Dear Mrs. Hellsten,

the Kleinmachnow Institute of Integrated Plant Protection and Institute of Technology Assessment in Plant Protection of the German Federal Biological Research Centre of Agriculture and Forestry (BBA) have discussed the Commission's communication entitled 'Towards thematic strategy for sustainable use of pesticides', as the Commission requested.

We would like to outline the following ideas, on which we have agreed as a result of this discussion:

- The aim of this thematic strategy – achieving sustainable use of pesticides and marked reduction of use and risks of pesticides while at the same time effectively protecting agricultural crops – makes it necessary to define the necessary minimum in the use of pesticides. Enclosed you find a methodical work which will allow to define the necessary minimum in the meaning of the necessary intensity of crop protection and which seems suited to
    - describe the status quo in the use of pesticides,
    - reduce 'unnecessary' treatments, and
    - formulate and realise common objectives such as environmental and quality standards.

We suggest to consider this methodical work when quantifying the ends of the thematic strategy.

- Concerning point 3 of the thematic strategy 'Reduction of amounts of harmful active substances by substituting more dangerous substances by harmless (including non-chemical) alternatives', our idea is to set up an EU-wide on-line database on alternatives to pesticides. Germany is currently starting to build up such a database.
- We also suggest to call an EU workshop on strategies to minimise pesticide use and exchange relevant experience among Member States.

These ideas are our contribution to the discussion of the Commission's above-mentioned communication.

Kind regards

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Defining the ‘necessary minimum’ of pesticide use

by Ulrich Burth, Volkmar Gutsche, Bernd Freier and Dietmar Roßberg

Abstract

Limiting application of chemical plant protection products to the necessary minimum is a demand raised by German legal regulations and increasingly also by international programmes and concepts of crop protection. Elimination of ‘unnecessary’ treatments helps to reduce the risk to consumers, operators and the environment. So far, there has been no tool to determine the necessary minimum of pesticide use, and thus, to critically state and cautiously reduce what is over-use. A standardised treatment index provides a methodical tool to assess the necessary extent or minimum of treatment on the basis of the *status quo*. The upper limit of appropriate intensity of pesticide application is set by the maximum tolerable intensity of pesticide application in a specified crop. It is formed from the mean value of the standardised treatment index plus standard deviation, and is subject to regional conditions. This method seems suited to describe the current situation of pesticide use, reduce ‘unnecessary’ treatments, and formulate and achieve common objectives by awarding environmental and quality labels.

Key words: Necessary minimum, treatment index, risk reduction, intensity of pesticide application

The question of what is really necessary in chemical crop protection is increasingly coming to the focus of public attention and being controversially discussed. It is not only raised in German legal provisions, but increasingly also in international programmes and approaches which conceive future development of crop protection in the framework of sustainable agriculture. Obviously, it is high time to discuss what is the necessary minimum, or extent, of pesticide application, trace the development of this concept, describe its meaning and make it usable for practical work in crop protection.

A necessary minimum – society's demand to farmers

A first critical reaction to the massive increase in pesticide use in the 1950ies was the development of the concept of integrated pest management. This was a technical approach, which took account of the fact that the use of chemical plant protection products would not provide permanent remedy to pest situations if biological contexts were not sufficiently considered. Public unease about increasing routine use of pesticides in farming and horticulture found expression in Rachel Carson's 'Silent Spring' from 1962. From that time on, the public was sensitised and kept a critical eye on pesticide use, though pesticides were used 'as much as necessary, but as little as possible' (DIERCKS, 1980).

German law cites the idea of the necessary minimum of the use of chemical plant protection products for the first time in the Crop Protection Act of 15 September 1986. As part of the definitions in Article 2, the Act says,

> 'integrated plant protection shall be a combination of methods in which, with particular attention being paid to biological, bio-technical, plant-breeding and cultivation-related measures, the use of chemical plant protection substances is limited to the essential minimum'.

This formulation has been taken over in the First Act Amending the Crop Protection Act, of 14 May 1998, Article 2 (2). It says that the actual and most important objective of integrated crop protection is to reduce the use of chemical pesticides to the necessary minimum. It goes on by saying, in Article 2a (1), that consideration of the principles of integrated plant protection is part of good professional practice, and that good professional practice has to rule both crop protection in general (Article 2a) and the use of pesticides in particular (Article 6 (1)). This underlines the importance of the concept of the 'necessary minimum' for the practice of crop protection. Accordingly, the principles of good professional practice in crop protection (Federal Gazette 220a of 21 November 1998) include the demand

> 'to carry out all crop protection measures according to the conditions of the site, crop and situation, and limit application of plant protection products to the necessary minimum'.

Yet, we have not had a practicable approach to quantifying what is the necessary minimum in applying chemical plant protection products. Other documents which followed the 'Principles of good professional practice ...' made clear, in which direction the term 'necessary minimum' is aimed: the aim is to minimise risks to consumers, operators and the environment by minimising pesticide use. EU Council Directive 91/414/EC on the placing of plant protection products on the market says, in its definition in Article 2, that in integrated plant protection the use of chemical plant protection products is limited to the strict minimum necessary to maintain pest populations at levels below those causing economically unacceptable damage or loss. AGENDA 21 of the 1992 United Nations Conference on the Environment (and Development) in Rio de Janeiro says:

> 'Integrated pest management, which combines biological control, host plant resistance and appropriate farming practices and minimises the use of pesticides is the best option for the future, as it guarantees yields, reduces costs, is environmentally friendly and contributes to the sustainability of agriculture.'

At the follow-up conference, the World Summit on Sustainable Development in Johannesburg in September 2002, the German Federal Government tabled a national strategy paper for sustainable development. On the point of sustainability in agriculture, the paper says, among other things:

> 'The use of synthetic chemical plant protection products is to be reduced to the necessary minimum.'

Definition of 'necessary minimum'

The necessary minimum of application of chemical plant protection products describes the amount of plant protection products which is necessary to maintain profitability because there are no other practicable or profitable pest control measures. It is a problem in the field of tension between contrary interests – intensity of production, which is ruled by economic interests, on the one side, and expectations and requirements of consumer and environment protection on the other.

High-level education and technical training as well as advice and information by extension agents, including on preventive and non-chemical measures, are aimed at optimising the use of chemical plant protection products. Mostly – but not necessarily – this brings a reduction in the use of chemical products. The economic side of the problem is confronted with the side of prevention of damage to operators, consumers and the environment. Chemical substances are viewed as xenobiotics and therefore viewed critically on principle. Their application must be handled restrictively as a precaution to minimise unknown residual risks.

