LIST OF FIGURES

2.1 Generation and Utilisation of flyash from 1996-97 to 2017-18 (CEA) 16 2.2: Disposal of Flyash slurry through pipe line from TTPS into residual quarry of Balanda OCM, MCL 16 2.3 Flyash mound formed in the used quarry of Balanda, OCM after disposal of ash slurry from TTPS 16 3.1 Location map of study area Singrauli, M.P 27 3.2 Mine blocks of Singrauli coalfield 27 3.3 Flow diagram of method and methodology 28 3.4 Drainage pattern in the various mines of Singrauli 28 3.6 Water bodies and sampling sites in various mines of Singrauli 34 Coalfield 37 Preparation of samples for different laboratory experiment and analysis 34 3.8 Preparation of samples for different laboratory experiment and analysis 38 3.9 Flyash and overburden sample for analysis of elemental and minerals by SEM, XRD and XRF 310 3.10 XRD instrument using for sample analysis and parameter 40 3.11 Analysis of trace metals in water quality by ICP-ES instrument 48 4.1 XRD analysis of flyash different type of Thermal Power Plants Singaruli Coalfield 63 <	Fig. No.	Figure Caption	Page No.
2.2: Disposal of Flyash slurry through pipe line from TTPS into residual quarry of Balanda OCM, MCL 16 2.3 Flyash mound formed in the used quarry of Balanda, OCM after disposal of ash slurry from TTPS 1 3.1 Location map of study area Singrauli, M.P 27 3.2 Mine blocks of Singrauli coalfield 27 3.3 Flow diagram of method and methodology 28 3.4 Drainage pattern in the various mines of Singrauli 28 3.5 Sampling collection of different mines of NCL 31 3.6 Water bodies and sampling sites in various mines of Singrauli 34 Coalfield 7 Preparation of samples for different laboratory experiment and analysis 38 3.8 Preparation of samples for different laboratory experiment and minerals by SEM, XRD and XRF 38 3.10 XRD instrument using for sample analysis of clemental and minerals by SEM, XRD and XRF 40 3.11 Analysis of trace metals in water quality by ICP-ES instrument 48 3.12 Water sample analysis by Multi parameter 51 4.1 XRD analysis of flyash different type of Thermal Power Plants 63 5.1 XRD analysis o	2.1	Generation and Utilisation of flyash from 1996-97 to 2017-18	16
residual quarry of Balanda OCM, MCL 2.3 Flyash mound formed in the used quarry of Balanda, OCM after disposal of ash slurry from TTPS 3.1 Location map of study area Singrauli, M.P 27 3.2 Mine blocks of Singrauli coalfield 27 3.3 Flow diagram of method and methodology 28 3.4 Drainage pattern in the various mines of Singrauli 28 3.5 Sampling collection of different mines of NCL 31 3.6 Water bodies and sampling sites in various mines of Singrauli 34 Coalfield 37 3.7 Preparation of samples for different laboratory experiment and 38 analysis 3.8 Preparation of samples for different laboratory experiment and 38 analysis 3.9 Flyash and overburden sample for analysis of elemental and 38 minerals by SEM, XRD and XRF 31.1 Analysis of trace metals in water quality by ICP-ES instrument 48 3.12 Water sample analysis by Multi parameter 51 4.1 XRD analysis of various type of overburden NCL mines 62 4.2 XRD analysis of various type of overburden NCL mines 63 Singrauli Coalfield 63 4.3 Cumulative XRF analysis of overburden, flyash, and overburden 64 + 30% flyash 41 42 SEM image (2µm) of flyash of Shaktinagar TPP 68 4.6 SEM image (2µm) of flyash of Shaktinagar TPP 69 4.7 SEM image (2µm) of flyash of Shaktinagar TPP 69 4.8 SEM image (2µm) of flyash of Shaktinagar TPP 70 4.9 SEM image (2µm) of flyash of Shaktinagar TPP 70 4.9 SEM image (2µm) of overburden of Gorbi mine 71 4.11 SEM image (2µm) of overburden of Gorbi mine 71 4.12 SEM image (2µm) of overburden of Gorbi mine 71 4.13 SEM image (2µm) of overburden of Bina mine 72 4.14 SEM image (2µm) of overburden of Bina mine 72 4.15 SEM image (2µm) of overburden of Bina mine 74 4.16 SEM image (2µm) of overburden of Judhichua mine 74 4.17 SEM image (2µm) of overburden of Judhichua mine 74 4.18 SEM image (2µm) of overburden of Judhichua mine 74 4.19 SEM image (2µm) of overburden of Judhichua mine 74 4.19 SEM image (2µm) of overburden of Judhichua mine 74 4.19 SEM image (2µm) of overburden 430% flyash of Amlohri mine 75 4.20 SEM image (2µm) of overburden 430% flya		(CEA)	
2.3 Flyash mound formed in the used quarry of Balanda, OCM after disposal of ash slurry from TTPS 16 3.1 Location map of study area Singrauli, M.P 27 3.2 Mine blocks of Singrauli coalfield 27 3.3 Flow diagram of method and methodology 28 3.4 Drainage pattern in the various mines of Singrauli 28 3.5 Sampling collection of different mines of NCL 31 3.6 Water bodies and sampling sites in various mines of Singrauli Coalfield 34 3.7 Preparation of samples for different laboratory experiment and analysis 38 3.8 Preparation of samples for different laboratory experiment and analysis of supplies of sample analysis of clemental and minerals by SEM, XRD and XRF 38 3.10 XRD instrument using for sample analysis of elemental and minerals by SEM, XRD and XRF 40 3.11 Analysis of trace metals in water quality by ICP-ES instrument 48 3.12 Water sample analysis by Multi parameter 41 4.1 XRD analysis of various type of overburden NCL mines 62 4.2 XRD analysis of flyash different type of Thermal Power Plants Singrauli Coalfield 63 4.3	2.2:	Disposal of Flyash slurry through pipe line from TTPS into	16
disposal of ash slurry from TTPS 3.1 Location map of study area Singrauli, M.P 27 3.2 Mine blocks of Singrauli coalfield 27 3.3 Flow diagram of method and methodology 28 3.4 Drainage pattern in the various mines of Singrauli 28 3.5 Sampling collection of different mines of NCL 31 3.6 Water bodies and sampling sites in various mines of Singrauli 34 Coalfield 3.7 Preparation of samples for different laboratory experiment and analysis 3.8 Preparation of samples for different laboratory experiment and analysis 3.9 Flyash and overburden sample for analysis of elemental and minerals by SEM, XRD and XRF 31.1 Analysis of trace metals in water quality by ICP-ES instrument 48 3.12 Water sample analysis by Multi parameter 51 4.1 XRD analysis of various type of overburden NCL mines 62 4.2 XRD analysis of lyash different type of Thermal Power Plants Singrauli Coalfield 4.3 Cumulative XRF analysis of overburden, flyash, and overburden 64 4.3 Cumulative XRF analysis of overburden, flyash, and overburden 65 4.4 SEM image (2μm) of flyash of Shaktinagar TPP 68 4.5 SEM image (2μm) of flyash of Shaktinagar TPP 69 4.6 SEM image (2μm) of flyash of Shaktinagar TPP 69 4.7 SEM image (2μm) of flyash of Shaktinagar TPP 70 4.9 SEM image (2μm) of flyash of Shaktinagar TPP 70 4.9 SEM image (2μm) of overburden of Sorbi mine 71 4.11 SEM image (2μm) of overburden of Gorbi mine 71 4.12 SEM image (2μm) of overburden of Sorbi Block 'B' 72 4.13 SEM image (2μm) of overburden of Bina mine 71 4.14 SEM image (2μm) of overburden of Bina mine 72 4.15 SEM image (2μm) of overburden of Handini mine 74 4.16 SEM image (2μm) of overburden of Jhingurdah mine 74 4.17 SEM image (2μm) of overburden of Jhingurdah mine 74 4.18 SEM image (2μm) of overburden of Jhingurdah mine 74 4.19 SEM image (2μm) of overburden 430% flyash of Amlohri mine 74 4.19 SEM image (2μm) of overburden + 30% flyash of Jiningurdah 76		residual quarry of Balanda OCM, MCL	
