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Sustainable settlement development – Assessing the effects of state measures in scenario analysis

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1 INTRODUCTION

Although there are a number of regions in Europe which are affected by shrinkage, land consumption continues on a high level. The settlement density has risen up since decades caused both by demographic changes and continued land consumption (Kasanko et al. 2006, EEA 2006). Recent expansions of cities and towns often are characterised by a lower density e.g. for detached houses and land intensive services such as logistics. Both ecological and economic consequences are established amongst planners and environmental scientists (Schultz & Dosch 2005):

- Splinter development has negative effects on the development of landscape and its function for ecology and recreation. New streets and linear settlements dissect valuable landscapes which are dependant on coherence. The amount of open near-nature land is strongly declining.
- Existing towns and villages are more and more fragmented in splattered parts of low density. The declining unity of settlements is highly problematic in terms of long term development of infrastructure and neighbourhoods.
- The policy actors often don't take into account the long-time costs of infrastructure maintenance, when declaring a new site for development. If demand is only temporarily or already declining, the municipality has to bear more costs for fewer inhabitants.

These and other problems are brought up in the sense of the sustainability of settlement development (Goetz et al. 2005). Many nations implemented qualitative objectives concerning land-use into their sustainability programs or strategies (e.g. European Commission 2004). The European Spatial Development Perspective declares the "compact city" as a concept for urban development in Europe (European Commission 1999). The above mentioned problems are of special relevance for regions which face population stagnation or shrinkage in the future. Therefore the context of sustainability of settlement structures is critical to the development of many nations in Europe. Especially in Germany a broader discussion on this topic has been taken place in recent years. In July 2004 the Council on Sustainability in Germany has presented its recommendations entitled "More Value for Land: the 30 Hectare-objective for a Sustainable Urban and Rural Development" for the revision of the National Sustainability Strategy of the Federal Government. The land consumption for settlement and transport in Germany is to be reduced to 30 hectares per day (75 acres / 0.118 square miles) until 2020. The current annual demand amounts to

over 100 hectares (ha) per day. In the strategy of the following Federal Government this objective was affirmed in 2005; progress was evaluated in 2008 (Federal Government 2008). It defines the reduction of greenfield development and the initiation of sustainable land management as a central task. Amongst others the following steps towards an improved planning practice were identified:

- Improvement of cooperation and communication in urban und rural planning to reduce greenfield development. Creation of more cost transparency for new developments.
- Mobilisation of brownfields and other empty sites within existing settlements (Thornton et al. 2007)
- Improvement of Land Use Monitoring to create better basics for future analysis and decisions.

There are many tools and measures which are discussed for sustainable land management. To make them practicable the Federal Ministry of Education and Research (BMBF) launched a Research Programme called REFINA.

In general, there is a call for creation of specific stimulators for investors to avoid disproportional handling with greenfields (Einig 2005). This implies all government measures, which increase the price for greenfield land and support a more sensible use of land. Therefore they are concerned with innovative taxation and extra duties.In 2003 and 2005 there were already inquiries made on the effects of specific subsidies and fiscal instruments on land use (Ahlert et al. 2005).

The purpose of the intent PANTA RHEI REGIO is to assess the effects of such measures on land use and on socioeconomic development and to analyse them in a regional perspective. Statements are to be made concerning future development and scenarios until the year 2020. The presented paper attempts to provide answers to the following questions. Which are the central determinants of land use change and how can they be implemented and linked to the general economic and socioeconomic development? How is land consumption going to develop in Germany until 2020? What effects do state measures have on the development? Recently there has been a discussion on various economic instruments to meet the challenges of making settlement expansion more sustainable (Nuissl & Schroeter-Schlaack 2009; Walz & Ostertag 2007: León 2005). Taxes to reduce the urban land consumption can lead to positive effects but also have several negative side effects (Nuissl & Schroeter-Schlaack 2009). Earlier modelling approaches (comparable with the approach used here) already revealed, that special taxes for greenfield development have to be very high to achieve a significant decrease in land consumption (Ahlert et al. 2005). The instrument which will be analysed here is meant to implement new market mechanisms in the process of declaration of new sites. “The development of land requires some form of public approval, i.e., actors who intend to develop a new site must be authorized to do so before development begins. Using tradable permits for the declaration of new sites as an instrument of land use policy is based on the idea that their distribution would be organized along economic principles.” (Nuissl & Schroeter-Schlaack 2009) The paper seeks to bring insights to the effects of an introduction of a market for tradable permits in Germany.

