

Breathing Easy: How SERVIR Applies Research to Address Air Quality Challenges in Data Scarce Regions

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I. Introduction

A joint initiative of NASA, USAID, and leading geospatial organizations in Asia, Africa, and Latin America (Fig. 1), SERVIR partners with countries and organizations in these regions to address critical challenges in climate change, food security, water and related disasters, land use, and **air quality (AQ)**. Using satellite data and geospatial technology, SERVIR co-develops innovative solutions through a network of regional hubs to improve resilience and sustainable resource management at local, national and regional scales. Air quality is one of these challenges estimated to be associated with 6.7 million premature deaths annually. Across SERVIR's regional hubs there is an increasing need to improve the monitoring, forecasting, and management of air quality.

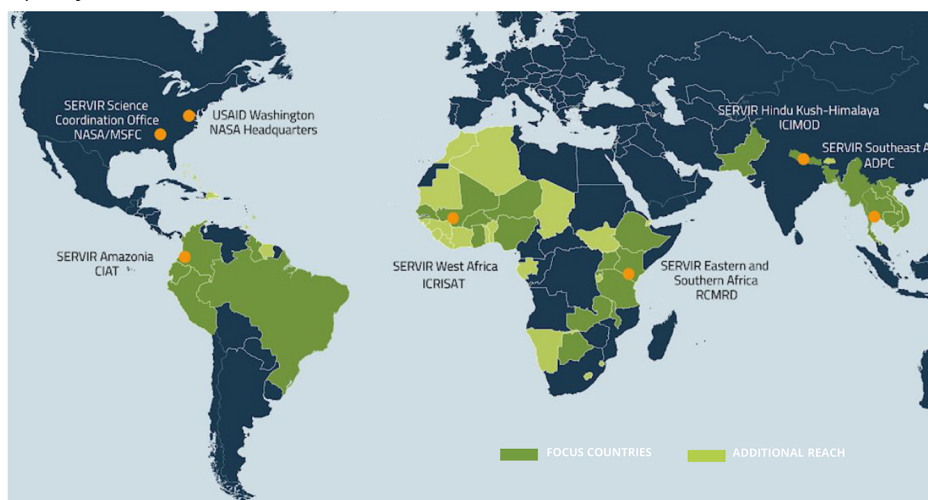


Fig. 1. SERVIR coverage area

SERVIR Service Planning Approach

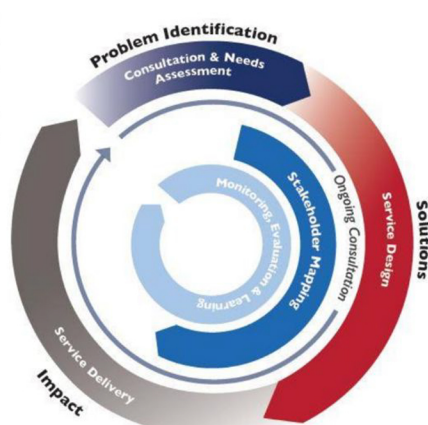


Fig. 2. SERVIR Service Planning Toolkit Approach for engaging with stakeholders and developing services

Who is SERVIR?

Regional Hub Host Institutions and Consortium Members

NASA SERVIR Applied Sciences Team

Private Sector Collaborators: Google, Esri, Planet, Maxar technologies, Development Seed, Mapbox and AWS.

US Government Collaborators: NOAA, USGS, USFS, and Department of State.

Intergovernmental NGO Collaborators: SERVIR helps inform aid agencies such as Food and Agriculture Organization, World Food Program, Red Cross Red Crescent, and Mercy Corps.

II. SERVIR Hindu Kush Himalaya (HKH)

Regional Hub Host Institution: International Centre for Integrated Mountain Development, Kathmandu, Nepal

Focus Countries: Nepal, Bangladesh, Pakistan, Myanmar

Service: Monitoring and prediction of Air Quality and visibility reduction in HKH region

Products

- Air Quality Forecast Data: displayed in the ICIMOD Air Quality Watch, an interactive tool to view and compare remote sensing datasets and ground sensors in different locations.
- Satellite Products of Aerosol and Trace Gases including surface-layer estimates: Level 4 CO, PM_{2.5}, SO₂, NO₂, HCHO

Datasets Used: MODIS & VIIRS AOD, TROPOMI, OMI, AMI, GEMS

Science: Regional WRF-Chem Model with AOD and NO₂ assimilation, HYSPLIT dust dispersion modeling

Stakeholders: Department of Environment in Nepal, National Environment Commission in Bhutan