3.1 Location map of study area Singrauli, M.P 3.2 Mine blocks of Singrauli coalfield 3.3 Flow diagram of method and methodology 3.4 Drainage pattern in the various mines of Singrauli 3.5 Sampling collection of different mines of NCL 3.6 Water bodies and sampling sites in various mines of Singrauli 3.7 Preparation of samples for different laboratory experiment and analysis 3.8 Preparation of samples for different laboratory experiment and analysis 3.9 Flyash and overburden sample for analysis of elemental and minerals by SEM, XRD and XRF 3.10 XRD instrument using for sample analysis of elemental and minerals by SEM, XRD and XRF 3.11 Analysis of trace metals in water quality by ICP-ES instrument 3.12 Water sample analysis by Multi parameter 4.1 XRD analysis of various type of overburden NCL mines 4.2 XRD analysis of flyash different type of Thermal Power Plants 3.8 Singrauli Coalfield 4.3 Cumulative XRF analysis of overburden, flyash, and overburden 4.4 SEM image (2μm) of flyash of Anpara TPP 4.5 SEM image (2μm) of flyash of Shaktinagar TPP 4.6 SEM image (2μm) of flyash of Shaktinagar TPP 4.7 SEM image (2μm) of flyash of Renusagar TPP 4.8 SEM image (2μm) of flyash of Renusagar TPP 4.9 SEM image (2μm) of flyash of Renusagar TPP 4.9 SEM image (2μm) of flyash of Ronusagar TPP 4.10 SEM image (2μm) of overburden of Gorbi mine 4.11 SEM image (2μm) of overburden of Gorbi mine 4.12 SEM image (2μm) of overburden of Bina mine 71 All SEM image (2μm) of overburden of Bina mine 72 All SEM image (2μm) of overburden of Amlohri mine 73 All SEM image (2μm) of overburden of Amlohri mine 74 SEM image (2μm) of overburden of Amlohri mine 75 SEM image (2μm) of overburden + 30% flyash of Bina mine 76 SEM image (2μm) of overburden + 30% flyash of Jhingurdah 77 SEM image (2μm) of overburden + 30% flyash of Jhingurdah	2.3	Flyash mound formed in the used quarry of Balanda, OCM after	16
3.2 Mine blocks of Singrauli coalfield 3.3 Flow diagram of method and methodology 2.8 3.4 Drainage pattern in the various mines of Singrauli 2.8 3.5 Sampling collection of different mines of NCL 3.6 Water bodies and sampling sites in various mines of Singrauli 3.7 Preparation of samples for different laboratory experiment and analysis 3.8 Preparation of samples for different laboratory experiment and analysis 3.9 Flyash and overburden sample for analysis of elemental and minerals by SEM, XRD and XRF 3.10 XRD instrument using for sample analysis of lemental and minerals by SEM, and water quality by ICP-ES instrument 3.11 Analysis of trace metals in water quality by ICP-ES instrument 3.12 Water sample analysis by Multi parameter 4.1 XRD analysis of various type of overburden NCL mines 4.2 XRD analysis of flyash different type of Thermal Power Plants 3.13 Singrauli Coalfield 4.3 Cumulative XRF analysis of overburden, flyash, and overburden 4.4 SEM image (2μm) of flyash of Anpara TPP 4.5 SEM image (2μm) of flyash of Shaktinagar TPP 4.6 SEM image (2μm) of flyash of Shaktinagar TPP 4.7 SEM image (2μm) of flyash of Shaktinagar TPP 4.8 SEM image (2μm) of flyash of Renusager TPP 4.9 SEM image (2μm) of flyash of Renusager TPP 4.9 SEM image (10μm) of flyash of Renusager TPP 4.9 SEM image (10μm) of flyash of Anpara TPP 4.10 SEM image (2μm) of overburden of Gorbi mine 4.11 SEM image (2μm) of overburden of Gorbi mine 4.12 SEM image (2μm) of overburden of Bina mine 4.13 SEM image (2μm) of overburden of Bina mine 4.14 SEM image (2μm) of overburden of Bina mine 7.1 SEM image (2μm) of overburden of Amlohri mine 7.1 SEM image (2μm) of overburden of Amlohri mine 7.2 SEM image (2μm) of overburden of Amlohri mine 7.3 SEM image (2μm) of overburden of Bina mine 7.4 SEM image (2μm) of overburden of Bina mine 7.5 SEM image (2μm) of overburden of Bina mine 7.6 SEM image (2μm) of overburden of Bina mine 7.7 SEM image (2μm) of overburden of Bina mine 7.8 SEM image (2μm) of overburden of Bina mine 7.9 SEM image (2μm) of overburden of Bina		disposal of ash slurry from TTPS	
3.3 Flow diagram of method and methodology 3.4 Drainage pattern in the various mines of Singrauli 3.5 Sampling collection of different mines of NCL 3.6 Water bodies and sampling sites in various mines of Singrauli 3.6 Coalfield 3.7 Preparation of samples for different laboratory experiment and analysis 3.8 Preparation of samples for different laboratory experiment and analysis 3.9 Flyash and overburden sample for analysis of elemental and minerals by SEM, XRD and XRF 3.10 XRD instrument using for sample analysis 3.11 Analysis of trace metals in water quality by ICP-ES instrument 4.1 XRD analysis of various type of overburden NCL mines 4.2 XRD analysis of flyash different type of Thermal Power Plants 3.12 Singrauli Coalfield 4.3 Cumulative XRF analysis of overburden, flyash, and overburden 4.4 SEM image (2μm) of flyash of Anpara TPP 4.5 SEM image (2μm) of flyash of Shaktinagar TPP 4.6 SEM image (2μm) of flyash of Shaktinagar TPP 4.7 SEM image (2μm) of flyash of Shaktinagar TPP 4.8 SEM image (10μm) of flyash of Renusagar TPP 4.9 SEM image (10μm) of flyash of Renusagar TPP 4.9 SEM image (10μm) of flyash of Anpara TPP 4.9 SEM image (2μm) of overburden of Gorbi mine 4.10 SEM image (2μm) of overburden of Gorbi mine 4.11 SEM image (2μm) of overburden of Bina mine 71 4.12 SEM image (2μm) of overburden of Bina mine 71 4.13 SEM image (2μm) of overburden of Bina mine 72 4.14 SEM image (2μm) of overburden of Amlohri mine 73 4.15 SEM image (2μm) of overburden of Amlohri mine 74 4.16 SEM image (2μm) of overburden of Amlohri mine 75 4.17 SEM image (2μm) of overburden of Amlohri mine 76 77 78 78 79 70 70 71 71 71 72 73 74 74 74 75 76 76 77 76 77 76 77 78 78 79 79 70 70 70 70 70 70 71 71 72 73 74 74 74 75 76 76 77 76 77 76 77 76 77 78 78 79 79 70 70 70 70 70 70 70 70 70 70 70 70 70	3.1	Location map of study area Singrauli, M.P	27
