Economic Scenarios of Flood Risks: A Look at Regional Development[1]

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Paper prepared for
the 45th Congress of the European Regional Science Association
"Land Use and Water Management in a Sustainable Network Society",
Vrije Universiteit Amsterdam, 23-27 August 2005

Abstract

Protection from the threats posed by water in the Netherlands has a centuries old history. Remarkably, if one takes a historical prospective, it becomes apparent that water protection policy has not changed much through time. In fact, one may detect a certain "path dependency". Today many experts agree that technocratic philosophy of raising dikes (though now upgraded with certain new techniques for water retention) has reached the limits of its development cycle. This means that new solutions have to be found to guarantee long run sustainability under conditions of increasing risk of sea level rise. A number of implications for regional development are addressed in this paper.

We will present a novel way of thinking about the complex flood protection problem in a densely populated country with a highly developed economic network. We present a first effort to model major distortions caused by natural disasters using an adapted Input-Output (I-O) model. In contrast to the existing I-O models, our model is able to deal with production disturbances and emerging disequilibria on the market, which has not been the case before. As a result, we can explore various flood scenarios and describe possible recovery paths. Here we shall focus our analysis on the regional structure.

The Western provinces of the Netherlands, the areas most prone to flooding, are industrially highly developed. Once such a province has been hit, this may have direct and indirect consequences for other regions in the medium and long term. For example, other (peripheral) areas of the country may experience an incentive for output growth, overtaking the lost production from the central part to satisfy demand needs. We discuss how a multi-regional approach may enhance the exploration of changes in the spatial and sectoral landscape of a country on the example of a major flooding in the Netherlands. Furthermore, this may have implications for the bordering countries as well as for specific parts all over Europe.

Our proposed approach is not only a device to study possible regional change as a result of a disaster; it can also serve an instrument for policy advice. This may assist policymakers in thinking about the long-run dynamics in regional development strategies.

Key words: flood consequences; economic network; long-term policy; input-output model; regional development.

[1] Preliminary version, please do not quote without the permission of the authors.

1. *Introduction*

Nowadays natural disasters are becoming more important than ever before. It is hard to resist their nature if they come unexpectedly or prevent them from happening in the future. Even on the contrary, some experts expect various extreme weather events to increase in number. Thus, we have to learn to live with them, adapting accordingly. This means, we have to look far ahead in making today's choices.

In this paper we are presenting a tool to analyse regional development subject to the long-run flood-protection strategies. Today the world is experiencing frequent extreme disasters, such as tsunamis, earthquakes, floods and tornadoes. As appears from different sources ((IPCC 2001; WWF 2004), etc) this trend is on the increasing path. The reasons named are mostly climate change, as a result of which natural balances are being altered, and the consequences of which are virtually unpredictable. However, it is becoming widely recognised that unscheduled extreme natural events will form a part of our future, therefore we need to take the unexpected into account when thinking about the development trajectories.

The focus of this paper is the specificity of regional challenges. Regions and regional policy are one of the important spheres in the achievement of sustainable development. In the European context it is essential that the countries and regions of the countries be developing in a coherent manner and no major differences in the economic welfare exist among them.

The paper is organised as follows. First, in Section 2 we will introduce the issue of disasters in the Netherlands. After that, in Section 3 we will particularly focus on the issue of regions and the purpose of regional analysis. Next, in Section 4 we will present the state of art in the analysis of disaster effects, which will be followed by the presentation of the core model developed by the Twente group as one of the ways of thinking about analysing large-scale shock problem in Section 5. This will form the basis for drawing some sample scenarios to illustrate the suggested approach for the case of a hypothetical vast flooding in the central part of the Netherlands (Section 6). Thereafter we will discuss the policy implications for regional development (Section 7). Conclusions in Section 8 drawn from this extended analysis are closing the paper.

2. *The Dutch and the water*

The Netherlands has a long history of dealing with water. For centuries, the Dutch were building up dikes forming a complex system of polders. The techniques of protecting from the high water were advancing, but virtually up until the 20th century the Netherlands has seen merely "technocratic" solutions of water-related problems. Currently primary and secondary dikes are protecting the country and have their own purposes. Primary dikes are the ones built along the coast and along the main rivers. Secondary dikes are the ones limiting the artificial water reservoirs and canals. The water level in these artificial storages can be regulated by men (pumping the extra water back to the rivers and the sea).

The devastating flood of February 1953, caused by the failure of the sea dikes due to the combination of high tide and a heavy storm, has at once put the existing at the time protection system under a question mark. It became a crucial point also in politics to rethink the system in place and to look for new solutions. Although the research into the matter was launched, no drastic changes in the approach were adopted as a result of it. Delta works we started in 1960's - a new technology but virtually the same philosophy: keep the water away behind the built structure - sluices. Finally, after the successive threatening floods in the downstream of the Meuse river in 1995 and 1998 the turn in the way of thinking became more visible. Proving the ongoing crisis in the established technology of protection against the high water these events have provided a major push for the switch in the protection philosophy. More investigation had been asked for.

