# VINOBA BHAVE UNIVERSITY,

## HAZARIBAG - 825301


http:// **www.vbu.ac.in**


VINOBA BHAVE UNIVERSITY
HAZARIBAG – 825 301
JHARKHAND, INDIA
http:// www.vbu.ac.in


# Hon'ble President of India, Shri Pranab Mukherjee graced the 7th Convocation on 09th Jan 2016 as Chief Guest




# Inauguration of the University Centralized Online Admission System

# Sustainable Mining in Goa

**Dr. Gurdeep Singh**

**Vice Chancellor**

**Vinoba Bhave University, Hazaribag-825301**

**vc@vbu.ac.in / s_gurdeep2001@yahoo.com**

**www.gurdeepsingh.in**

## Major Controversial Mines

- Aravali Mining Banned: The Supreme Court on February 19, 2009, ordered closure of 157 of the 261 mines in the Aravalli hills in Rajasthan.
- Kudremukh Iron ore Mine, Karnataka
- East coast Bauxite Mine, Orissa
- North-Eastern Coalfields, Assam
- Gandhmardhan Bauxite Mines
- Lime Stone Mines in Doon Valley
- Iron Ore Mines in Singbhum
- Iron Ore Mines in GOA and Bellary- Hospet Region
- Panna Diamond Mine
- Jharia Coal Mines, Jharkhand

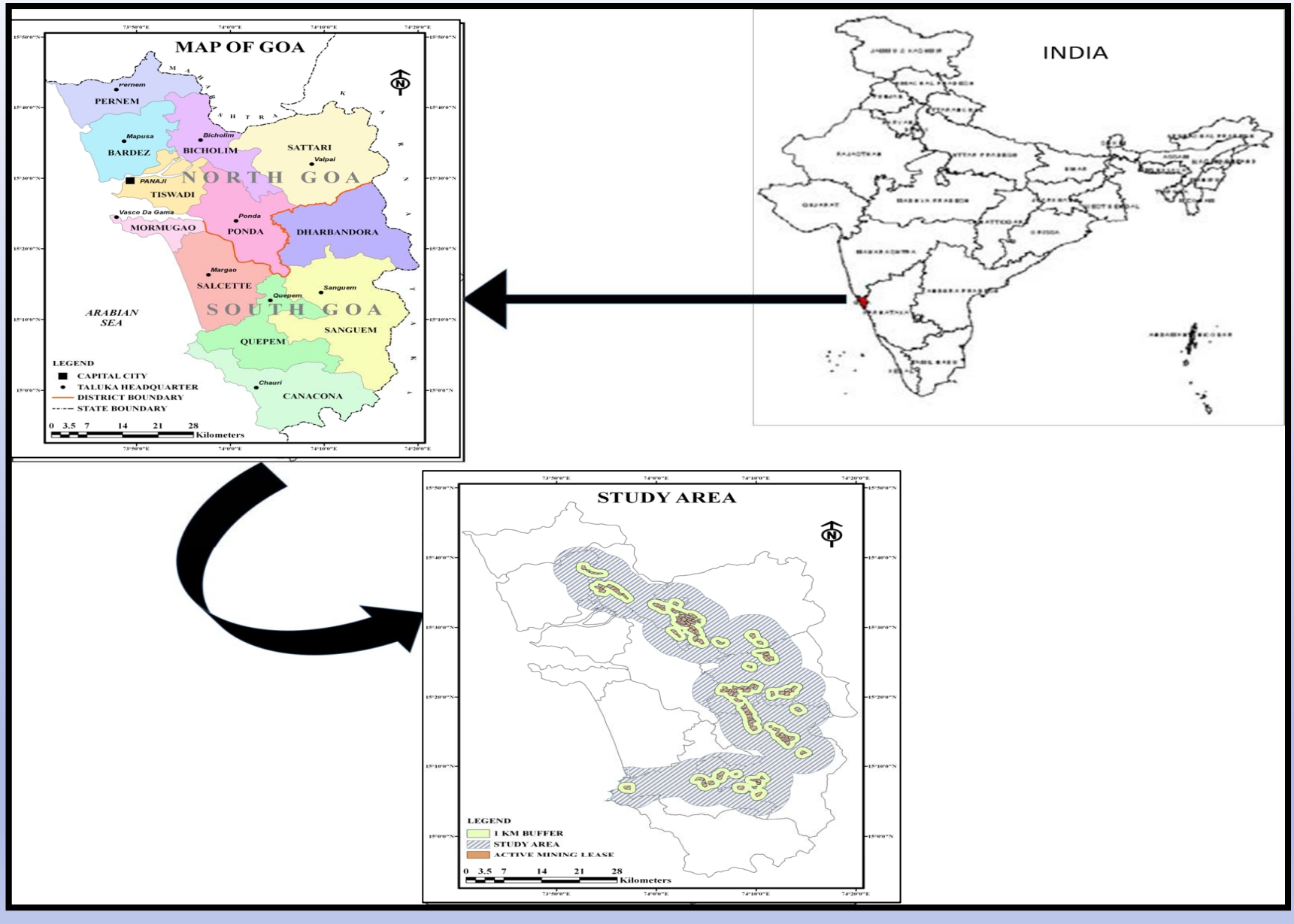
# Recent Controversies in Mining Areas

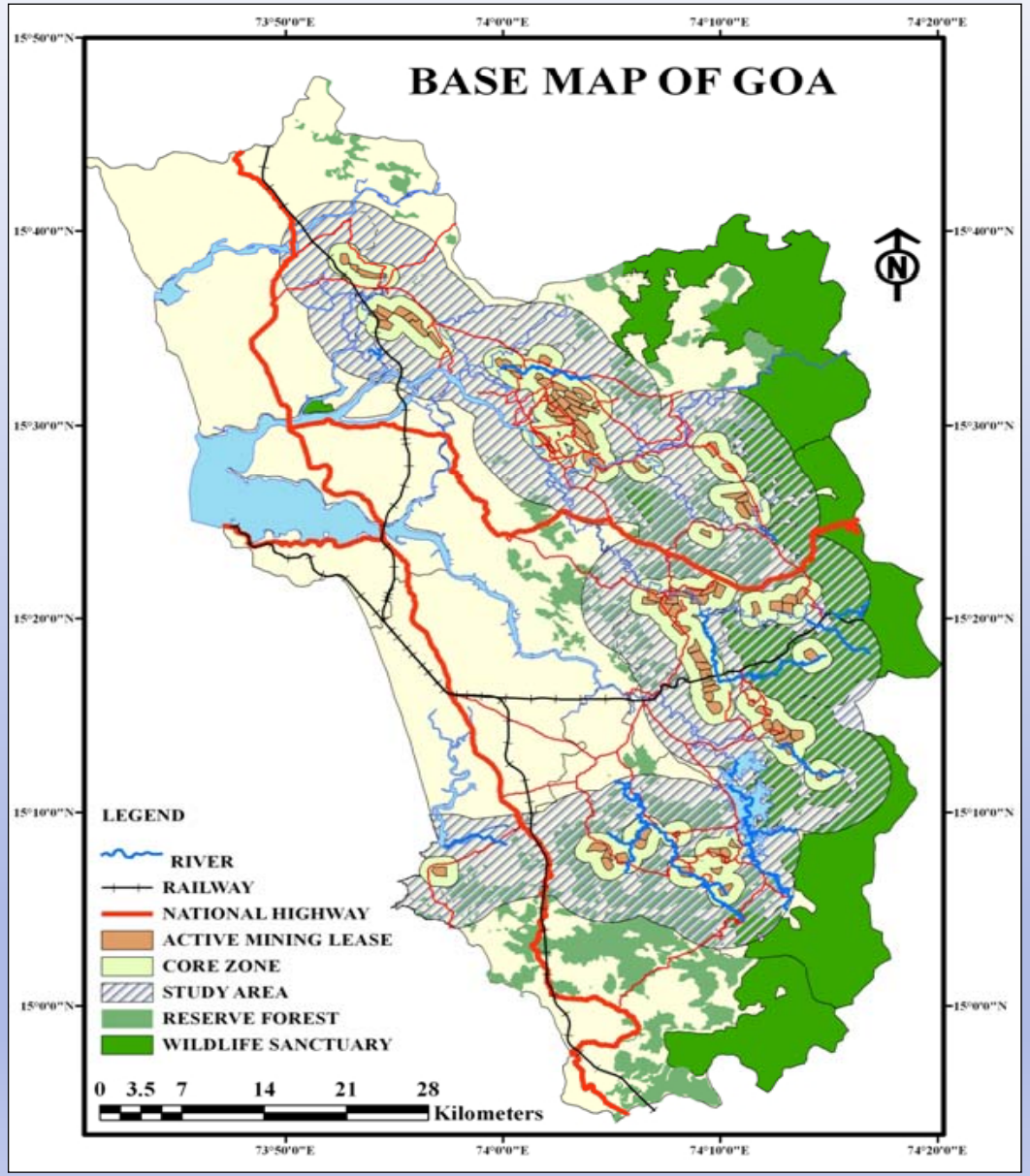
- **Ban on Mining in Karnataka**: Hon'ble Supreme Court of India banned mining in Karnataka in July 2011 in the wake of the Karnataka Lokayukta report about irregularities in the mining sector. The Hon'ble Supreme Court allowed resumption of mining operations in Category 'A' and 'B' (108) mines with a cap on production of 30 MTPA in April 2013.
- **Ban on Iron Ore Mining in Goa**: Hon'ble Supreme Court of India had imposed a blanket ban on mining operations of Goa in October 2012 due to certain illegalities as reported by Justice Shah Commission. Hon'ble Supreme Court has lifted the ban in Goa on 21 April 2014 and imposed a cap on production up to 20 MTPA.
- **Ban on Mining in Orissa**: In its recent order dated 16 May 2014, Hon'ble Supreme Court imposed a partial ban on iron ore mining in Odisha considering the findings of the Justice MB Shah Commission which establishes the prevalence of rampant illegal mining in Odisha. It stayed ban on mining in the 102 leases with no environmental clearances and 26 mining leases operating as second and subsequent renewals.

# Environmental Scenario of Goa Iron Ore Mining Region

# Study Area

- Goa is the 25$^{th}$ State of India, attaining statehood in May 1987.
- It is a famous International tourist destination and attracts around 2 million tourists annually.
- lies between the latitudes 14°53'54" N & 15°40'00" N and longitudes 73°40'33" E & 74°20'13" E with geographical area of 3,702 km$^2$ and a coastline of 105 km.
- Mining is the major economic activity contributing about 20.4% of SDP to the State's economy.
- Mining is more focused in the midland of Goa, while tourism is generally limited along the coastal belt of Goa.
- Mining is concentrated in five (5) Talukas namely Bicholim, Sattari, Dharbandora, Quepem and Sanguem


MAP OF GOA
Pernem
PERNEM
Mapusa
Bicholim
BARDEZ
BICHOLIM
SATTARI
Valpai
PANAJI
NORTH GOA
TISWADI
Vasco Da Gama
Ponda
MORMUGAO
PONDA
DHARBANDORA
Margao
SALCETTE
Quepem
Sanguem
ARABIAN SEA
SOUTH GOA
SANGUEM
QUEPEM
Chauri
CANACONA
LEGEND
CAPITAL CITY
TALUKA HEADQUARTER
DISTRICT BOUNDARY
STATE BOUNDARY
0 3.5 7 14 21 28
Kilometers
INDIA
STUDY AREA
LEGEND
1 KM BUFFER
STUDY AREA
ACTIVE MINING LEASE
0 3.5 7 14 21 28
Kilometers


BASE MAP OF GOA
73°50'0"E
74°0'0"E
74°10'0"E
74°20'0"E
15°50'0"N
15°40'0"N
15°30'0"N
15°20'0"N
15°10'0"N
15°0'0"N
N
LEGEND
RIVER
RAILWAY
NATIONAL HIGHWAY
ACTIVE MINING LEASE
CORE ZONE
STUDY AREA
RESERVE FOREST
WILDLIFE SANCTUARY
0 3.5 7 14 21 28
Kilometers

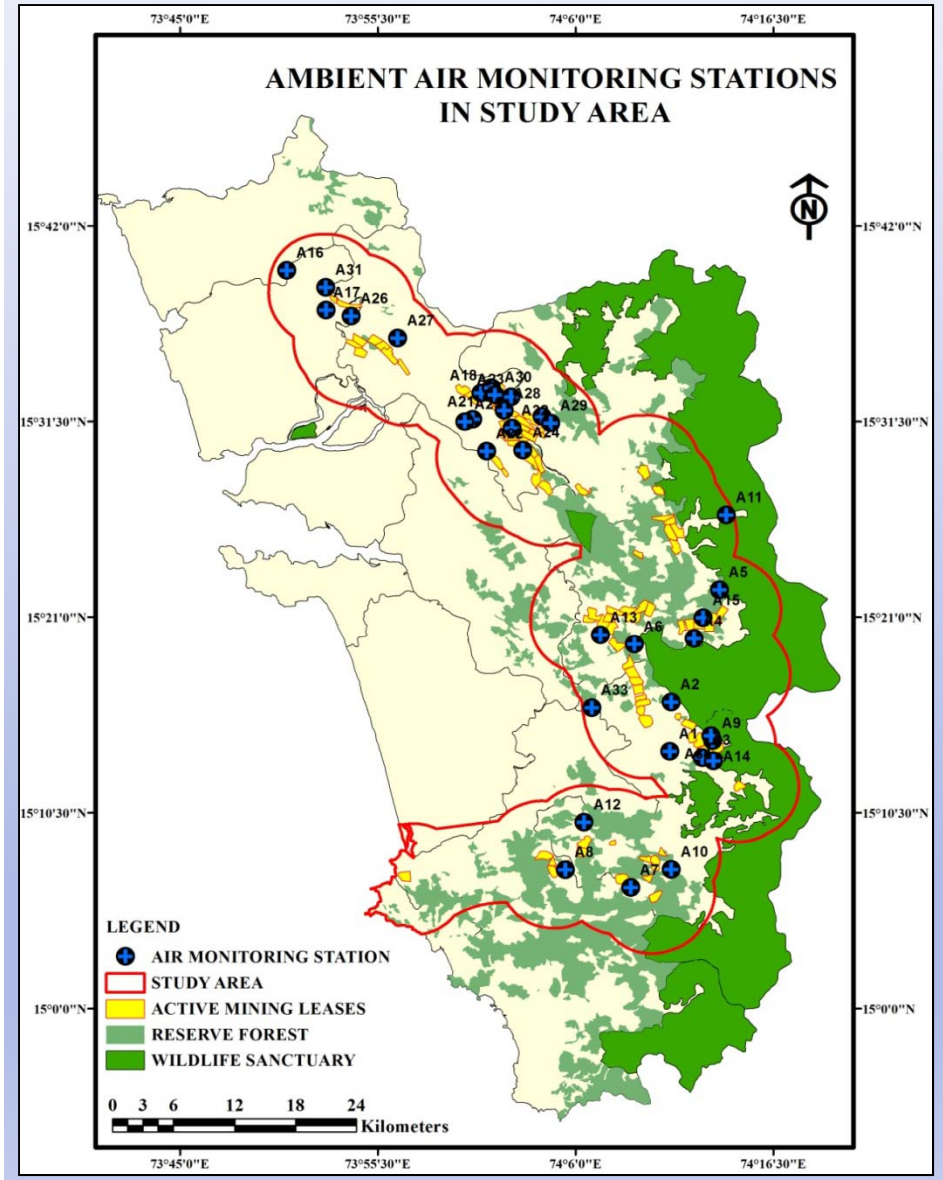
# IRON ORE MINE PIT

# Iron Ore Mining, Goa

# CHANGES IN TOPOGRAPHY DUE TO IRON ORE MINING

# Iron Ore Mining, Goa

# Ambient Air Quality within the Study Area

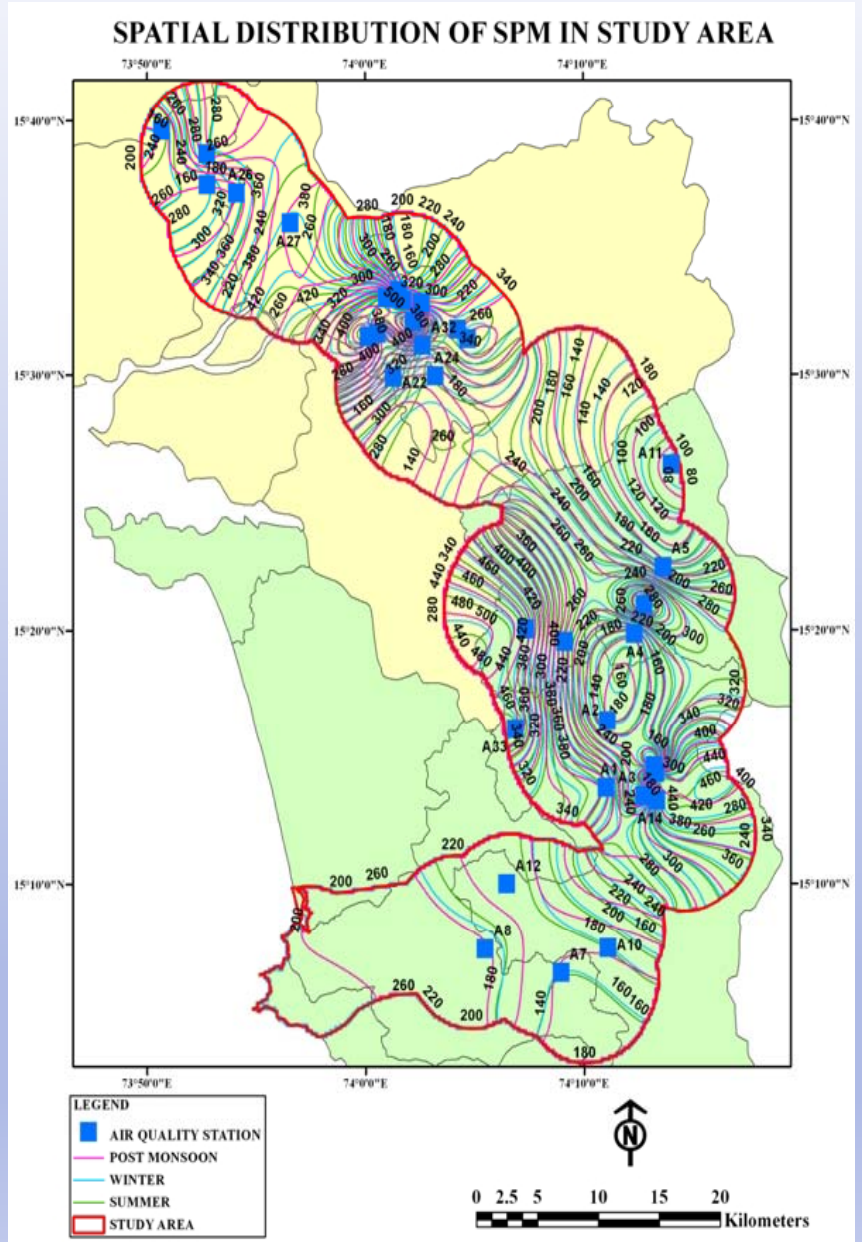



•Ambient air quality monitoring was carried out at 34 locations set-up as per **IS: 5182 Part XIV** in the study area during Post-Monsoon, Winter and Summer seasons as per CPCB guidelines / NAAQS.

