Applied Research Institute – Jerusalem (ARIJ)
P.O.Box 860, Caritas St.
Bethlehem, Palestine
Tel: +972-(02)-277-0535
Tel: +972-(02)-274-1889

Middle-East Transboundary Pollutant Transport Study

R. Bornstein*, M. Luria[+], Y. Mahrer[+], M. Peleg[+], D. Rammar[+], E. Weinroth[+],
E. Tas[+],V. Matziev[+], E. Feitelson[+], J. Kaplan[+], U. Dayan[+], J. Issac[#], H. Maoh[#],
M. Ghanayem[#], J. Safi[0],Y. Einahhal[0], A. Bitan^, E. Ben-Dor^, I. Benenson^,
Setter[%], & Y. Levi[%]

[*]San Jose State University, San Jose, CA, USA
[+]The Hebrew University, Jerusalem, Israel
[#]Applied Research Institute-Jerusalem, Bethlehem, West Bank
[0]Environmental Protection & Research Institute, Gaza City, Gaza
^Tel Aviv University, Tel Aviv, Israel
[%]Israel Meteorological Service, Bet Dagan, Israel

1. Introduction

The overall aim of this USAID sponsored project is to generate information required by govern-ment air quality planning agencies in Israel and West Bank/Gaza to develop strategies for the socially and environmentally sustainable urbanization of their coastal areas. The project research team is composed of experts (from Israel, West Bank/Gaza, and U. S.) in meteorology, atmo-spheric chemistry, pollutant emissions, land use/GIS, (urban and regional) planning, and socio-economic impacts.

Specific research objectives include: (1) Installation of environmental monitoring sites and prep-aration of a comprehensive environmental database and a regional climatology, (2) Intensive field observational campaigns during periods conducive to poor regional air quality during July 2002, (3) Adaptation and application of the RAMS meteorological model and the CAMx photo-chemical air quality model to increase understanding of air quality problems.

2. Objectives

The overall aim of the proposed effort is to generate the information required by government planning agencies in Israel and West Bank/Gaza to develop strategies for the socially and en-vironmentally sustainable development of their coastal areas. The four

Applied Research Institute – Jerusalem (ARIJ)
P.O.Box 860, Caritas St.
Bethlehem, Palestine
Tel: +972-(02)-277-0535
Tel: +972-(02)-274-1889

main research objectives instrumental to achievement of the above overall aim are (Bornstein et al. 2001)[1]:

Objective 1: Data Bases

The main objectives of this task are: (1) installation of three new environmental monitoring sites in the Gaza and West Bank and (2) preparation of a comprehensive environmental data base and climatology of the study area.

Objective 2: Field Studies

The main objective of this task is the execution of short-term intensive field observational campaigns during meteorological conditions producing poor regional air quality. Such campaigns involve measurement of both meteorological and air quality parameters.

Objective 3: Modeling Current Conditions

The main objective of this task is the adaptation and application of appropriate meteorological and air quality model to the study area to increase understanding of air quality problems associated with current levels of regional urbanization. Meteorological, air quality, geographic, and emission data collected to satisfy Objectives 1 and 2 will be used to initialize and evaluate the accuracy of these simulations of current emission patterns. Verification of model results against available meteoro-logical and air quality data will provide confidence limits of the ability of the selected models to carry out the planning simulations using input based on a variety of possible development strategies.

Objective 4: Modeling Possible Future Conditions

The main objective of this task is simulation of possible future regional meteorological and air qual-ity patterns using validated models of Objective 3. The models will be applied to a variety of poten-tial urban growth/emission scenarios associated with various urban/industrial development plans supplied by government planning agencies. Results will aid governmental development agencies concerned with regional air quality trends of societal (health and economic) air pollution impacts.

3. Accomplishments

Objective 1: Databases

With respect to the new environmental monitoring sites:

1. Required instruments were selected to be the identical to those used in Israel.

Applied Research Institute – Jerusalem (ARIJ)
P.O.Box 860, Caritas St.
Bethlehem, Palestine
Tel: +972-(02)-277-0535
Tel: +972-(02)-274-1889

2. Building, exposure, infrastructure, and communications criteria for the three new sites were determined.
3. Three sites fulfilling the above criteria were identified.
4. Instruments were delivered.

With respect to environmental database and climatology:

1. The required (for modeling) already processed meteorological, air quality, emissions, and geo-graphic parameters were identified.
2. The required period of data coverage was identified (i.e., planned summer 2002 field study).
3. The locations of the future joint shared databases were determined as the HUJI and ARIJ.
4. Discussions were begun on how to construct the required databases.

