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**Steering Body to the Cooperative Programme for Monitoring and Evaluation
of the Long-range Transmission for Air Pollutants in Europe (EMEP)**

(Twenty-ninth session, Geneva, 5-7 September 2005)

Working Group on Strategies and Review

(Thirty-seventh session, Geneva, 26-30 September 2005)

**WORKSHOP ON THE RAINS MODEL METHODOLOGY FOR INTEGRATED
ASSESSMENT MODELLING**

Summary report and conclusions of the workshop prepared by
the organizers with the assistance of the secretariat

Introduction

1. A workshop on the methodologies for integrated assessment modelling took place on 20-21 January 2005 at the EMEP Centre for Integrated Assessment Modelling (CIAM) in Laxenburg (Austria). It was organized by the Task Force on Integrated Assessment Modelling and the International Institute for Applied Systems Analysis (IIASA) in conjunction with the seventh meeting of the Expert Group on Techno-economic Issues.

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2. The workshop was attended by 80 experts from: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Slovenia, Spain, Sweden, Switzerland and United Kingdom. Representatives of the European Commission (Directorates General for Environment, Enterprise and Industry, and the Joint Research Centre) attended. A representative of the World Bank also attended. Representatives of the Coordination Center for Effects (CCE), the EMEP Meteorological Synthesizing Centre-West (MSC-W) and a member of the secretariat were present. Several industrial and consulting organizations and trade associations were represented.

3. Mr. R. Maas (Netherlands) chaired the workshop.

I. OBJECTIVE AND INTRODUCTORY REMARKS

4. The objective of the workshop was to assess a review of the methodology used in the Regional Air Pollution Information System (RAINS) model. The review had been conducted jointly with the European Commission's Clean Air for Europe (CAFE) programme. The team of peer reviewers presented their findings.

5. Presentations and a list of participants are available at: www.iiasa.ac.at/rains/meetings/.

6. Mr. L. Hordijk, Director of IIASA, welcomed the participants. Mr. Rob Maas stressed that the workshop should determine, through the results of the review process, the usefulness of the RAINS model in air pollution policy and negotiations. Mr. D. Johnstone (European Commission) noted the use of RAINS by the Commission in its CAFE programme.

II. SUMMARY OF MAIN DISCUSSION POINTS

7. Mr. P. Grennfelt (Sweden) reported on the review process, carried out from December 2003 to September 2004, stressing that the model should support the work of the Convention as well as CAFE, have legitimacy and be widely accepted. A team of 10 reviewers had been established. The review had been based on material supplied by CIAM, conclusions reached at meetings of the review team, as well as on information from other contacts and sources. The scope of the review included all scientific aspects of the model except inputs from atmospheric source-receptor relationships, health impacts and mapping of critical loads.

8. Mr. M. Amann (CIAM) stressed the importance of the model in finding the most cost-effective way to achieve given policy targets in improving environmental quality. The workshop agreed that cost-effectiveness could be determined by the integration of economic and energy projections, the state of emission controls, available technologies and costs, atmospheric processes and environmental sensitivities. The workshop noted that RAINS did not currently

cover greenhouse gas emissions and climate change policies, agricultural policies, air pollution impacts on water and soil or emerging technologies.

9. Mr. Z. Klimont (CIAM) presented the historical development of European emission inventories, underlining the need for reporting formats compatible with those used by the United Nations Framework Convention on Climate Change. The workshop agreed that the model required a logical and realistic aggregation of sources, including: the most important sources; the possibility for using uniform activity rates and emission factors; plausible forecasts of future activity levels; and high-quality data for control technologies.

10. Mr. J.G. Bartaire (France), Chairman of the Expert Group on Techno-economic Issues, reported on the conclusions of its seventh meeting, held on 19 January 2005 in Laxenburg (EB.AIR/WG.5/2005/6). Mr. J. Cofala (CIAM) explained how emission control technologies were integrated into RAINS and how costs were calculated.

11. The review team had concluded that costs had historically been overestimated in RAINS and that sensitivity analysis was needed, at country and sector levels, to better understand the nature of this bias. The review team had assessed the list of available control options, challenged their use and applicability in countries and was reassured that cost information had been taken from a representative sample. The workshop agreed that the algorithms and calculations in the model, including cost curves and the associated optimization process, were technically defensible and fit for purpose, but further improvement was needed.

12. The workshop agreed, moreover, that dialogue with Parties was indispensable in identifying control options and their costs. It recommended that CIAM should analyse calculations that were the most significant sources of bias in estimating costs (e.g. learning effects, economies of scale, structural changes). Greater participation by industry in the collection of cost data was also needed, while cooperation should continue with the Expert Group on Techno-economic Issues and the European Commission's Joint Research Centre's Institute for Prospective Technological Studies to develop data sets on emerging technologies.

13. Mr. J. Schneider (Austria) outlined the conclusions of the systematic review by the World Health Organization (WHO) on the health effects of particulate matter (PM) and ozone. Epidemiological evidence had linked daily air pollution levels with mortality and long-term PM exposure with life expectancy. Intervention studies had shown that a decrease in air pollution led to health benefits.

14. The workshop noted that the review team had found that there was possibly an under estimation in RAINS regarding health impacts. It agreed that the objective of the health impact assessment was to estimate the loss of life expectancy attributable to PM exposure. The health module was scientifically defensible, though results related to health effects should be treated

with caution. The workshop recognized that the health aspect of RAINS was relatively new, since the model had traditionally focused on ecosystems.

