Empty Pipes in Empty Regions? Water Networks in Peripheral Rural Eastern Germany

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Abstract

Drinking water supply and wastewater disposal in Eastern Germany are confronted with two challenges: firstly, the general transformation of the German water market, leading to more private sector involvement and commercialisation of municipal companies. Secondly, shrinking processes in cities and regions not only in most parts of Eastern Germany but elsewhere, too, cause new problems for water infrastructure. Population decline and less economic activity lead to decreasing demand for water services. Water infrastructures, originally an instrument of regional cohesion, could turn into an additional disadvantage, especially for rural regions, and lead to new and regional forms of 'splintering urbanism' (Graham & Marvin 2001).

Introduction

The influence of water infrastructure systems, such as drinking water supply and waste water disposal, on regional development was for a long time seen as marginal. Connection rates to public supply and disposal systems – at least in western industrial countries – ran to over 90 percent and water services were taken for granted (Graham & Marvin 2001). This perspective on water networks is currently changing for two reasons. Firstly, water infrastructure systems worldwide are experiencing a variety of transformations including liberalisation, privatisation and commercialisation. These developments are often connected with new spatial configurations and disparities. Secondly, new spatial developments are questioning the 'modern infrastructural ideal' of cheap, standardised and centralised supply for everyone. Using the case of peripheral rural regions in Eastern Germany, I will show that not only the current transformations of water networks but also new patterns of regional development lead to new geographies of water services.

This chapter is structured as follows: First, I will briefly sketch how water networks are interrelated with regional development. Secondly, I will illustrate these interrelations using the example of water networks in Eastern Germany. Thirdly, I will introduce the approach of 'splintering urbanism' as a theoretical attempt to conceptualise the spatial dimension of infrastructural transformation. Fourthly, using 'splintering urbanism' as an analytical framework, I will analyse the transformation of water networks in two rural regions in Eastern Germany. Finally, I will conclude with some remarks on infrastructure and regional development and potential implications for social science research on infrastructure systems.

Water networks and regional development

Infrastructure systems of drinking water supply and wastewater disposal are interrelated with regional development. Water networks are shaped by, and shaping, regional development. Four aspects are crucial for this interrelationship:

(1) Water infrastructure systems are spatially bounded (Page 2005, 295). Drinking water abstraction is only possible at certain locations and depends on a great number of hydrological factors. Once constructed, waterworks, sewage plants and pipes cannot be easily transferred to other places.

(2) Safe drinking water supply and wastewater disposal are not only necessary preconditions for regional economies. Water utilities themselves are important economic actors. Being employers, investors, property owners and innovators, they shape regional economies (Marvin, Graham & Guy 1999).

(3) Drinking water abstraction and wastewater discharge are significant factors for local ecosystems and therefore influence the quality of life in cities and regions (Kaika 2005, 28).

(4) Water networks are an important element of regional planning and policy-making. Planning boards have to coordinate land use require-

ments of water companies with other land users. Municipalities control a large number of public utilities (Tietz 2007, 209).

Although all these interrelations are obvious, the importance of supply and disposal systems is mostly neglected so long as no transformations or dysfunctions of existing systems occur. As an example of these transformations I use the current commercialisation of German water utilities and point to problems of overcapacities in water networks in Eastern Germany to illustrate transformations and dysfunctions of infrastructure systems, which for a long time were taken for granted.

Transformations and dysfunctions in the German water sector

Like nearly all sectors of technical infrastructure water supply and wastewater disposal are undergoing fundamental transformations. One aspect of this infrastructural change is a bundle of developments which can be summarised as 'commercialisation'. Although the majority of German water companies are still publicly owned, there is an increasing involvement of private companies. Shares of municipal utilities, e.g. in Berlin or Potsdam, were sold to private investors and private companies take over the operational management.

The introduction of competition in the water market, as a competition *within the market*, was not realisable but there is a competition *for the market*, e.g. competitive bidding for shares of companies or supply areas. Furthermore, competitive elements such as benchmarking were introduced to the German water market.

