Asian Regional Research Programme on Environmental Technology (ARRPET)

Improving Air Quality in Vietnam

By

Hoang Xuan Co

Faculty of Environmental Sciences
Hanoi University of Science
334 Nguyen Trai road, Hanoi, Vietnam

and

Nghiem Trung Dung

Institute for Environmental Science and Technology
Hanoi University of Technology
1 Dai Co Viet road, Hanoi, Vietnam

ACTIVITIES AND ACHIEVEMENTS

1. Monitoring issue
2. Modeling issue
3. Policy study

MONITORING ISSUE

Sampling and analytical information

Site	Type of PM	Samplers	No. of samples		Filters used	Parameters analyzed
			Dry season	Wet season		
Mixed	$PM_{2.5}$	Dichot	58	11	Cellulose 37 mm	Element
	$PM_{2.5-10}$	Dichot	58	11		
	PM_{10}	LoVol	50	11	Quartz, 47 mm	Ions, PAHs, BC
	TSP	HiVol	57	11	Glass fibre 8x10 inches	PAHs, BC
Background	PM_{10}	LoVol	59	12	Cellulose 47 mm	Element
	PM_{10}	HiVol	58	12	Glass fibre 8x10 inches	PAHs, BC
Residential	$PM_{2.5}$	Dichot	10	5	Cellulose 37 mm	Element, BC
	$PM_{2.5-10}$	Dichot	10	5		
	PM_{10}	LoVol	10	5	Quartz, 47 mm	Ions, PAHs
	TSP	HiVol	7	5	Glass fibre 8x10 inches	-
Commercial	$PM_{2.5}$	Dichot	7	5	Cellulose 37 mm	Element, BC
	$PM_{2.5-10}$	Dichot	7	5		
	PM_{10}	LoVol	7	5	Quartz, 47 mm	Ions, PAHs
	TSP	HiVol	7	5	Glass fibre, 8x10 inches	-
Traffic	PM_{10}	LoVol	10	-	Cellulose 47 mm	Element, BC
	PM_{10} (Q)	LoVol	10	5	Quartz, 47 mm	Ions, PAHs, BC
	TSP	HiVol	10	-	Glass fibre 8x10 inches	PAHs
	PM_{10}	HiVol	-	5	Glass fibre 8x10 inches	Ions PAHs, BC
Total of samples collected			435	118		

Sampling and analytical information

- **Number of sampling site: 5**
- **Number of sample: 579 (479-dry and 118-wet)**
  - **$PM_{2.5}$: 118**
  - **$PM_{2.5-10}$: 118**
  - **PM_{10}: 259**
  - **TSP: 102**
- **Samplers used: Dichot, Low Vol, High Vol**
- **Parameters analyzed: elements, ions, PAHs, BC**

Information on analytical methods

Parameters analyzed	Analytical method
Mass	Microbalance
12 and 33 Elements	XRF and ICP/MS
8 Ions	IC
PAHs	HPLC and GC/MS
BC	Light reflectance

QA/QC

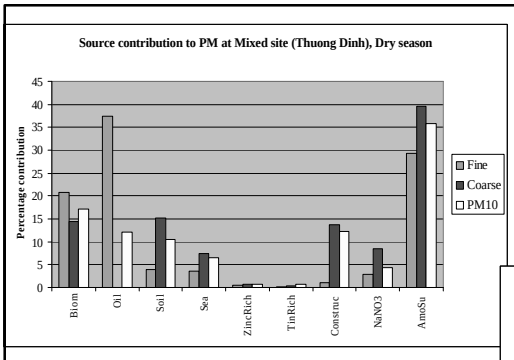
For sampling	For analysis
• Weighing filters before and after sampling at the same conditions • Collocated samplers • Blank samples	•Using filters with low blank levels •Using SRM samples •Using different analytical methods for the same parameters •Ion balance

