The Dilemma of the Illegibility of State Visions: The Greek Coastal Legislation

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Key words: climate changes, erosion, inundation setback lines

SUMMARY

In the last decades there has been an increasing concern about the nature and results of coastal dynamics, especially coastal erosion and its adverse effects on social and economic livelihoods. The impacts differ world wide not only in magnitude and frequency, but also in vulnerability of different coastal regions and populations which are related to the degree to which social structures have evolved. Depending on the local situation, different integrated coastal zone management approaches can be implemented. However, general issues, such as the notion of social equity, sustainability and setback lines have remained a cornerstone in most of these approaches.

The Greek state visions regarding protection and development of its coastal areas have been “presented” in the law 2971/2001. The law regulates the limits of the seashore and beach zones and related matters. Marginal issues on coastal protection have been abstractly taken into account which by no means can create an environmental friendly and sustainable coastal development. Development close to the sea and damage to natural dune system such as bulldozing dunes to improve sea views and sand extraction have created widespread coastal hazard problems. Many houses, properties and coastal infrastructure are now threatened by coastal erosion and flooding.

A number of Greek coastal areas are herein examined by assessing the impacts of sea level rise and erosion on them. The predicted rate of change of the seashore limit in each particular area can lead to the determination of the setback lines. Primary setback lines delineate land at risk from fluctuations in natural beach erosion under existing conditions and secondary setback lines delineate the additional land at risk from the effect of sea level rise and climate change over the next 100 years. Only if such setback lines exist in a coastal area, then the state visions of sustainable development could come true.

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1. INTRODUCTION

It is a common belief today that fuels such as oil, coal and natural gas cause global climate change. There is also strong evidence that climate is already changing and if the increasingly reliable model forecasts prove accurate, the change will accelerate bringing much warmer temperatures more rainfall and more droughts. In many cases these impacts could be severe both to the environment and economy. However, there is much that can be done today and in the near future to avert the worst of these impacts and reconcile with nature. To address climate change, we extend sort-term solutions, such as conservation, increased energy efficiency and renewable energy to long-term strategies to reduce our reliance on fossil fuels, move to clean energy future and preserve our climate and quality of life for future generations.

Over the last hundred years (20^{th} century) global climate has warmed by about 0.6^{o} C, the decade of the 1990's was the warmest in recorded history and 1998 was the warmest year in instrumental record (since 1860) in the Northern Hemisphere over the last thousand years. The effects of this seemingly small change can be seen on the melting of the glaciers, the earlier arrival of spring, the warming of the oceans and the dying of the coral reefs. There is international scientific consensus that most of the warming over the last fifty years is due to human activities. In less than three centuries, we have burned a large amount of carbon and, consequently, carbon dioxide, methane and other greenhouse gases, were trapped in the atmosphere, forming a thick blanket around the Earth trapping heat, raising temperatures on the ground and steadily changing the climate. Depending on how much greenhouse gas pollution occurs and using a range of climate models, global temperatures are expected to rise from 1.4 to 5.8^{o} C by the end of the 21^{st} century (IPCC, 2001). Scientists believe that warming of this magnitude and speed has not occurred in the last thousand years (Gornitz, 1995).

The earth's mean sea level has been rising between 1 and 2 mm/year for the last 100 to 150 years with 1.8 mm/year being the best estimate of the Intergovernmental Panel on Climate Change (IPCC, 2001). This is a rapid rate of sea level rise compared with the average of the last few thousand years (Gornitz, 1995). The global mean sea level is projected to rise by 0.09 to 0.88 m between 1990 and 2100 (IPCC, 2001). Consequently, the rate of rise in this century could be as much as four times greater than that of the last 100 years. More than half of this effect comes from projected thermal expansion of seawater, another 30% from the melting of mountain glaciers and the rest 10% from the melting of the polar ice caps. Despite the fact that all these are not certain, warming during the 21^{st} century could possibly have devastating effects on coastlines in the following centuries. Even with modest global warming by 2100, some research suggests that the West Antarctic Ice Sheet could become irreversibly destabilized and then disintegrate over the next hundred years (Oppenheimer, 1998). Our confidence in the ability of models to project future climate has increased mainly due to their ability to reproduce the current climate and recent climate changes accurately. Long-term averages of the results of global climate models are the most accurate but applied to smaller and smaller areas they become less and less accurate. People often wonder how climate can be predicted 100 years in advance when meteorologists have difficulties predicting the weather a week in advance. But climate and weather are two different and distinct terms. The large seasonal changes that one experiences every year where one lives can easily be predicted from year to year. These all are part of what we call climate. Weather, the day-to-day variations in temperature, rain or snowfall is much harder to predict. Although we may not be able to say exactly what the weather will be on a given day, we do know what range is typical.

