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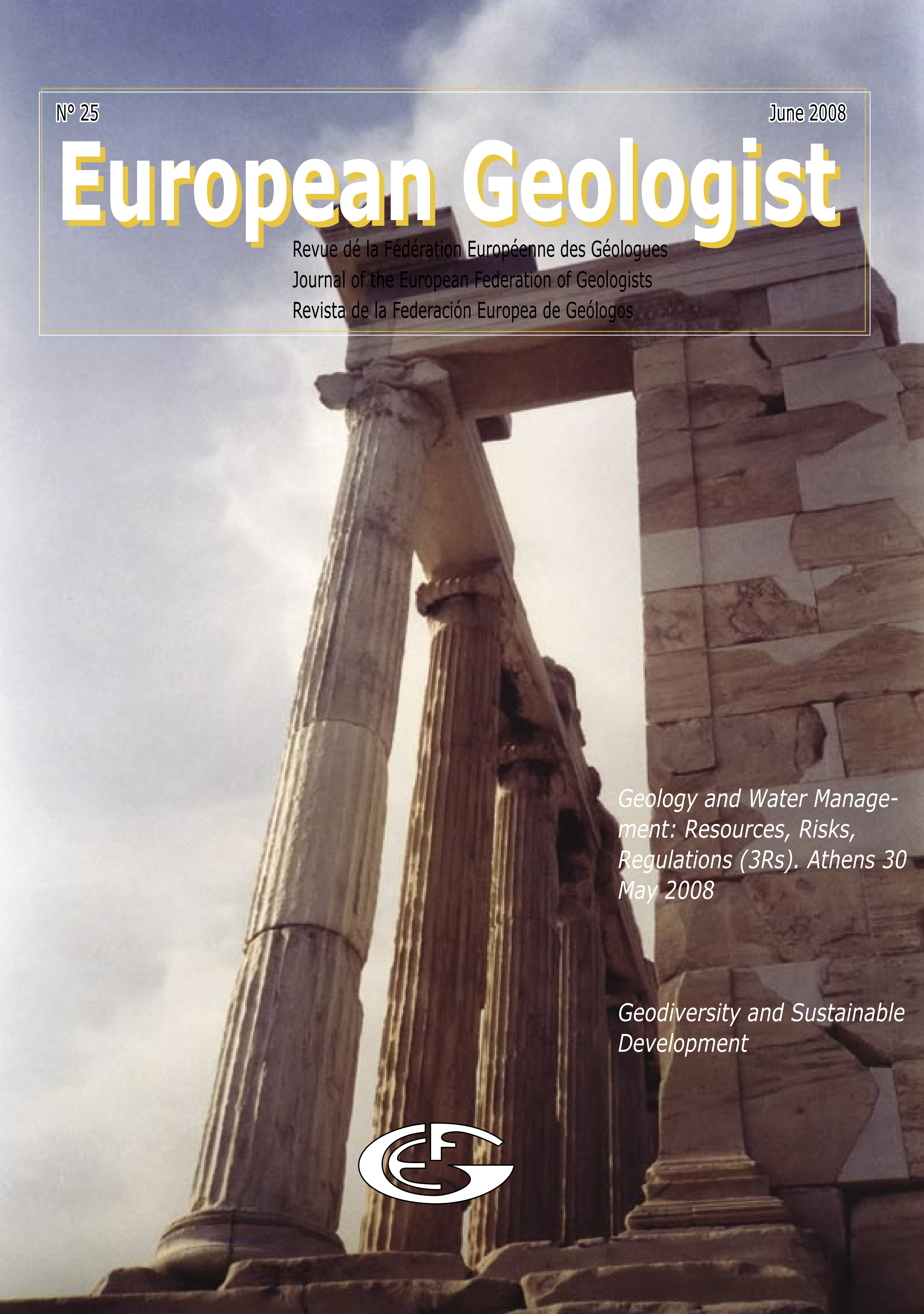

Geology and Water Management: Resources, Risks, Regulations (3Rs). Athens 30 May 2008

Geodiversity and Sustainable Development

EUROPEAN GEOLOGIST

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Foreword

Geology for the citizens of Europe

by EurGeol. Manuel Regueiro, President

Dear reader,

The last time I had the opportunity to address you from this editorial was in 1999, in the 8th issue. Then I announced the creation of the NGO World Geologists, as an EFG reaction to the disasters caused by hurricanes. In those nine years, the extraordinary development of both the magazine and the NGO represent a collective success of which we can be proud.

EG is today our most effective asset, and is also a financially sound product. It is also our binding cement as it physically represents us, and it should be used more by our member associations. The quality of the articles has undoubtedly improved and its objective as the voice of geologists in Europe fully achieved in this last few years. WG is now operating projects all over the world with a budget of over 1M€/year; the teenager has clearly surpassed his father, but a proud father we are.

But let´s look now to our current reality and my vision of the future. When assuming the task of leading the Federation in the coming two years (the International Year of Planet Earth years), I based my programme to develop the current EFG Strategic Agenda on the following points, under a single motto "***Geology for the Citizens***":

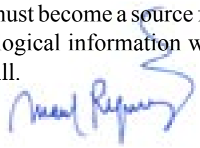
- An outreach and image campaign
- The creation of the World Federation of Professional Geologists
- The promotion of geology and best practices in Europe
- Providing more benefits for EurGeols such as:

--SO 9002 quality assurance system for the EurGeol. titles awarding procedure
--Liability Insurance coverage for EurGeols
--EFG certification of technical projects.

Visibility is a key factor in having influence in Europe. We are now a recognized stakeholder in Brussels and our lobbying ability has been proved by the geological input in European Directives, such as Groundwater, Soil Protection and, recently, Renewable Energies. But EFG is also a frequent attendee at European Exhibitions such as Green Week and the European Union Week on Sustainable Energy. These outreach activities are also important in informing the public about what we are doing.

And another good way of interacting with European policies is of course by participating in EU projects. So far we have been very successful in projects such as Terrafirma, Geotrainet and Argo, as well as in organizing TAIEX workshops, an EU initiative that fits well with our current strategy of pan-European networking in matters of geological interest (see articles, this issue).

But lobbying also needs a new face. We are now preparing the EFG image for the next decade, which will go together with a new web page and new capabilities for that web page, from powerful intranet services for associations and EurGeols, to abundant downloadable material for the general public, including all the geological related legislation of our member associations. We must become a source for professional geological information worldwide. And we will.



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Cover photograph
Pillars of the Acropolis, Athens, Greece. The acropolis is built on a hill of Late Cretaceous limestone, but the great monuments were built using limestone from Piraeus, Aegina, Penteli and the adjacent Hill of the Nymphs.
(Photo: Gareth Jones)

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Geology and Water Management: Resources, Risks, Regulations (3Rs). Athens 30 May 2008

Monitoring water quality: The EuroGeoSurveys' Geochemical Atlas of Europe approach

by A. Demetriades, B. De Vivo, M. Bidovec, A. Lima, S. Pirc, S. Reeder, U. Siewers,B. Smith, S. Albanese, M. Batista, A. Bel-Ian, M. Birke, N. Breward, W. De Vos, M. Duris, P. Gravesen, V. Gregorauskiene, J. Halamic, G. Jordan, K. Lax, J. Locutura, P.J. O'Connor, A. Pasieczna, I. Slaninka, T. Tarvainen, A. Gilucis, P. Hayoz, P. Heitzmann, J. Kivisilla, G. Klaver, P. Klein, J. Lis, A. Mazreku, K. Marsina,P.J. O'Connor, S.Å. Olsson, R.T. Ottesen, V. Petersell, C. Reimann, R. Salminen,I. Salpeteur, H. Sandström, O. Selinus, A. Steenfelt, J. Svecova, and H. Taylor

For Europe's sustainable development, clean and abundant water is just as important as fertile and uncontaminated soil. The Geochemical Atlas of Europe documents the high spatial variability (usually several orders of magnitude) of major and trace element concentrations in stream water. The high geochemical variability reflects predominantly natural conditions (climate, geology, topography, biology), locally disturbed by other influences, such as human contamination. Unknowingly, populations in Europe may be affected by a natural deficiency, excess or imbalance of inorganic elements in surface and ground water.

The EC Directive 2000/60 introduces the integrated river basin concept, the approach used for the Geochemical Atlas of Europe, for the management of surface and ground water. However, the presently proposed methodology of sampling, storage and laboratory analyses, will not produce harmonized data across Europe. Water is the most sensitive and most easily contaminated sample medium. It requires special attention during sampling, storage and laboratory analysis. In order for analytical results to be comparable at the European scale, the same type of trace element-free bottles, filters, and acid for acidifying samples, must always and everywhere be used. Additionally, the same suite of elements must be determined at the same laboratory.

Terrafirma

by David Norbury[1]

Terrafirma is being developed to use radar satellite technologies to measure and monitor terrain motion with the aim of saving lives, improving safety and reducing economic costs across each country of the EU25. InSAR service providers in Europe have been consolidated to provide standardized terrain measurement products to national geological institutions for interpretation and exploitation, and to stimulate awareness and demand. The service has been concentrated on urban subsidence (including mining, dewatering and subsidence) and landslides, but is broadening its portfolio to include flood risk, crustal deformation and volcanoes.

[1]EFG Secretary General

The products referred to are ground motion records showing historic and ongoing movements down to sub-centimetric levels of accuracy. Current work is developing confidence in the products and broadening their appeal and application. This includes combining the records with geological ground truth information.

EFG represent the users of the exciting new technology. The EFG role is to advertise the activities of the project and to inform geoscientists across Europe as to what this technology can do to assist projects and protection of society.

The presentation will give examples of the project outputs from a variety of sites from around Europe.

Environmental management of mine water in Greece and in the European Union

by P. Tsangaratos[1] , E. Vasileiou[1], E. Grigorakou[1] and D.Rozos[2]

Mine water pollution differs from other forms of industrial pollution as it requires specific regulations quite distinct from those applicable to most other industrial processes. This is the reason why mine water demands drastic measures from authorities. The aim of this paper is to investigate mine water management in relation to environmental policy, in Greece and in the European Union.

Mining activity in Greece has, in many cases, created problems in the surrounding areas of the mines. There is acid drainage in mixed sulphide mines in Stratoni as well as high values of some heavy metals and trace elements. In Olympiada Gold Mines, toxic deposits are discharged into the mine water lake. There is acid drainage in the abandoned lignite mines of the Aliveri area. In all these cases, various methods concerning mine water management have been planned. The Public Power Corporation has carried out two European Projects in order to investigate the effect of mining activity in water resources (MINWATER and WATERCHEM). Many others research projects have been carried out in order to examine the environmental problems in the surroundings of the mines.

There are several federal laws and regulations in Greece and in the European Union that influence the mining industry and mine water management.

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Land desertification and the impact on groundwater in Greece

by C. Kosmas[1] and V. Zorapas[2]

Land desertification, a series of natural processes leading to gradual land degradation, is one of the most serious environmental issues at global, national, regional and local levels. Land degradation means the reduction or loss of the biological and economic productivity and complexity of irrigated and non-irrigated agricultural lands, pastures, rangelands, forests and forested lands.

Erosion represents a serious hazard for land degradation and desertification in dryland ecosystems, bringing about large reductions in vegetation growth, siltation of water courses, filling of valleys and reservoirs, and the formation of deltas along coastal areas.

Soil salinization is an important process of desertification especially in irrigated lowlands with improper soil drainage conditions. It has increased in recent decades due to the prevailing warmer and drier climatic conditions favouring aridity and drought hazards on growing plants. The increasing water consumption, combined with the substantial increase in water requirements associated with high-input agriculture is likely to create a significant water allocation problem bringing about further degradation of the plains through salinization.

Extensive areas in Greece such as eastern Crete, the Aegean islands, eastern Peloponnesus, Evia, eastern Sterea Ellada, parts of Thessaly, Macedonia and Thrace have been characterized as high desertification risk areas. The extensive deforestation and intensive cultivation of hilly areas in Greece since ancient times has already led to soil erosion and degradation.

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Guidance on the collection, presentation and interpretation of geological and hydrogeological information for quarry developments in Ireland

by EurGeol. Kevin Cullen[1] and EurGeol. Fionnuala Collins[2]

The extractive industry is a potentially environmentally unfriendly business. Even the best operations have difficulties, often due to their location close to population centers. It is no surprise therefore that the extractive industry is not a welcome neighbour.

There can be no doubt that we need the extractive industry and so it remains for the industry, the regulators and the public to agree on the acceptable level of impact associated with any new development. Experience in the Irish planning system has shown that much time and effort is wasted arguing about the absence of geological and hydrogeological information in the Environmental Impact Statements. The absence of this information has resulted in the refusal of many new excavations on the precautionary principle.

The Institute of Geologists of Ireland has published a template of the information to be included in EISs for quarry developments. The template has been well received by both the Industry and the Regulator. Its implementation has resulted in a much greater awareness among quarry owners of sensitive groundwater aquifers and dependent eco-systems during the pre-planning stage. The Regulators have benefited through the provision of the necessary data on which to make informed decisions.
Download the Template at: *www.igi.ie*

[1]PGeo., President, Institute of Geologists of Ireland
[2] PGeo., MCIWEM. BMA Geoservices Ltd.

Groundwater artificial recharge in Greece

by E. Spyridonos[1], A. Panagopoulos[2] and I. Gerolymatos[3]

Groundwater artificial recharge is primarily based on the storage of winter surplus runoff in aquifers which is subsequently recovered during dry summers and is especially suited to Mediterranean xerothermic conditions, with long hot dry summer periods and short intensive rainfall periods in autumn and spring. Successful application of the methodology requires good knowledge of the hydrological budget, deep understanding of the hydrogeological conditions, detailed assessment of possible hydrogeochemical interactions and therefore calls for in-depth feasibility studies prior to systematic application.

Such studies were initiated in the 1960s when extensive experiments were carried out at the Argolis alluvial system (Eastern Peloponnese). Later, a fractured aquifer on Naxos Island was successfully treated. In the 1990s, four major-scale pilot projects across Greece investigated groundwater artificial recharge potential in different hydrogeological environments (karstic at the river Enippeas basin-central Greece, alluvial at northern Corinth coastal basin-Peloponnese, fluvial at Xanthi basin-western Thrace, volcanic sediments at river Edessaios basin-central Macedonia). Recently, an ASR feasibility study was successfully completed in Kilkis Prefecture and a recharge project is underway in the Gallikos basin (northern Greece), as well as smaller-scale projects across the country.

Although virtually every feasibility study carried out in the country provided strong evidence of the merits of systematic groundwater artificial recharge, the method has not as yet gained a significant share in the water resources management schemes. With few exceptions, groundwater artificial recharge solutions in Greece have been of temporary and fragmented character.

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[2]Natonal Agricultural Research Foundation, Land Reclamation Institute, 57400, Sindos, Greece.
[3]EYDAP

Groundwater quality issues in urban areas and Groundwater Directive tasks

by Umberto Puppini[1]

Although the EU legislation framework is still relevant, major decisions on natural resources, including water, have been made more recently, as a result of serious disasters, as well as the evidence for climatic change.

In the Groundwater Directive, groundwater is pin-pointed as a natural resource to be protected against pollution and deterioration, in particular for dependent ecosystems and for the use in water supply. It is the most sensitive freshwater body and the main source of public drinking water supply in many regions.

The need to evaluate sustainability of actions in using such a valuable resource should be based on:

- Good Science
- Best Practice
- Modelling (conceptual, analytical, numerical)
- Human Health and Ecological Risk Assessment
- LCA
- Early expert judgement.

The first step to comply with good practice is to design a conceptual model as an early schematization of the key hydrogeological, hydraulic, hydrochemical and biological processes active in a groundwater body. Desk and filed studies are all essential for an understanding of the basic processes influencing groundwater quality. As quality and quantity problems of groundwater can be initiated via the unsaturated zone, their schematization should also be included where required.

With respect to direct and indirect inputs, the conceptual model allows a basic assessment of remediation and/or attenuation mechanisms relevant to groundwater quality improvement.

European Geologists are strongly expected to comply with such scientific and technical tasks whenever needed.

[1]Board Member of CNG (Italian Consiglio Nazionale Geologi)

Water resources: Framework Directive 60/2000 and the role of IGME

by I. Dandolos[1] and V. Zorapas[1]

Greece, among other Mediterranean countries, is suffering from global climatic changes leading to direct and evident effects both in quantity and quality of water resources.

The percentage of water consumed in various economic sectors is as follows: Agriculture 86%, Water supply 9%, Industry 5%. In periods of prolonged drought (e.g. 1989-1993), a large number of new and deeper boreholes were constructed, without the supervision of competent scientists, such as geologists. Moreover, uncontrolled waste disposal sites aggravate groundwater quality.

In Coastal systems' groundwater, overexploitation without any contingency plan caused large-scale salinization due to the intrusion of sea water.

The Geological Survey of Greece, IGME, was founded in the 1950s, having at its disposal most of the relevant infrastructure (mapping, geochemistry, hydrogeology and geophysics). According to its statute, IGME is responsible for the exploration and monitoring of groundwater systems per river basin district. It has undertaken projects, financed by the EC and the Greek Government, as well as private contracts. Despite this, the 3199/2003 law which harmonizes the legal framework of the country to the directive 60/2000, left its role ambiguous.

The water authority established in the Ministry of Environment and Public Works has to re-examine IGME's role, allowing Greece to achieve the goals postulated by the directive.

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Groundwater artificial recharge based on alternative sources of water: advanced integrated technologies and management

by Klisthenis Dimitriadis[1] and Athanassios Soupilas[2]

Aquifers are the main source of potable water in the Mediterranean region. However, overexploitation and poor management practices in the Mediterranean countries have resulted in the degradation of their quality and quantity.

In parallel, the recent urbanization of the Mediterranean coastline has resulted in an increase in the water quantities discharged into the sea, mainly from water treatment stations serving large cities (secondary treated waters). These waters, although treated, still contain one significant pollution load (expressed as BOD and COD content) that affects the sea water and has caused the degradation of sea life in the vicinity.

The EU programme GABARDINE has targeted these two negative effects in one positive action towards the preservation of the environment and water quality. It has been proved from previous studies that the earth surface acts as a "filter" to the pollutants as the contaminated water travels along the unsaturated zone. In one critical distance of a few meters, the soil has the capability to filter the pollutants, thereby providing high quality water to the aquifer below. The project examines the capacity of the unsaturated zone to act as a filter to the pollutants, by recharging the aquifer with secondary treated waters.

