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Assessment of the uncertainty of CO2 sink of forest land in the EU 15's GHG inventory

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UNFCCC requirement on uncertainty

Annex I parties shall quantitatively estimate the uncertainty of **data** used and … qualitatively discussed it … in NIR, in particular for …. key categories

… as well as **methods used and underlying assumption** …and with the purpose (..) to prioritize efforts to **improve** the accuracy of GHG inventories …. and **guide decisions** on methodological choice" (FCCC/SBSTA/2006/9)

Peculiarities of EU LULUCF GHG inventory (!UNFCCC submission!)

EU estimates: bottom up, summing of the individual MS estimates

Assumption: best available estimates provided by the MS (*bona fides*, own QA/QC, **EU QA/QC**, revision by UNFCCCC, verification)

Most disaggregate explicit quantitative data is accessible on pool/sources on each LU sub-category

Incomplete reporting of LUs, pools & sources (how much ?)

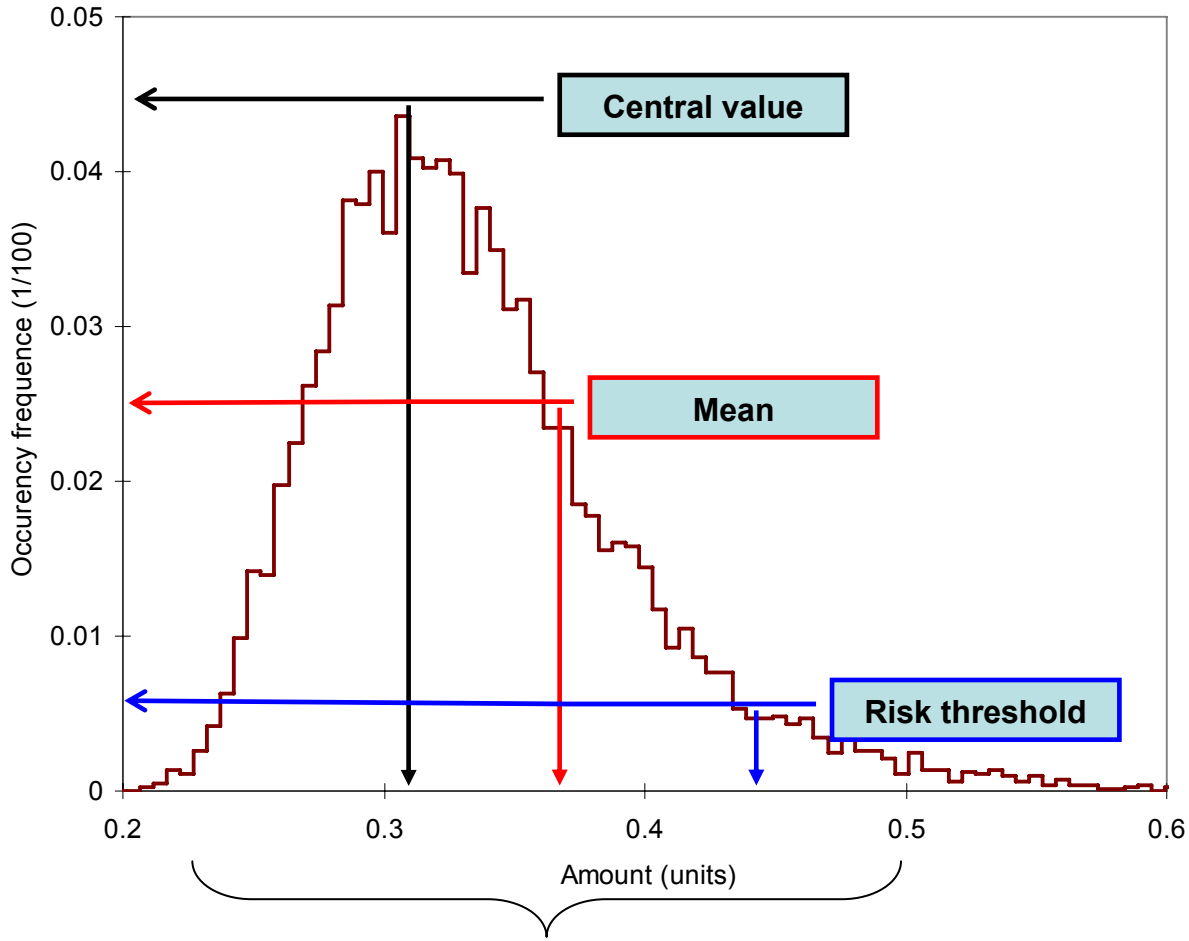
Methods for assessment and quantification of uncertainties (underpinning principles)