2 THE PANTA RHEI REGIO APPROACH

PANTA RHEI (Greek philosopher Heraklit: “all things flow“) is an ecologically extended version of a disaggregated econometric simulation and forecasting model INFORGE. It comprises a highly detailed energy and land use model in addition to its economic component. This makes it particularly well adapted to environmental economic analysis (Meyer et al. 2007). The performance of the model INFORGE is based on the INFORUM philosophy, which means to build econometric input-output models bottom up and fully integrated (Almon 1991). The construction principle bottom-up says that each sector of the economy has to be modelled in great detail and that the macroeconomic aggregates have to be calculated by explicit aggregation within the model. The construction principle fully integrated means a model structure that takes into account the input-output structure, the complexity and simultaneity of income creation and distribution in the different sectors, its redistribution among the sectors, and its use for the different goods and services the sectors produce in the context of globalizing markets. In this way it is possible to describe properly the role of each sector in the interindustry relations, its role in the macroeconomic process as well as its integration into international trade (Meyer et al. 2007).

For PANTA RHEI REGIO the emphasis is put on the linkage of the macroeconomic model to land consumption in a regional context. This requires two major steps:

1) The driving forces for construction (housing, plants and office buildings) and their impact on land consumption have to be identified and implemented into the model.
2) The modules which forecast the economic development have to be regionalized and linked to demographic changes in the regions.

The regional level is NUTS3, which means that 439 Regions in Germany have to be modelled. The model seeks to completely integrate the various interdependent parts (modules) in a consistent database and to integrate all interdependencies. The equations in the land-use extensions are based on macroeconometric statistics and multivariate analysis. The nation-wide approach leads both to challenges in database handling and to restrictions concerning data sources. Only official data published for all regions was to be used.

The regionalisation of the model PANTA RHEI is based on both top-down and bottom-up approaches. The projection of basic economic indicator is based on a system of linking nation-wide developments (structural and technological change) to the economic development in the regions. Mainly is it an econometric shift-share approach applied to the most detailed structural data available. This means that equations were also implemented on a supraregional level, i.e. the German provinces (Bundesländer). Furthermore employment and productivity were linked to the regional development of disposable income (via compensation of employees and distributional income effects). Moreover a bottom-up approach was used for the modelling of housing and construction. The changes in population and total number of private households were implemented to forecast regional construction in housing. This effect contributes to the performance of construction works in the region and, as an aggregate, determines gross investment for housing in Germany.

3 DRIVING FORCES OF LAND CONSUMPTION

For the analysis of future land "consumption" (settlement expansion), which takes into account the macroeconomic and demographic developments in Germany, the driving forces have to be identified. The official German statistics offers information about the "areas by type of actual use" in all regions (Federal Statistical Office 2005). The major categories in these statistics can be regrouped to form 3 major areas by type of "users".

Table 1: Land use categories

Applied categories	Provided categories (official statistic)	Users
Settlement area housing	Building and adjacent open area, related to housing/residential area	Private Households
Settlement area industry and services	Building and adjacent open area, all other (without housing)	Enterprises, Public Infrastructure
Other Settlement areas	Recreation area, cemeteries, plant area (dump and storage)	miscellaneous
Traffic area	Traffic area	miscellaneous

To complete the monitoring of human settlement expansion the areas for traffic must be added up to form the "built-up and traffic area", an indicator on which the above mentioned objectives are based on. The first 2 categories are the ones in focus here. They can be summed up as built-up settlement area (or "building settlement area"). In the following emphasis is on these categories. Different driving forces have been identified for these two types of land use by empirical analysis and were integrated in the modelling context.

The expansion of the settlement area for housing is determined by house building activity. Furthermore it is important how much, how large and what type of buildings are to be built as well as the size of the lot. The demand for housing units derives from the development of the number of private households. The demand for living space is additionally a result of regional income growth. In some regions with strong structural changes there is additional need for replacement of housing estates. For the way new houses are built (detached / semi-detached houses or apartment buildings) there are several factors taking effect. Of special importance is the age distribution of the population in the region. The starting-a-family stage corresponds to a certain age-group and so do preferences for type of buildings. An increase in the percentage of old people in the long run was found to increase demand for apartments. In addition the land value has an effect on the density of new settlements (mean size of a lot).