Finally, public water companies all over the world are also dominated by economic criteria of efficiency leading to job cuts, outsourcing etc. (Bakker 2005, 542). Water as a 'public good' has been redefined to be looked upon as a commercial service. Municipal water companies were transformed into legally independent enterprises, becoming more and more orientated towards economic efficiency (Edeling, Stölting & Wagner 2004). This leads to new strategies of investment and innovation, to out-

sourcing, the introduction of balanced Scorecards and staff reduction in water companies (Egerer & Wackerbauer 2006, 16).

The commercialisation of the German water sector is far from spatially homogenous but is marked by and shaping regional disparities. Thus, there are major differences in the development of water consumption which cause problems or even dysfunction of existing systems.

While water consumption in Germany went down by 20 percent on average between 1991 and 2007, the East German states registered a decrease of almost 50 percent (see Table 1). Reasons for this decrease were the introduction of new water tariff systems and new water-saving technologies as well as the reduction of water leakage. However, the main cause of reduced water consumption has been declining population numbers and the loss of industrial water consumers after 1990.

Table 1. Development of water consumption in Eastern Germany

	1991	2007	1991–2007
	in 1,000 m^3		in percent
Brandenburg	188.2	108.6	-42.3
Mecklenburg-Western Pomerania	142.3	83.2	-41.5
Saxony	331.7	187.5	-43.5
Saxony-Anhalt	221.7	105.7	-52.3
Thuringia	185.4	94.3	-49.1
East Germany (without East Berlin)	1,069.3	579.3	-45.8
Germany	5,747.9	4,544.0	-20.3

Source: Statistisches Bundesamt 2009; 1993

Decreasing consumption of a natural resource, though having a positive effect on sustainable development, causes major problems for existing supply and disposal systems. Water infrastructure systems in Eastern Germany, which for the most part had been modernised and extended after 1990, are now facing technical, economic and institutional problems because of major over-capacities.

Technical problems

When drinking water supply networks and plants are under-utilised, the residence time of water increases, leading to a rise of temperature, excessive growth of bacteria and microbial recontamination or gradual 'blocking' of pipes. The sewage system is affected by problems of unpleasant smell, corrosion and plugging or treatment problems. In order to maintain supply and disposal standards, additional technical measures become necessary, such as flushing the pipes, reducing pipe cross-sections, laying temporary pipes etc. As an alternative, drinking water in regions with particularly high under-utilisation could be chlorinated to ensure proper hygienic conditions (Koziol 2004). In the medium term, however, the existing systems will have to be replaced by networks and plants that are adapted to declining consumption.

Economic problems

Although these adaptations are technically unproblematic in most cases, they cause serious problems from an economic point of view. Even short-term technical measures generate high additional costs. The Cottbus-based infrastructure expert Matthias Koziol (2004), for example, reported that the costs for flushing the pipes in Frankfurt on Oder have sextupled in recent years. In the medium term, however, even higher investments will be necessary: 'The costs for the conversion of supply and disposal systems are at least twice as high as the production costs' (Tietz 2006, 170). This need for additional expenses comes at a time when most Eastern German water companies have just made huge investments in the last decade. Since the 1990s investment has often not yet paid for itself, a high number of companies and associations find themselves in a situation in which they have to put up with a reduction in profits and pay off high debts. Subsequently, water and wastewater associations are running large deficits and consumers are faced with rising fees (Schiller & Siedentop 2005).

Institutional problems

In addition to economic and technical problems, shrinking processes also require the adjustment of existing institutional structures of water networks (Naumann & Bernt 2009). Here, the necessary short- or medium-term adjustments to decreasing consumption collide with long payment periods for existing or planned investment in water supply infrastructures. Infrastructure planning has to cope with uncertainty of the future development. Whereas in growth situations, infrastructure providers relied on a 'build and supply' logic (basically a system in which new users are simply connected to the existing grids), and due to a safe and steadily increasing demand, the necessary investments would eventually pay off, even with long payback periods.

Problems of under-utilisation lead to a situation where water infrastructures are no longer a standardised and taken for granted location factor. Formerly universalised networks experience a differentiation process, resulting in new regional disparities (Griapos & Munday 2000). Regional differentiation of infrastructure systems and regional differentiation caused by such systems is not a phenomenon limited to water networks in Eastern Germany, but an international phenomenon of technical infrastructure systems. Stephen Graham and Simon Marvin developed the concept of 'splintering urbanism', an exciting approach to conceptualise the spatial dimension of infrastructural transformation (Graham & Marvin 2001).

