DR. SOMA GIRI
DST Women Scientist (WOS-A)
Water Resource Management Section, NREM Research Group
CSIR-Central Institute of Mining and Fuel Research
Dhanbad, Jharkhand
Mobile No. – 08603700242
E-mail –soma0307@gmail.com, soma0307@yahoo.co.in

Publications: 30 in SCI International journals | **Cumulative impact factor:** 67.48
Google Scholar Citation indices: 724| **h- index:** 14 | **i10- index:** 16
https://scholar.google.co.in/citations?hl=en&user=uy7IJkIAAAAJ
ORCHID ID: https://orcid.org/0000-0003-2791-4788
Scopus ID: 35785649700
Date of Birth: July 3rd, 1978 | **Blood Group:** AB+
Passport No: G 7033916 | Aadhaar **No.:** 252213914568| **PAN No.:** ANPPG1052Q

ACADEMIC QUALIFICATIONS:

- **Ph.D (Environmental Science): April 2010:-** from IIT-Indian School of Mines, Dhanbad, on the topic "DISTRIBUTION OF RADIONUCLIDES AND HEAVY METALS IN ENVIRONMENTAL COMPONENTS AROUND THE BAGJATA AND BANDUHURANG URANIUM MINING AREAS, EAST SINGHBHUM, JHARKHAND, INDIA*"*.

- **M.Sc (Environmental Science): July 2004**:- Passed from Banaras Hindu University, Varanasi, India, with **DISTINCTION** and the prestigious **GOLD MEDAL** of Banaras Hindu University.
  Special papers: Water Pollution Management & Air Pollution Management.
  Overall Percentage: 75.5%

- **B.Sc (Biotechnology): June 2001**:- Passed from Ranchi Women's College, Ranchi, with **DISTINCTION in 9 papers** and holds the 8**th** **position** in the University for the Year.
  Overall Percentage – 71.55%

- **All India Senior School Certificate Examination: 1996**
  Passed Class 12th examination (C.B.S.E) from Chinmaya Vidyalaya, B.S.City, Jharkhand.
  Subjects: Physics, Chemistry, Maths, Biology, English, Hindi
  Overall Percentage: 70.8%

- **All India Secondary School Examination: 1994**
  Passed class 10th examination (C.B.S.E) from Chinmaya Vidyalaya, B.S.City, Jharkhand.
  Subjects: Science, Maths, Social Sc., Hindi, English, Sanskrit
  Overall Percentage: 85%

PROFESSIONAL QUALIFICATION:

UGC-NET (Lectureship) Qualified in December, 2003 in first attempt.

***WORK EXPERIENCE*:**

1. As Research Scholar under ISM-JRF Ph.D Scheme in the Dept. of Environmental Science and Engineering, Indian School of Mines from Feb 2006 to June 2009.

2. As ***Fast Track Young Scientist*** in Natural Resources and Environmental Management Research Group (NREM), CSIR-Central Institute of Mining and Fuel Research, Dhanbad from July 2011 to October 2014 (Consolidated salary: Rs. 35000/- p.m)

3. As ***CSIR- Senior Research Associate*** in Natural Resources and Environmental Management Research Group (NREM), CSIR-Central Institute of Mining and Fuel Research, Dhanbad from October 2014 to October 2015 (Basic Pay: Rs. 21000/- p.m)

4. As ***DST- Young Scientist*** in Natural Resources and Environmental Management Research Group (NREM), CSIR-Central Institute of Mining and Fuel Research, Dhanbad from October 2015 to October 2018 (Consolidated salary: Rs. 55000/- p.m).

5. As **Project Scientist in** Natural Resources and Environmental Management Research Group (NREM), CSIR-Central Institute of Mining and Fuel Research, Dhanbad from December 2018 to July 2019 (Consolidated salary: Rs. 48200/- p.m).

6. As ***DST- Women Scientist (WOSA)*** in Natural Resources and Environmental Management Research Group (NREM), CSIR-Central Institute of Mining and Fuel Research, Dhanbad from July 2019 to till date (Consolidated salary: Rs. 55000/- p.m).

COMPLETED PROJECTS:

1. As ***Principal Investigator*** of ***Fast Track Young Scientist*** Project, ***Funding agency***: Department of Science and Technology, GOI; ***Project cost***: 22 lakhs, ***Duration***: 3 years. ***Project Title:*** Impact Evaluation of Mining and Industrial Activities on the Surface Water Quality of Subarnarekha River: Using Fish as a Bio-indicator

2. As ***Principal Investigator*** of ***DST Young Scientist*** Project, ***Funding agency***: Department of Science and Technology, GOI; ***Project cost***: 36.3 lakhs, ***Duration***: 3 years. ***Project Title:*** Human health risk assessment due to ingestion of metals through food and water in mining dominated areas of Southern Jharkhand

ONGOING PROJECTS:

1. As ***Principal Investigator*** of ***DST-Women Scientist (WOSA)*** Project, ***Funding agency***: Department of Science and Technology, GOI; ***Project cost***: 31.60 lakhs, ***Duration***: 3 years. ***Project title:*** Fluoride and Toxic metal contamination in great mica belt of Jharkhand: Geochemistry and Health implications

COMPUTER EDUCATION:

Completed the “Vidya” Course from APTECH, Bokaro.

