Air Quality Index (AQI)

Air Quality Communication Workshop
San Salvador, El Salvador

April 16-17, 2012

ACUERDO DE COOPERACIÓN USAID - CCAD

How Do People Know What Particle Pollution Levels Are In their City or Country?

- Air quality monitors measure $PM_{2.5}$ and PM_{10} concentrations in $\mu g/m^3$

- Local, regional, and national governments decide how to disseminate monitor measurements to the public

- Preferred way to communicate is via a color-coded **Air Quality Index (AQI)** that is easy for the public to understand

What is the Air Quality Index?

- Index for reporting air quality

- Color is key for communication

- Ranges from 0 to 500 (no units)

- Provides indicator of the quality of the air and its health effects

- 101 typically corresponds to the level that violates the national health standard

Air Quality Index (AQI)

AQI Value	AQI Category	AQI Color
0 - 50	Good	Green
51 - 100	Moderate	Yellow
101 - 150	Unhealthy for Sensitive Groups	Orange
151 - 200	Unhealthy	Red
201 - 300	Very Unhealthy	Purple
301 - 500	Hazardous	Maroon

Daily Air Quality Standard

AQI Health Messages

AQI Value	Health Message	AQI Color
0 - 50	None	Green
51 - 100	Unusually sensitive people should reduce prolonged or heavy exertion	Yellow
101 - 150	Sensitive groups should reduce prolonged or heavy exertion	Orange
151 - 200	Sensitive groups should avoid prolonged or heavy exertion; general public should reduce prolonged or heavy exertion	Red
201 - 300	Sensitive groups should avoid all physical activity outdoors; general public should avoid prolonged or heavy exertion	Purple
301 - 500	Everyone should avoid all physical activity outdoors	Maroon

AQI Video

Actions People Can Take to Protect Their Health When Particle Pollution is High

- Avoid exercising or working outdoors for long periods of time

- Choose less strenuous outdoor activities

- Avoid exercising near busy roads

- Postpone outdoor recreational activities

- Avoid sources of particles indoors:
  – Wood-burning stoves
  – Fireplaces
  – Candles

Example of How Athletics Coaches Use the AQI to Protect Children's Health

- "I coach youth baseball and I do not have strenuous practice sessions on bad air quality days."

- "Our school cancels practices for outdoor sports activities during air quality episodes, when the AQI exceeds the Code Yellow range."

- "I coach a boys' soccer team, and I cancel practice when the AQI reaches 100."

Actions People Can Take to Reduce Particle Pollution

- Conserve electricity

- Use dry, seasoned wood for fireplaces and stoves

- Carpool, use public transportation, bike, or walk when possible

- Avoid idling of car engines for long periods of time

- Keep car tires properly inflated

- Maintain car, boat, and other engines to ensure maximum fuel efficiency

Communicating via AQI is Effective

- 52% of people in the U.S. had heard of AQI **Code Orange** or **Code Red** air quality days (2002)

- 46% of people in the U.S. who knew about the AQI had reduced their exposure to air pollution on **Code Orange** and **Code Red** air quality days (2002)

