ADVANCES ON THE ESTIMATION OF MEASUREMENT UNCERTAINTY FOR THE NATIONAL GHG EMISSION FACTORS DATABASE OF COSTA RICA

METROLOGY FOR CLIMATE ACTION
26–30 SEPTEMBER 2022

Gabriel Molina-Castro[1*], Bryan Calderón-Jiménez[1], Jorge Montero-Arguedas[2], Marian Rojas-Acosta[2], Ana Rita Chacón-Araya[3]

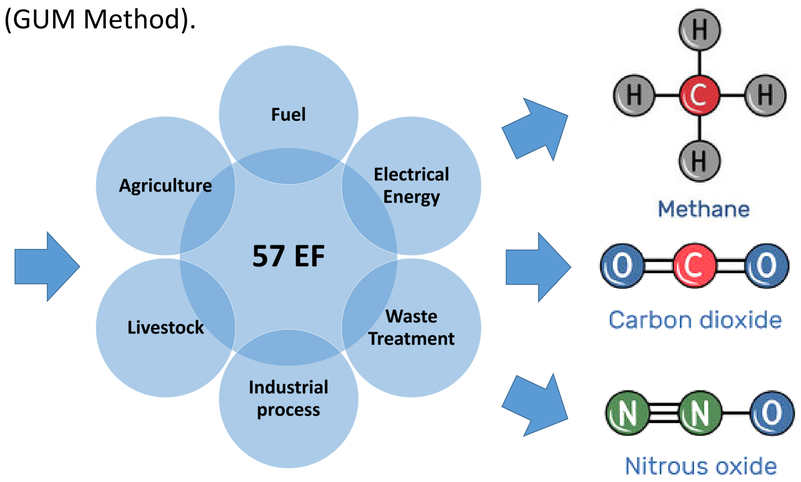
[1]Chemical Metrology Division, National Metrology Laboratory of Costa Rica (LCM), SJ, CR. *Email: gmolina@lcm.go.cr
[2]Planning and Sustainability Department, Costa Rican Institute of Electricity (ICE), SJ, CR.
[3]Development Department, National Meteorological Institute of Costa Rica (IMN), SJ, CR.

1 INTRODUCTION

- A new environmental challenge for Costa Rica on its path to the fight against climate change involves the precise and reliable quantification of its greenhouse gas (GHG) emission data.
- With the publication of the latest version of ISO 14064-1:2018, the National Program for Carbon Neutrality of Costa Rica included measurement uncertainty as a mandatory requirement for the reporting of GHG inventories.
- Technical gaps remain for an optimal implementation of this requirement, including a lack of information regarding uncertainties in Costa Rican official emission factors database.

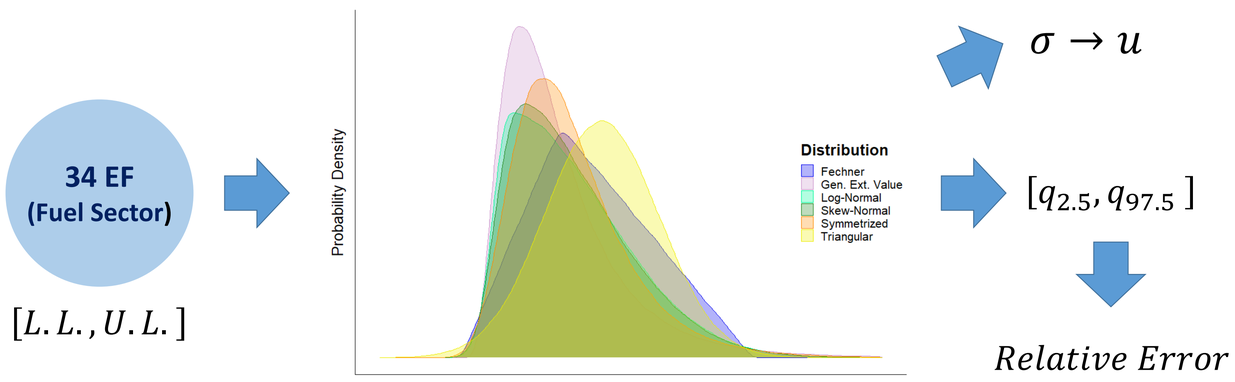
2 MAIN GOAL AND SCOPE

- To fill the gap of uncertainty information for the Costa Rican official emission factors (EF) database, providing uncertainty values (standard uncertainties and variation intervals, if needed) through the collection of input information, use of expert criteria, fitting of probability distributions, and the application of the Monte Carlo simulation method or the Law of Propagation of Uncertainty (GUM Method).