STATISTICAL KNOWLEDGE:

Proficient in SPSS Statistical Software

FIELD TRAININGS:

- At **Central Fuel Research Institute**, Dhanbad, for 6 weeks (19th May'03 to 27th June'03) on the topic ***"Role of Aero biology in Control and Abatement of Pollen Allergy"***

- At Institute of Animal Health and Production, Ranchi for 2 weeks (1st August'2000 to 16th August 2000) on ***Vaccine Production, Quality Control and use of ELISA.***

- At Rajendra Medical College, Ranchi for 7 days (29th Oct'99 to 6th Nov'99) in the ***Department of Microbiology.***

DISSERTATIONS:

- One year dissertation work from Department of Botany, BHU, Varanasi during M.Sc. (Final) on the topic *"* ***Bloom Forming Algae in Freshwater bodies of Varanasi"***

- One year project from Ranchi Women's College, Ranchi, during B.Sc. (Part III) on the topic "***Phytohormones and Seed Viability".***

PROFICIENCY IN STUDY AREA:

- Radioactive analysis including Uranium, Thorium, Polonium and Radium of all Environmental Matrices

- Heavy metal analysis in different Environmental matrices

- Analysis of Physico chemical parameters of Water and Sediment samples

- Study of Risk assessment due to intake of heavy metals and radionuclides

- Dermal risk assessment due to contact of heavy metals

- Handling of instruments e.g. Inductively Coupled Plasma Mass Spectrometer, Atomic Absorption Spectrophotometer, Ion Chromatograph, Microwave digestion system, etc.

- Knowledge of software like SPSS 16.0, Grapher 8.0.

DETAILS OF AWARDS, MERIT CERTIFICATES, SCHOLARSHIPS & RECOGNITION:

- Awarded **BHU Gold Medal** for standing ***first in Environmental Science*** at the M.Sc (Special Course) Examination of 2004 at Banaras Hindu University.

- Received **4 Dr. Adinath Lahiri Awards (First & Second prizes)** for the highest impact factor of papers published in SCI journals by PDF/ Project Fellows/Project Scholars in the years 2019-20, 2018-19, 2017-18 & 2016-17, by **CSIR-Central Institute of Mining and Fuel Research** on the CSIR Foundation day.

- Received the **Young Scientist Award** in the International Symposium on Environment Pollution, Ecology and Human Health organized by S.V.University, Tirupati in collaboration with USEPA, on 27th July, 2009.

- Received the **Best Poster Presentation award** in the 6th International Congress in Environmental Research (ICER-13) held on 19-21st December 2013, at Aurangabad.

- Received the **Best Performance award** in the BRNS-AEACI Eighth School on Analytical Chemistry (SAC-8) held on 14-21st April, 2014, at CSIR-National Metallurgical Laboratory, Jamshedpur

- Received Certificate of **Outstanding contribution in reviewing** from the Elsevier Journals of ***Ecotoxicology and Environmental Safety*** (June 2017) and ***Ecological Indicators*** (Nov 2018).

- Awarded the **Certificate of Excellence** for outstanding academic performance as a Graduate student and securing ***8th position*** in the Ranchi University Examination in 2000.

- Received the **Second Best Presentation award** in the National Conference on Coal Mine Environment and its Management (CMEM-2017) held on 14-15th April 2017, at CSIR-Central Institute of Mining and Fuel Research, Dhanbad.

- Received Scholarship from I.S.M. for Ph.D (I.S.M. – JRF) from February 2006 to June 2009.

- Reviewer for the international journals of ***Science of the total environment, Ecotoxicology and Environmental Safety, Ecological Indicators, Environmental Pollution, Environmental Monitoring and Assessment***, ***Environmental Science and Pollution Research***, ***Environmental Earth Sciences,*** etc.

- Associated with National Children Science Congress as Evaluator of projects at the State Level.

DETAILS OF TRAINING RECIEVED:

- One week national workshop on Analytical techniques for Research organized by Global Network of Business Researchers from 10.06.2013 to 16.06.2013 at Shimla.

- BRNS-AEACI Eighth School on Analytical Chemistry (SAC-8) organized by BRNS-AEACI and CSIR-NML from 14.04.2014 to 21.04.2014 at Jamshedpur.

- One week national workshop on Research methodology and data analysis organized by Maharaja Agrasen University from 09.07.2018 to 15.07.2018 at Baddi.

PUBLICATIONS:

International Journals (30): Cumulative Impact Factor: 67.48

1. **Soma Giri**, Gurdeep Singh, S.K.Gupta, V.N.Jha and R.M.Tripathi. (2010). Evaluation of Metal Contamination in Surface and Groundwater around a Proposed Uranium Mining Site, Jharkhand, India. ***Mine Water and the Environment,*** **Springer,** 29, 225-234, ISSN: 1025-9112; **Impact factor: 3.184**

2. **Soma Giri,** Gurdeep Singh, V.N.Jha and R.M.Tripathi. (2010). Ingestion of U(nat) , ^{226}Ra, ^{230}Th, and ^{210}Po in vegetables by adult inhabitants of Bagjata uranium mining area, Jharkhand, India. ***Radioprotection***, **EDP Sciences,** 45, 183-199**.** ISSN: 0033-8451; **Impact factor: 0.541**

3. **Soma Giri,** Gurdeep Singh, V.N.Jha and R.M.Tripathi. (2010). Natural radionuclides in Fish Species from Surface Water of Bagjata and Banduhurang Uranium Mining Areas, East Singhbhum, Jharkhand, India. ***International Journal of Radiation Biology,*** **Taylor and Francis,** 86(11), 946-956, ISSN: 0955-3002; **Impact factor: 2.368**

4. **Soma Giri**, Gurdeep Singh, V.N.Jha and R.M.Tripathi. (2011). Risk assessment due to ingestion of natural radionuclides and heavy metals in the milk samples: A case study from a proposed uranium mining area, Jharkhand. ***Environment monitoring and assessment,*** **Springer,** 175, 157-166, ISSN: 0167-3639; **Impact factor: 1.903**

5. **Soma Giri,** Gurdeep Singh, V.N.Jha. (2011). Evaluation of radionuclides in groundwater around proposed uranium mining sites at Bagjata and Banduhurang, Jharkhand (India). ***Radioprotection***, **EDP Sciences,** 46, 39-57, ISSN: 0033-8451; **Impact factor: 0.541**

6. **Soma Giri,** Mukesh K. Mahato, Gurdeep Singh, V.N.Jha. (2012). Risk assessment due to intake of heavy metals through the ingestion of ground water around two proposed uranium mining areas in Jharkhand, India. ***Environment monitoring and assessment,*** **Springer,** 184, 1351-1358, ISSN: 0167-3639; **Impact factor: 1.903**

