Assessment of Uncertainties in Activity Data and Emission Factors for Indian Emission Inventories

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Uncertainty and Validation of Emission Inventories

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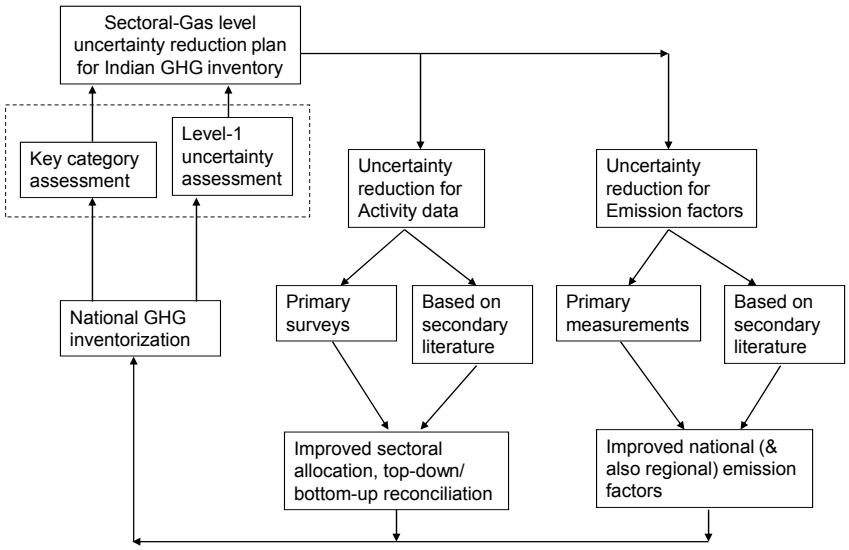
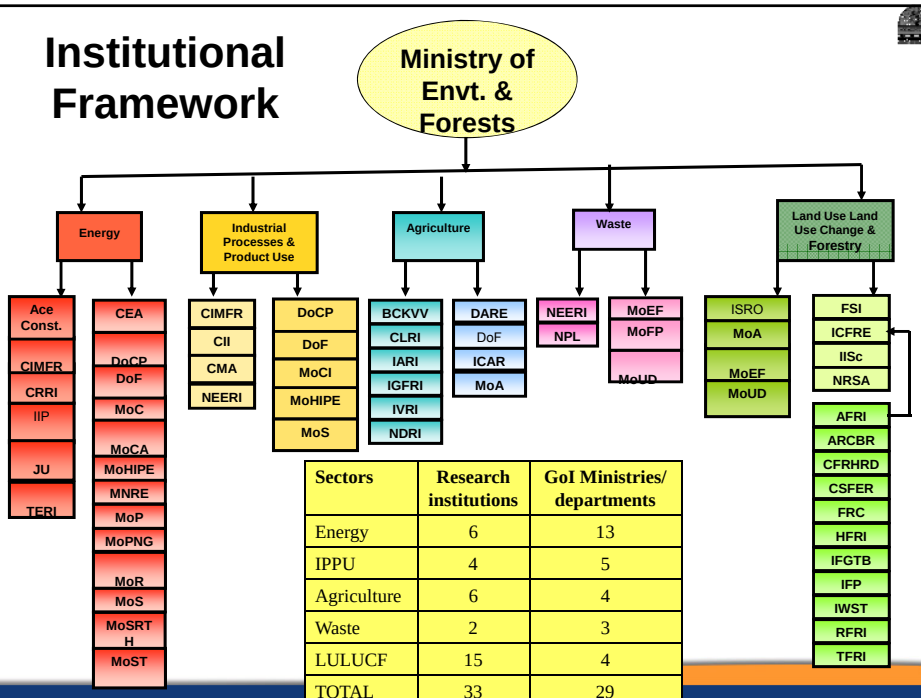
Some slides are courtesy India's National Communication Project

Assessment & Institutional Frameworks

Assessment & Improvement Framework



Institutional Framework



Sectors	Research institutions	GoI Ministries/ departments
Energy	6	13
IPPU	4	5
Agriculture	6	4
Waste	2	3
LULUCF	15	4
TOTAL	33	29

Key Category Analysis

Key Category Analysis of 1994 GHG Inventory

(CS: Country Specific EF, D: IPCC default EF, R: Improvement Required)

