

Urban Outdoor Particulate Air Pollution: New Estimates

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Key Points of the Presentation

- Lack of city specific environmental indicators are a detriment to effective action.
- World Bank has developed a model to estimate PM10 concentrations for all world cities larger than 100,000.
- Health Impacts of urban particulate matter outdoor air pollution are substantial.
- The dissipative capacity of the environment is significantly different across cities. National urban policy needs to incorporate differential shadow prices.

Health Impacts of PM Air Pollution

- **Most Health Impacts of air pollution are from fine particles PM_{2.5}/PM₁₀ not from coarser TSP, SO_x, NO₂**
- **Particulate Emissions has been linked to mortality and morbidity**
 - **Cardiopulmonary diseases**
 - **Lung Cancer**
 - **Acute Respiratory Infection**

Health Impacts of Air pollution

- WHO estimates 800,000 (range 530,000 to 1,260,000) worldwide deaths per year from background level of ambient PM pollution.
- Health Impact Estimates based on World Bank PM10 estimates for 3200+ cities worldwide.
- Health Impacts would be even higher if impacts from exposure to high concentration microenvironments such as along transport corridors or industrial districts were included.

Developing Air Pollution Policy

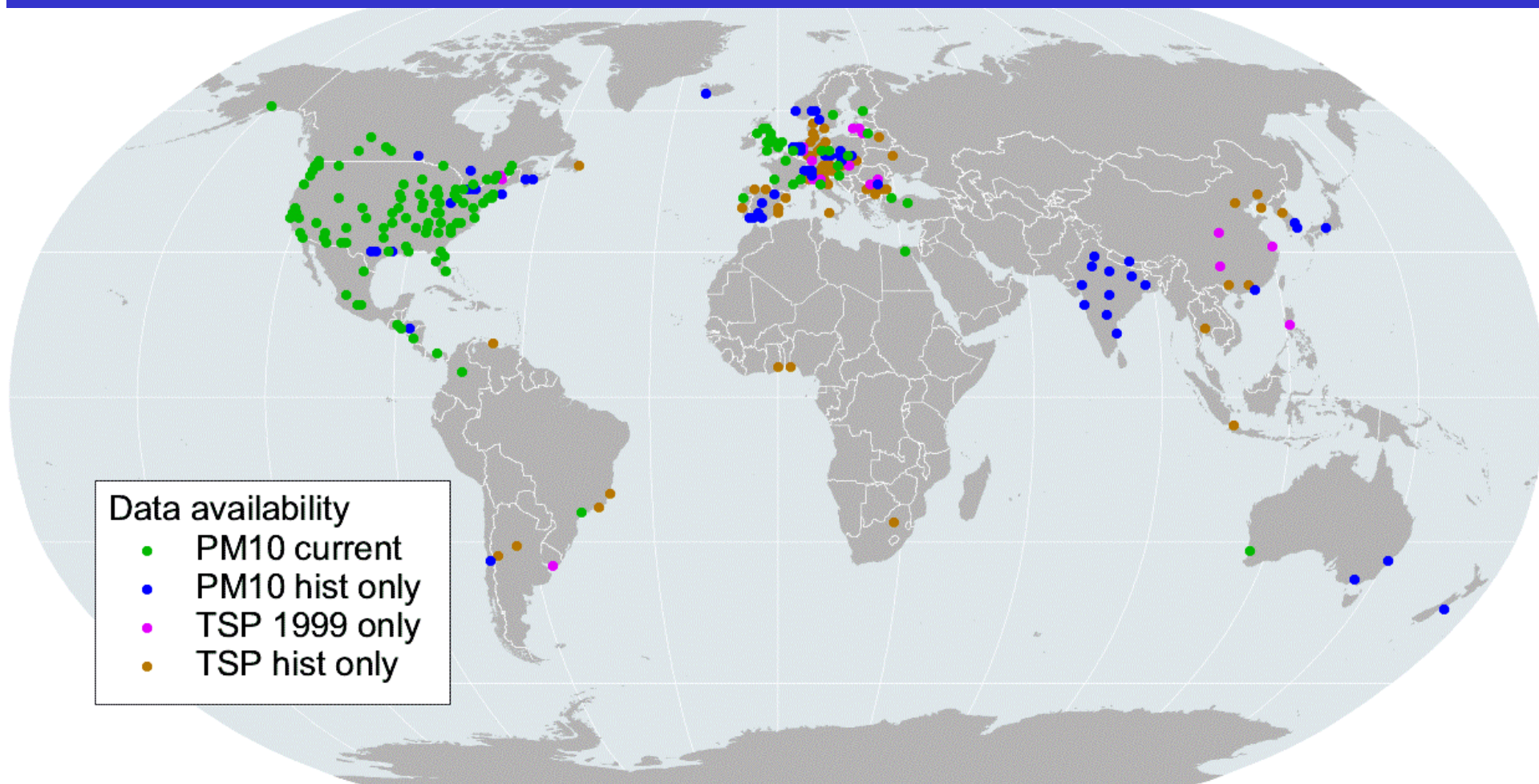
- **Pollutant Ambient Concentrations**
- **Spatial Exposure Model**
- **Health Impacts Estimate**
- **Economic Valuation of Impacts**
- **Cost Benefit Analysis of Policies**

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Developing Air Pollution Policy

- **Emission Inventory**
- **Spatial Dispersion Model**
- **Pollutant ambient concentration (benchmark)**
- **Spatial Exposure Model**
- **Health Impacts Estimate**
- **Economic Valuation of Impacts**
- **Cost Benefit Analysis of Policies**