- 4-7% reduction in pediatric hospital admissions for asthma in the U.S. due to reduction in children's exposure on poor air quality days
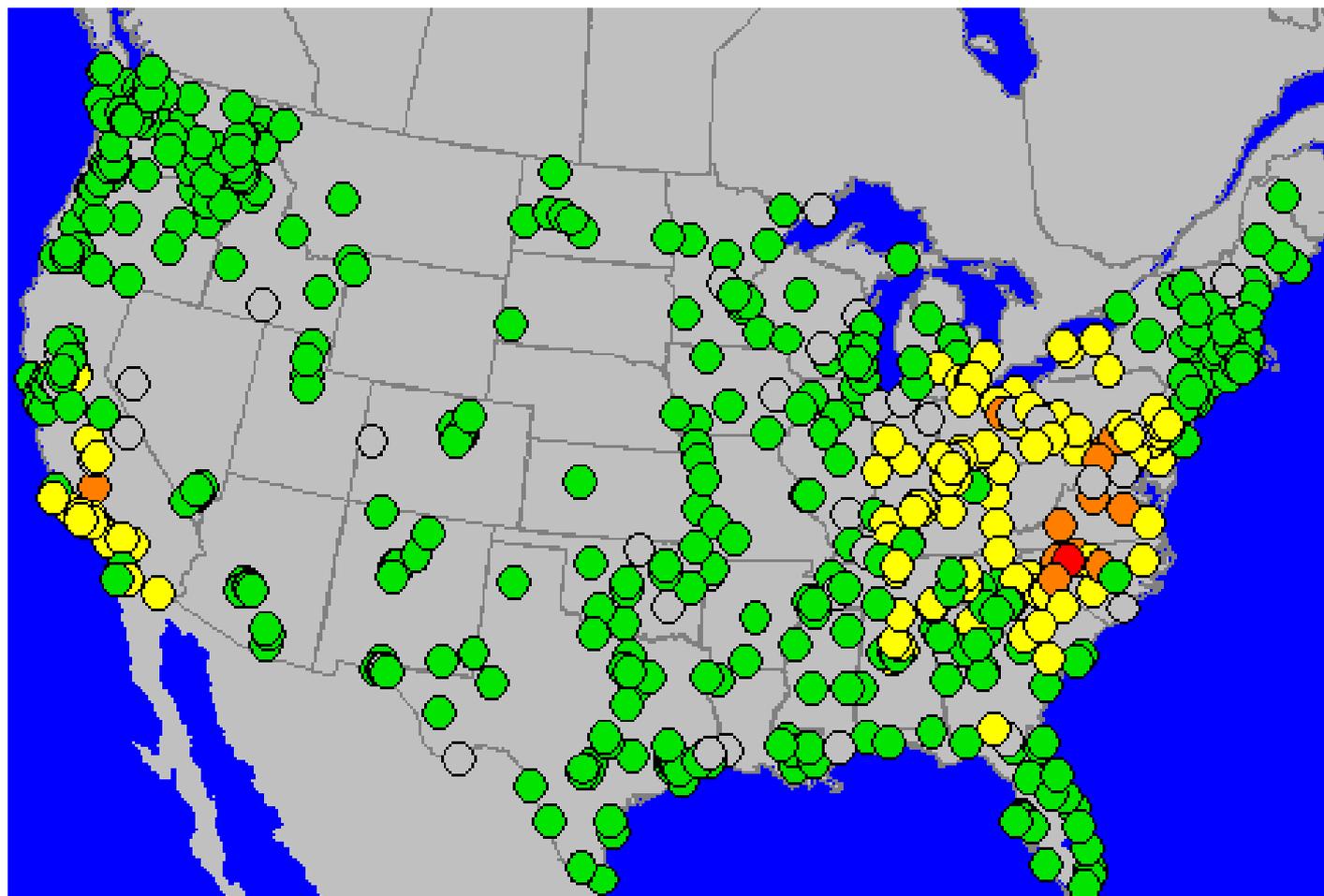
U.S. EPA PM$_{2.5}$ AQI

AQI Category	AQI Value	24-hr Average PM$_{2.5}$ Concentration (μg/m^3)
Good	0 - 50	0 - 15.4
Moderate	51 - 100	15.5 - 40.4
USG	101 - 150	40.5 - 65.4
Unhealthy	151 - 200	65.5 - 150.4
Very Unhealthy	201 - 300	150.5 - 250.4
Hazardous	301 - 500	250.5 - 500.4

U.S. EPA PM$_{10}$ AQI

AQI Category	AQI Value	24-hr Average PM$_{2.5}$ Concentration (μg/m³)
Good	0 - 50	0 – 54
Moderate	51 - 100	55 – 154
USG	101 - 150	155 – 254
Unhealthy	151 - 200	255 – 354
Very Unhealthy	201 - 300	355 – 424
Hazardous	301 - 500	425 – 604

Example of PM$_{2.5}$ Monitor Measurements Reported using the AQI in the U.S.

June 13, 2008

1 – 50 Good

51 – 100 Moderate

101-150 USG

151 – 200 Unhealthy

201 – 250 Very Unhealthy
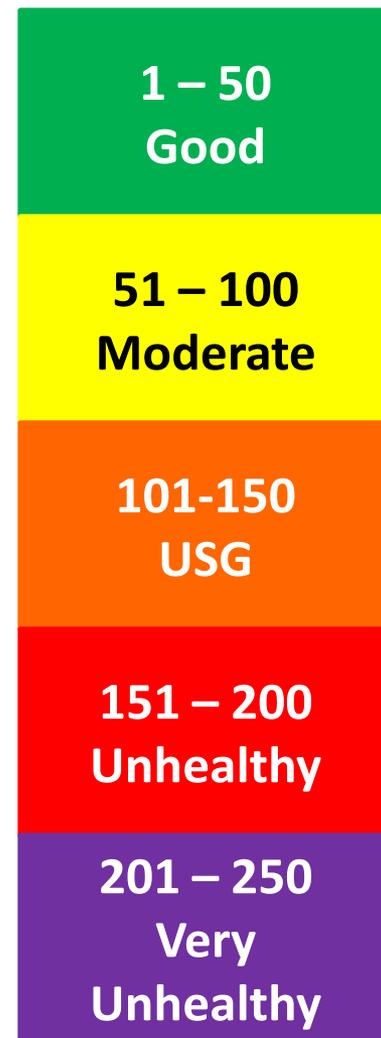
Example of IMECA in Mexico City

