# Coastal landscape and the hedonic price of accommodation

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**Abstract:**
The impact of climate change on tourism has been examined in terms of changes in a destinations climate; the impact of ancillary effects such as sea-level rise has been neglected. In this study the role that coastal and other landscape features have on the attractiveness of tourist destinations is examined using the hedonic price technique. The average price of accommodation in the coastal districts of Schleswig-Holstein is explained using landscape and other characteristics of these districts. As the western coastline of Schleswig-Holstein is protected by dikes, adaptation measures as well as natural coastal features are represented in the data set. The analysis shows that an increase in the length of dikes in a given district would result in a reduction in the average price of accommodation. An increase in the length of open coast results in an increase in the average price of accommodation. The impact of sea-level rise is examined through an assessment of the financial losses in the accommodation sector through the modification of the coastline caused by the construction of different coastal protection measures. It was found that, purely in terms of accommodation revenues, beach nourishment rather than dike construction is the more beneficial adaptation measure.

**Keywords:** accommodation price, hedonic price technique, coastal landscape, climate change, adaptation

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# 1 Introduction

Studies on the impact of climate change on tourism focus on the relationship between climate and demand. Ancillary effects, however, like sea-level rise, will also have an impact on demand. Sea-level rise will result in the loss of low-lying islands, the loss of low-lying land at the coast and the erosion of beaches and cliffs. Nevertheless, there is a range of adaptation measures that can minimize these problems. In some cases, these measures will also change the appearance of the coast. To calculate the cost of the impact of climate change on tourism information is needed on the relationship between coastal morphology and tourism demand. The importance of the coast for tourism can be seen in works of cultural history (Corbin, 1999), in qualitative studies (for example Mieczokowski, 1990) and in quantitative studies (Hamilton et al., 2005; Lise and Tol, 2002; Maddison 2001). In the quantitative studies, different types of coastal landscape or morphology are not distinguished. This is the first study to link accommodation price with coastal and other landscape attributes.

The state of Schleswig-Holstein in Northern Germany has been chosen as the study area. Schleswig-Holstein has two quite different coastlines: first, to the west there is the North Sea coast and second, to the east there is the Baltic Sea coast. In addition, there is the coastline of the river Elbe, which is heavily influenced by the North Sea. Tourism promotion in Schleswig-Holstein is organised at the level of the *Gemeinde* or district. These are small administration units at the level of LAU[1] The coastal districts included in this study have an average area of 21 $km^2$, and the maximum area is 67 $km^2$. The smallness of the districts allows a high-resolution study of tourism in the region.

To examine the effect that landscape and in particular seascape have on tourism demand the hedonic price method is used. The hedonic hypothesis is that goods are valued for their utility bringing characteristics, and that this is reflected in the willingness to pay for these characteristics and hence in the price. In tourism research, this method is not frequently used.

[1] LAU2 is the lowest of the administrative classes of the NUTS classification system of the EU.

Fleischer and Tchetchik (2005), however, apply this method to the price of rural tourist accommodation in Israel. They focus on whether tourists value that their accommodation is located on a working farm. In this study the focus is on whether tourists value their accommodation being located in a district with certain coastal characteristics and if so by how much.

In the second section, the study area is described. The hedonic method is introduced in the third section. The data used in this study and the model specifications are described in the fourth section. The fifth section presents the results of the regression analysis. The implications of these are discussed in the sixth section, and the seventh section concludes.

## 2 Study area

Schleswig-Holstein is the most northerly state in Germany, bordering Denmark in the North, and its southern border is defined by the river Elbe and the City State of Hamburg. The eastern border is shared with the state of Mecklenburg-Western Pomerania.

The coastal zone of Schleswig-Holstein consists of three coastlines: at the North Sea, at the Baltic Sea and along the River Elbe. The North Sea and Baltic Sea coast are quite different from their coastal morphology. The North Sea coast was formed by post-glacial floods. This resulted in low lying marshland, which may even be below sea level. The sandy moorland, *Geest*, is higher than the coastal marshland. Overall, the North Sea coast is flat, although the barrier islands of Sylt, Amrum and Föhr have moranic hills, cliffs and dunes (Kelletat, 1993). These barrier islands as well as the marsh islands that were formerly part of the mainland lie in the Schleswig-Holstein section of the Wadden Sea. The Wadden Sea is a large area of tidal flats, tidal gullies, salt marshes and sandy barriers stretching from Denmark along the North Sea coast of Germany to the Netherlands (Hofstede, 2003). The North Sea is salty with a salinity of 25%-30% (Reese, 2003). The Baltic Sea coast was formed by glaciers resulting in semi-enclosed inlets and fjords. There are also some stretches of coastline with cliffs. The land surrounding the coast is slightly hilly. Compared to the North Sea the Baltic Sea is much less salty. It has a salinity of 10% to 15% (Reese, 2003).