Cities with Monitored PM Data



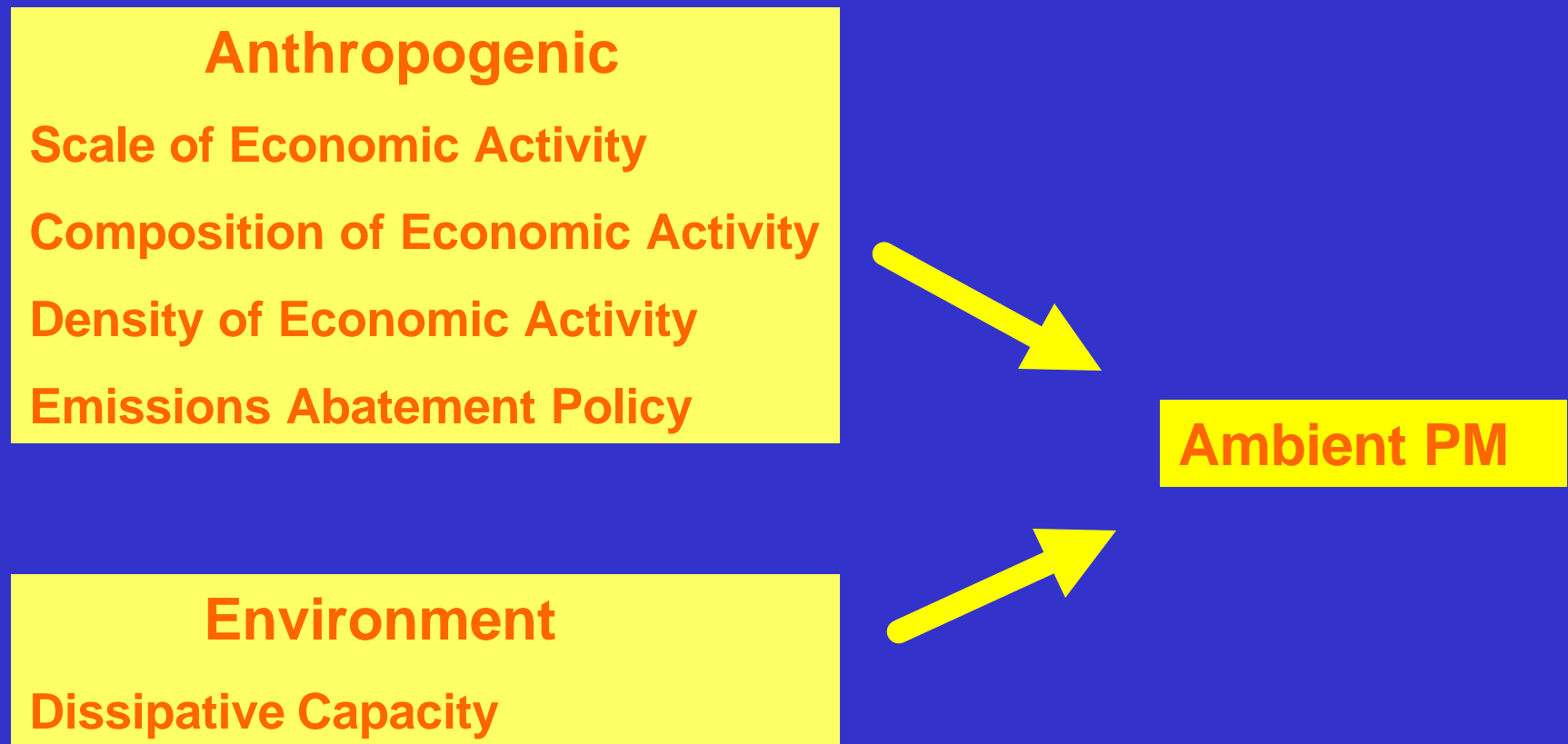
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Availability of Monitored PM Data by WHO Sub-Region

		Number of cities			Urban Population 2000*		
WHO Region	Mort stra Chld/adlt	Cities in region	Cities with monitors	% with monitors	Cities in region	Cities with monitors	% with monitors
Africa	H/H	107	2	2%	66,960	14,914	22%
Africa	H/VH	105	1	1%	68,367	2,388	3%
America	VL/VL	267	123	46%	232,439	178,240	77%
America	L/L	399	19	5%	217,159	64,121	30%
America	H/H	47	2	4%	29,512	3,291	11%
EMediter	L/L	89	0	0%	56,621	-	0%
EMediter	H/H	126	1	1%	99,397	8,124	8%
Europe	VL/VL	429	95	22%	161,808	79,160	49%
Europe	L/L	182	22	12%	81,756	21,494	26%
Europe	L/H	275	7	3%	109,178	7,670	7%
SEAsia	L/L	68	2	3%	53,708	18,793	35%
SEAsia	H/H	356	11	3%	214,175	67,081	31%
WPacific	VL/VL	242	5	2%	100,079	11,459	11%
WPacific	L/L	519	14	3%	528,318	81,817	15%
World		3211	304	9%	2,019,479	558,553	28%

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Model of Ambient PM



Model of Ambient PM

**Regression model of PM based on
available monitored ambient city data**

Determinants of ambient PM

- Fuel consumption mix
- Local economic activity intensity
- Population density
- Income per capita
- Meteorological and topographic variables
- Country specific factors

