The influence of the NEN on the Agricultural Land Market

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ABSTRACT

This study is designed to clarify the influence of the Nature Ecologic Network (NEN) on the nearby agricultural land market in the Netherlands. I investigated the influence of the NEN on both the land price and the land mobility. The differences between provinces were investigated as well. I also simulated a variety of scenarios using an agent-based land market model, to clarify the influence of different kind of nature policies on the land market.

The cross-section data of agricultural transactions in the Netherlands from 2008 and 2010 suggest that there is a relationship between the distance from a parcel to the NEN and the price paid for that parcel. When a parcel's location is closer to the NEN, the price per hectare decreases.

The different influences per province from the NEN on the price per hectare suggest that different kind of provincial characteristics like NEN-policy influence the land price. In all provinces land prices decreased near the NEN, except for Utrecht where an opposite effect was observed.

An aggregation of the amount of hectares included in transactions within grid blocks (amount of traded land) was used to measure the influence of the NEN on the amount of traded land. The outcomes of a regression analysis with this variable as a dependent variable suggest that the amount of traded agricultural land is smaller nearby the NEN.

An agent-based model was used to investigate several influences of NEN-policy on the land price and the land mobility. The outcomes are suggesting that there is a connection between the land mobility nearby the NEN and the perceived value of the NEN, on the local agricultural land market. When the positive influence of the NEN is higher, more transactions will take place and on average closer to the NEN.

This study demonstrates no immediate cause to change nature policy for farmers with land near the NEN, because of several reasons. The effect measured near the NEN was very small and in some occasions even positive. It is not clear what causes the differences, thus neither how the differences should be compensated.

Wageningen, October 2015

The title page contains an image which represents the Euclidian distance from the NEN together with the Baakse Beek region highlighted in black.

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1. INTRODUCTION

The agricultural land market is a market with very typical characteristics. The sum of all agricultural land in the Netherlands is declining, while the average farm size increases (Berkhout et al., 2008). The amount of farms is decreasing, meaning that the remaining farms are intensifying and expanding (Silvis et al., 2013). The expanding farms will have a preference for land nearby their home plot, therefore agricultural land markets are a local phenomenon (Cotteleer et al., 2008). The typical Dutch zoning policies are causing external influences on these markets. Zones for housing, infrastructure or nature are often planned on areas which are currently occupied by agricultural land. In 1990 the Dutch government decided to plan 271,000 hectares of new nature areas, which is about 7% of the total surface in the Netherlands. The goal was to finish the acquisition and establish nature on these lands in 2018. The new natural areas were designed to connect with existing national and international nature hubs and were mostly planned upon agricultural land (Jongeneel et al., 2012). Did this influence the agricultural land market? Studies have shown the influence of urban areas on the agricultural land market (Cavailhès et al., 2003; Chicoine, 1981; J Luijt et al., 2003), but do nature areas have an influence as well?

The zoning culture in the Netherlands, combined with the demands for several kinds of land use create an interesting market. One of the most important characteristics of the agricultural land market is its locality. Studies have shown that 90% of all land transactions done by Dutch farmers are within 6.7km of the parcel which locates their home (Cotteleer et al., 2008). Because of this limited freedom of choice, an extra actor joining the local land market, for example a representative for the 'National Ecologic Network' (NEN)[1], could have a strong influence on this local market. Such influence is also seen in the agricultural land near urban areas. Here land is often bought by individuals or companies that expect a zoning change. In case of urbanization, the value of the land could become worth a tenfold if the speculators are right. The farmer is generally aware of this potential extra value and earns extra too (Buurman, 2001). In this example the farmer receives a higher price per hectare then expected by just considering the agricultural value. A more unfortunate scenario for a farmer would be a transaction where less than the agricultural value for his land is expected. Unlike urban areas, nature areas are less valuable than agricultural land, because the yearly profit of a hectare of arable land is higher than a hectare of nature conservation. This could be a problem, because a farmer is not always selling voluntarily (retirement for example). This could occur near the NEN, and could be one of the reasons why an open market would probably not succeed to fulfil an Ecological Network by itself (Cotteleer et al., 2008), just like other public interest like dykes or the military. And even though the government takes action to prevent any financial disadvantage for farmers who owned land within the NEN (Structural Concept, 1994), a study from Cotteleer showed that farmers inside the NEN did have a financial disadvantage (Cotteleer et al., 2008).

[1] *In Dutch* - Ecologische Hoofdstructuur (EHS)

In addition, one may wonder if farmers *near* the NEN are also affected. This is because of two reasons: One is that plans are often changed during the process of implementing (Pressey et al., 2013) e.g. due to budget cuts. The uncertainty about the content of future nature policy may have a negative effect of land prices in the vicinity of the planned NEN. Second is that the local demand for land will most certainly increase. The government acquires land for nature development and pays the farmer the money for his land. In some cases this farmer will look for new lands nearby, increasing the demand for land just outside the NEN. This could cause price increases rather than decreases.

These two mechanisms lead to opposite effects, yet in both cases it is an undesired effect. If prices are lower because of the NEN, current shrinking farmers are disadvantaged. This would be at odds with the policy to pay a fair price for these lands. If the prices are higher because of the NEN, current expanding farmers are disadvantaged. So this thesis will investigate the following research question: how is the agricultural land market affected by the NEN? The agricultural land market is captured in two variables: land price and mobility of land.

Earlier studies on agricultural land prices in Minnesota (USA), the Czech Republic and Finland (Drescher et al., 2001; Pyykkönen, 2006; Sklenicka et al., 2013) related parcel size, city distance, population density and yield loss to agricultural land prices. They did not investigate the influence of nature-policy on the land price. Nearby functions with negative impact on agricultural land prices have been studied before e.g. the proximity of a nuclear power plant (Folland et al., 1991). A change in value of agricultural land in the proximity of the NEN is still a topic that has not been studied. With this research, new knowledge is provided on the effect of zoning-led nature development on the local agricultural land market. This does not only include the land price of transactions but also the mobility of land. Next to a study at national level, effects will be further disaggregated to the provincial level. This is because each province has its own way of implementing the NEN, and differences between provinces can reveal how the various provincial policies have different effects on the land market. With different future-scenarios on NEN-policy, insight is given on the influence that the implementation of different NEN-policy plans have in the Netherlands. In this study, a variety of common and uncommon methods will be used to gain knowledge on this topic. The commonly used hedonic pricing model will be used during the empirical research (Rosen, 1974). A state of the art model, an agent-based simulation model of the Baakse Beek (an area in the east of the Netherlands), will be used to visualize and simulate different NEN-policy strategies.

The research questions are as follows:

(1) How does the NEN influence the agricultural land price at national level?

(2) How does the NEN influence the land mobility at national level?

(3) How does the NEN influence the agricultural land price for each province?

(4) How does the NEN influence the land mobility for each province?

(5) What are the potential impacts of NEN implementation on the land market for different scenarios of zoning influence?

The study is divided in three parts: first I will use empirical data on transactions to measure the influence of proximity to the NEN on the agricultural land price (Q1) and land mobility (Q2). Second, I will add provincial data to these points to investigate regional differences on the agricultural land price (Q3) and land mobility (Q4), which might be caused by the regional differences in nature policy. Third, I will design scenarios, to simulate the effect of different levels of NEN-influence (Q5). The range of the scenarios will be determined by the different outcomes of the provinces (Q3). See figure 1 (a research scheme) for clarification.

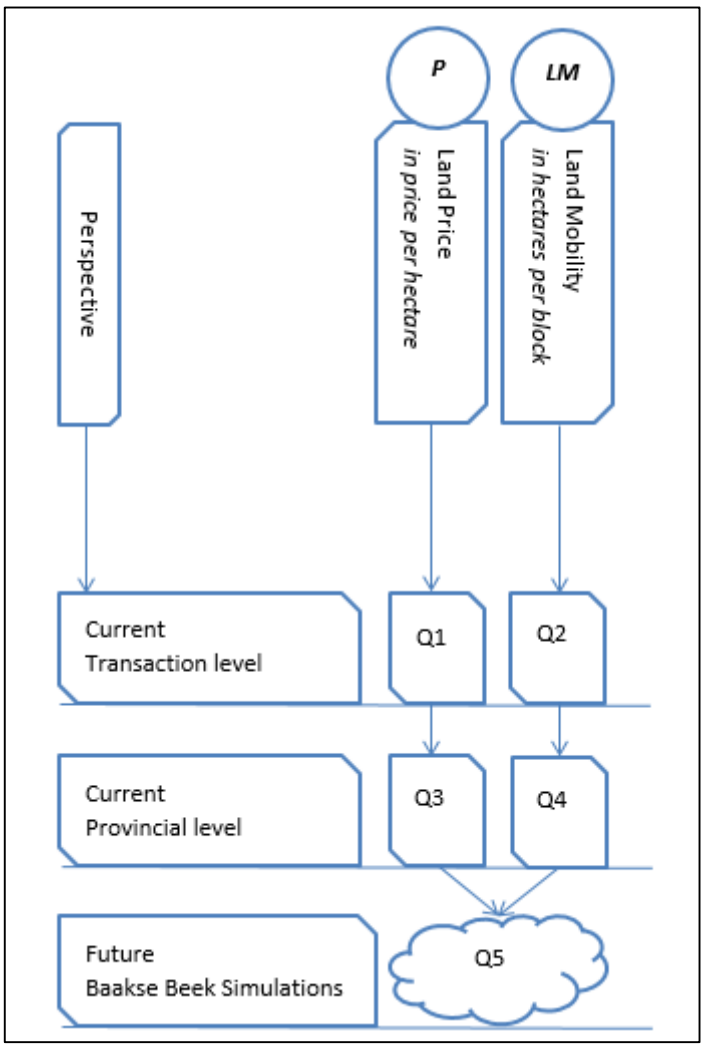

Figure 1: Research Scheme

2. Theoretical background

2.1 Background information on the NEN

Until 1990 the nature policy in the Netherlands had a defensive character, the last remaining pieces of nature were carefully protected, but other than that there was no policy to develop nature (Breeman et al., 2009). This changed when the people in the Netherlands were confronted with the idea of nature development. People learned that when they did not interrupt fallow land, nature would develop itself. This was discovered on several occasions. A variety of wildlife arose at areas where people had let nature alone for a while, in the 'Oostvaardersplassen' for instance or areas where people were not allowed to come because of contaminated soils. People slowly started to embrace the idea of natural nature development. When in 1990 the 'Nature Policy Plan'[2] was presented, they also introduced a tool for more aggressive nature policy, the NEN. Aggressive nature policy meant that new land was bought to develop nature, instead of only protecting what was already in possession. The goal set by the government stated: "Keeping several motives and views in mind with respect to nature policy, the goal is to sustainably conserve, recover and develop natural values."

Originally the NEN was divided into three different types of zones: Core zones, nature development zones and connection zones. Each zone had a different goal and approach. Core zones were large zones which had national or international importance for nature values. The goal was to secure and improve these nature values. Nature development zones were zones selected for their realistic potential to develop nature values with national or international importance. The goal was to prevent irreversible developments that would endanger future nature development without being too strict for the current activities. Connection zones were zones between the core zones and the nature development zones, the goal for these connection zones was to maintain and improve the migration possibilities of species between these zones. These three zones together became a network throughout the Netherlands.

In 1993 the NEN was mapped as a Key Planning Decision[3] for the first time. With the top-down planning policy at the time, it meant that the twelve provinces had to put the NEN in their regional plans. For municipalities it meant that they had to assign the NEN to certain areas as well. The government and the provinces made an agreement on the responsibility for the NEN. Provinces could decide on the exact zoning, but the government maintained to be the most important actor. The government was in charge of the regulations, management, policy, subsidies and the acquisition of the designated land. Around the same time also a European Ecological Network was established, it was mostly derived from the Birds Directive (1979) and the Habitats Directive (1992) to stop the loss in biodiversity in Europe. The difference in scale is not the only difference. The NEN can be seen as a tool for land acquisition, but the Natura-2000 areas are protected by European law, which forbid several kinds of activities in and around these areas. Member States have to register areas to become Natura-2000 areas, many of the NEN's core and nature development zones were granted a Natura-2000 licence in 2003.

[2] Natuur Beleidsplan

[3] Planologische Kernbeslissing (PKB)

In 2007 a new law for the NEN was created called Rural Area Development Act (WILG)[4]. The idea of this new law was to improve the control of the execution of the NEN and to solve cross-border issues. From this moment the provinces were responsible for the execution of the NEN and achieving the set goals. In 2012 a reassessment of the NEN meant that the final surface of the NEN was revised and became smaller, at the same time the finalization date was postponed.

