The need of statistical methodological tools in the compilation of air emission inventories

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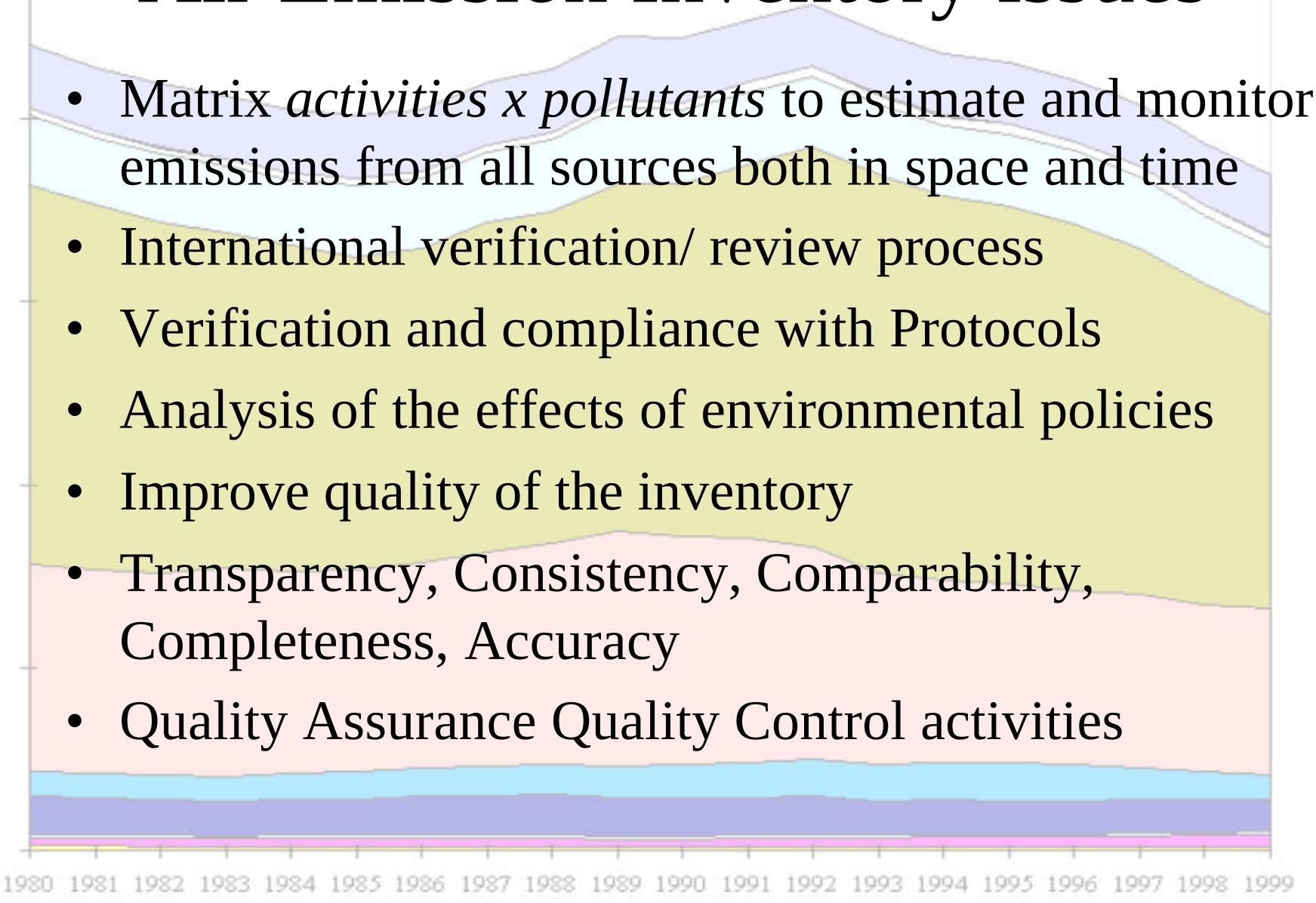
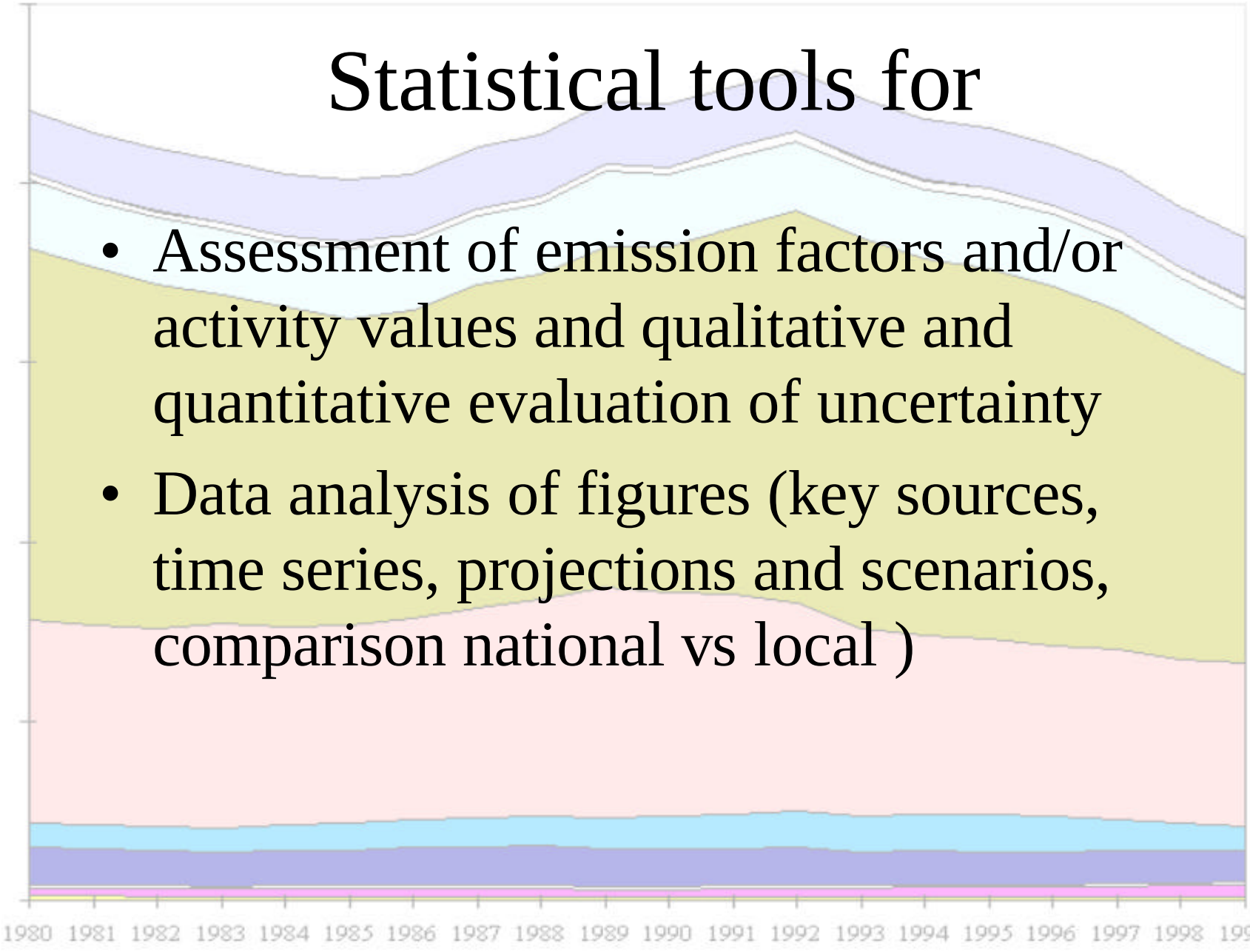
Air Emission Inventory issues