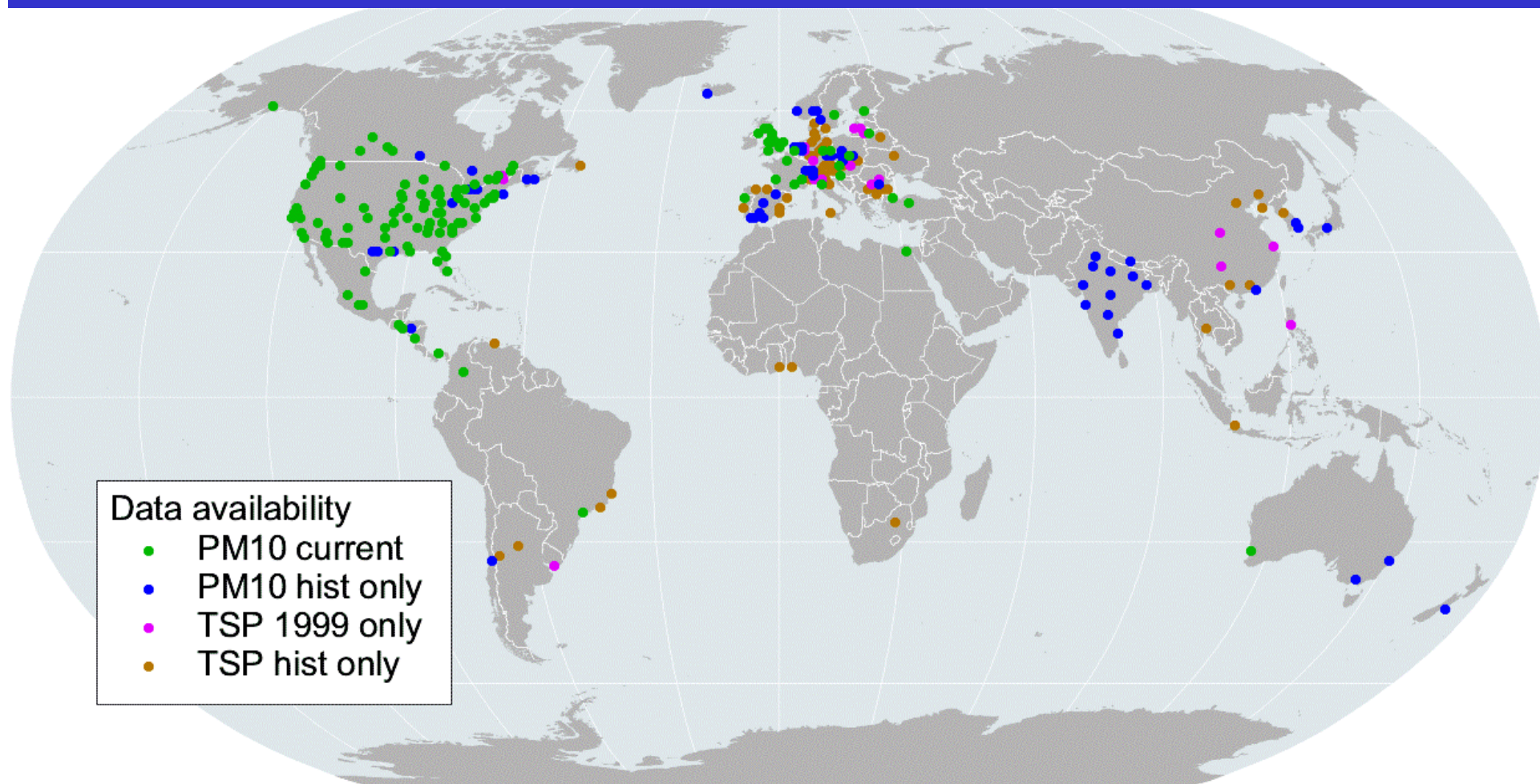
Estimation Approach

- Explains 88% of observed variation
- Details in Pandey K.D. et al (forthcoming 2002)
- Estimated in 2 stages to take advantage of panel
 - Marginal effect city model (with country fixed effect)
 - Cross-section model for average effect
- Uses information about site location
- Joint estimation of PM10 and tsp at residential and non-residential sites

