IEc

AQMP and Air Quality Measurement: Current Data and Gaps

Addis Ababa September 2019 Workshop

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September 24, 2019

Overview

- Motivations and Objectives
- Published Literature
- Methods

Our Methods

Used ArcMap to adjust satellite data based on ground measurement of $PM_{2.5}$

Calculate annual averages at monitor locations

- Using measured monitor data
- Using satellite data

Calculate ratio between annual averages

- Find the ratio between monitor annual average to satellite annual average at each monitor location

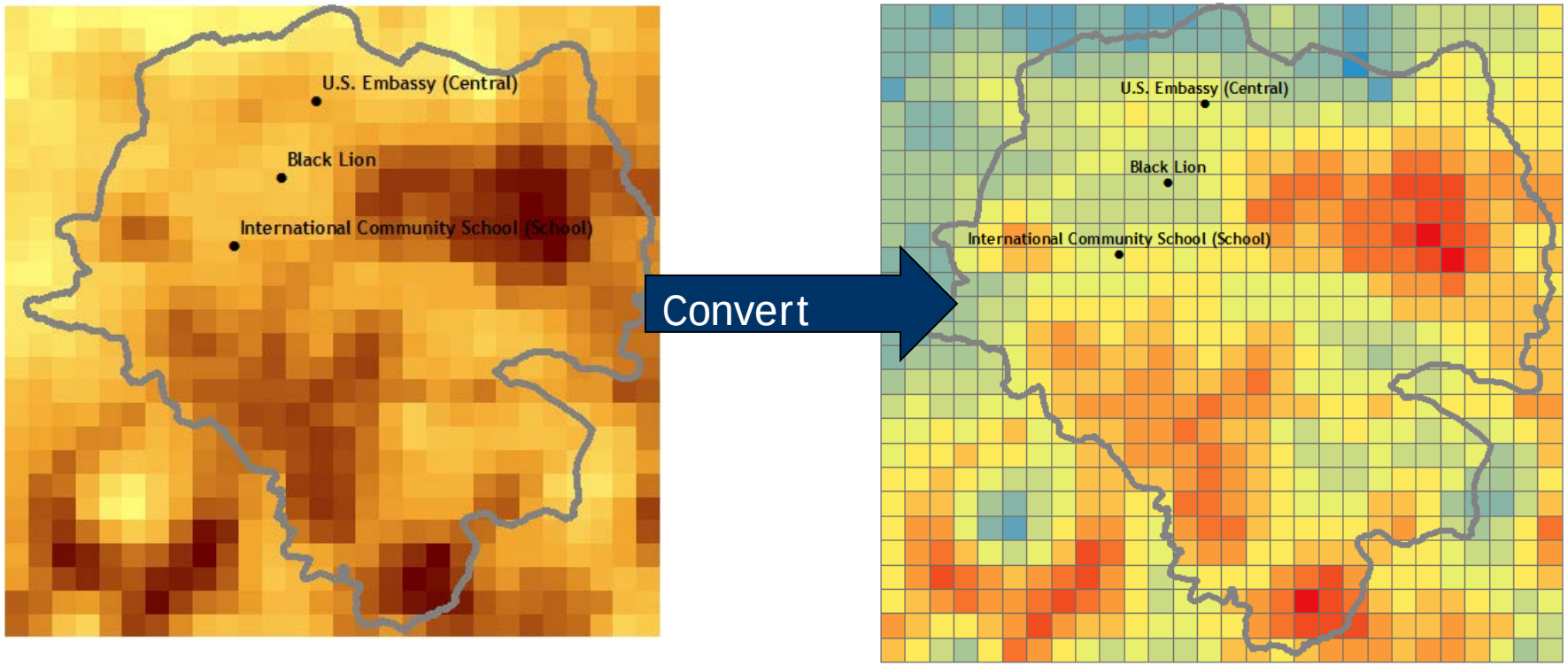
Interpolate and adjust original grid

- Interpolate the ratios across city
- For each grid, multiply interpolated ratio value by original satellite grid concentrations

