



ENVIS NEWSLETTER



ENVIS CENTRE ON BIOGEOCHEMISTRY
(Supported by: Ministry of Environment & Forests, Govt. of India)
SCHOOL OF ENVIRONMENTAL SCIENCES
JAWAHARLAL NEHRU UNIVERSITY,
New Delhi-110067

Vol. 13.

Issue No. 1

2008

Content

- Editorial
- Methane Emission from Landfill Areas
- Recent & Forthcoming Conference/Workshop related to Biogeochemistry
- Some Recent Publication Related to Biogeochemistry
- Recent News Clippings



FROM EDITOR'S DESK

This issue presents a special review of methane emissions from landfill sites in India. Methane, an important greenhouse gas responsible for global warming is produced by decomposition of organic matter present in municipal solid waste under anaerobic conditions. Most of the methane produced from landfill sites in India is getting released in atmosphere which is a cause of serious concern. The article seeks to highlight nearly exponential increase in methane emission in India and suggests tapping them for meeting energy needs in our country as part of mitigation measures to address the problem of global warming.

In addition, this issue consists of the details of recent and forthcoming conference/workshop and recent publications related to the field of biogeochemistry. In the end some general environmental news clippings are reported.

Prof. V.K. Jain
Editor

ISSN No. 0974-1364

Visit us: www.jnuenvs.nic.in

Methane Emission from Landfill Areas

Methane is produced in large quantity in landfills, as a consequence of the degradation of organic matter under anaerobic conditions. It escapes from landfills either directly to the atmosphere or by diffusion through the cover soil. Methane in landfill area results from the metabolic activities of a small and highly specific bacterial group. The bacteria metabolize glucose, amino acids and fatty acids to organic acids (primarily acetic acid and propionic acid) and carbon dioxide, hydrogen gas, ammonia gas and water.

The process involves breakdown of acetic acid as: $\text{CH}_3\text{COOH} \rightarrow \text{CH}_4 + \text{CO}_2$
 This process also involves reduction of: $\text{CO}_2 + 8\text{H} \rightarrow \text{CH}_4 + 2\text{H}_2\text{O}$

The huge amount of waste that are buried in landfill sites will produce methane for years, after even the site is closed, as the waste is slowly decaying under the ground. Methane, at its current atmospheric concentration of 1.7 ppm, accounts for about 15% of the anthropogenic greenhouse effect and concentration is on the increase (Dickinson and Cicerone, 1986; Rodhe, 1990). Global methane emissions from landfill are estimated to increase app. 30 million tons every year. Most of this landfill methane currently comes from developed countries, where the levels of waste generation per capita are high.

Landfills have been used for many years as a most economic method of refuse disposal. On the global scale approximately 6530 billion tones of waste is land filled (Thorneleo, 1993; Boeckx and Cleemput, 1996). Due to an increase in population and subsequently increase in waste generation, landfills could become a major source of atmospheric methane (Kreileman and Bouwman, 1994). There are some reports on quantification of methane flux from landfills (Jones and Nedwell, 1993; Nozheikov et al., 1993). The estimation in these reports on the global contribution of landfill methane has been based on

calculations of deposited amounts of waste and their estimated degradation rates (Peer et al., 1993).

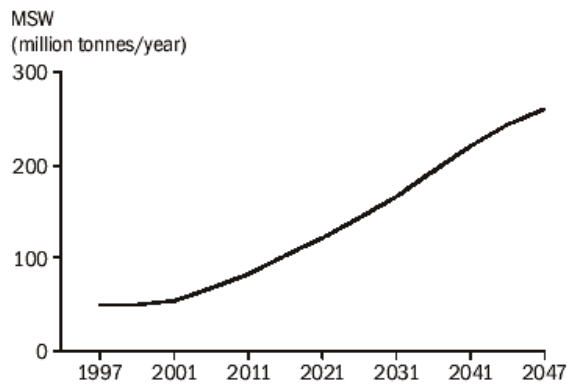


Figure (a) Trend of MSW generation in India.

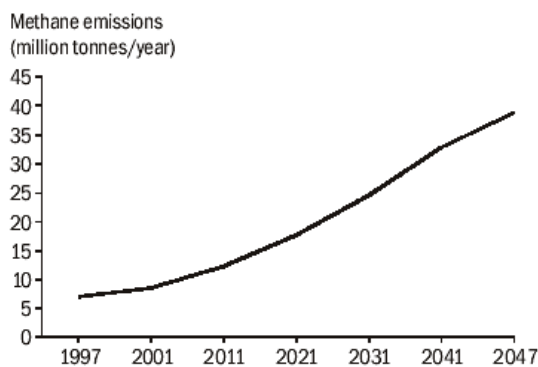


Figure: (b) Trend of Methane generation in India.
 Source: Singhal & Pandey, 2001

In India, dumping grounds or landfill areas are mainly open low-lying areas in the cities. The municipal solid waste (MSW) consists of wastes from domestic, agricultural, commercial sources and debris from demolishing works. Often it has illegally dumped hospital and toxic industrial waste, which causes ground water contamination. The MSW are generally dumped in landfill areas without segregating it into biodegradable and non-biodegradable. These organic components in the municipal refuse result in methane formation under anaerobic condition. The total solid waste generation in India is approximately 48 million tonnes per year (India, State of the Environment, 2001). Figures (a) and (b) shows that with the growth of MSW in India the methane production will also increase in future. Bhide (1998) had reported total methane flux from Indian cities as 0.33 Tg/y. Whereas, Bhattacharya and Mitra (2004) reported methane emission from MSW in India was 0.56 MT in 1990 and 0.93 MT in 2000. The average value of methane production from these six landfill areas (Perungudi landfill area, Chennai; Dapha in Kolkata; Okhla in Delhi; KCDC in Bangalore; Pirana landfill area, Ahmedabad; Doran, Dehradun) was 0.21 Tg/y (Rawat et al., 2008).

Methane flux in landfill areas depends on percentage of moisture content and organic materials. Gurijala and Sufliita (1993) also reported higher methane emission at pH 6.8-7.4 and at higher moisture contents in landfill areas. The increase in methane flux occurs at day time when temperature is 30-40°C. It is an optimum temperature and an important factor for the production of methane (Börjesson and Svensson, 1997). The pH near to neutral is reported as good for methanogenesis (Ladapo and Bariaz, 1997) as observed for these landfill areas.