Model Predictions

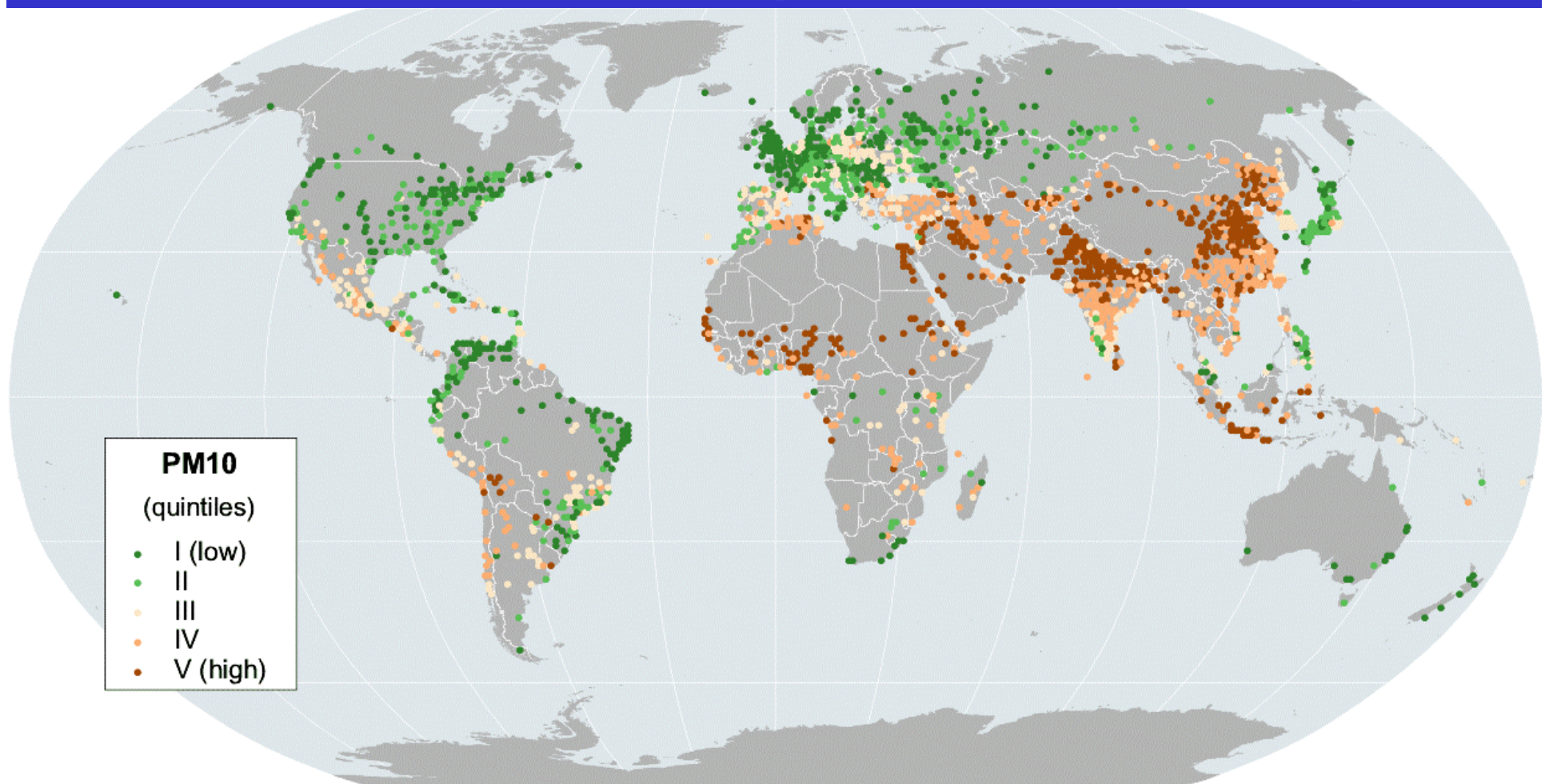
- **Model was used to predict PM10 levels for all world cities with 100,000 people or more and national capitals.**
- **Uncertainty estimates were also developed**

Availability of Exposure Data



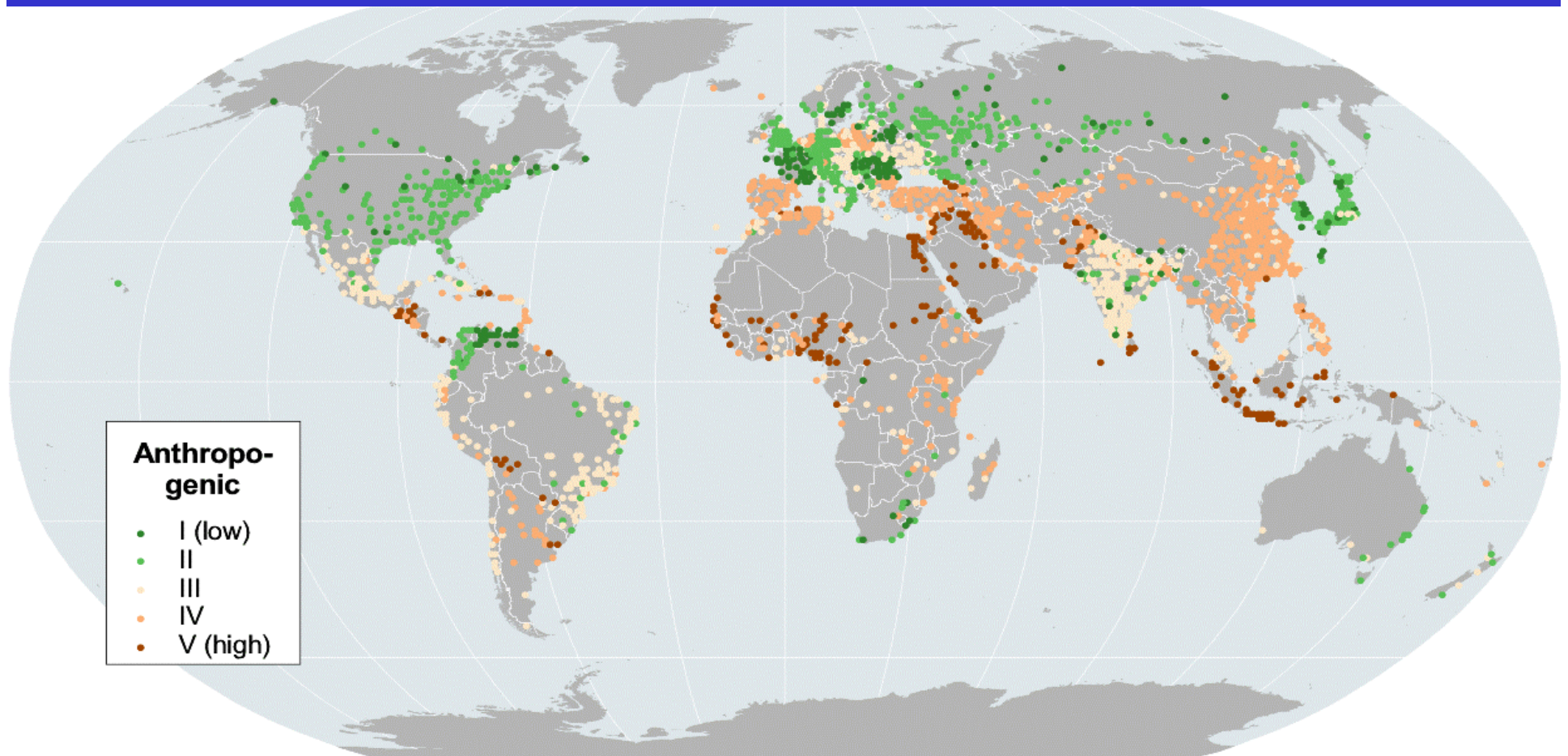
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Estimated PM10 Concentration in World Cities (pop=100,000+)