'Splintering urbanism': The spatial dimension of current infrastructural change

The concept of 'splintering urbanism' does not provide a fundamental theory about what 'space' or 'infrastructure' is about. Coutard and Guy regard 'splintering urbanism' as a 'middle-range theory' (Coutard & Guy 2008), formulating pointed, sometimes provocative theses about the spatial and social dimension of infrastructural change. The work of Graham and Marvin stands in the tradition of 'Science, Technology and Society' (STS) approaches, which always understand technical infrastructure systems as socio-technical systems.

The 'splintering urbanism' thesis has been developed around the observation that the modern infrastructural ideal has been experiencing a deep crisis since the 1960s. Infrastructure networks and plants are less and less able to cope with new economic, political, ecological and cultural challenges. In consequence, technical infrastructure undergoes complex technical and institutional changes. Infrastructure markets, formerly organised as public monopolies, were liberalised and privatised, and infrastructure networks were technologically and economically 'unbundled'. The main point of Graham and Marvin is 'how the transition away from integrated networks towards unbundled networks is involved in reconfigurations of social and spatial relations within and between cities' (Graham & Marvin 2001, 166). The authors illustrate this thesis with the notions of 'cold spots' and 'hot spots', 'premium network spaces', 'infrastructural bypass' and 'cherry picking'.

Because of raised pressure for greater efficiency and due to new patterns of demand, utilities differentiated their supply areas into 'cold spots' and 'hot spots' of infrastructure demand and supply. 'Hot spots' are, for instance, central business districts of global cities, while abandoned industrial districts or marginalised neighbourhoods are examples of 'cold spots'. Wealthy customers in the 'hot spots' benefit from a particularly high-quality supply and extra services due to increased competition in infrastructure markets. Graham and Marvin call these zones of privileged infrastructure supply 'premium network spaces'. These are, for example, airports and business centres with wireless internet access or certain locations in developing counties with safe and reliable water and energy supply.

To ensure the social selectivity of 'premium network spaces' it is necessary to exclude less economically lucrative consumers and supply areas. By using parallel networks and modern information and communication technologies, utilities create an 'infrastructural bypass' to serve only certain segments of consumers and places.

Graham and Marvin describe the spatially selective interest of infrastructure companies as 'cherry picking'. They argue that the city of London is served by a high number of telecommunication providers while customers in rural regions have far fewer options to choose a provider (Graham & Marvin 2001, 167).

The concept of 'splintering urbanism' triggered a lively debate (Coutard 2002; Coutard & Guy 2008; Moss 2009; Moss, Naumann & Wissen 2008) asking for empirical evidence in different contexts. In what follows I try to apply the 'splintering urbanism' thesis to the transformation of water networks in Eastern Germany.

'Splintering urbanism' is mainly concerned with the urban scale. An analysis of rural regions is still lacking. Is there also a 'splintering regionalism' that parallels urban developments? Graham and Marvin did not look into the phenomenon of shrinking cities and regions. Therefore, I explore whether the transformation of water networks in peripheral rural spaces in Eastern Germany shows aspects of a social and spatial differentiation of technical infrastructure. In addition, I am going to look at certain conditions of peripheral rural spaces regarding water supply and wastewater disposal: are empty regions soon confronted with empty pipes? What consequences have infrastructural problems for the further development of these regions? I analysed these questions in the administrative districts (*Landkreise*) Uckermark and Uecker-Randow in the north-eastern part of Germany.

Water networks and regional differentiation. Empirical evidence from peripheral rural Eastern Germany

Uckermark and Uecker-Randow are impressive examples of peripheral rural spaces in Eastern Germany. Both regions are characterised by a low population density and a massive decline in population after 1990, above-average unemployment rates, weak economies and a peripheral location within Germany (Beetz, Neu & Plieninger 2005). The problems of these regions are illustrated by an abundance of residential and commercial buildings with high vacancy rates (Pult 2006). In my fieldwork I analysed literature, local newspapers and statistical data about the regions and their infrastructural development. Due to the lack of data, the emphasis of my empirical work was on qualitative expert interviews which I conducted in Uckermark and Uecker-Randow, but also in other parts of Germany.