When the NEN was introduced the idea was that the acquisition of land for the NEN could do without expropriation (Structural Concept, 1994). Expropriation was allowed but it did not occur in practice. In 2001 the 10%-ceiling was introduced. This ceiling indicated a maximum amount of hectares that was allowed to be expropriated per project. This had to make sure that expropriation of agricultural land for the purpose of nature became an accepted tool. The number of expropriations, however, remained very small. The Rural Area Development Act[5] in 2007 resulted in different provinces using different strategies for land acquisition for the purpose of the NEN. Some provinces explicitly avoid expropriation while other provinces are very willing to accept this tool. These different strategies might lead to different kind of land markets per province. Since 2007 the provinces in the Netherlands have different policies for acquiring land for nature conservation. For instance the province Zuid-Holland is the only province which requested a royal expropriation decree before 2013. Overijssel on the other hand avoids expropriation and subsidizes farmers that are willing to move from inside to outside the NEN instead (Van Straalen et al., 2013). But there are more differences on provincial level, some provinces are maintaining the old NEN-goals despite the decrease in subsidies (Coninx et al., In prep.), which means that they need to acquire more land. The outcomes per province on the influence the distance to the NEN has on the agricultural land price will therefore probably differ.

2.2. Analysing land markets using empirical data

In order to analyse land markets, empirical data needs to fulfil several requirements. Appropriate observations are relatively scarce since several land markets coexist. A large part of the data can therefore not be used. In order to distinguish suitable from unsuitable data, the observations need to have enough attributes to be filtered accurately. In qualitative research, land markets are studied with indicators as policy and interviewing actors. In quantitative research, land markets are studied by comparing land price and land mobility from empirical data (Segeren et al., 2005; Søgaard, 1993; Woltjer et al., 2008). The data also needs location attributes (preferably coordinates), by having the locations at your disposal the influence of other spatial attributes can be investigated. The attributes coming from other sources, can contain information about a parcel's soil quality or the distance to spatial objects nearby.

The influence of fertility, a location attribute, on land prices has been discovered by Ricardo in 1817. Higher fertility resulted in lower production costs and therefore a higher land rent (Ricardo, 1891). The first influence of nearby spatial objects on land price has been found by Von Thünen. Von Thünen was the first to associate a higher land rent with the proximity of a market. A shorter distance to the market means lower transportation costs. Lower costs are causing higher marginal profits per produced unit and therefore a higher land rent can be paid (Thunen, 1826). The principles of Ricardo and Von Thünen still apply today. The classical principles on land rent can be converted to current views on land price. Other location attributes than fertility, have been associated with land prices since. Regression-

[4] Wet Inrichting Landelijk Gebied

[5] *In Dutch* - Wet Inrichting Landelijk Gebied

analysis can be used to examine the relationship between the attributes and the land price (Diamond, 1980). Other attributes like proximity to certain amenities are empirically estimated with hedonic price model. This model is assuming that people's willingness to pay is depending on a product's characteristics and qualities (Rosen, 1974). Hedonic Pricing can therefore not only estimate a functions that relates land prices with land characteristics, but also with the proximity to an amenity. These models have showed a positive relationships between the proximity of open spaces and residential property value (Anderson et al., 2006), and negative relationship between the proximity of a railroad (Strand et al., 2001) and residential property value. These relationships do not only exist for residential property, but also for agricultural land (Folland et al., 1991), hence these methods seem ideal to investigate the relationship of certain characteristics on the land market.

2.3. Analysing land markets using dynamic simulation models

Simulation models can be an interesting tool to investigate the influence of parameters. By tweaking a specific parameter, it is possible to simulate different scenarios. By studying the different outcomes, the influence of a parameter can be better interpreted. To improve the simulation artificial intelligence can be added, called agents. The term 'agent' is used when a software-program endows its artificial intelligence with the following properties: autonomy, interaction with other agents, reactivity and pro-activeness (Wooldridge et al., 1995).These agents are making decisions depending on their own characteristics and are partially based on probabilities, this mimics their interests. Two runs with the same model will therefore give different outcomes. Multiple simulations are therefore needed in order to get a good impression of the impact of a variable (Janssen et al., 2006). This method has been used before to measure a farmer's willingness to pay for a certain parcel (Bakker et al., In prep.).

3. METHODS AND DATA

Different methods were used to answer the research questions, below are the research questions once more.

(1) How does the NEN influence the agricultural land price at national level? (3.1.1)

(2) How does the NEN influence the land mobility at national level? (3.1.2)

(3) How does the NEN influence the agricultural land price for each province? (3.1.3)

(4) How does the NEN influence the land mobility for each province? (3.1.4)

(5) What are the potential impacts of NEN implementation on the land market for different scenarios of zoning influence? (3.2.1)

For the first four questions I used empirical analysis, while for the last question I used a model-based approach. Therefore this chapter is subdivided into two subchapters; Empirical analysis and model-based analysis.

3.1 Empirical analysis

For the empirical analysis I used data on the Dutch agricultural land market. There were two main reasons to choose data from the Netherlands in particular. One, the characteristics of the typical Dutch zoning policy and second, the comprehensive content of transaction databases including location data. That way the distance from transactions to other objects (like the NEN or cities) could easily be calculated. The hedonic pricing method is used to explain the influence of this object on the agricultural land price (Rosen, 1974). Due to the extensive amount of information available on land transactions, the data could be filtered in such a way, that it met various desired conditions.

3.1.1. Study Area

For the empirical analysis, the entire Netherlands was chosen as study area. The Netherlands is a densely populated country, with very precise zoning plans. The zoning plans used in the Netherlands are dynamic and change every once in a while, depending on the demand for a land use function. Though the amount of suitable land per function is limited. However, due to the increase in population and decline in average size of households, the demand for the function housing was continuously present (Cotteleer et al., 2008). Another land use that demands space in the Netherlands is nature conservation. The largest supplier of land to meet this demand is the agricultural sector.

3.1.2. Timeframe

For the empirical analysis, the years 2008 and 2010 were selected. The 2009 data was not suitable for my research, since key-attributes were missing in that specific database. Since 2008 the demand for other functions than agriculture and the effects of speculation have decreased, mainly due to the economic crisis and budget cuts by the Dutch government (Aalbers, 2009; Bredenoord et al., 2011; de Boer et al., 2012). This reduces the competition originating from other land use functions on agricultural land. Compared to other sectors, agriculture is less vulnerable to recessions, therefore it is expected that during a recession the agricultural land price will be influenced less than other sectors (Jan Luijt et al., 2009).

3.1.3. Data

Land Market Data

The data I used came from a database that contains all land transactions from the Netherlands in the years 2008 and 2010, provided by the Agricultural Economics Research Institute6 (LEI) in The Hague. The data on land prices originated from the Dutch cadastre and was further processed by the Government Services for Land and Water Management7 (DLG). The Dutch cadastre supplied data on each transaction, while DLG added personal and transactional data. This data was then linked to the Agricultural Census data from CBS (Statistics Netherlands) by the LEI. Other spatial information such as yield loss or distances to other land use, were added to the database using ArcGIS. This program connected the location of a transaction with other spatial data by using its coordinates. The database was filtered using the Access-program. The next paragraph contains specification of the attributes used and the restrictions that shaped the filtered database.

Filter

Every record in the database represents a transaction. The records in the filtered database should represent transactions between farmers with the intension to maintain agricultural activities. In other words, every transaction that had a non-agricultural buyer or seller was removed from the database. Furthermore, each transaction which included a structure, like a house or a stable, was removed because of the extra added value. Each transaction which did not include a transmission of full ownership-rights was removed, since they represent a different type of transaction. Transactions smaller than 0.5 hectares or those involving economically very small farms were removed as well. Also very low and very high prices per hectare were removed. Prices far below the market value might indicate a family transaction, while prices far above the market value indicate investors which are also active in the agricultural sector. The amount of money paid in some transactions could not represent an agricultural future, since it would not be profitable as a future land use. It was more likely the land was bought as an investment or speculation on land-use change. Therefore these transactions, or records, were removed. Table 1 presents an overview of the filters used per attribute.

Table 1: Filters on Attributes

Attribute	Name	Measurement	Filter
BRS	BRS	Farmer-membership-number	If BRS is Null, delete
Structure	Opstal	Y or N	If Opstal is Y, delete
Rights	Recht	1,2,3,4,5	If Recht is >1, delete
Hectares	Hectare	Hectares	If hectares is <0.5, delete
Economic Size	NGE	NGE	If NGE is <3, delete
Land price per hectare	PrijsPerHa	EUR/ha	if PrijsPerHa <10,000, delete
Land price per hectare	PrijsPerHa	EUR/ha	If PrijsPerHa >500,000, delete

[6] *In Dutch* - Landbouw Economisch Instituut (LEI)

[7] *In Dutch* - Dienst Landelijk Gebied (DLG)

After applying these filters 2,146 suitable transactions remained, their locations and prices are shown in figure 2*[8]. From this map I also inferred a second variable of interest, which is the land mobility. Hereto I took the sum of the hectares of all transactions within blocks of 2 by 2 km, which resulted in the amount of land traded in *hectares per 4km*^{2}. This block size was chosen so that this variable showed a good distribution with not too many zero-observations, while still maintaining a large number of observations. Some of these grid blocks cover 100% non-agricultural land use, like cities or water, and these had to be removed. A grid block requires at least half a hectare of agricultural land within its borders to be counted as an observation, since transactions smaller than half a hectare were removed from the database. This way, a 'zero-observations' will represent a block where agricultural land is present and therefore transactions could have taken place, the 'zero-observations' will be inflated in order to have a smaller impact.

Every record, both the individual transactions as well as the 4km^2 blocks, has location data, which allowed other spatial data to be added to each record.

NEN data

For each location in the Netherlands, the nearest Euclidian distance to the NEN was computed in ArcGIS. The NEN was provided in the form of a shapefile. Figure 3* shows the distance from a certain point in the Netherlands to the nearest NEN. This data was then added to every transaction. To measure the land mobility I used the distance to the NEN from the centre of each block.

Province data

The province in which a transaction lies can have several influences on the transaction. Some regions are more attractive, which means more competition and therefore higher prices. But there are also different kinds of nature policies. Some provinces have a policy to expropriate for nature while other provinces try to avoid using those kinds of tools, as explained in chapter 1.4. Therefore I expected to see a different influence of the proximity of the NEN on the price per hectare per province. As a result I included a province dummy for the research questions which investigated the possibility of different influences per province. The different provinces are shown in figure 4*.

Ancillary data

Other studies already showed a connection between the agricultural land price and the distance to the city, the yield loss, the region and the parcel size (Cotteleer et al., 2008; Drescher et al., 2001; Pyykkönen, 2006; Sklenicka et al., 2013). Therefore I include these variables in the different models as well. Since these variables have already showed their connection with the land price, the outcome of the new variable should be more reliable.

Distance to the City: Several studies showed that the proximity of a city has an important influence on the price per hectare (Cavailhès et al., 2003; Chicoine, 1981; J Luijt et al., 2003). Since I was aware of this phenomenon, I included it in my research. This excluded the possibility of finding a connection between: 'the distance to the NEN' and 'the price per hectare' which might be the opposite of the relation 'distance to the city' and 'the price per hectare'. Since the NEN is relatively far away from the city this is a plausible connection and therefore both needed to be included in the research. Figure 5* shows the Euclidian distance in the Netherlands to the nearest city.

[8] *- indicates that the figure can be consulted in the appendix.

Yield loss: Yield loss is known to influence the land price (Cotteleer et al., 2008).Some lands are less fertile of have a higher water-level, which influences the yield. I combined the three most important yield loss maps from the Netherlands, which are the yield losses of grass, potatoes and corn. These yield losses were averaged to include the influence of yield loss in this research. Figure 6* shows the yield loss map for grass, figure 7* shows the yield loss map for potatoes and figure 8* shows the yield loss for corn.

Parcel size: Several studies showed different outcomes on the possible influence of parcel size on the price per hectare (Cotteleer et al., 2008; Sklenicka et al., 2013). On one hand the transaction costs are getting lower since the fixed costs remain the same. In theory the price per hectare should decrease when the transaction contains a larger parcel (Wunderlich, 1989). On the other hand, scales of economy suggest the opposite effect since every extra hectare will decrease the fixed costs per produced unit. The new bid price per hectare therefore gets higher again. Although in practice, from a negotiator's perspective, a lower price per hectare is expected. I used parcel size as an independent variable. Figure 9* shows the different sizes per transaction through the Netherlands.

The final list of variables used for the first part of the empirical research and their descriptive statistics can be found in table 2. The average price paid for a hectare in 2008 and 2010 was 48,200 euros, contained 5.4 hectares, was on a 881 meter distance from the NEN, was on a 2,685 meter distance from the city and had a predicted yield loss of 18,5%. The amount of observations per province are shown in figure 10.

The differences between table 2 and 3 are caused by the different transaction perspectives (point vs. block observations).