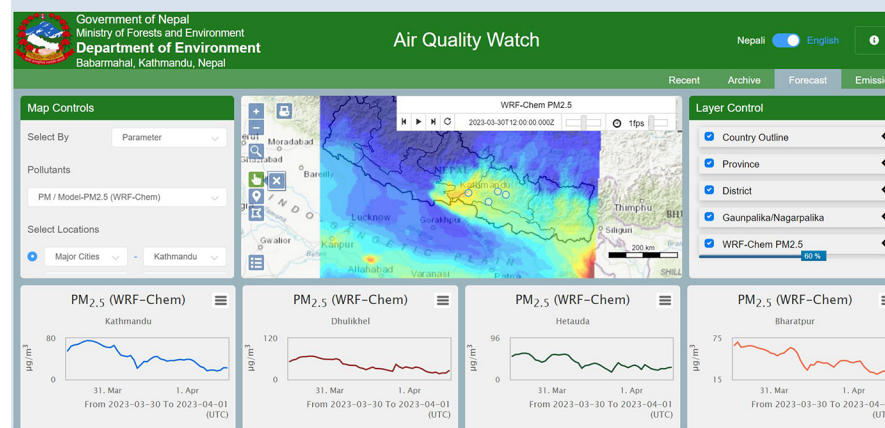


Fig. 3. ICIMOD Air Quality Watch interactive web tool

Future AQ Products

- Regional WRF-Chem model continued development including assimilation of GEMS data
- Dust RGB ML algorithm
- Updated emission inventories
- Air quality mobile application

III. SERVIR Southeast Asia (SEA)

Regional Hub Host Institution: Asian Disaster Preparedness Center, Bangkok, Thailand

Focus Countries: Thailand, Laos PDR, Cambodia, Vietnam, Myanmar

Service: Enabling sustainable landscape-scale agricultural management through fire and air quality monitoring

Products

- Mekong Air Quality Explorer: Visualize regional AQ
- Burn Check: uses 3 day AQ forecast to regulate agricultural burning
- Smoke Watch: provides info on location of fires for rapid response
- Gender assessment in North Thailand to understand agricultural considerations

Datasets Used: GEOS-FP, ground-based PM_{2.5}, MERRA-2, MODIS AOD, MODIS/VIIRS fire radiative power and FIRMS fire hotspots

Science: GEOS-FP bias correction and downscaling

Stakeholders: Thai Pollution Control Department, Rajamangala University of Technology, GISTDA, NIA, UNESCAP, ASEAN, Thai Northern Provincial Center for Solving Haze Problem and Forest Fire Control, PAM Air

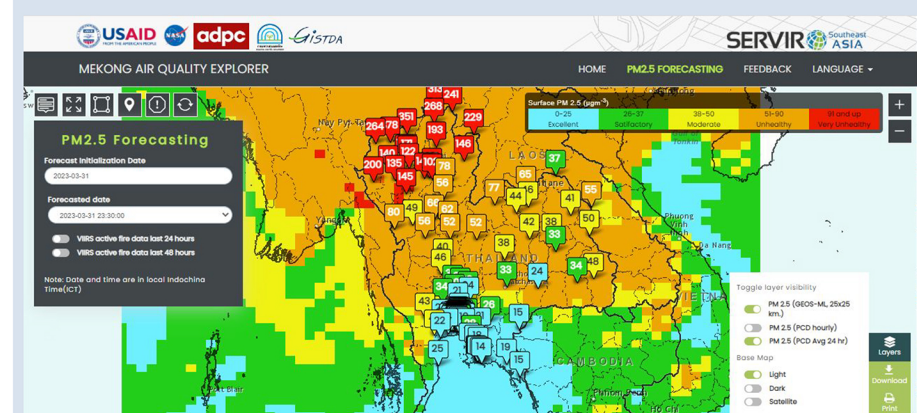


Fig. 4. Mekong Air Quality Explorer

Future AQ Products

- 1km exposure estimates of ozone and PM_{2.5} to inform human and vegetation health impacts
- 5km Downscaled GEOS-FP PM_{2.5} forecasts

IV. Activities in Other SERVIR Regions

- Eastern and Southern Africa:**
 - Development of WRF-Chem regional air quality forecast
 - Source attribution system: CO and BC tracers in model
 - Regional AQ Atlas 2003-2022
- AQ Challenges in other SERVIR regions:**
 - Amazonia: volcanos, agricultural fires,
 - West Africa: dust from arid and semi-arid areas

V. Lessons Learned

- Operational forecasting:** Bandwidth issues pose a barrier to download and assimilate data into forecast models.
- In-situ sensor maintenance:** ground sensors require long term maintenance plans and continued funding for institutions to provide their personnel and time to maintain stations.

VI. Support to NASA Missions

- Asia-AQ:** SEA hub coordinates with the U.S. embassy in Thailand to connect the Asia-AQ campaign to existing AQ efforts in the region.
- MAIA:** During mission scoping SERVIR advocated for secondary sites such as Bangkok and Nairobi.
- GEO AQ Satellite Constellation:** TEMPO's domain may extend over Central America in the winter. GEMS provides valuable hourly AQ data over SERVIR-HKH and SERVIR-SEA.

VII. Research Needs

- In-situ monitor accuracy:** Accuracy assessment of in-situ monitors both government and low cost enables the validation of air quality products.
- Source attribution:** source apportionment, inverting emissions through inverse modeling could help inform policy.