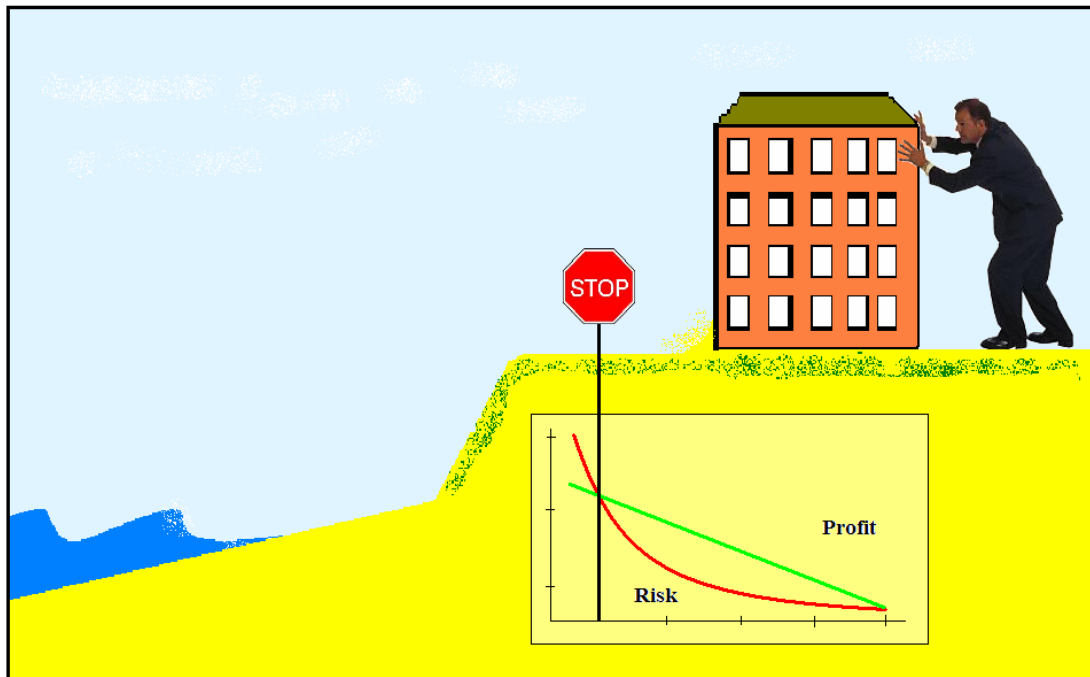


*“Developing a building policy for the Dutch erosion zone-
Solutions for the key questions”*



Thesis Report

 Technische Universiteit Delft	Graduation committee: Prof. drs. ir. J.K. Vrijling Prof. dr. ir. M.J.F. Stive Dr. ir. J. van de Graaff Ir. T.H.W. Horstmeier
Student: P.R.Winckel Stud.nr. 9960605	Delft April 2004

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Thesis report

Philip R. Winckel

Delft University of Technology
Faculty of Civil Engineering

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Preface

Imagine it's 7.00 AM and you have just woken up on a beautiful summer morning at your beach house. You decide to go for a swim in the ocean to wake up and walk down your porch steps onto the beach. After just a few steps, you can dive into the fresh water. Ah, what luxury!

This is where my dream house would be, right on the edge of the dunes, where I can enjoy the ocean and sunsets in peace and quiet.

Unfortunately this type of beach house is not available in The Netherlands, simply because one is not allowed to build a house that close to the sea. The beach and part of the dunes are periodically subject to erosion, and so the risk of damage is always present; hence this zone is called the erosion zone. Reason enough for me to investigate whether this erosion is actually a real problem and whether I will ever get my beach house?

The final section of the Masters of Science study program at Delft University of Technology consists of an individual thesis on a subject related to the student's specialization. This report is an overview of the results of an investigation on the thesis subject: Developing a building policy for the Dutch erosion zone; solutions for the key questions.

The most important objective of this investigation is to answer the question; what buildings should be allowed where in the erosion zone and why?

During this investigation a graduation committee, consisting of the following persons, supervised all stages of the thesis work, for which I am very grateful; Prof. drs. ir. J.K. Vrijling (head of the committee), Prof. dr. ir. M.J.F. Stive, Dr. ir. J. van de Graaff and Ir. T.H.W. Horstmeier.

Besides the graduation committee I would like to thank all those who have donated their time and energy during interviews, questionnaires and giving advice.

Delft, 1st of March 2005

Executive Summary

The coastal zone in The Netherlands consists mainly of sand dunes. Three functions can be distinguished for the most seaward part of these dunes: as sea defence for the inland areas that lie below sea level (main function), as living environment and as natural habitat. Only the living environment is the target of this investigation.

During storms and increased hydraulic conditions these dunes will erode. The section of these dunes that is sensitive to erosion processes is called the erosion zone. With the help of probabilistic calculations methods, it is possible to assess the chance of erosion in different parts of the erosion zone. Erosion contour lines can be used to illustrate the different chances of damage within the erosion zone.

For any building policy in this erosion zone at least two aspects are important: the economic potential and the risk of erosion, which can lead to destruction of any buildings present. The continuous increase of knowledge of the erosion processes can be put to use to help investors and policy makers. Aspects of this knowledge include the probabilistic methods used to calculate the expected erosion and knowledge on the influence of the present sea level rise.

The building policy should therefore be a compromise between two ambitions: **exploiting potential and averting risk**.

The present government building policy (still under construction) includes a system of regulatory contour lines that must divide the suitable and unsuitable building areas. These lines must be drawn along the present development, with the intention to qualify all areas outside the present developed areas as unsuitable. These regulatory contour lines should then stop the increase of risk. The obvious question that results from such a policy is then: what compromise between exploiting potential in the erosion zone and risk has been made?

It is strongly doubted that the policy has taken the market potential and risk into account in a suitable manner. For this reason four key questions for the building policy are readdressed in this investigation:

1. Regarding the present situation; **what structures should be allowed at which locations in the erosion zone at this time and why?**
2. **How should we deal with the future effects of sea level rise on the erosion zone?**
3. **How should we deal with the responsibility of damage?**
4. **How should the present development be handled in the near future?**

Suitable building locations

To begin, the relevant aspects and stakeholders within the erosion zone were identified and the relations between them. The main investors could be categorized into three stakeholder groups: homeowners, business owners and the general public.

For these stakeholders it was investigated what potential was available in the erosion zone (market potential) and what risk was related to it. To be able to decide on investments, a valuation method was suggested that takes both aspects into account. The basic underlying thought used in this valuation is to compare similar investments inside and outside of the erosion zone, but within the same urban coastal area/community, regarding the available market potential and risk.

In this valuation method the different aspects of an investment are then categorized in the following values: The initial value (IV) is considered to be the value of a similar investment outside of the erosion zone, where the value depends only on the market potential, as no risk is taken into account. The potential increase in value of the investment in the erosion zone was valued by quantifying the market potential in the erosion zone for the specific investment. The potential increase in value is here called hedonic value (HV).

Besides this hedonic value, the investment in the erosion zone is subject to risk. This risk contributes to devaluation of the investment (DbR). By adding these values (IV+HV-DbR) the total value (TV) of the investment is calculated. When the total value equals or exceeds the initial value the investment can be justified.

This makes it possible to investigate what risk is acceptable (the maximum acceptable chance of destruction, P_{face}) for each investment and what areas in the erosion are therefore suitable. In this investigation maximum acceptable chances of destruction were calculated for different investments (houses, hotels and a boulevard), of which the frequencies ranged between once every 43 and 140 years, depending on the specific investment. Regarding the location of the relating erosion contour lines, it can be concluded that suitable locations can be found also on the dune slope within 25 meters of the beach, where at present no developments have yet been realized. The exact locations however, depend on the specific location of the erosion contour lines of each area.

In relation to the government policy it can be said that the regulatory contour lines can not guarantee that the full potential of the area is exploited.

The influence of sea level rise (SLR)

Three aspects cause a landward movement of the erosion contour lines:

- 1. SLR
- 2. The relative reduction of the dune height, because of SLR
- 3. The future increase in storm frequencies

An average sea level rise of 0,2 metres per century has been observed for the last 400 years. As no acceleration, or any clues lead to the suggestion that the future SLR will be more than the measured 20 centimetres per 100 years, the assumption is made that this is the correct SLR to be taken into account.

The conclusion was drawn that in the situation where the cross profile is increased in height with the same rate of SLR (of 20 centimetres per century), which is the present policy, the maximum resulting landward movement of the erosion contour lines (because of the relative decrease of the dune height and the increase in storm intensities) is approximately 5 metres per century.

The influence of sea level rise and the increase of risk can be included in the valuation of the different investments. Two aspects are important in this respect: the planning timeframe of the building policy and the expected increase of the chances of damage. For the first it was argued that a planning timeframe of 50 years was suitable, considering that the present lifetime cycles of building projects are approximately the same. Any new insight in the erosion processes or in risk-decreasing building techniques can then be implemented during these next 50 years.

For the next 50 years an estimated maximum landward rate of retreat of the erosion contour lines was made at 0,05 meters per year.

It is considered essential that structures are not situated in areas where the chance of destruction of the building exceeds the maximum acceptable chance during the next 50 years. When this situation does occur, a number of options for the building policy are available to reduce the chance of destruction to acceptable levels:

- Strengthening of the dunes with either sand nourishments or sea defence structures.
- Strengthening of the structure with erosion-proof foundations.
- Not build any buildings in areas where the maximum acceptable chance of destruction will be exceeded during the next 50 years.

The alternative which results in the highest increase in value (when taking all benefits and costs for the total timeframe per alternative into account) is considered the best option.

Responsibility of damage

The aspect of responsibility of any damage in the erosion zone is at present an important topic of discussion at government level. The value of benefits and costs of any investment remains unchanged when the responsibility for these benefits and costs are varied amongst different stakeholders. However, differences in responsibility can result in different building policies as new possibilities to distribute the costs can give an individual investor the opportunity to invest in areas with different chances of damage.

The influence of this aspect of the policy was investigated by using three different scenarios concerning this aspect:

- When the responsibility was for the owner;
- When the responsibility could be transferred to an insurance company;
- When the government was responsible for (part of) the damage.

The possibility of exploiting the potential of the erosion zone is considered the greatest when insurance for erosion damage is available. It is, however, considered of the utmost importance that the aspect of responsibility is dealt with as soon as possible. At the moment investors are either unaware of the risk or do not think they are liable for any possible damage. Exploitation of the potential is therefore only included in the present investment decision and risk is disregarded. At the same time these investors are in fact legally responsible for all damage.

Present problems

The present chances of destruction were investigated for investments in the investigation areas (Noordwijk aan Zee and Katwijk aan Zee). No problems were identified here for the next 50 years, as the maximum acceptable chances of destruction will not be exceeded.

When these chances are exceeded, the property devaluates and becomes a hazard. There are then three options that should be considered:

- Doing nothing (no action);
- Decrease the risk;
- Increase the hedonic value.

The best option is the option with the most increase of value. It is important that all (probable) options are taken into account and all costs and benefits calculated.

Doing nothing (no action) is considered unacceptable. The value of the total loss for all the stakeholders in the erosion zone by letting property become hazardous is considered much higher than the benefits (if any).

For the option of decreasing the risk, various possibilities are present.

The most probable are:

- (1) Increasing the strength of the dunes with sand nourishments or sea defence structures;
- (2) Reinforcing the structures;
- (3) Removing the property.

For these options the following notes are important:

- (1) Dune nourishments and sea defence structures are mostly only profitable when the risk involved is very high.
- (2) Although there is reason to believe that the decrease in risk, of using “erosion proof” foundations, can exceed the costs of the foundations, it must be investigated if this is also profitable when foundations have to be made for an existing building.
- (3) The option of removing property can result in an increase of the hedonic value of surrounding properties and in a decrease in risk simultaneously. When the increase in value exceeds the cost of removing the (devaluated) property, profit is made.

In case it becomes apparent that the risk will be too high in the near future, the same options must be assessed. It is then also important to calculate what the most profitable moment is to use any of these options.

Finally it must be noted that the methods and insight used to deliver these results are more valuable for future decision makers than the actual results or quantities produced with it. Although much time and effort has been put into obtaining usable data for the investigation areas, decisions should not be made for the entire erosion zone without obtaining data that is representative for the entire erosion zone.

Conclusions

The conclusions that have been drawn in this investigation will be discussed per subject.

Relations within the erosion zone

After identifying the relevant relations within the erosion zone, it was concluded that **all stakeholders must take into account the available market potential and risk when making investment decisions**. At present only the available market potential is taken into account, because of a lack of awareness of the risk and the responsibility of risk.

Government building policy

The present draft of the government building policy for the erosion zone (which includes a system of regulatory contour lines) **can not guarantee that the full potential of the erosion zone will be exploited**.

Valuation method

By comparing similar investments in and outside of the erosion zone, suitable compromises on the available market potential and risk can be made. By using the increase of value in the erosion zone (hedonic value) and the value of the risk of the specific investment, the total value of investments can be calculated. **Decisions can then be made** as to what locations are suitable in the erosion zone for these investments, **by calculating the maximum acceptable chance of destruction**. In these cases the hedonic value of an investment must always equal or exceed the value of risk.

Furthermore it was concluded that:

- In the erosion zone a relatively high hedonic value increase for investments is possible (up to 100% of the value of a similar investment outside the erosion zone).
- Large differences exist between the values of houses and hotels in the erosion zone that have sea view and do not have any sea view.
- Different types of investments have different hedonic values and risk.
- **In this investigation maximum acceptable chances of damage were calculated for different investments, and ranged between frequencies of once every 43 to 140 years.**
- The location of these maximum acceptable chances of destruction can be found with the relating erosion contour lines. For the investigation areas these locations are very close to the beach (within 25 meters).
- A positive valuation of an investment in a house depends largely on the real rate of return.
- A positive valuation of an investment in a business depends largely on the potential increase of sales prices in the erosion zone.

- To value the hedonic value of an investment in a boulevard, the willingness of the community to pay for protection of the boulevard is considered to represent this value best. A positive valuation of an investment in this boulevard (or infrastructure in general) depends greatly on the willingness of the community to pay (WTP) to protect the boulevard and on the possible loss of business (revenue) along the boulevard.
- The influence of the value of “emotional discomfort” in case of destruction can be very great in valuating an investment.

The influence of sea level rise (SLR)

The conclusion was drawn that in the situation where the cross profile is increased in height with the same rate of SLR (of 20 centimetres per century), **the maximum resulting movement of the erosion contour lines** (because of the relative decrease of the dune height and the increase in storm intensities) **is approximately 5 metres per century in the investigation areas** (Noordwijk aan Zee and Katwijk aan Zee).

To take the SLR into account in the building policy a suitable timeframe for the policy has been used of 50 years, which relates strongly with the present building cycle timeframes. In conclusion:

- **For the next 50 years an estimated rate of retreat of the erosion lines because of sea level rise was made of 0,05 meters per year.**
- It is considered essential that structures are not situated in areas where the chance of destruction of the building exceeds the maximum acceptable chance during the next 50 years.

Responsibility of damage

To decide who should be responsible for any damage in the erosion zone, three scenarios have been discussed; responsibility of the owner (1), an insurance company (2) and the government (3):

- **The possibilities to exploit the potential of the erosion zone were considered the greatest when insurance for erosion damage is available.**
- As the government is not likely to become responsible for all chances of damage, this scenario would lead to inequalities and besides that, the costs of executing such a policy should not be underestimated.
- The scenario in which the owners are responsible is only suitable when the different stakeholders are able to decide on risk matters independently, without getting into serious financial problems.

Present problems

From the examples taken from Noordwijk aan Zee and Katwijk aan Zee it was shown that at these locations no problems will occur in the next 50 years. Problems occur mainly when investments are located in areas where the maximum acceptable chance of destruction is

exceeded for the specific investment. In case problems do occur along the Dutch coast a number of conclusions are important:

- Doing nothing (no action) when the maximum acceptable chance of destruction is exceeded is considered unacceptable.
- The risk-decreasing option of removing property in unsuitable areas can result in an increase of the hedonic value of surrounding properties and in a decrease in risk simultaneously.
- Very little has been done in The Netherlands to increase the safety of buildings in the erosion zone with the help of the different construction methods available. The resulting decrease in risk by using “erosion proof” foundations can possibly exceed the costs of the foundations.

Finally, it should be mentioned that the different coastal communities all have their own spatial problems and no two communities are the same. For each community the relevant local data regarding the subjects mentioned in this investigation must be obtained to decide on local building policy matters.

Recommendations

The recommendations that resulted from this investigation are:

- **The present draft of the “Policy for the coast” made by the government should be revised** and suitable compromises on the available potential and risk in the erosion zone should be taken into account when it is considered necessary to design regulations.
- **It is considered of the utmost importance that the aspect of responsibility of damage in the erosion zone is dealt with as soon as possible.** Some coastal policies from abroad, like the policy of the Federal Emergency Management Agency (USA), can be used to learn more about the consequences of responsibility.
- **It is recommended to investigate whether the appointment of a single agency with the sole task to manage (all national) risk could add value to the situation in the Netherlands.** The objectives here are to reduce agency costs, accelerate policy-making, increase the expertise on risk and create a national overview of risk in general.
- **The fact that most of the public is unaware of the risk involved and does not think they are liable for any damage, is considered a problem.** It is important to inform all stakeholders of the actual facts. All relating problems that may derive from sharing this information are considered less troublesome than the possible problems that can develop in the present situation, because the public remains mostly unaware.
- **Because differences exist between suitable locations for each investment, it is recommended to divide the areas used for business and for housing.** These areas can then have different chances of damage and it is possible to use the maximum potential of each investment without considerably affecting the building layout.
- **It should be investigated whether the decrease in risk of using “erosion proof” foundations can exceed the costs of the foundations.** Also when foundations have to be made for an existing building.
- Although much effort has been put into obtaining usable data from the investigation areas, decisions should not be made for the entire erosion zone without obtaining data that is representative for the entire erosion zone.
- The subjective values used in the valuation method, such as the emotional discomfort caused by erosion damage, need further investigation to obtain more precise values.
- **Detailed maps of the erosion contour lines are necessary for future development of policy.**
- In this investigation the assumption was made that the chance of destruction of a structure was equal to the chance of exceedance of the erosion contour line at the most

seawards boundary of the specific structure. Two recommendations are thought to be important here: (1) an investigation into the actual chance of destruction for different structures in relation to the position of the erosion contour lines is required. (2) Present methods used for calculating the total risk for all structures located in a specific cross profile, differentiate the value of the structures and the resulting risk per meter of cross profile. It is very probable (as was assumed in this investigation) that for instance a structure, which has a width of 30 meters, is already completely destroyed, when erosion exceeds the most seaward boundary of the property with only 10 meters. The present methods are therefore considered only partly true, as in reality the resulting damage costs relating to a specific chance of erosion, can greatly exceed the theoretical calculated damage costs.

- The effect of structures on the position of the erosion contour lines must be investigated to be able to take it into account in the risk analysis.

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1. Introduction

1.1 Background

1.1.1 Erosion zone

The coastal zone in The Netherlands consists mainly of sand dunes, a very dynamic environment where people live, work and where industry thrives. In general these dunes have three functions: as sea defence for the inland areas that lie below sea level (main function), as living environment and as natural habitat.

Storms and the forces of the sea can erode this sea defence and inflict major damage to the structures that are present. The section of the dunes that is sensitive to these erosion processes is therefore called: the erosion zone.

Probabilistic calculation methods are used to assess the expected erosion of the dunes. In case the hydraulic circumstances occur for which the sea defence is designed, roughly a width of 100 meters of the dunes will erode. However, this has only a chance of happening of 1/100.000 per year. Part of the erosion zone should therefore be more than suitable for building purposes, as seems at present.

1.1.2 Need for building policy

There are a number of reasons why the development of a new building policy for the coastal zone is especially important at this moment in time.

One of these has to do with the fact that “50-70% of the world population will be living in the coastal zone in the near future¹.” This is one of the prognoses concerning the coastal zone worldwide and it is safe to say that these areas will become of higher economic importance in the near future. The erosion zone, as part of the coastal zone, has potentially the highest economic value. This is not a problem in itself, but the erosion zone is somewhat different to the rest of the coastal zone as it is periodically victim to extreme forces of the sea. Because of a global climate change and a resulting sea level rise, the frequencies and forces of these events will probably increase in the future. Buildings in the erosion zone can therefore have a higher chance of damage in the future.

¹ Prediction from the World Coast Conference 1993 (1994)

The continuous increase of knowledge of the processes within the erosion zone has led to the ability to calculate the risk associated with building in the erosion zone in more detail, which can be put to use by investors and by policy makers. A new building policy is therefore required which will take this (increasing) risk into account.

Another reason why the development of a building policy for the coastal zone is important is because The Netherlands is presently trying to deal with a housing shortage. It has become increasingly difficult for the government to allocate suitable areas for housing projects, as there is little building space available. The use of less suitable areas for housing projects has been the result. It then becomes important to know what areas in the erosion zone are usable for housing projects.

The fact that the general public is mostly unaware of the level of danger of erosion or flooding is another reason to re-develop a more transparent building policy. Damage to property in the erosion zone in the case of storms, is legally the responsibility of the owners. Unfortunately the main reason for this lack of awareness is because major damage has not occurred in the recent past. The last major disaster due to flooding by the sea was in 1953, when 1835 people died, but only limited damage was done to the coast.

The result is that unaware citizens and municipalities confront the government with an increasing number of damage claims. Even worse, the government has paid a large number of these claims, unable to divert the public and media pressure to do so.

1.1.3 Policy in the making

Since 1996, the European Commission has been working to identify and promote measures to remedy any problems in the coastal zones and to improve the overall situation. The Commission is now promoting Integrated Coastal Zone Management (ICZM) in which sustainable development is the key factor. It has also made a Recommendation for the member states to develop their own Coastal strategies, which are due in 2006. Although the EU does not have direct authority over spatial planning, the scope of the increased integration of European development plans has expanded.

At the moment the Dutch Government is developing their coastal policy in which safety against flooding and the achievement of high quality space are important aspects. The development process is divided into three steps. Firstly a 'Policy agenda for

the coast' (Beleidsagenda voor de kust²) has been made, which was published in February 2002. This was followed by organizing discussions with the different stakeholders, and the preparation of the 'Policy for the coast' (Beleidslijn voor de kust³) of which a design draft has been published in August 2003. Finally, when this Policy for the coast is finished it will be integrated in the next national 'Spatial Policy' (Nota Ruimte).

1.2 Thesis objective

1.2.1 Targeted issue

The government still has to address a number of issues to be able to finish the 'Policy for the coast'. To stop any further increase of risk for buildings in the erosion zone, the design draft of this policy includes a system of regulatory contour lines that mark the areas designated for building. These regulatory lines are drawn along the edge of the present development in the erosion zone, making the possibilities to expand the urban areas an exception. A number of questions can then be asked; is the present urban area sufficient for future use? Should there be space for expansion? Or is this area too risky altogether for any development?

First of all it seems logical to investigate the potential of the erosion zone and what risk is acceptable **before** determining any regulatory contour lines. The question can then be asked whether these regulatory contour lines are the best method to deal with the problems in the erosion zone.

A building policy is, however, difficult to reverse and therefore the future consequences of any possible developments should be taken into account, as should the future opportunities to exploit the potential of these areas. A key development that can lead to significant problems is for instance the sea level rise.

Nevertheless, any building policy for the erosion zone should be a compromise of two ambitions: **exploiting potential and averting risk**. Drawing a regulatory contour line along the present urban areas hardly seems the answer.

² Rijkswaterstaat Rijksinstituut voor Kust en Zee, *Naar integraal kustzonebeleid-Beleidsagenda voor de kust* (2002)

³ Ministerie van Verkeer en waterstaat, *Beleidslijn voor de kust* (2003)

1.2.2 Key questions

This thesis will focus on finding solutions for a number of key questions that concern the building policy at present.

The four key questions are:

1. Regarding the present situation: **What structures should be allowed at which locations in the erosion zone at this time and why?**
2. **How should we deal with the future effects of sea level rise on the erosion zone?**
3. **How should we deal with the responsibility of damage?**
4. **How should the present development be handled in the near future?** What should be done now when the present development differs largely from the previous results?

The result of the thesis work will be a framework of recommendations, which can be projected on any given part of the erosion zone, and should illustrate a preferred building policy.

1.2.3 Value of results

Coastal zone management requires constant input from the areas that are managed, as the demand from and of these areas change at a relatively high rate. Besides this, the different Dutch coastal communities are all very unique and often require site-specific solutions.

It must therefore be emphasized that, although the objective of this investigation is to find solutions to the key questions, the methods and insight used to deliver these solutions are more valuable for future decision makers than the actual solutions.

1.2.4 Targeted area

In this investigation, solutions for the thesis questions will be sought for the erosion zone along the urban areas, from the edge of the dunes land inwards. The beach is therefore not considered in this investigation. Other parts of the erosion zone are mostly nature conservation areas, and will not be considered in the building policy.

The function of the dunes as sea defence is considered most important of all. However, this aspect is disregarded in this investigation, as the objective is to find solutions for the building policy in the erosion zone, not for the safety of the inland areas.

1.3 Layout of report

This chapter has given a brief outline of the important issues in the erosion zone and the need for a new building policy. The thesis objective has been discussed more explicitly, with the help of the four thesis questions.

To answer these, one must first develop a good understanding and an objective view of the relevant aspects within the erosion zone and their respective relations, which will be given in Chapter 2. Only then is it possible to answer the thesis questions in a suitable manner. In Chapter 3 an answer to the first key question, “what buildings should be allowed where in the erosion zone and why”, will be given. In Chapter 4 the key question is discussed: how to deal with the future effects of sea level rise. The influence of the responsibility of damage is illustrated in Chapter 5 with the help of a number of different scenarios. In Chapter 6 the final key question is dealt with: what should be done now when the present spatial layout differs largely from the previous result.

2. Understanding the Dutch erosion zone

2.1 Introduction

This chapter will discuss the relevant aspects within the erosion zone and their respective relations. As has been argued in Chapter 1, it is this insight that is most valuable for future use. The final results gathered with this insight further on in this investigation, are mostly only valuable for this moment in time.

In Paragraph 2.2 the Dutch coast in general will be discussed, including an assessment of the relevant functions of the dune system. The erosion zone and the morphological processes that govern this area are discussed in Paragraph 2.3. In Paragraph 2.4 the development within the erosion zone is illustrated. Erosion risk is the topic of Paragraph 2.5 followed by a schematization of all the relevant aspects within the erosion zone in Paragraph 2.6. In Paragraph 2.7 the present government building policy for the erosion zone is discussed in relation to the insight delivered in the earlier paragraphs. Finally, in Paragraph 2.8 the compromise on the relevant aspects is discussed, that is used for beach pavilions.

2.2 The Dutch coast

2.2.1 Formation of dunes

The Dutch coast consists mostly of dunes, of which most parts are natural areas and some have been built up into highly populated urban areas. The development of dunes is governed by available energy, sediment and trapping facilities. Marine processes deliver sand to the beach, from where the wind transports the sand until it is trapped, depending on the presence or absence of vegetation. The specific morphologic development of the dunes depends on the sand supply rates and trapping capacity of the vegetation.

Figure 2.1 shows the natural dune area at Wassenaar.



Figure 2.1 Dunes at Wassenaar (from RIKZ⁴ 1999)

2.2.2 Short history of the Dutch dunes

Looking back at the earth's history, we can see that the Dutch dunes were formed first and the land behind the dunes is a result of the protection the dunes gave against the forces of the sea.

The sea estuaries have long since attracted man with all its riches. Settlers moved to the coast and towns were built on and near the dunes, where fishing was the most important source of income. More recently the recreational opportunities on and near the dunes started to attract the tourist industry, which has grown into a major coastal industry of which the highly developed coastal towns are the result.

2.2.3 Functions of the dune system

Three functions of the dune system can be identified which are:

- Sea defence
- Human settlement, both permanent and periodically
- Natural habitat

Sea defence

In this day and age, unlike most of the European coastline, the Dutch dunes still have the function of protecting the inland area. This function has become more and more important because

⁴ Rijksinstituut voor Kust en Zee (RIKZ) is a subsidiary of the ministry of Transport, Public works and water management (Verkeer en Waterstaat) and is responsible for investigating the coast and sea.

large areas behind the dunes now lie below mean sea level, as a result of a slowly subsiding land level and rising sea level. Besides this, old lakes and parts of the inland sea have been made dry during the last centuries, resulting in mostly even lower inland areas.

In the case of storms, when higher water levels and waves attack the dunes, part of these will be destroyed and disappear. Sand at the seaside of the dunes will erode very quickly moving the edge of the dunes inland. This part of the dunes, which will disappear during storms, is called the erosion zone (Afslagzone). The policy of the central government has been to maintain the dunes so that the chance of a breakthrough is smaller than $1 \cdot 10^{-5}$ per year. In that case, roughly the first 100 meters of the dunes will disappear into the sea. The chance of a storm of this intensity occurring in the near future is very small, though it is of course possible.

Human settlement

The dune system is used as living environment both permanently and periodically. Towns are situated in these areas, where people live and work. Money is earned from the many recreational and tourist endeavours, that profit from the natural surroundings.

Sun, sea and beaches is what drives this industry, so any hotel or restaurant will want the best view and easiest access to the beach. Hotels have been built close to the seaside edge of the dunes to accommodate its visitors with these spectacular bedroom views. Not only hotels and restaurants value the areas close to the sea, but also the local inhabitants have built houses here to enjoy the coastal surroundings year round.

As the width of the erosion zone is relatively small (roughly 100 metres), only a relative small part of these settlements are actually located in the erosion zone.

Natural habitat

Another function of the dune area is that it houses a major part of the Dutch flora and fauna. Although the dune area only amounts to 1% of the total territorial space, this area houses more than 60% of the Dutch flora species. These areas are both nationally and internationally recognized and protected as very valuable natural habitats. As this investigation focuses on urban areas in the erosion zone, the function of natural habitat will not be considered relevant.

Two functions, those of the coastal defence and human settlement, are increasingly claiming the scarcely available coastal zone areas. At the same time the population and economy in this area are increasing, which requires more space as well.

2.3 The erosion zone

2.3.1 Introduction

The erosion zone is that part of the coast where erosion takes place. This can be on the foreshore, the beach and also on the dunes, depending on the momentarily hydraulic conditions and the profile of the coast.

The sandy coast is constantly changing shape because of the changing forces of the sea and wind. The volume of sand in the erosion zone is measured every year, which is very important for maintaining the sea defence. For investigations on risk in the erosion zone, the erosion processes during storms, which have a much shorter duration, are more important. During storms the changes of the profile of the coast are much more significant, and this is also when the safety of the dunes is put to the test.

For this investigation we are only interested in the more severe erosion processes that occur during storms when parts of the dunes erode in a relatively short time and are an acute threat to buildings.

2.3.2 Hydraulic forces in the erosion zone

Wind and tides are the driving forces for all hydraulic and morphological processes in the coastal zone. The winds are responsible for the transport of sand on the dry beach and for the generation of waves, currents and water level fluctuations. The tides are responsible for the periodical rise and fall of the water level and the generation of tidal currents.

Waves and currents are responsible for the sediment transport in most cases, though sometimes the effect of the wind cannot be ignored.

In the near shore zone, the most intense sediment transport occurs where the waves approaching the shore break and wave energy is dissipated. This energy is then mainly converted into turbulence, which brings sediment into suspension. Currents then transport this suspended sediment. In the case when the amount of sediment differs that an area receives and that goes out of it, the bathymetry of this area changes in time.

2.3.3 Dune profile

During storms erosion will take place and the coastline will retreat inland. The rate of retreat (dx/dt) during a specific storm depends on the volume of sand (and the specific diameter of the sand particles) in the profile. More sand, or higher dunes, will result in a lower rate of retreat. The longer the duration of a

storm the farther the retreat goes, so the width of the dunes is also an important factor when assessing the possible retreat of the coastline.

The height and width of the dunes can be illustrated by drawing the dune profile, which tells us about the volume and location of sand within the dunes.

In Figure 2.2 we can see an example of a cross-profile of the Dutch dunes.

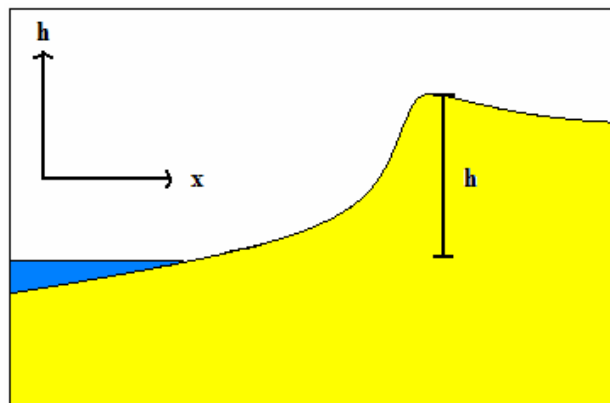


Figure 2.2 Example of dune cross-profile

The profile is thus a function of the height and distance from a chosen reference point:

$$\text{profile} = h(x) \quad (1)$$

2.3.4 Equilibrium of the erosion zone

In case the hydraulic conditions of the erosion zone remain unchanged, the dune profile will also not change. This equilibrium profile depends on the fall velocity and d_{50} of the particles (sand), and the H_s of the wave climate (Vellinga, 1986⁵). In this situation the transport of sediment seaward is the same as landward.

In case of a sea level rise, the best-known model relating the resulting shoreline retreat is proposed by Bruun. The process is described with the “Bruun rule” (1962; 1988)⁶ of which Figure 2.3 is an illustration. The analysis by Bruun assumes that with a

⁵ Vellinga, Beach and Dune Erosion during Storm Surges, Dissertation, Delft University of Technology (1986)

⁶ Bruun, P., *Sea level rise as a cause of shore erosion*, Journal Waterways and Harbours Division, American Society Civil Engineers, number 88, P117-130 (1962).

Bruun, P., *The Bruun Rule of erosion by sea level rise*, Journal of Coastal Research, number 4, P627-648, 1988.

rise in sea level, the equilibrium profile of the beach and shallow offshore moves upward and landward.

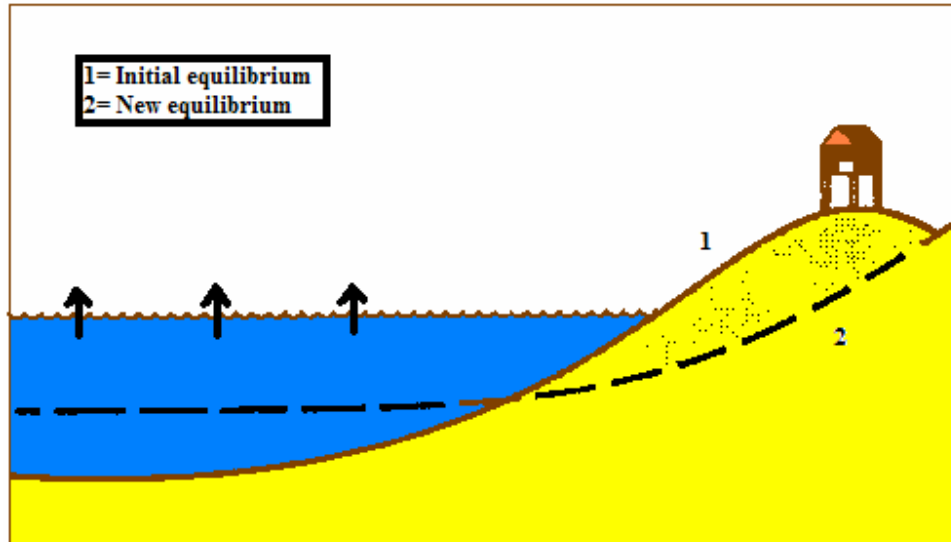


Figure 2.3 Profile change caused by sea level rise (“Bruun rule”)

Following a number of assumptions, Bruun derived the basic relationship for the extent of shoreline recession, R , due to an increase in sea level:

$$R = (L/B + H) * S \quad (2)$$

In which:

R = shoreline recession (metres)

L = the cross shore distance to the water depth H (metres)

B = the height of the dune (metres)

H = the depth to which near shore sediments exist (depth of closure) (metres)

S = sea level rise (metres)

The analysis is two-dimensional and assumes:

1. The upper beach is eroded due to the landward translation of the profile.
2. The material eroded from the upper beach is transported immediately into the offshore and deposited, such that the volume eroded is equal to the volume deposited.
3. The rise in the near shore bottom as a result of deposition is equal to the rise in sea level, thus maintaining a constant water depth in the offshore.