Locally-Ground Truthed Air Quality Surface

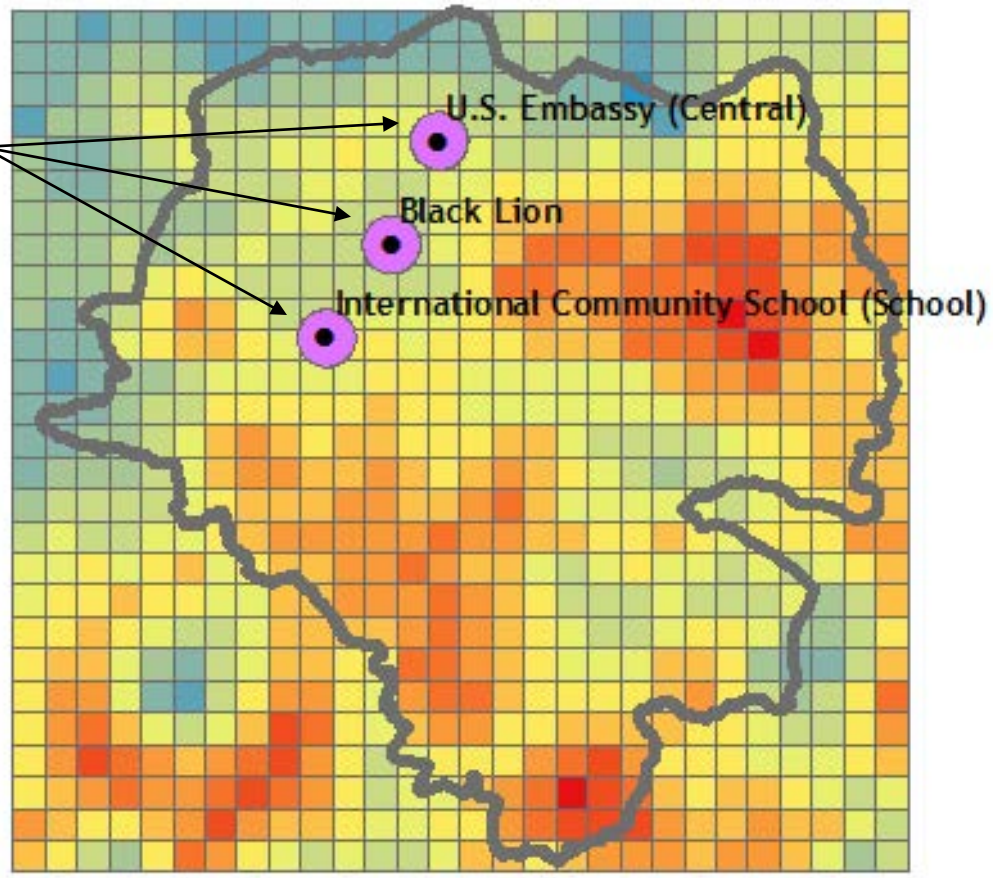
- Satellite data adjusted based on measured monitor values interpolated to cover the entire city