A person faced with practical crop protection problems will use the frame of action set by good professional practice. In some cases, he will proceed according to a precise purpose, and maybe even follow the principle of economic injury thresholds, or apply reduced pesticide doses on the basis of his experience or advice by extension agents. In other cases, he may use more pesticides than usual to be safe with regard to yields and quality of the produce. To a certain extent, chemical crop protection is also used to make up for cropping disadvantages such as tight crop rotations, one-sided choice of varieties, extremely early sowing, ignorance about preceding crops etc., which in turn may depend on economic pressure.

How to determine the necessary minimum

Determining the necessary minimum is at the core of a strategy aimed to find out which amounts of pesticides have been brought out without need and eliminate these treatments, or excess amounts.

This problem has so far been part of efforts to describe a model of integrated plant protection and evaluate the quality of crop protection in farms. Such evaluation may be based on a scoring system or on the degree to which practical crop protection schemes approach an idealised model (PLUSCHKELL, 1996), but has hardly been used in practice.

It is another approach to determine the necessary minimum in the sense of a quantitative goal when applying chemical plant protection products. Technical knowledge, experience and suitable experimental designs form a good basis to estimate which groups of plant protection products are used in major crops, and to what extent they are used. Relevant studies show that the intensity of pesticide use is subject to regional influences and, above all, to yearly influences. The typical comparison of conventional and integrated crop protection has probably been made in all regions of Germany now. Extremely sound relevant data have been worked out by the Göttingen INTEX project (STEINMANN and GEROWITT, 2000).

It is only a small step further to develop long-term objectives on that basis. Denmark has done this since the middle of the Nineties. Danish scientists developed a treatment index (KUDSK, 1989) and set out an objective for each major agricultural crop and each group of pesticides, which is to be met on the average of several years (J∅RGENSEN, 1999). It remains open how far the ‘necessary minimum’ is determined technically or politically, but so far, the treatment index has provided the best methodical tool to quantify the necessary extent of pesticide use.

Ways to reach goal parameters

There are various ways to reach goal parameters in the use of chemical plant protection products, and they may well be combined, namely

- **Voluntary self-commitment.** This way usually brings a gain in image and is only to a limited extent applicable in farming. Voluntary self-commitment may be, for instance, for voluntary adherence to regional guidelines for integrated production, including direct or indirect restrictions on the use of pesticides.
- **Economic instruments.** These will give individual incentives by interfering in the costs of chemical crop protection measures. Economic instruments form part of the Common Agricultural Policy of the European Community (environmental programmes, cross compliance schemes), which promotes and sponsors non-chemical crop protection measures. This includes the idea to raise a tax on plant protection products.
- **Administrative instruments.** These include certain restrictions on the use of chemical plant protection products which must be observed by users. Adherence to these restrictions is watched by the state and non-adherence may be punished by fines.

Some EU countries follow their political objectives with programmes to reduce the application of pesticides. These programmes have two disadvantages:

- They focus on pesticide amounts, but not on pest risks. By treating all products in the same manner, they give a misleading picture of the real situation.
- Only some time after treatment can one know which pesticides or treatments were necessary and which were not, and this largely depends on the region and situation. So, in the individual case, it may be counterproductive to put a ceiling on pesticide use.

Such disadvantages can be largely compensated when determination of the necessary minimum of pesticide use is differentiated for regions and main crops and farmers are left enough space to bring in their own understanding and make their own decisions over a longer period, for instance one crop rotation. A recent research project entitled NEPTUN has provided a set of tools to tackle this problem in a promising way.

The necessary minimum – quantified as a standardised treatment index

A statistical survey of application of chemical plant protection products in field crops in Germany conducted in 1999 and 2000 gives a profound insight into current crop protection practice. Under the NEPTUN 2000 project, some 1000 farms, randomly distributed over 34 soil-climate regions throughout Germany, were surveyed for crop protection measures. These were recorded with accurate description of the product and dose rates used, dates of treatment, and crop and crop area treated. In the end, there were 44 067 data sets about chemical crop protection measures for statistical evaluation.

Analysis of these data is a first statistical approach towards defining the necessary minimum of application of chemical plant protection products.

The approach proceeds from two assumptions:

1. Farmers apply pesticides according to good professional practice.
2. Pesticide use in the 1999/2000 growing season reflects the normal, average level.

It is obvious that there should be an intensity limit above the average crop protection intensity found in the survey beyond which crop protection measures are no longer in accordance with the concept of integrated crop protection. At first, a measure has to be defined by which the intensity of application of crop protection products can be determined. A suitable measure would be the standardised treatment index which is described in detail in the NEPTUN 2000 project (ROßBERG et al., 2002). It represents the number of pesticides used in a crop (listed separately by function as herbicides, fungicides, insecticides and growth regulators) and a process of standardisation with regard to the crop growing area and to the application rate as stated in the product's authorisation. The process of standardisation is plausibly explained by the following example.

If a farmer treats the total of his wheat growing area with herbicides, the herbicide treatment index of his wheat is 1.0. If he applies herbicides on only half of the area and other measures, for instance mechanical weed control, on the other half, the treatment index is 0.5. If he reduces dosage on the treated half by 30% from the authorised rate, the treatment index is 0.5x0.7=0.35. More examples are to be found in ROßBERG et al. (2002).

Table 1 lists the average values of standardised treatment indices calculated for Germany's main field crops under the NEPTUN project, separately for the functional groups herbicides, fungicides, insecticides and growth regulators. The last two columns of Table 1 show the total treatment index as sum of the functional groups and its standard deviation. These two indices are used in a definition of the necessary minimum**,** by defining the maximum tolerable treatment intensity as follows:

Maximum tolerable intensity of treatment in a crop = average of standardised treatment index + standard deviation.

If this defined measure is to be used in the definition of the necessary minimum of treatment, the question of a regional differentiation of the values arises. Both pressure of pest infestation and yield expectancy – two factors which essentially influence a pest control decision – are not the same everywhere in Germany. Yet, if differentiation shall remain practicable, it is important not to differentiate between too many regions per crop.

The procedure was to compare the averages of treatment indices of all soil-climate regions by pairs for significant differences. The indices differ significantly when their confidence intervals, calculated with a 5-% probability of error, do not intersect (Figure 1).

The current model tried to form 3 major regions for each crop. Region 1 included soil-climate regions with very high intensity of chemical crop protection, while region 3 included those with very low crop protection intensity. Soil-climate regions of region 1 are all significantly different from those in region 3 in a pair-wise comparison. Those regions which are not significantly different from each other are grouped in major region 2.