Índice Metropolitano de la Calidad del Aire

Valores	Clasificación	Recomendaciones
0 - 50	**Buena**	Adecuada para llevar a cabo actividades al aire libre.
51 - 100	**Regular**	Posibles molestias en niños, adultos mayores y personas con enfermedades.
101 - 150	**Mala**	Causante de efectos adversos a la salud en la población, en particular los niños y los adultos mayores con enfermedades cardiovasculares y/o respiratorias como el asma.
151 - 200	**Muy mala**	Causante de mayores efectos adversos a la salud en la población en general, en particular los niños y los adultos mayores con enfermedades cardiovasculares y/o respiratorias como el asma.
>200	**Extremadamente mala**	Causante de efectos adversos a la salud de la población en general. Se pueden presentar complicaciones graves en los niños y los adultos mayores con enfermedades cardiovasculares y/o respiratorias como el asma.

Example of Possible Regional Air Quality Measurements Reported using the AQI
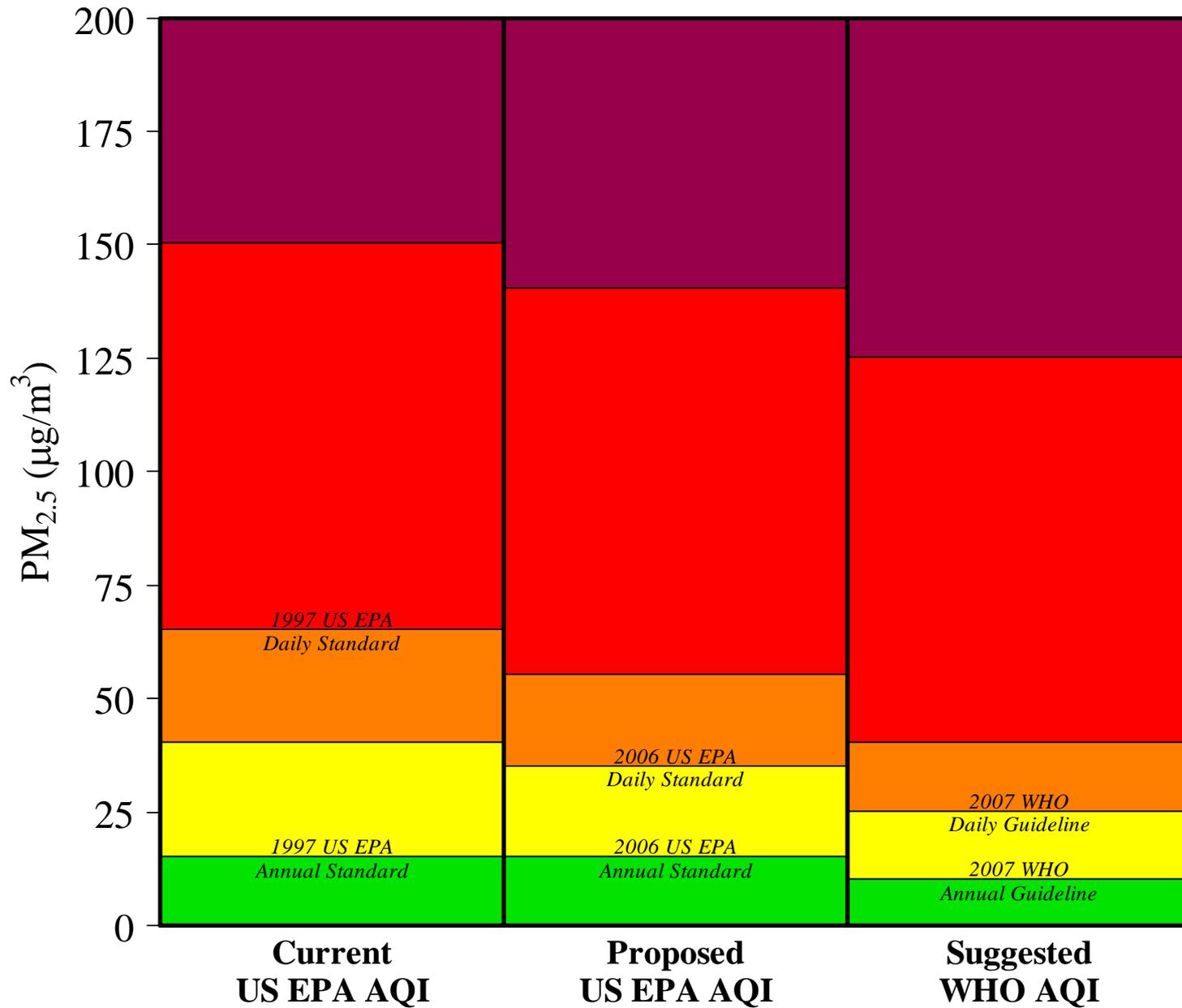