- **Average concentrations of PM in the dry season were higher than those in the wet season.**
- **In both seasons, the lowest levels of PM_{10} were found at the mixed site while the highest levels of PM_{10} were found at the traffic site.**
- **In the dry season, except the background site and the mixed site, the average concentrations of PM_{10} at the remaining sampling sites were higher than U.S. 24-hour standard for PM_{10} and higher than allowable concentration of TSP regulated by Vietnamese Standard.**
- **The average concentrations of PM_{10} at all sampling sites in the wet season were lower than U.S. 24-hour standard for PM_{10}.**
- **The concentrations of ions, especially of SO42-, NO3-, NH4+, Ca2+ and Cl-, cover high rate of total PM10 mass in both dry and wet season**
- **BC concentration on PM10 is highest at traffic site, especially in dry season.**

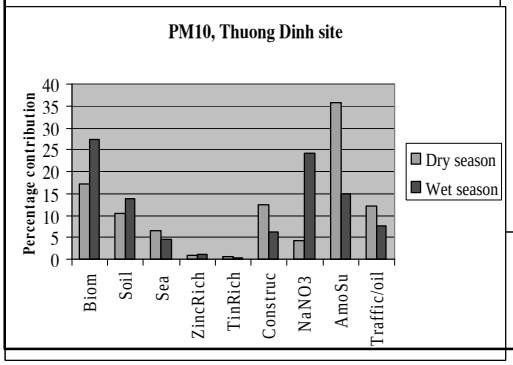
MODELING ISSUE

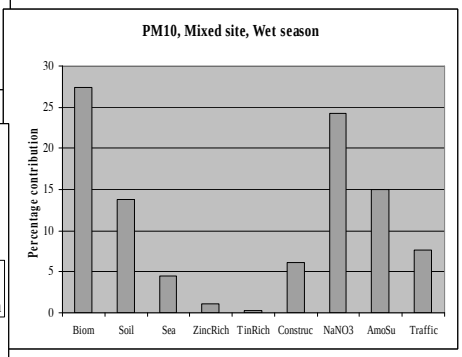
RECEPTOR MODEL

CMB and PMF receptor model were used for source apportionments at the five sites and in two seasons

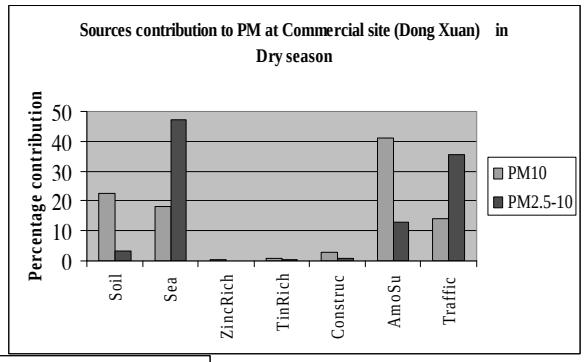


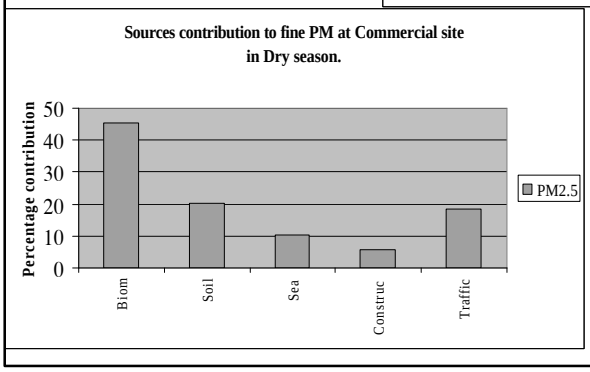
CMB 8





CMB 8





Dry season CMB results

- **Main sources contributed to PM at Mixed site (TD) are ammonia sulphate, oil burning (in fine PM), refuse and biomass burning, soil and construction. High percentage contribution of ammonia sulphate with high concentration of SO_4^{2-} showed that PM collected at this site comes not only from local sources, but also from the long distance source.**

- **Main sources contributed to PM at at Residential site (Bach Khoa) in dry season are traffic and/or oil burning, biomass burning and construction.**