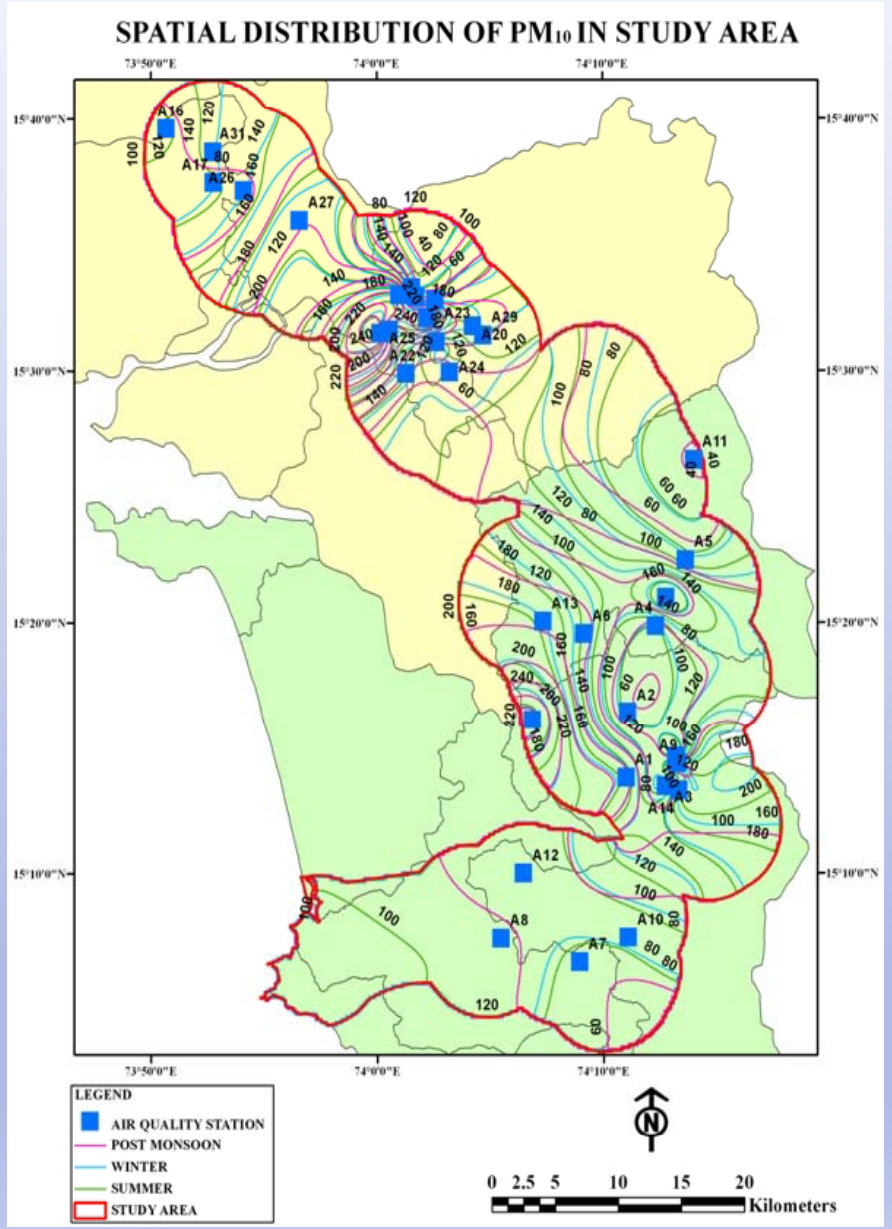
•The monitoring locations are further classified under three categories to emphasize & characterize the sources responsible for particulate matter:

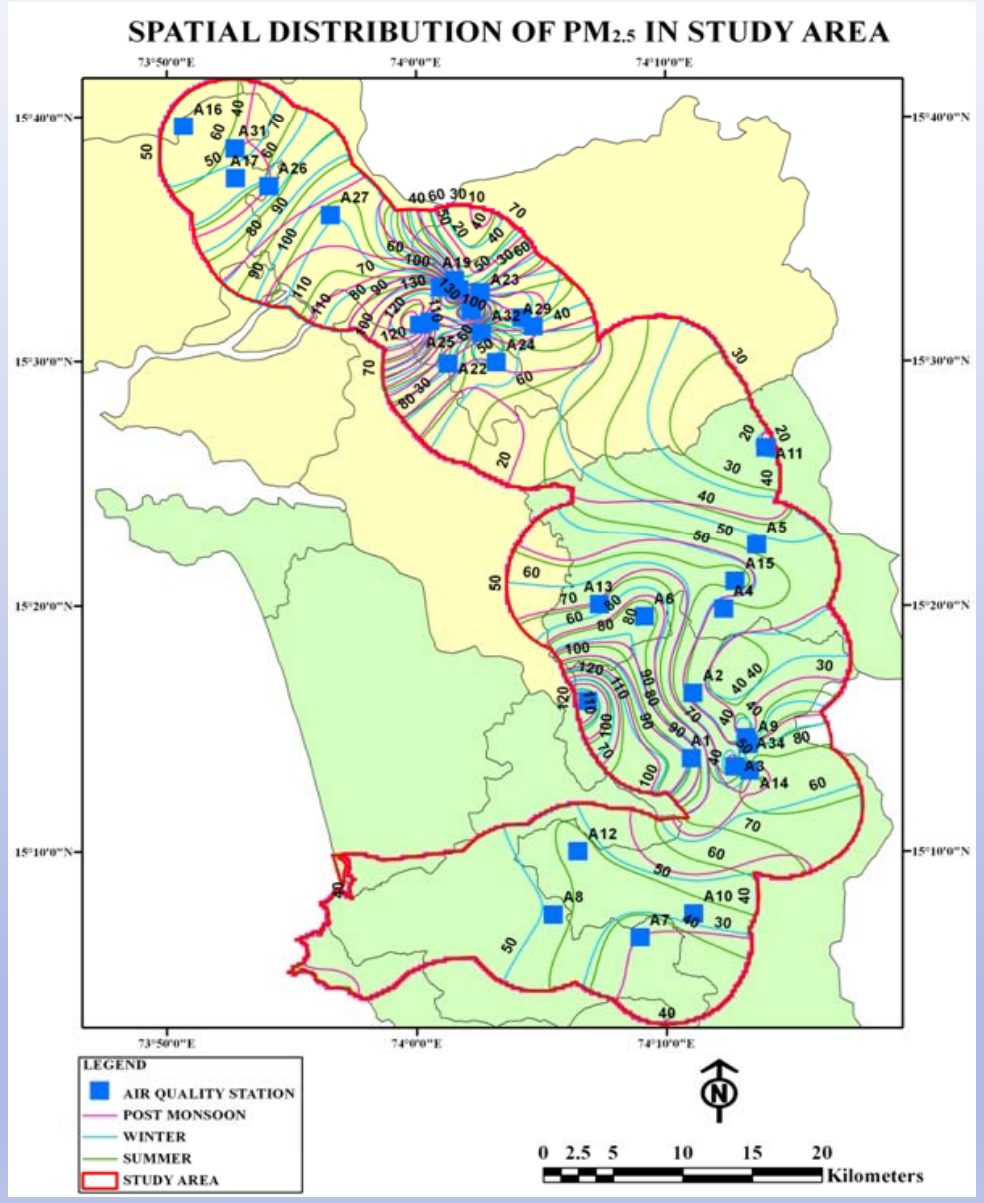
1. Stations within Mines (8 stations)
2. Stations in Buffer Zone along Core mining activities (12 stations)
3. Stations along Ore Transportation Route (14 stations)

## SPATIAL DISTRIBUTION OF SPM IN STUDY AREA




## SPATIAL DISTRIBUTION OF $PM_{10}$ IN STUDY AREA

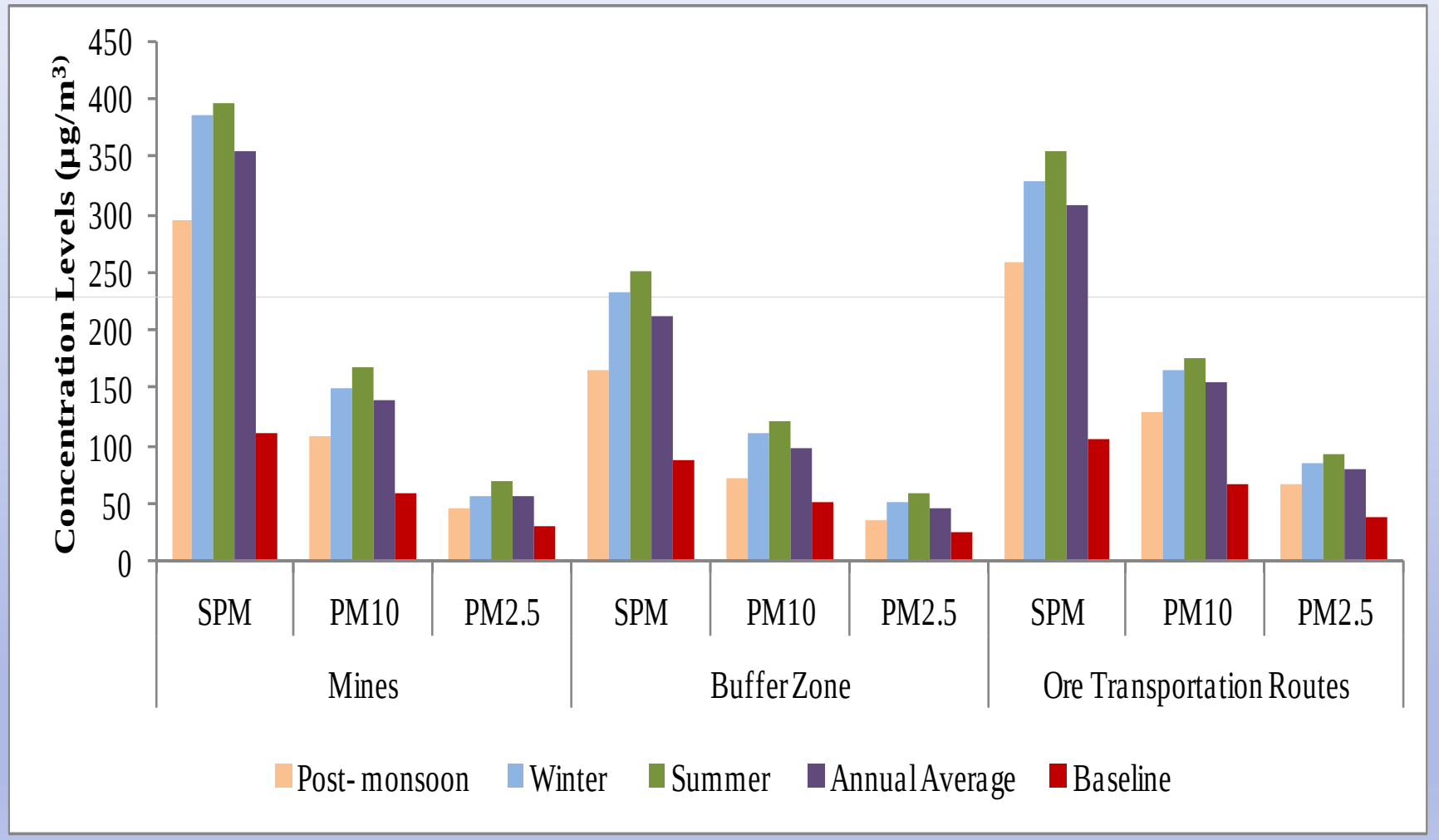



SPATIAL DISTRIBUTION OF PM2.5 IN STUDY AREA
73°50'0"E
74°0'0"E
74°10'0"E
15°40'0"N
15°30'0"N
15°20'0"N
15°10'0"N
A16
A31
A17
A26
A27
A19
A23
A32
A29
A25
A24
A22
A11
A5
A15
A4
A13
A6
A2
A9
A1
A34
A3
A14
A12
A8
A10
A7
LEGEND
AIR QUALITY STATION
POST MONSOON
WINTER
SUMMER
STUDY AREA
N
0 2.5 5 10 15 20
Kilometers

# Ambient Air Quality Status in the Study Area with respect to Particulates (SPM, $PM_{10}$ and $PM_{2.5}$)

| Locations | | Mines | | | Buffer Zone | | | Ore Transportation Routes | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Particulates | | SPM | $PM_{10}$ | $PM_{2.5}$ | SPM | $PM_{10}$ | $PM_{2.5}$ | SPM | $PM_{10}$ | $PM_{2.5}$ |
| Permissible Limit (24 hourly Basis ) ($\mu g/m^3$ ) | | 500 | 100 | 60 | 200 | 100 | 60 | 500 | 100 | 60 |
| Observed Range of Concentration Levels ($\mu g/m^3$ ) | Post - monsoon | 256-437 | 85 - 135 | 39-51 | 70-214 | 38 - 86 | 20-41 | 138-423 | 64-229 | 30-124 |
| | Winter | 330-455 | 119-180 | 46-66 | 75-326 | 40-155 | 19-72 | 160- 547 | 75 - 274 | 35-145 |
| | Summer | 316-469 | 113-195 | 53-84 | 83-374 | 41-178 | 21-90 | 161- 625 | 77 - 294 | 35-156 |
| | Annual Average | 313-452 | 115-167 | 48-63 | 75-290 | 39-133 | 20-63 | 152- 509 | 72 - 252 | 33-133 |
| | Baseline | 89-153 | 48 - 67 | 26-35 | 48-100 | 26-72 | 16-34 | 69 -178 | 39 - 105 | 24-80 |
| Average Concentration Levels ($\mu g/m^3$ ) | Post-monsoon | 295 | 108 | 45 | 166 | 71 | 35 | 259 | 130 | 67 |
| | Winter | 385 | 150 | 57 | 233 | 111 | 51 | 330 | 166 | 86 |
| | Summer | 397 | 169 | 70 | 250 | 122 | 58 | 354 | 176 | 92 |
| | Annual Average | 356 | 140 | 56 | 212 | 99 | 47 | 309 | 155 | 80 |
| | Baseline | 111 | 58 | 30 | 88 | 51 | 26 | 107 | 68 | 38 |
| 98 Percentile Concentration Levels ($\mu g/m^3$ ) | Post-monsoon | 419 | 133 | 51 | 213 | 84 | 41 | 417 | 228 | 123 |
| | Winter | 448 | 179 | 66 | 325 | 153 | 72 | 533 | 270 | 142 |
| | Summer | 462 | 195 | 84 | 370 | 176 | 84 | 607 | 291 | 152 |
| | Annual Average | 442 | 179 | 66 | 289 | 132 | 63 | 500 | 251 | 132 |
| | Baseline | 149 | 67 | 35 | 100 | 71 | 33 | 164 | 101 | 73 |

# Observed Concentration Levels of Particulates (SPM, $PM_{10}$ and $PM_{2.5}$)



# Observations

SPM

- All stations within Mines shows concentration value below permissible limit
- 7 stations within Buffer Zone shows concentration values above permissible limit
- 10 stations along Ore-Transport Route shows concentration above permissible limit
- 8 stations out of 34 stations shows concentration value above permissible limit

$PM_{10}$

- All stations within Mines have concentration above permissible limit
- 6 stations within Buffer Zone have concentration above permissible limit
- 9 stations along Ore-Transportation Route have values above permissible limit
- 23 stations out of 34 stations have concentration values above permissible limit

$PM_{2.5}$

- 2 stations within Mines have their concentration value above permissible limit
- 2 stations within Buffer Zone have concentration above permissible limit
- 9 of stations along Ore-Transportation Route have values above permissible limit
- 13 stations out of 34 have concentration values above permissible limit