Table 2: Descriptive statistics *P*

Variable			Obs.	Mean	Std. Dev.	Min	Max
P	Price per hectare	€	2,146	48,200.71	31,590.02	10,000	461,526
x1	Distance to NEN	meters	2,146	881.11	951.22	0	6,718.13
x2	Distance to City	meters	2,132	2,684.77	1,758.36	0	10,819.54
x3	Yield loss	%	2,146	18.45	8.72	3.33	90.66
x4	Surface	Hect.	2,146	5.39	6.14	0.5	67.62

Table 3: Descriptive statistics *LM*

Variable			Obs.	Mean	Std.	Min	Max
LM	Surface traded	hectares per	6,870	1.64	4.84	0	67.63
x1	Distance to NEN	meters	6,870	835.8	932.33	0	4,993.2
x2	Distance to City	meters	6,870	2,511.	2,004.42	0	23,047
x3	Yield Loss	%	6,870	18.08	5.63	4.4	44.90

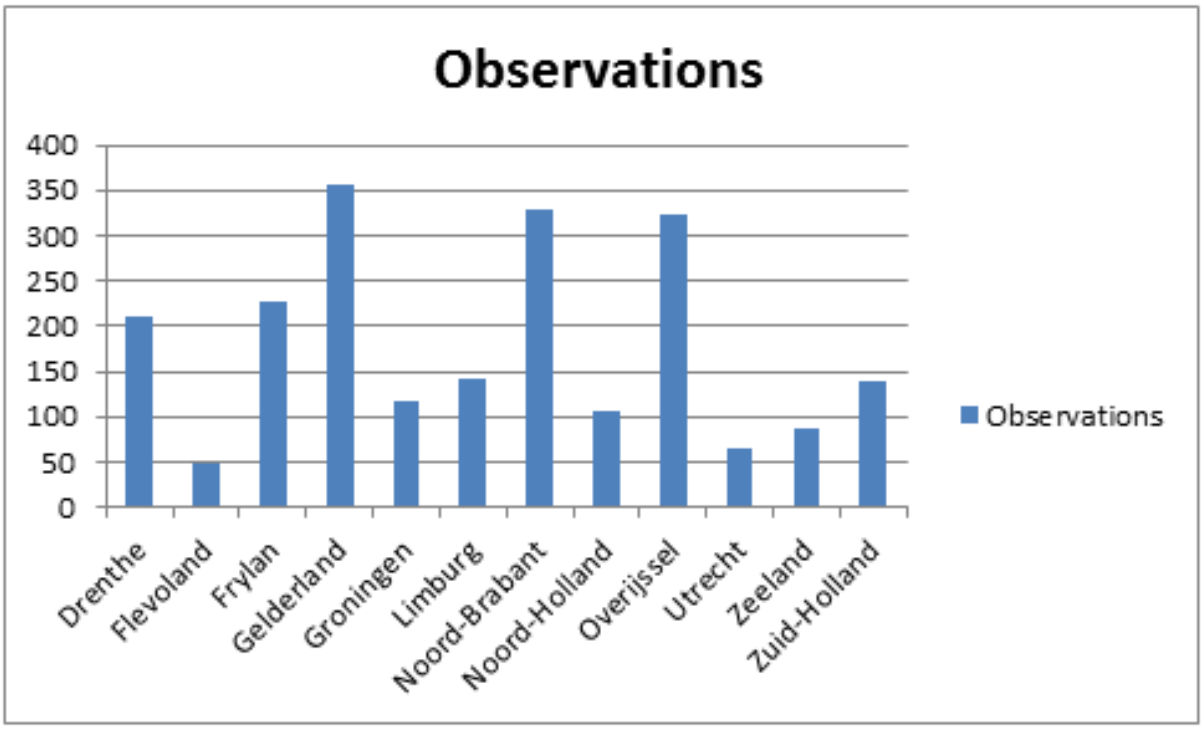

Figure 10: Total number of observations per province

3.1.4. Analysis

To investigate the influence of the NEN on agricultural land prices I used the 'price per hectare' as the dependent variable (*P*). The primary relationship of interest is that with "Distance to NEN", but other variables were included because they correlated with the distance to the NEN. This way I controlled for a possible confounding effect. Hence, next to "Distance to NEN" also "Distance to City, "Yield Loss" and "Surface Area" were added as variables. Due to the characteristics of the "Distance to NEN" variable, a rapidly declining influence when the distance increases, I implemented an inverted version in the model. An extra 100 meters was added to prevent the possibility of dividing by zero, which occurred when a parcel was located within the NEN's borders. The regression model used the "Inverted distance to NEN" which is given by:

$$INV\_DIST\_NEN = \frac{1}{(Distance\ to\ NEN(m) + 100)}$$

The final model also included the other variables, I used a standard regression to estimate the model. The model was estimated with the following formula:

$$P = \beta_0 + \beta_1 INV\_DIST\_NEN + \beta_2 DIST\_CITY + \beta_3 YIELD\_LOSS + \beta_4 HECTARES + e$$

Where P is the land price per hectare, β0 is the intercept, β1 represents the coefficient for the inverted distance to the NEN, INV_DIST_NEN represents the inverted distance to the NEN, β2 represents the coefficient for the distance to the city, DIST_CITY represents the distance to the city, β3 represents the coefficient for the yield loss, YIELD_LOSS represents the yield loss, β4 represents the coefficient for the amount of hectares, HECTARES represents the amount of hectares, e represents a mutually independent normally distributed random variable to account for unexpected variance.

To investigate the influence of the NEN on the land mobility I used 'traded hectares per block' as a dependent variable (LM). The model used to answer this question looks somewhat like the previous model, although the distance to the NEN is not inverted anymore. The difference is that the variables were aggregated to blocks of 400 hectares (2,000 x 2,000 meters).

$$LM = \beta_0 + \beta_1 DIST\_NEN + \beta_2 DIST\_CITY + \beta_3 YIELD\_LOSS + e$$

Where LM is the amount of hectares traded in a block of 400 hectares, β0 is the intercept, β1 represents the coefficient for the average distance to the NEN, DIST_NEN represents the average distance to the NEN, β2 represents the coefficient for the average distance to the city, DIST_CITY represents the average distance to the city, β3 represents the coefficient for the average yield loss, YIELD_LOSS represents the average yield loss, e represents a mutually independent normally distributed random variable to account for unexpected variance.

The model to determine the influence per province on the agricultural land price was estimated with the following formula:

$$P = \beta_0 + \beta_1 INV\_DIST\_NEN + \left(\beta_1 INV\_DIST\_NEN * (Province)\right) + \beta_2 DIST\_CITY + \beta_3 YIELD\_LOSS + \beta_4 HECTARES + e$$

The difference with the first model is the addition of "$\left(\beta_1 INV\_DIST\_NEN * (Province)\right)$", a dummy-variable. It works like an "On" (1) / "Off" (0) switch. That way it was possible to distinguish the effect of the NEN per province and directly compare them with other provinces.

To measure the influence per province on the land mobility I used the second dependent variable 'traded hectares per block' (LM) and the province as an extra variable.

$$LM = \beta_0 + \beta_1 DIST\_NEN + \left(\beta_1 DIST\_NEN * (Province)\right) + \beta_2 DIST\_CITY + \beta_3 YIELD\_LOSS + e$$

It is a combination of the models I used for the second and the third question. The variables are averages again, just like in the second model.

3.2 Model-based analysis

3.2.1. Study area

The Baakse Beek is a region in the Netherlands that is named after the brook that runs through it. Villages that are included in this region are Ruurlo, Hengelo, Zelten and Lichtenvoorde. Furthermore this area contains farmland including land that is planned to become part of the NEN. This area was selected because RULEX was calibrated for this area. For this study, it was considered an appropriate case study area, with a mix of farmer types and presence of the NEN.

3.2.2. Time frame

Every scenario ran ten times, started in 2010 and ended in 2025.

3.2.3. Model

The RULEX-model has been used for earlier studies (Bakker et al., 2015). The RULEX-model has been developed to explore land exchange, specifically among farmers and nature corporations. The model uses data about a farmer's age, economic size and succession to estimate whether a farmer will try to expand, shrink, or remain stable in that particular time step. Parcel data is also present, and for each parcel it is known to which farmer it belongs. The simulation takes steps of a year, and during such a time step, a shrinking farmer will place a parcel on the market, while an expanding farmer will try to buy a parcel. To estimate whether or not a transaction takes place, the willingness to pay or accept (WTP or WTA) is calculated. WTP and WTA depend on: the parcel's proximity to the farmstead of the buyer or owner, the distance to built-up areas, the distance to the NEN, and the soil quality (calculated as the expected yield loss for that parcel). Every shrinking farmer will place their least-valued parcel on the market, and every farmer willing to expand makes an offer (as high as their perceived value) on all for-sale parcels. When a parcel has a willing seller, a willing buyer and the two perceived values overlap (the WTP is higher than the WTA) a transaction occurs (Bakker et al., 2015).

The only variable that was varied in the model to measure the policy effect was the coefficient that specified to what extent the proximity of the NEN had an effect on the WTP or WTA of a farmer. This coefficient is here called the "NENcoefficient". A farmer's willingness to pay for a parcel was calculated as follows[9]:

$$WTP = \left(4.16E-05 + NENcoefficient * \frac{1}{(Distance\ to\ NEN(m) + 100)}\right)^{-1}$$

3.2.4. Scenarios

Nine scenarios, including a baseline scenario, were designed. Every scenario was ran ten times, since outcomes differ every time and I wanted to level of the outlying observations. The average of all runs per scenario were taken. The baseline scenario the NENcoefficient was 0.0005. A scenario with a negative coefficient (-0.0005) and a scenario which has a coefficient three times the value of the baseline scenario (0.0015) were simulated as well. The other scenarios are using a coefficient that lies in between the -0.0005 and 0.0015, see table 4. These varying coefficients reflect the various zoning possibilities: from those whereby farmers fear having land close to the NEN, to policies whereby

[9] This formula was simplified for clarification purposes. The RULEX-model contains many other variables.

farmers are not afraid of the presence of the NEN. To clarify what influence the “NENcoefficient” has on the WTP on different distances from the NEN please consult figure 11, other RULEX-variables were not taken into account.

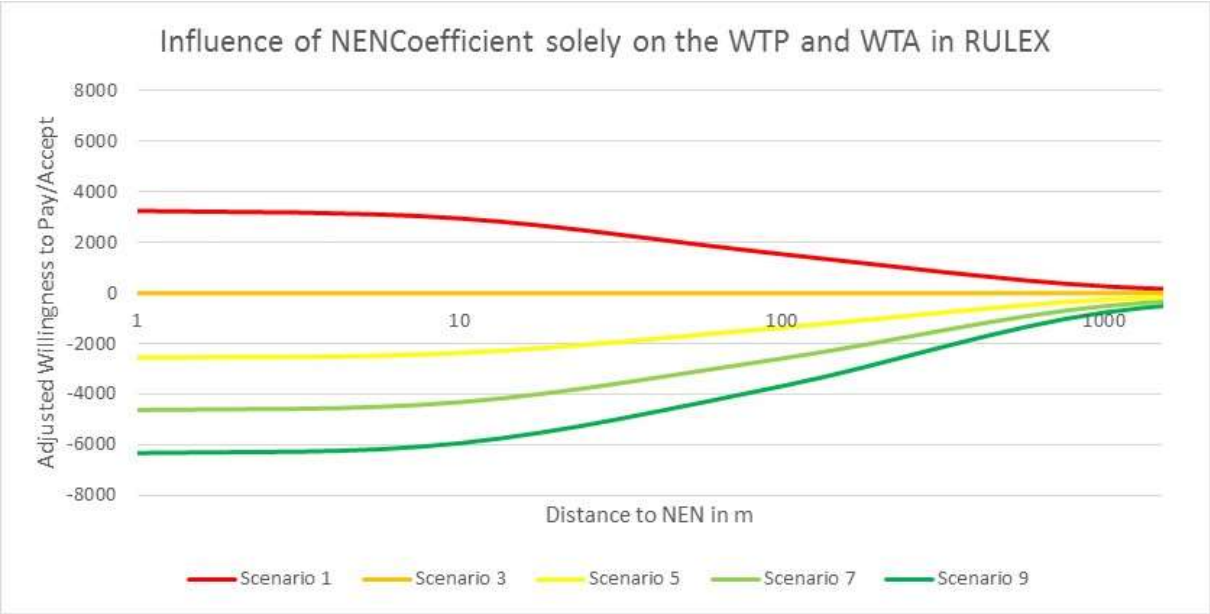

Figure 11: Influence of the NEN Coefficient solely on the WTP and WTA in RULEX

Table 4: NENcoefficients per scenario

Scenario #	Baseline Multiplier	NENcoefficient
Scenario 1	-1	-0.0005
Scenario 2	-0.5	-0.00025
Scenario 3	0	0
Scenario 4	0.5	0.00025
Scenario 5	**1***	**0.0005**
Scenario 6	1.5	0.00075
Scenario 7	2	0.001
Scenario 8	2.5	0.00125
Scenario 9	3	0.0015

***Baseline Scenario**

4 RESULTS

4.1 The effect of the NEN on the price per hectare

Table 5 shows the outcome of the statistical analysis on the first research question. Although all variables are significant the adjusted R-squared of 0.035 is low. The intercept is higher than the average price per hectare in the Netherlands, this is possible since all variables have a negative influence on the price. The only exception is the variable "Distance to the NEN" since I used "1/Distance to the NEN". To illustrate the measured influence of the distance to NEN on the parcel price I reversed the formula, and displayed the relationship in a graph (Figure 12). The other variables were assigned their mean value.