7. **Soma Giri**, V.N.Jha. (2012). Risk Assessment (chemical and radiological) due to intake of uranium through the ingestion of drinking water around two proposed uranium mining areas, Jharkhand, India. ***Radioprotection,*** **EDP Sciences,** 47(4), 543-551, ISSN: 0033-8451; **Impact factor: 0.541**

8. **Soma Giri**, V.N.Jha, R.M.Tripathi, Gurdeep Singh. (2012). Dose estimates for the local inhabitants from ^{210}Po ingestion via dietary sources at a proposed Uranium mining site in India. ***International Journal of Radiation Biology,*** **Taylor and Francis,** 88, 540-546, ISSN: 0955-3002; **Impact factor: 2.368**

9. **Soma Giri**, Abhay Kumar Singh, B.K.Tewary. (2013). Source and distribution of metals in bed sediments of Subarnarekha River, India. ***Environmental Earth Sciences***, **Springer,** 70, 3381-3392, DOI 10.1007/s12665-013-2404-1, ISSN: 1866-6280, **Impact factor: 2.180**

10. **Soma Giri,** V.N.Jha, Gurdeep Singh and R.M.Tripathi. (2013). Estimation of annual effective dose due to ingestion of natural radionuclides in foodstuffs and water at a proposed Uranium mining site in India. ***International Journal of Radiation Biology,*** **Taylor and Francis,** 89(12):1071-1078, ISSN: 0955-3002; **Impact factor: 2.368**

11. **Soma Giri,** Abhay Kumar Singh. (2013). Assessment of human health risk for heavy metals in fish and shrimp collected from Subarnarekha river, India. ***International Journal of Environmental Health Research,*** **Taylor & Francis,** 24(5), 429-449, ISSN: 0960-3123, **Impact factor: 1.916**

12. **Soma Giri,** Abhay Kumar Singh. (2014). Risk assessment, statistical source identification and seasonal fluctuation of dissolved metals in the Subarnarekha River, India. ***Journal of Hazardous materials,*** **Elsevier,** 265, 305-314, ISSN: 0304-3894 **Impact factor: 9.038**

13. **Soma Giri,** Abhay Kumar Singh. (2014). Assessment of Surface water quality using heavy metal pollution index in Subarnarekha River, India. ***Exposure and Health*. Springer,** 5, 173-182, ISSN: 1876-1658, **Impact factor: 4.762**

14. **Soma Giri,** Gurdeep Singh. (2014). Heavy metals in fish species, sediment and surface water around two proposed uranium mining areas in India. ***Asian Journal of Water, Environment and Pollution.*** **IOS press,** 11(3), 89-96. ISSN: 0972-9860.

15. **Soma Giri,** Abhay Kumar Singh. (2015). Human health risk and ecological risk assessment of metals in fishes, shrimps and sediment from a tropical river. ***International Journal of Environmental Science and Technology.*** 12, 2349-2362, **Springer,** ISSN: 1735-1472, **Impact factor: 2.540.**

16. **Soma Giri,** Abhay Kumar Singh. (2015). Metals in some edible fish and shrimp species collected in dry season from Subarnarekha River, India. ***Bulletin of Environmental Contamination and Toxicology.*** 95 (2), 226-233, **Springer,** ISSN: 0007-4861; **Impact factor: 1.657.**

17. **Soma Giri,** Abhay Kumar Singh**.** (2015). Human health risk assessment via drinking water pathway due to metal contamination in the groundwater of Subarnarekha River Basin, India. ***Environmental Monitoring and Assessment.*** 187, 63, **Springer,** ISSN: 0167-3639; **Impact factor: 1.903,** DOI 10.1007/s10661-015-4265-4.

18. **Soma Giri,** Abhay Kumar Singh. (2016). Spatial and temporal variation in distribution of metals in bed sediments of Subarnarekha River, India. ***Arabian Journal of Geosciences.*** 9, 9, **Springer,** ISSN: 1866-7511; **Impact factor: 1.327.** DOI 10.1007/s12517-015-2090-2.

19. **Soma Giri,** Abhay Kumar Singh. (2016). Spatial distribution of metal(loid)s in groundwater of a mining dominated area: recognizing metal(loid) sources and assessing carcinogenic and non-carcinogenic human health risk. ***International Journal of Environmental Analytical Chemistry.*** 96, 1313-1330, **Taylor and Francis,** ISSN: 0306-7319; **Impact factor: 1.431.**

20. **Soma Giri,** Abhay Kumar Singh, Mukesh Kumar Mahato (2017). Metal contamination of agricultural soils in the copper mining areas of Singhbhum shear zone in India. ***Journal of Earth System Science,*** 126, 49, **Springer,** ISSN: 0253-4126; **Impact factor: 1.423**

21. **Soma Giri,** Abhay Kumar Singh (2017). Ecological and Human health risk assessment of agricultural soils based on heavy metals in mining areas of Singhbhum copper belt, India. ***Human and Ecological Risk Assessment: An International Journal,*** 23:5, 1008-1027, **Taylor and Francis** ISSN: 1080-7039; **Impact factor: 2.300**

22. **Soma Giri,** Abhay Kumar Singh (2017). Human health risk assessment due to dietary intake of heavy metals through rice in the mining areas of Singhbhum copper belt, India.