- Matrix *activities x pollutants* to estimate and monitor emissions from all sources both in space and time
- International verification/ review process
- Verification and compliance with Protocols
- Analysis of the effects of environmental policies
- Improve quality of the inventory
- Transparency, Consistency, Comparability, Completeness, Accuracy
- Quality Assurance Quality Control activities



Statistical tools for

- Assessment of emission factors and/or activity values and qualitative and quantitative evaluation of uncertainty
- Data analysis of figures (key sources, time series, projections and scenarios, comparison national vs local)



Assessment EF/Activity values

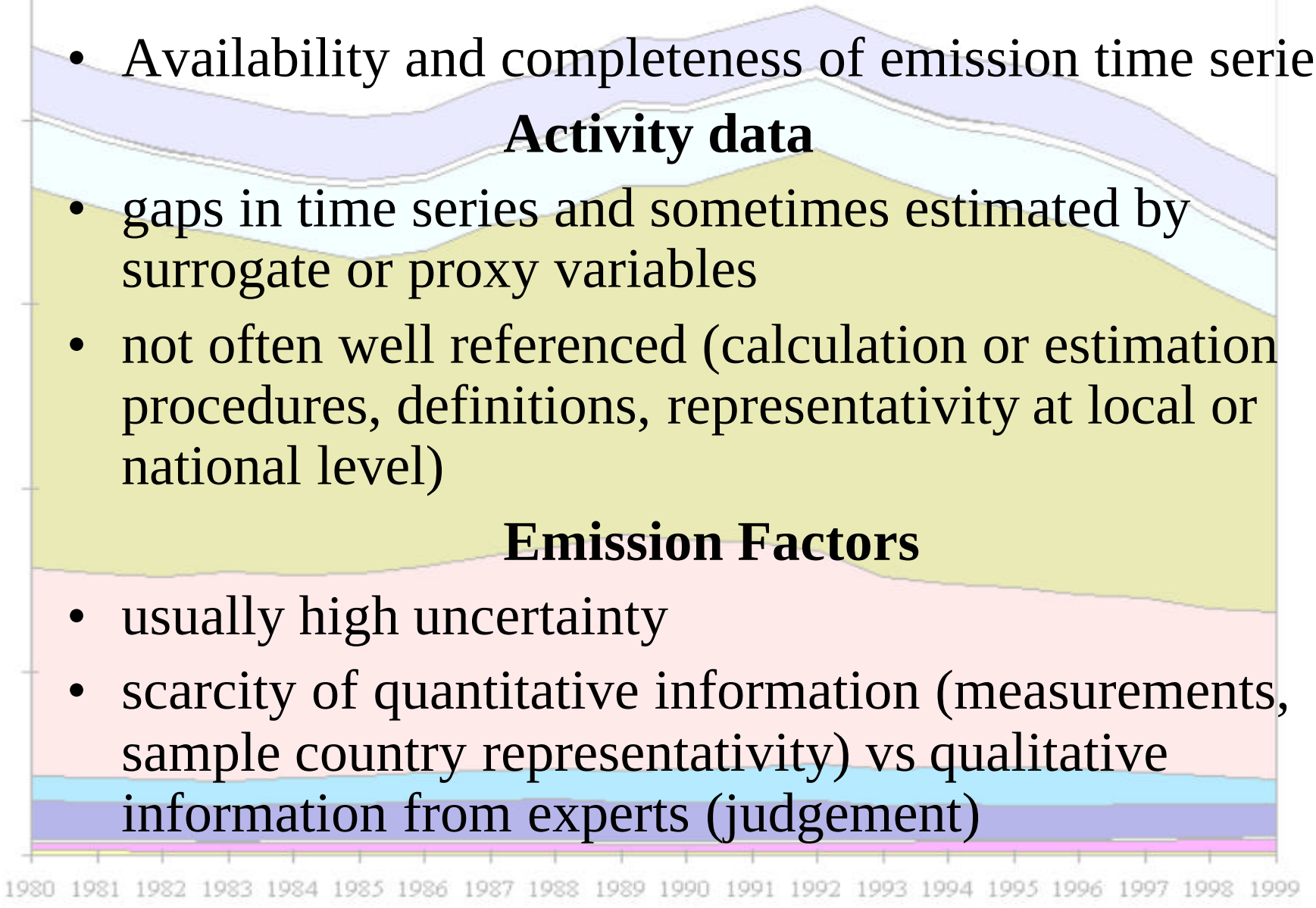
- Availability and completeness of emission time series

