



# ENVIS NEWSLETTER



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### FROM EDITOR'S DESK

This issue presents an article containing a special review of “Atmospheric dust in India- A natural geo-engineering tool to combat climate change”. It has been argued that soil driven SPM and atmospheric dust can cause negative radiative forcing and thus may be useful as counter agents to greenhouse gas induced global warming. The article also emphasizes the other useful role played by Ca in soil driven aerosols in buffering the acidity of the atmosphere.

In addition, this issue consists of the details of recent and forthcoming conference/ workshop and recent publications related to the field of biogeochemistry

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## Atmospheric dust in India- A natural geo-engineering tool to combat climate change

Very recently IPCC has established that global climate is changing due to man made activities and their emissions. Increased demand of energy with the increase in population is main cause of these adverse emissions. In fact, the globe has been pushed into climate change problem from the beginning of industrial revolution. Since then industrialized countries have consumed huge amount of fossil fuel to generate energy to develop technology driven society. These activities have contributed a large amount of greenhouse gases and various pollutants into the atmosphere. It is believed that the amount emitted already into the atmosphere will have climate change impacts for next 50 years even if we stop all emissions today. But the increased demand of energy consumption in developing countries like India and China warns us against much more adverse emission scenario in future. The basic source of fuel and energy in India and China is coal burning. Apart from carbon dioxide and fly ash, coal combustion emits significant amount of sulphur dioxide which creates acid rain problem.

### 1. Atmospheric soil-dust: Boon for India

Regions like Europe, north America and east Asia have acid rains as common phenomenon (Rodhe et al., 2002; Galloway et al., 1987; Hara et al., 1995). In these regions very low pH of rain water has been reported indicating high acidity. Mainly this acidity has been attributed to the presence of sulphuric acid formed due to oxidation of  $\text{SO}_2$ . It is important to note that these regions have very insignificant dust in atmosphere and hence much low suspended particulate matter (SPM) as reported in India. The nature of rain water in India has been noticed alkaline having pH value more than 5.6 (Jain et al., 2000; Khemani et al., 1989; Kulshrestha et al., 1996; 2003a; Saxena et al., 1991; Rao et al., 1990). It is to be noted that 5.6 is the natural pH of rain water due to dissolution of atmospheric  $\text{CO}_2$ . The equilibrium of which brings 5.6 pH value of natural water system. A detailed review of Indian rain chemistry has been reported by Kulshrestha et al. (2005). A few systematic network studies like Indo-Swedish Network on precipitation chemistry in Indian and Nepal (Parashar et al., 1996), BAPMoN network (Mukhopadaya et al., 1992) and Composition of Atmospheric Deposition (CAD) programme have also reported the alkaline pH of rain water in India in general.

It is now well established that the reason for alkaline nature of rain water in India the abundance of calcium in rain water which buffers the acidity. Most of the rains in India occur in monsoon period (June-September). It is to be noted that it does not rain daily and hence soil dust is suspended again and again into the atmosphere even during monsoon season. Also, most soils of India are highly alkaline (Sehgel, 1996) which contribute alkaline suspended dust into

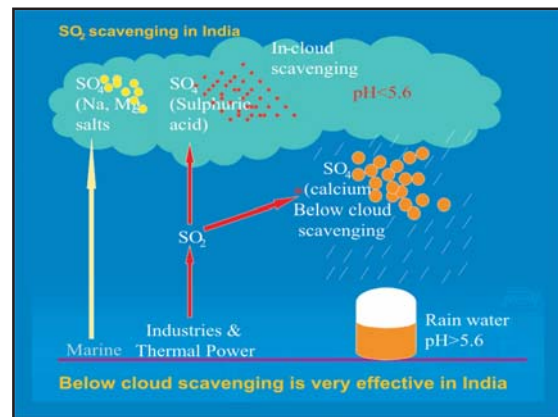
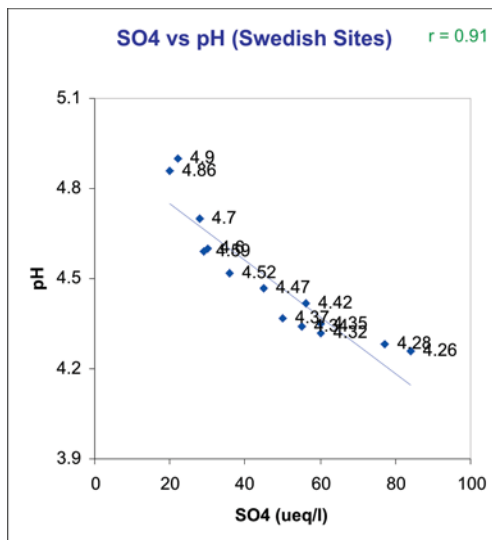