Environmental Science and Pollution Research, 24, 14945-14956**, Springer,** ISSN: 0944-1344; **Impact factor: 3.056**

23. Abhay Kumar Singh, **Soma Giri,** Aaditya Chaturvedi (2018) Fluvial geochemistry of Subarnarekha River basin, India: Implications for weathering and solute acquisition processes and water quality assessment. ***Journal of Earth System Science,*** 127,119, **Springer,** ISSN: 0253-4126; **Impact factor: 1.423**

24. **Soma Giri,** Abhay Kumar Singh (2019). Heavy metals in eggs and chicken and the associated health risk assessment in the mining areas of Singhbhum Copper Belt, India. ***Archives of Environmental and Occupational Health,*** 74(4), 161-170, **Taylor and Francis,** ISSN: 1933-8244, **Impact factor: 1.180 DOI:** 10.1080/19338244.2017.1407284

25. **Soma Giri**, Abhay Kumar Singh (2019). Assessment of metal pollution in groundwater using a novel multivariate metal pollution index in the mining areas of the Singhbhum copper belt. ***Environmental Earth Sciences***, 78, 192, **Springer, Impact factor: 2.180,** DOI 10.1007/s12665-019-8200-9, ISSN: 1866-6280,

26. **Soma Giri**, Abhay Kumar Singh, Mukesh Kumar Mahato (2020). Monte Carlo simulation-based probabilistic health risk assessment of metals in groundwater via ingestion pathway in the mining areas of Singhbhum copper belt, India. ***International Journal of Environmental Health Research,*** 30(4), 447-460, **Taylor & Francis,** ISSN: 0960-3123, **Impact factor: 1.916**

27. **Soma Giri**, Abhay Kumar Singh (2020). Human health risk assessment due to metals in cow's milk from Singhbhum copper and iron mining areas, India. ***Journal of Food Science and Technology,*** 57(4), 1415-1420, **Springer,** ISSN: 0022-1155, **Impact factor: 1.946**

28. **Soma Giri**, Mukesh Kumar Mahato, Santanu Bhattacharjee, Abhay Kumar Singh (2020). Development of a new noncarcinogenic heavy metal pollution index for quality ranking of vegetable, rice, and milk. ***Ecological Indicators,*** 113, 106214, **Elsevier,** ISSN: 1470-160X, **Impact factor: 4.229**

29. **Soma Giri**, Mukesh Kumar Mahato, Abhay Kumar Singh (2021). Multivariate linear regression models for predicting metal content and sources in leafy vegetables and human health risk assessment in metal mining areas of Southern Jharkhand, India. ***Environmental Science and Pollution Research,*** 28, 27250-27260, **Springer,** ISSN: 0944-1344; **Impact factor: 3.056**

30. **Soma Giri,** Mukesh Kumar Mahato, Pramod Kumar Singh, Abhay Kumar Singh (2021). Non-carcinogenic health risk assessment for fluoride and nitrate in the groundwater of the mica belt of Jharkhand, India. ***Human and Ecological Risk Assessment: An International Journal,*** *published online,* **Taylor and Francis** ISSN: 1080-7039; **Impact factor: 2.300, DOI:** 10.1080/10807039.2021.1934814

Publication in Books:

31. **Soma Giri**, Gurdeep Singh, V.N.Jha. (2012). Cancer Risk Assessment due to Intake of Radionuclides through the Ingestion of Drinking Water around Bagjata and Banduhurang Uranium Mining Area, Jharkhand, India.. In: ***Environmental pollution, Ecology and Human Health*** Edited by Gottipolu R. Reddy, S. J. S. Flora, Riyaz Basha, **Narosa Publishing House Pvt. Ltd** New Delhi, INDIA, ISBN: 978-81-8487-112-8.

32. **Soma Giri**, Abhay Kr. Singh, Ashwani Kr. Tiwari, Mukesh Kr. Mahato and B.K.Tewary. (2012). Risk assessment due to intake of metals and fluoride through the ingestion of ground water in Giridih District, Jharkhand, India. ***Frontiers in Environmental Research,*** Editor: Anish Chandra Pandey, Academic Excellence Publishers and Distributors, New Delhi, ISBN No. 978-93-80525-71-6.

33. Abhay Kr. Singh, **Soma Giri** (2014). Subarnarekha River: The Gold Streak of India. In: The Indian Rivers. Springer, DOI: 10.1007/978-981-10-2984-4_22 ISBN No. 978-981-10-2983-7

Proceedings in Conferences:

34. **Soma Giri**, V.N.Jha, N.K.Sethy, A.K.Shukla, Gurdeep Singh and R.M.Tripathi. (2007). Evaluation of Radionuclides in Terrestrial Ecosystem around proposed U mining sites at Bagjata, Jharkhand. 15th National Symposium on Environment, Bharatiar University, Coimbatore, June 5-7, 2007.

35. V.N.Jha, **Soma Giri**, Sangita Paul, N.K.Sethy, A.K.Shukla, Gurdeep Singh R.M.Tripathi and V.D.Puranik. (2007). Radionuclides uptake by native vegetation growing around proposed U mining sites at Banduhurang, Jharkhand. 15th National Symposium on Environment, Bharatiar University, Coimbatore, June 5-7, 2007.

36. **Soma Giri**, V.N.Jha, Gurdeep Singh, Mukesh Mahato, N.K.Sethy, R.M.Tripathi. (2008). Estimation of Radionuclides in Chicken and Egg samples around the Bagjata and Banduhurang Mining Areas, (East Singhbhum), Jharkhand. 28th Indian Association for Radiation Protection Conference, 2008.

Research Papers presented in Conferences:

1. **Soma Giri**, Gurdeep Singh, S.K.Gupta. Estimation of Heavy Metal pollution Index for Surface and Ground water around Bagjata Uranium Mining Area, Jharkhand, India. Paper presented in ISARC 24 International Conference on Water, Environment, Energy and Society held on 28-30 June, 2009, at S.R.K. College, Firozabad.

2. **Soma Giri**, Gurdeep Singh, V.N.Jha. Cancer Risk Assessment due to Intake of Radionuclides through the Ingestion of Drinking Water around Bagjata and Banduhurang Uranium Mining Area, Jharkhand, India. Paper presented in International Symposium on Environmental Pollution, Ecology and Human Health held on 25-27 July, 2009, at S.V University, Tirupati.

