# THE IMPACTS OF CASPIAN SEA LEVEL RISE ON THE HOUSING MARKET

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## Abstract

**Risk of sea level rise is becoming an important risk in coastal areas. Many studies have been undertaken in an attempt to assess the impacts of this risk. To date none of these studies have investigated the impact of the sea level rise on the housing and property market. This study utilizes an indirect contingent valuation method (CVM) to find out the monetary impacts of sea level rise in the city of Anzali (Iran), a coastal city affected by the recent rise in the Caspian sea level. Thus, the aim of this research was to assign money values to the negative impacts associated with the sea level rise. The results show that housing and property market have been significantly affected by this risk. These results can provide basic data for coastal zone planners while evaluating the response strategies and also property developers.**

## Introduction

Sea level rise had been among the main environmental issues during the last few years. Although many studies have been undertaken, there is still little knowledge about the exact causes of sea level rise. Global climate change through the enhancement of the greenhouse effect is argued to be the main important reason for sea level rise. Accordingly, the sea level rise is due primarily to the thermal expansion of the oceans and to the melting of continental ice, that is, glaciers and the Greenland ice sheet. Whatever the sources of the sea level rise, its impacts on coastal zones' communities cannot be neglected. Considerable number of the worlds' population live along the coastal areas and their life directly and/or indirectly is affected by environmental

changes. Urban settlements and economic activities, especially tourism, on the coast have expanded rapidly in the last twenty years especially in developing countries (Rakidi and Treloar, 1997). As sea level rise becomes an issue, the need to protect and enhance the wealth creation potential of coastal zones leads to widespread response strategies among which coastal constructions are the main ones. However, each strategy has its own economic and environmental costs and has to be balanced with the benefits before its application can be jutified (Turner et al., 1995).

Caspian Sea level has been rising during the 1990s. Although Caspian Sea level rise is not a new phenomenon and historical data show the same pattern in the past, it is only during the past decades that there has been a growing expansion in human settlements and economic activities, especially tourism and oil industry in coastal areas of this sea, so that sea level rise has become an important environmental risk today. Housing and property markets in coastal cities have been affected by the recent Caspian Sea level rise and can somewhat show the extent of economic damages that sea level rise has imposed upon coastal communities. While planners and policy makers try to find out the best possible response strategies, they need to know the cost and benefits of response strategies. It seems that the impact of sea level rise on the housing market can help find some information about the benefits of mitigatory measures or costs of sea level rise.

The rest of this paper is organized as follows. The second part describes the main features of the Caspian Sea level rise. Part three explains some theoretical aspects of the methods that can be applied to derive the impact of the sea level rise risk on the housing market. Part four briefly discusses the study area and data collection approach. In Part five, the main results of the study are reported. Finally, part six concludes the paper.

## Caspian Sea Level Rise Problem

The Caspian sea is the greatest closed lake. It is bordered with Kazakstan to the northeast, Russia to the northwest, Azarbayjan to the west, Iran to the south, and Turkmenstine to the southeast (Fig. 1). The Caspian sea is isolated from the world ocean level. One of its main features is a specific pattern of water level fluctuations. Lake levels have periodically risen and fallen since the Middle Pliocene. Over the past century, the water level of the Caspian sea has shown a strong tendency toward lowering although there have been short-lived reversals of this downward trend when the lake level rose (Rodionov, 1990). A high level of the Caspian sea was registered during most of the 19th Century, lasting until 1929 (Ignatov, 1992). Observations show that the fluctuations of the Caspian sea level follow cycles of 30-50 years.