3.3 Flow diagram of method and methodology 3.4 Drainage pattern in the various mines of Singrauli 3.5 Sampling collection of different mines of NCL 3.6 Water bodies and sampling sites in various mines of Singrauli 3.6 Coalfield 3.7 Preparation of samples for different laboratory experiment and analysis 3.8 Preparation of samples for different laboratory experiment and analysis 3.9 Flyash and overburden sample for analysis of elemental and minerals by SEM, XRD and XRF 3.10 XRD instrument using for sample analysis 3.11 Analysis of trace metals in water quality by ICP-ES instrument 4.1 XRD analysis of various type of overburden NCL mines 4.2 XRD analysis of flyash different type of Thermal Power Plants 3.12 Singrauli Coalfield 4.3 Cumulative XRF analysis of overburden, flyash, and overburden 4.4 SEM image (2μm) of flyash of Anpara TPP 4.5 SEM image (2μm) of flyash of Shaktinagar TPP 4.6 SEM image (2μm) of flyash of Shaktinagar TPP 4.7 SEM image (2μm) of flyash of Shaktinagar TPP 4.8 SEM image (10μm) of flyash of Renusagar TPP 4.9 SEM image (10μm) of flyash of Renusagar TPP 4.9 SEM image (10μm) of flyash of Anpara TPP 4.9 SEM image (2μm) of overburden of Gorbi mine 4.10 SEM image (2μm) of overburden of Gorbi mine 4.11 SEM image (2μm) of overburden of Bina mine 71 4.12 SEM image (2μm) of overburden of Bina mine 71 4.13 SEM image (2μm) of overburden of Bina mine 72 4.14 SEM image (2μm) of overburden of Amlohri mine 73 4.15 SEM image (2μm) of overburden of Amlohri mine 74 4.16 SEM image (2μm) of overburden of Amlohri mine 75 4.17 SEM image (2μm) of overburden of Amlohri mine 76 77 78 78 79 70 70 71 71 71 72 73 74 74 74 75 76 76 77 76 77 76 77 78 78 79 79 70 70 70 70 70 70 71 71 72 73 74 74 74 75 76 76 77 76 77 76 77 76 77 78 78 79 79 70 70 70 70 70 70 70 70 70 70 70 70 70	3.2	Mine blocks of Singrauli coalfield	27
3.4 Drainage pattern in the various mines of Singrauli 3.5 Sampling collection of different mines of NCL 3.6 Water bodies and sampling sites in various mines of Singrauli Coalfield 3.7 Preparation of samples for different laboratory experiment and analysis 3.8 Preparation of samples for different laboratory experiment and analysis 3.9 Flyash and overburden sample for analysis of elemental and minerals by SEM, XRD and XRF 3.10 XRD instrument using for sample analysis 3.11 Analysis of trace metals in water quality by ICP-ES instrument 4.8 3.12 Water sample analysis by Multi parameter 4.1 XRD analysis of various type of overburden NCL mines 4.2 XRD analysis of flyash different type of Thermal Power Plants Singrauli Coalfield 4.3 Cumulative XRF analysis of overburden, flyash, and overburden + 30% flyash 4.4 SEM image (2μm) of flyash of Anpara TPP 4.5 SEM image (2μm) of flyash of Shaktinagar TPP 4.6 SEM image (2μm) of flyash of Shaktinagar TPP 4.7 SEM image (2μm) of flyash of Renusagar TPP 4.8 SEM image (10μm) of flyash of Renusagar TPP 4.9 SEM image (10μm) of flyash of Anpara TPP 4.9 SEM image (2μm) of overburden of Gorbi mine 4.10 SEM image (2μm) of overburden of Gorbi mine 4.11 SEM image (2μm) of overburden of Bina mine 71 4.12 SEM image (2μm) of overburden of Bina mine 71 4.13 SEM image (2μm) of overburden of Amlohri mine 72 4.14 SEM image (2μm) of overburden of Amlohri mine 73 4.15 SEM image (2μm) of overburden of Amlohri mine 74 4.16 SEM image (2μm) of overburden of Amlohri mine 75 76 77 78 78 79 79 70 70 71 71 71 72 73 74 74 74 75 76 76 77 76 77 76 77 77 78 78 79 79 70 70 70 70 70 70 70 70 70 70 70 70 70	3.3	<u> =</u>	28
3.5 Sampling collection of different mines of NCL 3.6 Water bodies and sampling sites in various mines of Singrauli Coalfield 3.7 Preparation of samples for different laboratory experiment and analysis 3.8 Preparation of samples for different laboratory experiment and analysis 3.9 Flyash and overburden sample for analysis of elemental and minerals by SEM, XRD and XRF 3.10 XRD instrument using for sample analysis 3.11 Analysis of trace metals in water quality by ICP-ES instrument 3.12 Water sample analysis by Multi parameter 4.1 XRD analysis of various type of overburden NCL mines 4.2 XRD analysis of various type of overburden NCL mines 4.3 Cumulative XRF analysis of overburden, flyash, and overburden 4.4 SEM image (2μm) of flyash of Anpara TPP 4.5 SEM image (2μm) of flyash of Shaktinagar TPP 4.6 SEM image (2μm) of flyash of Shaktinagar TPP 4.7 SEM image (2μm) of flyash of Shaktinagar TPP 4.8 SEM image (2μm) of flyash of Renusagar TPP 4.9 SEM image (2μm) of flyash of Renusagar TPP 4.9 SEM image (2μm) of flyash of Renusagar TPP 4.9 SEM image (2μm) of overburden of Gorbi mine 4.11 SEM image (2μm) of overburden of Singha mine 4.12 SEM image (2μm) of overburden of Gorbi mine 4.13 SEM image (2μm) of overburden of Bina mine 4.14 SEM image (2μm) of overburden of Sorbi Block 'B' 72 4.13 SEM image (2μm) of overburden of Bina mine 73 4.15 SEM image (2μm) of overburden of Mindori mine 74 4.16 SEM image (2μm) of overburden of Amlohri mine 75 4.17 SEM image (2μm) of overburden of Jhingurdah mine 76 78 79 81 81 82 83 84 83 84 84 84 85 86 86 86 87 87 86 87 87 87 87 87 88 88 88 88 88 88 88 88	3.4		28
3.6 Water bodies and sampling sites in various mines of Singrauli Coalfield 3.7 Preparation of samples for different laboratory experiment and analysis 3.8 Preparation of samples for different laboratory experiment and analysis 3.9 Flyash and overburden sample for analysis of elemental and minerals by SEM, XRD and XRF 3.10 XRD instrument using for sample analysis 40 3.11 Analysis of trace metals in water quality by ICP-ES instrument 48 3.12 Water sample analysis by Multi parameter 51 4.1 XRD analysis of various type of overburden NCL mines 62 4.2 XRD analysis of flyash different type of Thermal Power Plants Singrauli Coalfield 4.3 Cumulative XRF analysis of overburden, flyash, and overburden + 30% flyash 4.4 SEM image (2μm) of flyash of Shaktinagar TPP 68 4.5 SEM image (2μm) of flyash of Shaktinagar TPP 69 4.6 SEM image (2μm) of flyash of Shaktinagar TPP 69 4.7 SEM image (2μm) of flyash of Renusagar TPP 69 4.8 SEM image (2μm) of flyash of Renusagar TPP 70 4.9 SEM image (10μm) of flyash of Anpara TPP 70 4.10 SEM image (2μm) of overburden of Gorbi mine 71 4.11 SEM image (2μm) of overburden of Mighai mine 71 4.12 SEM image (2μm) of overburden of Bina mine 72 4.13 SEM image (2μm) of overburden of Bina mine 72 4.14 SEM image (2μm) of overburden of Hadia 73 4.15 SEM image (2μm) of overburden of Hadia 73 4.16 SEM image (2μm) of overburden of Jhingurdah mine 74 4.17 SEM image (2μm) of overburden of Jhingurdah mine 74 4.18 SEM image (2μm) of overburden of Jhingurdah mine 74 4.19 SEM image (2μm) of overburden of Jhingurdah mine 74 4.19 SEM image (2μm) of overburden of Jhingurdah mine 75 4.20 SEM image (2μm) of overburden + 30% flyash of Jhingurdah 76 4.21 SEM image (2μm) of overburden + 30% flyash of Jhingurdah 76	3.5		31