According to the recent RIVM report "Dutch dikes and risk hikes. A thematic policy evaluation of risks of flooding in the Netherlands" ((RIVM 2004), p.12) currently the Netherlands is not protected enough from the threat of flooding, both from the sea and the rivers. The quote makes it crystal clear:

> Dams in the Netherlands have never been stronger… Yet the risks of causalities and economic damage have become much greater since <1953>.
>
> This controversial statement has been largely attributed to a creeping discrepancy between the existing set of design standards for dike strength used for dam assessment and reinforcement programmes in the Netherlands, and a steady social and economic development. These standards, set down in national law are, to a large extent, based on insights from the years 1953-1960. The present spatial distribution of economic interests of 'dike rings' is no longer in accordance with the spatial variation of these

> economic security standards. Besides, it seems like the public no longer considers flooding in the Netherlands to be a natural hazard…
>
> A further increase in flooding risks is expected due to the rise in sea level, climate change and further economic and social development. Technical solutions no longer form the sole answer to this increase. Up till now focus has been on reducing chances of dike breaches by technical means. Efficient solutions in spatial planning have been overlooked… Political support is essential: the past has shown that this support rapidly declines after disasters.

It is absolutely remarkable that the report virtually states that the policy with respect to the protection from the high water in the country is just myopic: the standards are retrospective, not taking into account the increasing threats of the future. Moreover, what is more remarkable and even shocking is the resistance to recognise the problem on the part of the general public. They consider it more comfortable not to take any account of living on lowland, which actually keeps the probability of a flooding positive (though low) at any point in time.

The main conclusion of the RIVM report ((RIVM 2004), p.13) is: "The current safety policy does not lead to the 'safe and fit for habitation' Netherlands as it has been provided by the determination of the safety norms of 1960… The safety norms are not (no longer) cost effective with regard to the spatial distribution of the economic assets… Economic values and the live of people are less protected than it has been provided in 1960".

The report claims that it is even not about the dikes and thus technological response to the threat of flood. What is asked for is spatial solutions as the dynamics of economic asset accumulation as well as human settlements have been overlooked for decades by the former generation of planners. Not the standards of the today are to be taken as a threshold for the drawing up and the implementation of current protection paths, but the standards taking into account future developments in the country.

Realising that, the government at the moment is promoting the new philosophy of giving more space for water. In 2004 the reports "National Spatial Strategy" (VROM, LNV et al. 2004) and "Peaks in the Delta" (MEA 2004) were published by the government marking the change in the thinking about water. This practically means that on the one hand, new strategy of protection against floods is being put in place. On the other hand, a new spatial planning is under way involving many more interested parties, which may change the pattern of future human activity distribution.

The arguments drawn above are only a snapshot of the wider public, political and academic discussions going on in the Netherlands. However, it provides strong evidence in favour of the conclusion about the significance of the moment for the decision-making that may have enormous influence on the future of the country.

3. The regional dimension

The previous section has discussed the state of affairs in the Netherlands with respect to the flood protection issues and current strategies. We have learnt that the government is taking effort to promote the implementation of the new spatial solutions to the problem of water management within the country. Still, we would argue that even this change in the approach is not yet enough for the 'global' solution. We suggest that the broader international regional dimension should be added to the approach. Nowadays, when European Union is operating virtually without inner borders, one may not neglect the complex economic interactions between regions across the political country borders. This is especially true for a country like the Netherlands, which has always had strong economic ties with other countries. Thus, we should analyse the advantages and disadvantages such an open international position brings while thinking about the consequences of a large-scale disaster within the country.

Let's start with the definition of a region. In principle, the term 'region' means many different things and can be approached from many different angles – geographical, historical, cultural, social, economic and political. Groups of countries (like Latin America or Europe), groups of provinces (like the Western part in the Netherlands), countries and provinces on their own, counties (like in the US where the scale of the country is relatively big) or even smaller localities can be referred to as regions. However, independent of the chosen angle of analysis it is clear that its main characteristic is the spatial dimension. This or another way, the definition of the region in a particular research predefines the scale of the analysis. It should also be expected that the choice of the analytical demarcation of the territory under exploration be connected to the research problem at hand.

For our investigation of vast disaster consequences in general the choice of scale is quite a task. On the one hand, it is of interest and importance to look at the larger picture of meso- and macro-effects a calamity incurs like within a province or a country rather than limiting oneself to the microanalysis of the damage within the locality in question. For example, it can be essential to know to what extent a country is vulnerable to a shock like a large-scale

flood in terms of lost GDP. Consequently, one is looking at the hit area in the framework of the whole country. On the other side, if the country is big, then the effect even of a large calamity may not be considerable at all for the overall GDP. This is in particular an example of the US, Canada, and other relatively big nations. Then, it makes sense to concentrate on the state or county level, as probably the wider significant effects will not be in place. Another limitation for the choice of a desirable scale and the level of detail is data availability.

As far as we are especially exploring the case of the Netherlands, we may consider taking a look at least at the provincial level of damage incurred by a major flood. The latter is defined roughly as the one comparable to that of 1953 when 1800 people went dead[2]. However, the Netherlands is a densely populated country with a highly developed economic network, which makes it logical to look for the national effects like indirect damage in the rest of the country. It is a convenient scale of analysis relative to the size of the country the disaster consequences are likely to have national reflection. Moreover, the national level is the one where the financial decisions are made and thus it is the country who is taking the burden of losses of lives and assets. In addition, national statistics are usually available as well. At the same time, if we look at the European map, the Netherlands is a small country (with an open economy), which makes one question whether a number of bordering regions in Belgium and Germany make sense to be included to extend the analysis.