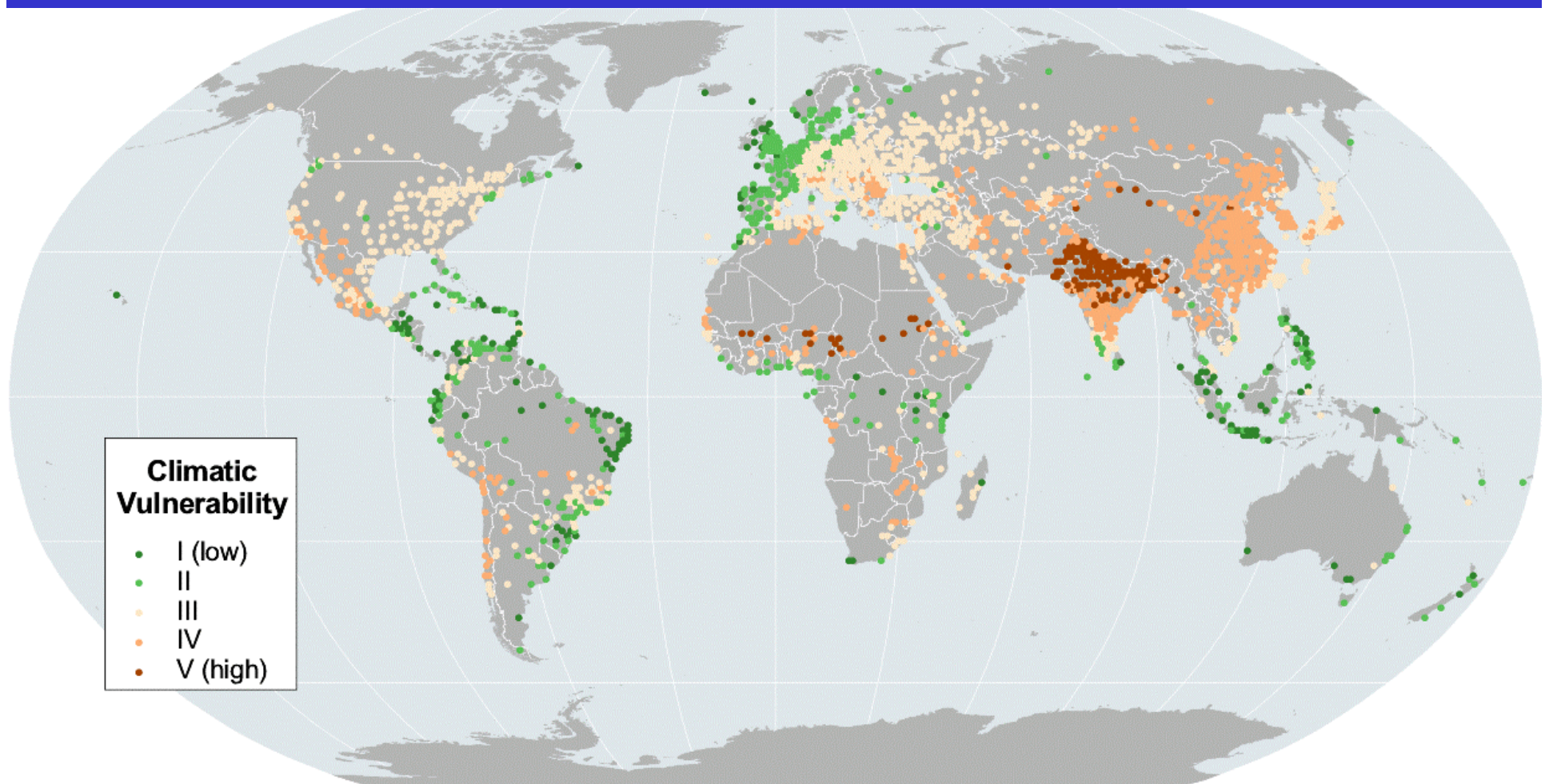
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Anthropogenic Contribution to PM₁₀