Sources of emission	CO2 equivalent (Gg)	% of total emissions	Cumulative emission (Gg)	Cumulative emissions (%)	Tier used	EF used	Current status of EF
Energy and transformation industries	355037	28.9	355037	28.9	II	CS	R
Enteric Fermentation	188412	15.3	543449	44.2	II	CS	R
Industry	150674	12.3	694123	56.5	I	D	D
Rice Cultivation	85890	7	780013	63.5	II	CS	R
Transport	80286	6.5	860299	70	I	CS	R
Emission from Soils	45260	3.7	905559	73.7	I	D	CS
Iron and steel	44445	3.6	950004	77.3	I	D	CS
Energy in Residential	43918	3.6	993922	80.9	I	D	D
Biomass for energy	34976	2.8	1028898	83.7	I	D	D
All other energy sectors	32087	2.6	1060985	86.3	I	D	D
Cement production	30767	2.5	1091752	88.8	I	CS	R
Energy consumed in Commercial/institutional	20571	1.7	1112323	90.5	I	D	D
Manure Management	20176	1.6	1132499	92.1	I	D	D
Ammonia production	14395	1.2	1146894	93.3	I	D	CS
Coal mining	13650	1.1	1174836	94.4	III	CS	CS

Non-key Category Analysis of 1994 GHG Inventory

(CS: Country Specific EF, D: IPCC default EF, R: Improvement Required)

Sources of emission	CO2 equivalent (Gg)	% of total emissions	Cumulative emission (Gg)	Cumulative emissions (%)	Tier used	EF used	Current status of EF
Oil and natural gas system	12621	1	1187457	95.4	I	D	D
MSW Disposal	12222	1	1199679	96.4	I	D	CS
Domestic Waste water	7539	0.6	1207218	97	I	D	D
Lime stone and dolomite use	5751	0.5	1212969	97.5	I	D	D
Agricultural crop residue	4747	0.4	1217716	97.9	I	D	D
Nitric acid production	2790	0.2	1220506	98.1	II	CS	CS
Human Sewage	2170	0.2	1222676	98.3	I	D	D
Lime production	1901	0.2	1224577	98.5	I	D	D
Industrial Waste Water	1302	0.1	1225879	98.6	I	D	CS
Ferro alloys production	1295	0.1	1227174	98.7	I	D	D
Aluminium production	749	0.1	1227923	98.8	I	D	D
Carbide production	302	0.03	1228225	98.8	I	D	D
Soda ash use	273	0.03	1228498	98.8	I	D	D
Black carbon and styrene pro.	42	0.004	1228540	98.8	I	D	D

Learnings, Transitions and Challenges

Learnings

- Inventory uncertainties and validation need to capture national circumstances and dynamics
- Coal
  - High ash, low sulfur
  - High variability in coal grades
  - Need for wider measurements for coal NCV, CEF, coal mix
- Enteric fermentation
  - Small cattle size (body weight)
  - Conventional feed
  - Sub sustenance nature (mitigation implications)
- Vast unorganized sector
  - Activity data uncertainty is large, especially on energy consumption
  - Biomass use is highly uncertain – both for AD and EF

Indian Transitions

- Share of imported coal rising
  - Weighted average NCV and Sulfur contents rising
- Buffalo population rising
  - Higher milk yield, higher emissions
- Share of deeper coal mining likely to increase in coming decade
  - Surface coal mining reaching saturation
  - Higher methane emissions
- Transportation mix changing
  - Faster towards road dominance
  - More fuel efficient vehicles
  - Many more being added every year
- Private power back up systems on the rise
  - Private cost of public failure
  - More diesel diversion from road (allocation issue?)

Indian Transitions

- Cement industry becoming cleaner
  - Consolidation, international players increasing their share
  - State of the art technology, share of dry production increasing
- Technology transitions in all sectors
  - Enhancing weighted average emission factors in all sectors of economy
  - Need for more frequent CS EF estimation
- Municipal solid waste
  - More composting (methane reduces)
  - More collection in cities (methane increases)
- Unorganized sector
- Energy & transformation industries
- Urbanization
- Land use: satellite imagery and ground-truthing validation
- Continuous emission monitoring started for a few coal-based power plants

Challenges

- Regular reporting
  - Every two years?
  - NC or NIR?
- National systems
  - Technical capacity exists, but are activated only from NC to NC
  - Systems need to be created – legal, networking, institutional coordination
- Many sectoral stocks are changing very fast
  - New plants are almost best available technology (reducing weighted national emission factor)
  - Need for more frequent measurements and reporting
- Linking local and global emission data and systems
- Indian (South Asian) Emission Factor Data Base
  - Many similarities in the region
  - Robust scientific systems and institutions exist in India