# AIR QUALITY INDICES (USEPA)

| Air Quality Index Values | Levels of Health Concern | Colours | Health Concern |
|---|---|---|---|
| 0-50 | Good | Green | Air quality is satisfactory and poses little or no health risk. |
| 51-100 | Moderate | Yellow | Air quality is acceptable; however, pollution in this range may pose a moderate health concern for a very small number of individuals. People who are unusually sensitive to ozone or particle pollution may experience respiratory symptoms. |
| 101-150 | Unhealthy for Sensitive Group | Orange | Members of sensitive groups may experience health effects, but the general public is unlikely to be affected. People with heart or lung disease, older adults, and children are considered sensitive and therefore at greater risk. |
| 151-200 | Unhealthy | Red | Everyone may begin to experience health effects. Members of sensitive groups may experience more serious health effects. |
| 201-300 | Very Unhealthy | Purple | AQI values between 201 and 300 trigger a health alert, meaning everyone may experience more serious health effects. |
| Above 300 | Hazardous | Maroon | AQI values over 300 trigger health warnings of emergency conditions. The entire population is even more likely to be affected by serious health effects. |

# Comparison of Annual Average and Base Line Air Quality Index at Various Mines

| Station Code | Station Name | $PM_{10}$ | | $PM_{2.5}$ | | $SO_2$ | | $NO_X$ | |
|---|---|---|---|---|---|---|---|---|---|
| | | Annual | Base Line | Annual | Base Line | Annual | Base Line | Annual | Base Line |
| A9 | Tollem Mine | 101 | 54 | 137 | 90 | 22 | 19 | 7 | 6 |
| A13 | Codli Mine | 115 | 44 | 152 | 74 | 22 | 14 | 7 | 3 |
| A14 | Bombod Mine | 98 | 49 | 145 | 77 | 21 | 14 | 7 | 3 |
| A15 | Bimbol Mine | 100 | 52 | 126 | 72 | 22 | 14 | 7 | 3 |
| A29 | Pissurlem Mine | 90 | 57 | 137 | 83 | 21 | 14 | 6 | 4 |
| A30 | Harvalem Mine | 86 | 55 | 128 | 84 | 19 | 14 | 6 | 4 |
| A31 | Advalpale Mine | 82 | 52 | 116 | 75 | 22 | 15 | 6 | 3 |
| A32 | Velguem Surla Mine | 81 | 52 | 118 | 79 | 21 | 14 | 6 | 3 |

## Comparison of Base Line Air Quality Index with Annual Average Air Quality Index of Buffer zone

| Station Code | Location | $PM_{10}$ | | $PM_{2.5}$ | | $SO_2$ | | $NO_X$ | |
|---|---|---|---|---|---|---|---|---|---|
| | | Annual | Base Line | Annual | Base Line | Annual | Base Line | Annual | Base Line |
| A2 | Dudal Village | 65 | 41 | 106 | 67 | 18 | 16 | 5 | 5 |
| A3 | Tudou Village | 67 | 39 | 104 | 74 | 19 | 16 | 5 | 4 |
| A4 | Sigao Village | 68 | 44 | 104 | 74 | 18 | 17 | 5 | 4 |
| A11 | Tambadi Surla | 36 | 24 | 60 | 51 | 13 | 9 | 3 | 3 |
| A16 | Revora Village | 73 | 46 | 110 | 67 | 21 | 13 | 5 | 3 |
| A17 | Tivim Village | 76 | 41 | 120 | 65 | 19 | 13 | 6 | 3 |
| A19 | Harvalem Village | 76 | 44 | 122 | 73 | 19 | 13 | 5 | 3 |
| A22 | Surla Village | 88 | 57 | 145 | 87 | 19 | 15 | 6 | 4 |
| A23 | Honda Village | 90 | 59 | 143 | 82 | 21 | 16 | 7 | 4 |
| A24 | Velguem Village | 80 | 55 | 116 | 74 | 19 | 15 | 6 | 4 |
| A26 | Assonora Village | 80 | 54 | 132 | 81 | 19 | 15 | 6 | 4 |
| A34 | Darguina Village | 67 | 45 | 91 | 66 | 19 | 12 | 6 | 3 |

## Comparison of Base Line Air Quality Index with Annual Average Air Quality Index of Ore Transportation Routes

| Station Code | Location | $PM_{10}$ | | $PM_{2.5}$ | | $SO_2$ | | $NO_X$ | |
|---|---|---|---|---|---|---|---|---|---|
| | | Annual | Base Line | Annual | Base Line | Annual | Base Line | Annual | Base Line |
| A1 | Ugeum Village | 105 | 60 | 163 | 92 | 22 | 20 | 7 | 5 |
| A5 | Mollem Village | 63 | 42 | 99 | 81 | 18 | 15 | 6 | 5 |
| A6 | Carmonem Village | 94 | 54 | 157 | 88 | 21 | 17 | 7 | 5 |
| A7 | Sulcorna Village | 59 | 42 | 85 | 81 | 18 | 16 | 5 | 5 |
| A8 | Maina Village | 68 | 54 | 112 | 84 | 18 | 17 | 6 | 5 |
| A10 | Curpem Village | 62 | 47 | 97 | 69 | 18 | 13 | 5 | 3 |
| A12 | Rivona Village | 62 | 36 | 102 | 74 | 19 | 16 | 6 | 4 |
| A18 | Cudnem Village | 129 | 51 | 176 | 85 | 22 | 13 | 8 | 3 |
| A20 | Pissurlem Village | 98 | 68 | 158 | 121 | 19 | 15 | 6 | 4 |
| A21 | Navelim Village | 120 | 66 | 172 | 121 | 29 | 20 | 7 | 5 |
| A25 | Amona Village | 149 | 76 | 188 | 160 | 38 | 17 | 10 | 5 |
| A27 | Bicholim Town | 106 | 58 | 161 | 89 | 22 | 15 | 8 | 4 |
| A28 | Sonshi Village | 147 | 67 | 190 | 99 | 21 | 11 | 9 | 3 |
| A33 | Sanvordem Village | 146 | 63 | 186 | 84 | 22 | 14 | 9 | 4 |

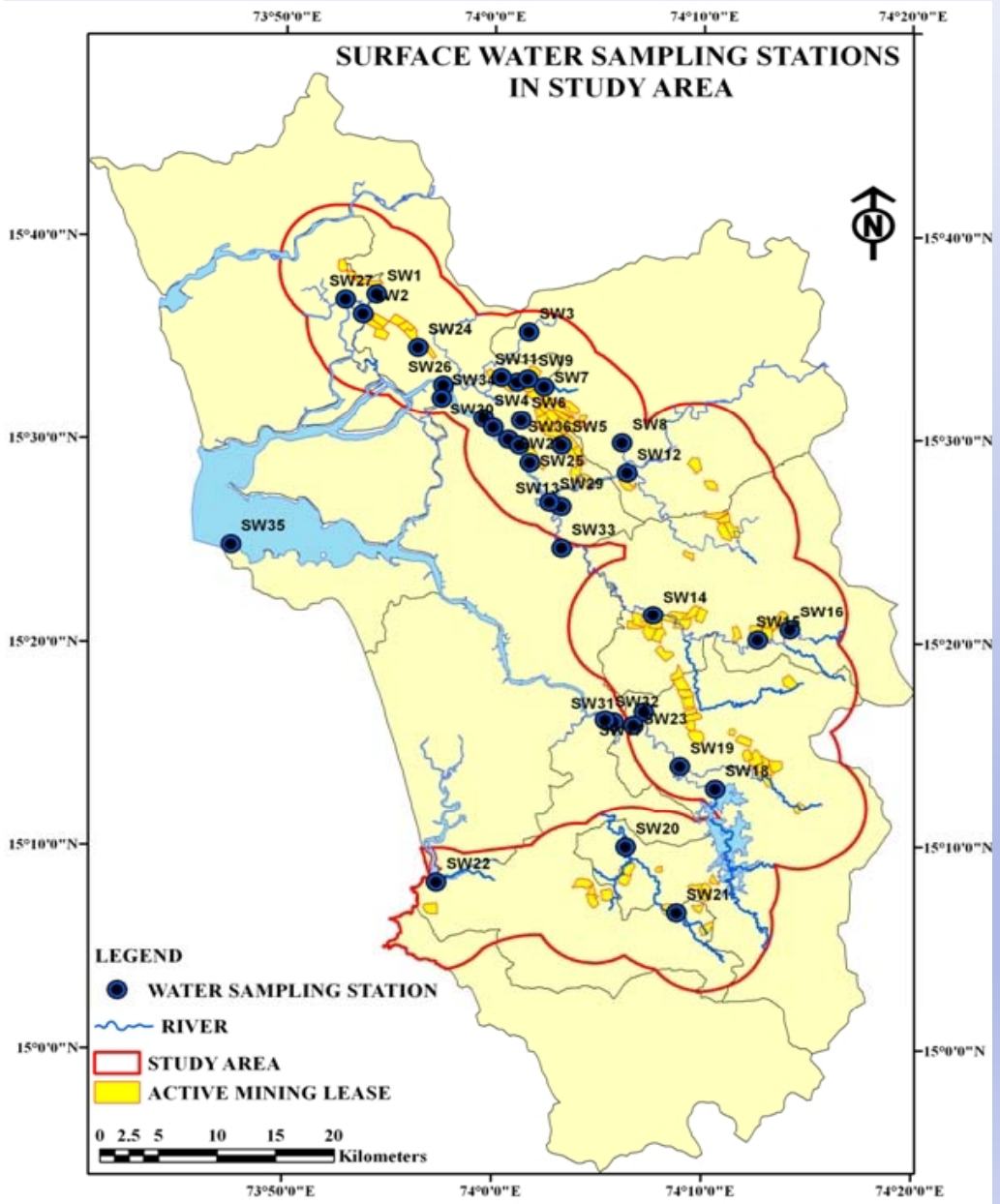
## Comparison of Base Line Air Quality Index with Annual Average Air Quality Index of Hotspots

| Location | $PM_{10}$ | | $PM_{2.5}$ | | $SO_2$ | | $NO_X$ | |
|---|---|---|---|---|---|---|---|---|
| | Annual | Baseline | Annual | Baseline | Annual | Baseline | Annual | Baseline |
| Sonshi Junction | 1245 | 87 | 710 | 152 | 32 | 21 | 19 | 8 |
| Navelim - Maina Junction | 1098 | 133 | 669 | 169 | 51 | 38 | 19 | 13 |
| Navelim Junction | 996 | 96 | 561 | 132 | 41 | 29 | 18 | 7 |
| Sanquelim Junction at PHC | 717 | 63 | 445 | 137 | 28 | 19 | 16 | 9 |
| Surla-Tharmata Junction | 877 | 72 | 542 | 151 | 23 | 15 | 18 | 6 |
| Pilgao-Sarmanas Junction | 870 | 70 | 515 | 133 | 24 | 16 | 17 | 6 |
| Honda Tisk | 556 | 58 | 395 | 116 | 26 | 15 | 17 | 9 |
| Pale Bazar | 1100 | 90 | 565 | 155 | 22 | 13 | 13 | 6 |
| Usgao, Wadakade | 1078 | 88 | 673 | 164 | 23 | 18 | 19 | 9 |
| Dharbandora-Sacordem Tisk | 1015 | 74 | 635 | 156 | 22 | 12 | 18 | 7 |
| Dabal/Codli Tisk | 1232 | 87 | 735 | 162 | 24 | 15 | 20 | 6 |
| Assonora Tisk | 629 | 65 | 402 | 126 | 24 | 19 | 17 | 10 |
| Sanvordem Junction | 1384 | 93 | 823 | 143 | 22 | 16 | 21 | 7 |
| Tilamol Junction | 1168 | 66 | 701 | 154 | 22 | 13 | 19 | 9 |
| Sigao Tisk | 802 | 61 | 523 | 135 | 22 | 10 | 17 | 5 |

# Observations

| Pollutant | Annual | Baseline |
|---|---|---|
| **$PM_{10}$** | •Only 1 station have shown a good health status<br>• 24 stations have moderate health concern<br>•9 were representing unhealthy condition for sensitive group. | • 14 of stations have shown a good health status<br>• 20 had moderate health concern. |
| **$PM_{2.5}$** | •5 stations have shown moderate health concern<br>• 19 shows unhealthy condition for sensitive group<br>• 10 have unhealthy conditions prevalent. | •31 of stations have shown moderate health concern<br>•2 have unhealthy condition for sensitive group<br>• 2 have unhealthy conditions prevalent |

# SURFACE WATER QUALITY EVALUATION




- **36 stations were established for monitoring the surface water quality**

- **The Water Quality Parameters which were significantly impacted were Turbidity, Chloride and Sulphate in major areas and Iron and Manganese at few locations**

# Observed Concentration of Various Water Quality Parameter

| Water Quality Parameter | | pH | Turbidity (NTU) | Electrical Conductivity (µMhos/cm) | TDS (mg/L) | Chloride (mg/L) | Sulphate (mg/L) |
|---|---|---|---|---|---|---|---|
| Permissible Limits | IS:10500, 1991 | 6.5-8.5 | 5 (10*) | | 500 (2000*) | 250 (1000*) | 200 (400*) |
| | IS:2296, 1982 | 6.5-8.5 | — | 2250 | 2000 (max) | 600 (max) | 1000 (max) |
| | IS:2490, 1981 (Inland Surface water) | 5.5-9.0 | — | — | 2100 | 1000 | 1000 |
| Observed Concentration Range | Post-monsoon | 6.3-8 | 4 to 10 | 19 to 850 | 11 to 720 | 3 to 2955 | 9 to755 |
| | Winter | 6.1-8.1 | 4 to 12 | 25 to 883 | 18 to 735 | 6 to 2991 | 5 to 763 |
| | Summer | 6.2-7.9 | 4 to 17 | 38 to 1100 | 21 to 876 | 17 to 3010 | 7 to 822 |
| | Monsoon | 5.7-7.3 | 9 to 350 | 38 to 428 | 17 to 629 | 6 to 1664 | 6 to71 |
| | Annual Average | 5.4- 6.9 | 6 to 94 | 30 to 773 | 19 to 664 | 10 to 2586 | 5.5 to 598 |
| | Baseline | 6.4.-7.9 | 2 to 9 | 15 to 750 | 9 to 439 | 9 to 1400 | 3 to 70 |
| Average Concentration Value | Post-monsoon | 7.1 | 6.63 | 305.72 | 215.86 | 403.1 | 219.25 |
| | Winter | 7.1 | 7.16 | 344 | 232.61 | 518.36 | 125.61 |
| | Summer | 7 | 8.16 | 416.86 | 249 | 508.3 | 131.5 |
| | Monsoon | 6.54 | 48.91 | 131.4 | 113 | 227.361 | 21.4 |
| | Annual Average | 6.13 | 17.83 | 299.66 | 202.7 | 387.6 | 82.8 |
| | Baseline | 7.31 | 5.5 | 190 | 138 | 214 | 6.8 |
| * Permissible Limits in the Absence of Alternative Source | | | | | | | |

| Class of water | Impacts |
|---|---|
| **B** | In Cudnem River in Arvalem of Bicholim Taluka and Sanguem River in Sanguem taluka, the Impact of Turbidity is rated high on the Significant point rating |
| | High impact on Chloride Concentration is also seen in this area |
| | Sanguem River in Sanguem taluka also has a very high significant rating in terms of turbidity |
| **C** | Turbidity, Iron (Fe), Manganese (Mn), Sodium, Potassium and Nitrate have moderate significance rating in Opa treatment plant |
| **D** | Considerable concentration levels of Manganese and Iron |
| | High values of Turbidity and moderately high Concentration levels f Chloride, Sodium, Manganese and Iron |
| **E** | Khandepar River in Shigao was rated high in turbidity and moderate in metal content |
| | Sanvordem Nallah and Kushavati river Significant Values of Turbidity was observed. |
| **Jetty Points** | Turbidity, Sulphate, Fe and Mn was found to have high |

# MANAGEMENT STRATEGIES

## APPLICATION OF NATURAL ( COCO) FILTERS FOR SILT CONTROL

# MANAGEMENT STRATEGIES

**Garland Drainage Channel along the Toe of the Dump**

**Series of silt arrestors lined with Coco filter**

# MANAGEMENT STRATEGIES

**Settling Ponds**

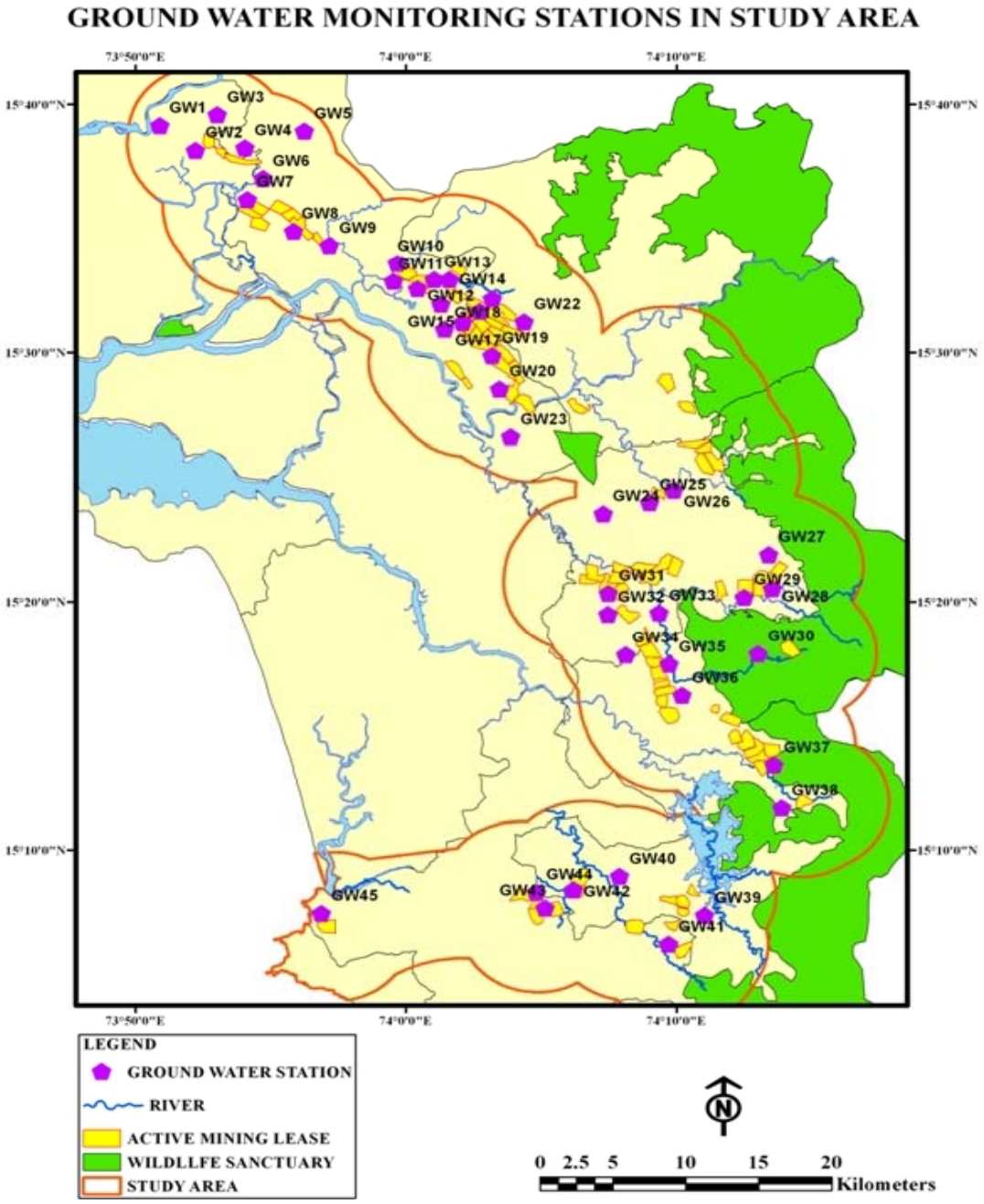
**Check dams**

# MANAGEMENT STRATEGIES

**Zig-Zag bunds**

**Clean water before leaving mining premises**

# Ground Water Scenario




- 45 wells were selected for water quality and availability studies.