Activity data

- gaps in time series and sometimes estimated by surrogate or proxy variables
- not often well referenced (calculation or estimation procedures, definitions, representativity at local or national level)

Emission Factors

- usually high uncertainty
- scarcity of quantitative information (measurements, sample country representativity) vs qualitative information from experts (judgement)



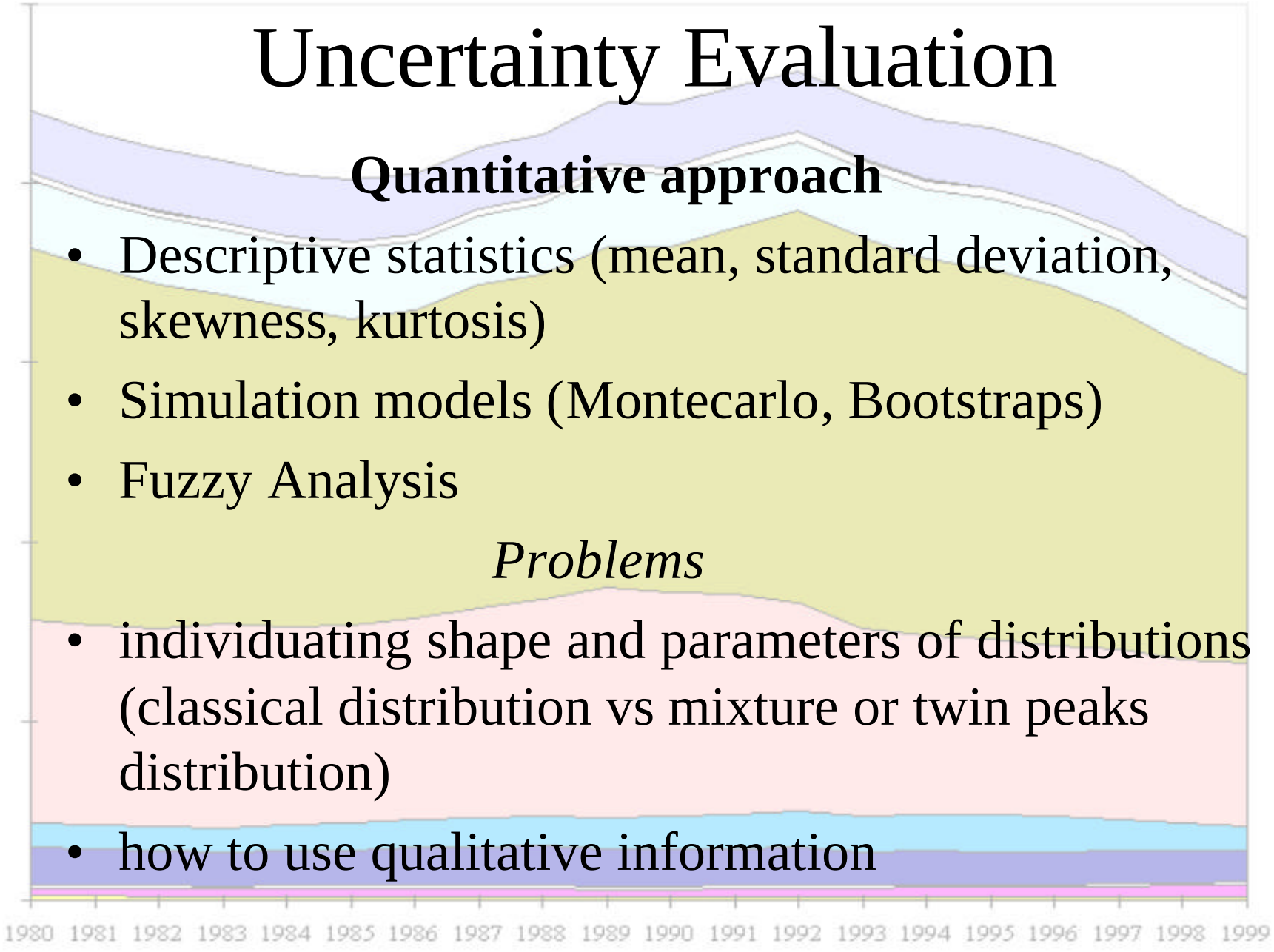
Uncertainty Evaluation

Quantitative approach

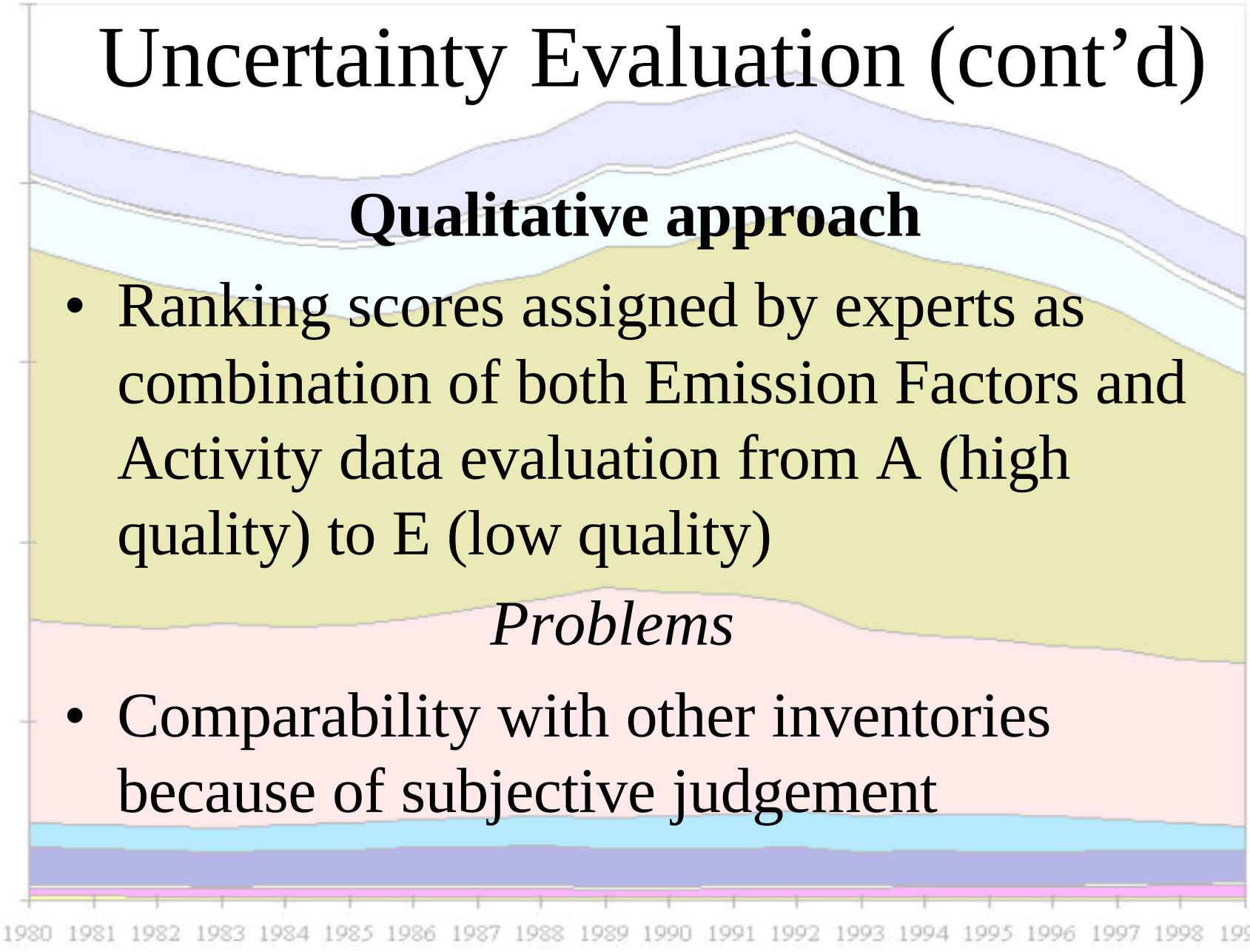
