



# Methods used for producing population estimates and projections

Population Division | Department of Economic and Social Affairs | United Nations

Second technical workshop on nowcasting in international organizations, May 25-26, 2022



# UNPD's work programme

UNPD produces global datasets with **annual estimates and projections** for all countries and areas:

- Population size and age-structures
- Fertility
- Mortality
- International migration
- Urbanization
- Contraceptive use and family planning

} **World Population Prospects 2022**  
(release in July 2022)

<https://www.un.org/development/desa/pd/>

# Challenges of producing current estimates and short-term projections

## What is needed?

- Estimates of the current situation and analyzing trends over time
- Comparing countries at the same time period and calculating aggregates

Type of data sources used: Census, Survey, Vital Statistics, Administrative data sources, National estimates

## Why are estimates needed?

- To fill-in gaps in missing data: most information often available only for some countries and/or dates
- To reconcile differences (a) between data sources and/or estimation methods for a specific date and (b) within sources over time
- To ensure international comparability using similar methodology and assumptions across countries



# Bayesian Statistical Models

Bayesian statistical models used by the Division:

- ‘Sharing information’ in a principled and rigorous way to improve estimation for all countries and time periods according to a clustering/hierarchy
- Can incorporate covariates and/or systematic trend based on substantive knowledge
- Account for **biases** and **uncertainty**
  - Observation-specific biases are accounted for (and estimated) through model parameters
  - Uncertainty is estimated and quantified with uncertainty intervals that have a probabilistic interpretation

# Two groups of models used by UNPD

## Data-driven smoothing models:

- Spline functions, sometimes using covariates
- In general, difficult to project from the latest observation available
- Examples: child mortality (IGME), maternal mortality (MMEIG), age-specific fertility and mortality rates estimates (WPP), total fertility estimates (WPP)

## Models incorporating substantive knowledge:

- Knowledge based on historical trends and theoretical basis (for example, demographic transition) or behavioral changes that can be modelled through diffusion processes
- Include a parametric function
- Enable to generate **projections**
- Examples: fertility projections, family planning estimates and projections

# GLOBAL MONITORING OF KEY FAMILY PLANNING INDICATORS


International commitments require monitoring at the country, regional and global levels

**Global monitoring (SDGs)** – UNPD is a custodian agency for SDG 3.7.1

The Division produces global data sets and analytical studies on contraceptive use and family planning:

- **Global data compilations:** World Contraceptive Use
- **Estimates and projections of key family planning indicators:** annual model-based estimates and projections, 1970 to 2030

In UNCTAD paper on “Feasibility of nowcasting SDG indicators”, this indicator is classified as highly likely for nowcasting feasibility

TARGET	3·7	INDICATOR	3·7·1
		Proportion of women of reproductive age (aged 15-49 years) who have their need for family planning satisfied with modern methods	
UNIVERSAL ACCESS TO SEXUAL AND REPRODUCTIVE CARE, FAMILY PLANNING AND EDUCATION			