I conducted about 60 interviews with representatives of water utilities, public administration and associations as well as with policy-makers. It is not my intention to give a detailed description of my research results (Naumann 2009). I will rather point out some crucial findings which illustrate splintering processes in peripheral rural spaces.

In both regions water consumption has gone down dramatically since 1990. Table 2 shows the development of water demand in Uecker-Randow between 1991 und 2008. Since 1991 water consumption has decreased by up to 80 percent.

Table 2. Development of water consumption in Uecker-Randow

	1991	2007	1991–2007
	in m^3		in percent
Mecklenburg-Western Pomerania	**142,344**	**83,230**	**-41.5**
Uecker-Randow	**8,061**	**2,403**	**-70.2**
Amt Am Stettiner Haff	*1,013*	*369*	*-63.6*
Amt Löcknitz-Penkun	*975*	*294*	*-69.8*
Amt Torgelow-Ferdinandshof	*2,173*	*480*	*-77.9*
Amt Uecker-Randow-Tal	*729*	*212*	*-70.9*
Pasewalk	*1,513*	*498*	*-67.1*
Strasburg	*729*	*357*	*-51.0*
Ueckermünde	*929*	*193*	*-79.2*

Source: Statistisches Landesamt Mecklenburg-Vorpommern 2009; 1993

Although Uckermark and Uecker-Randow experienced a sharp decline in water consumption and one would have expected these regions to be affected by large-scale under-utilisation, the problems show a small-scale spatial pattern with great differences within the regions. Technical problems caused by decreasing demand must be seen in relation to the technological solutions chosen by the utilities. This applies in particular to the wastewater disposal sector. Some existing systems of wastewater disposal will 'still cope somehow' (as a representative of a local water utility put it),

while others are already beset by problems of smell, corrosion and sedimentation. Complete dysfunction has not yet occurred. In view of the expected further decline in demand a debate has started about the necessity to adapt the technical and institutional structures of water supply and wastewater disposal to the new situation. We are now already observing a high degree of commercialisation of water utilities in both regions, to a large extent even without private investors. Utilities cut jobs and re-organise in-house operational procedures. This commercialisation also shapes decisions concerning the connection to centralised disposal systems or to decentralised small wastewater treatment plants and mobile disposal systems. Furthermore, utilities form alliances to bundle capacities and save money.

How do problems of water supply and wastewater disposal affect regional developments in Uckermark and Uecker-Randow? The most controversial issue are the prices and fees to be paid for drinking water supply and wastewater disposal. In both regions wastewater fees are far above both the state-wide and federal average. Especially house owners in villages are protesting against high connection and consumption fees. Most spectacular is the case of the village of Wismar (Uckermark), which – because of the high prices charged by the regional water company – sought to be annexed by its neighbouring state (Naumann 2009, 169).

