

IAM: APPROACHES, MODELS AND UNCERTAINTY ASSESSMENT

**A PROPOSAL FOR A WORKING GROUP IN THE
FRAMEWORK OF NIAM**

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AQD: Use of Models

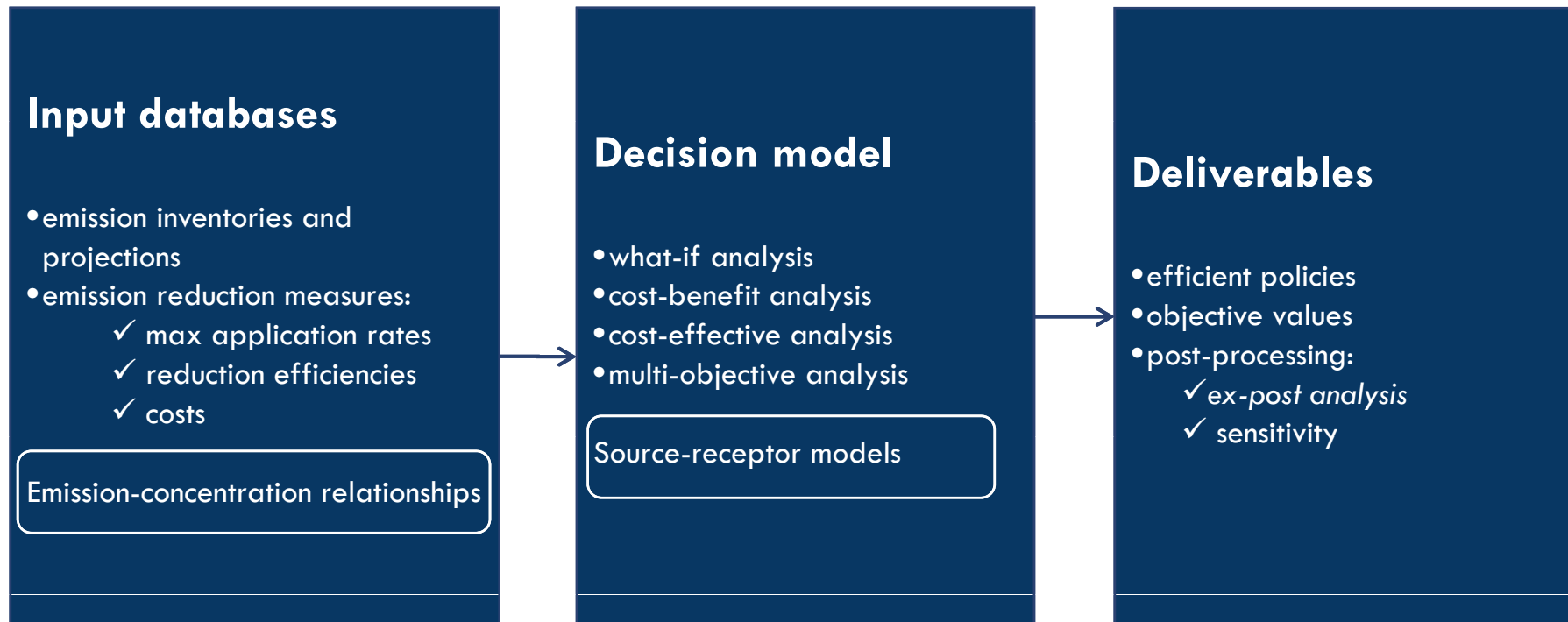
- ✓ assessment of ambient air quality
- ✓ planning and mitigation strategies
- ✓ assessment of the contribution of natural sources, road dust and sea salt
- ✓ short-term forecast for exceedance of human health or environmental protection thresholds

AQD: Use of Models

- ✓ assessment of ambient air quality
- ✓ planning and mitigation strategies
- ✓ assessment of contribution of natural sources,

- ✓ determine emission scenarios
- ✓ compute the impact of actual or foreseen measures on concentration levels and exposure
- ✓ support the selection of effective policies