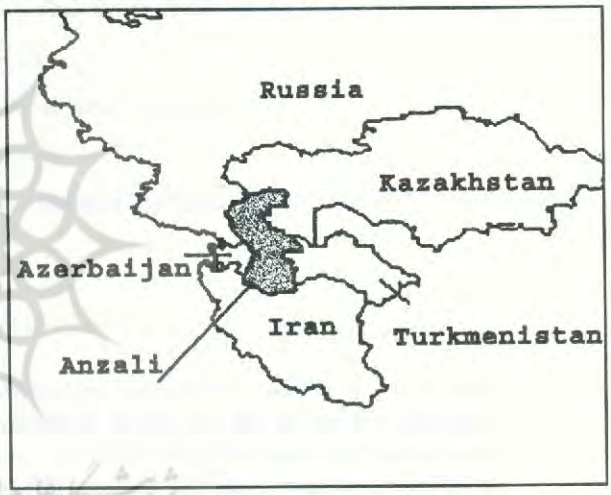


**Figure 1.** Map showing Caspian Sea and border countries and study area (Anzali)

Since 1978, the Caspian sea level has been steadily rising after having reached a record low mark of -29.00 m above MSL in 1977 (Table 1). Evidence shows that -29.00 has been the lowest level for the Caspian sea over the past 400-500 years.

**Table 1.** Caspian Sea level fluctuations during 1977-1994

| Year | Sea Level | Year | Sea Level | Year | Sea Level | Year | Sea Level |
|---|---|---|---|---|---|---|---|
| 1977 | 28.49 | 1982 | 27.63 | 1987 | 27.30 | 1992 | 26.50 |
| 1978 | 28.50 | 1983 | 27.66 | 1988 | 27.10 | 1993 | 26.45 |
| 1979 | 28.17 | 1984 | 27.63 | 1989 | 27.05 | 1994 | 26.27 |
| 1980 | 28.01 | 1985 | 27.54 | 1990 | 27.20 | 1995 | 26.15 |
| 1981 | 27.84 | 1986 | 27.44 | 1991 | 26.80 | 1996 | 26.15 |

The Iranian side of the Caspian sea coastal area is thickly populated and is among the main internal tourist resorts. More than 50 small and medium size Iranian cities are located in the coast and almost 50 percent of them are severely affected directly or indirectly by the sea level rise during the 1990s. The sea level rise risk is perceived to be very high by both the communities and policy makers, therefore, attempts were made to take some risk mitigation measures. There are several strategies in response to sea level rise: retreating, developing the conditions, abandoning private market forces, making accommodation, changing the activities, accepting the risk, and taking protection (Bray et al., 1997). Each of these strategies has its own method, implementation, impact and applicability. Protection is divided into hard and soft structures. Dykes, levees, embankments, sea walls, groynes and tidal barriers are among the main methods for hard protection. These methods work best and in the short run. In terms of negative impacts, protection strategy is not environmentally sustainable, it usually interferes with the natural process and is very costly; it reduces the amenity benefits. In terms of positive impacts, protection strategy safeguards the community assets and prevents the community from relocation costs. This strategy is applicable to vulnerable developed coasts such as coastal cities (Rakidi and Treloar, 1997). Therefore, protection has clear economic, social and political advantages because assets and investments are safeguarded while economic activity can largely continue unhindered (Bray et al., 1997: 24). The Iranian decision makers chose the protection strategy to protect urban areas through hard measures such as sea walls. Although it is costly and environmentally problematic, studies have shown that even conventional cost-benefit analysis suggests that it should remain economically viable to protect most developed coasts (Ball et al., 1991). However, planners and policy makers need more information about the coasts of the sea level rise and its impact on different socioeconomic aspects of the communities to take suitable and appropriate decisions. Moreover, if the monetary value of the impacts of sea level rise is estimated, it is expected that this information while disseminated would change the behavior of property developers and home buyers not to develop or buy properties subject to sea level rise risk.

## Measuring the Impacts of Environmental Attributes and Risks on House Prices

There are different methods developed by economists to estimate the impacts of environmental risks and attributes. Hedonic price method (HPM) and contingent valuation method (CVM) are among the famous methods currently used in assessing the costs and values of environmental risks and attributes. The basic theory behind both methods derives from the microeconomics theory in which housing is considered as a composite good and the utility derived from housing can be divided into utilities coming from different attributes. Since each house represents a unique combination of characteristics, the price a potential buyer is willing to pay depends upon its physical, accessibility, neighborhood and environmental characteristics (Garrod and Willis, 1992). Evaluating the economic consequences of changes in the price, quantity or quality of environmental goods is concerned with determining the positive and negative changes in individuals' welfare or utility. Changes in the utility can be measured by consumer surplus, or compensating and equivalent variations. For some goods, which consume a large proportion of income such as housing, or have large income elasticities, income effects from a price change is likely to be significant.