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Flood hazard assessment in Laconia Prefecture, Peloponnesus, Greece

by I. Mariolakos[1], I. Fountoulis[1], E. Andreadakis[1], E. Sampaziotis[1], E. Kapourani[1] and E. Karagiozi[1]

Flood Risk Management is closely bound to Water Resources Management in the European Union and implemented through the 2007/60 Directive with 2000/60. A uniform methodological approach is difficult though, because of the different hydrological, climatological and other features in the member countries. Flash Floods are rapid and particularly destructive and they occur rather often in Greece and other Mediterranean areas. In the absence of appropriate hydrometeorological archives, that would provide a basis for implementation of common methodologies dealing with flood hazard, a different method was developed for flood hazard mapping in the Laconia Prefecture (Peloponnesus, Greece). In tectonically active areas, and especially where vertical tectonic movement is intense, floods are instant results of the long-term trends of a tectono-climatic feedback process, forming floodplains, alluvial fans etc. Taking into account the fact that the study area belongs to the most tectonically active part of Europe, flood hazard mapping in Laconia was based on Intrinsic Flood Hazard mapping using morphometric features of basins and sub-basins. Gross Stream Power calculations and Instant Unit Hydrographs for certain streams were also used. The results were compared with recent flood incidents in the area, with very good results. This method concluded in a reliable hazard map, a zoning of proposed anti-flood measures along streams and finally a map of priority areas (preliminary "risk" map) for the prefecture.

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Groundwater management of coastal karstic aquifers: results of a COST project

by P. G. Marinos[1]

Scientists from 13 countries (Austria, Croatia, France, Germany, Greece, Hungary, Israel, Italy, Malta, Portugal, Slovenia, Spain and Turkey) participated in the COST Action 621, "Groundwater management of coastal karstic aquifers" The key objective of the action was to systematize current knowledge and improve it by fusing the experiences acquired. The action focused on the aquifer characteristics, the hydraulics, the application of environmental tracers, the engineering aspects of capture works and over-exploitation consequences. The work led to the proposal of new methodologies and principles that enable rational and sustainable integrated water resources management.

Engineering works present particularities and difficulties. Remediation and development against sea water intrusion, have been applied worldwide and may be categorized as:

- isolation,
- interception,
- elevation of spring level
- regulation of pumping stresses in order to control hydraulic gradients.

With the intention of choosing the proper method, the geological model of the karstic aquifer should be determined as accurately as possible in order to derive a well-defined hydrogeological model. Thus, there are neither single nor simple solutions to coastal karst aquifer exploitation.

EUR 21366-COST Action 621. Luxembourg: Office for Official Publications of the European Communities, 2005-II, 363 pp., ISBN: 92-898-0002-X

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President of the Geological Society of Greece

Aquifer storage and recovery in the Atlantic Coastal Plain of the United States

by Daniel J. St. Germain[1]

Aquifer Storage and Recovery (ASR) is an inexpensive groundwater management tool that can be used to increase a water supply's peak demand. This technique has been successfully used many places around the globe, including the United States, Great Britain, Israel, Australia, and South Africa. By injecting excess treatment capacity during off-peak times (e.g., October to May) into a suitable generally non-potable aquifer, the capacity of a water supply system can be increased during peak demand by augmenting the treatment plant's full capacity with the potable water recovered from the aquifer. This alternative is typically much less expensive than increasing the size of the treatment plants to meet peak demand.

Some of the scientific and engineering challenges of a successful ASR system in the Atlantic Coastal Plain include; maximizing the amount of injected water that can be recovered (also called recovery efficiency), evaluating the size of the storage zone for each cycle, evaluating potential well plugging issues and determining back flushing frequency necessary to maintain well capacity, controlling the dissolution if iron, manganese and other minerals from the aquifer matrix, documenting the natural degradation of disinfection by-products such as trihalomethanes and halo acetic acids that are the result of injecting chlorinated drinking water, and documenting any potential effects on nearby users or local water levels. During this presentation we will discuss the critical issues associated with a successful ASR system, how to plan for and conduct a pilot test, and how to evaluate and control these scientific and engineering challenges.

[1]AIPG

Surface runoff water management by construction of small reservoirs

by A. Kaplanidis[1]

The Greek Ministry of Rural Development and Food/Land Reclamation Service, has commenced a project for construction of small reservoirs, for irrigation and potable purposes, mainly in arid areas of the Greek islands.

These 'Off-stream' or 'Pond' reservoirs derive their water from nearby rivers or streams. Most consist of small dams (10-15 m high) with a water storage capacity ranging from 40,000 to 2,000,000 m^3.

The aim of this project is to capture torrent runoff in small hydrological basins. The reservoirs are sited where geological conditions and the hyrodrological profile of the catchment area is suitable.

The main amount of stream runoff is to the downstream area. The longer the base flow period can last, the smaller and easier the construction of the derivation spillway will be. The spillway's derivation system consists of a ditch with grid and sink tank for coarse material (sand, wood, leaves etc.) This tank needs almost annual maintenance, because of turbulent torrent runoff. Water flows to the reservoir by conduit or canal, according to topography and water quantity.

Geomembrane lining is used where the underlying rock is permeable.

The reservoir is created in a morphological suitable location by constructing an embankment and by excavations on the lake slopes. The embankment volume's balance is of critical value for the project's financial point of view.

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The policy of the Ministry of Rural Development and Food in the artificial recharge of aquifers

by Eythymios Drossos[1] *and Vassilis Tsarbos*[1]

One of the tools for managing water resources in agriculture is the artificial recharge of depleted aquifers. Five projects have been carried out lately, on this basis, in Greece, on behalf of the Ministry of Rural Development and Food, in the following areas: Rodopi-Xanthi (Thrace), Corinth (Peloponnese), Larisa-Karditsa (Thessaly), Troizinia (Peloponnese) and NW Achaia (Peloponnese).

Another artificial recharge project is already under way in Eastern Voiotia (Sterea Ellada), one more is in the final planning stage (technical specifications completed), whereas five additional artificial recharge projects are being proposed for the near future.

This introductory paper presents the results of the aforementioned projects and explores their contribution to the sustainability of agricultural water resources. In short, the following conclusions were reached:

- artificial recharge of depleted aquifers is a fairly inexpensive method that helps manage water resources that are otherwise lost to the sea during the winter
- artificial recharge can help aquifers recover their former state and can be combined with other water management projects (i.e. dams, reservoirs)
- artificial recharge is not the only solution for achieving a good and sustainable state (quality-wise and quantity-wise) of ground water.

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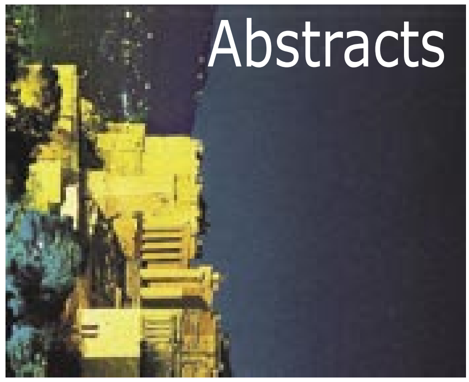
The qualitative and quantative state of Ljubljana field and marsh aquifers

by Bračič Železnik Branka[1]



When using groundwater as a drinking water source, groundwater level and quality monitoring must be established. The groundwater of the Ljubljansko polje aquifer has been a drinking water source for the city of Ljubljana and its vicinity for more than a hundred years. When the first well in the Kleče water work began pumping, groundwater level control began. Until 1993, groundwater quality was monitored only from time to time, but since then, regular groundwater quality monitoring has been carried out between two and twenty-four times per year, depending on the location and parameters to be controlled. In the last few years, a dense net of piezometers was established and on the basis of groundwater level measurements and chemical analyses, we can define the groundwater body chemical status.

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Fortey's Recollections

Book review by David Harper[1]

Dry Store Room No. 1. The Secret Life *of* the Natural History Museum.
by Richard Fortey.

Published by HarperPress ISBN 978-0-00-720988-0
Date: 2008, 338 pages
Price: £20 (stg)

Museums have been with us for a long time. The cabinets of curiosities of the nobility and crowned heads of Europe have evolved into the many great museums of the contemporary world. But are museums merely characterized by their accumulated collections of fine material? Well, yes and no. Richard Fortey's new book focuses on an essential, often neglected, but so obvious dimension to our museums, their staff, hidden like phantoms at the opera behind the public galleries. They are colourful characters, some certainly eccentric and many apparently engaged on the most esoteric of endeavours; but together their goal is to understand the animals and plants of our world and to chart what evolutionary change has accomplished during some 4 billion years of life on our planet. Fortey, in his engaging and lucid style, tempts us into the world of Dry Store Room No. 1 of the Natural History Museum, London. Resonating from the pages are the rasping tones of the hard-drinking, Scots head warder addressing his team of attendants every morning before start of business, contrasting with the fruity, patrician eruditions of the scientists on second floor where cladistic analysis and the expanding Earth were amongst the main topics of conversation. One can almost feel the tentacles of the octopus-like former Keeper of Botany as he groped women in the lift, marvel at the skills of the inebriated conservator as he carefully dismembered a whale and sympathize with the family of the leading mosquito expert, left in the car waiting to drive off on their Summer holidays, while he had absent-mindedly gone to work.

There is no doubt that tenure can encourage such alternative behaviour but also fertilize creativity and freedom of expression. This was all to change with the Thatcher era. In a more serious side to the book, Fortey maps out the changes in the museum's management structure during the 1980s. The influence of the scientists was drastically reduced with the appointment of a Head of Science; he would represent all the departments on the management team, rather than, as before, the keepers from each department. The initial appointee, wildly enthusiastic for anything innovative and new, is compared with Mr Toad in the Wind in the Willows; he was responsible to the affable, charming but rather sinister Director, who was in turn responsible to the Board of Trustees that now reflected various business interests. Fortey also outlines the Gerald Ronson scandal, the generous benefactor and head of the Heron Group, who had to conduct his Trustee business from a prison cell. Could Trustees really be trusted?

Fortey's journey through the museum takes us behind the galleries, and onto his Noah's Ark in Kensington. In many ways part of the journey parallels his own career from a new recruit having just finished his Ph.D. at Cambridge, first given his white coat, bunch of keys and permission to join staff in the Senior Common Room to his retirement as one of the museum's most influential scientists. In his final chapter, Fortey reflects on the trends in contemporary science. Hypothesis-driven science is extremely important for fund-raising and publication in high-profile journals. The large equipment-base of the museum, the Kingdom of Machines, together with its molecular laboratory is at the forefront of many important scientific advances. But how do we protect our collections and systematic research in such a changing culture? These are challenges that all museums face today, placing another heavy burden of responsibility on the dedicated workers in Fortey's hidden and secret museum, benignly supported by the ghosts of Dry Store Room No. 1.

[1]Professor of Palaeontology. Head of Geology, Natural History Museum of Denmark, University of Copenhagen.

Environmental and health risk estimation for potentially toxic elements in groundwater in Slovakia

by Stanislav Rapant [1] and Katarína Krčmová [1]*

A methodology for evaluating and mapping of environmental and health risks from harmful elements of anthropogenic/geogenic origin in Slovak groundwaters is presented here. On the base of environmental risk index (I_{ER}) the Slovak territory was divided into areas with different environmental risk levels. Health risk for groundwater contents of potentially toxic elements was estimated for chronic effects (method of Hazard Quotient - HQ=ADD/RfD) as well as for carcinogenic effects (Cancer Risk - CR=ADD/RfD).The risk estimates were graphically visualized in the form of maps of health risk estimates. The results were verified within the regional pilot medical-geochemical research (the area of Spišsko-Gemerské Rudohorie Mts.) through analyzing the concentration levels of potentially toxic elements in the food chain (locally grown vegetables) and biological materials of residents (hair, nail, urine and blood).

Cet article expose une méthode d'évaluation et de cartographie des risques environnementaux et de santé liés à la présence d'éléments dangereux d'origine anthropogénique/géogénique dans les eaux souterraines de Slovaquie. Basé sur un index (IER) de risque environnemental, le territoire slovaque a été divisé en aires de niveaux différents de risques environnementaux. Les risques touchant la santé et dépendant d'éléments potentiellement toxiques contenus dans les eaux souterraines ont été évalués d'après leurs effets chroniques (méthode du Quotient de risque – HQ =ADD/RfD) et aussi selon les risques cancérigènes (Risque de Cancer – CR= ADD/RfD). Les évaluations de risques ont été visualisées graphiquement sous la forme de cartes d'estimation de risques. Les résultats ont été vérifiés à l'intérieur d'une zone pilote de recherche médicale (éléments géochimiques) dans le secteur des Monts de Spissko-Gemerské Rudohorie, en analysant les niveaux de concentration des éléments potentiellement toxiques dans la chaine alimentaire (légumes locaux) et les éléments biologiques prélevés chez les habitants (cheveu, ongle, urine et sang).

En este artículo se presenta una metodología para evaluar y cartografiar los riesgos ambientales y para la salud causados por elementos perjudiciales de origen antropogénico/geológico, en las aguas subterráneas de Eslovaquia. Se ha dividido el territorio eslovaco en base a un índice de riesgo ambiental (IER), en áreas con diferentes niveles de riesgo ambiental. Se ha estimado el riesgo para la salud para el contenido de elementos potencialmente tóxicos para efectos crónicos (método del cociente de peligrosidad – HQ = ADD/RfD) y para efectos carcinogénicos (Riesgo de cáncer – CR= ADD/RfD). Las estimaciones del riesgo se han visualizado gráficamente en forma de mapas de valoración del riesgo para la salud. Los resultados se han verificado en el marco de un estudio piloto médico-geoquímico (en la zona de Spišsko-Gemerské y los montes Rudohorie) por medio del análisis de los niveles de concentración de los elementos potencialmente tóxicos en la cadena de alimentación (vegetales cultivados localmente) y en material biológico de los residentes (pelo, uña, orina y sangre).

Drinking water is the most common natural medium through which human populations are exposed to harmful elements of anthropogenic or geogenic origin. The health-based criteria for drinking water quality (Anon, 2004; Anon, 2006) include limits for the number of potentially harmful microbes or bacteria, inorganic elements, ionic species and series of organic pollutants. In addition, there are technical and aesthetic target values for drinking water. All these elements/compounds/parameters summarily determine qualitative properties of groundwaters and for their concentration levels, potential health risks of drinking water ingestion can be derived.

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In Central Europe and also in Slovakia, groundwater is considered to be a potential source of drinking water. Natural processes of mineralization which give the chemical composition of groundwater, generally determine its qualitative properties in whether it is suitable for drinking purposes. In present-day Slovakia, more than 85% of drinking water used for public supply is from groundwater sources (Anon, 2005).

There are many examples of the negative health impact of contaminated geological sources, of which groundwater, used as a significant drinking water source, mainly poses the most serious threat to human health worldwide e.g. Bangladesh, West Bengal, Southern China, Argentina and others. In Slovakia, there are some areas showing higher occurrences of various diseases and/or significantly shorter lifespan where there is an increased probability of the negative influence of these unfavorable environmental factors.

In this paper, the results of research dealing with environmental and health risk assessment for Slovak groundwater is summarized (Rapant *et al*., 2008, Rapant & Krčmová, 2007). Examples of the application of national as well as regional data on groundwater quality for estimation of environmental and health risk are presented, based on methodologies developed by the Geological Survey of the Slovak Republic, and / or international methodologies adjusted for the natural conditions in Slovakia.

Environmental and health risk estimation: principles and approaches

Environmental risk estimation

Environmental risk, the probability of possible adverse effects on biotic and abiotic environmental compounds, was estimated in accordance with the methodological approach of Rapant & Kordík (2003) in the form of so-called environmental risk index I_{ER}. The I_{ER} was calculated as the sum of hazard quotients [Q] with Q equal to the ratio of Predicted Environmental Concentration [PEC] and Predicted Non Effect Concentration [PNEC]. For PEC the data set of groundwater chemical analyses (16,359 samples) gathered nationally (1 sample/3 km^2) within the compilation of the Geochemical Atlas of Slovak Republic, Part Groundwater (Rapant et al., 1996) was used. For PNEC, national standards for chemicals in drinking water was used (Anon, 2004). The characterization of the input data is summarized in Table 1.

The calculations of environmental risk indices were visualized in a form of surface pixel maps using standard methods of data interpolation (inverse distance method, pixel of area 1 km^2, 15 neighbour samples on average). Additionally, the results were transformed into maps for administrative units including districts and municipalities.

Health risk estimation

The groundwater data set from the Geochemical Atlas of Slovak Republic (Rapant et al., 1996) was applied at a national scale to the calculation and mapping of health risk estimates arising from groundwater contamination. Health risk, generally defined as the probability of adverse effects of human exposures due to environmental hazards, was estimated using the U.S. EPA approach in risk assessment, including the concept of threshold (reference "safe" dose, RfD) for chronic risk characterization and the concept of no threshold (no safe dose) for carcinogenic risk characterization (U.S. EPA, 1989). Chronic risk was estimated for a group of potentially toxic elements including As, Ba, Cd, Cu, F, Hg, Mn, NO_3, Pb, Sb, Se and Zn while carcinogenic risk was quantified only for arsenic as a proven human carcinogen. The following basic equations were used for health risk level quantification:

$$\text{Chronic risk: } HQ = ADD / RfD$$

$$\text{Carcinogenic risk: } CR = ADD \times CSF$$

$$\text{with } ADD = \frac{C \times IR \times ED \times EF}{BW \times AT}$$

where HQ is the Hazard Quotient (-), RfD is the reference dose (mg kg^{-1} day^{-1}), CR is the carcinogenic risk (-), CSF is the cancer slope factor (for arsenic = 1.5 [(mg kg^{-1}) day^{-1}]), ADD is the average daily dose (mg kg^{-1} day^{-1}), C is chemical groundwater concentration (mg l^{-1}), IR is the ingestion rate (l day^{-1}), ED is the exposure duration (year), EF is the exposure frequency (day year^{-1}), BW is body weight (kg), AT is the averaging time = average lifetime (days). The adult population was evaluated as the exposure receptor with conventionally accepted exposure parameters including 2 l of ingested groundwater, 70 years for exposure duration, 365 days for exposure frequency and 70 years for the lifespan. Carcinogenic risk is conventionally expressed in a form of excess lifetime cancer risk as the number of cases per population (U.S. EPA, 1989).