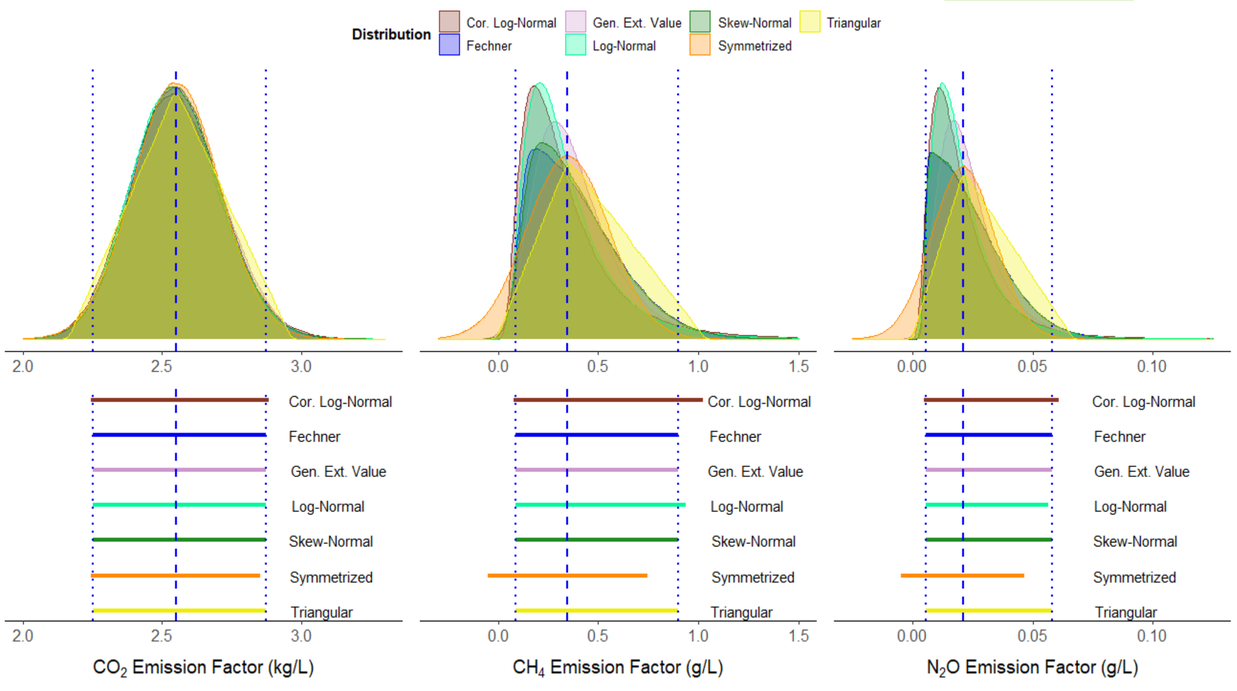


3 EF WITH ASYMMETRIC INTERVALS OF VARIATION

- The 2020 official list of national EF included asymmetric intervals of variation (95 % confidence intervals) for the fuel sector. These intervals were estimated by the National Meteorological Institute of Costa Rica, considering the specific properties of fuels in Costa Rica and using IPCC Tier 1 and Tier 2 methods.
- Standard uncertainties (u) for these EF were estimated by fitting five asymmetric distributions and a "symmetrization" method. To evaluate the fit, quantiles of interest were extracted from simulated populations and compared with the original data values using relative errors.

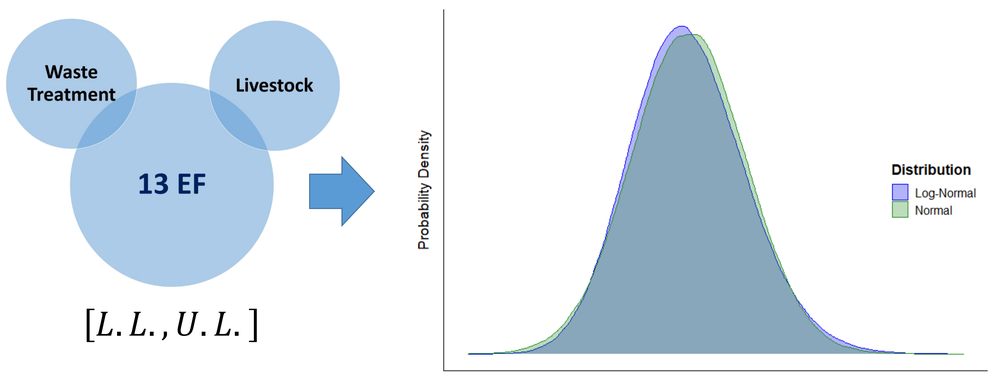


- Overall, a systematically better fit was evidenced for the asymmetric triangular and generalized extreme value distributions. Estimated standard uncertainties range from **1 % to 75 %.**