Despite its simplicity and numerous assumptions, which have in some instances led to criticism, the Bruun rule works remarkably well in many settings.

2.3.5 Erosion processes during storms

During storms the hydraulic conditions change temporarily; higher waves, longer wave periods, higher wind velocities, higher sea levels or a combination of these. Because of these increased hydraulic forces the dune profile will also shift to a new equilibrium situation. To reach this new equilibrium situation sand will erode from the fore shore and beach seawards, and depending on the force and duration of the hydraulic forces the dunes can also erode.

The sand is transported seaward where it gradually forms a barrier, which diminishes the possibility of further erosion.

After each storm the hydraulic forces will more or less return to the prevailing (average) level with the water level as normal again. However, the transformation to the equilibrium situation after severe storms takes relatively much longer, which is logical as in this case the hydraulic conditions are much calmer and the sediment will need to be transported landwards and thus upwards.

2.3.6 Variables of hydraulic forces during storms

Research done in the eighties on dune erosion has resulted in the development of a method⁷ to calculate the safety of the dunes as sea defence. This research has shown that the amount of erosion depends on a large number of variables (7). The preferred calculation method was based on a probabilistic approach, which used a predefined chance of failure of the dunes.

The most important variables that represent the forces during storms that contribute to erosion are the significant wave height (H_s), wave period (T_p), the water level (H_w) and the duration of the storm (D).

$$Forces \approx \varepsilon(H_s, T_p, H_w, D) \quad (3)$$

By measuring these variables over a long period of time, with the help of offshore buoys and other equipment, it is possible to obtain a statistical overview of the values of these variables.

⁷ This method is described in the 'TAW Leidraad voor de beoordeling van de veiligheid van de duinen als waterkering' (1984).

2.3.7 Chances of erosion

The amount of erosion depends on the hydraulic forces and the profile of the dunes. The forces depend on the probability of the different variables. Whether a certain dune profile will be able to sustain the force depends on the probability that the strength is greater than the force.

If we consider a certain point x along a dune profile we can also calculate the probability that the erosion due to the forces will exceed this point.

Firstly we determine Z as a variable of reliability:

$$Z = \text{Strength} - \text{Force} \quad (4)$$

When $Z < 0$ the system fails and erosion will exceed the specific point. When $Z > 0$ the system will hold and the point will not erode and remain unharmed. The strength of the dune up to a certain point (x) is here given by the cross profile or $h'(x)$; the forces are described with $\varepsilon(H_s, T_p, H_w, D)$.

For the dune system this results in the following reliability function for point x_a on the dune:

$$Z = h'(x_a) - \varepsilon(H_w, T_p, H_w, D) \quad (5)$$

The probability of failure (P_f), or in other words, whether erosion will exceed point x on the dune depends on the probability that $Z < 0$:

$$P_f = P(Z \leq 0) \quad (6)$$

2.3.8 Erosion point and contour line

It can be useful for making comparisons to calculate the location of a fixed frequency of exceedance, for instance $1 \cdot 10^{-3}$ per year.

Once this point is calculated in a cross profile, the next objective is to calculate the point in a different cross profile. When these points are known they can be connected to form an erosion contour line. Erosion contour lines are lines with a fixed probability of exceedance per year and run more or less parallel along the edge of the dunes.

Storms with smaller impact occur more often, so the parts of the dunes closer to the sea have a larger chance of being destroyed. The closer to the sea, the higher the frequency of the erosion contour lines will be. In Figure 2.4 an example of a plot of these erosion contour lines can be seen. In general the distance between the edge of the dunes and the landward boundary of the

erosion zone (the erosion contour line with a frequency of exceedance of $1 \cdot 10^{-5}$ per year) is approximately 100 metres.

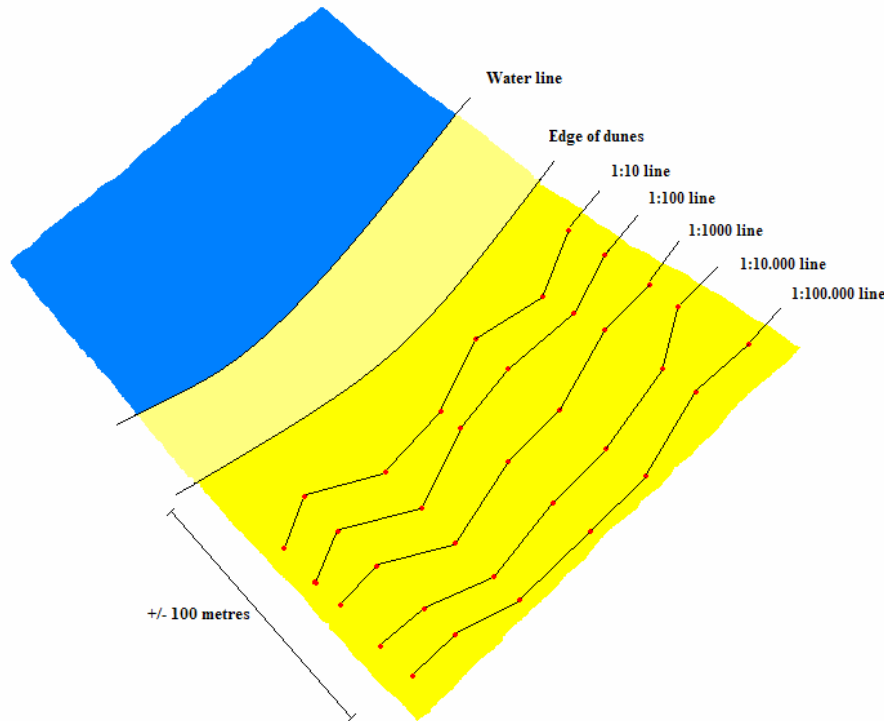


Figure 2.4 Example of erosion contour lines

At present the probabilistic approach to calculate the erosion points is a topic of discussion, because it seems that certain effects are not satisfactorily accounted for in the method, for instance the peak wave period (T_p). At present, investigations to solve these issues are in progress.

2.3.9 Relations between strength and force

The relations between strength, force and the chance of erosion are schematized in Figure 2.5 in the following way:

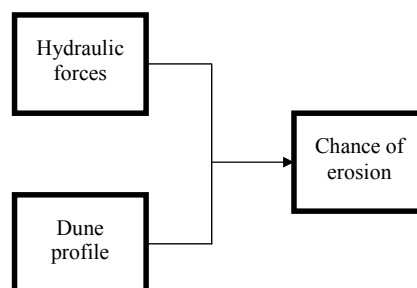


Figure 2.5 Relation between strength and force

In short it shows that the hydraulic forces, together with the strength of the dunes, determine the chance of erosion. With the help of erosion contour lines these chances can be illustrated on a given dune profile.

In Figure 2.6 this is schematized with the help of illustrations.

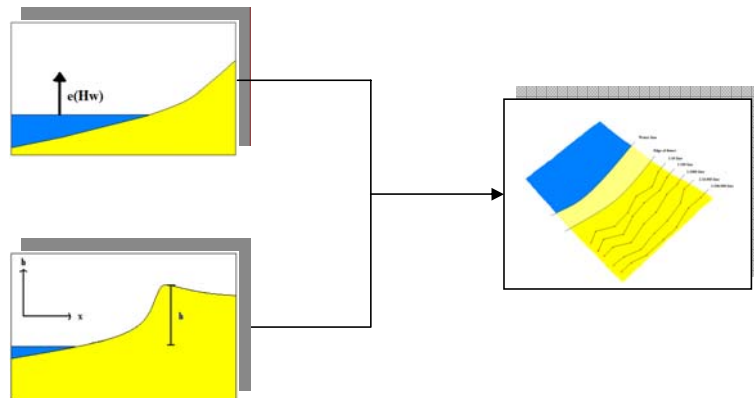


Figure 2.6 Illustrated relations between strength and force

This simple schematization will be used to illustrate relations with other aspects in the erosion zone during the rest of this investigation

2.4 Development of property in the erosion zone

In order to be more confident of making a good investment, one should have a good idea of the potential of the market one is investing in. The erosion zone has a specific building potential for each different investment that should be considered before development plans are made.

2.4.1 Stakeholders

Once a person or entity invests in the erosion zone, he or she will become a stakeholder. Stakeholders in the erosion zone are persons or legal entities with an interest in the erosion zone. Their interest is defined as a probability of a gain or loss of value within the erosion zone.

In general a democratic system, like the one we have in The Netherlands, gives everyone the right to decide on national problems through a system of representation. Although many argue that our system is far from being democratic, democracy is still considered the preferred system. With the notion of real

democracy in mind, this investigation will proceed and therefore all the direct stakeholders in the erosion zone, and not their representation, will be considered. The ignored group of representatives consists of all political institutions like ministries, municipalities etc.

The group of direct stakeholders is a rather large group and therefore specific stakeholders will be grouped together when possible. This means that if government tax money is invested in the erosion zone (which of course is the case) then all taxpayers are stakeholders. To simplify matters these taxpayers will be grouped together with others, like voters, as the general public.

The following stakeholders (groups) in the erosion zone can be identified:

- Inhabitants
- Property owners
- Business owners
- Workers
- Tourists
- Inhabitants of possible flood areas behind the dunes
- General public, consisting of: tax payers, voters, nature lovers, and occasional beach guests.

Seven groups of stakeholders is a fairly large number to work with, but these are easy to combine without compromising too much of their interests, which has been done in the following way.

1. The stakeholder group “house owners” is formed from the erosion zone inhabitants and those property owners who own houses or apartments. The simplification made here is that it is assumed that the inhabitants live in houses owned by them.

2. The second stakeholder group is that of the “business owners”, which is formed from those who own the property (Hotels, Restaurants, Bars or Pavilions) used for the business and those who own the business. Moreover, these business owners will represent the people they employ, the workers, as it is assumed that the workers interests’ are similar to those of their bosses. House owners that also work in the erosion zone are considered to be house owners first, as it is assumed that their interest in housing is more important.

3. The third and last group, the “general public”, is formed from the tourists, inhabitants of possible flood areas behind the dunes and the general public consisting of taxpayers, voters, nature

lovers and occasional beach guests. The most important interest to identify in such a stakeholder is considered to be that either he or she lives in possible flood areas behind the dunes or is an occasional beach guest. This is directly related to the two functions of the erosion zone, sea defence and (periodical) settlement.

Investments in infrastructural structures in the erosion zone are mainly done with tax money from local municipalities, but also with government tax money. The sea defence works are generally paid for by government tax money.

2.4.2 Market potential

There are numerous reasons for someone to build in the erosion zone. In this investigation only the most important building markets are considered, which are housing and buildings for the tourist industry. Besides that, infrastructure is taken into account. These are all related to the identified stakeholder groups.

Housing

The first settlers came to earn a living from the sea by fishing and built houses close to the sea. Around that time the development of the coastal areas started. Although there is still fishing going on, the industry has modernised considerably and the amount of professional fishermen living in the coastal area is very limited. However, the attraction that now draws people to live in the coastal area in The Netherlands is still the same: the sea. Houses with views of the sea and beach are highly valued and space is very limited.

The market potential identified here is for:

- Houses
- Apartment buildings

Tourist industry

In summer the weather in The Netherlands allows for swimming and sun bathing, which attracts not only many Dutch inhabitants, but also foreigners from all countries in the world (especially many from Germany). The erosion zone offers great potential to build tourist endeavours with views on the sea and easy access to the beach.

The market potential identified here is for:

- Hotels
- Restaurants
- Bars
- Pavilions

Infrastructure

Besides these buildings there are two other types of structures that are present in the erosion zone and are acknowledged here because of the relatively large investments needed:

- Infrastructural structures
- Sea defence works

2.4.3 Criteria of market potential

In general the market potential of a certain building plot, or site, represents the attractiveness for a potential investor to invest and depends on a number of criteria. These criteria can be divided into financial and social (preference) criteria.

A financial criterion concerning a certain plot can for instance be the site-specific business opportunities. A social criterion can for instance be the surrounding building layout. Per stakeholder these criteria will be discussed.

House owners

House owners are primarily interested in a suitable living environment, and therefore the spatial layout of the surroundings is important. This includes the allocation of building sites and types of building in the nearby areas. Important criteria for the location of a house are the view on the coast and the distance to the sea. Financial considerations of a certain location can be specific building regulations that have to be adhered (for instance building regulations set by an insurance company).

Business owners

Business owners are interested in profit and look for locations that draw the most business. Although the erosion zone has a relatively small width, there can be significant differences in business opportunities; as for instance easy access to the beach is very important.

General public

The general public wants to have a good time during their day on the beach and wants the sea defence to be kept in a good state. The building layout influences the way they appreciate a coastal town.

To get a good overview of all the market potential criteria these have been illustrated together in Figure 2.7.

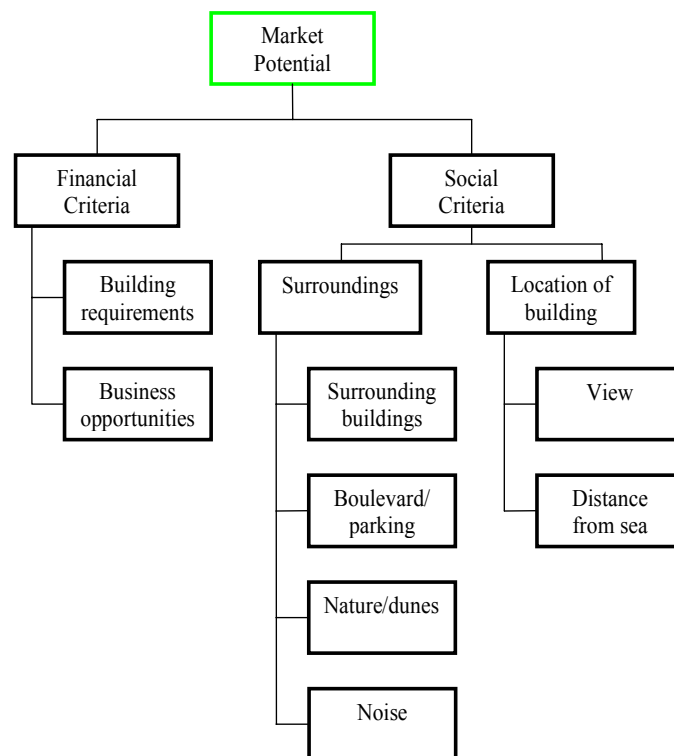


Figure 2.7 Overview criteria of market potential

Each stakeholder, however, will have a different set of criteria that influences his or hers interest.

2.4.4 Policy development

Stakeholders want to either keep the value or increase their value within the erosion zone. Because the building space in the erosion zone is limited, and in most coastal communities has run out, the effort stakeholders make to assure their (increase of) value leads to conflicts between them.

Solutions and compromises have to be made of which rules and regulations are the result. The building policy is in this case the

combination of rules and regulations that should lead to the desired compromises. In the ideal situation, the stakeholders are able to make compromises that lead to a situation where the most potential is exploited.

Any decrease in these opportunities, because of regulations forced by groups from outside the stakeholder groups, will result in a loss of potential and decrease in investments.

2.4.5 Development in the erosion zone

The different stakeholders in the erosion zone will decide to invest in buildings after considering the market potential and the possibilities within the building policy. The result is the actual spatial layout of buildings, or simply development, as it will be referred to here. These relations have been schematized in Figure 2.8.

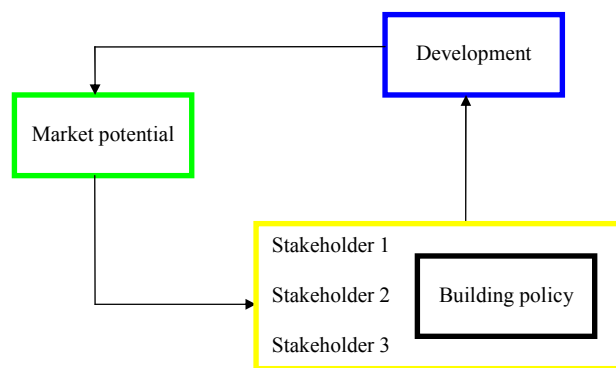


Figure 2.8 Relation between stakeholders and development

In Figure 2.8 the building policy has been integrated into the “stakeholders’ box”, as building policy represents the agreements between the different stakeholders on their relation with other aspects.

The resulting policy must include a description of the following four aspects:

- (1) The areas where building is allowed/suitable,
- (2) Information on the chance of damage in the area,
- (3) The specific building regulations that must be adhered to, and
- (4) The responsibility for damage because of erosion.

2.5 Erosion risk

2.5.1 Definition of risk

The common definition of risk is a combination of the probability that a hazard will occur and the (usually negative) consequences of that hazard. In essence it comes down to the following expression:

$$R = P_f * C_f \quad (7)$$

Where:

R = Risk [value per year]

P_f = Probability of the hazard occurring [per year]

C_f = Consequence of the hazard [value]

When the value of the consequence can be expressed in money, the risk can be expressed in an amount of money per year. In other cases different measures of value have to be used.

2.5.2 Applying the definition of risk to the erosion zone

The definition of risk can be applied to different values in the erosion zone and to different hazards. The hazard in this case is, logically, the dune erosion. The probability of erosion occurring has been discussed in Paragraph 2.3.7, which discussed the calculation of erosion contour lines. These lines represent the chance of exceedance of erosion within the erosion zone, and create the possibility to differentiate the chance of erosion in a spatial layout.

The consequence of erosion is that the part of the dune which erodes will be lost to the sea, together with everything on this part of the dunes (buildings, roads etc.). What is left after the storm dies down and the sea retreats, is a broader beach covered with debris, and a sharp edge cut through the dune where the erosion stopped and the dune once was. In Figure 2.9 an example can be seen of a dune after erosion, where some concrete structures have tumbled down the (new) dune slope. In this case there is hardly any development in the area and thus little debris. To assess the actual expected damage of a building depends on the actual erosion processes around the building in case of a disaster and the strength of the building. At the moment there is still a lot of uncertainty regarding the actual influence of buildings on the erosion processes.

Whether a building will be destroyed is therefore hard to say for each individual case. **The assumption made here is that when a building is situated along a specific erosion contour line, with the seaside of the building on the contour line, the building will be totally destroyed when a disaster with the frequency of the specific erosion contour line occurs.** Other cases than total damage are not considered, as almost none of the buildings have adequate foundations that can withstand the erosion.



Figure 2.9 Example of dune after erosion⁸

The consequence or losses due to erosion damage can be divided into two categories according to the way they can be valued: objectively or subjectively. Objective valuation concerns the valuation of objects, and subjective valuation concerns the valuation of psychological and social values and is related to the acceptability of risk. The following categories and consequences can be identified:

Objectively valuable consequences

1. Casualties or injuries (number of casualties or specific injuries);
2. Loss of economic value (in euros);
3. (Irreversible) loss of land area (in euros).

Subjectively valuable consequences:

1. Emotional discomfort;
2. Perception of safety;

⁸ Taken from www.nederlandleefmetwater.nl

3. Loss of historically valuable objects;
4. Loss of nature and ecological values.

Regarding the consequences of erosion the following is assumed:

- No casualties or injuries are expected because of adequate emergency plans and the fact that people can leave the area relatively quickly and easily.
- The economic value in the erosion zone consists of property, business activity and infrastructure and is valued in money (euros). (Undamaged property can also lose value.)
- Morphological processes ensure the reclamation of lost land (see Paragraph 2.3.5), but it is assumed that investments will be made to clean up debris and to accelerate the reclamation processes.
- To value historical objects, specific valuation methods are required. These objects are further ignored in this investigation, as these objects are relatively rare.
- There is no loss of nature and ecological values in the urban erosion zone. (Any erosion disaster is in fact a natural phenomenon in any case.)
- Emotional discomfort is expressed as the level of distress of the stakeholders because of their loss.
- The perception of safety is expressed as the willingness of the stakeholders to re-invest in the erosion zone.

The following example shows how the definition of risk is used to determine the risk involved:

An exemplary area in the erosion zone has been drawn in Figure 2.10, where erosion contour lines with different frequencies of exceedance can be seen and buildings of all sorts.

The risk in this area can be determined by the chance of damage and the value of the expected damage. For this example building A is used, which is an apartment building. It is situated along the erosion contour line with a frequency of exceedance of $1 \cdot 10^{-3}$ per year, which is therefore the chance of total destruction of the building per year.

The value of the expected damage consists of financial and social aspects. Examples of the financial damage are: the replacement value of the destructed building, the costs for cleaning up the debris and the value of the furniture and other assets inside the apartment building.

An example of social damage is the emotional discomfort of the apartment owner(s) after the disaster.

By adding up all the values of the expected financial and social damage and multiplying this with the frequency of the damage, the total risk for the apartment building can be calculated.

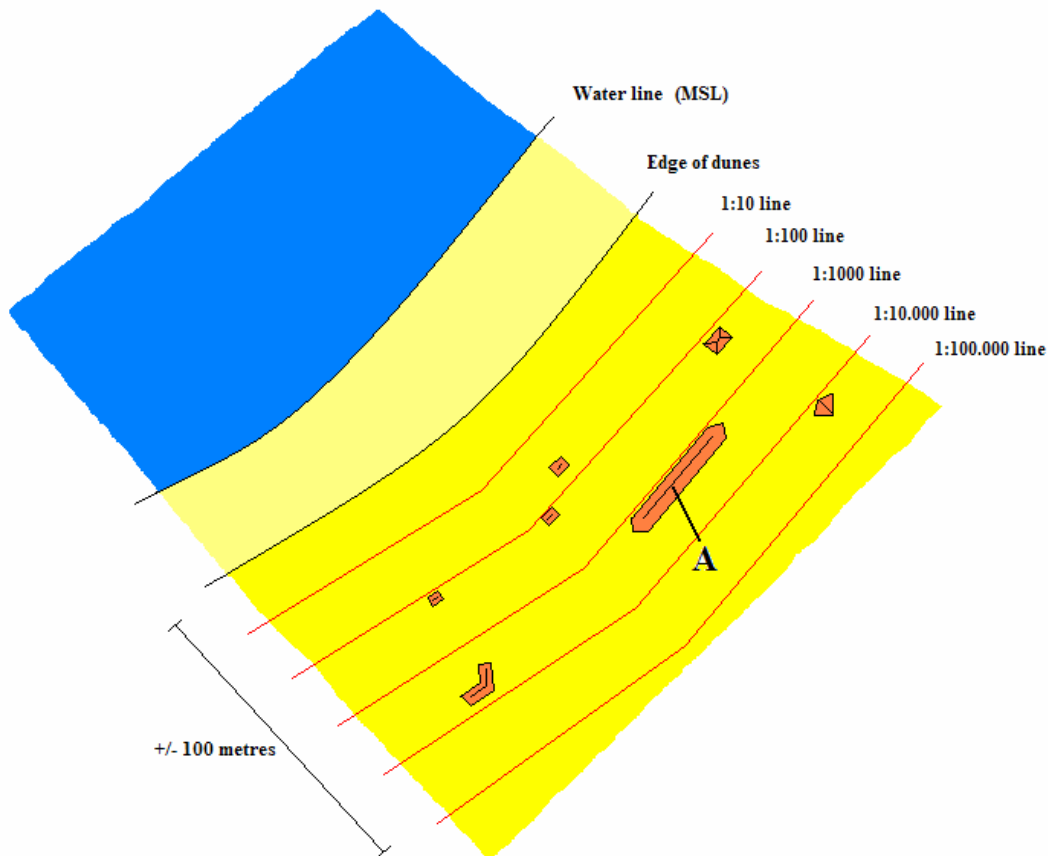


Figure 2.10 Example of risk of an apartment building

2.5.3 Criteria of risk

A number of criteria can be identified for the risk involved, as has been done for the market potential. These can be divided into financial and social risk criteria. Before investing in the erosion zone these criteria need to be considered.

The financial risk is determined by economic values, the social risk by psychological criteria. Financial loss occurs after a disaster when a house owner loses his property, or a business is unable to function. In addition it can be considered an option to initiate reclamation works to speed up the recovery of lost land. An important issue here is the responsibility of these losses. From previous disasters it has become apparent that in certain cases when the responsibility of damage was for the owner, the owner was partly compensated by the government and/or a non-

profit organisation called the ‘Nationale Rampenfonds’⁹, which raises money to compensate victims in case of disasters of all sorts.

Besides financial loss, emotional loss can be a result of a disaster, which occurs when people lose value, which is irreplaceable. Emotional discomfort can for instance be a result of financial loss, or because of the fact that people lose something they have become very attached to. The safety perception of an area represents the subjective value of risk. In case disasters have not occurred in the recent past, the safety perception will in general be that the situation is safe (as is the case at present). In case of a disaster this perception will change into an unsafe perception, resulting in a devaluation of property. However, this criterion will only play a role when the frequency of occurrence of a disaster is of the same magnitude as the average lifetime of an investment.

In Figure 2.11 a total overview of the risk criteria have been illustrated.

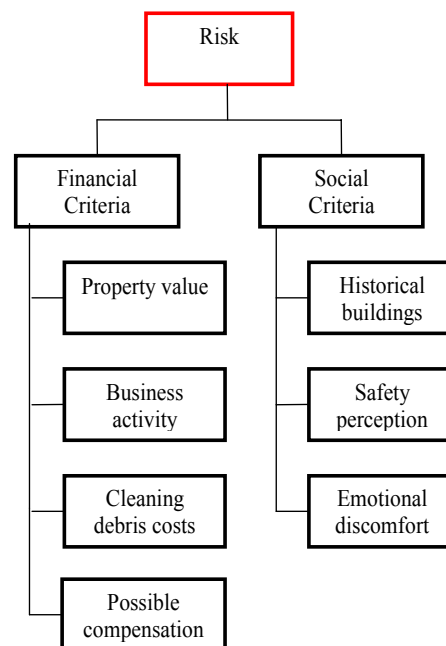


Figure 2.11 Overview criteria of risk

Each stakeholder will have a different set of criteria that influences his or hers interest.

⁹ The ‘Nationale Rampenfonds’ was founded in 1935 to financially help the victims of a twister.

2.5.4 Relation between the chance of erosion and development

The existing development and the chances of erosion together determine the risk in the erosion zone. Therefore it is possible to link the schematizations from Figure 2.5 and 2.8 in the following way (see Figure 2.12):

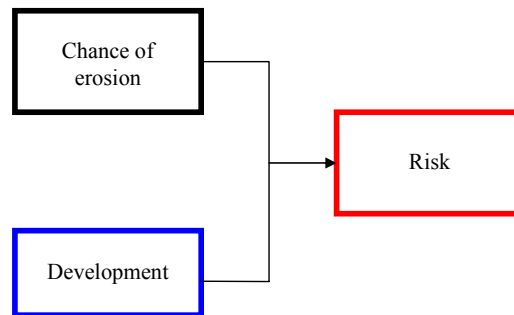


Figure 2.12 Relation between chance of erosion and development

2.5.5 Public awareness of risk

Besides the market potential and the existing building policy, stakeholders now have to take another aspect into account when deciding to invest: risk. The awareness of this risk is essential, but unfortunately there is at present little knowledge on the actual risk amongst citizens, lower government authorities and beyond.

This is, however, different from past centuries, when citizens used to be more aware of the danger of the sea. Over the last couple of decennia citizens have had great confidence in the erected coastal protection works, the result of powerful technical solutions. At the moment there is little information available on the level of knowledge these groups have on erosion risk. Most of the population is aware of the fact that without the coastal defence works half of the country would be flooded. They seem not to be interested in danger, which they think cannot be influenced by them.

The information that civilians should know about the erosion zone is: how often do specific storms occur and what part of the erosion zone will be destroyed. It is then possible for them to assess any financial consequences regarding their investments. Without this knowledge both citizens and coastal authorities can easily make mistakes concerning coastal projects.

2.5.6 Risk reduction

Two methods of reducing risk in the erosion zone can be identified:

1. Reducing the value of the development can decrease the consequence of erosion and thus the risk, or;
2. Increasing the strength of the dunes, or that of the structures, can reduce the probability of the hazard, and thus the risk.

(1) By removing buildings or other investments made in the area the value of development is reduced. Important aspects to consider when removing development are the financial responsibilities and acceptability of the stakeholders.

(2) The strength of the dune profile can be increased by a number of ways:

- Increasing the amount of sand on the foreshore, beach or dunes with sand nourishments.
- Construction of sea defences like seawalls or other reinforcements made of concrete, stones, bricks, (sand) bags or chemical substances. In the extreme situation breakwaters and dams can be considered.

Reducing the probability of damage to structures by strengthening them is only considered effective when foundations are used that can actually withstand the erosion processes and the possible forces of the sea.

2.6 Schematization of the erosion zone

2.6.1 Relations within the erosion zone

In order to illustrate all the relevant relations in the erosion zone the following schematization has been made in Figure 2.13, where the following relations have been added:

- The relation between risk and the stakeholders
- The relation between the stakeholder and the strength of the dunes

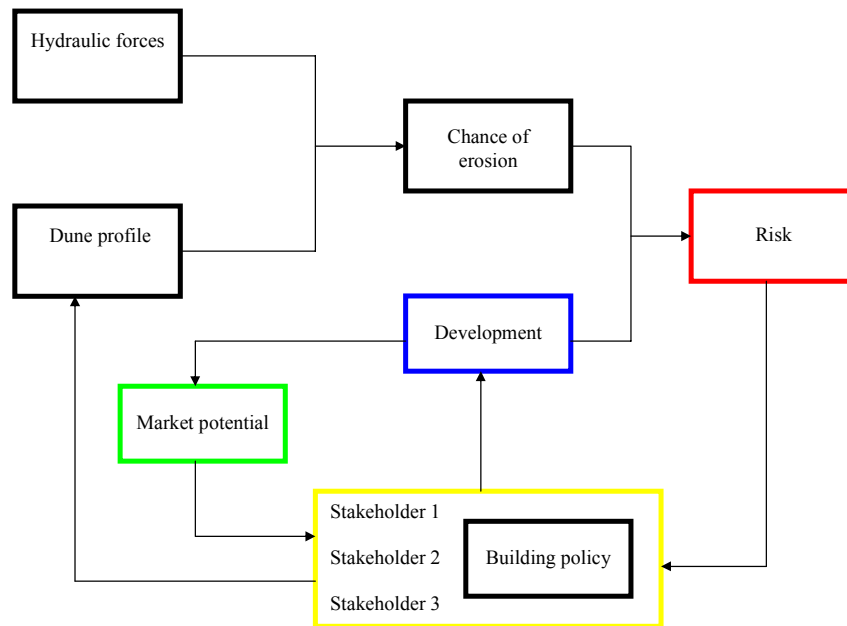


Figure 2.13 Schematization of the erosion zone

2.6.2 Building policy within the schematization

Building policy is developed by the stakeholders and consists of the agreements made between them. Every stakeholder is influenced by the market potential and risk that he or she has an interest in, when these agreements are made. Stakeholders will then invest in the erosion zone, taking the resulting market potential, risk of the new building policy into account. Once developments are realised this will influence the market potential and risk, which in their turn will influence the stakeholders.

In case the market potential or risk becomes unattractive for the stakeholders to invest, the stakeholders can either change the building policy, the development or the profile of the dunes.

2.7 Government policy

2.7.1 Introduction

The present policy made by the government (of which parts are still under construction) and additional laws and regulations that are relevant in the erosion zone, will be discussed here in short. Additional EU and Dutch regulation are given in Appendix 1 to give a more thorough overview.

It is stressed that the following information on policy is ignored throughout the rest of this investigation. It is only discussed here to illustrate the potential impact of this policy.

2.7.2 Policies, regulations and additional laws made by government

Development process

The central government has divided the development process for the key planning decisions into three steps: Firstly a 'Policy agenda for the coast' (Beleidsagenda voor de kust¹⁰) has been made, which was published in February 2002. This was followed by the organization of discussions with the different stakeholders, and the preparation of the 'Policy for the coast' (Beleidslijn voor de kust¹¹) of which a design draft was published in August 2003. Finally, when this Policy for the coast is finished, it will be integrated in the national spatial planning policy (Nota Ruimte¹²).

In the following the contents of the Policy for the coast will be discussed.

First draft of the "Policy for the coast"

There are a number of policies that set the rules within the coastal zone.

The two functions that occupy the largest part of the coastal zone are the sea defence and nature conservation area. Both have a specific territory within the coastal zone and a specific policy.

For the most part, the coastal zone is an uninhabited nature conservation area. The policy in these areas is given in the Ecologische Hoofdstructuur¹³, which is part of the Structuurschema Groene Ruimte¹⁴, the policy for nature conservation.

In the design draft of the new policy, 'Policy for the coast', great importance has been given to reserve space for future landward extensions of the erosion zone, being the sea defence, in anticipation of the sea level rise. The width of this reserved space should be adequate for the next 200 years.

The regulations that are set to protect the part of the coastal zone that is the sea defence, both the cross profile for the required defence as the extension areas, can be found in the

¹⁰ Rijkswaterstaat Rijksinstituut voor Kust en Zee, *Naar integraal kustzonebeleid-Beleidsagenda voor de kust* (2002)

¹¹ Ministerie van Verkeer en waterstaat, *Beleidslijn voor de kust* (2003)

¹² Ministerie van VROM, *Vijfde nota over de ruimtelijke ordening*, Rijksplanologische dienst (2001)

¹³ Ministerie van Landbouw, Natuur en Voedselkwaliteit, *Ecologische Hoofdstructuur* (1990)

¹⁴ Ministerie van Landbouw, Natuur en Voedselkwaliteit en Ministerie van VROM, *Structuurschema Groene Ruimte* (1995)

Waterstaatswetgeving. These two areas have an overlap almost along the entire coast, where a combination of both policies has to be made.

Urban areas within the sea defence areas have to abide by the Waterstaatswetgeving. Drawing a regulatory contour line around the urban area identifies its boundaries. This is done for urban areas located on the sea defence and in the reserved area for future extensions. It can be necessary to draw these lines around urban areas that lie even outside the sea defence and extension areas at locations where nature conservation and spatial quality is important.

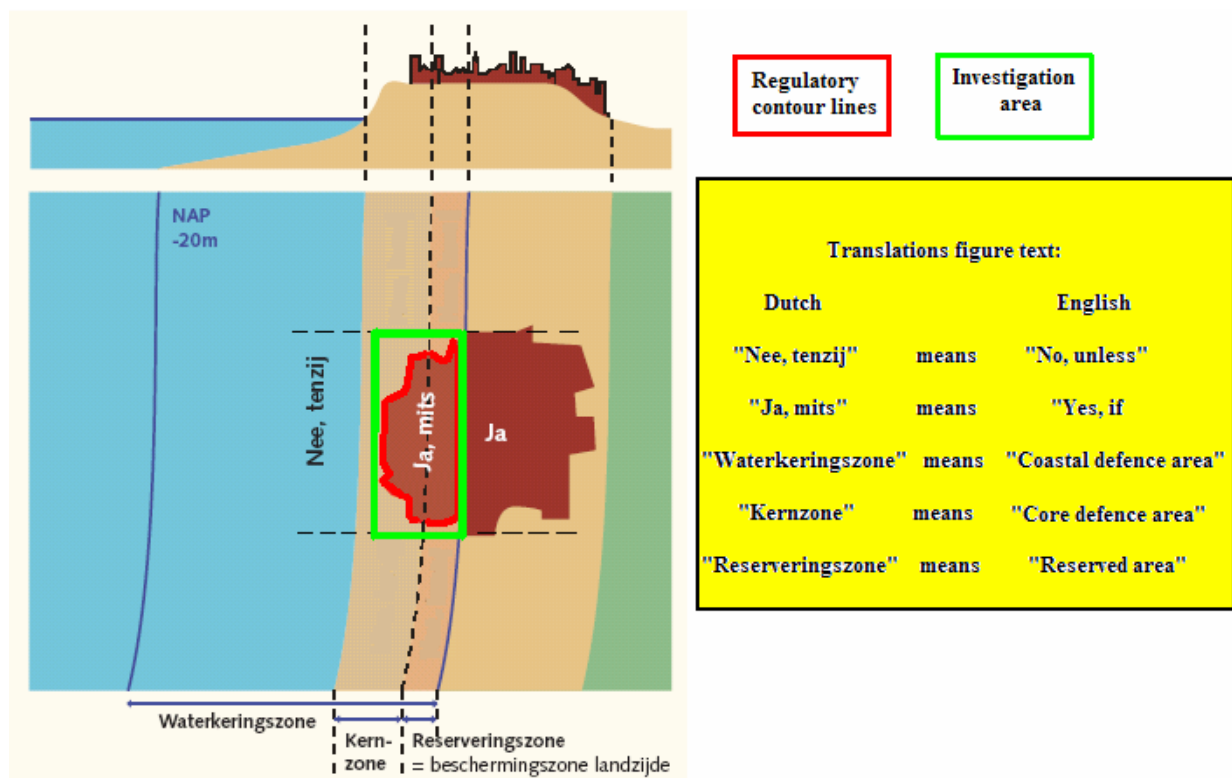


Figure 2.14 Policy for the coast; Regulatory contour lines

*Building outside of the regulatory contour lines in the defence area (including the extension areas) is not possible, unless a: there is enormous benefit for society to be gained or b: the activity cannot be placed anywhere else. Building within the contour lines on the sea defence is possible if certain rules set by the Water Boards are followed and the structure does not obstruct the sea defence plan. These plans and the rules of the Water Boards are slightly different for the actual sea defence and the extension area, but both have the important criteria that the erosion contour lines should not shift landwards. **No regulations***

will be made to control the risk of damage to structures or buildings. Figure 2.14 illustrates the described policy and highlights the area that is considered in this investigation: the urban erosion zone.

