Investigating the Announcement Effects in Flood Risk Management:
Using the Designation of Emergency Inundation Areas as a Quasi-Experiment[1]

Vanessa E. Daniel, Raymond J.G.M. Florax and Piet Rietveld

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Abstract

The use of emergency inundation areas is one of the tools dedicated to flood risk management. In the Netherlands, zones at risk along rivers are protected by dike rings. The probability of a dike break is set as small as possible and is guaranteed by the commitment to stringent norms. However, even if highly unlikely, the chance that an uncontrolled dike break occurs is real. Designating specific areas where water is allowed to flow over to prevent a dike break down stream may occur is a supplementary tool in flood risk management. The use of emergency inundation areas is meant to keep the situation under control in case of an imminent flood disaster. Discussion about the use of such zones in the Netherlands has been very animated. It was decided in 2003 to consider the use of such zones as an option to face river flood risk, but a few years later the authorities retracted this proposal. We want to investigate the reaction of households by analysing the evolution of property values a few years before proposals on emergency inundation areas had been developed and during the period of uncertainty prior to the final decision. We match similar dwellings inside and outside these areas, and compare systematically their selling prices, making use of propensity scores. We find a significant announcement effect on the average housing transaction price in 2000. It appears that a house located in the zone had a selling price about 17% lower than a similar house in the control zone. Though the final decision not to implement this decision was not taken before 2005, difference in prices then already disappears in 2001.

Key words: flood risk communication, propensity score matching

JEL codes:
C31 Cross-Sectional Models; Spatial Models; Treatment Effect Models
D81 Criteria for Decision-Making under Risk and Uncertainty
H54 Infrastructures; Other Public Investment and Capital Stock
Q51 Valuation of Environmental Effects
Q54 Climate; Natural Disasters
D83 Search; Learning; Information and Knowledge; Communication; Belief
J41 Contracts: Specific Human Capital, Matching Models, Efficiency Wage Models, and Internal Labor Markets

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1. Introduction

The relationship between water and the Netherlands has been tumultuous over the centuries. On the one hand, the country of low lands took benefit of its geographical situation as a node in inland water transportation and as a gate to the sea. The country has also taken the advantage over water by claiming land from the sea, creating *polders* for various purposes. But on the other hand, the country had to struggle to maintain water safety levels as high as possible. If no appropriate water safety infrastructures were present, about two thirds of the properties in the Netherlands would lie under water, either sea- or fresh water. These infrastructures have been conceived during the course of the century. The most recent major update took place in the 1960s, after an extreme flood killed about 2,000 persons in 1953. Because of both the evolution in land use and the rising uncertainties related to climate change, new directions are actively investigated to adapt flood management to nowadays' needs. One of them is the use of *emergency inundation areas*.

The idea underlying the use of an emergency inundation area is to reduce the risk of a large scale uncontrolled flood by letting water flowing in a pre-designated area. By making the flood event under control it is expected to reduce the overall costs of the disaster. In the past it used to be natural to let water flow in specified regions in case of flood threat. But the use of floodplains in the Netherlands disappeared over the centuries; the last emergency floodplain to loose its status was the Beersche Overlaat in Brabant. There are two main reasons for this. First, technical advances allowed the strength and height of dikes to be enhanced, rendering the use of emergency inundation areas less attractive. Second, demographic growth has lead to more pressure on land use. The Luteijn Commission (2002) also mentions the fact that flood risk has been little by little disregarded by populations as the last event died out in memories. But the high water in the river Rhine that happened in 1995 has necessitated the evacuation of 250,000 persons, and flood risk management has been completely reassessed, allowing for the consideration of reintroducing the use of emergency inundation areas. If river flow is controlled, the water level does not increase downstream and the dikes can guarantee the required safety level. A large scale evacuation and a flood in an unpredictable zone with a large number of victims and high damage are then largely avoided. (Luteijn 2002). Then the overall costs related to a large scale disaster may be reduced owing to such a decision. These costs include the number of victims, material and non-material damage, and social disruption. It can further be argued that if no decision is taken in advance, the authorities may decide in last-minute to make use anyway of an emergency inundation area in order to save endangered downstream locations; it is better to take such a decision in advance (Luteijn 2002), so that the population has time to prepare, municipalities have time to adapt their emergency plans, and the government can take measures to limit damage and enhance efficiency and safety resulting from the use of floodplains.