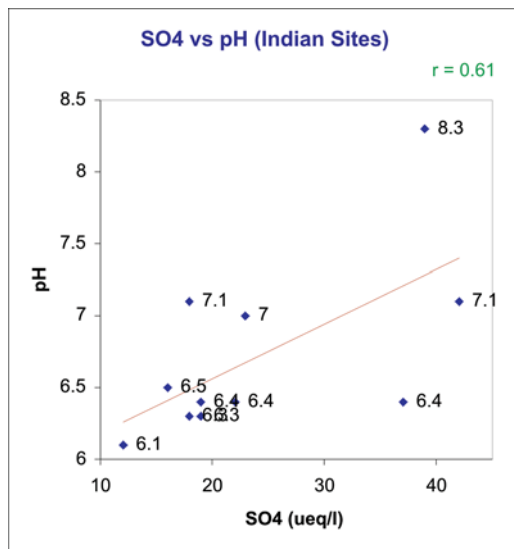
Fig. 1. Soil-dust interference and below cloud scavenging of Calcium sulphate. (Kulshrestha 2005).

the atmosphere during dry weather conditions. Kulshrestha et al. (2003b) have reported that being acidic gas, most of the  $\text{SO}_2$  is taken up by the soil derived SPM/dust which is rich in  $\text{CaCO}_3$ . In the presence of sufficient humidity,  $\text{SO}_2$  is then adsorbed onto dust particles which are further oxidized forming calcium sulphate. When it rains, calcium sulphate is scavenged by below cloud scavenging. Fig. 1 is the simple illustration showing interference of soil dust which makes Indian rain water of alkaline nature.

However, sometimes reduced alkalinity or some times slightly acidic pH of rain water is observed at certain sites in India under the following conditions-



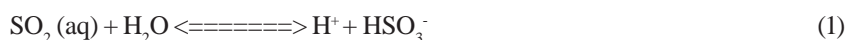
1. If rain is continued for 2-3 days during which small drizzles wash out SPM and dust particles. In the absence of these CaCO<sub>3</sub> rich particles, pH of rain water is noticed lower.
2. In the areas where ground is covered with vegetation and soil is acidic itself having very low buffering capacity e.g. central-east India (Bhubneswar), north-east (Jorhat) and south-west India (Hudagadde).
3. Acidic rains have been reported near thermal power plants where SO<sub>2</sub> concentrations are very high which contributes higher non-sea salt sulphate exceeding equivalent calcium concentrations.
4. Also, in and around metro cities where emissions of NO<sub>x</sub> and SO<sub>2</sub> are very high due to various industrial and vehicular activities slightly reduced pH has been reported in India.



## 2. Scenario of pH and SO<sub>4</sub> in India and at acidified region like Europe

A comparison of pH and SO<sub>4</sub> in rain water at different sites in Sweden, a country which observes frequent acid rains and in India has been shown in Figs 2 and 3. These figures show that in case of Sweden, pH decreases with increase of SO<sub>4</sub> concentration while at Indian sites, even at higher SO<sub>4</sub> levels the pH of rain water is observed to be higher. It indicates that in Sweden, the sulphate is present as sulphuric acid which gives free H<sup>+</sup> in rain water (through reactions 1 and 2 below) but in India, it is in different form which is consuming free H<sup>+</sup> (reactions 4 and 5 below).

As reported by Kulshrestha et al.(2003b), the possible mechanism of SO<sub>2</sub> removal is the adsorption of SO<sub>2</sub> onto the CaCO<sub>3</sub> dominated dust particles forming calcium sulphate is as follows –



This mechanism was hypothesized in our previous studies (Kulshrestha et al., 1997; Jain et al., 2000) where crustal associated SO<sub>4</sub> was differentiated at various sites in India.