Looking for a more normative tag in region definition, one may find it in the official EU statistics. Eurostat has established the Nomenclature of Territorial Units for Statistics (NUTS) more than 25 years ago in order to provide a single uniform breakdown of territorial units for the production of regional statistics for the European Union (Eurostat 2005). In 2003 the legal basis, a Regulation of the European Parliament and of the Council on the NUTS, was adopted. The NUTS is a three-level hierarchical classification and it favours institutional breakdowns of the nation states. The NUTS nomenclature serves as a reference for the collection, development and harmonisation of Community regional

[2] Rose (2003, p.4) provides a sort of operational threshold for the large-scale catastrophe definition: "2% or greater output reduction in the economy affected". Though, he does not make any particular temporal or spatial scale tag (i.e. whether he refers to the county, state or nation), leaving it to the discretion of a particular research.
Rose, A. Z. (2003). A Typology of Economic Disruptions. 50th Annual North American Meetings of the Regional Science Association International. Philadelphia, PA, USA..

statistics; for the socio-economic analyses of the regions[3] and for the framing of Community regional policies (for the purposes of appraisal of eligibility for aid from the Structural Funds, regions whose development is lagging behind (mostly concern NUTS 2 level regions concerned by Objective 1; under some priority Objectives at the NUTS 3 level)[4]. To visualise the nomenclature, the maps of all the NUTS levels are included in the Appendix I.

For the purposes of our analysis we choose to concentrate on the level, compatible to that of NUTS1 or NUTS2. This choice can be justified by a number of reasons. First of all it is our goal to broaden the spatial dimension of the conventional modelling beyond the country level, for example adding explicitly the adjacent regions of the bordering countries. Second, the regions can be a more useful unit of analysis that a bordering state, as during the aggregation to the country level important regional details are left behind. Moreover, one may also assume that following the gravity theory most transactions are taking place between the areas found geographically closer to each other. Provided the industrial cluster of the Rhine-Ruhr area in Germany in the vicinity of the Dutch border, this seems to be a reasonable level to stop at. Thus, we suggest viewing the disaster analysis in the Netherlands in terms of multi-regional international setting. Particularly, one may think that it may cover "Province (the Netherlands) – Bundesland (Germany) – Gewest (province in Belgium)" framework.

4. The state of research

Independent research on the large-scale flooding carried out in the academic spheres as well as the investigation ordered by the government point out at the need for the longer time perspective to be accounted for in decision-making. The attempts at estimating the consequences of a large flood in the Netherlands are available by now (see e.g. (Briene, S.Koppert et al. 2003)). These studies, however, use different methodologies, partly involving different sets of concepts and definitions. Differences exist, e.g., in the treatment of direct and indirect costs, the role attributed to substitution effects, and the statistical database. Consequently, outcomes will differ from ours in a number of ways. A recent

[3] The socio-economic analysis is carried out on the following levels: NUTS 1 - major socio-economic regions grouping together basic regions - should be used for analysing regional Community problems; NUTS 2 - Basic regions - the appropriate level for analysing regional-national problems, NUTS 3 - small regions - to establish specific diagnoses or to pinpoint where regional measures need to be taken.

[4] More information is available on the Eurostat website http://europa.eu.int/comm/eurostat/ramon/nuts/home_regions_en.html

Centraal Planbureau publication presents a cost-benefit analysis of infrastructural alterations of river courses (CPB 2000) with only limited attention for typical indirect effects of the type we are interested in. Virsou and Kok (Vrisou van Eck and Kok 2001) offer the so-called 'standard method', using unit loss functions.

For other approaches on the international arena, among the recent publications see Rose (Rose and Lim 2002; Rose 2004), Cole (Cole, Pantoja et al. 1993; Cole 1998), Cochrane (Cochrane 1997; Cochrane 2003), Okuyama and Chang (Okuyama, Hewings et al. 2002; Okuyama and E.Chang 2004), or (Freeman, Martin et al. 2004). Existing analytical frameworks include Computable General Equilibrium, Input-Output, Macro-models, Linear programming variants and SAMs. All have their strong and weak points. However, generally speaking, all models suffer from malfunction at least in one of the two respects: first, most do not provide clear insight in the immediate post-disaster situation; second, some lack a convincing geographical dimension.

We intend to addresses these points. The Twente group have been carrying out research on the large-scale shock modelling with the particular focus on the Input-Output techniques. We were looking for a methodology that will give us insight in the concepts of economic vulnerability and adaptability after a 'large-scale' event. In this area, conceptual matters and data aspects still dominate the agenda to a large extent. Nonetheless, a certain agreement seems to exist on the strategy for such research. One tries to obtain insight about the post-disaster surviving capacity, thereby focusing on direct and indirect effects. These arise as a result of disruptions in sectoral purchases and inter-industry supply and demand imbalances.