Step 1: Convert Raster to Polgyon

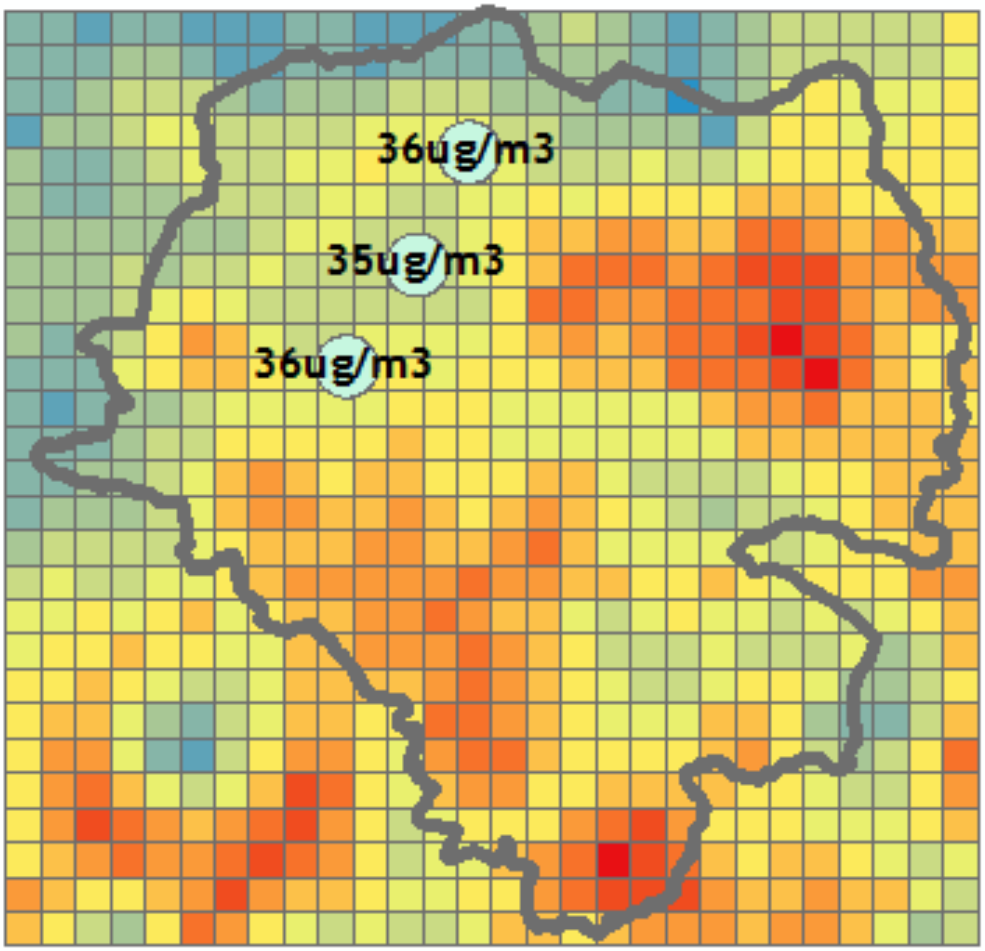


Step 2: Buffer Monitor Locations by 1 km

1 km Buffers



Step 3: Calculate area-weighted average within buffer for each monitor

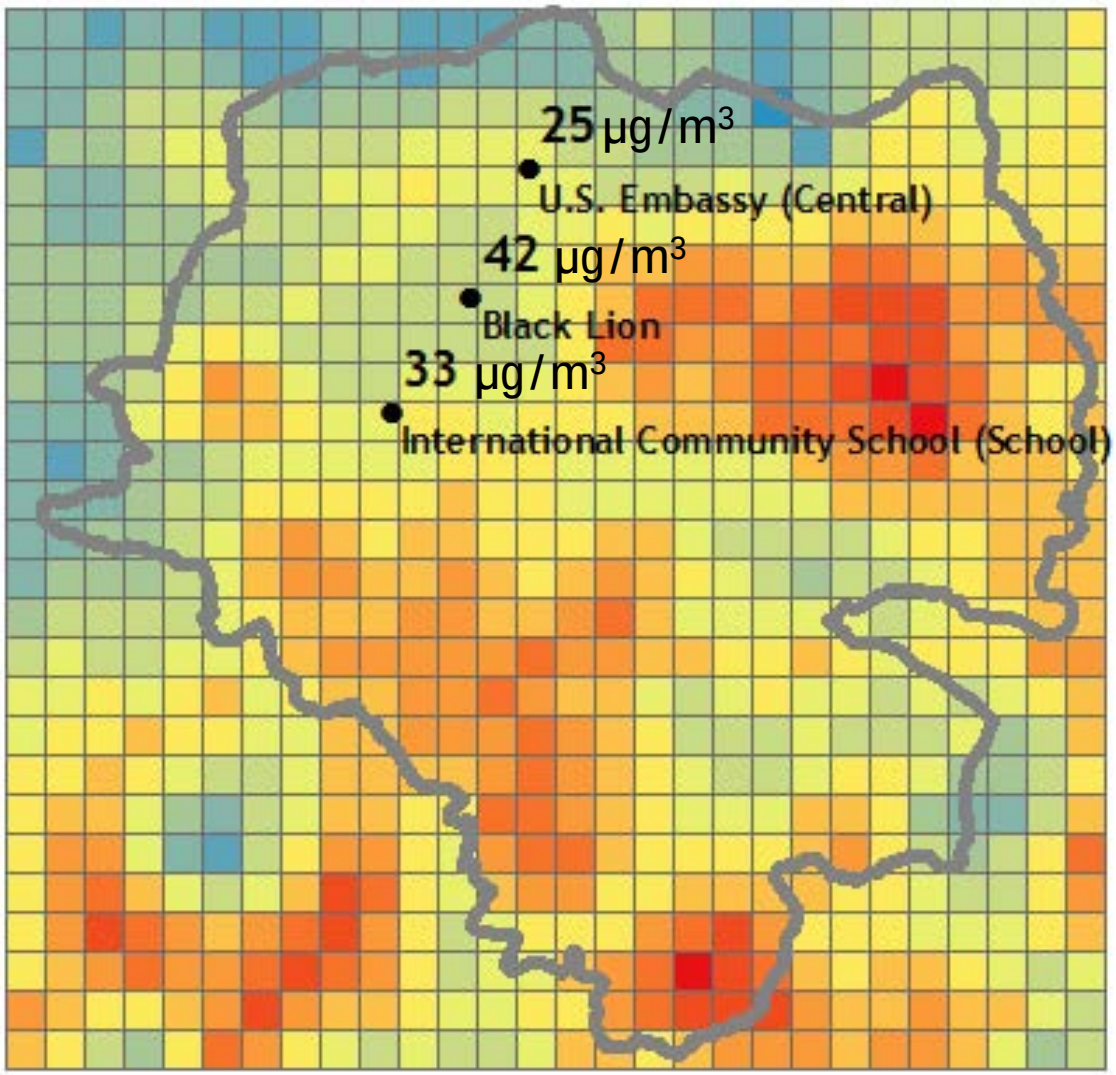


Step 4: Calculate measured monitor average for each monitor

Monitor	Online Date	Annual Average Dates[1]	N. Days	Annual Average (µg/m^3)
Central	8/15/2016	9/1/2016 – 8/31/2017	330	25
School	6/25/2016	7/1/2016 – 6/30/2017	247	32
Black Lion	N/A	1/1/2017 – 12/31/2017	N/A	42