Table 5: Influence NEN on transaction level (Price)

	Coefficients	Estimate Std. Error	t value	Pr(>|t|)	Significance
(Intercept)	6.51E+04	2.04E+03	31.968	< 2e-16	***
INV_DIST_NEN	-1.06E+06	2.42E+05	-4.371	1.30E-05	***
DIST_CITY	-2.08E+00	3.87E-01	-5.378	8.37E-08	***
YIELD_LOSS	-3.69E+02	7.75E+01	-4.757	2.10E-06	***
HECTARES	-2.99E+02	1.15E+02	-2.593	0.00958	**

Signif. codes: 0 '*' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1**
Obs. 2,146

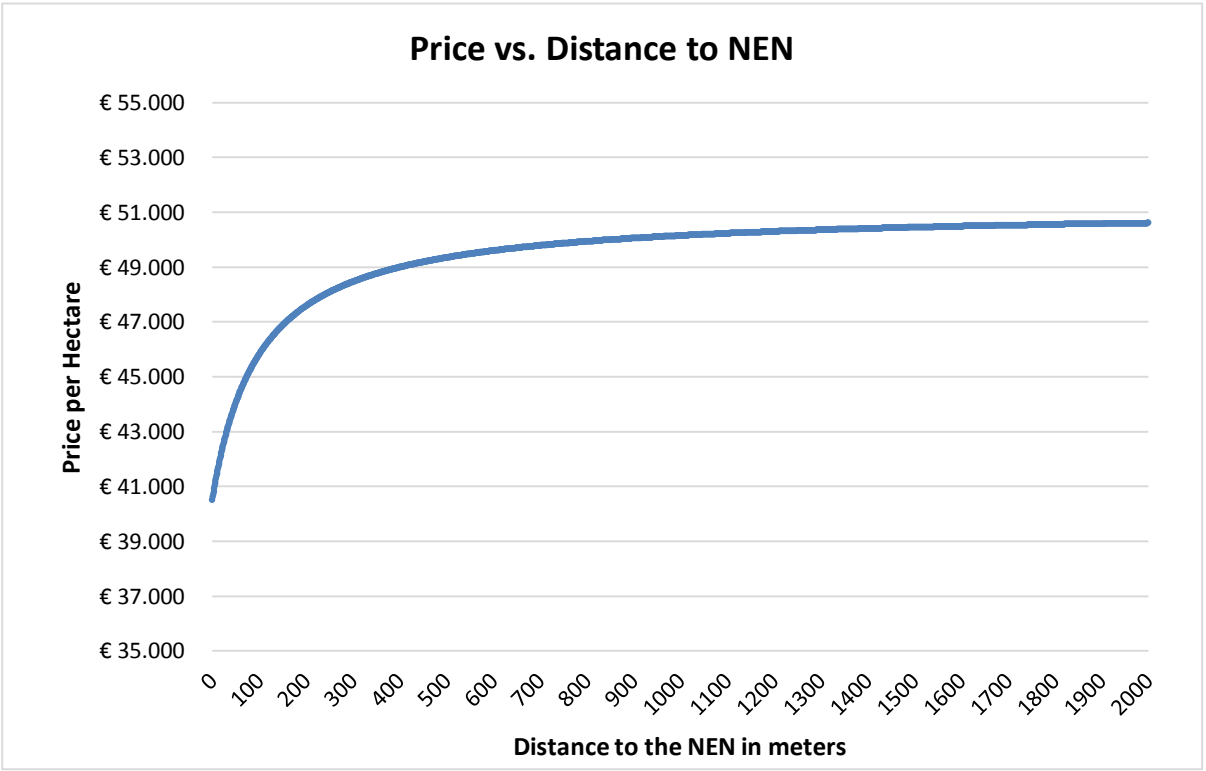

Figure 12: Price vs. Distance NEN

4.2 The effect of the NEN on land mobility

Table 6 shows the outcome of the statistical analysis on the second research question, showing that all variables are significant. Similar to the relationship between NEN-distance and parcel price, the Adjusted R-squared is also low with a score of 0.013. This means that many other variables play a role as well. The coefficient shown in table 6 shows is that for every 1000 meters away from the NEN on average 0.5 hectares more land is sold, which is also illustrated in figure 13. This is within an area of 400 hectares (2,000 x 2,000 meter). In figure 14* you can see where the transactions took place compared to the NEN.

Table 6: Influence of the NEN on transaction level (Land mobility)

	Coefficients	Estimate Std. Error	t value	Pr(>|t|)	Significance
(Intercept)	4.00E-01	2.25E-01	1.775	0.0759	.
DIST_NEN	5.24E-04	6.34E-05	8.274	< 2e-16	***
DIST_CITY	1.32E-04	2.90E-05	4.545	5.60E-06	***
YIELD_LOSS	2.62E-02	1.05E-02	2.498	0.0125	*

Signif. codes: 0 '*' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1**

Obs. 6,870

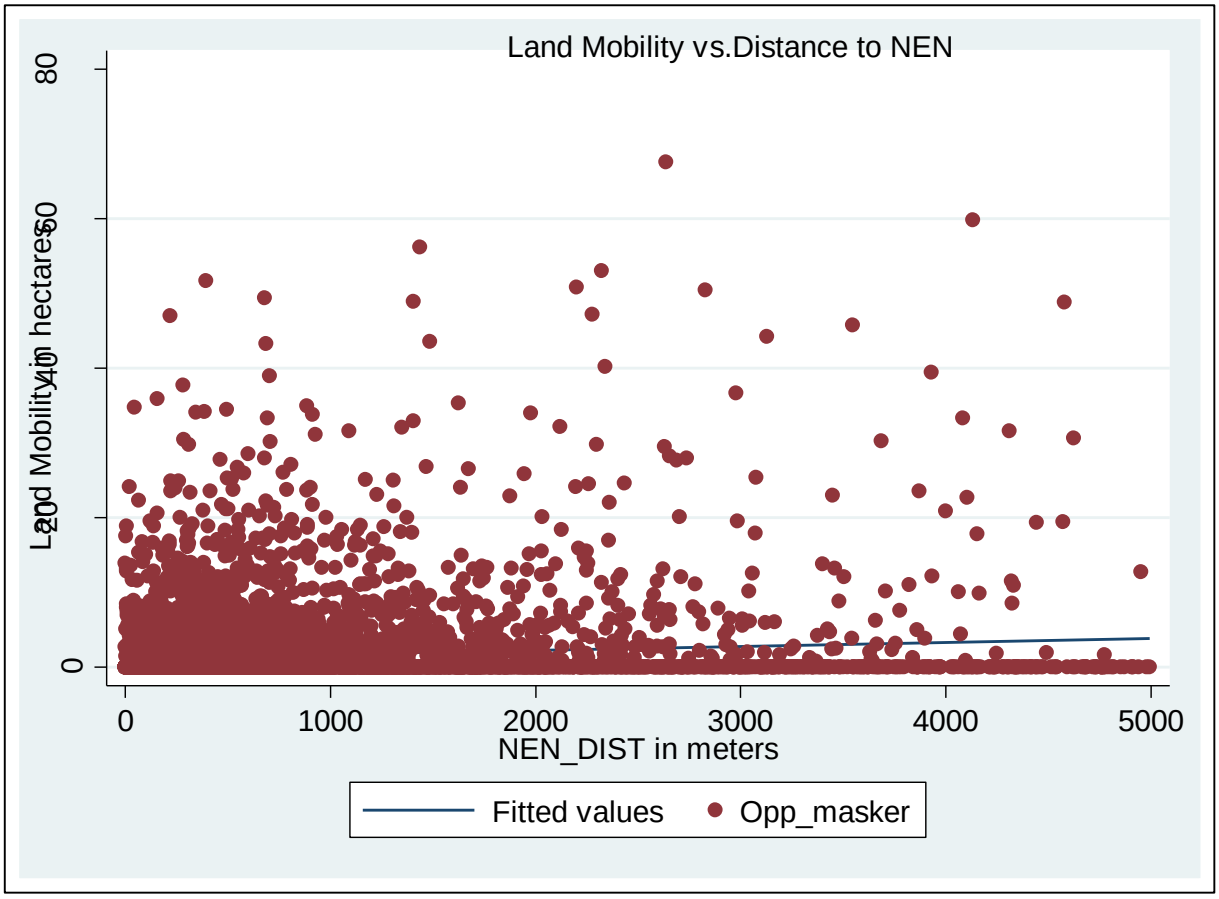

Figure 13: Transaction size versus the Distance to the NEN

4.3 The effect of the NEN on transaction prices per province

Table 7 shows a summary of the outcome of twelve province-specific outcomes for the relationship between distance to NEN and parcel price. “Zuid-Holland”, “Limburg” and “Flevoland” are the provinces with the most negative coefficient. The rest of the provinces also have a negative coefficient but these are not as extreme as the others. “Utrecht”” has a positive coefficient, which means agricultural land near the NEN is more expensive. Figure 15 shows the graphs for significant provinces according to the coefficient I found for the first 500 meters near the NEN. After 500 meters the effect of the influence of the NEN levels off.

Table 7 The influence of the NEN on land price per province

	INTERCEPT	INV_DIST_EHS	Pr(>|t|)	Significance
DRENTHE	4.45E+04	-6.35E+05	0.37348	
FLEVOLAND	8.00E+04	-3.33E+06	0.529027	
FRYSLÂN	5.21E+04	3.45E+05	0.793066	
GELDERLAND	6.07E+04	-8.22E+05	0.091052	.
GRONINGEN	5.04E+04	-9.48E+05	0.40655	
LIMBURG	6.90E+04	-2.44E+06	0.015972	*
NOORD-BRABANT	7.25E+04	-9.73E+05	0.135128	
NOORD-HOLLAND	6.61E+04	-1.58E+06	0.03351	*
OVERIJSSEL	6.04E+04	-6.16E+05	0.305397	
UTRECHT	5.37E+04	2.84E+06	0.077421	.
ZEELAND	5.68E+04	-6.63E+05	0.632805	
ZUID-HOLLAND	7.81E+04	-2.32E+06	0.021181	*
Signif. codes: 0 ‘*’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1**				
Obs. 2,146				

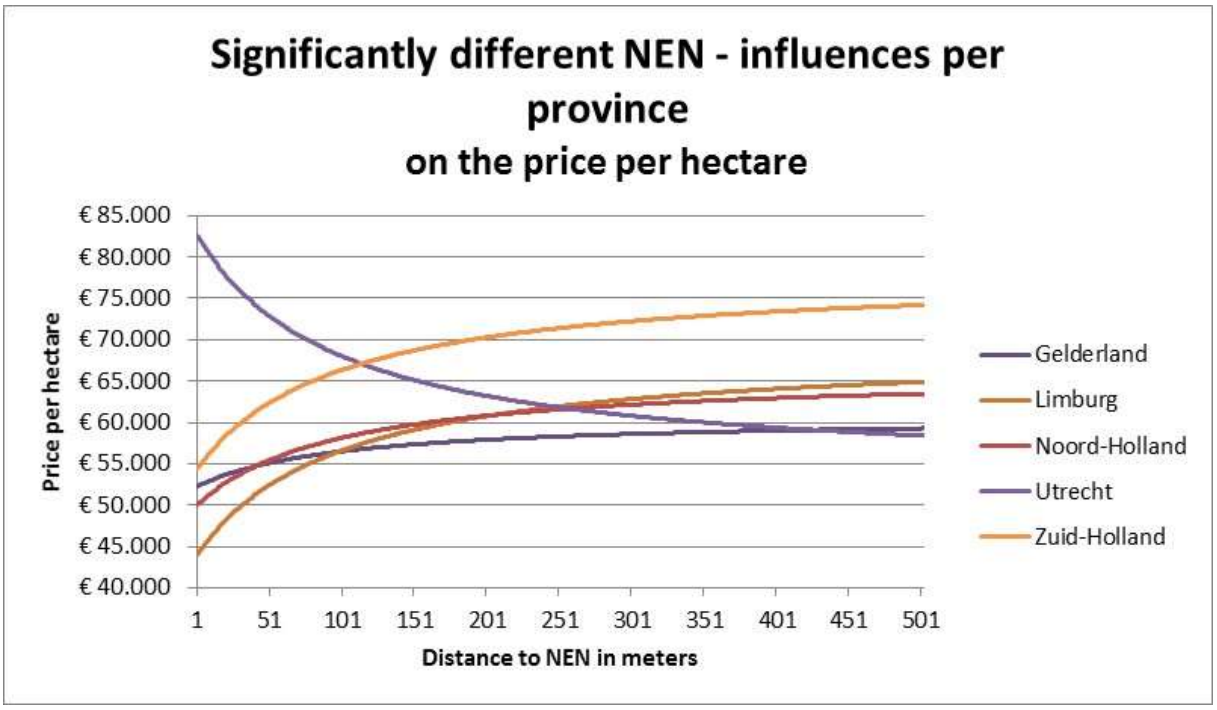

Figure 15: Distance to NEN vs Price graph per province

4.4 The effect of the NEN on land mobility per province

The results in table 8 are showing the influence of the NEN per province on land mobility. The Adjusted R-squared scored 0.017, this means the model has very little explanatory power. The influence of the distance to the NEN per province did not show any significant results. The distance to the city showed a significant relationship with the land mobility. Every kilometre further away from the city, land mobility increased with 0.4 hectares per block. Some provinces showed significant differences as well, but these are location dummies.