Some Studies Undertaken

Examples: Activity Data Uncertainty Reduction

Sectors	Energy & transformation	Industrial processes	Agriculture
Initial National Communication (INC): Primary survey	3 Power plants, 1 steel plant	Nitric acid production	Rice, Dairy cattle, Agri soils, Crop residue burning
Initial National Communication (INC): Secondary literature	Road vehicles, cement plants	50% cement plants	
Second National Communication (SNC): Primary survey	Fuels in road	Ammonia production	Rice, Livestock Species wise EFs
Second National Communication (SNC): Secondary literature		90% cement plants	

Examples: Emission Factor Uncertainty Reduction

Sectors	Energy & transformation	Industrial processes	Agriculture	Waste
Initial National Communication (INC): Primary survey	Coals, Power/ cement/ steel plants, some road vehicles, mining	Cement, nitric acid	In-situ measurements	1 MSW site
Initial National Communication (INC): Secondary literature	Road vehicles		Cattle CH4	National
Second National Communication (SNC): Primary survey	Coal, power plants, Mining			More MSW sites
Second National Communication (SNC): Secondary literature				National

Improvements in SNC (Energy)

- Coal NCV:
  - INC: Type of coal NCV measurements, mean and variability (non-coking, lignite and coking)
  - SNC: Grade wise estimation of NCVs of Indian coal types
- On line measurement of CO2 emission factors from power plants
  - INC: coal based NCVs used to estimate the CO2 emissions from power plants
  - SNC: continuous monitoring of CO2 emissions at a few plants
- Allocation of petroleum, diesel and fuel oil consumptions across different vehicle types
  - INC: the base year was 1994
  - SNC: the base year is 2000, the update captures the change in consumption pattern in this sector keeping in line with the 3-4 fold increase in cars during this period
- Assessment of diesel based generators in towns where outages in electricity is substantial (Lucknow & Gurgaon)
  - INC: not done
  - SNC: case studies help to quantify diesel oil used for power generation in domestic and residential sector and improves fuel allocation in the transport sector

Improvements in SNC (Energy)

- Assessment of activity data related to cement plants (98% large plants, all medium plants, and 88% of small scale plants)
  -INC: Activity data collected only for large plants
  - SNC: Activity data extended to all plant types (98% coverage)
- Assessment of leakages of CH4 due to transportation and storage of oil and natural gas
  - INC: used IPCC default values
  - SNC: Country specific values being developed
- Determination of plant specific emission factors for steel plants (fossil fuel)
  -INC: one integrated steel palnt
  -SNC: extended to an additional plant, thereby increasimg the robustness of emission factors
- CO2, CH4 and NOx emission from road transport sector (on KVT basis)
  - INC: based on a small stock of vehicles on road
  - SNC: extended to new stock as available in 2000
- Updating CH4 emission from coal mining
  - covered underground and open cast mining
  - updated emission measurements for the same mines

Improvements in SNC (Energy & IPPU)

- Estimating CO2 emission from ammonia production
  - INC: captured N2O emission from HNO3 prod
  - Ammonia has been identified as one of the
- Estimating CO2 emission factors for fuel & process from sample steel plants
  - INC: carried out in one plant
  - SNC: extended to an integrated steel plant
- Bridging activity data gaps with respect to INC by including energy categories not covered
  - agriculture (crops/fishing)
  - transportation (others)
- Bridging activity data gaps in IPPU sector
  - INC: covered metals, minerals, chemicals
  - SNC: covers solvent use, electronic industries (to the extent data is available)

Improvements in SNC (Agriculture)

- Updating CH4 emission from continuously flooded fields
  - INC: covered all water management categories with sample measurements
  - SNC: focused on measuring from continuously flooded fields in eastern part of India, that are the key sources within this category
- Estimating CH4 emission factors for key dairy cattle species in India
  - INC: lab base measurement using SF6 technique of available dairy cattle (both indigenous & cross bred)
  - SNC: three institutes across regions measuring CH4 ef from indigenous dairy specific to the region they are located
- Estimating CH4 EFs with variations in feed intakes simulating actual feeds of typical Indian dairy cattle
  - INC: did not have this
  - SNC: Since its not possible to cover all indigenous cattle species in the country, the feed intake for distinctive feed types across different agro-ecological zones have been simulated (14 such simulations done)
- Strengthening sub-regional estimates of CH4 EF and activity data for cattle typical to that region (Tamilnadu to be specific)
  - INC did not conduct any such studies
  - SNC: Tamilnadu included to capture for the first time the state wise diversity