Discussions about the use of such zones in the Netherlands have been very animated in the last decade. After deciding in 2003 that the use of such zones may be an option to face river flood risk, the authorities retracted this proposal in 2005. If emergency inundation areas would have been implemented, house prices in the concerned areas would have logically been lowered, compensating for the increased levels of flood risk and evacuation risk. We want to investigate if announcing the use of these zones had an impact on prices.

To do so, we analyse the evolution of property values a few years before flood risk communication had been initiated and during the period of uncertainty prior to the final decision. We use risk communication as a quasi-experiment, in which some locations are non-randomly affected to the potential emergency inundation areas, hereafter noted EIA. The structure of the paper is as follows. We first present the mechanisms by which house prices may be affected by the implementation of, and beforehand communication on, EIA. This is followed by a description of the risk communication process in itself and of the selection process of EIA. Propensity score matching is presented and applied in a specific EIA, the Ooijpolder. Some concluding remarks follow.

2. Risk communication and economic consequences

The use of emergency inundation areas, as well as its announcement, is expected to be associated with lower property values. We present two underlying mechanisms that can be related to each other: a modification in risk perception, and an anticipation on the consequences related to the use of EF.

A risk is typically defined as a chance of occurrence of an adverse event weighted by some expected damage; it is then expressed as the product between a probability and an expected loss value. Though a given risk may have a definite given value, it may be perceived differently among persons and across time or space. Slovic et al. (2004) presents the following distinction in risk comprehension. On the one hand, risk may be understood analytically on the basis of logics and reasoning, making use of algorithms and normative rules. On the other hand, risk may be grasped within what he calls an experiential system according to intuition and instinct. This distinction provides two complementary dimensions to risk: a conscious and an unconscious one. In the context of risk valuation, it is possible to account for these two dimensions by giving some weight to the initial risk probabilities, following the early works of Kahneman and Tversky (1979). This allows reflecting the fact that chances of gains are perceived as higher than equivalent chances of losses, and that low probabilities are in general overestimated. The difference between actual and perceived risk – perception bias – is strongly shaped by individual experience, such as actual flood experience, but also by the interpretation of available information.

Past experience influences perception by modifying image and representation of flood risks that inhabitants can have. On housing markets, fear of experiencing a flood may affect location choices, and a lower demand in housing may results in lower property values. It has to be noted that in the pre-designated EIA, flood history may be well known because of recurrent occurrences in the last century. In 1926, the zone was under water due to an extreme water tide. Then in 1945, the region was flooded again, by unnatural means this time: the Germans destroyed a dike in order to slow down the march of the Allies. Finally, in 1995, the zone was evacuated in order to avoid a large-scale disaster. This preventive measure was fortunately unnecessary. Communication on flood risk may remind concerned inhabitants of these recent bad experiences.

Next to this, communicating on flood risk may also amplify individual biases in perceptions. Announcements and mediatization processes can strongly affect perception even if the risk level in itself is not modified. In recent literature and specifically in the context of technological risks, this is referred to social amplification (Flynn et al. 1998) where stigmatization plays a prominent role.

The effective use of EAI may have both positive and negative effects. Though the balance between these positive and negative consequences is not clear beforehand, anticipation of price changes can have a direct impact on property values.

Property values may be lowered ex-ante if new inhabitants want the future damage to be already discounted in housing prices. An indirect factor may also pass though the job-market; if firms do not want to locate anymore in the concerned regions, employment may decline, lowering the demand for houses in the region.

Next to these phenomena, three factors may drive prices up, as mentioned by WL-BCC-NEI (2001). First, because of the EIA plan, new houses may not be built anymore in the concerned zone. This may reduce in the mid-term the supply of houses, pushing prices up. Second, by giving back some space to water, inhabitants may enjoy greener housing conditions, benefiting from more open-space. Finally, it could be that some people anticipate on damage compensation conditions.