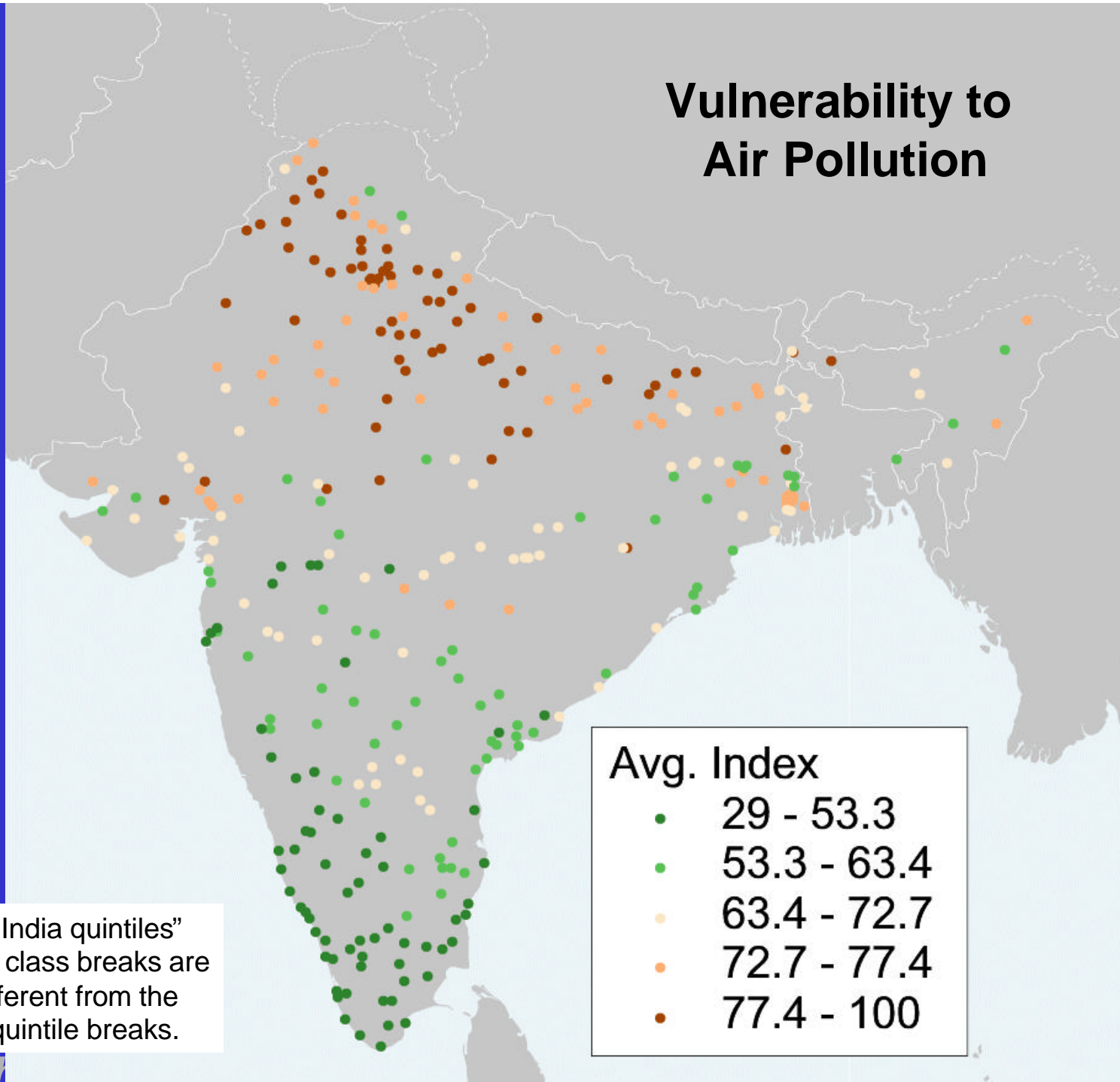
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City Vulnerability to PM10



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Vulnerability to Air Pollution



“Within India quintiles”
i.e., the class breaks are
a bit different from the
global quintile breaks.