For example, the Twente group have recently developed a new method to establish post-disaster surviving capacity based on a (new) decomposition of the economy's transaction matrix (Bočkarjova, Steenge et al. 2004). Provided the knowledge on the economic assets that remain physically intact after a disaster, recovery should be modelled. Here a lot depends on the combination of a number of factors. In the literature (Cochrane 1997) the following is mentioned: the strength of the shock itself; the ability of the businesses to react on that shock; and the ability of the government to steer the recovery and reconstruction processes. As far as one disaster is different from another, it is sensible to examine a number of scenarios providing a range of post-disaster possibilities. Thus, obtaining total cost figures for each exercise, we would get an impression about the respective total costs involved. At the same time, scenario work would enable us to

compare the economic costs of various options. On this basis, policy proposals can be developed with respect to steering economic adaptation in the desirable directions.

5. *The model*

We suggest one of the ways one may think about major catastrophes and their consequences. We are of the opinion that a two-step procedure should be involved. Literally, the economic mechanism of disaster evolution can be translated as follows. Large-scale flood if happen in the Netherlands inter alia would impact businesses, bringing disruption in the established economic network. Damage incurred at the production facilities that appear to be in the flooded area is counted as a direct loss. The dropping out of some businesses from the established network will inevitably lead to the failure of a part of the system, resulting in the countrywide disturbances in production and consumption. In addition to that some businesses outside the flooded region and even outside the country may experience disturbances as their suppliers or customers are not able to fulfil their obligations anymore. The businesses suffering this sort of secondary damage are counted as indirect loss. Thus it is important to realise at this point which of the activities remain in business and which are (temporary) dysfunctional. Here we will shortly outline the model introduced in (Bočkarjova, Steenge et al. 2004) to describe such processes.

The model presented is an Input-Output type. However, it is given more flexibility. It proceeds as follows. First, we take the standard open I-O model as a starting point. We have:

$$x^0 = A^0 x^0 + f^0, \qquad [1]$$

where x^0 and f^0 respectively stand for total output and final demand vectors, and A^0 – for the matrix of input coefficients in the initial situation before the flood. Let's also introduce the labour market as an essential factor in the analysis of a major adverse shock. In the I-O notation we have:

$$L^0 = l^0 x^0 \qquad [2]$$

Here L^0 represents total labour supply csalar and l^0 - the vector of direct labour input coefficients in the situation before the flood.

We now shall try to reconstruct the state of affairs in the economy, directly after a flood, accounting for those parts that are *not* directly damaged and, in principal, remain active.

We shall assume that a reduction in the sector's labour input requirement directly translates into a corresponding reduction in final demand as given in [1][5].. With this in mind, we shall rewrite the model ([1], [2]) as:

$$x^0 = A^0 x^0 + \left[\left(\frac{f^0}{L^0} \right) l^0 \right] x^0 \qquad [3]$$

Now let us define the inter-industry transactions matrix M^0:

$$M^0 \equiv \left[A^0 + \left(\frac{f^0}{L^0} \right) l^0 \right] \hat{X}^0 \qquad [4]$$

The elements of M are the sum of the flows of intermediate deliveries and the imputed parts of final demand. We have, for each individual element of M^0 *just before* the shock:

$$M_{ij}^0 = Z_{ij}^0 + F_{ij}^0, \qquad [5]$$

where $Z_{ij}^0 = A_{ij}^0 x_j^0$ - nominal inter-industry transaction matrix, and where F_{ij}^0 is the i^{th} element of $\left(\frac{f^0}{L^0} \right) l_j^0 x_j^0$, nominal intersectoral final demand. It may be though of as if a bundle of final goods consumed by the employees of each sector.

So, with the fraction of productive capacity that is *lost* in sector i denoted by γ_i, we now can write:

$$M^0 = \begin{bmatrix} \gamma_1(Z_{11}^0 + F_{11}^0) + (1-\gamma_1)(Z_{11}^0 + F_{11}^0) & \cdots & \gamma_n(Z_{1n}^0 + F_{1n}^0) + (1-\gamma_n)(Z_{1n}^0 + F_{1n}^0) \\ \vdots & \ddots & \vdots \\ \gamma_1(Z_{n1}^0 + F_{n1}^0) + (1-\gamma_1)(Z_{n1}^0 + F_{n1}^0) & \cdots & \gamma_n(Z_{nn}^0 + F_{nn}^0) + (1-\gamma_n)(Z_{nn}^0 + F_{nn}^0) \end{bmatrix} \qquad [6]$$

We can re-write this equation, splitting it into two parts. Thus we can single out the elements that represent firms that remain active. Then, if we denote the total of the i^{th} row entries by the symbol x_i, we have, in input-output 'fashion', the following.

$$\begin{bmatrix} (1-\gamma_1)Z_{11}^0 + & \cdots & + (1-\gamma_n)Z_{1n}^0 \\ \vdots & \ddots & \vdots \\ (1-\gamma_1)Z_{n1}^0 + & \cdots & + (1-\gamma_n)Z_{nn}^0 \end{bmatrix} + \begin{bmatrix} \sum_i (1-\gamma_i)F_{1i}^0 \\ \vdots \\ \sum_i (1-\gamma_i)F_{ni}^0 \end{bmatrix} = \begin{bmatrix} x_1 \\ \vdots \\ x_n \end{bmatrix} \qquad [7]$$

[5] However, we shall assume that proportions within the final demand basket remain the same.