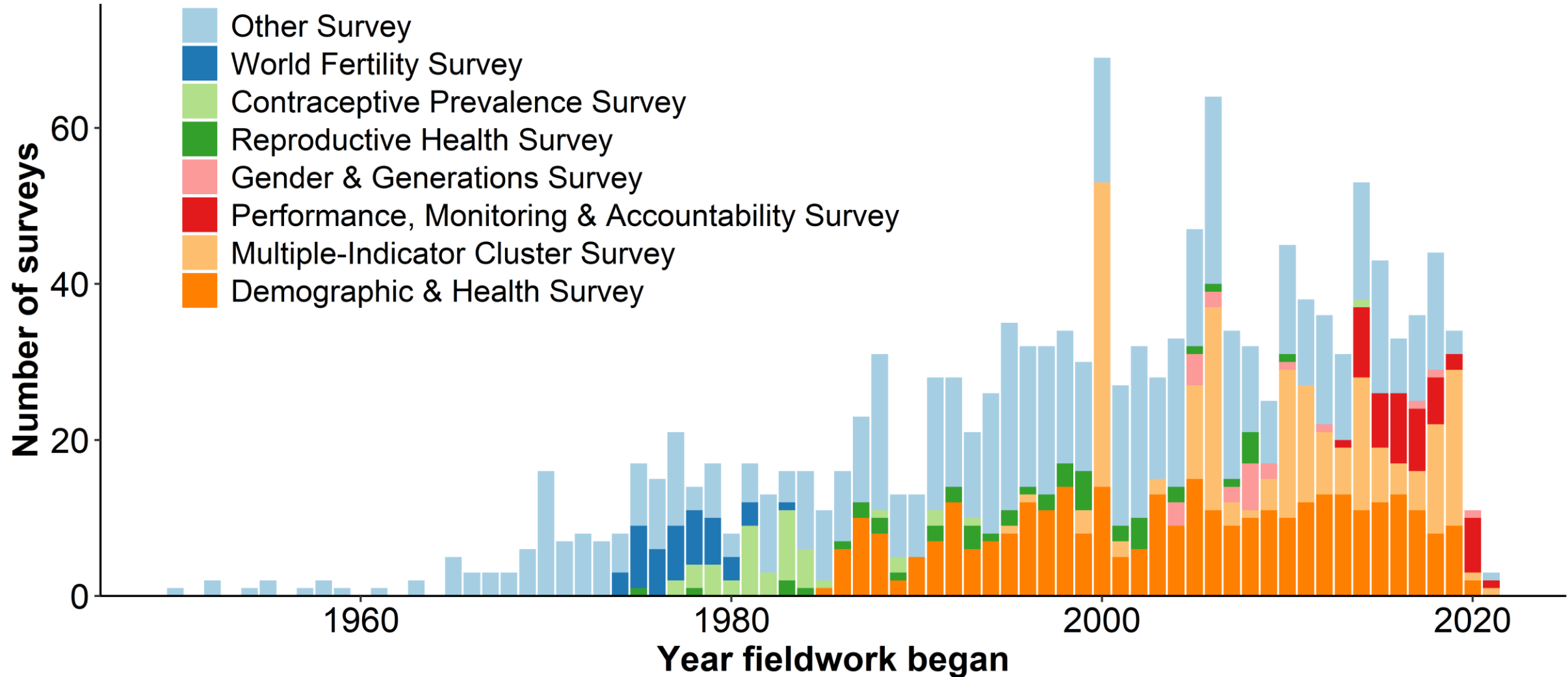
# Data availability for global monitoring

## World Contraceptive Use dataset

- Survey-based observations of contraceptive prevalence and unmet need for family planning
- For all women of reproductive age (15-49 years) and by marital status
- More than 1,400 surveys from 1950 to 2021
- 197 countries or areas
- 2022 revision will be released in July 2022
- Biases in sample representativeness (age groups, marital status), differences in contraceptive method classifications, data sources variance depending on the type of survey
- More information available: <https://www.un.org/development/desa/pd/themes/family-planning>