Surface maps of chronic as well as carcinogenic risk levels for potentially toxic elements in Slovak groundwater were compiled using an inverse distance and moving average method for data interpolation.

At regional level, causal association between the groundwater contamination and health status of the residents in one of the most contaminated regions in Slovakia, Spišsko-Gemerské rudohorie (SGR) Mts., was studied. The additional collection of geochemical data, local biomonitoring and statistical correlation of geochemical data (chemical groundwater contents) with medical type of data (health indicators) were performed to confirm mutual relationships between contaminated groundwater and the health state of residents.

Main results and discussion

The results of environmental risk estimation for the potentially toxic elements/compounds in Slovak groundwater are visualized in Figure 1.

A dominant part of Slovak territory falls into the category of negligible to low environmental risk level. However, there are some areas with estimated high or very high environmental risk (about 15% of Slovak territory) where adverse effects on abiotic and/or biotic environmental compounds could be expected. These are lowlands with prevalent anthropogenic origin of increased chemical levels in groundwater, mainly NO_3, Mn, Fe and Total Dissolved Solids as the most significant parameters of concern and mountainous regions with prevalent geogenic or miscellaneous geogenic-anthropogenic origin of

Parameter		TDS	NH_4	NO_3	Cl	F	SO_4	Al	As	Cd	Cr
Groundwater content[1]	Median	483.3	0.025	8.8	9.4	0.1	42.8	0.005	0.0005	0.00025	0.00025
	Min Max	14.95 3267.9	0.025 33.5	0.25 1032.2	0.18 535.3	0.05 4	0.3 1297.9	0.005 72.6	0.0005 4.9	0.00025 0.4	0.00025 0.3
Limit value[2]		*1000*	*0.5*	*50*	*100*	*1.5*	*250*	*0.2*	*0.01*	*3*	

Parameter		Cu	Fe	Hg	Mn	Na	Pb	Sb	Se	Zn
Groundwater content[1]	Median	0.0009	0.01	0.0001	0.003	9.1	0.0005	0.0001	0.0005	0.02
	Min-Max	0.00025 0.3	0.005 36.61	0.0001 0.2	0.0025 16.1	0.05 370	0.0005 0.3	0.0001 2.4	0.0005 0.045	0.00025 4
Limit value[2]		*1*	*0.2*	*0.001*	*0.05*	*200*	*0.01*	*0.005*	*0.01*	*3*

[1]*Rapant* et al. *1996;* [2]*Anon 2004*

Table 1. Review of content levels for evaluated chemicals in Slovak groundwater with their limit values established for drinking water

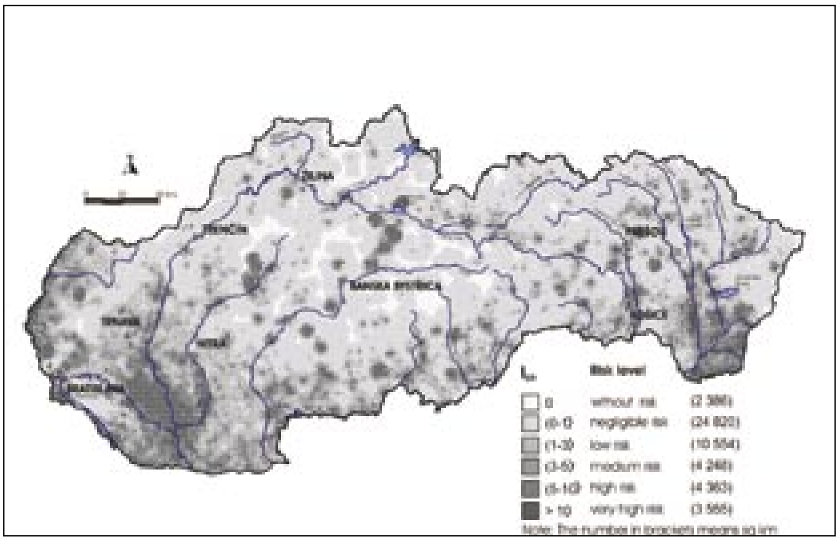

Figure 1. Environmental risk for the potentially toxic elements/compounds in Slovak groundwaters

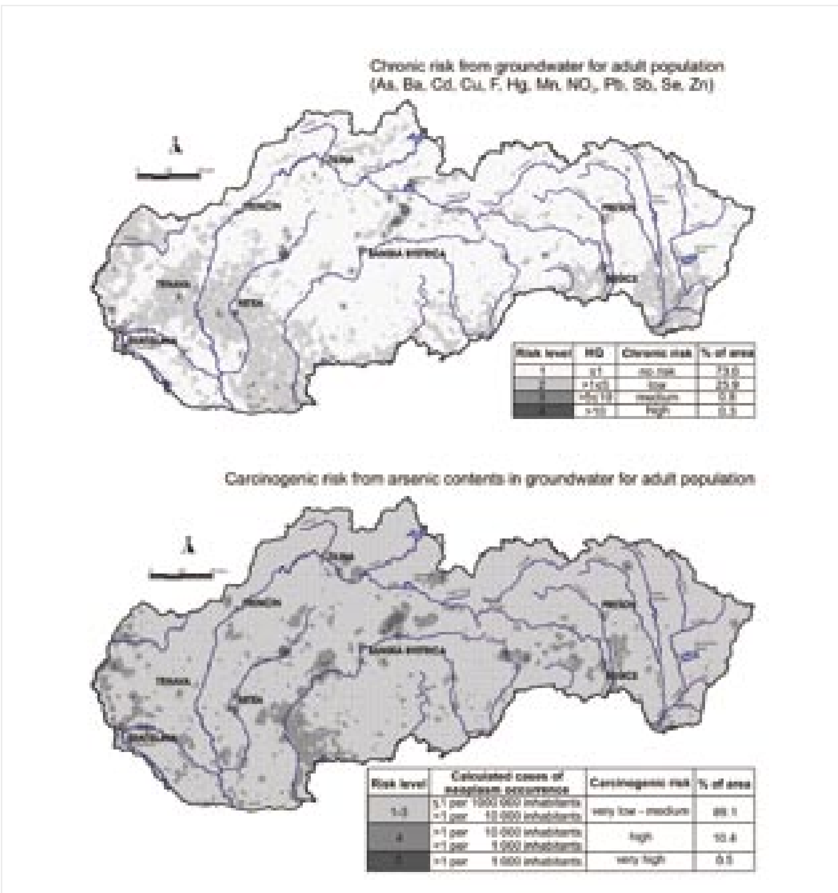

Figure 2. Health risk for the potentially toxic elements/compounds in Slovak groundwaters

higher chemical concentrations, with As, Sb Cd, Fe, SO_4 as the most significant.

The examples of health risk quantification performed at a national level are shown in Figure 2. The results of total chronic risk estimates for a group of potentially toxic elements/compounds in Slovak groundwaters indicate that the category of no or low risk level is dominant. Only about 1% of the Slovak territory can be characterized by medium to high chronic risk for groundwater. From evaluated chemicals, As, Cd, Hg and Sb are the most significant substances of concern with derivated locally higher risk levels and could pose a threat to the health of residents through ingestion of contaminated groundwaters.

The model estimates of carcinogenic risk for groundwater arsenic (Fig. 2) indicate high possible risk occurrence in about 10 % of Slovakia. Since the majority of the Slovak population is supplied with public drinking water, the risk from increased groundwater concentrations of arsenic as well as of other potentially toxic chemicals could exist only in small local areas with the absence of public water supplies. In these areas, detailed medical-geochemical research is needed to verify the possibility of real threat to the residents due to elevated arsenic groundwater content.

Such a detailed medical-geochemical study was undertaken in a pilot region in one of the most significantly contaminated regions in Slovakia, Spišsko-Gemerské rudohorie Mts., with widespread ore mineralization occurrences and historical mining activities (Rapant *et al*., 2008). Model environmental and health risk calculations have indicated possible high occurrence of risk in some municipalities of the region with As and Sb as the most significant substances of concern.

Statistical correlation of geochemical data and medical data has confirmed high or very high dependence between groundwater contents of potentially toxic elements and some health indicators, mainly mortality for malignant tumours and cardiovascular diseases.

Additionally, the results of detailed geochemical research focused on groundwater sampling of local wells, together with garden soil and vegetable sample collection and biomonitoring based on hair, nails and urine collection and analysis revealed the presence of real health risk for residents in those municipalities with high contents of potentially toxic elements in the local environment (Rapant *et al*., 2008). The measures to minimize the risk included the installation of plant for groundwater treatment. In addition, residents were given information about the bad quality of local well water and instructed that regular ingestion of such water could damage their health.

Conclusion

This paper deals with environmental and health risks to which the resident population is exposed through groundwater ingestion. Although in Slovakia about 85% of the inhabitants are supplied with drinking water from a public supply and only

15% use water from their own individual household wells, there are still areas at potential risk from drinking water. These areas need to be studied in more detail. Present results show evidence of mainly arsenic and nitrates as the most significant groundwater contaminants that could pose increased health risks to residents.

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Sustainable transboundary groundwater management: SE Europe and the Balkans

by Zoran Stevanovic[1]

The article evaluates and highlights the importance of groundwater management in the still politically "hot" Balkans and the Southern Europe region. In recent years, many activities aiming at improving water management among neighbouring countries have been undertaken or initiated. Among them, the Danube River Basin international project (ICPDR) is one that significantly helped introduce the aims of the EU Water Framework Directive (WFD) into local water practices. Some other on-going transboundary projects are based on bilateral cooperation. However, such activities should be followed up with adequate funding and not have support only from the local authorities.

L'article évalue et souligne l'importance de la gestion des eaux souterraines dans la région toujours politiquement sensible, des Balkans, et en Europe du Sud. Ces dernières années, de nombreuses actions avec pour but l'amélioration de la gestion des eaux, parmi des pays voisins, ont été entreprises ou initiées. Parmi elles, le Projet international du bassin du Danube (ICPDR) est celui qui a aidé de façon significative à transposer les objectifs définis dans le cadre de la Directive européenne sur l'Eau, sous forme de règles d'application locale. Quelques autres projets actuels transfrontaliers sont basés sur une coopération bilatérale. Cependant, de telles activités devraient être accompagnées de financements appropriés et ne pas dépendre seulement de l'aide fournie par les autorités locales.

El artículo evalúa y resalta la importancia de la gestión del agua subterránea en los todavía políticamente "calientes" Balcanes y la región del sur de Europa. En años recientes se han llevado a cabo o iniciado muchas actividades orientadas a mejorar la gestión del agua subterránea entre países vecinos. Entre ellas, el Proyecto Internacional de la Cuenca del Danubio (ICPDR) ha ayudado de manera significativa a introducir los objetivos de la Directiva Marco Europea del Agua (WFD) en las prácticas locales. Otros proyectos transnacionales en curso se basan en la cooperación bilateral. No obstante tales actividades deberían tener un seguimiento con una financiación adecuada y no sólo tener el apoyo de las autoridades locales.

During the last decade we have been witnessing many activities aiming at improving water management among neighbouring countries worldwide. It is a logical outcome for many identified hotspots and a proclamation of the 21st century as a period of water crisis.

How does this reflect on the Balkans and SE Europe as well-known hot areas not only in water and engineering issues, but also in political terms? Recent wars, new states and newly-created boundaries, at the centre of which is the former Yugoslavia, give rise to many questions regarding common and optimal water strategy in the region. However, during the last two or three years many initiatives and concrete actions have been undertaken and now provide an optimistic ambience for future work and cooperation.

One of the main activities of the Danube River Basin international project (ICPDR) is the implementation of the Water Framework Directive (WFD). All countries from the catchment are actively engaged in the implementation of this project. Thus, the initial characterization of groundwater bodies including delineation of transboundary aquifers has been done so far. The number of aquifers at risk of not achieving a good chemical or a good quantitative status by the year 2015 has also been identified. The next steps would include their close monitoring and measurement to improve the situation in the field. As a continuation of these activities, the international conference "Ground water management in the Danube river basin and other large basins" held in Belgrade in June, 2007 gathered together more than 100 experts from the region and abroad.

Within the frame of the International conference and field seminars Water Resources and Environmental problems in Karst-Cvijic 2005 held in Belgrade in September 2005, two working sessions of the symposia Karst resources and related ecosystems in SE Europe were also organized at the University of Belgrade. Fifteen invited representatives from the SEE countries (from Slovakia to Turkey) had an opportunity to discuss the impact of karst water and environment on existing biodiversity. Support was provided by UNESCO-ROSTE and MAB (Man and Biosphere).

The Workshop DIKTAS (Dinaric karst transboundary aquifer sustainability) was held in Belgrade on March 2006. The University of Belgrade and The Faculty of Mining and Geology hosted the meeting initiated by UNESCO UVO, GEF (Global environmental facilities) and Commission of Transboundary Aquifers of IAH (International Association of Hydrogeologists). Experts and governmental representatives from Albania, Bosnia & Herzegovina, Croatia, Greece, Republic of Macedonia, Slovenia and Serbia & Montenegro participated, provided national reports, and drafted the project for transboundary water management. The presentations emphasized the national experiences in dealing

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Figure 1. Participants of the WSSTP meeting in Podgorica (Montenegro), at the excursion over Kotor Bay

with karstic aquifer systems, general and concrete problems in groundwater mismanagement, potential conflicts and similar issues. The source of funding for this project (GEF, UNEP, UNDP?) has not yet been ensured. However, the success of such a project in the Dinaric Region where there are almost no exclusively national aquifer systems could possibly be used as a model for other karst regions in the world.

During 2006 and 2007, under the organization of the UNECE, groundwater transboundary issues in the entire SE Europe have been evaluated based on data submitted by all countries involved. The task of the UNECE programme is to ensure that transboundary waters are used with the aim of ecologically sound and rational water management, conservation of water resources and environmental protection. Initially, questionnaires were completed by experts from the national institutions or national committees of professional organizations such as IAH. Subsequently, based on conclusions from the meeting held in Thessaloniki in 2007 (support has been provided by the International Groundwater Assessment Centre IGRAC), all aquifer systems that neighbouring countries at least have identified as important will be further monitored and measures to improve water management accordingly implemented. This will be the obligation of respective national water entities.

There are also several bilateral cooperation programmes that are currently on-going. For example, Hungarian and Serbian experts are working on a project SUDEHSTRA, aiming at improving the situation in terms of groundwater use from common intergranular aquifers of the Pannonian (Great Hungarian) basin. The project, executed by ATIKO VIZIG Szeged and the Faculty of Mining and Geology, Belgrade, is fully financed and supported by EAR (European Agency for Reconstruction). Similarly, good cooperation has been established between the Montenegro-Albania state hydrometeorological surveys, which is very important for the groundwater and surface water management of Skadar (Shkoder or Skutari) lake, the biggest lake in SE Europe and the Balkans (at Ramsar list). There are also some other regional on-going projects or initiatives (such as Romania - Bulgaria) that expect support from the ex-EU Interreg programme (now "European Territorial Cooperation") or similar sources.

Under the bilateral cooperation programme of the Serbian Academy of Science and Art and the Bulgarian Academy of Science, the first International workshop "VUSPLAN" (Vulnerability assessment of Stara Planina) took place at the shared border mountain Stara Planina (intended to become a large ski resort and sport centre) and the city of Pirot, in August 2007. The main topic discussed at the workshop was "Karst and karst groundwater in the boundary region of the Western Balkans".

At the end of September 2007 in Podgorica, the capital of Montenegro, the first meeting of Implementation case no. 4 of WSSTP (Water Supply and Sanitation Technology Platform) entitled "Transboundary Water Management along the Southern Adriatic/Dinaric Coast" was organized with the participation of the experts and stakeholders from eight countries (Albania, Austria, Bosnia & Herzegovina, Croatia, Greece, Montenegro, Serbia and Slovenia) (Fig. 1). The aim of WSSTP is to bring together research, industry, financial institutions, decision-makers and end-user groups involved in European water supply and sanitation to federate all water stakeholders across sectors and disciplines around the development of joint technological solutions within an Integrated Water Resources Management (IWRM) framework. WSSTP produced a common vision document, a strategic research agenda and an implementation plan for the short (2010), medium (2020) and long term (2030) (authors: 300 people in 20 countries over 2 years). WSSTP aims to contribute to the competitiveness of the European water industry (Lisbon Strategy), solving the European water problems and reaching the Millennium Development Goals (Johannesburg). Therefore, this project should create a base for a new network of excellence in this part of Europe, similar to the existing and very successful K-net operation (involving over 60 Austrian, Italian, Slovenian and Croatian stakeholders).

Most of the above activities were led by experts from ex-Yugoslavia. While the experienced colleagues from that area know each other well and took the opportunity to continue to work together, many new professional links and friendships were established among colleagues from the wider region. Some of the countries such as Hungary, Romania or Bulgaria that were earlier behind the iron curtain, today are respected EU members. Just some 20 years ago, it was almost impossible to imagine that intensive exchange of geological and hydrological data would take place. Lastly, we all have an opportunity as professionals to take the initiative with the politicians, and to guide and advise them on how to prevent potential conflicts and ensure that groundwater use and protection will benefit all involved. However, it is important that such actions be followed by adequate funding and that they have not only local support, but also support from the wider international community.

The age of deep aquifers in Milan province: development of a new Tritium – I.E.B. calibration curve

by Maurizio Gorla[1]

This paper deals with a new method to determine the age of groundwater samples, simply using the concentrations of chloride, sodium and potassium (expressed in meq/liter) and, thanks to a new calibration curve, correlating tritium (T.U.)/time (years) with the ionic ratio i.e.b. (base exchange index or better alkali-chloride disequilibrium index, introduced by Schöeller, 1962). These experimental curves can be considered a new practical, managing tool to evaluate the "blue gold" of the third millennium in an even better way, just by making an easy laboratory analysis. The age of deep groundwater generally encompasses a time span of about 50-60 years. Having collected a huge number of "field" data, we could say that the method proposed was completely vindicated.