The range of methane emission measured by Börjesson and Svensson (1997) is 0.54-320 mg/m²/h on average for landfill areas in Sweden. The global projection for landfill methane flux by 2050 is estimated as 63-93 Tg/y, which will be due to population growth and subsequently increase in waste dumping in landfills.

Houghton et al. (1992) suggested that soils are considered as a significant sink for atmospheric methane. They also reported that landfill covered with smaller soil particles are important for attenuating fluxes of methane and transforming methane to carbon dioxide, by means of methane oxidation. As highly active communities of methanotrophs can develop in these overlying soils, they can greatly reduce the amounts of methane emitted. They have further suggested that only soil cover can not decrease methane emission from landfills, therefore gas extraction would remain the best tool to reduce methane emission from landfills in the future.

Methane gas is among major contributors of global warming. There is need to initiate mitigation steps for decreasing the methane emission from landfill areas. It can be done in first place by reducing the dumping of organic materials in landfills, which is possible by segregating organic component from solid waste, which can be effectively used for making compost. Secondly, we can also construct a planned landfill site, from where methane gas can be trapped and used as green energy source as practiced in most of the developed countries.

References:

Bhattacharya S and Mitra AP (2004): **A Scientific analysis of Greenhouse gas Emission Trends in India**. Published by Centre for Global Change, National Physical Laboratory. New Delhi-12, India.

Bhide AD (1998) *Global Environmental Chemistry* (eds. Parashar DC, Sharma C, Mitra AP), Narosa Publication House. New Delhi, India, pp. 116-127.

Boeckx P, Cleemput VO (1996) Flux estimates from soil methanogenesis and methanotrophy: Landfills, Rice paddies, natural wetlands and aerobic soils *Environ. Monit and Ass* pp. 42, 189-207.

Börjesson G, Svensson HBo (1997) Seasonal and diurnal methane emissions from a landfill and their regulation by methane oxidation. *Waste Mag and Res*, pp. 15, 33-54.

Dickinson RE, Cicerone RJ (1986) Future global warming from atmospheric trace gases. *Nature*, pp. 319, 109-115.

Gurijala KR, Sufliata JM (1993) Environmental factors influencing methanogenesis from refuse in landfill samples. *Environ. Sci. and Technol.* pp. 27, 1176-1181.

Houghton JT, Callander BA, Varney SK (1992) Climate Change. *The supplementary report to the IPCC scientific assessment*. University Press, Cambridge, UK, pp. 200.

India: State of the Environment, UNEP Publication, 2001, pp. 136-137.

Jones HA, Nedwell DB (1993) Methane emission and methane oxidation in landfill cover soil. *FEMS Microb Ecol.* pp. 102, 185-195.

Kreileman GJJ, Bouwman AE (1994) Computing land use emission of greenhouse gases. *Water, Air and Soil Poll*, 1994, pp. 76, 231-258.

Ladapo JA, Bariaz MA (1997) Isolation and characterization of refuse methanogens. *J of Applied Microb*, pp. 82, 751-758.

Nozheikov AN, Lifshitz AB, Lebedev VS, Zavarzin GA (1993) Emission of Methane into the atmosphere from landfills in the former USSR. *Chemos*, pp. 26,401-417

Peer RL, Thorneloe SA, Epperson DL (1993) A comparison of methods of estimating global methane emission from landfills. *Chemos*, pp. 26, 387-400.

M. Rawat, Singh UK, Mishra AK, Subramanian V (2008): Methane Emission from landfill areas of India. *International Journal of Environmental Monitoring and Assessment*. 137 (1-3) pp. 67-74.

Rodhe H (1990) A comparison of the contribution of various gases to the greenhouse effect. *Science* , pp. 248, 1217-1219

Singhal S, Pandey S (2001): Solid waste management India, status and future direction. **TERI Information monitor on Environment Sciences**. 6 (1): 1-4.

Thorneleo SA (1993) Methane emission from landfill and open dumped, in van Amsted, A.R. (ed), **Proceeding of the International IPCC workshop**, Amersfoort, The Netherlands. pp 93-109.

Dr. Manju Rawat (Young Scientist) & Dr. AL Ramanathan, School of Environmental Sciences, Jawaharlal Nehru University, New Delhi-110067

Recent & Forthcoming Conference/Workshop related to Biogeochemistry

11th to 14th November 2008 NALMS 2008, 28th International Symposium - Lake Management in a Changing Environment
Website: <http://www.nalms.org/Conferences/2008LakeLouise> **Contact name:** Al Sosiak Lake Louise, Alberta, Canada Our symposium theme concerns lake management during unprecedented development, water scarcity and climate change. More than 30 special sessions have been proposed and are posted on the NALMS web site. Organized by: North American Lake Management Society Deadline for abstracts/proposals: 1 June 2008

11th to 13th November 2008 Energy for Sustainable Development **Website:** <http://www.dawoodcollege.edu.pk/conference.html> **Contact name:** Abdul Waheed Bhutto, Karachi, Pakistan. This Conference is aimed to provide a forum to Professors, researchers, policy makers, investors, professionals working in industry and other stakeholder to share the latest research and innovations to counter energy crises. Organized by: Dawood College of Engineering and Technology, Karachi / COMSATS Institution of Information Technology. Deadline for abstracts/proposals: 31 June 2008

12th to 14th November 2008 3rd International Conference on Health, Environment and Development Alexandria, Egypt.
Website: <http://www.hiphegypt.net/Conferences.php?link=con> **Contact name:** Dr Ashraf Wahdan. It is a great pleasure to welcome you in Alexandria, the pearl of the Mediterranean for participation in Alex Health 2008; a great event held by the High Institute of Public Health, Alexandria University. Two grand health conferences will Organized by: High Institute of Public Health. Deadline for abstracts/proposals: 1 October 2008.

14th to 15th November 2008 Drought - Past & Future. Canberra, ACT, Australia. **Website:** <http://www.water.anu.edu.au/events/dpf/index.php> **Contact name:** Noel Chan. This conference is the first stage of The Climate Risk Project and an international study funded by the ANUWI that will compare drought management and planning for climate change in the world's southern and northern temperate zones. RSVP. Organized by: ANU Water Initiative. Deadline for abstracts/proposals: Not available.