# Data sources for global monitoring

The sources of survey observations in World Contraceptive Use 2022

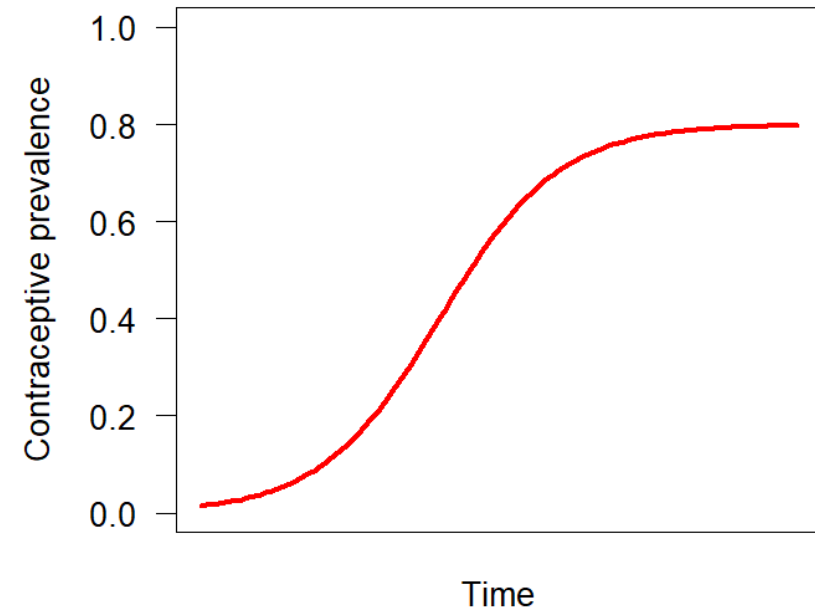




# Logistic Growth Curve Models for Prevalence

- Systematic trend underlying the model is based on 'diffusion' model for uptake of contraceptive methods.
- Countries over time are moving along the systematic trend from low levels of contraceptive use to higher levels
- We used logistic growth curves to model the systematic trends in
  - Contraceptive Prevalence, All Methods ( $P_{c,t}^*$ )

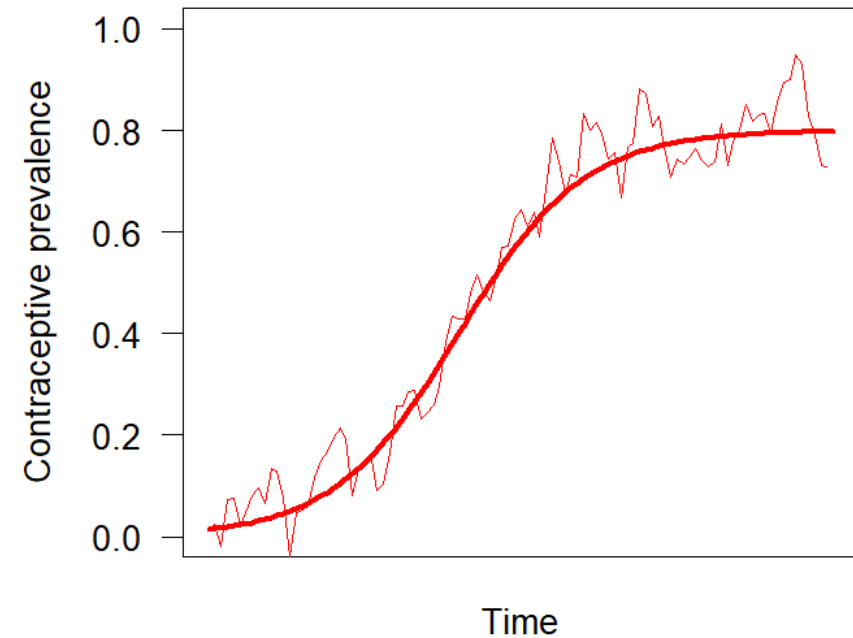
$$P_{c,t}^* = \frac{\tilde{P}_c}{1 + \exp(-\omega_c(t - \Omega_c))}$$