This principle was applied on all soil-climate regions where the confidence interval of the treatment index was smaller than the average. A number of soil-climate regions were left over and could not be grouped because they displayed a wide dispersion of values, often attributable to the low number of random samples. These regions are shown as white patches on the map in Figures 3 to 10. A proposal for classification of these regions was worked out separately proceeding from the survey data and theoretical considerations based on Kluge's infestation atlas (KLUGE et al., 1999), and is still being discussed with crop protection experts of the respective federal states. The statistical analysis did not allow any regional classification whatsoever for potato and oats. For these two crops, overall results obtained for Germany have to be used without differentiation.

Table 2 lists maximum tolerable intensities of chemical crop protection for the major regions. These are proposed as a yardstick to measure the necessary minimum of application of plant protection products.

The standardised treatment index as a basis for assessing crop protection on farm level in the framework of environmental quality assurance programmes

The maximum tolerable intensity of crop protection as defined above is a first cautious approach to defining the necessary minimum of chemical crop protection. It seems suitable to

- describe the status quo of application of chemical plant protection products,
- reduce 'unnecessary' treatment,
- formulate and realise public objectives, for instance environmental and quality labels.

This opens up the possibility to assess farms for the degree of environmental safety of their crop protection practice and award environmental quality labels to farms (ECKERT et al., 1999, HEYER 2002). To this end, farm-specific treatment indices are calculated and compared with maximum tolerable crop protection intensities valid in the farm's region.
The authors propose to discuss the following algorithm in evaluating a farm's crop protection management for environmental compatibility:

1) All calculations of the standardised treatment index refer to a period of 3 years, and individual indices represent averages of 3 years in order to balance yearly differences and possible situations of extreme infestation.
2) All main crops grown in a farm are considered. If the standardised treatment index (average of 3 years!) in only one crop exceeds the maximum tolerable chemical crop protection intensity calculated for the region, the farm can no longer be awarded an environmental label (criterion of exclusion).
3) If the intensity of chemical crop protection is below the maximum tolerable level in all crops, the standardised treatment index is evaluated using the assessment function shown in Figure 2. Abstention from chemical measures in a crop is noted with mark 1.0 (maximum), crop protection intensity around the average of the region is marked with 0.8, and intensities approaching the maximum tolerable limit are assessed with marks near 0, accordingly.
4) For a final overall evaluation of the farm, one has to calculate the arithmetic mean of assessment marks over all crops grown on the farm, weighted by the proportion of farm area on which the crops are grown. For a farm to get the environmental label, this farm-level index has to be above the preliminary, empirically defined threshold value of 0.2.

Evaluation of a farm on the basis of its standardised treatment indices includes more than simply observance of maximum tolerable limits of chemical crop protection intensity. The evaluation covering the whole crop range of a farm, there is enough space for flexibility and variance between individual crops. The exclusion criterion of the maximum tolerable intensity of chemical crop protection, however, must never be exceeded.

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Table 1: Standardised treatment indices for Germany (mean values)

Table 2: Maximum tolerable intensities of chemical crop protection

Crops	**Number of farms**	**Treatment index**				**Treatment index**	**Standard deviation**
		F	**H**	**I**	**GR**	**F + H + I + GR**	
Winter wheat	790	1,39	1,37	0,36	0,62	3,8	1,6
Winter barley	724	1,10	1,07	0,10	0,49	2,8	1,2
Winter rye	332	0,90	0,85	0,14	0,72	4,4	2,6
Triticale	319	0,46	0,96	0,09	0,74	2,3	1,3
Spring barley	320	0,72	1,21	0,15	0,05	2,1	1,0
Oats	131	0,07	0,98	0,33	0,26	1,6	1,1
Potatoes	130	6,08	1,55	0,94	0,00	8,6	3,9
Sugar beet	382	0,15	2,59	0,19	0,00	2,9	1,3
Maize	489	0,00	1,22	0,03	0,00	1,2	0,5
Rape-seed	644	0,68	1,18	1,44	0,12	3,4	1,5

F: Fungicides

H. Herbicides

I: Insekticides

GR: Growth regulators

Crops	Major region 1 MV	St. dev.	MTP	Major region 2 MV	St. dev.	MTP	Major region 3 MV	St. dev.	MTP
Winter wheat	4,7	1,4	6,1	3,6	1,5	5,1	2,7	1,4	4,1
Winter barley	3,4	1,0	4,4	2,8	1,1	3,9	2,0	0,9	2,9
Winter rye	3,7	1,2	4,9	2,8	1,2	4,0	2,0	1,1	3,1
Spring barley	2,8	1,0	3,8	2,1	0,9	3,0	1,4	0,6	2,0
Triticale	3,4	1,2	4,6	2,0	1,0	3,0	1,2	0,6	1,8
Rape-seed	4,2	1,4	5,6	3,4	1,5	4,9	2,6	1,2	3,8
Maize	1,5	0,6	2,1	1,2	0,5	1,7	1,0	0,3	1,3
Sugar beet	3,4	1,4	4,8	2,9	1,2	4,1	2,2	0,8	3,0
Potatoes *				8,6	3,9	12,5			
Oats *				1,5	0,7	2,2			

MV Average of the sum of treatment indices of individual groups of pesticides
St. dev. Standard deviation
MTP maximum tolerable pesticide application (intensity of chemical crop protection)
* No regional differentiation (see article for explanation)

Figures

Figure 1: Confidence intervals of mean values (MV) of treatment index for winter wheat for soil-climate regions 16 (Ostbrandenburger Platten) and 22 (Münsterland). The two mean values differ significantly.

Figure 2: Assessment function for standardised treatment index.

Figure 3: Major regions of maximum tolerable pesticide application (MTP) in winter wheat.

Figure 4: Major regions of maximum tolerable pesticide application (MTP) in winter barley

Figure 5: Major regions of maximum tolerable pesticide application (MTP) in winter rye

Figure 6: Major regions of maximum tolerable pesticide application (MTP) in triticale