IAM architecture



Input databases

- emission inventories and projections
- technical and non-technical emission reduction measures:
 - ✓ application rates
 - ✓ reduction efficiencies
 - ✓ costs
- emission-concentration relationships:
 - ✓ air quality simulation models

Decision model design

- ✓ the decision model approaches
- ✓ the decision variables
- ✓ the planning indicators for human, ecosystems and materials exposure
- ✓ the optimization algorithms
- ✓ the source-receptor relationships
- ✓ the baseline and projection emission scenarios
- ✓ the spatial scales

Decision model approaches



- what-if analysis
- cost-benefit analysis
- cost-effective analysis
- multi-objective analysis

Decision model approaches

- what-if analysis
- cost-benefit analysis
- cost-effective analysis
- multi-objective analysis

$$\underset{\theta}{opt} [J(\theta)]$$

$$\theta \in \Theta$$

$J(\theta)$ is the objective function to be optimized

θ is the set of decision variables

Θ is the set of feasible decisions

Decision model

Cost-benefit analysis:

$J(\theta)$ is a scalar function

all benefits and costs are monetized and assessed in a single function

Rabl, A., Spadaro, J. V., & Zwaan, B. V. D. (2005). Uncertainty of air pollution cost estimates: To what extent does it matter. *Environmental Science & Technology*, 39, 399–408.

Reis, S., Nitter, S., & Friedrich, R. (2005). Innovative approaches in integrated assessment modelling of European air pollution control strategies - Implications of dealing with multipollutant multi-effect problems. *Environmental Modelling & Software*, 20, 1524–1531.

Vlachokostas Ch., Achillas Ch., Moussiopoulos N., Hourdakakis E., Tsilingiridis G., Ntziachristos L., Banias G., Stavrakakis N., Sidiropoulos C. (2009). Decision support system for the evaluation of urban air pollution control options: Application for particulate pollution in Thessaloniki, Greece, *Science of the Total Environment*, 407, 5937–5948.

Decision model



Cost-effective analysis

$J(\theta)$ is a scalar function

a single objective is optimized, while others required performances are included as constraints

RAINS/GAINS system, APD IIASA

Carlson, D., Haurie, A., Vial, J.-P., & Zachary, D. (2004). Large-scale convex optimization methods for air quality policy assessment. *Automatica*, 40, 385–395.

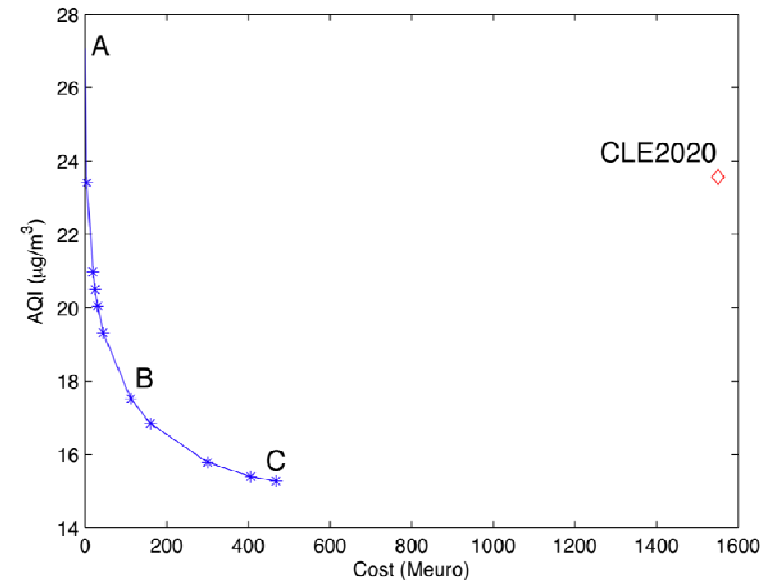
Shih, J.-S., Russell, A., & McRae, G. (1998). An optimization model for photochemical air pollution control. *European Journal of Operational Research*, 106, 1–14.

Decision model

Multi-objective analysis:

$J(\theta)$ is a vector

$J(\theta)$ represents different and often conflicting objectives.



Guariso, G., Pirovano, G., Volta, M. (2004). Multi-objective analysis of ground-level ozone concentration control. *Journal of Environmental Management*, 71, 25–33.