3. **Soma Giri**, Gurdeep Singh, V.N.Jha. Cancer Risk Assessment due to Intake of Radionuclides through the Ingestion of Cereals and Pulses around Bagjata Uranium Mining Area, Jharkhand, India. Paper presented in International Conference on Environment, Occupational & Lifestyle Concerns - Transdisciplinary Approach held on 16-19th September 2009, at ROCH-NIOH, Bangalore.

4. **Soma Giri**, Gurdeep Singh, V.N.Jha. Risk Assessment due to Intake of Radionuclides through the Ingestion of non vegetarian food around Bagjata Uranium Mining Area, Jharkhand, India. Paper presented in 3rd Bihar Science Congress held on 11-13th February 2010, at Gaya College, Gaya.

5. **Soma Giri**, A.K. Singh, V.N.Jha. Risk assessment due to intake of uranium through the ingestion of drinking water around two proposed uranium mining areas, Jharkhand, India. Paper presented in 4th International Congress in Environmental Research (ICER-11) held on 15-17th December 2011, at SVNIT, Surat.

6. **Soma Giri**, Abhay Kr. Singh, Ashwani Kr. Tiwari, Mukesh Kr. Mahato and B.K.Tewary. Risk assessment due to intake of metals and fluoride through the ingestion of ground water in Giridih District, Jharkhand, India. Paper presented in Frontiers in Environmental Research (FIER-12) held on 18-19th February 2012, at SLP-PG College, Gwalior.

7. **Soma Giri**, Abhay Kr. Singh Oral and dermal risk assessment and statistical source identification of dissolved metals in the Subernarekha River, India. Paper presented in International Conference of Advances in Water Resources Development & Management (AWRDM-2013) held on 23-27th October 2013, at Punjab University, Chandigarh.

8. **Soma Giri**, Abhay Kr. Singh Human health risk assessment due to the metals in the river water ecosystem: Case study from selected locations of Subarnarekha River, India Paper presented in National Seminar on Recent Approaches to Water Resources Management (RAWRM-2013) held on 9-10th December 2013, at Indian School of Mines, Dhanbad.

9. **Soma Giri,** Abhay Kr. Singh Human health risk assessment due to ingestion of metals in fishes, shrimps and water from Subarnarekha River, India. Paper presented in 6th International Congress in Environmental Research (ICER-13) held on 19-21st December 2013, at Maulana Azad College of Arts, Science & Commerce Aurangabad.

10. **Soma Giri,** Abhay Kr. Singh. Human health risk assessment, statistical source identification and seasonal variation of metals in edible fish and shrimp species collected from Subarnarekha River, India. Paper presented in National Conference on Harmony with Nature in context of Resource Conservation and Climate Change (Harmony-2016) held on 22-24th October 2016, at Vinoba Bhave University, Hazaribag.

11. **Soma Giri,** Abhay Kr. Singh. Heavy metal distribution in water and fish of Subarnarekha River and the associated human health risk assessment. Paper presented in Young Scientist Conclave of 2nd India International Science Festival (IISF-2016) held on 7-11th December 2016, at CSIR-National Physical Laboratory, New Delhi.

12. **Soma Giri,** Abhay Kr. Singh. Human health risk assessment and statistical source identification of dissolved metals in the groundwater of copper mining areas of East Singhbhum, India. Paper presented in National Conference on Coal Mine Environment and its Management (CMEM-2017) held on 14-15th April 2017, at CSIR-Central Institute of Mining and Fuel Research, Dhanbad.

13. **Soma Giri,** Abhay Kr. Singh. Human health risk assessment due to ingestion of metals through food and water in mining areas Singhbhum Copper Belt, Jharkhand. Paper presented in Young Scientist Conference of 5th India International Science Festival (IISF-2019) held on 5-8th November 2019, at Biswa Bangla Convention Centre, Kolkata.

REFERENCES:

(i) **Dr. Abhay Kumar Singh,**
Sr. Principal Scientist,
Water Resources and Management Section (NREM Research group),
CSIR-Central Institute of Mining and Fuel Research, Dhanbad, Jharkhand-826015
Email: singhak.cimfr@gmail.com
Mobile no.: 09835324263

(ii) **Prof. Gurdeep Singh,**
Professor (HAG)
IIT (Indian School of Mines), Dhanbad, Jharkhand-826004
Email: s_gurdeep2001@yahoo.com
Mobile no.: 09431711184

(iii) **Dr. V.N.Jha**
SO(D) and OIC
Health Physics Unit, BARC, Jadugoda,
Jharkhand-832102
Email: jhavn_barc@rediffmail.com
Mobile no.: 09431388751

Name	:	**Dr. SOMA GIRI**
Father's Name	:	Late Sri Ashis Kumar Giri
Mother's Name	:	Smt. Dipti Giri
Gender	:	Female
Date of Birth	:	3rd July 1978
Marital Status	:	Unmarried
Nationality	:	Indian
Language Proficiency	:	English and Hindi
Permanent Address	:	264, Shivpuri Colony, Jodhadih More At & PO- Chas, Dist -Bokaro, Jharkhand, PIN-827013

HUMAN AND ECOLOGICAL RISK ASSESSMENT
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Non-carcinogenic health risk assessment for fluoride and nitrate in the groundwater of the mica belt of Jharkhand, India

Soma Giri, Mukesh Kumar Mahato, Pramod Kumar Singh, and Abhay Kumar Singh

Natural Resources and Environmental Management Group, CSIR-Central Institute of Mining and Fuel Research, Dhanbad, India

ABSTRACT

Groundwater quality was investigated for fluoride and nitrate contamination in the mica mining areas of Jharkhand with special emphasis on seasonal fluctuation, source apportionment and human health risk assessment. Samples were collected from thirty-seven locations on a seasonal basis. The results indicated 31% and 32% samples of groundwater to exceed the Indian drinking water quality standards for F^- and NO_3^-, respectively. Marked seasonal variation was observed in the concentration of NO_3^- with highest levels in monsoon season; however, the seasonal fluctuation was insignificant for F^-. The NO_3^- contamination can be attributed to agricultural activities while F^- can be related to geogenic sources. For the evaluation of non-carcinogenic risk, Hazard Quotient (HQ) and Hazard Indices (HI) were calculated as per United States Environmental Protection Agency methodology. The results suggested the child population to be most vulnerable to health risks due to ingestion of F^- and NO_3^-. The HI values for men (0.34–18.4), women (0.29–15.8) and children (0.55–29.3) suggested considerable health risk related to F^- and NO_3^- to all the population groups. As high as 95% of the groundwater samples were likely to cause non cancer health effects in the child populace advocating upgraded water management plan for the residents.