Improvements in SNC (Agriculture & Waste)

- Estimating N2O from different agricultural soil types in India
  - INC: covered only Punjab and Uttarpradesh
  - SNC: measurements have been extended to the eastern part of the country thereby including different soil type
- Updating data for estimating CH4 emission factors from waste water in industries
  - INC: Limited industries included in INC
  - SNC: Industries such as paper & food processing included
- Measuring CH4 emission factors from MSW in metro cities in India (Delhi, Kolkata, Chennai & Mumbai)
  - INC: Based on survey of MSW generation & disposal in class A, B & C cities
  - SNC: Actual CH4 emission measurements being undertaken on site where MSW is generated in largest quantities in India

A.D. Improvements in LULUCF

- Estimating soil C for Indian forests (across 800 data points)
  - INC: only literature survey carried out
  - SNC: actual measurements being taken by 11 institutions for all soil types under forests in the country
  - Further, bridging data gaps in soil C data for Indian forests through literature survey
- Estimating stock change in C for other land uses
  - INC: Only changes from forest and vise a versa were included
  - SNC: collecting data for other land uses and their change from & to (grass land, crop land, wet lands, settlements, and other land)

Coal EF Measurements

Objective

- To characterize the Indian coals in terms of the relevant quality parameters with the objective of improving upon the reliability of carbon emission factor for Indian coals and also to provide a more reliable basis of the conversion factor (NCV/GCV).
- Estimation of CO2 emission from different type of coals
- Actual measurement of CO2 emission from power plant, CO_2, NO_x and SO_2 from steel and Cement plant

Emission Factors of Indian Non-coking Coal

Coking coal			
		Production (MT)	
Grade	Mean NCV	1994-95	1999-00
S1	29.28	0.391	0.224
S2	27.93	1.494	0.561
W1	27.03	2.359	1.357
W2	25.98	4.418	3.951
W3	24.7	11.139	9.084
W4	22.86	21.785	17.597
SC1	26.39	0.388	0.209
SC2	25.4	0	0
Estimated	NCV	24.13	24.06
	CEF	25.53	25.53
Default	NCV	19.98	
	CEF	25.8	

Emission Factors of Indian Coking Coal

Non coking coal			
		Production (MT)	
Grade	Mean NCV	1994-95	1999-00
A	25.66	2.779	3.817
B	23.85	21.985	20.838
C	22.36	47.219	47.601
D	20.37	36.708	39.421
E	18.44	35.974	56.156
F	16.26	64.801	98.643
G	13.9	0.679	0.298
Estimated	NCV	19.63	19.14
	CEF	26.13	26.19
Default	NCV	19.98	
	CEF	25.8	

Emission Factors of Indian Lignite

		Lignite
Estimated	NCV	9.69
	CEF	28.95
Default	NCV	9.8
	CEF	27.6

EF Measurement from Power Plant

Talcher STPS

	Direct	Calculated		Direct Measurement		From Fuel Quality	
	measurement	I	II	kg/kg of coal		kg/kg of coal	
	CO_2	CO_2	CO_2	CO_2	SO_2	CO_2	SO_2
	kg/kwh	kg/kwh	kg/kwh				
	0.907	0.996	1.242	1.376	0.0051	1.384	0.0065
	1.006	1.023	1.278	1.482	0.0065	1.488	0.0077
	0.928	1.023	1.266	1.380	0.0067	1.387	0.0075
	1.022	1.000	1.268	1.518	0.0046	1.523	0.0056
	0.968	1.038	1.284	1.420	0.0065	1.423	0.0075
	1.032	1.031	1.266	1.535	0.0068	1.541	0.0079
	0.897	1.103	1.372	1.231	0.0065	1.235	0.0074
	0.986	1.024	1.274	1.457	0.0053	1.460	0.0063
	0.920	1.024	1.274	1.360	0.0067	1.365	0.0078
Mean	0.963	1.029	1.281	1.418	0.006	1.423	0.007
Std dev	0.052	0.031	0.036	0.094	0.001	0.094	0.001
Default	NCV	19.98					
	CEF	25.8					
Method I	Calculated Using actual CEF						
Method II	Calculated Using default CEF						