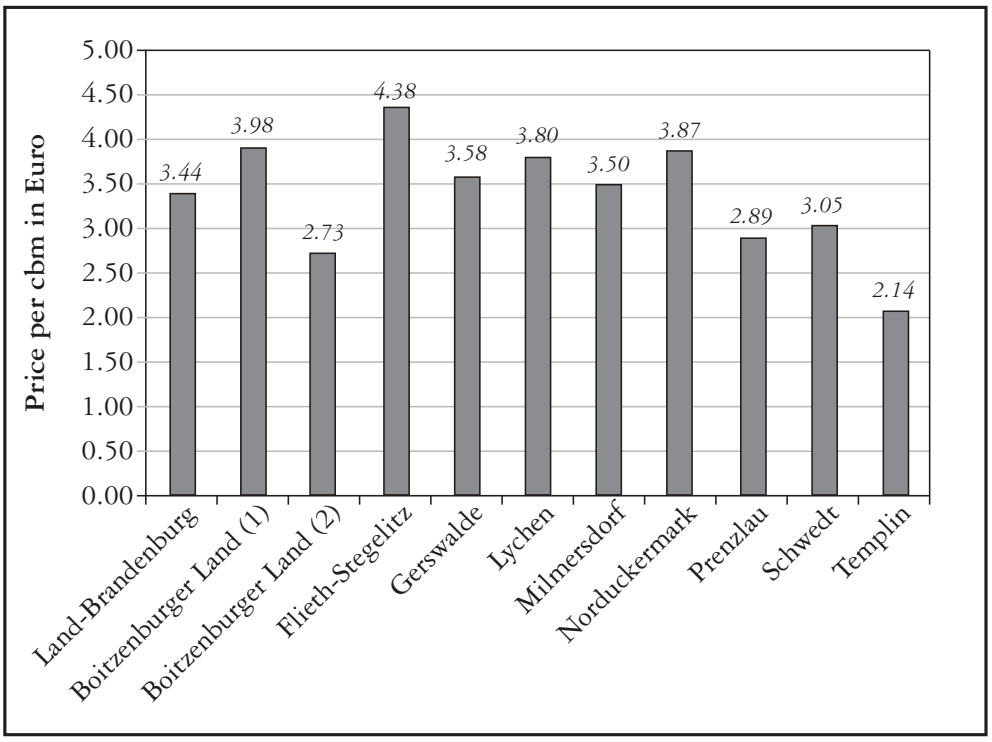
Waste water disposal fees are still marked by small-scale spatial differentiation as Table 3 shows.

As Table 3 illustrates, wastewater fees differ very much – even within the supply area of one municipality. There are a number of municipalities where wastewater fees are even above the average of the state of Brandenburg (which has the highest wastewater disposal fees in Germany) although places close by charge fees that are much lower and competitive with other German regions. These differences in wastewater disposal fees result from specific local conditions in the technological and institutional structure of wastewater disposal. In what follows I will discuss the small-scale differentiation of infrastructural problems from the perspective of 'splintering urbanism'.

The transformations of water networks in both regions can be understood as a farewell to the modern infrastructural ideal of standardised and homogenised infrastructure supply. Although this ideal has never

been completely realised in both regions, current developments show clear tendencies of an institutional and technical differentiation of drinking water supply and wastewater disposal. Institutional differentiation of water services includes a new variety of organisational forms of water suppliers and wastewater disposal utilities. The former GDR '*Wasserkombinate*', state combines that supplied large areas with water, were replaced by municipally owned '*Eigenbetriebe*' and '*Zweckverbände*', i.e. public or semi-privatised utilities or private operators. Technological differentiation entails different technological solutions (centralised, semi-centralised or decentralised systems). This is especially true of the wastewater sector. Following the enormous investments that were made to establish a central system of drinking water supply in rural areas, private and sometimes illegal de-centralised water supply systems are of growing significance.

Table 3. Wastewater disposal fees in selected municipalities in Uckermark in 2007



Source: Author's calculations

With their low water consumption, low population / consumer density and low household incomes Uckermark and Uecker-Randow are clear examples of 'cold spots' of demand for infrastructure services. Nevertheless, we observe single 'hot spots' within areas of 'cold spots'. Thanks to commercial consumers such as the PCK refinery in Schwedt (Uckermark) or the iron foundry in Torgelow (Uecker-Randow) problems of under-utilisation do not occur in these locations. There are also temporal differences in the demand for water. Because of an increasing number of 'part-time' residents, e.g. people who use their houses only at the weekend or in the summer, water consumption differs substantially on workdays and at weekends and during the holiday season and the off-season. 'Cold spots' in winter could turn into (very small) 'hot spots' in summer.

'Premium network spaces', as understood by Graham and Marvin, cannot be observed in the water sector of the two regions. So far, problems of quality are rare exceptions and water utilities are obliged by law to maintain quality standards. As Table 3 shows, inhabitants of different municipalities pay different prices for the same service of wastewater disposal. This equals to a certain extent the development of 'premium network spaces' where some consumers are more privileged than others.