Beach systems erode only if the supply of sand or other sediment they gain is less than the amount of sediment they lose. Seasonal erosion, the reduction or complete loss of sand on the visible beach, during winter storms for example, does not usually imply a loss of sand from the system. Sediment can be supplied from rivers, from cliff and shore erosion, from sources offshore or along shore or from materials blown from the land. In addition, humans can supply beaches with sand in a process known as beach nourishment (Bird, 2000). One effect of the large-scale human development in Greece has been a marked decrease in the supply of sand or sediment from existing natural sources. The construction of dams, the canalization of rivers and the intense coastal development (more than one million houses built in thirty years) have greatly reduced the supply of sediment from rivers by eliminating flows and trapping sediment behind the dams as well as reducing the ability of streams to erode their channels further.

Climate changes are likely to affect both the sources of supply and the rates of loss at beach sand. The rise in sea level is likely to increase the loss of sediment from beaches through inundation or flooding, particularly where the position of the shoreline has been immobilized by heavy coastal infrastructure. Increased rain could mobilize more sediment in the river flood plains and result in an increase in sand supply. But the amount of sand replenishment may be not enough to maintain the beaches, especially because much of the sand and sediment are trapped behind dams and prevented from reaching the beaches. The supply of sediment to both the beaches and the near shore may also be augmented by more cliff erosion. Both increased beach nourishment and restoration of natural sources of sand supply are possible responses to the beach erosion. Nevertheless, it is a common secret in Greece that beaches are starving for sand.

In the face of existing beach erosion, beach nourishment (if sand exists) is often advocated to maintain the existing beach widths. Although beach nourishment may offer significant benefits, it is expensive and has a number of limitations and concerns associated with it. In most cases, beach nourishment must be repeated every few years. Offshore sand supplies are rarely abundant and their collection can disrupt near shore habitats. But if the sand is transported from an inland source, the cost would be much higher and its removal would cause additional environmental harm. Over time, beach nourishment prices are likely to rise as the sources of sediment become increasingly scarce (Griggs, 1999). Approaches such as building retention structures (breakwaters, groins etc.) must be carefully designed and constructed to prevent losses to neighboring beaches. But armoring is often very expensive ranging from 3,000 to 15,000 Euros per meter (Griggs, 1997).

It is worldwide known that the scenic beauty of the Greek coasts draws tourists both from the country and abroad to participate in swimming, sunbathing, surfing, viewing and experiencing nature. The broad sandy beaches lining much of the Greek coastline attract millions of visitors each year, create jobs and stimulate economy. Coastal property owners would be faced with higher costs to maintain their property value as a result of climate change, including building protective structures and abandoning some areas due to the accelerated sea level rise impacts on the coastal areas.

2. COASTAL FACTS AND LEGISLATION IN GREECE

People have inhabited the Aegean region in Greece for more than 8,000 years. Modern disciplines such as art, democracy, philosophy and science were conceived there. In the last half of the 20th century the Greek coastal areas have seen a large increase in population, development and an expansion and diversification in their economic base. The development of the region has proceeded despite of the occurrence of repeated large magnitude extreme geophysical events such as earthquakes, volcanic eruptions and tsunamis. However, such events have impacted severely on human settlements, structures and activities and on the natural environment. Due to the concentration of larger populations, greater economic activity and wider infrastructure, the potential impacts of future extreme geophysical events are likely to be much greater than in the past.

Greek coastal areas are extremely valuable as they concentrate a significant part of the total population, the majority of the main urban centers, a large variety of human activities and most transport and communication infrastructure facilities. Additionally, coastal areas are very important and fragile from the ecological perspective as the interface between land, sea and air. The Greek coastal areas represent a rich diversity of natural and cultural characteristics and must be carefully managed and protected. The coastal areas of Greece face particular problems due to the intensive pressures resulting from the human activities which often lead to the deterioration of coastal ecosystems and natural resources. A long-term strategy for sustainable development and a rational management are necessary to solve the problem and develop the Greek coastal areas. These cannot be fulfilled unless both public authorities and private actors are involved for an efficient approach.