17th to 20th November 2008 Coastal Cities Summit: Values and Vulnerabilities St. Petersburg, Florida, United States. **Website:** <http://www.coastalcities.org>
Contact name: Mara Hendrix. **Conference Announcement / Call for papers**, Coastal Cities Summit: Values & Vulnerabilities, 17 to 20 November 2008, St. Petersburg, United States. "The International Ocean Institute - USA's Coastal Cities Summit" aims to bring together coastal city leaders, managers, and academics to discuss environmental, social, economic, and public policy challenges and viable solutions. The deadline for abstracts/proposals was 15 June 2008. Enquiries: mara@ioiusa.usf.edu. Web address: <http://www.coastalcities.org>. Sponsored by: International Ocean Institute - USA.

17th to 19th November 2008 Carbon Markets Africa Cape Town, South Africa. **Website:** http://greenpowerconferences.com/carbonmarkets/carbonmarkets_africa_2008.html. **Contact name:** Ryan Winchester. CDM business opportunities in Africa. The introduction of programmatic CDM should help to attract more investors to African countries as unilateral CDM projects decrease the potential investment risks. Organized by: Greenpower Conferences. Deadline for abstracts/proposals: Not available.

20th to 21st November 2008, HYDROLOGICAL CYCLE MANAGEMENT AND SUSTAINABLE DEVELOPMENT: PROPOSALS AND SOLUTIONS FOR AFRICA IN A GLOBAL CONTEXT, Las Palmas de Gran Canaria, Gran Canaria, Spain. **Website:** <http://www.congresos.ulpgc.es/hcm-susdev>, **Contact name:** Ana. The Workshop is an opportunity to learn about the investigations carried out within the African and other developing contexts. There will be discussions on water management and solutions. Organized by: ECOMAS. Deadline for abstracts/proposals: 30 September 2008

21st to 23rd November 2008 International Scientific Conference ECO-TREND 2008, V-th edition, Targu-Jiu, Romania. **Website:** http://www.utgjiu.ro/fse_new/ecotrend_2008/index.html. **Contact name:** Pociovalisteanu Diana-Mihaela. The

main goal of the 2008 ECO-TREND is to provide an opportunity for academics and professionals from a variety of fields to meet and exchange ideas and expertise. Organized by: Constantin Brancusi University. Deadline for abstracts/proposals: 14 September 2008

25th to 27th November 2008, Energy Intensive Industries & Climate Change, Brussels, Belgium. **Website:** <http://www.integer-research.com/EII>. **Contact name:** Amy Woolmer. EII & Climate Change is a time critical platform for high energy consumers and policy makers to come together and discuss the most effective ways to reach European emission limits without negatively impacting on the global competitiveness. Organized by: Integer. Deadline for abstracts/proposals: Not available.

1st to 5th December 2008, GEOSTATS 2008--VIII INTERNATIONAL GEOSTATISTICS CONGRESS, Santiago, Chile. **Website:** <http://geostats2008.com>. **Contact name:** Olga Cherepanova. One of the most important international geostats events, held every 4 years, first time to be held in South America. Organized by: Gecamin/University of Chile. Deadline for abstracts/proposals: Not available.

3rd December 2008, One Planet One Day - Cost Effective Sustainability, London, United Kingdom. **Website:** <http://www.oneplanetoneday.co.uk>. **Contact name:** Ronan Leyden. Find out how to create cost effective solutions for the challenges of creating sustainable places and lifestyles. Organized by: Bioregional Development Group. Deadline for abstracts/proposals: Not available.

8th to 10th December 2008, 9th National Conference on Science, Policy, and the Environment: Biodiversity in a Rapidly Changing World, Washington D.C, United States. **Website:** <http://ncseonline.org/conference/biodiversity/>. **Contact name:** Nicole Buell. Plan on joining part in the discussion goals to develop a new biodiversity strategy in a 21st century context with government officials, scientists, businesses, and NGOs. Registration will open in early fall. Organized by: National Council for Science and the Environment Deadline for abstracts/proposals: Not available.

9th to 12th December 2008, Blueprints for Sustainable Infrastructure. Auckland, New Zealand. **Website:** <http://www.nzsses.auckland.ac.nz/conference>. **Contact name:** Vicky Adin. Abstracts are invited for peer review to be presented at the Conference. The global momentum for sustainable development must now lead to practical applications of the engineering and science of sustainability. Organized by: NZ Society for Sustainability Engineering and Science Deadline for abstracts/proposals: 8 April 2008

9th to 12th December 2008, WORLD BIODIVERSITY CONGRESS. Chiang Mai, Thailand. **Contact name:** Dr. V. Sivaram, **E-mail:** sivaram900_AT_gmail.com (to e-mail the conference organizers, please replace _AT_ with @). Organized by: Century Foundation, India and UNISERVE, Chiang Mai University, Thailand. Deadline for abstracts/proposals: 30 September 2008.

10th to 13th December 2008, First Global Summit on Sustainable Development and Biodiversity, Raipur, Chhattisgarh, India. **Website:** <http://www.gloss2008.com>. **Contact name:** Dr R.N. Pati. The Global Summit aims at exploring various dimensions of people oriented environmental governance issues and biodiversity conservation. Organized by: VRM Foundation. Deadline for abstracts/proposals: 15 May 2008

Some Recent Publication Related to Biogeochemistry

- Ajay Kumar, R. K. Singhal, J. Preetha, K. Rupali, U. Narayanan, Sughandhi Suresh, Manish K. Mishra and A. K. Ranade (2008) Impact of Tropical Ecosystem on the Migrational Behavior of K-40, Cs-137, Th-232 U-238 in Perennial Plants; *Water, Air, & Soil Pollution*; Volume 192, Numbers 1-4 pp. 293-302
- Alan L. Wright and K. R. Reddy (2008) Catabolic diversity of periphyton and detritus microbial communities in a subtropical wetland; *Biogeochemistry*, Volumes 89; No. 2, pp. 199-207
- Ana M. Noguez, Ana E. Escalante, Larry J. Forney, Maribel Nava-Mendoza, Irma Rosas, Valeria Souza and Felipe García-Oliva (2008) Soil aggregates in a tropical deciduous forest: effects on C and N dynamics, and microbial communities as determined by t-RFLPs; *Biogeochemistry* Volume 89, Number 2; pp 209-220
- Anders Lindroth, Leif Klemetsson, Achim Grelle, Per Weslien and Ola Langvall (2008) Measurement of net ecosystem exchange, productivity and respiration in three spruce forests in Sweden shows unexpectedly large soil carbon losses; *Biogeochemistry*, Volumes 89; No. 1, pp. 43-60
- Andrea L. Pineda Rojas and Laura E. Venegas (2008) Dry and Wet Deposition of Nitrogen Emitted in Buenos Aires City to Waters of de la Plata River; *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pp. 175-188