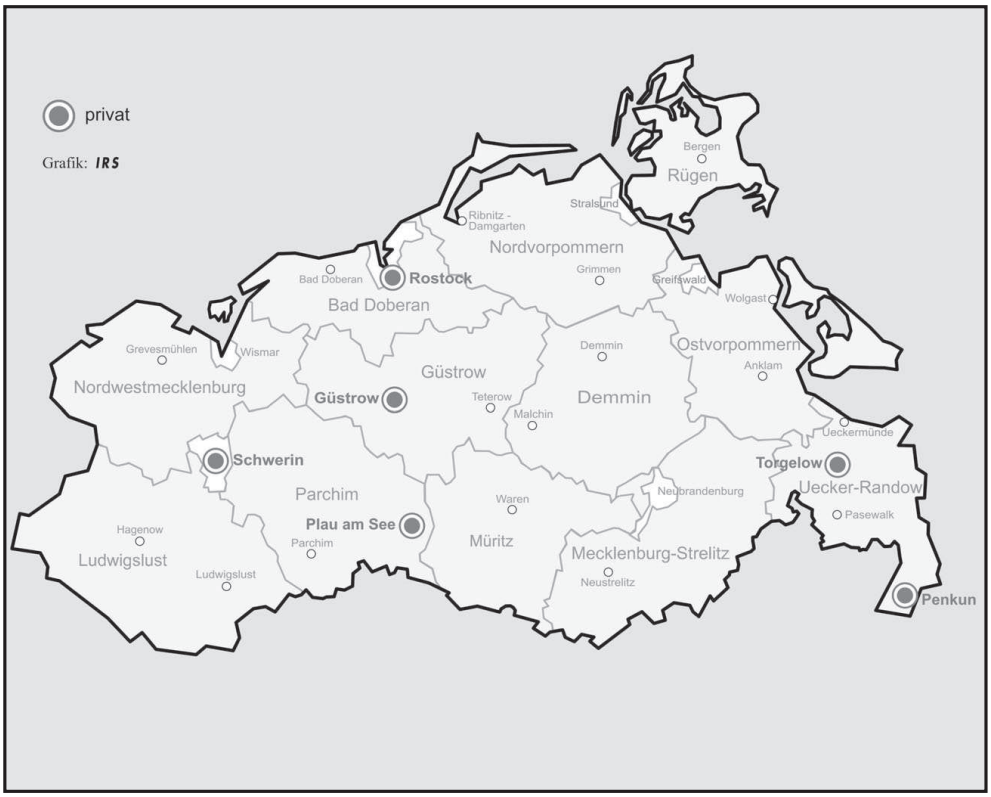
The supply of drinking water and the disposal of wastewater are municipal responsibilities in Germany. This means that customers cannot be excluded from these services since the utilities are obliged to connect all customers. Instead of an 'infrastructural bypassing' on the part of companies, we find examples of consumers bypassing the public systems. Private consumers are reactivating private wells instead of using public water supply services. House owners are anxious to run their own wastewater sewage plant and refuse to be connected to public sewage systems as a result of high water prices and wastewater fees. Sometimes the police must intervene to settle these conflicts.

The spatially selective interest of utilities in infrastructure markets – what Graham and Marvin call 'cherry picking' – cannot be observed in the water market of the two regions. With public water companies still dominating the market, private investors have to seize every chance to get a foothold in the market. Buying shares of companies or taking over

the operational management of indebted companies in shrinking regions are one of the few possibilities for private companies to extend their market share.

As the bullets in Figure 1 show for the state of Mecklenburg-Western Pomerania, private investors do not confine their engagement to big cities in the sense of 'cherry picking' but are also involved in organising water supply and sewage disposal in peripheral rural regions. Private utilities are not only a phenomenon of bigger cities and their growing suburbs. In Mecklenburg-Western Pomerania they are just as active in shrinking cities like Torgelow or even in peripheral rural spaces around Penkun.