- error propagation (IPCC T1) (only for normal distribution for the parameters involved!) generates confidence limits for unknown true values
- re-sampling techniques (IPCC T2, Monte Carlo) (for any type of distribution), generates PDFs for unknown values

and… Adrian Leip's approach (improved Tier 1: Climatic Change 104/2010)

Advantage of UA via probability distributions (PDF)

Simultaneously described by several statistical means of data range (e.g. percentile, median, etc)



(p2.5%) μ-2σ < *μ* < μ+2σ (p97.5 %)

Advantage of UA via probability distributions (PDF)

… consider PDF shape, an issue for EF/AD in LULUCF:

- symmetric distributions CO2 both to dis- and aggregated levels
- asymmetric distributions CH4 & N2O at least at disaggregate levels

PDFs allow to ….

… assess versatile (“near nil”) operators and avoids indeterminate numbers (eg. division by 0)

…. easily combine the uncertainty of various GHG (i.e. symmetric /non-symmetric distributions)

… assess time propagation of errors and effect of correlations

UA of CO2 FL sink in 1990 and 2008

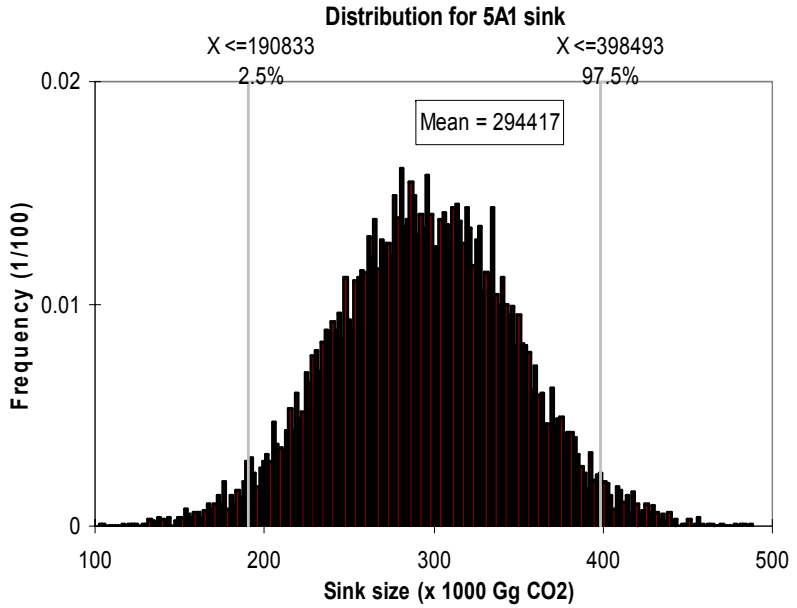
- Purpose: methodological development of a tool for uncertainty assessment at EU aggregated level
- Excel model for UA of 5A1 FL at EU level, module @Risk by Palisade
- Input data from **MS** inventories outputs on **C stock change in pools**: Biomass Gain, Biomass Loss, DOM, SOMmin, SOMorg, Disturbance (***N.B. not on land sub-categories***)
- Assumptions: input data as **normal PDF**, Monte Carlo simulations, 3x10000 runs (<1% change of the monitored estimate)
- UA only for reported pools