3. Uncertainty related to the use of EIA in the Netherlands

This section gives some lights on the risk communication process that occurred in the last decade in the Netherlands, with a special focus on EIA. The discussion begins with the distinction of both time and space dimensions. A final word concerns some practical aspects and the legal framework.

Since the late 1990s, the technical potentials and engineering challenges of EIA have been studied by various organisations (van Haselen for RIZA (1997) with a focus on the Ooijpolder, WL-BCC-NEI (2001) with a focus on the Tieler- en Culemborgerwaard). Simultaneously, the historical use of such zones in the Netherlands is reminded in some publications (Moll (1997), Segeren (1998)).

Political interest was clearly shown off from 2000 under the motto *"better a controlled flood than an uncontrolled one"*. By the end of February 2000, the vice-minister of Transport and Water Management de Vries mentioned for the first time the potential use of *calamity polders* during her presentation of water management policy lines (in press, Algemeen Nederlands Persbureau). Negative reactions followed immediately. Figure 3 illustrates such protest.

– Figure 3 about here –

In April 2001, the government decided the instigation of an Emergency Inundation Area Commission (*Commissie Noodoverloopgebieden)*. The formal task of this commission was to give an independent advice on whether to use, in extreme cases, controlled floods as a way to reduce the consequences of a flood along the Meuse and Rhine rivers in order to limit in large parts the number of victims and the amount of material damage. This Commission published its recommendations a year later in a final report (Luteijn 2002). The use of EIA was advertised as a *cheap* tool to reduce the costs of a large scale disaster, though not being an alternative to maintenance and structural protection measures. The argumentation in favour of the use of this tool was not exclusively driven by economic analysis of the situation. Social and societal aspects, including emotional traits, also played a role. Three zones were selected: the Ooijpolder, the Rijnstrangen and the Beersche Overlaat.

These recommendations, made public at the end of May 2002, were considered as interesting by the cabinet about a month later, claiming a final decision would be taken in the coming years. But the parliament did not share this point of view and asked for further investigation. Simultaneously, inhabitants of the concerned regions opposed to the project. In December 2003, the three zones were officially reserved for a period of 10 years, and the use of EF is considered as a *serious option*. However in 2005, the government claimed that the use of the Ooijpolder and Rijnstrangen would not be cost-effective and would definitely not be used as EIA. A year later, the Beersche Overlaat shares this destiny. Table 1 provides an overview of the decision process and its timing.

– Table 1 about here –

These three zones were selected by the Commission Luteijn. The Commission restricted itself in finding appropriate zones in the Netherlands. Indeed, room in Belgium was considered as too scarce because over there the Meuse flows trough a narrow valley. Although Nordrhein-Westfalen is in theory well adapted, it appeared that floodplain had insufficient governmental support after consultation with the administration of the German state. This is why the commission Luteijn has recommended looking for an optimal coherence between floodplains in the Netherlands and compartmentation of dike rings in Nordrhein-Westfalen (Luteijn 2002).

Basic criteria for not considering a region as a potential floodplain were a high population density, or a too long distance from the river. The position of a floodplain upstream the splitting points of the Rhine has been designated as an advantage because such floodplains could in case of needs lower the water level on all the three branches of the Rhine. Six zones along the Rhine and three along the Meuse were pre-selected. These pre-selected zones had the specificity of potentially being evacuated within half a day, and all but one pre-selected floodplain lied upstream in the embarked parts of the Meuse and Rhine rivers.

A multi-criteria analysis has been carried out on the basis of social and societal aspects, chance of bringing extra risk due for instance to the presence of a chemical plant, economic damage subsequent to the inundation of the plain, and consequences to the landscape, environment and historical valuables. Farming and recreation appeared not to be determining in the final choice. As a result, the regions that have been considered as potential floodplains were the Beersche Overlaat (Meuse River), the Rijnstrangen and the Ooijpolder (Rhine River). Table 2 summarizes the overall costs related to the use or not of EIA. Table 3 summarizes some of the main features of these areas. The non selected zones are: Duivense Broek, Land van Maas en Waal, Betuwe Oost, Betuwe West and Julianakanaal bij Born.