The above equation system evidently ‘looks like’ an I-O system. But is it? This equation is called “Basic equation” and gives a systematic representation and ordering of production capacity that is still intact immediately in the post-disaster situation. It has the form of a system of inequalities written in a format derived from I-O accounting. However, it cannot be interpreted as an I-O system because row and column totals do not balance (which is the consequence of the disruption in linkages).

During the second step, the Basic equation becomes our point of departure for a systematic investigation of the options open to the economy when entering the post-disaster period. Whenever production network is disrupted, companies remaining in business have to make choices about their future trajectories. This means that the recovery of the whole system depends on the way the businesses concerned are able to adjust to the critical situation, find new solutions, deal with the problems. They may be facing such questions as: Where new customers will be sought? Should new suppliers be found? New markets? New production locations? New strategies? New technologies? As the businesses react to the new circumstances and make their choices, we may eventually see a newly evolving economic landscape in the aftermath of a disaster. The equation [7] from step One enables us to relate each recovery options (such as buying supplies domestically or abroad) to a specific cost total (with associated break-down in sub-categories). Next, the various recovery and reconstruction options can be classified according to criteria based on these cost calculations.

However, the way one wishes to proceed the analysis may differ. Obviously, the I-O framework can be followed to ‘extract’ the real balances from the Basic Equation and model the recovery paths. At the same time, models alternative to I-O can be used, like CGE to study the recovery of the economic system in the aftermath of the disaster under the assumption of flexible markets and prices. This is actually a matter of choice and proficiency.

It should also be kept in mind that the model so far as outlined above is yet a single region one. The extension to the bi-regional or multi-regional framework follows the same principle of a two-stage procedure.

Let us now analyse the disaster consequences based on the described model brought in the multi-regional dimension as set forth in Section 3.

6. The regional disaster mechanism

Provided the data for interregional I-O tables, the framework can be expanded to the analysis of links between the regions. First, we will briefly describe the multi-regional IO table. It is a table possessing the same properties as a usual IO table. In general it may be of the type as seen from Table 1. However, in addition to the sectoral sales (row entries) and purchases (column entries) the transactions between the regions are reflected, often by sector as well. The final demand and the value-added entries are also broke down by region. In this way, more insight into the complex economic network is obtained.

Table 1. Expanded Flow Bi-regional Input-Output Table

		Processing sectors (purchases)		Final demand		**Total output**
		Region R	Region N	Region R	Region N	
Processing sectors (sales)	Region R	$\mathbf{A^{RR}}$	$\mathbf{A^{RN}}$	F^{RR}	F^{RN}	$\mathbf{X_i^R}$
	Region N	$\mathbf{A^{NR}}$	$\mathbf{A^{NN}}$	F^{NR}	F^{NN}	$\mathbf{X_i^R}$
Payments sector	Value added	W_i^R	W_i^N	W_F^R	W_F^N	**W**
		N_i^R	N_i^N	N_F^R	N_F^N	**N**
	Imports	M_i^R	M_i^N	M_F^R	M_F^N	**M**
Total outlays		$\mathbf{X_i^R}$	$\mathbf{X_i^N}$	$\mathbf{C^R}$	$\mathbf{C^N}$	**X**

On the provincial level, a flood (in principle any disaster) is hitting businesses in the province in question and in other provinces via the mechanism of direct and indirect loss (as described Section 5). However, besides the costs side of a disaster, one should necessarily consider the possible benefits to complete the analysis. A calamity is not only a threat to the economy, it opens the opportunities as well. The companies in the areas outside the flooded region within a country may eventually experience an incentive to

increase output, as their rivals in the flooded area are not able to ship anymore. This is the so-called substitution effect. If this effect is in place, the total loss figures of the country due to a calamity may be decreased, as new economic activity is created. However, if substitution comes from abroad (via imports), i.e. other regions in other countries, it will have only a limited positive effect during the immediate recovery. Imports will only satisfy instant shortages in consumption, the final demand. In case the (temporary) overtaken production by the companies abroad does not "return" to the country after the recovery from a disaster, the long-run effect of the import substitution will be negative. This happens due to the fact that the disrupted linkages in the intermediate production structure are not restore and the value-added is not generated at home anymore, thus leading to the lower level of the long-run development path.

Let us discuss the case of the Netherlands, now in the international context. Traditionally, in the Netherlands the Western provinces like South and North Holland are the most industrialised ones. Together with the central part of the country up to Utrecht they form the Randstad area. Thus they constitute the core of production of value added in the country, where 50% of GDP is earned on 25% of the territory. As pointed out in Section 2, the accumulation of economic values in the low-laying area in the country during the past decades has lead to the substantial increase in the risk connected to a possible flooding. In addition to that, the recent RIVM report (2004, p.55) reveals eight weak points in the primary coastal dikes, which brings the odds of a flooding to a much higher level than the general public used to assume. Found below the sea level, the provinces expose themselves as the most disaster-prone areas of the country. Thus, in case a flooding comes, some parts of Randstad metropolitan area may become temporarily dysfunctional. However, while some companies in other provinces will suffer losses after their partners become suddenly out of business, others may consider a chance of taking over the lost production. This may actually lead to the restructuring of the whole economy both sectorally and spatially as some activities are lost and others become created, thus altering the established status quo between the provinces. This rebalancing within a country, if significant, may ultimately have repercussions on the regional composition in the bordering countries, as well as in the general European landscape.