L'article traite d'une nouvelle méthode pour déterminer l'âge des échantillons d'eau en utilisant simplement les concentrations en chlorure, sodium et potassium (exprimées en meq/litre) et, grâce à une nouvelle courbe de calibration, la corrélation entre le tritium (T.U.)/temps (années) et le rapport ionique i.e.b.(l'index d'échange de base ou mieux l'index de déséquilibre alcali-chlorures, introduite par Schöeller, 1962). Ces courbes expérimentales peuvent être considérées comme un nouvel outil pratique et de gestion pour évaluer « l'or bleue » du troisième millénaire d'une façon optimale, en faisant facilement une simple analyse de laboratoire. L'âge des eaux souterraines profondes dépasse généralement la fourchette de temps de l'ordre de 50-60 années.Ayant récolté un nombre impressionnant de données, nous pouvons dire que la méthode proposée a été complètement validée.

Este artículo trata sobre un nuevo método para determinar la edad de muestras de agua subterránea utilizando únicamente las concentraciones de cloro, sodio y potasio (expresadas en meq/l) y gracias a una nueva curva de calibrado, correlacionamos el tritio (T.U.)/tiempo (años) con el radio iónico (índice de intercambio base o mejor el índice de desequilibrio álcali-cloruro, introducido por Schöeller en 1962). Estas curvas experimentales se pueden considerar como una herramienta nueva y práctica para evaluar mejor el "oro azul" del tercer milenio, haciendo un análisis de laboratorio muy sencillo. La edad del agua subterránea profunda suele cubrir un período de tiempo de unos 50-60 años. Al haber tomado una enorme cantidad de datos de campo, podemos decir que el método está completamente ratificado.

The aim of this paper is to demonstrate a new method to calculate the age of groundwater, circulating into deep confined hydrogeologic complexes.

Despite the reasonable reconstruction of the hydrogeological setting of deep aquifers, we know little about their age.

These deep aquifer systems will play an increasingly strategic role in supplying fresh drinking water in the future, so the knowledge of the processes regulating their flow and also a better understanding of deep groundwater paths and time of residence in the subsurface, in other words, their age, becomes a fundamental question in carryimg out a sustainable withdrawal and eco-compatible management of this strategic and vital natural resource.

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The quaternary stratigraphic profile of Milan Province

The first 200-300 m in depth show the following stratigraphical profile; from top to bottom, we can distinguish these lithologic units (Fig. 1):

- Gravelly-Sandy Unit (Unità Ghiaioso-sabbiosa). It indicates a fluvioglacial palaeo-environment, when streams were meandering throughout the alluvial plain during the Late Pleistocene - Olocene. The gravel fraction generally dominates the sandy one, and there are rare clayey lenses with a limited spatial extension. The thickness of this unit is about 20-40 m
- Sandy-Gravelly Unit (Unità Sabbioso-ghiaiosa). Composed of sand deposits, prevailing on the gravel ones, of Middle Pleistocene age. Locally, silt-clay strata and arenitic-conglomeratic lenses are recognizable. Thickness is 40-60 m. Within the city of Milan, this formation reaches a depth of 100-110 m
- Conglomerate and Sandstone Unit (Unità a Conglomerati e Arenarie "Ceppo"). Made up of conglomerate and sandstone lithologies, of Lower Pleistocene age, passing laterally and southward to uncemented gravel and sand. This unit can be found principally in the pedemontan region, at up to 50-100 m depth. Its maximum thickness is about 80 m. It derives from a palaeo-environment of river channels
- Sandy-Clayey Unit (Unità Sabbioso-argillosa). During the Lower Pleistocene, there was a phase of marine regression, which constituted lagoon, beach, palustrine and alluvial deposits. This unit, that represents the bottom of the traditional unconfined aquifer, shows a predominance of grey and yellow clay and silt (with frequent interposition of colour), blended with peat, and locally lenses of gravel, sand

and conglomerates, which generate confined groundwater reservoirs, recognizable within a depth range between 100 m and 160 (eastern sector) - 200 m (western sector)

- Clayey Unit (Unità Argillosa). Composed of prevalent grey-blue clay and silt, with macro and microfossils (e.g Hyalinea *balthica* and Ammonia *beccarii*) and thin cemented sandy levels. It derives from a shallow-deep marine palaeo-environment, referred to Calabriano age. This unit can be observed at up to 280-300 m depth.

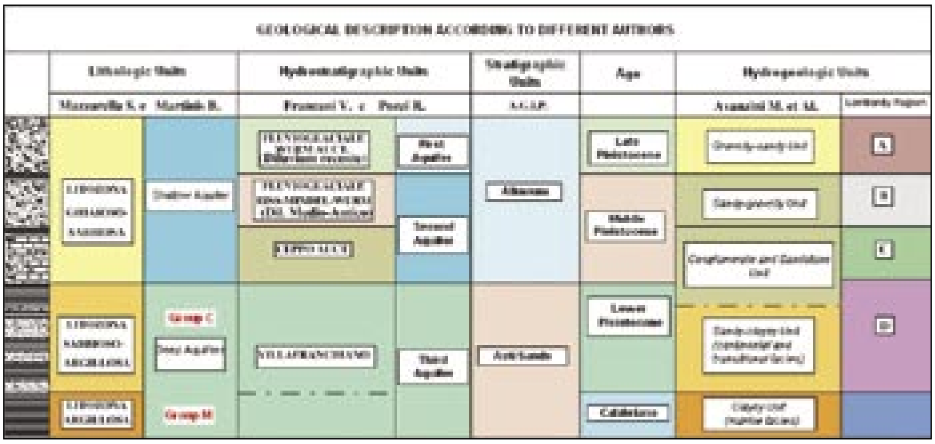


Figure 1. Stratigraphical sketch of the Milan Province quaternary deposits.

The hydrogeologic setting of Milan Province

Within the borders of Milan Province, a huge primary aquifer system, mostly in a phreatic, unconfined condition can be recognized, which results from the coalescence of the two/three litologic/hydrogeologic units, described in Figure 1.

The bottom of this aquifer can be encountered, on average, at 100 m beneath the ground level. It has a great yield, due to high transmissivity and saturated thickness, respectively of about $1\div2\cdot10^{-2}$ m^2/s or even greater ($1\cdot10^{-1}$ m^2/s) and up to 70-80 m. The isopiezometric map clearly shows the flow pattern of this aquifer (Fig. 2).

The principal direction of flow is commonly due south, but we can also observe a divergent radial geometry of the water table to the east and to the west in respect to the city of Milan, where we can see a prominent, convergent radial geometry, due to the abnormal pumping rates of the 70s and the 80s, mainly, which caused a large and deep depression of the piezometric surface, with a drawdown of the undisturbed water table of 30 m or more. The hydraulic gradient diminishes from north to south, varying from 1 % within the upper part of the province and 1÷2 ‰ in its southern portion. As regards the deep aquifers, at province scale, two main water-bearing systems can be recognized: the so- called C and M aquifers (C stands for continental and M stands for marine environment). Both of them are confined aquifers, with transmissivity values mainly ranging from $1\div2\cdot10^{-3}$ m^2/s to $8\div9\cdot10^{-3}$ m^2/s (see Tables 1 and 2).

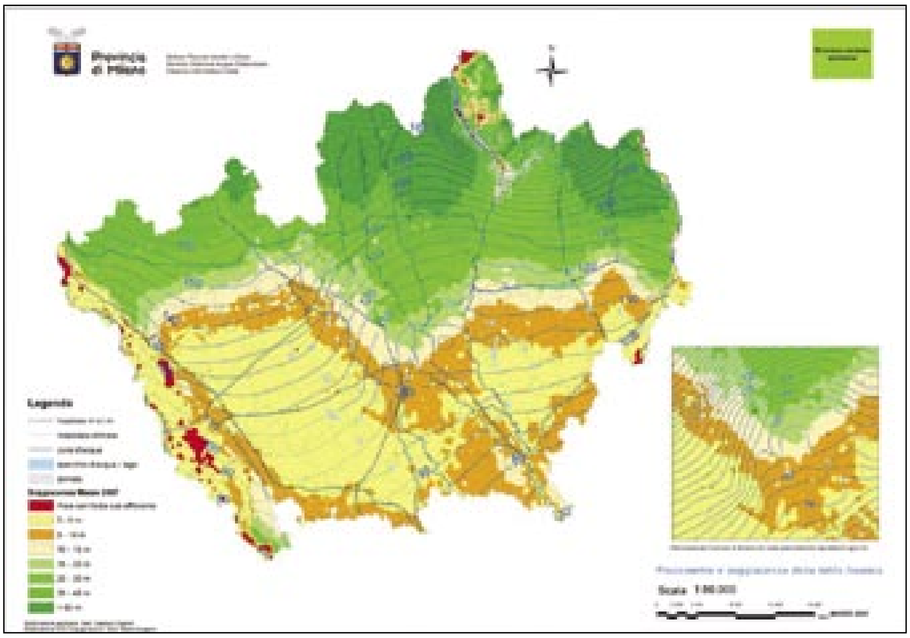


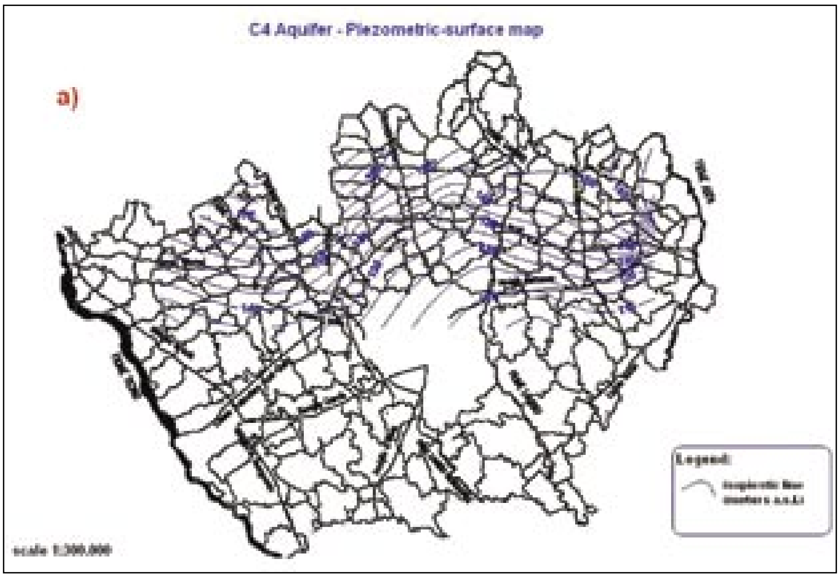
Figure 2. The flownet of the main phreatic aquifer within the Milan Province.

Table 1. Hydrogeologic parameters of the two main deep confined aquifers.

C4 Aquifer			
parameter	minimum	maximum	mean value
Transmissivity T (m^2/s)	1,1÷1,3·10[illegible]	8,1÷9,2·10[illegible]	4,9÷5,9·10[illegible]
Thickness b (m)	5÷8	24	15,8
Hydraulic Conductivity K (m/s)	8,5·10[illegible]	1,1÷3,3·10[illegible]	3,9·10[illegible]
Effective Porosity n_e (%)	5,3	10,1÷13,3	7,3÷7,8
Storage Coefficient S (adim.)	1,4÷1,5·10[illegible]	7,3·10[illegible]	4,75·10[illegible]
Hydraulic Gradient i (‰)	3,3 (west)	6 (east)	4,5
M Aquifer			
parameter	minimum	maximum	mean value
Transmissivity T (m^2/s)	1,1÷1,2·10[illegible]	1,2·10[illegible]	4,3·10[illegible]
Thickness b (m)	4÷5	26÷29	14,7
Hydraulic Conductivity K (m/s)	4,9÷5,5·10[illegible]	1,9·10[illegible]	3,7·10[illegible]
Effective Porosity n_e (%)	4,5÷4,8	11,6	7,7
Storage Coefficient S (adim.)	1,1·10[illegible]	1,1÷1,2·10[illegible]	4,4·10[illegible]
Hydraulic Gradient i (‰)	2,5 (west)	4,5 (east)	3,5

Table 2. Effective velocity and related time of travel for the main confined aquifers.

C4 Aquifer			
value	minimum	maximum	mean value
Effective velocity	3,40 m/day	12,8 m/day	2 m/day
	167 m/year	4695 m/year	733 m/year
TOT (years)	30	1,1	6,8
	100	6,4	41
M Aquifer			
value	minimum	maximum	mean value
Effective velocity	3,41 m/day	6,4 m/day	1,45 m/day
	151 m/year	2324 m/year	530 m/year
TOT (years)	33	2,15	9,4
	109	12,8	67



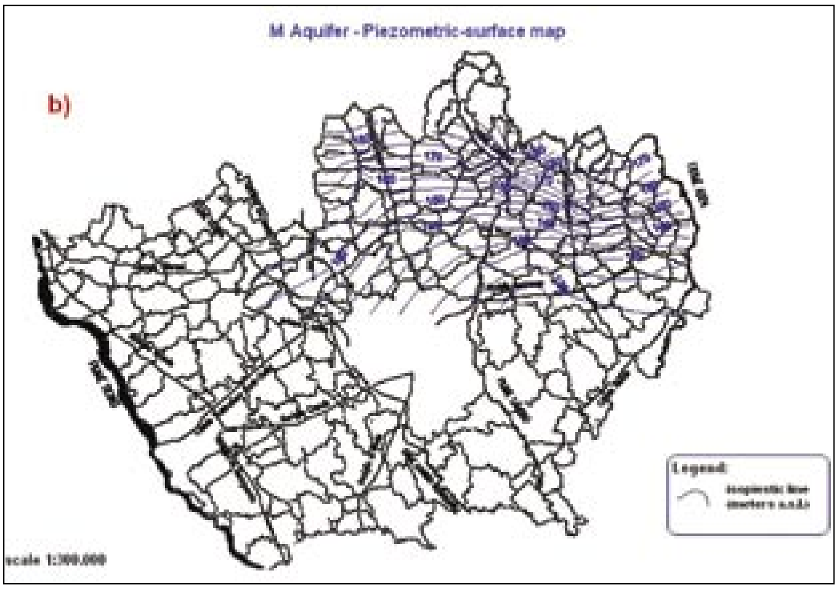


Figure 3a. Isopiezometric map of C4 aquifer. 3b. Isopiezometric map of M aquifer.

Velocity and time of residence in the subsurface were calculated. Table 2 shows the values obtained.

These are mostly wedge-shaped, with thicknesses ranging from 5-6 m, southward, up to > 20 m, within the highland zone, in the northern part of the province.

The flow pattern at provincial scale shows a principal flow direction from north to south, with a hydraulic gradient varying from 5÷6 ‰ upstream to 1÷2 ‰ downstream (Fig. 3a, b).

Tritium: a good tracer to determine the age of groundwater

Tritium is a natural unstable isotope, with a half-life of 12.43 years, commonly used to determine groundwater age, or better to estimate whether groundwater has been recharged before or after 1953 (after this, the radioactive fallout, due to atmospheric thermonuclear testing, became apparent and tritium levels increased during the following period.

The unit of measure of tritium in water is the tritium unit (T.U.). One tritium unit equals 1 tritium atom in 10^{18} hydrogen atoms. In SI units, one tritium unit is about 0.118 Becquerel per litre (Bq/liter), where the Becquerel is one decay per second. In picoCurie per litre, 1 T.U. is approximately 3.19 pCi/litre.

Scientists can also use the ratio of tritium to its decay product Helium-3 (^3He) to date groundwater (the $^3H/^3He$ method can be used to date groundwater recharged within the past 30 years). If all the Helium-3 was derived from tritium decay and from air, a sample's age can be calculated from the following formula:

$$t = (T_{1/2}/\ln 2) \cdot \ln[1+(^3He_{trit}/^3H)]$$

where: $T_{1/2}$ = 12.43, half-life of tritium, in years; $^3He_{trit}$ = amount of tritiogenic Helium-3 (^3He derived from radioactive decay of tritium in water), in T.U.; ^3H = sample's tritium concentration, in T.U.

T.U. can even offer a qualitative approach, that is to say we can have an idea of the groundwater's range of time, according to these references (Table 3).

Table 4 reports the tritium values for a group of deep groundwater samples.

Range of T.U.	Related ages
< 0,8	recharge before 1952
0,8 ÷ 5	groundwater age between 10 and 50 years
5 ÷ 15	groundwater age between 1 and 10 years
> 15	possible pollution

Table 3. References for groundwater age based on tritium level.

Sample (type of aquifer)	^3H (T.U.)
Carnate 23 (M2)	4,9
Carnate 24 (M3)	1,19
Garbagnate Milanese 5 (M1)	3,2
Marcallo con Casone 4 (C1)	24,2
Marcallo con Casone 6 (C4)	1,49
Paderno Dugnano 22 (M1)	1,19
Pregnana Milanese 3 (trad.)	31,7
Pregnana Milanese 4 (C2)	1,5
Pregnana Milanese 5 (C4)	0,79
Cogliate 6 (C4)	5,9
Cogliate 7 (M)	0,6
Usmate Velate 135 (M)	6,9
Usmate Velate 136 (C4)	8,9

Table 4. Values of T.U. for some confined groundwater samples

The i.e.b. ionic ratio

Schöeller, at the beginning of the 1960s developed a new method to get a clue about the "oldness" of a groundwater sample; he called it "alkali-chloride disequilibrium index" and he gave to it the form of an ionic ratio, as (concentrations expressed in meq/liter):

$$I.E.B. = [Cl^- - (Na^+ + K^+)]/Cl^-$$

this ionic ratio really being in direct proportion with "oldness" of groundwater, but giving only qualitative information. Positive values indicate a young groundwater, but negative values reflect a condition of oldness for the analyzed sample.

Thematic maps of i.e.b. can be compared for different times and so this operation can be useful to verify possible degradation of groundwater quality, for example a too rapid renovation of the resources, highlighted by an increase of the i.e.b. value (Fig. 4a, b).

The new curve tritium – i.e.b.

A new method to evaluate groundwater age is proposed here.

Using all the available data pairs ^3H (T.U.) – i.e.b. (meq/liter), a new calibration curve was developed. The numerical terms of the curve are:

^3H (T.U.) = $4.43e^{0,2 \cdot \text{i.e.b. (meq/liter)}}$

with a regression coefficient R^2 equal to 0,70.

And so, the curve i.e.b. – time of residence is:

time (years) = - 0.712 · i.e.b.^{2} – 12.484 · i.e.b.+ 20

or

log time (years) = - 0.725 · i.e.b.^{2} – 12.705 · i.e.b.+ 19,292

with a regression coefficient R^2 equal to 0.81. The two curves of interest are plotted in Figure 5.