The main problem at the coast is the effect of storm floods. Around 24% of Schleswig-Holstein lies in the flood prone area, which is below 5m in the west and 3m in the east (Hofstede and Hammann, 2000). At the North Sea coast, these areas contain the main areas of

high population and of high economic value, which has resulted in the coastline being protected with dikes. Hard structures such as dikes are not the only protection measures used: beach nourishment is also carried out on the barrier islands of Föhr and Sylt. This not only stabilises the coastline of the islands but also provides protection for the mainland as well as sandy beaches for recreation. The Baltic Sea coast has fewer stretches of dikes because of its natural protection system of beach walls and spits.

Climate change will result in sea-level rise and increased storminess. This will mean that existing dikes will have to be strengthened and raised. Currently Schleswig-Holstein spends 24 million Euros per year on keeping present safety levels. Under a scenario of 25cm sea-level rise by 2050, it is expected that the cost will rise by 5% to 15%. For the worst-case scenario of 50cm sea-level rise by 2050, the costs are estimated at 42 million Euros per year (CPSL, 2001). Furthermore, sea-level rise will increase the volume of sand required for beach nourishment.

3.1 million tourists spent their holiday at the coast and on the islands of Schleswig-Holstein in 2003. 10% of these tourists were from abroad. As a destination for German tourists, Schleswig-Holstein has a market share equivalent to that of France or Greece (NIT, 2001). In terms of its market share of tourism within Germany, Schleswig Holstein has a market share of approximately 4%. Tourism is important economically for the state: 7% of all jobs are in the tourism sector and 4.6% of the state income comes from tourism.

## 3 The hedonic price method

The hedonic price method, developed theoretically by Rosen (1974), is based on the idea that any differentiated product can be seen as a bundle of characteristics. The value that consumers attach to the characteristics will be reflected in the price of the differentiated product. The price of an individual characteristic is called the implicit or shadow price.

Hedonic price analysis is widely used for different goods such as cars (Irandoust, 1998), computer equipment (Doms and Forman, 2005) and agricultural products (Langyintuo *et al.*, 2004). The method has been extensively used for housing and in particular the valuation of environmental amenities. Moreover, it has been used to examine the impact of climate change on the price of housing in Italy (Maddison and Bigano, 2003), the UK (Rehdanz, 2002) and Germany (Rehdanz and Maddison, 2004). In tourism research, it has been applied to package

tours (Clewer *et al.*, 1992; Sinclair *et al.*, 1990). Fleischer and Tchetchik (2005) have applied the technique to estimate the value to tourists of rural accommodation being located on a working farm. They find that an outstanding view from the tourist accommodation is positively related to price. Tourists are indifferent to the accommodation being located on a working farm.

Following Fleischer and Tchetchik's (2005) hedonic price framework for rural accommodation, $P_i$ represents the minimum price per person per night for a particular district and accommodation type. $X_i$ is the matrix of attributes of the districts and the accommodation types. The hedonic price equation is:

Equation 1: $$P_i = f(X_i)$$

The effect of an incremental increase in the *k*th attribute on price, that is the implicit price, is the partial derivative of Equation 1:

Equation 2: $$\partial P_i / \partial X_{ik} = \partial f(X_i) / \partial X_{ik}$$

# 4 Data and model specification

## 4.1 Data

The accommodation price data used in the analysis is taken from the tourist brochures of the coastal districts. These brochures, as well as containing the marketing and promotional information about the district, list all of the businesses providing accommodation with details on the number of beds, price per room or per unit and the facilities of each accommodation unit. From the 146 coastal districts, it was possible to calculate price data for 92 districts, which is more than is available from the official statistics.[2] The tourism marketing strategy of Schleswig-Holstein divides the state in to four regions: the North Sea coast, the Baltic Sea coast, inland and cities and large towns. As cities and large towns are marketed separately, such districts were not included in the analysis.[3] Furthermore, city or urban tourism is quite different from the rural coastal tourism under examination here.

[2] Official statistics only include business with more than nine beds, which leads to the exclusion of certain districts from the statistics. Data on accommodation prices is collected but not published.

[3] This applied to the cities and towns of Kiel, Lübeck and Flensburg and to the districts Harrislee and Wedel, which are so close to cities that they have a suburb function.