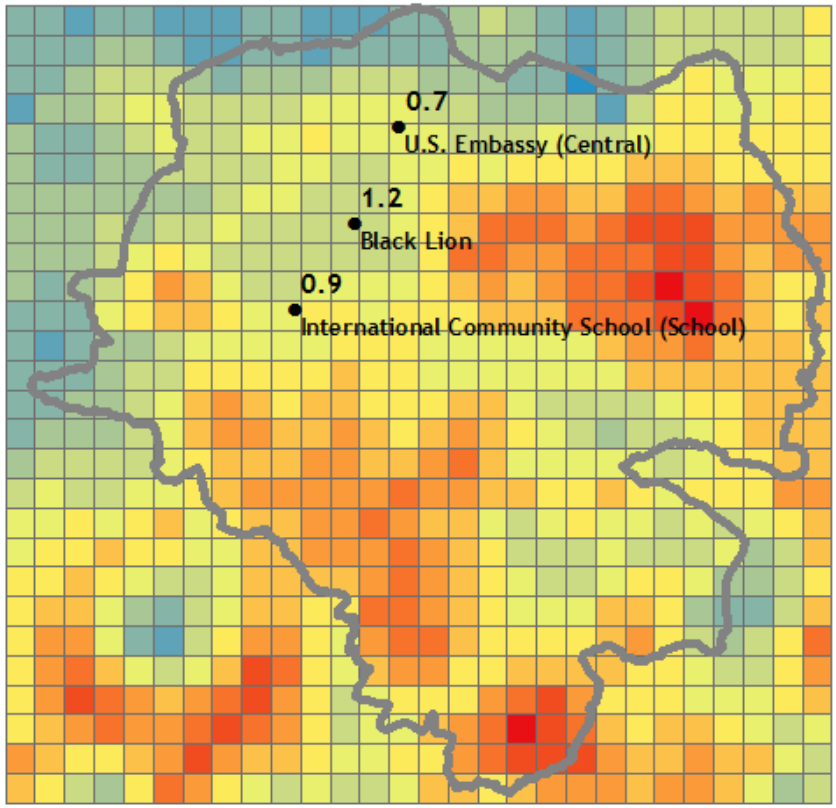
[1] Note that the Central and School annual averages run from summer 2016 to summer 2017 and the Black Lion annual averages run from January-December 2017 for comparison with January –December 2016 satellite estimates.

Step 5: Bring measured monitor average for each monitor into GIS



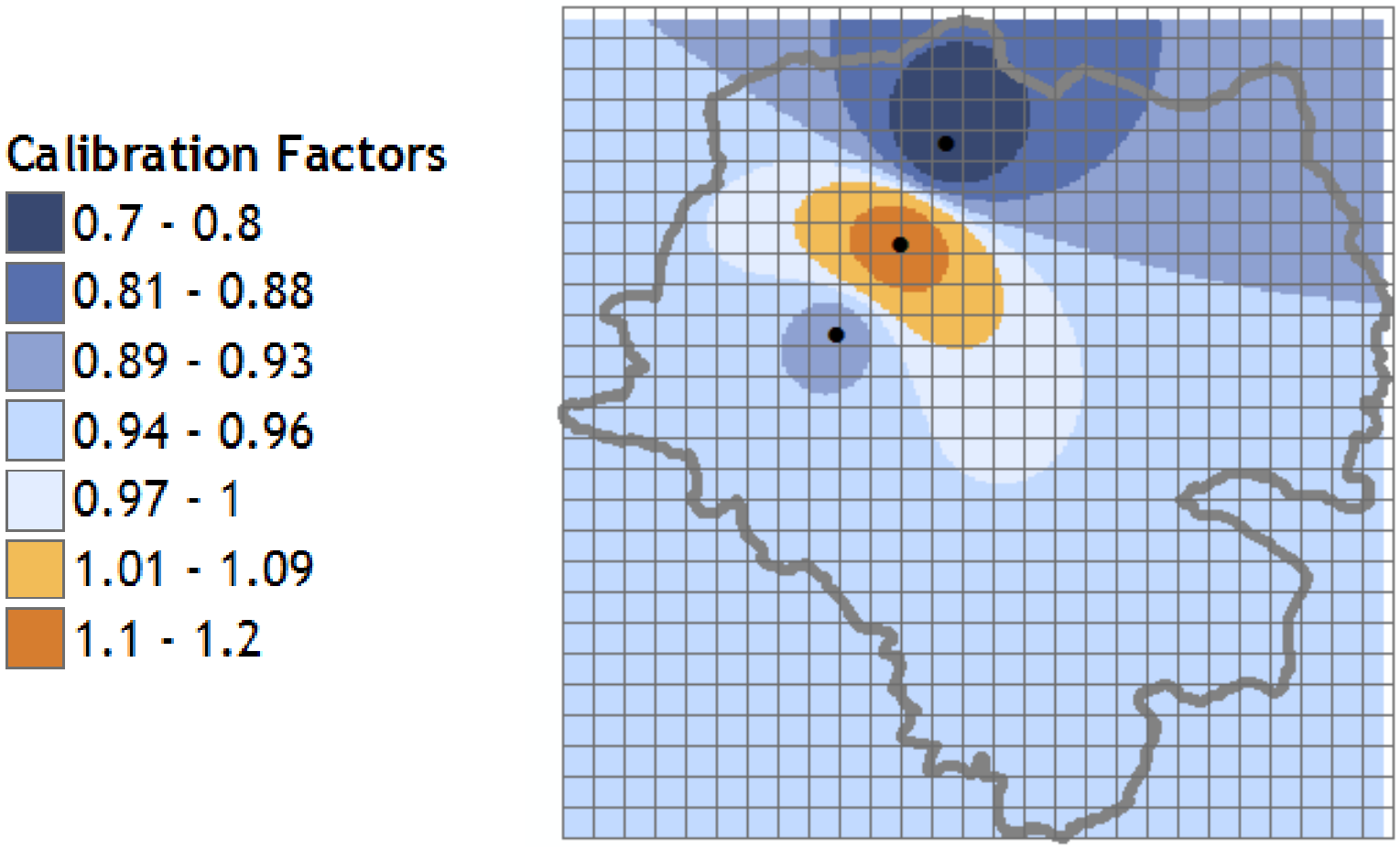
Step 6: Calculate calibration factors for each monitor

