To plan effectively, planners and landowners must share a common landscape vision and a common acceptance of planning.

A. Dan Tarlock

Environmental compliance in land use planning in Germany

Karsten Leschinski-Stechow

Abstract

This paper deals with the question in what way statutory environmental objectives become considered in land use plans in Germany. The inducement for such research on environmental compliance can be found in a crucial meaning of land use planning as the very basic planning area to implement any (environmental) policy and to make a difference. This evaluation makes use of a sub-dataset of a quite broader research approach, to which the author is devoted. It comprises 197 cases distributed over eleven German federal states and form a multiple proportional layered random sample. Results do indicate that the environmental objectives in most cases are fully or partly met. But it also shows that the sealing with impervious surfaces more or less is not limited by the planning bodies. An analysis of possible influential factors does on the one hand confirm some theoretical expectation, like e.g. shrinking cities do rather apply inner city development than growing ones. On the other hand factors like the location or built up area types turned out to be meaningful for the surface sealing.

1. Introduction

Although this facet of spatial planning could be understood as a little old fashioned, its first and foremost purpose is regulating the use of soil. Such 'regulatory' planning is crucial for defining the presence or the absence of 'natural' amenities like urban open space, or recreational places adjacent to settlements, but of course, regulatory planning may convey environmental problems like pollution as well. Normally this planning task is conducted using 'land use plans on a local level', but as the denomination and understanding of planning tools differs widely it is worth mentioning that this kind of plan in the English language often is titled as a 'zoning plan'. This contribution subsequently refers to the term 'land use plan' to mean a spatially precise plan that incorporates legally binding designations that allow and restrict the use of lots for building purposes. Such a land use plan normally comprises a multitude of existing properties or developments but covers an area that is significantly smaller than an urban district or even a whole municipality. As this paper deals with land use planning in Germany, the proper term translation of land use plan into German is 'Bebauungsplan.'

First of all it is worthwhile to acknowledge the reciprocity of land use planning's scope and its actual meaning. While it focuses on the local development, land use planning may appear to be small and rather meaningless in comparison to larger scale[1] planning instruments. But actually land use plans are the most spatially detailed ones and - what is far more important – they can claim to be quantitatively the most widespread planning instrument since literally thousands of them are set up in Germany each year (Schmidt-Eichstaedt 1998: 29, 62; Führ et al. 2008). The above considerations lead to the conclusion that land use planning from a theoretical standpoint should have an extraordinary impact for implementing overarching planning goals and policies. Necessarily, this includes those in the field of environmental precautions, which in the author's understanding, is a primary task of land use planning.

Accordingly, these main planning objectives are settled in the German Federal Building Code (Baugesetzbuch –BauGB), whose provisions can be understood as a basic legal framework. As planning issues are multidimensional (e.g. provide housing, transportation, economic development, environmental precautions along with others) so are the objectives of the Baugesetzbuch. Since their intention is to provide guidance in a particular planning context they are subject to interpretation and are not clearly directed towards a particular action in terms of a resulting designation in a land use plan.

With regard to the above rationale it easily becomes clear that land use plans' contents may differ while the underlying legal provisions remain the same. However differences among land use plans cannot be attributed to different legal environmental provisions but only to different planning settings and circumstances.

This fosters several basic questions for the 'environmental compliance' of land use plans and the environmental provisions of the BauGB:

1 Unfortunately the logically proper naming as 'small scale' often leads to misunderstandings. However, the expression does mean a large geographical area covered.

1. To what extent are environmental objectives accounted for in land use plans?
2. Can particular settings be attributed as explanatory factors for the extent of environmental objectives accounted for in land use plans?
3. How can an influential relationship among explanatory factors and environmental compliance in land use planning be explained?

A brief summary of underlying research results

Though many publications do question the relationship among legally defined goals of planning and the actual practice of planning, very few authors have analyzed planning and related compliance issues in a quantitative way. Therefore it appears to be pretty difficult if not impossible to assemble a comprehensive and recent information fundament about this topic. This may be an outcome of an attitude towards planning that does not care for data acquisition or systematic monitoring (Deutscher Bundestag 2014), though there are a lot of very considerable reasons to take planning evaluation more seriously. Since the overall information availability is scarce, the following few sources are of major importance for defining variables that may influence the land use planning output.

A very comprehensive analysis of environmental compliance in relation to zoning plans is provided by Gruehn (1998). Using a 414 case sample Gruehn's findings point out that on average a majority of legal environmental objectives are not recognized by planning bodies and not implemented into plans (Gruehn 1998: 286-288; 294-295). The analysis of influential factors is of central importance for formulating causation models based on numerical evidence. According to Gruehn (1998) such factors are (besides others): presence of a preceding environmental plan such as a landscape plan, integration of landscape plan and comprehensive plan (p. 301), city size (p. 289), federal state (p. 290), and professional origin of the planner (p. 296). With particular respect to land use planning Gruehn & Kenneweg (2001) analyze a set of such plans in the federal state Rhineland-Palatinate and find that nature conservation and landscape planning objectives are implemented at only 10-33% of the spatial extent of land use plans (p. 103). Führ et al. (2008) provide an analysis of environmental impact assessment procedures and point at differences with the concluding planning decision depending on whether environmental information were available or not to the planning body (p. 123). Further planning evaluations that point to deviations of environmental provisions can be found with Wende (2001) on the environmental impact assessment, Von Bosse (2004) on the impact mitigation regulation within land use planning in the federal states of Schleswig-Holstein and Mecklenburg-West Pomerania and with Siedentop et al. (2010) on land use plans for inner city development related to the federal state Baden-Württemberg.