## 3. Natural Geo-engineering: Opportunity for economic benefits through climate change negotiations

At present, global efforts are being made towards geo-engineering to combat various atmospheric issues. Spreading sulphur in the stratosphere to counter global warming is one of the great ideas of the Nobel Laureate Professor Paul Crutzen. In a way nature has blessed India by enriching with soil-derived SPM and atmospheric dust to counter acid rain problem. Higher estimates of dust emissions for Indian region have also been reported by Tegen and Fung (1995). The process of addition of CaCO<sub>3</sub> rich dust into the atmosphere is continuous from the Thar Desert as major source. Later on it is spread to other parts of the country during 'Aandhi' and summer dust storms. Due to high CaCO<sub>3</sub> loadings, SO<sub>2</sub> is scavenged significantly. This is one of the reasons why increasing SO<sub>2</sub> levels have not been reported at most of the sites (Kulshrestha et al., 2003b). This is unique example of natural geo-engineering. Similarly, atmospheric dust is interacting with other species (OH, CO<sub>2</sub>, CH<sub>4</sub>, NO<sub>x</sub>, various intermediates and organics) through complex transformation mechanisms which are beyond our knowledge

at present. In the atmosphere, mixed aerosols (mixture of carbon, organic carbon, dust and sulphate) are participating in atmospheric cooling, dimming and, warming. Therefore, it is required to investigate net radiative forcing (positive or negative) of atmospheric soil-dust in Indian region to reveal its response to climate change. From the present research out puts, it can be said that soil-derived dust in India naturally counters the global warming effect. In depth research on this aspect will be helpful in formulating GHGs emission reduction strategies. It gives us a great opportunity to take economic advantage of the natural boon for climate change negotiations. It seems that in the present scenario, natural soil sources dominate in most parts of the country. However, anthropogenic sources do have influence in certain parts like central-east part which is mining area with several thermal power plants. In the regions like Kerala and north-east, acidity is reported due to natural vegetation. These areas need to be further investigated (Kulshrestha et al., 2003).

#### 4. Acidification of Indian Ocean and need of geo-engineering

In contrast to continental sites in India, situation over Indian Ocean is very much different where suspended soil dust is insignificant but nss  $\text{SO}_4$  concentrations are very high. As observed during Indian Ocean Experiment (INDOEX) (Kulshrestha et al., 1999), lower Ca levels are not sufficient to buffer the acidity which creates higher acidity of rain water over Indian Ocean. Figures 4 and 5 show the variation of nss Ca and nss  $\text{SO}_4$  aerosols over Indian Ocean during INDOEX. nss Ca which is predominantly of crustal origin has coarse mode and is transported only upto very close to coast. But higher nss  $\text{SO}_4$  (down upto  $5^\circ \text{N}$ ) indicates higher sulphuric acid formation from  $\text{SO}_2$  oxidation resulting in acid rain over Indian Ocean. Unlike calcium sulphate, fine mode sulphate aerosols can be transported to larger distances by winds. The source of  $\text{SO}_2$  over Indian Ocean could be India, Middle East, Africa Bay of Bengal or Australia regions as reported in air trajectories by Granat et al. (2002). Apart from  $\text{CO}_2$  acidification, extra wet deposition of sulphate over Indian Ocean is adding to ocean acidification problem. It raises the issue how severe this could be in future? Does it require geo-engineering? I think, this is the high time to start research on aspects before it becomes devastating to marine ecosystem.

#### 5. Gap area: Need of attention

Since, rain water chemistry is very good indicator of air quality, atmospheric transformations, sources and transport of pollutants, it needs focused research in the following manner-

1. It is need of the time to assess the economic benefits of this natural environmental geo-engineering in India in terms of changing climate and development.
2. It is very essential for the country that a systematic close network of sites with quality assurance data should be set up to monitor future scenario of acidification in India. This network should include different sites based on soil type, source distribution and land use pattern etc.
3. Deposition and chemical transport modeling coupled with above measurement network should be carried out to estimate the trends, implications (if any) and future potential of acidification in Indian region.