Table 8 The influence of the NEN per province on land mobility

	Estimate	Std. Error	t value	Pr(>|t|)	Significance
(Intercept)	1.28E+00	3.76E-01	3.417	0.000637	***
DIST_NEN	4.07E-04	3.05E-04	1.332	0.182768	
DIST_CITY	1.36E-04	3.23E-05	4.197	2.74E-05	***
YIELD_LOSS	1.92E-02	1.18E-02	1.622	0.10487	
# Flevoland	-7.16E-02	5.54E-01	-0.129	0.897125	
# Friesland	-3.90E-01	3.72E-01	-1.05	0.293795	
# Gelderland	-8.69E-01	3.48E-01	-2.497	0.012556	*
# Groningen	-5.06E-01	4.53E-01	-1.118	0.263405	
# Limburg	-8.37E-01	4.38E-01	-1.912	0.055951	.
# Noord-Brabant	-1.21E+00	3.68E-01	-3.294	0.000993	***
# Noord-Holland	-3.55E-01	3.93E-01	-0.903	0.366641	
# Overijssel	-9.09E-01	3.76E-01	-2.416	0.015721	*
# Utrecht	-1.08E+00	5.09E-01	-2.124	0.03369	*
# Zeeland	-1.56E+00	5.23E-01	-2.987	0.002824	**
# Zuid-Holland	-8.36E-01	4.51E-01	-1.856	0.063432	.
DIST_NEN_Flevoland	3.72E-04	4.07E-04	0.915	0.360132	
DIST_NEN_Friesland	-9.68E-05	3.35E-04	-0.289	0.772545	
DIST_NEN_Gelderland	5.22E-05	4.21E-04	0.124	0.901264	
DIST_NEN_Groningen	-9.87E-05	3.39E-04	-0.291	0.771133	
DIST_NEN_Limburg	-1.83E-04	6.64E-04	-0.275	0.78321	
DIST_NEN_Noord-Brabant	5.80E-04	4.17E-04	1.39	0.16444	
DIST_NEN_Noord-Holland	-2.00E-04	3.87E-04	-0.518	0.604759	
DIST_NEN_Overijssel	2.48E-04	3.65E-04	0.679	0.497237	
DIST_NEN_Utrecht	6.12E-04	7.29E-04	0.84	0.401211	
DIST_NEN_Zeeland	6.09E-04	9.08E-04	0.67	0.502639	
DIST_NEN_Zuid-Holland	1.28E-04	4.57E-04	0.28	0.779859	

Signif. codes: 0 '*' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1**
Obs. 6558
 # - Dummy variable

4.5 The potential impacts of NEN implementation on the land market for different scenarios of zoning influence?

Table 9 shows the outcome of the different scenarios. Scenario's 1 and 2 simulate a higher WTP near the NEN, while scenario 9 simulates a WTP three times lower (than the baseline). The simulations did not seem to be affected that much by these different inputs. Figure 16 shows the amount of transactions on the Y-axis and the NENcoefficient-factor (baseline=1) on the X-axis. Figure 17 shows the average distance of all transactions to the NEN on the Y-axis and the NENcoefficient-factor (baseline=1) on the X-axis. Although both variables are slightly explanatory, the volatility is very small.

Table 9: RULEX Scenario output

Scenario #	NENcoefficient	Transactions	Average Distance to NEN
Scenario 1	-1	1,298.7	523.8
Scenario 2	-0.5	1,281.4	523.5
Scenario 3	0	1,301.9	523.9
Scenario 4	0.5	1,310.1	523.2
Scenario 5 - *Baseline*	1	1,324	522.7
Scenario 6	1.5	1,303.2	523.2
Scenario 7	2	1,308.1	523.3
Scenario 8	2.5	1,301.9	523.7
Scenario 9	3	1,298.7	523.1

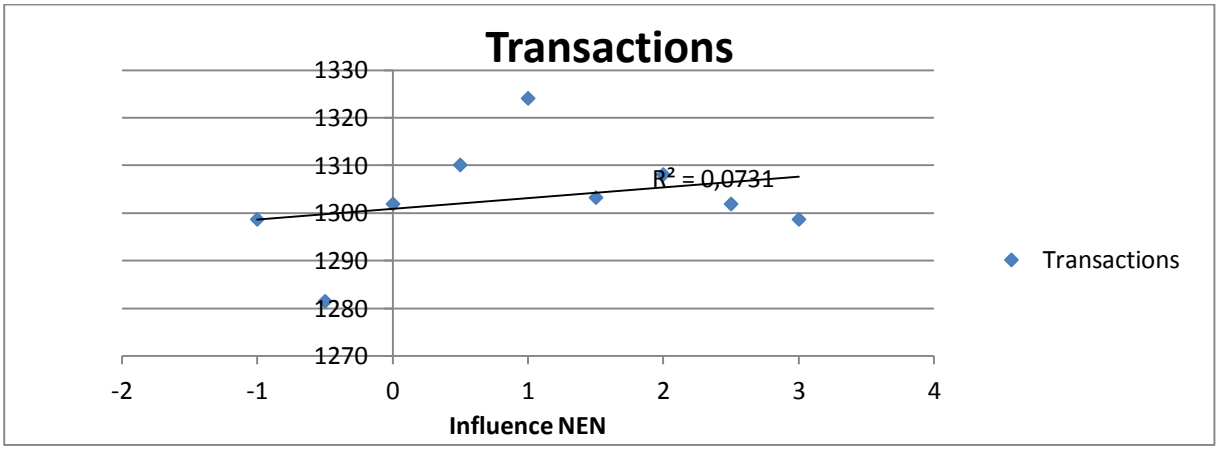

Figure 16: Transactions vs. Influence NEN

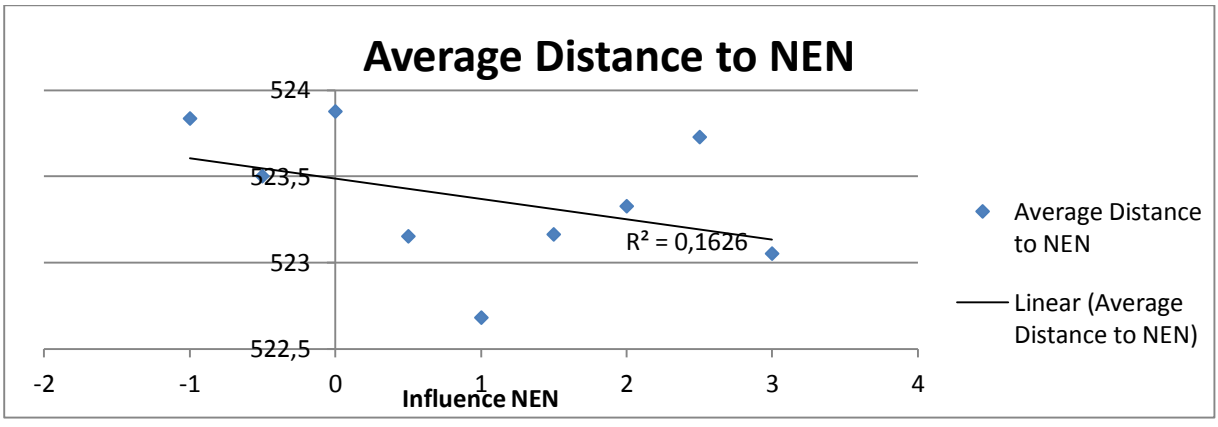

Figure 17: Transaction distance to NEN vs. Influence NEN

5. DISCUSSION

The effect of the NEN on the land price

The proximity of the NEN had a negative effect on the price per hectare on a transactional level. This was significant, although with a low coefficient. The strong intercept shows one of the main characteristic of agricultural land, namely its solid value. The main influence of the NEN was measured to a distance of one kilometre, farther out the effect levels off. The land market is, in terms of land price, slightly influenced by proximity of the NEN. Which indicates lower attractiveness for farmers willing to buy.

The effect of the NEN on land mobility

To measure the land mobility near the NEN, I aggregated the transactions. I found that further away from the NEN there were more transactions, for each kilometre away that was 0.5 hectares more (per 400 hectares). I expected more transactions near the NEN because of the extra competition nearby, due to provinces buying land for the NEN. The records in this study were from an economic unsure period. Nature is one of the early budget cutting targets in unsure economic times. Therefore farmers might have the idea that the "risk" of an expanding NEN was very minimal, while the urge and priority for provinces to accumulate the NEN-lands degraded as well. The land market is, in terms of land mobility, slightly influenced by the proximity of the NEN. This shows again that the willingness to buy is lower near the NEN. The scatter plot also showed that I should not have done a linear regression, a logarithmic regression would probably have been better.

The effect of the NEN on the land price per province

Far from all provinces showed significant influence, except for Utrecht the NEN showed a negative influence. It could be that the NEN has a different effect on the agricultural land price per province. It is tough to say if it has anything to do with nature policy, because their policies do not differ very much from most other provinces. So what else could it be? One possible explanation is that in Utrecht the beautiful recreational activities and holiday homes are located near the NEN (think of the peat excavation lakes in Utrecht). Therefore the proximity influence might play a role for perceived future value. Another explanation could be that the value for current activities is higher when farmers are allowed to combine recreational functions on their agricultural land. Notable is that the results of two provinces discussed earlier Zuid-Holland (expropriation) and Overijssel (subsidising), which seem to differ so much in their policy, are not that far apart. This feeds the discussion if a different kind of policy can steer the land market in a way that is measurable in terms of land price, or land mobility. The agricultural land market might have succeeded in finding a balance for land in terms of price and transactions near the NEN itself. From this study it cannot be concluded that different NEN-policies cause different outcomes. Another flaw is that the amount of observations per variable decreases when they are divided into provinces. Especially for Friesland, Utrecht and Zeeland, where the amount of observations were between 50 and 100.

The effect of the NEN on land mobility per province

The first two research questions proved that the NEN influences the price per hectare and land mobility on the transactional level. On a provincial level, the NEN showed to have a significant influence in just a few provinces and those were not the provinces from where I started the hypothesis. The NEN did not show any significant influence on the land mobility on a provincial level. At this moment I was not surprised to see an insignificant result because the NEN seems to influence the land price more than the land market. The land price was less influenced on the provincial level than on the transactional level. When I extrapolate this line of reasoning, I would not expect a significant result. One of the problems can be the numerous conditions the dataset has to meet, after aggregating the transactions

they are also divided into provinces. The number of observations per province are quite low and contain many 'zero-observations'. Perhaps the database can be enlarged with data from more recent years, in following studies.

The potential impacts of NEN implementation on the land market for different scenarios of zoning influence?

For the simulations to predict future land use, I used the RULEX model. I saw that when I improved the perceived value, more transactions took place and on average also more proximate to the NEN, but these results were barely significant. However I was expecting more dynamic outcomes for the different scenarios on both the amount of transactions and the average distance to the NEN. The influence on the land market based on the perceived value near the NEN can be considered low.