- 22 Locations in North Goa
- 23 Locations in South Goa

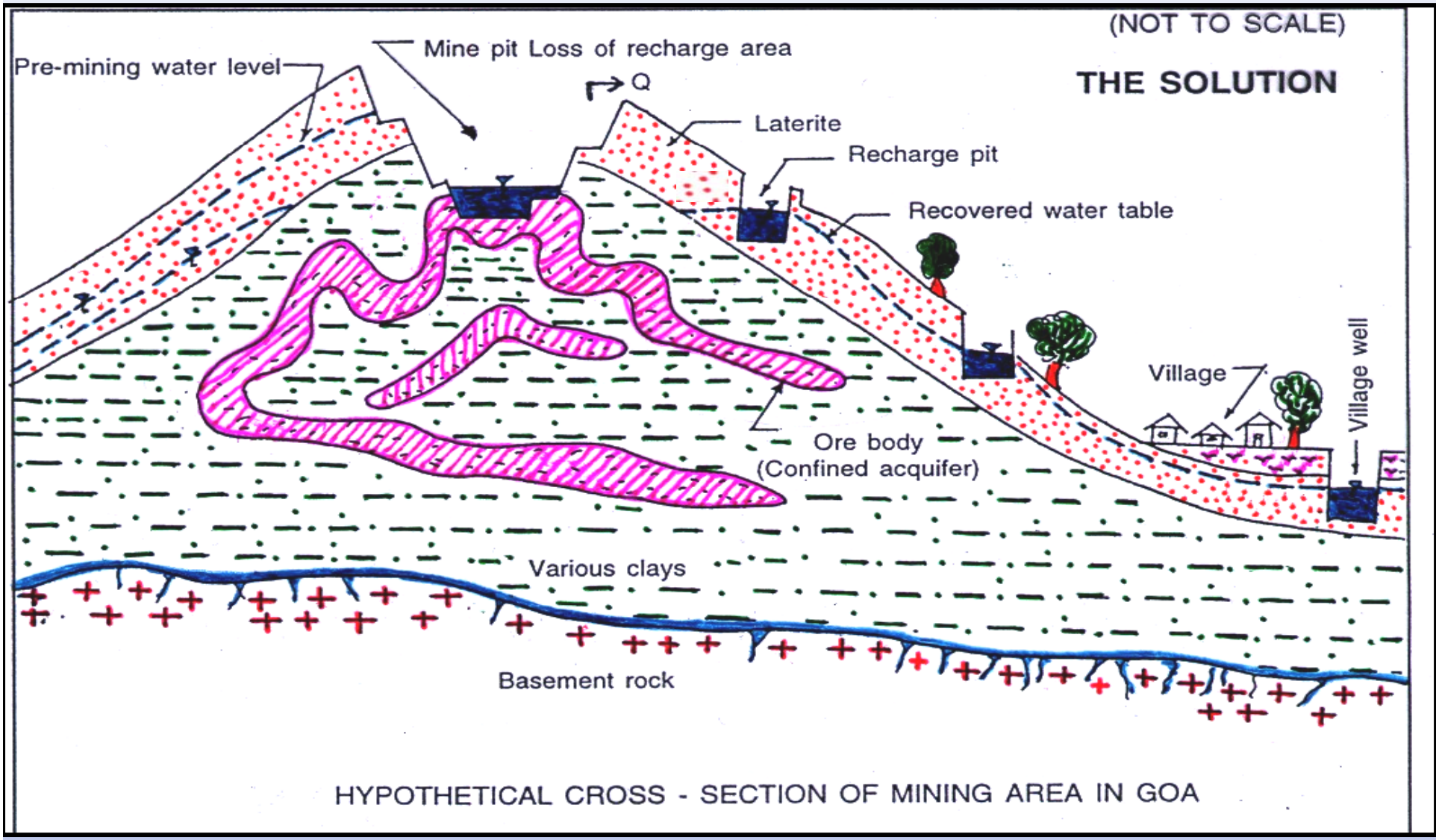
## Dynamic Ground Water Resource (March 2009)

| PARTICULARS | NORTH GOA | SOUTH GOA |
|---|---|---|
| (1) Net ground water availability (ham) | 7,802 | 5,473 |
| (2) Total Annual Ground Water Draft (ham) | 2,547 | 1,837 |
| (3) Projected demand for domestic & industrial uses upto 2025 (ham) | 2,110 | 1,639 |
| (4) Stage of Ground Water Development (%) | **33 % (SAFE)** | **34 % (SAFE)** |

## GROUND WATER CONTROL & REGULATION

| PARTICULARS | NORTH GOA | SOUTH GOA |
|---|---|---|
| (1) Number of Over Exploited (OE) Blocks | NIL | NIL |
| (2) Number of Critical Blocks | NIL | NIL |
| (3) Number of Notified Blocks | NIL | NIL |

# HYPOTHETICAL CROSS SECTION OF MINING AREA IN GOA



# Groundwater Augmentation

- Pumped groundwater from the active mining pit is being sent to the storage water pit, which is situated at a higher elevation within the micro- watershed covering the mine lease area.
- Mining operations are ensuring prolonged duration of stream flow through controlled releases of surplus water from the water storage pit inside the mines in the upstream
- The storm water management measures through garland canals at the toe of benches are further providing storage of surface water within the mine.
- Above measures are ensuring water availability in the stream for recharging dug wells

# Taluka wise Seasonal variation of Water Quality Index for Groundwater

| Taluka | Post-Monsoon | Rank | Winter | Rank | Summer | Rank | Monsoon | Rank | Annual Average | Rank | Status |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bicholim | 8.76 | 1 | 12.06 | 2 | 8.82 | 2 | 9.24 | 2 | 9.72 | 1 | Very Good |
| Sattari | 8.50 | 2 | 18.00 | 1 | 0.00 | 5 | 9.50 | 1 | 9.00 | 2 | Very Good |
| Dharbandora | 7.63 | 5 | 8.75 | 5 | 8.13 | 4 | 6.88 | 4 | 7.84 | 5 | Very Good |
| Sanguem | 8.25 | 3 | 10.50 | 3 | 9.13 | 1 | 7.5 | 3 | 8.84 | 3 | Very Good |
| Quepem | 7.71 | 4 | 10.29 | 4 | 8.43 | 3 | 6.86 | 5 | 8.32 | 4 | Very Good |

# Seasonal Fluctuation of Water Table

| S. No. | Season | No. of Wells | Fluctuation Levels ( m bgl) |
|---|---|---|---|
| 1 | Post-Monsoon | 2 | 1.2-2.5 |
| | | 14 | 2.5-4.5 |
| | | 21 | 4.5-6.5 |
| | | 8 | >6.5 |
| 2 | Winter | 2 | 1.2-2.5 |
| | | 6 | 2.5-4.5 |
| | | 24 | 4.5-6.5 |
| | | 13 | >6.5 |
| 3 | Summer | 2 | 1.2-2.5 |
| | | 6 | 2.5-4.5 |
| | | 20 | 4.5-6.5 |
| | | 13 | >6.5 |
| 4 | Monsoon | 19 | 1.2-2.5 |
| | | 18 | 2.5-4.5 |
| | | 4 | 4.5-6.5 |
| | | 4 | >6.5 |

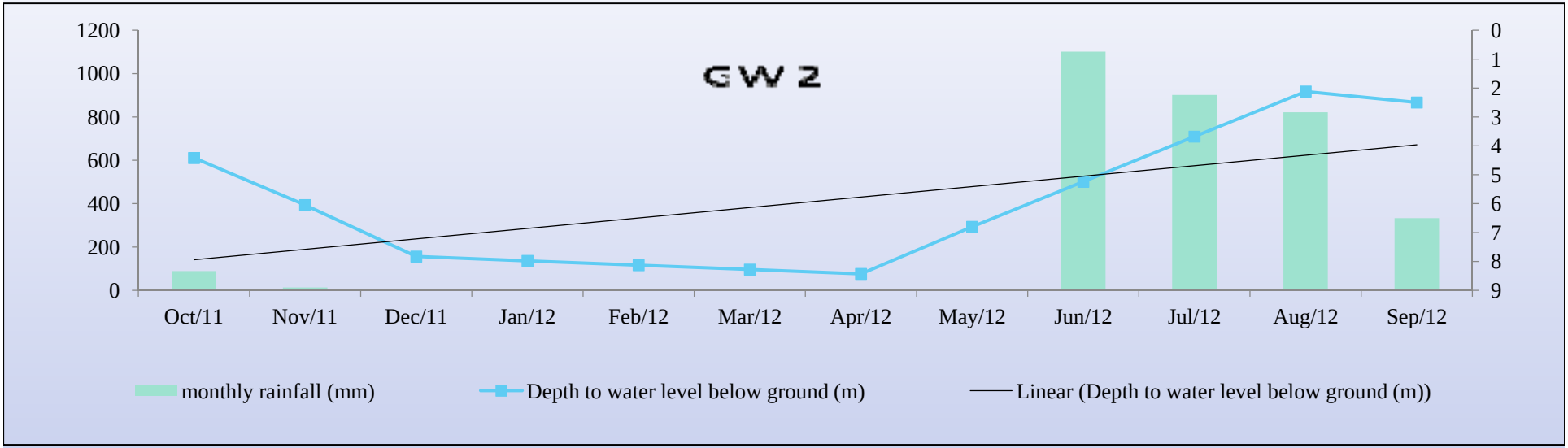
# Well Hydrographs

Total 38(82.2% )wells in the study area show increasing trend. Increasing trend is an indicative of surplus amount of groundwater being retained in these aquifers during the study period.

Only seven(15.5%) wells in the study area shows no trend and reason may be attributed to the balance in the recharge and discharge of these well.

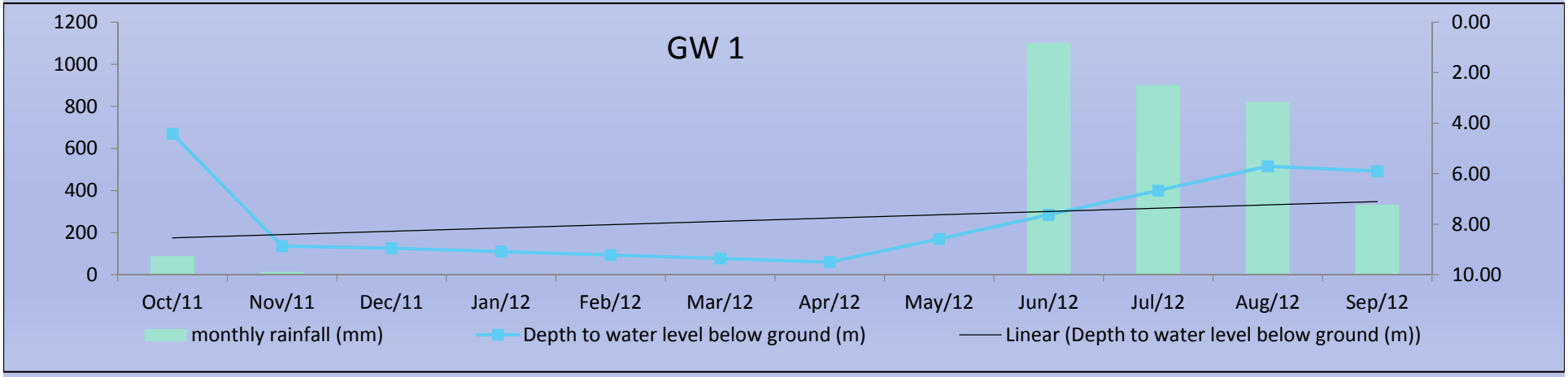
The well hydrograph indicates that the water levels in the phreatic aquifers response prominently to rainfall recharge.

# Well Hydrographs Showing Increasing Trend




GW 2 : Kansa (Tivim)

# Well Hydrographs Showing No-trend




GW 1 : Revora

# Management Strategies

**Series of silt arrestors lined with Coco filter**

**Garland Drainage Channel along the Toe of the Dump**

**Zig-Zag bunds**

**Check Dams**

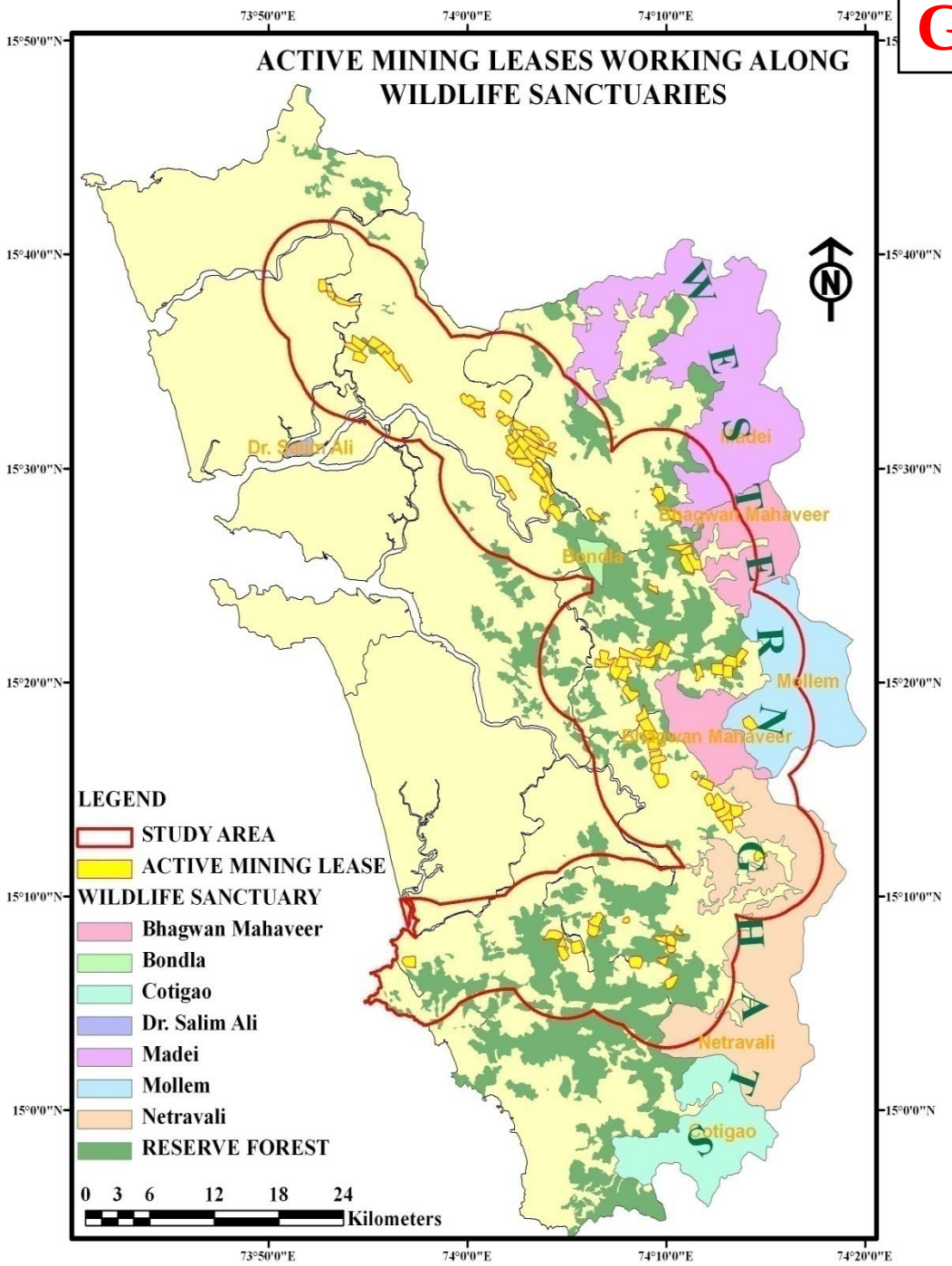
# Recharge Structure

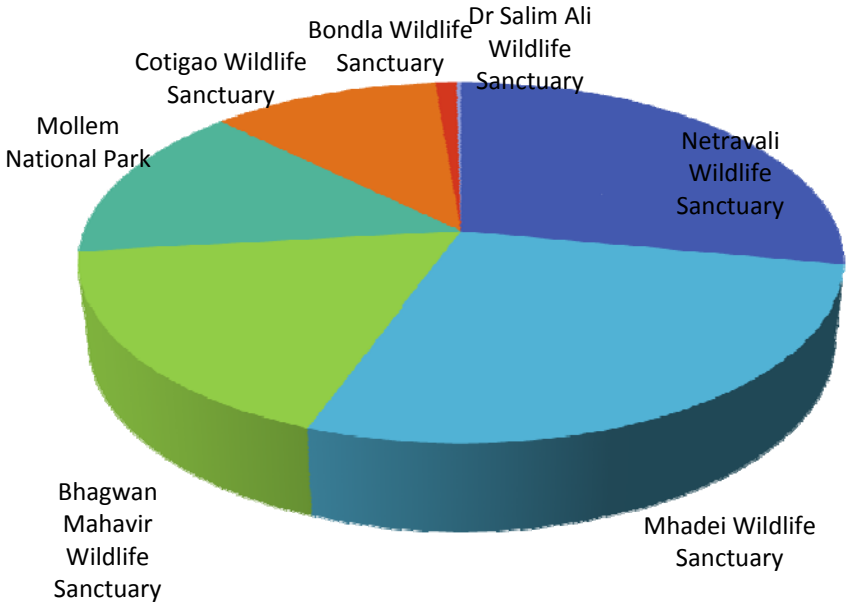

SHALLOW RECHARGE WELL
SILT SETTLING POND
SAND BED FILTER
DEEP RECHARGE WELL
DEEP WELL RECHARGE POND

# Demarcating ESZs

- To protect the exceptionally rich biodiversity of the Western Ghats from loss due to unsustainable use of natural resources.
- To protect and guard the natural and cultural heritages.
- To prohibit the unsustainable use of natural resources.
- To ensure sustainable development in the Ecologically Sensitive Regions.

