**Table 2: Definition, limitations, and requirements of the two source apportionment approaches**

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| Category | Receptor (top-down) modelling approach | Emissions (bottom-up) modelling approach |
| Definition | Ambient sample is analysed for its chemical composition (in the form of ions, metals, carbon, and other chemical species) and statistically matched with the chemical profiles of different sources to ascertain their share of contribution to the measured ambient sample (Watson et al., 2002). | An emissions inventory is established for all the known sectors (anthropogenic and natural) and processed through a meteorology coupled chemical transport model to ascertain their share of contribution to the select airshed (Guttikunda et al., 2019). |
| Source definition | Typically, source refers to the type of fuel and depending on the granularity of the profile, the chemical signatures can also refer to a sector. | Typically, source refers to a sector and, in some cases, it can also refer to a region or a fuel or all of them, depending on the granularity of the emissions inventory. |
| Major limitations | Differentiating between the sectors burning the same fuels is a major bottleneck. For example, diesel burnt at a generator and diesel burnt in a truck will show similar chemical profile; dust from wind erosion and dust from the side of the roads that is resuspended due to vehicular traffic could have similar chemical profile; and biomass burnt in an open field and biomass burnt for cooking will show same chemical profile. | The emissions inventory depends on the depth of activity levels, fuel consumption data, and emission factors which vary by region and combustion technology in place. |
| Spatial representativeness | Analysis results are representative of an area covering 2-km radius of the sampling location. The representativeness of the overall result to a city or a region depends on the number of sampling locations and the number of samples collected. | Analysis results are representative of the entire airshed selected for the emissions and the chemical transport modelling exercise. The grid resolution can provide further details within the airshed. |
| Temporal representativeness | Analysis results are representative of the day and time of the sample collected. Multiple samples are required by month or by season to ascertain the temporal trends in source contributions. | Analysis results are available at various temporal scales – by hour, by day, by month, and by season, depending on the granularity of the emissions and the chemical transport modelling exercise. |
| Financial burden | HIGH - depending on the number of sampling locations in the airshed and number of samples collected per season. | VARIABLE - depending on the granularity of the emissions and chemical transport modelling exercise; primary data collecting activities; and modelling tools employed. |
| Laboratory needs | HIGH - a stringent set of protocols must be followed starting from sampling, storage, chemical analysis, source profiling, QAQC, and statistical modelling. | HIGH/MEDIUM - when primary data collection is carried out to ascertain the emission factors by fuel and by sector. LOW – when the study relies on the existing databases. |
| Personnel needs | HIGH - study requires personnel to perform field, laboratory and statistical modelling tasks. Advanced, semi-autonomous samplers can reduce personnel time in the field. | HIGH - when primary emissions inventory work is carried out and the chemical transport modelling setup starts from scratch. MEDIUM/LOW - when emission inventories are available, and the chemical transport model setup is operational. |
| Personnel skill needs | HIGH - experienced staff is required to collect/store/record the samples during the field experiment; experienced staff is required to operate/calibrate/analyse the samples in the lab; and experienced staff is required to select relevant source profiles and conduct receptor modelling. | HIGH - experienced staff is required to collate/manage/map/analyse the emissions inventory for the airshed; experienced staff is required to operate/calibrate/analyse the meteorology coupled chemical transport models for the airshed. |
| Computational needs | LOW - most of the statistical packages can be installed and run on a personal computer. | HIGH - depending on the chemical transport model of choice, chemical mechanism selected, spatial and temporal resolution of the modelling system, and range of output parameters. |
| Time required to complete the study | Typically, one year for sampling and 6 months to 2 years for chemical analysis and statistical modelling. | Typically, less than one year. |
| Uncertainty in the results | HIGH - when the source profiles for all the known sources are not developed locally and the number of samples and sampling locations are statistically not representative of the airshed. | HIGH - when the activity and fuel-based emission factors information for all the known sources is not developed locally. |

Guttikunda, S.K., Nishadh, K.A., Jawahar, P., 2019. Air pollution knowledge assessments (APnA) for 20 Indian cities. Urban Climate 27, 124-141.

Watson, J.G., Zhu, T., Chow, J.C., Engelbrecht, J., Fujita, E.M., Wilson, W.E., 2002. Receptor modeling application framework for particle source apportionment. Chemosphere 49, 1093-1136.