If the measured level of attribute corresponds to that perceived by the households, then HPM will reflect households' marginal willingness to pay (WTP) for a particular attribute. Application of HPM in case of sea level rise risk needs data on houses sold during a certain period of time in an urban area and their physical and environmental characteristics including their distances from the sea.

CVM is based on Hicksian measures of utility. Welfare change is estimated as the money income

adjustment necessary to maintain a constant level of utility before or after the change in provision of the environmental good or service being investigated. In practice, estimates are generated through the use of a questionnaire survey. Here, respondents are presented with a hypothetical scenario in which they are asked to estimate their WTP, or willingness to accept (WTA) compensation for a given change in the level of provision of environmental quality (Garrod et al., 1992).

CVM is now quite widely accepted as a method of valuing environmental attributes. Although it is subject to potential biases (Garrod and Willis, 1992), most biases can be controlled by careful questionnaire and survey design (Arrow et al., 1993). Application of this type of CVM in case of sea level rise could be performed in different ways. One possible way is to ask respondents maximum willingness to pay for sea level rise safety attribute. Another possible way would be to ask respondents maximum willingness to pay for risk mitigation measures.

Real estate agents have an important role in the housing market. They link potential home sellers and buyers and provide both sides with the portrayal of land values and neighborhood characteristics that can affect home buyers' decisions. In daily contact with sellers, buyers, appraisers, and so on, real estate agents gain a detailed and practical picture of the area of the city in which they work (Palm, 1990). The valuation of property by real estate agents is usually based on an experimental method. Appraisers use different variables in their valuation process. In most of the cases, however, the subject property is compared to comparable property that has recently been sold.

Several studies have already used indirect CVM. Through a survey of 30 California appraisers conducted in late 1982 and early 1983, Palm (1990) analyzed how real estate appraisers incorporate information about earthquake hazards into their practice. In this study, respondents were provided with a sample property to elicit appraisal practice. They were asked to estimate the current price of a 15-year-old tract or semicustom house with particular characteristics and the price reduction they would expect if the property was in a surface-fault rupture zone. In a different study but using the same method, Willis and Garrod (1993) estimated the impact of waterways and canals on property values. They also collected the households' willingness to pay through the real estate agents. Information about three different houses each with defined distance from the waterways in England were given to the real estate agents and were asked to value each house. Another study of this type was carried out by Willis and Asgary (1997) to find out the value of earthquake safety attribute of houses in Tehran. In this study, real estate agents were asked to value two houses with similar structural and environmental attributes except their earthquake safety measure. They found significant differences between the two houses which could be assigned to earthquake risk or safety attribute of the houses. Finally, there are studies undertaken to investigate the economic impacts of the sea level rise and global warming (Milliman, 1989; Titus, 1991; Yohe, 1991; Ball et al., 1991; Bateman et al., 1991; Broome, 1992; den Elzen, 1992; Adger and Fankhauser, 1993; Fankhauser, 1994; Turner and Adger, 1995), but none of them has studied the impact on the housing and property market. In this study, an indirect CVM is applied. It is indirect because it assesses a household's WTP for distance to the sea attribute or sea level rise risk through real estate agents' judgments.

## Study Area and Data Collection

This study was conducted in the city of Anzali which is one of the main ports in the Iranian side of the Caspian Sea. Historically, it has been a commercial city before the USSR Anzali has been a gateway to Europe. It has the highest level of rainfall (average of 1400-2000 mm per year) in Iran. The population of the city has rapidly increased during the past four decades and has reached to 98544 in 1996 (Table 2). Anzali is the second largest city of Gilan province. It is among the tourist

attraction centers of the country and considerable number of tourists visit this city each year.

**Table 2.** Population of Anzali during 1966-1996

| Year | 1966 | 1976 | 1986 | 1996 |
|---|---|---|---|---|
| Population | 43328 | 61008 | 87063 | 97544 |

Anzali was among the cities which were affected by the sea level rise during the 90s. Houses, economic activities and urban infrastructure were partially damaged by the sea level rise. To protect the residents and infrastructure, a sea wall was built along the coast of Anzali and all other cities.