# Goa Region




| Protected Areas | Area(Km$^2$) |
|---|---|
| Netravali Wildlife Sanctuary | 211.05 |
| Mhadei Wildlife Sanctuary | 208.48 |
| Bhagwan Mahavir Wildlife Sanctuary | 133 |
| Mollem National Park | 107 |
| Cotigao Wildlife Sanctuary | 85.65 |
| Bondla Wildlife Sanctuary | 7.95 |
| Dr Salim Ali Wildlife Sanctuary | 1.78 |

# Mhadei  Wildlife Sanctuary

# Mollem National Park

# View of Western Ghats

# Methodology to categorize and valuing the attribute layers

| Sl No | Attributes | Category | Valuing | Criteria |
|---|---|---|---|---|
| 1 | Biological feature | BHV (Biologically Highly Valued)<br>BMV (Biologically Modestly moderately Valued)<br>BLV (Biologically Less Valued) | 10<br>5<br>0 | Very dense forest, only water body, dense forest with water body<br>Moderately dense forest, with water body<br>Barren land |
| 2 | Geo-morphological feature | EHS (Environmentally Geo-climatically Highly Sensitive)<br>EMS (Environmentally Geo-climatically Moderately Sensitive)<br>ELS (Environmentally Geo-climatically Less Sensitive ) | 10<br>5<br>0 | High Slope aspect<br>Moderate slope aspect<br>Slight slope aspect |
| 3 | Places of public importance | VIPP (Very Important through Public Perception)<br>MIPP (Moderately Important through Public Perception)<br>LIPP (Less Important through Public Perception) | 10<br>5<br>0 | Heritage sites, Important religious sites, sanctuary<br>Agriculture, Important hospitals<br>No such site |

# Methodology to combine the valued layers and grading the ESAs

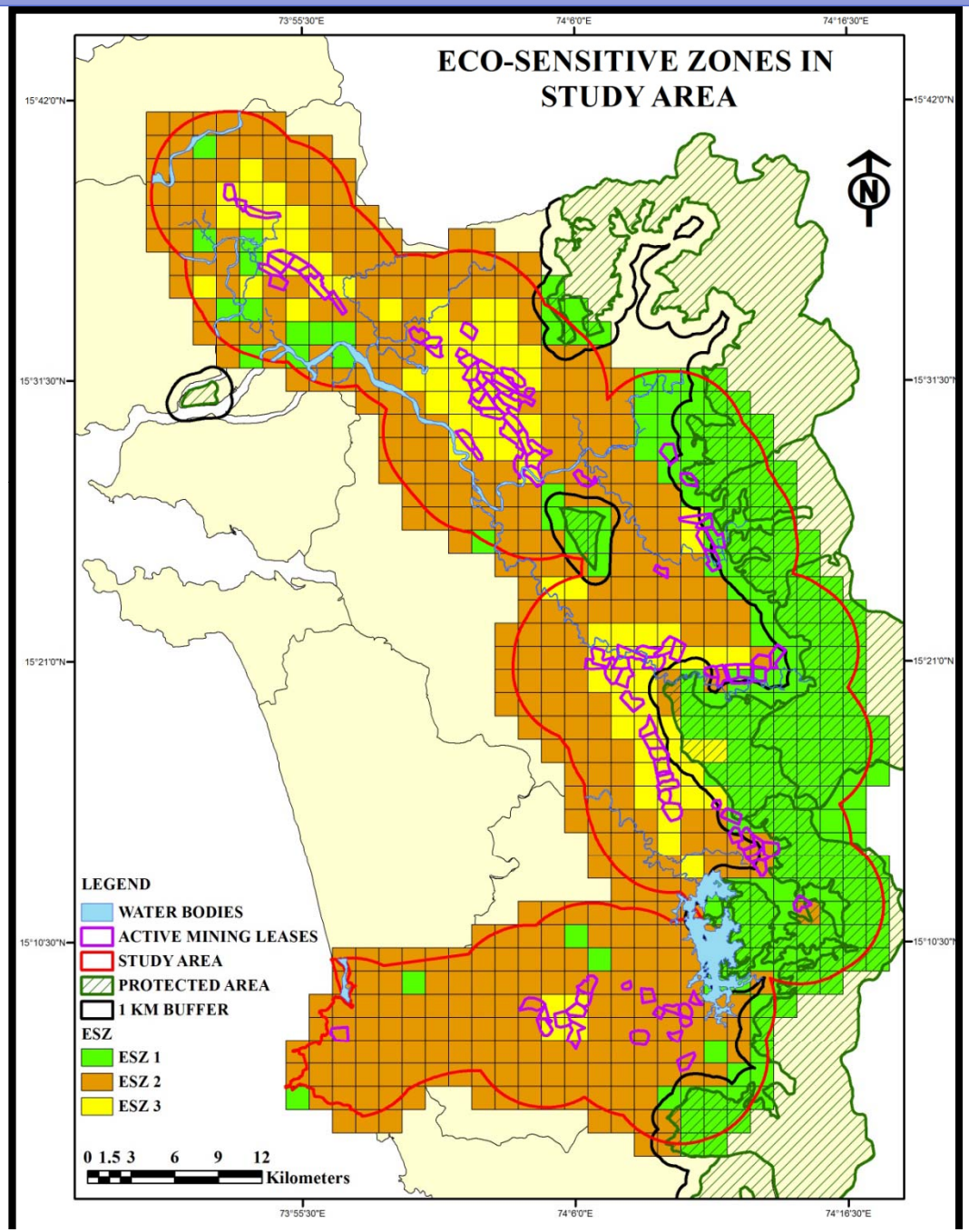
| Combined Value from biological and geo-morphological factors | Value from Public Perception | ESA Grade | Extent of protection |
|---|---|---|---|
| 20-10 | 5-10 | Grade 1 | Highly Protected |
| | 0-5 | Grade 2 | High protection with regulated activities |
| 0-10 | 0-10 | Grade 3 | Regulated Protection |

# Activities in ESZs

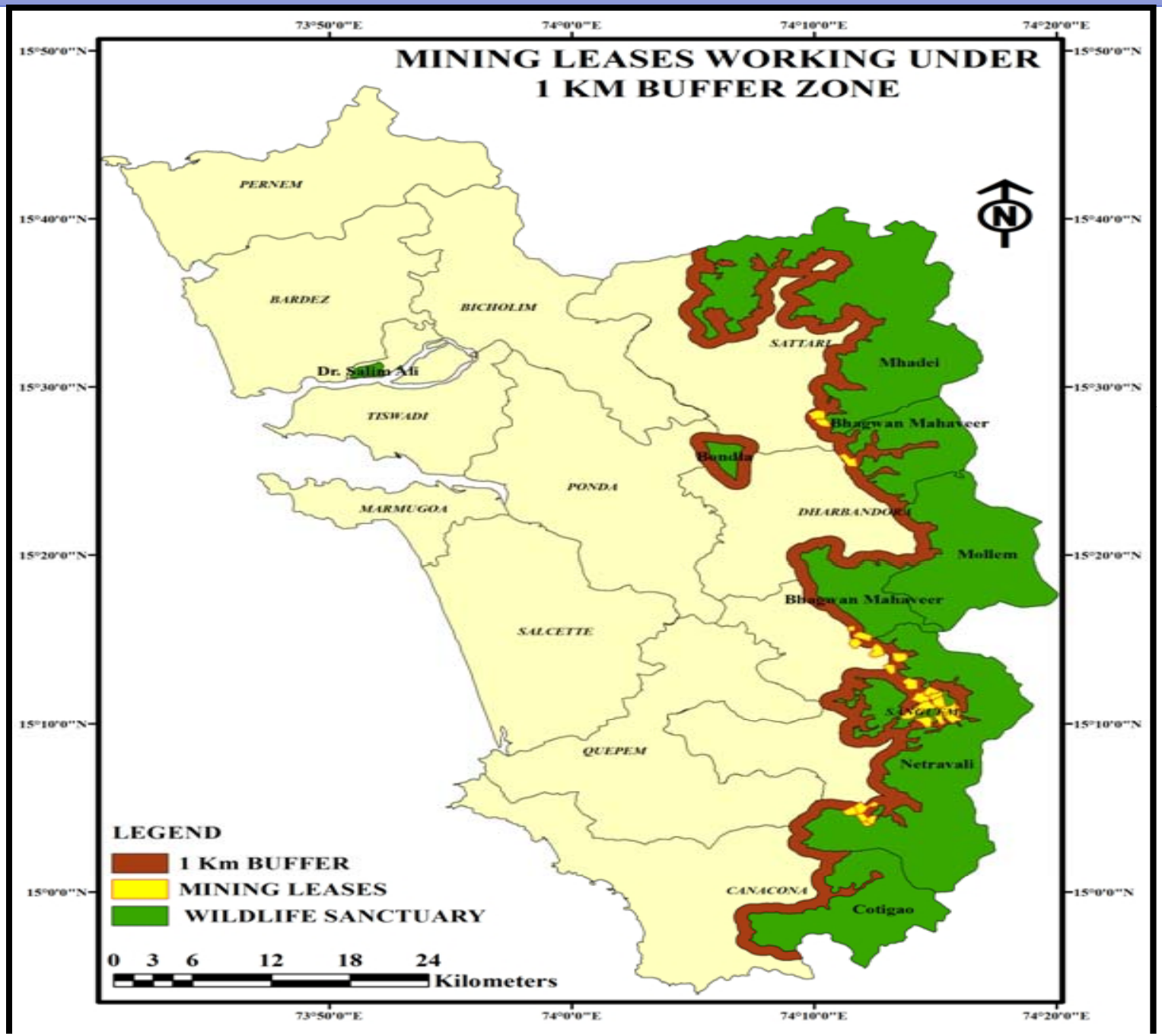
| Prohibited | Regulated |
|---|---|
| Commercial mining | Felling of trees |
| | Establishment of hotels and resorts |
| Setting of saw mills | Drastic change of agriculture system |
| Setting of industries causing pollution (water, air, soil, noise etc.) | Commercial use of natural water resource including ground water harvesting |
| Commercial use of firewood | Erection of electrical cable |
| Establishment of major Hydroelectric project | Fencing of premises of Hotels and lodges |
| Use or production of any hazardous substance\ | Use of polythene bag by the shopkeeper |
| Undertaking activities related to tourism like- Overflying the national park area by any aircraft or hot air balloon | Widening of road |
| Discharge of effluent and solid waste into natural water bodies/ terrestrial areas | Movement of vehicular traffic at night |
| - | Introduction of exotic species |
| - | Protection of hill slopes and river bank |

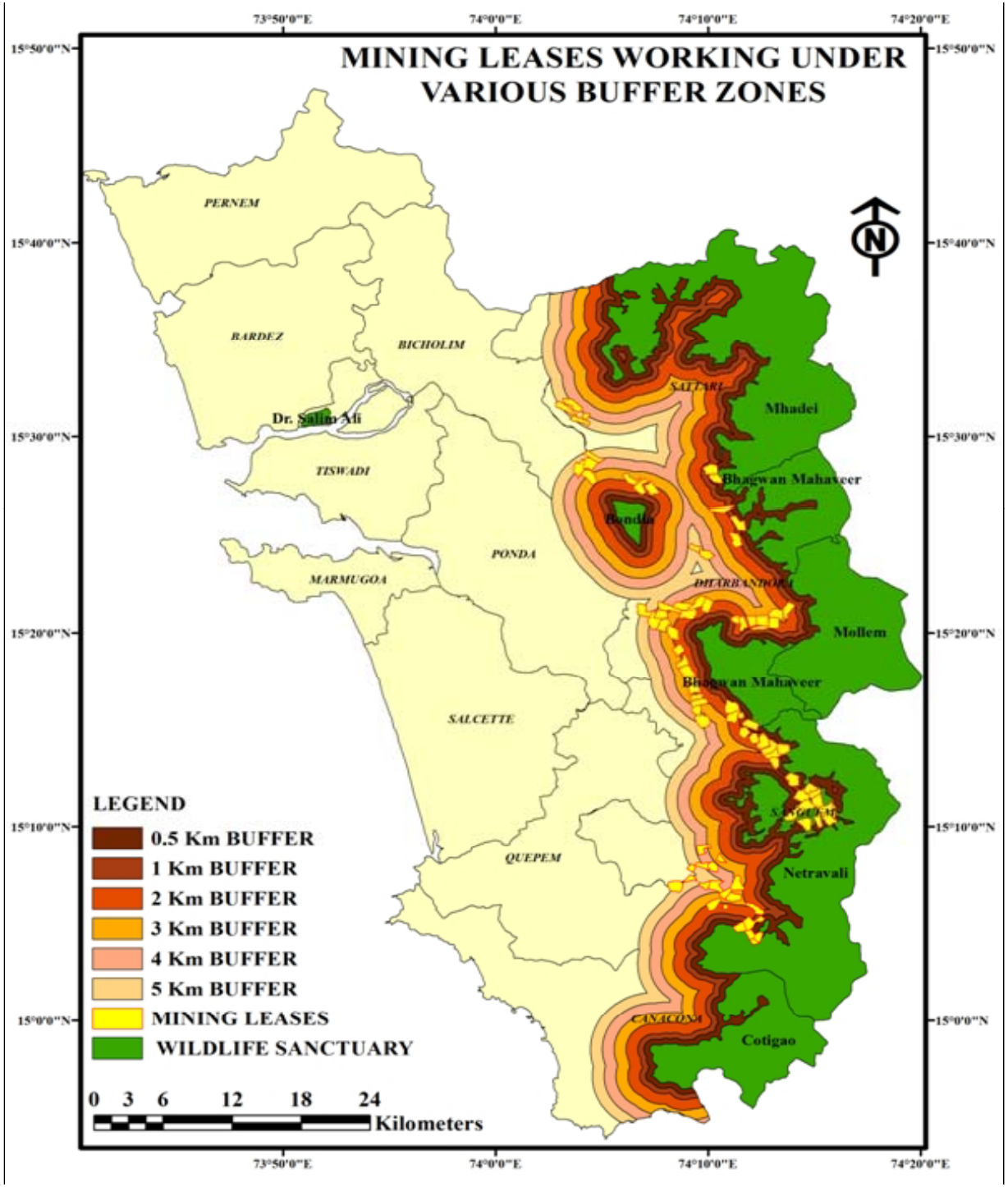
*Source : Guidelines by MoEF (F.No.1-9/2007 WL-I (pt) dated 9th February 2011)*

# Eco-sensitive Zone



# Buffer Zones along the Wildlife Sanctuaries with Existing Mining Leases




MINING LEASES WORKING UNDER VARIOUS BUFFER ZONES
73°50'0"E
74°0'0"E
74°10'0"E
74°20'0"E
15°50'0"N
15°40'0"N
15°30'0"N
15°20'0"N
15°10'0"N
15°0'0"N
PERNEM
BARDEZ
BICHOLIM
TISWADI
PONDA
MARMUGOA
SALCETTE
QUEPEM
SATTARI
DHARBANDORA
SANGUEM
CANACONA
Dr. Salim Ali
Bondla
Mhadei
Bhagwan Mahaveer
Mollem
Bhagwan Mahaveer
Netravali
Cotigao
N
LEGEND
0.5 Km BUFFER
1 Km BUFFER
2 Km BUFFER
3 Km BUFFER
4 Km BUFFER
5 Km BUFFER
MINING LEASES
WILDLIFE SANCTUARY
0 3 6 12 18 24
Kilometers

# Need of Infrastructural based Capping

- Major Source of air pollution is identified as ore transportation activity

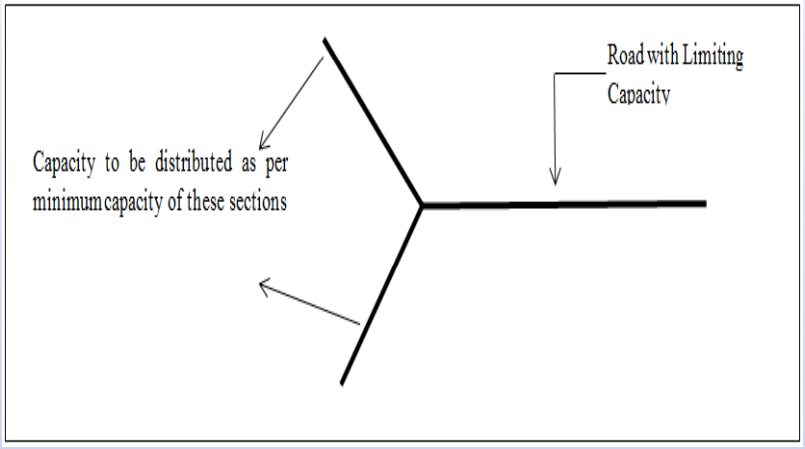
- This is primarily due to huge congestion owing to interference of ore transport route with that of public transport

- Thus, there is a need of capping of ore transportation of iron ore.