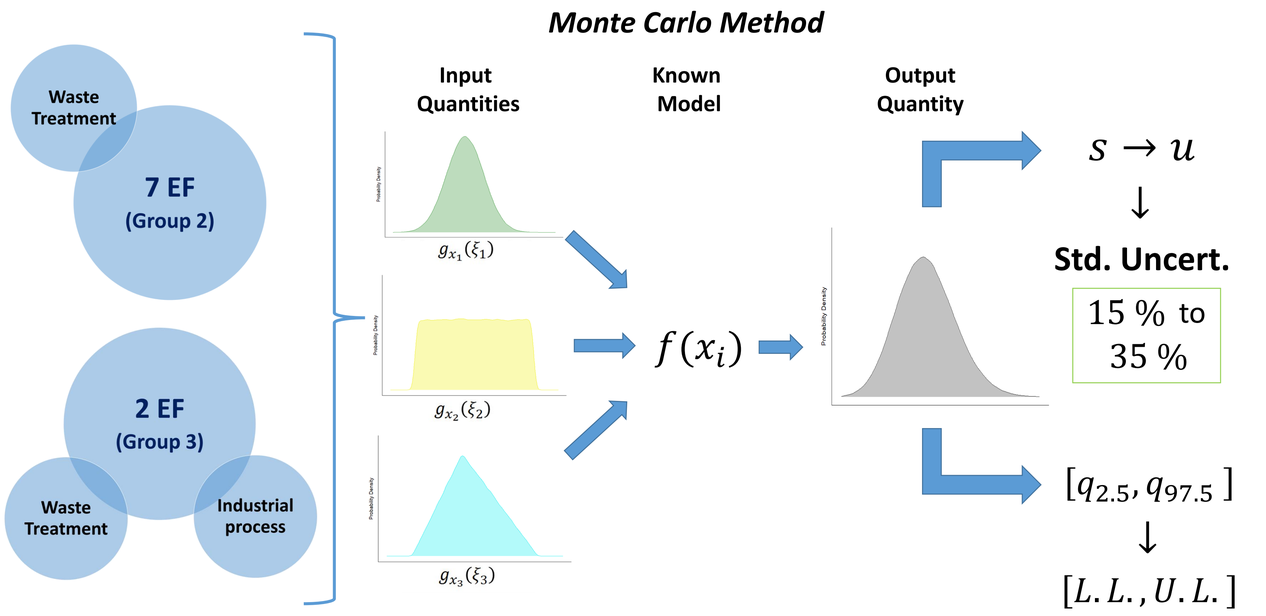


4 EF WITHOUT UNCERTAINTY INFORMATION

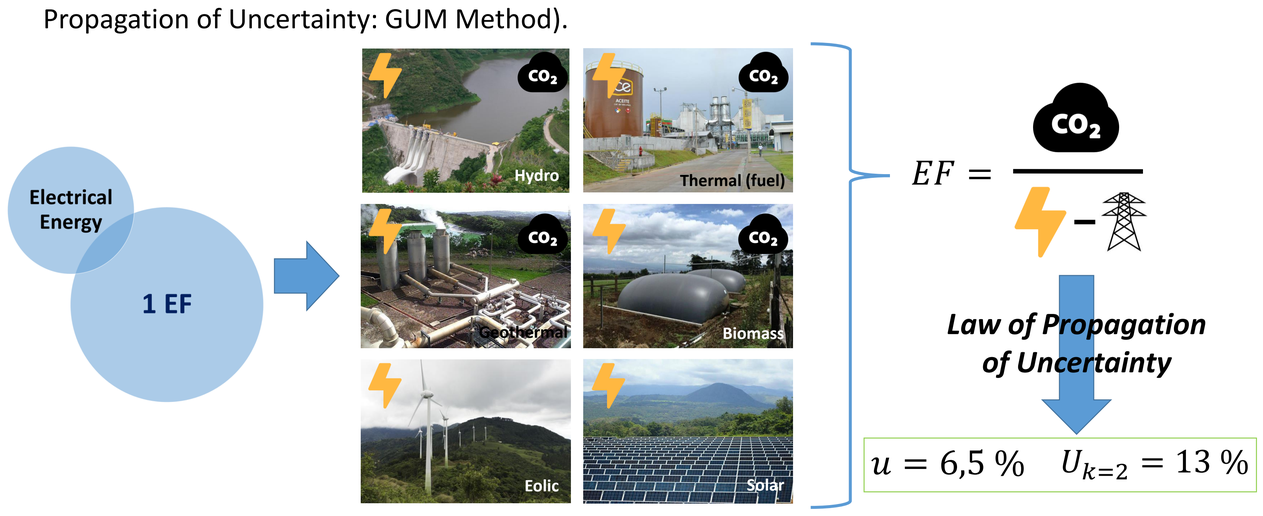
- **Group 1**: 13 EF with values taken directly from the literature, specifically from IPCC Guidelines.