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KEYWORDS
Groundwater; nitrate; fluoride; risk assessment; source; mica mining areas

Introduction

Groundwater forms the lone source of drinking water for nearly 2.5 billion people worldwide inspite of being just 20% of world's total fresh water (Sefie et al. 2018; Villholth and Rajasooriyar 2010). In India, approximately one third of the population uses groundwater for consumption (Adimalla et al. 2018). However, the contamination of the subsurface water has drawn 200 million people across 28 nations in danger, making the groundwater pollution a global issue (Kut et al. 2016; Wu et al. 2015). Amongst the numerous pollutants of groundwater having adverse health effects on human beings, nitrate and fluoride are more prevalent (Adimalla et al. 2019; Li et al. 2018). High levels

CONTACT Soma Giri soma0307@gmail.com Natural Resources and Environmental Management Research Group, CSIR-Central Institute of Mining and Fuel Research, Barwa Road, Dhanbad, 826015, India

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RESEARCH ARTICLE

Multivariate linear regression models for predicting metal content and sources in leafy vegetables and human health risk assessment in metal mining areas of Southern Jharkhand, India

Soma Giri[1] · Mukesh Kumar Mahato[1] · Abhay Kumar Singh[1]

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Abstract

The present study was intended to investigate the metal concentrations in the leafy vegetables, irrigation water, soil, and atmospheric dust deposition in the iron and copper mining areas of Southern Jharkhand, India. The study aimed to develop a multivariate linear regression (MVLR) model to predict the concentration of metals in leafy vegetables from the metals in associated environmental factors and assessment of the risk to the local population through the consumption of leafy vegetables and other allied pathways. The developed species-specific MVLR models were well fitted to predict the concentration of metals in the leafy vegetables. The coefficient of determination values (R^2) was greater than 0.8 for all the species-specific models. Risk assessment was carried out considering multiple pathways of ingestion, inhalation, and dermal contact of vegetables, soil, water, and free-fall dust. Consumption of leafy vegetables was the major route of metal exposure to the local population in both the metal mining areas. The average hazard index (HI) value considering all the metals and pathways was calculated to be 5.13 and 12.1, respectively for iron and copper mining areas suggesting considerable risk to the local residents. Fe, As, and Cu were the major contributors to non-carcinogenic risk in the Iron mining areas while in the case of copper mining areas, the main contributors were Co, As, and Cu.

Keywords Metals · Leafy vegetables · Health risk assessment · Multivariate linear regression model

Introduction

A significant quantity of tailings and wastewater is produced during the mining exploitation and ore smelting processes which results in severe metal pollution in the surface water, groundwater, soils, and food crops (Amoakwah et al. 2020; Rodríguez-Estival et al. 2019). The metals in the mining environment pose a health risk to the population in the vicinity through different pathways like ingestion, dermal contact, or inhalation of dust and soil; ingestion and dermal contact of water; and consumption of food crops grown in contaminated soils or irrigated with polluted water (Doabi et al. 2018; Park and Choi 2013; Wu et al. 2015).

Consumption of metal-contaminated crops, particularly vegetables, from a mining dominated area form a major exposure pathway for the local consumers. Metal concentrations in plants grown in mine contaminated soils are considerably elevated compared to the reference soils (Cao et al. 2016). Nevertheless, in addition to soil, irrigation water and atmospheric deposition are impending sources of heavy metals in the vegetables (Bi et al. 2018; El-Radaideh and Al-Taani 2018; Li et al. 2012). However, in a similar environment, concentrations of metals in the vegetables are also dependent on plant categories and species.

Leafy vegetables accrue elevated metal concentrations compared to rootstalk and fruiting vegetables. Foliar deposition of metals through atmospheric dust emitted from anthropogenic sources form the governing pathway of metal uptake for the leafy vegetables (Luo et al. 2011; Noh and Jeong 2019; Xu et al. 2015). Also, the leafy vegetables have higher transportation rates of metals compared to other vegetable types

The original online version of this article was revised: The entries in the 3rd column of Table are overlapping.

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✉ Soma Giri
soma0307@gmail.com

[1] Natural Resources and Environmental Management Group, CSIR-Central Institute of Mining and Fuel Research, Barwa Road, Dhanbad 826015, India

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Development of a new noncarcinogenic heavy metal pollution index for quality ranking of vegetable, rice, and milk

Soma Giri*, Mukesh Kumar Mahato, Santanu Bhattacharjee, Abhay Kumar Singh

Natural Resources and Environmental Management Group, CSIR-Central Institute of Mining and Fuel Research, Barwa Road, Dhanbad 826015, India

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ABSTRACT

A new heavy metal pollution index (HMI) has been proposed for ranking noncarcinogenic heavy metal pollution in vegetable, rice, and milk. HMI comprises a pair of one positive index (Pqi) and one negative index (Nqi). Pqi represents metals present above the maximum allowable concentration, while Nqi corresponds to those below. Higher the Pqi, greater is the pollution. In the case two similar food items have same or close Pqi, Nqi decides the relative degree of contamination; lower the Nqi, lesser is the pollution. Three different databases of 12 heavy metals in 57 vegetable samples (15 different species), 12 in 14 rice samples, and 10 in 24 milk samples were separately used for developing and calibrating the newly proposed HMI. All the samples were collected from mineral-rich country sides of Jharkhand state in India. USEPA Hazard Index (HI) was used as the referral standard for calibrating HMI using a Multi-Variate Linear Regression (MVLR) model. It is also possible to apply the same model to other types of food items. If properly calibrated, HMI may not only be independently used for ranking heavy metal pollution in food but may also be used for theoretically predicting maximum allowable metal concentrations in food items for which reliable experimental data are not available.