The way the reshuffling between the regions takes place depends on a number of aspects. The new economic geography theory (NEG), gaining nowadays ever more popularity (see, for example (Fujita and Thisse 2002)), suggests the division between the regions into the

so-called ‘centre’ versus ‘periphery’. Due to the existence of two core reasons, the spatial dimension and thus the imperfect competition on the markets situated in different spatially distributed areas, and the existence of transportation costs, at some point the ‘centre’ becomes the area where the concentration of production as well as consumption takes place. The more businesses are operating in the area, the more the increasing returns to scale production mode are observed, thus creating the so-called ‘centrifugal’ forces that attract even more and more businesses and labour to the area. Other areas, that do not possess the described features are called ‘periphery’. This is a nominal division, roughly separating in analytical way the dynamically developing regions from the more static ones. Depending on the scale of analysis, the central and peripheral regions can be distinguished as within a country (like the industrialised West in the Netherlands versus the East and the North of the country) or within a larger unit, like Europe (here the “Blue Banana” seems to represent the agglomerated ‘centre’).

Provided the evidence of the economic geography theory, our analysis may be given another twist. The NEG theory actually offers the explanation of the accumulation of the agglomeration effects, though not explaining why ‘centres’ are found at the locations they exist. We are not aiming at filling this gap in this paper, though we may suggest how some possibilities emerge for regions to gain this central position and how they can be realised. If we assume that a disaster hits such a ‘central’ region, will it be restored and maintain its position or will the conditions be created for other peripheral regions to gain more importance? Or will other agglomerations take over the loss of the flooded ‘centre’? These are the crucial questions to be answered.

Applying the conception just outlined, we may get the following. Whereas one considers the regions within the Netherlands as the unit of analysis for a hypothetical large-scale flood, its Eastern, Southern and Northern provinces may be considered as the ones possibly able to overtake the production (for the moment) lost in the flooded area. Being able to maintain the increased manufacturing volume, these provinces may experience an overall revival of activity, both in the production and consumption. The ‘peripheral’ areas thus may gain more dynamics and ultimately the ‘agglomeration’ momentum, growing into the new ‘centre’.

However, a look at the map of Europe suggests that the Netherlands is a relatively small country, and the close proximity of the Ruhr-Rhine agglomeration would make a difference in the province importance logics. Economic actors, instead of moving their

activities within the Netherlands (in the end forming new 'centres') may seriously consider the advantages of shifting their attention to the already existing saddle points. Germany, France, Belgium and the UK are the countries offering closest 'clustering' possibilities.

Although the Netherlands is situated in a strategically important position, possessing a major seaport (Rotterdam) and one of the Europe's largest international airports (Amsterdam); and being on the crossroads of the European mega-corridors to the East and South, the rebalancing of international scale in favour of other countries may well be the case. A number of reasons of global importance can be mentioned here. Europe currently is struggling to survive on the world market due to the high exchange rate of the euro. The sluggish growth performance of the EU compared to the US in the last years has proven that. For the businesses this means in fact that they are trying to boost the productivity and to increase efficiency in order to stay in the game. Thus, they are making choices with respect to the inputs, technology, and locations. As the new economic geography theory asserts, clusters in the economy (like industrial, knowledge and hi-tech ones) are characterised by increasing returns to scale processes, and thus businesses tend to operate within those. This proposition is valid with respect to 'centre' versus 'periphery'. But which locality would exercise its agglomeration forces if a number of clusters are compared. On the international level Randstad area in the Netherlands competes with other locations in Europe like Greater London, the Ile de France, the Antwerp-Brussels-Ghent triangle and the Rhine-Ruhr region. Who would win if a major disaster eventually hits Holland? Under such circumstances, if Randstad is flooded, the country may (partially) loose its strategic comparative advantage. Maybe then geographical 'immunity' to the natural catastrophes will become one of the factors to be considered by businesses when looking for alternative locations. The question whether economic activity would return to Randstad after experiencing a major calamity should be well taken.

7. The policy

One of the issues that has to be addressed by the policy-makers today is the insurance of long-term development of the country in future subject to pressures of the nature interfering into dense socio-economic, administrative and political networks. In the Netherlands this is an even more topical problem, where water and economy form a seamless system, and where the state and the market interact actively. Thus, water management and flood protection policies cannot be considered apart from the national

long-term development path. This asks for the co-evolvement of modern economic thinking and current policy-making.

In the previous sections we have developed an approach with the help of which we are able to determine the effects (in terms of direct and indirect costs) of a large-scale flooding of a certain area. We have considered a number of recovery scenarios in the process of analysis. These scenarios are drawn based on the assumptions about the characteristics of the economy and policy options available to the government to steer the recovery. Here we will draw some more proposals concerning the possible revisions of the current flood protection policy in the Netherlands. In principle, two types of policy exist: the proactive/preventive ex-ante policies aiming at the reduction of risk connected to the eventual flooding; and the reactive ex-post policies, aiming at the resilient recovery of the economy after an eventual disaster.