Coalfield 3.7 Preparation of samples for different laboratory experiment and analysis 3.8 Preparation of samples for different laboratory experiment and analysis 3.9 Flyash and overburden sample for analysis of elemental and minerals by SEM, XRD and XRF 3.10 XRD instrument using for sample analysis 3.11 Analysis of trace metals in water quality by ICP-ES instrument 48 3.12 Water sample analysis by Multi parameter 4.1 XRD analysis of various type of overburden NCL mines 4.2 XRD analysis of lyash different type of Thermal Power Plants 5 Singrauli Coalfield 4.3 Cumulative XRF analysis of overburden, flyash, and overburden 4.4 SEM image (2µm) of flyash of Anpara TPP 4.5 SEM image (2µm) of flyash of Shaktinagar TPP 4.6 SEM image (2µm) of flyash of Shaktinagar TPP 4.7 SEM image (2µm) of flyash of Renusagar TPP 4.8 SEM image (2µm) of flyash of Renusagar TPP 4.9 SEM image (10µm) of flyash of Anpara TPP 4.10 SEM image (2µm) of overburden of Gorbi mine 4.11 SEM image (2µm) of overburden of Forbi mine 4.12 SEM image (2µm) of overburden of Bina mine 71 4.13 SEM image (2µm) of overburden of Bina mine 72 4.14 SEM image (2µm) of overburden of Bina mine 73 4.15 SEM image (2µm) of overburden of Judhichua mine 74 4.16 SEM image (2µm) of overburden of Judhichua mine 75 4.17 SEM image (2µm) of overburden of Judhichua mine 76 4.18 SEM image (2µm) of overburden of Judhichua mine 77 4.19 SEM image (2µm) of overburden of Judhichua mine 78 4.10 SEM image (2µm) of overburden of Judhichua mine 79 4.11 SEM image (2µm) of overburden of Judhichua mine 70 4.12 SEM image (2µm) of overburden of Judhichua mine 71 4.13 SEM image (2µm) of overburden of Judhichua mine 72 4.14 SEM image (2µm) of overburden of Judhichua mine 73 4.15 SEM image (2µm) of overburden of Judhichua mine 74 4.17 SEM image (2µm) of overburden of Judhichua mine 75 4.18 SEM image (2µm) of overburden of Judhichua mine 76 4.19 SEM image (2µm) of overburden of Judhichua mine 77 4.19 SEM image (2µm) of overburden of Judhichua mi	3.6	1 0	34
3.7 Preparation of samples for different laboratory experiment and analysis 3.8 Preparation of samples for different laboratory experiment and analysis 3.9 Flyash and overburden sample for analysis of elemental and minerals by SEM, XRD and XRF 3.10 XRD instrument using for sample analysis 40 3.11 Analysis of trace metals in water quality by ICP-ES instrument 48 3.12 Water sample analysis by Multi parameter 51 4.1 XRD analysis of various type of overburden NCL mines 62 4.2 XRD analysis of flyash different type of Thermal Power Plants Singrauli Coalfield 4.3 Cumulative XRF analysis of overburden, flyash, and overburden + 30% flyash 4.4 SEM image (2μm) of flyash of Anpara TPP 68 4.5 SEM image (2μm) of flyash of Shaktinagar TPP 69 4.6 SEM image (2μm) of flyash of Shaktinagar TPP 69 4.7 SEM image (2μm) of flyash of Renusagar TPP 69 4.8 SEM image (10μm) of flyash of Anpara TPP 70 4.9 SEM image (10μm) of flyash of Anpara TPP 70 4.10 SEM image (2μm) of overburden of Gorbi mine 71 4.11 SEM image (2μm) of overburden of Forbi mine 71 4.12 SEM image (2μm) of overburden of Forbi Block 'B' 72 4.13 SEM image (2μm) of overburden of Bina mine 72 4.14 SEM image (2μm) of overburden of Khadia 73 4.15 SEM image (2μm) of overburden of Amlohri mine 74 4.16 SEM image (2μm) of overburden of Jhingurdah mine 74 4.17 SEM image (2μm) of overburden of Amlohri mine 74 4.18 SEM image (2μm) of overburden + 30% flyash of Vindhyachal 75 TPP 4.19 SEM image (2μm) of overburden + 30% flyash of Amlohri mine 75 4.20 SEM image (10μm) of overburden + 30% flyash of Bina mine 76 4.21 SEM image (20μm) of overburden + 30% flyash of Jhingurdah 76			
analysis 3.8 Preparation of samples for different laboratory experiment and analysis 3.9 Flyash and overburden sample for analysis of elemental and minerals by SEM, XRD and XRF 3.10 XRD instrument using for sample analysis 3.11 Analysis of trace metals in water quality by ICP-ES instrument 48 3.12 Water sample analysis by Multi parameter 4.1 XRD analysis of various type of overburden NCL mines 4.2 XRD analysis of flyash different type of Thermal Power Plants 5.1 Singrauli Coalfield 4.3 Cumulative XRF analysis of overburden, flyash, and overburden 4.4 SEM image (2μm) of flyash of Anpara TPP 4.5 SEM image (2μm) of flyash of Shaktinagar TPP 4.6 SEM image (2μm) of flyash of Shaktinagar TPP 4.7 SEM image (2μm) of flyash of Renusagar TPP 4.8 SEM image (2μm) of flyash of Renusagar TPP 4.9 SEM image (10μm) of flyash of Anpara TPP 4.10 SEM image (2μm) of overburden of Gorbi mine 7.1 4.11 SEM image (2μm) of overburden of Mighai mine 7.1 4.12 SEM image (2μm) of overburden of Bina mine 7.1 4.13 SEM image (2μm) of overburden of Bina mine 7.2 4.14 SEM image (2μm) of overburden of Shadia 7.3 4.15 SEM image (2μm) of overburden of Shadia 7.3 4.16 SEM image (2μm) of overburden of Shalohri mine 7.4 4.17 SEM image (2μm) of overburden of Jhingurdah mine 7.8 4.18 SEM image (2μm) of overburden of Jhingurdah mine 7.9 4.19 SEM image (2μm) of overburden + 30% flyash of Vindhyachal 7.5 7.6 4.19 SEM image (2μm) of overburden + 30% flyash of Jhingurdah 7.6 4.20 SEM image (10μm) of overburden + 30% flyash of Jhingurdah 7.6 4.21 SEM image (20μm) of overburden + 30% flyash of Jhingurdah	3.7		38