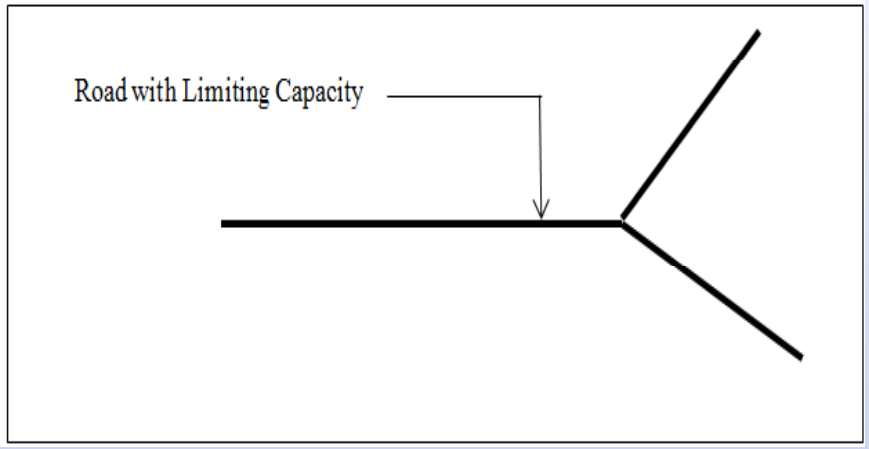
# Major Routes

1. Adawlpale to Sirsai Jetty
2. Shrigao to Sirsai Jetty
3. Shrigao to Kalvim Jetty
4. Dahbdhaba to Sarmanas Jetty
5. Sonshi to Amona Jetty
6. Sanquelim to Amona Jetty
7. Honda to Navelim(Maina)
8. Sonshi to Khazan Jetty (Vagus)
9. Ambesi to Cotambi Jetty
10. Digneum to Surla Jetty
11. Codli to Amona Jetty
12. Codli to Capxem Jetty
13. Shigao to Capxem Jetty
14. Costi to Sanvordem Jetty
15. Collem to Amona Jetty
16. Tollem to Shelvona Jetty
17. Sulcorna to Shelvona Jetty
18. Maina to Shelvona Jetty

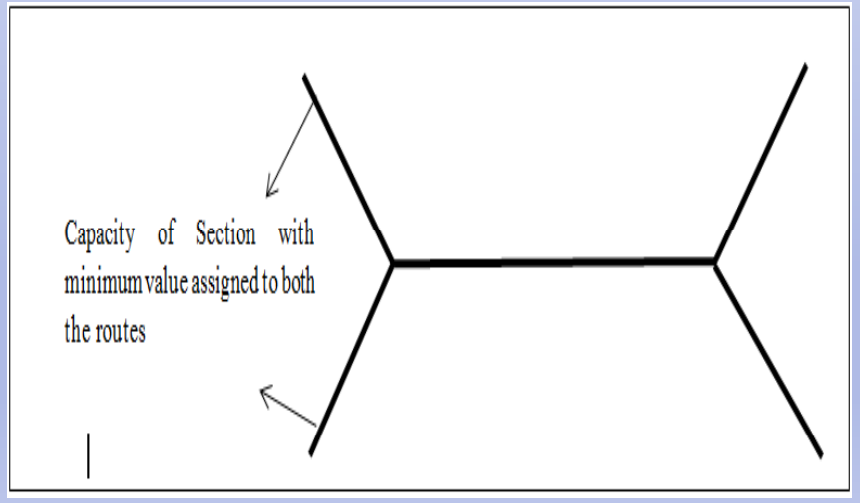
# Methodology for Assigning Capacity of Ore Transportation



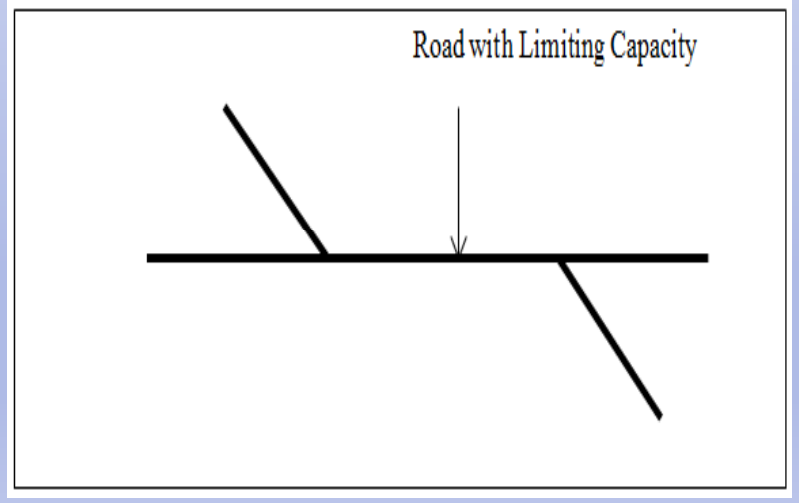

**Routes that Meets at Junction and Coalesce**




**Route that Bifurcate at Common Junction**

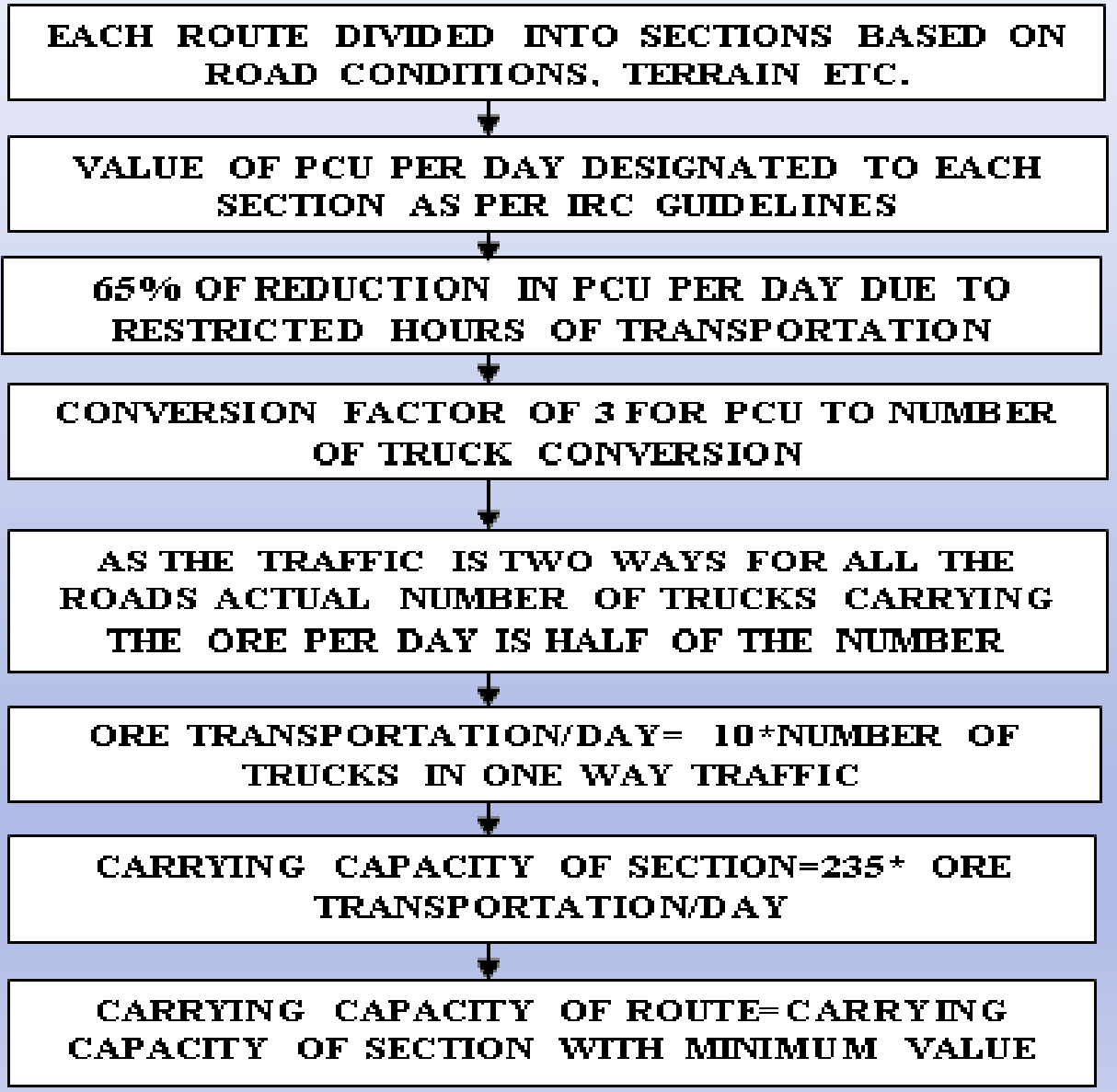



**Routes that Meets at Junction and Bifurcates**

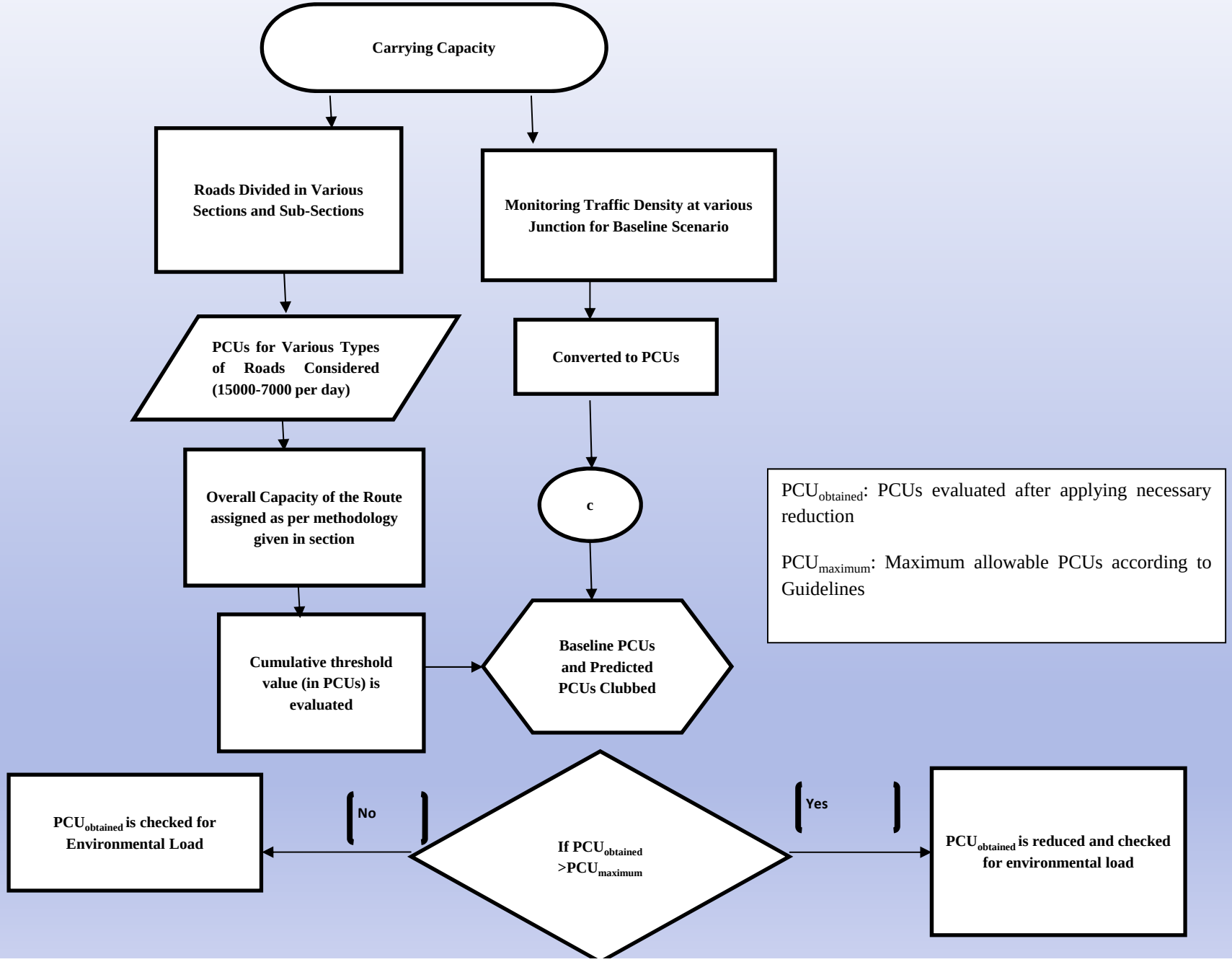



**Auxiliary Routes Meeting a Common Main Route**

# Algorithm for evaluation of Capacity of Ore Transportation



# Determination of Carrying Capacity of the Ore Transportation Routes

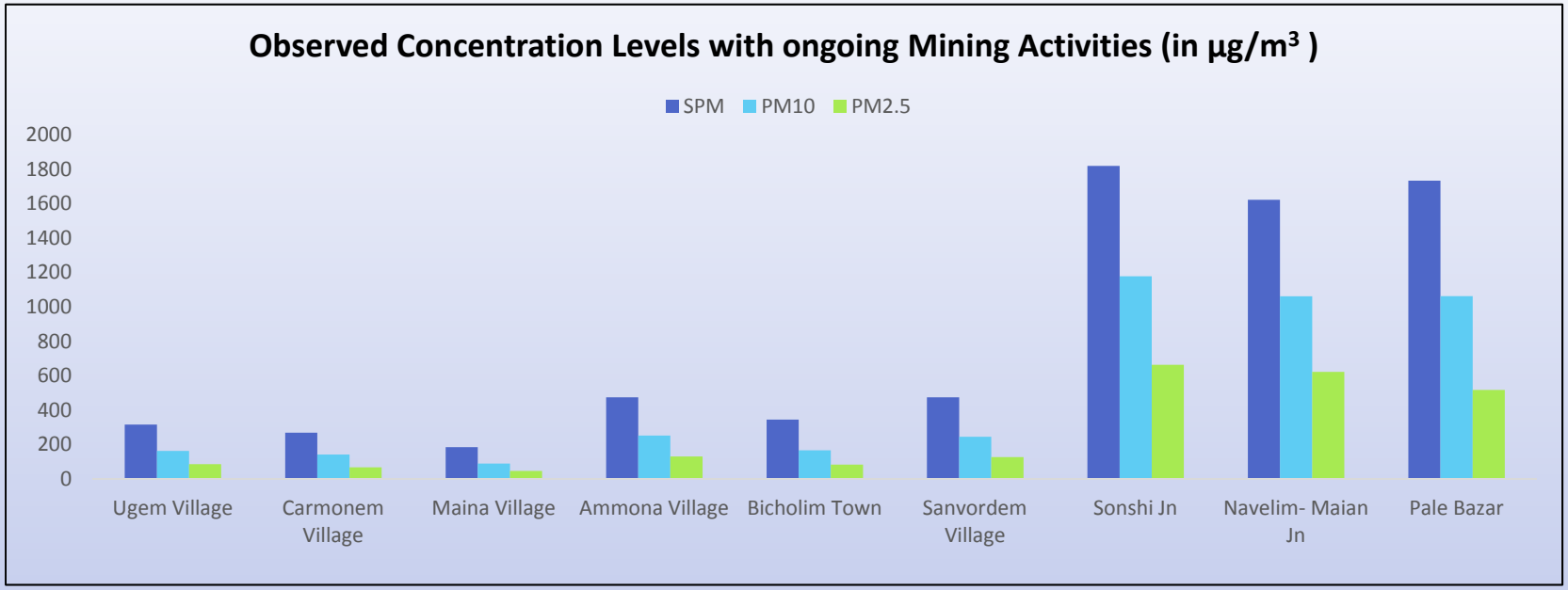


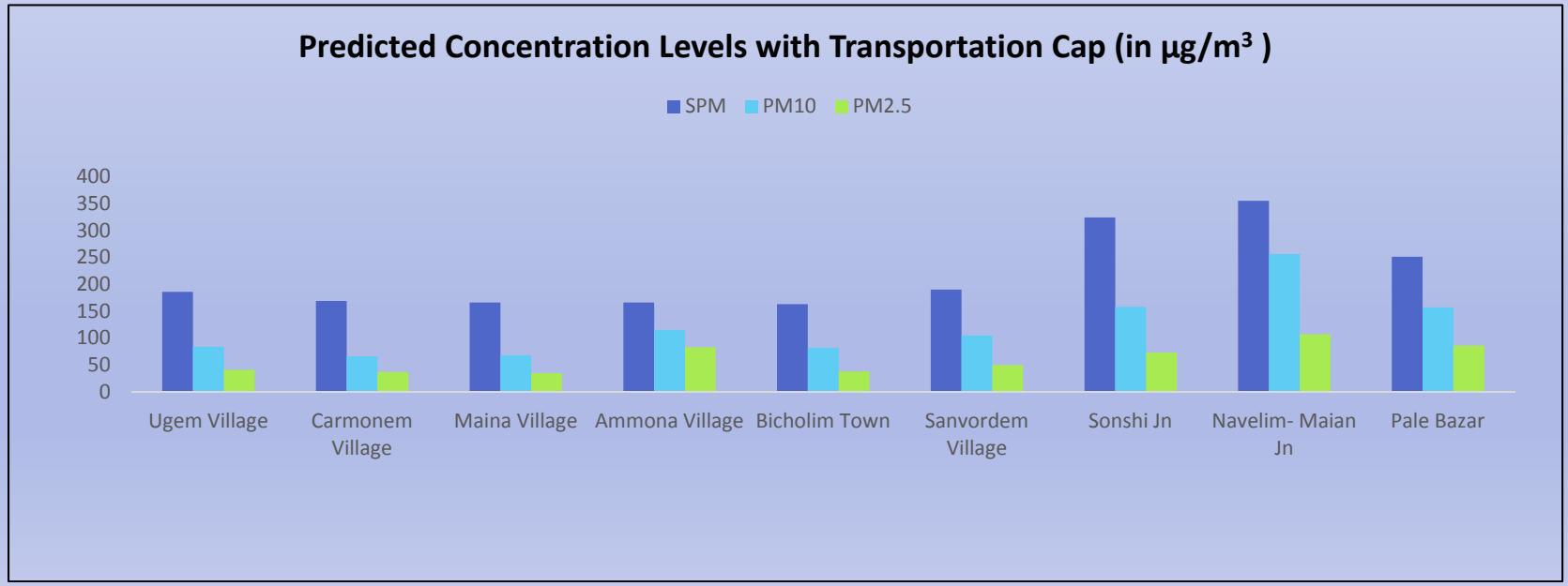
**Traffic Monitoring and Evaluation of Road Condition**

