

Treated Wastewater Proportion in Large Rivers Based on Spatially Aggregated Wastewater Volumes



Sewer outlet into river Rhine near Koblenz, Germany (04/2025). Picture: B. Schima/BfG

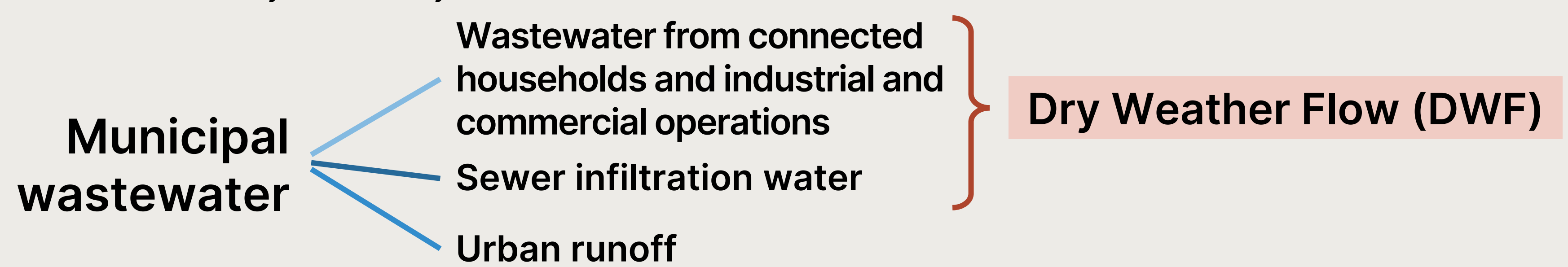
Introduction

Effluents from municipal wastewater treatment plants have a negative impact on surface water quality. Numerous trace substances, including pharmaceuticals and constituents of personal care products, are not adequately removed by conventional wastewater treatment technologies. In rivers, they pose a threat to aquatic ecosystems and can be a risk factor for drinking water extraction from bank filtrate.

Objective

The aim of the study is to estimate the volume of treated municipal wastewater during dry weather (**Dry Weather Flow, DWF**) and its proportion in the total discharge of large rivers in Germany. The analyses cover a reference

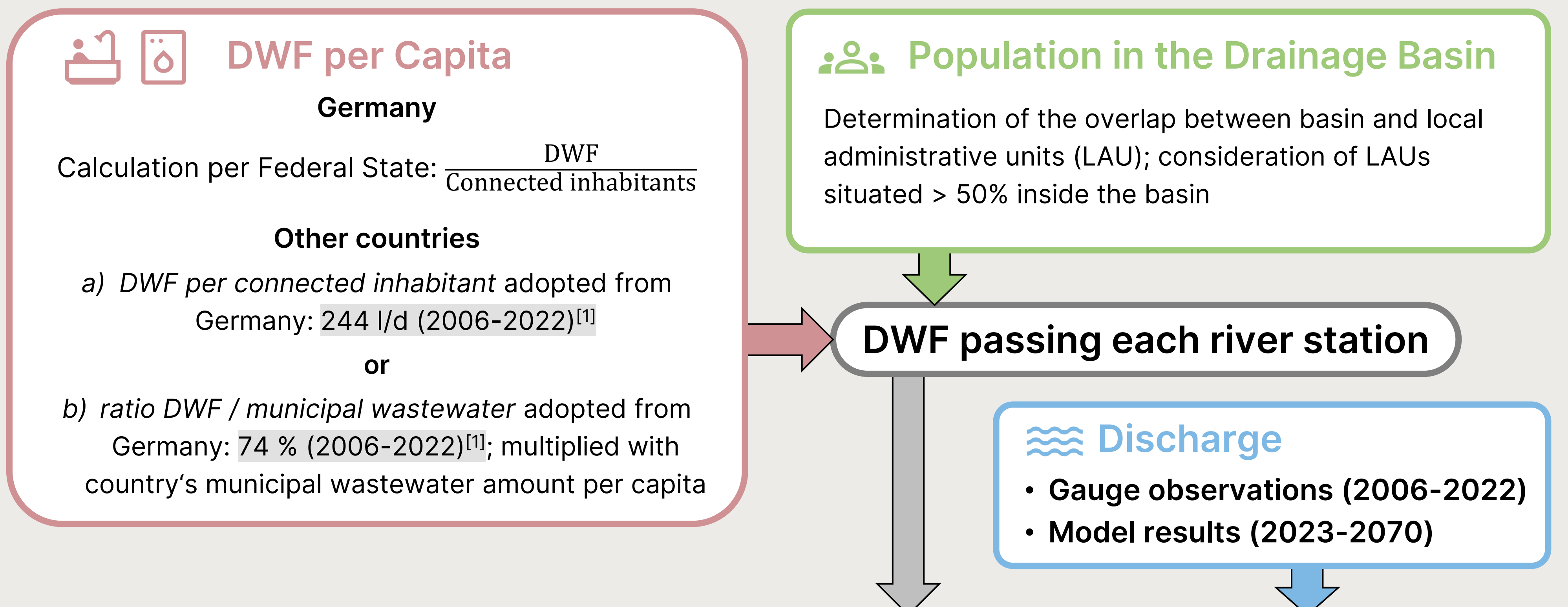
period (2006–2022) and projections of future developments based on climate, discharge and population projections (2023–2070).