With respect to emission database preparation

1. The Canadian EMME/2 model was used to estimate the spatial distribution of 1997 and 2000 transportation emissions (Kaplan 1997)[5]. The effort started with GIS distributions of urbanized, industrialized, and roadway areas. These data were then combined with estimates of roadway, population, home, workplace, and fuel usage patterns. Pollutant emission factors were then calcu-lated using observations from concurrent field measurements at highway-tunnel entrances and exits (Tratakovsky et al. 1997)[8] and from California automobile emission factors (Pierson et al. 1996)[7]. Finally, all data sets were input into EMMA/2 to produce both urban-nodal (at urban center points) and highway segment (at midpoint of segment) emission values for an average workday peak activ-ity hour (0800-0900 LST or 0600-0700 UTC). Emission values are thus provided for total organic com-pounds (TOC), carbon monoxide (CO), and nitrogen oxides (NO_x) for all points in Israel and the West Bank (Weinroth 2001)[9]. Average vehicle-count data for the latter area were supplied as part of a German sponsored Trilateral Research effort.

2. The first (transportation, stationary, and biogenic) emission inventory for the study area for 1997 was compiled. The first step involved use of the Kaplan transportation data in conjunction with Kleindienst (1992)[6] empirical relationships, derived from chemical chamber measurements. Sta-tionary point-source emissions were tabulated for the following source types: 10 large (electric gen-erators, oil refineries, and cement factories), about 400 medium (factories), and various small (every-thing not in first two categories, and lumped together as area-source emissions). Civilian aircraft takeoff and landing emissions were calculated in a slanted three-dimensional line source along a corridor between Ben Gurion Airport and the Mediterranean coast, where aircraft are above the mixing layer. Area-source biogenic volatile organic compound (VOC) emissions were calculated from GIS vegetation coverage data.

With respect to climatology

The report of Dyan (2001)[2] details the following aspects of the air-pollution climatology of the study area: large scale climate forcings, regional air masses, large scale wind and pressure patterns, regional wind flows, seasonal winds, sea-surface, air, and soil temperatures, heat fluxes, relative hu-midity, and atmospheric stability. The report will be useful in planning various aspects of the pro-posed field-study measurement programs, e.g., selection of times when different large scale systems should produce ozone episodes at various locations within the study region, locations for the various surface and upper air measurement systems, and the appropriate frequency of the measurements.

Objective 2: Field Studies

With respect to the execution of short-term intensive field observational campaigns during periods conducive to the existence of periods with poor regional air quality, the following schedule was originally established and partly carried out:

1. Feb 2000: A successful preliminary field observational study was carried out to estimate the flux of pollutants from Gaza into Israel. This involved deployment of the HUJI mobile laboratory, equipped with a large variety of in situ surface meteorology and air quality instrumentation, as well as with the remote sensing DOAS system. Results showed that all systems worked properly.

2. June 2000: Another successful similar preliminary field observational study was carried out to estimate the flux of pollutants from Israel into the West Bank. Again the systems worked well.

3. June 2002: The two above preliminary field studies were carried out in preparation for this main study, but additional time will be required to coordinate all the equipment and groups necessary for this larger study. This final campaign will involve measurements of meteorological and air quality parameters by project scientists, as well as by a number of visiting international meteorological and chemical measurement groups who have expressed an interest in joining the study.

Objective 3: Modeling Current Conditions

With respect to the adaptation and application of appropriate meteorological and air quality models to the study area to gain an increased understanding of the air quality problems associated with cur-rent levels of regional urbanization, the following has been accomplished:

1. The RAMS model was selected as the study meteorological model.

2. The HYPACT Lagrangian particle model was selected to carry out the preliminary air pollutant transport study (Luria et al. 2001)[4].
3. The CAMx photochemical model was selected as the study chemical model.
4. The UAH1D chemical mechanism model was selected to allow for development of new chemical mechanisms tailored for the climate and emission mix of the current study area.
5. Additional state of the art chemical mechanisms developed in Europe have been tested at Stan-ford (Jacobson 2001). These mechanisms will be inserted into the CAMx photochemical model.
6. The urbanization of MM5, and updating of the PAVE graphics package (based on the NCAR package) and MAPS statistical evaluation package has been carried out at SJSU. The first effort will expand the capabilities of RAMS to better simulate the effects of urban areas on regional flow patters. The latter two packages, supplied by Alpine Geophysics, Inc., will improve the graphical presentation and statistical evaluation opportunities, respectively, for output fields generated by RAMS, CAMX, and HYPACY. MAPS have been expanded under this project, and can now carry out statistical evaluations on arbitrary specified sub-domains. PAVE has likewise been expanded, and is now able to construct vertical cross-sections in arbitrary directions, so that model output can be directly compared to observations.
7.Research scientists at the U.S. EPA Research Triangle Park (RTP), North Carolina re-search cen-ter have expressed interest in the application of their new MODELS3 photochemical system to Israel, Gaza, and the West Bank.

