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Summary

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Demographic change as a challenge to secure and develop cost- and resource-efficient wastewater infrastructure

Summary

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SUMMARY

Background

Demographic change will result in a clear overall decline in Germany's population but there will be very large variations in the population development at both regional and local levels. There will continue to be large differences between eastern and western Germany, which have been ongoing since the 1990s. At the same time, processes of growth and decline will take place in close spatial proximity. For the spatially-based technical infrastructure systems such as water, wastewater or district heat, this development means there is a need for adaptation, considering that the efficiency of such systems is dependent on population density and that additional technical changes may be necessary with decreasing numbers of users.

Because the important components of conventional wastewater infrastructure systems are in use for very long periods (up to 100 years for sewers) and because they are associated with high investment and maintenance costs, it is necessary to plan for the very long term future and take all the changing parameters into account.

The relevance of demographic change for the wastewater infrastructure - identifying particularly affected areas

Demographic developments interfere with changes in the other framework conditions of wastewater infrastructure systems. These include climatic changes, the development of drinking water consumption and changing settlement structures and user densities of wastewater infrastructure systems. Natural conditions such as the local topography also fall under this category.

To assess the impacts of demographic changes on wastewater infrastructure and the overlap with the interfering framework conditions cited, the districts and urban districts of Germany were categorized demographically. These districts and urban districts were divided into 12 types based on past and future population trends (6 main types for both the western and eastern Länder) and then characterized with regard to their population density, housing and traffic development, the development of water consumption, climatic changes and topographical parameters as well as the rate of utilization of wastewater treatment plants. Subsequently, parameter constellations and to some extent also parameter values can be listed for Germany which are causing problems for the wastewater infrastructure or could do so in the future. This then provides a basis for

assessing the distribution and intensity of problem areas, which can be presented graphically and enables a first appraisal of the potential need for measures in the wastewater infrastructure. The result of the work identifying particularly affected areas is illustrated in Figure 1.

In order to judge to what extent past demographic changes have actually resulted in negative impacts on wastewater infrastructure in the regions affected by problematic parameter constellations, telephone interviews were conducted in 19 selected communities (7 in the western and 12 in the eastern Länder) with the person responsible for sewage disposal. The interviews were based on a standardized guideline which asked for and checked data concerning population development, water delivery, the state and age of sewers, water rates, housing developments and topography and documented concrete technical and economic impacts; both planned and implemented technical, economic and organizational measures; possible and/or used funding programmes as well as any proposals and recommendations.