3.8 Preparation of samples for different laboratory experiment and analysis 3.9 Flyash and overburden sample for analysis of elemental and minerals by SEM, XRD and XRF 3.10 XRD instrument using for sample analysis 40 3.11 Analysis of trace metals in water quality by ICP-ES instrument 48 3.12 Water sample analysis by Multi parameter 51 4.1 XRD analysis of various type of overburden NCL mines 62 4.2 XRD analysis of flyash different type of Thermal Power Plants 63 Singrauli Coalfield 4.3 Cumulative XRF analysis of overburden, flyash, and overburden + 30% flyash 4.4 SEM image (2μm) of flyash of Anpara TPP 68 4.5 SEM image (2μm) of flyash of Shaktinagar TPP 69 4.7 SEM image (2μm) of flyash of Shaktinagar TPP 69 4.8 SEM image (2μm) of flyash of Renusagar TPP 69 4.9 SEM image (10μm) of flyash of Anpara TPP 70 4.9 SEM image (10μm) of flyash of Anpara TPP 70 4.10 SEM image (2μm) of overburden of Gorbi mine 71 4.11 SEM image (2μm) of overburden of Gorbi Block 'B' 72 4.13 SEM image (2μm) of overburden of Bina mine 71 4.14 SEM image (2μm) of overburden of Bina mine 72 4.15 SEM image (2μm) of overburden of Bina mine 73 4.16 SEM image (2μm) of overburden of Jhingurdah mine 74 4.17 SEM image (2μm) of overburden of Jhingurdah mine 74 4.18 SEM image (2μm) of overburden of Jhingurdah mine 75 4.19 SEM image (2μm) of overburden + 30% flyash of Jhingurdah 76 4.20 SEM image (10μm) of overburden + 30% flyash of Jhingurdah 76			
analysis 3.9 Flyash and overburden sample for analysis of elemental and minerals by SEM, XRD and XRF 3.10 XRD instrument using for sample analysis 3.11 Analysis of trace metals in water quality by ICP-ES instrument 48 3.12 Water sample analysis by Multi parameter 51 4.1 XRD analysis of various type of overburden NCL mines 62 4.2 XRD analysis of flyash different type of Thermal Power Plants Singrauli Coalfield 4.3 Cumulative XRF analysis of overburden, flyash, and overburden + 30% flyash 4.4 SEM image (2µm) of flyash of Anpara TPP 68 4.5 SEM image (2µm) of flyash of Shaktinagar TPP 69 4.7 SEM image (2µm) of flyash of Shaktinagar TPP 69 4.8 SEM image (2µm) of flyash of Renusagar TPP 4.9 SEM image (10µm) of flyash of Renusager TPP 70 4.10 SEM image (2µm) of overburden of Gorbi mine 71 4.11 SEM image (2µm) of overburden of Gorbi Block 'B' 72 4.13 SEM image (2µm) of overburden of Bina mine 71 4.14 SEM image (2µm) of overburden of Bina mine 72 4.15 SEM image (2µm) of overburden of Mindichua mine 73 4.16 SEM image (2µm) of overburden of Amlohri mine 74 4.17 SEM image (2µm) of overburden of Amlohri mine 74 4.18 SEM image (2µm) of overburden of Jhingurdah mine 75 4.19 SEM image (2µm) of overburden + 30% flyash of Vindhyachal 76 4.20 SEM image (10µm) of overburden + 30% flyash of Amlohri mine 76 4.21 SEM image (20µm) of overburden + 30% flyash of Jhingurdah 76	3.8		38
Flyash and overburden sample for analysis of elemental and minerals by SEM, XRD and XRF		1 1	
minerals by SEM, XRD and XRF 3.10 XRD instrument using for sample analysis 3.11 Analysis of trace metals in water quality by ICP-ES instrument 4.8 3.12 Water sample analysis by Multi parameter 5.1 4.1 XRD analysis of various type of overburden NCL mines 4.2 XRD analysis of flyash different type of Thermal Power Plants Singrauli Coalfield 4.3 Cumulative XRF analysis of overburden, flyash, and overburden 4.4 SEM image (2µm) of flyash of Anpara TPP 4.5 SEM image (2µm) of flyash of Shaktinagar TPP 4.6 SEM image (2µm) of flyash of Shaktinagar TPP 4.7 SEM image (2µm) of flyash of Renusagar TPP 4.8 SEM image (2µm) of flyash of Renusagar TPP 4.9 SEM image (10µm) of flyash of Anpara TPP 4.10 SEM image (2µm) of overburden of Gorbi mine 4.11 SEM image (2µm) of overburden of Gorbi Block 'B' 4.12 SEM image (2µm) of overburden of Bina mine 71 4.13 SEM image (2µm) of overburden of Bina mine 72 4.14 SEM image (2µm) of overburden of Madia 4.15 SEM image (2µm) of overburden of Madia 4.16 SEM image (2µm) of overburden of Amlohri mine 73 4.17 SEM image (2µm) of overburden of Amlohri mine 74 4.18 SEM image (2µm) of overburden of Jhingurdah mine 75 4.19 SEM image (2µm) of overburden + 30% flyash of Amlohri mine 76 4.20 SEM image (2µm) of overburden + 30% flyash of Bina mine 76 4.21 SEM image (20µm) of overburden + 30% flyash of Jhingurdah 76	3.9	· · · · · · · · · · · · · · · · · · ·	38
3.10 XRD instrument using for sample analysis 3.11 Analysis of trace metals in water quality by ICP-ES instrument 3.12 Water sample analysis by Multi parameter 4.1 XRD analysis of various type of overburden NCL mines 4.2 XRD analysis of flyash different type of Thermal Power Plants Singrauli Coalfield 4.3 Cumulative XRF analysis of overburden, flyash, and overburden 4.4 SEM image (2μm) of flyash of Anpara TPP 4.5 SEM image (2μm) of flyash of Shaktinagar TPP 4.6 SEM image (2μm) of flyash of Shaktinagar TPP 4.7 SEM image (2μm) of flyash of Renusagar TPP 4.8 SEM image (10μm) of flyash of Renusagar TPP 4.9 SEM image (10μm) of flyash of Anpara TPP 4.10 SEM image (2μm) of overburden of Gorbi mine 4.11 SEM image (2μm) of overburden of Gorbi Block 'B' 4.12 SEM image (2μm) of overburden of Gorbi Block 'B' 4.13 SEM image (2μm) of overburden of Bina mine 4.14 SEM image (2μm) of overburden of Dudhichua mine 4.15 SEM image (2μm) of overburden of Shadia 4.16 SEM image (2μm) of overburden of Amlohri mine 4.17 SEM image (2μm) of overburden of Amlohri mine 4.18 SEM image (2μm) of overburden of Jhingurdah mine 4.19 SEM image (2μm) of overburden + 30% flyash of Vindhyachal 75 TPP 4.19 SEM image (2μm) of overburden + 30% flyash of Amlohri mine 5 SEM image (2μm) of overburden + 30% flyash of Bina mine 5 SEM image (2μm) of overburden + 30% flyash of Bina mine 5 SEM image (2μm) of overburden + 30% flyash of Jhingurdah 7 SEM image (2μm) of overburden + 30% flyash of Jhingurdah		· · · · · · · · · · · · · · · · · · ·	
3.11 Analysis of trace metals in water quality by ICP-ES instrument 3.12 Water sample analysis by Multi parameter 4.1 XRD analysis of various type of overburden NCL mines 4.2 XRD analysis of flyash different type of Thermal Power Plants Singrauli Coalfield 4.3 Cumulative XRF analysis of overburden, flyash, and overburden + 30% flyash 4.4 SEM image (2μm) of flyash of Anpara TPP 68 4.5 SEM image (2μm) of flyash of Shaktinagar TPP 68 4.6 SEM image (2μm) of flyash of Shaktinagar TPP 69 4.7 SEM image (2μm) of flyash of Renusagar TPP 69 4.8 SEM image (10μm) of flyash of Renusagar TPP 70 4.9 SEM image (10μm) of flyash of Anpara TPP 70 4.10 SEM image (2μm) of overburden of Gorbi mine 71 4.11 SEM image (2μm) of overburden of Nighai mine 71 4.12 SEM image (2μm) of overburden of Bina mine 71 4.13 SEM image (2μm) of overburden of Bina mine 72 4.14 SEM image (2μm) of overburden of Bina mine 73 4.15 SEM image (2μm) of overburden of Amlohri mine 74 4.16 SEM image (2μm) of overburden of Amlohri mine 75 4.17 SEM image (2μm) of overburden of Jhingurdah mine 76 4.18 SEM image (2μm) of overburden + 30% flyash of Amlohri mine 76 4.20 SEM image (2μm) of overburden + 30% flyash of Bina mine 76 4.21 SEM image (20μm) of overburden + 30% flyash of Jhingurdah 76	3.10	The state of the s	40