- **Group 2**: 7 EF with values estimated from simple multiplicative models with no more than three variables with uncertainty (use of Monte Carlo method).
- **Group 3**: 2 EF with values estimated from complex models including multiplications and additions, with more than three variables with uncertainty (use of Monte Carlo method).

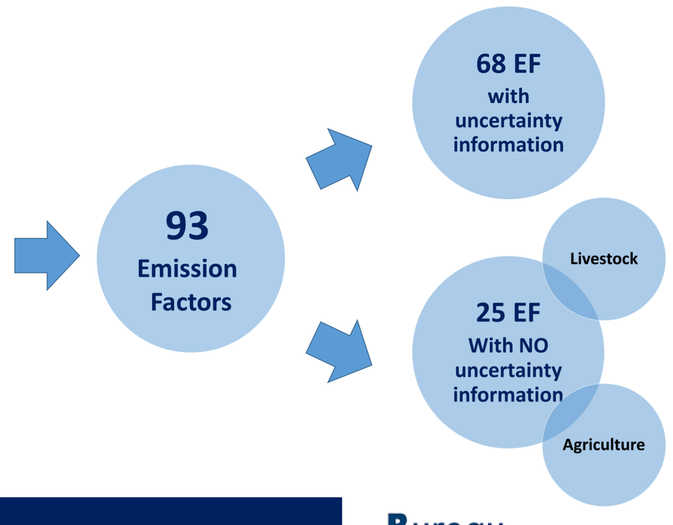


- **Group 4**: Electrical energy EF estimated from data regarding electricity generation, emissions due to generation processes and losses on transmission and distribution (use of the Law of Propagation of Uncertainty: GUM Method).



5 CURRENT SITUATION

- The 2022 updated Costa Rican official list of emission factors (EF) includes 93 emission factors.
- 68 EF now have uncertainty information, including variation intervals (95 % confidence intervals) and standard uncertainties.
- The remaining 25 EF, all from livestock and agricultural sectors, are still missing information on their associated uncertainties.



6 CONCLUSIONS, GAPS AND OUTLOOK

- Results showed to be consistent with studies carried out in other latitudes and are currently used by national organizations within the National Program for Carbon Neutrality.
- Lack of national studies to improve the accuracy in the quantification of some factors which come from generalized recommendations found in the literature.
- Lack of studies in countries with economic, geographic, demographic, and social characteristics similar to Costa Rica that allow a better comparison of results.
- Scientific population is invited to develop more studies focused on the uncertainty quantification of local emission factors to improve GHG emission accuracy.

7 REFERENCES

- [1] Molina-Castro, G. and Calderón-Jiménez, B. (2021). *Evaluating Asymmetric Approaches to the Estimation of Standard Uncertainties for Emission Factors in the Fuel Sector of Costa Rica*. Front. Environ. Sci. doi: 10.3389/fenvs.2021.662052.
- [2] Molina-Castro, G. (2022). *A Monte Carlo Method for Quantifying Uncertainties in the Official Greenhouse Gas Emission Factors Database of Costa Rica*. Front. Environ. Sci. doi: 10.3389/fenvs.2022.896256.
- [3] ISO 14064-1. (2018). *Greenhouse Gases — Part 1: Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals*.
- [4] IMN. (2022). *Factores de Emisión de Gases de Efecto Invernadero*. 12th ed. Available online at: http://cglobal.imn.ac.cr/index.php/publications/factores-de-emision-2022/

Bureau International des Poids et Mesures
WORLD METEOROLOGICAL ORGANIZATION
LCM Laboratorio Costarricense de Metrología
ICE
imn