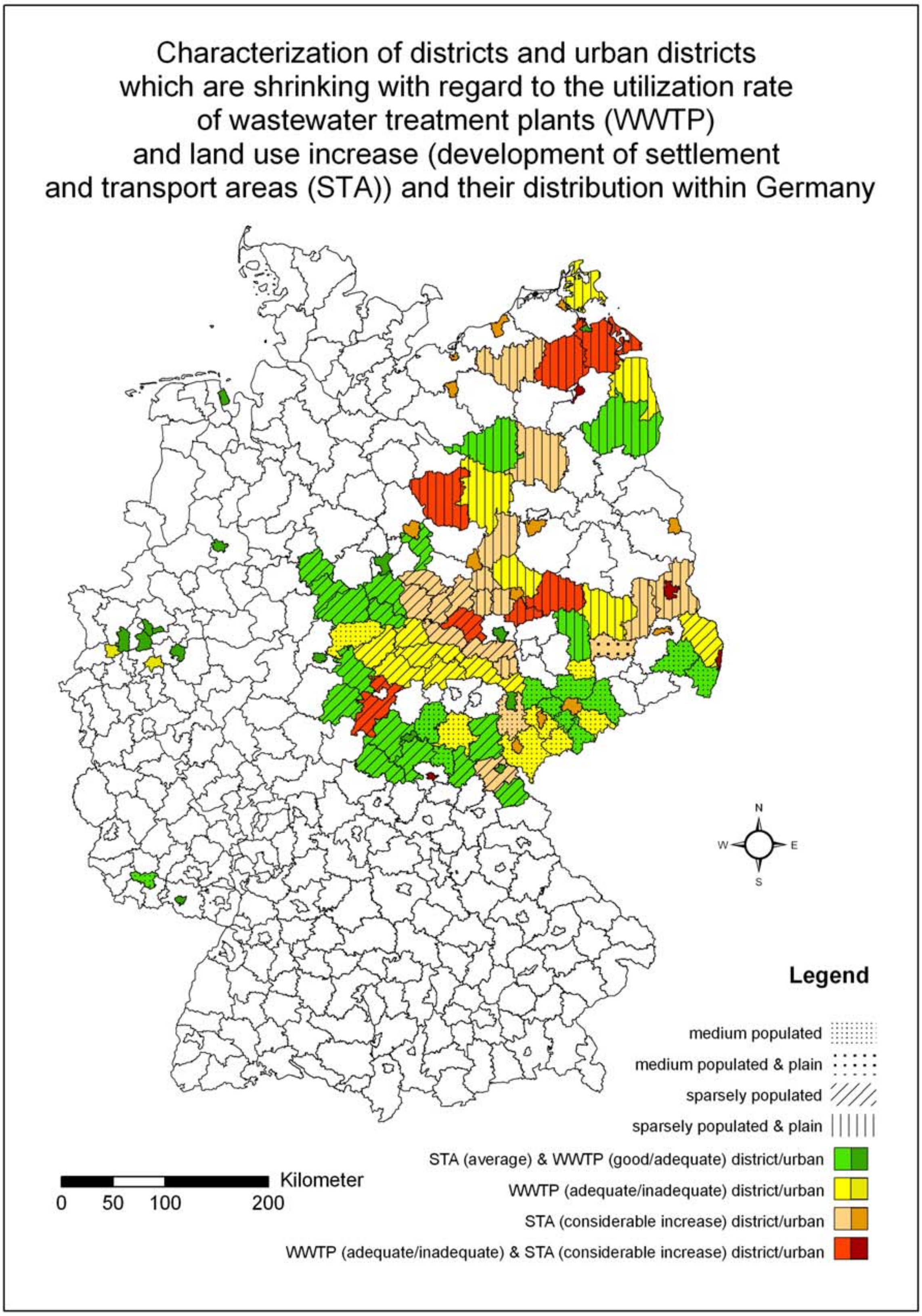

Figure 1: Distribution of the identified problem areas

Impacts of demographic changes on wastewater infrastructure

The identified impacts of demographic change can be distinguished into the operational impacts on water supply, wastewater transport systems and sewage plants as well as the ecological, structural and economic impacts. The consequences of lower water consumption associated with a shrinking population were identified as were qualitative consequences such as, e.g. changes in the medication consumption of an ageing society. A drop in the amount of water consumed has a direct effect on the specific costs because of the high share of fixed costs involved. The actual cause of the decline in water consumption is irrelevant. Different factors converge at this point and result in the consumption reduction. One of them is demographic change; other factors include more water-conserving behaviour in households, the growing use of water-efficient technologies and the drop in the water demand in industry and commerce, for example because of closing water cycles or because of structural change.

The sources listed below were used to identify the impacts:

- literature reviews,
- experiences of project partners in the field,
- (interim-)results of BMBF's research project DEMOWAS,
- additional expert interviews and
- results of interviews with municipalities who are already being strongly affected (see above).

The impacts were evaluated with regard to their significance. It could be shown that some are heavily dependent on local framework conditions, or that different framework conditions may coincide in an exacerbating way. Concerning the expected odour and corrosion problems in the sewer network, which are frequently mentioned in the literature, the evaluations showed that these occur mainly if different framework conditions coincide (e.g. in connection with long pressure sewers, a low specific water consumption or at low gradients). It is difficult here to estimate the actual contribution of demographic change to these problems. The economic impacts are judged to be particularly important. These are expected because of the problem of high fixed costs in (waste)water infrastructure: A dwindling number of users means reduced (waste)water volumes in both water supply and sewage disposal and falling revenues given the current tariff stricture for water and sewage. Costs can only be reduced to a minor extent because of the very high fixed cost share. If this trend cannot be influenced by efficiency improvements or adaptation measures, the consequences will be clear increases in the specific water rates/sewage levies in those regions strongly impacted by demographic change.