Research limitations and recommendations for further research

While I tried to filter the transactions in the best way, it was not possible to exclude family transactions, these might blur the outcomes slightly. Furthermore I had to deal with an imperfect market since location is very important, especially for the buyer who searches for parcels nearby. Therefore low offers can be successful sometimes, because a seller that urgently needs to sell his land on one hand and a lack of competition on the other hand. To improve the study, one might also have the idea to add more variables to improve the model. While that might be interesting, the agricultural land will maintain a strong intercept, because its value is largely fixed. A search for measurable variables with strong coefficients will therefore be tough. The questions on the provincial differences of the NEN on the land market were probably a step to far. The dataset could have been too small for a study this specific.

The outcome of the simulations did not enable me to draw any mayor conclusions. There may be a problem in the nature of the model, for this kind of research. The stochastic character of RULEX simulations are causing pollution in the observations. Averaging the outcomes are levelling off any other outcome as well. Maybe I could have been more aggressive on the NENcoefficient for more evident results. This may have resulted in greater differences and therewith more useful outcomes.

Learning outcomes

This study showed that there is a connection between the NEN and the land market on a transactional level. The lower land price and lower land mobility demonstrate less interest from farmers. This study did not demonstrate that different policies have different influences. The effect of the NEN on the land market is presumably only present in the close vicinity to the NEN. The next subdivision to provinces may have been a step to far. RULEX could not demonstrate either that any differences in NEN-policy (and therefore differences in Willingness to Pay), changed the land market significantly.

6. CONCLUSION

The NEN has an influence on the agricultural land market, both price and quantity of land were influenced by the proximity of the NEN. The closer a piece of land was located to the NEN, the lower the average paid price per hectare. The lower price near the NEN can be explained. Agricultural plots that are near other plots with high land prices, housing for example, are more expensive than other agricultural plots. The reason for this particular difference is the proximity zoning policy in the Netherlands, one of the ways to keep contrast between urban and rural areas. The proximity to plots with a lower land price, nature in this case, appear to have the same characteristic. I have found that the proximity of the NEN resulted in lower land price, which is a negative consequence for the current land owner.

As for future scenarios with different kinds of influences from the NEN, simulated with the RULEX model, I saw more transactions and slightly closer to the NEN when prices near the NEN increased. This might indicate that, with higher prices near the NEN, farmers are more willing to sell their land. Causing more transactions and decreasing NEN distance as a result. However, the results did not show a large enough impact that requires governmental interventions.

In conclusion, this study demonstrates no immediate cause to change nature policy for farmers with land near the NEN because of several reasons. First of all it is not clear which kind of policy would have a levelling effect on land prices, there was no clear distinction between the outcomes of Zuid Holland and Overijssel while there policies are far apart. Second of all if there was an effect, it would be so minor that it is not worth the effort, think of it as an occupational hazard. Third of all the influence of the NEN is not always negative, like I spotted in Utrecht, so a new policy should include a lot of exceptions making it more complex and difficult to implement.

ACKNOWLEDGEMENTS

I would like to thank Martha for her guidance and support during this thesis. It has been a long ride with a lot of obstacles, sometimes because of weak results, other times because of the use of new and difficult models and parameters. Especially near the end when I got a setback because of wrong interpretations of how to use the RULEX model. It meant I had to re-simulate the very time-consuming RULEX model to get the correct outcomes. Martha however, continued to be patient and confident in my abilities to finish this study. Thank you Martha!

For the data of the study itself I would like to thank the Agricultural Economics Research Institute[10] in The Hague for temporary access to their transaction data. Otherwise this study could not have been executed.

I would like to thank Shah, he made a user-friendly interface for the RULEX model for me. That way I could carry out the simulations in RULEX for different kind of NEN influences. It was a very interesting model to work with, unfortunately for this study its outcome was not earth-shaking, but it has a lot of potential within the discipline of Spatial Planning (and Policy).

Last but not least I would like to thank Luca for proofreading this paper, but also for her support during the final months which motivated me to finally finish this thesis. ☺

[10] Landbouw Economisch Instituut (Den Haag)