- Andrew K. Gordon, Gregory L. Blatch, Sheril Daniel and Wilhelmine J. Muller (2008) Stress Protein Responses in South African Freshwater Invertebrates Exposed to Detergent Surfactant Linear Alkylbenzene Sulfonate (LAS) ; *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pages 123-130
- Blair D. Page, Thomas D. Bullen and Myron J. Mitchell (2008) Influences of calcium availability and tree species on Ca isotope fractionation in soil and vegetation ; *Biogeochemistry* Volume 88, Number 1; pp1-13
- Brenda M. Johnson, Laura E. Kanagy, John H. Rodgers and James W. Castle (2008) Chemical, Physical, and Risk Characterization of Natural Gas Storage Produced Waters ; *Water, Air, & Soil Pollution*; Volume 191, pp. 33-54
- Catarina Leote, J. Severino Ibánhez and Carlos Rocha (2008) Submarine Groundwater Discharge as a nitrogen source to the Ria Formosa studied with seepage meters; *Biogeochemistry*, Volumes 88; No. 2 pp. 185-194
- Chun Ling Luo, Zhen Guo Shen and Xiang Dong Li (2008) Root Exudates Increase Metal Accumulation in Mixed Cultures: Implications for Naturally Enhanced Phytoextraction ; *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pp. 147-154
- Chun Yang Yin, Mohamed Kheireddine Aroua and Wan Mohd Ashri Wan Daud (2008) Enhanced Adsorption of Metal Ions Onto Polyethyleneimine-Impregnated Palm Shell Activated Carbon: Equilibrium Studies ; *Water, Air, & Soil Pollution*; Volume 192, Numbers 1-4 pp. 337-348
- Chunming Su and Robert W. Puls (2008) Arsenate and Arsenite Sorption on Magnetite: Relations to Groundwater Arsenic Treatment Using Zerovalent Iron and Natural Attenuation ; *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pp. 65-78
- D. M. Antosiewicz, C. Escudé-Duran, E. Wierzbowska and A. Skłodowska (2008) Indigenous Plant Species with the Potential for the Phytoremediation of Arsenic and Metals Contaminated Soil; *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pp. 197-210
- Dan Berggren Kleja, Magnus Svensson, Hooshang Majidi, Per-Erik Jansson, Ola Langvall, Bo Bergkvist, Maj-Britt Johansson, Per Weslien, Laimi Truus, Anders Lindroth and Göran I. Ågren (2008) Pools and fluxes of carbon in three Norway spruce ecosystems along a climatic gradient in Sweden; *Biogeochemistry*, Volumes 89; No. 1, pp. 7-25
- Daniel E. Meeroff, Frederick Bloetscher, Thais Bocca and Frédéric Morin (2008) Evaluation of Water Quality Impacts of On-site Treatment and Disposal Systems on Urban Coastal Waters; *Water, Air, & Soil Pollution*; Volume 192, Numbers 1-4 pages 11-24
- E. C. Machado, W. Machado, L. F. Bellido, S. R. Patchineelam and A. V. B. Bellido (2008) Removal of Zinc from Tidal Water by Sediments of a Mangrove Ecosystem: A Radiotracer Study ; *Water, Air, & Soil Pollution*; Volume 192, 1-4 pp. 77-83
- E. Meers, F. M. G. Tack, I. Tolpe and E. Michels (2008) Application of a Full-scale Constructed Wetland for Tertiary Treatment of Piggery Manure: Monitoring Results; *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pp. 15-24
- En-Rong Yan, Xi-Hua Wang, Jian-Jun Huang, Guang-Yao Li and Wu Zhou (2008) Decline of soil nitrogen mineralization and nitrification during forest conversion of evergreen broad-leaved forest to plantations in the subtropical area of Eastern China; *Biogeochemistry*, Volumes 89; No. 2, pp. 239-251
- F. Andrieux-Loyer, X. Philippon, G. Bally, R. Kérouel, A. Youenou and J. Le Grand (2008) Phosphorus dynamics and bioavailability in sediments of the Penzé Estuary (NW France): in relation to annual P-fluxes and occurrences of *Alexandrium Minutum* *Biogeochemistry*, Volumes 88; No. 2 pp. 213-231
- F. Madrid, E. Diaz-Barrientos, M. C. Florido and L. Madrid (2008) Inorganic Amendments to Decrease metal Availability in Soils of Recreational Urban Areas: Limitations to their Efficiency and Possible Drawbacks; *Water, Air, & Soil Pollution*; Volume 192, Numbers 1-4 pp. 117-125
- F. Taube, L. Pommer, T. Larsson, A. Shchukarev and A. Nordin (2008) Soil Remediation – Mercury Speciation in Soil and Vapor Phase During Thermal Treatment; *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pp. 155-163
- Franz Zehetner, Georg J. Lair, Franz-Josef Maringer, Martin H. Gerzabek and Thomas Hein (2008) From sediment to soil: floodplain phosphorus transformations at the Danube River ; *Biogeochemistry* Volume 88, Number 2; pp117-126
- Frieda Beaugard and Benoît Côté (2008) Test of soil extractants for their suitability in predicting Ca/Sr ratios in leaves and stems of sugar maple seedlings; *Biogeochemistry* Volume 88, Number 2; pp195-203
- G. Brooks Avery, Robert J. Kieber and Kelly J. Taylor (2008) Nitrogen release from surface sand of a high energy beach along the southeastern coast of North Carolina, USA ; *Biogeochemistry*, Volumes 89; No. 3, pp. 357-365
- G. J. Reinds, M. Posch, W. de Vries, J. Slootweg and J.-P. Hettelingh (2008) Critical Loads of Sulphur and Nitrogen for Terrestrial Ecosystems in Europe and Northern Asia Using Different Soil Chemical Criteria; *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pp. 269-287
- Göran I. Ågren, Riitta Hyvönen and Torbjörn Nilsson (2008) Are Swedish forest soils sinks or sources for CO₂—model analyses based on forest inventory data; *Biogeochemistry*, Volumes 89; No. 1, pp. 139-149
- Guangliang Liu, Yun Qian, Shugui Dai and Nan Feng (2008) Adsorption of Microcystin LR and LW on Suspended Particulate Matter (SPM) at Different pH; *Water, Air, & Soil Pollution*; Volume 192, Numbers 1-4 pp. 67-76
- Gull Olli and Georgia Destouni (2008) Long-term Heavy Metal Loading to Near-Shore Lake Sediments ; *Water, Air, & Soil Pollution*; Volume 192, Numbers 1-4 pp. 105-116