Tab. 1. Model variables

Code[a]	Group	Variable clear name
X1C		Federal state / Bundesland
X1E	External	City size classification
X1F	conditions	General development outlook
X7A/B	Commitments	Land use plan that changes the zoning plan
X7C/D	in respect to content and	Land use plan tailored according to a particular investment proposal
X7E/F	procedure	Land use plan for inner city development
X8A		Land use plan set up for the first time
X8B	Reuse of	Land use plan changes one or more existing plans
X8C	planning areas	Land use plan cancels one or more existing plans
X4A		Spatial extent of the land use plan
X4B		Area dedicated as built up area
X4C	Area key	Area dedicated to transportation purposes
X4D	characteristics	Area dedicated to impact compensation
X5A		Overall impervious area
X5B	Impervious	Additional impervious area
X5C	surfaces	Additional pervious area
X6A		Built up area type (single variable)
Z1		Extent of implementation of the inner city development approach
Z2		Limitation of impervious surface to an appropriate extent
Z3	Environmental	Preservation of agricultural areas against a change of use
Z4	compliance	Preservation of forest areas against a change of use

a As the variables' numbering is taken from the land use plan main study, it might appear deranged. However, numbers do not correspond with an order within that table and simply should be recognized as a variable identifier.

2. Methodology

2.1 Model and Variables

The main methodological approach used to answer the research questions in section 1 is a factor model that tests influence and interrelations each variable has on planning outcomes. The following table 1 shows all these model variables at a glance.
As described above, the basic assumption is that the planning output in terms of environmental compliance with the respective set of legal provisions in the Federal Building Code [Z1,…,Z4] does not happen randomly, but rather is subject to determination[2]..

In the first place the model assumption will be that each factor [X1C,…,X6A] may directly influence the environmental compliance variables. Of course from a numerical standpoint this is easily possible. Therefore as an important constraint only those variables will be included in the numerical model that provide for plausibility in terms of a cause-effect relationship. Such cause-effect relationships rely on yet available research results (see above) and on logical considerations.

Since a couple of independent input variables are more or less closely interrelated, mediating effects on the dependent variables are to be expected. Considering the groups in the above scheme counting 17 independent variables and a resulting[3] number of up to 136 reverse dependencies, it becomes pretty clear that not all of them can be inspected within this work. Nevertheless, a few of these relationships among independent input variables are obviously meaningful and so need to be analyzed within the results' interpretation in section 3.

2.2 Introduction to the variables

External conditions are those related to general administrative differences that are known as meaningful for planning practice. Also economic perspectives may influence how land use planning is conducted. The German federal state ('Bundesland') [X1C] accounts for up to 16 different administrative state entities. City size classification [X1E] is a derived variable that is based on the population number. Three subdivisions that form classes of towns with less than 20,000; 20,000 up to less than 100,000 and 100,000 or more population account for different capabilities of the municipal planning administration. The general development outlook [X1F] is a complex indicator that estimates population development and economic prosperity. This indicator is published by the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) and in this paper will be reclassified to comprise only three possible values rather than the original five.

Commitments in respect to content and procedure indicate ties that take effect on the land use plan's contents. Different from the 'regular' procedure with a top-down approach, some procedure types are eligible to subverse this principle according to §§ 8 (3) and 13a (2) BauGB. In these cases apparently the land use plan changes the zoning plan [X7A/B] which simply means that no higher-level (zoning) plan can ensure a strategic comprehensive planning approach. In a multitude of cases the land use plan has been tailored according to a particular investment proposal [X7C/D]. This situation is present either when an urban development contract results in a land use plan according to §§ 11 and 12 BauGB or the plan's justification documents make clear that the final users and their needs are known in advance of the whole planning process. In contrast to 'regular' land use plans the planning output must be understood as widely predetermined by private or public investors' interests rather than the result of an open-ended planning process where the sole obligation is to meet the best solution from a professional perspective. The so called 'land use plan for inner city development' [X7E/F] according to §§ 13 and 13a BauGB is a planning instrument, that puts an attractive incentive e.g. for using brownfields or increasing the density within existing settlement. Mainly this incentive is about waiving the normally mandatory strategic environmental impact assessment (SEA) for land use plans and the impact mitigation regulation. This procedure allows for a reduced involvement of the general public and stakeholders[4], but the instrument comes with the risk of a significantly diminished information basis in terms of environmental outcomes of the land use plan.

The *reuse of planning areas* accounts for differences that are related to challenges which arise from brownfield or greenfield. This becomes pretty clear if a new plan needs to integrate a yet existing brownfield or greenfield and include a preexisting built environment. If a plan starts from scratch, it will be coded as a 'land use plan set up for the first time' [X8A]. This option also includes those areas that are currently considered as 'inner area' according to § 34 BauGB[5]. The remaining case is the 'land use plan [that] changes one or more existing plans' [X8B] and the 'land use plan [that] cancels one or more existing plans'[X8C]. As mixed forms[6] are often reality, no single variable logically excludes from coding another within the X8-variables group. The coding is based on the information provided through the plan's justification document and the procedure documentation of the town council. As some procedural treatments of land use planning issues significantly differ among planning bodies, this can lead to a notable uncertainty with coding of [X8A] and [X8C]. If a brand new plan is set up covering the area of a prevailing plan fully or partially, the 'old' lower-layer plans designations will expire[7]. The coding then reads [X8A] = true

2 Nevertheless this assumption acknowledges the presence of a residual that may either account for randomness or for as yet unknown influential factors.

3 $C_{17,2} = \binom{17}{2}$

4 But it is worth to amend that a lot of local planning bodies use to maintain the 'regular' involvement procedure as they are aware of the results of a lacking involvement. This does mean, that there is no reliable tie among a § 13a land use plan for inner city development and a reduced participation according to § 13 BauGB.

5 This is meaningful as the 'inner area' elsewhere is eligible as built up area according to another permission scheme and therefore need to become differentiated against those areas, where a built up use anyways is subject to the existence of a land use plan (of course except of those that are subject to special planning legislation, e.g. roads a.s.o.).

6 e.g. new land use plan is set up using while the designations of an old one become changed and implemented

7 This is a common conflict resolution principle known as 'lex posterior' rule. It means that the most recent legal provision takes

and [X8C] = false despite the circumstance, that the legal effect regarding the old plan is the same as if [X8C] would be coded as 'true'.