3.12 Water sample analysis by Multi parameter 4.1 XRD analysis of various type of overburden NCL mines 4.2 XRD analysis of flyash different type of Thermal Power Plants Singrauli Coalfield 4.3 Cumulative XRF analysis of overburden, flyash, and overburden + 30% flyash 4.4 SEM image (2μm) of flyash of Anpara TPP 68 4.5 SEM image (2μm) of flyash of Shaktinagar TPP 69 4.7 SEM image (2μm) of flyash of Renusagar TPP 69 4.8 SEM image (10μm) of flyash of Renusager TPP 70 4.9 SEM image (10μm) of flyash of Anpara TPP 70 4.10 SEM image (2μm) of overburden of Gorbi mine 71 4.11 SEM image (2μm) of overburden of Nighai mine 71 4.12 SEM image (2μm) of overburden of Bina mine 72 4.13 SEM image (2μm) of overburden of Bina mine 72 4.14 SEM image (2μm) of overburden of Milhichua mine 73 4.15 SEM image (2μm) of overburden of Amlohri mine 74 4.16 SEM image (2μm) of overburden of Amlohri mine 75 4.17 SEM image (2μm) of overburden of Jhingurdah mine 74 4.18 SEM image (2μm) of overburden + 30% flyash of Amlohri mine 75 4.19 SEM image (2μm) of overburden + 30% flyash of Bina mine 76 4.20 SEM image (20μm) of overburden + 30% flyash of Jhingurdah 76			48
4.1 XRD analysis of various type of overburden NCL mines 4.2 XRD analysis of flyash different type of Thermal Power Plants Singrauli Coalfield 4.3 Cumulative XRF analysis of overburden, flyash, and overburden + 30% flyash 4.4 SEM image (2μm) of flyash of Anpara TPP 68 4.5 SEM image (2μm) of flyash of Shaktinagar TPP 68 4.6 SEM image (2μm) of flyash of Shaktinagar TPP 69 4.7 SEM image (2μm) of flyash of Renusagar TPP 69 4.8 SEM image (10μm) of flyash of Renusager TPP 70 4.9 SEM image (10μm) of flyash of Anpara TPP 70 4.10 SEM image (2μm) of overburden of Gorbi mine 71 4.11 SEM image (2μm) of overburden of Nighai mine 71 4.12 SEM image (2μm) of overburden of Gorbi Block 'B' 72 4.13 SEM image (2μm) of overburden of Bina mine 72 4.14 SEM image (2μm) of overburden of Dudhichua mine 73 4.15 SEM image (2μm) of overburden of Amlohri mine 74 4.16 SEM image (2μm) of overburden of Jhingurdah mine 74 4.17 SEM image (2μm) of overburden of Jhingurdah mine 75 4.18 SEM image (2μm) of overburden + 30% flyash of Vindhyachal 75 77 4.19 SEM image (2μm) of overburden + 30% flyash of Bina mine 76 4.20 SEM image (20μm) of overburden + 30% flyash of Jhingurdah 76		•	
4.2 XRD analysis of flyash different type of Thermal Power Plants Singrauli Coalfield 4.3 Cumulative XRF analysis of overburden, flyash, and overburden + 30% flyash 4.4 SEM image (2μm) of flyash of Anpara TPP 68 4.5 SEM image (2μm) of flyash of Shaktinagar TPP 69 4.6 SEM image (2μm) of flyash of Shaktinagar TPP 69 4.7 SEM image (2μm) of flyash of Renusagar TPP 69 4.8 SEM image (10μm) of flyash of Renusager TPP 70 4.9 SEM image (10μm) of flyash of Anpara TPP 70 4.10 SEM image (2μm) of overburden of Gorbi mine 71 4.11 SEM image (2μm) of overburden of Nighai mine 71 4.12 SEM image (2μm) of overburden of Gorbi Block 'B' 72 4.13 SEM image (2μm) of overburden of Bina mine 72 4.14 SEM image (2μm) of overburden of Dudhichua mine 73 4.15 SEM image (2μm) of overburden of Amlohri mine 74 4.16 SEM image (2μm) of overburden of Amlohri mine 74 4.17 SEM image (2μm) of overburden of Jhingurdah mine 74 4.18 SEM image (2μm) of overburden + 30% flyash of Vindhyachal 75 TPP 76 4.19 SEM image (2μm) of overburden + 30% flyash of Amlohri mine 76 77 4.20 SEM image (2μm) of overburden + 30% flyash of Bina mine 76 78 79 79 70 70 70 70 70 70 70 70 70 70 70 71 71 72 73 74 75 75 76 76 77 79 70 70 70 70 70 70 70 70 70 70 70 70 70		1 , 1	
Singrauli Coalfield 4.3 Cumulative XRF analysis of overburden, flyash, and overburden + 30% flyash 4.4 SEM image (2μm) of flyash of Anpara TPP 68 4.5 SEM image (2μm) of flyash of Shaktinagar TPP 69 4.6 SEM image (2μm) of flyash of Shaktinagar TPP 69 4.7 SEM image (2μm) of flyash of Renusagar TPP 69 4.8 SEM image (10μm) of flyash of Renusager TPP 70 4.9 SEM image (10μm) of flyash of Anpara TPP 70 4.10 SEM image (2μm) of overburden of Gorbi mine 71 4.11 SEM image (2μm) of overburden of Nighai mine 71 4.12 SEM image (2μm) of overburden of Gorbi Block 'B' 72 4.13 SEM image (2μm) of overburden of Bina mine 72 4.14 SEM image (2μm) of overburden of Dudhichua mine 73 4.15 SEM image (2μm) of overburden of Khadia 73 4.16 SEM image (2μm) of overburden of Amlohri mine 74 4.17 SEM image (2μm) of overburden of Jhingurdah mine 74 4.18 SEM image (2μm) of overburden + 30% flyash of Vindhyachal 75 TPP 4.19 SEM image (2μm) of overburden + 30% flyash of Amlohri mine 76 4.20 SEM image (20μm) of overburden + 30% flyash of Bina mine 76 4.21 SEM image (20μm) of overburden + 30% flyash of Jhingurdah 76			
4.3 Cumulative XRF analysis of overburden, flyash, and overburden + 30% flyash 4.4 SEM image (2μm) of flyash of Anpara TPP 68 4.5 SEM image (2μm) of flyash of Shaktinagar TPP 68 4.6 SEM image (2μm) of flyash of Shaktinagar TPP 69 4.7 SEM image (2μm) of flyash of Renusagar TPP 69 4.8 SEM image (10μm) of flyash of Renusager TPP 70 4.9 SEM image (10μm) of flyash of Anpara TPP 70 4.10 SEM image (2μm) of overburden of Gorbi mine 71 4.11 SEM image (2μm) of overburden of Nighai mine 71 4.12 SEM image (2μm) of overburden of Gorbi Block 'B' 72 4.13 SEM image (2μm) of overburden of Bina mine 72 4.14 SEM image (2μm) of overburden of Dudhichua mine 73 4.15 SEM image (2μm) of overburden of Khadia 73 4.16 SEM image (2μm) of overburden of Amlohri mine 74 4.17 SEM image (20μm) of overburden of Jhingurdah mine 74 4.18 SEM image (20μm) of overburden + 30% flyash of Vindhyachal 75 TPP 4.19 SEM image (2μm) of overburden + 30% flyash of Amlohri mine 76 4.20 SEM image (20μm) of overburden + 30% flyash of Bina mine 76 4.21 SEM image (20μm) of overburden + 30% flyash of Jhingurdah 76		· · · · · · · · · · · · · · · · · · ·	
+ 30% flyash 4.4 SEM image (2μm) of flyash of Anpara TPP 4.5 SEM image (2μm) of flyash of Shaktinagar TPP 4.6 SEM image (2μm) of flyash of Shaktinagar TPP 4.7 SEM image (2μm) of flyash of Renusagar TPP 4.8 SEM image (10μm) of flyash of Renusager TPP 4.9 SEM image (10μm) of flyash of Anpara TPP 4.10 SEM image (2μm) of overburden of Gorbi mine 4.11 SEM image (2μm) of overburden of Nighai mine 4.12 SEM image (2μm) of overburden of Gorbi Block 'B' 72 4.13 SEM image (2μm) of overburden of Bina mine 73 4.14 SEM image (2μm) of overburden of Dudhichua mine 73 4.15 SEM image (2μm) of overburden of Khadia 73 4.16 SEM image (2μm) of overburden of Amlohri mine 74 4.17 SEM image (20μm) of overburden of Jhingurdah mine 74 4.18 SEM image (20μm) of overburden + 30% flyash of Vindhyachal 75 TPP 4.19 SEM image (2μm) of overburden + 30% flyash of Bina mine 76 4.20 SEM image (20μm) of overburden + 30% flyash of Bina mine 76 4.21 SEM image (20μm) of overburden + 30% flyash of Jhingurdah 76	4.3		66