Figure 1. Private investors in the water market of Mecklenburg-Western Pomerania



Source: Author's calculations

In summary, it can be said that water infrastructure transformation in Uckermark and Uecker-Randow shows only small-scale differences displaying a heterogeneous patchwork pattern which does not completely fit into the thesis of 'splintering urbanism'. While in both regions there is evidence of the end of the modern infrastructural ideal and a differentiation of supply areas into 'cold spots' and 'hot spots' can be observed, there are no clear indications that water utilities have developed 'premium network spaces' or 'cherry picking' strategies. 'Infrastructural bypassing' takes place in both regions, however not as understood by Graham and Marvin on the part of utilities, but rather by customers who refuse to be connected to public networks. Hence, the 'splintering urbanism' approach provides an analytical framework for the investigation of infrastructural transformations in different cities and regions – an approach which requires critical reflection based on empirical findings from different regional contexts.

Conclusion

The empirical results from the case studies carried out in the north-eastern part of Germany show a highly differentiated picture of water market transformation. Based on these results I intend to derive some general reflections on peripheral rural regions and their infrastructure supply as well as on the 'splintering urbanism' approach and infrastructure in general.

A new geography of the water market or spatial (re)differentiation of technical infrastructure systems

Both regions show evidence of new emerging spatial differences in the provision of technical infrastructure services. Before 1990 there were huge differences between cities and the countryside in the connection rate to public drinking water supply and disposal systems. After 1990 new differences have emerged with regard to water and wastewater disposal fees, institutional and technical solutions. These differences hold an enormous potential for conflicts.

The heterogeneous periphery or reconfiguration of spatial differences by technical infrastructure

Spatial differences in infrastructure supply contribute to a further small-scale spatial differentiation of regional development. Instead of a general picture of 'empty pipes in empty regions' or clearly polarised 'splintering', water sector transformation in peripheral rural Eastern Germany shows a patchwork of different problems and developments. Small-scale disparities do not entail a trend towards balancing uneven development but a danger of disconnecting sub-regions from positive dynamics.

The end of standardised infrastructure concepts or differences in the governance of technical infrastructure

Differentiated problems and developments make it impossible to apply universal concepts to infrastructure planning. Both case studies show different strategies to cope with current problems in water supply and wastewater disposal. These strategies are not only the result of spatial differences, but contribute in their turn to a further differentiation of regional development.

What can social science research on infrastructure systems learn from the cases of Uckermark and Uecker-Randow? Three points should highlight the interconnections between the transformation of the water sector in the north-eastern part of Germany and infrastructural change in general.

Discontinuities vs. linearity: infrastructural change as an asynchronous process

The transformation of infrastructure systems is not a linear process with a clear 'before' and 'after'. Commercialisation of water services has to be understood, not only in Eastern Germany, as a subtle process. Its beginning and its end are not easy to identify.

Local implications vs. global developments: infrastructural change as a problem of different scales

The results from the case studies point to the importance of different scales on which infrastructural change takes place. Global processes of

water privatisation have very specific implications on the local scale. Regional co-operations of water utilities and municipalities create a new regional scale for infrastructure supply and planning.

Special cases vs. mega-trends: infrastructural change as sectorally differentiated and cumulative processes

The case of water supply and wastewater disposal systems illustrates the specific character of different infrastructure sectors. Unlike telecommunication markets, the water sector is confronted with different technical obstacles to full liberalisation. Furthermore, there are cumulative effects between different sectors of infrastructure. The regions Uckermark and Uecker-Randow are disadvantaged not only by high wastewater fees but also by high gas prices, a lack of high-speed internet and limited access to public transport systems. This could result in reinforcing spirals of different infrastructural problems.

These theses on infrastructural change, based on the results from peripheral rural regions in the north-eastern part of Germany, are a call for further research into the manifold interconnections between infrastructural and regional development. Infrastructure systems like water, energy or telecommunication are not only the result of a co-evolution of technology, space and society but also a vehicle for social and environmental justice.

References

Bakker, Karen J. (2005), 'Neoliberalizing nature? Market environmentalism in water supply in England and Wales, *Annals of the Association of American Geographers* 95 (3): 542–565.

Beetz, Stephan, Neu, Claudia, and Plieninger, Tobias (2005), *Zwischen Berlin und Stettiner Haff. Eine naturräumliche, politische und sozioökonomische Analyse der Region Barnim / Uckermark / Uecker-Randow*, Berlin: Berlin-Brandenburg Academy of Sciences and Humanities.