Measures to use (redesign) existing systems in a way that makes ecological and economic sense

Starting from the described impacts, a broad range of measures were identified. These can be differentiated into operational measures, measures concerning under-utilized parts of the system and innovative measures which have only been implemented on a limited scale so far. The measures could be applied at both wastewater collection via the sewer network (e.g. measures to counter sediment build-up) and at wastewater treatment in sewage plants (e.g. measures to improve the C/N ratio). Various general, organizational measures could also be identified (for example strategic rehabilitation and investment planning or deconstruction and closure strategies). Many of the described measures target the optimization of wastewater plants both operationally and in terms of economizing resources. They are strategically aimed at reducing costs and should help to compensate the economic impacts of demographic change. The measures were described with regard to existing experiences and problems and important parameters and their significance was evaluated against the backdrop of demographic change. Table 1 shows a summary of the different approaches.

Table 1: Overview of the described measures

Measure groups	Measure package	Single measure
Operational measures sewer	Sedimen-tation	Rinsing
		other types of cleaning (removing slime)
		adapting the hydraulics
	Corrosion (H2S)	Overview
		Lining shafts
	Odour (H2S)	Chemical additives
		Constructive oxygen enrichment and ventilation
		Waste gas filter
		Biological short-term treatment
		Planning measures
Utilizing free capacities in sewer network	Sewer network control	
	Rain water management	Disconnecting impervious areas
		Harvesting and using rain water
	Using spare system parts	Storage for sewer rinse water
		Links with other infrastructure networks
Innovative measures sewer		Vacuum system as alternative to sewer rehabilitation
		Using heat from wastewater
Operational measures sewage plant	C/N-ratio	external C source
		Down-scaling primary treatment
		Reducing ventilation in the grit chamber
		Load-dependent input / MSR
Energy manage-ment	Improving energy efficiency	Overview
		Practical examples
	Improving energy production	Overview
		Practical examples
		Sewage sludge disintegration
		Co-fermentation
Utilizing spare capacities sewage plants		Overview
Innovative measures sewage plants		nutrient recovery
		MAP precipitation
		Deammonification of centrate water
		Process switch aerob --> anaerob
		2-stage anaerobic process
		Cultivating own co-substrates
Organization/Management		Merging neighbouring plants
		co-treating industrial effluent
		Strategic rehabilitation and investment planning
		Strategies for deconstruction and closure
		New business areas
		Tariff structure
Innovative disposal concepts and organization models		

In addition to this, technically-oriented, innovative wastewater disposal concepts and alternative models of organization were identified and examined. All the measures, concepts and models focus on making the infrastructure more flexible while simultaneously ensuring its reliability and the highest possible resource efficiency (energy, recyclables). Possible approaches such as partial flow orientation, the central operation of distributed systems, or anaerobic wastewater treatment in the sense of energy efficiency are described and evaluated with a view to adapting the wastewater infrastructure to demographic change. Figure 2 gives an overview of the different application points of the examined measures.