Data inputs: EU 15, 5A1, CO2

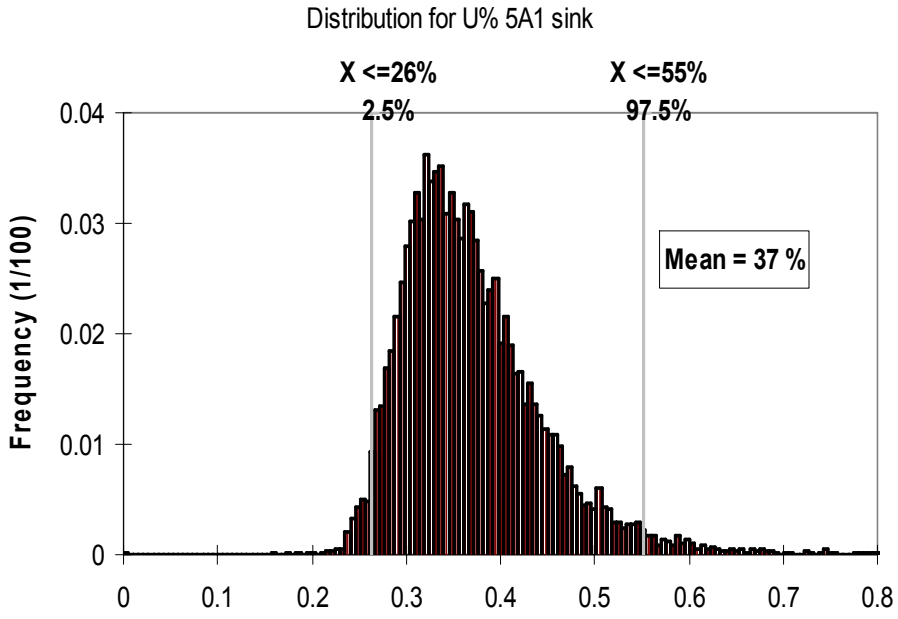
Pool	Annual 5A1 aggregated sink shares (%)	Uncertainty of the aggregated pools by MS (2Std, %)	Annual 5A1 sink shares (%)	Uncertainty of the pool (2Std, %)
Biomass - stem	85 %	Overall: 10-30% (including < 100 % for disturbances)	70 %	10%
Biomass - roots			20 %	30%
Biomass - branches			10 %	60%
SOM - organic soils	10 %	Overall: 20-184 %	70 %	80%
SOM - mineral soils			30 %	60%
DOM - litter	5 %	Overall: 28-107%	40%	75 %
DOM – dead wood			60%	60 %

Simply summing up of independent estimates results in lower relative uncertainty

Parameters	Overall annual removal EU 155 A1 (gG CO2)
(Most) expected sink	294417
StdDev	52285



EU 15 5A1 sink distribution



EU 15 5A1 sink uncertainty

Question: are always MS estimates independent ?

- Multiple sources of **co-variation** among MS estimates
  - IPCC default data: BEFs, Root-to-Shoot, CF
  - same allometric equations in trees/stands volume
  - “neighboring country” common parameters
  - IPCC default values of uncertainties
  - Time co-variation (issued by NFIs?)
  - **Overall effect of *independent vs. correlated* inputs ?**

	Biom Gain	Biom Loss	DOM	SOM Mineral	SOM Organic	Overall Sink
Independent estimates						
Expected sink (GgC)	155815	-65617	2850	13709	-4321	
Expected uncertainty (%)	**15%**	**16%**	**69%**	**66%**	**48%**	**34%**
Lower bound (p2.5)	13%	14%	41%	39%	33%	**25%**
Higher bound (p97.5)	17%	20%	218%	182%	96%	**53%**

35 % (25-53)

105 % (89-213)

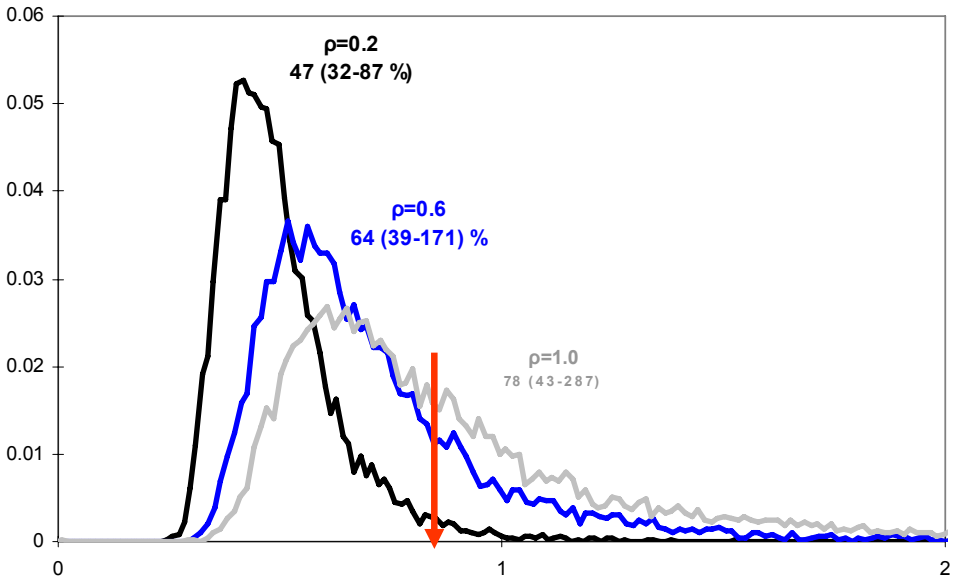
79 % (43-208)