– Table 2 about here –

– Table 3 about here –

By making use of a floodplain along the Rhine or the Meuse rivers, the water level downstream can be potentially reduced by 20-70 cm (Luteijn 2002). More precisely, the use of the Rijnstrangen would allow a reduction of ±20cm (a discharge lowered by 450m^3/s) both in Nijmegen and Tiel, and the use of the Ooijpolder would allow a reduction of ±15cm (a discharge lowered by 300m^3/s) both in Nijmegen and Tiel (RIZA (1997)). In these zones, the normative flood risk is set at 1/1250 per year. In the zones selected as EIA, evacuation chance would turn to 1/500 per year, with a chance of effectively use the EIA of 1/1000 per year (WL-BCC-NEI (2001)).

Once the floodplain has been used, it is necessary to make the region dry. This is possible by letting the water flow to the river. But an opening alone is not sufficient. Pumping is also needed. It is important to keep in mind that the shorter the period under water, the smaller the damage (Luteijn 2002). A drying period of four weeks seems reasonable: two weeks to let the water flow out and two weeks for pumping (WL-BCC-NEI (2001)).

In order to be sure that the high tide wave does not cause a flood, it is necessary to raise the height of dikes upstream. The easiest way to let the water flow in the floodplain is to get the dikes of the floodplain lower than the surrounding dikes. The disadvantage is that the water level and the precise time of inflow cannot be controlled. But this would be possible with inlet constructions (Luteijn 2002). To make sure that surrounding polders do not flood, it is necessary to get protection by dikes all around the floodplain, ie in practice heighten old dikes, the height depending on the amount of water the region can store. (Luteijn 2002).

Concerning the protection of private properties, a possibility is to build surrounding dikes, a side effect being the damage to the landscape (an illustration is to be found in Figure 1). Moreover, such a measure is very costly and it may reduce the efficiency of the use of EIA. The Commsission Luteijn limits itself to mention that the government would have to look for balanced and broad solutions with the inhabitants and local and regional authorities. The Commission mentions that safety, with or without surrounding dikes, is of primary importance, and that good evacuation paths and plan have to guarantee this fundamental safety. Concerning this specific point, a lack of concrete practical solutions has probably been one of the main brakes to popular support.

– Figure 1 about here –

The commission finds that all material damage must be completely compensated because they mainly depend on the implementation of protection measures such as surrounding dikes of main residences. This compensation should include losses in property sales. Indeed, the Commission expects that the decrease in property values will be limited by clearly claiming that all damage will be compensated by the State. If owners would encounter property values losses during the designation procedure, they would be able to claim for compensation. But no compensation would be allocated to people who would become owners after the designation of EIA. Indeed the Commission considers that if a lower selling price would be observed, the new owner would be compensated by this lower price.

4. The economic valuation of risk communication using RP

We make the distinction between two types methods, both grounded on revealed preference: the traditional hedonic price method, expanded to spatial tools and the use of propensity score matching.

Hedonic price models have been widely applied in the context of the valuation of non market goods, including environmental risks such as floods, earthquakes, and other pollution related risks. The idea underlying this type of method when applied on the housing market is that dwellings prices can be decomposed into the prices of each house component. A dwelling is then seen as a bundle of goods, including house characteristics and any other characteristics attached to the location of the house: visual amenities, social endowments, accessibility patterns, environmental characteristics, and so on… Individual willingness to pay for each characteristic of the house is obtained by regressing the dwelling price against the set of characteristics of the good.

This type of model has the advantage of giving the possibility to model the spatial relations present on housing markets. In short, the use of spatial models allows (1) to correct for the omission of variables that are spatially correlated and (2) to model the spatial correlation binding the dependent variable, i.e. house selling prices.

Applying this method in the present case would reduce to model dwelling prices as a function of the above mentioned variables, and of the location inside or outside the designated emergency floodplains. Because these zones have been designated according to criteria also affecting house prices (populations density, proximity to the river, proximity to other risks…), multi-collinearity would be a potential problem in the model. It may be difficult to disentangle the individual effect of each of these variables. Multi-collinearity would also be caused by the inclusion of the necessary municipality dummies in the regression.