EF Measurement from Cement Plant

Jamul Cement

Process							
			EF	EF	EF	EF	EF
IPCC	feed	meas.-fuel	from CaO	from feed	meas.-fuel	Measured	
Total CO2	Total CO2	Total CO2	C02/clink	C02/clink	C02/clink	SO2/clink	Nox/clink
t/day	t/day	t/day	t/t	t/t	t/t	kg/t	kg/t
284.578	318.752	322.767	0.499	0.559	0.566	1.200	7.265
286.368	320.580	411.479	0.502	0.562	0.722	1.352	8.281
291.392	324.562	175.187	0.502	0.560	0.302	0.778	4.603
284.578	319.050	199.488	0.499	0.560	0.350	0.878	5.458
231.104	260.093	390.458	0.502	0.565	0.849	1.712	10.678
225.727	251.352	320.436	0.502	0.559	0.712	0.905	8.060
231.104	281.496	118.845	0.502	0.612	0.258	1.318	5.100
548.323	590.614	835.643	0.498	0.537	0.760	1.191	4.476
		Mean	0.501	0.564	0.565	1.167	6.740
		Std. Dev	0.002	0.021	0.231	0.307	2.201

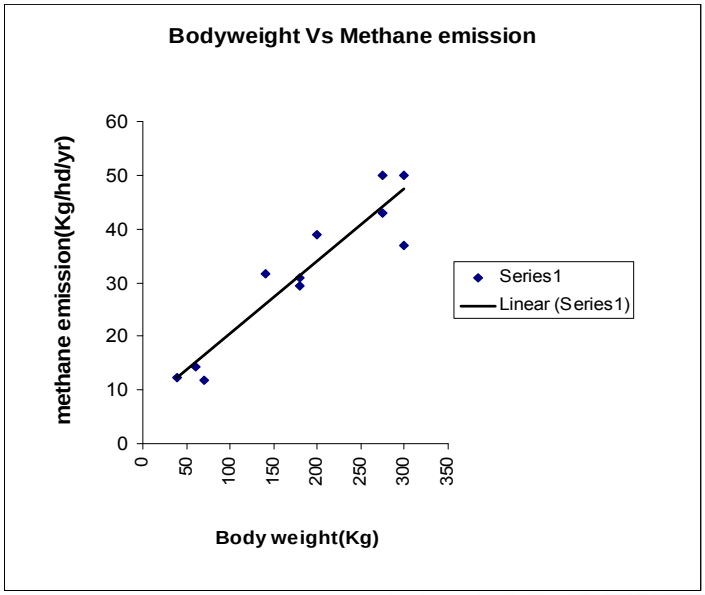
EF Measurement from Steel Plant

			SO_2 Emissions Estimate from Fuel (Bokharo Steel Plant)							
Month	Coke	Nutcoke	Coke Breeze	Total Coke	%S	SO_2 coke	Coal dust	%S	SO_2 coal	SO_2 coal & coke
	t/tHM	t/tHM	t/tHM	t/tHM		t/tHM	t/tHM		t/tHM	t/tHM
	1	2	3	4	5	6	7	8	9	10
				(1+2+3)		4*5 *(2/100)			7*8*(2/100)	6+9
May, '01	0.5717	0.0246	0.0978	0.6940	0.38	0.0053	0.0097	0.46	0.0001	0.0054
June, '01	0.5465	0.0290	0.0706	0.6461	0.38	0.0049	0.0148	0.46	0.0001	0.0050
August, '01	0.5511	0.0307	0.0802	0.6620	0.38	0.0050	0.0163	0.46	0.0002	0.0052
Sept. '01	0.5466	0.0287	0.0819	0.6572	0.38	0.0050	0.0133	0.46	0.0001	0.0051
October, '01	0.5533	0.0311	0.0836	0.6680	0.38	0.0051	0.0122	0.46	0.0001	0.0052
December. '	0.5571	0.0271	0.0841	0.6683	0.38	0.0051	0.0230	0.46	0.0002	0.0053
Jan.02	0.5286	0.0246	0.0724	0.6255	0.38	0.0048	0.0177	0.46	0.0002	0.0049
Feb,02	0.5285	0.0255	0.0751	0.6291	0.38	0.0048	0.0164	0.46	0.0002	0.0049
Mar.02	0.5303	0.0246	0.0781	0.6330	0.38	0.0048	0.0195	0.46	0.0002	0.0050
April,02	0.5398	0.0265	0.0794	0.6457	0.38	0.0049	0.0137	0.46	0.0001	0.0050
August'02	0.5321	0.0239	0.0800	0.6360	0.38	0.0048	0.0122	0.46	0.0001	0.0049
Mean	0.5442	0.0269	0.0803	0.6514	0.3800	0.0050	0.0153	0.4600	0.0001	0.0051
Std. Dev	0.0138	0.0026	0.0072	0.0208	0.0000	0.0002	0.0038	0.0000	0.0000	0.0001