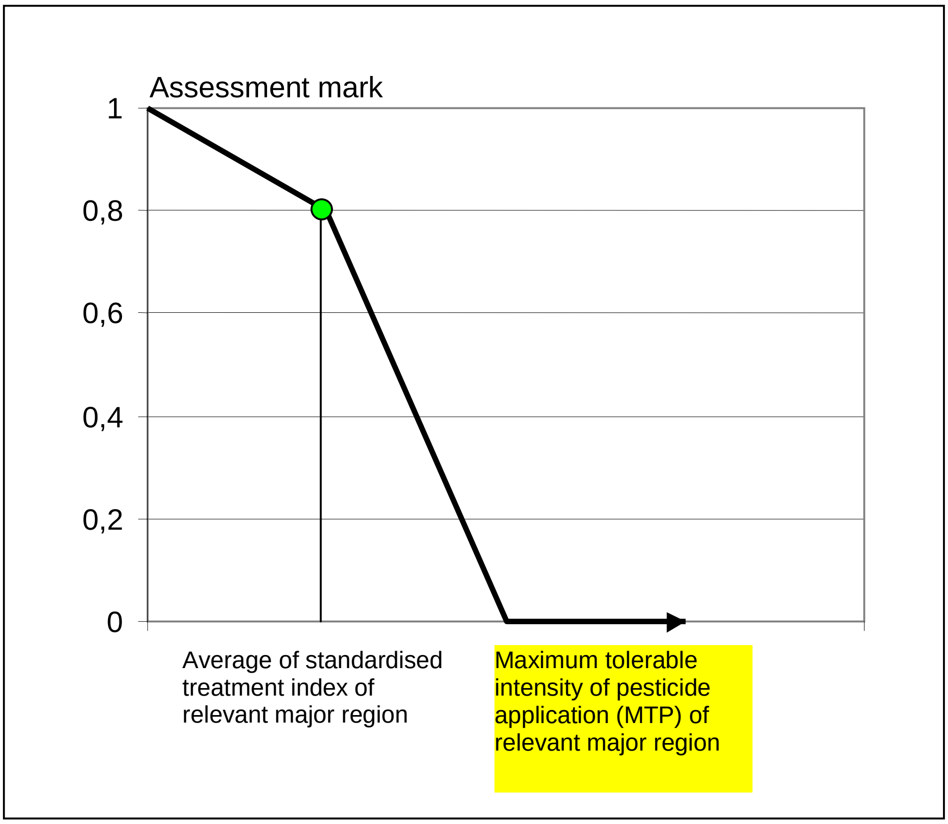
Figure 7: Major regions of maximum tolerable pesticide application (MTP) in spring barley

Figure 8: Major regions of maximum tolerable pesticide application (MTP) in rape-seed

Figure 9: Major regions of maximum tolerable pesticide application (MTP) in maize

Figure 10: Major regions of maximum tolerable pesticide application (MTP) in sugar beet

BKR: soil-climate region (*B*oden-*K*lima-*R*egion)
MW: average (*M*ittel*w*ert)