- Descriptive statistics (mean, standard deviation, skewness, kurtosis)
- Simulation models (Montecarlo, Bootstraps)
- Fuzzy Analysis

Problems

- individuating shape and parameters of distributions (classical distribution vs mixture or twin peaks distribution)
- how to use qualitative information



Uncertainty Evaluation (cont'd)



Qualitative approach

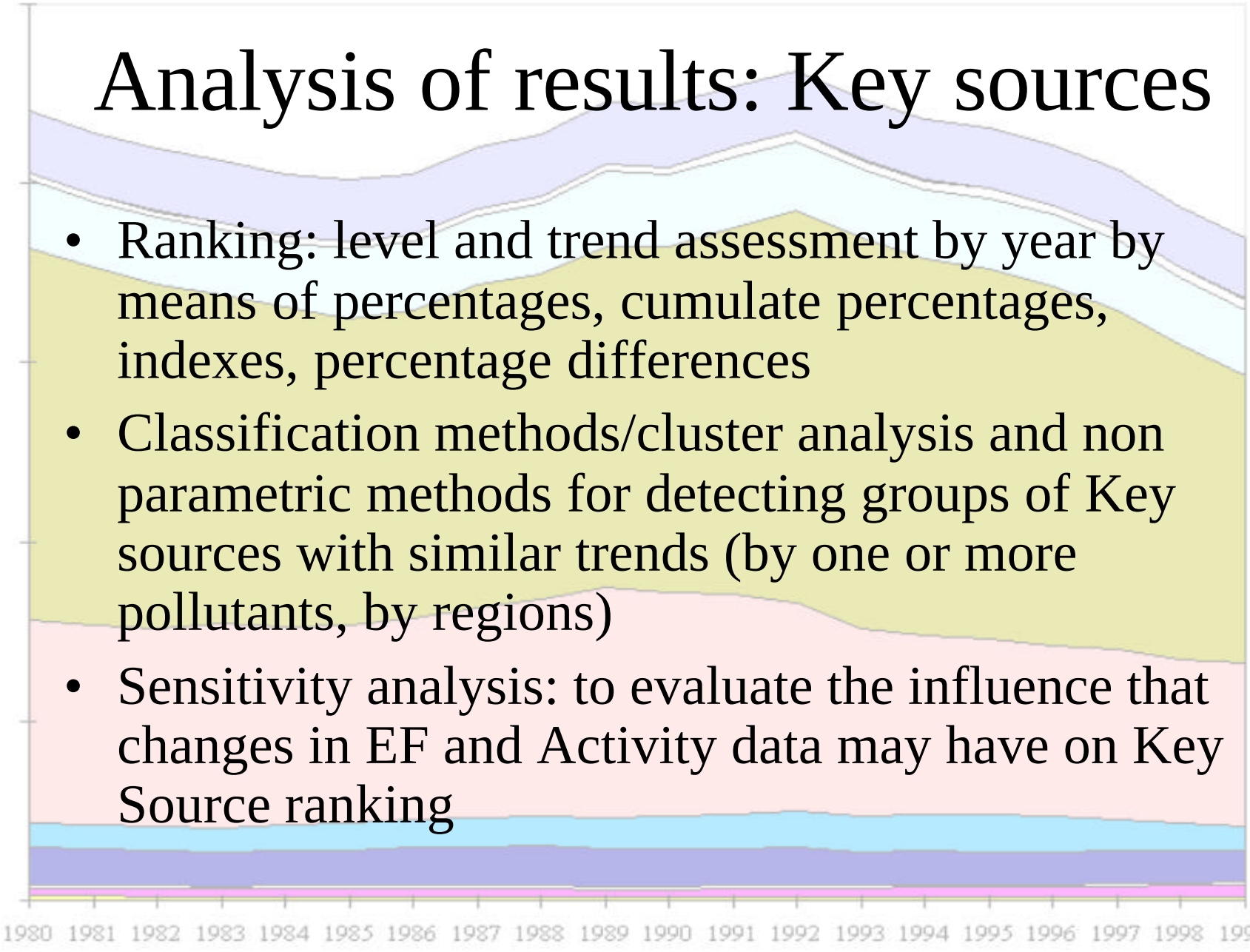
- Ranking scores assigned by experts as combination of both Emission Factors and Activity data evaluation from A (high quality) to E (low quality)