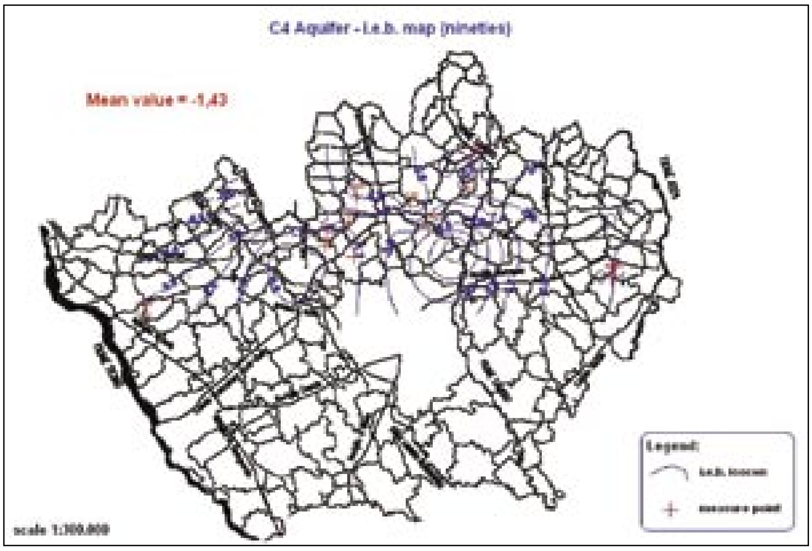
Initial results of the research

The curves proposed highlight respectively an exponential (tritium-i.e.b.) and a logarithmic trend (time-i.e.b.), with a direct proportion between these two variables.

The age of this deep groundwater encompasses a time span of about 50-60 years and matches perfectly with the values of time obtained using the hydrogeologic classical approach.

Conclusions

The initial results are very promising and so the basis on which the method was founded seems to be correct. These experimental curves can be considered a new practical, operative tool to manage the "blue gold" of the third millennium in an even better way, using simple laboratory analysis.



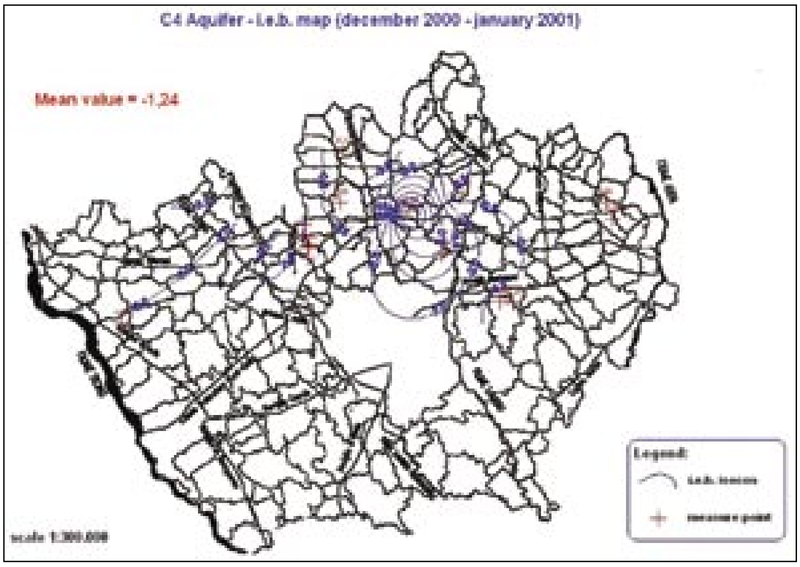


Figure 4a. i.e.b. map in the 1990s. 4b. i.e.b. map in 2001.

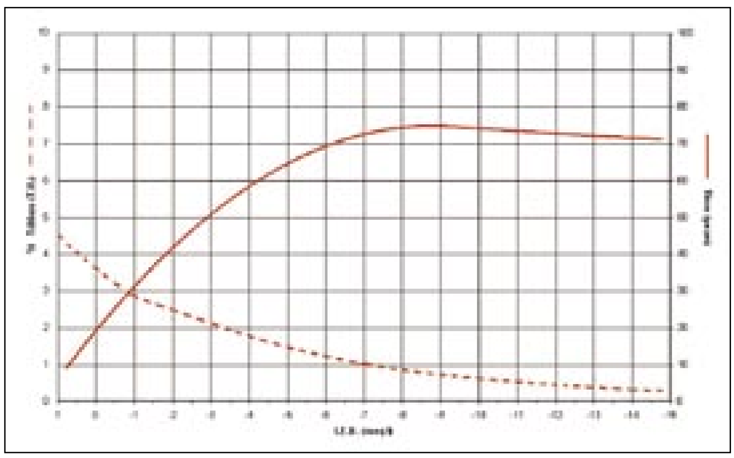


Figure 5. The tritium-i.e.b. curve and the time-i.e.b. curve.

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This paper will be presented at the 33rd IGC meeting in Oslo in August 2008

Darfur: conflict and water security in a vulnerable environment

by EurGeol. Geoff Wright[1]

Widespread armed conflict in Darfur since 2003 has displaced over 2.5 million people. Most of the camps for Internally Displaced People (IDPs) depend on emergency groundwater supplies from poorly permeable Basement Complex aquifers, and their sustainability after a poor rainy season is untested. Humanitarian Agencies have facilitated assessments of the groundwater resources in some of the most vulnerable camps, and instituted groundwater monitoring programmes. The initial monitoring data are yielding new information about the behaviour of the wells, the aquifers which they tap, and the recharge mechanisms on which they depend. As more data are generated, further insights are expected.

Le conflit armé s'étendant dans la région du Darfour depuis 2003, a provoqué le déplacement de plus de 2.5 millions de civils. La plupart des camps pour Personnes Intérieurement Déplacées (IDP) dépendent de l'approvisionnement en eau souterraine puisée dans les aquifères de faible perméabilité du « Basement Complex » et leur pérennité après une maigre saison des pluies est non vérifiée. Les Agences humanitaires ont aidé à l'évaluation des ressources en eaux souterraines dans quelques camps parmi les plus vulnérables et à la mise en place de programmes de surveillance des ressources en eau. Les premières données fournissent de nouvelles informations sur le comportement des puits, des aquifères qu'ils sollicitent et des mécanismes de recharge des réservoirs. Comme de plus en plus de données sont disponibles, des informations plus détaillées sont attendues

La extensión del conflicto armado en Darfur desde el 2003 ha desplazado a más de 2,5 millones de personas. La mayoría de los campos para Personas Desplazadas Internamente (IDPs en sus siglas en inglés) dependen de suministros de emergencia de aguas subterráneas, provenientes de acuíferos del escasamente permeable Complejo Basal, cuya sostenibilidad tras una estación de lluvias escasas, no se ha comprobado. Las agencias humanitarias han facilitado la evaluación de los recursos de aguas subterráneas de los campos más vulnerables y han establecido programas de control de los mismos. Los datos iniciales provenientes de dichos controles están aportando nueva información sobre el comportamiento de los pozos, los acuíferos de los que se nutren y los mecanismos de recarga de los que dependen. A medida que se vayan adquiriendo más datos, se espera obtener más detalles sobre su funcionamiento.

Darfur, once an independent sultanate, occupies the western part of Sudan, and is divided into three states - North, South and West Darfur. At the centre, where the three states meet, stands the extinct volcanic massif of Jebel Marra, rising to a height of over 3000 m above sea level. Around the Jebel lies a mountainous area of deeply dissected topography.

Since early 2003 there has been widespread armed conflict in Darfur, causing the displacement of over 2.5 million people. Many of these have fled to Chad or to other Sudanese states, but the majority have remained in Darfur as Internally Displaced Persons (IDPs). This substantial redistribution of the region's population has resulted in unprecedented concentrations of population, imposing very high localized demands on water resources. Over 2 million people, previously dispersed across a multitude of small towns and villages, are now living in camps, often around the major population centres such as El Fasher, Nyala and El Geneina, the capitals of the three states, North Darfur, South Darfur and West Darfur.

Relief agencies and societies, both national and international, have intervened to meet the humanitarian needs at the IDP Camps. Adequate safe drinking water supply is a prime concern for the relief agencies, and in such an arid area, groundwater must be the principal water resource. Unfortunately, most IDP camps are underlain by Basement Complex rocks which are poor aquifers, raising concerns about groundwater availability and vulnerability to depletion, particularly when 12 to 15 boreholes ran dry in Abu Shouk/Al Salaam camps. Uncertainty remains over water resources at many camps - including some of Darfur's largest camps, Otash, Kalma, Abu Shouk and Al Salaam.

The concentration of the population has resulted in significant adverse environmental impacts, especially on the region's forestry and water resources. Recognizing this, the relief agency *Tearfund* launched an initiative in 2006 which produced a report entitled 'Darfur: Relief in a vulnerable environment' (available at: *http://www.tearfund.org/darfurenvironment)*, to which I contributed. Subsequently, I visited Darfur again early in 2007 to examine the relative vulnerability of five large IDP camps (with populations of 50-100,000) to groundwater depletion, and to identify other camps potentially vulnerable to groundwater depletion.

The results of that study were summarized in another Tearfund report: 'Darfur: Water supply in a vulnerable environment' (available at: *http://www.tearfund.org/darfurwatervulnerability*). This report set out a number of recommendations. Some of the most important dealt with the urgent need to implement a programme of groundwater monitoring which would (a) help practitioners to understand the groundwater systems on which the camp water supplies depended, and (b) give advance warning of problems which are likely to arise in a dry year.

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MSc. Hydrology, UCL

Figure 1. WES (Water & Environmental Sanitation Department) Hand Pump No. 4 at Mornei IDP Camp, West Darfur

Later in 2007, the responsibility for pursuing these environmental studies was taken up by the United Nations Environment Programme (UNEP). Early in 2008 I returned to Darfur again on behalf of UNEP to review the progress which had been made over the last year.

Climate

Climatically Darfur ranges from arid in the far north, grading to semi-arid further south, to savanna-type in South Darfur. Since 1917, rainfall has been monitored at El Fasher, and at Nyala and El Geneina since 1946. At present, the rain gauges at the airports in the three state capitals are the only 'official' rain gauges in Darfur recognized by the Sudan Meteorological Service. In the past, a number of other rain gauges were operated and some data are available in various reports.

Annual rainfall in Darfur is very variable from year to year. There is a weak correlation between the rainfalls (annual or daily) at the three state capitals, showing that rainfall is often rather localized. From the 1960s to the mid-1980s, annual average rainfall decreased by around 30%. Since then it appears to have partially recovered, but is still significantly lower than in the 1950s, especially at El Fasher. There are rather few rain days in any year. Rainfall is largely confined to the months from June to September, although small amounts may fall in May or October, especially on the west side of Jebel Marra.

Evaporation is high, but decreases in the rainy season because of increased cloud cover, and decreases in the winter months as temperatures fall, so there are peaks in the early and late dry season. Open water evaporation rates at Nyala (HTS/MMP 1974) range from about 4mm/day in August to 11mm/day in March.

Groundwater Resources

The hydrogeology of Darfur has been well documented since the 1960s, but almost all of the attention has been devoted to the 'major' aquifers, the large sedimentary basins and the larger wadi alluvial deposits. Darfur has four basic types of aquifer:

Deep sedimentary basin aquifers (sandstones, with some mudstones):
Nubian Sandstone (North & South Darfur)
Umm Ruwaba Series (South Darfur)
Paleozoic Sandstone (West Darfur)

These aquifers (predominantly sandstones, but with substantial mudstone sequences in the Umm Ruwaba Series) are widespread in North and South Darfur, and occur to a lesser extent in West Darfur. They are characterized by a moderate to high permeability, deep water table and very large total storage capacity. Hence they are relatively invulnerable to drought and borehole supplies should be reliable for many years.

Wadi Alluvial aquifers, predominantly sands, have a high to very high permeability, a shallow water table and high specific yield. Where the aquifer is deep enough and the upstream catchment area large enough, water sources can survive at least one dry season, but many wadi alluvial aquifers are rather shallow and hold groundwater for only a portion of the dry season.

Volcanic rocks (e.g. basalt, tuff, variably fractured) occur in a relatively small, but important, area around the main massif of Jebel Marra, which rises to an altitude of over 3000 m. Groundwater occurs in fractures in the harder rocks, and also in the pore space of the less indurated ash deposits. The area of occurrence has relatively high relief, so water table gradients are steep and groundwater will tend to flow rather rapidly along the fracture zones. Groundwater often issues as springs. Due to the occurrence of mobile minerals in the volcanic rocks, the chemical quality of the groundwater is sometimes unsatisfactory.

Basement Complex rocks (metamorphic rocks, variably fractured and weathered) are very widespread in central Darfur, in all three states. Consequently, they underlie many (probably most) of the IDP camps with water supply problems. Until the 1980s, the Basement Complex in Sudan was hardly considered as an aquifer. All groundwater investigation and research concentrated on the deep sedimentary aquifers and, to a lesser extent, on the wadi alluvial aquifers. In the 1980s the use of geophysical surveys to optimize drilling sites, and the advent of 'down-the-hole-hammer' (DTH) drilling rigs, changed this situation, and made it possible to develop small water supplies from the Basement Complex. However, the current Darfur emergency has imposed much greater demands on water wells in the Basement.

The Basement Complex aquifer is characterized by zero intrinsic permeability, anisotropy, deep weathering along fracture zones, a surface regolith, low well yields (generally <1 litre/sec), significant incidence of dry boreholes, elongated 'cones' of depression along main fracture directions, and reduced permeability and storativity with depth. It can be expected that initial yields measured or estimated in short pumping tests may often be unsustainable in the longer term.

Recharge to the Basement Complex mainly depends on infiltration through the beds of wadis. The concentration of runoff leads to rapid saturation of the wadi sediments, which can then allow water to infiltrate deeply into the underlying Basement Complex rocks. Since wadis often flow along courses which pick out weaknesses (i.e. fracture zones) in the rock, they are often favourable routes for deep infiltration. Hence boreholes close to wadis are often the most favourable places to optimize well yields. Work in South Darfur near Nyala in the 1970s indicated that it requires about 6mm of rainfall to generate any runoff into local wadis, and that most wadis are fully recharged by the end of July in an average year. Direct recharge through superficial deposits may occur through sandy soils as a result of persistent rainfall on several successive days, but is unlikely to be large.

Basement Complex rocks in Africa are not usually considered to have the potential to sustain water supplies to urban populations of 30,000 or more people in a semi-arid area. In this context, what has been achieved in large IDP camps in Darfur is quite remarkable - camps of tens of thousands of people have been supplied with water for approaching four years (Fig. 1). What is surprising is that these supplies have been maintained for so long. This may be due to the relatively good rainfall in the past two rainy seasons (although 2004 rains were poor at El Fasher and about average elsewhere).

Groundwater quality is chemically and microbiologically acceptable for drinking in most of the camps. Water quality problems encountered include excessive nitrate and fluoride, and occasionally iron and manganese. Bacteriological contamination sometimes occurs, usually due to inappropriate proximity of wells and latrines.

Water wells are routinely sited using geophysical surveys (electromagnetic profiling, and vertical resistivity sounding and profiling).

Approaches to assessing groundwater sustainability at IDP camps

The assessments made use of records of water provision in camps, including drilling and pumping records, field observations at camps, discussions with stakeholders in Darfur and Khartoum, and previous hydrogeological reports in Sudan and the UK.

Essentially, two approaches were used in the groundwater assessments:

- physical evidence (groundwater levels, groundwater monitoring, or evidence of boreholes drying up) to demonstrate the extent, if any, of groundwater depletion
. a Water Budget approach, looking at the likely recharge to the local aquifer, the apparent groundwater catchment, the current withdrawals of water from the aquifer, and the likely balance, or lack of it, between the two.

The first approach is preferable, but depends on the availability of suitable data. At Mornei, the data demonstrated clearly that no groundwater depletion has occurred or is likely to occur. At the camps near Nyala (Kalma and Otash) there were insufficient data to allow any firm conclusions to be reached, and a water budget approach was adopted. However, the water budget approach was hindered by any clear evidence as to the actual zones of contribution to the boreholes, and the conclusions reached are tentative. At El Fasher (Abu Shouk/El Salam camps) there are some water level data, and reasonably good evidence of reducing yields in a number of boreholes, so the assessment combined both approaches.

Progress since 2007

Since early 2007, when there was virtually no groundwater monitoring in Darfur, considerable progress has been achieved. Thanks to significant investment by UNICEF and Oxfam, about 50 water level loggers have been installed in wells, manual dipping is undertaken in several other wells, and there are plans for the installation of additional loggers and for more manual dipping. Rain gauges have been installed at several sites, and more are planned. Initial datasets have been derived from most of the monitoring wells, and preliminary interpretation of the data is already helping our understanding of the aquifers' response to pumping and recharge. The initial datasets are also helping to show how future monitoring should be managed.

The monitoring data available so far have revealed a wealth of information about the behaviour of the wells themselves, the aquifers in which they are located, and the recharge mechanisms on which they depend. As more water level data are collected, and additional data generated (e.g. wellhead levels, surface water observations, local rainfall measurements), even more insights will be obtained.

The 2007 rainy season generated good quantities of groundwater recharge. In some wells, individual recharge events can be identified, and some correlations can be made between rainfall and recharge events. It may be possible to compare rainfalls with water level rises and derive approximate values of specific yield.

Wadi flows are vital to the recharge pattern. The monitoring in some locations demonstrates how recharge begins in the wadis and khors and then disperses laterally into the Basement Complex. Recharge also occurs to the deep sandstone aquifers where wadi flow concentrates runoff into discrete locations.

Drawdown data from pumped wells, and from observation wells near pumped wells, can be used to derive approximate values for aquifer transmissivity and (in observation wells) storativity.

When I first worked in Darfur in the early 1970s, the Basement Complex was scarcely considered to be an aquifer at all. What is taking place now is like a major experiment; just how good an aquifer can the Basement Complex be, and how sustainable are the water supplies which draw from it? The work done during the current emergency is teaching us much more about the Basement Complex as an aquifer and, perhaps to a lesser extent, about the volcanic rocks. When the conflict is over and reconstruction is possible, this new knowledge, if properly documented, should be of great benefit in facilitating new development.