Assessment mark
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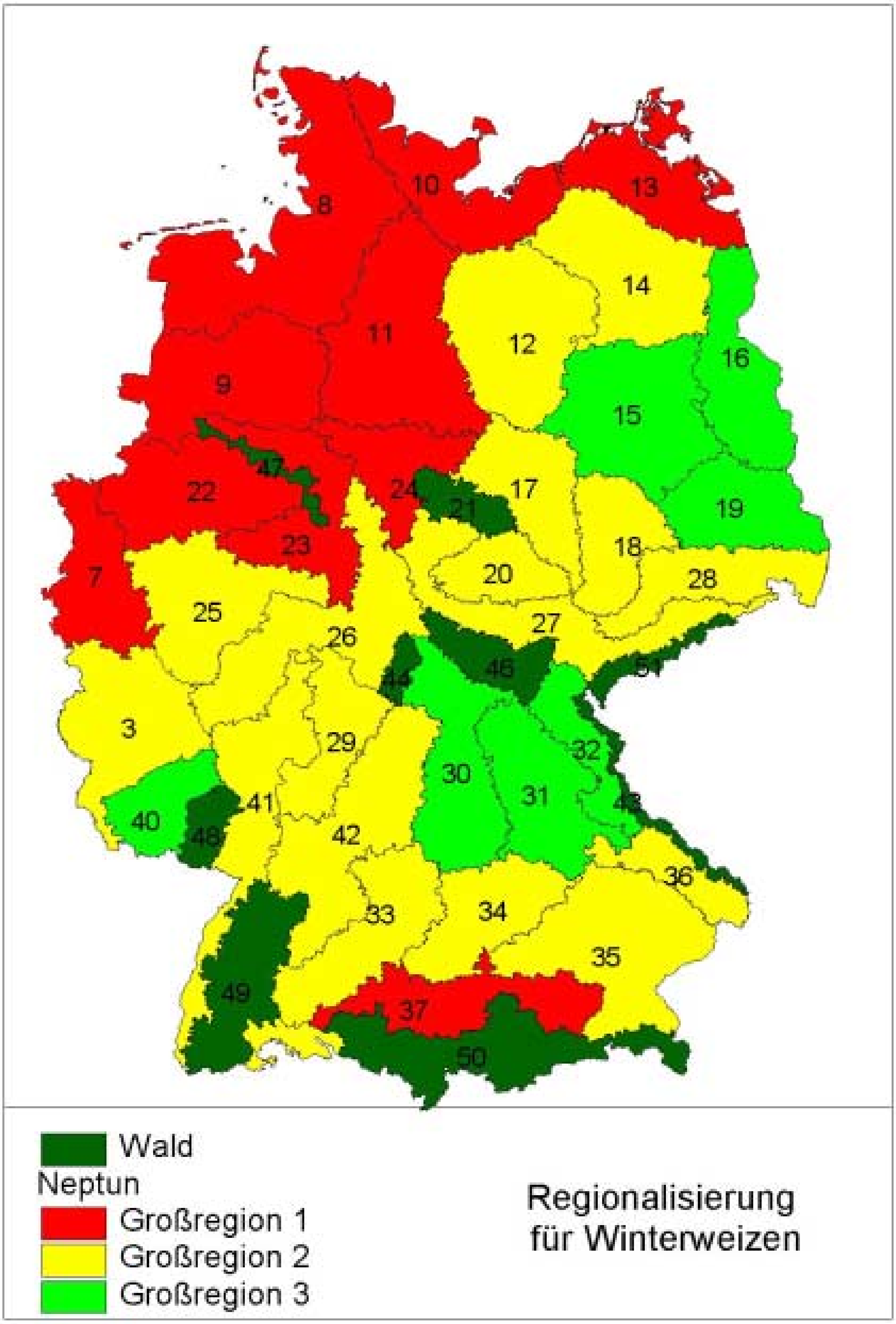
Average of standardised treatment index of relevant major region
Maximum tolerable intensity of pesticide application (MTP) of relevant major region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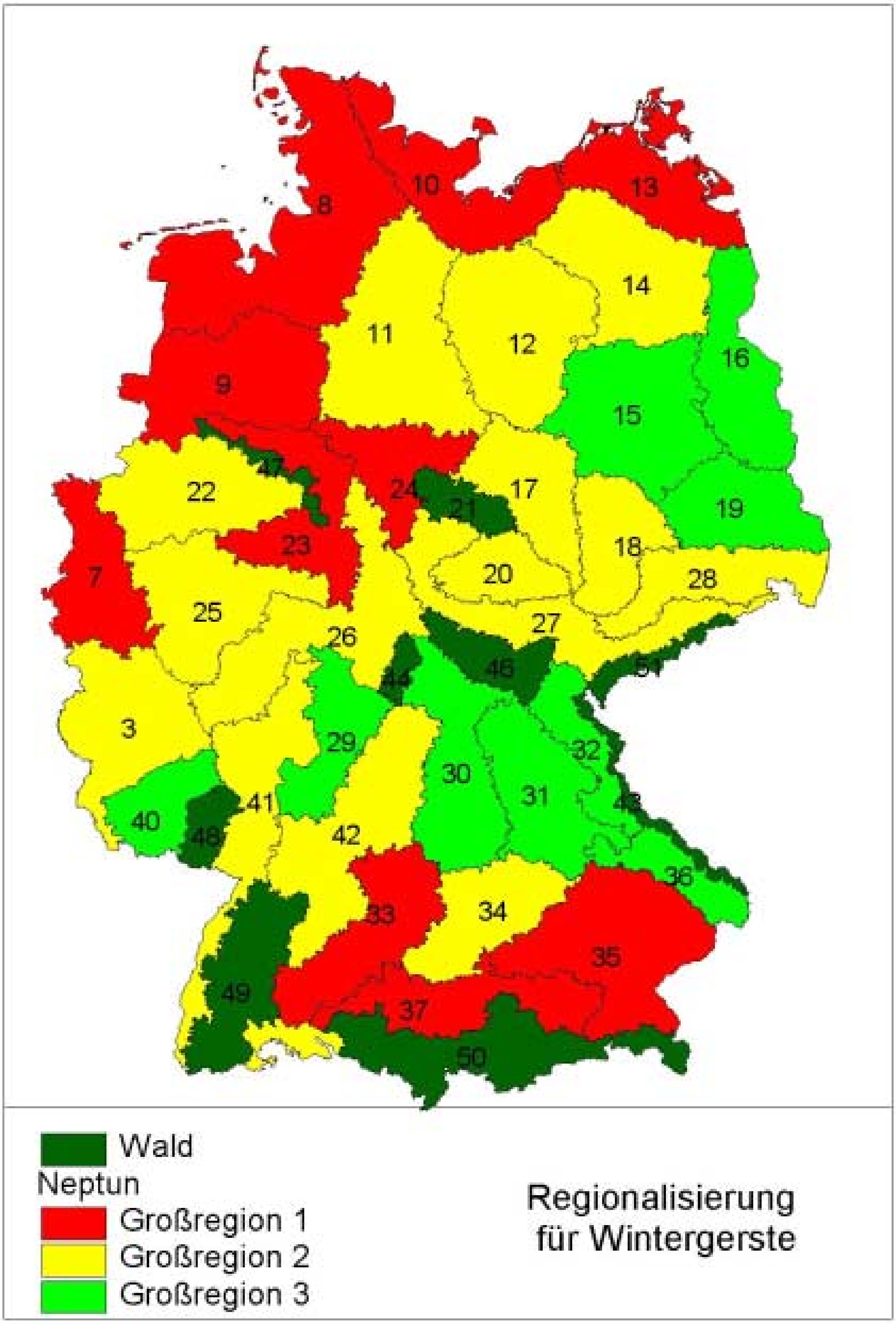
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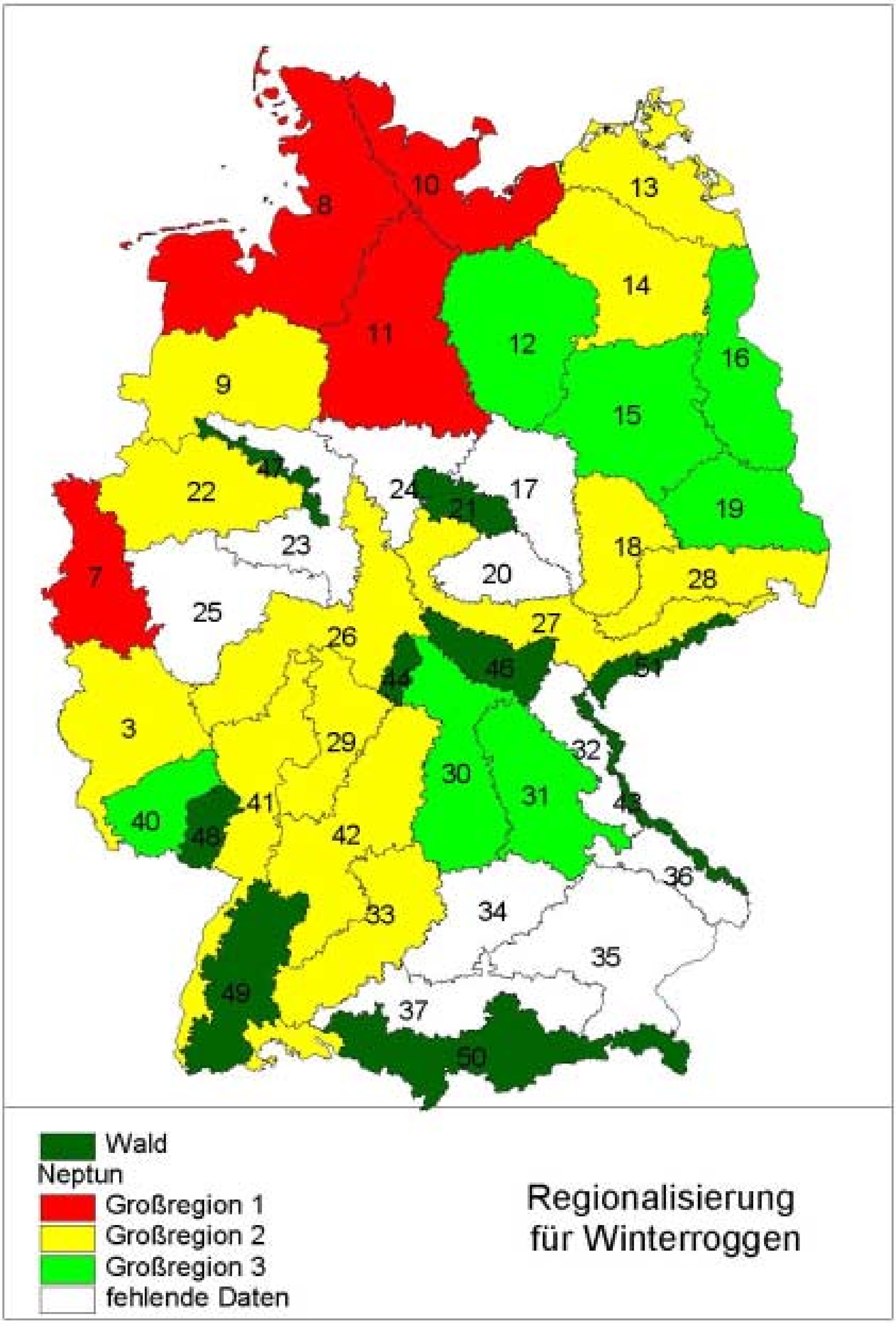