# Logistic Growth Curves + Distortion

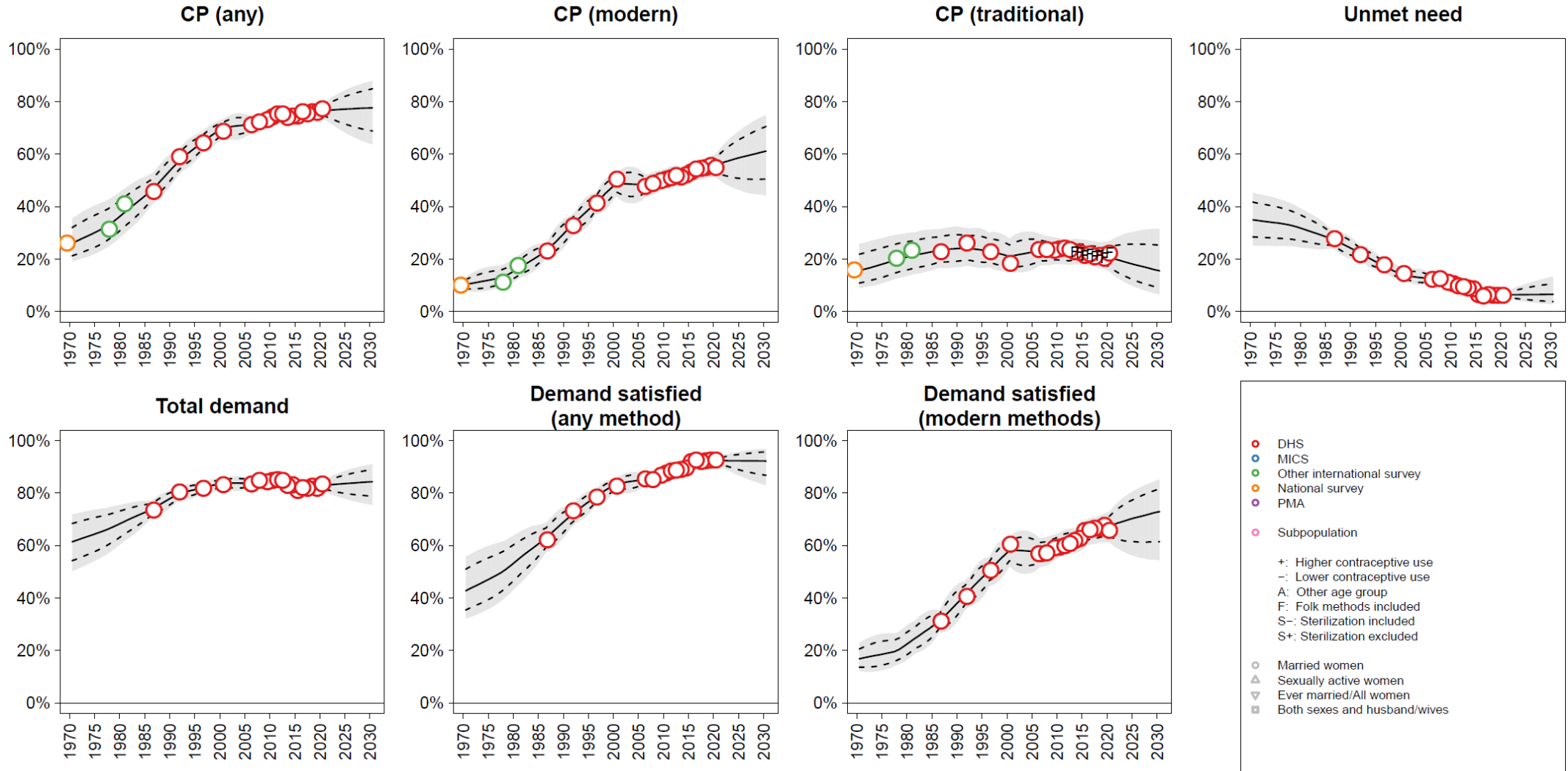
- The logistic curves are flexible but reality is noisier and the results need to reflect the data available.
- Observed evolution of prevalence is assumed to follow a logistic growth curve only *on average*.
- Autocorrelated (AR1) distortions were added to allow for realistic deviations from the systematic trend.

$$P_{c,t} = \text{logit}^{-1}(\text{logit } P_{c,t}^* + \epsilon_{c,t})$$
$$\epsilon_{c,t} \sim \text{Normal}(\rho_{\epsilon} \cdot \epsilon_{c,t-1}, \tau_{\epsilon}^2)$$