- H. Silvennoinen, A. Liikanen, J. Torssonen, C. F. Stange and P. J. Martikainen (2008) Denitrification and N₂O effluxes in the Bothnian Bay (northern Baltic Sea) river sediments as affected by temperature under different oxygen concentrations; *Biogeochemistry* Volume 88, Number 1; pp 63-72
- Hannah M. Clilverd, Jeremy B. Jones and Knut Kielland (2008) Nitrogen retention in the hyporheic zone of a glacial river in interior Alaska; *Biogeochemistry*, Volumes 88; No. 1 pp. 31-46
- Hardiljeet K. Boparai, Patrick J. Shea, Steve D. Comfort and Thomas A. Machacek (2008) Sequencing Zerovalent Iron Treatment with Carbon Amendments to Remediate Agrichemical-Contaminated Soil; *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pp. 189-196
- I. Gnecco, J. J. Sansalone and L. G. Lanza (2008) Speciation of Zinc and Copper in Stormwater Pavement Runoff from Airside and Landside Aviation Land Uses; *Water, Air, & Soil Pollution*; Volume 192, Numbers 1-4 pp. 321-336
- J. Hoorman, T. Hone, T. Sudman, T. Dirksen, J. Iles and K. R. Islam (2008) Agricultural Impacts on Lake and Stream Water Quality in Grand Lake St. Marys, Western Ohio; *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pp. 309-322
- J. T. Trevors and M. H. Saier (2008) A Global Environmental Person; *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pp. 1-2
- J. T. Trevors and M. H. Saier (2008) Our Common Shared Biosphere Cannot Be Sustained By Looking in a Rear View Mirror; *Water, Air, & Soil Pollution*; Volume 190, Numbers 1-4 pp. 1-3
- Jeňýk Hofmeister, Filip Oulehle, Pavel Krám and Jakub Hruška (2008) Loss of nutrients due to litter raking compared to the effect of acidic deposition in two spruce stands, Czech Republic; *Biogeochemistry*, Volumes 88; No. 2 pp. 139-151
- Jianyong Wu and Jinhui Wang (2008) Impacts of Pollution from Different Sources on Ecological Quality of a Multiple-use Coast; *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pp. 25-35
- Jonathan Sanderman and Ronald Amundson (2008) A comparative study of dissolved organic carbon transport and stabilization in California forest and grassland soils; *Biogeochemistry*, Volumes 89; No. 3, pp. 309-327
- Julie Corriveau, Eric van Bochove, Geneviève Bégin and Daniel Cluis (2008) Effect of Preservation Techniques on the Determination of Nitrite in Freshwater Samples; *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pp. 335-342
- Kristell Hergoualc'h, Ute Skiba, Jean-Michel Harmand and Catherine Hénault (2008) Fluxes of greenhouse gases from Andosols under coffee in monoculture or shaded by *Inga densiflora* in Costa Rica; *Biogeochemistry*, Volumes 89; No. 3, pp. 329-345
- L. Negral, S. Moreno-Grau, J. Moreno, X. Querol, M. M. Viana and A. Alastuey (2008) Natural and Anthropogenic Contributions to PM₁₀ and PM_{2.5} in an Urban Area in the Western Mediterranean Coast; *Water, Air, & Soil Pollution*; Volume 192, Numbers 1-4 pp. 227-238
- Leif Klemetsson, Per-Erik Jansson, David Gustafsson, Louise Karlberg, Per Weslien, Karin von Arnold, Maria Ernfors, Ola Langvall and Anders Lindroth (2008) Bayesian calibration method used to elucidate carbon turnover in forest on drained organic soil; *Biogeochemistry*, Volumes 89; No. 1, pp. 61-79
- Li Hua, Weixiang Wu, Yuxue Liu, Yingxu Chen and Murray B. McBride (2008) Effect of Composting on Polycyclic Aromatic Hydrocarbons Removal in Sewage Sludge; *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pp. 259-267
- M. Peris, L. Recatalá, C. Micó, R. Sánchez and J. Sánchez (2008) Increasing the Knowledge of Heavy Metal Contents and Sources in Agricultural Soils of the European Mediterranean Region; *Water, Air, & Soil Pollution*; Volume 192, Numbers 1-4 pp. 25-37
- M. S. M. B. Salomão, J. J. Cole, C. A. Clemente, D. M. L. Silva, P. B. de Camargo, R. L. Victoria and L. A. Martinelli (2008) CO₂ and O₂ dynamics in human-impacted watersheds in the state of São Paulo, Brazil; *Biogeochemistry* Volume 88, Number 3; pp. 271-283
- Marc J. Russell, Donald E. Weller, Thomas E. Jordan, Kevin J. Sigwart and Kathryn J. Sullivan (2008) Net anthropogenic phosphorus inputs: spatial and temporal variability in the Chesapeake Bay region; *Biogeochemistry* Volume 88, Number 3; pp. 285-304
- Maria Ernfors, Karin von Arnold, Johan Stendahl, Mats Olsson and Leif Klemetsson (2008) Nitrous oxide emissions from drained organic forest soils—an up-scaling based on C:N ratios; *Biogeochemistry*, Volumes 89; No. 1, pages 29-41
- Marisa Terezinha Garcia de Oliveira, Silvia Beatriz Alves Rolim, Paulo Celso de Mello-Farias, Álvaro Meneguzzi and Camila Lutckmeier (2008) Industrial Pollution of Environmental Compartments in the Sinos River Valley, RS, Brazil: Geochemical–Biogeochemical Characterization and Remote Sensing; *Water, Air, & Soil Pollution*; Volume 192, Numbers 1-4 pp. 183-198
- Marwan Fahs, Jérôme Carayrou, Anis Younes and Philippe Ackerer (2008) On the Efficiency of the Direct Substitution Approach for Reactive Transport Problems in Porous Media; *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pp. 299-308
- Masahiro Sakata and Kazuo Asakura (2008) Evaluating Relative Contribution of Atmospheric Mercury Species to Mercury Dry Deposition in Japan; *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pp. 51-63