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APPENDIX

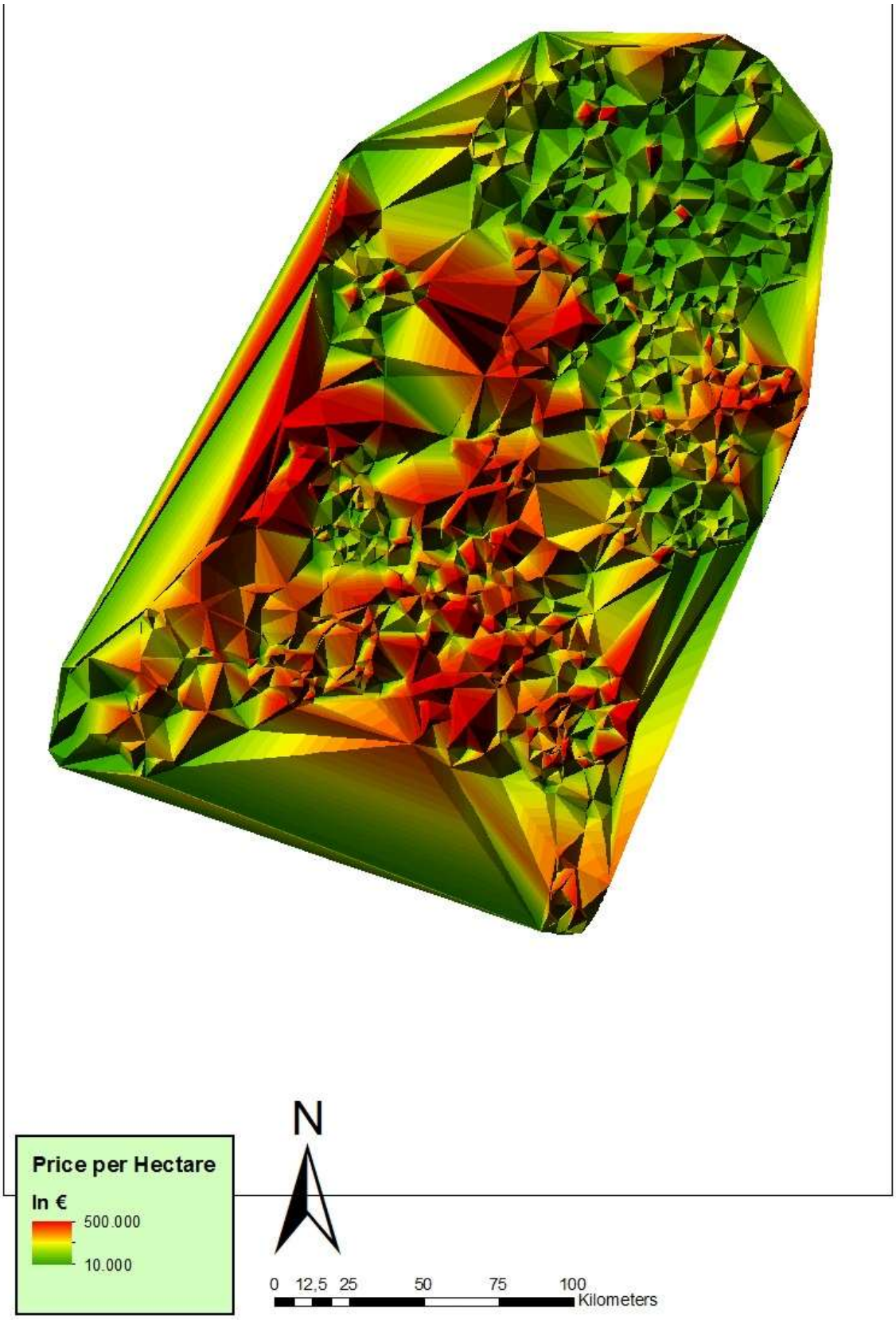

Figure 2: The price per hectare per transaction

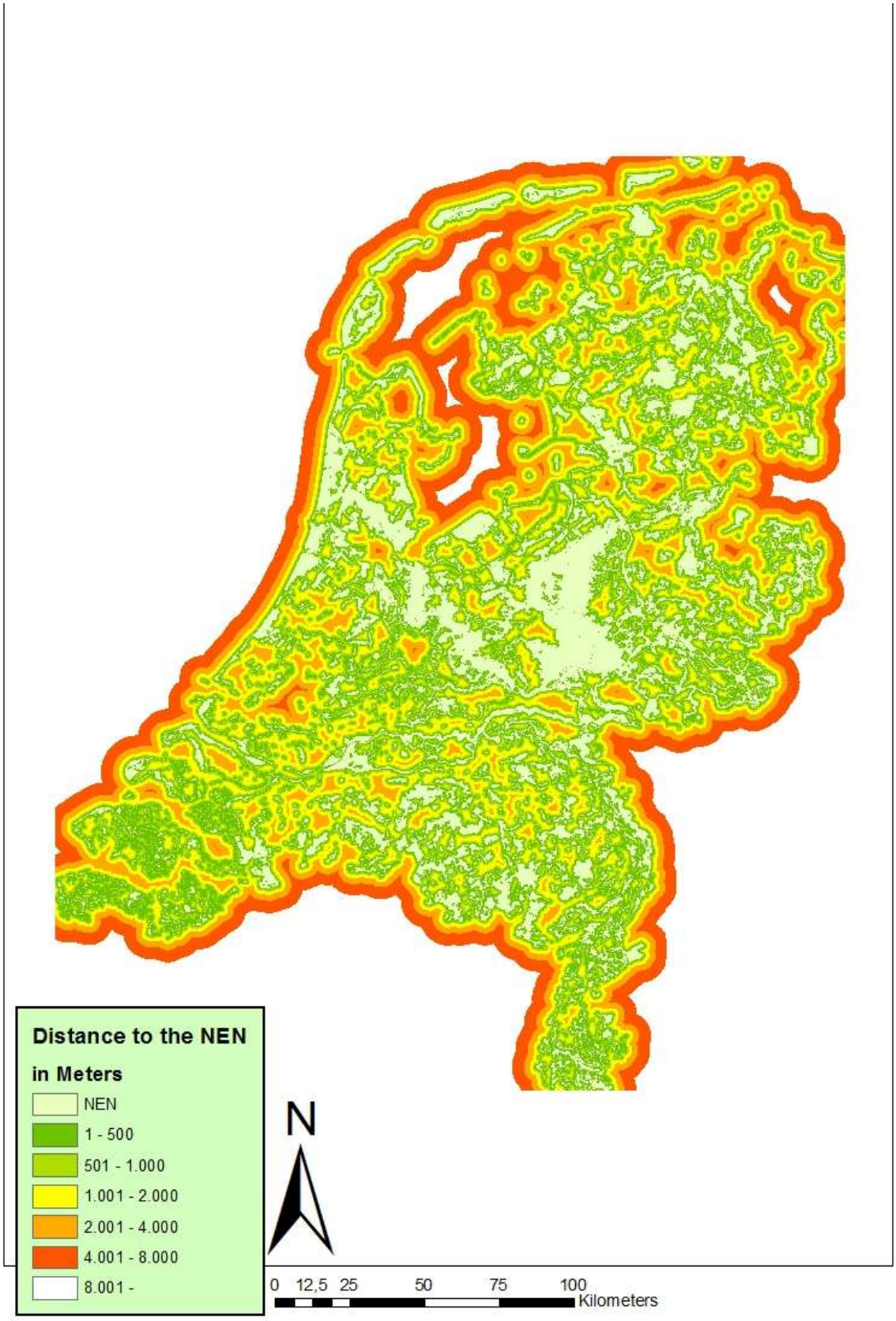

Figure 3: The distance to the NEN

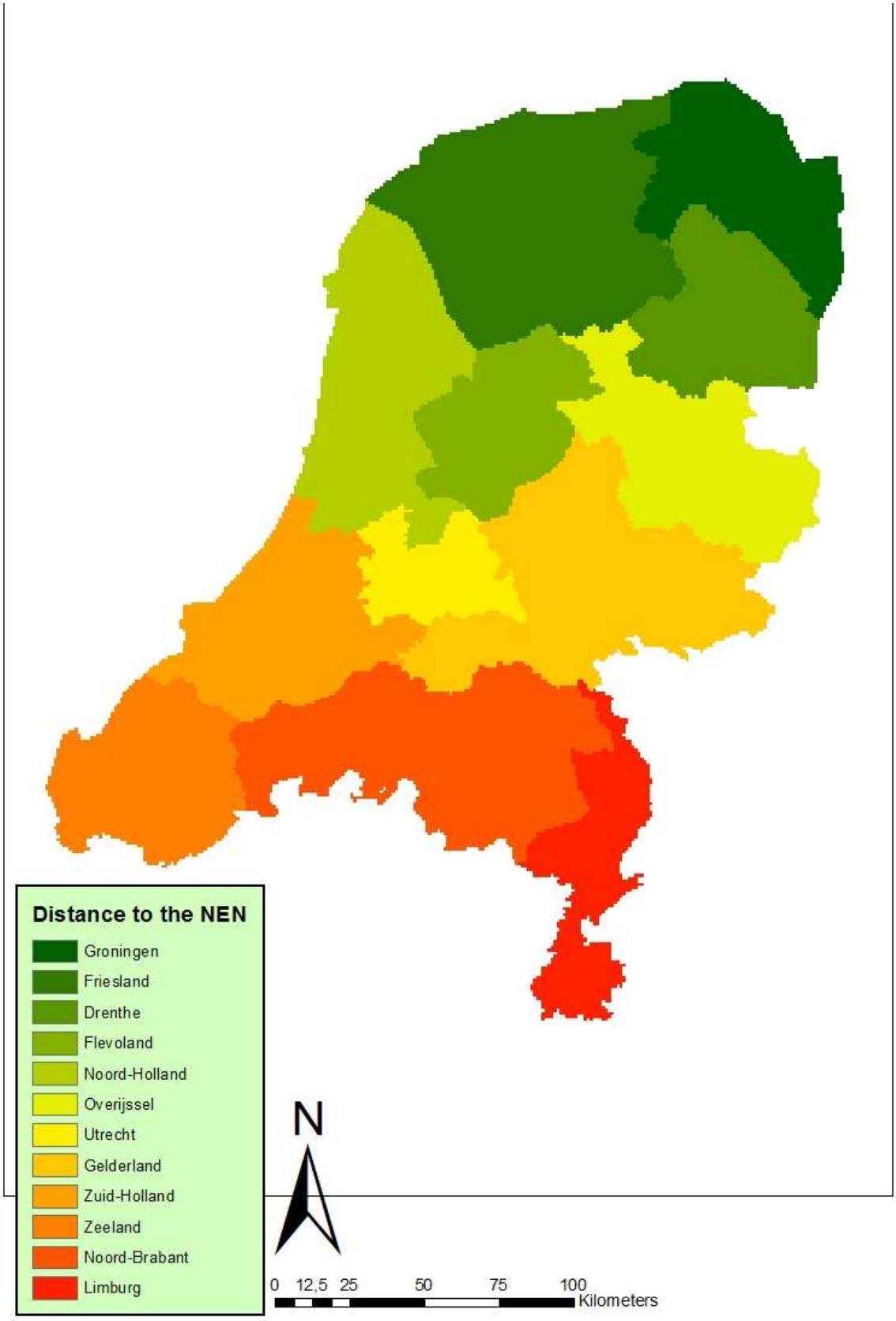

Figure 4: The provinces

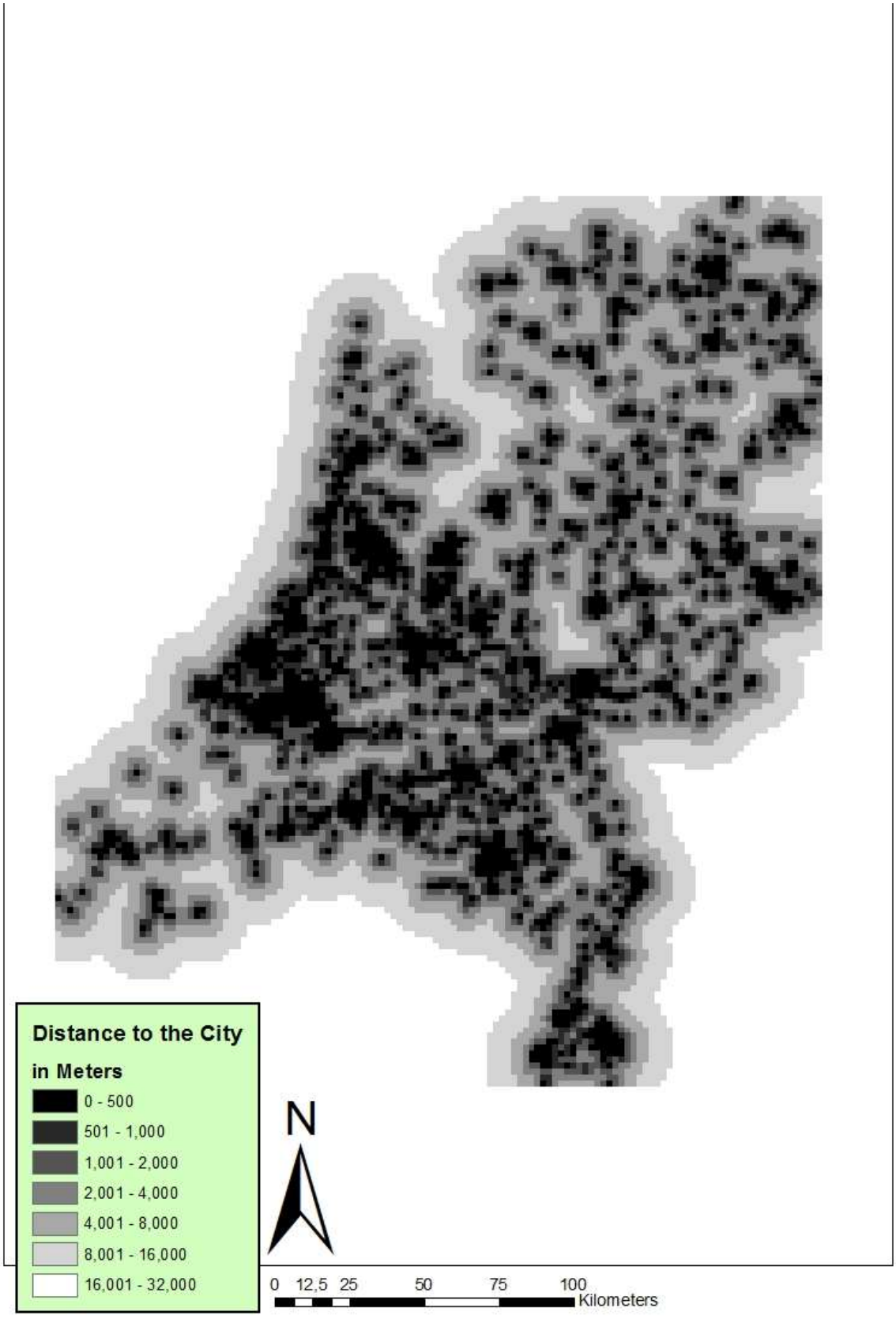

Figure 5: The distance to the city

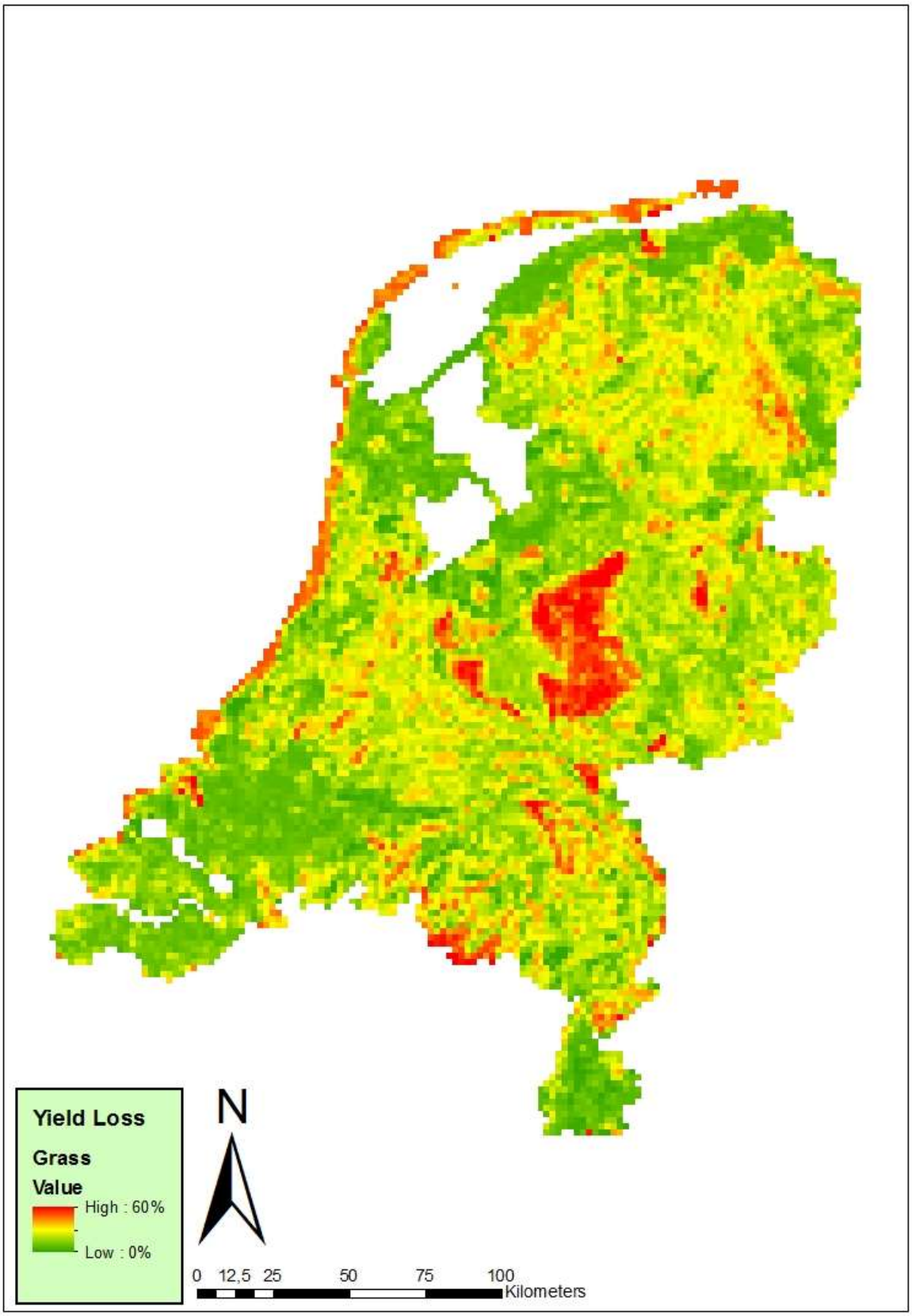