Calibration factor = Annual Average monitor data / Annual average area-weighted satellite data



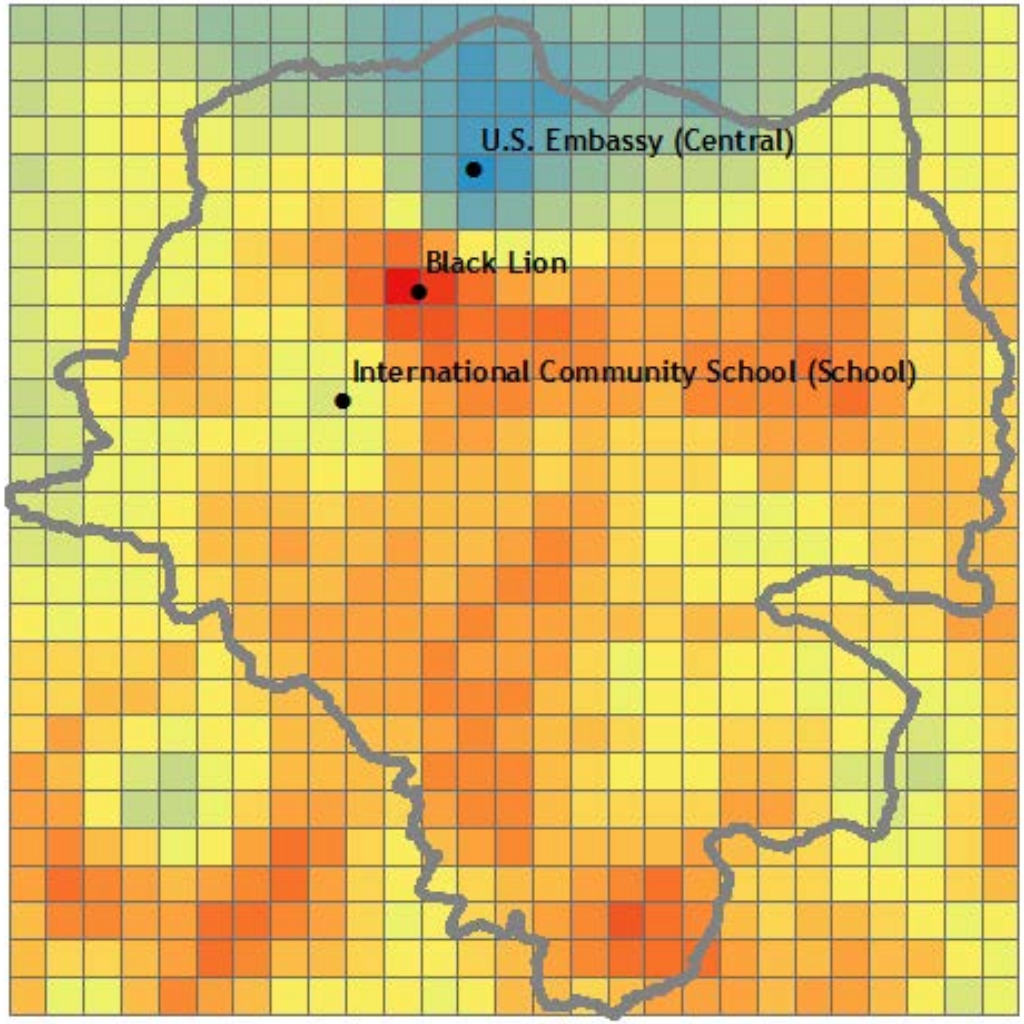
Calibration factors > 1 will adjust satellite data upwards, and calibration factors < 1 will adjust satellite data downwards

Step 7: Interpolate calibration factors across grid



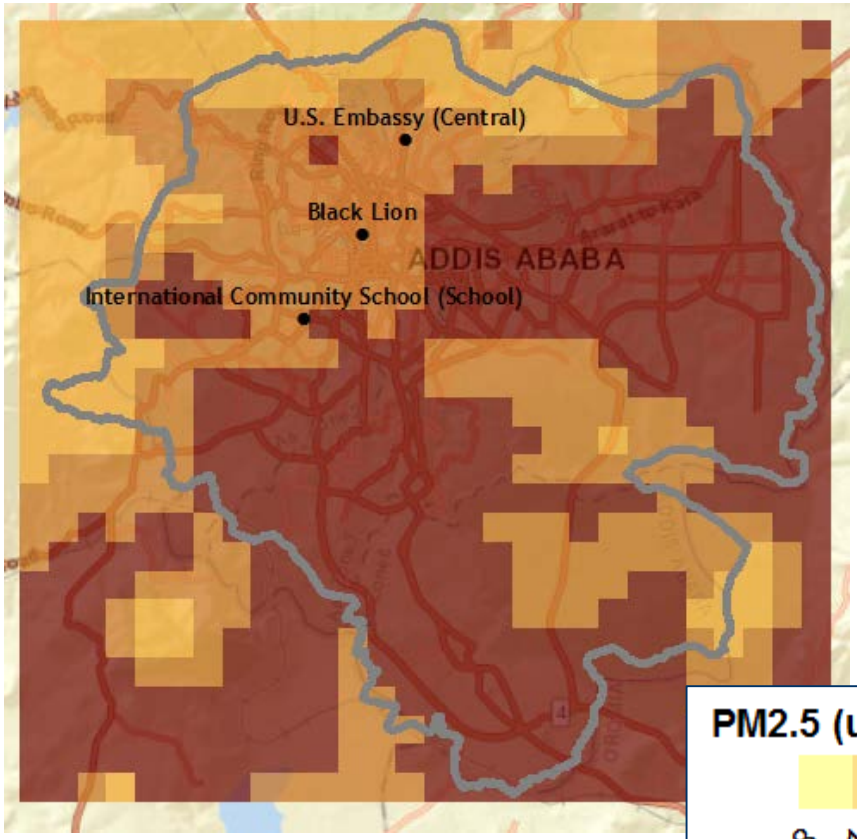
All concentrations associated with orange grid cells will be adjusted upwards; blue grid cells adjusted downwards.