Full correlations **(among years, MS)** results in doubling the overall EU 15 5A1 uncertainty

… but this is not realistic …

Co-variation matrix for EU 15 for each pool & source

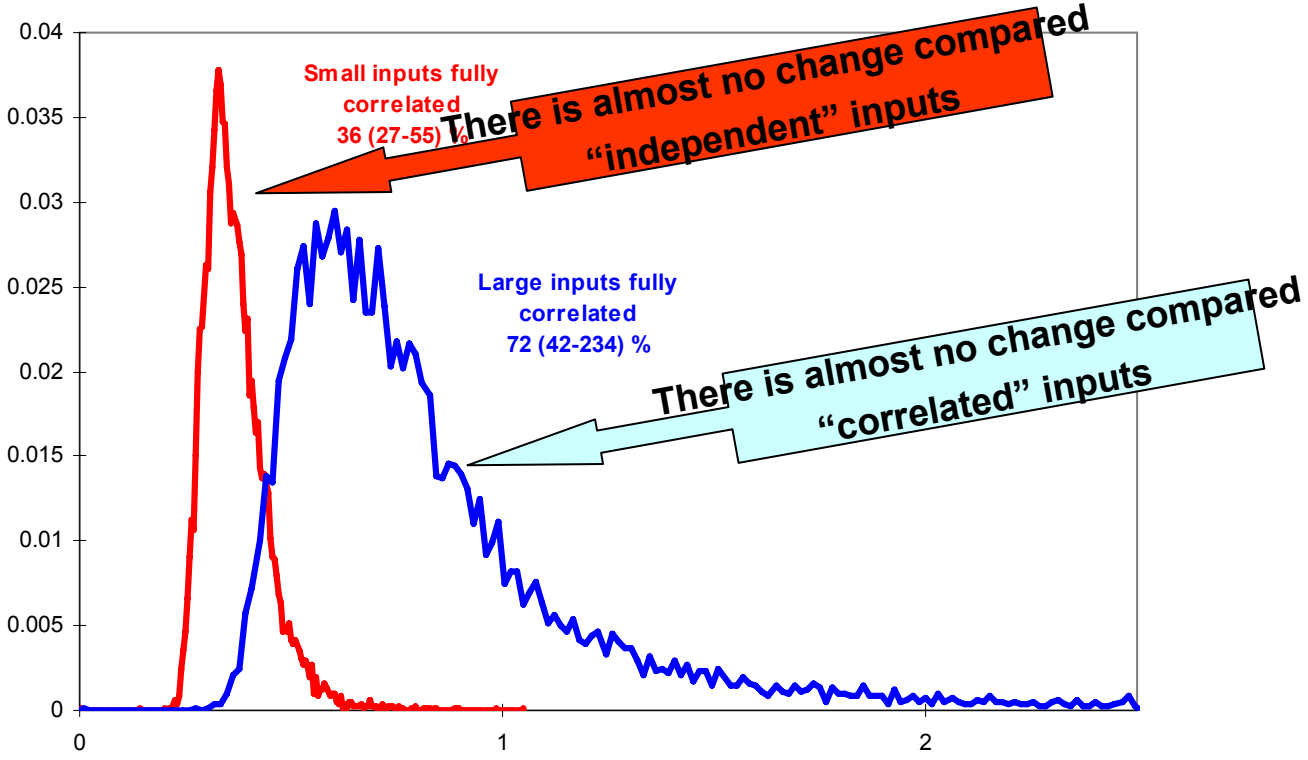
Biomass Gain	Austria	Belgium	Germany	Greece	Spain	…..
Austria	1					
Belgium		1				
Germany			1			
Greece		……	**1**	1		
Spain	…….	……	**1**		1	
…..						…..