Figure 6: Grass Yield loss

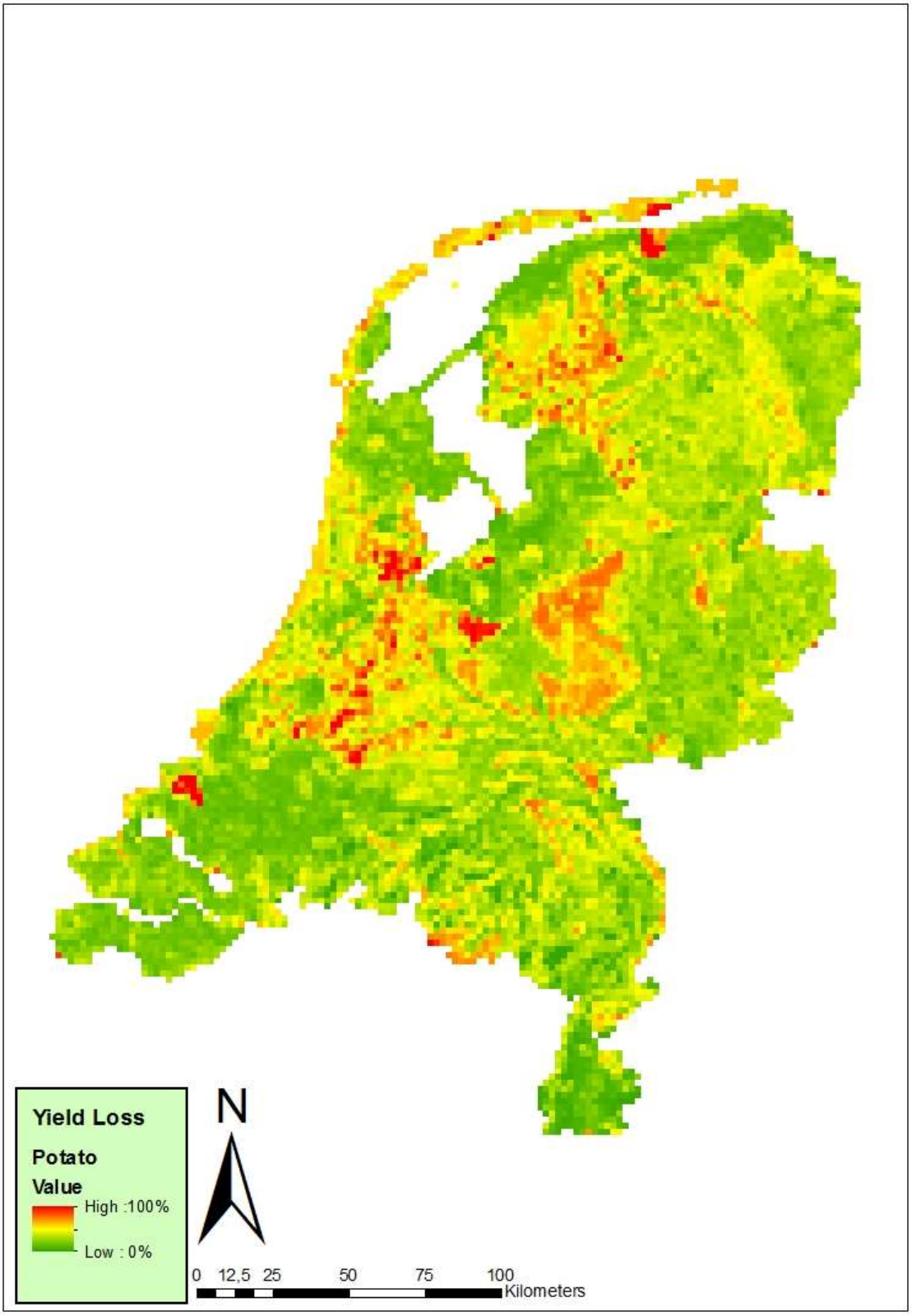

Figure 7: Potato Yield loss

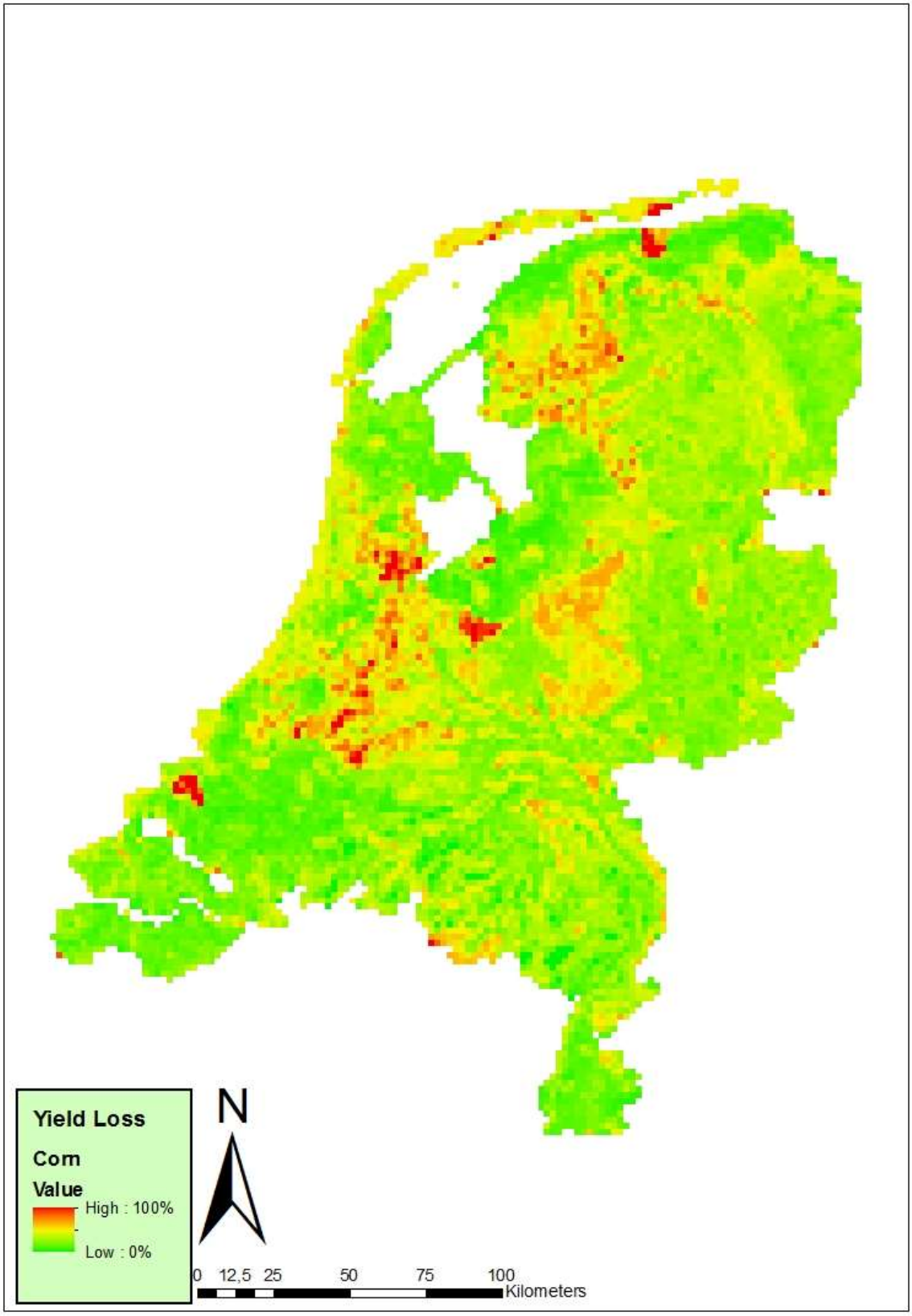

Figure 8: Corn Yield loss

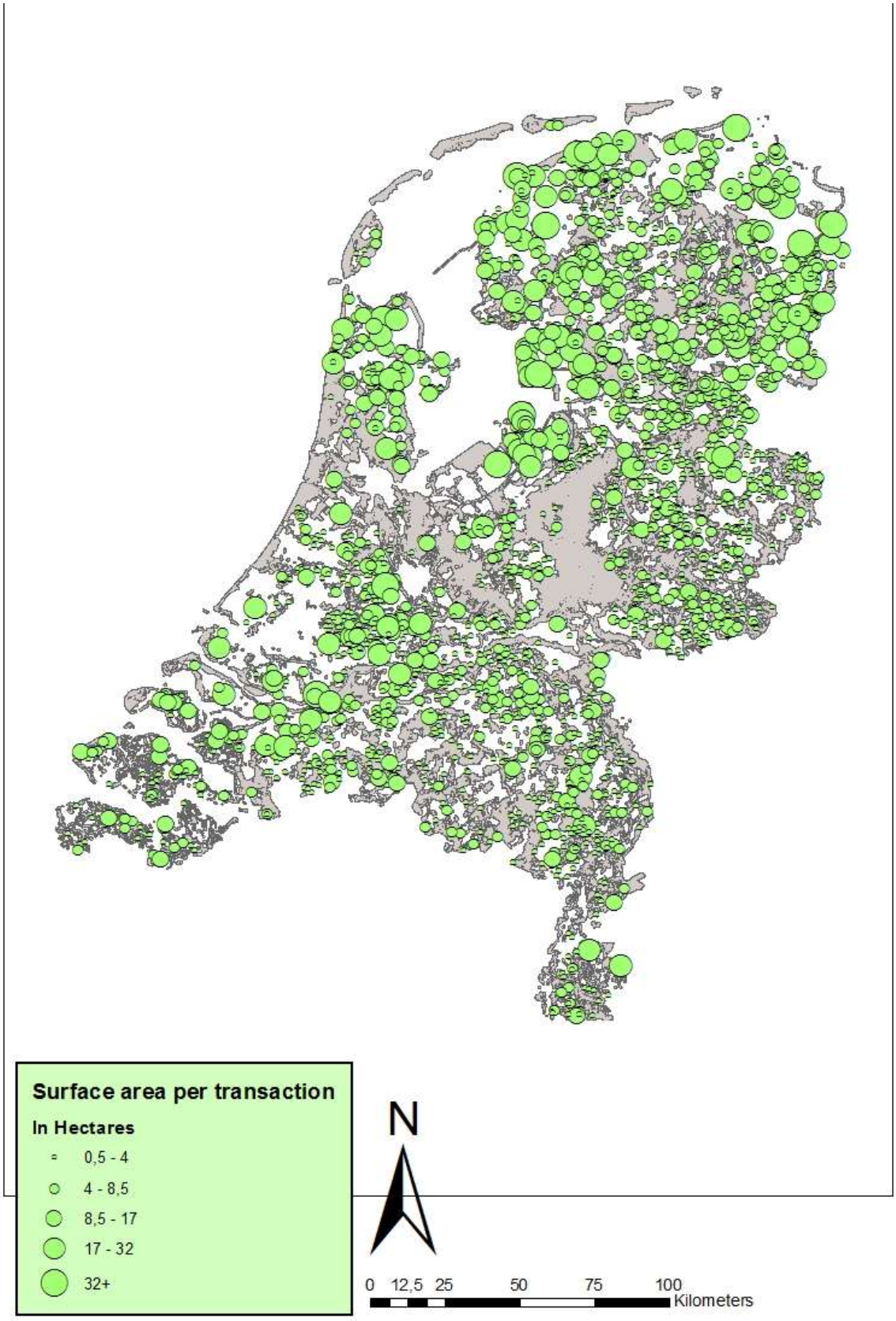

Figure 9: The size (in hectares) per transaction and the NEN (in grey)

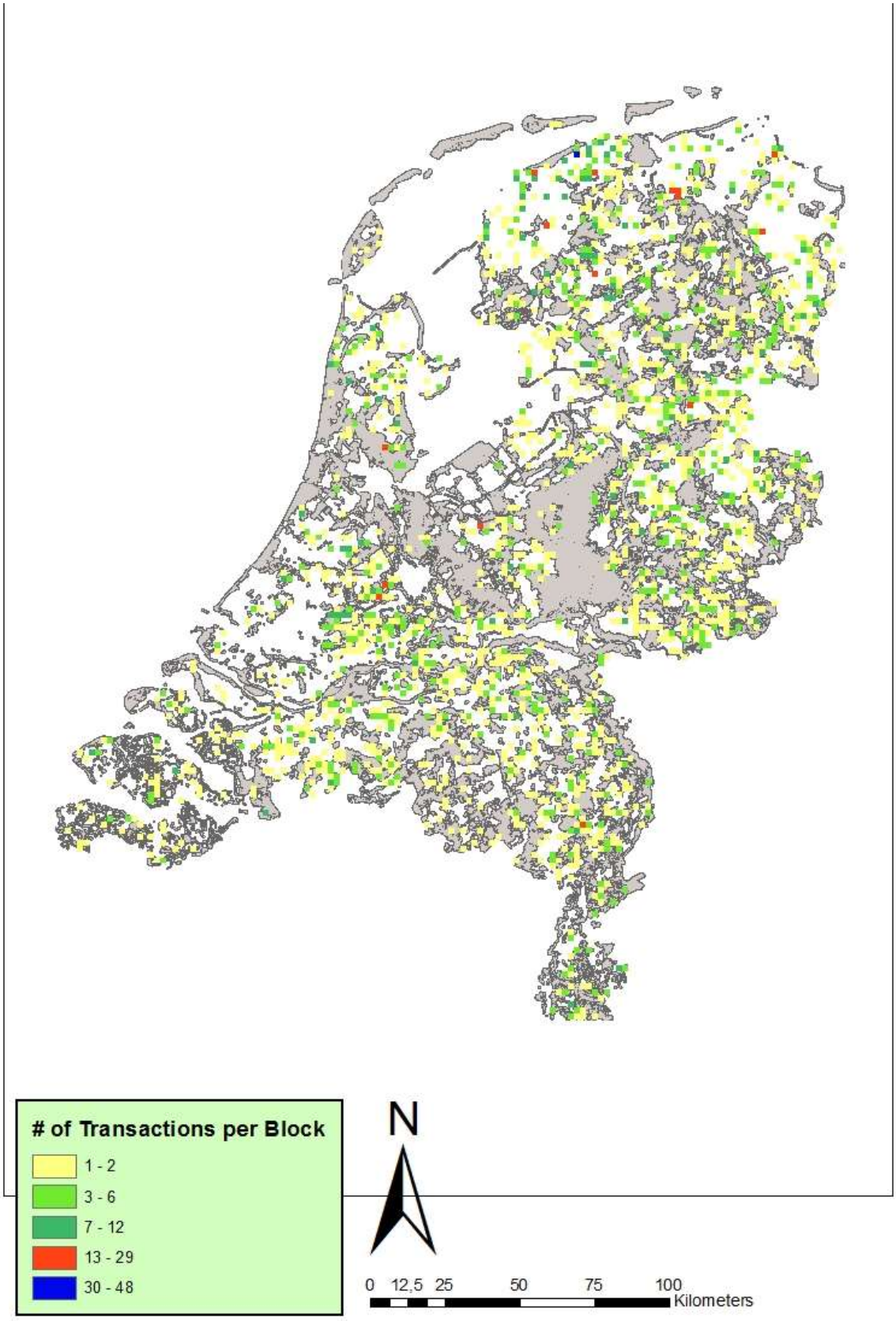

Figure 14: The number of transactions within a block and the NEN