The risk concerning a specific location is the responsibility of the owner. Building within the urban area outside of the sea defence is possible without restriction. In the area outside the contour lines and outside of the sea defence area is either nature conservation area, where the Ecologische Hoofdstructuur policy has to be abided, or is not a protected area, in which case mostly the local municipality policies have to be abided.

Furthermore, any structures that are presently located in the sea defence area but outside of the contour lines are allowed a one-time opportunity to increase their use of space by 10%. This extension will be made at the owners' risk.

A different type of structure is the beach pavilion, which is either present throughout the year or part of the year. These are mostly located outside the contour lines and on the sea defence. Pavilions are allowed here as exception, but have to abide by certain rules of which the most important are that they are built on poles and can be removed within a week. Year round presence of a pavilion is allowed in specially designated areas and a number of rules concerning the spatial planning of the area have to be followed. The risk concerning the location of the pavilions is for the owner.

Maintaining the position of the coastline

Maintaining the present position of the coastline has been part of the coastal policy since 1990¹⁵. Compensation of erosion takes place by nourishing sand on the foreshore and beaches with the main objective of keeping the most upper part of the profile constant. In general, this part largely determines the safety level. The position of the coastline is regularly measured and it is common for the rate of erosion to differ in time. The required nourishments are therefore seldom the same.

2.7.3 Discussion on the potential impact of the present government policy

As has been mentioned in Chapter 1, the building policy should be a compromise of exploiting the potential of the erosion zone and averting risk. In order to make these compromises it is firstly essential to understand what potential is available where in the erosion zone and what the risk is. The next step would be

¹⁵ The position of the coastline, measured in 1990, has been maintained since, and is referred to as the 'Basis Kust Lijn' (BKL)

to design a method that can help to decide on what compromises should be made. The available potential and risk involved will then need to be valued and with the help of the decision method compromises can be developed.

However, the present government policy seems to lack these fundamental compromises. The most interesting policy to discuss is the 'Policy for the coast', which is nevertheless still under construction, but includes a number of regulations that are already fairly clear. A number of aspects of this policy will be discussed:

Regulatory contour lines

The regulatory contour lines are implemented to stop any further development outside of the present urban areas. Whether this means that the conclusion was drawn that; outside of the present urban areas the risk is unacceptable for any buildings, has not been stated. It seems a compromise of some other sort has been made here.

The result is that any potential outside of the regulatory contour lines will never be exploited (only in unusual situations). More so, in the future this regulation can result in a decline of the total market potential (and thus the value of all buildings) of the area, as investors will look for other areas to invest, where the total potential can be exploited. This would then of course be outside of The Netherlands.

Building extensions for buildings outside the regulatory contour lines

Buildings that are at present situated outside of the regulatory contour lines are allowed a one-time opportunity to increase their use of space by 10%. What could be the idea behind this regulation?

Again it seems obvious that the market potential and risk were not evaluated properly before designing this regulation. This restriction on the present buildings to further exploit potential can also lead to a decrease in the total market potential.

Extension areas for the sea defence

To anticipate the sea level rise the government wants to reserve areas for future extensions of the sea defence for the next 200 years. Regulatory contour lines will be drawn also in these areas around the present development, to stop any further increase of development here. Although this seems a very sincere action to initiate preparations for the future sea level rise, the compromise on market potential is gigantic. This means that for the next 200 years any available market potential in the undeveloped extension areas will be left unexploited, of which the consequences for the local communities are hardly predictable.

What is even more startling is that the sea level rise, which has been taken into account to calculate these extension areas, is based on the most dramatic predictions. The result is that the calculation of the size of the necessary extension areas depends on many uncertainties and therefore safety margin after safety margin has been included. The market potential, however, is not that difficult to calculate, and is something that can be taken into account fairly accurately at the moment, as should have been done.

2.7.4 Conclusion

A lot of criticism has been projected at the present building policy of the government in the previous section. It is strongly doubted whether the policy has taken the market potential and risk into account in a suitable manner. For this reason four key issues of the building policy will be readdressed in the following chapters. In Chapter 3 solutions for the first key question will be sought: What buildings should be allowed where in the erosion zone and why?

The basic underlying argument made throughout this investigation is that compromises have to be made regarding the available market potential and risk. Any other aspects regarding building in the erosion zone will be ignored, as they are considered of much lower importance, or not relevant for any building policy.

In Paragraph 2.8 an example is given on how satisfactory compromises regarding market potential and risk have been made in the past.

2.8 The compromise of the beach pavilion

A simple strategy, but therefore very useful for illustration purposes, is that used for the beach pavilion. The compromise that all stakeholders have to make, regarding the exploitation of market potential and the avoidance of risk, is a yearly routine exercise for any pavilion owner.

In short, the market potential for the pavilion owner is highest in summer. During summer the weather mostly provides the right conditions that attract a steady stream of sun and beach lovers to the coast. This is the high season for the tourist industry and most, if not all, their yearly profit is made during these months.

The chance of the most intense storms occurring during summer, which result in high water levels and erosion, is relatively small compared to the chance in winter. The chance of destruction of the pavilion is therefore much lower during summer than during

the rest of the year, and thus the risk for the owner is much lower.

When winter arrives, the steady stream of tourists shrinks and profits decline. In autumn, the pavilion owner will dismantle his pavilion (which by law is compulsory for most pavilions) and he disappears during this time of decreased market potential.

At the same time the chances of more intense storms occurring is higher during the winter season. The chance of destruction of the pavilion would then be higher than in summer, and this is another reason for the pavilion owner to retreat from the beach. In Figure 2.15 a simplification of the market potential and risk during summer and winter is illustrated, in case the pavilion is located on the beach all year round.

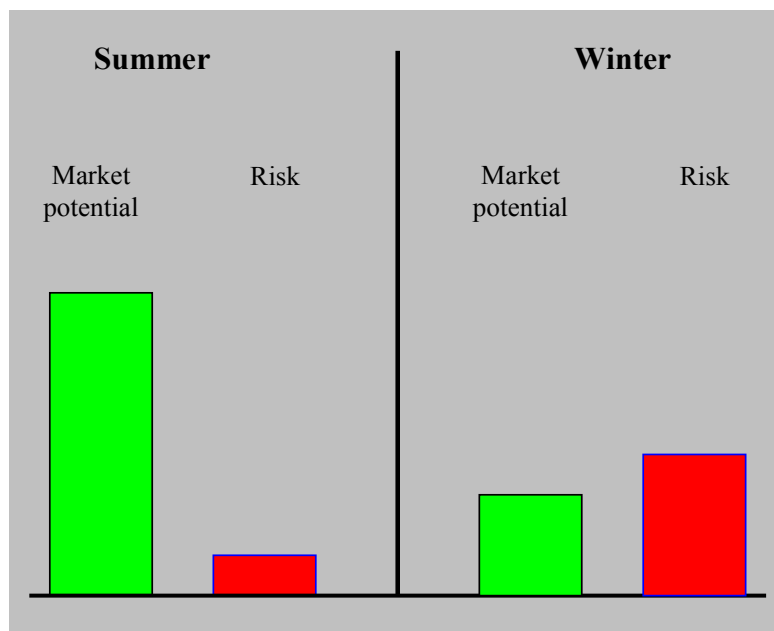


Figure 2.15 Market potential and risk during summer and winter for a beach pavilion

In Figure 2.15 it can be seen that in summer the available market potential, and thus the expected profit, exceeds the risk by far. In winter the risk is higher than the available market potential, and the likelihood of making a loss is higher than of making a profit, in this example. Of course there are ways to decrease the risk, but those will not be discussed here. By removing the pavilion during winter the chance of a loss in this season is nil. The pavilion owner can then spend his winter running an après ski bar somewhere in the Alps, where the tourist season is then at its peak.

The pavilion owner tries to exploit the market potential of the erosion zone to its full potential with this strategy. These

pavilions are not discussed further during the rest of this investigation, as it is far more important to investigate the market potential and risk of the permanent structures on the dunes. Nevertheless, the compromises that are made for pavilions illustrate how compromises can be made on the two most important aspects that concern any of the stakeholders: exploiting potential in the erosion zone and averting risk.

3. Key question 1: What buildings should be allowed where and why?

3.1 Introduction

To answer the key question, we must investigate ways of dealing with the available market potential and risk in the erosion zone.

Three building investments have been chosen that are considered good examples of the majority of buildings in the erosion zone and represent all the stakeholder groups. These are:

- An investment in a house (homeowners)
- An investment in a hotel (business owners)
- An investment in a boulevard along the edge of the dunes (all stakeholders)

For this purpose an imaginary part of the urban erosion zone is considered free of any development and without any building policy. The boundaries of this area are the following (Figure 3.1 also illustrates this):

- The landward boundary: erosion contour line with a frequency of exceedance of 10^{-5} per year (edge of the sea defence).
- The seaward boundary: the edge of the dunes. (The beach is thus not included.)
- The boundaries perpendicular to the coastline: in this case the area borders on nature conservation areas on both sides, as is very common in reality.

Besides these boundaries two assumptions have been made throughout this chapter:

- The position of the coastline is fixed, as are the positions of the erosion contour lines. (In Chapter 4 the sea level rise and resulting movement of the erosion contour lines are discussed.)
- The building market is transparent in such a way that all stakeholders can obtain information on the location of the erosion contour lines.

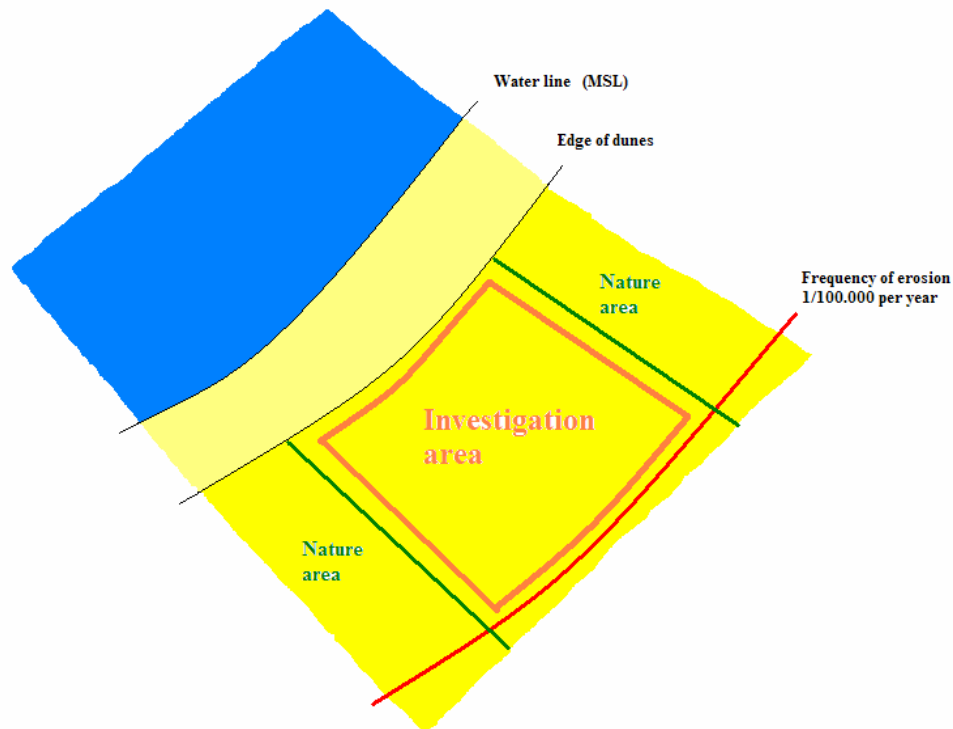


Figure 3.1 Boundaries of investigation area

The strategy used to answer the key question will be discussed in Paragraph 3.2. The valuation method that it used to make decisions for the specific investments is given in Paragraph 3.3. A range of information is required about the stakeholders and their preferences. The methods that have been used to obtain these are discussed in Paragraph 3.4. In Paragraph 3.5 the exemplary investments will be valued with the help of the obtained values. The solutions to the key question are given in Paragraph 3.6

3.2 Research strategy

The strategy that this investigation will follow is perhaps different from other investigations carried out concerning coastal zone problems. The difference lies in the fact that a solution will be generated without taking any existing problems into account. The objective of this investigation is to find suitable building locations in: an imaginary area in the erosion zone, that is undeveloped, consists of a beach with dunes as the only sea defence and where problems are not present. In other words the stakeholders have the opportunity to arrange the whole building layout without interruption.

To find this preferable building policy the following strategy will be used throughout this chapter:

- Development of valuation method;
- Investigation into the present opinion of the stakeholders on the criteria of market potential and risk;
- Investigation into possible building locations;
- Propose a suitable solution for the building policy.

3.3 Valuation of investment in the erosion zone

3.3.1 Valuation method

To be able to use the criteria of the market potential and risk for making decisions, a method of valuation is required that takes these into account appropriately. In this section the valuation method is illustrated.

The investment decision is essentially a choice between consumption in the present and consumption at a future time. The investment decision is based on expectations regarding: the timing of the expected costs and benefits, the magnitude of the expected costs and benefits, and the risk concerning the expected costs and benefits. Expressing these costs and benefits in cash flows is often problematic, especially when investments in private houses are considered. After identifying the criteria of interest of the stakeholders it is important to value these criteria in order to use them in a valuation analysis.

To value an investment a simple approach is used in this investigation: **Similar investments inside and outside of the erosion zone, but within the same urban coastal area, will be compared regarding the market potential and risk.** An example of this simple approach is illustrated in Figure 3.2, where two similar investments are illustrated.

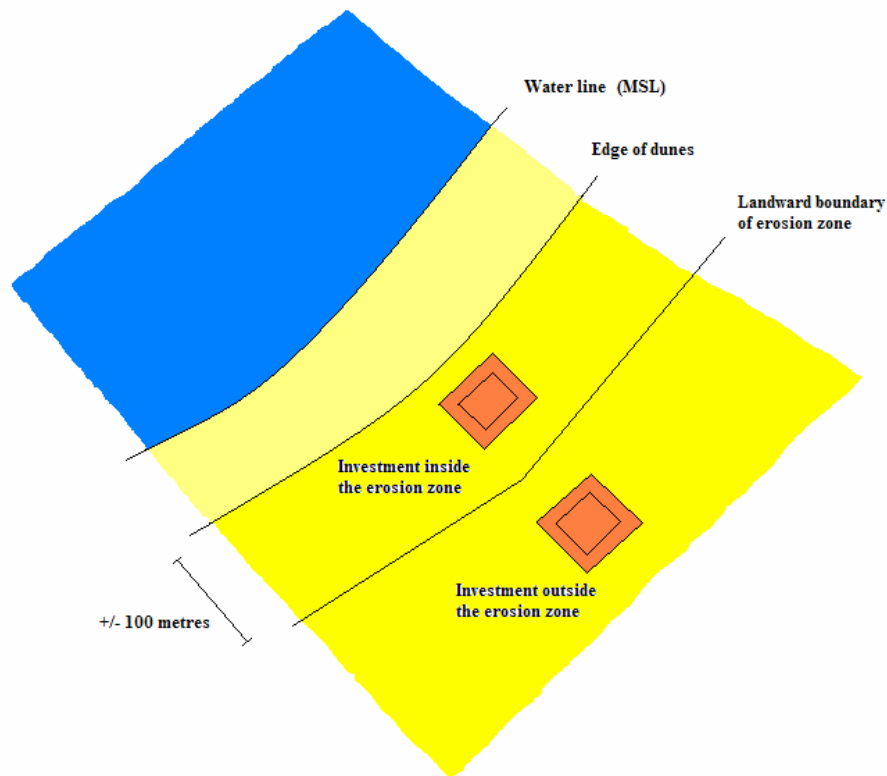


Figure 3.2 Comparison of investment in and outside of the erosion zone

For example, the buildings in Figure 3.2 are two completely similar houses, one outside of the erosion zone, and the other within the erosion zone. The significant difference is that the house within the erosion zone is much closer to the sea and may even have a good view of the sea. The market potential for the house within the erosion zone is significantly higher because stakeholders value the houses closer to the sea more, which is apparent in the higher market value of these houses. For a housing project this means that the potential profit on investments in houses in the erosion zone is significantly higher than outside of the erosion zone.

At the same time the risk of damage of the house in the erosion zone will in general be higher, as the locations within the erosion zone will have a chance of eroding, which is not the case outside the erosion zone. Risk will result in devaluation of the house, as this is an extra cost to be taken into account in the valuation of the investment.

The comparison will illustrate the following differences in market potential and risk:

- The house outside the erosion zone will be considered the perfect compromise between market potential and risk. The market value of the house is the value that stakeholders have determined for such an investment. The risk of erosion outside the erosion zone is nil, so the value depends only on the market potential.
- Inside the erosion zone, the market potential increases, and the risk of erosion is introduced. When the combined value of the value-increase, because of the increase in market potential, and devaluation by risk is nil, the investment can be regarded as similar to the one outside the erosion zone. In case the combined value is nil or is positive, the investment is considered justifiable. In cases where the combined value is negative, the value of the investment is less than the similar investment outside of the erosion zone. This is considered not justifiable.

To simplify this valuation method the different aspects of an investment are categorized in the following way:

The initial value (IV) is considered to be the value of the specific type of investment outside of the erosion zone (but within the coastal area) at the beginning of the investment cycle ($t=0$). Then the erosion zone is considered where the value of the same investment depends on the specific criteria of the market potential. The more the preferences of a stakeholder towards the criteria of the market potential of the erosion zone are met, the more he will value the investment. The difference in value compared to the initial value is here called hedonic value (HV). **This hedonic value in the erosion zone thus represents the potential increase of value compared to building outside of the erosion zone.** Besides this, the investment is subject to risk. This risk contributes to devaluation of the investment, and is here called devaluation by risk (DbR). By adding these values the total value (TV) of the investment is calculated. In Figure 3.3 a valuation diagram is illustrated.

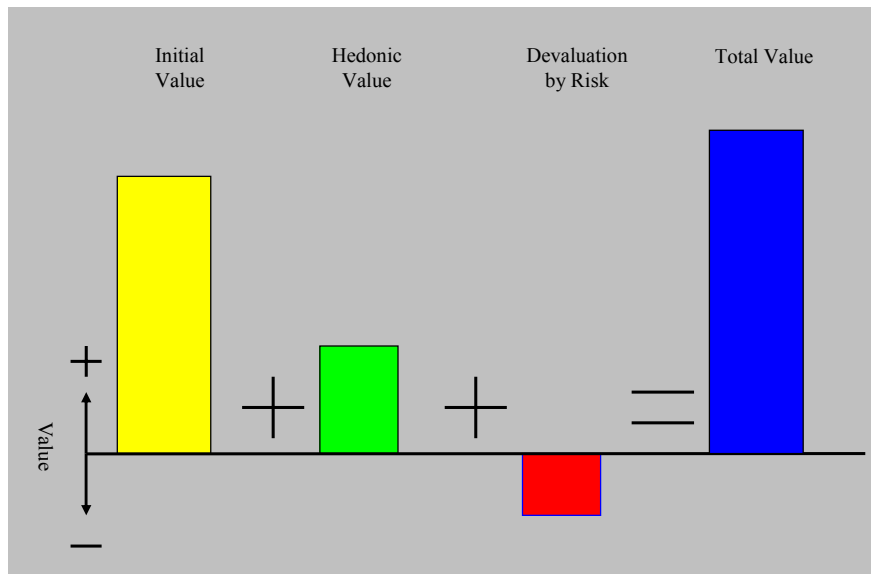


Figure 3.3 Valuation diagram of investment

The different aspects of this diagram are different for each stakeholder as the criteria of interest of the stakeholders are not completely the same. It is, however, essential that the hedonic value in the erosion zone is equal or more than the devaluation by risk for the investment to be justified. In other cases there is no reason to invest in the erosion zone and the initial investment outside of the erosion zone should be considered.

$$\text{Hedonic Value} \geq \text{Devaluation by Risk} \quad (8)$$

In case the opportunities for investing in the coastal zone in general become scarce, this will be reflected in an increase of all aspects of the valuation at the same rate, and will not influence the results of this valuation method.

The risk of an investment increases towards the edge of the dunes, as the frequencies of erosion increase. The HV of an investment can also be differentiated along an axis perpendicular to the coastline. At first it is considered that the locations closer to the coastline offer possibilities of higher HV. This is illustrated in Figure 3.4 where these values are plotted along an axis perpendicular to the coastline.

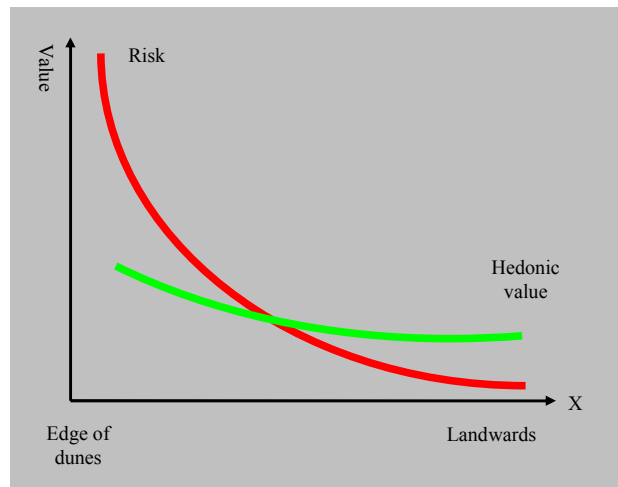


Figure 3.4 Risk and HV plotted perpendicular to the coastline

From the point where the hedonic value and risk are equal in Figure 3.2 to the edge of the dunes, investments are therefore undesirable.

3.3.2 Possible valuation methods for the market potential

In Section 2.4.3 the criteria on which the market potential depends have been discussed. There is no straightforward method to express all these values in terms of money as a large number of the criteria are based on personal preferences and can largely vary between stakeholders. Nevertheless a number of basic valuation methods¹⁶ for real estate can be distinguished that have proved to be very useful in the past and will be used here to obtain suitable value for the market potential:

- (1) Market price: possible in a competitive market (equilibrium price).
- (2) Shadow price: when markets are imperfect and need correction (for instance for household content or also agricultural land).
- (3) Hedonic price method: this separates some components of amenity gains or losses from other determinants of house prices. The housing market is the most difficult market to apply this method to, because the demand of houses is not met by production, but largely by the resale of houses of existing stock.

¹⁶ Valuation methods taken from: Penning-Rowsell, C.E., *The Economics of Coastal Management*, London, Belhaven Press, 1992

- (4) Contingent valuation method: by use of a social survey/questionnaire (not yet very accurate).
- (5) Case specific approaches: for instance, taking the amount that the government pays to compensate for losses to individuals (a problem in this case can arise when an attempt is made to determine for what the payment is made exactly), or the willingness to pay (WTP) method in which the willingness to obtain something or a situation is quantified in currency.

In this investigation a number of these methods will be used to gauge the magnitude of the investment values.

It is, for instance, possible to gauge the magnitudes of these values by using a combination of market prices and the shadow or hedonic price methods, supplemented with estimates from the stakeholders and local property brokerages. Besides this, a distinction in the consumption in time of the cost and benefits has to be made.

3.3.3 Possible valuation methods for risk

In Section 2.5.3 the criteria on which the risk depends have been illustrated. The valuation of the financial risk can be carried out rather easy as the objective values that are required can be obtained mainly with the market price method, and are easy obtainable. The social risk criteria are somewhat more difficult to value, and this will be mainly carried out by using the contingent valuation method.

In the next Paragraph (3.4) the methods used to obtain the necessary values are discussed.

3.4 Investigation methods used to obtain values of the market potential and risk

3.4.1 Introduction

Because the stakeholders have different interests in the erosion zone, they will have different criteria that influence these interests, though some will be the same amongst all stakeholders. It is therefore essential to assess which criteria are important and what the values of these are.

To obtain suitable values for the investigation, real values are taken from target areas in the erosion zone. In Section 3.4.2 it is discussed which areas should be used and what areas have been used in this investigation. The investigation methods used to

obtain the necessary values are discussed in Section 3.4.3. In Section 3.4.4 it is discussed whether the results of the survey, or contingent valuation method, are a good representation of reality.

The results of the investigation are illustrated in Paragraph 3.5, where they will be used to value the exemplary investments. In Appendix 4 the results of the investigation are also given.

3.4.2 Target areas for investigation into market potential and risk

To ensure that the areas used can represent the majority of the coastline, a number of criteria have been used to help choose them.

The criteria used in helping to choose the investigation areas for the stakeholder groups of homeowners and business owners, have been divided into two groups of different importance: primary criteria and secondary criteria.

Primary criteria:

- The sea defence must consist of dunes.
- Buildings have to be present in the erosion zone.
- The following problems should be relevant: the necessity to maintain the coastline at the present location, a declining safety level due to sea level rise and the need for risk management. (These are the main problems in most of the coastal areas.)

Secondary criteria:

- The profile of the dunes represents the majority of profiles found along the coast.
- The presence of a large number and variety of buildings in the erosion zone is required. (Relatively small towns, or towns built mainly behind the erosion zone, will not fit this criterion.)
- A large variety of human activities (tourism, housing etc.) must be present in the erosion zone.

Using the primary criteria, the resulting number of eligible investigation areas is nine (9). These are: Bergen aan Zee, Egmond aan Zee, Industrial area Corus, Zandvoort, Noordwijk aan Zee, Katwijk aan Zee, Scheveningen, Domburg and Zoutelande.

Using the secondary criteria to choose from this list, the resulting three areas are: Noordwijk aan Zee, Katwijk aan Zee

and Zandvoort, of which the first two are chosen as investigation areas.

Between these two areas a number of differences and similarities can be observed. Some notes will first be given to illustrate these¹⁷.

- There are no significant erosion problems at present at both locations.
- Artificial sand nourishments have successfully maintained the coastline at the desired location without any problems.
- All locations have structures in areas where the frequencies of exceedance of erosion are higher than $1 \cdot 10^{-5}$ per year.
- Noordwijk is considered a weak link in the sea defence and has a high priority for reinforcement. It will have to be reinforced within the coming decades. (At the moment discussions are being held whether this reinforcement should be placed either at the seaside, landside or at the present location of the erosion zone.)
- In Katwijk aan Zee large areas are already located in front of the erosion contour line with a frequency of exceedance of $1 \cdot 10^{-5}$ and $2 \cdot 10^{-3}$ per year. (At the moment Katwijk aan Zee has hired a consultancy agency to investigate the possibility of extending part of the coastline seawards, with the additional possibility of a harbour.)
- Reinforcing the dunes will be necessary at Katwijk aan Zee within the next 50 years. This location will possibly become a high priority location for reinforcement in the near future.

Although the two areas chosen as examples for the investigation all fit the criteria mentioned above, they still illustrate different situations, which are representative for the majority of the coast.

In Appendix 3 a short description of these areas is given.

¹⁷ Notes derived mainly from 'Strategische visie Hollandse kust 2050' by Arcadis-Nieuwe Gracht-Alkyon, February 2002.

3.4.3 Methods used to obtain the values of market potential and risk

Specific information on the opinions of the stakeholders is not readily available. The information that must be obtained is: what criteria are important and what values do these have?

Because the stakeholders groups consist of large numbers of individuals, there are a limited number of methods that can deliver results within a reasonable time frame.

The following three methods have been used:

(1) Survey

A survey was prepared in the form of questionnaires for each stakeholder group, to investigate their opinions. The survey is believed to be the most celebrated method to acquire data that reflects the preferences of a large group, although there are numerous reasons why surveys often provide incorrect data. When possible these errors have been corrected by using professional opinions. The homeowners and the general public are the largest stakeholder groups and therefore the survey is most suitable to obtain a good idea of their interests.

(2) Interview

Opinions of business owners (and homeowners) were also obtained with the help of a more precise method: interviews. Besides this, additional information and opinions were obtained in this manner from both real estate and other specialists.

(3) Market research

Where possible, values have been obtained with the help of market research on prices. This proved to be useful in the housing market and in the tourism industry.

The procedure of investigation is divided into two parts: investigation into opinions on market potential, and opinions on risk.

Opinions on market potential

To investigate the opinion of stakeholders on the market potential of the erosion zone, a schematization is used to simplify matters. As the Dutch coast consists mainly of beaches and dunes, the total area can be divided into three zones; the beach, the dunes and the area where the dunes and beach meet, which will be called the edge of the dunes. The dunes are most important for this investigation, so this part is subdivided into

additional zones. From observations done at coastal towns, it is assumed that 25 meters is a suitable width to use for roads/boulevards, building blocks, the edge of the dunes and the space used for pavilions on the beach. In Figure 3.5 the schematization illustrated was used to obtain several of the stakeholders' preferences.

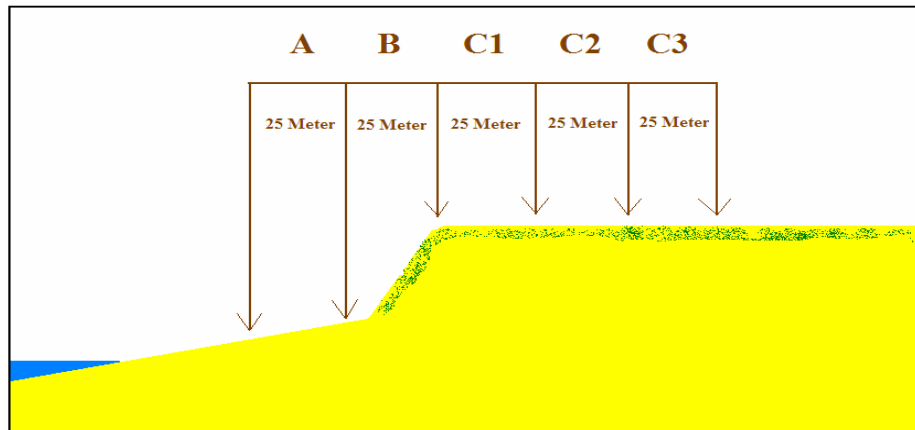


Figure 3.5 Schematization of 5 zones in the erosion zone

Note that it is more important, for communicative means, to create a common understanding on the general location of these zones rather than on the exact distances.

Opinions on risk

Within the erosion zone the frequencies of occurrence of erosion lie between 10^{-5} and ~ 1 per year. By relating these to the chances of other hazards like flooding due to extreme river discharge or fire, a preference can be given for the risk of erosion damage.

A key value to obtain is the value of emotional discomfort, as financial damage can be mostly calculated without the opinion of the stakeholder.

In addition it is useful to know with what knowledge of the coastal areas the stakeholders decide on their preferences. To get an idea on this, a number of extra questions were asked on present problems in the coastal areas, such as sea level rise.

In Appendix 4 the result of the survey, interviews and market research is given.

3.4.4 Validation of the contingent valuation method (survey)

It can be argued that there are certain topics in which the stakeholders do not have adequate insight, and they should therefore not decide on these issues.

Here this will be discussed in the two criteria categories, market potential and risk.

Market potential

This category requires knowledge on the site-specific potential for each stakeholder. For a homeowner this potential depends largely on personal preferences. A homeowner values his living environment from the natural and built-up environment surrounding him. Also the business owner will know what the preferred environment is for him to be able to make money. These are aspects which the individual stakeholder can see and experience. It will be assumed that the homeowner, business owner and general public, are the preferred individuals to decide on matters concerning the market potential.

Besides the actual preferences of the stakeholders, it is considered even more useful to obtain information from professionals concerning the market potential. Real estate agencies and property valuers are considered the most accurate source of data, as they are able to give estimates on averages across the whole coastal community.

Risk

In this chapter it was assumed that all stakeholders were able to obtain all relevant information on risk. This transparency is presently not the case, as most of the stakeholders have little knowledge on the present risk levels.

The risk category is somewhat different than market potential, as it is hardly possible to see or experience risk in a way that all stakeholders are able to develop good judgement. In literature the choice of who should decide on matters of risk, is often a battle between democracy and dictatorship, with the politicians and scientists as the dictators. Their argument is mostly that they have the knowledge to save the public from disasters, and so many argue that scientists or politicians should decide on these matters. However, scientists are human too, and they are not free of error or personal preference, without even mentioning politicians.

In this investigation we will not go into this debate, but remember that in a democracy the real stakeholders should decide what is best for them.

Nevertheless, the way that civilians value risk should be discussed before trusting their opinions completely.

The acceptance of risk depends on the age and personal preferences of the individual and furthermore on a number of factors:

- Whether exposure to the specific risk is voluntary
- Whether an individual can recognise the risk
- The personal gain if the risk is averted
- The means of society to decrease the risk
- The historical background of the risk (frequency of occurrence)

In general the risk in the erosion zone is voluntary, though the fact that most of the population is unaware of this risk makes this statement debatable. Due to the fact that the last flooding disaster occurred more than 50 years ago, it is assumed that the recognition or level that people can relate to this risk is minimal. Consequently the personal gain from averting this risk cannot be expressed satisfactorily. However, civilians seem to be very confident that the government can protect them from all sorts of hazards.

These facts can only lead to the conclusion that civilians will probably claim to require a higher safety level to protect them from this hazard than scientists would. But that should not be the reason not to let them decide on matters. When civilians invest voluntarily (in this investigation; deciding whether to build at a specific location), they should have the right to decide how much risk they take.

Besides the acceptance of risk another aspect of risk is important, as civilians tend to value risk in two dimensions. These are:

- The magnitude of the consequence
- The degree of organised security measures

The fact that the chances of damage to individual buildings parallel to the coast are largely dependent, leads to the conclusion that the magnitude of damage to property is not limited to individual cases. This can only increase the impact of the risk on the stakeholders' preferences.

The degree of organised security measures is not easily apparent to the stakeholders. The sea defence they are located on, was not designed to protect the erosion zone, but the lower inland areas. Most of the stakeholders in the erosion zone do not make this distinction.

In order to value risk, it is often related to the event of physical injury or mortality. In the case of the erosion zone this is not very useful, as these consequences are not expected to occur. (The combination of a warning system, the possibility to forecast storms well in advance and the ease with which individuals can leave the erosion zone justifies this assumption.) It is, however, possible to relate the risk to other hazards such as fire, or flooding due to extreme river discharges. Using these types of examples, the stakeholders should be able to express their preferences to risk.

With regard to the erosion zone, it can be concluded that it is of vital importance that stakeholders are indeed aware of the risk, if they are to make decisions for which they are to be responsible. If not, the government is very likely to be held responsible, as they were after the river flooding events in 1993 and 1995. A summary of this case is given in Appendix 2.

Conclusion

For the preferences regarding the market potential, the opinions of professionals (real estate agencies) are valued most.

The factors that influence the acceptance of risk of civilians will probably result in higher safety preferences for the erosion zone than scientists would. On the other hand the magnitude of the potential damage of which most stakeholders are unaware, can again justify any over-estimated safety demands.

Nevertheless, the preferences of the stakeholder are valued most and are obtained by relating the risk to other hazards like fire, or river flooding, due to extreme river discharges. Where possible, the "willingness to pay" is considered a good alternative to value certain criteria.