Acknowledgements:

The Tearfund work team in 2007 included Hamid Omer Ali, Ahmed Hussein Maneise (Hydrogeologists) and Brendan Bromwich (Water and Environment Engineer). For the 2008 work I am again indebted to Brendan Bromwich (now with UNEP), Hamid Omer Ali (UNEP consultant), Ahmed Hussein Maniese (now with Oxfam), as well as St John Day (Oxfam), Clive Bates (UNEP), and numerous staff of UNICEF, Oxfam, Tearfund, Care International, and other humanitarian agencies, and staff of the Ground Water and Wadis Directorate, Ministry of Irrigation and Water Resources, Sudan, and of the Water & Environmental Sanitation Departments,

Geodiversity and the sustainable development of the regions

Short overview of the Taiex workshop 8 – 10 October, Sibiu, Romania

by Hanneke van den Ancker[1] and Patrick McKeever[2]

From 8-10 October 2007, about 70 participants from 25 countries across east and west Europe assembled in Sibiu, Romania, for a TAIEX Workshop on '*New Practices in Geodiversity for the Sustainable Development of the Regions'*. The Workshop was organized by the European Federation of Geologists (EFG), the European Geoparks Network (EGN) and the Hateg Country Dinosaurs Geopark in Romania, with support from the Geological Survey of Romania.

TAIEX (Technical Assistance and Information Exchange) is an instrument of the Directorate-General Enlargement of the European Commission aimed at transferring expertise and experience from the older member states to the new member states, candidate countries and potential candidate countries and territories, through short courses and workshops. In this case, the objectives were to disseminate good practices in the use of geodiversity and geoconservation for sustainable development in Eastern Europe.

The first day's programme was about involving new and potential member states in the European Branch of the Unesco Geopark Network *(EGN)* explaining the aim of the geoparks, how to become a member and how to make a management plan. Next, participants were introduced to relevant EU legislation and the Framework Programme 7. Then some of the best practices in raising awareness of the public and school education programmes and local product development were presented.

The visit to Hateg Country Dinosaurs Geopark, the first of only two Geoparks in Eastern Europe, was very useful in realizing and discussing the many practical difficulties many new member states experience when starting up geo-tourism and education. Apart from the limited financial possibilities, very often tourist infrastructure such as brochures, walking paths, tourist offices, restaurants and hotel accommodation are totally lacking. Then social and language problems have to be overcome.

[1]EFG coordinator Soil Heritage and Geological Heritage
[2]EGN coordinator European Geopark Network

The third day of the workshop was devoted to improving the role of geosciences in landscape planning through new land planning approaches such as the seven EU soil functions, panarchy, university education and research and the importance of a quality guarantee such as the certification of the profession.

The articles

The articles in the following pages give you an impression of the workshop. The first introduces the concept of geodiversity and gives an overview of recent European developments in geodiversity and geoconservation. There follows a series of short articles in which a practical introduction is given to the Unesco European Geopark Network. The last article is about panarchy, the interaction between physical and social systems, and introduces you to modern new lines of research; how small-scale human intervention over time through many gradual Earth Science processes can eventually lead to a large mass-movement. Or how legal measures are often directed at the wrong phase of the land restoration process, for example erosion-combating measures starting off while the soil already is eroded.

Results of the workshop

Probably more plans and ideas arose during the workshop than can be realized in the near future. The members of the European Geoparks Network realized the importance of twinning and mentoring for involving new member states in their network. They will try to set this up within the next half year. Croatia, present with many interested members, is already active in working on Geoparks and promoting geotourism. For them the workshop was very useful through its many practical examples. The three Baltic countries: Estonia, Latvia and Lithuania decided to work together in establishing geoparks as well as to organize a next Taiex workshop on Sustainable Coastal Management. Also the Polish participants announced the start of a coastal geopark and will try to start up an Interreg project on Integrated Coastal Zone management. The Turkish participants will organize a meeting promoting the Geopark and geodiversity concepts next year within their country. Bulgaria, Serbia and Slovenia agreed to discuss and further follow up the ideas of Geoparks, geoconservation, geotourism and geodiversity with their governments and tourist institutions. Assistance to Bosnia-Herzegovina was offered by Romania concerning the problems they encounter with water in the former salt mines. The need for more books and handbooks for a sustainable regional development of the regions was realized. A meeting with DG Research is scheduled to discuss the issues and problems encountered. Progressing further collaboration on the issues of geoconservation and geodiversity within the diverse range of Earth Sciences organizations and the setting up of international university courses is also a result from the workshop. The list is already quite long.

Acknowledgement

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Geodiversity and the sustainable development of the regions

by Murray Gray[1] and John Gordon[2]

Just as biodiversity is the variety of living nature, so we can use the term 'geodiversity' to describe the variety of non-living or abiotic nature. More specifically, geodiversity is "the natural range of geological (rocks, minerals, fossils), geomorphological (land form, processes) and soil features" (Gray, 2004). There are, for example, about 5000 named minerals that combine to form thousands of rock types. There are also millions of fossil species. The USA alone has 19,000 named soil types. In addition, there is a great diversity of physical processes - fluvial, coastal, glacial, slope, aeolian, hydrological, volcanic, tectonic - and a huge variation in land form and topographic character. The conclusion must be that there is as much geodiversity in the world as biodiversity.

This geodiversity is important both as an intrinsic part of the natural heritage and because it provides a foundation for biodiversity and many aspects of our cultural heritage. It has provided a wide range of sites, materials and processes that human ingenuity over the millennia has exploited in many ways. It also contributes to sustainable economic development through local community involvement in geotourism and confers public health benefits through opportunities for outdoor recreation and enjoyment of the natural world. In fact, it is possible to identify over 30 separate values of geodiversity (Gray, 2004), ranging from aesthetic values of landscape, through the economic value of building materials to the research value of the fossil record and the evidence it provides to support the theory of evolution. However, this geoheritage is threatened by a range of human actions and activities (Gordon, 2004) and these can result in loss, damage or pollution of elements of geodiversity (e.g. Fig. 1). This leads to the conservation equation:

value + threat = conservation need

since features that are of value but threatened need to be protected.

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Geodiversity and the conservation of sites

Over the last 100 years or so, many European countries have developed complex nature conservation systems that can benefit geoconservation. In some cases, general protected area designations may, fortuitously, include geoheritage features (e.g. national parks, nature reserves, national monuments, natural parks and natural heritage areas). In other places, specific geological protected areas have been established (e.g. geotopes, geosites, fossil reserves and geological monuments). Some of these national systems have developed in an *ad hoc* fashion, often designating geomorphological curiosities rather than giving priority to scientifically important sites, such as stratotypes. Arguably, it is now expedient to reassess the value of, and threats to, our geoheritage and the approaches to geoconservation. The new paradigm of 'geodiversity' provides the fundamental basis for valuing and conserving abiotic nature at both national and international levels.

At the national level, many countries have selected geoconservation sites in order to provide representative examples of the range of the nation's geology and geomorphology (i.e. geodiversity). For example, a new geoconservation programme - the Irish Geological Heritage programme - has been initiated in Ireland. Sixteen geological themes have been identified and each "is intended to provide a national network of Natural Heritage Area sites and will include all components of the theme's scientific interest" (Parkes & Morris, 2001).

Geoparks

There have also been attempts to co-ordinate international geoconservation, though not always successfully. In particular, most of the world's important Global Stratotype Sections and Points have no *international* protection. Only two world-wide geoconservation series exist at present - World Heritage Sites and Global Geoparks - though neither of these has adopted a systematic global approach. In particular, Global Geoparks are now UNESCO supported and as of October 2007 had 55 members, 32 in Europe, 20 in China, and one each in Iran, Brazil and Malaysia. The aim of Geoparks is to enhance the value of nationally important geological sites while creating sustainable development, employment and geotourism as part of an integrated programme (Eder and Patzak, 2004). Geoparks should:

Figure1A. Quarrying destroying a volcanic cone, Pico, Azores, Portugal (Photo: Murray Gray).

- encompass sites of scientific importance for geology, but may also include archaeological, cultural and ecological heritage
- have a management plan that fosters sustainable geotourism and socio-economic development
- provide a means of teaching geoscientific principles and broader environmental issues
- be part of a global network that demonstrates best practice in geoconservation and its integration into sustainable development practices.

Local involvement is essential, with applications coming from local communities and local authorities committed to developing and implementing a management plan that promotes and protects the geodiversity of the local landscape and meets local economic needs.

Several presentations at the TAIEX workshop covered experience from existing European Geoparks in Germany, Greece and Ireland, with the aim of helping potential new applicants. The discussion included issues of applying for membership, managing Geoparks and obtaining funding. There were also presentations on the only Geopark in eastern Europe, the Hateg Country Dinosaurs Geopark about 100km from Sibiu. The second day of the Workshop involved a fieldtrip there, led by Professor Dan Grigorescu from the University of Bucharest, to look at dinosaur sites, the remarkable Orthodox Church at Densus with its recycled Roman building stone and to meet the local people responsible for managing and developing the Geopark (Fig. 2). The hope is that economic development can result from sustainable geotourism in the Geopark.

Geoconservation in Great Britain

Great Britain arguably has the best developed geoconservation systems and methods anywhere in the world. The cornerstone is the Geological Conservation Review (GCR) network of c.3000 scientific sites which have been distilled into c.2300 Sites of Special Scientific Interest (SSSIs) which have statutory protection. The GCR sites are being described in a series of 45 scientific volumes that will be completed in the next few years (Ellis *et al*., 1996). Other geoconservation sites are designated as National Nature Reserves, and there is separate legislation protecting c.100 Limestone Pavements. There is also an important legislative link between nature conservation and spatial planning. New national planning guidance on 'Biodiversity and Geological Conservation' (PPS9) was published in England in 2005 and gives much more prominence to the conservation of the country's geodiversity sites within the planning system.

There is also an informal series of c. 2500 Regionally Important Geological/Geomorphological Sites (RIGS) being developed by local (RIGS) groups throughout Britain. Many of these sites are important for educational purposes without having the national importance of SSSIs. Many of the RIGS Groups are also developing Local Geodiversity Action Plans to guide future local work on geoconservation. There is also national guidance for good practice in site management (Prosser *et al.,* 2006), a state of nature report on geodiversity for England (Stace & Larwood, 2006), a Scottish Fossil Code, an emerging National Geodiversity Action Plan and development of country soil protection policies.

Raising wider awareness has been a key part of geoconservation activity in Britain and Ireland, including engagement with the minerals industry, planners and others. In addition, a variety of forms of interpretation based on the themes of 'reading the landscape' and 'landscapes from stone' have been used widely to add value to the appreciation of rural and urban landscapes by visitors and local people (e.g. Gordon *et al*., 2004; O'Connor *et al*., 2004).

Figure1B. Graffiti on the wall of the lava tube at Grutas das Torres, Pico, Azores, Portugal (Photo: Murray Gray).

"Protecting Beyond the Protected"

The protected area approach to geoconservation has worked well where it has been actively adopted and integrated into land-use planning systems. However, in the last 20 years, there has been a growing dissatisfaction within nature conservation circles with an approach that relies solely on protected areas to conserve nature. For example, Myers (2002, p.54) argued that "setting aside a park in the overcrowded world of the early twenty-first century is like building a sandcastle on the seashore at a time when the tide is coming in deeper, stronger and faster than ever". In other words, protected areas are seen as becoming isolated from each other and vulnerable to human impacts. What is needed is a less fragmented approach to nature conservation that values nature wherever it occurs.

What has become known as the 'wider landscape', or simply 'landscape' approach began in relation to protecting fauna, which is dynamic and cannot identify when it is leaving the protection of a designated area. Thus the idea of 'wildlife corridors' or 'greenways' linking protected areas emerged, which could allow wildlife to move along these corridors. In this way, the matrix in which sites sit is given greater significance in landscape ecology. In some countries, whole ecological networks of protected areas linked by these corridors have been or are being created, at least on paper. Subsequently, the concept of biodiversity has extended nature conservation philosophy to the whole landscape, including urban areas, identifying the need to protect habitats and species wherever they occur.

Similar arguments can be applied to geodiversity since it also occurs everywhere, even in cities. We therefore also need a 'landscape' approach to geoconservation where sites are seen in a wider context and topography and processes are respected wherever they occur. This means that geoconservation merges with a wider land management approach that should bring understanding of geomorphology and soils into a more central role in nature

Figure 2. The TAIEX party being greeted by local representatives at the Hateg Country Dinosaurs Geopark in Romania, 9 October 2007 (Photo: Murray Gray)

conservation and the sustainable management of land and water (e.g. Gordon & Leys, 2001; Gordon, 2004). In particular, sustainable solutions depend on working in sympathy with natural processes at appropriate spatial scales. This is well exemplified in integrated catchment management and shoreline management planning. Some examples can be given.

First, integrated catchment management offers the potential for consensus-based management across a wide geographical area, founded on an understanding of physical processes, land use and other human activities. It should allow an integrated approach to issues such as accelerated soil erosion, sedimentation, river erosion and flood management. From a geological point of view, catchment management is particularly important for the conservation of underground caves since the whole river catchment needs to be managed in order to protect the caves from enhanced sedimentation and pollution arising from soil erosion and from streams flowing into them. Similarly, coastal process systems operate over many kilometres of coastline so that coastal management requires an understanding of the coastal circulation cells at this wider landscape scale.

Second, in many rural areas of Europe the topography is essentially natural, even if modified by centuries of agriculture. Conservation of natural topography is about retention of contour patterns. Too often, topography is remodelled unthinkingly to create golf courses, agricultural reservoirs and diverse wildlife habitats, for example. This needs to be planned so that the topographies created are geomorphologically authentic.

Third, there is an important role for landscape restoration in which processes and landforms are returned to a more natural state, with benefits not only from enhanced quality of geodiversity and biodiversity, but also from contributing to more sustainable land and water management, particularly in relation to flood mitigation through river floodplain restoration and managed realignment at the coast. On the Portuguese island of Madeira, most of the rivers are heavily channelized so that they do not operate as natural rivers. Yet in many European countries, river restoration schemes have been instituted to allow rivers to operate under more natural conditions. Similarly on the south-east coast of England, flood embankments have been breached in several places, allowing the sea to reoccupy arable fields that were reclaimed from saltmarsh land in the last century or earlier.

Fourth, restoration of quarries and mining landscapes provides opportunities not only for geoconservation through the establishment of permanent conservation sections, but also for geotourism, enhancement of biodiversity and the provision of greenspace for public recreation. Such restoration should therefore be planned in an integrated way that maximizes multiple benefits. This is well illustrated in the case of the Abberley and Malvern Hills Geopark in England.

The landscape approach is one that leads inevitably to closer integration of wider nature conservation objectives and to sustainable land management approaches that include geodiversity, biodiversity and cultural diversity across Europe.

Conclusions

Our planet has a huge physical diversity, a geodiversity, that is valuable in many different ways but is threatened by a large number of human activities. There is therefore a need for its conservation, and site selection ought to be based around choosing a network of features representative of the geodiversity of a country or region. But geoconservation needs to extend beyond protected sites into the wider landscape to ensure that natural topography is protected and natural processes continue to operate. This takes geoconservation into the field of sustainable land and water management at a particularly crucial time in view of projected climate changes and rising sea-levels and in the context of implementation of the Water Framework Directive, the Directive on the Assessment and Management of Flood Risks and the proposed Soil Framework Directive. Finally, Geoparks offer significant potential to stimulate sustainable development through conserving geodiversity and at the same time promoting economic development of the regions.

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Developing a community based Geopark: the Copper Coast Geopark, Ireland

by John H. Morris[1]

The Copper Coast Geopark (CCG) is located in southeast Ireland, and covers an area of about 120 km^2 (Fig. 1). The remains of a 19th century copper mining complex lie at its heart, and the local communities chose the name for their region to reflect the historical, technical and social legacy bequeathed to them by that industry. In 1997, five local community groups established "Copper Coast Tourism" as a voluntary organization to focus upon developing inward tourism into the region. They recognized the value of the copper mining heritage, and its geological context as a key attraction. They established a "geological garden", published various information, walking trail guides, information plaques, and opened a small Heritage Centre. In parallel, they requested GSI to produce a set of geological guides to the region, published in 1999. This established a strong and enduring relationship between GSI and the Copper Coast, and facilitated pursuit of a number of subsequent opportunities.

The European Geoparks Network was established in 2000. With the encouragement and support of GSI, the Copper Coast applied for, and was granted membership in 2001. CCG is unusual as, unlike most other European Geoparks, its ownership and operation is based within the community, rather than being owned, managed and funded directly or indirectly by Government agencies or bodies. GSI acted as a key partner to CCG in two subsequent EU-funded projects: INTERREG 3C and, most substantially, INTERREG 3B NW Europe. The latter provided a gross budget of c. €1.6M to facilitate a range of major Geopark infrastructure developments necessary to underpin the continued existence of CCG into the future, for example, road signage, information panels, acquisition and conservation of an iconic copper mining heritage complex, numerous publications, development of schools and general public educational activities, and operation of a combined bistro and heritage centre in temporary, rented premises.

But above all else, people lie at the

Figure 1. Tankardstown. A view of the iconic Cornish design Engine House complex at Tankardstown. This formed part of an extensive 19th century copper mining district, from which the "Copper Coast" derives its name.

[1]Geological Survey of Ireland (GSI)
www.coppercoastgeopark.com

heart of all that has been achieved. The CCG initiative has created a number of community-based activities: twinning between villages; a Women's Initiative Group which sought to develop upon concepts developed in the Petrified Forest of Lesvos Geopark, Greece; and provision of a facility for community events (including a variety of themed lunches, an Easter Festival, a German Christmas market, and a number of courses, ranging from mosaic to basket weaving and wreath making).

The twinning programme is arguably the most successful development. The village of Bunmahon in the CCG is now twinned formally with Strohn, Vulkaneifel Geopark, Germany and Gams, Eisenwurzen Geopark, Austria. There have been numerous exchange visits by adults and student groups between these villages, and organization of various festivals, including a choral festival in CCG in 2006 (Fig. 2). The success of these events is now contributing towards acquisition and development of a facility which will provide a permanent home for all such activities, as well as provision of new facilities, such as a community records and performing arts centre, a field studies classroom and a "youth café".