Coutard, Olivier (2002), '"Premium network spaces": A comment', *International Journal of Urban and Regional Research* 26 (1): 166–174.

Coutard, Olivier and Guy, Simon (2008), 'STS and the City. Soziotechnische Perspektiven auf eine Politik der Hoffnung', in Moss, Timothy, Matthias Naumann, and Markus Wissen (Eds.), *Infrastrukturnetze und Raumentwicklung. Zwischen Universalisierung und Differenzierung*, Munich: oekom, 63–86.

Edeling, Thomas, Stölting, Erhard, and Wagner, Dieter (2004), *Öffentliche Unternehmen zwischen Privatwirtschaft und öffentlicher Verwaltung. Eine empirische Studie im Feld kommunaler Versorgungsunternehmen*, Wiesbaden: VS.

Egerer, Matthias and Wackerbauer, Johann (2006), *Strukturveränderungen in der deutschen Wasserwirtschaft und Wasserindustrie* 1995–2005, Munich: ifo.

Graham, Stephen and Marvin, Simon (2001), *Splintering Urbanism. Networked Infrastructures, Technological Mobilities and the Urban Condition*, London / New York: Routledge.

Griapos, Peter and Munday, Max (2000), 'Regional winners and losers from recent trends in utility regionalization', *Regional Studies* 33 (8): 769–778.

Kaika, Maria (2005), *City of Flows. Modernity, Nature, and the City*, London / New York: Routledge.

Koziol, Matthias (2004), 'Folgen des demographischen Wandels für die kommunale Infrastruktur', *Deutsche Zeitschrift für Kommunalwissenschaften* 43 (1): 69–83.

Marvin, Simon, Graham, Stephen, and Guy, Simon (1999), 'Privatised networks, cities and regions in the UK', *Progress in Planning* 51 (2): 89–165.

Moss, Timothy (2009), '"Cold spots" of urban infrastructure: "Shrinking" processes in eastern Germany and the modern infrastructural ideal', *International Journal of Urban and Regional Research* 32 (2): 436–451.

Moss, Timothy, Naumann, Matthias, and Wissen, Markus (Eds.) (2008), *Infrastrukturnetze und Raumentwicklung. Zwischen Universalisierung und Differenzierung*, Munich: oekom.

Naumann, Matthias (2009), *Neue Disparitäten durch Infrastruktur? Der Wandel der Wasserwirtschaft in ländlich-peripheren Räumen*, Munich: oekom.

Naumann, Matthias and Bernt, Matthias (2009): 'When the tap stays dry: Water networks in Eastern Germany', *Local Environment* 14 (5): 461–471.

Page, Ben (2005), 'Paying for water and the geography of commodities', *Transactions of the Institute of British Geographers* 30 (3): 293–306.

Pult, Heiko (2006), *Schrumpfung und Wüstung in ländlichen Gemeinden Nordostdeutschlands*, Berlin: Technische Universität Berlin.

Schiller, Georg and Siedentop, Stefan (2005), 'Infrastrukturkosten der Siedlungsentwicklung unter Schrumpfungsbedingungen', *disP* 160: 83–93.

Statistisches Bundesamt (2009, 1993), *Fachserie 19 Reihe 2.1. Umwelt. Öffentliche Wasserversorgung und Abwasserbeseitigung*, Wiesbaden: Statistisches Bundesamt.

Statistisches Landesamt Mecklenburg-Vorpommern (2009, 1993), *Öffentliche Wasserversorgung und Abwasserbeseitigung in Mecklenburg-Vorpommern*, Schwerin: Statistisches Landesamt Mecklenburg-Vorpommern.

Tietz, Hans-Peter (2006), 'Auswirkungen des demographischen Wandels auf die Netzinfrastruktur', in Gans, Paul and Ansgar Schmitz-Veltin (Eds.), *Demographische Trends in Deutschland. Folgen für Städte und Regionen*, Hannover: Akademie für Raumforschung und Landesplanung, 154–172.

Tietz, Hans-Peter (2007), *Systeme der Ver- und Entsorgung. Funktionen und räumliche Strukturen*, Wiesbaden: Teubner.