The Aegean sea is one of the eastern Mediterranean sub-basins, located between the Greek and Turkish coasts and the islands of Crete and Rhodes. It has about 3,000 small and big islands forming small basins and narrow passages with very irregular coastline and topography. Its coastline length is about 16,000 Km with 50% of them sandy beaches, low inclination coastal areas, lagoons, wetlands, deltas, etc.

In a natural environment on a sandy coast the interface between the sea and the land moves freely as erosion and accretion take place according to the forces of nature. Nothing is actually wrong with erosion, until public or private property is threatened. During extended periods of stability and/or accretion, people may begin to feel secure enough to begin developing along the coastal areas for residential, commercial and other purposes. When erosion occurs and dry land is placed at risk, the question arises as to whether or not the land should be protected, and if so, at what cost. If the economic activities threatened by the erosion are only marginal it will probably make sense to abandon the land. On the other hand, if urban or commercial development has occurred, the decision may well be otherwise. In such circumstances, erosion becomes a hazard. The pressure for land development in coastal areas (and in Greece as well) continues to grow and has escalated in recent times. This, in turn, increases the value of the coastal assets, thus making a decision to allow nature to take its course without human intervention including, if necessary, removal of buildings increasingly more difficult. Sensible coastal management practice requires new development to be setback a certain distance from the coast. The setback distance should reflect the coastal hazard risk, but other factors such as natural character and cultural values may also be relevant considerations. This is fine for undeveloped coastal areas but where infrastructure, housing, etc. already exists, the establishment of planning restrictions becomes problematical both in a practical sense as well as from a personal (land owner) perspective.

In simple terms, the erosion of coastal areas occurs when elevated water levels (sea level rise, storm surge, tsunamis) combine with the action of waves and currents to attack beaches and the cliffs or dune systems bordering the hinterland. The extent to which property is lost depends, particularly, on the elevation of the water relative to the level of the beach. It will also depend on the energy remaining in the impacting waves, which affect run-up, as well as the storm event. It is also worth noting that erosion of sandy beaches can occur, albeit at a less significant rate, even when there is only modest wave action, providing water levels are sufficiently elevated relative to the beach.

The Greek state visions regarding protection and development of its coastal areas have been depicted in the law 2971/2001. The law regulates the inland limits of the seashore and beach zones where private construction is strictly prohibited (Greek government law, 2001). The limit of the seashore connects the points where the usual maximum winter waves run up the beach and the beach zone extends beyond the seashore limit for 50 m. Only article 12 is briefly dedicated to the protection of the beach environment for the erosion, and namely:

"*In case of beach erosion, hard protection measures can be exercised and if a private owner is threatened by erosion, he can construct hard protection structures by his own expenses. The structures belong to the state*"

It is intuitively understood that such legislation cannot attain severe criticism and, by no means, secure sustainable development. Furthermore, life and property are constitutionally protected. Thus in case of a severe storm surge and microtidal environment (as Greece has) life and property are in an immediate threat. It is also important to realize that the occurrence of a storm surge does not necessarily imply severe coastal erosion as the latter depends to a great extend on the approach angle of the waves, wave height and period and tide level. Furthermore, many large and destructive earthquakes, volcanic eruptions and associated tsunamis have occurred from antiquity to the present in the eastern Mediterranean ((IPCC, 2001). Only in the gulf of Corinth (in Greece), we experienced more than seven tsumanis during the last century with severe magnitudes (Soloviev, et aal. 2000). So, it is clear that

Greek shorelines are threatened by a number of serious hazards and solutions must be exercised to secure life, property and sustainability. On the following lines, the setback philosophy is discussed in a number of Greek shorelines and recommendations for adjustment are made.

3. GREEK COASTAL VULNERABILITY AND SETBACK LINES

To examine the implementation of the setback lines in Greece, five sandy beaches with different orientation have been examined. Using successive aerial photographs since 1945 to the present (2000), the historical shoreline changes were deduced. The Bruun's model was then applied to calculate beach erosion exerted by the wave impact and sea level rise (Bruun, 1960). Assuming the middle scenario for expected sea level rise (+50 cm) and the pessimistic one (+100 cm), then the inundation zone for each coastal area could be calculated. The sum of these three models gives the total retreat of the particular shoreline. It is clear that from this final future position of the shoreline we have to add the 50 m beach zone to delimitate the "non-building" zone. This procedure leads to the "red zone" or the primary setback lines using the middle scenario for sea level rise (SLR). In case of the pessimistic scenario for SLR, we can deduce the secondary setback lines. In Fig. 1, one of the coastal areas considered is depicted with all the topographic information and different scenarios used and in Fig. 2 a simplified picture of the shoreline retreat and setback lines is given for reasons of clarity. Due to the lack of space, all other coastal areas are not presented here, but their characteristics and results of the calculated setback lines are given in Table 1.