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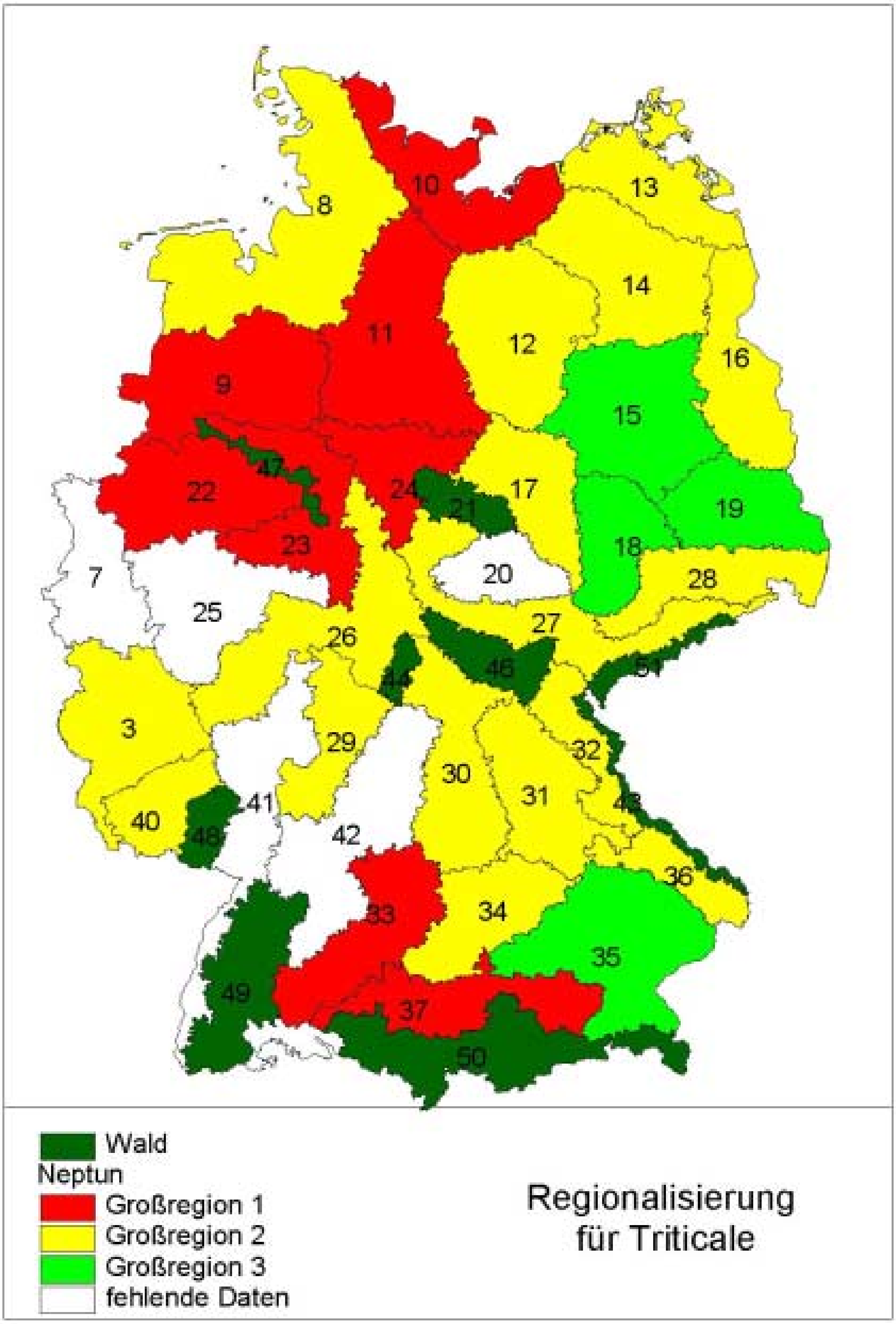
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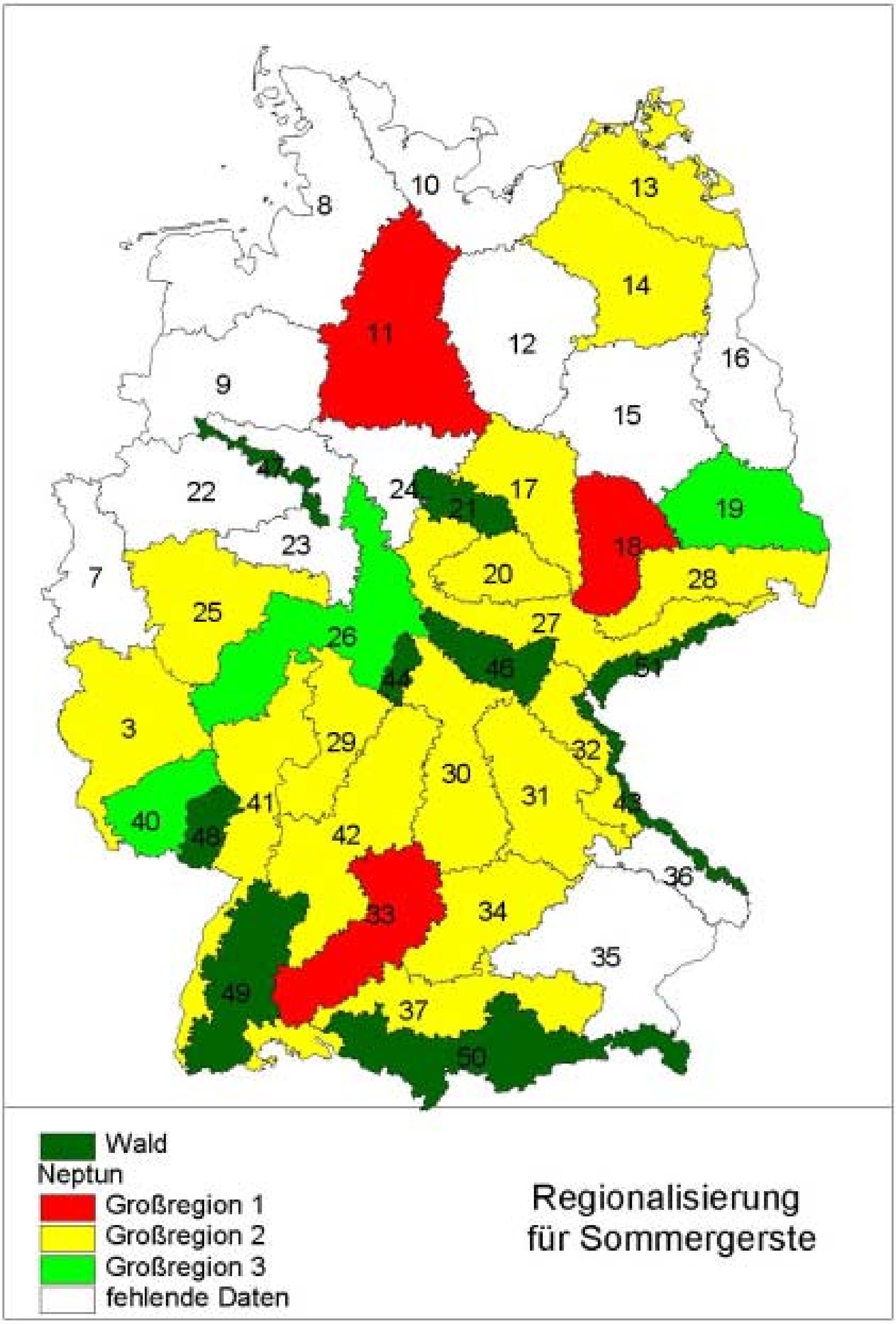

