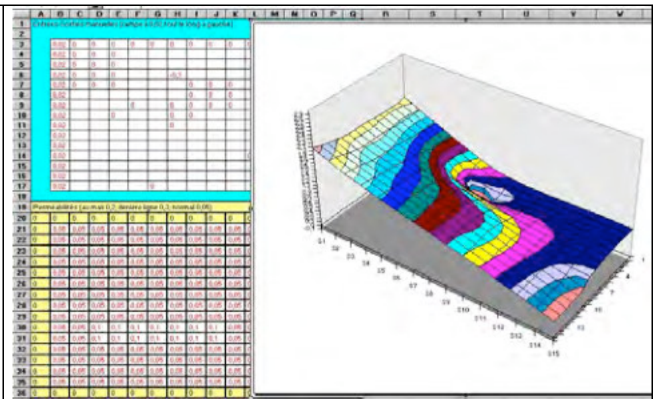
Numeric modeling of underground water

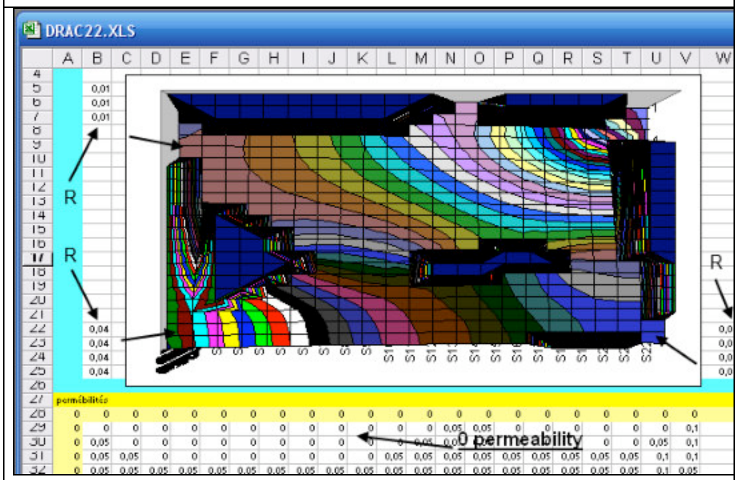
In Excel, the Darcy law is used to show the 3D underground water level.

Students can create their own model with simple equations using sums and products. It is then possible to see the underground water level when it rains or when pumping, to make rivers, or to simulate landscape to see realistic situations.

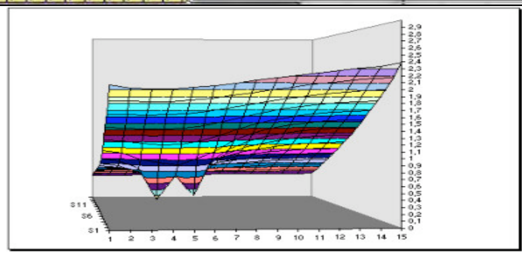
The model is run with 4 arrays: prescribed amounts of water coming in and out, permeability, calculation of water flow, and the water level which is drawn by in Excel in a 3D representation.

Excel draws the water level with colors to create a piezometric map.