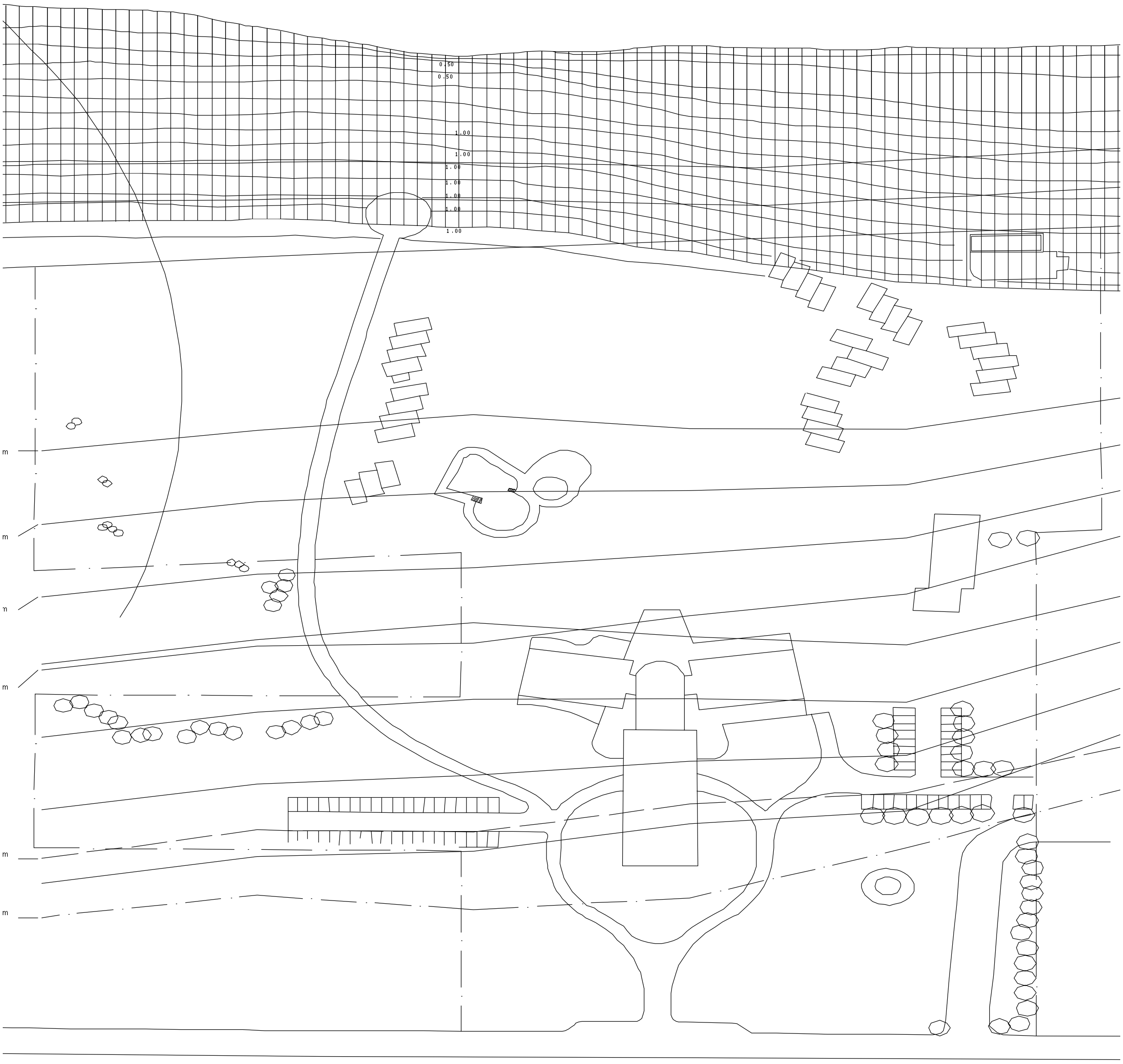

Fig.1: Implementing sea level rise, erosion and historical retreat for a coastal area in Kos island in Greece. The scale is arbitrary.