1. Introduction

Heavy metals, being integral part of the environment, are ubiquitous in nature. Some of the heavy metals and metalloids such as Co, Cu, Ni, Fe, Mn, Zn, Mo, and Se are essential micronutrients for living organisms. Deficiency of these elements is the cause of many health ailments (WHO, 1996); however, ingestion of these elements beyond a limit may also impact health adversely. A typical case is the metalloid Se. While it is an essential micronutrient for plant growth, Se deficiency is also the root cause of a wide spectrum of health issues in humans. Interestingly, selenium toxicity due to excess Se ingestion has also been reported, albeit such occurrences being much less than that of Se deficiency (Fordyce, 2013). Heavy metals/metalloids such as Pb, Hg, Cd, and As have no known beneficial role for living organisms (Vieira et al., 2011; Cobbina et al., 2015; Jia et al., 2018), and these are counted amongst the most toxic of the heavy metals. Various manifestations of chronic exposure to these elements include neurotoxic and carcinogenic expressions. A detailed registry of different heavy metals and metalloids along with their beneficial and deleterious roles with reference to human health may be found (ATSDR, 2003a, 2003b, 2004, 2007, 2008).

Undisturbed nature usually balances the concentration of heavy metals in its various components. However, anthropogenic activities such as industrialization, urbanization etc., often tilt this balance. For example, mining, metallurgical and chemical industries are major environment polluters with reference to heavy metals (Luo et al., 2011; Li et al., 2018; Tepanosyan et al., 2018). Geogenic events such as volcanic eruption, cyclone, flood, tsunami, and landslides may also occasionally tip the ecological balance of heavy metals (Varrica et al., 2000; Antić-Mladenović et al., 2019).

As part of the biota, plants and vegetables depend on beneficial heavy metals for a healthy growth. However, they often do not have a screening mechanism to selectively choose the metals of their choice in desired quantity from the source that is primarily soil, air and water. Consequently, plants and vegetables may get contaminated with heavy metals if the soil, air and water have them in excess. This has a cascading effect on higher trophic levels including humans in the form of bio-magnification and associated health hazards (Zheng et al., 2007; Zhuang et al., 2009; Gupta et al., 2019).

Indexing heavy metal pollution is a common practice for different environmental matrices that include all types of water, soil, sediment, food items, crops, cereals etc. Metal Pollution Index (MPI), based on the geometric means of constituent metals, was applied on crops, cereals and vegetables (Usero et al., 1997; Singh et al., 2010; Giri and Singh, 2017). With regard to soil indexing, researchers used enrichment factor (EF) (Sutherland, 2000; Kartal et al., 2006), geo-accumulation index

* Corresponding author.
E-mail address: soma0307@gmail.com (S. Giri).

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ORIGINAL ARTICLE

Human health risk assessment due to metals in cow's milk from Singhbhum copper and iron mining areas, India

Soma Giri[1] · Abhay Kumar Singh[1]

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Abstract The concentration of Al, As, Ba, Co, Cr, Cu, Fe, Mn, Ni, Pb, Se and Zn were determined in the milk collected from the locally rearing cows from the vicinity of copper mining areas of East Singhbhum and iron mining areas of West Singhbhum using inductively coupled plasma-mass spectrometry for a risk assessment and source apportionment study. Principal component analysis suggested both natural and anthropogenic activities as causative sources of metals in the milk. The hazard indices ranged from 0.26 to 0.89 with a mean of 0.56 in the iron mining areas and 0.29–1.89 with a mean of 1.17 in the copper mining areas due to ingestion of milk, which indicated that the risk is negligible in the iron mining areas while there is an appreciable risk to the health of consumers of milk in the copper mining areas.

Keywords Milk · Metals · Principal component analysis · Risk assessment · Mining areas

Introduction

Amidst the rapid developmental activities, one of the most serious problems that have emerged for the human society is the metal contamination of the environment. One of the sources of metals in the environment can be attributed to the metal mining and processing industries (Navarro et al. 2008). The metals in the environmental components like soil and water can easily be transferred to the plants, livestock and ultimately human beings through the food chains causing serious human health issues. Not only the plants, but food products of animal origin also depict high levels of metals due to bioaccumulation (Licata et al. 2012). Grazing of the livestock on the contaminated soil and feeding them with contaminated feed and water are the probable sources of metals accumulation in the meat and milk.

Milk is regarded as a nearly complete food for its being a good source of proteins, fats, minerals and vitamins and thus consumed widely by all age group of people worldwide (Malhat et al. 2012). Milk is also an ideal source of macroelements like P, K, Ca and microelements like Fe, Zn, Se, Cu, etc. However, the contamination of milk with toxic metals at very low levels as well as concentration of essential metals at high levels beyond limits both can cause toxicity to the consumers (Li et al. 2005).

Singhbhum craton and shear zones of Eastern India harbors one of the largest deposits of iron and copper, respectively. The regions are under the extensive influence of metal mining and processing industries thus paving the way for metal contamination of the environment and subsequently the food chains. Considering these facts, the present study was undertaken to examine the metal concentrations in the milk of the locally rearing cows. Statistical source apportionment of the metals and human health risk assessment due to consumption of the milk is also addressed in the study.