We want to explore an alternative method. Instead of departing from house prices and looking at implicit prices of each of its components, we depart from each of the components of the prices, and check how the house prices are related when the components are similar, and how this relation is affected when the announcement is made.

The following discussion is based on Meyer (1995), Heckman (1998), Rosenbaum and Rubin (1983) and Dehejia and Wahba (2002).

The idea underlying propensity score matching is to compare house prices of comparable dwellings. Comparable dwellings are matched according to a similarity measure – their propensity score – which measures their propensity to be located in the designated EIA.

We consider a population (a set of locations) in which each individual (each specific site, measured at the 6-PC level) may receive a treatment (being designated as an emergency floodplain) or not (control group). We are interested in identifying if there is a systematic difference of a certain outcome of interest (the selling price of houses located on each specific site) due to the treatment. Formally, the treatment variable T is dichotomous, value 1 if inside the EF zone, 0 otherwise.

Ideally we would like to measure how far house prices are affected by the designation, once the designation is known. At the individual level, this would be measured by the following: $Y_{1, post} - Y_{0, post}$. This is the difference in the outcome variable for both states of the world, once the treatment is implemented (post). Note that before the treatment, we assume no difference exists between outcomes, so that $Y_{1, pre} = Y_{0, pre}$. This means that each individual responds to both events, being treated or not. But we can observe only one state of the world for each individual: $Y_{post} = T\, Y_{1, post} + (1-T)\, Y_{0, post}$

To overcome this missing observation issue, we would like to measure the difference in outcomes of the treated with the outcomes of comparable non-treated individuals. At the population level, given a set of covariates X, the average outcome of the treated observations is $E(Y_1|T=1, X)$, and the no-treatment outcome of the treated is $E(Y_0|T=1, X)$, which is approximated by $E(Y_0|T=0, X)$. This approximation causes the following selection bias: $B(X)= E(Y_0|T=1, X)- E(Y_0|T=0, X)$. Rosenbaum and Rubin show that conditioning on X eliminates this bias.

In a randomised experiment, the chance of being associated to one or the other group would be equivalent, so that the outcome of interest (the selling price of houses located on each specific site), could directly be compared. There would be no reason to get different values of X between the two groups.

Natural experiments, called quasi-experiments in psychology, deal with the investigation of outcome measures in treatment groups and comparison groups that are not randomly assigned; this is typically the case when the treatment follows a political decision. This is the reason why quasi experimental studies are common in social sciences, aimed at measuring the effect of social insurance programs on labour supply, the effect of taxes on labour supply and investment, where participation to social programs can depend on a pre-defined criterion.

Comparison between both groups of interest could be based on exact matching. We could compare conditional expectations for a certain value of the covariates X=x. But this solution is not adapted when the number of conditioning variables is high, as it is the case in the present paper. A way to reduce dimensionality is to make use of a propensity score.

Keeping in mind the distinction between randomised and natural experiments, we can define a propensity score as the conditional probability of being assigned to a particular treatment given a vector of observed covariates. In the case of a randomised experiment, such a score is 0.5 at the population level. Each individual has an equal chance to be assigned to one or the other group. In the case of a quasi-experiment, this score depends on a certain number of covariates describing the characteristics of each individual.

This score, not observed in quasi-experiments, is typically estimated via a logit model. The predicted value of the propensity score can then be used to construct matched samples from the treatment groups. It is possible to consider using a same unit as a control more than once; this refers to matching with replacement. Matching can be performed on the basis of stratification, or selecting (multi-)nearest neighbour, with the possibility to use a calliper (limiting matching within a maximum similarity distance). Matching with multiple nearest-neighbour allows reducing the expected variance of the treatment effect estimate, but on the other hand it may enlarge the bias by increasing the probability of poor matching. To reduce the chance of very poor matching, we can make use of calliper matching, which restricts matching to a given maximum distance (it may be then that some treated cases do not match control cases).

5. The pre-designation of the Ooijpolder as a quasi-experiment

After a short description of the dataset, we present the estimated logit models, and the matching procedure results.