Range	Category
1 – 50	Buena
51 – 100	Normal
101-150	Mala
151 – 200	Muy Mala
201 – 250	Extremadamente Mala

Possible PM$_{2.5}$ AQI Categories for Region

Category	AQI Value	Current USEPA		Proposed USEPA		WHO-based	
		PM$_{2.5}$ ($\mu g/m^3$)	$\mu g/m^3$ range	PM$_{2.5}$ ($\mu g/m^3$)	$\mu g/m^3$ range	PM$_{2.5}$ ($\mu g/m^3$)	$\mu g/m^3$ range
Buena	0 - 50	0 - 15.4	15.5	0 - 15.4	15.5	0 - 10.4	10.5
Normal	51 - 100	15.5 - 40.4	25	15.5 - 35.4	20	10.5 - 25.4	15
Mala	101 - 150	40.5 - 65.4	25	35.5 - 55.4	20	25.5 - 40.4	15
Muy Mala	151 - 200	65.5 - 150.4	85	55.5 - 140.4	85	40.5 - 125.4	85
Extremadamente Mala	>200	>150.4		>140.4		>125.4	

PM$_{2.5}$ Standard ($\mu g/m^3$)	1997 USEPA NAAQS		2006 USEPA NAAQS		2007 WHO Guidelines	
	daily	65	daily	35	daily	25
	annual	15	annual	15	annual	10

Comparison of Possible PM$_{2.5}$ AQI Categories

PM$_{2.5}$ (µg/m^3)

- 1997 US EPA Daily Standard
- 1997 US EPA Annual Standard
- 2006 US EPA Daily Standard
- 2006 US EPA Annual Standard
- 2007 WHO Daily Guideline
- 2007 WHO Annual Guideline

Current US EPA AQI   **Proposed US EPA AQI**   **Suggested WHO AQI**

PM$_{2.5}$ AQI Used by University of Panama
(Current USEPA AQI)

Categoría ICA	Valor ICA	Concentración PM$_{2.5}$ Promedio en 24 Horas (μg/m³)
Buena	0 - 50	0 - 15.4
Moderada	51 - 100	15.5 - 40.4
Dañina para Personas Sensibles	101 - 150	40.5 - 65.4
Dañina	151 - 200	65.5 - 150.4
Muy Dañina	201 - 300	150.5 - 250.4
Peligrosa	301 - 500	250.5 - 500.4