15. Ms. H. Fagerli (MSC-W) reported on the state of knowledge on atmospheric modelling, noting the EMEP Eulerian model reproduced daily variations well, though it neglected some high peaks, tended to overestimate SO₂ and lacked time series data for NO_x.

16. Mr. Amann reported on modelling urban air quality. Using the model inter-comparisons of the European Commission's City-Delta project in which 17 models and 8 cities were considered, differences between exposure in cities and background calculations of ozone and PM had been identified. The models agreed that most PM concentrations in urban areas originated from the regional background and the urban increment could be described by a linear relation between primary PM emission densities and concentrations.

17. The review team had noted that the EMEP model review showed that source-receptor matrices could be used for policy purposes. For ozone, the model description of the regional concentration and its relationship with emissions within Europe was reliable. However, the importance of the increasing background ozone concentrations needed to be further addressed in hemispheric modelling within both the EMEP model and RAINS. There was considerable underestimation of PM_{2.5} concentrations from the EMEP model, and secondary organic and natural aerosols were entirely missing. The workshop concluded that the understanding of atmospheric processes had increased rapidly during the past year, and new source-receptor matrices could be expected in future.

18. Mr. J.-P. Hettelingh (CCE) reported on progress made in the Convention's Working Group on Effects related to environmental impacts used in RAINS, including critical loads and levels and dynamic modelling. The workshop agreed that more knowledge was needed on the dynamics of ecosystem change and the relationships between ozone exposure, acidification, eutrophication and climate change. It concluded that long-term monitoring was indispensable and critical loads and levels had been successfully implemented in RAINS.

19. The review team had found that there was an underestimation of the deposition in complex terrain (e.g. hills, forest edges) which could lead to an underestimation of control needs. Concerning eutrophication, the importance of nitrogen for biodiversity losses in Europe was not well understood by policy makers, or communicated effectively to them. The workshop concluded that further work was needed on ecosystem impacts for RAINS.

20. Mr. Amann presented the baseline calculations for CAFE, showing a decoupling of economic development and energy use, as well as a decoupling of energy use and emissions between 1990 and 2020. Emission trends in the enlarged European Union showed a decline for SO₂, NO_x, VOC and PM_{2.5}, but NH₃ emissions remained constant. In 2020, PM_{2.5} emissions

were expected to come mainly from domestic wood stoves with less from diesel exhaust (heavy-duty trucks and cars). The share of emissions from industrial processes was expected to increase. Contributions from agriculture and off-road equipment were expected to remain stable. NO_x emissions from heavy-duty vehicles and cars were expected to decline, though transport would still make a significant contribution to total emissions in 2020. Ship emissions would surpass those from land-based sources. There would be a significant decrease in sulphur from power generation, but an increase in sulphur from industrial processes.

21. The review team had considered four types of uncertainties: those in basic scientific understanding; those due to assumptions and simplifications in the model design; those due to statistical variance in input data; and those related to socio-economic and technological developments. It recommended that the Convention's task forces and expert groups should review the uncertainties associated with RAINS, in particular factors causing bias. It also recommended screening the scientific knowledge used for each module in RAINS with respect to: the general maturity of the theory; the understanding of the mechanism and process; and empirical evidence and field observations. The workshop agreed that sensitivity analysis illustrated the influence of uncertainties on model results.

22. Ms. H. ApSimon (Imperial College, United Kingdom) presented the Abatement Strategy Assessment Model (ASAM). The workshop agreed that regional studies could supplement RAINS modelling by exploring local and regional cost-effective solutions that could reduce the need for Europe-wide actions. These could include non-technical measures such as spatial planning around sensitive ecosystems as well as traffic management in cities.

23. Mr. F. Wagner (CIAM) reported on the Greenhouse Gas Interactions and Synergies (GAINS) model. GAINS covered anthropogenic sources of greenhouse gas emissions including available mitigation options and costs. Mr. Amann noted the co-benefits of greenhouse gas mitigation on air pollution. The workshop agreed that since both greenhouse gases and air pollutants originated from the same sources, the potential for co-benefits from abatement measures was high.

III. CONCLUSIONS AND RECOMMENDATIONS

24. The workshop agreed that:

(a) The process of developing and improving RAINS had not ended. Negotiations on the revision of the Gothenburg Protocol were expected to begin in 2006 and the European Commission had planned to use RAINS to revise its national emissions ceilings (NEC) directive. RAINS was expected to play a pivotal role in both. It was seen as an important analytical tool, critical to policy processes, with a descriptive rather than a prescriptive function;

(b) While achievements had been significant, further improvements in RAINS should include PM modelling, dynamic modelling of ecosystems, improved source-receptor relationships, sub-grid processes and effects of local measures, as well as further development of energy and agricultural scenarios and options for non-technical measures. The inclusion of greenhouse gas abatement measures was supported;

(c) For uncertainty analysis, a systematic compilation of biases for the different modules, with suggestions from the Convention's task forces and expert groups, would be useful;

(d) Target setting was a priority policy issue and should be considered by the Working Group on Strategies and Review;

(e) Parties could gain more confidence in the RAINS model by being active on data support (scenarios, emissions, critical load inventories) and by applying RAINS nationally or regionally;

(f) Communication and transparency were important components of the model to help attain legitimacy, encourage participation and influence the process. The use of, and feedback on, RAINS via the Internet was encouraged: <http://www.iiasa.ac.at/web-apps/tap/RainsWeb>;

(g) The next meeting of the Task Force on Integrated Assessment Modelling would be held from 25 to 27 May 2005, in Berlin.