- Mathieu Rauch and Lionel Denis (2008) Spatio-temporal variability in benthic mineralization processes in the eastern English Channel; *Biogeochemistry*, Volumes 89; No. 2, pp. 163-180
- Mats Fröberg, Paul J. Hanson, Donald E. Todd and Dale W. Johnson (2008) Evaluation of effects of sustained decadal precipitation manipulations on soil carbon stocks; *Biogeochemistry*, Volumes 89; No. 2, pp. 151-161
- Melanie Beck, Olaf Dellwig, Jan M. Holstein, Maik Grunwald, Gerd Liebezeit, Bernhard Schnetger and Hans-Jürgen Brumsack (2008) Sulphate, dissolved organic carbon, nutrients and terminal metabolic products in deep pore waters of an intertidal flat; *Biogeochemistry*, Volumes 89; No. 2, pp. 221-238
- Milton H. Safe (2008) Are Megacities Sustainable?; *Water, Air, & Soil Pollution*; Volume 191, Numbers 1-4 pp. 1-3
- Munir H. Shah and N. Shaheen (2008) Annual and Seasonal Variations of Trace Metals in Atmospheric Suspended Particulate Matter in Islamabad, Pakistan; *Water, Air, & Soil Pollution*; Volume 190, Numbers 1-4 pages 13-25
- Nicolas Lugon-Moulin, Florian Martin, Marc R. Krauss, Patrice B. Ramey and Luca Rossi (2008) Arsenic Concentration in Tobacco Leaves: A Study on Three Commercially Important Tobacco (*Nicotiana tabacum* L.) Types; *Water, Air, & Soil Pollution*; Volume 192, Numbers 1-4 pp. 315-319
- Nouri Hassan, John D. Murimboh and Chuni L. Chakrabarti (2008) Kinetic Speciation of Ni(II) in Model Solutions and Freshwaters: Competition of Al(III) and Fe(III); *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pp. 131-146
- Paolo Bruno, Maurizio Caselli, Gianluigi de Gennaro, Lucia Scolletta, Livia Trizio and Maria Tutino (2008) Assessment of the Impact Produced by the Traffic Source on VOC Level in the Urban Area of Canosa di Puglia (Italy); *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pp. 37-50
- Per-Erik Jansson, Magnus Svensson, Dan Berggren Kleja and David Gustafson (2008) Simulated climate change impacts on fluxes of carbon in Norway spruce ecosystems along a climatic transect in Sweden; *Biogeochemistry*, Volumes 89; No. 1, pp. 81-94
- Peter Morgenstern, Lutz Brüggemann, Frank Krüger, Anke Hofacker and Rainer Wennrich (2008) Judging Fitness for Purpose of a X-ray Fluorescence Based Method Investigating the Vertical Distribution of Metals and Metalloids in Soil Profiles; *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pp. 289-298
- Prithviraj V. Chavan, Keith E. Dennett and Eric A. Marchand (2008) Behavior of Pilot-Scale Constructed Wetlands in Removing Nutrients and Sediments Under Varying Environmental Conditions; *Water, Air, & Soil Pollution*; Volume 192, Numbers 1-4 pp. 239-250
- Qing Song and Ernest K. Yanful (2008) Monitoring and Modeling of Sand-Bentonite Cover for ARD Mitigation; *Water, Air, & Soil Pollution*; Volume 190, Numbers 1-4 pp. 65-85
- R. Krishna Prasad, R. Ram Kumar and S. N. Srivastava (2008) Design of Optimum Response Surface Experiments for Electro-Coagulation of Distillery Spent Wash; *Water, Air, & Soil Pollution*; Volume 191, Numbers 1-4 pp. 5-13
- Riitta Hyvönen, Trygve Persson, Stefan Andersson, Bengt Olsson, Göran I. Ågren and Sune Linder (2008) Impact of long-term nitrogen addition on carbon stocks in trees and soils in northern Europe; *Biogeochemistry*, Volumes 89; No. 1, pp. 121-137
- RothC Jens Leifeld (2008) Biased ¹⁴C-derived organic carbon turnover estimates following black carbon input to soil: an exploration with *Biogeochemistry* Volume 88, Number 3; pp. 205-211
- S. Fu, K. Li, Z. Z. Yang and X. B. Xu (2008) Composition, Distribution, and Characterization of Organochlorine Pesticides in Sandstorm Depositions in Beijing, China; *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pp. 343-352
- S. Sollie and J. T. A. Verhoeven (2008) Nutrient Cycling and Retention Along a Littoral Gradient in a Dutch Shallow Lake in Relation to Water Level Regime; *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pp. 107-121
- Sanya Sirivithayapakorn and Sunun Limtrakul (2008) Distribution Coefficient and Adsorption-desorption Rates of di (2-ethylhexyl) Phthalate (DEHP) onto and from the Surface of Suspended Particles in Fresh Water; *Water, Air, & Soil Pollution*; Volume 190, Numbers 1-4 pp. 45-53
- Sara C. Kerr, Martin M. Shafer, Joel Overdier and David E. Armstrong (2008) Hydrologic and biogeochemical controls on trace element export from northern Wisconsin wetlands; *Biogeochemistry*, Volumes 89; No. 3, pp. 273-294
- Sheila F. Christopher, Hideaki Shibata, Megumi Ozawa, Yasunori Nakagawa and Myron J. Mitchell (2008) The effect of soil freezing on N cycling: comparison of two headwater subcatchments with different vegetation and snowpack conditions in the northern Hokkaido Island of Japan; *Biogeochemistry*, Volumes 88; No. 1 pp. 15-30
- Shuhe Wei, Qixing Zhou and Uttam Kumar Saha (2008) Hyperaccumulative Characteristics of Weed Species to Heavy Metals; *Water, Air, & Soil Pollution*; Volume 192, Numbers 1-4 pp. 173-181
- Suqing Li, Binsheng Yang and Dongmei Wu (2008) Community Succession Analysis of Naturally Colonized Plants on Coal Gob Piles in Shanxi Mining Areas, China; *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pp. 211-228
- T. Satapanajaru, P. Anurakpongsatorn, P. Pengthamkeerati and H. Boparai (2008) Remediation of Atrazine-contaminated Soil and Water by Nano Zerovalent Iron; *Water, Air, & Soil Pollution*; Volume 192, Numbers 1-4 pp. 349-359
- Tara M. Higgins, James H. McCutchan and William M. Lewis (2008) Nitrogen ebullition in a Colorado plains river; *Biogeochemistry*, Volumes 89; No. 3, pp. 367-377
- V. Antoniadis (2008) Sewage Sludge Application and Soil Properties Effects on Short-Term Zinc Leaching in Soil Columns; *Water, Air, & Soil Pollution*; Volume 190, Numbers 1-4 pp. 35-43