The accommodation listings provide information on up to seven different types of accommodation: hotel, hotel garni, guesthouse, bed and breakfast, rooms in private accommodation, holiday homes and flats. Holiday homes and flats, which make up half of all the available accommodation, show a great range in price dependent on the size of the unit and the quality of the features. For this reason, the price data set was constructed only for the categories hotel (including hotel garni), B&B (including guesthouse) and private rooms.

For each establishment the minimum price per person per night and the number of rooms was recorded. It was not possible to calculate separate prices for the different seasons as many establishments and individual districts have their own "seasons" that deviate from the typical high and low seasons. From the listed establishment price and capacity data the district average minimum price per person per night was calculated for the three groups of accommodation. The accommodation listings are from the years 2001 to 2005. The year 2002 was taken as the base year. The prices for the other years were adjusted to 2002 prices using the German consumer price index for accommodation and hospitality services (Statistiches Bundesamt, 2005). If there was no average price for 2002 then the price for 2003 was used and so on until 2005. If there was not a price available for 2005 then the data for 2001 was used. In this case, the prices were converted from DM into Euro. The resulting dataset covers 92 coastal districts and has 189 observations. Note that as there are three types of accommodation each district may be represented by more than one observation. The 48 districts that are not covered in the data set may have specialised in self-catering accommodation or tourism might not have developed there at all.[4]

In addition to the price data, data on landscape features of each district were collected. First, for each district the area in hectares of sandy beach that extend beyond the main coastline was measured using the 1:50000 topographical map from the TOP50 CD-Rom (Landesvermessungsamt Schleswig-Holstein, 2005). Second, using maps showing coastal protection structures and coastal morphology from the Ministry of Coastal Protection (Ministerium für ländliche Räume, Landesplanung, Landwirtschaft und Tourismus des Landes Schleswig-Holstein, 2001) the length of dikes, cliffs and open coast in each district were measured using MAPINFO. The area in hectares of water surface, heathland, moorland

[4] In comparison, the official statistics report tourism data (but not price data) for 86 coastal districts, which means that for 54 districts data are not available.

and agricultural land were taken from the land use dataset of the state statistical office (Statistisches Landesamt Schleswig-Holstein, 1999).

In some demand studies (Lise and Tol, 2002; Maddison, 2001) population and population density were included in the model specifications. For this dataset, it is not possible to include population and population density as they are highly correlated, that is, population density is rather homogenous in Schleswig-Holstein. Instead of using both, only population will be included as a variable (POP). This is used as a proxy for the number of man-made attractions or for the amount of infrastructure in each district. The source of the population data is the state statistical office (Statistisches Landesamt Schleswig-Holstein, 2001).

Climate variables have been omitted, as the climate is largely homogenous over the small area of Schleswig-Holstein.

Three regions are included in the dataset: the districts at the North Sea coast, the districts at the Baltic coast and those at the Elbe.[5] The North Sea districts border on the Wadden Sea National Park. The flora and fauna of this unique area, as well as the national park's facilities for education are an attraction for tourists that can only be found at the North Sea. In addition, the water at the North Sea is generally cooler than at the Baltic, and the waves tend to be higher. To control for these effects a dummy variable, NORTH, has been created for the districts at the North Sea coast. It is also possible, however, that this variable also picks up a preference for the North Sea coast that has nothing to do with the coastal landscape, such as the popularity of the distinctive Frisian culture.

Table 1 presents the variables used in this analysis, and table 2 presents the summary statistics of these variables.

[5] The districts at the river Elbe belong to the marketing category "Inland". In this analysis, however, they have been included as part of the coast, as the Elbe is strongly influenced by the tidal regime of the North Sea and the districts are part of the coastal defence programme.

| Variable | Definition |
|---|---|
| MINP | The average minimum price for an accomodation category |
| HOTEL | Is unity if the price is for the hotel category, otherwise 0 |
| BANDB | Is unity if the price is for the B&B category, otherwise 0 |
| NORTH | Is unity if the district lies at the North Sea coast, otherwise 0 |
| BEACH | Area of beach in hectares |
| OPENTOT | Length of open coast in kilometres |
| CLIFFTOT | Length of cliffs in kilometres |
| DIKETOT | Length of open coast in kilometres |
| OPENSH | Percentage of total coastline that is classified as open |
| CLIFFSH | Percentage of total coastline that is classified as cliffs |
| DIKESH | Percentage of total coastline that is classified as dikes |
| WATER | Area of water bodies in hectares in 1997 |
| HEATH | Area of heathland in hectares in 1997 |
| MOOR | Area of moorland in hectares in 1997 |
| AGRIC | Area of agricultural land in hectares in 1997 |
| POP | Number of people resident in each district in 2000 |