An example of an active policy would be protection of a particular area with production facilities, cultural and environmental assets located there. In comparison to the 'do-nothing' case, these assets would be protected, and thus the costs of loosing them would not be incurred in case a flooding outbreaks. This also implies that the government while adopting these preventive measures makes some ex-ante costs. Such an approach opens the possibility of confronting particular post-disaster recovery policy options that have influence on the final cost figures, with pre-disaster policies aiming at protecting particular areas or production / consumption facilities.

However, we should make a note here. Concerning the policy-making, significant change in the chosen approach, in political economy, incurs costs. Usually fixed costs are produced in the short run, i.e. especially before and at the start of the change. At least a part of these costs becomes sunk costs, which are project-related and are irrevocable. However, the benefits of the new approach (lower operation costs) are to be collected at some point in the future. This means, that there exists a temporal gap between the making of the costs and the reaping of the benefits. It makes the politicians who are elected for the office for a limited time period averse of decisions on the significant change in policy, which would only incur costs for them, but virtually no benefits. Such a stalemate situation leads to the rigidity of policy, or as it is sometimes referred to as "path dependence". This is argued inter alia in Pierson (Pierson 2000; Pierson 2004), Woerdman (Woerdman 2004),

etc[6]. We can apply this argumentation here with regard to the pre-disaster preventive policies. It usually takes time and probably a real disaster for the policy-makers to work out new protection standards. We have described the situation in the Netherlands in Section 2 with respect to high water protection policy. Not having changed for centuries, it appears to reveal similar "path dependent" characteristics.

We may also think of the government ex-post policies helping the economy and businesses in particular to cope with the extreme situations in future in the event of a flood (or any other major disorder). This means, that the possibilities to steer the recovery are designed in advance. These contingency plans should form an integral part of the high water protection strategy as in the immediate aftermath of a catastrophe it should be clear for the decision-makers what options exist and which of them are preferred to others. One should realise that action in such extreme situations needs to be taken straight away, and the consequences of this action will have impact on the later development stages. Therefore, recovery and reconstruction have to be at once directed in the trajectory of the 'best expected outcome'.

In this paper we have introduced the principles of multi-regional approach in the thinking about the post-disaster economic recovery processes. One of the relevant implications of this extension is that the chance exists that the country may not only suffer from the losses incurred directly by a calamity, but also long-run potential losses due to the crowding out of domestic production by imports. With this idea at hand, policy-makers may have a clearer picture of possible future development scenarios. In the first instance it is important not only for the provision of the immediate incentives for businesses and help to people suffering from the disaster, but rather for the insurance of long-run recovery and future sustained development. Thus, policies directed at the encouraging of uninterrupted production processes in the country are the logical answer. Moreover, international competitiveness and attractiveness of the country for businesses is to be addressed in the due manner. All these considerations, if taken into account, may already have direct and indirect implications on the current economic map of the country.

To sum it up, for the Dutch government it is becoming even more important to realise what consequences a large-scale flood may have not only for the possibly hit area, but also for

[6] Although the path dependency of political processes and policy formation is explained by the existence of the increasing returns in the political processes, I would rather argue that the rigidity is triggered by the "sunk cost fallacy".

the entire of the economy. Provided with the wider international-interregional context the "threat of the worst" may shift from a purely theoretical hypothesis to a feasible scenario if no action is taken.

8. Conclusions

We have discussed the large-scale natural disasters in connection with the regional development. We have taken a look at the possible effects a major flood in the Netherlands may have in the European context. In the EU regional policy is one of the priority areas, though not often the analysis of a major shock in one country is brought to the higher international level.

In this paper we have presented a model that can provide an estimate of damage consistently reflecting the disturbances in the economic network. Furthermore, we can provide the calculations of the initial phases of development in the aftermath of a calamity under various assumptions. We are aiming at building a number of feasible scenarios. The main idea is that depending on the government policy objectives, recovery can be steered differently with different final outcomes. This means that at the moment we do not provide a particular prediction of possible disaster losses, but rather suggest an analytical framework for provision of an interval where the losses might end up depending on particular case circumstances.

We have also argued in favour of adding a new dimension to the discussed model, extending the analysis beyond the nation state borders. The discussion has been set that this sort of analysis may have implications on the long-run development paths of the regions, and particularly in Europe. The large-scale disasters as a possible future event should be viewed not only as a hydrological feature, but as an economic phenomenon as well. Moreover, not only the level of the possibly hit province should be taken, the problem should be analysed on the country level. However, this may not always bring the 'true' results. Because of the globalisation processes dominating in the world, and the ongoing European (economic) integration, it is crucial to take the international aspect into account. The paper suggests taking a special look particularly at the international cross-border regional level due to their gravitation forces. Such an approach will provide more information on the possible development trends in the post-calamity period, thus enabling governments to form their preliminary view on the preferred economic policy in case the real disaster comes.