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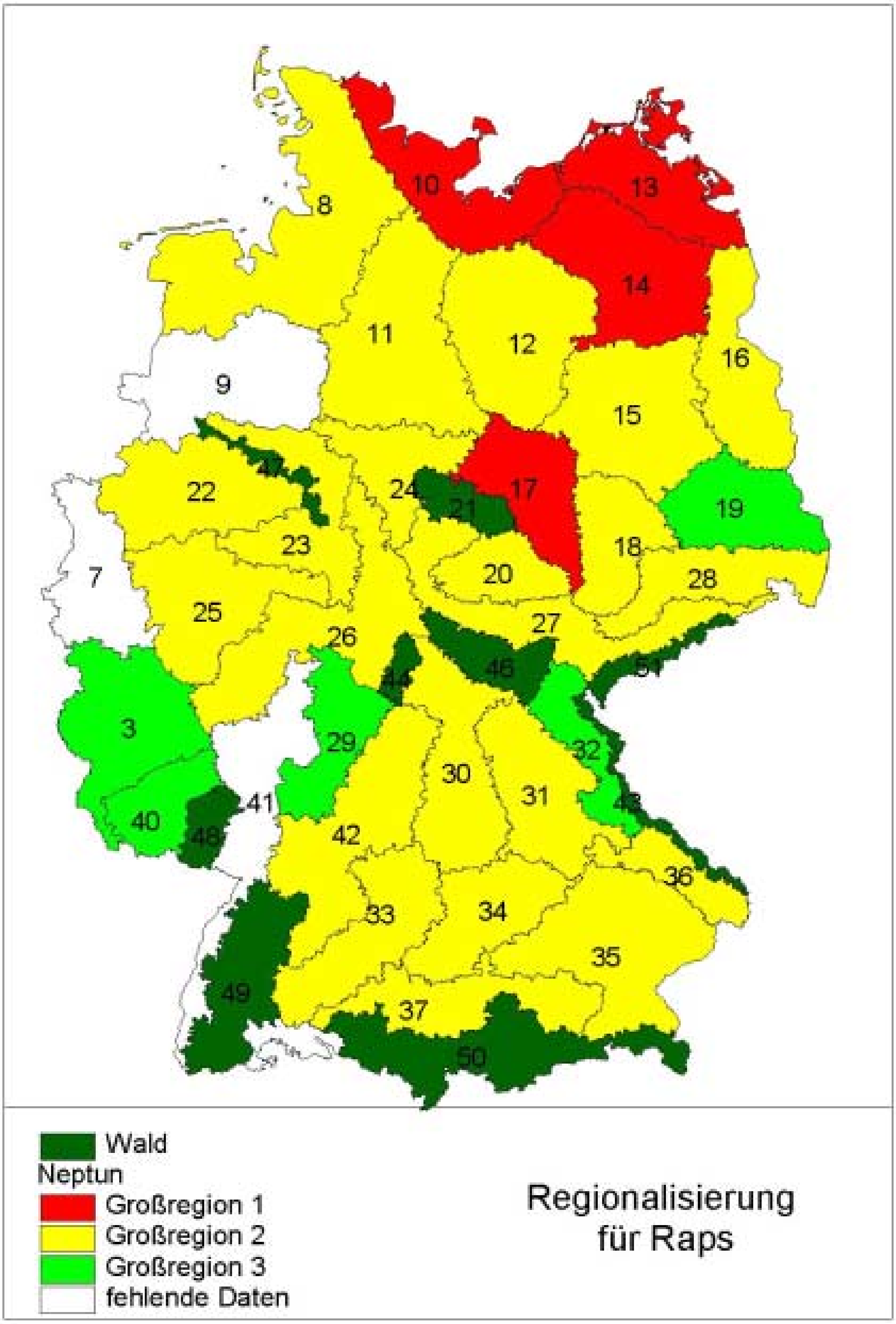
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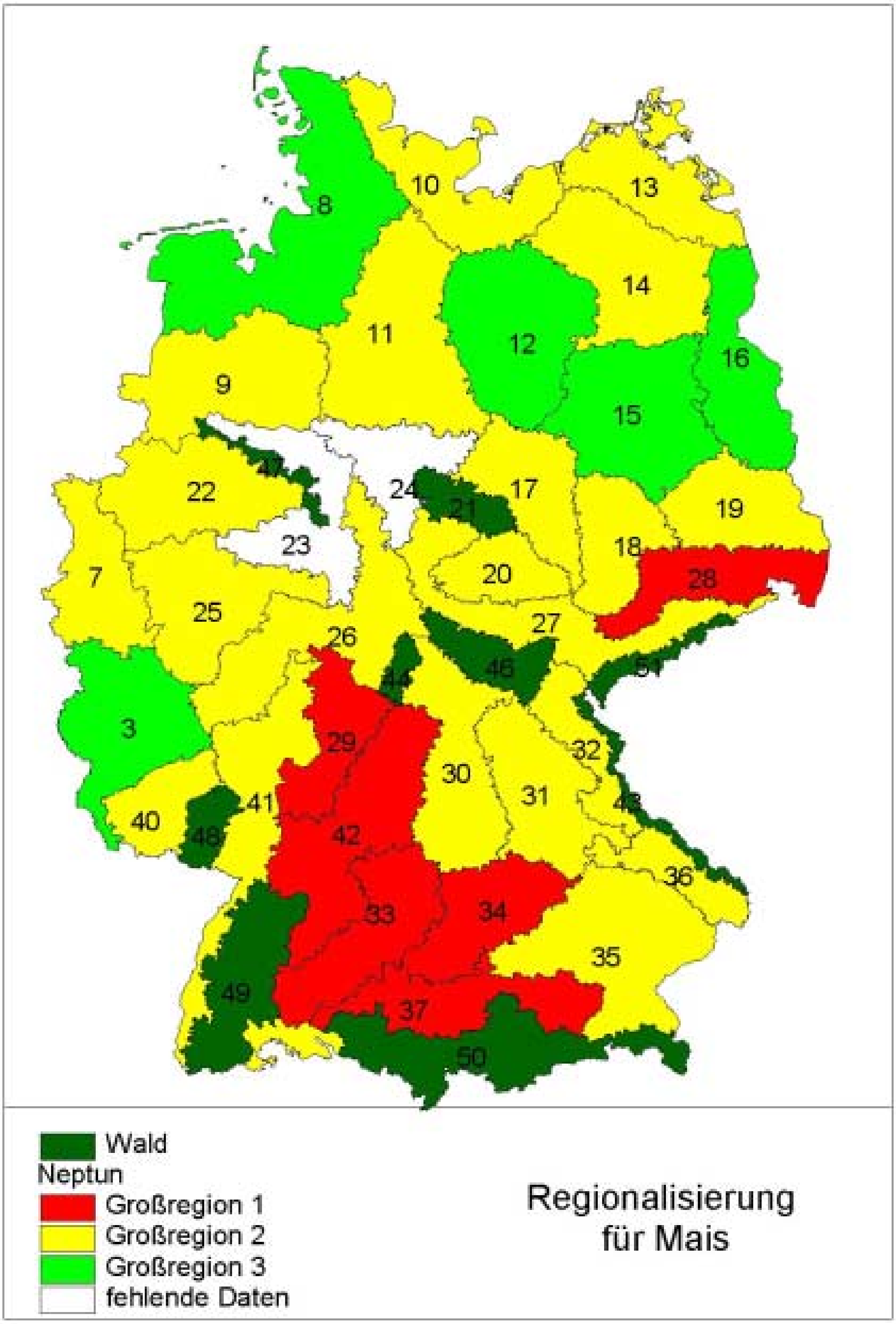