PM$_{2.5}$ AQI Used by MARN
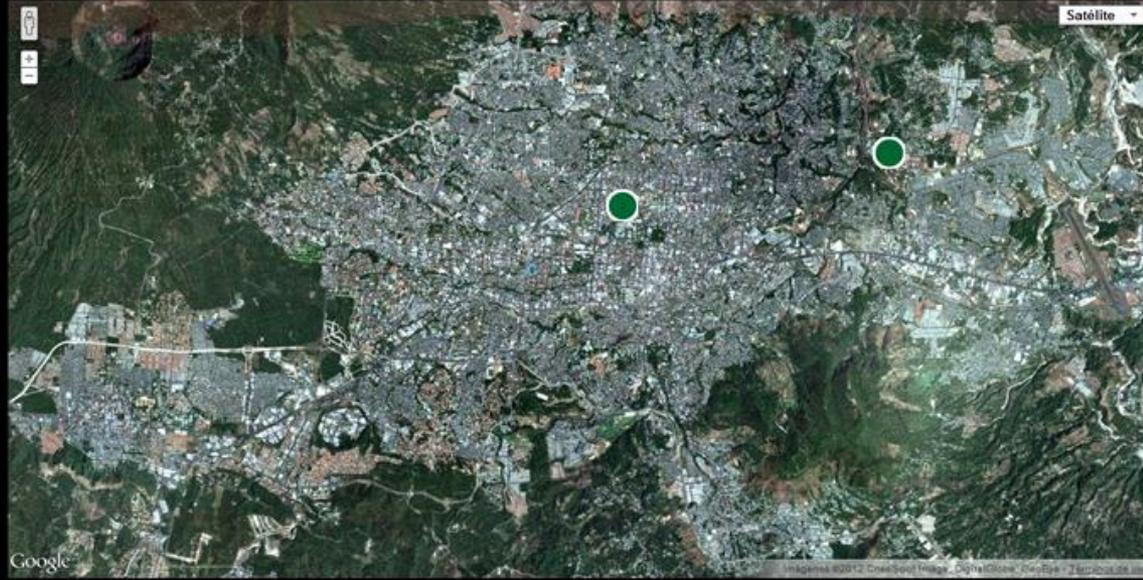
Background and History in the U.S.

- Prior to 1976:
  - 55 cities used 14 different indices
  - Different cautionary messages
  - Confusing to the public
- In 1976:
  - U.S. Clean Air Act required U.S. Environmental Protection Agency (EPA) to establish a national air quality index
  - EPA established the **Pollutant Standards Index (PSI)**
- From 1976 to 1998, EPA and U.S. cities used the PSI that covered:
  - Ground-level ozone
  - Particulate matter
  - Carbon monoxide
  - Sulfur dioxide
  - Nitrogen dioxide

Background and History in the U.S.

- In 1999, EPA revised the PSI
  - Updated the index
  - Changed the name to **Air Quality Index (AQI)**
  - Received extensive input from:
    - State/local experts (outreach, health, and air quality)
    - General public (8 focus groups in major U.S. cities)
    - Workshops
- Ozone and particle pollution standards were added:
  - 8-hour O_3 standard
  - 24-hour $PM_{2.5}$ standard
- AQI has been used internationally in China, Mexico, Chile, and Brazil

Advantages of the AQI

- AQI is more successful than PSI in many ways:
  - Name is better – "Quality" Index versus "Pollutant Standard" Index
  - Simple categories (Good, Moderate, etc.)
  - Colors are key for communication
    - Ability to visualize pollution via maps
    - Association between colors and health
  - Uniformity – AQI is standard and consistent across the United States

Calculating AQI Values

- Calculate the AQI using pollutant concentration data in the following equation:

$$AQI = \left[\frac{(PM_{obs} - PM_{min}) \times (AQI_{max} - AQI_{min})}{(PM_{max} - PM_{min})} \right] + AQI_{min}$$

PM_{obs} = observed 24-hour average concentration in µg/m^3
PM_{max} = maximum concentration of AQI color category that contains PM_{obs}
PM_{min} = minimum concentration of AQI color category that contains PM_{obs}
AQI_{max} = maximum AQI value for color category that corresponds to PM_{obs}
AQI_{min} = minimum AQI value for color category that corresponds to PM_{obs}

Example AQI Calculation

Calculate the AQI corresponding to a 24-hr $PM_{2.5}$ concentration of 31 µg/m³

AQI Value	PM$_{2.5}$ Breakpoints (µg/m³)
0	0
51	15.5
101	40.5
151	65.5
201	150.5

$$AQI = \left[\frac{(PM_{obs} - PM_{min}) \times (AQI_{max} - AQI_{min})}{(PM_{max} - PM_{min})} \right] + AQI_{min}$$

$$AQI = \left[\frac{(101 - 51) \times (31 - 15.5)}{(40.5 - 15.5)} \right] + 51$$

$$AQI = 82$$

Summary

- The Air Quality Index (AQI) is a simple, color-coded, unitless index that is an effective way to communicate air pollution concentrations to the general public

- The AQI provides an indication of the quality of the air and its health effects

- Options exist for scaling the AQI categories to $PM_{2.5}$ and PM_{10} concentration values ($\mu g/m^3$)
  - Examples from El Salvador (MARN) and Panama (UP)

- Simple equation can be used to convert concentration values ($\mu g/m^3$) to AQI values (unitless)