3.5 Valuation of exemplary investments

In this paragraph the three exemplary investments; a house, a hotel and a boulevard, will be valued using the method described in Paragraph 3.3. In Paragraph 3.3 it was discussed that the comparison of similar investments, in and outside of the erosion zone, will enable to determine whether investments in the erosion zone should be justified. For these valuations it is essential to value the different investment aspects, which are the initial value, the hedonic value, the devaluation by risk and the total value. These values have been obtained with the methods discussed in Paragraph 3.4 and will be used in the following examples. In Appendix 4 a total overview is given of the results of the survey, interviews and market research.

3.5.1 Example 1: Valuation of investment in a house

In this valuation example the responsibility of the investment is solely for the investor/home owner and no building requirements are stated.

Initial value

The initial value of the house consists of the value of the plot and the building. This is valued using the market price method and consists of the value of a property in the coastal area, but outside (in landward direction) of the erosion zone. By taking this value the influence of the regional house market is included in the market price and the hedonic value of the erosion zone is excluded. This data can be obtained through local real estate brokers. This value therefore already includes the future costs and benefits that are **not** related specifically to the erosion zone, including general maintenance costs, taxes and benefits that derive from the investment. The actual benefits that flow from a house are not cash flows but rather the pleasure that results from living in a specific house. These benefits can only be represented in the market value of the property.

The value of houses in The Netherlands is subject to fluctuations that are caused by a number of outside factors. On average though, the value increases at the same rate of inflation.

For the investigation areas (Noordwijk aan Zee and Katwijk aan Zee) an initial value of the building is taken at €180.000 and a plot value at €70.000. For the result of the valuation, the ratio of the building and plot value is important, not the actual values. This average ratio (180/70) has been obtained with the help of market research on the present market prices.

Criteria of market potential and risk

Before discussing the hedonic value and risk it is important to identify the important criteria that determine the market potential and risk for an investment in a house.

By using the results of the survey and several interviews with real estate brokers, the following information was obtained: For the homeowners the location criteria are far more important than the surroundings. Extra costs of building regulations are presently not applicable. The market potential in the erosion zone solely depends on two criteria: the nearness of the sea and possible sea view from the house.

Of the social risk factors the emotional discomfort is most important. The safety perception can only result in devaluation of the property in case the frequency of damage is of the same

magnitude as the frequency with which the property ownership changes.

In Figure 3.6 the relevant criteria for an investment in a house are illustrated.

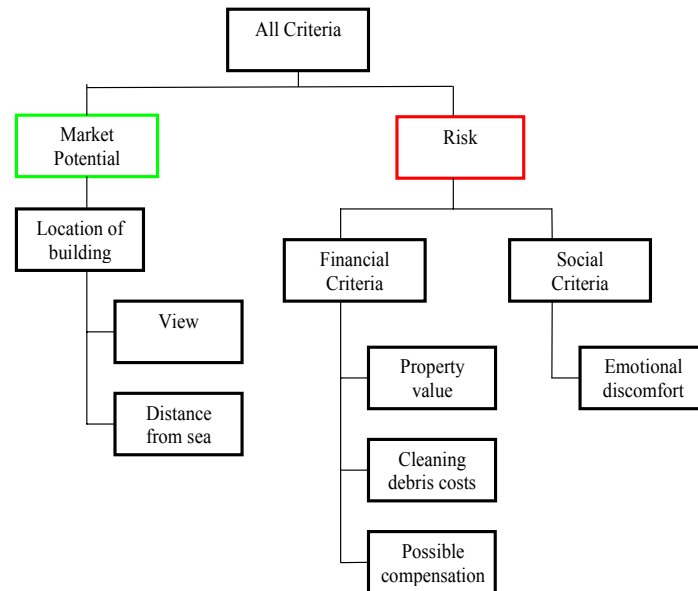


Figure 3.6 Criteria for a house owner

Hedonic value

The hedonic value (HV) represents the additional market value of a property in the erosion zone, compared to a **similar** property outside the erosion zone.

$$HV = \text{Value in the erosion zone} - \text{Value outside the erosion zone} \quad (9)$$

To calculate this hedonic value, the hedonic price method can be used with information provided by real estate specialists. Homeowners can also give their input by using the contingent valuation method, but the opinions of the professionals are preferred. The hedonic value can then be expressed as a percentage of the initial value, which is the market value of a house outside the erosion zone:

$$HV = \Delta * IV \quad (\text{euro}) \quad (10)$$

In which :

Δ = factor of hedonic value (–)

With the help of market prices of apartments the hedonic values of the two most important market criteria: location near the sea and view of the sea, were obtained. These have an average hedonic value of 50% and 100% of the initial value, or factors of hedonic value of 0,5 and 1,0. To further clarify this, this means that the value of a house with a sea view is 100% higher than a similar house outside the erosion zone, without any sea view. This is in fact quite remarkable as these two houses are located only a couple of hundred meters apart. Using these values and Figure 3.7, an improved illustration can be drawn with the hedonic values for the different criteria.

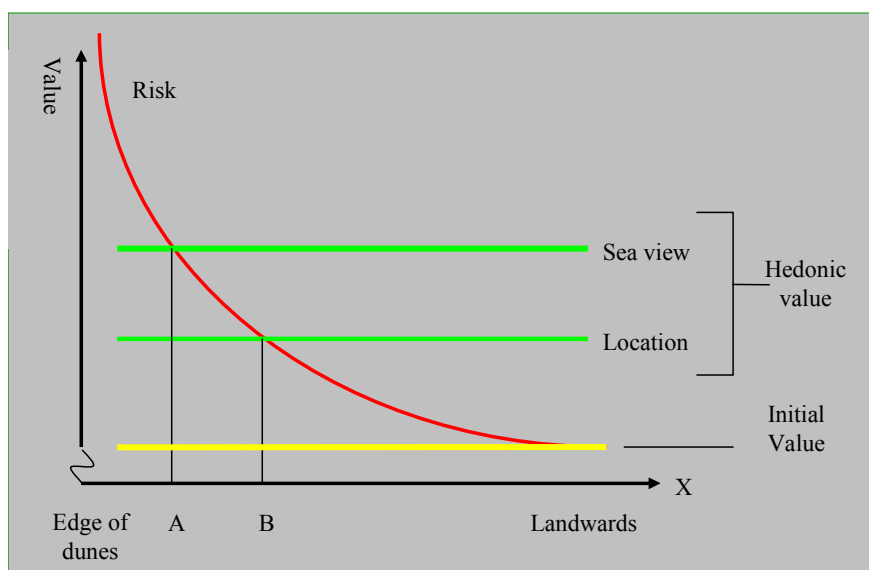


Figure 3.7 Risk and the most important HV's plotted perpendicular to the coastline

It is interesting that these values are more or less constant across the erosion zone. Point B in the figure represents the minimum distance between a building and the edge of the dunes, with only the hedonic value of a location near the sea. Point A represents the minimum distance between a building and the edge of the dunes, with the hedonic value of a location near the sea and sea view.

The actual costs for the investor to acquire this hedonic value are calculated in a different way. On a yearly basis the costs of this hedonic value for the investor depends on the method that is used to finance the investment. In this investigation one option is considered: the investment is financed with capital from the investor. The cost of capital is then calculated in the following way: the cost of capital is the yearly real rate of interest times

the total hedonic value. The value of the total investment increases with the same rate of inflation.

The yearly cost for the investor of the HV can then be expressed as:

$$\text{Yearly cost of HV} = r * HV = r * \Delta * IV \text{ (euro/ year)} \quad (11)$$

In which :

HV = Hedonic Value (euro)

r = real rate of interest (per year)

Δ = factor of hedonic value (-)

IV = Initial Value (euro)

In effect, these capital costs represent the willingness to pay more per year for having a house in the erosion zone, compared with a similar house outside of the erosion zone.

Additional information is required when the hedonic value is financed with a mortgage, as actual costs of the mortgage vary, depending on the duration of the loan agreement. As risk is valued as a yearly cost, it then becomes essential to know the duration of the investment to calculate the total risk and cost of capital. However, mortgages are not considered in this investigation.

Devaluation by risk

The devaluation because of risk depends on financial and social criteria. The different aspects of this risk will be discussed here per aspect.

The yearly risk of the building is calculated according to the chance of destruction per year and the value of the property. In this investigation it is considered more suitable to use the replacement costs of the building, as it is assumed that the house will be rebuilt after destruction. The replacement costs of the building are a percentage of the initial value of the building. During interviews with real estate brokers this value was estimated to be roughly 65% of the building value. The replacement costs of the building are calculated by multiplying the building value with a factor α ($\alpha=0,65$).

The financial risk of the building can then be calculated with the chance of destruction (P_f) and the replacement costs of the building:

$$\text{Financial risk of building} = P_f * \text{Building Value} * \alpha \text{ (euro/ year)} \quad (12)$$

In which :

P_f = the chance of destruction (per year)

α = the factor of replacement costs (-)

The second aspect of financial risk is that of the cost of cleaning up of the debris and cost of reclamation works. It is, however, highly unlikely that homeowners will ever be held responsible for these costs, even though they are at present responsible for their property, but for the sake of being (financially) correct, the costs of cleaning up the debris will be included. These costs have been obtained through demolition specialists who estimate these costs at 1,5% of the initial value (building and plot value).

The cleaning costs of the plot are calculated by multiplying the initial value of the house with a factor β : $IV \cdot \beta$. The financial risk is then:

$$\text{Financial risk of cleaning debris} = P_f * \text{Initial Value} * \beta \text{ (euro/ year)} \quad (13)$$

In which :

P_f = the chance of destruction (per year)

β = the factor of cleaning costs (-)

The cost of the reclamation works will be paid by the government, as the plot is part of the sea defence and must be reconstructed to provide the necessary safety for the inland areas. At the end of the investment cycle the original state of the plot should be considered.

The value of furniture and other assets inside the building is rather significant and should not be ignored. From insurance policies it can be concluded that the value of assets in houses, like furniture and electric appliances etc., range from € 30.000 to € 100.000 per household. The exact value is determined with a set of factors like the age of the inhabitants, the income and value of the house.

Relating the value of the assets only to the initial value, the following relation can be abstracted: value of assets $\approx IV \cdot \lambda$. The value of λ has been obtained through the insurance policy data and is valued at 0.29.

The financial risk of the assets is then:

$$\text{Financial risk of assets} = P_f * \text{Initial Value} * \lambda \text{ (euro/ year)} \quad (14)$$

In which :

P_f = the chance of destruction (per year)

λ = the factor of assets value (-)

The costs of alternative housing and other disaster-related costs after the disaster are ignored in this valuation.

The total financial risk can then be calculated by integrating all the financial risk aspects into one equation:

$$\text{Total financial risk} = P_f ((BV * \alpha) + (IV * (\beta + \lambda))) \quad (\text{euro/ year}) \quad (15)$$

In which :

P_f = the chance of destruction (per year)

BV = the value of the building (euro)

α = factor of replacement costs (-)

IV = the Initial Value (euro)

β = the factor of cleaning costs (-)

λ = the factor of assets value (-)

The social risk, consisting of emotional discomfort, is somewhat more difficult to quantify. Here the emotional discomfort has been quantified with the contingent valuation method by relating this value to the specific financial loss. About 60% of the owners had valued the emotional discomfort in the range of 40-60% of the financial risk, 30% valued this lower. Seeing that the method of questioning in the survey does not allow for simply averaging of this data, it is chosen to take the preference of the majority. The emotional discomfort is therefore taken at 50% of the financial risk. The risk of the emotional discomfort is calculated as a percentage, factor γ , of the total financial risk.

The risk of emotional discomfort is then:

$$\text{Risk of emotional discomfort} = \text{total financial risk} * \gamma \quad (\text{euro/ year}) \quad (16)$$

In which :

γ = the factor of emotional discomfort (-)

Because the frequency of occurrence of a disaster is considered much lower than the frequency of occupancy of an owner, the safety perception is assumed not to play an important role here.

Present legislation states that all risk in the erosion zone is the responsibility of the owner/investor. If the possibility exists for an investor to transfer the risk to an insurance company this can influence the social risk, as the emotional discomfort in case of a disaster will possibly be reduced. This will also be true if the government decides to include parts of the erosion zone in the compensation legislation for disasters (Wet Tegemoetkoming Schade, WTS¹⁸), as this compensation normally exceeds 60% of all damage costs. Obviously this also decreases the financial risk. The possible compensation, in case compensation is given, is assumed to be approximately 90% of building damage, and 50% of loss of assets and business. These values have been taken from similar disasters in the past when compensation was given. In this example the possible compensation is nil, but this aspect will be illustrated in the equation. This compensation is given as a percentage, factor δ , of the resulted financial damage:

$$\text{Possible compensation} = \text{total financial risk} * \delta \quad (\text{euro}) \quad (17)$$

In which :

δ = the factor of possible compensation (–)

The total risk is then the sum of the yearly financial risk and the risk of emotional discomfort minus the possible compensation. The yearly DbR during the duration of the investment can be calculated by:

$$DbR(t) = \text{FinancialRisk}_t + \text{EmotionalRisk}_t - \text{PossibleCompensation}_t \quad (\text{euro}) \quad (18)$$

In which:

t = the year in which risk is calculated

¹⁸ Wet Tegemoetkoming Schade bij rampen en zware ongevallen (version dated 13-09-2004)

Combining the different aspects of the annual risk in one equation gives:

$$DbR(t) = P_t (((BV_t * \alpha) + (IV_t * (\beta + \lambda))) * (1 + \gamma) * (1 - \delta)) \quad (\text{euro} / \text{year}) \quad (19)$$

In which:

P_t = Chance of destruction (per year)

BV_t = Building value at t (euro)

α = factor of replacement cost (-)

IV_t = Initial value at t (euro)

β = factor of cleaning debris cost (-)

λ = factor of assets value (-)

γ = factor of emotional discomfort (-)

δ = factor of possible compensation (-)

Total value

The total value is the initial value plus the yearly hedonic value and yearly risk capitalized to the start of the investment. The total value is considered to be the new market value of the property. Subtracting the devaluation by risk from the cost of hedonic value, the remaining capital can then be used to value the exact increase of value of the investment inside of the erosion zone. However, in reality the real estate market is not as perfect as it seems, as every stakeholder will have different criteria preferences, and all objects of investment mostly differ. Besides this, the devaluation by risk is mostly not (almost certainly never) included in the market prices at present, as there are no suitable means to enable the public to calculate these, even if they would like to. At the moment the public is mostly unaware of the risk. This combined with the fact that these seaside properties are scarce drives the market prices upwards (the hedonic value goes up because of higher demand). This in itself is not a problem when all aspects of the valuation stay transparent for all investors, and at the moment it gives the opportunity to obtain reasonable hedonic values without much difficulty.

In Figure 3.8 the process of this valuation example is again illustrated, but now visually.

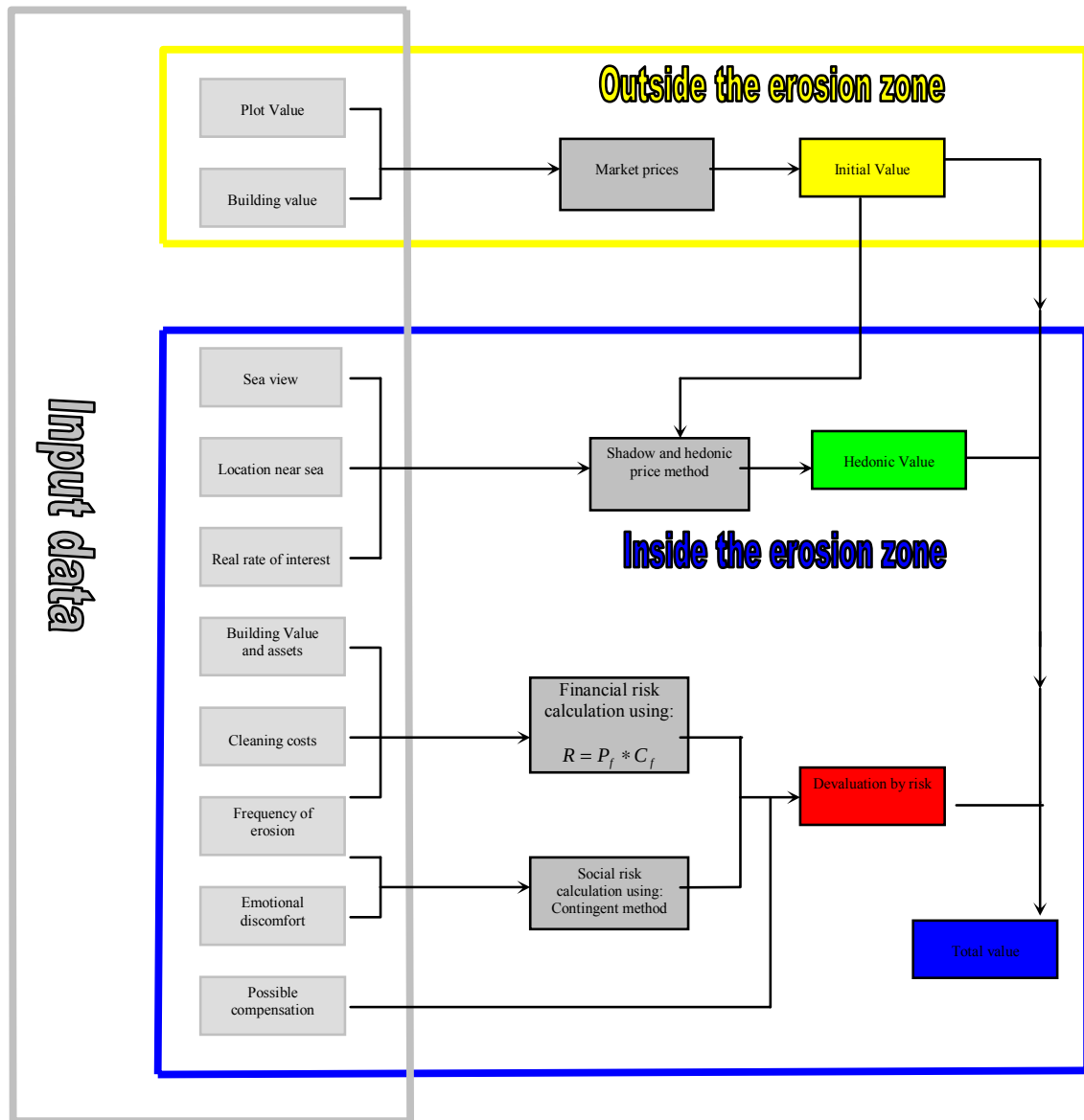


Figure 3.8 Valuation process of an investment in a house

Investment decision

The most important criterion remains the question of whether the hedonic value is higher than the devaluation by risk, which means that for the housing market the cost of capital to acquire the hedonic value must exceed the risk.

As both the hedonic value and the risk depend on the initial value, which increases at the same rate of inflation, the costs are

not capitalized for different time steps. This simplification can however not be justified when fluctuations in time occur.

When fluctuations are taken into consideration the costs can be capitalized to a preferred moment in time, using the following equation:

$$TotalCost(t = 0) = \sum_{t=0}^t \frac{Cost_t}{(1+r)^t} \quad (euro) \quad (20)$$

In which:

r = the real rate of interest

When the yearly cost of capital to acquire the hedonic value and the yearly risk are equal, it means that the willingness to pay for living in the erosion zone is equal to the risk, and the value of such an investment is equal to that outside of the erosion zone. The market prices of the houses should then be equal and the maximum risk that investors are willing to pay for is included. With regard to the erosion contour lines, it can be concluded that a maximum frequency of erosion damage for the house is found and the distance between the sea and the location of this house (i.e. the frequency of erosion) cannot decrease any further.

The maximum acceptable chance of destruction is then found when the cost of the hedonic value is equal to the total risk.

Using the previous equations for the cost of hedonic value and risk, the following equation can be derived where the maximum acceptable chance of destruction (P_{facc}) is used:

$$r * HV = P_{facc} ((BV * \alpha) + (IV * (\beta + \lambda))) * (1 + \gamma) * (1 - \delta) \quad (euro / year) \quad (21)$$

r = real rate of interest (per year)

HV = hedonic value (euro)

P_{facc} = Maximum acceptable chance of destruction (per year)

BV = Building value (euro)

α = factor of replacement cost (-)

IV = Initial value (euro)

β = factor of cleaning debris cost (-)

λ = factor of assets value (-)

γ = factor of emotional discomfort (-)

δ = factor of possible compensation (-)

As was shown in equation (10) the hedonic value is related to the initial value by $HV = \Delta * IV$, with Δ = factor of hedonic value.

Using this equation and rewriting equation (21) gives:

$$P_{facc} = \frac{r * \Delta * IV}{((BV * \alpha) + (IV * (\beta + \lambda))) * (1 + \gamma) * (1 - \delta)} \quad (\text{per year}) \quad (22)$$

With the use of the values obtained from the investigation areas the maximum acceptable chances of destruction can now be calculated. An overview of this data is given again in Table 3.1.

House		
Initial Value (IV)		
Value of Building		€ 180.000
Value of Plot		€ 70.000
Total		€ 250.000
Hedonic Value (HV)		
Location near sea criterion	(Δ)	Hedonic factor 0,5 (Increase of 50% of initial value)
View of sea criterion	(Δ)	Hedonic factor 1,0 (Increase of 100% of initial value)
Devaluation by Risk (DbR)		
Factor of replacement costs	(α)	0,65 (65% of value of building)
Factor of assets value	(λ)	0,29 (29% of initial value)
Factor of cleaning costs	(β)	0,015 (1,5% of initial value)
Factor of emotional discomfort	(γ)	0,5 (50% of financial risk)
Factor of possible compensation	(δ)	Nil

Table 3.1 Obtained data for an investment in a house

The calculations have been made for a house near the sea, without sea view and a house with sea view.

For the house near the sea, the following relation is then obtained:

$$P_{facc} \approx 0.43 * r \quad (23)$$

For a house with sea view the following relation is obtained:

$$P_{facc} \approx 0.86 * r \quad (24)$$

Choosing a real rate of interest will then result in a specific acceptable chance of destruction. As can be seen, the real rate of interest has significant influence in the result. It should be understood that in a time of relatively high real rates of interest, the costs of capital for the investor that invests in houses, is higher than when the real rate of interest is lower. This then results in a higher acceptable frequency of destruction.

In this investigation two real rates of interest are used which are considered relatively low (2%) and relatively high (4%). Using equations (23) and (24) the maximum acceptable chances of

damage are obtained. These are given in Table 3.2 in chances per year and in the return period of destruction:

Investment in a house	Real rate of interest 2%	Real rate of interest 4%
	Chance per year / return period	Chance per year / return period
House without sea view	0.0086 per year / 116 years	0.017 per year / 59 years
House with sea view	0.017 per year / 59 years	0.034 per year / 29 years

Table 3.2 Maximum acceptable chances of damage per year for a house

Conclusion

The return periods of destruction that have been calculated with these maximum acceptable chances lie in the range of 29 to 116 years. In reality the locations with these frequencies of exceedance of erosion are located very close to each other. In the investigation areas these locations would be some 10 to 15 metres apart, and would be located very close to the beach, somewhere on the slope of the dunes, where in general no buildings can be found at present. So regarding the influence of the real rate of interest it should be noted that in reality the results may not have a great influence at all.

During the last two decades the average real rate of interest has been approximately 4.8%. For building purposes it is considered not appropriate, however, to use any judgement on expected future real rates of return. It is considered appropriate to use a safe assumption on this value and a real rate of interest of 2% is therefore used.

With regard to the erosion contour lines, the locations suitable for building houses are then:

- Locations with a maximum acceptable frequency of erosion of 0.0086 per year for houses without sea view, or a return period of erosion of 116 years.
- Locations with a maximum acceptable frequency of erosion of 0.017 per year for houses with sea view, or a return period of erosion of 59 years.

3.3.2 Example 2: Valuation of investment in a hotel

In this valuation example the responsibility of the investment is solely for the investor and no building requirements are stated.

The valuation of a business like a hotel is obviously very different from that of a house. Besides the value of the plot and building, the cash flow from such a business is an important factor in valuating a business. A simple, easy, and therefore also very crude valuation method used by investment banks to get a preliminary bearing on the value of a business, is to multiply the expected net profit of a company times a factor (usually in the range of 6 to 10).

The basic underlying thought used in this valuation is to calculate the possible increase in net profit that the market potential of locations in the erosion zone provide in relation to those locations without this market potential. The increase of risk results in a devaluation of the business venture. The criterion of a financially justifiable investment is whether the net increase of profit exceeds the risk.

$$\text{Increase in net profit} \geq \text{Risk} \quad (25)$$

The valuation of a hotel is a different science altogether, as the value depends largely on the state of the market and which target groups within the market are considered potential clients. Each area, from forest to metropolitan, has its unique tourist market potential which is hardly comparable. Besides that, large differences are possible within a specific area like the coastal zone. It is therefore seriously debatable whether a comparison of different hotels in and outside of the erosion zone will generate useful conclusions. Even within the erosion zone these values can vary largely, but here comparisons can be justified to a certain extent. The available differences in prices of hotel rooms, however, can give useful information on possible sales price increases. Furthermore the expertise of business owners can be used for estimating business profits.

The housing market does not have these kinds of discrepancies, as more strict similarities in valuations can be found across large urban areas.

Initial rate of return on investment (Initial ROI)

The initial rate of return on an investment in a hotel is considered to be the ratio of the yearly net profit and the **replacement costs of the building** of the hotel, here called **initial value**. Normally, the rate of return on investment for a business

is calculated for the total invested capital, but in this case only the replacement costs of the building are considered, as this will simplify the valuation.

$$\text{InitialROI} = \frac{\text{Net profit}}{\text{Initial Value}} \quad (\text{per year}) \quad (26)$$

In this example the financial data of a hotel is used of which the manager/owner has been interviewed to obtain more in depth information such as the details of the profit/loss statement. At present the hotel is situated outside of the erosion zone. In this example this hotel will be referred to as “Hotel Potential”, which has a yearly net profit of €125.000 per year. The replacement costs of the building were estimated to be €1.500.000. This results in an Initial ROI of 0.08 per year.

Criteria of market potential and risk

For a business owner the same criteria of the market potential and risk are important as was for the house owner, only some additional criteria have to be added. The business opportunities together with the extra maintenance costs in the erosion zone are important. Furthermore, it is important to quantify the business loss after a specific disaster. The following criteria in Figure 3.9 are found to be relevant.

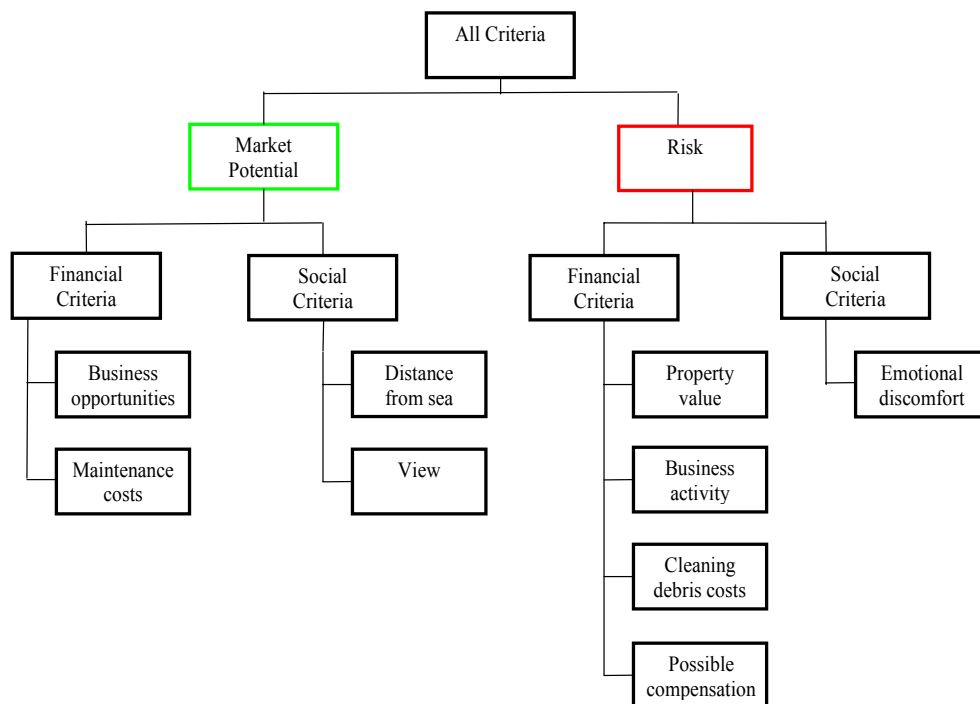


Figure 3.9 Criteria for an investment in a hotel

Hedonic rate of return on investment (Hedonic ROI)

The hedonic rate of return on investment is the ratio of the potential increase of net profit in the erosion zone and the replacement costs of the building (Initial value).

$$\text{HedonicROI} = \frac{\text{Potential increase in net profit} *}{\text{Initial Value}} \quad (\text{per year}) \quad (27)$$

*Potential increase in the erosion zone for a hotel outside the erosion zone

The potential increase in yearly net profit in the erosion zone depends on the criteria of the market potential: business opportunities, maintenance costs, and location criteria. To calculate this hedonic value, the expert judgement of the business owners and the hedonic price method can be used, supplemented with differences in prices of for instance hotel rooms. Afterwards these results are compared and used to derive suitable values. The assumption has been made that the increase in sales price will not influence the total sales made per year, which means that the business opportunities, or number of customers per year, are considered constant.

The results that were obtained from the market research, the survey and several interviews show many similarities, and lead to the conclusion that a hotel close to the sea with sea view can increase the sales price with an average of **at least** 15% in relation to a hotel outside of the erosion zone, or not close to the sea. For each hotel the potential sales price is different, but in general an average increase of 15% is possible for almost all businesses. Furthermore, a distinction must be made between rooms with and without sea view. Rooms with sea view can have an estimated average price increase of 20% and without sea view 10% in relation to hotels outside the erosion zone, or not close to the sea. It was not attempted to obtain the differences in prices for specific locations in the erosion zone. The fact that these prices are very specific per business leaves them unusable for simple comparison.

One other aspect that should not be left unmentioned is the maintenance costs. These costs are higher for a building in the erosion zone as sand and the sea air result in extra cleaning costs and inflict minor wear and tear. (This is also true for houses, but is negligible.) This increase has been estimated, with the use of the survey results and an interview, and is approximately 15% of the initial maintenance costs.

To obtain the resulting net profit with the increased sale prices and maintenance costs it is essential to use the profit loss statement of the specific business. The profit/loss statement of “Hotel Potential” is shown in Table 3.3.

Profit/loss statement	“Hotel Potential”		
			% of total
Business income	Rooms revenue	€ 360.000	30
	Restaurant revenue	€ 840.000	70
	Boutique revenue	€ 0	0
	Other income	€ 0	0
	Total operational revenue	€ 1.200.000	100
Business costs	Personnel cost	€ -450.000	43
	Advertising cost	€ -75.000	7
	Food cost	€ -90.000	9
	Building maintenance	€ -20.000	2
	Depreciation of building and assets	€ - 251.000	24
	Interest	€ -60.000	6
	Other costs	€ -100.000	10
	Total operational costs	€ -1.046.000	100
	Profit/loss	€ 154.000	
	Tax	€ -29.000	
	Profit/loss after tax	€ 125.000	

Table 3.3 Profit/loss statement of “Hotel Potential”

A number of aspects of this statement are important to note:

- On the income side the restaurant revenue is most significant.
- The personnel cost represent 43% of the total business costs.
- The initial building cost (replacement cost) of the hotel building and assets is depreciated in 7 years, after which additional investments in the building are made.
- A factor of yearly net profit/total operating revenue of 10% is considered good business practise.
- The maintenance costs are negligible in comparison to the rest of the costs.

To calculate the net profit, with the increase of sales price and increase of maintenance costs, the increased values are simply imputed in the profit/loss statement to obtain the resulting profit. Some caution is however required on what sales price

increase should be used. For this reason two situations are considered:

- (1) “Hotel Potential” will be situated near the sea, but without any sea view.
 - (2) “Hotel Potential” will be situated near the sea, with sea view.
- (1) In the first situation the sales prices of all hotel rooms are increased by 10% and the sales prices of the restaurant also by 10%. This will result in an increase of 10% of both the revenue of hotel rooms and the restaurant. Filling the increased revenues and maintenance costs in the profit/loss statements results in a yearly hedonic net profit of €219.000. The increase in net profit in relation to the initial situation is € 219.000-€124.000 = € 95.000 per year.
- (2) In this case it is important to note that most hotels in the erosion zone have both rooms with sea view with and without. The ratio of the rooms for an average hotel with and without sea view is around 50/50. The average sales price increase of the hotel rooms is therefore 15%. The restaurant will in most cases make use of the possible sea view and here the possible sales price increase is 20%. Filling the increased revenues and maintenance costs in the profit/loss statements results in a hedonic net profit of €302.000. The increase in net profit in relation to the initial situation is € 302.000-€124.000 = € 178.000 per year.

With these hedonic profits the hedonic ROI can be calculated. The hedonic ROI for these two situations are:

- (1) $95.000/1.500.000 = 0.06$ per year
(2) $178.000/1.500.000 = 0.12$ per year

Devaluation by risk (Risk Ratio)

The devaluation because of risk depends on financial and social criteria. To use this risk in the valuation it is presented in a similar way as the previous aspects: a ratio will be used of the total risk and replacement costs of the building (Initial value). This will be called the risk ratio:

$$RiskRatio = \frac{Total\ Risk}{Initial\ Value} \quad (per\ year) \quad (28)$$

The financial risk is rather straightforward: with the chance of destruction and the value of the objects the yearly risk of these

objects can be calculated. Besides this, a disaster will result in a loss of business, as no revenues can be expected without a hotel building. The different aspects of the financial and social risk will be discussed firstly per aspect.

For the building the financial risk is then:

$$\text{Financial risk of building} = P_f * \text{Replacement costs (euro/year)} \quad (29)$$

In which :

P_f = the chance of destruction (per year)

The second aspect of financial risk is that of the cost of cleaning up of debris. These costs have been obtained through demolition specialists who estimate these costs at 1,5% of the initial value of the plot and building. "Hotel Potential" has a replacement value of the building of €1.500.000 and the value of the plot is €1.000.000. (Initial value is thus €2.500.000) Relating the costs of cleaning only to the replacement costs of the building results in the relation: cleaning costs are 1,0% of the replacement costs. The cleaning costs of the plot are calculated by multiplying the replacement costs of the building with a factor β : Replacement Costs * β . The financial risk is then:

$$\text{Financial risk of cleaning debris} = P_f * \text{Replacement costs} * \beta \text{ (euro/year)} \quad (30)$$

In which :

P_f = the chance of destruction (per year)

β = the factor of cleaning costs (-)

The cost of the reclamation works will be paid by the government, as the plot is part of the sea defence and must be reconstructed to provide the necessary safety for the inland areas.

The value of furniture and other assets inside the building is rather significant and should not be ignored. The same information is used as was obtained from insurance policies for houses. Here the value of assets was related to the initial value of the house (value of building and plot). To relate these costs only to the replacement costs of the hotel building the following relation is used: value of assets $\approx$ Replacement costs of building * λ .