Area key characteristics represent major numerical features of a land use plan. It is pretty easy to understand that the overall planning area can be a limiting factor towards the limitation of impervious surface[8]. But in contrast to the other groups these variables also need to be understood as dependent[9] from the planning output. Furthermore, they also can be used as control variables to better understand the relations among dependent variables. The 'spatial extent of the land use plan' [X4A] is the overall area the plan covers and comprises parts that are detached e.g. for impact compensation purposes, although it does not account for so called stand-alone land use plans for impact compensation purposes[10]. As an important portion of [X4A], the 'area dedicated as built up area' [X4B] sums up areas where buildings and attached facilities could be placed. This figure must not be mistaken with the area that results from the site occupancy index. The 'area dedicated to transportation purposes' [X4C] comprises all roads, footpaths, paths, parking lots and similar facilities that are meant to be necessary to secure access to transportation networks beyond the land use plan's limits. Finally the plan's area profile shall be completed by using the indication of the 'area dedicated to impact compensation' [X4D] according to the impact mitigation rule put in § 1a (3) BauGB. In contrast to [X4A] this number comprises those impact compensatory areas within the land use plan itself, as well as those that are shown in a detached (compensation-) part of the original land use plan, in a stand-alone compensation land use plan and areas that are drawn from a timely advanced pool of compensation areas and actions.

The *built up area type* [X6A] represents the land use zone according to the classes that are set in § 19 BauNVO (ordinance on the use of buildings – Baunutzungsverordnung). Those classes assign a profile of permissions and restrictions to each built up area type. If a development plan (§ 12 BauGB) uses its own built up area types[11] the coding accounts for this by using the 'unable to assign' code. As this variable is supposed to be notably related to both independent variables and dependent variables, it is main purpose is to be a control variable. The use of a control variable reduces a known or supposed amount of variance at the side of the independent input variables.

Finally the *environmental compliance* variables are set as the dependent ones, which mean that they need to be understood to result from the independent variables through a supposed causal relationship. As just explained above, only a few environmental provisions of § 1a BauGB are subject of this discussion. The 'extent of implementation of the inner city development approach' [Z1] accounts for land use plans that fully or partly make use of yet existing areas in the inner city areas. There's a logical relationship between such planning types and the prevention of the additional sealing of soil. Furthermore, this approach has massively been promoted through research, politics and planning professionals. Therefore, today it is an uncontested standard from a planning law and a planning practice perspective.

The decision to consider [Z1] as fulfilled requires one of the following provisions

- to include the area of any existing land use plan,
- to make use of the inner area as defined by § 34 BauGB (see fn. 5 above) or
- to include an area where built up uses are present and the additional built up uses are aimed at increasing the density of the setting rather than expanding into yet open areas.

Besides the qualitative feature, the variable [Z1] also records the spatial extent related to its overall area [X4A]. These four ordinal steps represent a proportion of 0%, the intervals of 1%-49%, 50%-99% and finally 100%. Next, the 'limitation of impervious surface to an appropriate extent' [Z2] will be investigated. As an indicator of this limitation the site occupancy index will be used. The decision whether this requirement is met is made by the comparison with the maximum site occupancy indices as provided in § 17 (1) BauNVO. A limitation in terms of [Z2] requires a site occupancy index in the land use plan that is lower than the upper limits provided in § 17 (1) BauNVO. The remaining features 'preservation of agricultural', 'areas against a change of use' [Z3] and 'preservation of forest areas against a change of use' [Z4] are self-explanatory. Their requirements are not to plan on top of a present agricultural or forest designation in any other valid plan (e.g. land use plan, zoning plan), and independently from any plan, not to create plans on such land uses.

2.3 Sampling & data collection

As the research questions are not geographically limited, sampling aims at representing the practice of land use planning over Germany as a whole. Therefore, it is very important to understand that the sample is not meant to represent any equivalence between administrative entities and a quantitative estimate of the number of land use plans rather than the planning actions of planning bodies. According to this consideration the basic population would be formed through the number of planning bodies, meaning municipalities. As especially small municipalities often form overarching cooperative municipal administrations there is a considerable reason to include (just) those administrations, that actually deal with land use planning.

effect.

8 The rationale is quite simple. Even though land use plans can become downsized to one single lot or less, built up uses cannot be reduced beyond the limitations set by their purpose.

9 A good example is a land use plan that does not account for the preservation of forest areas [Z4] and therefore would need to appoint an area dedicated to impact compensation [X4D]. Ceteris paribus such a compensation area would not have been put if the plan had taken another preceding use e.g. like a brownfield.

10 Of course there are comprehensible reasons as well: First, just from a legal standpoint two single land use plans can hardly be treated as one. Second, as the Federal Building Code allows storage of compensatory measures that have been realized (long) before a land use plan is enacted, accounting for compensatory stand-alone land use plans would just mean a significant bias in the dataset.

11 The Federal building code actually does open up this opportunity to § 12 development plans, as it could mean an additional flexibility to investors and stimulate their engagement. Nevertheless, a big number of development plans uses the classic built up area types of § 19 BauNVO.

The primary distinctions between those planning bodies are to be expected in the scales of German federal state / Bundesland, city size classification and general development outlook.

The sampling procedure comprises two steps, where within each step a proportional sampling is achieved. In the first place each city size class (refer to variable [X1E]) contains 96 cases equal distributed across city size class. A short example illustrates why an equal number of city size samples were used: The share of all 77 municipalities in Germany with 100,000 inhabitants and more is 1.7% of all municipal administrations that can prepare land use plans. The share of all those 690 planning bodies who serve communities populated from 20,000 up to 100,000 is slightly higher at 15.3%. Even if the overall target sample size would number 1,000; there would only be 17 'big' cities represented. In other words, the resulting analysis would omit both groups of big and medium size cities in favor of a strict proportionality.

Because of peculiarities with the inner administrative structure of the cities Berlin, Bremen and Hamburg, the big cities' group needs to get an additional 19 cases and sums up to 96. As the first step of sampling aims at an equal distribution, the target sample size is 288.

The second step of sampling takes care of a simple proportional representation of the German federal states [X1C] as well as a representation of the economic development outlook [X1F]. Finally the resulting data set can be entitled as 'multiple proportional layered random sample'. At each respective layer, all elements (e.g. municipal administrations) had an equal probability to be drawn into the dataset once. Technically the sample was acquired using a random number generator that is able to output a sample table according to a particular presetting.