With increasing ρ: shift to left of central value + increased 95 % interval

Which is the impact of sink size on overall uncertainty of EU 15?

full correlation only among small inputs, others independent
full correlations only among large inputs, others independent
Small sink = AT, BE, DK, GR, IRL, LUX, NL
Large sink = DE, ESP, FI, FR, IT,PT, SW, UK

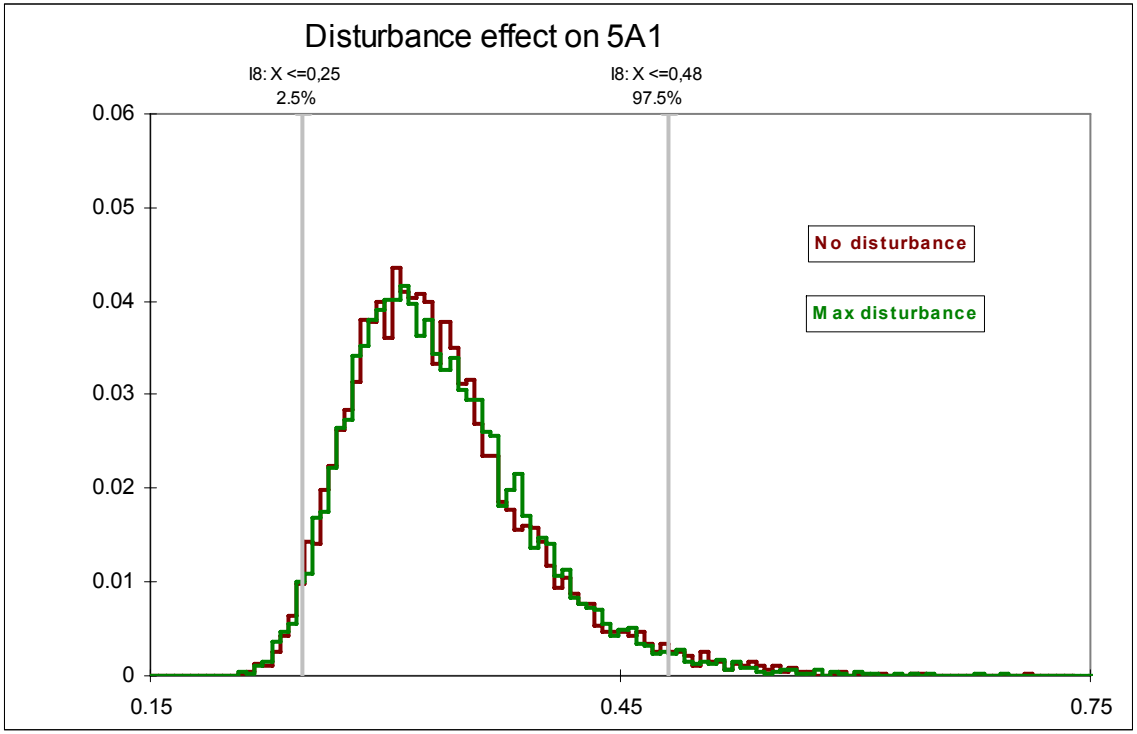


Disturbance effect seems low at EU 15 level (only fire)

Actual annual disturbance (< 10 th. Gg CO2) < 1 % of EU 15 annual sink, it adds up to 2pp to no fire occurrence inputs