Problems

- Comparability with other inventories because of subjective judgement

Analysis of results: Key sources

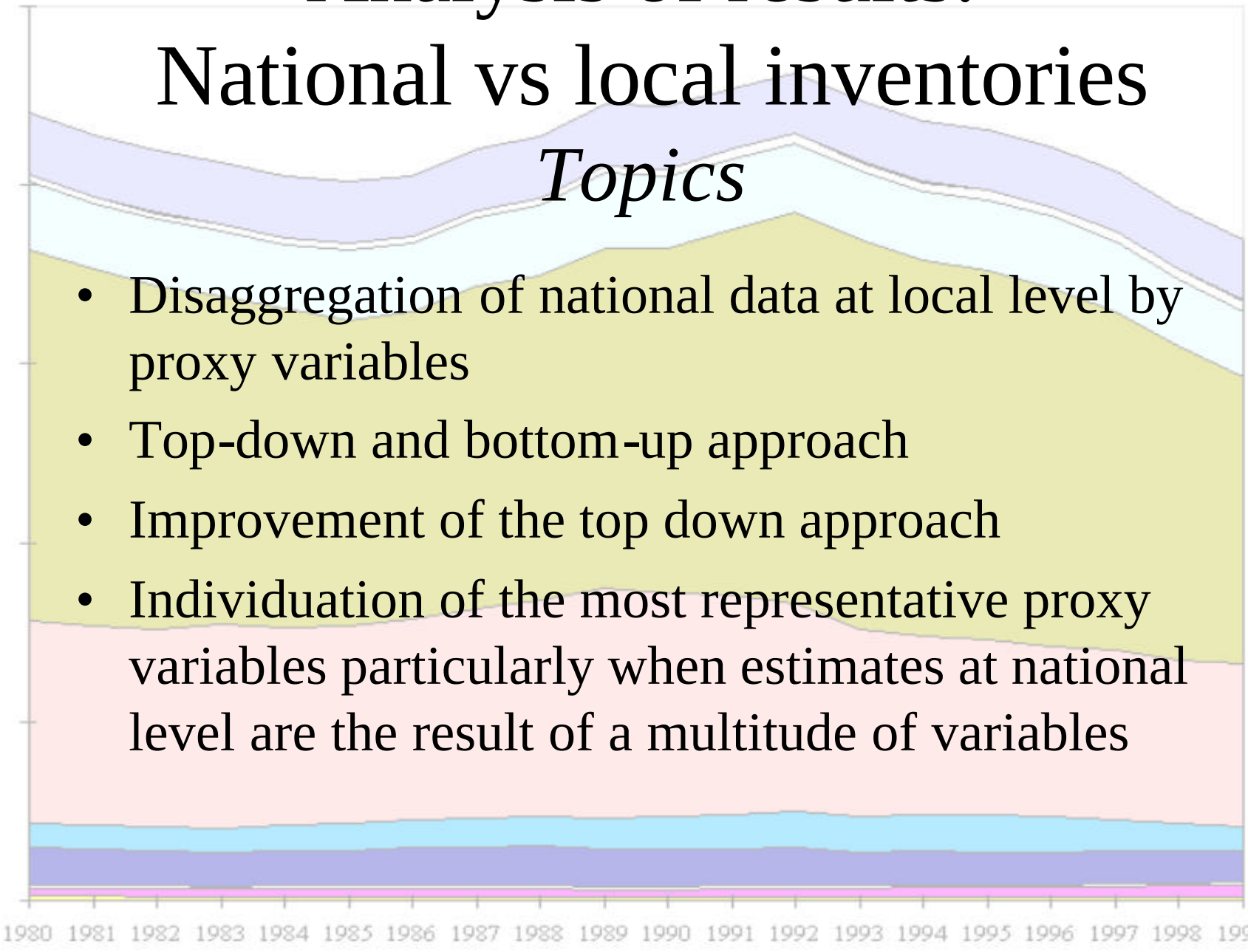
- Ranking: level and trend assessment by year by means of percentages, cumulate percentages, indexes, percentage differences
- Classification methods/cluster analysis and non parametric methods for detecting groups of Key sources with similar trends (by one or more pollutants, by regions)
- Sensitivity analysis: to evaluate the influence that changes in EF and Activity data may have on Key Source ranking