Data collection was aimed at pulling one land use plan for each municipal administration into the sample dataset. To ensure a comparable legislative framework, only land use plans that were politically enacted from September 2011 to December 2014 where considered. The first step of the land use plan selection was to figure out one or more plans which were enacted closest to 31st December 2014. Often two or more plans were enacted on the same day. The selection was once again made with the help of a random numbers generator. The information on which land use plans where set up, was gathered either using a web-based parliamentary information interface or through a written and/or telephone inquiry with the administrative body of interest.

3. Results

3.1 Feedback

As expected, not every municipal administration could provide for the requested land use plan. Since the scope of this paper is limited to only 11 of 16 German federal states, the maximum number of acquired land use plans is 241. As the feedback numbers 197, the feedback quota is 81.7%; which can be interpreted as a quite good value. As easily can be seen, the feedback quotas are pretty different among regions. It turned out especially difficult to gather data from a couple of Bavarian municipalities, as unexpectedly many of them were not willing to cooperate.

Tab. 2. Sample distribution and feedback according to federal state / Bundesland

[a]

German federal state / Bundesland	Number of cases		Quota
	Target	Feedback	
Schleswig-Holstein	10	10	100.0%
Hamburg	8	8	100.0%
Lower Saxony	25	23[1]	92.0%
Bremen	2	2	100.0%
North Rhine-Westphalia	58	57	98.3%
Hesse	21	15	71.4%
Rhineland-Palatinate	14	9	64.3%
Baden-Württemberg	37	31	83.8%
Bavaria	50	29	58.0%
Saarland	3	2	66.7%
Berlin	13	11[1]	84.6%
Overall	241	197	81,7%

a Since two district planning administrations yet promised to provide recent land use plans, the resulting quota underestimates the 'Berlin' feedback.

Since two district planning administrations yet promised to provide recent land use plans, the resulting quota underestimates the 'Berlin' feedback.

With respect to table 3 a different average city size classification is also related to different regional quotas. However as expected, the portion of feedback increases towards bigger municipalities. The data acquisition clearly showed that planning information was pretty easy to get through the municipalities' parliamentary information resources. Small communities often did not provide such interfaces and the data was more difficult to acquire. Additionally, many small municipalities appeared to have very few administrative staff and therefore could not serve inquiries for planning information.

Tab. 3. Sample distribution and feedback according to city size classed

City size classification	Number of cases		Quota
	Target	Feedback	
less than 20,000	73	46	63.0%
20,000 up to less than 100,000	81	70	86.4%
100,000 and more	87	81	93.1%
Overall	241	197	81.7%

To conclude, despite particular difficulties the data acquisition went very well. The feedback quotas are pretty good, though they do differ. Some of these deviations obviously do accumulate, as some German federal states like Rhineland-Palatinate or Bavaria are crowded with rather small municipalities. A general summary needs to recognize in the end, that the land use plan availability is pretty good in the northern half of Germany and slightly worse in the southern regions.

3.2 Extent of environmental objectives accounted for in land use plans

With regard to table 4, two basic observations need to be noted. First, the percentages of environmental objectives which were accounted for in the land use plans do obviously differ. Second, the numbers indicate that the implementation of environmental objectives either is done on the full spatial extent of the land use plan or not at all. The classes what represent the partial implementation only comprise up to about 10% of the cases. The distributions appear to be bipolar.

While table 4 shows the observed quantities and the respective percentages, table 5 provides an estimate of the 'real' share. Assuming an infinite number of observations, the upper and lower boundaries make sure the value will be in this interval at a 95%-probability.

A notable finding is that the inner city development approach [Z1] is put into practice in more than half of all cases. If the point estimator in table 4 is true, about two thirds of all land use plans do not consume additional, often unsealed, soil outside of those areas that yet were used as built up areas. It is worth to amend that the average spatial extent [X4A] of a land use plan which fully implements the inner city development approach comes without any statistical difference from those plans, who do not account for that objective at all. The descriptive differences are 4.09 ha ('not at all') compared to

Tab. 4. Achievement of environmental objectives

Environmental objective / Extent of fulfilment	Inner city development approach [Z1]		Limitation of impervious surface [Z2]		Use of agricultural areas [Z3]		Use of forest areas [Z4]	
not at all	29	17.1%	80	48.5%	124	78.5%	146	92.4%
partly*	7	4.1%	12	7.3%	6	3.8%	7	4.4%
mostly**	9	5.3%	5	3.0%	7	4.4%	0	0.0%
fully	112	65.9%	36	21.8%	16	10.1%	1	0.6%
no assignment	13	7.6%	32	19.4%	5	3.2%	4	2.5%
coded cases	170	100.0%	165	100.0%	158	100.0%	158	100.0%
missing information	27		32		39		39	

*≤ 50% of land use plan area **> 50% of land use plan area

3.75 ha ('fully'). The same conclusions apply to the remaining area characteristics [X4B] … [X5C] as well.

In contrast to [Z1], the 'limitation of the impervious surface to an appropriate extent' [Z2] seems to be applied far less. Only 21.8% of the sample cases can be attributed to the sealing with impervious surfaces, the confidence interval reaches up to a 26.8% share. The mirror image is that a pretty big value of the point estimator at 48.5% for the 'not at all'-group and at an additional 7.3% for the 'partly' implementation shows, that preserving the soil is not yet that advanced as figures like those concerning [Z1] might indicate.