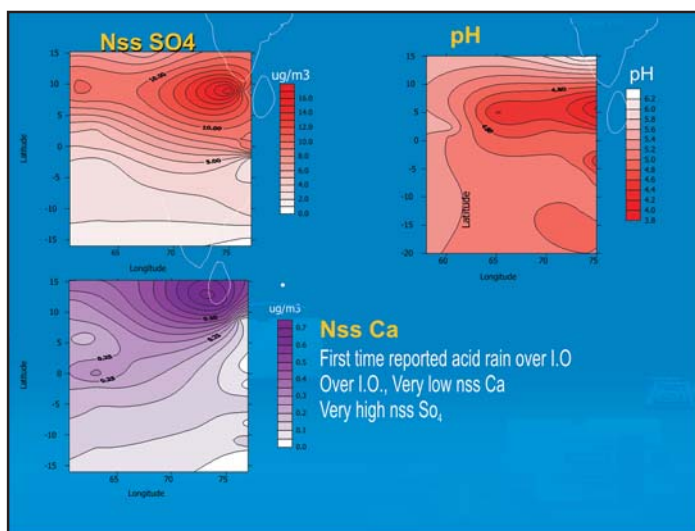


Fig 4 Variation of nss  $\text{SO}_4$  ( $\mu\text{g m}^{-3}$ ), nss Ca ( $\mu\text{g m}^{-3}$ ) aerosols and pH of rain water over Indian Ocean

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### Some Recent Publication in Journal related to Environmental Biogeochemistry

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### Recent & Forthcoming Conference/Workshop related to Biogeochemistry

**April 12–16, 2010, Langkawi Geopark, Malaysia** 4th International UNESCO Conference on Geoparks 2010: “Geoheritage Education for Sustainability”. URL: <http://www.geoparks2010.com>

**April 20–25, 2010, Lublin, Poland** 5th International Symposium on Gully Erosion: Human Impact on Gully Erosion is being organized by the Institute of Earth Sciences, Maria Curie-Skłodowska University and the Association of Polish Geomorphologists. Contact: Wojciech Zg<sup>3</sup>obicki. E-mail: [zglobek@hektor.umcs.lublin.pl](mailto:zglobek@hektor.umcs.lublin.pl) URL: <http://gis.umcs.lublin.pl/gullyerosion2010>

**August 2–10, 2012, Brisbane, Australia** Australia 2012: the 34th International Geological Congress “Unearthing Our Past and Future” will be organized by Australian Geoscience Council. Contact: Ian Lambert, Geoscience Australia. E-mail: [ian.lambert@ga.gov.au](mailto:ian.lambert@ga.gov.au) URL: <http://www.ga.gov.au/igc2012>

**August 23–30, 2009, Sopron, Hungary** The International Association of Geomagnetism and Aeronomy (IAGA) 11th Scientific Assembly hosted by Geodetic and Geophysical Research Institute of the Hungarian Academy of Sciences. Contact: Local Organizing Committee of the IAGA 11th Scientific Assembly. E-mail: [iaga2009@oaga2009sopron.hu](mailto:iaga2009@oaga2009sopron.hu) URL: <http://www.iaga2009sopron.hu>

**August 23<sup>rd</sup> to 28<sup>th</sup> 2009; Waterville Valley Resort, United States.** Gordon Research Conference — Atmospheric Chemistry. **Weblink:** <http://www.grc.org/meetings.aspx?year=2009>

**August 24–28, 2009, Salvador, Bahia, Brazil** 11th International Congress of the Brazilian Geophysical Society. URL: <http://congresso.sbgf.org.br>

**December 15–17, 2009, Western Cape, South Africa** Second International Conference on Management of Natural Resources, Sustainable Development and Ecological Hazards, Western Cape, South Africa; Ravage of the Planet II; Contact Information: Conference Secretariat, Ravage of the Planet 2009, Wessex Institute of Technology Ashurst Lodge, Ashurst, Southampton S040 7AA, UK. E-mail: [ravage2009@wessex.ac.uk](mailto:ravage2009@wessex.ac.uk) URL: <http://www.wessex.ac.uk>

**July 12–17, 2009, Andover, NH, USA** Gordon Research Conference on Catchment Science “Interactions of Hydrology, Biology and Geochemistry: Thresholds, Tipping Points, and Non-Linearity—Integrated Catchment Science for the 21st Century”. Contact: Conference Chairman, Keith N. Eshleman, University of Maryland, Center for Environmental Science, 301 Braddock Road, Frostburg, MD 21532, USA. E-mail: [eshleman@al.umces.edu](mailto:eshleman@al.umces.edu) URL: <http://www.grc.org>

**July 12<sup>th</sup> to 17<sup>th</sup> 2009; Proctor Academy, United States.** Gordon Research Conference — Catchment Science: Interactions Of Hydrology, Biology & Geochemistry - Thresholds, Tipping Points, And Non-Linearity: Integrated Catchment Science For The 21st Century. **Weblink:** <http://www.grc.org/meetings.aspx?year=2009>