The development of settlement area for industry and services in general is an outcome of changes in economic structure and production technology. Additionally the productivity per land unit is changing. There are both sectors which increase their need for land area per production unit and some sectors, which need less land for it than ten years ago. The productivity (settlement area per value added) is relatively low in logistics but shows decreasing tendencies, while machine construction has a higher productivity, which is slowly increasing. The consequences of the general and land-use specific structural

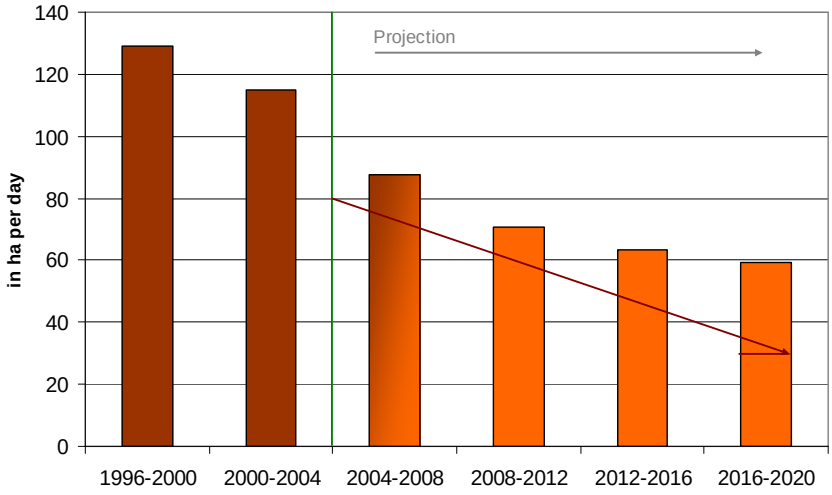
changes in Germany were projected to the regions considering the regional composition of sectors and their change. Also on the regional level differences in land productivity were taken into account and linked to land value levels.

By integrating price effects (with regard to land values) the manifold interdependencies concerning settlement development are displayed in the model. Increasing prices for land, e.g. new taxes, cause a slight downward decline of spending capacity and of housing construction. In addition the average size of the lot goes down. In the case of industry and services there is a shift in productivities following changes in prices. Sectors, which are dependant on area expansion, realise a disadvantage in comparison to those who produce with less area expansion. In a regional context there is an increase of land productivity. The model does not identify changes in the supply-side determinants of land consumption, if they are not reflected in land value changes. These factors are integrated and linked to demand-side variables. However we assume that supply-side elements such as government planning strategies do not change in comparison to the past development.

4 FUTURE SETTLEMENT EXTENSION IN GERMANY

The daily expansion of built-up and traffic area in Germany according to the official statistic accounted to 115 ha in the period from 2000 to 2004. Since then the number slightly diminished. Taking into account the statistical inaccuracies the newly developed areas add up to approximately 95 ha per day (Dosch 2008). The results of the projection generated with PANTA RHEI REGIO show that the land "consumption" noticeably decreases until 2020.

Figure 1: Growth of built-up and traffic area until 2020

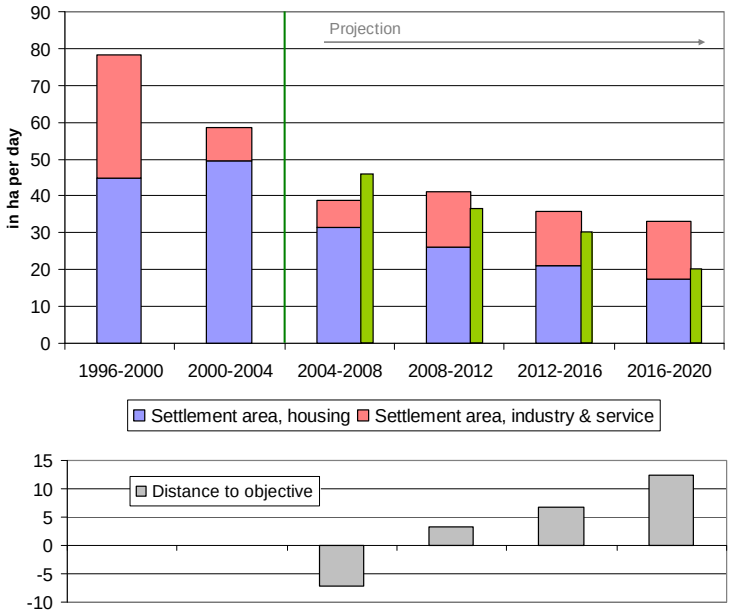


In the period 2016 to 2020 the daily consumption of greenfield land amounts to approximately 60 ha per day. The decrease slows down towards the end of the forecasting horizon. A larger part of the decrease until 2008 is due to resolving the statistical inaccuracies. The results provide a strong indication that the 30-hectare objective is not achieved without further political measures or a fundamental behaviour change by the actors. Due to the continued dynamic expansion of settlements and the expected general

shrinking of population in Germany the settlement density would decline from around 1800 inhabitants per square kilometre (sqkm) built-up and traffic area today to 1630 in 2020. This could lead to an increasing dispersion of population and more fragmented settlement structures (Federal Office for Building and Regional Planning (BBR) 2007).