- Valérie Cappuyns and Rudy Swennen (2008) The Use of Leaching Tests to Study the Potential Mobilization of Heavy Metals from Soils and Sediments: A Comparison; *Water, Air, & Soil Pollution*; Volume 191, Numbers 1-4 pp. 95-111
- Veronica Bianchi, Grazia Masciandaro, David Giraldi, Brunello Ceccanti and Renato Iannelli (2008) Enhanced Heavy Metal Phytoextraction from Marine Dredged Sediments Comparing Conventional Chelating Agents (Citric Acid and EDTA) with Humic Substances; *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pp. 323-333
- Vincent Roubeix, Sylvie Becquevort and Christiane Lancelot (2008) Influence of bacteria and salinity on diatom biogenic silica dissolution in estuarine systems; *Biogeochemistry*, Volumes 88; No. 1 pp. 47-62
- Virendra Kumar Mishra, Alka Rani Upadhyay, Vinita Pathak and B. D. Tripathi (2008) Phytoremediation of Mercury and Arsenic from Tropical Opencast Coalmine Effluent Through Naturally Occurring Aquatic Macrophytes; *Water, Air, & Soil Pollution*; Volume 192, Numbers 1-4 pp. 303-314
- William R. Wieder, Cory C. Cleveland and Alan R. Townsend (2008) Tropical tree species composition affects the oxidation of dissolved organic matter from litter; *Biogeochemistry* Volume 88, Number 2; pp127-138
- Wilverth R. Villatoro-Monzón, Marcia G. Morales-Ibarria, Elia K. Velázquez, Hugo Ramírez-Saad and Elías Razo-Flores (2008) Benzene Biodegradation under Anaerobic Conditions Coupled with Metal Oxides Reduction; *Water, Air, & Soil Pollution*; Volume 192, Numbers 1-4 pp. 165-172
- Xiaohui Wang, Jinping Jia, Ling Zhao and Tonghua Sun (2008) Mesoporous SBA-15 Supported Iron Oxide: A Potent Catalyst for Hydrogen Sulfide Removal; *Water, Air, & Soil Pollution*; Volume 193, Numbers 1-4 pp. 247-257
- Yuqing Xu, Shiqiang Wan, Weixin Cheng and Linghao Li (2008) Impacts of grazing intensity on denitrification and N₂O production in a semi-arid grassland ecosystem; *Biogeochemistry*, Volumes 88; No. 2 pp. 103-115
- Z. Balogh-Brunstad, C. K. Keller, R. A. Gill, B. T. Bormann and C. Y. Li (2008) The effect of bacteria and fungi on chemical weathering and chemical denudation fluxes in pine growth experiments; *Biogeochemistry* Volume 88, Number 2; pp153-167
- Zoran Nikic, Jovan Kovacevic and Petar Papic (2008) Uranium in the Groundwater of Permo-Triassic Aquifers of the Visok Region, Stara Planina, Eastern Serbia ; *Water, Air, & Soil Pollution*; Volume 192, Numbers 1-4 pp. 47-58

Recent News Clippings

- Times of India, 27th Nov 08, **Industrialized world slow to reduce emissions**, Greenhouse gas emissions by 40 leading industrialized nations have dropped an average of 5% below 1990 levels-mostly due to economic decline in eastern European countries in the 1990s. But the UK warns that an upward tick for industrial and developing nations between 2000 and 2006 threatens to undo the previous drop.
- Hindustan Times, 19th Nov 08, **Heat on Himachal apple belt**, Climate change is likely to impact agricultural activities in India and all natural ecosystems, says expert. Global warming forces cultivators to move to upper reaches. The “shift of apple belt upward” is due to “decrease in chilling hours”. Simply put, “chill hours” mean the amount of cold weather certain fruit trees need to grow.
- Times of India, 18th Nov 08, **Marine ‘jelly balls’ to combat warming**: Scientists have found a large number of marine “jelly balls” appearing off the Australian east coast that could be part of the planet’s mechanism for combating global warming. According to a report in the Sydney Morning herald, the jellyfish-like animals are known as slaps and their main food is phytoplankton (marine algae), which absorbs the greenhouse gases carbon dioxide in the top level of the ocean, which in turn comes from the atmosphere.
- Times of India, 16th Nov 08, **China in a fix over toxic disposal**, dumps Melamine – Tainted milk into river, raising fear of water Contamination.
- Times of India, 16th Nov 08, **An excuse for West to get India, China?** While the a west sees atmospheric brown clouds as a major climate change factor in global warming, India sees the charge that its “traditional” bio-fuels are the primary reason for the toxic haze as an attempt to put the developing world on the back foot over climate change. But the senior sources in the Ministry of Science and Technology rejected the claim that carbon soot generated by bio-fuels burnt in India were the major contributor to global warming.
The use of firewood, dung cakes and fossil fuels has not increased so significantly as to pose any more of a climate change risk than has been the case till now. “It is a way of getting at Indian and China. We say that the developed world is primarily responsible for global warming so the West has latched on to the brown cloud formation to target us on traditional fuels,” said an official familiar with the debate.