Figure 2. International Geoparks Choral Festival held in Bunmahon, Co. Waterford in 2006: a view of some of the adult choir members, beside the Twinning sign in Bunmahon.

Development of geoconservation and geotourism in Europe

from European Geoparks and the European Geoparks Network

European Geoparks aim to explore our geological heritage, trying to combine geoconservation, sustainable development, education and value creation. Across Europe there are examples of landscapes and rocks that provide key evidence of a particular moment in Earth history and they are too a part of our geological heritage, which in many ways is as diverse and interesting as the multicultural heritage of Europe's many regions. In addition there is an increasing acceptance of the need not only to preserve but also to enjoy our geological heritage. This gives the opportunity to support rural regions' economic development by establishing a special kind of tourism. Geoparks are carriers that appoint the geological monuments of each location, offering visitors the opportunity to admire these breathtaking monuments of nature and to participate in numerous creative and pleasant activities through which they best learn the exact nature and creation of these geotopes.

The founding of the European Geoparks Network and its fast development as well as an official agreement of collaboration with UNESCO confirms all of the above. The coordination of actions and the cooperation among the most important European Geoparks contributes towards the further development of Geotourism, the evolving of new initiatives, the participation in European Union programmes and the exchange of knowledge and expertise between the members, as they seek the best methods for geoconservation and the promotion of their regions.

The European Geoparks Network concerns itself with the conservation of unique geological regions across Europe and the communities found within them along with education of the public. In order to achieve this, Geoparks need people to come and visit them. Therefore the European Geoparks Network has been very busy since its inception in June 2000 with the tasks involved in developing and promoting geotourism. Members have constructed a main website, annual magazine, many leaflets and posters, a cd-rom promoting the EGN as a tourist attraction, a promotional corner for every Geopark that familiarizes visitors with all other geoparks in the Network, and various souvenirs, with great success. It is not only people's interest that has focused on Geoparks. Many regions across Europe have shown interest by applying to become Geoparks. Any region possessing geological uniqueness and wishing to develop a European Geopark may complete and submit an application dossier. From four original Geoparks in 2000 there are currently 32 European Geoparks from 12 countries joining the Network, while many other territories rich in geological heritage have expressed their will to join the Network. The establishment of an evaluation process (applied every three years) within the Network makes sure that the Geoparks keep providing excellent services and products to their visitors.

An exciting journey into the boiling past

by Dr. Andreas Schueller[1]

The Vulkaneifel displays many unique geological phenomena that have significant international importance for natural science. Topical research projects lead consistently to new perceptions, but also to new questions. The geo-museums of the Vulkaneifel are the locations in which to explore and be informed about its origin and its development. They are the key to the understanding of this impressive scenic area and its history. Each museum is centred around specific topics and is dedicated to the corresponding facets with regard to geo-scientific, natural, historical, cultural, and technical relations to the Vulkaneifel. Besides the exhibition and explanation of geological features within the Vulkaneifel, the geo-museums also explore relevant topics relatined to its cultural and industrial history.

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Children amazed by volcano eruption (Photo: H. Gassen)

Understanding by experience

This is the common didactic basic concept. See, feel, smell, listen, using all senses, thus making complex interactions transparent and truly "comprehensive". There is a wide range of target groups, and even the scientifically experienced visitor will find something new. Children of all ages become acquainted through play with the topics; let us say there is a "fun factor". Additional and in-depth events are also offered by the museums, such as guided museum tours, excursions, workshops, open lectures, exhibitions, and special programmes for children and school groups.

Lesvos Museum – education offer to school children

by Ilias Valiakos

The Natural History Museum of the Lesvos Petrified Forest located in Sigri, Lesvos Island, Greece was established in 1994 and aims at the study, research, promotion, conservation and preservation of the Lesvos Petrified Forest.

The Museum includes two permanent exhibition halls, the first dedicated to the Petrified Forest and the evolution of plants and the second to the volcanic activity and evolution of the Aegean. It has also a temporary exhibition hall, open air amphitheatre, library, fully equipped research laboratories, audiovisual room, cafe, museum shop, as well as accommodation facilities for visiting researchers. It includes suitable infrastructure for research and study of the Petrified Forest.

The Museum integrates the preservation of the Petrified Forest and other significant elements of the geological heritage of Lesvos island in a strategy for regional sustainable socio-economic and cultural development, safeguarding the environment. Its premises provide the venue for international scientific conferences, educational programmes, cultural events, exhibitions, scientific meetings, lectures and audio-visual presentations.

The Natural History Museum of the Lesvos Petrified Forest functions simultaneously as a centre of knowledge, education, study, inspiration, fun and recreation.

It provides an opportunity to schools from all over Greece and abroad to participate in one or more of its 28 education programmes. These programmes aim to communicate geoscientific knowledge and environmental concepts to the public. They are broad in content and duration (from 1 day up to 5 days), and specifically adapted to the needs and theme of particular visits.

The objective of the education programmes is for students to get acquainted with the Petrified Forest of Lesvos, to experience the varied and intact natural and geological environment of Lesvos, and to enjoy the sights of historical, archaeological, religious, environmental and folklore interest.

The aim is to bring children into contact with the subjects of natural history, the permanent and temporary exhibits, to tweak their imagination and their interest in the planet, the history of the development of life, the importance of geotopes, natural processes, the protection of ecosystems, and modern environmental problems, by allowing them to express themselves creatively in the space of the Museum.

Depending on the theme, the educational programmes include tours through the exhibition halls, the laboratories and in the parks. The tours encourage the active participation of the children in their observations and discussions on the exhibits. The visual and aesthetic stimuli that engage the children at the briefing carry over into educational activities such as their own pictures and crafts through games with different materials.

Museum inside

With the completion of each programme, each student takes home a specifically designed booklet, which he/she can process alone or with the remainder of the team at school.

The precise programme of each visit is prepared by the Museum depending on the objectives, interests and wishes of teachers and students via direct contact between the Museum's staff and school teachers.

Local art in the activities of Psiloritis Geopark, Crete

by Zacharenia Zskoula[1]

From ancient times until today the beautiful environment of Psiloritis Mountains and region has influenced indigenous civilizations. The high geodiversity and biodiversity is reflected in architecture and most certainly in art. The dry stone shepherds' houses "mitata" which illustrate the integration of local people with the environment, as well as the spectacular finds and wall paintings from the Minoan Era inside the cave of Ideon Andron in the Nida plateau are merely a few examples of the integration of this environment with the communities which have lived there.

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Today, this territory hosts numerous settlements where local people, with tools fashioned from the natural environment, as well as their imagination triggered by this environment, create art. This ranges from paintings illustrating landscapes to wood, stone and wax sculptures that represent native animals and local people to glass and ceramic handcrafts and other useful objects. In addition, local art includes the manufacture of musical instruments and traditional textiles. All these products have one common feature: they are made from natural materials from the area of the Psiloritis Geopark and represent something commonly found in it.

AKOMM – Psiloritis S.A., the management body of the Psiloritis Geopark, has put as a major priority the efforts of encouraging, enhancing and promoting this art, not only for preserving it but also for disseminating it to the World. In order to achieve this, strong relationships with the local communities and artists are achieved through the organization of numerous art exhibitions, workshops and contests.

The building of strong relationships is based on contracting the artists to the Psiloritis Geopark and informing them on issues related to the existence and targets of the European Geoparks Network and the Global Geoparks. The contract strives at incorporating into their work specific themes -monumental ones- of the Psiloritis Geopark, which contribute to the Geopark's effort to enhance geotourism in its area. In addition, the Geopark has organized a large number of exhibitions which sometimes include the participation of artists from other European Geoparks. Such exhibitions have taken place in the Armi Square in Anogia (Fig.1) and in Margarites. Additional activities have also been implemented, such as the paint festival in Gergeri Village.

A significant outcome of these efforts is that local artists have been educated about the fossils and other geological features of their territory and are now making representative objects of these. This will assist in preserving the fossils of the geopark while it is strongly believed that the overall effort will certainly give stimulus for new economic activities in the area.

A widely-embraced course of action is the release of a logo for the Psiloritis Geopark (also known as the "Psiloritis Natural Park") which is now being incorporated in all handcrafts and visitors' souvenirs that local artists produce. Furthermore, a booklet will soon be published that will include all Psiloritis Geopark's artists and samples of their magnificent creations.

Figure 1. Exhibition in the Armi Square in Anogia.

Geosites in the Bergstrasse-Odenwald Geopark, Germany: an integrated approach

by Claudia Eckhardt[1] and Dr. J. Weber[1]

The membership of the Geopark Bergstrasse-Odenwald in the Global and European Geoparks Networks and the related commitment to the philosophy and objectives determines the overall strategic approach of the Geopark towards the protection and promotion of geological heritage.

One of the essential prerequisites for the enhancement of public appreciation and understanding of our geological heritage is the provision of adequate conditions to "use" in the sense of to "adapt" and to "experience" a geosite. That implies site accessibility, qualified interpretation and different options to experience a location.

The process of site selection, establishment of site infrastructure and the development of visitor programmes are performed as a multi-stakeholder process in order to consider all relevant concerns with regard to site protection and sustainability of use.

Geoscientific aspects as an essential information base for decision making are provided by the expertise of Geopark staff and by the geotope database of the geological surveys (at state level). Once a geosite has been pre-selected based on its scientific significance (including the value of the site as a location for public presentation and the consideration of existing site specific sensitivities), a round table with relevant stakeholders is established. Depending on the nature of the site, representatives from different administrations (nature protection, forest, agriculture), tourism institutions, the education sector, private businesses, NGOs and local stakeholders are involved in site development together with the Geopark administration and the geological surveys.

In addition to geoscientific aspects, existing sensitivities with regard to natural habitats, tourism potential (activity based

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Figure 1. Assessing options for outdoor education together with the target group

Figure 2. Information boards at the Geosite

and experience-oriented tourism), options for outdoor education (Fig. 1), the connections of geological heritage to cultural heritage and the general feasibility with regard to performing "Geopark events" are assessed. The result of the process is an integrated management concept targeted to the respective geosite with agreed tasks and shared responsibilities. The enhancement of local commitment is one important pillar for the sustainable use of a geosite. In this context the "Geopark on site" programme provides training for local residents who want to present their geological and cultural heritage. Up to the present, more than 150 Geopark on Site guides have been trained and, together with the Geopark Rangers, are actively involved in the presentation of geosites.

Currently, a management concept for a former sandstone quarrying area which has been developed under the described approach is under discussion. The draft concept identifies geological and cultural topics to be addressed by information panels (Fig. 2), outlines a "sandstone experimental playground" and the related outdoor education programmes, includes economic aspects by assessing the site's feasibility for mountain biking programmes offered by a local enterprise and for the refurbishment of a former hotel that could be used for accommodation within education tourism, and determines subareas of the site that should have limited access due to habitat protection. The integration of all relevant stakeholders in the development of the concept has built a strong local and regional identification in the sense of "project ownership". Public event series and the implementation of "geo-traditions" such as the award and celebration of the "Geotype of the Year" essentially contributes to public awareness rising towards the value of geological heritage. This approach also proved to convince decision makers on the political level as well as potential project sponsors.

Wine and rocks in the Geopark Bergstrasse-Odenwald: Earth history, nature and culture

by Dr. Jutta Weber[1]

Wine and rocks – this represents a very special combination in experiencing and enjoying our Earth and cultural heritage. Tasting the different rocks and soils inside the wine and getting an impression of this relationship during a trip through the vineyards is a unique adventure.

The Global and European Geopark Bergstrasse-Odenwald and the regional wine growers *Bergsträsser Winzer e.G* have developed a wide range of different products dealing with this relationship of wine and rocks.

Geopark wine and *Geopark champagne*, which is promoted by wine tastings, presentations and events, has been produced and promoted by the wine growers since 2001. This strong cooperation has been intensified by the joint development and implementation of a Geopark adventure trail called *wine and rocks adventure trail* though the vineyards. The 7 km trail, which consists of 29 information panels, touches topics like wine history, grape varieties, geology, rocks of the Geopark territory, terroir, climate, cultural history, flora and fauna of the territory (Fig. 1).

Besides the trail, there are several art pieces, which underline the overall topic. One prominent piece is called the *rock bottle*, a wired cage 4 m in height, shaped as a bottle (Fig. 2), and filled with the typical rocks of the Geopark territory, representing different stages of Earth history.

This art piece which is accompanied by an interpretative panel, communicates both the wine and the rocks in direct relationship. Additionally, it represents a stratigraphic column and the geological development of the territory in combination with the typical rocks.

Sandstone and granite sculptures, which reflect the overall motto of the Geopark *between granite and sandstone* complete the scenery and support the Geopark message.

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Figure 1. Impressing panoramic views and resting places invite the visitor to discover the special relationship between wine and rocks (Photo: J. Weber)

Figure 2. The rock bottle: art piece and message at the same time. (Photo: R. Antes)

The Geopark and the wine growers have developed an adventure and event programme for groups of special interest as well as for families with children and for school classes.

After one season the experiences with the *wine and rock adventure trail* are very promising. Especially the seasonal events like *Roman barbecue*, *Rocks, game animals and wine*, evening torch trips, rocks and wine tasting in the vineyard, and adventure days have attracted thousands of participants.

Meanwhile, the trail is well known all over Germany, a well established part of the local and regional Geopark infrastructure and a pilot project for other areas interested in adopting this concept. It is suitable for combining two exciting issues by experiencing, discovering and enjoying.

The adaptive cycle and panarchy: implementing geodiversity in sustainable land and nature planning

by A.C.Imeson[1]

The adaptive cycle and panarchy are used to support the implementation of integrated projects. They enable the geologist to prioritize his actions more efficiently. A case study in Dutch South Limbourg is used to demonstrate the application. Adaptive cycles were constructed at different scales to explain the patterns of soil formation and erosion, from 12,000 years ago until the present. The erosion caused by the down-cutting of the Maas, the deforestation in Neolithic and Roman times and as a result of modern agriculture can be explained within a common framework. The practical benefits of applying this approach are explained.

Un cycle évolutif et la « *panarchie* » sont utilisés comme appui à la réalisation de projets intégrés. Ils permettent au géologue de hiérarchiser ses actions avec plus d'efficacité. Un cas d'étude situé dans la partie sud du Limbourg hollandais sert d'exemple pour l'application de ces mécanismes. Les cycles évolutifs ont été élaborés à différentes échelles pour expliquer les modèles de formation et d'érosion des sols, depuis 12 000 ans jusqu'à nos jours. L'érosion occasionnée par l'abattage dans le MAAS, la déforestation aux temps néolithique et romain et les conséquences de l'agriculture moderne peuvent être expliquées au sein d'une ossature commune. Les avantages pratiques liés à la mise en œuvre de cette approche sont explicités.

Se utiliza el ciclo adaptativo y la panarquia en la implementación de proyectos integrados. Esto permite a los geólogo priorizar sus actividades de un modo más eficiente. Se utiliza un caso práctico en el Sur de Limbour holandés para demostrar esta aplicación. Se confeccionaron ciclos adaptativos a diferntes escalas para explicar los modelos de formación de suelos y de erosión, desde hace 12000 años hasta la actualidad. La erosión causada por el encajamieto del rio Maas, la deforestación en el Neolítico y en tiempo de los romanos y como resultado de la agricultura moderna, todos se pueden explicar en un marco común. Se explican los beneficios prácticos de aplicar este enfoque.

This paper is extracted from a more general and detailed presentation given at the TAIEX workshop

The objective of the paper is to introduce and describe some scientific frameworks that are increasingly being applied in the earth and environmental sciences. The concepts have many benefits. In some cases, in somewhat different guises they have been intuitively applied by geologists in the past and they are an integral part of how we interpret sediments and the structures and patterns in them. They were developed and applied principally by ecologists and in parallel by economists who were developing models to explain change.

Change in Geo-ecosystems

The soils and recent sediments that we see around us are part of continuously changing landscape. The changes taking place can be considered over different periods of time, for example, days, years, centuries or millennia and at different spatial scales. The geologist has to be concerned with and understand all of these scales and at the same time give advice to clients who lack his insight. To help them with similar problems, ecologists developed different frameworks for dealing with change and scale. An early framework was known as hierarchy theory (Allen and Star, 1982, O'Neill *et al*., 1986) and it is very simple to apply.

According to the aim of the stakeholder or client, such as the government department planning a Geopark or requiring criteria for identifying and protecting areas of outstanding geoheritage value, a level of interest within the geo-ecosystem or landscape is first defined.

An example could be that you are interested in the alluvium and its fossil or artifact content at a specific location in the proposed Geopark. The spatial scale of this level of interest is the area that you could see easily from this spot, e.g. 100 by 100 m and this could be the width of the floodplain or terrace. The theory states that the organization of this level of interest, or actually any level of interest, is explained by at least three levels:

- the focal level, which is the area in the geopark mentioned above and in which we are directly interested, which is in other words directly concerned with the objectives of a park manager
- a coarser, higher level of scale, associated with relatively broader spatial and temporal scales, at which changes occur more slowly. In the example, this means what is happening in the Geopark as a whole; not just at present but also in the past and in the coming decades, centuries and longer; the geologist will of course have even coaser levels of scale in mind but at the level of interest of the stakeholder these are too slow to affect the dynamics of what is happening. They do constrain the changes that could take place
- a lower level, at which changes occur rapidly on fine spatial and temporal scales. This level could refer to the spatial scale of a borehole or excavation that in the ground and the processes that are taking place there, such as the earthworms burrowing in the soil, the growth or decay of plant roots, the deposition of microscopic parts from the atmosphere. It also involves the water cycle and interactions with the river.

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In real landscapes it is also necessary to look at how things are connected with one another, so that measurements that describe or indicate this are studied. This includes the influence of buffering and storage. Therefore, connectivity is a vital element of landscape and geosystem structure.