Analysis of results: National vs local inventories

Topics

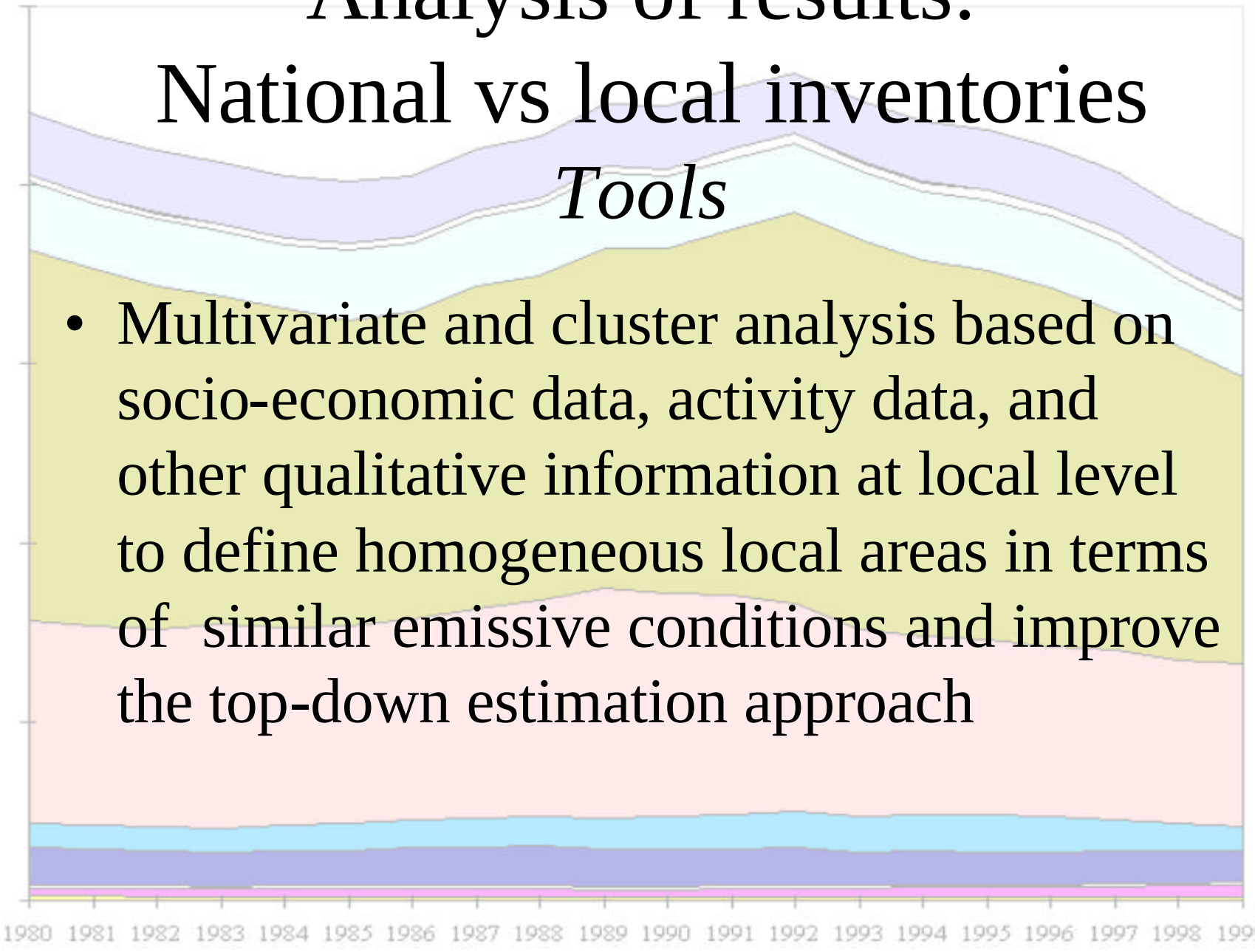
- Disaggregation of national data at local level by proxy variables
- Top-down and bottom-up approach
- Improvement of the top down approach
- Individuation of the most representative proxy variables particularly when estimates at national level are the result of a multitude of variables