Step 8: Multiply calibration factors and satellite concentration for each grid cell

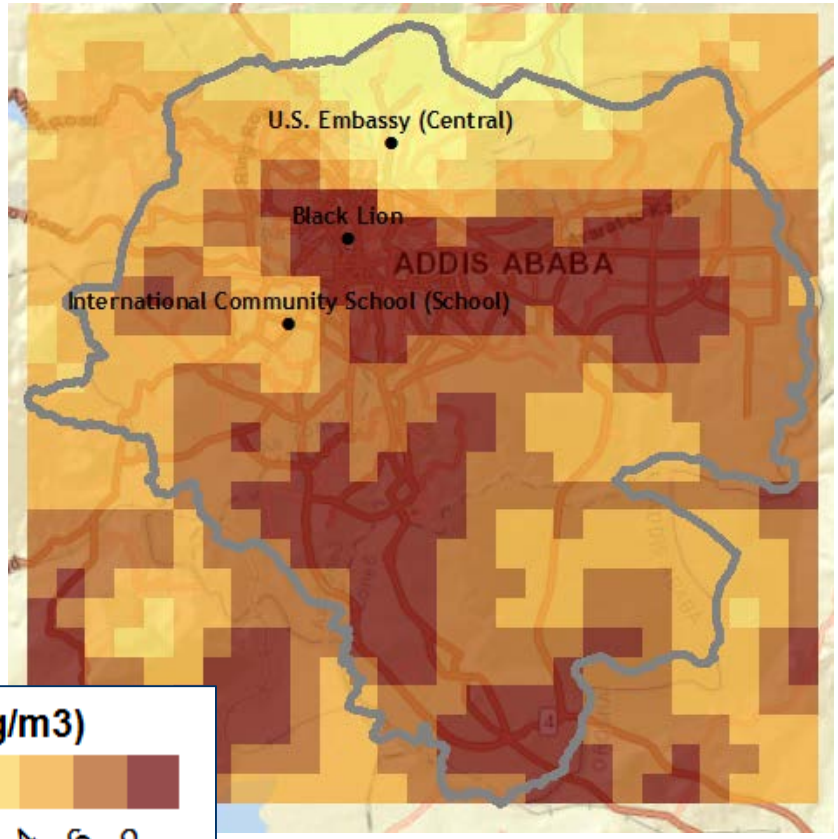


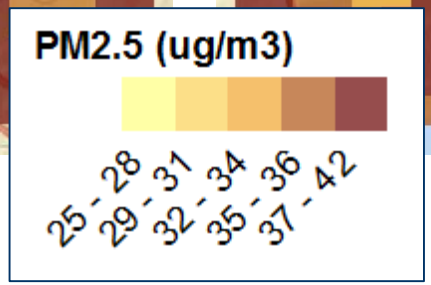
Original and Ground-Truthed Comparison

Original van Donkelaar et al. (2019) satellite



Locally ground-truthed satellite surface





Takeaways

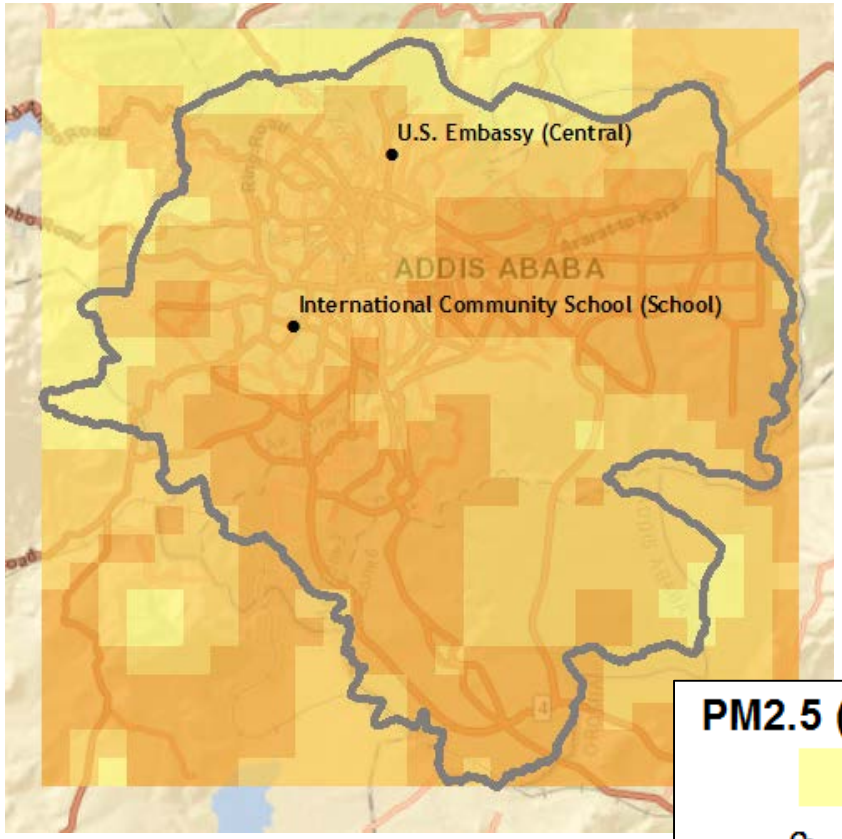
- City center (around Black Lion monitor) concentrations are adjusted upwards
- In other areas, calibration suggests on-the-ground concentrations of $PM_{2.5}$ are slightly lower than satellite estimates
  - The majority of the grids fall within a calibration factor range of 0.94-1 showing satellite data models PM quite well
- High PM concentrations track the roads
  - The final grid extends high PM concentrations further into the city center