Agriculture Sector Examples

Emission Factors for Enteric Fermentation (kg CH4/head/yr)

Category		IPCC default	NDRI	CLRI	NPL	SD	Average EF	SD	ALGAS
Dairy cattle	Indigenous	46	33	23	28	4	28	5	23
	Crossbred	46	39	42	49	10	43	5	32
Non dairy cattle (indigenous)	0-1 year	17	8	6	12	2	9	3	
	1-3 year	25	16	23	31	4	23	8	
	Adult	25	31	27	38	3	32	6	23
Non-dairy cattle (CB)	0-1 year	17	10	9	14	2	11	3	
	1-2 ½ year	25	21	28	30	5	26	5	
	Adult	25	33	29	37	4	33	4	
Dairy buffalo		55	69	38	42	3	50	17	32
Non dairy Buffalo	0-1 year	23	6	6	12	2	8	3	
	1-3 year	55	17	21	29	4	22	6	
	Adult	55	52	32	49	4	44	11	32
Sheep		5	4	4	IPCC		4	1	
Goat		5	**3**	3			4	1	
Horses & Ponies		18							
Donkeys		10							
Camels		46							
Pigs		1							



Methane Emission Factor for Manure Management

Dairy Cattle	Sub category	IPCC			NPL							
		Warm	Temp	Cool	Warm	Temp	Cool	Mean	SD	CLRI	Mean	SD
Indigenous		6	5	5	3.82	3.52	3.25	3.61	0.29	3.3	3	0.217
Cross Bred		6	5	5	4.65	4.27	3.95	4.38	0.35	3.3	4	0.766
Non Dairy Cattle												
Indigenous	Below 1yr	2	2	2	1.26	1.14	1.06	1.17	0.10		1	
	1 to 3 yrs				2.99	2.71	2.51	2.78	0.24		3	
	AdultsM/F				4.16	3.76	3.49	3.86	0.34	1.9	3	1.388
Cross Bred	Below 1yr				1.16	1.05	0.98	1.08	0.09		1	
	1 to 21/2yrs				2.51	2.27	2.10	2.33	0.20		2	
	Adults				3.41	3.09	2.86	3.17	0.28	1.9	3	0.899
Dairy Buffaloes					4.93	4.77	4.63	4.82	0.15	4	4	0.577
Non Dairy Buffaloes	Below 1yr	5	5	4	1.87	1.77	1.71	1.80	0.08		2	
	1 to 3 yrs				3.55	3.36	3.25	3.41	0.15		3	
	Adults				4.18	3.96	3.83	4.03	0.18	4	4	0.020

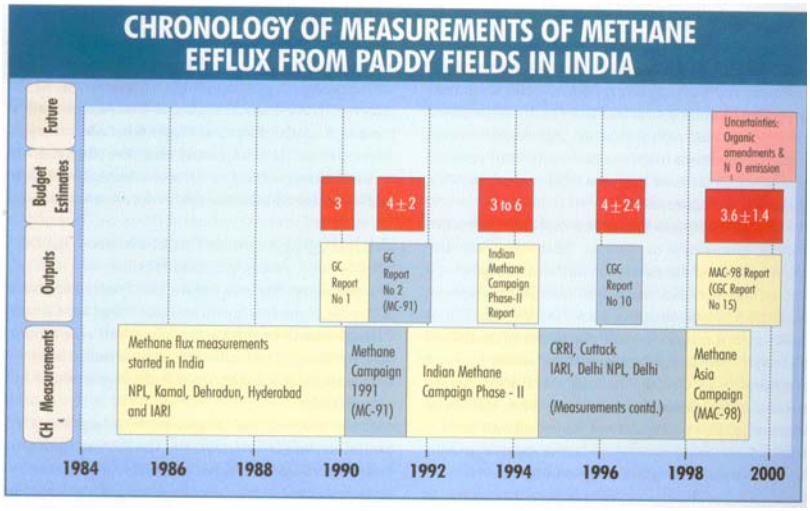
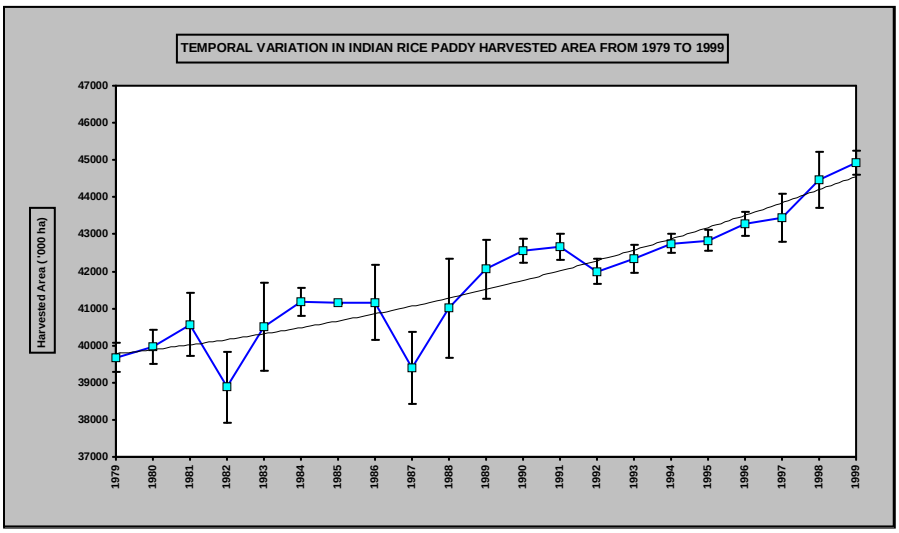