A cluster sample of 50 real estate agents in the city was chosen. A questionnaire was designed comprising 11 different questions. It followed standard design principles based on the work of Willis and Asgary (1997). It consisted of three parts, an introduction by the interviewer, valuation question, and some general questions about the respondents' characteristics and their opinions about the sea level rise and mitigation measures (A copy of the questionnaire is available upon request from the outhors). In the first part, respondents were informed about the aims of the study and the way they had to answer the questions. In the second part, members of the real estate agents were asked a valuation question and the specification for two new houses which had the same attributes in all aspects except their distance from the sea (Table 3).

Therefore, the only difference between the two houses was their distance from the Sea. It was assumed that one of them was close to the sea, while the other was far enough from the sea. Real estate agents were asked to estimate market prices of these properties based on the provided characteristics. The exact phrasing of the question was as follows:

> For consistency in research we have considered only two typical houses and two new houses in your area. These houses are identical. Their only difference is their distance from the sea. One of them is very close to the sea and is affected by the sea level rise and face damage. The other house is far enough from the Sea and it will not be affected by the current sea level rise pattern.

**Table 3.** Attributes of houses

| Attributes | First House | Second House |
|---|---|---|
| Number of Floors | 1 | 1 |
| Total Area | 250 $m^2$ | 250 $m^2$ |
| Constructed Area | 150 $m^2$ | 150 $m^2$ |
| Number of Bedrooms | 3 | 3 |
| Kitchen | 1 | 1 |
| Bathroom | 1 | 1 |
| Dinning Room | 1 | 1 |
| Parking | 1 | 1 |
| Yard | 1 | 1 |
| Central Heating | yes | yes |
| Telephone | yes | yes |
| Gas | yes | yes |
| Age | 1 year | 1 year |
| Distance from the Sea | short | large |

(Note: the following items were seen by the interviewee).

1. By considering the above characteristics, what would be the value of these houses?

a. House near the Sea .....

b. House far from the Sea .....

The difference between the estate agent's offered prices for two houses with respect to their distance from the sea, permits the house price premium for the distance from the sea or sea level rise risk to be calculated, since all other variables are held constant.

The third part of the questionnaire was allocated to some questions about the professional characteristics of the respondents and their opinions about any future regulation regarding coastal zone protection and their impacts. The main aim of these series of questions was to find whether or not the respondents' answers to the valuation questions have been affected by their professional characteristics,

qualification and experience. Questionnaires were completed in March 1997.

## Results

Before going to the results of CVM question, it is helpful to provide the general findings of respondents' answers to other questions which provide information about the real estate agents experience, opinions and knowledge about the sea level rise and policy responses. Almost 6% of the 50 real estate agents stated that they had less than one year experience in property valuation. About 68% had between 1 to 10 years of experience and 26% had experience in house valuation for more than 10 years. The average years of experience for study sample was 8.13 years ranging from .40 to 40. Real estate agents were asked a general question about their knowledge about the causes of the Caspian Sea level rise. The results showed that majority of respondents either know nothing about the causes of the Caspian Sea level rise (42.3%) or know very little about that (44.0%). About 10% of the respondents indicated that they somewhat know about the causes of the Caspian Sea level rise. Only 4% of the real estate agents stated that they know much about this environmental phenomenon and its causes. This low percentage is justifiable since even practitioners have not yet come to a clear answer either. Yet, the existing information could be widely spread among people.

To find out about their future expectations of the sea level rise, respondents were asked if the sea level will continue to rise. About 18% of the respondents answered "yes", 54% answered "no" and 28% said "did not know". These results were consistent with the current and later observations on the sea level. We asked respondents to provide information about the buyers' sensitivity to the sea level rise in their purchase decisions. In this case 92% of respondents indicated that buyers are "much" sensitive to the sea level rise, and the rest (8%) mentioned that home buyers are "some what" sensitive to the sea level rise. To check about the real estate agents' opinion about the impact of mitigation measures such as sea walls, they were asked about the impact of these measures on reducing the negative impact of sea level rise on house prices. 32% of respondents believed that sea walls had no impact on house price reduction. 36% mentioned that it had a little impact. only 12% of the real estate agents believed that sea walls reduced the negative impact of the sea level rise on house price. This can be an important finding for taking response strategies. It may be true that mitigation measures such as sea walls might reduce the risk, but it does not probably change the negative impact of sea level rise on property values. At least for the short and medium term where the perceived risk of sea level rise is considered to be high, this will remain unchanged.