Objective 4: Modeling Possible Future Conditions

With respect to the final objective, discussions have been carried out with urban planners to identify mechanisms for determination of the emission scenarios to be tested in the models.

4. Future Work

With respect to Objective 1: Data Bases

1. The three monitoring sites will be prepared (i.e., with respect to security, power supply, commun-ications, etc.) for the installation of the instruments.
2. The instruments will be made operational and installed at the three West Bank/ Gaza sites.
3. Meteorological, air quality, emissions, and geographic data required for modeling will continue to be collected.
4. Construction of databases at HUJI and ARIJ will continue.

With respect to Objective 2: Field Studies

With respect to the execution of short-term intensive field observational campaigns during periods conducive to the existence of poor regional air quality, during June 2002

measurements of the reg-ional transboundary pollutant fluxes will be made. This (final) campaign will involve measurement of both meteorological and air quality parameters by project scientists and students.

With respect to Objective 3: Modeling Current Conditions

With respect to the adaptation and application of appropriate meteorological and air quality mod-els to the study area to increase understanding of air quality problems associated with current levels of regional urbanization, the following will continue:

1. RAMS meteorological model will be used to simulate additional flow cases
2. HYPACT Lagrangian particle model will be used to simulate additional transport patterns
3. CAMX photochemical model will be tested using output from the above RAMS simulations, a
regional first
4. UAH1D chemical mechanism model will be tested, with new routines (appropriate for local
climate and emission mixes) developed as needed
5. chemical mechanisms used at Stanford University (Liang and Jacobson 2000)[3] will be tested in
the CAMx photochemical model
6. SJSU/Alpine Geophysics urbanization, PAVE graphics, and MAPS statistical evaluation pack-
ages will be used to improve the graphical presentation and statistical evaluation capabilities for out-put from the RAMS, CAMx, and HYPACY models
7. new U.S. EPA MODELS3 photochemical system will be made available via

collaboration with the EPA RTP Lab.

With respect to Objective 4: Modeling Possible Future Conditions

With respect to the simulation of possible future regional meteorological and air quality patterns using the validated models of Objective 3, the following will be done:

1. discussions will continue with transportation planners to identify various possible future regional emission scenarios to be tested in the models during the final project phase

Applied Research Institute – Jerusalem (ARIJ)
P.O.Box 860, Caritas St.
Bethlehem, Palestine
Tel: +972-(02)-277-0535
Tel: +972-(02)-274-1889

2. planning simulations will study environmental impacts from projected populations during the years 2010 and 2020 (when the regional population will have doubled from its present value).

Applied Research Institute – Jerusalem (ARIJ)
P.O.Box 860, Caritas St.
Bethlehem, Palestine
Tel: +972-(02)-277-0535
Tel: +972-(02)-274-1889

5. References

1. Bornstein, R., et al., 2001: Transbounmdry air-quality effects from urbanization. SJSU report to USAID, 215 pp.

2. Dayan, U., 2001: Air pollution meteorolgy in Israel. Unpublished HUJI report.

3. Liang, J., and M. Jacobson, 2000: Comparison of a 4000-reaction chemical mechanism with the Car-bon Bond IV and an adjusted Carbon Bond IV-EX mechanism. Atmos. Environ., 34, 3015-3026.

4. Luria, M., Mahrer, Y., Peleg, M., Rammar, D., Tas, E., Matziev, V., Feitelson, E., Kaplan, J., and Dayan, U., 2001: The impact of coastal transportation emissions on inland air pollution over Israel. Submitted to *Atmos. Environ*.

5. Kaplan J., 1997: Model Structure and Data Requirements. Working Paper for the Trilateral Research Project on GIS Tools for Sustainable Transport in Palestine and Israel.

6. Kleindienst T., et al., 1992:. The Photo-oxidation of automobile emissions -- measurements of the transformation products and their mutagenic activity. *Atmos. Environ.*, **26,** 3039-3053

7. Pierson W., et al., 1996: Real world automobile emissions – Summery of studies in Fort Mc-Henry tunnel. *Atmos. Environ.*, **30,** 2233-2256.

8. Tratakovsky L., et al., 1997:. Estimation of vehicles emission factors in Israel, *Research report –Technion Israel Institute of Technology, Transportation research Institute,* 87 pp.

9. Weinroth, E., 2001: Emission inventory for Israel. Unpublished HUJI report.

Presented 5-8 Decmber 2001 Tampe Arizona 6pp