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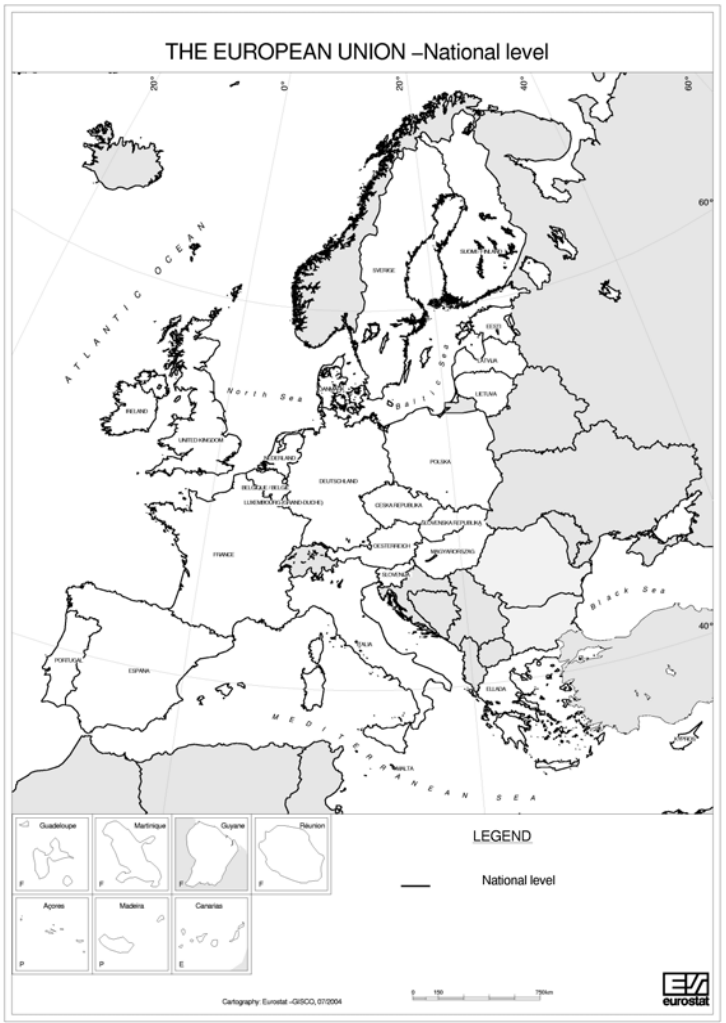
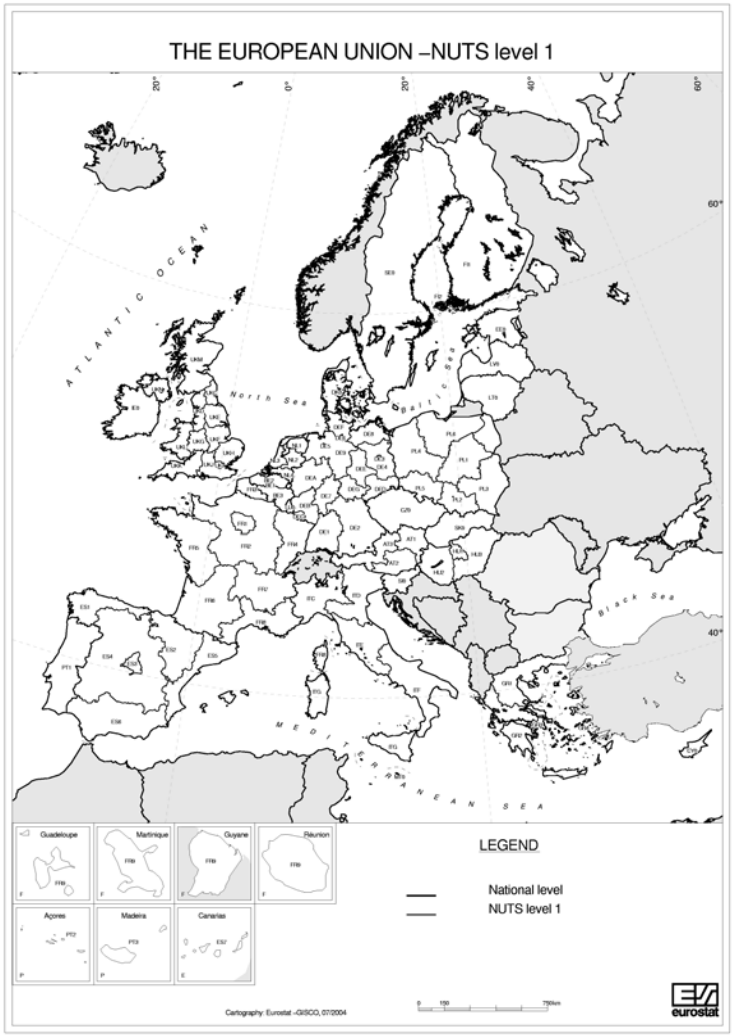
Appendix I

European NUTS level 0 (Figure A1) and level 1 (Figure B1)



A1



B1

*Appendix I (**CONTINUED**)*

European NUTS level 2 (Figure C2) and level 3 (Figure D2)

C2

D2