- Monitor concentrations to the north are most affected by the adjustment
- Interpolation applied to areas without monitors

More data points, more realistic!

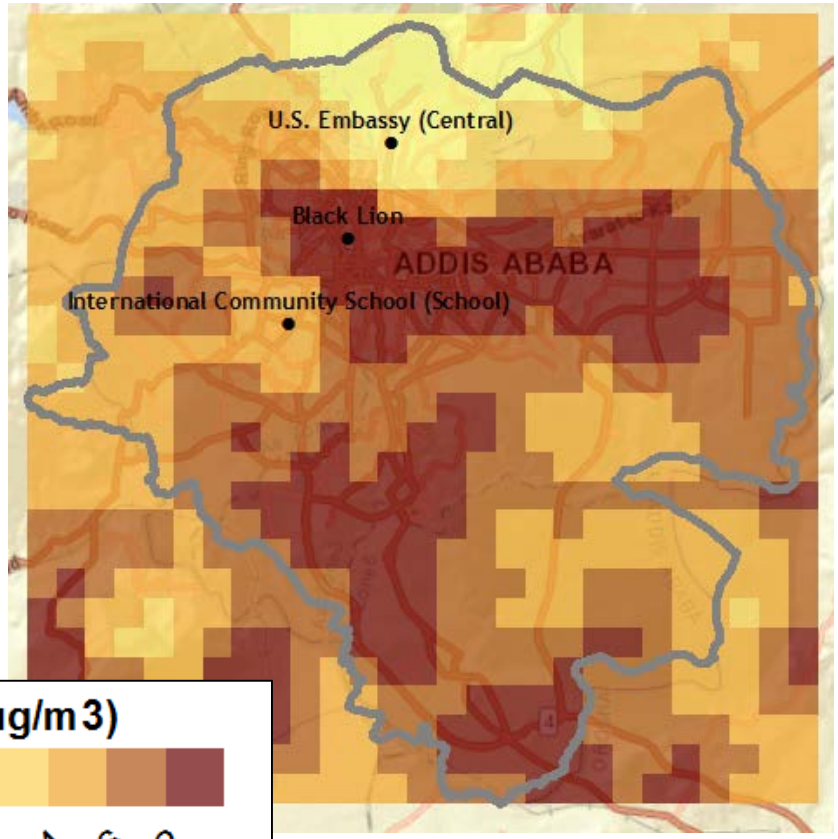
- One data point can change the analysis
  - Provides additional information on the relationship between satellite data and monitor data in the city
  - Currently assume the relationship between measured air quality and satellite data is fully captured with only 3 data points
  - Consider if we had multiple monitors, or a full monitor network?
- With a robust monitor network, using satellite data is no longer necessary

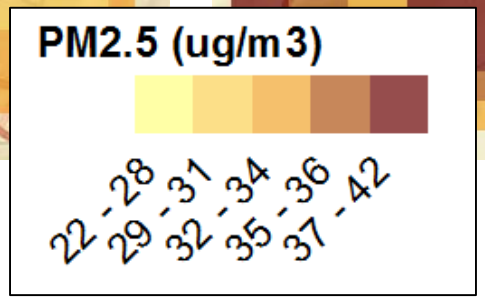
Ground-Truthed Comparison, with and without Black Lion Data