The average assessed price for the house close to the sea was found to be 47.1 million Iranian rials (Table 4). The average price of the house far from the sea was found to be 117.6 million rials. The minimum and maximum values for house type one (house close to the sea) was 20.0 and 80.0 million rials, respectively, while the minimum and maximum values for house type two (house far from the sea) was 60 to 200 million rials. The average difference between the two houses was 70.7 million rials. These findings show a very significant difference between the values of typical houses. A test proved that the mean values of the two prices was statistically significant. Thus it can be concluded

**Table 4.** Real estate agents valuation of typical houses

| Variable | Mean | Std Dev | Minimum | Maximum |
|---|---|---|---|---|
| Value of the house close to the Sea | 4.71 | 1.22 | 2.00 | 8.00 |
| Value of the house far from the Sea | 11.76 | 3.96 | 6.00 | 20.00 |
| Difference between the value of two houses | 7.07 | 3.46 | 2.00 | 17.00 |

that the null hypothesis that sea level rise does not affect house values of the sample properties can be rejected.

These results somewhat show the extent of damages and costs posed by the sea level rise to property owners whose properties are close to the Sea. It is important to notice that closeness to the sea before the sea level rise was an environmental attribute demanding for higher property value for properties near the Sea.

To examine the theoretical validity and factors describing the differences between the real estate agents' valuation of the typical properties, the impact of variables contributing to the determination of the value of distance from the sea attribute or sea level rise risk in housing was assessed using a multiple regression model. The model attempts to explain the value of the distance from the sea attribute or sea level rise risk of the house as a function of seven variables. The OLS results of regression model are displayed in Table 5. The explanatory power of the model considering the type of variables is relatively significant ($R^2$=0.20). Most of the variables have expected signs.

**Table 5.** OLS regression of determinants of the value of distance from the Sea.

| Variable | Parameter Estimate | T | Sig T | Mean | St. Dev. |
|---|---|---|---|---|---|
| Years of experience | -.012214 | -.189 | .8512 | 7.990 | 7.809 |
| Average Price of One Meter House in the Area (10000 Rials) | -042012 | 1.802 | .0790 | 64.776 | 22.547 |
| Knowledge about Sea Level Rise[a] | -.096925 | -.150 | .8811 | 1.776 | .798 |
| Number of Transactions on houses close to the Sea during the last year | -.040611 | -.509 | .6133 | 2.449 | 6.127 |
| Sensitivity of Buyers[b] | -.286362 | -.158 | .8752 | 2.122 | .666 |
| The Impact of Sea Walls on House Price Reduction[c] | .613815 | 1.163 | .2517 | 3.918 | .277 |
| Future Trend of Sea Level Rise[d] | -1.805976 | -2.313 | .0258 | 2.143 | 1.000 |
| (Constant) | 8.353943 | .2552 | | | |
| R Square | .20256 | | | | |
| F | 1.48778 | | .1987 | | |

[a] Nothing=1, Little=2, Moderate=3, Much=4
[b] Nothing=1, Little=2, Moderate=3, Much=4
[c] Nothing=1, Little=2, Moderate=3, Much=4
[d] yes=1 (if respondent believes that Sea Level Rise will continue), no=2 (if respondent believes that Sea Level Rise will not continue), Do not know=3.

## Summary and Conclusion

This study has shown that CVM does provide a valuable approach to the assessment of the economic costs of sea level rise or sea level rise safety attributes. The results can be used as a useful decision making aid in the context of the choice between alternative options for response strategies to the sea level rise. The results show that sea level rise risk has a very significant impact on the housing market. Up to 75% reduction in the values of properties close to the sea can be a huge cost for households. If the findings of this study are aggregated for all properties in risk, the total damage would be much higher than the monetary costs of the sea walls.

It is important to notice that if people especially

home buyers become aware of the risk in the long run, the demand for properties subject to risk would reduce significantly and it will become possible to change the land use to uses most appropriate with the risk.

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