Tab. 5. Estimates of the proportions to which environmental objectives are implemented

Environmental objective / Extent of fulfilment	Inner city development approach [Z1]		Limitation of impervious surface [Z2]		Use of agricultural areas [Z3]		Use of forest areas [Z4]	
Limits of 95%-Confidence interval	lower	upper	lower	upper	lower	upper	lower	upper
not at all	11.8%	22.9%	40.9%	58.4%	70.9%	84.8%	88.0%	96.2%
partly*	1.2%	7.1%	3.4%	12.1%	1.3%	7.0%	1.3%	7.6%
mostly**	2.4%	8.8%	0.7%	6.7%	1.3%	8.2%	0.0%	0.0%
fully	58.8%	72.9%	13.4%	26.8%	5.1%	14.6%	0.0%	5.1%

*≤ 50% of land use plan area **> 50% of land use plan area

Since it might appear self-evident that an inverse relationship between [Z1] and [Z2] exists, this question deserves a test for rank correlation. This leads to a very little (Spearman) ϱ of -0.014 which actually cannot be considered different from zero (p-value for this hypothesis reads 0.861). This finding is interesting, as the assumption that inner city development would be closely related to the limitation of the impervious surface is often stressed in the literature body. The descriptive differences within the present sample are shown in table 6 (below) to better understand the sample. However, the descriptive differences of the average built up area most likely are due to random, as the respective tests show[12].

12 Pairwise comparisons of [Z1] features while controlling for [Z2] features (and vice versa) using the Mann-Whitney U statistics. All p-values where ≥ 0.057 and thus unsuitable for concluding population differences.

Tab. 6. Average built up area depending to [Z1]*[Z2]

	Inner city development approach [Z1]			
Limitation of impervious surface [Z2]	not at all	partly	mostly	fully
not at all	3.7	2.0	1.2	4.1
partly	4.2	.	1.2	2.8
mostly	5.2	.	.	2.1
fully	1.5	3.1	.	2.4
Average built up area in hectares				

Finally the 'use of agricultural area' [Z3] and the 'use of forest area' [Z4] appear to be environmental objectives that all in all are met pretty well in comparison to [Z1] and [Z2]. Just 18.3% of the land use plans occupy agricultural areas and the share of such plans that fully use 'greenfields' is between 5.4% and 14.8%. Though this might be recognized as a quite 'good' estimate (e.g. with respect to earlier decades), the annotation is justified that the legal provisions aims at no additional use of agricultural areas for land use planning.

3.3 The influence of particular settings

As illustrated in section 3.2 above, the compliance with respect to the achievement of the legal environmental objectives is variable to some degree. Variations may either occur randomly or be the result of causation. If they are a result of a systematic influence of a factor, it is very important to unveil it. Since most factors are closely related to particular planning actions or external frame conditions, the understanding of their influence is the crucial prerequisite for improvements.

Table 7 (below) cross tabulates all supposed influence factors. Any factor model needs to be derived from theoretical considerations, and so this factor model follows the theoretical considerations discussed in chapter 2 (above). It is important to understand that this table does simply summarize a couple of systematic tests on the relationship between the influence factors and the environmental objectives variables. Though it superficially might appear as such, it is unlike a regression model. Each variable test was conducted independently; hence any result is valid unless the other factors become controlled. According to this explanation, no covariates (e.g. area metrics in this case) were accounted for.

Tab. 7. Single influence of model factors on environmental objectives

	Environmental objectives							
	[Z1]		[Z2]		[Z3]		[Z4]	
Factor	χ^2 (df)	p	χ^2 (df)	p	χ^2 (df)	p	χ^2 (df)	p
[X1C]	14.591 (10)	0.148	38.656 (10)	**0.000**	12.196 (10)	0.272	12.649 (10)	0.244
[X1E]	1.622 (2)	0.444	0.680 (2)	0.712	11.876 (2)	**0.003**	0.526 (2)	0.769
[X1F]	10.037 (4)	**0.040**	4.312 (4)	0.365	2.654 (4)	0.617	14.631 (4)	**0.006**
[X7A/B]	0.000 (1)	0.992	0.024 (1)	0.876	0.402 (1)	0.526	0.001 (1)	0.982
[X7C/D]	0.776 (1)	0.378	1.452 (1)	0.228	1.028 (1)	0.311	0.365 (1)	0.546
[X7E/F]	20.834 (1)	**0.000**	0.594 (1)	0.441	8.751 (1)	**0.003**	1.004 (1)	0.316
[X8A]	14.163 (1)	**0.000**	0.927 (1)	0.336	13.831 (1)	**0.000**	0.270 (1)	0.869
[X8B]	13.571 (1)	**0.000**	0.059 (1)	0.807	6.275 (1)	**0.012**	0.000 (1)	0.990
[X8C]	0.007 (1)	0.932	0.037 (1)	0.848	**0.019 (1)**	0.892	4.560 (1)	0.033
[X6A]	13.649 (8)	0.091	51.984 (8)	**0.000**	10.281 (8)	0.246	10.074 (8)	0.260

Statistical test method: Kruskal-Wallis test on rank sum differences. Significant results are shown in **bold.**

As some readers may not be accustomed to argumentations using such statistical rather than verbal considerations, the following explanation is worth to become amended. To better illustrate it, one could have a look at the first cell in table 7. This cell does represent the global test results using the Kruskal-Wallis test on rank sum differences (Kruskal & Wallis 1952), what is a wide-spread standard test method when it comes to the comparison of data distributions at ordinal data quality ('dignity') like in the present study.

As the outcome variable [Z1] comprises four features in an ordinal relation (better or worse achievement of the environmental objective), an unprejudiced assumption would argue there are no differences to be observed if that ordinal relation (= rank order) was compared using a distinction into federal states (or any other potentially explaining factor, provided its rationale can yet be put from theoretical considerations). Each distribution of [Z1]'s values over features of [X1C] (or any other factor to be examined) can be expressed through its median value or yet better a rank sum[13]. Since the present dataset contains hundreds of cases with many ties, the average rank sum values appear to be pretty high numbers. Nevertheless, the statistical test does determine the differences between the observations and the feature groups' average rank and transform and condense them to a single test value. This test value will be tested against the so called Chi-square (χ^2) distribution.

The χ^2-distribution[14] tabulates critical values for a defined

13 since considering a rank sum better allows to account for ties and unequal sample sizes among the feature groups of the analysed factor

14 Such tabulated distributions are to be found in almost every text book on statistics for applications within sciences. However, they

combination of degrees of freedom 'df' of the analysed factorial model and a particular level of statistical significance (p-value). If the observed χ^2-value exceeds the tabulated critical χ^2-value, it does indicate that the observed distribution differences are less likely than this particular level of statistical significance assuming the hypothesis is true, that no differences among distributions exist[15]. According to conventions within social sciences, this study does accept a statistically significant difference between distributions at p-values of 0.05 and less.