- **Main sources contributed to coarse PM and PM10 at Commercial site are sea/sea products, traffic, ammonia sulphate and soil.**

- **Main sources contributed to fine PM at Commercial site are biomass, soil and traffic one. In comparison, the biomass source contributed in high level to PM10 and coarse PM, and ammonia sulphate source contributed in high level to fine PM could be collinear one another.**

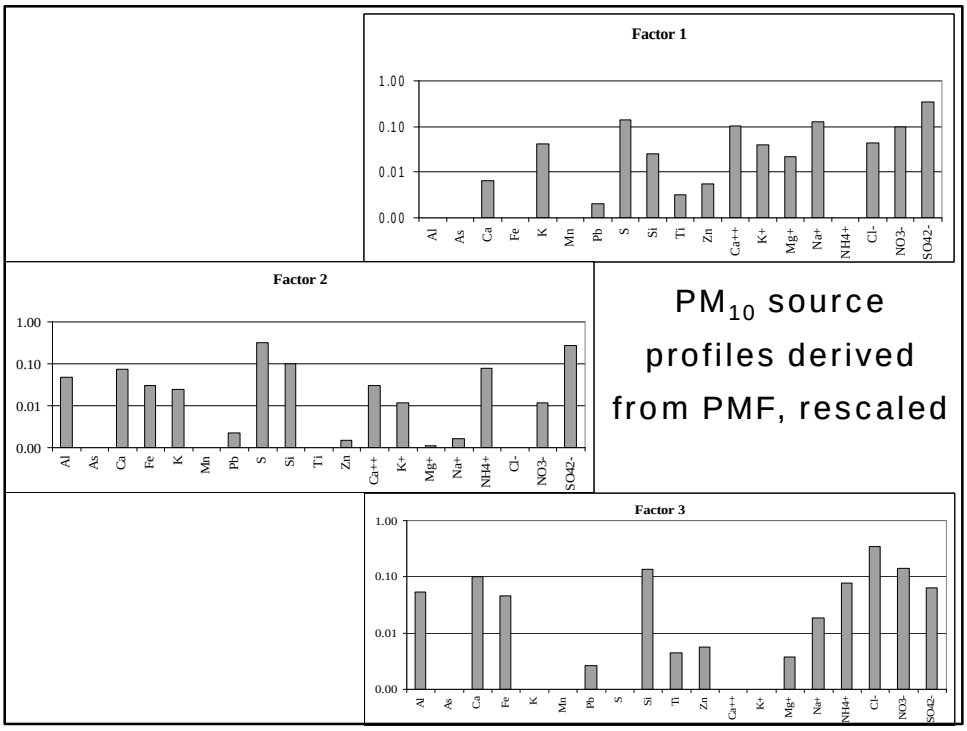
- **The monitoring data of Traffic site and background site was not good enough for CMB8 model.**