In a sensitivity analysis performed with the model it has become apparent, that a stronger decline in population and a weaker economic growth do not lead to a daily growth beyond 40 hectares in 2020. For the analysis of sustainability a closer look on the built-up settlement area (without other settlement area and traffic area) reveals interesting insight. The total demand in the forecast horizon derives from different potential users. When demand is analysed separately there is a continuous decline in demand for housing with deceleration tendencies towards the end of the projection horizon. On the other hand the demand by enterprises is persistent in the long run. We see a shift of demand distribution from the private households to industry and services (cf. Figure 2).

Figure 2: Growth of built-up settlement areas until 2020 and the resulting unsustainability



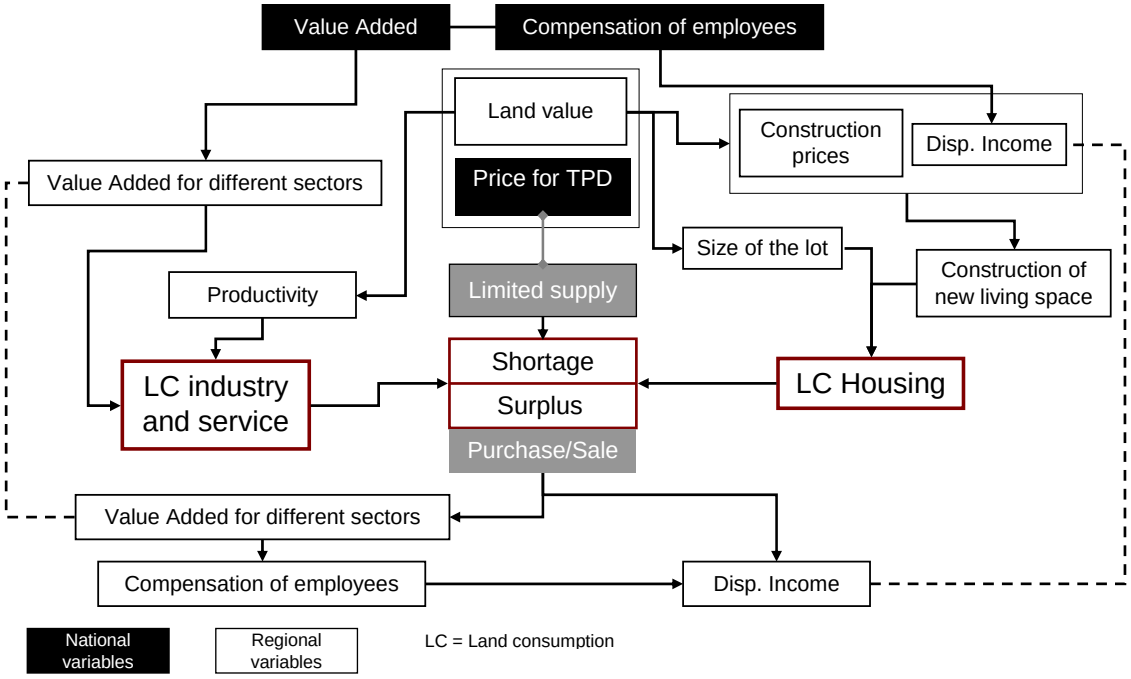
So far there are no suggestions on the way how to allocate the overall political objective to different land users or land-use categories. As the expansion of the defined built-up settlement area determinates the development of the other areas (other settlement areas and the traffic area), for example by defining the need of new transport infrastructure and leisure facilities, we concentrate on them. By using the shares of the area growth in the time period between 1996 and 2005 the 30 hectares in 2020 are distributed to the different settlement areas. This will lead to an target of 17.4 ha for built-up settlement area (12.6 for housing, 4.8 for all other uses) in 2020. To fully operationalise the objective there has to be found a path of reduction (Köck et al. 2008). In the following analysis we assume a linear path starting from around 80 ha per day, which means that the objective is set at 47.4 for built-up settlement areas in 2006. According to this analysis framework there is a growing lack of sustainability after 2008. In the time period 2016 to 2020 ca. 12 ha of the demand cannot be met with the designated amount (+60% of the objective).