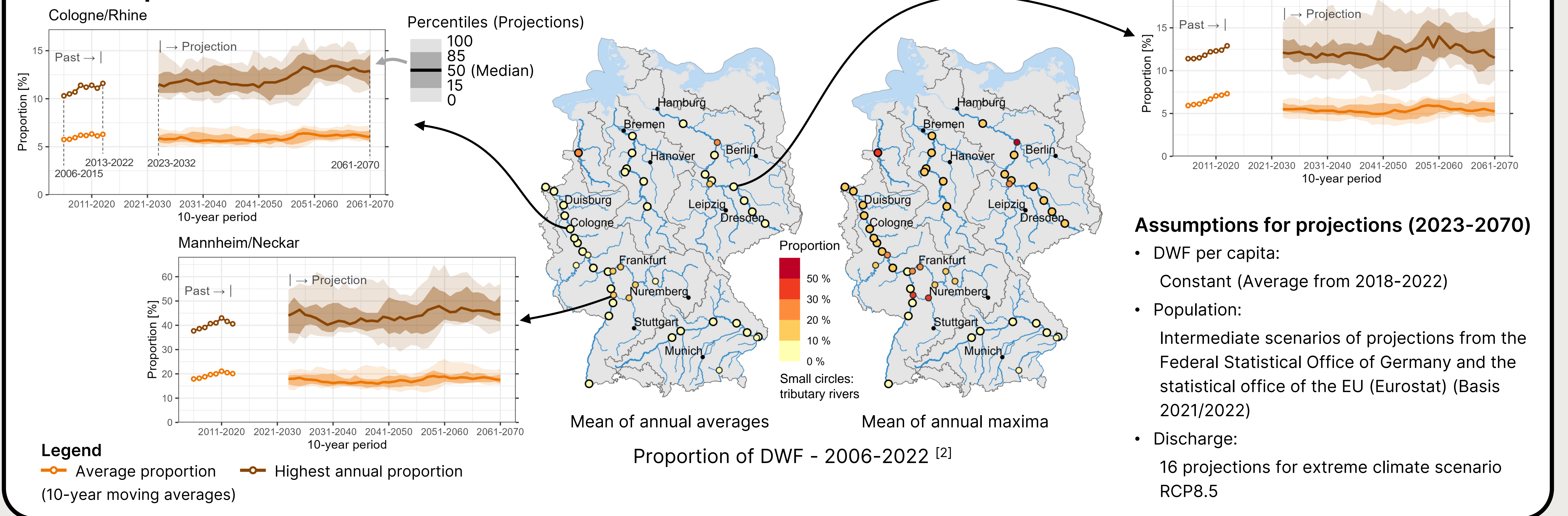
Method and Results

To determine the cumulative DWF passing a river station, its station specific drainage basin must be taken into account. Using data on wastewater generation and population in administrative units (e.g., federal states in Germany), per-capita amounts are determined and extrapolated to the drainage basin. Thus, the consideration of individual wastewater treatment plants can be omitted.

The cumulative DWF is divided by the daily discharge for each station to obtain the DWF proportion.



DWF Proportion



Validation

To validate the simulated results, they were compared with wastewater proportions calculated using a second method. This method related observed concentrations of the persistent micropollutant carbamazepine (CBZ) in the river to concentrations measured in treated wastewater samples from two monitoring stations over a period of one and two years, respectively.

When comparing the mean annual proportions (→ Table 1), the two methods differ by a factor of two at Bischofsheim (Main), while they show only slight deviations at Mannheim (Neckar).

However, the comparison of individual samples from Mannheim reveals variable results, with considerable deviations observed in some cases (→ Figure 1).

