Malé Declaration emissions inventory workshop
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Session 5 – Solvent and other product use (Sector 7) and Agriculture (Sector 8)

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Malé Declaration on Control and Prevention of Air Pollution and Its Likely Transboundary Effects for South Asia

Solvent and other product use

In some countries, the use of solvents and other products (paints, varnishes, glues) can be a major source of non-methane volatile organic compound (NMVOC) emissions. Major sources are:

- **Paint application (solvent based)**
- **Paint application (water based)**
- **Metal degreasing**
- **Dry cleaning of fabrics**
- **Chemical products manufacture, and**
- **Other use of solvents**

Solvent and other product use

Process	B Units for activity rate	C NMVOC emission factor (kg NMVOC/t) Default
Paint application (solvent based)		
Industrial	tonnes paint sold	750[a]
Decorative	tonnes paint sold	300[d]
Unknown	tonnes paint sold	750
Paint application (water based)	tonnes paint sold	33 [D][d]
Metal degreasing	tonnes solvent consumed	1000 [C][d]
Dry cleaning of fabrics	tonnes solvent consumed	1000 [D][d]

Solvent and other product use

Process	B Units for activity rate	C NMVOC emission factor (kg NMVOC/t) Default
Chemical products manufacture:		
Polyester resins		
manual lay-up	tonnes of resin	40[b]
closed system	tonnes of resin	10[b]
Polyvinylchloride	tonnes product	40[b]
Polyurethane		
rigid foam	tonnes product	15[b]
soft foam	tonnes product	25
Polystyrene foam	tonnes product	15[b]
Rubber processing	tonnes product	15[b]
Paint and varnish	tonnes product	15[b]
Ink	tonnes product	30[b]
Glue	tonnes product	20[b]
Adhesive tape	m^2 product	60[b]

Solvent and other product use

Process	B Units for activity rate	C NMVOC emission factor (kg NMVOC/t) Default
Other use of solvents:		
Glass/mineral wool enduction	tonnes product	0.8[b]
Printing industry		
Lithography (offset)	tonnes ink consumed	350[b]
Rotogravure (heliography)	tonnes ink consumed	100[b]
Packaging (helio-flexo)	tonnes ink consumed	1200[b]
Fat, edible and non-edible oil (solvent extraction)	tonnes oil processed	18[b]
Application of glue and adhesives	tonnes product used	600[b]
Other (please specify)		

Emissions from Agriculture (Sector 8)

Several types of agricultural practice emit pollutants relevant to the study of transboundary air pollution. Among these activities are:

- **treatment of livestock manures**
- **application of fertilizers**
- **burning of agricultural crop residues in the field**

The first two are sources of ammonia (NH_3) emissions; the last one emits a range of air pollutants (NO_x, SO_x, CO, NMVOCs, NH_3, and particulate matter (PM)).

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Emissions from Agriculture - *Livestock Manure Management*

This covers emissions of ammonia (NH_3) from the storage and disposal of livestock manures for each of 10 categories of livestock.

Emissions are calculated assuming an average nitrogen excretion rate for each category of animal and applying annually averaged emission factors (EFs) for:

- **Housing management (barns, stalls, stables), and**
- **manure deposited during grazing.**

These EFs were derived for developing country regions

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Emissions from Agriculture - *Livestock Manure Management*

Animal	A Activity rate (thousands of animals)	B Assumed annual nitrogen excretion rate per animal[b] (kg N/yr)	Ammonia (NH_3) emission factor (annually averaged in kg NH_3 per animal)[a]					F NH_3 emissions (tonnes)
			C Housing management (in barns/stalls/ stables etc.)		D Grazing		E Total	
				Default		Default	(C+D)	(A x E)
Dairy cattle[c]		60		17.5		3.6	0	0
Other cattle[d]		40		4.4		5.5	0	0
Buffalo[e]		45		5.1		5.5	0	0
Pigs[f]		14		4.8			0	0
Sheep[g]		10		0.34		0.87	0	0
Goats[h]		9		0.34		0.78	0	0
Horses, mules and asses[e]		45		5.1		5.5	0	0
Poultry[f] (chickens, ducks, geese etc.)		0.5		0.22			0	0
Fur animals		4.1		1.69[i]			0	0
Camels		55		6.1		6.7	0	0
Other (please specify)							0	0
Total								0

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Emissions from Agriculture - *Emissions from Fertilizers*

After application, some of the N contained in fertilizers is released to the atmosphere as ammonia (NH_3).