Finally the conclusion then is to adopt the alternative hypothesis. In the present example, the alternative hypothesis would be that [Z1] distribution differences exist among federal states [X1C]. According to the research design, the factor 'federal state' would be meaningful to explain observed differences. Since the respective p-value in this case reads 0.148, a 14.8% probability propones no such differences using the present dataset. More comprehensive explanations on the test method can be found e.g. with Sheskin 2003: 757-770.

easily can be accessed using statistics software on a computer, e.g. SPSS or R.

15 And that any differences in the observed data are subject to random deviations only.

The inner city development approach

Concerning the 'Inner city development approach' [Z1] the p-values indicate four factors that influence the degree of environmental compliance. The general development outlook [X1F] turns out to be significant. Data inspection (see table 8) shows that municipalities with a shrinking development outlook prefer to enact land use plans that implement the inner city development approach (indicated by a higher rank place number) as opposed to municipalities that expect to grow. As especially shrinking towns often suffer from abandoned areas and buildings, this finding suits theoretical considerations pretty well.

Tab. 8. Inner city development approach ranking according to general development outlook

Inner city development approach [Z1]		
Development outlook (BBSR) [X1F]	n	rank
shrinking	4	62.00
shrinking by trend	35	52.74
shrinking/growing possible	15	44.77
growing by trend	19	45.50
growing	19	34.11
rank places indicate the compliance with [Z1], where high rank places correspond with a higher compliance		

The next influential factor on [Z1] is the feature 'land use plan for inner city development' [X7E/F]. Though the definition of [Z1] for data collection purposes is not linked to the formal presence of a land use plan for inner city development (§ 13a BauGB), a statistical nexus must be expected here. The highly significant differences can also be confirmed regarding the right order in terms of average rank placement (92.12 vs. 63.95 for [X7E/F = 0/1]). In addition to this, the question whether a land use plan is set up for the first [X8A] or is a changed one [X8B] is of importance for the environmental compliance related to the inner city development approach. As both questions are logically related to each other, it is not surprising[16] that both are very highly significant at the same time. The post-hoc analysis shows that a higher rank is attributed if the plan is either not the first one on site [X8A] or it is a different plan [X8B]. Finally, the inner city development approach appears to be put into reality through changing existing land use plans rather than planning for the first time. Though the legal provision also addresses new land use plans to aim at inner city development, this finding confirms a theoretical expectation.

16 The respective test indicates a correlation with ϱ = -0,612 and p = 0,000. Both, prefix and strength do confirm the above assumption that both variables are complementary to each other.

Limitation of impervious surface

The next environmental objective to discuss is the 'limitation of impervious surface to an appropriate extent' [Z2]. There are only two influential factors identified that are the 'German federal state / Bundesland' [X1C] and the 'built up area type' [X6A]. Table 9 (below) shows rank places for each Bundesland. It turns out that in a group of four German federal states (Berlin, Hesse, Schleswig-Holstein and Lower Saxony) land use plans quite often limit impervious surface whereas this environmental objective is not met as well in the other regions. It is very questionable why land use plans in North Rhine-Westphalia rarely limit the impervious surface as opposed to many other federal states. A nearby explanation could be that in this very densely populated region the average spatial extent of the land use plans [X4A] is smaller than elsewhere?

As Figure 2 shows, the distribution of the average extent of land use plans apparently supports this assumption. The average of 2.69 hectares is one of the lowest among the dataset. But in contrast just those two federal states with a lower average (Schleswig-Holstein and Lower Saxony) contain a larger number of land use plans that limit the impervious surface, as table 9 shows.

With regard to table 10 it is of interest to determine differences of built up area types between samples. It is a surprise that the limitation of sealing objective seems to be met best through land use plans that designate special purpose use areas (e.g. shopping mall; university, technology park) and business zone areas (e.g. high rise building complex in the central business district) to be most compliant with [Z2]. An

Tab. 9. Limitation of impervious surface ranking according to German federal state / Bundesland

Limitation of impervious surface to an appropriate extent		
German federal state	n	rank
Schleswig-Holstein	10	107,8
Hamburg	7	75,07
Lower Saxony	19	107,39
Bremen	2	78
North Rhine-Westphalia	52	60,78
Hesse	11	112.36
Rhineland-Palatinate	5	77.30
Baden-Württemberg	29	75.52
Bavaria	20	85.65
Saarland	1	40.50
Berlin	9	129.83
rank places indicate the compliance with [Z2], where high rank places correspond with a higher compliance		