Table 1: Definition of the variables

| Variable | Mean | Std. Dev. | Minimum | Maximum |
|---|---|---|---|---|
| MINP | 25.41 | 11.57 | 10.36 | 80.68 |
| HOTEL | 0.30 | 0.46 | 0 | 1.00 |
| BANDB | 0.33 | 0.47 | 0 | 1.00 |
| NORTH | 0.50 | 0.50 | 0 | 1.00 |
| BEACH | 64.76 | 152.56 | 0 | 900.40 |
| OPENTOT | 4.17 | 5.47 | 0 | 25.94 |
| CLIFFTOT | 0.79 | 2.14 | 0 | 13.00 |
| DIKETOT | 4.88 | 6.42 | 0 | 29.81 |
| OPENSH | 38.09 | 37.71 | 0 | 100.00 |
| CLIFFSH | 9.33 | 19.94 | 0 | 89.74 |
| DIKESH | 52.58 | 100.42 | 0 | 100.00 |
| WATER | 204.78 | 380.33 | 0 | 2156.00 |
| HEATH | 6.80 | 23.54 | 0 | 132.00 |
| MOOR | 0.61 | 2.78 | 0 | 23.00 |
| AGRIC | 1394.39 | 1357.47 | 16 | 5317.00 |
| POP | 3546.49 | 4666.70 | 26 | 23304.00 |

Table 2: Summary statistics of the variables

### 4.2 Specifications

Three different ways of representing coastal features and two different ways of representing the landscape are examined in six specifications. In the first two coastal specifications, the coastal features, length of open coast, length of cliffs and length of dikes in each district are expressed as a percentage of the total coastal length of the district. Specification C1 contains the variables OPENSH and CLIFFSH, which represent the natural features of the coast. Specification C2 contains the variable DIKESH representing the man-made structures at the

coast. The third specification C3 contains all of the coastal variables expressed as absolute values (OPENTOT, CLIFFTOT and DIKETOT).

The landscape of the districts can be described in different ways. There are many possible variables, but because of multi-colinearity only some could be included in the final specifications. The first landscape specification L1 uses land use data on the area of water surfaces (WATER), the area of heathland (HEATH) and moorland (MOOR) in each district. In the second landscape specification L2, these three variables are replaced with the area in each district used for agriculture (AGRIC).

Combining the coastal and the landscape specifications gives six different specifications. Each of these contains the dummy variables HOTEL, BANDB and NORTH and the continuous variables BEACH and POP. (See Table 1 for the definitions of the variables and table 2 for the summary statistics.)

### 4.3 Functional form and implicit prices

There is no theoretical guidance on the best functional form. Using the specifications described above the linear, log linear and inverse functional forms were tested. The log-linear functional form performs the best, and so only the results of this functional form will be presented here. The price equation is now written as:

Equation 3: $$\ln P_i = \beta X_i + \varepsilon_i$$

Equation 4: $$P_i = e^{\left(\beta X_i + \varepsilon_i\right)}$$

Hence, the effect of an incremental increase is:

Equation 5: $$\partial P_i / \partial X_{ik} = e^{\left(\beta X_i + \varepsilon_i\right)} \cdot \beta_k$$

Substituting equation 4 into equation 5 means that the implicit price is the real price multiplied by the coefficient of the variable that has increased.

# 5 Results

## 5.1 Results of the regression analysis

The model specifications were estimated using panel corrected least squares (Williams, 2000). Each of the specifications has 189 observations allocated to 92 clusters. Table 3 shows the results for the combinations of C1 to C3 with the landscape specification L1. $R^2$ ranges from 0.68 to 0.70; coastal specification C3 has the highest $R^2$. Table 4 shows the results for the coastal combinations C1 and C2 with the landscape specification L2.[6] The landscape specification L2 has $R^2$ values of 0.66 and 0.65 for the specifications C1 and C2 respectively; these are slightly lower than for the combination with the landscape specification L1. Each of the specifications passes the Ramsay RESET test for correct functional form (the p-values range from 0.09 to 0.38).

The results for the variables describing the type of accommodation are highly significant and positively related to price. As can be expected the coefficient on the dummy HOTEL is much higher than that of BANDB; hotels are a much greater leap in quality than bed and breakfast establishments are from rooms in private accommodation. Hence, a greater price difference can be expected. The coefficient on HOTEL is significant at the 0.5% level for all specifications. The coefficient on the variable BANDB for the specification combinations L1 is significant at the 0.5% level, and for the combinations with L2 it is significant at the 1% level.