Analysis of results: National vs local inventories

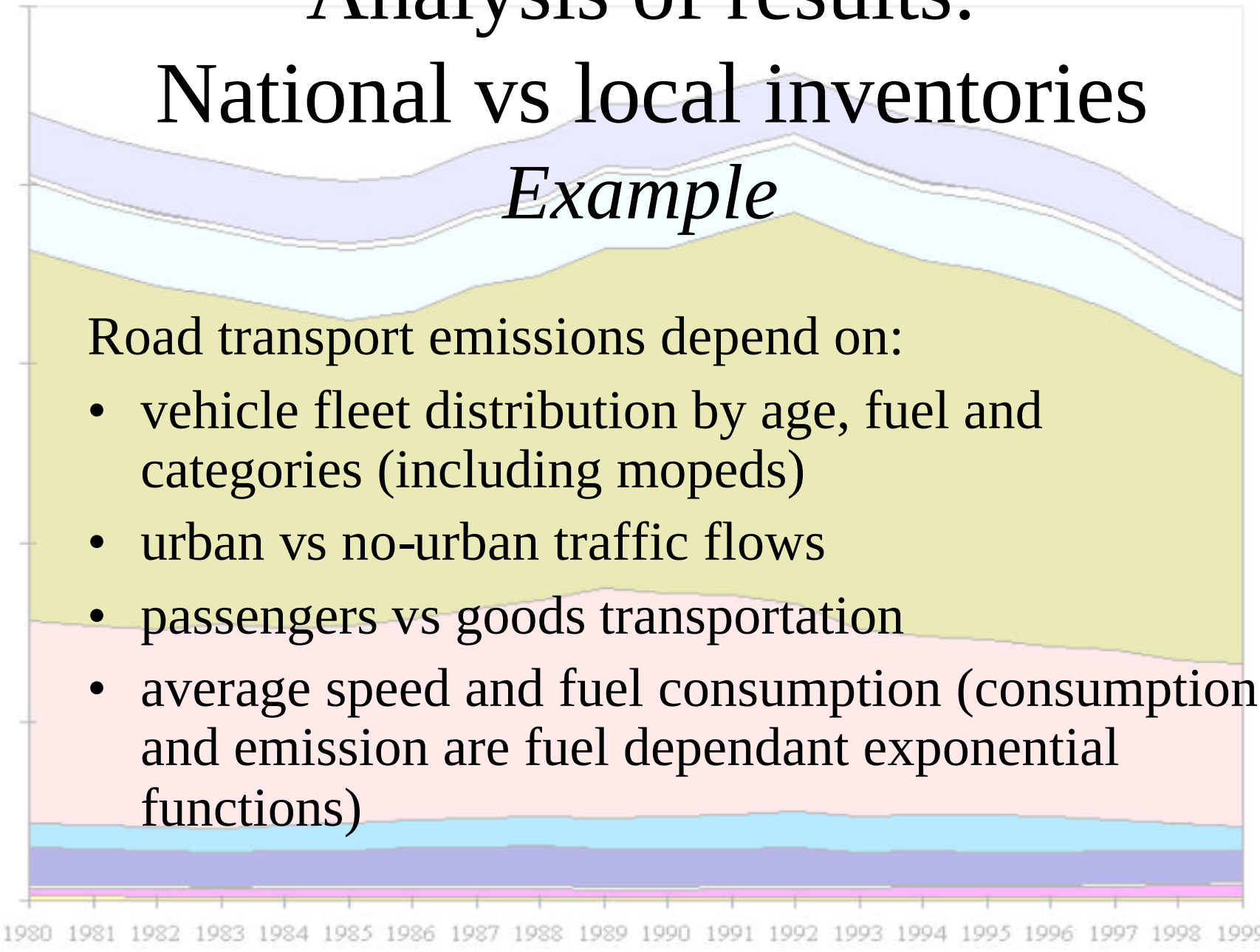
Tools

- Multivariate and cluster analysis based on socio-economic data, activity data, and other qualitative information at local level to define homogeneous local areas in terms of similar emissive conditions and improve the top-down estimation approach



Analysis of results: National vs local inventories

Example



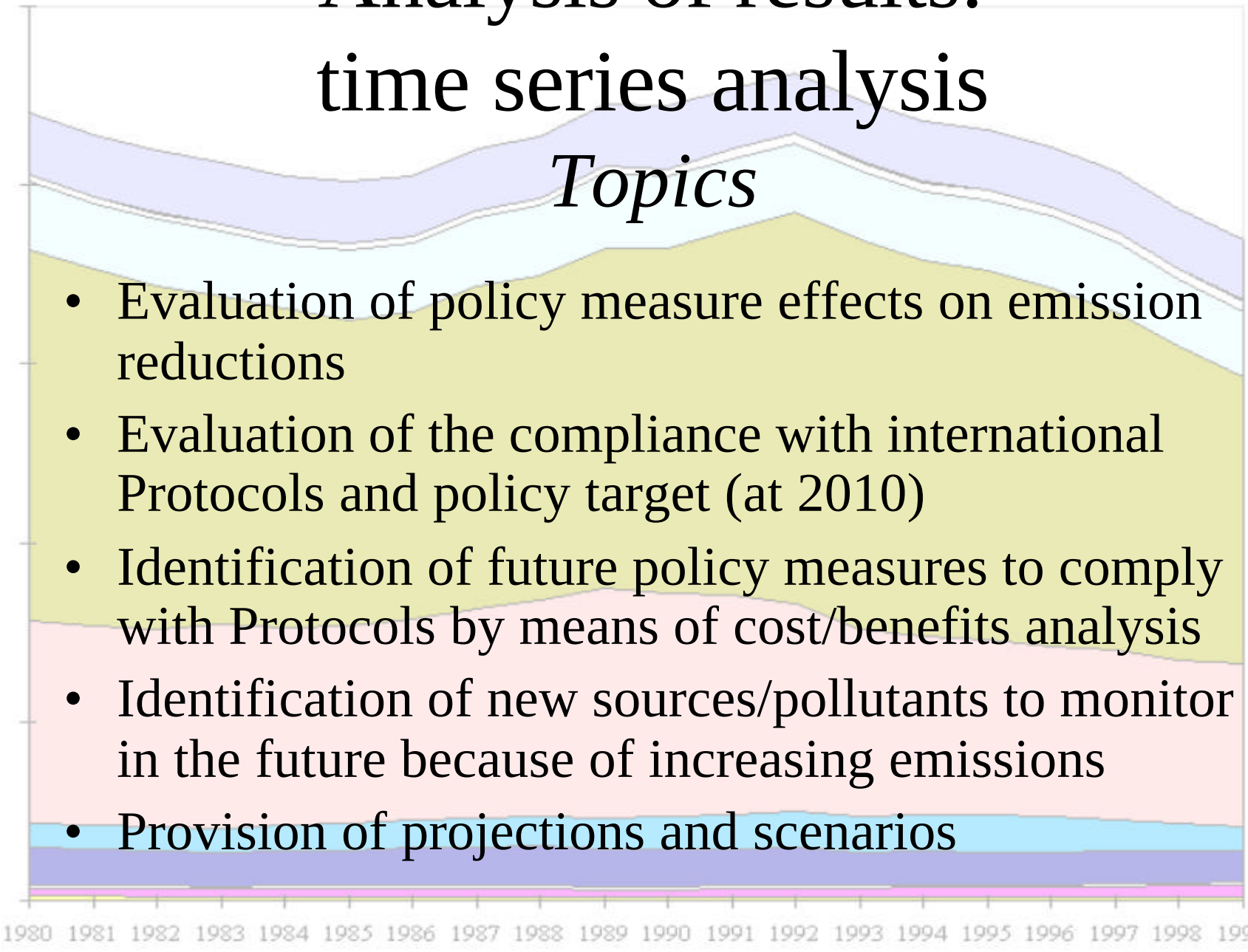
Road transport emissions depend on:

- vehicle fleet distribution by age, fuel and categories (including mopeds)
- urban vs no-urban traffic flows
- passengers vs goods transportation
- average speed and fuel consumption (consumption and emission are fuel dependant exponential functions)

Analysis of results: time series analysis

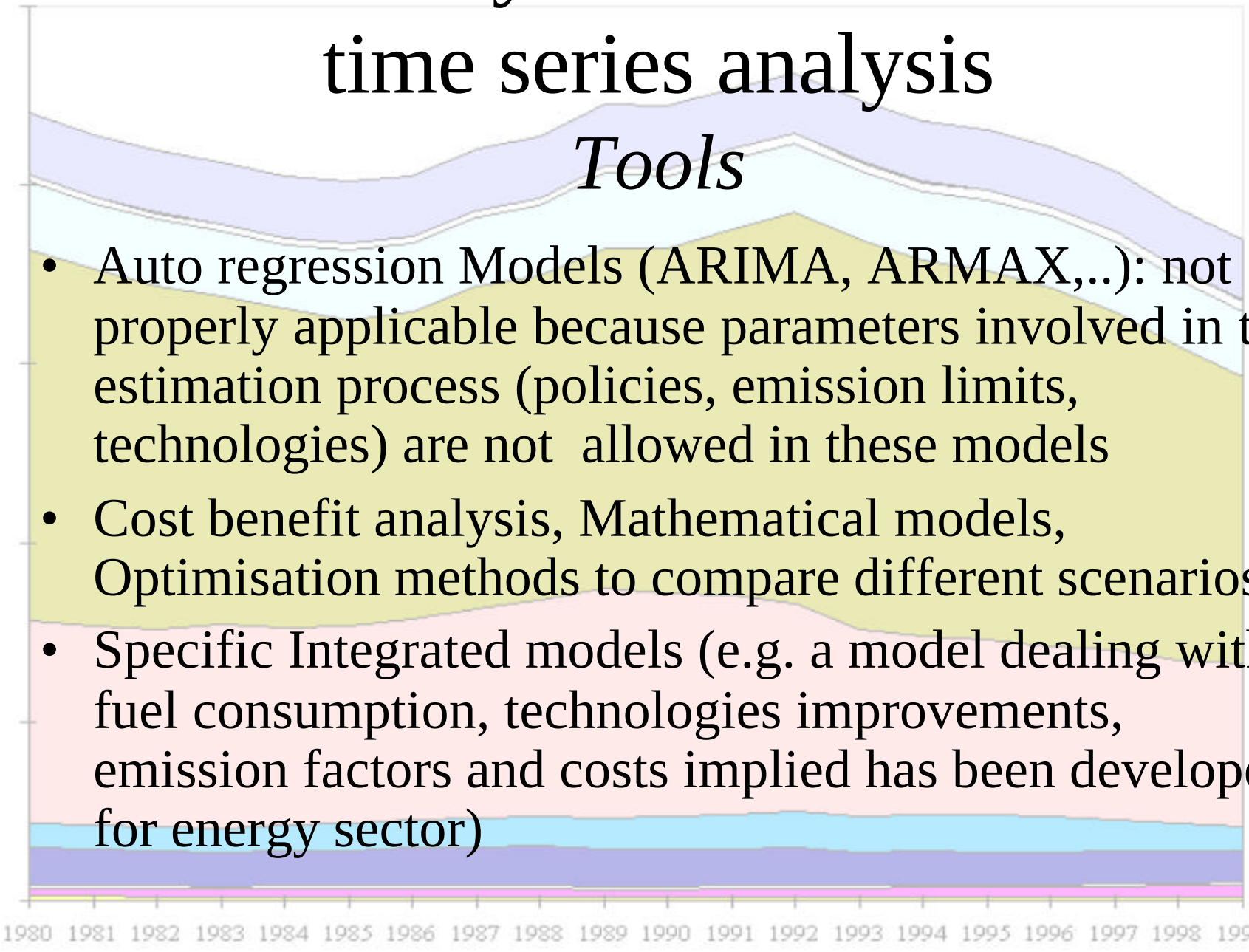
Topics

- Evaluation of policy measure effects on emission reductions
- Evaluation of the compliance with international Protocols and policy target (at 2010)
- Identification of future policy measures to comply with Protocols by means of cost/benefits analysis
- Identification of new sources/pollutants to monitor in the future because of increasing emissions
- Provision of projections and scenarios



Analysis of results: time series analysis

Tools



- Auto regression Models (ARIMA, ARMAX,..): not properly applicable because parameters involved in the estimation process (policies, emission limits, technologies) are not allowed in these models
- Cost benefit analysis, Mathematical models, Optimisation methods to compare different scenarios
- Specific Integrated models (e.g. a model dealing with fuel consumption, technologies improvements, emission factors and costs implied has been developed for energy sector)

Conclusions

- Statistical methodological tools are used in all the phases of the compilation of the emission inventory
- The application of all these methods guarantees a high quality emission inventory and a systematic quality assurance and quality control approach