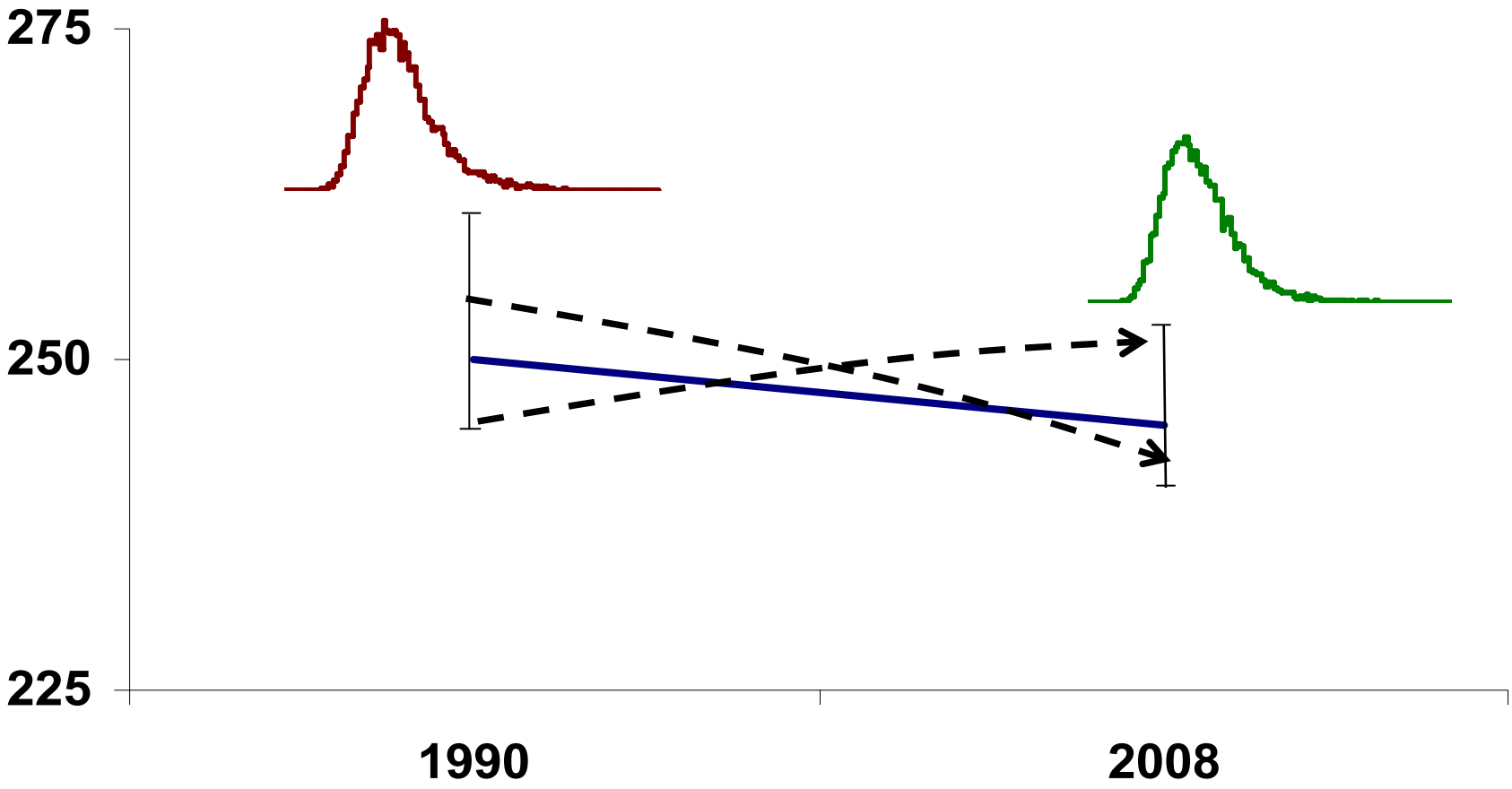
or

Maximal annual disturbance* in a year < 3 % of annual EU 15 sink (~22 th. Gg CO2) it adds up to 2 pp to actual uncertainty range



* - assuming maximal emissions of all fires since 1990 would occur in a year, i.e. 2008

Sink trend: decreasing, increasing ?



Uncertainty in the trend of C stock changes (EU 15, 1990-2008)

Parameters	Trend range (%)	Uncertainty of the trend
INDEPENDENT inputs		
Most expected trend value	+4.42%	2%
Lower range (*025*)	- 38%	- 36 %
Upper range (975)	+69%	+ 40 %
100% CORRELATED inputs (among years, MS)		
Most expected trend value	+4.42%	~
Lower range (*025*)	- 9.2%	- x 10^3
Upper range (975)	+10.0%	+ x10^3