# Traffic Monitoring Data (in PCU) during Ongoing Mining and Baseline Scenario

| Routes | Allowed Design PCU (as per IRC) | Car PCU | | Two wheeler PCU | | Heavy vehicle PCU | |
|---|---|---|---|---|---|---|---|
| | | Ongoing | Baseline | Ongoing | Baseline | Ongoing | Baseline |
| Adawlpale to Sirsai Jetty (5.5 km) | 1200 /hour | 2434 | 3552 | 1823 | 2216 | 2758 | 1311 |
| Shrigao to Sirsai Jetty (6.8 km) | 11000 /day | 2756 | 3212 | 1564 | 3016 | 2313 | 1419 |
| Shrigao to Kalvim Jetty (4.2 km) | 10000 /day | 68 | 4 | 132 | 6 | 340 | 18 |
| Dahbdhaba to Sarmanas Jetty (2.7 km) | 1200 /hour | 1432 | 1882 | 1212 | 1616 | 1613 | 549 |
| Sonshi to Amona Jetty (11.2 km) | 1200 /hour | 256 | 351 | 288 | 371 | 1804 | 315 |
| Sanquelim to Amona Jetty (7.6 km) | 1200 /hour | 1887 | 2889 | 1956 | 2062 | 3308 | 1989 |
| Honda to Navelim (Maina) (13.7 km) | 1200 /hour | 1543 | 1918 | 911 | 1062 | 2124 | 762 |
| Sonshi to Khazan Jetty (13.8 km) | 1200 /hour | 776 | 1021 | 231 | 561 | 1458 | 564 |
| Ambesi to Cotambi Jetty (6 km) | 1200 /hour | 598 | 1087 | 677 | 1006 | 1942 | 495 |
| Digneum to Surla Jetty (5.8 km) | 1200 /hour | 342 | 351 | 112 | 356 | 1129 | 150 |
| Codli to Amona Jetty (29.8 km) | 11000 /day | 1988 | 2034 | 2012 | 2766 | 3667 | 1710 |
| Codli to Capxem Jetty (12 km) | 15000 /day | 1854 | 1992 | 1665 | 1744 | 2700 | 1296 |
| Shigao to Capxem Jetty (18.9 km) | 10000 /day | 63 | 0 | 102 | 0 | 468 | 0 |
| Costi to Sanvordem Jetty (11.5 km) | 11000 /day | 473 | 546 | 438 | 566 | 2435 | 903 |
| Collem to Amona Jetty (38.8 km) | 1200 /hour | 1357 | 1512 | 1232 | 1404 | 2327 | 540 |
| Tollem to Shelvona Jetty (18.9 km) | 11000 /day | 1003 | 1123 | 1521 | 1404 | 1597 | 363 |
| Sulcorna to Shelvona Jetty (28.6 km) | 11000 /day | 697 | 877 | 1021 | 984 | 1537 | 303 |
| Maina to Shelvona Jetty (15.3 km) | 10000 /day | 756 | 895 | 665 | 877 | 1460 | 354 |

| Cluster | Routes | Capacity after proposed Capping with 65% Restricted Hours(MTPA) | Capacity of the Cluster |
|---|---|---|---|
| Adwalpale-Bicholim | Adawlpale to Sirsai Jetty | 0.81 | |
| | Shrigao to Sirsai Jetty | 1.26 | |
| | Shrigao to Kalvim Jetty | 1.16 | |
| | Dahbdhaba to Sarmanas Jetty | 2.645 | 5.785 |
| | Sonshi to Amona Jetty | 2.11 | |
| | Sanquelim to Amona Jetty | 0.52 | |
| Velguem-Pissurlem | Honda to Navelim(Maina) | 1.32 | |
| | Sonshi to Khazan Jetty | 1.32 | |
| | Ambesi to Cotambi Jetty | 1.29 | |
| | Digneum to Surla Jetty | 1.34 | 7.9 |
| Codli- Costi | Codli to Amona Jetty | 1.94 | |
| | Codli to Capxem Jetty | 1.24 | |
| | Costi to Sanvordem | 1.51 | 4.69 |
| Collem | Collem to Amona Jetty | 1.94 | |
| | Shigao to Capxem Jetty | 0.82 | 2.76 |
| Tollem | Tollem to Shelvona Jetty | 1.71 | 1.71 |
| Maina-Sulcorna | Sulcorna to Shelvona Jetty | 1.02 | |
| | Maina to Shelvona | 1.04 | 2.06 |
| Total of all Cluster | | 24.995 | 24.995 |


Observed Concentration Levels with ongoing Mining Activities (in µg/m³ )
SPM
PM10
PM2.5
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Ugem Village
Carmonem Village
Maina Village
Ammona Village
Bicholim Town
Sanvordem Village
Sonshi Jn
Navelim- Maian Jn
Pale Bazar


Predicted Concentration Levels with Transportation Cap (in µg/m³ )
SPM
PM10
PM2.5
400
350
300
250
200
150
100
50
0
Ugem Village
Carmonem Village
Maina Village
Ammona Village
Bicholim Town
Sanvordem Village
Sonshi Jn
Navelim- Maian Jn
Pale Bazar

## NAAQS Independent AQI of SPM at various Ore Transportation Locations and Hot Spots for Present and Predicted Future Scenario

| Station Code | Station Name | AQI with ongoing Mining Activity | AQI after Transportation Cap |
|---|---|---|---|
| A1 | Ugeum Village | 105 | 65 |
| A6 | Carmonem Village | 94 | 56 |
| A8 | Maina Village | 68 | 57 |
| A25 | Amona Village | 149 | 81 |
| A27 | Bicholim Town | 106 | 64 |
| A33 | Sanvordem Village | 146 | 76 |
| HS | Sonshi Jn | 1074 | 102 |
| HS | Navelim Maina Jn | 957 | 147 |
| HS | Pale Bazar | 958 | 102 |

# Proposed Dedicated Transport Corridors

## I. Bypass the Curchorem town and the Curchorem-Tilamol Road

**PhaseI:**
**Uguem to Guddemol**

**Phase II:**
**Guddemol to the Capxem jetties**

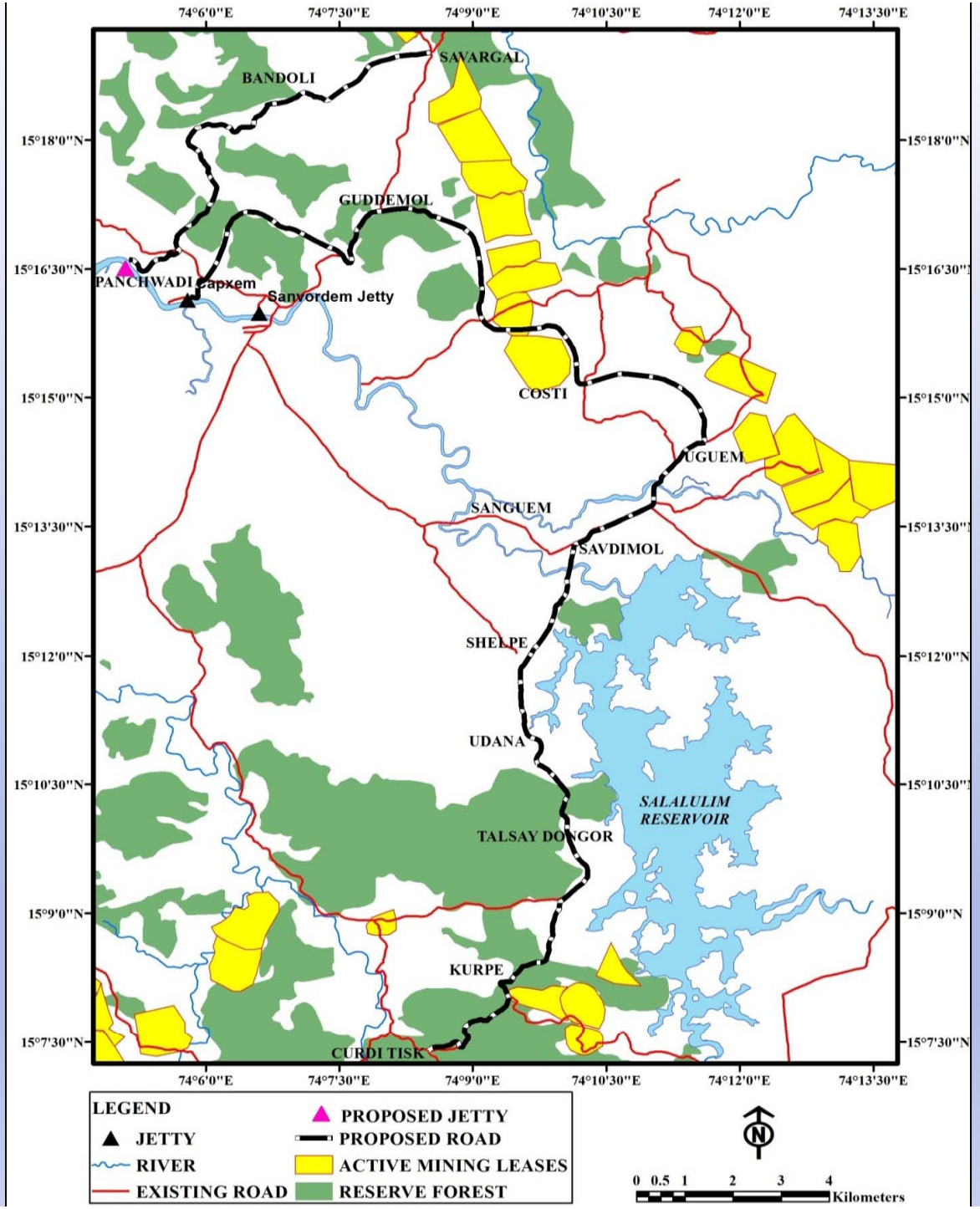
**Phase III:**
**Cudri tisk to Uguem.**

## II. Codli Panchwadi Road

**Bifurcation from SH7**

**Bifurcates at Savaragal to Bandoli**

**Bandoli to Panchwadi**

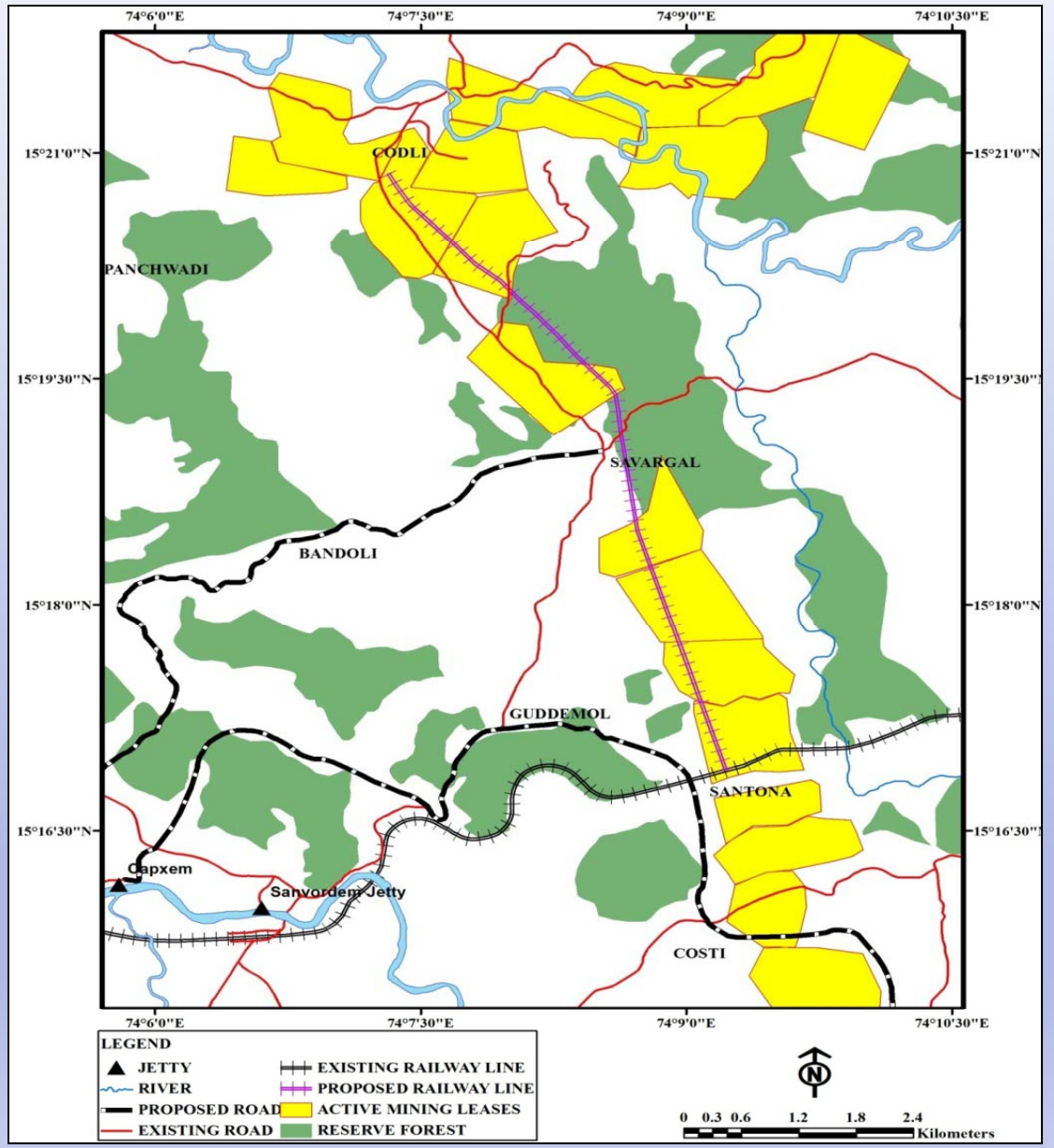

74°6'0"E
74°7'30"E
74°9'0"E
74°10'30"E
74°12'0"E
74°13'30"E
15°18'0"N
15°16'30"N
15°15'0"N
15°13'30"N
15°12'0"N
15°10'30"N
15°9'0"N
15°7'30"N
BANDOLI
SAVARGAL
GUDDEMOL
PANCHWADI Capxem
Sanvordem Jetty
COSTI
UGUEM
SANGUEM
SAVDIMOL
SHELPE
UDANA
SALALULIM RESERVOIR
TALSAY DONGOR
KURPE
CURDI TISK
LEGEND
JETTY
RIVER
EXISTING ROAD
PROPOSED JETTY
PROPOSED ROAD
ACTIVE MINING LEASES
RESERVE FOREST
N
0 0.5 1 2 3 4
Kilometers

# Proposed Railway Route

Codli cluster accounts about 30 % of the total iron ore production in Goa.