For the variable NORTH there is a positive relationship with price. This is significant at the 5% level in the specifications L1 and at the 1% level in the specifications L2. The various coastal specifications do not affect the significance. Here there is evidence that there is something attractive about the North Sea coast districts over and above the seascape and landscape elements included in the statistical models. The reasons for this advantage of the North Sea coast cannot be examined here and will be left for further research; it may be the waves, the salt, the Frisians, or accessibility.

[6] The combination C3–L2 has not been estimated because of the high correlation between AGRIC and TOTDIKE.

| Dependent varaible LN(MINP) | | | |
|---|---|---|---|
| | C1-L1 | C2-L1 | C3-L1 |
| HOTEL | 7.21E-01 *** | 7.20E-01 *** | 7.34E-01 *** |
| | 4.24E-02 | 4.23E-02 | 4.30E-02 |
| BANDB | 3.30E-01 *** | 3.27E-01 *** | 3.39E-01 *** |
| | 3.50E-02 | 3.50E-02 | 3.52E-02 |
| NORTH | 9.32E-02 * | 1.08E-01 * | 1.03E-01 * |
| | 4.56E-02 | 4.72E-02 | 4.11E-02 |
| BEACH | 1.26E-04 | 1.34E-04 | 1.57E-04 |
| | 1.00E-04 | 1.07E-04 | 8.37E-05 |
| OPENSH | 1.33E-01 * | | |
| | 6.04E-02 | | |
| CLIFFSH | 7.52E-03 | | |
| | 1.05E-01 | | |
| DIKESH | | -1.08E-01 | |
| | | 5.48E-02 | |
| OPENTOT | | | 8.50E-03 * |
| | | | 3.70E-03 |
| CLIFFTOT | | | -6.72E-03 |
| | | | 5.98E-03 |
| DIKETOT | | | -7.69E-03 ** |
| | | | 2.54E-03 |
| WATER | 1.05E-04 * | 9.78E-05 ** | 1.27E-04 ** |
| | 4.30E-05 | 3.87E-05 | 4.05E-05 |
| HEATH | 2.63E-03 * | 2.80E-03 ** | 2.60E-03 ** |
| | 9.97E-04 | 9.69E-04 | 9.02E-04 |
| MOOR | -1.39E-02 | -1.42E-02 | -1.23E-02 |
| | 7.06E-03 | 7.73E-03 | 7.26E-03 |
| POP | 3.61E-06 | 5.03E-06 | 2.87E-06 |
| | 3.59E-06 | 3.25E-06 | 3.44E-06 |
| Constant | 2.68E+00 *** | 2.77E+00 *** | 2.72E+00 *** |
| | 4.53E-02 | 4.30E-02 | 3.91E-02 |
| N | 189 | 189 | 189 |
| $R^2$ | 0.6849 | 0.6825 | 0.6967 |

* Significant at the 5% level
** Significant at the 1% level
*** Significant at the 0.5% level

Table 3: Results for the first landscape specification

The coefficient on the variable BEACH is not significant in any of the specifications. This is also the case for the variable POP. The population of each district had been included as a proxy for service infrastructure and man-made attractions. In this study, population has no influence on price.

Moving on to the coastal variables, the coefficient on OPENSH, in the first coastal specification C1, is positive and significant at the 5% level and at the 1% level in combination with L1 and

L2 respectively. Therefore, districts with a greater share of their coastline of the type open or flat coast will have higher prices for their accommodation. The coefficient on the variable CLIFFSH is not significant in either of the landscape specifications; therefore, the share of the coastline with cliffs plays no role in the determination of price.

| Dependent variable LN(MINP) | | |
|---|---|---|
| | C1-L2 | C2-L2 |
| HOTEL | 7.30E-01 *** | 7.29E-01 *** |
| | 4.35E-02 | 4.37E-02 |
| PENSION | 3.38E-01 *** | 3.37E-01 *** |
| | 3.54E-02 | 3.56E-02 |
| NORTH | 1.16E-01 ** | 1.31E-01 ** |
| | 4.37E-02 | 4.48E-02 |
| BEACH | 1.55E-04 | 1.65E-04 |
| | 9.50E-05 | 9.97E-05 |
| OPENSH | 1.51E-03 ** | |
| | 5.39E-04 | |
| CLIFFSH | 3.42E-02 | |
| | 1.15E-03 | |
| DIKESH | | -1.31E-03 * |
| | | 5.16E-04 |
| AGRIC | -3.12E-05 * | -3.42E-05 ** |
| | 1.21E-05 | 1.17E-05 |
| POP | 4.75E-06 | 5.81E-06 |
| | 3.65E-06 | 3.49E-06 |
| Constant | 2.72E+00 *** | 2.84E+00 *** |
| | 4.99E-02 | 4.15E-02 |
| N | 189 | 189 |
| $R^2$ | 0.66 | 0.65 |