Description of the dataset

We select house sales that occurred between 1995 and 2004, in the province Gelderland, located inside a circle of about 20 kilometres around the Ooijpolder. The reason why we limit our analysis to this zone is that it is the most populated designated area. Houses located in another EIA are dropped from the sample. Two characteristics of sales in the treated zone are that houses are located within a dike ring and that properties are located further than 500m from any highway. We ensure that all observations in our sample share theses two characteristics. The final dataset includes 25017 transactions, among which 410 happened in the Ooijpolder. Figure 2 illustrates the location of the treated and control groups. Table 4 and Figures 4 present some descriptive statistics of the sample.

– Table 4 about here –

– Figure 2 about here –

– Figure 4 about here –

Each observation represents a specific sale, geographically identified at the PC6 level, which corresponds roughly to the street level. Unfortunately there is no possibility to identify potential repeated sales. Besides the transaction price, we have information on a comprehensive set of house characteristics, completed by socio-economic features at the neighbourhood level corresponding to the year 2001. This information is completed by the computation of distances to the closest river and highway segments, as well as the distance to the closest entrance point to the highway. We also compute the distance of each house to the centroid of the Ooijpolder.

We estimate the propensity for any house of being treated on the basis of house and neighbourhood characteristics, including above-mentioned distances. The dependent variable is the dummy location in the Ooijpolder. We do not make distinction between the period before and after the pre-designation. Table 5 presents estimation results. We present two models, including or not the distance to the centroid as an explanatory variable.

– Table 5 about here –

We then subdivide the sample per selling year. For each of the 10 sub-samples we apply nearest-neighbour matching with replacement. This means that a same control case can be matched several times to different treated cases; the number of nearest-neighbours is set to 5. It appears that using a higher number of neighbours worsens the balancing properties of the control group, and that using a smaller number of neighbours reduces the significance of the estimated treatment effect. We make use of the Stata routine psmatch2 (E. Leuven and B. Sianesi, 2003). The outcome of interest is the transaction price. During the period of interest, transaction prices grew up very fast in the whole country (index 98.4 in the first quarter of 1995, index 214.9 in the last quarter of 2004). Table 6 presents the estimated average treatment on the treated for both the treated and the control group, the difference between transaction prices of the treated and of the controls, as well as the balancing tests of each covariate. These tests ensure that the average value of each covariate is not different among the treated and the controls. Balancing tests perform better when the propensity score is estimated on the basis of the second logit model, the one excluding the distance to the centroid as an explanatory variable. For completeness this test is also carried out for the surface of the house and for the month during which the sale occurred, though these two variables are not part of the propensity score. But it is interesting to note that the differences between the surface areas and selling months in both groups are not significant.

– Table 6 about here –

6. Concluding remarks

It has to be noted that work is still in progress and that results presented in this paper are very preliminary. The announcement effect of the designation of emergency inundation areas has been investigated by using the propensity score matching method. The propensity score has been estimated using a logit model describing the propensity for a house to be located within an emergency inundation area. This propensity appears to be a function of the relative location of the house (distance to the centroid of the Ooijpolder). This is expected to correct for the spatial dependence in prices during the matching process. A low degree of urbanization increases the probability that a house is within such a zone, as well as a relatively bad accessibility, and a residential environment. Houses close to a river are also more likely to be in such zones, as for practical reasons proximity to the river makes easier the filling and draining processes of the zone. Some characteristics of the house are also affecting the propensity score: simple houses suffering with low maintenance, and not built recently are more likely to be in the treated group.

Using these scores to match similar control and treated transactions, we find a significant announcement effect on the average housing transaction price in 2000. It appears that a house located in the zone had a selling price about 17% lower than a similar house in the control zone. Though the final decision not to implement this decision was not taken before 2005, difference in prices then already disappears in 2001.

Acceptability level of any risk is strongly affected by the fact that individuals actively take part to the risky activity. Inhabitants of the Ooijpolder apparently felt that the decision to transform their region in an EIA was imposed to them. The present study attempts to show how sensitive risk communication is in policy context. However, further work has to be conducted in order to determine the reason why difference in prices does not follow communication patterns. We intend to pay attention to the quality and quantity of information households could receive during this period, and participation in protests will be further investigated. Concerning methodological aspects, the matching process could not include proximity measures. Indeed the distance to the centroid is not systematically balanced. This is detrimental as the transaction prices of nearby houses are expected to be more similar. We would like to explore alternatives to include spatial patterns in the model.