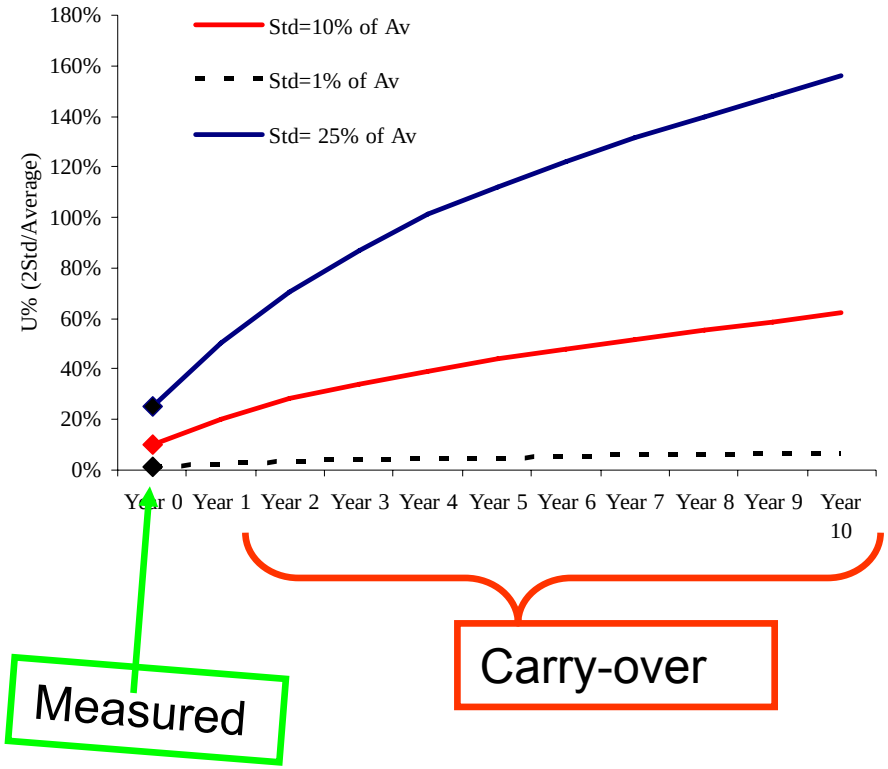
Trend by error propagation equation (for independent inputs on land categories)	+18%

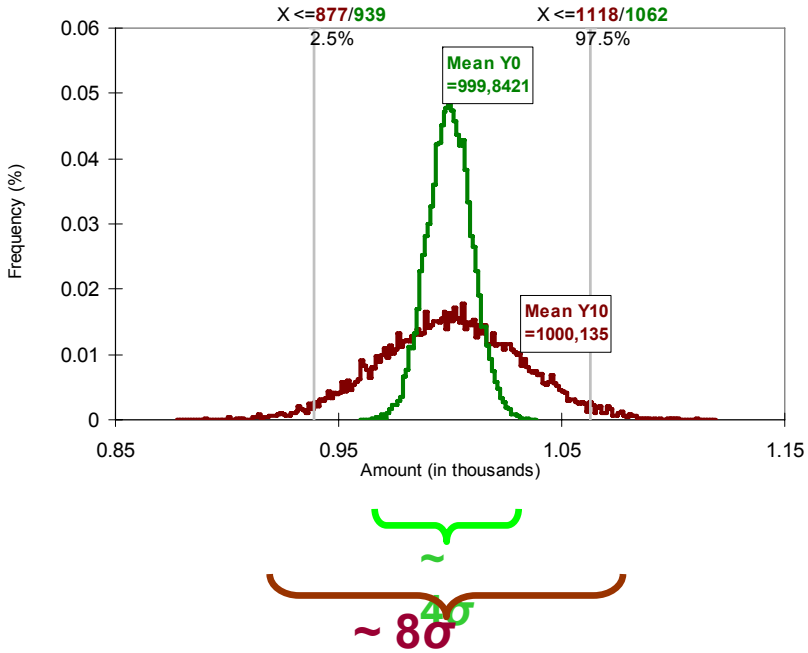
Statistics vs. uncertainty in LULUCF sector

- **Activity Data: Periodic assessments *vs.* requirement of annual reporting**
- **C stock change factors: periodic assessment** and **proxy or easy measurable parameters** (no major E/R is directly measured)

… thus **estimates for non measured years** are …
back/upward extra/interpolated … simple/moving averaged

Data uncertainty and time





mean uncertainty is non-linearly growing in time;

… with faster increase earlier;

… the uncertainty of smaller initial values is increasing bit faster than for those having high initial value;

… the *pdf*s widen and shape change over the estimated span (toward Uniform pdf?)

Can we do it better ? …and conclusions

- Input data, methods influence the results
- QAQC focus: uncertainties associated with data and computation model are accounted, transparent reporting of underlying uncertainties (i.e. annualization)
- GHG inventory are preset rules: is Tier 1 a hindrance toward GHG monitoring and research ?
- Scientific understanding vs. decision makers understanding

Future work

- Develop **LULUCF tool for uncertainty estimation** and refine **co-variation matrix**
- Input the uncertainty of “missing sources/sinks”
- **Accounting LULUCF** activities for KP compliance is a different issue …

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Thank you !

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