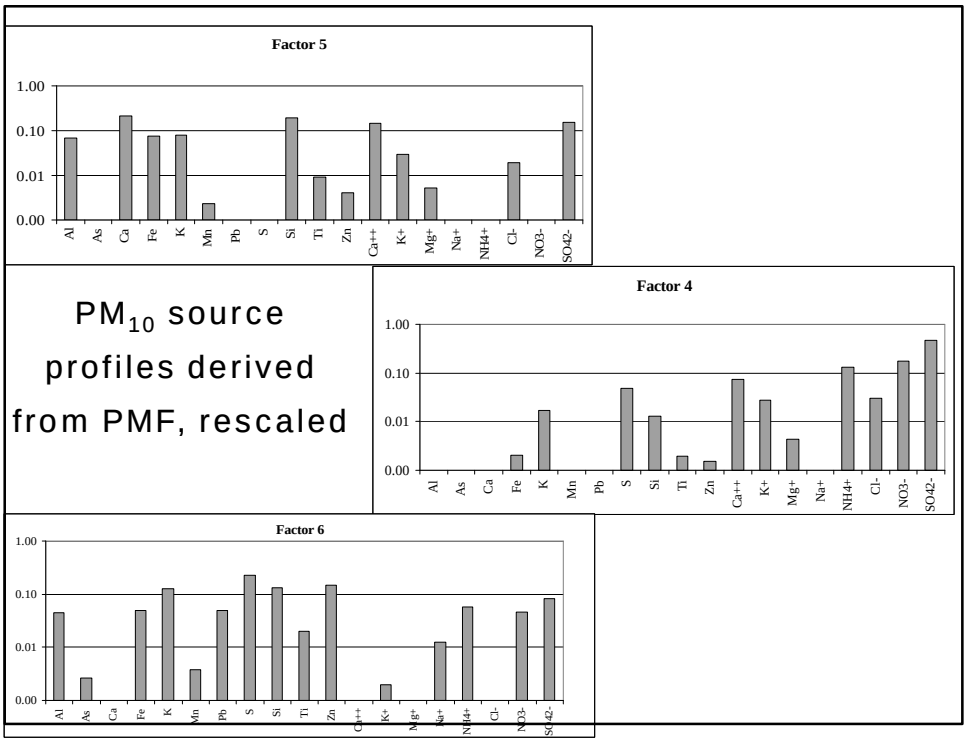
Wet season CMB results

- **Main sources contributed to PM_{10} at Mixed site in wet season are biomass burning, ammonia sulphate, sodium nitrate and soil.**
- **In comparison, contribution of biomass burning, soil and sodium nitrate sources in wet season is higher than in dry season while contribution of ammonia sulphate, construction and traffic sources in dry season is higher than in wet season.**
- **The data from other sites is not good enough for CMB8 model.**

PMF

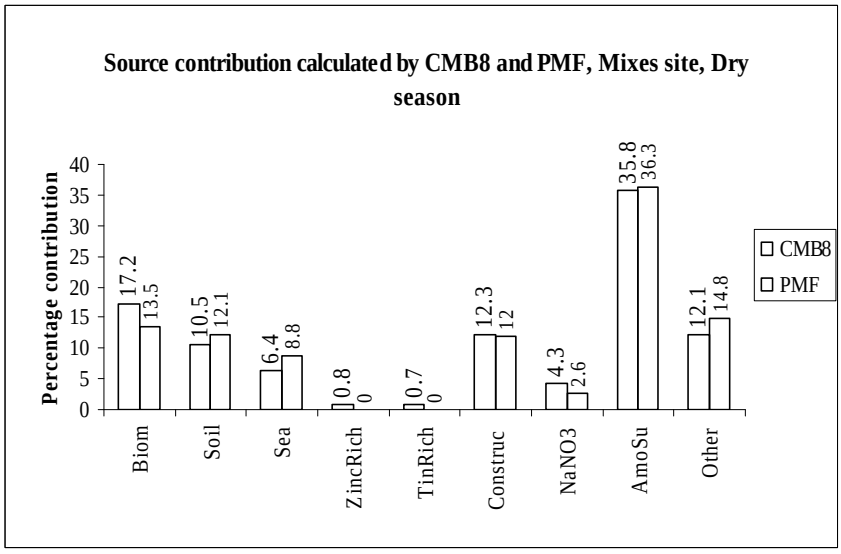
- **The only monitoring data of PM_{10} at Mixed site is good enough for PMF model. In Mixed site (TD), the elements, ions and BC were used as input data for PMF model.**
- **There are 6 factors/sources were found:**
  - **Factor 1: Biomass burning source**
  - **Factor 2: Sea source**
  - **Factor 3: Construction source**
  - **Factor 4: Ammonia sulfate source**
  - **Factor 5: Road dust/soil source**
  - **Factor 6: Sodium nitrate source**