✉ Soma Giri
soma0307@gmail.com

[1] Natural Resources and Environmental Management Group, CSIR-Central Institute of Mining and Fuel Research, Barwa Road, Dhanbad 826015, India

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ARTICLE

Monte Carlo simulation-based probabilistic health risk assessment of metals in groundwater via ingestion pathway in the mining areas of Singhbhum copper belt, India

Soma Giri, Abhay Kumar Singh and Mukesh Kumar Mahato

CSIR-Central Institute of Mining and Fuel Research, Natural Resources and Environmental Management Group, Dhanbad, India

ABSTRACT
Probabilistic health risk assessment was conducted for metal exposure through groundwater in mining areas of Singhbhum Copper Belt, India. The concentrations of metals showed notable spatial variation exceeding drinking water standards at some of the locations. Hazard Quotient revealed that chronic risks to the local population were largely contributed by Mn, Co and As. The 95th percentiles of Hazard Index (HI) calculated using Monte Carlo simulations showed that the HI for male, female and child populations was 2.87, 2.54 and 4.57 for pre-monsoon, 2.16, 1.88 and 3.49 for monsoon and 2.28, 2.02 and 3.75 for post-monsoon seasons, respectively. The Hazard Indices indicated that amongst the populations, risk was greater for child population and considering the seasons the risk was higher during the pre-monsoon season. The sensitivity analysis suggested that concentration of metals in groundwater and exposure duration were 2 most influential input variables that contributed to the total risk.

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Groundwater; metals; copper mining areas; probabilistic risk assessment; sensitivity analysis

Introduction

Heavy metals and their compounds are omnipresent in the nature, be it soil, water or biota. Some of the metals like Fe, Cu, Mn and Zn are needed for the well being of human beings and other living organisms since they are essential for proper physiological functioning of body. However, beyond limit these essential metals can also be toxic. Other metals like As, Cd, Cr, Pb and Co have no known requirement in the human body and can create havoc even at low concentrations (Marschner 1995; Bruins et al. 2000). Owing to their potential toxicity and persistent nature, some of the metals e.g. Cd, Cr, As, Hg, Pb, Cu, Zn and Ni have been listed as priory control pollutants as per United States Environmental Protection Agency (USEPA 1997, 2001; Rodrigues et al. 2013).

The metals enter the human body through many pathways of which ingestion particularly of drinking water forms the major one. Groundwater, which forms a major source of drinking water, may be contaminated with metals which can be attributed to both geological and anthropogenic sources (Ritter et al. 2002; Fry 2005). Continual exposure to toxic metals is known to be a major public health concern, thus a systematic human health risk assessment for the populations exposed to toxic metals through groundwater is a requisite.

Health risk assessments is the calculations of the probability of deleterious effects in the human body which accounts for risk sources, exposure routes and risk receptors (Man et al. 2013). However, uncertainty is associated with risk assessment intrinsically (Li et al. 2006), where the 'uncertainty' can

CONTACT Soma Giri soma0307@gmail.com CSIR-Central Institute of Mining and Fuel Research, Natural Resources and Environmental Management Group, Barwa Road, Dhanbad 826015, India

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Risk assessment, statistical source identification and seasonal fluctuation of dissolved metals in the Subarnarekha River, India

Soma Giri *, Abhay Kumar Singh

Geo-Environmental Division (EMG), Central Institute of Mining and Fuel Research, Barwa Road, Dhanbad 826001, India

HIGHLIGHTS

- Metals were analyzed in the water of Subarnarekha River for risk assessment.
- The concentrations of the metals showed significant spatial and temporal variations.
- PCA suggested both innate and anthropogenic activities as sources of metals.
- Risk assessment indicated As, V and Co as largest contributors to chronic risks.
- Oral intake was the primary exposure pathway and dermal absorption was negligible.

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ABSTRACT

Surface water samples were collected from 21 sampling sites throughout the Subarnarekha River during pre monsoon, monsoon and post monsoon seasons. The concentrations of metals were determined using inductively coupled plasma-mass spectrometry (ICP-MS) for the seasonal fluctuation, source apportionment and risk assessment. The results demonstrated that concentrations of the metals showed significant seasonality and most variables exhibited higher levels in the pre monsoon season. Principal component analysis (PCA) outcome of four factors together explained 76.9% of the variance with > 1 initial eigenvalue indicated both innate and anthropogenic activities are contributing factors as source of metal profusion in Subarnarekha River. Risk of metals on human health was then evaluated using hazard quotients (HQ) by ingestion and dermal pathways for adult and child and it was indicated that As with $HQ_{ingestion} > 1$, was the most important pollutant leading to non-carcinogenic concerns. The largest contributors to chronic risks were As, V and Co, in all the seasons. The HQ_{dermal} of all the elements for adult and child were below unity, suggesting that the metals posed little hazards via dermal absorption indicating that the oral intake was the primary exposure pathway.

1. Introduction

Surface waters are highly vulnerable to pollution due to their easy accessibility to the disposal of wastewaters, since river basins generally constitute areas with a high population density owing to favourable living conditions [1,2]. Natural processes, such as precipitation, erosion and weathering, as well as anthropogenic influences, urban, industrial, and agricultural activities and increasing exploitation of water resources, determine the quality of surface water in a region [3,4]. Identification and quantification of these sources should form an important part of managing land and water resources within a particular river catchment [5]. Simultaneously, seasonal variations in agricultural activity, storm water runoff, interflow and atmospheric deposition has strong effects on river water quality [6–8]. Thus, characterization of seasonal variability in surface water quality is imperative for evaluating temporal variations of river pollution from natural or anthropogenic contributions.

Heavy metals contamination is important due to their potential toxicity for the environment and human beings [9,10]. Some of the metals such as Cu, Fe, Mn, Ni and Zn are essential as micronutrients for the life processes for animals and plants while many other metals such as Cd, Cr, Pb and Co have no known physiological consequences [11,12]. Metals are non-degradable and can accumulate in the human body system, causing damage to nervous system and internal organs [9,13]. They enter into river water from mining areas through various ways such as mine discharge, run-off, chemical weathering of rocks and soils, wet and dry fallout of atmospheric particulate matter [14–16] or from industrial areas via discharge of untreated industrial effluent in the river [17]. Rivers in urban areas have also been associated with water quality problems because of the practice of discharging of untreated domestic and small scale

* Corresponding author. Tel.: +91 326 2296021; fax: +91 326 2296021.
E-mail address: soma0307@gmail.com (S. Giri).

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