* Significant at the 5% level
** Significant at the 1% level
*** Significant at the 0.5% level

Table 4: Results for the second landscape specification

In the second coastal specification, C2, the variable DIKESH, the share of the coastline with dikes, is the only variable. In both landscape combinations, the coefficient is negative. In the L1 combination, it is only significant at the 10% level. For the L2 combination, however, it is significant at the 5% level. In contrast to the existence of open coast, the existence of dikes has a negative effect on price.

The third coastal specification includes all of the coastal types as absolute values. The coefficient on OPENTOT is positive and significant at the 5% level. As was the case for the relative representations of the coastal variables, CLIFFTOT is not significant. DIKETOT is negative and significant at the 1% level. So not only does the length of the coastal type

relative to the total coastal length have an effect on price, but so does the absolute length of the coastal type. The results for this specification emphasis the positive effect that coastlines that are free from hard coastal protection measures such as dikes have on price.

For the first landscape specification, there are very similar results across the coastal specifications. The coefficient of the variable WATER is positive and significant. For specification C1-L1 it is significant at the 5% level. For the other two specifications, C2-L1 and C3-L1 water is significant at the 1% level. Therefore, the more water features such as lakes and rivers in a district the higher the price of accommodation will be. In addition, heathland in a district has a positive effect on price: the coefficient on HEATH is positive and significant at the 5%, 1% and 1% level for C1-L1, C2-L1 and C3-L1 respectively. MOOR is not significant in any of the specifications.

The second landscape specification has only one landscape variable AGRIC, which is negative in all of the specifications and significant at least at the 5% level. The size of the coefficients and their standard errors are similar for the specifications C1 and C2.

### 5.2 Hedonic prices of coastal and other landscape features

To recap on section 4.3, the hedonic price of a characteristic is calculated by multiplying the coefficient by the price of the accommodation type in each district. The hedonic prices for the significant variables for the landscape specifications L1 are shown in table 5. The hedonic prices are calculated using the average, the minimum and the maximum price of all the districts for one night in private accommodation. Table 6 shows the results for the specifications L2. As mentioned above it can be expected that hotel accommodation is valued higher than B&B accommodation. Here, the hedonic price for hotel accommodation is double that of B&B for all of the specifications. Dike share and absolute dike length have negative hedonic prices; that is, they are a disamenity. On the other hand, the share of open coast and the absolute length of open coast are amenities. Agricultural land use has a small but negative hedonic price.

| Variable | C1-L1 | | | C2-L1 | | | C3-L1 | | |
|---|---|---|---|---|---|---|---|---|---|
| | minimum | average | maximum | minimum | average | maximum | minimum | average | maximum |
| HOTEL | 7.47 € | 12.34 € | 17.75 € | 7.46 € | 12.32 € | 17.72 € | 7.60 € | 12.56 € | 18.05 € |
| BANDB | 3.41 € | 5.64 € | 8.11 € | 3.39 € | 5.60 € | 8.06 € | 3.51 € | 5.80 € | 8.33 € |
| NORTH | - | 1.59 € | 2.29 € | - | 1.85 € | 2.66 € | - | 1.77 € | 2.54 € |
| OPENSH | 0.01 € | 0.02 € | 0.03 € | - | - | - | - | - | - |
| DIKESH | - | - | - | -0.01 € | -0.02 € | -0.03 € | - | - | - |
| OPENTOT | - | - | - | - | - | - | 0.09 € | 0.15 € | 0.21 € |
| DIKETOT | - | - | - | - | - | - | -0.08 € | -0.13 € | -0.19 € |
| WATER | 0.001 € | 0.002 € | 0.003 € | 0.001 € | 0.002 € | 0.002 € | 0.001 € | 0.002 € | 0.003 € |
| HEATH | 0.03 € | 0.05 € | 0.06 € | 0.03 € | 0.05 € | 0.06 € | 0.03 € | 0.05 € | 0.06 € |