Pisoni, E, Carnevale, C., Volta, M. (2009). Multi-criteria analysis for PM10 planning. *Atmospheric Environment*, 43, 4833-4842

Deliverables

- the solutions of the decision problem
- the related estimation of the objectives
- the post processing of these results:
 - ✓ ex-post analysis: evaluation of other environmental indicators (human, ecosystems, materials exposure), not explicitly included in the decision problem

WG topics (1 / 2)

1. the **sensitivity** of the effective policies to

- ✓ uncertainty of the inputs
- ✓ different problem formulations, optimization algorithms, planning objectives, emission-concentration relationships, spatial scales ...

WG topics (2/2)

2. the definition of a set of **indexes** and a **methodology to measure the sensitivity** of the decision problem solutions.

the absolute
“optimal” policy is
not known

intercomparison

indexes

**methods and tools to support air quality authorities in
the application of IAMs**

WG activities (1 / 3)

- **Analysis and comparison of IAM methodologies** in Europe at different spatial scales.
- **Assessment of the integration of air quality and decision models** at regional, national and sub-national scales.

IAM online database

IAM database

- **Project:**
- **Contact person(s):**
- **IAM scale:**
- **IAM methodology:**
- **Planning indicators:**
- **Optimization algorithm:**
- **Source-receptor relationships:**
- **CTM models:**
- **Emission models:**
- **baseline emission scenario:**
- **Planning horizon:**
- **Meteorology:**
- **measures and internal costs:**
- **External costs:**
- **Sensitivity analysis of effective policies to:**
- **Methods and indexes to assess sensitivity:**
- **References:**

Web form

The screenshot shows a web browser window with the title 'IAM database'. The address bar contains the URL: <http://spreadsheets.google.com/viewform?formkey=df91VXd2UnBfZ2FtVhJCMnNkLV91TmcGMA>. The browser's search bar shows 'google docs'. The page content includes a header image of clouds, the title 'IAM database', and a description: 'IAM: approaches, models and uncertainty assessment' and 'Analysis and comparison of IAM methodologies in Europe'. Below this, a red asterisk indicates a required field. The form contains several input fields: 'Project *' with the value 'RAINS - ITALY', 'Contact person(s) *' with the value 'G. Vialetto', 'Affiliation *' with the value 'ENEA (I)', 'IAM scale: *' with a dropdown menu set to 'National', and 'spatial resolution *' with the value '20x20 km2'. At the bottom left, the text 'Completato' is visible.

IAM database

http://spreadsheets.google.com/viewform?formkey=df91VXd2UnBfZ2FtVhJCMnNkLV91TmcGMA

google docs

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Google Documenti - Tutti i doc... IAM database IAM database

IAM database

IAM: approaches, models and uncertainty assessment
Analysis and comparison of IAM methodologies in Europe

*Campo obbligatorio

Project *

RAINS - ITALY

Contact person(s) *

G. Vialetto

Affiliation *

ENEA (I)

IAM scale: *

National

spatial resolution *

20x20 km2

Completato

WG activities (2/3)

- Definition of a **methodology to assess IAM sensitivity** to:
 - ✓ Inputs
 - ✓ baseline and projection emission scenarios
 - ✓ decision model approaches
 - ✓ optimization algorithms
 - ✓ planning indicators for human, ecosystems and materials exposure
 - ✓ source-receptor relationships
 - ✓ spatial scales
 - ✓ meteorology

WG activities (3/3)

- Definition of **indicators and methods to measure of the sensitivity** of the decision problem solutions.
- An **inter-comparison exercise** to assess sensitivity of decision problem solutions.

Work plan

- the analysis and comparison of IAM methodologies in Europe at different spatial scales (regional, national, sub-national scales);
- the definition of a methodology to assess sensitivity to IAM design choices;
- the organization of an inter-comparison exercise.

Join the WG

- Visit the webpage (under construction)
- Fill the online form for the IAM database
- Fill the online form on sensitivity analysis:
 - ▣ Methodology
 - ▣ Indicators
 - ▣ Statistics