5 TRADABLE PERMITS FOR DECLARATION OF NEW SITES

The modelling of a permit trade system in Germany entails two major steps. First the permit scheme has to be defined in terms of organisation and regulative aspects. Then it has to be translated into a modelling framework. In Germany, the discussion on tradable permits and their applicability to the issue of declaration of new sites already has progressed in recent years (e.g. Nuissl & Schroeter-Schlaack 2009, Henger & Bizer 2008, Köck et al. 2008). The system that is implemented in PANTA RHEI REGIO can be characterised as "cap and trade" (Hansjürgens & Schröter 2004). The first step has been the definition of the cap, which partly has already been described in section 4, in which the objective for built-on settlement area was calculated. In addition the permits have to be allocated to the regions. In Germany the local municipalities hold the permits for declaration of sites by law. That is why a certain amount of permits have to be given out free of charge (Nuissl & Schroeter-Schlaack 2009). All these regional certificates sum up to the nation-wide objective. For this study a rather simple method of top-down distribution of the cap was used. The regions are allotted their permits according to their shares of both area and population in Germany (the allocation for a region whose share of population is 1% and share of area is 2% would constitute 1.5% of the cap). The modelling of trade involves some assumptions. The market participants are the regions, though they are not always equivalent to the municipalities. Additionally, the prices for the tradable permits for the declaration of new sites (TPD) are treated as a surcharge for prices of land.

The adjustment of the system to the scenario surroundings of TPD can be characterised by 3 effects: First, the surcharges always have a direct effect on the decision-making process of the investors as they are faced with the surcharge. This is primarily a reaction which takes place on the housing market. This is due to the assumption that the proportion of construction costs and income does affect the demand for living space. This price stimulus is treated as a first-round effect. Second, higher prices for undeveloped land initiate a certain change in the demand. For residential use the mean size of the lot decreases with increasing prices. Also for industry and services the changes in land value charges are meant to change the way area is used for production. The land intensity (as reciprocal value of land productivity) of new sites is slightly declining in the model. Third, the slightly reduced demand for new development sites (represented by the growth of built-up settlement area) is compared to the available permits to generate the amount of purchases or sales to be made. The shortages and surpluses equalise, hence the market clears. Valuated with the price the traded permits are allocated as costs to the sectors and private households in the region. We assume that the costs for the purchase of permits from other regions have to be born by the originator, represented by its value added or by disposable income. In the modelling process the monetary value of purchase is subtracted from these values, assuming that the municipality passes the specific expanses to the users. If permits can be sold, the revenue increases the added value of public services, assuming that the municipality always tries to maintain or expand its resources. These second-round effects take place one year after the trade.

Figure 3: Modelling scheme for the simulation of TPD



The system and its effects primarily remains a regional system of redistribution. As investment for housing is modelled bottom-up there is an effect on construction activity in the whole system. The market price for TPD cannot be calculated simultaneously with the simulation of the trade system. It must be generated beforehand while step-by-step approaching the reduction path for land consumption for every year. The first trade period is 2010, from this year on the price is calculated to match the nation-wide target. Therefore the system does not simulate the trade itself but the reactions on the generated market price changes and the effect on regional development.

6 RESULTS

The prices, which lead to an attainment of the reduction path under trade system conditions, are the result of the proportion of area demand to the amount of the cap. The gap between the objective and the actual demand grows from 2010 on, so that the first round effect has to become increasingly stronger while approaching 2020. Furthermore the price for the TPD generally has to be set in an incremental manner, because its effects tend to be compensated. In the model context prices have to increase at least with the same growth rate as the year before to force further adjustment in the system. The prices which were found to fit the sustainable reduction path increase exponentially.

The described scenario has effects both on the national level and on regional distribution. The effects can be analysed by calculating the deviation of the TPD-scenario from the baseline scenario. Table 2 characterises the baseline scenario and effects of TDP introduction on a macro-level as well as indicators for the trade system.