Table 5: Hedonic prices (€) of the accommodation and district characteristics for the first landscape specification

| Variable | C1-L2 | | | C2-L2 | | |
|---|---|---|---|---|---|---|
| | minimum | average | maximum | minimum | average | maximum |
| HOTEL | 7.56 € | 12.48 € | 17.95 € | 7.56 € | 12.48 € | 17.94 € |
| BANDB | 3.51 € | 5.79 € | 8.32 € | 3.49 € | 5.77 € | 8.29 € |
| NORTH | - | 1.98 € | 2.85 € | - | 2.25 € | 3.23 € |
| OPENSH | 0.02 € | 0.03 € | 0.04 € | - | - | - |
| DIKESH | - | - | - | -0.01 € | -0.02 € | -0.03 € |
| AGRIC | 0.000 € | -0.001 € | -0.001 € | 0.000 € | -0.001 € | -0.001 € |

Table 6: Hedonic prices (€) of the accommodation and district characteristics for the second landscape specification

## 6 Discussion

The results described above show that the type of coastal landscape has an effect on the price of accommodation. Sea-level rise will have an impact on the coastal landscape, whether through erosion or land loss. Flooding of low-lying areas is a particular problem in Schleswig-Holstein, which will be exacerbated with sea-level rise and an increase in storminess. Sterr (2000) reckons that with a 1m increase in sea level there will be an increase in the probability of flooding by up to 1/10 at both the North Sea and the Baltic Sea coast. Adaptation measures to cope with the increased probability of flooding include increasing the height of existing dikes or in some cases the construction of new dikes.

The district of Westerland, which is situated on the island of Sylt at the North Sea and the district of Timmendorfer Strand at the Baltic Sea are important tourism districts. Furthermore, they are located in low-lying areas of the coast of Schleswig-Holstein. Table 7 shows the hedonic prices of the four coastal variables for each of the accommodation types. The

coefficients are taken from the results of the model specifications L1. The minimum average price for each accommodation category is taken from the price database.

| District | Accomodation type | Price | 1km increase in: | | 1 percentage point increase in: | |
|---|---|---|---|---|---|---|
| | | | OPENTOT | DIKETOT | OPENSH | DIKESH |
| Westerland | Hotel | 67.26 € | 0.57 € | -0.52 € | 0.09 € | -0.07 € |
| (North Sea coast) | B&B | 27.59 € | 0.23 € | -0.21 € | 0.04 € | -0.03 € |
| | Private accomm. | 22.36 € | 0.19 € | -0.17 € | 0.03 € | -0.02 € |
| Timmendorfer Strand | Hotel | 50.50 € | 0.43 € | -0.39 € | 0.07 € | -0.05 € |
| (Baltic Sea coast) | B&B | 22.34 € | 0.19 € | -0.17 € | 0.03 € | -0.02 € |
| | Private accomm. | 18.41 € | 0.16 € | -0.14 € | 0.02 € | -0.02 € |

Table 7: Hedonic prices (€) of the characteristics for the coastal characteristics for the three accomodation types in the districts of Westerland and Timmendorfer Strand

The hedonic prices can be used to calculate the potential loss of revenue from accommodation, if a dike were to be built on 1 km of open coast. Data on the number of nights[7] spent by tourists in 2004 in each accommodation type is multiplied by the hedonic price for each variable. For the specification C3-L1 the loss from the conversion of 1km of open coast to 1km dike is calculated by adding the cost of a 1km reduction in open coast to the cost of a 1 km increase in dike length. The results are shown in table 8. For Westerland this change in the coastal landscape results in a loss of revenue of € 825,979 per year. A loss of € 410,252 is estimated for Timmendorfer Strand. Table 9 shows the loss estimates using the hedonic prices estimated for the specifications C1-L1 and C2-L2. To calculate the loss from a 1km change, the loss for a 1 percentage point change was multiplied by 15 in the case of Westerland or by 17 in the case of Timmendorfer Strand. These values are calculated from the total coastal length of the respective districts. For Westerland the estimated loss ranges from € 826,489 to € 1,017,806. The former estimate is very close to that of the hedonic prices of specification C3-L1. For Timmendorfer Strand the estimated loss ranges from € 465,239 to € 572,933.

These loss estimates must be taken as a lower bound because the district prices used are the average minimum price for one person per night, which can be seen as low season prices and for the minimum accommodation standard. Moreover, only three categories of

[7] Nights spent in hotels and bed and breakfast were estimated using the market shares for each accommodation type from the official tourism statistics for 2004 (Statistiches Amt für Hamburg und Schleswig-Holstein, 2005). Private accommodation is not included in the official statistics. In a market report on tourism in Schleswig-Holstein (NIT, 2001), however, it is estimated that an extra 67% of the total nights listed in the official statistics are spent in private accommodation. This figure was used to calculate the number of nights spent in private accommodation for both Westerland and Timmendorf.