These emissions depend on:

- **the type and amount of fertilizer applied**
- **climate (i.e. mean spring air temperature)**
- **the types of soils to which each fertilizer is applied (emissions are greater on calcareous soils)**

A portion of fertilizer-N is also emitted as NO (assumed 0.7% by default)

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Emissions from Agriculture - *Emissions from Fertilizers*

Default emission factors in the EMEP/Corinair guidebook (detailed methodology) are presented for three climate categories:

- **Region A - mean spring air temperature > 13 ºC.**
- **Region B - mean spring air temperature > 6 ºC but < 13 ºC, and**
- **Region C - mean spring air temperature < 6 ºC**

There is also a *'calcareous soil multiplier'* which should be entered if all the soils are calcareous (or modified according to the percentage calcareous soils using the equation provide at the bottom of the worksheet).

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Emissions from Agriculture - *Emissions from Fertilizers*

Fertilizer type	A Fertilizer use (consumption) (tonnes per year)	B % of applied fertilizer-N emitted as ammonia (NH_3) (100 x NH_3-N / fertilizer-N)				C Calcareous soil multiplier (enter this value if soils are alkaline)	
			Region A default[a]	Region B default[b]	Region C default[c]		Default multiplier ($M_{default}$) [f]
Ammonium sulphate			2.5	2	1.5		10
Ammonium nitrate			2	1.5	1		
Calcium ammonium nitrate			2	1.5	1		
Anhydrous ammonia			4	3	2		4
Urea			20	17	15		
Combined ammonium phosphates[e]			2.5	2	1.5		10
Other complex NK, NPK fertilizers			2	1.5	1		
Nitrogen solutions (mixed urea and ammonium nitrate)			11	9	7		
Total	0						

Activity data – i.e. annual consumption of each type of fertilizer by country - are given in the FAOSTAT database for all years from 1961-2007.

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Emissions from Agriculture - *burning of agricultural residues*

The steps include:

- **Finding activity data (e.g. from FAOSTAT) on the annual production of each crop (in kilotonnes)**
- **For each crop, estimating the biomass of crop residue actually burned from: crop to residue ratios, dry matter fraction, fraction burned in fields, fraction oxidised,**
- **Estimating CO emissions from the C fraction emitted as CO;**
- **Estimating NO_x emissions from the C:N ratio of the crop residues and an NO_x emission ratio (fraction of total N released as NO_x); and**
- **Estimating emissions of SO_2, NMVOCs, NH_3, PM_{10} and $PM_{2.5}$ by multiplying the amount of each crop residue burned by emission factors.**

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Emissions from Agriculture - *emissions from burning of agricultural wastes*

Parameter	Crop type										
	Rice	Wheat	Millet	Soya	Maize	Potatoes	Jute	Cotton	Groundnut	Sugarcane	Rapeseed and mustard
Residue to crop ratio [a]	1.4	1.5 [p]	1.2 [p]	2.1	0.33 [p]	0.4	2.15 [p]	3.0 [p]	2.0 [p]	0.1 [q]	1.8 [q]
Dry matter fraction [a]	0.83	0.80[o]	0.80 [o]	0.80 [o]	0.4	0.45	0.80 [o]	0.80 [o]	0.80 [o]	0.80 [o]	0.80 [o]
Fraction burned in fields [b a]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Fraction oxidized during combustion [a]	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Carbon fraction of residue [a]	0.4144	0.4853	0.45	0.45	0.4709	0.4226	0.45	0.45	0.45	0.45	0.45
CO emission ratio [c a]	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Nitrogen to carbon ratio [a]	0.014	0.012	0.016	0.05	0.02	0.04	0.015	0.015	0.015	0.015	0.015
NO_x emission ratio [e a]	0.121	0.121	0.121	0.121	0.121	0.121	0.121	0.121	0.121	0.121	0.121
NMVOC emission factor (kg/tonnes burned) [f]	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
SO_2 emission factor (kg/tonnes burned) [m]	4[g]	5.5[h]	9	9	9	9	9	9	9	9	9
NH_3 emission factor (kg/tonnes burned)	1.3[n]	2.4[l]	1.3[n]	1.3[n]	1.3[n]	1.3[n]	1.3[n]	1.3[n]	1.3[n]	1.3[n]	1.3[n]
$PM_{10}/PM_{2.5}$ emission factor (kg/tonnes burned) [j]	4 [g]	8.5 [k]	4.9 [i]	4.9 [i]	4.9 [i]	4.9 [i]	4.9 [i]	4.9 [i]	4.9 [i]	4.9 [i]	4.9 [i]

Compilation of emissions for Solvent and other product use (Sector 7) and for Agriculture (Sector 8)

Practical session:

1. Filling in workbook with dummy data *(see Exercise 7 notes)*
2. Plenary session – *sharing problems encountered etc.*