Factor 1
1.00
0.10
0.01
0.00
Al As Ca Fe K Mn Pb S Si Ti Zn Ca++ K+ Mg+ Na+ NH4+ Cl- NO3- SO42-
Factor 2
1.00
0.10
0.01
0.00
Al As Ca Fe K Mn Pb S Si Ti Zn Ca++ K+ Mg+ Na+ NH4+ Cl- NO3- SO42-
PM10 source profiles derived from PMF, rescaled
Factor 3
1.00
0.10
0.01
0.00
Al As Ca Fe K Mn Pb S Si Ti Zn Ca++ K+ Mg+ Na+ NH4+ Cl- NO3- SO42-


Factor 5
1.00
0.10
0.01
0.00
Al As Ca Fe K Mn Pb S Si Ti Zn Ca++ K+ Mg+ Na+ NH4+ Cl- NO3- SO42-
PM10 source profiles derived from PMF, rescaled
Factor 4
1.00
0.10
0.01
0.00
Al As Ca Fe K Mn Pb S Si Ti Zn Ca++ K+ Mg+ Na+ NH4+ Cl- NO3- SO42-
Factor 6
1.00
0.10
0.01
0.00
Al As Ca Fe K Mn Pb S Si Ti Zn Ca++ K+ Mg+ Na+ NH4+ Cl- NO3- SO42-

PMF model results

- The mass contribution of ammonia sulphate source to PM_{10} at Mixed site is the highest (about 36%). This source and sea source can be in long distance to the monitoring site.
- Other sources can be the local ones.
- The source contribution calculated by CMB8 model is close to the source contribution calculated by PMF model.



DISPERSION MODEL

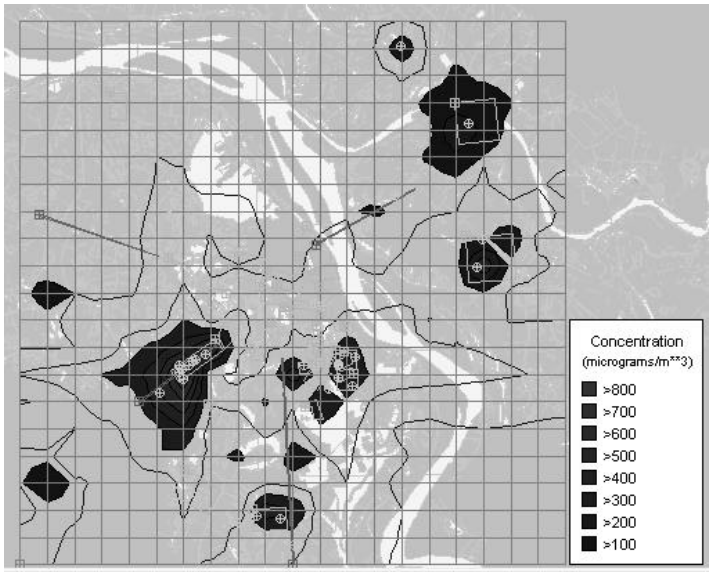
• ISC3 model were developed using local data for one year meteorological data ordered from NOAA was used for this purpose, too.

• Three scenarios with different assumptions of socio-economic development and air quality management tools were developed and assessed:

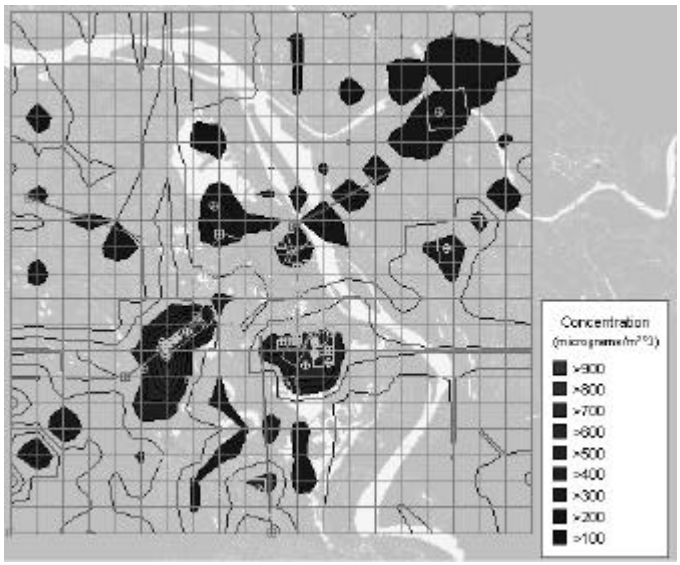
- **❖Scenario 1: Emission in 2010 without countermeasure**
- **❖Scenario 2: Emission in 2010 with countermeasure**
- **❖Scenario 3: Reduce of emission rate of some of point sources in 2002**