Table 2: General economic effects and outcome of the trade system

	2000	2005	2010	2015	2020
Baseline Szenario, Index 2005 = 100					
Population	99,80	100	99,26	98,77	98,36
Gross domestic product (GDP), price adjusted	97,13	100	112,29	120,33	129,73
Gross fixed capital formation, Construction, price adjusted	120,54	100	106,05	107,46	109,63
Price for building land, ex taxes & charges	65,81	100	113,30	122,07	129,93
Built-up settlement area	95,98	100	103,13	105,88	108,36
TDP Scenario, Distance to Baseline in %					
Gross domestic product (GDP), price adjusted			-0,047	-0,139	-0,281
Gross fixed capital formation, Construction, price adjusted			-0,462	-1,167	-2,715
Price for building land, ex taxes & charges			0,079	0,005	-0,348
Built-up settlement area			-0,027	-0,297	-1,020
TDP Scenario, Trade Outcome					
Price for TPD, EUR/qm			4,6	42,1	195,5
Primarily allocated permits, ha			14169,3	10245,19	6363,41
Trade Volume Indicator, ha			8155,91	5053,30	4729,88

As construction of housing buildings become more expansive it directly impacts on capital formation. The reduced building activity leads to a slight reduction of production in general as investment dampens the demand in corresponding industries. The GDP in 2020 is then around 0.28% lower than in the baseline. The purchase value for building land is a function of both general price level of investments in buildings and an indicator which can be described as “open land shortage”. The reduced land consumption leads to a weaker development of this indicator but this effect in the beginning is overcompensated by higher prices in investments.

The analysis of indicators of the trade system itself leads to several interesting insights. Table 2 shows how the prices and “trade volumes” develop. The price increases beginning with around 5 EUR per square meter (qm), and ends up with 195 EUR per qm. The trade volume calculated, in development land, decreases, since the general land consumption tends to slow down (also in the baseline). The total amount of traded permits corresponds to 6000 ha; this is 54.6 percent of the total amount of quotas between 2010 and 2020.

At least two different phases or regimes can be distinguished in the results. Until 2017 the trade volume follows the land consumption path and prices remain on a more or less realistic level. Furthermore the differences in regional developments always correspond to their predicted demand for land, paths remain stable. From 2018 on the prices can be characterized as unrealistic. Moreover the price generating process beforehand was accompanied with uncertainties. The trade volume shows slightly increasing tendencies. The costs for TPD arrive at a level where it has serious economical effects on a regional level. Those implications are limited to a few sectors in around 15 regions. However, they render the system unstable as the above mentioned second-round effect contributes to a stronger decline in land consumption in those regions. Because of the given lag structure first year’s expenditures can be the next year’s income.

Nevertheless, the results give insight to which role different regions play in the scenario world. They contribute to various extents to the reduction of land consumption and they are in different degrees losers or winners in an economic sense. In the following, the results are analysed by taking a closer look to certain variables in the year 2015. The mean size of the lot applied in new developed residential areas and the “land intensity” for new commercial areas characterise the regions dealing with open land. The level and reaction of these indicators are determined by the mean land value. The deviation of total built-up settlement area between the baseline and the simulation shows how much land has been

saved up to the examined year. The deviation of gross value added shows if and to what extent regions have suffered or profited from the trade or its effects. In this case the overall economic effect has to be considered (-1.2% in 2015). Table 3 shows the results of the TPD scenario on an area type level. This analysis facilitates the outcome of 439 modelled regions. We distinguish 3 types of area (referring to a classification of the BBR) in two greater regions in Germany. "West" represents the geographical part attributing to former federal republic and "East" regions formerly belonging to German Democratic Republic.

Table 3: Results of the TPD scenario on an area type level

Properties in 2005

Region	Type of area	Land Value	Mean size of lot	Mean land intensity	Build-up settlement area	Gross Value Added	Quota
		EUR/qm	qm	Mean(GER)= 1.2	Share	Share	Share
West	Agglomeration areas (119)	216,98	639,5	1,1	32,8%	50,0%	31,0%
	Urbanised areas (141)	110,24	920,6	1,3	32,0%	26,7%	30,6%
	Rural areas (66)	104,36	985,6	1,3	12,6%	8,2%	13,5%
East	Agglomeration areas (30)	57,34	1191,8	1,8	8,5%	7,9%	9,0%
	Urbanised areas (47)	38,76	1163,7	1,5	7,8%	4,6%	7,9%
	Rural areas (36)	36,49	1499,8	1,9	6,3%	2,6%	7,9%