Understanding what is happening at a certain level of interest requires that we should purposefully analyse what is happening at both broader and finer (spatial and temporal) scales. If a certain level of interest is studied within the framework of a hierarchical system, it is often the case that this certain level, which we considered stable and unchanging, is in fact actually changing or even unstable. This is because change or disturbance could take place at another level within the system. This also affects the level we are interested in. Regarding specifically the concept of change, this means that change in landscape systems can only be understood fully if the concept of scale and connectivity is considered as well. An example from fluvial geomorphology (Dorren and Imeson, 2006) illustrates this. When there is a change in base-level, that is if the land rises relative to the sea, the larger rivers in the area react to this. They start to incise into the landscape as the land rises and mean gradient of the river, measured between the upper part of the catchment and the sea level, increases. Therefore the running water increasingly has more energy to remove soil material or to incise into bedrock. Small rivers, in tributary catchments, where farmers have their agricultural fields, also react by incising the underlying terrain. If only the agricultural fields in the tributary systems are looked at, these are considered not to change, apart from some slow but constantly ongoing changes, such as biological, physical and chemical changes in the soil itself, slow weathering that produces more soil from the parent material, activities of the farmer that change the soil and some water that erodes particles from the surface of the soil. Why is soil erosion such a local problem in both Spain and Norway, for example? This is because both of these regions have undergone dramatic uplift of several hundreds of metres, in the recent geological past and the continuing adjustment of fluvial systems makes erosion almost inevitable.

Organization; patterns and structures

Dominant interacting processes at fine scales create patterns or structures often as emergent features at coarser scales. Examples of these are the sedimentary structures in sediments, riffles and bars in river channels and the soil profile. These may increase in time until critical conditions are reached. Patterns and structures are valuable because they are indicators of how a system is behaving. The Adaptive cycle and panarchy described below take this idea further. More information about this can be found at the Resilience Alliance home page.

Adaptive cycles and panarchy

Many processes can be represented by an adaptive cycle, in which four distinct stages have been identified: (i) exploitation or growth, (ii) conservation, (iii) release or collapse and (iv) reorganization. The adaptive cycle exhibits two major transitions. The first, from exploitation to conservation, is the slow, incremental phase of growth and accumulation. The other, from release to reorganization, is the rapid phase of reorganization leading to renewal. The first is predictable with higher degrees of certainty. The consequences of the second phase are unpredictable and highly uncertain.

A panarchy, as defined by Holling (2000) and Gunderson and Holling (2002), represents a hierarchical structure in which both human and natural systems are linked together in adaptive cycles. By examining complex natural systems within this structure it should be possible to identify moments or periods within a single

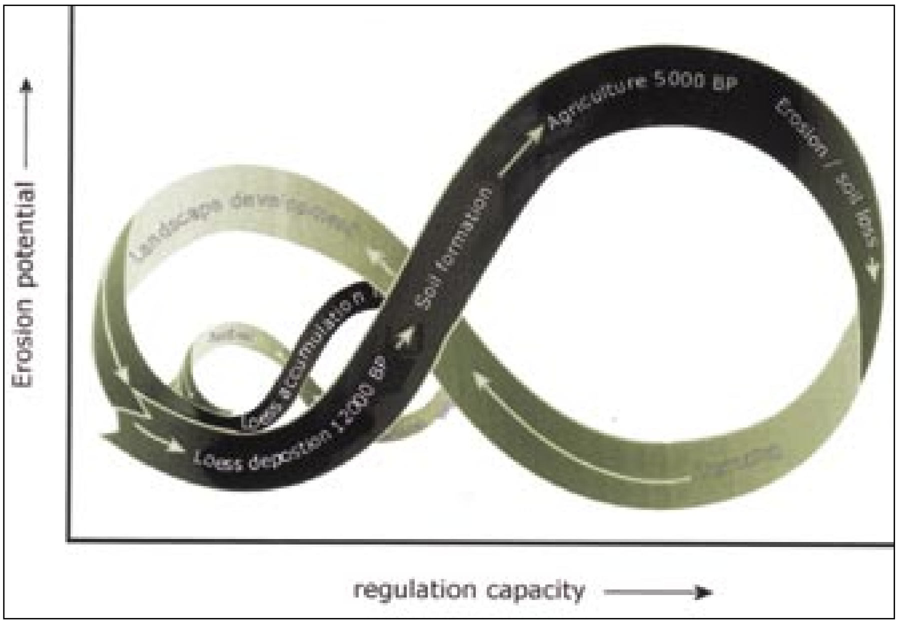

Figure 1. Representation of the adaptive cycle of the South-Limburg case (see the text for explanation). The x-axis represents the regulation capacity of the landscape, the axis of time follows an imaginary point that moves along the depicted cycle in the graph

cycle where the system is most receptive to actions that create positive change and enhance sustainability

An example: landscape change in loess areas (The Netherlands)

The example from South-Limburg in The Netherlands below illustrates the application of the framework (for more information see Dorren and Imeson, 2006)

The landscape of South-Limburg is formed by a number of plateaus, which are incised by river valleys. Many of these are dry valleys, which are the remnants of a colder and moister glacial past. For a large part, South-Limburg is covered with a layer of loess mostly 2 m but sometimes even 20 m thick. The loess overlies coarse-grained Quaternary fluviatile sediments, Tertiary sands and Cretaceous limestone. The loess was deposited between 12,000 and 20,000 years ago. During the last 10,000 years (the Holocene), when temperatures increased, the process of soil formation resulted in Luvisols that are characterized by an A, Bt and a C- horizon. The climate of the area is temperate oceanic, with rainfall in all seasons and an annual average precipitation of 750 mm. In the summer, rainfall intensity can be quite high, which sometimes leads to soil erosion. On the steeper slopes both the A horizon and the Bt horizon have been removed and therefore the C-horizon is exposed. In lower areas considerable amounts of colluvium have been deposited.

The main driving forces that have changed the functioning of the landscape in South-Limburg during the last 15,000 years may be generalized as a) the deposition of loess and b) colonization and use of the landscape by modern man. The impact of this is summarized in the large first part of the adaptive cycle shown in schematic form in Figure 1. In this figure, the axis of time follows an imaginary point that moves along the depicted cycle in the graph.

The starting point may be thought of as 12,000 years BP at a moment when loess began to be deposited on the pre-existing postglacial landscape. The history of one place can be schematized along a time-line. The two axes in the figure are described as the potential for erosion and the regulation capacity of the landscape, which is, in other words, to which degree the landscape is able to perform its regulating function by buffering and transmitting ecosystem processes. Examples of these are transportation of material through the landscape by rivers, intermittent streams or wind at different scales, migration of plant and animal populations, etc.

The gradual deposition and accumulation of loess profoundly influenced the hydrology. A loess layer behaves as a giant sponge. A 10 m thick loess layer could retain 4 to 6 m of rain, which was possibly also five to ten times the annual rainfall. Although its water retention makes it ideal for agriculture in a humid region, when it was deposited, it buried and fossilized the drainage system. Groundwater recharge would have dropped, springs would dry up, dry valleys would have formed and a new land surface created. In terms of the evolution of the landscape and its functioning, South-Limburg would gain a highly fertile loess soil but this was at the cost of losing the drainage system. At the same time, pedogenesis resulted in Luvisols due to an increase in temperature, as mentioned before.

Human beings settling in South Limburg enjoyed the benefits of the loess soil. These initially increased the fertility of the Luvisols that would have been rather resilient to disturbance because of the positive effect of organic matter and the calcium from the calcium carbonate that the original loess contained, on soil structure. Gradually, however, calcium carbonate was leached from surface soils, which would slowly become more erodable.

Agriculture in Neolithic and later Roman periods has been shown by many palaeo-ecological investigations to have had some impact on erosion. In the figure, about 3000 to 1800 years ago, we allow the adaptive cycle to experience a downward collapse as soil resources were redistributed by erosion. Sunken lanes were formed and soil accumulated as colluvium in valley bottoms. It is likely that some actions at that time were deliberately targeted at soil protection, such as the construction of hedgerows to accumulate sediment behind them. This formed terraces known as 'graften'. This may be thought of as a reorganization that led to a restructuring of the landscape. However, it is well known that the introduction of the plough in the early Middle Ages and the Little Ice Age also provided stresses that caused erosion and land degradation. Loss of the productive functions of the soil was then reflected in abandonment and migration, which was a temporal reorganization of the human system.

At the other end of the time line, the second small cycle in Figure 1 that represents the last century, first shows a net accumulation of loess in the terraced landscape. But after that period it shows the impact of land consolidation and reallocation and modern farming, which led to erosion (the downward loop in the small cycle in Figure 1). In South-Limburg, this meant that small-scale plots, which still existed in the fifties and sixties, were suddenly transformed into large agricultural fields. As a consequence, small hedges, trees and shrubs growing on the edges of the 'graften' disappeared. Land use changed from a diverse mixed agricultural/natural area to mainly maize, wheat and sugar beet. The combination of these agricultural practices and heavy rainfall events resulted in huge erosion problems in the 1980s. Tons of fertile soil were removed from the agricultural fields and were deposited in lower parts of the landscape. These so-called off-site effects of soil erosion were even more damaging. Sewage systems in the villages were clogged, which resulted in large mudflows on the streets. These led to considerable damage to infrastructure, as many of the villages in South-Limburg were built in the lower parts of the dry valleys, which is of course exactly were all the water accumulates in case of extreme events.

Conclusion

The adaptive management and panarchy analysis is based on an understanding of processes at different scales. Our understanding is much deeper than that we would have had from a statistical methodology in which we tried to interpret change from analysing the influence of different factors at different sites.

For example, in the case of soil erosion, at the moment most legislation to control soil erosion gives priority to controlling it where it has just taken place when no soil is left. When a gully is formed, the conditions that were present and which caused it to appear are changed. It makes no sense to invest money strategically and differently in places that are in different stages of the adaptive cycle. Expressed in a different way, it is essential to consider time. Nearly all of the soil conservation work in the world is planned and implemented using two-dimensional concepts of space, so that unfortunately the consequences are not only a waste of effort, they also destroy aspects of the system that might otherwise not be at risk.

Natural systems have a limited number of states of attraction in which they exist. These are strongly influenced by the geology and the way rocks weather, climate and life (including man). Hierarchy theory and panarchy enable an holistic interpretation of change and risk to be formulated by the consultant for the end user. This can be tailor made to his level of interest. They could provide a framework that enables geologists, biologists and social scientists to participate in a richer dialogue.

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News and events 2007 - 2008

News from Ireland

CRIRSCO 2007 – A breakthrough year

The Committee for Mineral Reserves International Reporting Standards ("CRIRSCO": *www.crirsco.com*) was adopted, in 2007, as a Task Force of the International Council on Mining and Metals ("ICMM": *www.icmm.org*). This decision by the ICMM has resulted in an increased level of funding for CRIRSCO. As a result, CRIRSCO has been able to aggressively advance on a number of fronts.

CRIRSCO, in its current format, dates back to 2002 when its predecessor sponsor, The Council of Mining and Metallurgical Institutions was formally disbanded. Since then CRIRSCO has depended on a combination of voluntary effort and limited funding by its supporting organizations. These include the Joint Ore Reserve Committee ("JORC") in Australia, the Chilean Comision Minera, the Pan-European Reserve Reporting Committee ("PERC"), the South Africa Mineral Resource Committee ("SAMREC"), and by technical societies and professional bodies including the Canadian Institute of Mining and Metallurgy ("CIM"), the European Federation of Geologists ("EFG") and the Society for Mining, Metallurgy and Exploration ("SME") in the United States. Thus, CRIRSCO is representative of the global family of mineral resource professionals.

CRIRSCO exists to promote best practice in the international public reporting of Exploration Results, Mineral Resources and Mineral Reserves and relies on its constituent members to ensure regulatory and disciplinary oversight at a national level. Its existence recognizes the truly global nature of the minerals industry and the agreed need for international consensus on high-quality resource-reserve reporting standards in line with the ICMM principles of ethical business practices, sound systems of corporate governance and transparent reporting.

CRIRSCO aims to achieve its stated objectives by:

- Promoting uniformity, excellence and continuous improvement in national and international reporting standards for Mineral Exploration Results, Mineral Resources and Reserves, through consultation and cooperation.

- Representing the international minerals industry on resource and reserve reporting issues, including discussions with international organizations, attending international meetings and providing written submissions.
- Encouraging the continued development of international reciprocity of Competent/Qualified Persons through nationally-based Recognized Overseas Professional Organization ("ROPO") schemes or equivalents.
- Promoting the use of uniform and coherent best practice reporting standards covering Mineral Exploration Results, Mineral Resources and Reserves, including the provision and maintenance of the CRIRSCO International Reporting Template.
- Facilitating the exchange of information and dialogue among CRIRSCO members and other stakeholders through an actively managed website that promotes discussion on current issues.

During 2007 significant progress was made in advancing these objectives.

Following its successful launch in mid-2006, the value of the CRIRSCO Template was highlighted when it provided the basic structure for a number of new national reporting codes, such as the Philippine Reporting Code. The Template is a generic guide to the reporting of mineral exploration results, mineral resources and mineral reserves and reflects the common features of the individual national reporting guidelines. The benefits of such developments should not be underestimated. Today, through the efforts of CRIRSCO and the National Reporting Organizations in the participating countries, the reporting standards of Australasia, Canada, Chile, Peru, Philippines, South Africa, UK/Ireland/Western Europe and USA (excluding the SEC) are over 90% compatible. This has brought about greater stakeholder understanding and certainty, facilitated the flow of investor funding and improved the ability of resource companies to operate confidently in non-domestic markets.

At the international level, CRIRSCO has taken an active role, in conjunction with the Society of Petroleum Engineers ("SPE"), in mapping the CRIRSCO Template to the SPE's Petroleum Resource Management System ("PRMS") hydrocarbon classification system. The output from this mapping exercise, summarized in the Figure below, has resulted in a joint CRIRSCO - SPE report to the International Accountancy Standards Board ("IASB") Extractive Activities Project Team, which is developing accountancy standards for the reporting of mineral resource assets. It is expected that these standards will be promulgated by the IASB as a discussion paper in mid- to late-2008.

As an adjunct of the above process, CRIRSCO has also taken a lead role within the United Nations Economic Commission for Europe (UN-ECE) Ad Hoc Group of Experts, in mapping the Template to the United Nations Framework Classification ("UNFC") system. The UNFC system, developed by the UN-ECE to facilitate resource reporting by member states, has been formally adopted by the UN Economic and Social Council ("ECOSOC"). CRIRSCO and the SPE have jointly presented proposals for certain modifications to the UNFC which, if adopted, would mean that the CRIRSCO Template and SPE PRMS become the de facto guidelines for the UNFC. A further potential outcome will be the need for CRIRSCO to develop guidelines for the reporting of non-economic mineral inventories.

These two mapping processes now mean that, for the first time, there is the potential for a globally unified resource classification system with conformity at a high-level between industry reporting practice for minerals and hydrocarbons and the UNFC.

The value of this potential breakthrough will be further enhanced by the on-going mapping studies comparing the Template to both the Chinese and Russian systems.

In a significant exception to this unified approach, the USA Securities and Exchange Commission ("SEC") requires adherence to its own standard, with adverse and costly implications for companies listed in the USA. The SME continues to communicate the advantages of a unified approach to the SEC and, to that end, published revised draft resource - reserve reporting guidelines in 2007 which attempts to address issues of concern to the SEC regulators.

In the coming year CRIRSCO faces a number of challenges. It will need to continue to remain proactive in its dealings with international bodies such as the UN-ECE and IASB to build on the progress made during 2007. However, in addition, it needs to assist in the development of the relationship with the financial regulatory authorities. This relationship is well developed, and valued, in Australia and New Zealand, Canada, Chile and South Africa where the reporting guidelines form an integral part of the stock exchange listing regulations and where mechanisms are in place to monitor resource – reserve reporting and, when considered appropriate, to take disciplinary actions for misreporting. Regrettably, this relationship does not prevail in the United Kingdom and European regulatory environment where PERC has been unable to seriously engage.

On a local front, the PERC Code is currently being updated to reflect recent revisions in the JORC and SAMREC codes. It is expected that this update will be released as a Consultation Draft in mid-2008. This will provide the regulators and the financial community with yet another opportunity to engage, which they hopefully will avail of.

EurGeol. John A Clifford, P.Geo, FIMM, FAusIMM, C.Eng(UK). Deputy Chairman, CRIRSCO

Submission of articles to European Geologist Magazine

The EFG calls for quality articles for future issues of European Geologist. Submissions should be in English and between 1000 and 3000 words, although longer articles may be considered. An abstract of between 100 and 120 words should be included in English, French and Spanish. Articles should be sent via e-mail to the Editor at Harper-mccorry@tele2adsl.dk or on disc to Vordingborgvej 63, 4600 Køge, Denmark. Photographs or graphics are very welcome and should be sent to the Editor as tif or jpg files in CYMG colour. Further details may be found on the EFG website: www.eurogeologists.de

Deadline for submission 30 March and 30 September.

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European Federation of Geologists (EFG)

The European Federation of Geologists was established in Paris in 1980 during the 26th International Congress of Geology. In the same year the Statutes were presented to the European Economic Community in Brussels.

The Council of the EFG is composed of the representatives of the national associations of geologists of Belgium-Luxembourg (UBLG), Czech Republic (CAEG), Finland (YKL), France (UFG), Germany (BDG), Hungary (MFT), Iceland (GSI), Ireland (IGI), Italy (CNG and ANGI), Netherlands (KNGMG), Poland (PTG), Portugal (APG), Slovakia (SGS), Slovenia (SGD), Spain (ICOG), Sweden (N), Switzerland (CHGEOL), United Kingdom (GS), whilst the American Institute of Professional Geologists (AIPG) is an Associate Member. The EFG currently represents about 40,000 geologists across Europe.

Mission
To promote the profession and practice of geology and its relevance.

Objectives

1. To promote and facilitate the establishment and implementation of national arrangements for recognizing geologists who, through academic training and appropriate periods of relevant experience in the profession and practice of geology, are qualified to be designated as EurGeol.
2. To organize meetings and conferences to discuss issues related to the profession and practice of geology.
3. To co-ordinate the activities of member national organisations in preparing briefing papers on geological issues and presenting these to European bodies, national governments and other relevant organisations.
4. To maintain contact with the European Commission and respond in timely manner to requests for information.
5. To communicate, through meetings and other means, the relevance of geology to the resolution of issues of concern to society.
6. To promote the establishment of best practice for training of geologists.
7. To safeguard and promote the present and future interests of the geological profession in Europe, including:

- to guarantee the free movement of geologists in Europe, with the mutual recognition of their academic and professional qualifications by the adoption of the title of European Geologist (EurGeol.).
- to promote the harmonisation of education and training.
- to define and protect the title of geologist and related professional titles.
- to promote the code of professional ethics of the EFG.
- to provide advice and assistance to constituent member National Associations.

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