Without Black Lion Data



With Black Lion Data

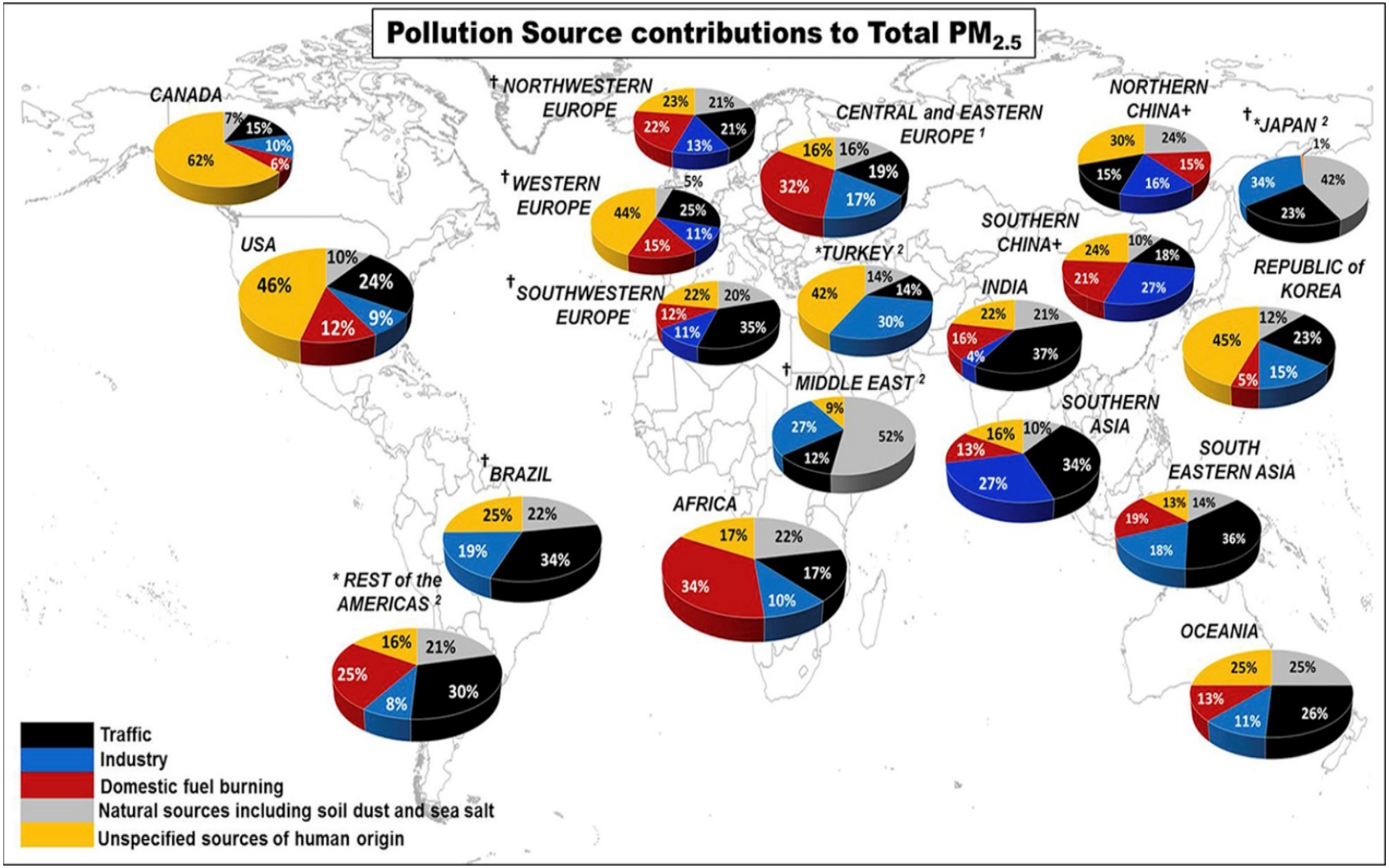




AQ Surface Evaluation

- What it does do:
  - Provides a scientifically sound starting point that can be updated as data improves
  - Provides estimated grid-cell level exposures
  - More geographically resolved than monitor data
  - Integrates satellite and monitored air quality data in ways not possible with the VNA functionality in BenMAP
- What it does not do:
  - Alleviate the need for an expanded monitoring network in Addis
    - Concentrations far from monitors still should be used with caution
  - Resolve inaccurate spatial patterns estimated by satellite

Source Apportionment Literature Review



Source: Karagulian et al. 2015, reprinted consistent with Open Access Creative Commons license CC BY-NC-ND

Draft AQMP Goals and Objectives Section

Establish an overall objective of the AQMP, for example:

- "Ambient air quality in Addis Ababa city is brought into full compliance with national and city ambient air quality standards by 2025, and the state of compliance is maintained as the city develops economically."

Establish goals by which the objective will be fulfilled, for example:

- Goal 1: Ambient concentrations of air pollutants comply with the relevant ambient air quality standards because of planned emission reductions
- Goal 2: Cooperative governance promotes the implementation of the AQMP
- Goal 3: Air quality management is supported by effective systems and tools
- Goal 4: Air quality decision- making is informed by sound research
- Goal 5: Knowledge and understanding amongst decision-makers, stakeholders, and the general public is improved according to an education and outreach plan

What Else Needs to be Done?

- Set/refine goals and objectives for the AQMP
- Refine the specific policy measures that will be taken to reduce emissions to meet the AQMP goals
- Identify other capacity building needs to achieve AQMP goals
- Review and improve the health benefits assessment and source attribution work
- Finish Draft AQMP

And, later this year:

- *Begin implementing some components of the AQMP with UN Environment (deploy sensors, conduct compliance and enforcement training, others)*
- *Finalize the AQMP*

Questions?