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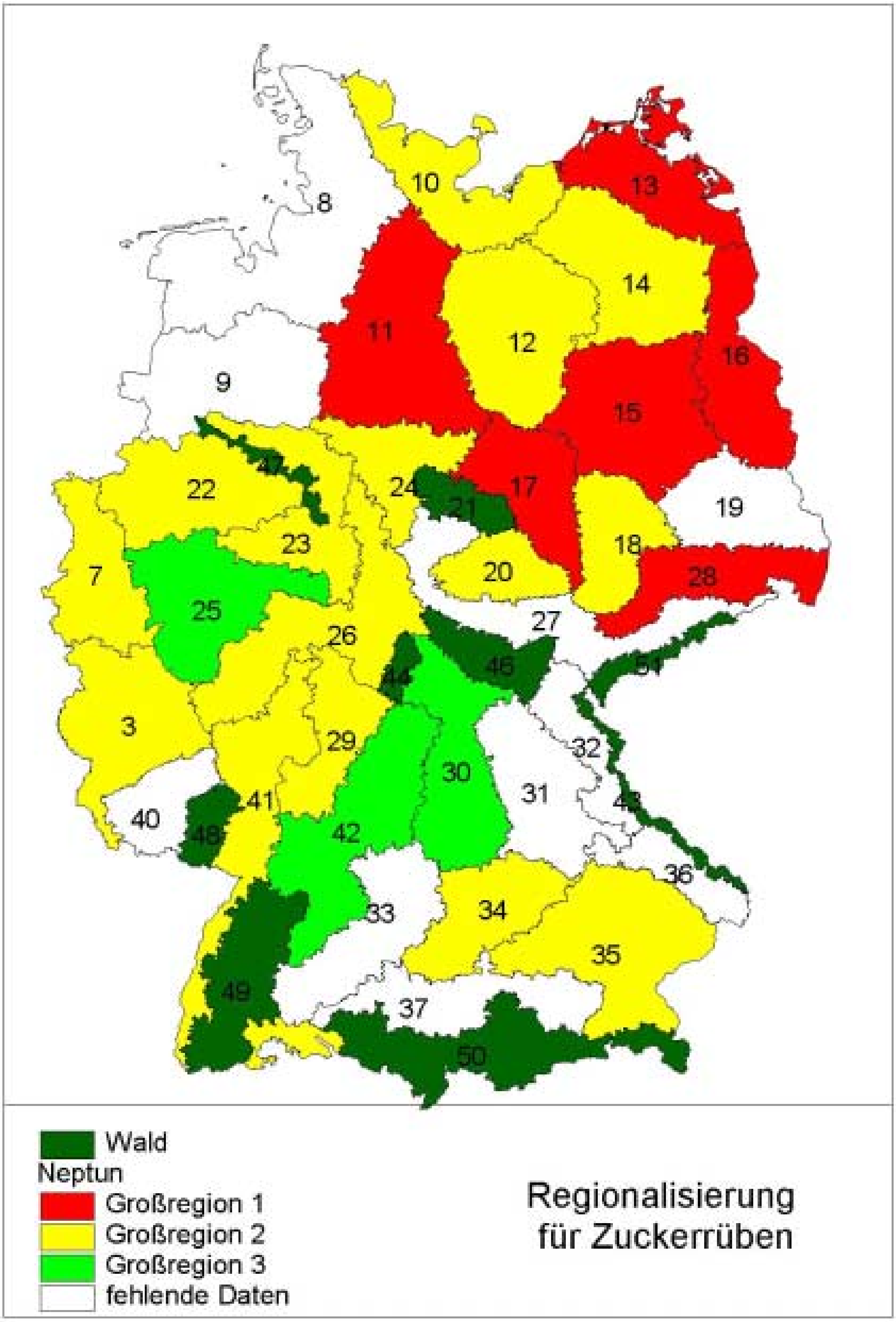
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Wald
Neptun
Großregion 1
Großregion 2
Großregion 3
fehlende Daten
Regionalisierung für Zuckerrüben