Railways can prove to be a good alternative

Railway route can be from Codli to Santona

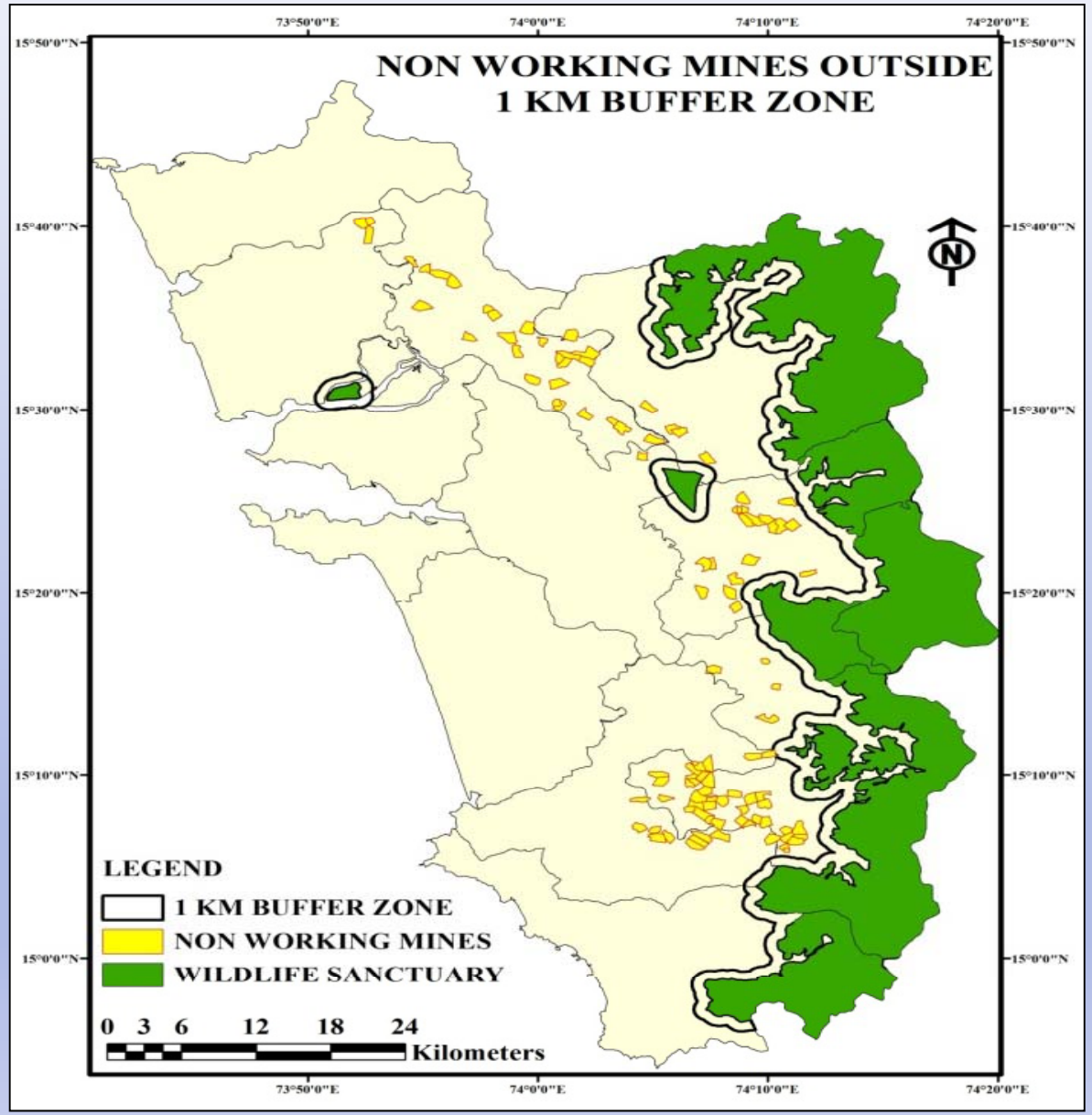


# Exploring Resources

- The mineral reserve should be exploited scientifically and consumed/processed in a way where they are utilized fully.
- Scientific Exploration both vertically and horizontally employing advanced geophysical techniques should be carried out to assess the exact quantity of the exploitable resources.
- Extraction of mineral resources located through exploration and prospecting has to be maximized through applying advanced scientific methods of mining, beneficiation and economic utilization.
- Exploration, extraction, processing and export activities create wealth contributing to sustainable development.

| Year | Reserves in Goa (MT) | Reserves in India (MT) |
|---|---|---|
| 1975 | 355.9 | 12667 |
| 2000 | 857.67 | 22108 |
| 2005 | 927.12 | 25249.87 |
| 2010 | 1,149.84 | 28526.16 |

# Alternatives for Socio-Economic Impact due to Closure of Mines



# SOME EXAMPLES OF SUSTAINABLE PRACTICES

# Surface Water Quality Management

**Retaining Wall at the Toe of the Dump**

**Parapet Wall Constructed Along the Toe of the Dump**

**Parapet Wall Constructed Along the Toe of the Dump**

## Check Dams

## Garland Drains

# Air Quality Management


WATER TANKER FOR MINE HAULAGE ROAD DUST SUPRESSION

DRILLING MACHINE EQUIPPED WITH WET DRILLING PROVISION

FIXED AUTO SPRINKLERS FOR MINERAL DISPATCH ROADS

TRUCKS COVERED WITH TARPLUINS

# Improving Environmental Conditions

Increased awareness on the part of mine owners, managers/staff, and consultants on the principles of sustainable and scientific mining.

Many lessees have undertaken intensive exploration activity.

Quality of mine planning has improved significantly.

Much better understanding of dump planning and surface water management

Since all activities are to be located within the lease area, better land use planning has come under focus; in some cases, lessees are exploring options of backfilling.

Most of the sub-grade ore is now being utilized, either through beneficiation or blending, thus leading to superior mineral conservation and minimizing old ‘dumps’.

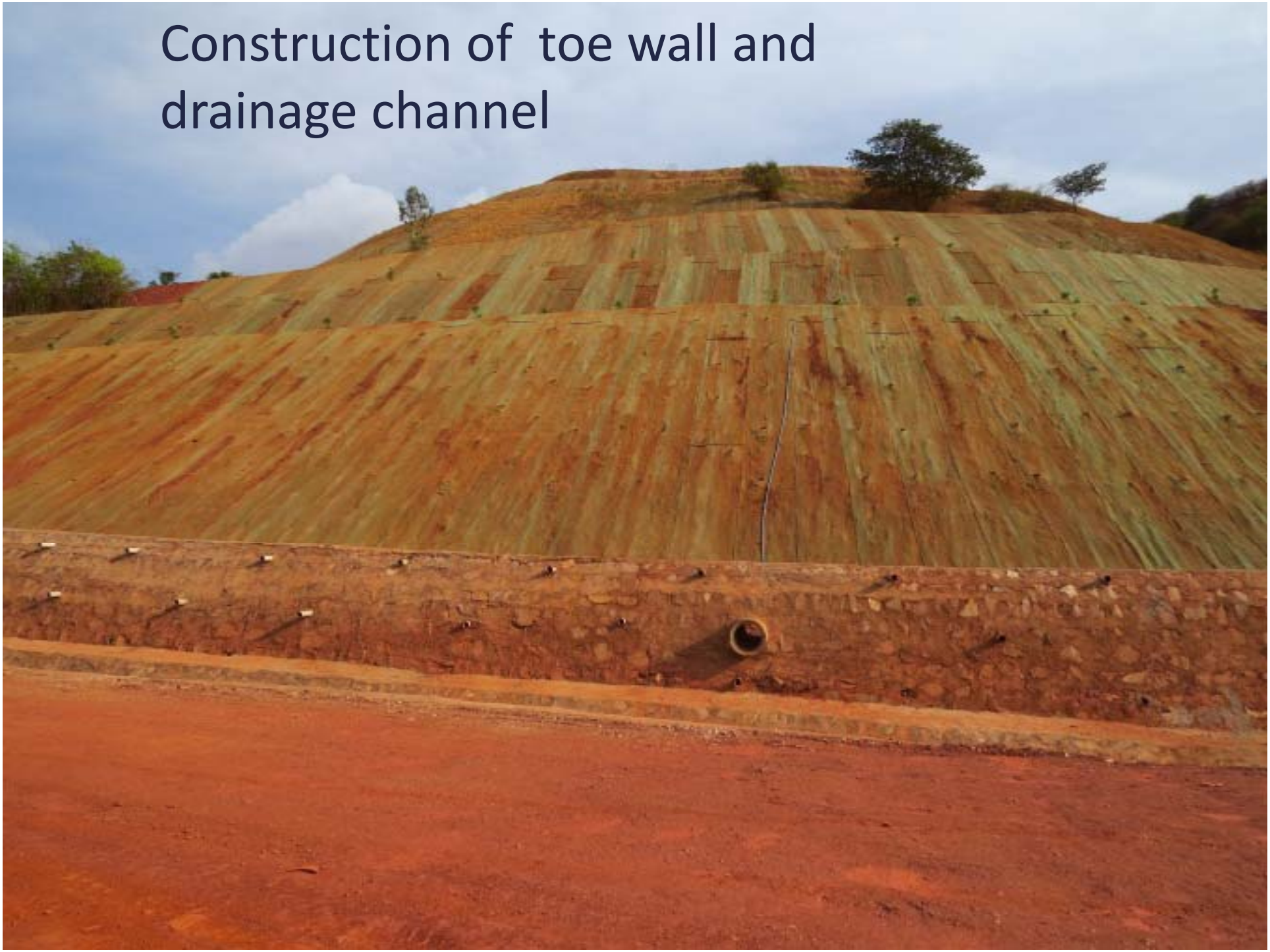
Better planning of roads and transport infrastructure; many railway sidings and rail lines are being planned; existing roads are being widened/improved; improved maintenance of roads.

Increased focus on complying with conditions stipulated in the statutory approvals.


27.08.2012

# After Terracing

# Construction of  toe wall and drainage channel



# After Geo green blanket

# After Geo green blanket

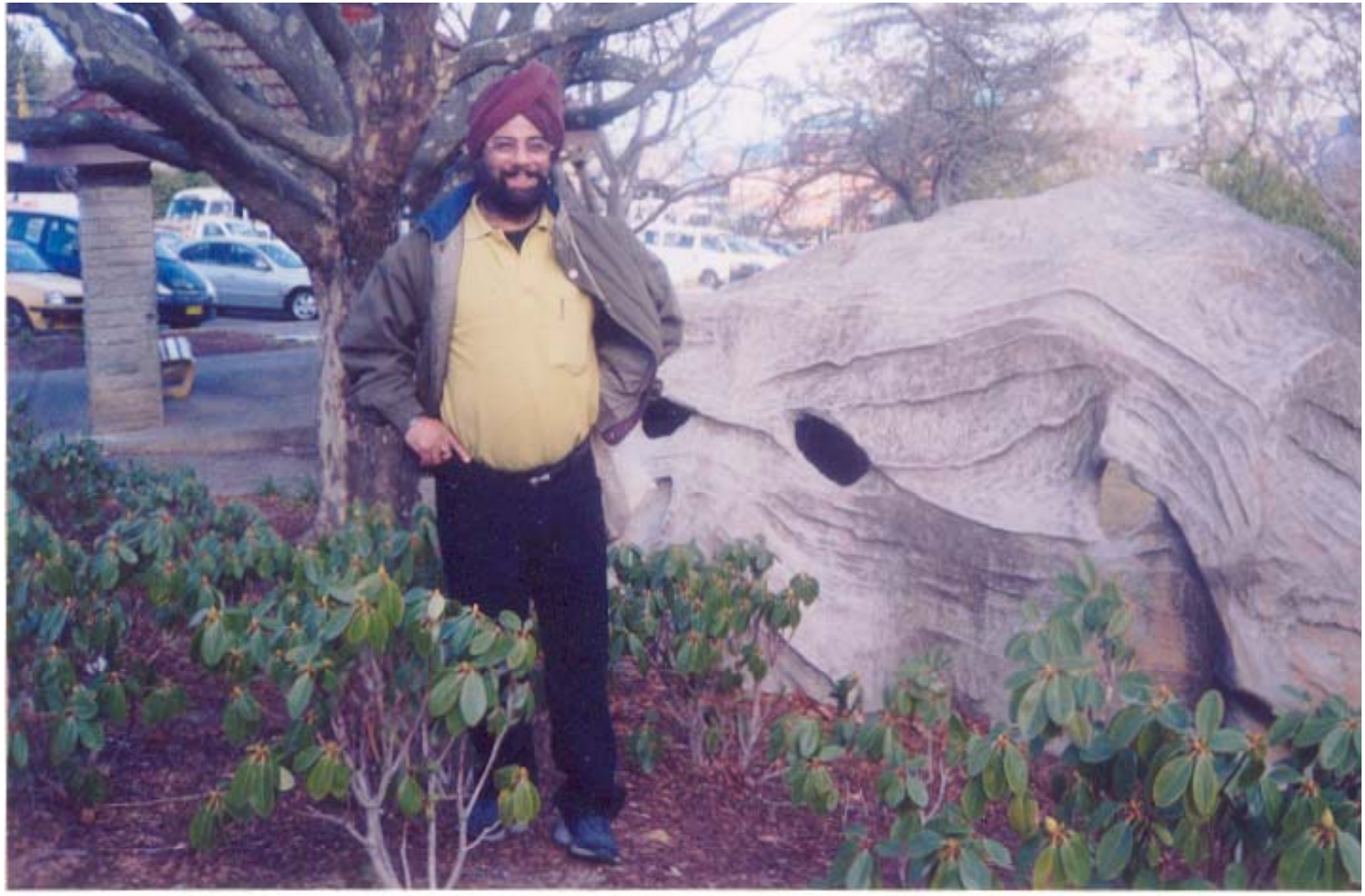
# Growth after Geo green blanket

# Rehabilitated Dump

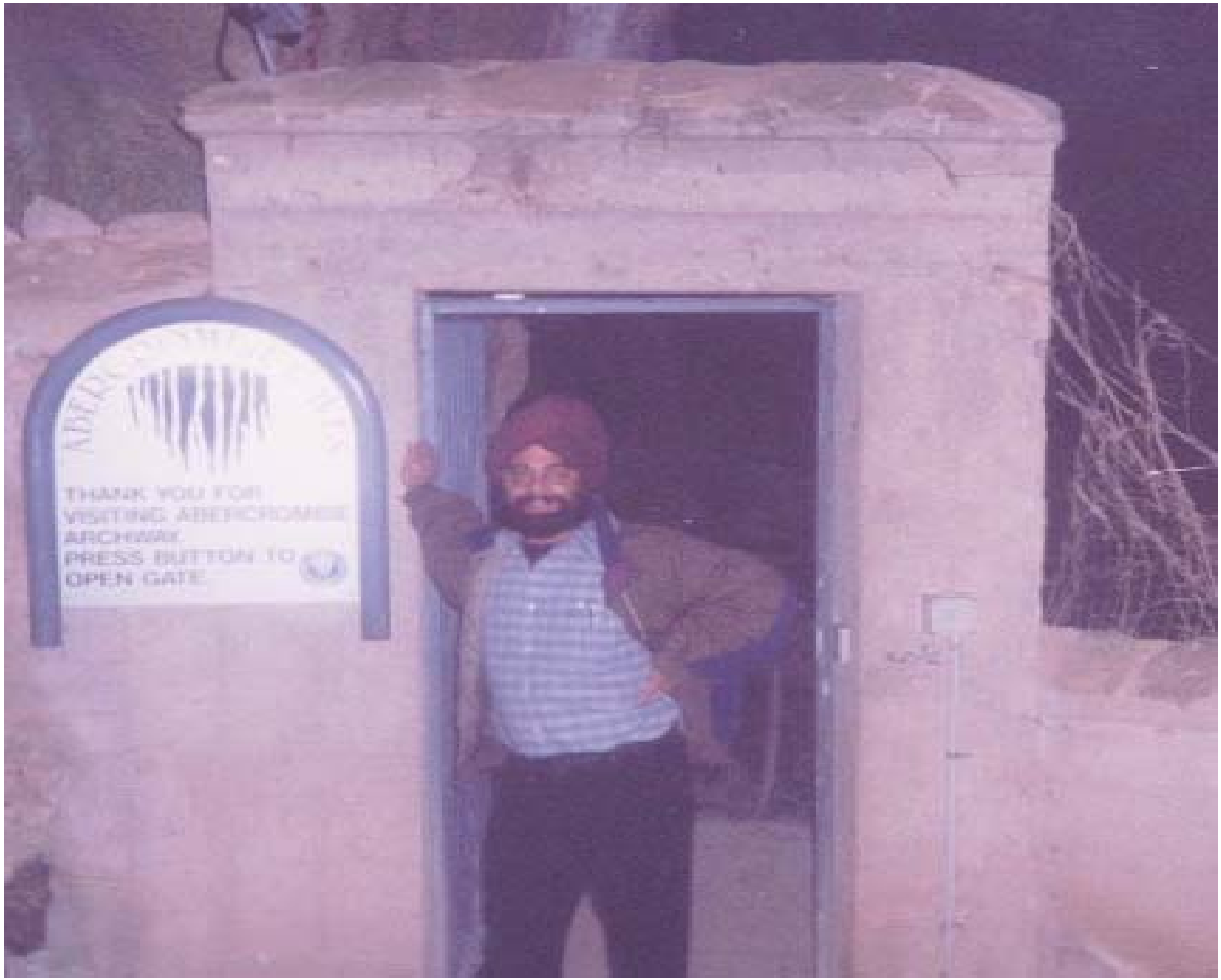
# Far-off from forest area: alternative- Eco-park

**Cadia Closed Mine**

# Utilization/Rehabilitation of worked out mine space



# CAVES BUILT IN LIMESTONE MINE



# Photograph showing Barlett Illinois limestone quarry site after mine closure.

Bluff City Sand and Gravel Pit
Bartlett, Illinois

Herons Landing
Bartlett, Illinois


Pratts Wayne Woods Forest Preserve
Bartlett, Illinois

# View of Horticulture Plant Garden At A. Narrain Mines

# NEED BASED PLANTATION

Productivity (Vegetables) at Reclaimed Mine Sites

**Thank You!!**