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Table 1 – Timing of the decision process

Date	Event
28th February 2000	Presentation of water management rules by the vice-minister of Transport and Water Management de Vries; first reference of the potential use of calamity polders
27th April 2001	Instigation of the Emergency Inundation Area Commission
31st May 2002	Publication of the recommendations of the Emergency Inundation Area Commission; mentions the advantages of the use of the zones, the locations of the pre-selected zones and provides advice on compensation
3rd July 2002	The cabinet considers the recommendations of the Emergency Floodplain Commission as interesting and states that a final decision would follow in the coming years
December 2003	The pre-selected zones are officially reserved for a period of 10 years, and the use of emergency floodplains is considered as a serious option
15th April 2005	It is decided that the Ooijpolder and the Rijnstrangengebiedwill not be used as an emergency floodplain
11th July 2006	It is decided that the Beersche Overlaat will not be used as an emergency floodplain

Table 2 – Costs and benefits related to the use of emergency floodplains as designated by the commission Luteijn

	Nb. of persons to be evacuated	Flood damage (billion Euros)	Investment costs (billion Euros)
No emergency floodplain	500.000	55	0
Making use of the suggested emergency floodplains	35.000	0.7	1.25

Table 3 – Main characteristics of the emergency floodplains

	Ooijpolder	Rijnstrangen	Beersche Overlaat
Nb. inhabitants	13200 (1440 living outside the main residential areas)	450	7700
Surface in ha.	3300	2300	17000
Storage capacity (million m^3 water)	130	85	375
Average level of water in case of use as an EF (m.)	4	3.7	1.7
Main municipalities	Ubbergen, Millingen aan de Rijn	Rijnwaarden	Cuijk, Grave, Landerd, Ravenstein, Oss, Lith, Maasdonk

Table 4 – Summary statistics; dependent variable (Ooijpolder) and covariates of the logit model

	Minimum	Maximum	Mean	Std. Dev.
Ooijpolder dummy	0	1	0,02	0,127
Distance to centroid in meters	935,6	24961,7	13013,3	3734,4
Urbanisation	1	5	3,1	1,0
Construction period	0	9	5,8	1,8
Distance to the river in meters	42,6	7134,5	2325,1	1420,9
Dist. to entrance highway within 4500m	0	1	0,9	0,2
Simple house	0	1	0,0	0,2
Inside maintenance quality	1	9	3,0	1,1
Residential district	0	1	0,5	0,5

Table 5 – Estimation results of the probability of a house being located in the Ooijpolder, including or not the distance to the centroid of the Ooijpolder as a covariate; Standard errors between brackets, * 1%, ** 5% levels of significance**

	Model 1	Model 2
Ln distance to centroid	-4,725	
	(0,305)***	
Urbanisation	0,936	0,596
	(0,128)***	(0,104)***
Construction period	-0,355	-0,137
	(0,044)***	(0,034)***
Ln distance to the river	-0,850	-0,834
	(0,140)***	(0,096)***
Proximity to the highway	-0,806	-5,232
	(0,324)**	(0,236)***
Simple house	0,881	0,876
	(0,344)***	(0,303)***
Inside maintenance quality	0,149	0,117
	(0,067)**	(0,054)**
Residential district	0,501	0,275
	(0,159)***	(0,129)**
_cons	41,886	2,633
	(2,987)***	(0,828)***
Log likelihood	-640,877	-938,939
Pseudo-R2	0,6937	0,5512
LR Chi2	2902,63***	2306,51***

Table 6 – Balancing properties of the covariates after matching and average treatment effects per year