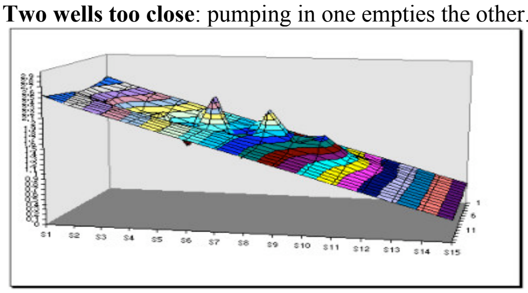




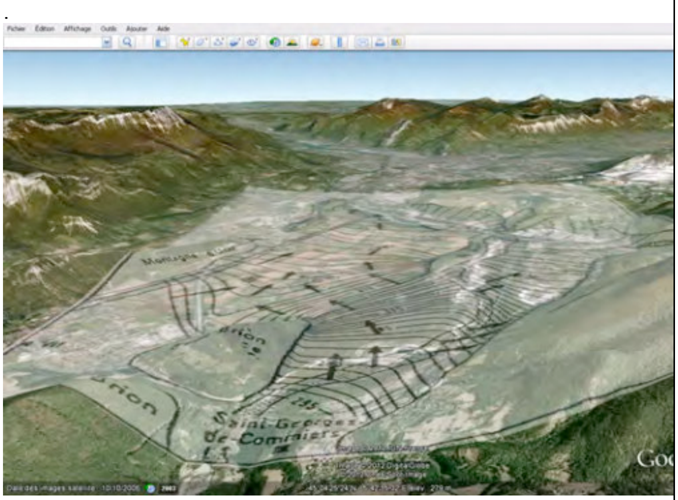
Simple numerical modeling of piezometric Drac underground water. Three rivers (R) are flowing into the model and water is stopped by a zero permeability area. (Mountains)



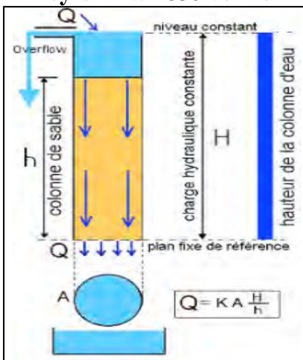
Two wells too close: pumping in one empties the other.

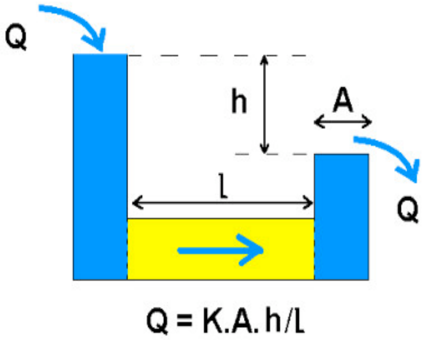


Model's limit: A wave appears when permeability is too high.

 **Piezometric level mapped in Google Earth**. This very pedagogical example is illustrated with the piezometric map and the protected areas overlaid on the image using Google Earth software. Grenoble is at the bottom adjacent to Chartreuse mountain and Vercors mountain to the left.	 **A ground study** shows that the Drac river entirely filters into the bank and the bank's water level is lower than the river water level. The underground water comes from the surface, flows underground and comes out downstream after 1 year just below the pumping station. http://www.ac-grenoble.fr/webcurie/bio/eau/

Darcy's Law 1856 vertical flow (left) **horizontal flow** (right)





Permeability: The Darcy law allows calculation of permeability (**K**) using constant pressure (**H**) and ground height (**h**). The water is added on top and we measure the downward flow (**Q -** a certain volume over a certain time). Students calculate the permeability using the Darcy equation. **A** is the area of tube diameter. Diagram on left.

The Excel model uses Darcy's law to evaluate the flow, **Q,** between 2 points that have different heights. Diagram on right)

Q (m^3/s) = K (m/s). A (m^2). h/l

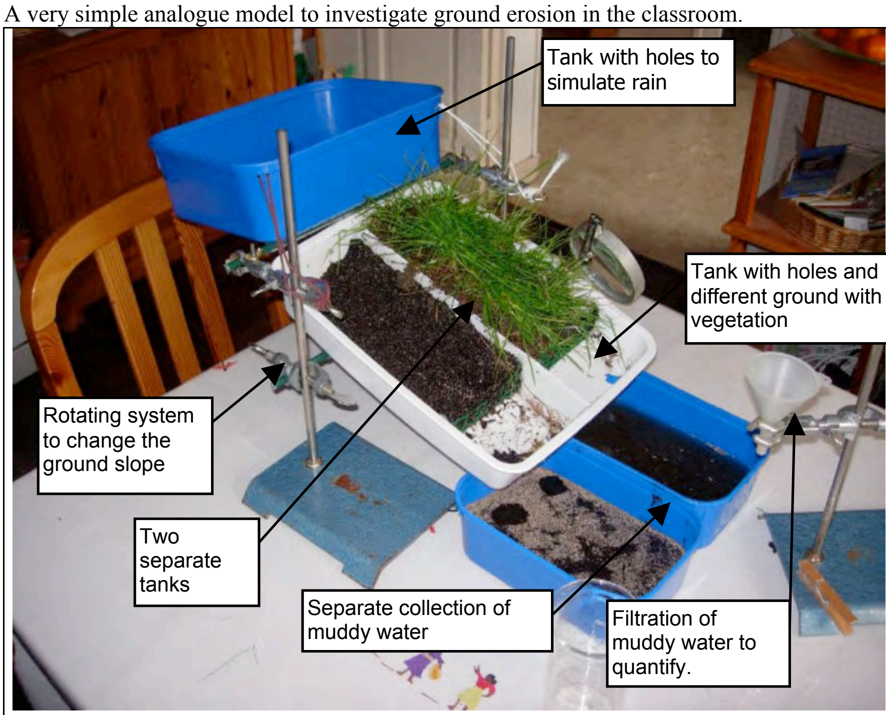
Q is calculated for each case. A and l are constants in the Excel spreadsheet because in this case they are the same.