**July 13–16, 2009, Chihuahua, Mexico** 10th International Conference On the Biogeochemistry of Trace Elements (ICOBTE) organized by the International Society of Trace Element Biogeochemistry and Centro de Investigaciones en Materiales Avanzados A. C. Contact: Teresa Alarcón, Miguel de Cervantes 120 Col. Complejo Industrial

Chihuahua, Mexico. E-mail: [icobte2009@cimav.edu.mx](mailto:icobte2009@cimav.edu.mx) URL: <http://icobte2009.cimav.edu.mx>

**July 13<sup>th</sup> to 16<sup>th</sup> 2009; Chihuahua, Mexico. ICOBTE 2009** — 10th International Conference on the Biogeochemistry of Trace Elements. **Weblink:** <http://icobte2009.cimav.edu.mx/index.php/contents/en>

**July 19–26, 2009, Kerrville, TX, USA** “Karst Horizons” 15th International Congress of Speleology (UIS-UNESCO) plans a session on “Cave Climate and Paleoclimate—Best Record of the Global Change—III”.. Contact: 15th International Congress of Speleology, P.O. Box 691965, San Antonio, Texas 78269, USA. Fax: 001-413-383-2276 E-mail: [secretary@ics2009.us](mailto:secretary@ics2009.us) URL: <http://www.ics2009.us/welcome.html>

**July 20<sup>th</sup> to 22<sup>nd</sup> 2009; Tallinn, Estonia. AIR POLLUTION 2009** — Seventeenth International Conference on Modelling, Monitoring and Management of Air Pollution. **Weblink:** <http://www.wessex.ac.uk/conferences/2009/index.html>. **Organizer:** Wessex Institute of Technology.

**July 6–11, 2009, Melbourne, Australia** Seventh IAG Conference on Geomorphology (ANZIAG) focuses the theme ‘Ancient Landscapes – Modern Perspectives’ with a special session on Southern Hemisphere/Gondwana Geomorphology. Contact: Geomorphology 2009 Conference Managers, GPO Box 128, Sydney NSW 2001, Australia. E-mail: [geomorphology2009@tourhosts.com.au](mailto:geomorphology2009@tourhosts.com.au) URL: <http://www.geomorphology2009.com>

**July 6–8, 2009, Gold Coast, Australia** SDIMI 2009: Sustainable Development Indicators in the Mineral Industry Conference focuses on enhancing the contribution of the global minerals industry to the goal of sustainable development. Contact: Stephanie Finlay, Coordinator, Conferences & Events, The AusIMM, PO Box 660, Carlton South VIC 3053, Australia. E-mail: [sfinlay@ausimm.com.au](mailto:sfinlay@ausimm.com.au) URL: <http://www.ausimm.com.au/sdimi2009/home.asp>

**July 8–10, 2009, Chianciano Terme, Italy** 7th International Conference on Ecosystems and Sustainable Development (ECOSUD). Contact: Irene Moreno, Conference Secretariat, ECOSUD 2009, Wessex Institute of Technology Ashurst Lodge, Ashurst, Southampton S040 7AA, UK. E-mail: [imoreno@wessex.ac.uk](mailto:imoreno@wessex.ac.uk) URL: <http://www.wessex.ac.uk>

**June 02<sup>nd</sup> to 05<sup>th</sup> 2009; Moscow, Russia, WasteTech-2009** — The 6th International Trade Fair on Waste Management, Recycling and Environmental Technology. **Weblink:** <http://www.waste-tech.ru>.

**June 14<sup>th</sup> to 17<sup>th</sup> 2009; Stockholm, Sweden.** 12th International Conference on Chemistry and the Environment. **Weblink:** <http://www.chemsoc.se/sidor/KK/icce2009.htm>

**June 15–20, 2009, Albena, Bulgaria** SGEM 2009: 9th International Multidisciplinary Scientific Conference and Exposition. E-mail: [sgem@sgem.org](mailto:sgem@sgem.org) URL: <http://www.sgem.org>

**June 22–25, 2010, Aberystwyth, Wales, UK** The Mineralogical Society’s Annual Meeting: Frontiers in Environmental Geoscience. The scientific focus of the meeting will be on recent advances in research into environmental mineralogy, geochemistry, biosystems and toxicology, under the overall theme of ‘Frontiers in Environmental Geoscience’. Contact: N. Pearce, University of Aberystwyth, Wales, UK. E-mail: [njp@aber.ac.uk](mailto:njp@aber.ac.uk) URL: <http://www.minersoc.org/pages/meetings/frontiers-2010/frontiers-2010.html>