4.4 SEM image (2μm) of flyash of Anpara TPP 4.5 SEM image (2μm) of flyash of Shaktinagar TPP 4.6 SEM image (2μm) of flyash of Shaktinagar TPP 4.7 SEM image (2μm) of flyash of Renusagar TPP 4.8 SEM image (10μm) of flyash of Renusager TPP 4.9 SEM image (10μm) of flyash of Anpara TPP 4.10 SEM image (2μm) of overburden of Gorbi mine 4.11 SEM image (2μm) of overburden of Nighai mine 4.12 SEM image (2μm) of overburden of Gorbi Block 'B' 4.13 SEM image (2μm) of overburden of Bina mine 4.14 SEM image (2μm) of overburden of Dudhichua mine 4.15 SEM image (2μm) of overburden of Khadia 4.16 SEM image (2μm) of overburden of Amlohri mine 4.17 SEM image (20μm) of overburden of Jhingurdah mine 4.18 SEM image (20μm) of overburden + 30% flyash of Vindhyachal TPP 4.19 SEM image (2μm) of overburden + 30% flyash of Bina mine 4.20 SEM image (20μm) of overburden + 30% flyash of Jhingurdah 76 78 79 79 70 70 70 70 70 70 70 71 71 71 71 71 71 71 71 71 71 71 71 71			
4.5 SEM image (2μm) of flyash of Shaktinagar TPP 4.6 SEM image (2μm) of flyash of Shaktinagar TPP 4.7 SEM image (2μm) of flyash of Renusagar TPP 4.8 SEM image (10μm) of flyash of Renusager TPP 4.9 SEM image (10μm) of flyash of Anpara TPP 4.10 SEM image (2μm) of overburden of Gorbi mine 4.11 SEM image (2μm) of overburden of Nighai mine 4.12 SEM image (2μm) of overburden of Gorbi Block 'B' 4.13 SEM image (2μm) of overburden of Bina mine 4.14 SEM image (2μm) of overburden of Dudhichua mine 4.15 SEM image (2μm) of overburden of Khadia 4.16 SEM image (2μm) of overburden of Amlohri mine 4.17 SEM image (20μm) of overburden of Jhingurdah mine 4.18 SEM image (20μm) of overburden + 30% flyash of Vindhyachal TPP 4.19 SEM image (2μm) of overburden + 30% flyash of Bina mine 4.20 SEM image (20μm) of overburden + 30% flyash of Bina mine 56 SEM image (20μm) of overburden + 30% flyash of Jhingurdah 76 SEM image (20μm) of overburden + 30% flyash of Jhingurdah	4.4		68
4.6 SEM image (2μm) of flyash of Shaktinagar TPP 4.7 SEM image (2μm) of flyash of Renusagar TPP 4.8 SEM image (10μm) of flyash of Renusager TPP 4.9 SEM image (10μm) of flyash of Anpara TPP 4.10 SEM image (2μm) of overburden of Gorbi mine 4.11 SEM image (2μm) of overburden of Nighai mine 4.12 SEM image (2μm) of overburden of Gorbi Block 'B' 4.13 SEM image (2μm) of overburden of Bina mine 4.14 SEM image (2μm) of overburden of Dudhichua mine 4.15 SEM image (2μm) of overburden of Khadia 4.16 SEM image (20μm) of overburden of Amlohri mine 4.17 SEM image (20μm) of overburden of Jhingurdah mine 4.18 SEM image (20μm) of overburden + 30% flyash of Vindhyachal TPP 4.19 SEM image (2μm) of overburden + 30% flyash of Amlohri mine 4.20 SEM image (20μm) of overburden + 30% flyash of Bina mine 4.21 SEM image (20μm) of overburden + 30% flyash of Jhingurdah 76			
4.7 SEM image (2μm) of flyash of Renusagar TPP 4.8 SEM image (10μm) of flyash of Renusager TPP 4.9 SEM image (10μm) of flyash of Anpara TPP 4.10 SEM image (2μm) of overburden of Gorbi mine 4.11 SEM image (2μm) of overburden of Nighai mine 4.12 SEM image (2μm) of overburden of Gorbi Block 'B' 7.2 4.13 SEM image (2μm) of overburden of Bina mine 7.2 4.14 SEM image (2μm) of overburden of Dudhichua mine 7.3 4.15 SEM image (2μm) of overburden of Khadia 7.3 4.16 SEM image (20μm) of overburden of Amlohri mine 7.4 4.17 SEM image (20μm) of overburden of Jhingurdah mine 7.4 4.18 SEM image (2μm) of overburden + 30% flyash of Vindhyachal 7.5 7.6 7.7 7.7 7.8 7.9 7.9 7.9 7.9 7.9			
4.8 SEM image (10μm) of flyash of Renusager TPP 4.9 SEM image (10μm) of flyash of Anpara TPP 70 4.10 SEM image (2μm) of overburden of Gorbi mine 71 4.11 SEM image (2μm) of overburden of Nighai mine 71 4.12 SEM image (2μm) of overburden of Gorbi Block 'B' 72 4.13 SEM image (2μm) of overburden of Bina mine 73 4.14 SEM image (2μm) of overburden of Dudhichua mine 73 4.15 SEM image (2μm) of overburden of Khadia 73 4.16 SEM image (2μm) of overburden of Amlohri mine 74 4.17 SEM image (20μm) of overburden of Jhingurdah mine 74 4.18 SEM image (20μm) of overburden + 30% flyash of Vindhyachal TPP 4.19 SEM image (2μm) of overburden + 30% flyash of Amlohri mine 75 4.20 SEM image (20μm) of overburden + 30% flyash of Bina mine 76 4.21 SEM image (20μm) of overburden + 30% flyash of Jhingurdah 76			
4.9 SEM image (10μm) of flyash of Anpara TPP 4.10 SEM image (2μm) of overburden of Gorbi mine 7.1 SEM image (2μm) of overburden of Nighai mine 7.1 SEM image (2μm) of overburden of Gorbi Block 'B' 7.2 SEM image (2μm) of overburden of Bina mine 7.3 SEM image (2μm) of overburden of Dudhichua mine 7.3 SEM image (2μm) of overburden of Khadia 7.3 SEM image (2μm) of overburden of Khadia 7.3 SEM image (20μm) of overburden of Amlohri mine 7.4 SEM image (20μm) of overburden of Jhingurdah mine 7.5 SEM image (2μm) of overburden + 30% flyash of Vindhyachal 7.5 TPP 4.19 SEM image (2μm) of overburden + 30% flyash of Amlohri mine 7.5 SEM image (20μm) of overburden + 30% flyash of Bina mine 7.6 SEM image (20μm) of overburden + 30% flyash of Jhingurdah 7.7 SEM image (20μm) of overburden + 30% flyash of Jhingurdah			
4.10 SEM image (2μm) of overburden of Gorbi mine 7.1 4.11 SEM image (2μm) of overburden of Nighai mine 7.1 4.12 SEM image (2μm) of overburden of Gorbi Block 'B' 7.2 4.13 SEM image (2μm) of overburden of Bina mine 7.2 4.14 SEM image (2μm) of overburden of Dudhichua mine 7.3 4.15 SEM image (2μm) of overburden of Khadia 7.3 4.16 SEM image (20μm) of overburden of Amlohri mine 7.4 4.17 SEM image (20μm) of overburden of Jhingurdah mine 7.4 4.18 SEM image (2μm) of overburden + 30% flyash of Vindhyachal 7.5 7.7 7.8 7.9 7.9 7.9 7.9 7.9 7.9 7.9 7.9 7.9 7.9			
 4.11 SEM image (2μm) of overburden of Nighai mine 4.12 SEM image (2μm) of overburden of Gorbi Block 'B' 4.13 SEM image (2μm) of overburden of Bina mine 4.14 SEM image (2μm) of overburden of Dudhichua mine 4.15 SEM image (2μm) of overburden of Khadia 4.16 SEM image (20μm) of overburden of Amlohri mine 4.17 SEM image (20μm) of overburden of Jhingurdah mine 4.18 SEM image (2μm) of overburden + 30% flyash of Vindhyachal TPP 4.19 SEM image (2μm) of overburden + 30% flyash of Amlohri mine 4.20 SEM image (10μm) of overburden + 30% flyash of Bina mine 4.21 SEM image (20μm) of overburden + 30% flyash of Jhingurdah 76 			