Source http://www.u-picardie.fr/beauchamp/cours.qge/du-7.htm

Surface water and underground water

The "Erosiotron":

A very simple analogue model to investigate ground erosion in the classroom.

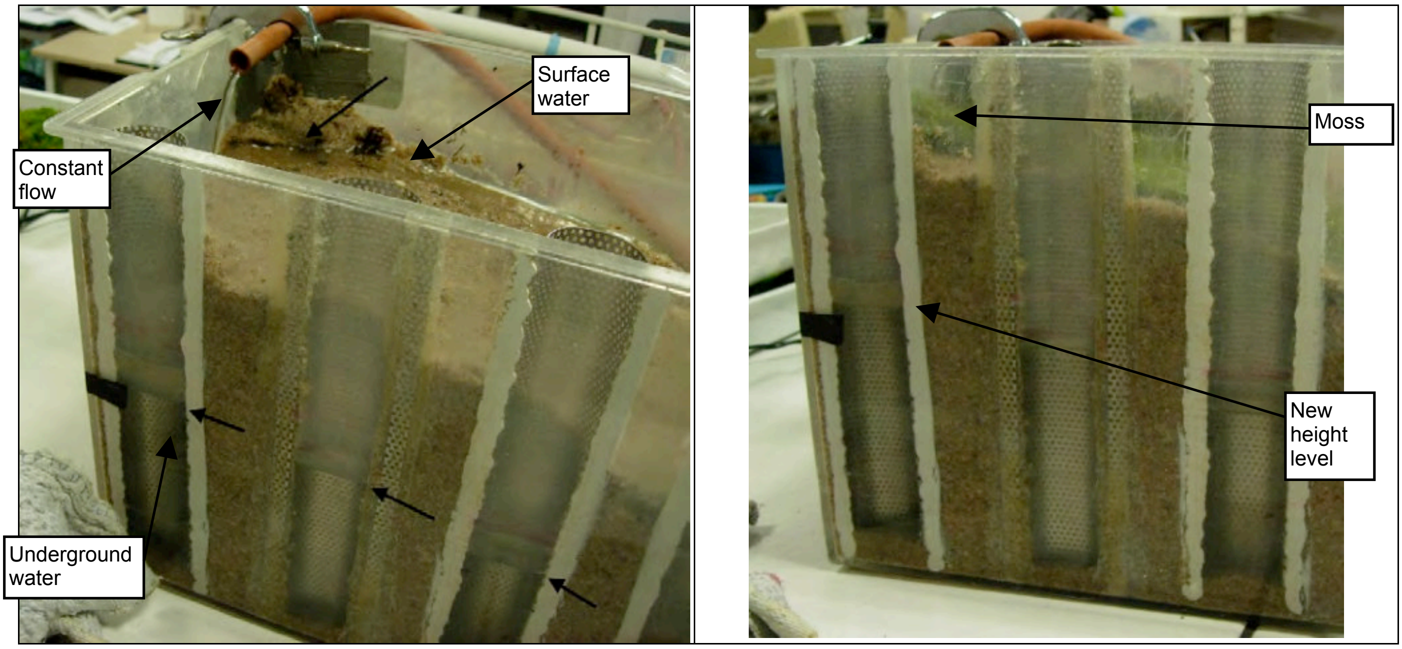


This analogue model allows investigation of ground erosion, and it is possible to change erosion parameters such as rain volume, rain flow speed, ground slope, vegetation cover, and different systems for preventing erosion.