Taking the factor λ found for the initial value of houses (0,29), and recalculating this for the replacement costs of the hotel is done with:

$$\lambda_{\text{house}} = \lambda_{\text{hotel}} * \frac{\text{Replacement costs}_{\text{hotel}}}{\text{Initial value}_{\text{hotel}}} \quad (31)$$

This gives a λ for the hotel of $0,29 * (1,5/2,5) = 0,17$.
The financial risk of the assets is then:

$$\text{Financial risk of assets} = P_f * \text{Replacement costs} * \lambda \text{ (euro/year)} \quad (32)$$

In which :

P_f = the chance of destruction (per year)

λ = the factor of assets value (-)

A disaster will also result in loss of business activity from the day of the disaster to the day that the occupancy rate of the hotel is back to normal. The duration and amount of this loss is quantified with opinions of the business owners. With regard to the potential business loss, the following information has been obtained: A disaster will result in loss of business activity from the day of the disaster to the day the occupancy rate of the hotel is back to normal. When looking at hotels that start up from scratch, it normally takes around 3 to 4 years to reach a stable and profitable hotel occupancy rate. In case of a disaster it is here assumed that for the first four years after a disaster, the operational loss is the equivalent of all operational costs in the erosion zone, and afterwards profits continue at the normal level. These four years consist of a building duration of two years, and two years to attract business. This assumption includes that all personnel will remain on the payroll during these four years and can therefore be excluded from this valuation. The following relation can be used:

$$\text{Financial risk of business loss} = P_f * \text{YOC} * \text{Duration}_{\text{loss}} \text{ (euro/ year)} \quad (33)$$

In which :

P_f = the chance of destruction (per year)

YOC = yearly operational costs (euro)

$\text{Duration}_{\text{loss}}$ = duration of loss (years)

The total financial risk can then be calculated by integrating all the financial risk aspects into one equation:

$$\text{Totalfinancialrisk} = P_f ((RC * (1 + \beta + \lambda)) + (YOC * \text{Duration}_{\text{loss}})) \text{ (euro/ year)} \quad (34)$$

In which :

P_f = the chance of destruction (per year)

RC = the replacement value of the building (euro)

β = the factor of cleaning costs (–)

λ = the factor of assets value (–)

YOC = yearly operational costs (euro/year)

$\text{Duration}_{\text{loss}}$ = duration of loss (years)

The social risk, or emotional discomfort (the safety perception is disregarded as in example of the house), depends largely on the amount of invested capital of the specific investor and the emotional attachment to the business. In most cases the (hotel) business owner first creates a company (in The Netherlands this is mostly a BV, *Besloten Vennootschap*) of which he then is the owner. Part, and in most cases the larger part, of the capital needed for the investment of building a hotel will be provided with the help of bank loans or other investment businesses. The business owner must provide the rest. This capital is then invested in the company and used to buy or build a hotel building. The hotel building is then part of the company assets. So when a disaster destroys the property, the emotional discomfort depends on the attitude of the different investors and the amounts invested. It is assumed that (institutional) investors like a bank, do not experience any emotional discomfort, but the business owner himself does. He can possibly lose all the capital he invested in the company. However, the banks with which the business owner is working can demand a higher rate of interest because of the risk. This aspect is ignored here.

The emotional discomfort has been quantified here with the contingent valuation method by relating this value to the specific financial loss. The results were rather diverse, and therefore the value has been used that was obtained from the owner of the hotel (“Hotel Potential”) in question. The risk of the emotional discomfort is calculated as a percentage, factor γ , of the total financial risk. In this example this factor is 0,3 or 30% of the financial risk.

The risk of emotional discomfort is calculated with:

$$\text{Risk of emotional discomfort} = \text{total financial risk} * \gamma \text{ (euro/year)} \quad (35)$$

In which :

γ = the factor of emotional discomfort (–)

Because the frequency of occurrence of a disaster is considered much lower than the frequency of occupancy of an owner, the safety perception is assumed not to play an important role here. In this example the possible compensation is nil, but this aspect will be illustrated in the equation. This compensation is given as a percentage, factor δ , of the resulted financial damage:

$$\text{Possible compensation} = \text{total financial risk} * \delta \quad (\text{euro}) \quad (36)$$

In which :

δ = the factor of possible compensation (–)

The total risk is then the sum of the financial risk and the risk of emotional discomfort minus the possible compensation. The yearly DbR during the duration of the investment can be calculated by:

$$\text{Total Risk}(t) = \text{FinancialRisk}_t + \text{EmotionalRisk}_t - \text{PossibleCompensation}_t \quad (37)$$

Combining the different aspects of risk in one equation then results in:

$$\text{Total risk} = P_f ((RC * (1 + \beta + \lambda)) + (YOC * \text{Duration}_{\text{loss}})) * (1 + \gamma) * (1 - \delta) \quad (38)$$

In which :

P_f = the chance of destruction (per year)

RC = the replacement value of the building (euro)

β = the factor of cleaning costs (–)

λ = the factor of assets value (–)

YOC = yearly operational costs (euro/year)

$\text{Duration}_{\text{loss}}$ = duration of loss (years)

γ = factor of emotional discomfort (–)

δ = factor of possible compensation (–)

The risk ratio is then calculated as the ratio of the total risk and the replacement cost of the building.

$$\text{RiskRatio} = \frac{\text{Total Risk}}{\text{Initial Value}} \quad (\text{per year})$$

Total rate of return on investment (Total ROI)

The total rate of return on investment is the sum of the initial ROI, hedonic ROI minus the risk ratio. This is then considered to be the new factor of yearly net profit and replacement cost of building at the specific location in the erosion zone. At present the risk is not included in the profit/loss statement of hotels.

Investment decision

The most important criterion for the investment in a hotel in the erosion zone depends on whether the total ROI, in the erosion zone, exceeds the initial ROI, outside of the erosion zone.

$$\text{Total ROI} \geq \text{Initial ROI} \quad (39)$$

This depends on whether the hedonic ROI exceeds the risk ratio. As both the hedonic ROI and the risk ratio depend on the initial ROI, which increases at the same rate of inflation, the costs are not capitalized for different time steps. This simplification can however not be justified when fluctuations in time occur.

When fluctuations are taken into consideration the costs can be capitalized to a preferred moment in time using equation (20).

When the hedonic ROI and the risk ratio are equal it means that the total increase of net profit is spent on the cost of the risk involved. The resulting net profit is then equal to that of the hotel outside of the erosion zone. The chance of destruction that is then used for the investment is the maximum acceptable chance of destruction, P_{face} . The maximum acceptable chance of damage is reached when:

$$\text{Hedonic ROI} = \text{Risk ratio} \quad (40)$$

Filling in the different equations and rewriting these leads to:

$$P_{\text{face}} = \frac{\text{Hedonic ROI} * RC}{((RC * (1 + \beta + \lambda)) + (YOC * \text{Duration}_{\text{loss}}) * (1 + \gamma) * 1 - \delta)} \quad (41)$$

In which :

P_{facc} = the maximum acceptable chance of destruction (per year)

RC = the replacement value of the building (euro)

β = the factor of cleaning costs (–)

λ = the factor of assets value (–)

YOC = yearly operational costs (euro/year)

$\text{Duration}_{\text{loss}}$ = duration of loss (years)

γ = factor of emotional discomfort (–)

δ = factor of possible compensation (–)

To illustrate this, the same two situations are used as in the discussion of the hedonic ROI:

- (1) “Hotel Potential” is situated near the sea, but without any sea view and has a hedonic ROI of 0.06 per year
- (2) “Hotel Potential” will be situated near the sea, but with sea view and has a hedonic ROI of 0.12 per year

With the use of the values obtained from the investigation areas the maximum acceptable chances of destruction can now be calculated. An overview of this data is given again in Table 3.4.

“Hotel Potantial”	
<u>Initial ROI</u>	
Initial ratio (net profit/initial value)	0.08 per year
<u>Hedonic ROI</u>	
With increased sales price near the sea	0.06 per year
With increased sales price with sea view	0.12 per year
<u>Risk ratio</u>	
Building replacement costs	€1.500.000
Business loss	Yearly operational costs = €1.049.000
Duration of loss	4 years
Factor of assets value (λ)	0.17 (17% of building replacement costs)
Factor of cleaning costs (β)	0.01 (1,0% of building replacement costs)
Factor of emotional discomfort (γ)	0.30 (30% of financial risk)
Factor of possible compensation (δ)	Nil

Table 3.4 Obtained data for an investment in “Hotel Potential”

Filling in this data gives the following relation:

$$P_{facc} \approx 0,19 * Hedonic ROI \quad (42)$$

Using the hedonic ROI's of "Hotel Potential" for the situation where the hotel is situated near the sea without sea view, and for the situation where the hotel has sea view, the maximum acceptable chances of destruction can be calculated. To illustrate the influence of the hedonic ROI additional calculations are made. Two extra scenarios for the hotel with and without sea view are considered:

- (1) The sales price increase is half (50%) of the values obtained in the investigation. The resulting hedonic ROI's for the hotel without sea view and with sea view are: 0.03 and 0.06 per year
- (2) The sales price increase is double (200%) the values obtained in the investigation. The resulting hedonic ROI's for the hotel without sea view and with sea view are: 0.12 and 0.23 per year.

The resulting maximum acceptable chances of destruction are listed in Table 3.5 below in chances per year and with the respective return period of destruction.

"Hotel Potential"			
Scenario	Sales price increase of 50% of obtained values	Obtained values of sales price increase	Sales price increase of 200% of obtained values
	Chance per year/ return period	Chance per year/ return period	Chance per year/ return period
Near sea, without view	0.006 per year / 167 years	0.011 per year / 91 years	0.023 per year / 43 years
Near sea, with view	0.011 per year / 91 years	0.023 per year / 43 years	0.044 per year / 23 years

Table 3.5 Maximum acceptable chances of destruction for "Hotel Potential"

To illustrate the results more, the maximum acceptable return periods of destruction have been plotted in a graph for the different increase of sales price scenarios. Figure 3.10 shows the results.

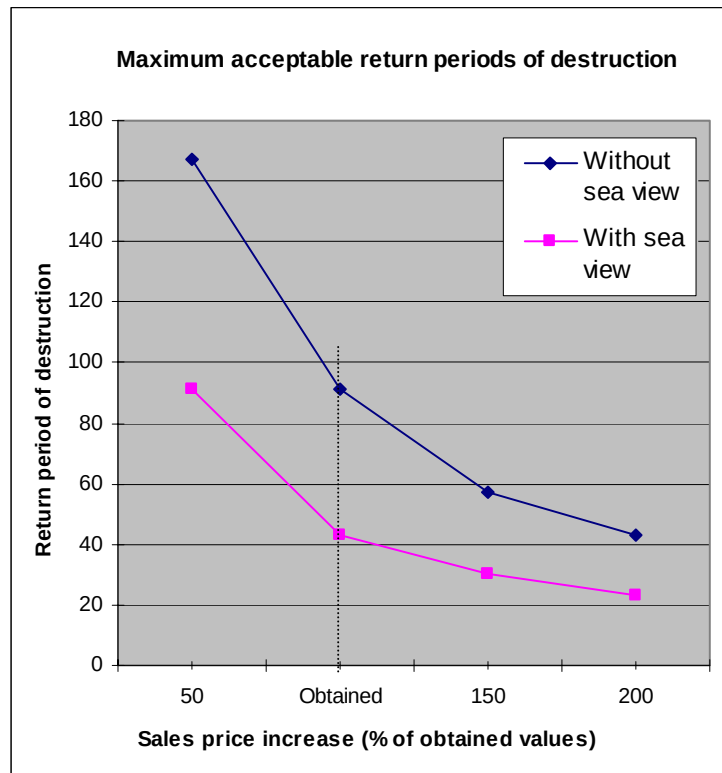


Figure 3.10 Maximum acceptable return periods of destruction for different sales price scenarios

Conclusion

For the hotel the same can be said as for the houses; the resulting maximum acceptable chances of destruction are in reality related to location very close to each other.

With the maximum acceptable chances of destruction the following is concluded on suitable locations for the exemplary "Hotel Potential" with and without sea view:

- For a hotel without sea view the suitable locations have a maximum acceptable chance of erosion of 0.011 per year.
- For a hotel with sea view the suitable locations have a maximum acceptable chance of erosion of 0.023 per year

As expected, the sales increase is highly influential in valuating a business. When reducing the potential sales price increase with 50% of the obtained values, the maximum chances of destruction for a hotel with and without sea view are also roughly reduced by a factor 2.

However, these results should be observed with the utmost caution. The value of income increase in the erosion zone strongly determines the risk that is acceptable and has been determined with the help of the opinions of hotel owners/managers and with sales price data. It then becomes evident that any error in this data will result in false conclusions with dire consequences. One should be aware of overenthusiastic profit predictions for the erosion zone, where at the moment many hotels are facing low occupancy rates.

It is without doubt possible though, to increase profit in the erosion zone because of the market potential present.

In reality a hotel faces far more dangers than only erosion, as there are numerous other factors that can influence the profit of a hotel. For one, the weather can influence the demand for hotel rooms considerably. A couple of bad summers in a row can result in a steep decline in the occupancy rate and seriously damage the profitability of the venture. Another important factor is the tourist business itself. The fact, that overseas holidays have become much more affordable for an increasing part of the population, has put pressure on the local tourism industry. Especially the upmarket hotels in The Netherlands are presently (the year 2005) confronted with steep declines in occupancy rates.

But probably the most important factor in the hotel business is public relations. Bad PR and negative reviews of the restaurant or hotel service can destroy a business in no time. Trends like these can possibly turn a business inside out long before erosion has. It is therefore very useful to compare this risk with the erosion risk.

3.3.4 Example 3: Valuation of investment in a boulevard

Boulevards are infrastructural investments made by the community that serve all of those who want to make use of them. In this case all three of the stakeholder groups are considered. It is mostly the community, thus the home and business owners, who produce the capital for these investments, as every community is more or less responsible for their own infrastructure.

However, a boulevard is much more than just another road. People will go out for a drive on the boulevard just to see the sea, or to be seen. Whatever the reason, it is certainly not comparable with any ordinary road. For the tourist business a pleasant boulevard, where people can stroll to and from the beach and in and out of the hotels, can influence the potential market considerably.

To value whether this investment in infrastructure should be justified, the same frame of thought is used from previous examples. However, three points should be mentioned beforehand:

- For every building a basic investment in infrastructure is required, meaning that all houses and hotels in the erosion zone need roads, sewage and gas/electricity in order to be of any value. The hedonic value of this infrastructure is therefore considered nil.
- The hedonic value of access to the beach, by either a road or a walking path, is considered to be higher than the risk in every situation. This is because absence of a beach access will result in A: People walking on unprotected sand dunes, which results in damage to the vegetation (that keeps the sand in place) and a decrease in the strength of the sea defence and B: Considerable devaluation of the market potential of the urban area for all stakeholders.
- Because of the complexity of the stakeholders' interest in infrastructure and the necessity of it, the actual benefits are hard to calculate.

Without a doubt there are numerous benefits for all stakeholders when a boulevard is constructed between the beach and buildings. In this investigation no attempts will be made to illustrate these benefits. To value the hedonic value of a boulevard along the edge of the dune, the "willingness to pay" method is considered very useful because of the large group of stakeholders and the absence of any market prices from which

the hedonic value could be derived. **The approach that is used is that the “willingness to pay” (WTP) extra for protecting the infrastructure from destruction is considered to be the hedonic value of the infrastructure/boulevard.** This willingness is quantified by asking the respective stakeholders to quantify this amount.

The aspects of risk differ largely per stakeholder. For instance, for the business owners the loss of the boulevard can result in a decrease or loss of business for a certain period after a disaster. The homeowners do not share this problem, but problems of accessibility of their property and emotional discomfort can be the result, as will for the business owners. It is rather complex to quantify the risk involved and therefore a number of assumptions have been made:

- The emotional risk is disregarded as a cost.
- The loss of business must be considered. The probability of the disaster happening in the low tourist season (winter) is considerably higher than in the high season (summer). Nevertheless an amount of loss should be considered.
- The discomfort of inhabitants because of the problems with accessibility of their property is ignored.
- The amount the general public is “willing to pay” for protection is considered as possible compensation, not as a direct investment.

In this example the sewage, gas and electricity infrastructure is included in the boulevard (constructed under the pavement) and should be considered in the costs. **To value an investment of a boulevard it is considered most appropriate to use a specific example.** For this reason **the boulevard in Noordwijk aan Zee has been chosen.** This is a boulevard of roughly 2 kilometres in length along which some 30 businesses are located. In this valuation example, the responsibility of the investment is for the local community. The following method will be used in valuating the investment in a boulevard in Noordwijk aan Zee:

Initial value

The initial value of the boulevard is equal to the building costs including those of the sewage, gas and electricity infrastructure. These will be calculated per kilometre of boulevard. The data for the IV has been taken from simplified cost indications for infrastructure works¹⁹. The IV for a kilometre of boulevard is

¹⁹ Cost indications taken from: ‘Vuistkengetallen voor de kostenindicatie in de verkenningsfase, 2003’, Directoraat-Generaal Rijkswaterstaat

€3.000.000 and a kilometre of infrastructure is €400.000. The boulevard in Noordwijk aan Zee is 2 kilometres long, which results in a total IV of €6.800.000.

Hedonic value

Although there is no doubt that the hedonic value of a boulevard along the edge of the dunes is significant, it is rather difficult to quantify this value, seeing that all stakeholders have to be included in this valuation. A method to quantify the hedonic value that is considered most appropriate is to obtain values of the yearly “willingness to pay” (WTP) to protect the boulevard from destruction, for each stakeholder. As the stakeholders have already paid for the construction of all infrastructural works in the community it is this WTP to protect the boulevard against the sea that is considered to be the hedonic value of the boulevard. This value then includes both the financial and social market potential criteria.

$$\text{Hedonic value} = \text{WTP by the community to protect the boulevard} \quad (43)$$

With the use of the survey the WTP of the different stakeholders was obtained. From the survey it showed that 50% of the homeowners were willing to pay €10 or more per year, 15% would pay €5, 10% would pay €2 and 25% would pay nothing. Of the business owners 35% would pay € 10 or more, and 35% would pay €2. These are all located in or close to the erosion zone, so of the total 10.000 housing units situated presently in Noordwijk aan Zee, 500 house owners are assumed to live in or close to the erosion zone. Approximately 30 businesses are situated in this same area. The rest of the community is considered to pay the same amount as the general public (likely to be an underestimation). 55% of the general public would pay €5, 15% would pay € 10 or more, 10% would pay € 2 and 10% would pay € 1. All in all, this amounts to a total WTP of the community in Noordwijk aan Zee of some € 50.000 per year.

Risk

Only the financial criteria are considered here, as the social risk of infrastructure is considered insignificant and is therefore ignored in this valuation. The two most important criteria are the financial risk of destruction of the boulevard and the resulting business loss for the businesses along it. The risk can be calculated as in the previous examples as a yearly cost. The financial risk is calculated as the chance of destruction times the building cost of the boulevard and other infrastructure and the

cost of cleaning up the debris. The cleaning costs are calculated as a percentage of the IV, and illustrated as a factor β :

$$\text{Financial risk of structure} = P_f * (1 + \beta) * IV \quad (\text{euro/year}) \quad (44)$$

In which :

P_f = the chance of destruction (per year)

β = the factor of cleaning costs (-)

IV = Initial Value (euro)

To calculate the loss of business, it is necessary to quantify the amount of businesses that are affected and the specific loss per business. As this requires very site-specific information on the number of businesses, the duration of the loss and the specific losses per business, a number of assumptions have been made.

The business loss is considered only for the businesses in or close to the erosion zone. These are approximately 30 businesses which will lose some 50% of their profit during 3 months of reclamation and construction works. To calculate the total loss, the assumption is made that on average the businesses have a normal profit of € 100.000. The total business loss then amounts to € 375.000. This is illustrated with the following equation, where the amount of loss is illustrated with a factor (χ) of the normal profit:

$$\text{Financial risk of business loss} = P_f (NOB * NP * \chi * \text{Duration}_{\text{loss}}) \quad (\text{euro/year}) \quad (45)$$

In which :

P_f = chance of destruction (per year)

NOB = number of businesses affected (-)

NP = normal profit of business (euro)

χ = factor of profit loss (-)

$\text{Duration}_{\text{loss}}$ = duration of loss (years)

The total risk of the boulevard can thus be calculated:

$$\text{Total risk} = P_f((1 + \beta) * IV + NOB * NP * \chi * \text{Duration}_{\text{loss}}) \text{ (euro / year)} \quad (46)$$

In which :

P_f = chance of destruction (per year)

β = factor of cleaning costs (-)

IV = Initial Value (euro)

NOB = number of businesses affected (-)

NP = normal profit of business (euro)

χ = factor of profit loss (-)

$\text{Duration}_{\text{loss}}$ = duration of loss (years)

Total value

The total value is the initial value plus the yearly hedonic value and yearly risk capitalized to the start of the investment. The cost of construction is assumed to increase with the same rate of inflation, as is the willingness to pay.

Investment decision

The investment can then be justified when the yearly hedonic value is higher than the yearly risk. As both the hedonic value and the risk depend on the initial value, which increases at the same rate of inflation, the costs are not capitalized for different time steps. This simplification can however not be justified when fluctuations in time occur.

When fluctuations are taken into consideration the costs can be capitalized to a preferred moment in time using equation (20).

When these values are equal, the relating chance of destruction is the maximum acceptable limit, P_{facc} . Rewriting the previous equations gives:

$$P_{\text{facc}} = \frac{\text{WTP}}{(1 + \beta) * IV + NOB * NP * \chi * \text{Duration}_{\text{loss}}} \text{ (per year)} \quad (47)$$

The data that was found on the different values is listed again in Table 3.6:

Boulevard (Example Noordwijk aan Zee)	
<u>IV</u>	
Cost of construction per km	€ 3.000.000 per km
Cost of other infrastructure per km	€ 400.000 per km
Total for two kilometres	€ 6.800.000
<u>HV</u>	
WTP by community	€ 50.000 per year
<u>DbR</u>	
Building costs boulevard	IV
Building costs other infrastructure	IV
Cleaning debris costs (b)	1,5% of IV
Number of businesses	30
Normal profit	€ 100.000
Factor of profit loss (χ)	0,5
Duration of loss	0,25 years
Possible compensation	Nil

Table 3.6 Obtained data for an investment in a boulevard in Noordwijk aan Zee

Using the data that was obtained during the investigation the following results were obtained: $P_{\text{face}} = 0.007$ per year or a rate of return of destruction of 140 years.

Conclusion

Any errors in the WTP of the stakeholders will of course dramatically result in different chances of damage.

As the population in the erosion zone is relatively small, most of the stakeholders (or members of the community) live outside of the erosion zone. The hedonic value is therefore mostly determined by (the WTP of) the community outside of the erosion zone. It is arguable whether the presence of businesses and houses along the boulevard influence the WTP of the community. It is assumed it does, as a boulevard without any buildings will be considered less important to protect by all stakeholders.

The loss of business should then be seriously considered, as it can be a significant part of the total risk. When the loss is considered to endure for 3 months, the resulting loss of business was estimated at € 380.000. The total risk is then not significantly influenced. However, when it is assumed that the business loss will endure for longer, it can be very influential. For this reason two situations are calculated: the business loss with duration of 3 months, and in a situation when the business loss endures for 2 years. The results are shown in Table 3.7.

Investment in a boulevard	Business loss 3 months	Business loss 2 years
	Chance per year/return period	Chance per year/return period
Maximum chance of damage	0.007 per year/140 years	0.005 per year/200 years

Table 3.7 Maximum acceptable chances of destruction for a boulevard

The results show that the need for a quick reconstruction of the boulevard after destruction is important, because of the effect of the loss of business on the total costs and therefore on the total tourist industry. The effect of a longer duration of this loss of business should therefore always be considered in case the boulevard is destroyed. Because it is assumed this will be taken into account, and a quick reconstruction will be executed, a business loss of 3 months is considered most appropriate. The maximum acceptable chance of destruction is then 0.007 per year.

3.6 Solutions for the key question

Using the valuation method and the stakeholder preferences, it was possible to calculate the maximum acceptable chance of damage for an investment. It is important to note that:

- A positive valuation of an investment in a house depends greatly on the actual real rate of return.
- A positive valuation of an investment in a hotel depends greatly on the potential increase of sales prices.
- A positive valuation of an investment in a boulevard depends greatly on the WTP of the community to protect the boulevard and the resulting loss of business (the values have been obtained with a survey).
- The influence of the criterion “emotional discomfort”, on the result of the valuation is very large. As it has been proved to be a significant criterion for all stakeholders it becomes important to investigate the values in greater depth.

The results of the maximum acceptable chances of destruction are listed in Table 3.8:

Investment	With sea view	Without sea view
House	0.017 per year	0.0086 per year
Hotel	0.023 per year	0.011 per year
Boulevard	0.007 per year	N.A.

Table 3.8 Overview of maximum acceptable chances of destruction per investment

With these maximum acceptable chances of destruction and the erosion contour lines with similar chances of exceedance, it is possible to determine, per investment, what are suitable building locations. It obviously makes sense that suitable building locations do not have higher chances of erosion than the maximum acceptable chances of destruction.

In this investigation all significant factors have been taken into account, of which the emotional discomfort has also proven to be an important factor. In case the social risk factors like the emotional discomfort are considered not appropriate to include in the valuation, the resulting acceptable chances will only increase.

Even after taking all these factors into account, the resulting magnitude of the acceptable chances of damage allow for building locations very close to the beach. This is because the locations of the erosion contour lines, with which the resulting maximum acceptable chances of destruction are related, are all situated very close to the beach. The erosion contour lines, with frequencies of exceedance higher than 0.01 per year, are located approximately not more than 50 metres from the beach. In Figure 3.11 a number of these erosion contour lines are illustrated for what is considered an average situation along the Dutch coast.

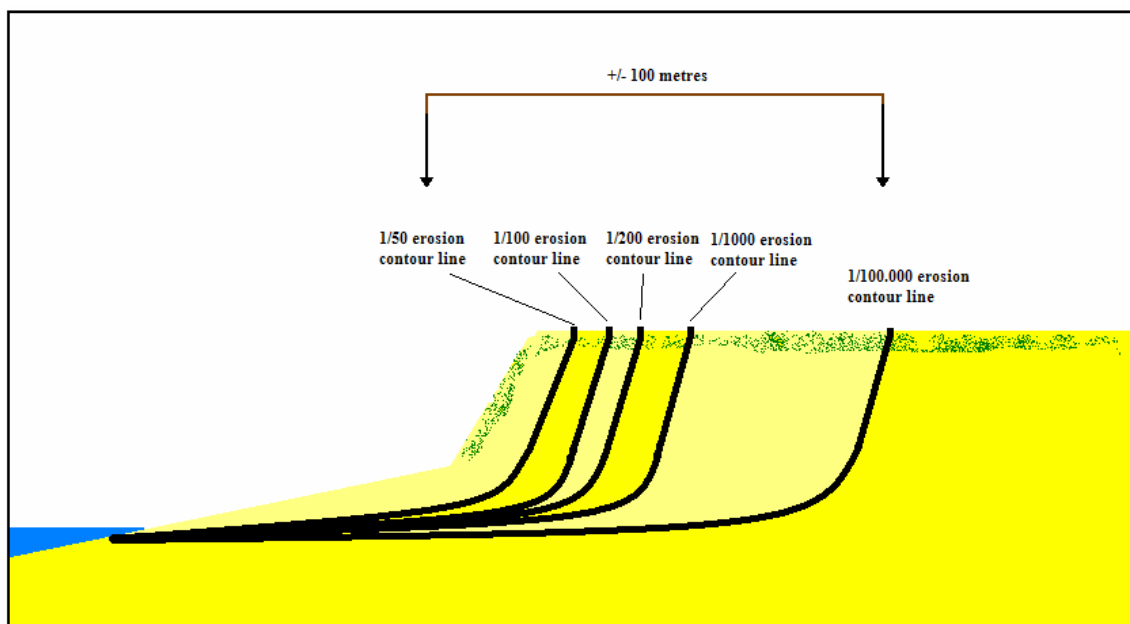


Figure 3.11 Approximate locations of erosion contour lines

In relation to the government policy it can be said that the regulatory contour lines can not guarantee that the full potential of the area is exploited. If the government would like to design a policy in which (part of the) potential of the erosion zone can be exploited, the regulatory contour lines should be related to certain erosion contour lines, not to the present building layout. As has been shown in this chapter, it is the chance of destruction which determines the risk and therefore the costs of certain investments. If the government desires to limit these costs for the respective stakeholders, the erosion contour lines are the appropriate tools to use.

Additional comments on the results

- The lowest acceptable chance of destruction was calculated for the boulevard. As is mostly the case, the boulevard is situated the most seaward of all constructions. When the boulevard is in that case constructed in a suitable location it makes sense that all other buildings, situated landward of the boulevard, are thus also on suitable locations, when considering the maximum acceptable chances of destruction.
- Large differences exist between houses and hotels in the erosion zone that have sea view and have no sea view. In reality the building layout mostly consists of a row of houses or hotels at the seaside of town that have sea view and a row parallel behind it, which mostly does not have sea view. For both rows of buildings it must be investigated whether the locations are suitable. The locations further inland are then considered all suitable.
- Differences exist between suitable locations for each investment. It is then appropriate to decide either on a uniform policy, or to allow differences for different investments within an area. This, however, could lead to undesirable building layouts. When visiting the coastal communities it is obvious that the areas are mostly divided per investment type already. This is either because of local regulations, or for instance, because of the preference of the business owners to be located closely together. In Scheveningen, the largest coastal town in The Netherlands, a master plan has been designed in which the tourism businesses have been grouped together as much as possible. The reasons for this are that: homeowners would not be troubled by any noise of the nightlife and; businesses can enhance the market potential by grouping together. It is therefore

recommended to determine what areas will be used for business and what areas for housing. These areas can then have different chances of damage and it is possible to use the maximum potential of each investment without considerably affecting the building layout.

- For the valuation of investments, values have been used that were obtained through a majority vote or values that have been derived from the respective market prices. There always remains a (relatively small) group that either values these lower or higher than the majority or market prices. With regard to the maximum acceptable chances of destruction, these stakeholders will accept different chances, either higher or lower. These stakeholders should not be ignored. As has been stressed, it is important that the market within the erosion zone is transparent. Most importantly this implies that information on the chances of destruction should be easily accessible. Only then all stakeholders can decide on their respective investments properly and the minority group that uses different values can also decide what is best for them.

4. Key question 2: How to deal with sea level rise?

4.1 Introduction

In the previous chapter it was presumed that the positions of the erosion contour lines were fixed in time. This situation will change as the sea level is rising and therefore the erosion contour lines will shift inland. The sea level rise can therefore influence the risk in the erosion zone and should be considered in the building policy.

In Paragraph 4.2 the present knowledge on sea level rise will be discussed, and in Paragraph 4.3 the influence this has on the position of the erosion contour lines. In Paragraph 4.4 the increase in risk is described and finally in Paragraph 4.5 the key question will be answered and conclusions and recommendations will be given to deal with the sea level rise in the building policy.

4.2 Present knowledge on sea level rise

Although the basic outline that was discussed on the hydraulic forces in the erosion zone is correct, there is another aspect that should be accounted for: the rise of the sea level.

An increasing body of observations around the globe has given a collective picture of a warming world and other changes in the climate system. The global average surface temperature has increased over the 20th century by about 0,6°C and the tide gauge data shows that the global average sea level rose between 0,1 and 0,2 metres during the 20th century, which is not out of the ordinary, as a rate of 0,2 metres per century has been observed for the last 400 years.

The Intergovernmental Panel on Climate Change (IPCC) has generated 35 possible future scenarios, which resulted in a wide range of values for the future sea level rise. The IPCC has estimated the most likely sea level rise (SLR) during the next century to be 50 cm. The IPCC scenarios can be seen in Figure 4.1.

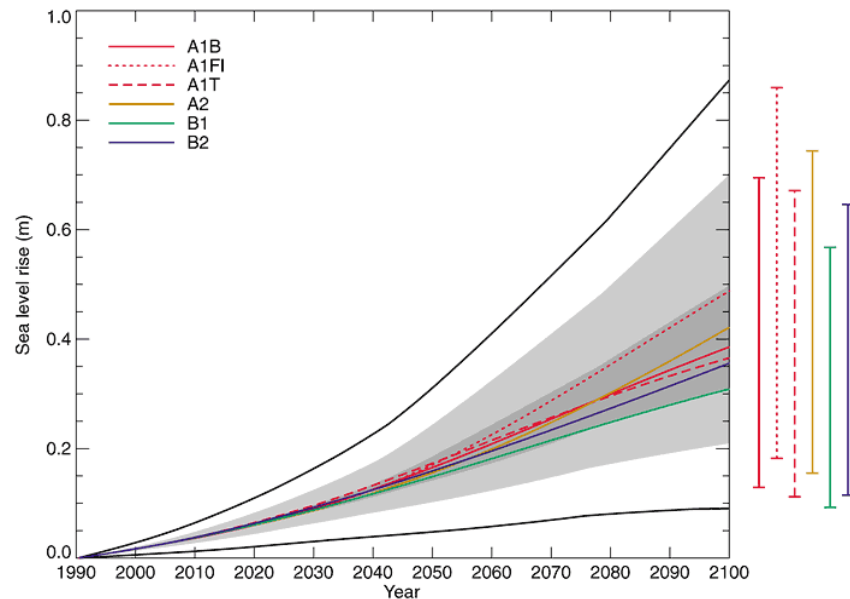


Figure 4.1 Global average sea level rise for 1990 to 2100 for the SRES²⁰ scenarios

Although it seems very attractive to try and ascribe probabilities to the given scenarios of SLR this is not yet possible. The fact that we are working with scenarios is already an indication that we are not able to compute the exact rise.

The increase in temperature has resulted in predictions of more intense storms and higher frequencies of occurrence of these storms. This means that besides the SLR, the change in frequencies of storm have to be taken into account. This results in a number of problems for the erosion zone, as the effects are not yet completely understood.

The amount of erosion depends on a number of factors. Important factors are the wave height, wave period, the water level (or set up) and duration of the storm. The effect for instance, of the wave period is known to a certain extent, which introduces uncertainties. The uncertainties regarding the future climate are greater than the expected sea level rise and have larger consequences. If the wind climate changes significantly (+5%) in the future, the set up can increase as well and this will affect the wave heights too (+5%).

All in all there is no reason for pessimism as the increase of knowledge at the moment is relatively fast. But, for the time being, some assumptions still have to be made on the expected SLR and the increase of frequencies and intensity of storms.

²⁰ Special Report on Emissions Scenarios (IPCC)

The ‘TAW Werkgroep Kust’ recommendations concerning the hydraulic prognoses for the situation in The Netherlands have been divided into three scenarios: a minimum, middle and maximum scenario, which are given in Table 4.1, and are used to determine the necessary increase of the flood defences. These scenarios are based on the IPCC reports and are incorporated into the *Derde Kustnota*²¹ (national spatial planning policy).

Year	2050	2100	2200
Minimum scenario:			
Sea level rise	+0.10 m	+0.20 m	+0.40 m
Extra set up (storm)	-	-	-
Wave height	-	-	-
Height beach profile	+0.10 m	+0.20 m	+0.40 m
Middle scenario:			
Sea level rise	+0.30 m	+0.60 m	+1.20 m
Extra set up (storm)	-	-	-
Wave height	-	-	-
Height beach profile	+0.30 m	+0.60 m	+1.20 m
Maximum scenario:			
Sea level rise	+0.45 m	+0.85 m	+1.70 m
Extra set up (storm)	+0.40 m	+0.40 m	+0.40 m
Wave height	+5%	+5%	+5%
Height beach profile	+0.45 m	+0.85 m	+1.70 m

Table 4.1 Recommendations for sea level rise from ‘TAW Werkgroep Kust’

The minimum scenario is the result of a prediction based on historical data in The Netherlands. The middle and maximum scenario illustrate acceleration in sea level rise, which until now has not yet been observed.

For the Dutch coastal defence works the following government policy has been applied: First there is a minimal scenario of 20 cm per century, which is used when decisions are made on short-term projects (5 years). Then there is a middle scenario of 60 cm per century, which is used when decisions are made on long-term

²¹ Ministerie van Verkeer en waterstaat, (2000) *3e kustnota*

projects (50 to 100 years). The maximal scenario of 85 cm per century (including an increase of wind force of 10%) is only used when reserving space for extending the defence works. This policy has a time horizon of 200 years. The government will assess the necessary space from time to time.

Especially in the urban coastal areas there is already little to no space available for this purpose. The task of the Water Boards is not easy when it comes to reserving this space and this influences their interest in the building policy considerably. Preventing any new buildings here is of course one way to deal with the future.

4.3 The influence of sea level rise on the position of the erosion contour lines

4.3.1 Sea level rise and global climate change

SLR will influence the position of the erosion contour lines. This influence will result in a landward movement of the lines. The question is of course how far the lines will move. Besides that it is important to know what the effect of the future climate change will be on the erosion contour lines. Three aspects cause the landward movement of the erosion contour lines:

- 1. The SLR, which can be approximated with the Bruun rule
- 2. The relative reduction of the dune height, because of SLR
- 3. The increase in storm frequencies

1. If only the SLR is taken into account the effect can be best approximated with the Bruun rule, discussed in Section 2.3.4. The result will be that the present coastline shifts landward and thus also the erosion contour lines. A sea level rise of 20 centimetres, during the next 100 years, will move the edge of the dunes back some 8 meters, depending of course on the specific dune profile. (With an active profile of 1000 m and an active height of 25 m the calculation is; $(1000 * 0,2)/25 = 8$). The new profile is then similar to the old one, only the location is altered. By nourishing sand this will be (mostly) obstructed, as is the policy at the moment. These nourishments are not only required at the edge of the dunes, but along the whole foreshore to give it the same level rise as the sea. As no acceleration, or any clues lead to the suggestion that the SLR will be more than the measured 20 centimetres per 100 years, the logical assumption

will be made that this is the correct SLR to be taken into account.