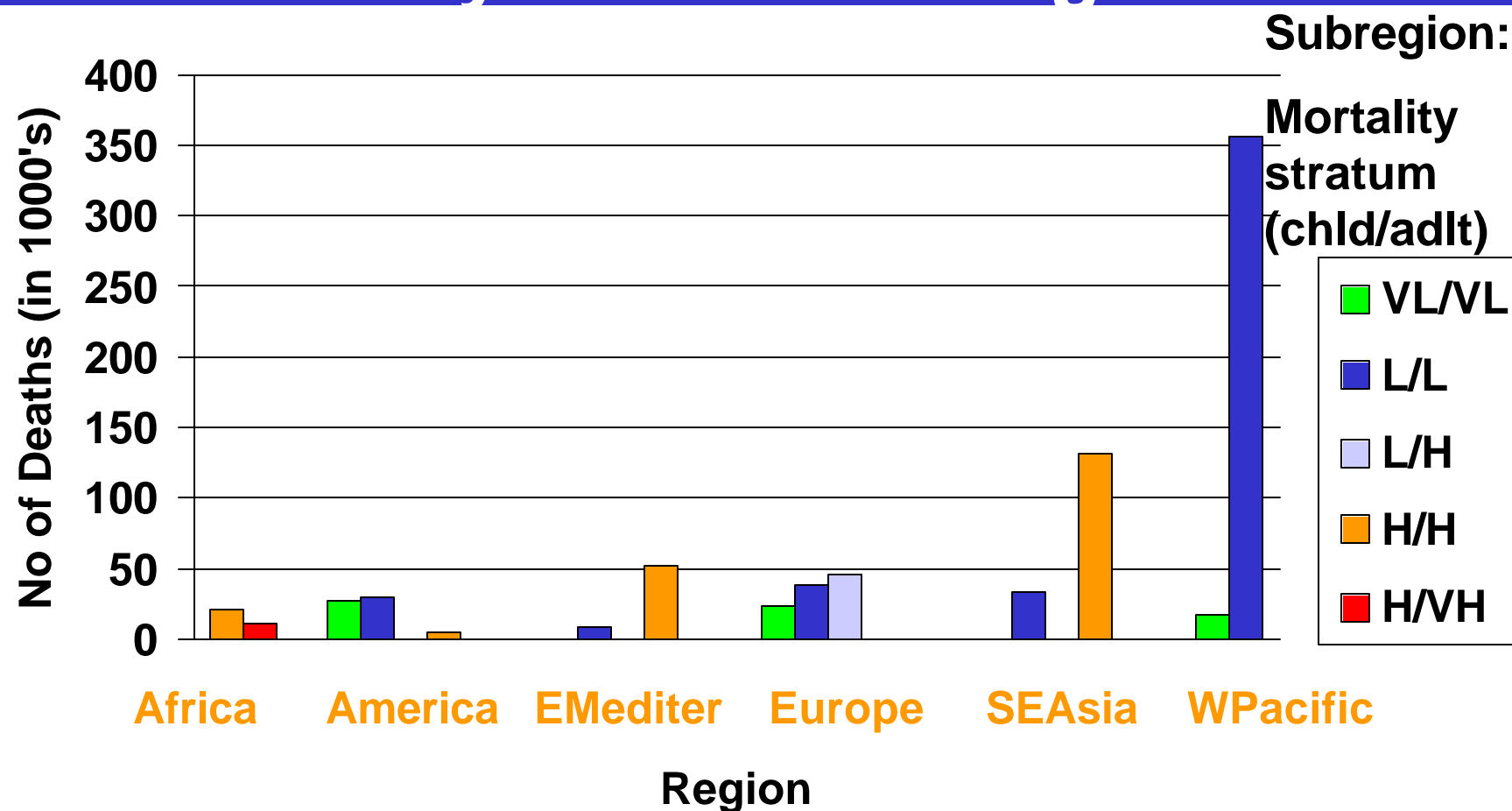
WHO Collaboration

**PM10 Model Predictions used as basis
for WHO Comparative Risk
Assessment of Different Risk Factors
and the Global Burden of Disease
Study**

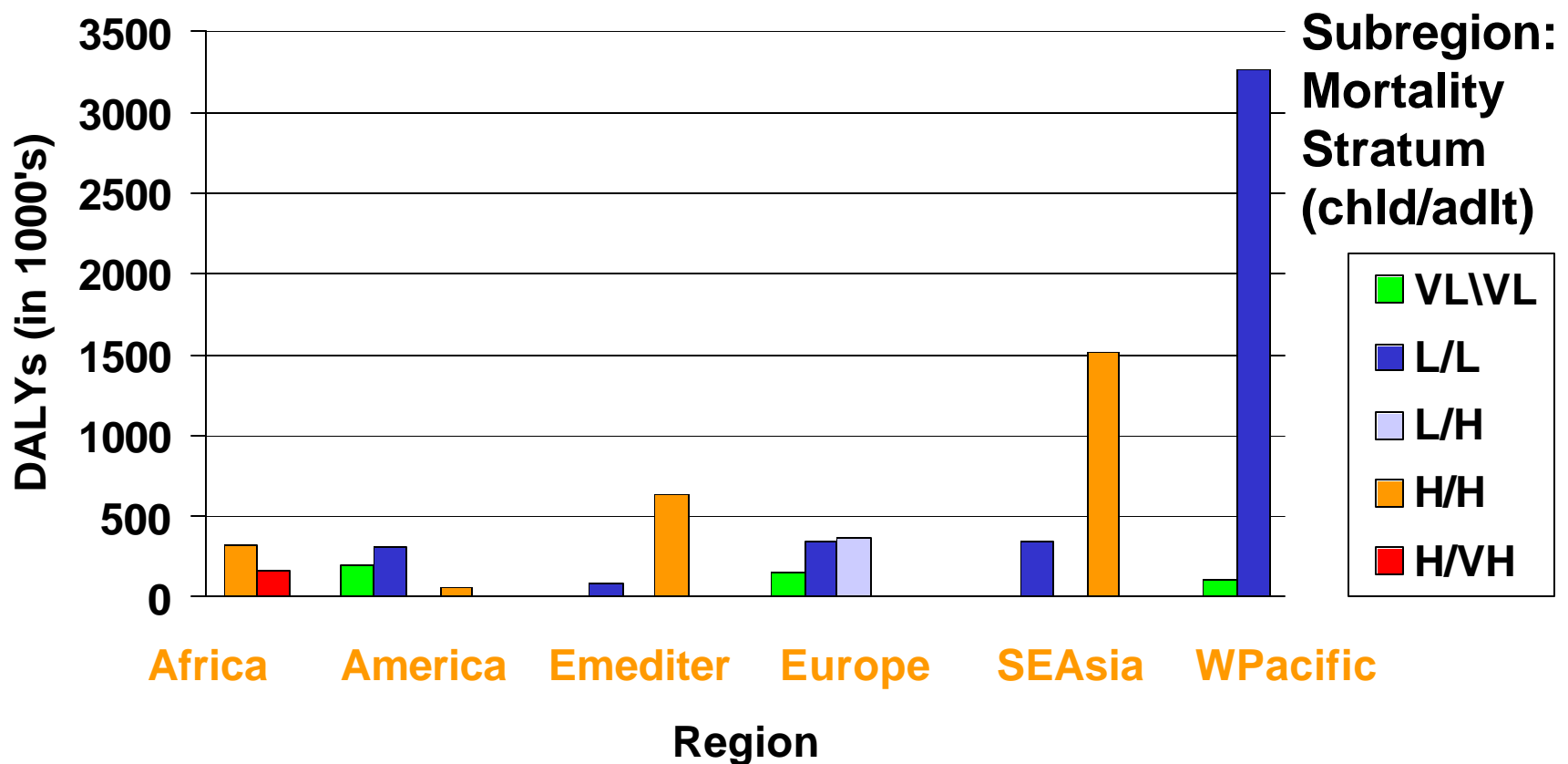
**Published in the World Health Report
2002.**