Simulation, 2015

Region	Type of area	Quota	Mean size of lot	Mean land intensity	Build-up settlement area	Gross Value Added	Trade balance (Transfer quote)
		ha	Dev. from Baseline	Dev. from Baseline	Dev. from Baseline	Dev. from Baseline	ha (%)
West	Agglomeration areas (119)	3181,0	-9,9%	-8,6%	-0,18%	-0,12%	-480,9 (40,9)
	Urbanised areas (141)	3131,4	-14,6%	-15,4%	-0,32%	-0,16%	-392,6 (40,01)
	Rural areas (66)	1385,0	-17,2%	-18,4%	-0,36%	-0,11%	65,5 (42)
East	Agglomeration areas (30)	921,9	-23,2%	-22,1%	-0,51%	-0,22%	-70,1 (55,55)
	Urbanised areas (47)	811,8	-27,8%	-36,5%	-0,38%	-0,04%	314,9 (59,92)
	Rural areas (36)	814,1	-28,8%	-31,0%	-0,30%	0,24%	418,6 (55,7)

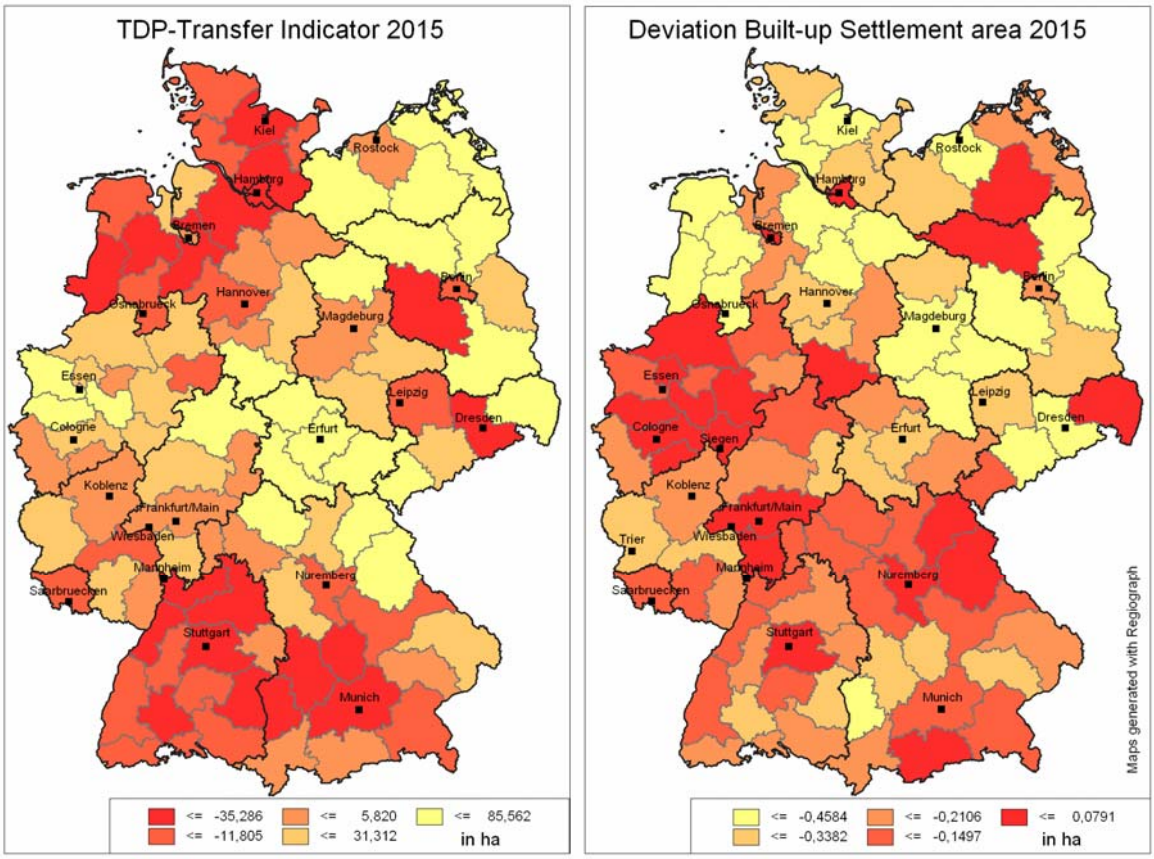
The land intensity indicators are lowest in the agglomerations and highest in the rural areas, especially in the eastern part of Germany. The lower the land value the higher is the primary impact of prices on land intensity and area per building. There are regions with land values below 30 EUR per qm, so that there is a strong change in investors behaviour facing these high prices. These impacts lead to a stronger saving of new land area in low-land-value regions. Looking at the stock of settlement area the deviation for Germany is around -0.3% in 2015. The impact in areas with high land intensity is higher in general. However, it still can be a stronger economical impact, which can contribute to a higher saving (e.g. Agglomeration areas East).