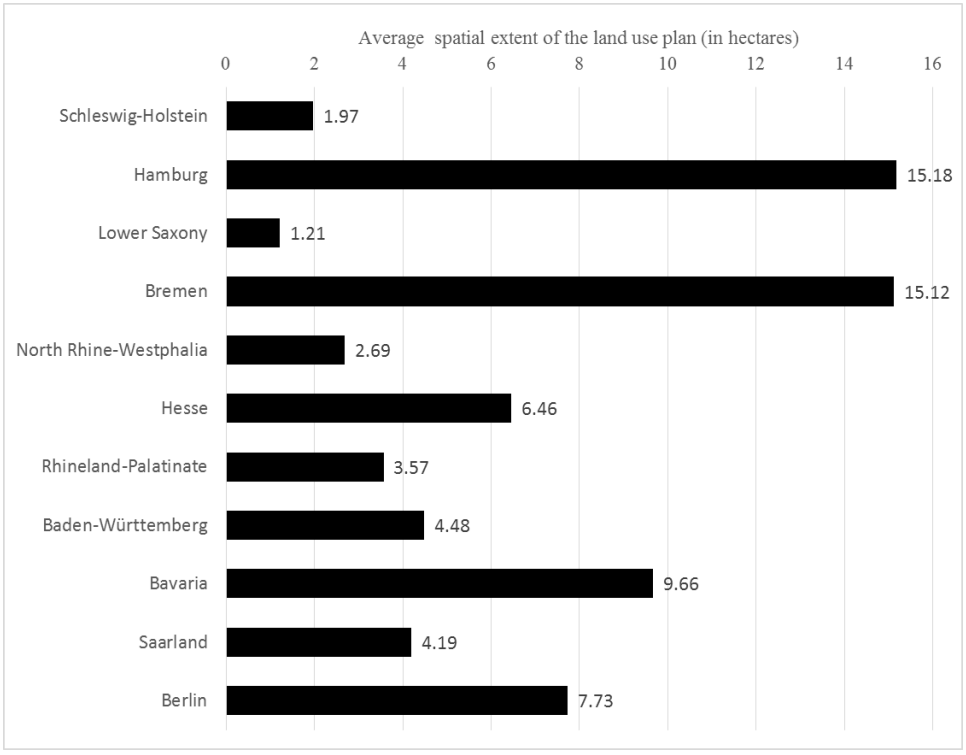

Fig. 2. Average spatial extent of land use plans

explanation could be that especially the above mentioned built up area types are related to a limited sealing, which demand quite large areas for their uses. With respect to table 10, this explanation probably does not really support the observations.

The preservation of agricultural and forest areas against a change of use

There are four influential factors that are meaningful for the preservation of agricultural areas [Z3]. Three of them, namely the 'land use plan for inner city development' [X7E/F], the

Tab. 10. Limitation of impervious surface according to the primary built up area type

Limitation of impervious surface to an appropriate extent			
Primary built up area type	n	average rank	average area dedicated as built up area (hectares)
WR - housing only	9	59.39	1.2
WA - housing	68	63.13	3.3
MD - village	2	38.50	no information
MI - mixed use area	18	77.14	3.3
MK - business zone	5	87.00	0.9
GE - trade/manufacturing	10	70.10	3.2
GI - industry	7	38.50	7.3
SO - special purpose use	20	101.60	2.7
Average rank places indicate the compliance with [Z2], where high rank places correspond with a higher compliance.			

'land use plan set up for the first time' [X8A] and the 'land use plan that changes one or more existing plans' [X8B] were discussed in relation the both preceding environmental objectives. Their effects on [Z3] is very similar: Land use plans for the inner city development consume significantly fewer agricultural areas than other plans, probably as the inner areas in most cases comprises very few agricultural areas. If the land use plan is set up for the very first time [X8A], then it is more likely to go into greenfields but if the land use plan just changes an existing one [X8B] it does not appear to make use of agricultural areas.

With the 'city size classification' [X1E], a new influential factor appeared to be highly significant when accounting for the variation of [Z3]. The influence can be easily explained. The rather small municipalities (population < 20,000) tend to enact land use plans on greenfields more often than medium (population 20,000 up to less than 100,000) or big (population ≥ 100,000) municipalities. As rather small towns often are part of a rural surrounding, it becomes pretty clear that the fundamental chance to get in touch with agricultural areas as a potential planning ground is much more likely than, say, in a major city.

Since the number of cases with forest conversion is very small, discussing those influence factors that turned out to be significant probably will not bring any new insights. Because of that, the discussion of this factor will be skipped.

4. Concluding remarks

Despite these four objectives for sure are only very few in relation to all environmental requirements towards land use planning, their placement within the federal building code is nonetheless exposed. They are exposed because their normative content supports a lot of other environmental objectives, e.g. preserving plant's and wild animals' habitats, sustaining the hydrological balance or taking care of the visual landscape scenery. In that understanding, the meaning of those four objectives is derived because they will be considered a surrogate. Furthermore, these objectives are exposed because they easily can become communicated as everybody will understand a normative order e.g. not to change a greenfield towards a residential area. Finally do these objectives form a pretty good benchmark for environmental considerations in land use planning since planning professionals as well as decision makers in the local politics sphere necessarily will understand the normative order of these objectives. There remain only few possibilities to misunderstand these objectives.

The conclusions of the present research need to put emphasis on three major but simple conclusions. First, the degree of the achievement of the four environmental objectives is a reason to be optimistic. Second, as only few land use plans comply partly with the discussed environmental objectives, it seems as if the compliance is the result of a conscious decision. Third, as none of the considered objectives was met entirely, the question remains if there is any 'hidden' ceiling or just a

practical reason that prevents the environmental objectives from being fully implemented?

Facing the questions formulated above must be clearly expressed that the four investigated statutory environmental objectives are mainly input into the development plans. The issue of consistency between the plans and the environmental objectives can be answered affirmative so far. Actually, this means that as many as three out of four environmental objectives in the majority of land-use plans are met. Regarding earlier findings (see chapter 1), this result is not self-evident.

About two-thirds of the studied land use plans follow the approach of inner city development. Yet much more consistently do planning authorities comply with the objective to prevent any agricultural and forest areas from become converted into another use. The proportion of plans that claim such areas is estimated to be not more than 14.8%. Reciprocally this means at least 71.1% of the land use plans require no agricultural land at all. The meaning of this finding reaches beyond the preservation of areas used for food production. Through the conversion of agricultural land to building land the use pressure is increased on the remaining agricultural land. This includes in particular permanent grasslands, which are often characterized by extensive farming and are recognized to be an important contribution to the preservation of biodiversity. Subsequently the use of former agricultural land may increase the yet observed pressure on permanent grasslands and promote that they in turn are converted towards arable land for food production. In this respect, nevertheless it must be noted, despite the very positive observation with respect to the claimed agricultural and forest area that even a small amount of land converted to agricultural fails to meet the environmental objective. Very positive is, however, that the use of forest land is quantitatively practically irrelevant.

The only objective dimension that is missed by a majority of the land use plans is the limitation of the impervious surface to an appropriate extent. The proportion of plans corresponding to this goal is only up to 26.8%. In this context, is certainly clear that this goal is clearly spelled out blurred and that especially the limitation to an ‚appropriate extent' opens a wide scope for interpretation.