2. In the new situation the elevation of the dunes relative to the sea level is then decreased. So the erosion contour lines will still shift landwards, but far less than without the nourishments. The expected movement of the erosion contour lines in the next 100 years with a SLR of 20 centimetres is then only in the range of a couple meters. Because of the present sand nourishment policy this is the maximum expected movement of the erosion lines because of SLR used in this investigation.

3. The effect of the climate change on the position of the erosion contour lines is somewhat more difficult. The effects of the climate change, for instance the increase in wind speeds, can result in higher water level set up and waves. The uncertainties are numerous and it is outside the scope of this investigation to try and clarify these. However, it is necessary to take the possible effect into account in the building policy, if only to illustrate the possible problems and solutions. Some preliminary data has been produced by Alkyon²², which has calculated the movement of the erosion contour lines **for the investigation areas (Noordwijk aan Zee and Katwijk aan Zee). In these calculations higher values for the SLR have been used.** The following aspects have been taken into account: a SLR of 50 centimetres in 100 years, an extra set up of 55 centimetres, a wave height increase of 8% and an increase of the wave period of 1,0 second. An increase of the cross profile with the same rate of sea level rise (50 centimetres per 100 years) because of sand nourishments, has also been taken into account. The results that have been calculated for the erosion contour lines with frequencies of exceedance of $1 \cdot 10^{-5}$ and $2 \cdot 10^{-4}$ per year are; that the movement of these erosion contour lines in the investigation areas during the next 100 years are 12 and 10 metres (Rijnland district). As these calculations have been done with a SLR of more than twice the average SLR of 20 centimetres per century, the effect of a decrease in relative dune height is overestimated. The results will therefore be divided by two. The resulting movement of the erosion contour lines are then roughly 5 meters per century.

The conclusion can now be drawn that in the situation where the cross profile will be increased in height with the same rate of SLR (of 20 centimetres per century), the maximum resulting movement of the erosion contour lines (because of the relative decrease of the dune height and the increase in storm intensities)

²² Alkyon, (2001) *Afslagkaart noordzeekust*, Marknesse

is approximately 5 metres per century for the investigation areas Zandvoort aan Zee and Katwijk aan Zee. For other areas than these, the influence of the SLR and climate change has to be assessed separately!

Seeing that these calculations were made with data on the dune profiles of only one specific moment in time, some errors are inevitable. The assumption used in this investigation is that ALL erosion contour lines will shift landwards with a maximum of 5 metres during the next 100 years. (In reality the erosion contour lines will not move landward at the same rate, but for the sake of simplicity this is neglected.) It follows implicitly that the exact shape of the dune profile is neglected.

It is possible to apply additional nourishments to keep the average location of the erosion contour lines fixed in time completely²³. However, this will require a lot more reshaping of the dune profile and capital. This option is further ignored in this investigation.

4.3.2 Effect of buildings on the erosion contour lines

One other aspect that has remained unmentioned is the effect that structures have on the position of the erosion contour lines. In short, it is not known at present what this influence is. What is known is that erosion increases when a structure is encountered. At the edges of the structure erosion is intensified and will inflict more damage. This increase of erosion is mainly the result of increased water velocities near the edges of the foundation of the structures, because of the obstruction of water movement by the foundation of the structure. However, when this structure either collapses (which is mostly expected) or stays erect, on for instance a strong enough foundation structure, the results are unknown. Either the erosion intensity decreases at this point because the (heavy) debris breaks the forces of the water, or it remains increased. Probably a significant factor in this erosion would be the shape of the debris, its weight and size.

A good first assumption would be that it does make a difference on the erosion rate and thus the position of the erosion contour lines. The houses along the coast are mainly made of bricks; the hotels are made out of concrete elements. When these collapse and form a layer of debris it is assumed that the concrete elements will result in a local decrease of the erosion, but an increase at the sides. This will result in a faster destruction of

²³ WL|Delft Hydraulics, (2002) *Haalbaarheid handhaven afslaglijnen kustplaatsen*, Delft

any buildings at the side etc. Once a row of buildings has collapsed it is assumed this will decrease the erosion along the row of debris. Concrete elements should be more effective than bricks, as bricks will again erode more easily than the concrete. For now, the effect of the buildings is ignored, because of the many uncertainties.

4.4 Sea level rise and the increase of risk

4.4.1 Risk increase for buildings in the erosion zone

The assumption that all erosion contour lines will shift 5 meters inland during the next 100 years will result in an increase of risk whenever structures are present in the erosion zone. The average rate of retreat in this case amounts to a 0,05 meter per year (the actual rate can differ during the 100 years). Using the valuation methods from Paragraph 3.3 the risk can be calculated for each year separately and thus also the total risk and value of an investment, assuming the chances of exceedance for all locations are known. The investment can be justified when the total hedonic value exceeds the total risk during the investment as shown before.

When taking only this into account, it is then theoretically even possible that after the duration of the investment, the building is situated on a location where the chance of damage is too high for a new investor to buy the property for the initial value. This will of course never be possible, because the initial valuation of the house also depends on the fact that the property will be eventually sold afterwards for the same price, plus an increase equal to the total deflation.

Therefore, when the property is located in areas where the risk exceeds the maximum hedonic value, the property will devalue and the former owner can only sell it at a loss (compared to a property outside of the erosion zone). The risk for businesses also increases and the resulting profits will therefore decrease.

When there is no effort to either consolidate, or to move the erosion contour lines seaward, or otherwise to strengthen the building, the property will continue to devalue and becomes a hazard. The (new) owner (if possible) will not invest in any maintenance which will result in additional devaluation of the surrounding properties as well and will have a negative effect on the tourism industry.

Even more so, the plot will be unsuitable for building purposes of the same sort. Maybe it will still be possible to use the land for other purposes, but devaluation of the plot value is inevitable.

Expropriation of the plot and/or property is the logical result (which is much more common abroad than here), for which at that time public acceptance should be adequate.

All in all, the continuous landward movement of erosion contour lines will result in problems when the risk of property exceeds the maximum hedonic value calculated with the valuation method.

4.4.2 Risk increase for buildings at the boundary of the erosion zone

What is just as important is the fact that the whole erosion zone increases and more structures will be possibly located in this zone with higher risk, as shown in Figure 4.2.

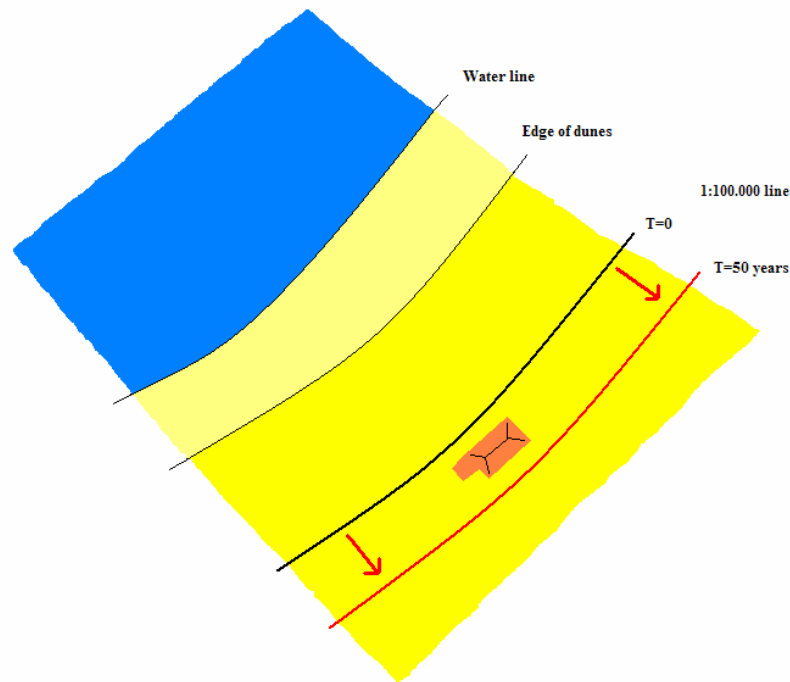


Figure 4.2 Increase of erosion zone

At first glance, the increase of risk will not be so important, as the risk at these locations are significantly lower compared to the sea side of the erosion zone. What is interesting is the legal aspect, because the property is now situated in an area with different regulations. Where the property used to be located in an area with a legal safety level, and the right of compensation, it is now subject to the laws in the erosion zone. At present all the risk is then the responsibility of the owner. In Chapter 5 this issue will be discussed in further detail.

4.5 Solutions to the key question

The result of increase of risk can be taken into account in the valuation of a plot or property and it was noted that the risk should never exceed the maximum hedonic value. However, the basic problem is then what increase of risk should be taken into account? This increase of risk depends on the rate of retreat of the erosion contour lines and the duration of the investment, or rather the duration for which should be planned in advance. The solution to the key question lies in the answer to these two questions: What is the rate of retreat and what planning timeframe should be used?

4.5.1 Planning

The choice of an appropriate timeframe is often the choice of either, taking a short timeframe (50 years) and risking the possibility of problems occurring in the near future, or taking a long timeframe (200 years) and risking the possibility of not having used the available potential. With longer timeframes come larger uncertainties.

The lifetime of newly built houses at present vary from 30 to 50 years after which they are either demolished or need major renovation because of technical deficiencies or for esthetical reasons. In that case (or when a new construction is added greater than 20% of the size of the house) the renovated house is considered to be a new construction.

In the last decades a large number of houses have been constructed with a relatively short lifetime of around 30 years. This is also true for larger buildings. Because of the present housing shortage, this trend will possibly continue in the near future.

What is important is that if the buildings in the erosion zone are on average rebuilt say every 50 years, there is an opportunity to implement any new insights or building techniques, such as erosion proof foundation structures for these buildings within the next 50 years. (Observing the present state of the buildings along the boulevard at Katwijk aan Zee, this opportunity could arise much quicker.) With regards also to the simultaneous increase in knowledge in alternative methods to reinforce the dunes, a planning timeframe of 50 years is considered a fair timeframe to use for planning. The probability of any new insights in the erosion calculation methods, or in the estimated SLR, during the next 50 years is considered high. Planning timeframes longer than 50 years are therefore considered unpractical.

For historical buildings, which are preserved in the original state for centuries, this is not true unfortunately, and here extra investment will be required to ensure the safety of the building.

4.5.2 Rate of retreat

The assumption was made that the SLR and climate change would result in a landward movement of the erosion contour lines of 0,05 meter per year in the investigation areas. It follows that for the next 50 years the erosion contour lines will move 2,5 meters land inwards. Using the data from the investigation areas and available maps a simple estimation is that: the chances of damage of the locations 2,5 metres inland have chances of damage that are approximately a factor 2 per year lower.

4.5.3 Solution for the building policy

Unfortunately there are no simple methods to decrease the sea level rise. But on the other hand, there are methods available to reduce the increase of risk for the different investments. A suitable planning timeframe for the building policy was considered to be 50 years. **It is considered essential that structures are not situated in areas where the chance of destruction of the building exceeds the maximum acceptable chance during the next 50 years.** When the maximum acceptable chance is not exceeded during the next 50 years for a given location and structure, there is no significant reason to decrease the risk.

An assumption has been made that the sea level rise and global climate change will result in a retreat of the erosion contour lines of 2,5 meters in the next 50 years. The increase of the cross profile with the same rate as the sea level rise has been taken into account here.

When the chance of destruction will exceed the maximum acceptable chance of destruction for a given location during the next 50 years, a number of options are available:

- Strengthening of the dunes with either sand nourishments or sea defence structures.
- Strengthening of the structure with erosion-proof foundations.
- Not build any building in areas where the maximum acceptable chance of destruction will be exceeded during the next 50 years.

The alternative which results in the highest increase in value (when taking all benefits and costs for the total timeframe per alternative into account) is considered the best option. It is therefore important that all alternatives are considered and calculated, in order to make a sound decision.

The rate of retreat is such that only the chances of destruction of the most seaward structures will possibly exceed the maximum acceptable chance of destruction. It is very unlikely that the benefits because of strengthening of the dunes will exceed the costs. Besides that, it is doubted whether the capital needed for strengthening the dunes can be raised by only these stakeholders at the seaside of town. Therefore the option to strengthen the buildings and the option **not** to build in the areas where the maximum acceptable chance will be exceeded are considered more likely to increase the total value of an investment.

For the last option this means that the buildings must be constructed at least 2,5 meters land inward from the location of the erosion contour line with the maximum acceptable chance of destruction.

During this timeframe of 50 years it is assumed that all (or at least most) buildings will be rebuilt and new techniques or methods can be applied to decrease the risk. Besides that, the simultaneous increase in knowledge of the position of the erosion contour lines and climate change can also be applied. For building purposes it is therefore assumed not necessary to use a larger planning timeframe, which is the case as far as the sea defence policy planning is concerned.

5. Key question 3: How should we deal with the responsibility for damage?

5.1 Introduction

It has been shown that policy is made between the stakeholders by taking the market potential and risk of the areas in the erosion zone into account. The resulting policy must include a description of the following four aspects:

- (1) The areas where building is allowed/suitable,
- (2) Information on the chances of damage in the area,
- (3) The specific building regulations that must be adhered to, and
- (4) The responsibility for damage because of erosion.

These will be first discussed:

- (1) The areas that are considered suitable for building have been discussed in Chapter 3 and 4.

(2) This investigation will proceed with the knowledge that the stakeholders can always obtain the necessary information about the chances of damage in the erosion zone. This automatically means that someone will have to be responsible for providing this information. The costs of these tasks have not been taken into account in this investigation. Depending on who hires a company or agency to provide this information, the responsibility for the costs are determined. In this investigation it is considered the government's responsibility to provide this information. The following reasons should explain why:

- Seeing that the chances of failure of the sea defence are calculated every 5 years by the government already, it is considered only a minor effort to calculate additional chances within the erosion zone. The costs of these tasks could then be reduced in relation to hiring an independent company.
- The government is responsible to protect and improve the living environment of the citizens (article 21 of the constitution). Providing information on any significant risk is considered an aspect of this responsibility.
- The government is considered to be impartial.

- (3) The specific building regulations that will be taken into account are those which are in effect at the moment and roughly

specify that the strength of the dunes may not be decreased due to the construction of buildings: it is prohibited to extract sand from the dune profile. The specific building regulations are stated in the *waterstaatswetgeving*.

(4) The aspect of responsibility should not be assumed beforehand, as this aspect is very influential in valuating an investment and at present is an important topic of discussion on a governmental level. The influence of this aspect of the policy is therefore investigated with the use of scenarios which are differentiated on this aspect.

At present a number of discussions are being held by government agencies on exactly this subject. The law at the moment is very clear and states that the responsibility is for the owner of the property in the erosion zone. Nevertheless, very different initiatives are being explored within the government to either (officially) include parts of the erosion zone in the 'law on compensation for damage due to disasters' (WTS), or on the other hand arrange possibilities for investors to buy damage insurance for their property. It is the objective of the government to first design an appropriate legal framework before starting to design any other aspect of the building policy.

It must be noted that there cannot be any difference in the benefits or costs of any investment when the responsibility for these benefits and costs are changed. Differentiating on the aspect of responsibility only means that the costs and benefits are distributed differently amongst the stakeholders.

However, differences in responsibility can still result in different building policies as new possibilities to distribute the costs can give an investor the opportunity to invest in areas with different chances of damage.

The following three scenarios are proposed, all differentiated on the aspect of responsibility:

- Scenario 1: the responsibility of building in the erosion zone is solely for the investor. This policy is presently in effect, although there is a difference with the policy proposed: at present the awareness of risk is minimal.
- Scenario 2: the responsibility of building in the erosion zone is for the investor, but the investor has the opportunity to obtain insurance from either a government agency or a private company.
- Scenario 3: the responsibility of building in the erosion zone is for the government. In this case part of the erosion

zone is included in the WTS, which means that victims will be compensated (partly) for their damage.

In Paragraph 5.2 these scenarios will be illustrated in more detail and in Paragraph 5.3 the impact of the scenarios on the stakeholders are discussed. In Paragraph 5.4 the stakeholders' preferences on the different scenarios are discussed. The solutions for the key question are given in Paragraph 5.5.

5.2 Policy scenarios

5.2.1 Scenario 1: Building with total responsibility for the investor

This scenario is in general the same situation as is at present. Using the stakeholder preferences on the building layout and risk, the preferred building policy will be designed. The valuation examples in Paragraph 3.5 were calculated for this scenario using assumptions for the necessary values. Important aspects of this scenario are:

- All the costs and benefits in this scenario are for the investor.
- The possibility of compensation from government or other institutions is ruled out.
- Providing information on the chances of damage in the area is assumed to be the responsibility of the government to ensure transparency of the potential market.
- The specific building regulations are those mentioned in the *waterstaatswetgeving*.

5.2.2 Scenario 2: Building with the possibility of insurance

In this scenario there is the possibility of insuring financial damage. The values that can be insured are the value of the replacement cost of the building, assets and the cost of cleaning up the debris and for businesses also the loss of business. Important aspects of this scenario are:

- The responsibility of building in the erosion zone is for the investor.
- All investors obtain insurance against all financial damage caused by erosion.
- The cost of insurance policies is calculated as the annual financial risk plus the cost for selling the premium (This is equal to the cost of selling the policy and so the insurance company is therefore a non-profit organisation.)

- The possibility of compensation from government or other institutions is ruled out.
- Providing information on the chances of damage in the area is assumed to be the responsibility of the government to ensure transparency of the potential market.
- The specific building regulations are those mentioned in the *waterstaatswetgeving*.

5.2.3 Scenario 3: Building with the right of compensation

The law on compensation for damage because of disasters or injury (WTS) is used in this example to illustrate the possible compensation. This law states that the possible compensation is quantified by experts and will be paid in full. However, a maximum compensation and a minimum standard cost for the victim can be determined depending on the nature of the cause of damage and the damage inflicted. It is highly unlikely that all areas within the erosion zone will be eligible for inclusion in this law. Taxpayers will not gladly pay damage costs for individuals who have a frequency of damage of once every 50 years. So here the erosion zone will be divided into an area with and without the right of compensation. The preferences of the stakeholders will determine these areas. For that reason only part of the erosion zone is included. Important aspects of this scenario are:

- The parts of the erosion zone that are included in the law on compensation are the areas with frequencies of damage lower than $1 \cdot 10^{-3}$. (This scenario is influenced by the present policy for the areas along the Dutch rivers, where specific areas with a chance of flooding of lower than 1/1250 per year now have the right of compensation. Any higher chances of destruction have not yet been included in the WTS, and are not considered to be appreciated by the public.)
- The amount that is compensated is equal to 90% of the (private) property damage and 50% of the assets and business loss. Infrastructure will be compensated for 100%.
- Providing information on the chances of damage in the area is assumed to be the responsibility of the government to ensure transparency of the potential market.
- The specific building regulations are those mentioned in the *waterstaatswetgeving*.
- (The Calamity Fund (Rampenfonds) is not taken into account here.)

5.3 Impact of scenarios on stakeholders

5.3.1 Scenario 1: Responsibility of the owner

In the valuation method the cost of risk was considered the responsibility of the investor. The resulting chances of damage are therefore similar in this scenario. The difference with the present situation is that here all stakeholders are aware of the exact risk. A number of situations will be discussed to analyze potential problems or benefits in this scenario.

After a disaster

The maximum acceptable chance of destruction that was calculated for a house with sea view was 0.017 per year, which is the location with a frequency of erosion once every 59 years. Seeing that the average duration of occupancy in the erosion zone is around 15 years, the safety perception is still not considered to have significant influence in the valuation. All financial and social costs have therefore been included in this calculation. In case of a disaster the owner will lose the money he invested and will face some additional costs.

Although this is what the valuation had been calculated for in this scenario, the following question should be asked: What will happen to the specific owner's financial situation after the disaster? This of course depends on the specific owner's situation, but without much difficulty it can be concluded that only the more wealthy citizens are able to afford such a risk without getting into heavy financial problems. In case the owners of property in the areas that are damaged are citizens with average or lower incomes, a disaster will often result in serious financial problems, not to mention emotional distress.

The logical result would be that the government will partly compensate these victims, including those who are able to cope with the financial problems, as has been done in similar cases. (The government has already confirmed this for the erosion zone²⁴.) The same can be said for the business owners. The most probable result is that from then on a much higher safety level will be used than before, because of resulting emotional response. This again has numerous negative results, for obvious reasons.

Whether the responsibility is ever solely for the investor is then of course debatable. For such a scenario to be suitable, it is essential that the specific investors, aware of the chances of

²⁴ Information from: "Risicobeheersing in kustplaatsen, document basisinformatie-concept" (2004), Directoraat-Generaal Water

damage, are able to decide themselves how much risk to take, without getting into problems afterwards.

From the stakeholder investigation it was concluded that on average the homeowners thought yearly costs of risk of € 500-800 were acceptable. For an average house the maximum frequency of damage is then only 0.0023 per year. 50% of the business owners thought 0-2% of the yearly net profit was acceptable. This would roughly relate to a frequency of damage of 0.00013 per year.

Over-valuation of investment

Seeing that in this scenario the yearly cost of risk must not be paid for example to an insurance company, the investor then never pays the cost of yearly risk to anyone. This does not mean there is no risk of course. However, this can easily lead to negligence of (part of) the costs when valuating investments, as no actual yearly costs have to be paid. Over-valuation is the result. (This is also the case at present, as no risk is ever taken into account in the investment decision.)

Sea level rise

The increase of risk because of SLR will have to be taken into account by the investors. Again it is essential that they are able to do so.

For buildings at the landward edge of the erosion zone, the increase of the zone can end in a situation where the building is included in the erosion zone. The investor is then suddenly responsible himself for the total risk of his investment.

5.3.2 Scenario 2: Possibility of insurance

In this scenario it is assumed that all the stakeholders have obtained insurance against erosion risk. Legally the risk is still for the investor but it is assumed the insurance policy covers all financial damage. A number of situations will be discussed to analyze potential problems or benefits in this scenario.

Decrease of emotional risk

The emotional discomfort of the stakeholder is the distress that occurs as a result of the loss of value. For house owners a house will usually mean more than just the replacement costs. This value is however irreplaceable.

The distress caused by the financial loss or potential financial problems is mostly erased, as this loss is compensated. This is however not the total amount of emotional discomfort that was obtained from the stakeholders, but a part of it. The insurance policy is sold for the amount of yearly risk, plus the cost for selling the policy. The potential gain for the investor is the

decrease in emotional risk, minus the cost of selling the policy. (The possible decrease of emotional discomfort could not be obtained from the survey results.)

Transparency

In case the insurance company sells this insurance it becomes essential to know the exact chances of damage to be able to secure its future as an insurer. Policies will be made, priced accordingly and advertised. This will lead to an insurance market in which all stakeholders can easily obtain information on risk through the cost of insuring it.

Possibility to sell insurance

Insurance companies can possibly insure every risk if they are able to quantify the risk involved. For the erosion zone this also should be possible. However, by law the insurance company must at all times possess the capital needed to compensate the total damage that is insured. In case of the erosion zone, where the chances of damage to buildings are highly dependant, this means that possibly a very high compensation will need to be paid out in case of a disaster. The problem for the insurers in The Netherlands is that it is unlikely they can raise the capital needed for such a policy. Solutions can be found by attracting foreign insurers or investors that do possess this capital.

5.3.3 Scenario 3: Responsibility of the government

Responsibility of the government is the same as responsibility of the general public, as tax-money is used for any compensation. There are numerous other situations in which the government is responsible for damage to structures, but the chances of damage in these situations do mostly not exceed a chance of 0.001 per year. This will be the chance of damage that the government will be responsible in this scenario. A number of situations will be discussed to analyze potential problems or benefits in this scenario.

Free government insurance

For investors interested in the part of the erosion zone with chances lower than 0.001 per year, the responsibility of the government here means they get free insurance for most of their risk. However, seeing that the chances of damage in this area are not very high, the benefit should not be overestimated.

Extra costs

For the government this will result in extra costs not only because of the risk involved. The costs of implementing the

policy, controlling the specific zone and act when citizens disobey the rules, also have to be taken into account.

Inequality

In case a disaster does occur, and the part of the erosion zone under government responsibility is destroyed, the more seaward zone will possibly be totally destroyed. In this case, is it then the concept to compensate only the few who were situated behind the frequency of erosion line of 0.001 per year? It is strongly doubted, as in scenario 1, that the government will be able to exclude victims of compensation in case of a disaster, while others are included.

Dividing the erosion zone

Seeing that the width of the erosion zone is relatively small (approximately 100 meters) and it was assumed that the government will not be held responsible for the entire erosion zone, and thus all relating chances of damage, the erosion zone must be divided into two or more areas. The erosion in this scenario zone must be divided into an area where the government is responsible, with frequencies of exceedance of erosion of $1 \cdot 10^{-3}$ per year to $1 \cdot 10^{-5}$ per year, and an area with higher chances. The building layout will most probably not permit easy division of these areas as buildings will be situated on the desired location of the regulatory contour lines that divide these areas. As a result, compromises will have to be made which can lead to very different responsibilities than was planned for.

5.4 Stakeholders preferences

Deciding on which scenario is most suitable is mostly a political question. With the help of the result of the survey results that have been obtained in the investigation areas some preliminary insight can be given.

For scenario 1 the following was said:

- 60% of the general public said the owner was to be responsible.
- 75% of the general public said everybody should pay according to their own risk.
- 65% of the homeowners, 60% of the business owners and 60% of the general public was interested to know what the chances of damage are.
- 65% of the business owners thought that living at the coast entails own responsibility.

For scenario 2 the following was said:

- 85% of the general public thought that citizens without the right of compensation should be able to buy insurance.
- >50% of the business owners are interested in buying insurance.

For scenario 3 the following was said:

- 55% of the general public disagreed with the fact that the government should (financially) protect citizens in the erosion zone (40% agreed).
- 55% of the homeowners and 60% of the business owners did not appreciate scenario 3 and also thought the chance was too low.

It is of course not possible to make a sound decision on the scenarios with only this information, but from these results it will be concluded that scenario 3 is far less appreciated by all stakeholders than scenario 1 and 2.

5.5 Solutions for the key question

5.5.1 Scenarios

In the discussions in Paragraph 5.3 and 5.4 the impact of the different scenarios has become more apparent:

- For scenario 1 (responsibility for the owner) it can be concluded that it is a suitable scenario when the investors are able to protect themselves from financial disasters. In case disaster occurs, most investors will possibly turn to the government for financial help. The government should be well prepared for this scenario, or consider doing something about the situation in advance.
- The only real problem with scenario 2 (possibility to insure risk) will be for the insurers to be able to offer the insurance for erosion damage, which requires a large amount of capital. Attracting foreign insurers, to obtain the capital needed, is considered the appropriate course. Other than that, the scenario offers the possibility to exploit the potential in the erosion zone without having to deal with the problems of scenario 1.

- The appreciation of scenario 3 (responsibility of the government) depends mainly on the appreciation of the general public, which in this case was minimal. Besides that, the other stakeholders' appreciation was minimal too.

In this investigation, scenario 2 with the possibility of insuring erosion damage is considered to offer the better opportunities, followed by scenario 1. A more detailed investigation is required to make a sound decision on this aspect.

It is, however, considered to be of the utmost importance that the aspect of responsibility is dealt with as soon as possible. Whatever option is chosen by the stakeholders or by the government, at the moment a disaster can only lead to problems beyond the scope of the actual damage. The unawareness of the public about the risk and the false judgment of most that they are at present insured, are the cause of this. When an option is chosen, be it the same as is at present, it is important that all stakeholders are aware of this policy and its implications.

5.5.2 Foreign policies

Some coastal policies from abroad can be used to learn more about the consequences of responsibility. Policies differ on almost every aspect, but almost all of them have differentiated a number of zones according to the risk involved. The aspect of responsibility is different in every policy, though insurance has in most cases been available with or without the help of the government:

- In the United States of America, the government agency FEMA (Federal Emergency Management Agency) has developed policies for the erosion zones that include several building regulations to decrease risk, in combination with the possibilities for the stakeholders to obtain insurance.
- In Germany insurance is widely available through the insurance company Munich Re.

All in all, cases can be found where the policies have integrated risk and the responsibilities for risk into policies than are different than in The Netherlands. In several cases though, policies have integrated the different aspects (Suitable areas / Information on risk / Building regulation / Responsibility of risk) into very specific policies that should deal with the problems of risk at the coast.

Besides that, the responsibility of executing these policies has in some cases been appointed to very specific agencies, with the sole task to manage risk. In some cases the risk-portfolio of these agencies includes all sorts of national risks, ranging from erosion to hurricanes etc. This of course enables such an agency to easily compare the different risks and act accordingly. With regard to the present organisational structure of agencies that are responsible for (parts of) the coast in The Netherlands, it is recommended to investigate whether such an agency could have added value for the Dutch situation. The author is aware of the fact that in The Netherlands the government agencies and institutions are already numerous and that the question whether another agency should be introduced is very legitimate.

However, the number of agencies, that are responsible (or have decided that they are) for one or more aspects of the coastal policy, is rather large (numerous ministries, numerous regional governmental agencies, coastal communities and so forth). A very interesting investigation would be to calculate the costs of these agencies for making the building policy for the erosion zone, in relation to the actual damage to the structures that occurs.

Dismissing these agencies of their responsibilities and handing them over to a single commission or smaller agency can possibly accelerate the design process, which at the moment is relatively slow (if the EU deadline is made, at least 4 years have been spent making the "Policy for the coast") and possibly reduce the costs of policy-making, which is without any doubt very expensive. Downsizing the present organisational structures is obviously then appropriate.

Seeing that at present risk of all sorts are receiving more attention from world leaders and the public, it seems appropriate to have a single agency that can create a total overview of the possible impacts and develop the necessary expertise. For years (possibly decades) the risk of flooding in The Netherlands has exceeded all other national risks together (plane crashes, nuclear disasters etc.), but is only now beginning to receive the attention that it deserves. Creating a single risk management agency can possibly prevent such situations from happening in the future.

Finally, it should be noted that the risk for structures in the erosion zone is insignificant in relation to the risk of flooding of the inland areas.

In Appendix 5 a more detailed discussion on foreign policies can be found.

6. Key question 4: How should development be handled in the near future?

6.1 Introduction

The results from Chapter 3 and 4 have shown which building locations are suitable and those which are not. In this chapter the present situation will be discussed. The key question will be answered by generating conclusions and recommendations on how development should be handled in the near future when taking into account the previous result.

In Paragraph 6.2 the present situation in the investigation areas (Noordwijk a/Z and Katwijk a/Z) will be described and problems will be identified. In Paragraph 6.3 solutions for these problems and the key question will be given.

6.2 Present situation in the investigation areas.

6.2.1 Information on the investigation areas

The relevant information of the investigation areas that needs to be discussed is the present location of the development and the location of the erosion contour lines. The location of the development and the building layout are easily obtained with the help of maps and site visits. The location of the erosion lines is somewhat more difficult to obtain. Some information however is available from the RIKZ²⁵, which possesses maps²⁶ of the Dutch coastline on which the erosion contour lines with frequencies of exceedance of $2 \cdot 10^{-4}$ and $1 \cdot 10^{-5}$ are illustrated. It has to be acknowledged that these maps are not up to date and not very accurate, but more recent and detailed maps are not readily available. Nevertheless, with the locations of these erosion contour lines, the location of other erosion contour lines can be estimated. Errors are therefore inevitable, but the emphasis in this chapter is on the methods used, not the accuracy of the results.

²⁵ Rijksinstituut voor Kust en Zee (RIKZ) is a research institution and part of the ministerie van Verkeer en Waterstaat

²⁶ Information in this paragraph taken from: Kaartenatlas afslagcontouren (RIKZ, 1998) and Beheersoordeel Rijnland (Hoogheemraadschap Rijnland, 1996)

6.2.2 Present situation Noordwijk aan Zee

Noordwijk aan Zee can best be divided into three areas, which differ significantly: the north boulevard, the south boulevard and Huis ter Duin, which is a hotel and apartment complex situated between the first two. Only the north boulevard will be discussed, as this is the only area with significant chances of damage to development (near raai 8175). Most of the development at the south boulevard and Huis ter Duin is situated outside the erosion zone.

North boulevard

At the north boulevard a dune row divides the boulevard and the beach. Along the boulevard the development consists mainly of hotels, restaurants and other tourist development. This part of the coastal town has the greatest chance of damage as the dunes here are lower than in the rest of the town and the distance between the sea and development is the smallest. In Figure 6.1 a photograph of the north boulevard illustrates the situation.



Figure 6.1 North boulevard at Noordwijk aan Zee

The building layout of this area is also given in a schematization in Figure 6.2, where the available erosion contour lines have been illustrated. Here it can be seen that the boulevard and roughly the first row of hotels are situated in an area with a frequency of damage higher than $2 \cdot 10^{-4}$ per year. (The black contour line drawn in the figure is to point out the location on the surface; the actual erosion line will not be vertical. The erosion line is drawn in red.)

The chance of destruction for the landward hotel is now $2 \cdot 10^{-4}$ per year. For the seaward hotel and the boulevard estimations were made. The erosion contour line with a frequency of exceedance of $2 \cdot 10^{-3}$ per year has been obtained by using data from Alkyon²⁷. The location of this erosion contour line should be around 20 meters from the edge of the dunes. This means the present location for all structures is suitable, when taking into account the maximum acceptable chances of destruction from Chapter 3. These are listed again in Table 6.1. When taking the effect of SLR into account it follows that this line will move inland approximately 2,5 meters, as discussed in Chapter 4. This would mean that the line with a frequency of exceedance of $2 \cdot 10^{-3}$ per year would still be located seaward of the boulevard. From Table 6.1 it shows that suitable locations for a boulevard have with a maximum acceptable chance of destruction of 0.007 per year or a frequency of once per 140 years. It is then not necessary to locate the corresponding erosion contour line, as the line with a frequency of exceedance of $2 \cdot 10^{-3}$ per year will be located seaward from the boulevard during the next 50 years.

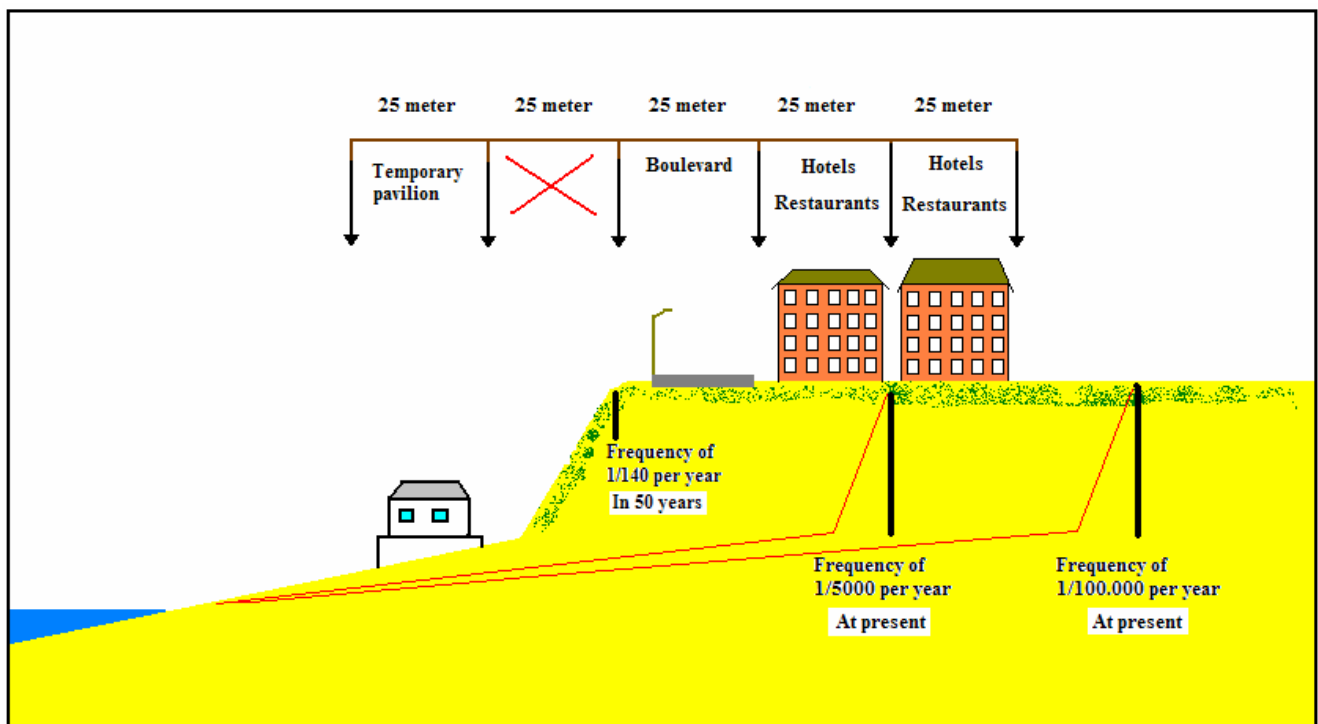


Figure 6.2 Schematization of the northern boulevard at Noordwijk a/Z

With some rough estimations the position of the erosion contour line of the maximum acceptable chance of destruction of the

²⁷ Alkyon, (2001) *Afslagkaart noordzeekust*, Marknesse

boulevard (chance of 0.007 per year) is also drawn Figure 6.2 for the situation 50 years from now.