The column "Trade" shows how much permits have been purchased (negative values) or sold (positive values). The percentage (in parenthesis) represents the proportion of traded permits to the total quota of the region group. The rural areas both in the West and in the East can sell permits in 2015, and so do the urbanised areas in the East. All other groups would have to acquire additional permits. Apparently settlement structure and land values also determine the roles regions play in the market for permits for the development of land. This is true at least in this analytical framework and for the chosen primary allocation of permits.

A more detailed look on the results shows that often differences within the area groups can be higher than the differences between the groups. For instance, in the agglomeration area of Northrine-Westfalia there is hardly any region which has to buy additional permits in 2015. 40 to 60% of the regions in the West area types are "sellers". In the East

categories the range of shares is 60 to 80%. A deeper look into regional distribution can be seen in Figure 4. The maps show regional patterns beyond the area type categories. The units are functional regions which merge several NUTS3-regions and whose composition is provided by the BBR. The distribution of the TPD-transfer indicator on the left side indicates that wider areas of purchasers (regions who do not get by with their quota) are located in southwest and northwest Germany. Large parts of eastern Germany do not use the total quota sum on the scenario conditions. Exceptions are the regions to the west of Berlin and in Saxony's growing cities. On the right side we observe that most of the regions in West Germany's agglomerations can maintain their settlement expansion in the scenario. They represent both sellers, in the case of Northrine-Westfalia, and purchasers, in the case of Stuttgart and Munich.

Figure 4: Results of the TPD scenario for functional regions



Not every region, which sales a part of their quota, realise gain in economic sense. It depends on the reaction of the whole circuit described in Figure 3. Every region has its own characteristic and adapts in an individual way. Weaker rural areas can profit by strong impact on their land productivity, stronger urban regions can profit by the ability of purchasing larger amounts of TPDs without serious impact.

7 CONCLUSIONS

Economic instruments are of special importance to obtain fast progress towards a sustainable development. Before they are implemented, research has to provide insight into

their expedience and potentially occurring negative effects. Especially for the analysis of settlement development a model has to include all the interdependencies to fully understand future developments. The model PANTA RHEI REGIO has several unique features allowing both forecast and impact assessment. It is evident that a regional modelling approach is indispensable for the analysis. Modelling the trade of development rights is of special importance as policy makers are uncertain about their implication. So far it was not discussed in a scenario analysis yet.

Germany's objective for the sustainability of their settlement growth is challenging. Even though population is expected to slowly decrease in the next 12 years, the annual expansion is likely to exceed 60 ha per day in 2020. These gaps were also a significant element of the scenario result. If we consider no land shortage and no substantial rethinking in planning new development sites, prices for land have to be very high to obtain sustainable development.

There are many components which need to be developed further in order to enable the system to perform appropriate scenarios. For the generation of the prices other methods have to be tested. From other research projects we expect further insight into the system and its actors. Some help may be provided by an experimental game with a set of 13 local authorities the system of TDR, which is tested in a project called "Spiel.Raum" (Walz & Ostertag 2007).

In terms of Germany's administrative system of regional planning a trade of permits for declaration of new sites would initiate a deep change in thinking. Many regional actors in Germany consider arguments, which conform to a sprit of future prosperity and growth. They hope that demand will follow their new local supply and that they can gain short-term profits from declarations of new sites. Besides the thinking about long-term costs of new settlement areas, a cap-and-trade system would make them think of how valuable a new site would really be for the long-term development of their region. If they increase their effort on sites within the grown settlement they can profit from sales of their quota. Thus far, local authorities, who saved their greenfields for future generations or were forced to do so due to environmental issues, were often disadvantaged.

A system of TPD not only can ensure that a given target is achieved. It also can contribute to a certain compensation for the unequal distribution of development conditions. The results of the model show that many rural areas can profit from a trade system. However, this result is much due to the chosen allocation of permits. If future developments are not considered, as in the case of the allocation only via population and total land area of regions, fast growing regions have to pay and shrinking regions gain. However, regions additionally have the option to activate brownfields and increase the compactness of their settlements. These options are not fully implemented in the model, as information about unused settlement area and its price is not available in the official statistic. The parameters of land intensity and lot sizes represent such options in the model. But they do not give much insight in the underlying processes.

The political approach for sustainable land management has to be different for every country as different authorities with different capacities are in charge for settlement development. A system of tradable permits for the declaration of new sights is an alternative for nations with a comparable autonomy for local authorities.

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