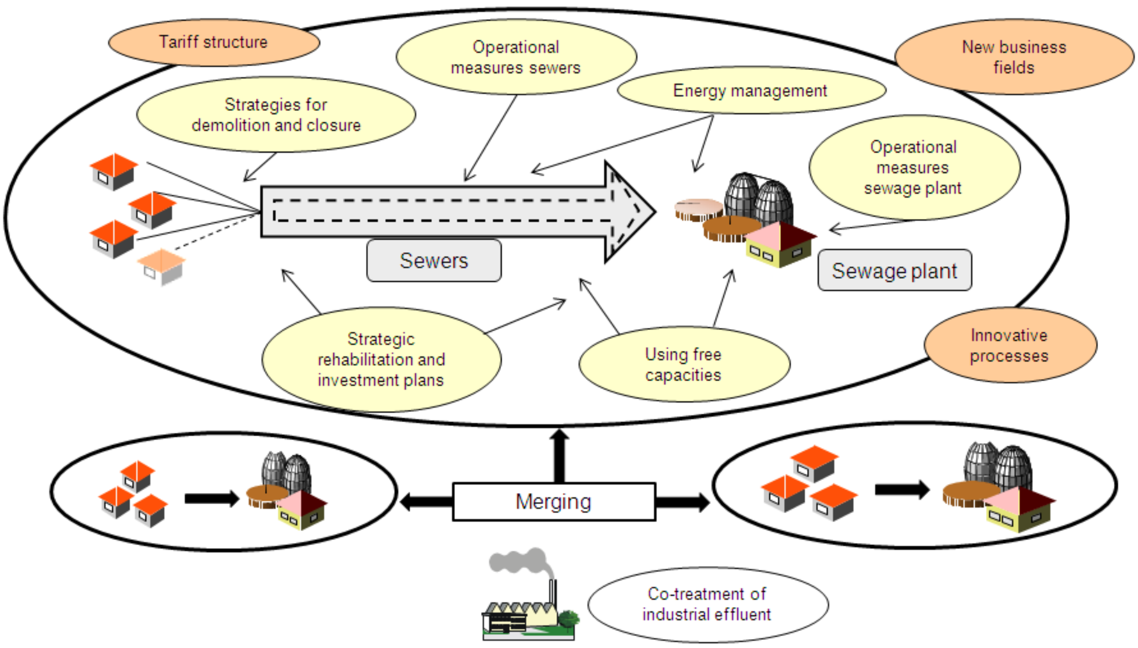

Figure 2: Overview of the examined possible solutions for affected areas

Recommendations

Recommendations were compiled for affected wastewater utilities and local authorities and for the wider setting (land use planning, funding authorities, legal framework etc.) against the background of the measures described and the new, more medium- to long-term system-based concepts. It will be decisive for wastewater utilities and local authorities to adapt to the changes taking place in plenty of time, to coordinate urban development and business strategy and to conduct long-term investment planning which takes into account the changing framework conditions. Table 2 summarizes the most important steps of developing such a long-term strategy from the perspective of a wastewater services provider.

Table 2: Necessary steps towards developing a long-term strategy from the viewpoint of a wastewater utility in the light of demographic changes

Question	Approach	Content
Where do I stand?	Status analysis	• Analysis of demographic development up to now • Stock-taking: water infrastructure system (need for rehabilitation, domestic and commercial water consumption, etc.) • Analysis of relevant framework conditions (e. g. urban development, topographical conditions)
What is going to change?	Scenario development surroundings	• Analysis of how this will affect me in the future (expected demographic changes, climate change impacts, land use planning/urban development, industry/commerce trends, technical progress, etc.) • Long-term evaluation periods necessary (> 50 years), at the same time some high uncertainties
What can I change?	Scenario development to identify the optional courses of action	• Scope for action: - measures in sewer network - measures in sewage plant - utilizing spare capacities - organizational measures - alternative concepts • in agreement with local authorities (urban planning, infrastructure-based risk analysis) • taking technological progress into account (innovative methods) • long-term evaluation periods necessary (> 50 years)
What do I want to achieve?	Target setting – strategy development	• Long-term, strategic orientation and overall concept
How do I proceed?	Planning measures	• comprehensive evaluation of different possible courses of action • Evaluation: - considering changing parameters - flexibility of technologies / concepts as evaluation criterion - accounting for technical progress • Setting priorities

The demographic developments mean it will be necessary to adapt the existing infrastructure. These changes can be designed more efficiently by influencing the main parameters using regional planning instruments and funding programmes for infrastructure measures.

Further research and development projects are necessary on account of these upcoming challenges. The most important objective has to be the development and implementation of all those measures, concepts and organizational models which guarantee the long-term high capacity, reliability, flexibility, resource and economic efficiency of wastewater disposal while also taking the described demographic development into account. Here it is important to integrate into the analyses the framework conditions and instruments necessary for implementation.