accommodation are included in the cost calculation. In Schleswig-Holstein, nearly 6 million nights were spent in self-catering accommodation in 2004, which are not included in the cost calculation.

| District | Accomodation type | Nights | 1km increase in: | | Conversion of 1km open coast to dike |
|---|---|---|---|---|---|
| | | | OPENTOT | DIKETOT | |
| Westerland | Hotel | 415,709 | 237,665 € | -215,017 € | -452,682 € |
| (North Sea coast) | B&B | 57,339 | 13,447 € | -12,165 € | -25,612 € |
| | Private accomm. | 960,432 | 182,540 € | -165,145 € | -347,684 € |
| | Total Westerland | | 433,652 € | -392,327 € | -825,979 € |
| Timmendorfer Strand | Hotel | 263,641 | 113,168 € | -102,384 € | -215,552 € |
| (Baltic Sea coast) | B&B | 36,364 | 6,905 € | -6,247 € | -13,152 € |
| | Private accomm. | 609,102 | 95,315 € | -86,232 € | -181,548 € |
| | Total Timmendorfer Strand | | 215,388 € | -194,863 € | -410,252 € |

Table 8: Losses (€) from the conversion of 1 km of open coast to 1km of dikes in the districts of Westerland and Timmendorfer Strand (Specification C3-L1)

| District | Accomodation type | Nights | 1 percentage point increase in: | | Conversion of 1km of open coast to dike | |
|---|---|---|---|---|---|---|
| | | | OPENSH | DIKESH | OPENSH | DIKESH |
| Westerland | Hotel | 415,709 | 37,188 € | -30,197 € | -557,814 € | -452,962 € |
| (North Sea coast) | B&B | 57,339 | 2,104 € | -1,709 € | -31,561 € | -25,628 € |
| | Private accomm. | 960,432 | 28,562 € | -23,193 € | -428,431 € | -347,899 € |
| | Total Westerland | 1,433,480 | 67,854 € | -55,099 € | -1,017,806 € | -826,489 € |
| Timmendorfer Strand | Hotel | 263,641 | 17,707 € | -14,379 € | -301,027 € | -244,443 € |
| (Baltic Sea coast) | B&B | 36,364 | 1,080 € | -877 € | -18,368 € | -14,915 € |
| | Private accomm. | 609,102 | 14,914 € | -12,111 € | -253,539 € | -205,881 € |
| | Total Timmendorfer Strand | 909,107 | 33,702 € | -27,367 € | -572,933 € | -465,239 € |

Table 9: Losses (€) from the conversion of 1 km of open coast to 1km of dikes in the districts of Westerland and Timmendorfer Strand (Specification C1-L1 and C2-L1)

Through beach nourishment it is possible to protect the coastline as well as maintaining the touristically important beach. In the past, beach nourishment has been carried out in the district of Westerland every six years costing approximately € 3.6 million on each occasion. The total costs of beach nourishment for the island of Sylt are estimated at € 5 million per annum (Amt für Land- und Wasserwirtschaft Husum, 1997). Dikes would be a costly alternative: costs would arise through construction and maintenance and through the loss of revenue from tourism. For example, if the total coastline of the district of Westerland were protected with dikes the loss of revenue in the accommodation sector would be approximately € 5.5 million per year.

## 7 Conclusion

This study has provided a way of examining the value that tourists attach to different coastal attributes. Districts with open coast accrue higher accommodation prices than districts with other coastal types. The hedonic prices of the different coastal types produced from this study can be used along with other tourism data in a cost-benefit analysis when considering the best adaptation measures to sea-level rise. Nevertheless, this study categorises coastal type in a very simple manner. Dikes are not the only hard engineering structures than can be used to protect the coast. In addition, tetrapods, groynes and revetments can be used; all of which change the appearance of the landscape. In this study, stretches of the coastline that have such structures in place still fall under the category of open coast.

Although this study examines tourism at a very high resolution, it would be an interesting extension to increase the resolution even further. Instead of the district average price, the prices of individual accommodation units can be used. At a higher resolution and with a smaller focus area, it would be possible to include measurements such as distance to the nearest beach and the area of coastline that has tetrapods or other such structures. Such an extension, however, would depend on the availability of appropriate GIS data.

Here the focus has been on only one of the coastal states of Germany. The other coastal states, Mecklenburg-Western Pomerania and Lower Saxony, have large tourism industries. Although the broad coastal types that can be found in these states can also be found in Schleswig-Holstein, a comprehensive study of coastal accommodation prices in Germany would be useful both for integrated coastal zone management as well as for tourism planning and marketing. This method and the results presented in this study are a good starting point for future research.

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