Figure-1: Chronology of Methane Emission Measurements from Rice Paddy Cultivation in India.


TEMPORAL VARIATION IN INDIAN RICE PADDY HARVESTED AREA FROM 1979 TO 1999
Harvested Area ('000 ha)
47000
46000
45000
44000
43000
42000
41000
40000
39000
38000
37000
1979
1980
1981
1982
1983
1984
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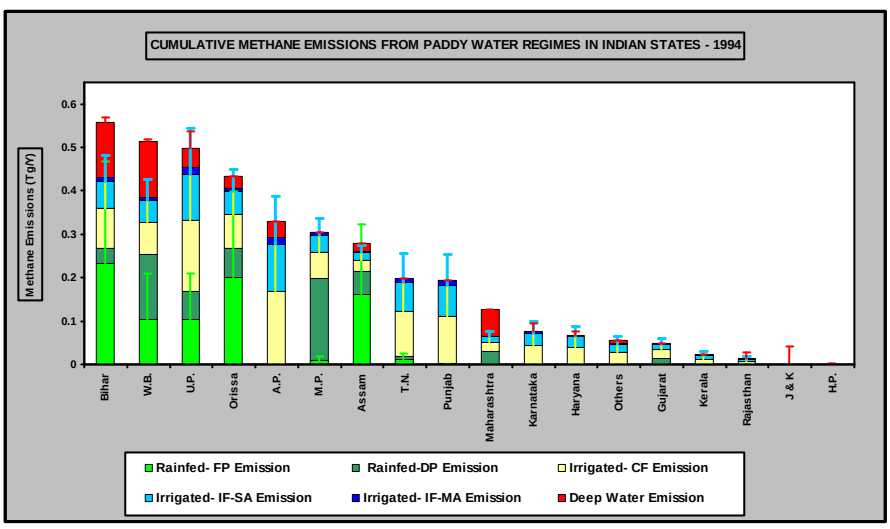
1999


CUMULATIVE METHANE EMISSIONS FROM PADDY WATER REGIMES IN INDIAN STATES - 1994
Methane Emissions (TgY)
0.6
0.5
0.4
0.3
0.2
0.1
0
Bihar
W.B.
U.P.
Orissa
A.P.
M.P.
Assam
T.N.
Punjab
Maharashtra
Karnataka
Haryana
Others
Gujarat
Kerala
Rajasthan
J & K
H.P.
Rainfed- FP Emission
Rainfed-DP Emission
Irrigated- CF Emission
Irrigated- IF-SA Emission
Irrigated- IF-MA Emission
Deep Water Emission

Residue to Crop Ratio Estimation & Surveys

Crop	Ratio of residue to main Produce	IPCC Residue to Crop ratio
Rice	1.29*	1.4
Wheat	1.5**	1.3
Maize	0.33 (cobs)**	1
Millet	1.2**	1.4
Jute	2.15**	-
Cotton	3**	-
Groundnut	2**	-
Sugarcane	0.1**	0.16
Rapeseed&Mustard	1.8**	-

*NPL literature survey **DST field Survey

Road Vehicles

Existing IPCC Coefficients

- IPCC Coefficients for transport sector adopted from US
- Indian Vehicle Mix & Technology different
- Hence, need to make India specific estimates