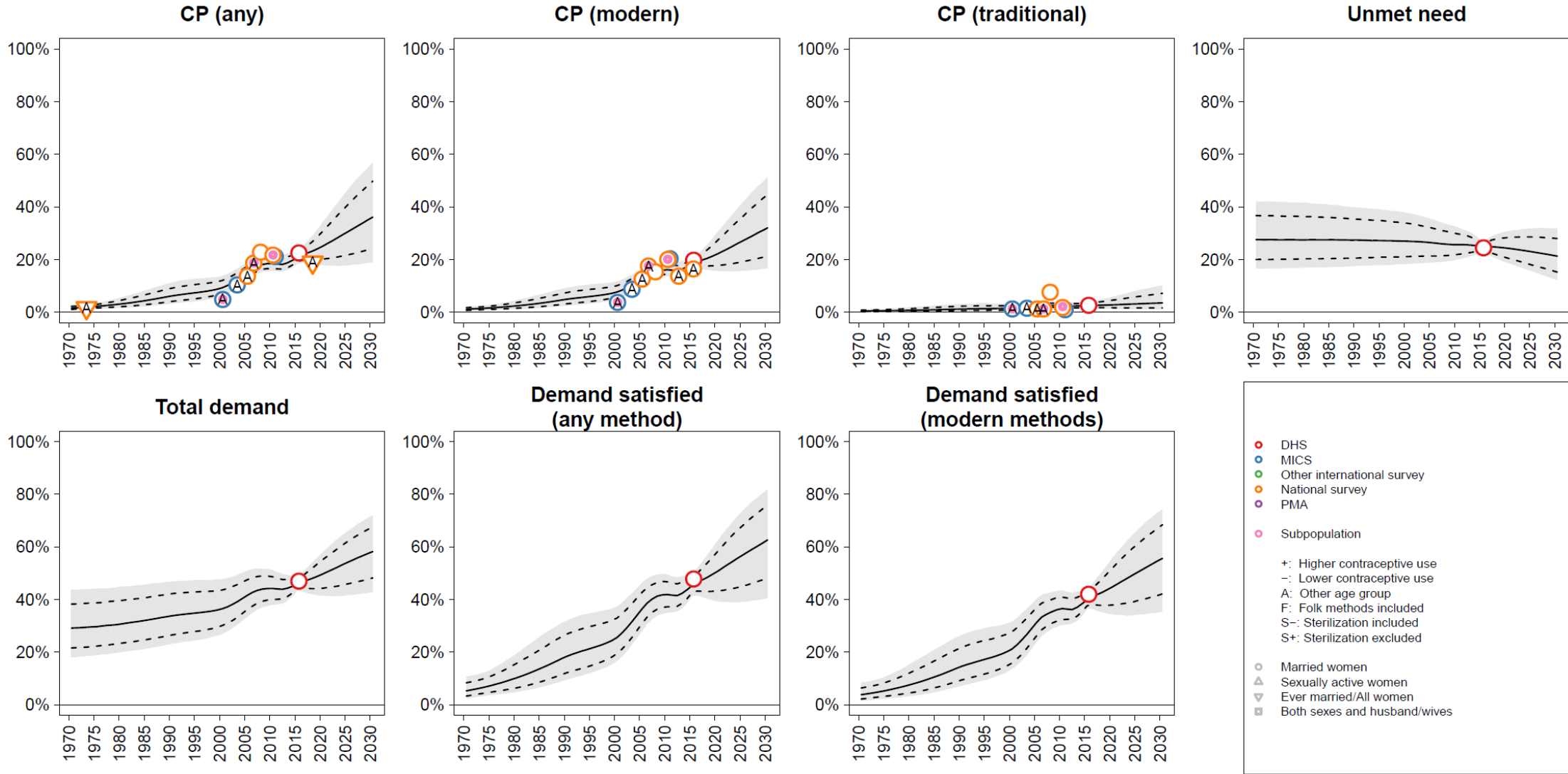
# Estimates and projections for Peru

Peru (South America) --- Married / In-Union



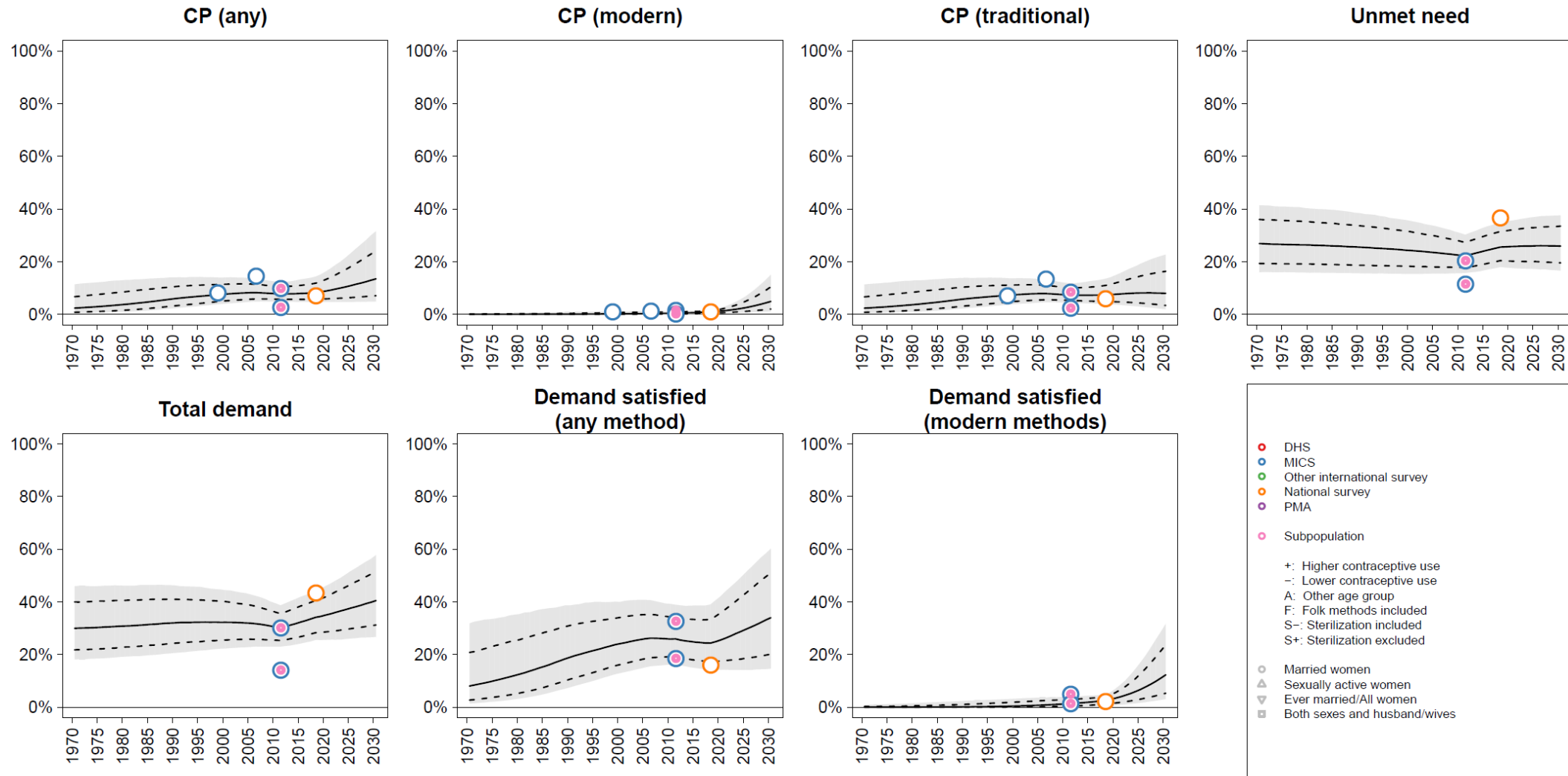
# Estimates and projections for Afghanistan