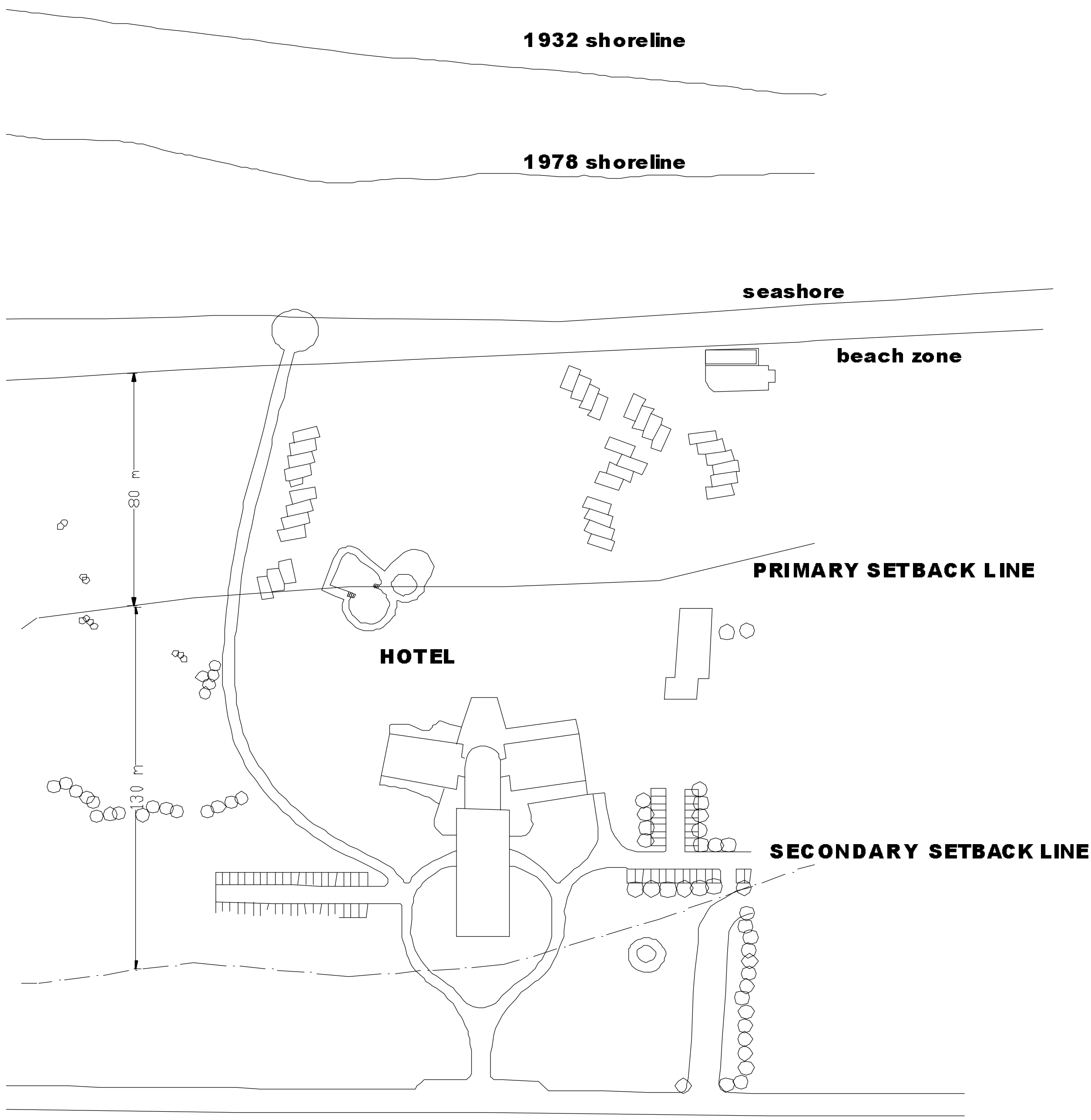

Fig.2: The implementation of the primary and secondary setback lines in a coastal area in Kos island in Greece. The scale is arbitrary.