 SEM image (2μm) of overburden of Gorbi Block 'B' SEM image (2μm) of overburden of Bina mine SEM image (2μm) of overburden of Dudhichua mine SEM image (2μm) of overburden of Khadia SEM image (2μm) of overburden of Khadia SEM image (20μm) of overburden of Amlohri mine SEM image (20μm) of overburden of Jhingurdah mine SEM image (2μm) of overburden + 30% flyash of Vindhyachal TPP SEM image (2μm) of overburden + 30% flyash of Amlohri mine SEM image (2μm) of overburden + 30% flyash of Bina mine SEM image (20μm) of overburden + 30% flyash of Jhingurdah SEM image (20μm) of overburden + 30% flyash of Jhingurdah 			
 SEM image (2μm) of overburden of Bina mine SEM image (2μm) of overburden of Dudhichua mine SEM image (2μm) of overburden of Khadia SEM image (20μm) of overburden of Amlohri mine SEM image (20μm) of overburden of Jhingurdah mine SEM image (20μm) of overburden of Jhingurdah mine SEM image (2μm) of overburden + 30% flyash of Vindhyachal TPP SEM image (2μm) of overburden + 30% flyash of Amlohri mine SEM image (2μm) of overburden + 30% flyash of Bina mine SEM image (20μm) of overburden + 30% flyash of Jhingurdah SEM image (20μm) of overburden + 30% flyash of Jhingurdah 			
 4.14 SEM image (2μm) of overburden of Dudhichua mine 4.15 SEM image (2μm) of overburden of Khadia 4.16 SEM image (20μm) of overburden of Amlohri mine 4.17 SEM image (20μm) of overburden of Jhingurdah mine 4.18 SEM image (2μm) of overburden + 30% flyash of Vindhyachal TPP 4.19 SEM image (2μm) of overburden + 30% flyash of Amlohri mine 4.20 SEM image (10μm) of overburden + 30% flyash of Bina mine 4.21 SEM image (20μm) of overburden + 30% flyash of Jhingurdah 76 76 			
 4.15 SEM image (2μm) of overburden of Khadia 4.16 SEM image (20μm) of overburden of Amlohri mine 4.17 SEM image (20μm) of overburden of Jhingurdah mine 4.18 SEM image (2μm) of overburden + 30% flyash of Vindhyachal TPP 4.19 SEM image (2μm) of overburden + 30% flyash of Amlohri mine 4.20 SEM image (10μm) of overburden + 30% flyash of Bina mine 4.21 SEM image (20μm) of overburden + 30% flyash of Jhingurdah 76 			
 4.16 SEM image (20μm) of overburden of Amlohri mine 4.17 SEM image (20μm) of overburden of Jhingurdah mine 4.18 SEM image (2μm) of overburden + 30% flyash of Vindhyachal TPP 4.19 SEM image (2μm) of overburden + 30% flyash of Amlohri mine 4.20 SEM image (10μm) of overburden + 30% flyash of Bina mine 4.21 SEM image (20μm) of overburden + 30% flyash of Jhingurdah 76 76 76 			
 4.17 SEM image (20μm) of overburden of Jhingurdah mine 4.18 SEM image (2μm) of overburden + 30% flyash of Vindhyachal TPP 4.19 SEM image (2μm) of overburden + 30% flyash of Amlohri mine 4.20 SEM image (10μm) of overburden + 30% flyash of Bina mine 4.21 SEM image (20μm) of overburden + 30% flyash of Jhingurdah 76 			
 4.18 SEM image (2μm) of overburden + 30% flyash of Vindhyachal TPP 4.19 SEM image (2μm) of overburden + 30% flyash of Amlohri mine 75 4.20 SEM image (10μm) of overburden + 30% flyash of Bina mine 76 4.21 SEM image (20μm) of overburden + 30% flyash of Jhingurdah 76 			
TPP 4.19 SEM image (2μm) of overburden + 30% flyash of Amlohri mine 75 4.20 SEM image (10μm) of overburden + 30% flyash of Bina mine 76 4.21 SEM image (20μm) of overburden + 30% flyash of Jhingurdah 76			
 4.19 SEM image (2μm) of overburden + 30% flyash of Amlohri mine 4.20 SEM image (10μm) of overburden + 30% flyash of Bina mine 4.21 SEM image (20μm) of overburden + 30% flyash of Jhingurdah 76 			, .
 4.20 SEM image (10μm) of overburden + 30% flyash of Bina mine 4.21 SEM image (20μm) of overburden + 30% flyash of Jhingurdah 76 	4.19		75
4.21 SEM image (20μm) of overburden + 30% flyash of Jhingurdah 76			
			, 0

4.22	Location map of study area (Northern Coalfield Ltd) Singrauli	86
4.23	Experimental setup for water quality analysis	88
4.24	Box fill with different lithotypes of sandstones	89
4.25	Fill the different type of sandstones in experimental setup	89
4.26	Rain water passing through different litho- types of overburden	90
4.27	Variation of pH of rain water leachate with time	91
4.28	Location of sample collection point in Gorbi abandoned mine,	92
	Singrauli coalfield (Image © 2019 CNES/Airbus, Image © 2019	
	Digital Globe, © 2018 F1:2 Google.)	
4.29	a) Water body of Gorbi abandoned mine; b) Sample collected	94
	from water body of Gorbi abandoned mine	, .
4.30	Change in leachate pH of Gorbi mine treated with OB, FA and	97
	OB-FA mix with time	
4.31	Reduction in TDS of Gorbi mine water with OB, FA and OB-FA	99
	mix with time	
4.32	Analysis of leachates	100
4.33	Trilinear piper dig Amlohri of mine water	112
4.34	Trilinear piper dig of Dudhichua mine water	112
4.35	Trilinear piper dig of Bina mine water	113
4.36	Trilinear piper dig of Amlohri ground water	113
4.37	Trilinear piper dig of Dudhichua ground water	114
4.38	Trilinear piper dig of Bina ground water	114
4.39	Contour map for Cadmium concentration in water samples	116
	during pre-monsoon season	110
4.40	Contour map for Chromium concentration in water samples	116
	during pre-monsoon season	110
4.41	Contour map for Copper concentration in water samples during	117
	pre-monsoon season	117
4.42	Contour map for Iron concentration in water samples during pre-	117
	monsoon season	11,
4.43	Contour map for Manganese concentration in water samples	118
	during pre-monsoon season	110
4.44	Contour map for Lead concentration in water samples during pre-	118
	monsoon season	
4.45	Contour map for Cadmium concentration in water samples	119
	during post-monsoon season	
4.46	Contour map for Chloride concentration in water samples during	119
	post-monsoon season	
4.47	Contour map for Chromium concentration in water samples	120
	during post-monsoon season	-
4.48	Contour map for Copper concentration in water samples during	120
	post-monsoon season	
4.49	Contour map for Iron concentration in water samples during	121
	post-monsoon season	
4.50	Contour map for Magnesium concentration in water samples	121
	during post-monsoon season	
4.51	Contour map for Manganese concentration in water samples	122
	during post-monsoon season	
4.52	Contour map for Lead concentration in water samples during	122
	post-monsoon season	

4.53	Contour map for pH concentration in water samples during post-	123
4.54	monsoon season Contour map for Sulphate concentration in water samples during	123
	post-monsoon season	