Investment	With sea view	Without sea view
	Chance per year/return period	Chance per year/return period
House	0.017 per year/59 years	0.0086 per year/116 years
Hotel	0.023 per year/43 years	0.011 per year/91 years
Boulevard	0.007 per year/140 years	N.A.

Table 6.1 Maximum acceptable chances and return periods of destruction per investment

6.2.3 Present situation Katwijk aan Zee

Katwijk aan Zee is divided into two areas, which have significant differences in chances of damage: (1) the northern and southern part of the boulevard together and (2) the centre part of the boulevard, which has higher chances of damage mainly because of the difference in elevation.

Only the centre part of the boulevard will be discussed because here the chances of damage of the development are highest.

Centre boulevard

The building layout here (near raai 8700) is very similar as in the previous example, only here the buildings are houses instead of businesses. In Figure 6.3 a photo of the location can be seen.



Figure 6.3 Centre part of boulevard in Katwijk a/Z

Alkyon did not calculate the erosion contour line with a chance of exceedance of $1 \cdot 10^{-5}$ per year for this area, because of a lack of cross profile data. In Figure 6.4 an assumption on the location has been made. The most seaward row of houses is located seawards of the erosion contour line with a frequency of exceedance of $2 \cdot 10^{-4}$ per year, as is the boulevard. Again it is important to verify whether the boulevard is situated in a suitable area and will be in the next 50 years to come. The erosion contour line with a frequency of exceedance of $2 \cdot 10^{-3}$ per year has been obtained by using data from Alkyon²⁸. This line is situated seawards of the boulevard. The location of the erosion contour line with a frequency of exceedance of once every 140 years, which is the maximum acceptable chance of destruction for a the boulevard, is therefore also located seaward of the boulevard. During the next 50 years both lines will move 2,5 meters inland, but still the boulevard will not be located seaward of the maximum acceptable erosion contour line with a chance of exceedance of 0.007 per year. This is illustrated in Figure 6.4.

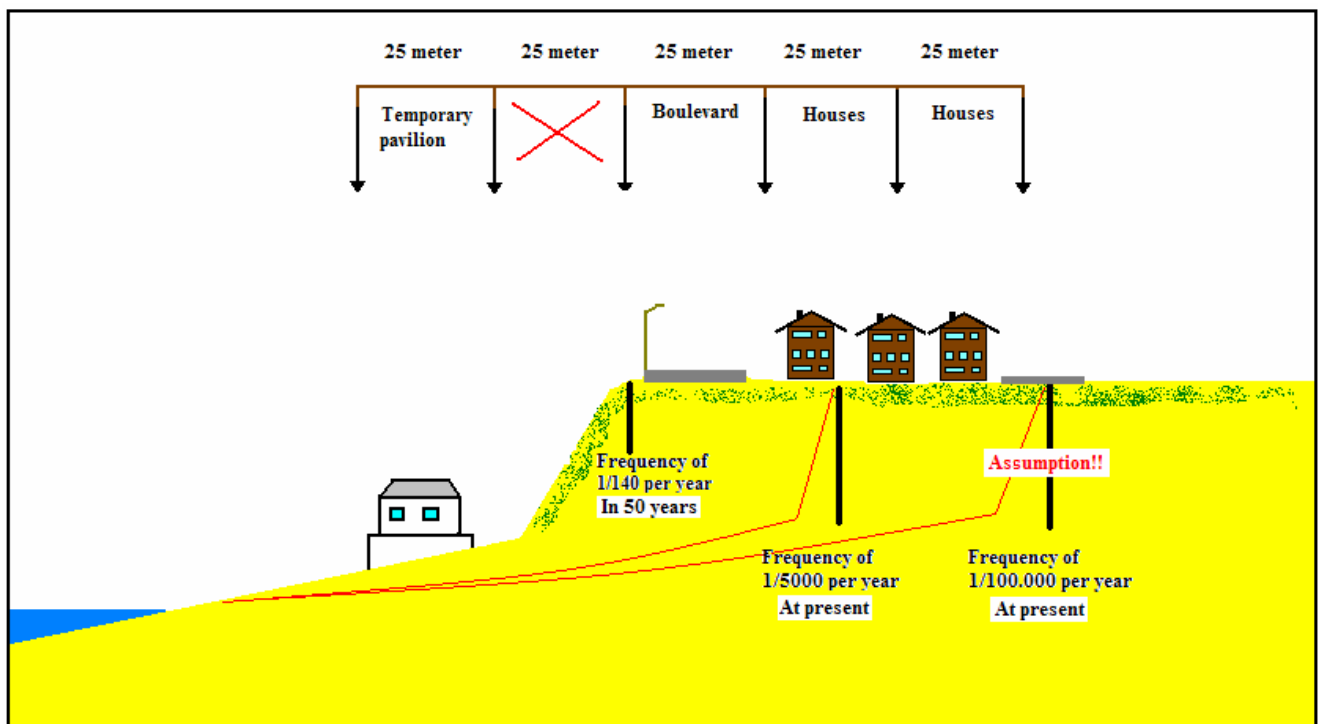


Figure 6.4 Schematization of the centre part of the boulevard in Katwijk a/Z

²⁸ Alkyon, (2001) *Afslagkaart noordzeekust*, Marknesse

6.2.4 Present problems

From the examples taken from Noordwijk and Katwijk a/Z it was shown that at these locations no problems were expected in the next 50 years because of structures being situated in unsuitable areas. Nonetheless, a problem is that the stakeholders are mostly unaware of the risk.

6.3 Solutions for the key question

6.3.1 Present problems

Although no problems were identified in the investigation areas, it is possible that problems exist in other coastal areas. To illustrate the possible solutions a number of potential problems are discussed. Two problems that are considered most relevant and will be discussed are:

- (1) A structure is situated in an area where the risk already exceeds the hedonic value.
- (2) A structure is situated in an area where the risk will exceed the hedonic value within the next 50 years.

To illustrate the possible solutions more effectively the schematization used in Chapter 2 will be used (illustrated again as Figure 6.5).

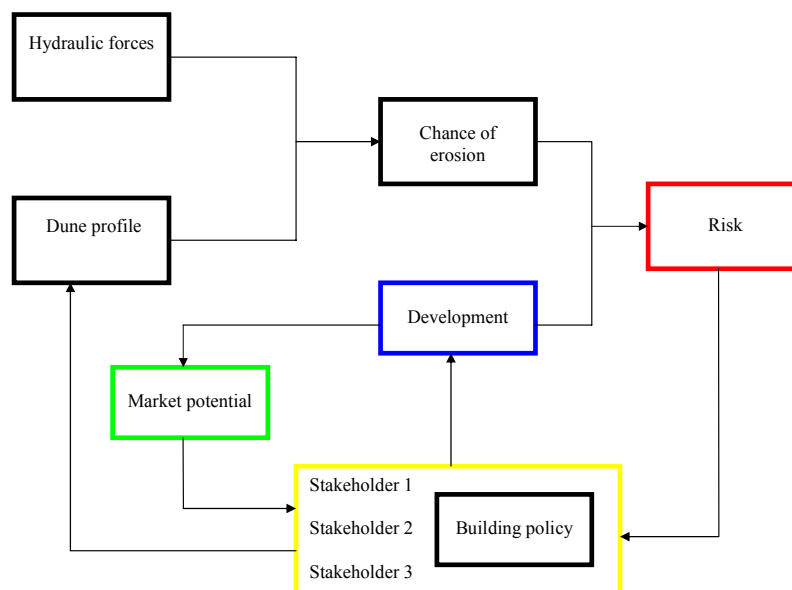


Figure 6.5 Schematization of the erosion zone

6.3.2 Possible solutions when the risk is too high

In case the risk already exceeds the hedonic value it can be concluded that the total value of the structure is lower than the initial value. There are three options for action:

- Do nothing (no action)
- Decrease the risk
- Increase the hedonic value

The option with the most value increase is considered the best.

Doing nothing (no action)

In this case it can be concluded that no similar investments will be made on the plot here any more. The structure will not be maintained and will become a hazard, also causing devaluation of the surrounding properties. No value increase is possible.

Decrease the risk

There are two methods to decrease risk as discussed in Section 2.5.6. Either the chance of damage is reduced, or the value of possible damage is reduced.

(In Figure 6.5 this are the relation between the stakeholders and the development and dune profile.) The possible options are listed here:

- Reducing the value of the development by (1) removing it.
- Increasing the strength of the dunes by either: (2) sand nourishments or (3) sea defence structures.
- Increasing the strength of the structures by using (4) “erosion proof” foundations.

The costs and benefits depend on the option chosen.

(In Appendix 6 information can be found on alternative methods to strengthen the dunes and buildings.)

Increase the hedonic value

This is possible in special situations and for buildings only. The maximum chances of damage for an investment to be justified are in the range of once every 43 to 140 years. The erosion contour lines of these chances are in reality only meters apart from each other, when observing the specific dune profile. When the most seaward building that is located in an unsuitable location would be removed, the building behind it would obtain sea view and thus a hedonic value increase of 50% of the initial value. When this increase of value exceeds the costs of removing

the (devaluated) seaward building, the total value can be increased.

Solution

In order to find the solution with the most increase in value, all the costs and benefits of all options need to be compared. Without calculating all the different options a number of useful notes can be made.

- “Doing nothing” is considered unacceptable. The benefits of letting property become hazardous (if any) are considered lower than the value of the loss in the erosion zone for all the stakeholders.
- The costs of increasing the strength of the dunes will be either that of the sand nourishments or of the defence structure. The benefit is the decrease in risk for all the properties perpendicular to the coastline, where the dunes are reinforced. Dune nourishments are mostly only profitable when the risk involved is very high.
- For buildings only: By removing the most seaward property, the hedonic value of the property behind it will increase, because of the obtained sea view. When the increase in value exceeds the cost of removing the (devaluated) property, profit is made. This is an option an individual investor can apply himself.
- Although there is reason to believe that the decrease in risk by using “erosion proof” foundations can exceed the costs of the foundations, it must be investigated if this is also profitable when foundations have to be made for an existing building. (Using concrete piles inserted with a flushing technique, foundations can be made strong enough to withstand the forces of the sea that are also relatively cheap. The total costs are around €10.000/15.000 for a relatively large house.)²⁹

6.3.3 Possible solution when the future risk becomes too high

There are two possible reasons why the risk can become too high in the future:

- The risk increases
- The hedonic value decreases

A decrease in hedonic value is of course possible, but the only probable reason could be that a building loses the hedonic value

²⁹ Estimation made by Hans van Egmond. (Hans van Egmond Architects, Noordwijk aan Zee)

of the sea view because another building is constructed in front of it. In most cases the risk would not be too high.

The more probable reason for the future risk increase is SLR. As discussed in Chapter 4, it was essential to take the SLR into account by making sure the investment would remain within the suitable areas for the next 50 years.

Solution

In case it becomes apparent that the future risk will become too high and sooner than the 50 years used as planning timeframe, the options of the previous section must be assessed. It is then also important to calculate what the most profitable moment is to use any of these options.

6.3.4 Stakeholders preferences

In addition some information from the stakeholder investigation (survey) can be used to show the present appreciation of the different options:

- Regarding the options: strengthening of the dunes or the buildings: >70% of the house owners preferred the option of strengthening the dunes as did 60% of the general public.
- 60% of the general public disagreed that the government should expropriate property when the risk becomes too high.
- >60% of the general public said that the government and owners should pay for any reinforcement of buildings together.

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Appendices

Appendix 1 EU and Dutch coastal policy

EU

In 2000, based on the experiences and outputs of the Demonstration Programme the Commission adopted two documents:

- Integrated Coastal Zone Management: A Strategy for Europe³⁰
- A proposal for the implementation of Integrated Coastal Zone Management in Europe³¹

The Communication explains how the Commission will be working to promote ICZM through the use of Community instruments and programmes. The Recommendation outlines steps, which the Member States should take to develop national strategies for ICZM. The national strategies are due for Spring 2006 and should involve all the coastal stakeholders.

An important conclusion taken from these two documents is: integrated solutions to concrete problems can only be found and implemented at the local and regional level; however, integration of policies at the local and regional level is only possible if the higher levels of administration provide an integrated legal and institutional context, as well as taking measures to enable local and regional action.

The development of a European Spatial Development Perspective (ESDP) calls for taking into account an integrated vision of the entire European territory. This has implication on spatial approaches to ICZM and would require (a) a more balanced geographical distribution of production activities to correct present trends towards concentration in the most competitive areas, (b) a more sustainable land use policy to ensure the most appropriate choices in terms of basic infrastructure, and (c) a greater sensitivity to specific territorial needs.

³⁰ Communication from the Commission to the Council and the European Parliament on "Integrated Coastal Zone Management: A Strategy for Europe" (COM/00/547 of 17 Sept. 2000)

³¹ Proposal for the European Parliament and Council including a recommendation concerning the implementation of Integrated Coastal Zone Management in Europe (COM/00/545 of 8 Sept. 2000), Council and Parliament adopted this Recommendation on 30 May 2002.

The Netherlands

In The Netherlands spatial planning policy is made in three steps:

- (1) First the central government makes key planning decisions (Planologische Kernbeslissing), with the help of a planning commission (Rijksplanologische Dienst). This results in a range of plans of which the Nota Ruimte is most important.
- (2) Using the key decisions the provincial authorities determine spatial plans for the provinces in more detail but have the authority to co-determine the municipality plans.
- (3) The municipalities use the provincial plans to determine detailed spatial plans for their respective municipalities. Only in this last step, when the municipal plan is determined, the plans are worked out in full detail and become legally binding.

*3^e Kustnota*³²

The provincial authority is the leading party when the determination of the erosion lines is concerned. The policy of the contour lines will be applied on all of the Dutch dune area and must stop the growth of structures on the coastal defence. The areas around which these contours will be drawn are; permanent structures that are grouped together (urban areas). Structures that are isolated from these are not included as well as recreational areas and areas used for sporting facilities (e.g. golf courses). The following three (3) criteria are used to evaluate the location of the lines; (1) to what extent the defence capacity is affected, (2) what is risk for development seaward of the contour line and (3) the acknowledgement of the fact that any new building outside the lines is no longer possible. At the land side of the urban areas there is a need for contour lines with regard to the nature conservation policies and spatial planning.

When, in exceptions, structures are allowed outside of the contour lines a compensation rule applies (*compensatiebeginsele*), which states that any negative effects the structure might inflict, must be compensated for in the nearby areas.

For new structures within the contour lines the following three (3) guidelines are applicable; (1) the natural characteristics of sand must not be affected, which can be done by building the structure on piles. (2) Sea level rise should be taken into account when choosing a location. (3) The design of the structure should be such that chances of damage to it and the surroundings are minimized.

The beach will always stay outside of the contour lines, as permanent structures are unwanted here. In case of storms these can increase erosion levels and always attract further

³² Ministerie van Verkeer en waterstaat, *3^e kustnota*, 2000

development. The only exceptions here are the pavilions. (So this is the reason why no houses are present on the beach!)

Besides these, there are some other relevant policies and regulations to take into account.

Legal safety level in the erosion zone

The law concerning the safety levels of the inland areas, the *Wet op de Waterkering*³³, does not include a definition of the areas outside the protected inland, but only defines the areas enclosed by defence works, the *dijkring area*, where a safety level is maintained. This policy for the coast defines the areas outside the *dijkring area* as areas not secured by the *Wet op de Waterkering* and are called *buitendijks*. All areas that are considered not to be within the *dijkring* are therefore *buitendijks*, including the defence works itself. In the dunes the border between these two zones lies at the landward edge of the cross profile of the dunes that offers the required defence. In the areas that are *buitendijks*, there are no legal safety levels and any risk is the responsibility of the owner. The chance of damage differs per position in the *buitendijks* areas but is on average higher than the inland areas. The following coastal safety plan taken from the *Policy for the coast*, and illustrated below, has not been put into force at this time and there is no significant reason to believe it will. However, it is interesting to consider what plans the central government has made before:

The first stage of maintaining the present safety levels in the buitendijks areas is to define the standard safety level of these areas to be upheld. The government together with the Water Boards (Waterschappen) defines these standards for coastal towns in the buitendijks areas. Any new insights concerning the hydraulic conditions at the coast are to be taken into account. With the use of these a set of hydraulic conditions are set up with which the standard safety level and the location of the relevant erosion line are determined for each area. In 2006 these safety levels and erosion lines must be determined for all areas buitendijks.

The second stage is to develop a method to test whether this standard is being met. Again the government together with the regional coastal defence authority will develop this method. From 2005 onwards the government will finance any sand supplementing that is necessary to uphold the determined standards.

³³ Wet op de waterkering (version dated 01-09-2002)

Sea defence law (Wet op de waterkering)

From article 7; plans to construct a new sea defence or to alter existing sea defence structures have to take all relevant aspects into consideration which are the environment, nature, culture and history, housing and spatial planning. The plan must include an estimation of the impact of the plan and in what way the relevant aspects have been taken into account.

Form article 30; when ownership of property is necessary to perform the construction works these can be obtained through the 'onteigeningswet', and will be obtained by the sea defence manager. There is no possibility to appeal against such a decision.

Law on compensation for damage due to damage disasters (Wet tegemoetkoming schade bij rampen en zware ongevallen³⁴)

This law organises the compensation in case of disasters and only includes disasters regarding fresh water floods and earthquakes. The law can be applied to other disasters of the same magnitude, if the Royal representative (Dutch Queen) decides so.

The government has declared that they will compensate to a certain degree when the damage inflicted is unreasonable high for a certain group. Then a contribution from the victims will be also required. This seems to be contrary to article 21 of the constitution, which states that the government is responsible to protect and improve the living environment. However, this is a socially orientated article of the constitution from which no rights can be obtained from citizens. The article is in fact a responsibility to perform a duty without any legal right to results.

Citizens can also try to obtain compensation from the government on grounds that the government has acted unjust or has come short in their tasks. However, the legal opportunities here are minute.

Looking at the present procedure of issuing building permits in the erosion zone, the risk of building is not even included as a criterion.

³⁴ Wet tegemoetkoming schade bij rampen en zware ongevallen (version dated 13-09-2004)

Appendix 2 Government responsibility; Flooding events '93 and '95

An interesting case on government responsibility to discuss is the situation after two flooding events in 1993 and 1995 in The Netherlands. These occurred because river discharge increased and the river width temporarily exceeded its normal boundaries. These floods were responsible for a lot of damage to property. However, this damage was the responsibility of the respective owners, like in the erosion zone these houses were built in flood risk areas on condition that the owners would be responsible for any damage.

The main question is whether the government was responsible to avert the risk concerning these disasters and whether they should compensate the victims. It is the government's task to decide on matters regarding safety but also environment and finance. It was concluded that a number of citizens and organisations had objected to defence projects like the strengthening of the dikes. In conclusion, the government has not neglected her duty of safeguarding the public, as didn't the local authorities. They have permitted buildings in risk areas after careful consideration of a number of aspects. Safety is not always the key factor in such a decision, which means that any occurring damage is not always a reason for liability of the government. Which leads to the question; to what extent are the government and citizens responsible?

Prior to the flooding event in 1993 very few citizens were aware of the risk involved. The government had done little to raise any awareness and citizens were under the impression that the government should regulate any risk involved. Nevertheless, more than half said that they would move back to the same areas, regardless of the risk. The conclusion can be drawn that the government was not liable to pay for any compensation, even though they had. The decision had been made on moral and political grounds, of which solidarity was the main factor. This means that nobody can legally demand compensation in a recurring disaster.

The following was obtained on the compensation given:

Het Nationaal Rampenfonds

The National Disaster Fund, or Nationaal Rampenfonds, received 82 million guilders from private donations. The government decided to double this amount with government funding. The funding of the National Disaster Fund was only to be distributed among citizens, which were compensated for 90 %

of the damage to houses and between 50 and 100 % of other assets (furniture etc.). Besides this, compensation was given for some indirect damage, like assistance given during rescue works.

The Ministry of Internal Affairs

The Ministry of Internal Affairs developed a number of regulations to be able to compensate as much victims as possible. This included direct cash compensation of 500 guilders to help victims immediately after the disaster and some regulations to help the municipalities and other local organisations to overcome the first phase of damage.

The Ministry of Agriculture

To keep farmers happy after the disaster a lot of effort was needed from the Ministry of Agriculture. The evacuation costs were all compensated as was between 65 and 90 % of the direct and indirect damage that had occurred (with a fixed minimum of 2000 guilders to be paid by the victim). Besides this compensation (on interest) was given to farmers that needed to loan money after the disaster.

Ministry of Economy

This ministry focussed on companies and had the main objective that no company was to go bankrupt because of the disaster. Damage to equity was compensated for 65 % and a special credit facility was developed. Companies that were also victim of the 1993 disaster were given 90 % compensation in the 1995 disaster. Evacuation costs were compensated up to 1,500 guilders. Finally, the victims and the government paid most of the damage costs of both disasters.

Appendix 3 Short description of the target areas for the opinion investigation

Noordwijk aan Zee:

Also Noordwijk aan Zee was originally founded by fishermen and was declared a religious sanctuary in the 15th century. Today tourism is big in this popular coastal town.

On the 1st of January 2004 the municipality of Noordwijk roughly had 24.500 inhabitants, 10.000 housing units and was spread out on some 36 square kilometres. Three different areas can be defined at the waterfront.

- Characteristic of the south boulevard (see Figure A.1) is the presence of parking facilities just behind the first dunes. Between the parking and boulevard a second dune can be found, several meters higher.
- The north boulevard has only one dune row between the beach and boulevard.
- A hotel (Huis Ter Duin) and some apartment complexes are built on a relative much higher dune in the centre of the waterfront.

The average value of a house in Noordwijk aan Zee was € 202.000 in 2002. In 2001 Some 89 new houses were built, 618 real estate transactions took place and 584 new mortgages were registered. Almost none of the houses have any major foundation structure.



Figure A.1 South boulevard Noordwijk aan Zee

Katwijk aan Zee:

The history of Katwijk is long and includes the presence of Roman structures dating from the 1st century and later on fishermen's families dominated the village. In 1460 the Old Church, in Figure A.2, (Oude Kerk) stood in the centre of the town Katwijk aan zee. In the seventeenth century the sea destroyed a large part of the town, leaving the Old Church standing on what is now the boulevard.



Figure A.2 Old Church in Katwijk aan Zee

In 2002 the municipality of Katwijk roughly had 41.000 inhabitants, 15.200 housing units and was spread out on some 19 square kilometers. When walking from the beach to the boulevard, one will encounter first a small dune crest, then immediately the boulevard on which a variety of old and newer buildings can be found. From the average waterline it is approximately 180 meters to the front of the first houses. Most of the buildings here are houses of mediocre size. The average value of a house in Katwijk was € 158.000 in 2002. In 2001 Some 330 new houses were built, 672 real estate transactions took place and 1.030 new mortgages were registered.

When walking along the boulevard it is easy to see that the level of the centre part of the dunes (approximately NAP +7 m) and boulevard (app +6 m NAP) is significantly lower than to the north and south (approximately NAP +11 m). Calculations of the erosion lines show a distinctive inland curve of the lines at this part.

Rijkswaterstaat has divided the Dutch coastline into segments called “raaien”, which are cross-sections perpendicular to the coastline.

The following “raaien” are part of the investigation area;

Raaien Noordijk: 8050-8350

Raaien Katwijk: 8550-8850

Appendix 4 Obtained information on market potential and risk

The following information was obtained with the help of surveys and interviews. In the Table A.1 the methods and the number of times these were used are illustrated for each stakeholder. Besides that, the additional interviews and research that were done are listed.

<i>Stakeholder</i>	<i>Investigation area</i>	<i>Method</i>
Homeowner	Noordwijk a/Z	Survey (11), Interview (1)
	Katwijk a/Z	Survey (9)
Business owner	Noordwijk a/Z	Survey (3), Interview (1)
	Katwijk a/Z	Survey (3), Interview (1)
General public	Provinces North and South Holland	Survey (14)
<i>Professional opinions</i>	<i>Investigation area</i>	<i>Method</i>
Real estate brokers	Noordwijk a/Z	Interview (1)
	Katwijk a/Z	Interview (1)
Architect	Noordwijk a/Z	Interview (1)
Property valuator	N.A.	Interview (1)
VROM	N.A.	Interview (1)
V&W, DGW	N.A.	Interview (1)
Market research	Hotels	Survey, internet

Table A.1 Investigation methods used per stakeholder

The results of the survey are discussed per stakeholder. Of the actual stakeholders who filled in the following can be said:

- The homeowners were within the age group of 30-65 years. The spread on income differences between the owners is assumed to be normal.
- Of the business owners approximately 75% are the actual owners, 25% are business managers.
- The general public consists of persons within the age group of 25-60 years and live in the areas: Rotterdam, Amsterdam and The Hague. The spread on income differences is considered slightly above average.

The results are listed as follows: first the questions on awareness on risk (1), then the market potential (2) and finally the risk (3) preferences. First a summary is given, and then the total

overview of the questions and answers will follow. (The questions have been formulated in this table as short as possible.) Where no obvious preference was obtained, N.A. (not available) will be marked.

Summary:

Homeowner

Awareness

The homeowners seem to be aware of the sea level rise and that severe problems can occur. Seldom has any damage been experienced though, and the general consensus is that the present risk is acceptable. In case the boulevard would be destroyed more than 65% thinks this is a disaster.

Market potential

The location criterion seems to be favoured equally as the view of the sea, which can be the result of misinterpretation of the questions in the survey. The nearness of the sea is however a strong criterion. The criteria of the surroundings are mostly unimportant. The additional hedonic value increase that owners think is achievable (while already living in or close to the erosion zone) ranges from 20-25%.

Risk

More than half of the owners are interested to know what the level of risk is, but at the same time half of the owners think the insurance company is responsible for any damage. When asked what acceptable costs of risk per year would be 35% answered between in the range of € 500-800, 20% in the range of € 0-200 and 20% said more than € 1.200. About 60% of the owners value the emotional discomfort in the range of 40-60% of the financial risk.

For protecting the boulevard 50% would pay €10 or more per year, 15% will pay € 5, 10% will pay €2 and 25% would not pay anything.

Business owners

Awareness

The business owners seem to be aware of the sea level rise and that severe problems can occur. Mostly seldom any damage has been experienced. The insurance companies are thought to be responsible for damage costs.

Market potential

The view of the sea is the most important criterion after which comes the nearness from the sea. The potential increase in sales prices by changing the location or building layout is estimated by 40% of the owners to be in the range of 10-20%, and another 40% estimates this to be in the range of 5-10%. The resulting increase of maintenance costs is estimated by 40% of the owners in the range of 0-5%, the rest estimates this to be higher. 80% of the owners estimate the potential increase in net profit in the range of 0-10%. The initial ratio (although given by only a few owners) was to be in the range of 0.04-0.08.

Risk

When asked what acceptable damage costs would be, (only few answered) half the answers were in the range of 0-2% of the net profit and half in the range of 4-6%. More than 50% of the owners were interested in buying insurance, and on average this would have an added value for the owner of approximately 30% of the financial risk. The emotional discomfort is estimated to be in the range of 20-100% of the financial damage. This is rather varied and high, but at least illustrates the importance of the criteria.

When asked what the amount is that owners would like to pay for protection of the boulevard 30% would pay nothing, 35% would pay € 2 per year and 35 % would pay € 10 or more per year.

All in all, the business owners feel erosion risk is slightly less important a hazard as for instance bad weather.

General public

Awareness

The public does not think the sea level rise is a severe problem.

Market potential

The public is mainly interested in the beach and sea, and thinks the criterion of sea view is most important for any tourism venture.

Risk

60% said the owner is responsible for any damage and at the same time 60% was interested in knowing the chances.

When asked if they are willing to contribute to strengthen the boulevard 55% would pay € 5 per year, 15% would pay € 10, 10% would pay €2 and 10% would pay € 1.

Question and answers:

Homeowners

Questions	Answer
1. Awareness of risk	
Are you aware of the sea level rise?	100% Yes;
How severe can the resulting problems be?	>60% Severe;
Have you had any damage so far?	80% Never;
2. Market potential	
What is more important: the view or location?	40% view; 50% location
What is more important: the surroundings or the nearness of the sea?	>50% nearness; 30% not sure
<i>(With regards to Figure A.3 below. Possible answers are houses/ apartments/ hotels/ restaurants/ pavilion/ boulevard/ parking/ no building at all)</i>	
What buildings are allowed in zone A?	50% pavilion; 50% no buildings
What buildings are allowed in zone B?	80% no buildings; 15% pavilion
What buildings are allowed in zone C1?	70% no buildings; 10% boulevard; 10% houses
What buildings are allowed in zone C2?	45% no buildings; 25% boulevard/parking; rest evenly spread; 15% houses
What buildings are allowed in zone C3?	30% no buildings; 30% houses/apartments; 25% boulevard/parking; 10% hotels
What is your first choice for a building location?	50% C1; (100% said A was last choice)
How do you experience the presence of tourists?	>60% positive
Must the tourism and housing buildings be separated?	45% separated; 25% not separated
What is the potential increase in value in the ideal situation?	Average around 20-25%
Which aspect is most important?	35% view; 35% location
What is the main reason for living at the coast?	40% family; 50% surroundings
What is the value of the historical buildings?	85% very valuable
3. Risk	
Is the chance of damage by erosion higher than by fire?	(An average) slightly higher;
Is this acceptable?	>70% acceptable;
Who is responsible for compensation?	50% insurance; 30% owner
Are you interested to know the chance of damage?	65% is interested;
What are acceptable yearly costs (risk)?	35% in the range of €500-800; 20% more than €1.200; 20% in the range of €0-200
In case of the owner's responsibility: do you want to buy insurance?	40% interested; 25% not interested
What is the value of emotional discomfort? (Compared to financial damage)	60% in the range of 40-60% of financial damage; 30% in range of 0-20%
What is the added value to have insurance? (Compared to the financial risk)	N.A.
<i>(With regards to the policy in river areas. Compensation for damage with chances lower than</i>	

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<i>1/1250 per year)</i>	
Would you appreciate having this policy at the coast?	55% not appreciate; 15% not sure
What about the chance?	>50% low; 25% not sure
Does it affect you more when damage is done to more buildings?	N.A.
What would you prefer: strengthening the house or dunes?	>70% dunes;
Must everyone pay according to his or her own risk?	65% disagrees;
Does living at the coast bring any responsibility for the owner?	70% disagrees;
Are you willing to contribute to protecting historic buildings?	65% little;
When the boulevard is destroyed is this an incident or disaster?	65% disaster;
What are you willing to contribute to strengthen the boulevard?	50% will pay €10 or more; 15% will pay €5; 10% will pay €2; 25% will pay nothing
How much influence must the Water Boards have?	55% much influence

Business owners

Questions	Answer
1. Awareness of risk	
Are you aware of the sea level rise?	100% Yes;
How severe can the resulting problems be?	85% severe problems;
Have you had any damage so far?	65% seldom;
2. Market potential	
What is more important: the view or location?	65% view; 35% location
What is more important: the surroundings or the nearness of the sea?	85% nearness of sea
<i>(With regards to Figure A.3 below. Possible answers are houses/ apartments/ hotels/ restaurants/ pavilion/ boulevard/ parking/ no building at all)</i>	
What buildings are allowed in zone A?	50% no buildings; 50% pavilion or restaurant
What buildings are allowed in zone B?	65% no buildings; 20% boulevard
What buildings are allowed in zone C1?	50% no buildings; 40% pavilion or restaurants
What buildings are allowed in zone C2?	50% no buildings; rest is divided
What buildings are allowed in zone C3?	50% no buildings; rest is divided
What is your first choice for a building location?	75% C1; (75% B is last choice)
Must the tourism and housing buildings be separated?	N.A.
Which aspect is most important?	60% location near sea
What is the potential increase in sales prices?	40% in range of 10-20%; 40% in range of 5-10%; 20% in range of 0-5%
What is the resulting increase in maintenance costs?	40% in range of 0-5%; 20% in range of 5-10%; 20% in range of 10-20%; 20% in range of 30% or more
What is the potential increase in net profit?	80% in range of 0-10%; 20% in range of 20-30%
What is at present the initial ratio?	65% in range of 0.04 and 0.08 (very low response)
3. Risk	
Is the chance of damage by erosion higher than by fire?	50% higher; 50% equal
Is this acceptable?	N.A.

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Who is responsible for compensation?	70% insurance; 30% government
Are you interested to know the chance of damage?	60% interested;
What are acceptable yearly costs (risk) as percentage of the net profit?	50% in range of 0-2%; 50% in range of 4-6% (only 4 answered)
In case of the owner's responsibility: do you want to buy insurance?	>50% interested
What is the value of emotional discomfort? (Compared to financial damage)	100% in range of 20-100% of financial damage (spread evenly)
What is the added value to have insurance? (Compared to the financial damage)	35% said 20%; 35% said 40% of financial damage
<i>(With regards to the policy in river areas. Compensation for damage with chances lower than 1/1250 per year)</i>	
Would you appreciate having this policy at the coast?	60% not appreciate
What about the chance?	75% low (very low response)
What would you prefer: strengthening the house or dunes?	N.A.
Must everyone pay according to his or her own risk?	30% disagrees; 50% not sure
Does living at the coast bring any responsibility for the owner?	65% agrees; 15% disagrees
Who should pay for any necessary reinforcement of buildings?	40% government; 50% combination owner/government
What are you willing to contribute to strengthen the boulevard?	30% nothing; 35% will pay € 2 per year; 35 % will pay € 10 or more
How much influence must the Water Boards have?	65% much influence
Is the sea the most important risk factor?	(On average) slightly less important than other hazards (bad weather)

General public

Questions	Answer
1.Awareness of risk	
How often do you visit the coast?	50% in the range of 10-20 per year;
What is the main reason for visiting?	85% the beach and sea
How severe can the resulting problems of sea level rise be?	On average not very severe
2. Market potential	
What is the most important aspect of the coast?	55% beach and sea; 35% nature
How important is the view for the tourism business?	80% very important
<i>(With regards to Figure A.3 below. Possible answers are houses/ apartments/ hotels/ restaurants/ pavilion/ boulevard/ parking/ no building at all)</i>	
What buildings are allowed in zone A?	75% pavilion/restaurant; 20% no buildings
What buildings are allowed in zone B?	75% no buildings; 25% pavilion
What buildings are allowed in zone C1?	40% no building; 30% pavilion/restaurant; 30% pavilions/parking;
What buildings are allowed in zone C2?	45% boulevard and parking; rest houses, apartments, hotels, restaurants, pavilions; no building 5%
What buildings are allowed in zone C3?	Spread evenly over all answers; no building 10%
Must the tourism and housing buildings be separated?	Slight disagree

3. Risk	
Who is responsible for compensation?	60% the owner; 35% insurance
Are you interested to know the chance of damage?	60% interested; 25% not sure
<i>(With regards to the policy in river areas. Compensation for damage with chances lower than 1/1250 per year)</i>	
Would you appreciate having this policy at the coast?	60% appreciate; 25% not appreciate
What about the chance?	55% low; 25% not sure
Is it fair for the government to financially protect citizens in the coast?	55% disagrees; 40% agrees
Should citizens without the right of compensation be able to get insurance?	85% agrees
When awareness is nil, are owners still responsible?	40% acceptable; 30% not acceptable
When protection is too expensive, must the government expropriate?	60% disagrees; 30% agrees
Does it affect you more when damage is done to more buildings?	55% says it does a lot; 25% not sure
What would you prefer: strengthening the house or dunes?	60% dunes; 25% houses
Who should pay for any necessary reinforcement of buildings?	>60% combination of government and owner
Must everyone pay according to his or her own risk?	75% agrees
When the boulevard is destroyed is this an event or disaster?	N.A.
What are you willing to contribute to strengthen the boulevard?	55% will pay € 5; 15% will pay € 10; 10% will pay €2; 10% will pay € 1
How much influence must the Water Boards have?	55% a lot; 25% little

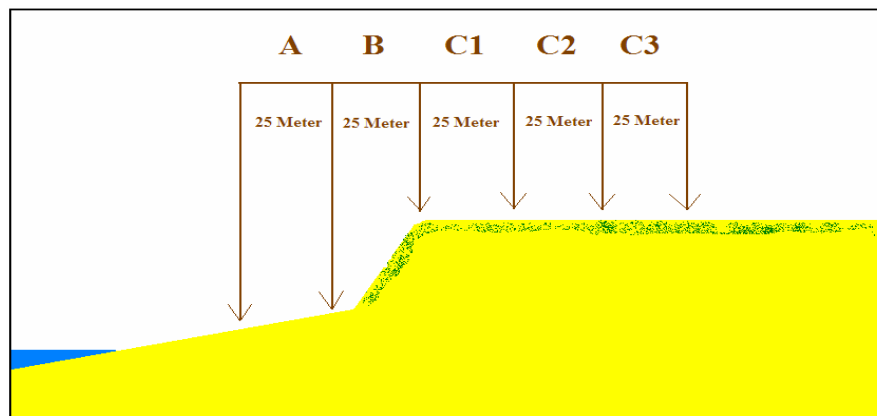


Figure A.3 Schematization of the erosion zone used in survey

Professional opinions

Hans van Egmond Architects (Noordwijk aan Zee)

The public awareness on risk is nil, so this aspect is not included in the market price of property. However, considering the extra cost of risk, it is without doubt true that the citizens in Noordwijk aan Zee will pay a lot more (hedonic) value for certain

aspects in the coastal zone. The most important criterion is the possible sea view and after that the distance from the sea. Differentiating the value perpendicular to the coast is not relevant as sea view is possible from a variety of locations. Seeing that the erosion zone is relatively small, the whole zone is valued more or less the same and only differentiation of the sea view is important. Interesting is that the true local population (there is a large group of owners who actually live somewhere else) prefers the sheltered locations somewhat away from the sea, as they do not appreciate the strong winds and blowing sand all year round. Sea view for them is of lesser importance. For businesses the sea view is essential.