• The ISC3 was run successfully and the results were analysed and assessed, too.

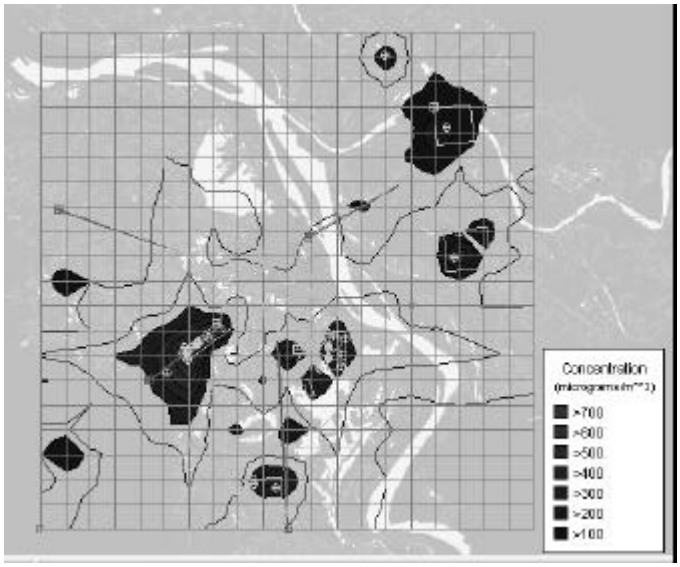
Hourly highest concentrations of SPM calculated by ISC3ST model using NOAA meteorological data, case 2002 (base case)



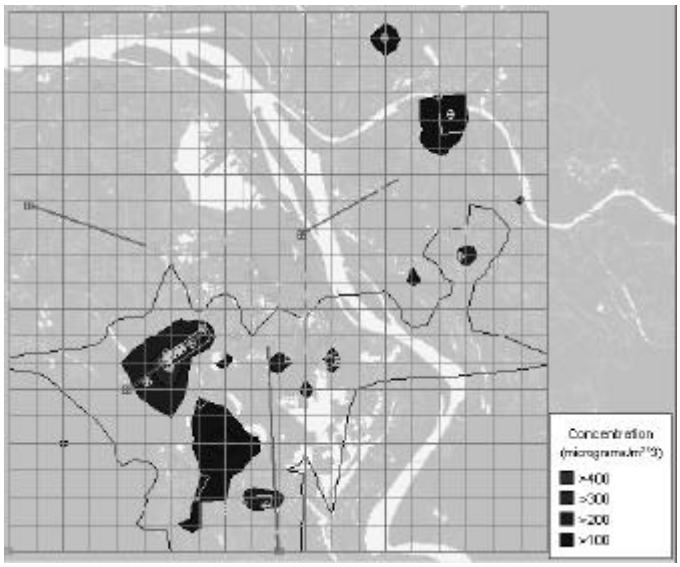
Hourly highest concentrations of SPM calculated by ISC3ST model using NOAA meteorological data - scenario 1



Hourly highest concentrations of SPM calculated by ISC3ST model using NOAA meteorological data - scenario 2



Hourly highest concentrations of SPM calculated by ISC3ST model using NOAA meteorological data - scenario 3



➢ **The results of ISC3 model estimated the current status of air quality in Hanoi, and indicated that some areas nearby the industrial zones and areas of high population density in Hanoi were polluted by TSP.**