- Times of India, 16th Nov 08, **Haze phenomenon due to pollution, duststroms**, atmospheric brown clouds are not new scientists in India, recent efforts have pointed to duststroms and local conditions as being responsible for the phenomenon. The Indian Institute of tropical Meteorology recently released a paper titled ‘Aerosol Radiation Forcing During Dust Events Over New Delhi’ which dealt with dust particles seen in the region during different parts of the year and their impact on the local area. The data that the study threw up showed that there was a “stronger contribution from absorbing aerosols (particles) which are a mixture of both desert dust and anthropogenic (vehicular and industrial) aerosols”.
- Times of India, 16th Nov 08, **Just Global Dimming, Not Warming. Brown clouds local phenomenon, seasonal in nature: Experts**. Hazy days for world’s 13 megacities – Lagos, Cairo, Tehran, Karachi, New Delhi, Mumbai, Kolkata, Dhaka, Beijing, Bangkok, Seoul, Shanghai, Shenzhen. And the way out of this phenomenon is far easier compared to the challenge of reducing GHG emissions, need to reduce pollution by switching over to ‘clean’ fuels and stop burning wood.
- Times of India, 16th Nov 08, **How the ‘Dirty Clouds’ is darkening ours lives**
 1. Experts say that rice harvests would have been up to 10.6% higher if the brown haze had not been there
 2. Some of the biggest cities in Asia are getting darker by 10-25%.
 3. The Hindu Kush-Himalaya-Tibetan glaciers are melting, causing water shortage across Asia.
 4. Changes the whether patterns and destroy crops all over the world when mixes with greenhouse gases.
- Times of India, 15th Nov 08, **Haze behind melting glaciers in Himalayas**, one of the most serious problems resulting from brown haze that envelops vast areas of Asia, the Middle East, southern Africa and the Amazon Basin, is the retreat of the glaciers in the Himalayas and Hindu Kush and in Tibet. The glaciers feed most Asian rivers and “have serious implications for the water and food security of Asia”. Soot winds up on the surface of the glaciers that feed the Ganges, Indus, Yangtze and Yellow rivers, which makes the glaciers absorb more quickly and also pollute the rivers, the researchers says.
- Times of India, 15th Nov 08, **Haze poses danger to health: Expert**, the long-term hazards of the haze, or brown cloud, which forms over north Indian cities in winter have adverse impact on health of the people is clear, a leading Indian expert said. “The winter haze in north India has a different composition from the brown cloud over the rest of Asia,” said Dr. J Srinivasan, professor, Centre for atmospheric and Oceanic Sciences at the Indian Institute of Science (I I Sc) in Bangalore. The Indian haze is predominantly made of soot which has a different affect on the surroundings than that form brown clouds elsewhere.
- Times of India, 15th, Nov 08, **UN report: Experts sceptical, say brown clouds not limited to Delhi, mercury not rising**.
- Times of India, 15th, Nov 08, **High risk of asthma, cardiac trouble**, experts says that in the last five years there has been a cumulative increase of 20% in asthma cases, and even cardiovascular events shoot up due to smog.
- Times of India, 14th Nov 08, **Emissions can ward off the big freeze**, humans may have prevented onset of Ice age. Scheduled shifts in Earth’s orbit should plunge the planet into an enduring Ice Age thousands of years from now but the event will probably be averted because of man-made greenhouse gases, scientists said.
- Times of India, 6th Nov 08, **This year’s ozone hole in Antarctica is 5th biggest**, reaching a maximum area of 10.5 million square miles in September, Nasa says. Nasa has tracked the size of the hole for 30 years. Last year, it was 9.7 million square miles, about the size of the North America.
- Times of India, 6th Nov 08, **Diesel from fungus fuel of the future? A microbe found in Rain forest can synthesis the fuel from cellulose**.
- Times of India, 1st Nov 08, **Antarctica too feeling the heat: Study**
- Times of India, 1st Nov 08, **Warming helps short-lived creatures**, the researchers in Germany and Canada said that studies of the physical characteristics of animals showed that all have widely differing “ thermal windows” – a range of temperatures in which they best feed, grow and reproduce. That meant that climate change would not affect all equally. “Climate change will favour species with wide thermal windows, short life spans, and a large gene pool amongst its population,” the journal Science said of the findings.

Our ENVIS Team at SES, JNU

- Prof. V.K. Jain, Coordinator
- Dr. Krishan Kumar
- Dr. Sudesh Yadav
- Dr. Jayant K. Tripathi
- Dr. Menakshi Dua
- Dr. AL Ramanathan
- Mr. C. Chatterjee
- Ms. Jayanti Shukla
- Mr. Manoj Kumar
- Mr. Arun Kumar

Any further information, query and suggestions, please contact

The Coordinator
ENVIS Centre on Biogeochemistry
School of Environmental Sciences
Jawaharlal Nehru University
New Delhi-110067
Email: envis@mail.jnu.ac.in
Telephone: 011 26704315
Visit us: www.jnuenvis.nic.in

PRINTED MATTER BOOKPOST



If undelivered please return to:
The Coordinator
ENVIS Centre on Biogeochemistry
School of Environmental Sciences
Jawaharlal Nehru University
New Delhi-110067

To.

Inorganic Chemistry
Principles of Structure and Reactivity

James E. Huheey
Ellen A. Keiter
Richard L. Keiter
Okhil K. Medhi

Genes IX
Benjamin Lewin

Genes IX
Benjamin Lewin

Environmental Economics, Book 2 Thonus, Callau	42.
Principles and Techniques of Biochemistry and Molecular Biology	43.
Water Pollution and Management. Reviews, 1982. C.K Varshney (Edited by Keith Wilson)	44.
Environmental Chemistry Gaoy.W.Vandan, Stephen.J.Duffy	45.
Global Change Processes and Impact in Africa C.Ayndhesis	46.
Second International Conference: Ground Water for Sustainable Development I.G.C., 2006	47.
Africa and Global Climate Change, CR Special, 8 Book Version (Guest Editor) Paul Densan Key	48.
Environmental Research, Executive Summaries of Completed Projects, Volume III	49.
An Introduction to Environmental Chemistry Second Edition, Julian.E.Andrews, Peter. Brionbiecombe	50.
Environmental Chemistry a Global Prospective Gary W. Vanboon, Stephen J. Dusfy, (Two Book)	51.
General Hydrology P.P.Kiimentoy	52.
Inorganic Chemistry Principles of Structure and Reactivity Fourth Edition James.E.Huheey, Ellen.A.Keiter, Richard L.Keiter, Okhil K. Medhi	53.

Atkins. Physical Chemistry Peter Atkins, Julio de Paula (Indian Edition)	54.
Genes IX Benjamin Lewin	55.
Remote Sensing of Soil Salinization: Impact on land Management Edited by Graceial Metternicht, J. Alfred Zinck	56.
Introduction to Marine Biogeochemistry Second Edition Susan M. Libes	57.
Molecular Biology of The Cell Fifth Edition B. Alberts, A.Johnson, J.Lewis, Martin Raff, K.Roberts, Peter Walter	58.