Result after decantation

Relationships between surface water and underground water

The following experiment shows that if we decrease surface flow, erosion is limited and the underground water is protected. The experiment protocol consists of using a constant flow in the analogue underground model until a dynamic balance is set. We mark the water height and we put some vegetation at the surface (e.g. moss). A few seconds later, we can see the increased water level.



Some of the surface water filters into the ground and becomes underground water.
Vegetation cover and slow surface water flow favors underground water accumulation.
http://www.ac-grenoble.fr/webcurie/bio/sol/

Dr. Annegret Schwarz

annegret.schwarz@online.de

School:
Gymnasium an der Stadtmauer
Hospitalgasse 6
55543 Bad Kreuznach
Germany
http://www.stamaonline.de

Activities:
- Head of the German highschool (Gymnasium, grades 5 – 13)
- geography teacher, PhD in geography
- before:
  Secretary for Education of Sustainable Development at the Federal Department of Education and Cultural Affairs in Mainz, Rhineland-Palatinate,
  Regional Adviser for Geography teachers of secondary education

Water Footprint – Education of Sustainable Development in Class

We use lots of water every day, for drinking, cooking and washing, and even more for producing things such as food, paper, or cotton clothes. The water footprint is an indicator of the water use. It looks at both the direct and indirect water consumption of a consumer or producer and measures the total volume of freshwater that is used to produce the goods and services. The amount of water that is embedded in food or other products is also called virtual water. It is a global issue that affects us all. The developed nations are the largest global importers of virtual water. Hence, it must be in our interest to provide clean water access to all people on this planet.

Facing today's global challenges, Education of Sustainable Development (ESD) helps students to explore the concept of global interdependence by investigating the origins of the foods they eat. Students will recognize the fact that many of the foods they eat, and the ingredients that go into making them, are produced in other countries. This supports the capacity of students to make judgements and choices in favour of a safer, healthier and more prosperous world, thereby improving the quality of life in general. This learning process can provide a critical reflection and greater awareness, which might lead to a change of lifestyle, including the patterns of consumption and production.

Dr. Phil Smith, MBE

http://www.tsn.org.uk/

Coordinator,
Teacher Scientist Network (TSN)
John Innes Centre,
Colney Lane,
Norwich,
UK
NR4 7UH

phil.smith@bbsrc.ac.uk

Activities:
Dr. Phil Smith has for the last 9 years run a highly successful independent science education charity, the Teacher Scientist Network (TSN), that works closely with science teachers across Norfolk in the East of England. TSN is recognised as an exemplar activity lining the science and education communities.

Trained as a plant pathologist with a specific interest in fungal diseases of cereal crops, Phil started engaging with schools during his PhD. This led to a highly successful partnership with a primary school teacher which continued after Phil 'hung-up' his lab-coat. Phil regularly runs courses for teachers and coordinates the Networks activities which all focus upon linking real science with the school community. Phil received an MBE, a national order of merit, for services to science education in recognition of both his own science communication endeavours and those of TSN as a whole in Summer 2008.

Hands-on Activities - Water

Water is a great resource for working with in science lessons: usually cheap, safe and abundant. Our practical session will look at the importance of studying and understanding where Water comes from, its uses and the issues of water scarcity and water quality in a changing climate set in the context of living more sustainable lives. Some international Water programmes will be highlighted.

PRADEEP K. AGGARWAL

Isotope Hydrology Section
International Atomic Energy Agency
Wagramer Str 5
Vienna, A1400, Austria

Dr. Aggarwal was born and born and raised in New Delhi, India and acquired a Bachelor's degree in Geology at the University of Delhi in 1976.

He then moved on to the University of Roorkee (now Indian Institute of Technology). Roorkee is located about 100 km north of New Delhi and has been a center of higher education in engineering since mid-1800s. Dr. Aggarwal acquired a Master's degree in Applied Geology in 1979 at Roorkee and was awarded a University Gold Medal.

He carried out his doctoral studies in geology at the University of Alberta in Edmonton, Canada from 1980-1985 and earned his Ph.D. degree in 1986.