➢ **The air quality of Hanoi in 2010 will be more serious than 2002 if no countermeasure of reducing the emission sources and emission rate is employed (scenario 1).**

➢ **With current environmental planing (scenario 2), the emission rate in some sources can be reduced but the amount of sources will increase, so the air quality of Hanoi in 2010 will be more or less at the same level as in 2002.**

➢ **One of the efficient ways for reducing the concentration of TSP is removal of old enterprises from inner Hanoi city and/or using the new technology and high efficiency treatment system as in scenario 3.**

POLICY STUDY

- **Health effects by PM were conducted in Phu Thi - background site and Thanh Xuan - mixed site.**
- **A cross-section study with controlled groups was conducted for evaluating the effect of air pollution on health of people living near the mixed site and near the background site.**
- **The results of a direct survey by 1.481 people from 412 households have revealed as follows:**

Effect on respiratory system

	Phu Thi	Thanh Xuan Bac	P
- Upper respiratory tract injury symptoms	13.1%	36.1%	<0.01
- Chronic bronchitis	2.8%	6.5%	<0.01
- Lower respiratory tract injury symptoms	15.5%	18.9%	>0.05

- The rate of people with symptoms or/and disease related to respiratory tract injury in mixed site is higher than those in background, especially, the rates suffering from symptoms of upper respiratory tract injury and chronic bronchitis.
- The rate suffering from upper and lower respiratory tract injury of children is higher than those of adults in both study sites.

Symptoms of sick building syndrome (SBS)

	Phu Thi	Thanh Xuan Bac	P
Symptom of eye	16.0%	29.4%	< 0.01
Symptom of nose	13.7%	20.2%	< 0.01
Symptom skin	6.5%	17.6%	< 0.01
Symptom of throat	26.3%	31.3%	< 0.05

- The rate of people with symptoms of SBS (sick building syndrome) at eyes, nose, throat and skin in mixed site is significantly higher than those in back ground.
- The rates suffering from these symptoms of children are higher than those of adults in both study sites.

WORK PLAN
OF PHASE II

3 main issues:

- Monitoring issue
- Modeling issue
- Air quality control in Brick Manufacturing Village

Monitoring issue:

- **Select 8 monitoring sites (4 old ones in Hanoi as in Phase 1; 4 new ones outside Hanoi)**
- **<u>For 4 old sites in Ha Noi:</u> focus mainly on mixed site and traffic site.**
  - ✓ TD (mixed site) and CD (traffic site): 60 samples in wet season and 15 samples in dry season for each. Total is 150 samples.
  - ✓ BK (residental site) and GL (back ground site): 15 samples in wet season and 15 samples in dry season for each. Total is 60 samples**.**
- **<u>For 2 new sites:</u> focus mainly on Bac Ninh site (the typical site of the Red river delta area):**
  - ✓Bac Ninh site: 50 samples in dry season and 15 samples in wet season. Total is 65 samples.
  - ✓Tam Dao (background) site: 20 samples in each season for each site. Total is 40 samples.

<u>Source profile development</u>

2 sources:

- **Coal burning**
- **Biomass burning**

Modeling issue

- **Continue to use receptor model CMB8, PMF and dispersion model ISC3 with new input data and new source profile**
- **Photochemical smog model application:**
  - ✓ **UAM-V/SAIMM and Model 3**
  - ✓ **Data (2000-2004) mainly from the Auto Station and Upper Air Station.**
  - ✓ **Expected output: the result could be used to forecast the situation of the air quality in research areas.**

Air quality control in Brick Manufacturing Village

- **Regulation study and recommendation**
- **Selection of low cost technology for SO_2 and PM emission mitigation**
- **Design and install the system for controlling SO_2 and PM**
- **Monitoring and evaluating the system efficiency**
- **Cost-benefit analysis for estimating the economic efficiency of policies**

National workshops

- 12/2004: Methodology workshop (organizing)
- 2005: Photochemical smog model application workshop
- 2006: First progress workshop
- 2007: Final workshop

Thank you for your attention!