Methodological Steps

- Test Equipment Preparation
- Chassis Dynamometer Calibration
- Vehicle Preparation
- Exhaust Gas Sampling System
- Procedure of measurement
- Analytical Equipment
- Standardisation & calibration of instrument
- Accuracy of Techniques
- Calibration Gases
- System Leak
- Mass Emission Measurement from Diesel Engines

Accuracy of Techniques

Technique	Gas	Accuracy
NDIR	CO, CO_2	$\leq 2\%$
FID	THC	$\pm 0.5\%$
CLA	NO_x	$\pm 0.5\%$
GC	Methane	$\pm 2\%$

Summary of GHG's Emission Coefficients for different categories of Vehicles

Category		CO_2	CH_4	N_2O
Passenger Cars	Range (gm/kg)	2292.94 – 2993.93	17.83 gm/kg	0.06 gm/kg
	Standard Deviation	179.35		
Motor Cycles	Range (gm/kg)	1274.28 – 2793.22	For Two-Wheelers / Three-Wheelers 86.45 gm/kg	For Two-Wheelers/ Three-Wheelers 0.05 gm/kg
	Standard Deviation	359.58		
Scooters	Range (gm/kg)	791.80 – 2295		
	Standard Deviation	316.42		
Mopeds	Range (gm/kg)	1264.53 – 2173.71		
	Standard Deviation	246.45		
Three Wheelers	Range (gm/kg)	1274.28 – 2793.22		
	Standard Deviation	359.58		
Commercial Vehicles	Range (gm/kg)	3074.03 – 3106.38	0.10 gm/kg	0.24 gm/kg
	Standard Deviation	22.87		

Solid Waste

Uncertainty Analysis of Methane Emission on National Level Data Estimated Using Default Methodology

The uncertainty estimation in methane emission on national level solid waste quantity reaching landfill has been estimated based on the data available for the year 1999.

Data used

Activity data = 16187.1 Gg (with ±15% variation*)
Emission factor = 0.03104 (with ±20% variation*)
Emission = Activity data x Emission factor
(16187.1 x 0.03104) = 502.46 Gg

Range of activity data = 13759.03 to 18615.16 Gg
Range of emission factor = 0.02480 to 0.03720
Assumed standard deviation for activity data * = 950
Assumed standard deviation for emission factor * = 0.003
Mean emission after simulation = 502.508 Gg
Standard deviation for emission after simulation = 56.324

$$\text{Uncertainty for emission} = \frac{2 \times \text{standard deviation}}{\text{mean}} \times 100 = 22.4\%$$

* Based on expert judgement

- ± 15% variation is taken into account for the total MSW. This is done, as the reliability of data available for different cities is different.
- Similarly the variation in emission factor is also increased to ± 20%.

Uncertainty Analysis of Methane Emission on National Level Data Estimated Using Triangular Methodology

The uncertainty estimation in methane emission on national level solid waste quantity reaching landfill has been estimated based on the data available for the year 1999.

Data used

Activity data = 16187.1 Gg (with ±15% variation*)
Emission factor = 0.02470 (with ±20% variation*)
Emission = Activity data x Emission factor
(16187.1 x 0.02470) = 400.66 Gg

Range of activity data = 13759.03 to 18615.16 Gg
Range of emission factor = 0.01980 to 0.02970
Assumed standard deviation for activity data * = 950
Assumed standard deviation for emission factor * = 0.00230
Mean emission after simulation = 399.637 Gg
Standard deviation for emission after simulation = 44.024

$$\text{Uncertainty for emission} = \frac{2 \times \text{standard deviation}}{\text{mean}} \times 100 = 22.03\%$$

* Based on expert judgement

- ± 15% variation is taken into account for the total MSW. This is done, as the reliability of data available for different cities is different.
- Similarly the variation in emission factor is also increased to ± 20%.

Comparative Analysis of Results

The comparative analysis of results on uncertainty estimation using Monte Carlo Simulation Technique is detailed below:

Sr. No.	Location	Methodology adopted	Activity data	Emission factor	Emission
1.	Okhla	Default	3311.87 Gg	0.0308	102.00 Gg
		Triangular	461.232 Gg	0.0166	7.67 Gg
		Field	461.232 Gg	0.0044	2.07 Gg
2.	National	Default	17362.94 Gg	0.0310	539.00 Gg
		Triangular	17362.94 Gg	0.0247	429.76 Gg

Thanks