Now it may be argued that already the maximum permissible site occupancy index of the Land Use Ordinance figures represents a boundary that corresponds to that environmental objective. In this respect any land use plan would aim for compliance. On the other hand, this raises the question whether in fact it makes sense to speak of a limit to an appropriate extent when this extent in up to 58.4% of all cases coincides with the already legally fixed ceiling.

Possibly the planning authorities see no substantive difference between an environmentally protective provision formulated as an 'appropriate extent' and the maximum allowable building density in an area. However, not achieving that objective is independent from pursuing inner city development. It may therefore by no means the wrong conclusion be drawn that a clear orientation towards inner city development and – as the mirror image - protection of the outer region and protection of local agricultural land would have resulted in an increase of land consumption within the city. In the contrary, the evaluations rather lead to the conclusion that the average area size and the urban density are independent from the matter of inner city development. However, regional differences in this respect can be observed. One central conclusion can be drawn: Obviously, there is no indication that particular factors would inhibit a further rise of the proportion of land use plans fully in accordance with the defined targets.

However, it should not be overlooked that there is a certain residue on development plans which do not correspond to the concept of inner city development. The first reason for this statement is simple, since it cannot be expected that any municipality has inner city development potential or this has already been exhausted. This assumption is also supported by the observation, that municipalities with a growth perspective match the objective of inner city development less than shrinking administrative entities.

Much more important than such trivial relationships is the note that this statutory objective comes with formulating a completely undifferentiated normative direction. The latent conflict is in fact that the inner city development objective implies an abstract environmental value difference among area types. The manifest thesis is namely that outer region areas and yet unused area are more valuable than others. That argument cannot be accepted from an environmental professional point of view. Yet a quick view e.g. on urban extreme habitats or the climatic compensation function in the city makes clear, that a schematic contempt in relation to e.g. intensively farmed agricultural land, cannot be carried out. In this respect should therefore be accepted that a certain proportion of land use plans justifiably will not fulfill an undifferentiated understanding of inner development.

To conclude that very brief discussion on environmental compliance in land use planning it is worth to add that a responsible land use planning should not pursue any environmental objective for its own sake, but as a part of an integrated view of sustainable development.

Literature

Baugesetzbuch (Federal Building Code - BauGB): Baugesetzbuch in der Fassung der Bekanntmachung vom 23. September 2004 (BGBl. I S. 2414), das zuletzt durch Artikel 6 des Gesetzes vom 20. Oktober 2015 (BGBl. I S. 1722) geändert worden ist.

Baunutzungsverordnung (Federal Building Ordinance – BauNVO): Baunutzungsverordnung in der Fassung der Bekanntmachung vom 23. Januar 1990 (BGBl. I S. 132), die zuletzt durch Artikel 2 des Gesetzes vom 11. Juni 2013 (BGBl. I S. 1548) geändert worden ist.

Bortz, Jürgen/ Lienert, Gustav A./ Boehnke, Klaus (1990): Verteilungsfreie Methoden in der Biostatistik. Springer. Berlin.

Deutscher Bundestag (2014): Auswertung der ohne Umweltprüfung und mit reduzierter Bürgerbeteiligung erstellten Baupläne für die Innenentwicklung von Städten. Antwort der Bundesregierung auf die Kleine Anfrage der Abgeordneten Christian Kühn (Tübingen), Peter Meiwald, Matthias Gastel, weiterer Abgeordneter und der Fraktion BÜNDNIS 90/DIE GRÜNEN. Drucksache 18/2111.

Führ, M.; Bedke, N.; Belzer, F.; Bizer, K.; Dopfer, J.; von Kampen, S.; Kober, D.; Mengel, A.; Schlagbauer, S. (2008) Evaluation des UVPG des Bundes. Auswirkungen des UVPG auf den Vollzug des Umweltrechts und die Durchführung von Zulassungsverfahren für Industrieanlagen und Infrastrukturmaßnahmen. Darmstadt/Göttingen/Kassel.

Gruehn, D. (1998): Die Berücksichtigung der Belange von Naturschutz und Landschaftspflege in der vorbereitenden Bauleitplanung. Ein Beitrag zur theoretischen Fundierung und methodischen Operationalisierung von Wirksamkeitskontrollen. Berlin/Frankfurt am Main.

Gruehn, D.; Kenneweg, H. (2001): Kritische Evaluation der Wirksamkeit der Landschaftsplanung im Rahmen der Bauleitplanung in Rheinland-Pfalz. Berlin.

Kruskal, William H./ Wallis, Allen W. (1952): Use of Ranks in One-Criterion Variance Analysis. Journal of the American Statistical Association 260(47): 583-621.

Mann, H. B./ Whitney, D. R. (1947): On a test of whether one of two random variables is stochastically larger than the other. Ohio State University.

Schmidt-Eichstaedt, G. (1998): Art und Umfang von Beanstandungen und Maßgaben im Rahmen des Anzeige- und Genehmigungsverfahrens von Bebauungsplänen. Bonn. Rechtstatsachenuntersuchungen und Gutachten zur Vorbereitung der Städtebaurechtsnovelle 1997

Sheskin, D. J. (2003): Handbook of parametric and nonparametric statistical procedures. Boca Raton / London / New York / Washington D.C.

Siedentop, S.; Fina, S.; Junesch, R.; Krause-Junk, K. (2010): Nachhaltige Entwicklung durch beschleunigte Planung? Analyse der Anwendung von § 13a BauGB in baden-württembergischen Kommunen. Stuttgart.

Von Bosse, A. (2004): Die Wirksamkeit der naturschutzrechtlichen Eingriffsregelung in der verbindlichen Bauleitplanung mit einer rechtstatsächlichen Untersuchung am Beispiel von Mecklenburg-Vorpommern und Schleswig-Holstein. Unter Berücksichtigung der Regionalplanung, der Fauna-Flora-Habitat-RL und der neuen europarechtlichen Umweltprüfung. Berlin.

Wende, W. (2001): Praxis der Umweltverträglichkeitsprüfung und ihr Einfluß auf Zulassungsverfahren. Eine empirische Studie zur Wirksamkeit, Qualität und Dauer der UVP in der Bundesrepublik Deutschland. Baden-Baden.