**June 22–26, 2009, Davos, Switzerland** Goldschmidt 2009: “Challenges to Our Volatile Planet”.E-mail: [helpdesk@goldschmidt2009.org](mailto:helpdesk@goldschmidt2009.org) URL: <http://www.goldschmidt2009.org>

**June 22–26, 2009, Skellefteå, Sweden** Securing the Future—Mining, Metals and the Environment in a Sustainable Society and the 8th International Conference on Acid Rock Drainage (ICARD). Contact: Björn Öhlander. E-mail: [Bjorn.Ohlander@ltu.se](mailto:Bjorn.Ohlander@ltu.se) URL: <http://www.securing.skelleftea.se>

June 22<sup>nd</sup> to 25<sup>th</sup> 2009; Aachen, Germany. Second International Conference on Transport, Atmosphere and Climate. **Weblink:** <http://www.pa.op.dlr.de/tac/>. **Contact:** R. Sausen Deutsches Zentrum für Luft- und Raumfahrt e.V., Institut für Physik der Atmosphäre, Münchner Str. 20 Wessling Germany D-82234; phone: (+49-8153-28-2500). : The conference will cover all aspects of the impact of the different modes of transport (aviation, road transport, shipping etc.) on atmospheric chemistry, micro-physics, radiation and climate.

June 22<sup>nd</sup> to 26<sup>th</sup> 2009; Davos, Switzerland. Goldschmidt 2009: Challenges to our Volatile Planet. **Weblink:** <http://www.goldschmidt2009.org>. **Contact:** P. Beattie; phone: (+44-0-1223-333438). : The conference will cover the full range of geochemistry, from the accretion of the planets to the origins of life via mantle geochemistry, climate change, mineralogy and aqueous and economic geochemistry.

**June 27–July 2, 2010, Galway, Ireland** 27th SEGH (Society for Environmental Geochemistry and Health) Contact: SEGH2010 Organizing Committee, Dept. of Geography, National University of Ireland, Galway, Ireland. Fax: +353-91- 49 5505 E-mail: [SEGH2010@nuigalway.ie](mailto:SEGH2010@nuigalway.ie) URL: <http://www.nuigalway.ie/segh2010/>

**June 29–July 1, 2009, Bytom, Poland** International Symposium on Soil, Sediment and Dust Magnetism “SoilSEDUMA” Contact: Tadeusz Magiera, Institute of Environmental Engineering, Polish Academy of Sciences, 41819 Zabrze, Poland. E-mail: magiera@ipis.zabrze.pl URL: <http://www.ipis.zabrze.pl/dokumenty/soil.pdf>

**June 29–July 3, 2009, Helsinki, Finland** BIOGEOMON 2009: 6th International Symposium on Ecosystem Behavior. Contact: BIOGEOMON 2009 Conference Coordinator, Liisa Ukonmaanaho. E-mail: liisa.ukonmaanaho@metla.fi URL: <http://www.environment.fi/syke/biogeomon2009>

**June 30–July 3, 2009, Dublin, Ireland, UK** 4th International Symposium on Contaminated Sediments: Sustainable Management and Remediation. Contact: Chairperson, Mark Dyer, Trinity College Dublin, Ireland. E-mail: astm4ISCS@googlemail.com

**June 8–10, 2009, Panama City, Panama** Groundwater for the Americas is an NGWA conference that focuses on a broad spectrum of issues and concerns that inhibit efficient and effective groundwater management strategies in Latin America. Contact: E-mail: info@ngwa.org URL: <http://www.ngwa.org/DEVELOPMENT/conferences/details/09-06-08-5077.aspx>

**May 17–21, 2010, Tainan City, Taiwan** “As2010”: 3rd International Congress on Arsenic in the Environment contact: As2010 Secretariat, 9F, No.16, Jian 8th Road., Jhonghe City, Taipei County 23511, Taiwan. Fax: +886-2-8226-2785 E-mail: arsenic2010@gmail.com URL: <http://www.as2010tainan.com.tw/>

**October 10<sup>th</sup> to 14<sup>th</sup> 2009; Hangzhou, China.** International Symposium of Molecular Environmental Soil Science at the Interfaces in the Earth’s Critical Zone. **Weblink:** <http://zjklsp.zju.edu.cn/ISMESS/>.



<b>Our ENVIS Team at SES, JNU</b>	<b>Any further information, query and suggestions, please contact</b>
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