	PELOPONISSOS VARTHOLOMIO	RHODOS AFANTOU	KOS TIGAKI	KOS KARDAMAINA	KOS AMMOGLOSSA
Shoreline Length (Km)	2.7	2.4	2.7	0.6	0.3
Shore type	Undeveloped	Heavily developed	Undeveloped	Semi-developed	Hotel infrastructure
Coastal slope (%)	0.025	0.031	0.022	0.032	0.027
Historical retreat (m) [period]	11 [1960-2000]	55 [1932-1981]	2.8 [1932-1987]	5.7 [1932-1988]	38.6 [1932-1978]
Rate of retreat (m/yr)	0.28	1.1	0.05	0.1	0.8
Retreat due to inundation (m) SLR = 0.5m	5.8	5.5	6.6	7.0	17.6
Retreat due to inundation (m) SLR = 1.0m	11.4	14.4	20.6	13.5	69.0
Retreat due to erosion (m) SLR = 0.5m	36	16.8	46.0	16.3	17.0
Retreat due to erosion (m) SLR = 1.0m	72	33.7	92.0	32.6	34.0
Total retreat (m) Sum of impacts SLR = 0.5m	58.6	156.6	58.4	34.8	137.0
Total retreat (m) Sum of impacts SLR = 1.0m	113.6	182.3	118.3	54.8	205.2
Width of beach zone (m)	50	50	50	50	50
Primary setback lines (m)	109	207	109	85	187
Secondary setback lines (m)	164	232	168	105	255

Table 1: The estimation of the Primary and Secondary setback lines using models for inundation, erosion and historical retreat as well as geomorphologic data for five coastal areas in Greece. All regions have high land prices and aesthetic values.

4. RESULTS AND CONCLUSIONS

From Table 1 given above, it is evident that all five coastal areas are expected to retreat in the future. Rates of total retreat between 30 to 100 m (middle scenario) and 60 to 200 m (pessimistic scenario) are considered really severe to exercise measures for future development. The essential purpose of the primary setback lines is to identify that area along the seaward boundary of coastal property. Because of the level of risk from erosion, it would be prudent to prevent the construction of buildings to avoid the exacerbation of risk for coastal erosion. Therefore, in the zone between the present shoreline and the primary setback line construction should not be permitted by any means. Normally, this will mean not allowing construction for habitation or commercial use, but structures in connection with landscaping such as pools, fences, walls and decks or structures of certain public use, may be permitted in some circumstances and rules relating to this need to be clearly described in the plans. In establishing the width of the primary setback line from an erosion perspective, the main issue is to ensure that development adjacent to the coast is set back a sufficient distance to avoid being inundated by erosion. Such a distance, of course, is not only time related, but it is also risk related. If, for example, one studies the setback lines in the Gulf of Corinth in Greece, one should take into account that between 1963 and 1996 six tsunami events have been recorded with destructive waves of even 5m run-up height. Since new buildings have a life expectancy of around 100 years, this is a suitable period to apply the hazard area. In other words, the risk of inundation due to coastal erosion beyond the hazard area should be acceptably low within this period. The purpose of the secondary setback lines is to identify a further area where there remains a moderate hazard of erosion within the 100 year period but there is sufficient uncertainty about this to allow construction to take place, subject to conditions that may be imposed with respect to proposed use, floor levels, ability to resist the effects of erosion and removability.

Using a simple geometric model, the potential maximum retreat can be determined as summarized in Table 1. We have to note that these results are conservative and need to be adjusted according to various influences specific to the location e.g. storm surge, strong winds, tsunamis, etc. An assessment of the recommended setback lines that will define the two hazard areas can thus be made based on the results of the model, driven by the historical erosion rates. It is important to understand that these distances are not precise because even with the best models of the world and the best data, it is just not possible to predict nature and the response of natural forces with certainty. At best, the setback lines delimitate a compromise based on available information coupled with an understanding of the nature and impacts of future events.

No matter how likely the hazard, it will not be serious unless the consequences are serious.

The concept of the modern state presupposes a simplified and uniform regime that is legible and manipulable from the center. Any coastal management program must first be concerned with a careful definition of the precise character of community and meaning of social equity. However, it must be acknowledged that humans generally have high adaptation potential and that constant adaptive behaviour is a characteristic of economic, political and social activities.

Thus, a flexible institutional and legislative setting should call for adaptation due to climate change impacts on the coastal zones. If the state wants to have legible visions….

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- Impacts of The Accelerated Sea Level Rise on Greek Protective Regions**,** 3rd International Forum on Integrated Water Management: The Key to Sustainable Water Resources, Athens, March 21-22, 2002.
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