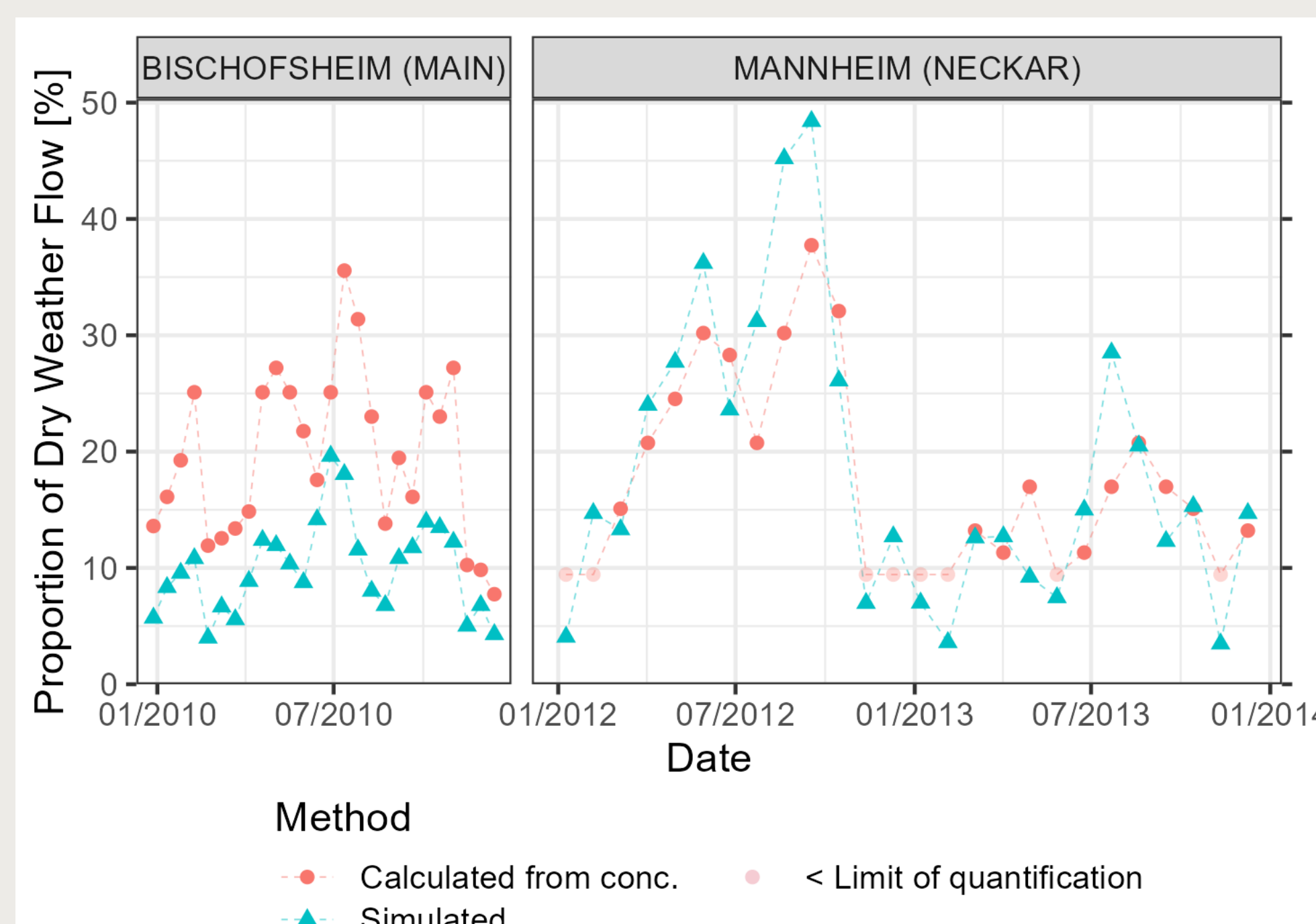


Figure 1: Comparison of values for individual samples

Table 1: Comparison of annual mean values

Station	Year	Simulated	Calculated using observed concentrations
Bischofsheim/Main	2010	10 %	20 %
	2012	23 %	20 %
Mannheim/Neckar	2013	13 %	12 %

Future Outlook

Based on the proportions of treated wastewater, future work will consider river concentrations of substances typically appearing in wastewater effluent. Scenario analyses will show possible impacts of an increasing use of quaternary wastewater treatment on these substances.