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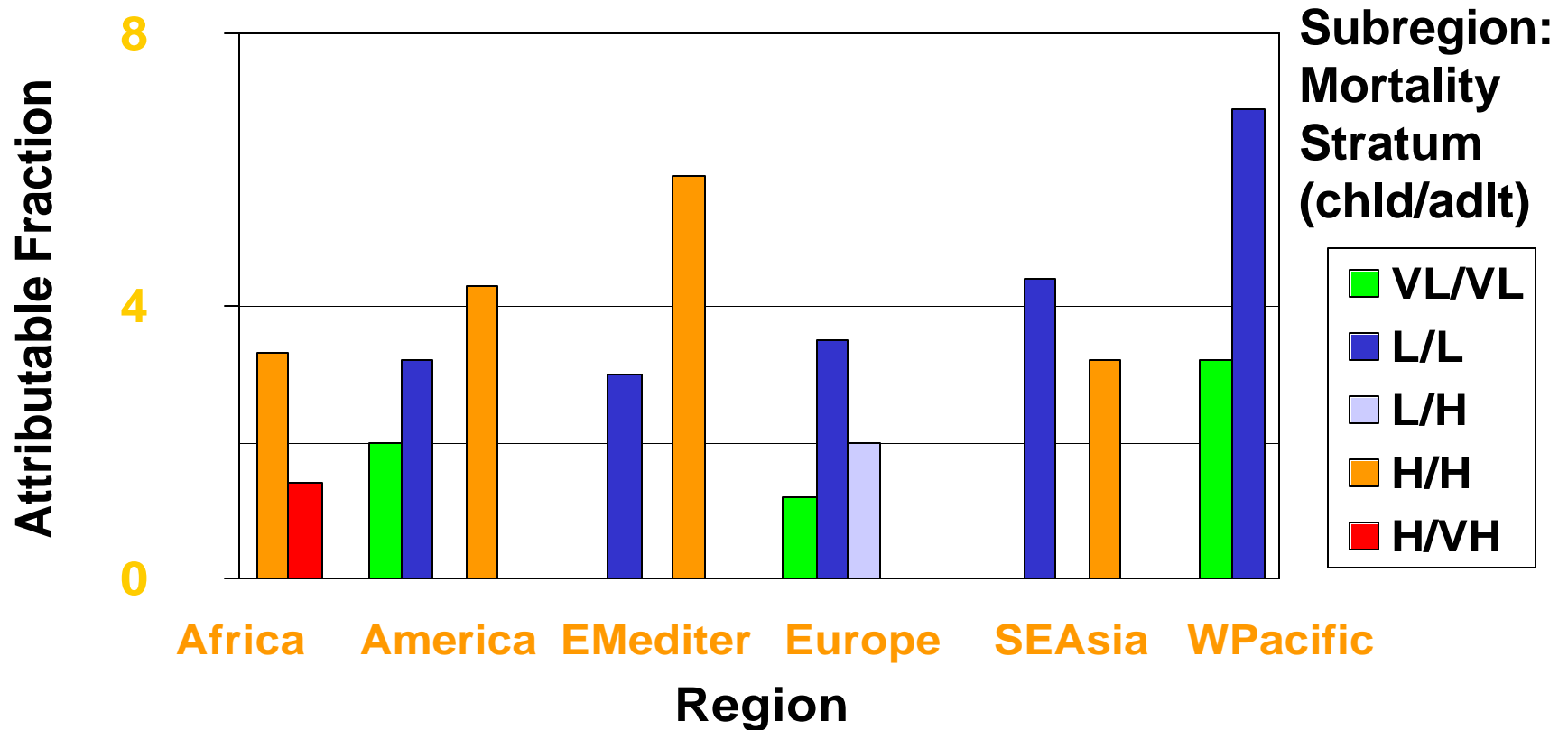
No of Deaths (1000's) from Outdoor PM Pollution by WHO Sub-Region



Dalys (1000's) from Outdoor PM Pollution by WHO Sub-Region



Fraction of Cardiopulmonary Deaths Attributed to Outdoor PM Pollution by WHO Sub-region



Incorporation in World Bank Operations

- **Environmental Monitors – Thailand, Philippines**
- **Incorporation into CAS**
- **Economic Losses implied by health outcomes incorporated in National Genuine Savings accounting**
- **Publication in WDI/Little Green Book**

Conclusions

- **Localized environmental indicators necessary for effective policies can be estimated using models with geographic information system data.**
- **Modeled data can**
 - **Indicate need for more precise information,**
 - **Provide incentives for immediate action.**

Conclusions (continued)

- Health Impacts of urban particulate matter outdoor air pollution are substantial.
- The dissipative capacity of the environment is significantly different across cities. National urban policy needs to incorporate differential shadow prices.