Afghanistan (Southern Asia) --- Married / In-Union

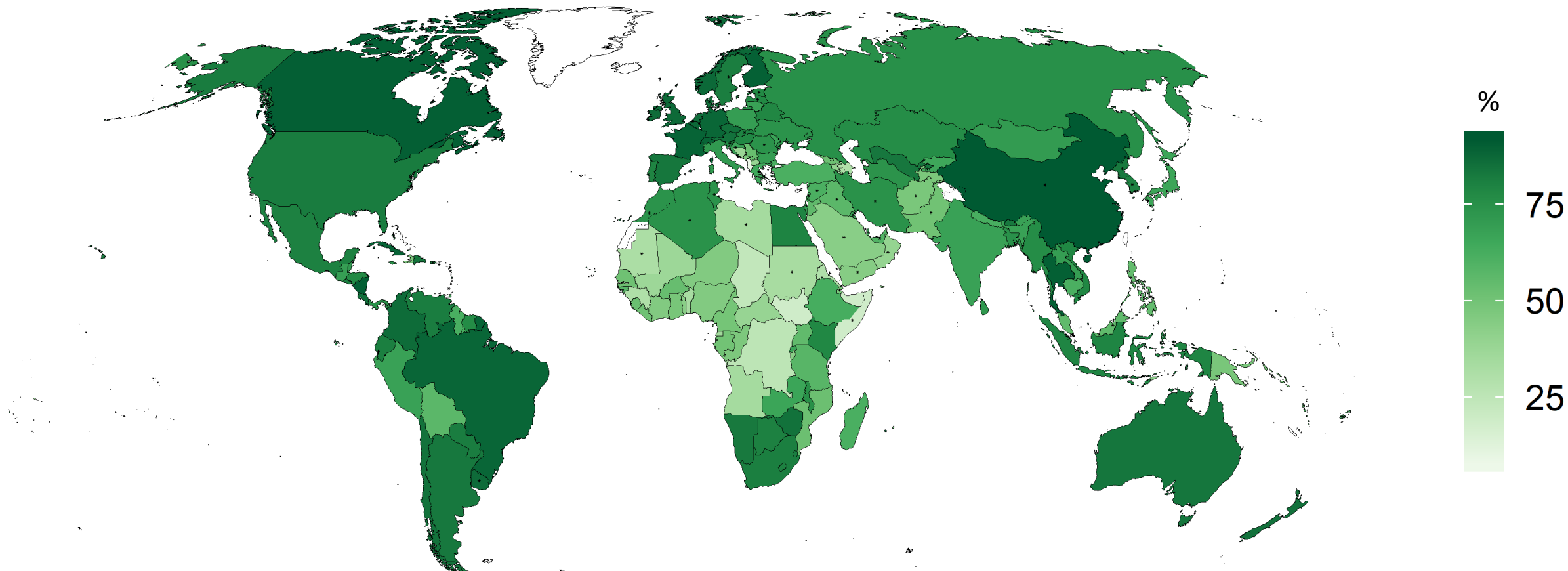


# Estimates and projections for Somalia

Somalia (Eastern Africa) --- Married / In-Union



## SDG 3.7.1. Proportion of need satisfied with modern methods among all women 15–49, 2021



# Summary

- How accurate the current estimates are? Validation of the results of short-term projections using out-of-sample validation by excluding last 5 years of estimates and seeing how well the projections match them
- Probabilistic results reflect data sources biases, data availability and uncertainty related to projections
- Improvement of **transparency and replicability** of estimates
  - Underlying data used in the models and R codes are publicly available
  - Application of one-country-run for the use by countries that is consistent with the global model

## Challenges

- Computationally intensive processes
- Interpretation of probabilistic results not yet much used
- Whether and how to incorporate impact of unexpected events (COVID-19 example)

# COVID impact on contraceptive use and births

- At the start of pandemic: many assumptions about how COVID-19 pandemic would influence contraceptive use, fertility intentions, number of pregnancies and births
- New data and methods used by research community:
  - Internet searches (pregnancy)
  - Monthly births statistics
  - Monthly data from health services statistics
- Expert group meeting on the impact of the COVID-19 pandemic on fertility  
<https://www.un.org/development/desa/pd/event/egm-impact-covid-19-fertility>
  - Review of the current evidence and research
  - Considering how these additional data and methods could be used in the model
  - However, mixed results and no consistent patterns that could be used for adjusting the models for the impact of COVID-19 pandemic



# Additional resources

## Online Family Planning Estimation Tool from Avenir Health

- Used by country teams
- Allows running the model for one country and sub-national estimates
- Allows adding additional data, including health service statistics

[http://www.track20.org/pages/data\\_analysis/publications/methodological/family\\_planning\\_estimation\\_tool.php](http://www.track20.org/pages/data_analysis/publications/methodological/family_planning_estimation_tool.php)

- More information about how the UN Population Division produces estimates and projections of family planning indicators may be found on our website at:

<https://www.un.org/development/desa/pd/data/family-planning-indicators>

- The methods were developed in collaboration with Leontine Alkema (University of Massachusetts), Niamh Cahill (Maynooth University) and Avenir Health
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