A trend which is growing strong because of the limited building plots is that high-rise buildings are increasing, which accommodates more people with sea view. This trend will probably continue in the far future.

If there was a (legal) possibility of building on the edge of the dunes, this will be certainly done, as this is technically feasible. Using poles as foundations, constructed with a flushing technique, is relatively cheap (total costs are around €10.000/15.000 for a large house) and can be made strong enough to withstand the forces of the sea. Other methods include periodically removing buildings, which is done at the moment with a relatively large clubhouse.

To obtain data for the initial and hedonic values a former research done by Hans van Egmond Architects, on price differences amongst some 80 properties, has been used. From this investigation the following averaged prices for a m² in an apartment can be distinguished in Noordwijk aan Zee, illustrated in Table A.2:

Location of apartment	View	Average price / m ²	HV
Outside the erosion zone	No sea view	€ 3072	
Within 200 metres of the beach	Little to no sea view	€ 4387	+43%
Within 200 metres of the beach	With sea view	€ 6350	+107%

Table A.2 Average prices of apartments in m² (Van Egmond, Noordwijk aan Zee)

Note! The average price for the apartments with sea view within 200 meters includes a large number of prices taken from sales at the Huis ter Duin complex. This more prestigious housing complex has a significant hedonic value not influenced by the criteria used in this investigation. Some caution is therefore necessary when using this averaged price.

Den Haan, real estate agency (Noordwijk aan Zee)

The most appropriate way to calculate the hedonic value is to use sales prices of apartments. The sales prices of houses are a bit more complicated regarding the criteria of the hedonic value. The most important factor for this hedonic value is the possible sea view. The houses in the centre of town are also relatively close to the sea but do not have any view. The Market potential criteria can be listed from highest level of importance downwards in the following way: sea view, location from the sea, surrounding buildings and the presence of tourists. For the central town area this would be: surrounding buildings, location from the sea and the presence of tourists. On average houses are kept in possession longer than apartments, but all in all both timeframes of occupancy are between 10 and 20 years.

The following price differences can be distinguished, illustrated in Table A.3:

Location of apartment	View	Average price / m ²	
Outside the erosion zone	Little to no sea view	€ 2550	
Within 200 metres of the beach	Little to no sea view	€ 4000	+57%
Within 200 metres of the beach	With sea view	€ 5180	+103%

Table A.3 Average prices of apartments in m² (Den Haan, Noordwijk aan Zee)

In addition, a garage will cost approximately € 25.000-28.000. These have been excluded from the above-mentioned prices when possible.

Ancora real estate agency (Katwijk aan Zee)

The following average prices can be distinguished in Katwijk aan Zee, illustrated in Table A.4:

Location of apartment	View	Average price / m ²	
Outside the erosion zone	Little to no sea view	€ 2400	
Within 200 metres of the beach	With or without sea view	€ 3500	46%
Building plot	View	Average price / m ²	
Outside the erosion zone	Little to no sea view	€ 800	
Within 200 metres of the beach	With or without sea view	€ 1250	56%

Table A.4 Average prices of apartment in m² real (Ancora, Katwijk aan Zee)

These price differences between the boulevard and centre are the result of the view of the sea in the erosion zone and only this view. All other criteria are of secondary importance. The replacements costs of the apartments in the centre equal about 65% of the selling price.

The average duration that a homeowner lives in the centre is 7,5 years and for the erosion zone this is around 15 years. This is because most people in the erosion zone don't give up this location gladly.

Ruud Verbeek Makelaars (certified property valuator)

Valuating apartments and houses can be done rather straightforward as there exist useful similarities within this market. The buildings used for the hotel and tourist business in general cannot be valued this easily. For instance the value of a hotel depends largely on the state of the market it is operating in. Therefore the value of the building is of secondary importance and can fluctuate largely per m². Valuation must then be done with the use of profit expectations of the respective business.

Marco Knaap, hotel Duinoord (manager)

A number of general notes can be made on the profit/loss statement of a hotel:

- The ratio of revenue from the rooms and restaurant is normally about 30/70.
- The personnel costs are the largest post on the cost side normally amounting to some 40% of the total cost.
- Advertising costs only attributes to around 5% of total costs as does the food costs at around 6-7%.
- A new hotel building will be depreciated in 6-8 years.
- A 10% profit margin on the total revenue is considered to be average business activity.

The maintenance costs in the erosion zone are roughly double those outside of the zone. The emotional discomfort of damage to the building will amount to around 30-40% of the financial damage, mainly because being out of business brings a lot of emotional stress.

The price of a room within the erosion zone will on average cost approximately 20% more than outside the erosion zone. Rooms with sea view will cost some 25% more, without sea view around 15%.

The amount of stars, or the level of luxury, the hotel offers tremendously influences the potential market of a hotel. Each luxury level is a different market within the local tourist

business. At the moment the 5 star hotel are experiencing difficult times.

The greatest risk for a hotel is loss of image. Continuously delivering good quality service is essential. The weather is less important. A good image lasts longer than a bad summer, and regular guests will not cease to come.

Especially the bungalow parks suffer because of the increasing tourist groups going overseas.

Sake Zitteema bedrijven (sloopwerken)

When the debris of a brick house built on the sand (without major foundation) needs to be removed, the costs will amount to some € 10,- per cubic meter of house.

Research on hotel prices

The following prices for rooms with and without sea view have been obtained from hotels in the erosion zone in Noordwijk aan Zee and Katwijk aan Zee, illustrated in Table A.5:

Hotel	Location	Price per room, no sea view	Price per room, with sea view	Increase	Stars
Huis ter Duin	Noordwijk a/Z	€ 290	€ 310	7%	5
Mercure	Noordwijk a/Z	€ 111	€ 138	24%	4
Hotels van Oranje	Noordwijk a/Z	€ 245	€ 280	14%	5
Beach Hotel	Noordwijk a/Z	€ 200	€ 230	15%	4
Zeezicht	Katwijk a/Z	€ 42	€ 90*	(114%)	3
Noordzee	Katwijk a/Z	€ 90	€ 120	33%	4
			Average increase	19%	

*This room is substantially more luxurious than without sea view, and is not taken into account in the average.

Table A.5 Hotel room prices in investigation areas

Value of assets

From insurance policies it can be concluded that the value of assets in houses, like furniture and electric appliances etc., range from € 30.000 to € 100.000 per household. The exact value is determined with a set of factors like the age of the inhabitants, the income and value of the house. Relating the value of the assets only to the value of the house, the following relation can

be abstracted: value of assets ≈ 0.29 * value house. The assumption has been made that this is also true for hotels.

Possible compensation

Two cases are discussed, in case the government is responsible for compensation, and when the government is not.

From former events or disasters it can be concluded that when the government was not legally responsible, compensation has still been paid out because of special circumstances. These compensations have been between 65 and 90% of the total financial damage. The national disaster foundation (National Rampenfonds) has formerly compensated 90 to 100% of the damage to buildings and 50 to 100% of other assets. Considering the possible damage in the erosion zone it is assumed that, in case compensation is given, 90% of building damage will be compensated, 50% of assets and 50% of business loss. It is of course the question whether a disaster in the erosion zone is considered "special circumstances".

In case the government is responsible, compensation amounts to 100% of all damage.

Appendix 5 Foreign policies

This chapter gives insight into a number of situations around the world that are in some ways similar to the coastal zone problems in The Netherlands. The key aspect that has been looked for when selecting these situations has been the presence of risk of damage to structures because of a natural disaster. It was therefore not a necessity to select situations that are bound to the coastal zone. For instance the problems some communities face in mountain areas regarding avalanches can be very useful. By looking at the policies or solutions that have been developed to deal with these similar problems a greater understanding of the possibilities for the Dutch coastal zone can be obtained.

USA, FEMA

The Federal Emergency Management Agency in the United States of America is an independent federal agency with about 2,500 full-time employees stationed in Washington D.C. and across the country and nearly 4,000 standby disaster assistance employees who are available to help out after disasters. FEMA's mission is to reduce the loss of life and property and protect the nation's critical infrastructure from all types of hazards, through a comprehensive emergency management program of risk reduction, preparedness, response and recovery.

There are a number of areas, which suffer from erosion and flooding disasters. The following states all have flood proofing projects that are part of the National Flood Insurance Program (NFIP) of the FEMA that have been designed to reduce future damage; Massachusetts, North Carolina, South Carolina, Florida, Louisiana, Washington, Michigan, New York, New Jersey, Ohio and Rhode Island. The problems here range from flooding damage due to storms and hurricanes to erosion and structured erosion inflicted damage.

The FEMA has offices all over the United States whose employees work together with state and local officials to determine the risk and necessary precautions to be taken for each potential hazard and area. In an event of disaster it is the FEMA who steps in and takes charge of the rescue or salvation actions.

To solve the problems of flooding- and erosion-damage the NFIP was created by the Congress in 1968. The Program aims to reduce future damage to new and substantially improved structures through prudent floodplain development and to transfer the risk of that development from the taxpayer to the property owner through an insurance structure that protects the financial interest of the property owner while requiring a premium to be paid for that protection. The Federal Emergency Management Agency identifies and maps flood hazards nation wide. Flood Insurance Rate Maps distinguish several flood hazard zones, including the 100-year floodplain, which is defined as an area inundated by a flood that has a one-percent chance of being equaled or exceeded in any year (i.e., the 100-yearflood, also called the Base Flood Elevation). In river areas and tidal

areas subject to waves of less than three feet in height, the 100-year floodplain is referred to as the Special Flood Hazard Area and is designated Zone A. In coastal areas where wave heights equal or exceed three feet, the 100-year floodplain is referred to as the Coastal High Hazard Area and is designated Zone V.

In communities that participate in the program, construction is allowed within the Special Flood Hazard Area if it complies with local floodplain ordinances that meet National Flood Insurance Program requirements. The National Flood Proofing Committee, which is part of the US Army Corps of Engineers, sets these requirements. The fundamental requirement is that any new or substantially improved residential building must have its lowest floor elevated to or above the Base Flood Elevation. A building is considered substantially improved when the cost of any rehabilitation, enlargement of the building, or other improvement, repair or reconstruction after damage, equals or exceeds 50 percent of the pre-improvement/pre-damage value of the building. In A Zones, the lowest residential floor must be elevated either on earthen fill or solid or open foundations to or above the Base Flood Elevation. In V Zones, the lowest horizontal structural member must be elevated to or above the Base Flood Elevation on foundation of piles or columns. The foundation of the NFIP is a quid pro quo: if a community will adopt and enforce ordinances to reduce future flood risks, the federal government will make flood insurance available to property owners in the community. Lending institutions require the purchase of flood insurance for buildings located in the Special Flood Hazard Area as a condition of obtaining a federally sponsored or insured mortgage or home improvement loan. Flood insurance policies are available from private insurance companies under an arrangement with the federal government or directly from the federal government.

At the moment all 30 states bordering the coast and shorelines of the Great Lakes have problems with coastal erosion. In fact, a recent report by the FEMA states that more than 1,500 houses along these coasts will be lost this year and 25 percent of homes and other structures within 500 feet of the shorelines will fall victim to the effects of erosion within the next 60 years.

FEMA does not respond to every disaster that occurs in the U.S. FEMA responds when a disaster overwhelms a state's resources and is requested by a state governor. Federal disaster declarations are made by the President, and allow the federal government to pay for disaster recovery. Disaster assistance comes from a special fund set up by Congress under the Stafford Act. Floods cause more destruction in the U.S. than any other disaster. In 1993, for example, the Midwest Floods hit nine states and the costs of the FEMA disaster assistance were more than \$1 billion.

A pre-statement of FEMA: "The best preparation to flooding is not to be there". Buy-outs of property in high-risk areas by the government are very common. The Government even arranges alternative housing.

Australia, EMA

In Australia the EMA takes the same role as the FEMA in the US. In 1974 the Australian Government decided to start an organisation that would prevent (natural) disasters. At first the Ministry of Defence was responsible for the EMA, but later this was the duty of the Attorney General's Department (Justice and Safety). One of the objectives of the EMA is to increase the communication capacity, and also the awareness and understanding of natural disasters. Management is very decentralized and the local authorities play the major role during any disaster. It is stressed that an effective strategy requires all levels of government and all citizens to participate. Increasing the survival skills of local community (community capacity) is one of the main objectives. The same all hazard approach is used.

Risk reduction

Risk reduction through planning usually involves creating a continuum along which, as risks increase, controls on the use and development of land also increase. This can be achieved in a number of ways, such as:

- Prohibiting development in high-risk areas through zoning and overlay controls;
- Limiting the types of development allowed in high to moderate risk areas – zoning such areas for recreation or other forms of public uses can reduce the potential impacts of hazard events; and
- In moderate and lower risk areas, establishing and applying appropriate development controls based on the assessed risk. These controls can include minimum elevations, setbacks and lot sizes, as well as maximum densities and site coverage. Development control plans should minimize a performance-based approach.

All states and territories have a suite of policies applicable to land use planning – some are advisory and others are statutory. This regulatory context is derived from the legislation, regulations, codes and roles and responsibilities applicable to risk reduction in the planning area.

Legislation

Planning legislation that contains goals for community safety or sustainable development provides a context for risk reduction. Other legislation that may be relevant to planning and risk reduction includes legislation for building, emergency management, local government, environment protection, fire management, flood protection, environmental health, nature conservation and conservation of the built heritage.

Policies

All states and territories have developed policies that impact on planning and natural hazards. They may include fire management, flood management, landslide management, coastal protection, protection of biological diversity, agricultural land protection, wetlands protection, water quality management and management of urban expansion.

Codes of practice

Codes of practice relevant to planning and risk reduction have been adopted at national, state and local level, albeit not comprehensively. The regulatory context provides a framework for development of risk reduction objectives. However, it must be understood that while they are a part of the planning issues, they are not the sole determinant or control factor. Many of the documents deal with risk reduction as part of broader considerations.

Risk mapping

Risk mapping brings together data on hazard exposure, the elements at risk and the context within which land use policies are to be developed. Maps can be produced, to a variety of scales, to indicate the level of risk either from individual hazards or from a range of hazards. Many settled areas of Australia have been mapped for bushfire and flood risk. Geographic Information Systems and other spatial mapping techniques are becoming important tools in this area. Risk mapping provides a spatial overview that indicates hazard distribution by type, intensity and frequency. The risk levels are usually descriptive and are only indicative of actual risk (for example, high, medium and low). They can act as a trigger in identifying sites that require a more detailed analysis of the risks from natural hazards. In Figure A.4 an example of flood risk mapping can be seen.

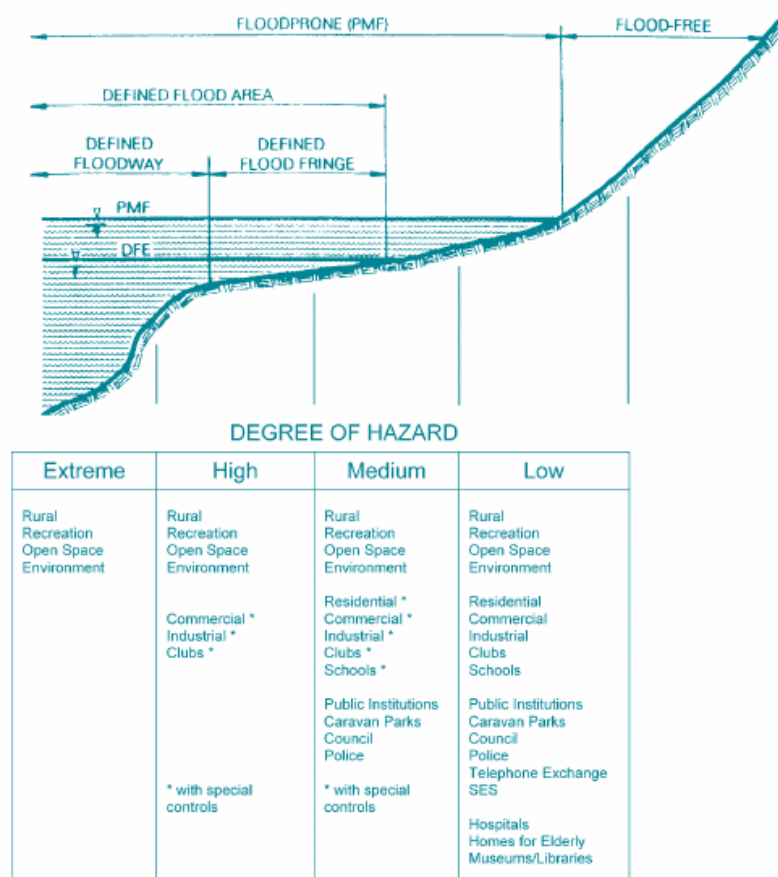


Figure A.4 Example of flood risk mapping (EMA)

The level of acceptable risk has to be established through an informed consultative process. Determining risk acceptability is central to the allocation of resources to risk reduction.

Establishing acceptable risk levels for different localities in the planning area is also necessary for identification of a set of risk reduction objectives and priorities for resource allocation.

Consideration of coastal erosion or recession is also important since it is one of the natural hazards that may increase in frequency and severity due to postulated sea level rise under climate change scenarios.

The information produced through risk evaluation and analysis should be taken forward to the strategic planning stage. It provides valuable input into identifying:

- Future settlement directions;
- Type of land use and regulatory instruments needed to manage development to reduce risk; and
- Areas of existing settlements vulnerable to disasters that may need mitigation measures.

England, MAFF

The land-use planning system regulates development and the use of land in the public interest. It covers issues related principally to the location, layout and appearance of new development. The Government has placed sustainable development at the heart of its vision for flood management and coastal protection.

It is not appropriate to prevent all new developments in the mapped areas of flood risk. In the near future about 10 per cent of England – by land area, population and housing stock – will be located within those areas. In such cases development may be needed to avoid social and economic stagnation or blight.

The Planning Policy Guidance (PPG) Note 25, published in July 2001, provides policy guidance on the consideration of flooding issues at all stages in the land-use planning process. It introduced a risk-based "sequential" test that gives priority to locating development in areas at lower risk of flooding.

However, it recognizes that there is much existing development within the high-risk zone (defined as areas where the annual probability of flooding is greater than 1 per cent and 0.5 per cent in the case of river and coastal flooding, respectively). PPG 25 advises planning authorities, when considering proposed developments in flood risk areas, to take account of the risks involved and to work towards ensuring that an appropriate minimum standard of protection will be in place for the lifetime of the proposed development. It advises that new housing should generally be protected against a flood with an annual probability of 1 per cent and 0.5 per cent for river and coastal flooding respectively.

The construction of more properties in flood risk areas will increase the consequences should a flood occur, and thereby the overall level of flood risk. In order to achieve the aim of reducing, and certainly not adding to, the overall level of flood risk, the Government will seek to ensure that where developments take place in flood risk areas the risk is managed in ways that include:

- Putting in place, and maintaining for the lifetime of the development, protection measures to provide, as a minimum, the standards of protection specified in PPG 25. In deciding whether a higher standard of protection would be appropriate in some cases, the Government expects planning authorities to take account of the consequences should a flood event occur in spite of the protection measures;
- The provision of features, such as sacrificial areas, compartmentalization arrangements, and other appropriate measures that can reduce the consequences of flooding should defenses be breached or over-topped;
- The use of construction techniques that increase the flood-resistance and resilience of buildings. The Government has issued interim guidance on this. By lessening the degree of vulnerability to flooding these techniques and methods can reduce the consequences of flooding events if they occur.

There are two aspects to managing the risk to buildings from floodwater: resistance and resilience. Resistance measures are aimed at keeping water out of

a building or at least minimizing the amount that enters whilst resilience measures are aimed at facilitating the recovery of buildings following a flooding event.

Developers are obliged to follow Building Regulations (governed by the Building Act 1984) when constructing a new building or significantly altering an existing one. Making a building flood resilient will minimize the impact of a flooding event.

Flood resilience measures can cover a range of procedures such as locating electrical sockets at mid level rather than floor level, using treated wood and wall boarding and installing non-return valves in plumbing. The Government is of the view that, in general, individual building owners should be responsible for improving the flood resilience of their buildings.

However, in July 2002 the Government, through The Regulatory Reform Order (Housing Assistance, England & Wales), gave local authorities more flexibility to decide how they would provide home improvement grants, loans, help and advice to the most vulnerable within their areas.

Insurers can and do have a role to play in encouraging building owners to make their buildings more resilient. Many insurance companies are being more flexible and are paying to allow the owner to use more expensive flood resilient products than the basic ones, the owner paying the difference between the two.

Denmark, Kystinspektorat

An obvious difference between the coastal policy in the Netherlands and Denmark is that the policy in the Netherlands is dominated by the need for coastal defence and in Denmark it is dominated by coast preservation. The main objective in Denmark is to have a “free passage to a beautiful natural coast”. The view of urban areas from the waterline is an important criterion. In view of this a protection line has been drawn 300 meters from the waterline. Within this area no building is allowed, but this rule is not applicable to urban areas included in the spatial planning plan. This zone also has the purpose of protection against flooding. Since 1994 a “coastal nearness zone” has been implemented of three kilometres from the waterline, of which the objective is to maintain the natural beauty. Building rules here are less strict than in the 300-meter area. The “coastal nearness zone” must be kept free of activities that have no direct relation to the coast and sea. The provinces by law have some explicit tasks concerning spatial planning. They will have to be active in the future planning and must try stop over-urbanization. The ‘Kystinspektorat’ is the main stakeholder at the coast and is a coastal expert. All advice and sanctions come from this organisation, which results in hardly any illegal activities.

The coast of Denmark is not very similar as in the Netherlands; the areas at the coast in Denmark are much higher in relation to the sea level and the level of urbanisation is much lower, which makes a more ‘relaxed’ policy possible. Nevertheless, the structure in Denmark can have some educational value. The risk of flooding is implemented in the policy in a number of ways. The safeguarding of second houses, or holiday houses, has been a topic of discussion, because the costs for protection are seemingly too high. Citizens and companies that do not follow the guidelines from the government are held responsible for

any damage to their property. They cannot take part in the common insurance programs, for which all Danish contribute. This highly stimulates the awareness of all citizens.

Germany

In Germany several organizations are responsible for the management of situation for and after natural disasters. Water related disasters get the most attention and it is common policy that all levels of government organization have a role in the management. The prevention of disasters is part of the internal affairs policy as well as the environmental, agricultural, spatial planning and housing policies. The responsibilities are very decentralized so that the local authorities have total say over certain areas. The main objective is to achieve synergy between the government, companies, insurers and citizens, to effectively manage disasters.

France, MATE

By law it is the responsibility of the government to inform the public on any danger of disaster and it is the responsibility of citizens to be informed on these. The central government is in charge of all management of which the *Ministère de l'Amenagement du Territoire et de l'Environnement* (MATE) is the main stakeholder. They do not only take all necessary precautions but also manage the lower authorities. An important project is the *Plan de Prévention des risques naturels* (PPR) in which the spatial planning is arranged. When a certain area is considered to be very sensitive to damage, building here can be legally forbidden. The main objectives are; to map all possible risk (see Figure A.5) and develop means to manage these; develop safety plans and educate the public on risk through the regular educational system.

Le risque inondation

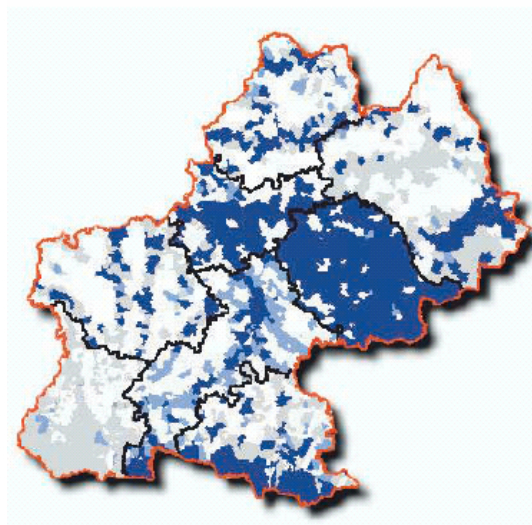


Figure A.5 Inundation risk in France

Switzerland

In 1999 and 2000 Switzerland was victim of a number of disasters. They are busy with a number of projects, ranging from organisational improvements to high-tech solution, to manage any future disasters. Different ministries, of which the ministry of water and geology is the main stakeholder, develop the policies. The *Planat* institute has been set up in which politicians, scientists, economists and insurers investigate risk situations and report or advice the government. This is to stimulate highly integrated solution to any problems. Besides this, there are several specialized investigation groups (like the SLV for snow and avalanche disasters) who participate in developing government policy. The general public has a lot of confidence in these organizations. Reports on past disasters are commonly available to stimulate awareness and to learn of any past mistakes. The government is seemingly confronted with a demand of the public of a risk-free environment. Citizens really expect the government to guarantee safety on all aspects. Responsibility of the citizens does not seem to be a hot item.

Natural hazard prevention firstly consists of an adapted use of space by trying to avoid hazards. Where it is not possible to avoid hazards, structural, technical or biological measures have to be taken, which are supposed to minimize the intensity of the natural process. Prevention basically consists of the following:
Hazard assessment is to determine the magnitude and frequency of processes in affected areas, taking into account already existing protective structures. The result of hazard assessment is represented in a hazard map (see Figure A.6). Experts are supported in their work by process simulations. The results of grounds' assessment and simulations are compared to the records of preceding natural disasters. For this purpose the Federal Government puts a database at the disposal.

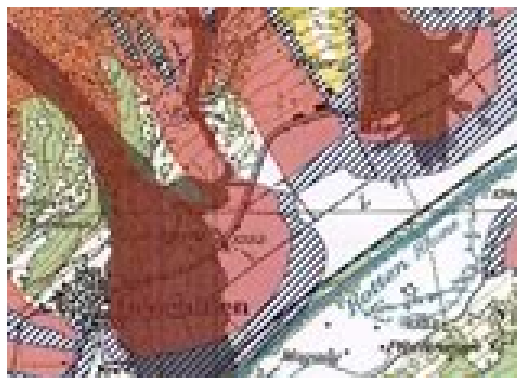


Figure A.6 Hazard map (Planat)

The actors in charge are usually the local authorities or the Canton (Switzerland is divided into Cantons, which are states within the country) and they call for a hazard and risk assessment. Specialized private engineering companies draw the

maps and write the reports. Simulation models usually are being developed during research projects.

Development planners divide the utilizable floor space into different zones according to the danger zone map (see Figure A.7).

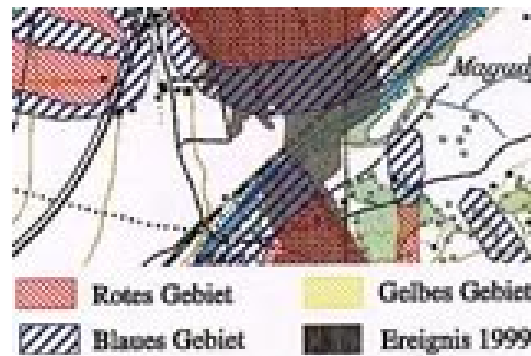


Figure A.7 Zones within the hazard map (Planat)

When determining development planning, protection aims are defined, as well. In red zones (high risk) building is generally prohibited. In blue zones (medium risk) building is allowed, but only with special conditions (e.g. strengthened walls to counteract the pressure of avalanches). In yellow zones (low risk) building is generally possible without any particular condition whatsoever. In these areas, however, natural disasters occur either only very rarely but intensely or have a rather small impact. "Sensitive buildings" with a high concentration of people, as for example schools, should not be built in such zones. It is the same with yellow-white striped zones. These are zones where natural processes might occur but only with a very small likelihood. Development planning measures are usually laid down by statutory regulations and ordinances of authorities, but changes in zones and utilization plans must be approved by communal plebiscite. Specialised offices deliver the required data for these procedures. Structural conditions are partly imposed by building insurers of which Swiss Re and Kantonale are the larger insurance companies.

Appendix 6 Alternative methods to strengthen the dunes

A policy that forbids building in the coastal zone is not a very realistic one. ‘Soft’ defence structure options are possibly a far better option. By using more innovative solutions locally it is possible to reduce risk and cost to more acceptable levels:

-BioCement-stabilization of beaches and dunes; by injecting BioCement in the beaches and dunes it is possible to enforce this part of the coastal defense and reduce any possible erosion. The process that is used here to harden the soil is that of the formation of lime in the soil in a natural way. Figure A.8 shows the preferred location of the BioCement. This will mostly occur where the sand particles are touching each other. The strength of this solution depends on the number of treatments that are undertaken, where the resistance of the soil increases after each treatment. This method, originating from Australia, is now being developed for cases in The Netherlands. The natural chemicals used are allowed by the Dutch laws on building materials and in the near future it can be assessed what the influence is of the different soil types and the durability. The costs of this method have so far been estimated to be €50, - per m³. This is a lot considering the price of beach nourishments and it is therefore not suitable to apply on the total Dutch coastline. It can however be very helpful solving local problems like the stabilisation of a seaward part of the dunes. In case of disaster this part will then act as a barrier. Treating the soil under buildings and roads can also stabilise these parts considerably which will result in a decrease of damage during erosion. Important aspects to investigate here are the amounts and heights of sand that will need to be treated.

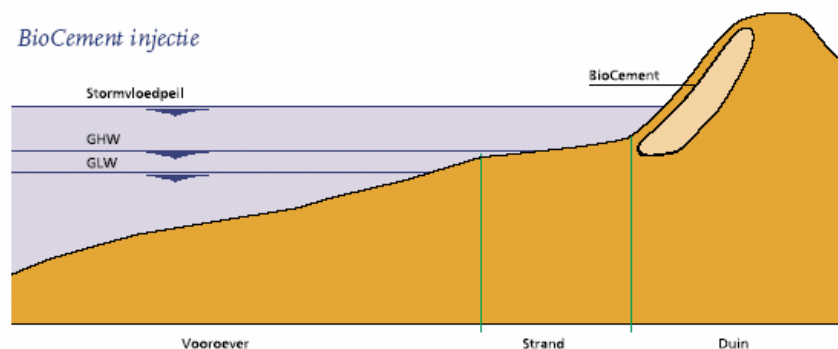


Figure A.8 Biocement injection

-Large sandbags; these sandbags are placed at the foot of the dunes or when possible within the core of the dunes, similar to the BioCement. This is possible when enough space is available between the buildings and the edge of the dunes to position these (or when the front dunes are excavated for other construction works). Both the cost of the sandbags together with the flexibility, of the actual form and ways to place these, make it an attractive alternative. This solution has

been used at locations around the world with much success. In the Netherlands studies have also shown this method to be very effective.

The following methods are given by the FEMA:

Elevation:

Elevating a structure so that floodwaters are less likely to cause damage is an effective permanent flood-proofing technique when erosion is not a concern. Elevating to the Base (or 100-year) Flood Elevation (BFE), as required by the NFIP substantial improvement and damage regulations, can significantly reduce or prevent damages when floods do occur (see figure A.9).

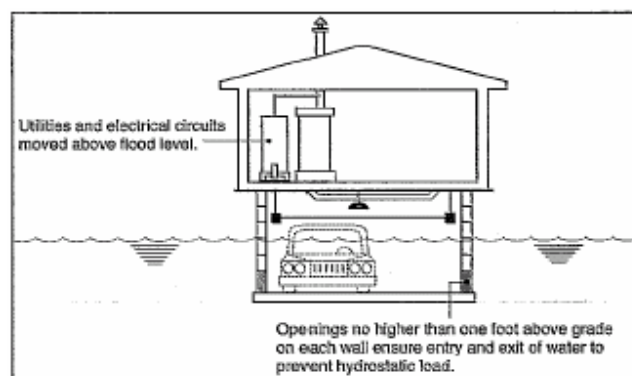


Figure A.9 Elevation of house

Elevation on Piles:

Due to velocity flow, wave impacts, and soil types, elevation on deeply embedded piles is the primary technique used in Coastal High Hazard Areas subject to episodic storm-induced erosion. Shorelines that are relatively stable or retreating very slowly over time may still be subject to large horizontal and vertical variations during storms.

Elevation on Piers:

Piers are vertical structural members that are supported entirely by concrete footings. While they may be the most commonly used type of open foundation in areas subject to flooding from rivers and coastal plains not subject to wave action or high velocity flow, they are the least suited for withstanding flood forces in Coastal High Hazard Areas. In conventional use, piers are designed primarily for vertical loading. When located in Coastal High Hazard Areas, however, they will also experience hydrodynamic forces for which they are not suitable.

Elevation on Posts:

Elevation on posts has limited applicability in Coastal High Hazard Areas because these areas may be affected by scour or erosion. This technique is used in coastal areas where the underlying ground is bedrock or coral to which the column can be structurally tied and building loads transferred, or in areas where conditions make it appropriate to simulate the effect of bedrock or coral by

pouring enough concrete in the post hole to transfer the load to the surrounding soil.

Elevation on Solid Foundation Walls:

Elevation on extended solid foundation walls is normally used in areas of low to moderate water depth and velocity. The most important concern is that the original foundation and footing be able to withstand the extra loading, not only from the additional vertical dead load of the new wall, but also from the additional flood and wind forces associated with coastal storms.

Relocation:

A flood-proofing alternative to elevation that is also common in coastal areas is relocation of the building beyond the reach of erosion and either the limits of the floodplain or the level of the BFE at the new location. The building may be moved to either another location less threatened by flooding and erosion on the existing property or to a new site.

Demolition:

In some cases, demolition of the structure may be a reasonable course. The Upton-Jones amendment provides up to ten percent of the value of eligible insured homes to defray demolition costs, in addition to paying for the value of the structure itself (subject to policy limits).

Other Methods:

Contractors experienced in flood proofing have developed interesting technologies to accomplish elevation projects. For example, a method of angular pile driving may eliminate the need to temporarily relocate a structure to be elevated during pile placement. In another case, a contractor has used inflatable bags to lift structures being elevated in areas where site conditions restrict the placement of lifting beams under the home.