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Balancing properties										
Model 1										
Ln distance to centroid	Ns.	Ns.	Sign.	Ns.	Ns.	Sign.	Ns.	Sign.	Sign.	Sign.
Urbanisation	Sign.	Ns.	Ns.	Ns.	Sign.	Ns.	Sign.	Ns.	Ns.	Sign.
Construction period	Ns.	Ns.	Ns.	Ns.	Sign.	Ns.	Ns.	Ns.	Ns.	Ns.
Ln distance to the river	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Sign.
Proximity to the highway	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.
Simple house	Ns.	Sign.	Ns.	Sign.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.
Inside maintenance quality	Sign.	Ns.	Ns.	Ns.	Sign.	Ns.	Ns.	Ns.	Ns.	Ns.
Residential district	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Sign.	Ns.	Sign.	Ns.
Model 2										
Urbanisation	Ns.	Sign.	Ns.	Sign.	Ns.	Ns.	Ns.	Sign.	Ns.	Ns.
Construction period	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.
Ln distance to the river	Ns.	Sign.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.
Proximity to the highway	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.
Simple house	Ns.	Ns.	Ns.	Sign.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.
Inside maintenance quality	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.
Residential district	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.	Sign.	Ns.
Number of transactions	1700	1798	2025	2459	2469	2571	3040	3046	3019	2892
Among which in the Ooijpolder	17	28	36	46	35	40	55	56	48	49
Average transaction price of the treated	106838	122407	150929	153192	193907	203145	261155	264094	244464	258980
Average transaction price of the matched controls (model 1)	115379	134095	140752	141150	171906	247479	259620	275443	245078	260430
t-stat	-0,99	-1,28	0,78	1,04	0,89	-1,71	0,05	-0,37	-0,03	-0,08
Relative difference in transaction prices	-7,4%	-8,7%	7,2%	8,5%	12,8%	-17,9%	0,6%	-4,1%	-0,3%	-0,6%
Average transaction price of the matched controls (model 2)	102752	129222	154650	160928	213523	245800	261117	261000	253042	238235
t-stat	0,48	-0,77	-0,31	-0,63	-1,06	-2	0	0,14	-0,55	1,38
Relative difference in transaction prices	4,0%	-5,3%	-2,4%	-4,8%	-9,2%	-17,4%	0,0%	1,2%	-3,4%	8,7%

Figure 1 – A virtual example of a village (Leuth) surrounded by protection dikes (present situation (left), virtual protection dikes with (right) and without (centre) water (design found on the HoogWater platform website)

Figure 2 – Observed house sales in the treated and control zones

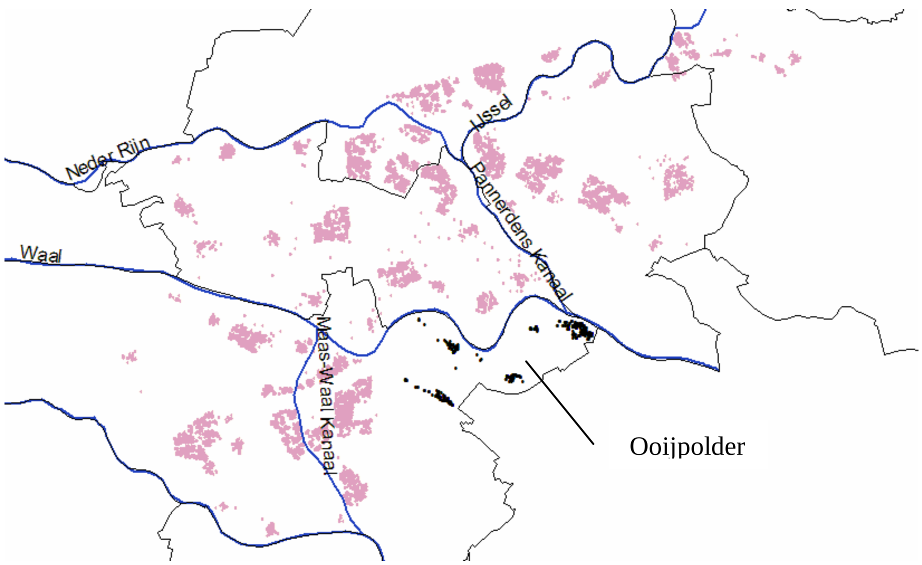

Figure 3 – An example of local protest
EMERGENCY FLOODPLAINS?? AN INSANE AND INHUMAN PLAN. WE DON'T WANT TO BE THE NATIONAL BATHTUB.