While his educational background was related to mineral deposits, he chose to pursue a career in the geochemistry of hydrogeological systems and moved to to the US Geological Survey in Menlo Park as a visiting scientist in 1986 to develop a computer program for the geochemical modelling of water-rock interactions in sedimentary basins. This program - SOLMINEQ.88 - was written as a collaborative effort between the Alberta Research Council and the US Geological Survey. SOLMINEQ.88 is a useful tool particularly for higher temperature and pressure systems and is still used for understanding geochemical issues related to, for example, oil field brines, secondary recovery of oil, and carbon dioxide sequestration.

Following this brief assignment at the US Geological Survey, he took a position in 1987 with the Battelle Memorial Institute in Chicago, Illinois and Columbus, Ohio where he focused on research related to the safe disposal of high-level nuclear waste and remediation of groundwater contaminated with industrial or agricultural products. Using his background in geochemistry and isotope geochemistry, he developed new means of using stable isotope ratios of carbon in soil gas to monitor bacterial breakdown of jet fuel in contaminated soils.

In 1991, he moved to the Argonne National Laboratory in Illinois, USA where he expanded his work on the use of isotopes and geochemical tools to characterize and monitor groundwater systems. Here, he developed a new technique to monitor biogeochemical processes by using the isotope ratios of molecular oxygen in soil gas and groundwater.

In 1997, he accepted a position with the International Atomic Energy Agency in Vienna, Austria and has led the isotope hydrology section of the IAEA since 1999.

How much water do we have and where – using naturally occurring isotopes to understand the water cycle and map groundwater resources

Pradeep K. Aggarwal

Isotope Hydrology Section
International Atomic Energy Agency
Wagramer Str 5
Vienna, A1400, Austria

In this presentation, I will provide an overview of the history of isotope hydrology, its use in understading the atmospheric water cycle (or precipitation), rivers and groundwater systems, and how the IAEA helps strengthen scientific capacity in its member states.

Sustainable development and management of water resources requires an understanding of the prevailing hydrogeologic regimes of surface and subsurface resources and interactions between them. A lack of adequate scientific data on water resources for national assessments of water availability and sustainability has been recognized since the 1977 United Nations Water Conference in Mar del Plata. However, despite continuing efforts of governments and the international community, significant gaps exist in resources assessments, and the problem is particularly acute with respect to groundwater resources even though groundwater provides more than half of freshwater used world wide. One of the important means of acquiring water resource information is through the use of Isotope Hydrology. This is the branch of hydrology that uses stable and radioactive isotopes of water and its dissolved constituents to trace water cycle processes, including the pathways of rainfall and snowmelt to, and hydraulic interactions between, aquifers, lakes and rivers.

Following the discovery of heavy oxygen and hydrogen isotopes (^{18}O, ^{2}H), measurement of isotope contents of water in the 1930s was based on density differences and these measurements indicated significant variations in natural waters. Precipitation and freshwaters were found in general to be depleted in heavy isotopes in comparison to the ocean. The first systematic sets of data on isotopic compositions of oceans and freshwaters were published in the 1950s and confirmed the initial observations. Based on measurements of only 400 water samples from around the world, it was then shown in early 1960s that the hydrogen and oxygen isotopic compositions of natural waters varied along a line of slope eight and this line has become known as the "Global Meteoric Water Line". Possible applications of naturally occurring radioactive isotopes of hydrogen (tritium) and carbon (carbon-14) for dating natural waters, particularly groundwater, were also recognized in the early 1950s.

A worldwide effort to monitor isotopes in precipitation was begun in 1961 by the IAEA and data from this network provided a tool to understand the atmospheric processes responsible for precipitation. Isotopes also helped to characterize the sources and rates of moisture evaporation. Based on these concepts, the isotope compositions of rain in the earth's history, which is preserved in carbonate minerals (in fossil shells, cave concretions and lake deposits), snow and ice (from polar and high mountains), groundwater, and wood, have provided unmatched evidence of past changes in the climate, and help to improve the ability for predicting future climate changes. Similarly, the sources of runoff to rivers can be characterized. The origin of water in runoff and its time lag in a catchment — commonly known as residence time — are important characteristics of river basins which are better defined through the use of isotope data. For groundwater, isotopes provide the ability to document the origin, source, and rate of recharge of aquifers rapidly and at much lower costs. As irrigation depends increasingly on groundwater, and more so on 'fossil' groundwater, the use of isotopes to define the age of water and map the extent of fossil water distribution also becomes more important.