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Losing Ground: Mediterranean Shoreline Change from an Environmental Justice Perspective

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Loss of land due to coastal erosion is a problem in the Mediterranean region and worldwide. Following a review of environmental justice (EJ) issues among different sectors of activity and contexts, this article describes research that examines the sociodemographic characteristics of populations destined to be effected by erosion in the city of Netanya, Israel. It also examines the availability of open space serving as an alternative to that expected to erode. Results provide a basis for which to explore the EJ implications of coastal erosion. The study finds that seashore dwellers in the case study area are generally mixed populations, not particularly strong or weak as defined herein. Also, planners and city managers have increasingly provided residents in close proximity to the shore with alternative open space. This work highlights the complexities of considering coastal erosion from a justice perspective. Although coastal erosion does not fit the typical EJ paradigm, the use of this analytical approach in the future at appropriate temporal and spatial intervals is recommended.

Keywords beach loss, coastal erosion, environmental justice, recreational open space, sea-level rise, shoreline change

Introduction

For many people, coastal environments provide economic livelihood. Coasts are also attractive places to live and recreate. Yet coastlines are also vulnerable, high risk locales, especially in view of climate change effects. The shores surrounding the Mediterranean Sea make up the longest stretch of coastline of the European continent affected by erosion (reportedly 30% of all erosion-affected shores) with a high rate of vulnerability due to intensive development (European Environment Agency 2006).

Like most environmental hazards, coastal erosion has environmental justice (EJ) implications that have yet to be explored. This research considers the effects of accelerated shoreline change in the city of Netanya, Israel, by examining the relationship between affected areas (erosion "hotspots") and the demographic and socioeconomic makeup of populations living close by. In addition to the dangers posed from injury and damage

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to property, another concern is the loss of much needed open spaces and recreational infrastructure. By characterizing residents this research examines who will be most affected from the loss of amenities and then it examines whether alternatives to lost open space will be available.

The first section of this article consists of a review of EJ literature related to development in general and to coastal development in particular. The article then explores the case study context, and presents an analysis of impacted areas, population groups and relevant alternative land uses. The subsequent discussion frames the local problems from an EJ perspective. I conclude with recommendations for coastal managers including policy options that address distributive, procedural and corrective justice.

Environmental Justice in Broad Terms

Environmental justice first entered currency in the United States in the 1980s as an outgrowth of the environmental and the civil right movements (Portney 2003). EJ discourse focuses on the claim that disproportionate public health and environmental risks are borne by minority and/or low-income populations (Bullard 1990; Shmueli 2008). Much of the research on EJ has been framed by the particularities of the EJ movement in the United States where it initially addressed the sociospatial distribution of pollution within U.S. borders (Walker and Bulkeley 2006) and centered on racial inequalities (e.g., Anderton et al. 1994).

In recent years the concept of EJ has broadened substantively and geographically. Topics shaping the EJ research agenda include access to myriad environmental goods and services and the threat of natural as well as technologically produced risks. The equitable allocation of public goods, including clean air and water, open space and public transit, has become just as important as risk from environmental hazards. Increasingly, the basic concepts of EJ are applied to myriad distributional concerns about the provision of amenities, or lack thereof (Tarrant and Cordell 1999; Smoyer-Tomic et al. 2004; Sister, Wolch, and Wilson 2010), and to allocation of resources for the protection from natural hazards (e.g., Floyd and Johnson 2002). Geographically, EJ has expanded from mostly local and regional emphases to application of EJ principles at national and global scales the world over (Walker and Bulkeley 2006).

Stallworthy (2006) defines EJ is a type of social justice involving environmental concerns. An early and straightforward definition of a social justice conflict is a situation in which one group of people bear the costs for the benefit of another distinctly defined group of people (Dobson 1998). In the EJ subset, the mal-distribution of environmental consequences between groups is involved (Portney 2003). Groups typically consist of low-income populations and/or those of minority ethnic and/or racial backgrounds (Anderton et al. 1994; Floyd and Johnson 2002; Byrne, Wolch, and Zhang 2009) but they can also include those belonging to future generations and even other species (Portney 2003).

Going beyond spatial (geographical) and temporal (inter-generational) distribution of amenities or protection from hazards are EJ sub-types based on procedural concerns or corrective actions, respectively "procedural" or "corrective" justice (Rechtaschaffen and Guana 2002). Taylor (2000) provides a definition of environmental racism,[1] which emphasizes the *discriminatory* impact of environmental decisions, actions, and policies that can be distributional, procedural, or corrective in nature. Accordingly, three issues interact to engender this discrimination: (a) prejudiced belief and behavior; (b) power to enforce prejudicial policies and behavior; and (c) privilege (Taylor 2000). This definition can be applied to low income groups as readily as to those of specific backgrounds or origin.

Both race and class, the two predominant factors in EJ issues (Pulido 2000; Agyeman 2005), are relevant when considering responses to coastal hazards (Walker and Bulkeley 2006) although research on the topic is lacking. Shoreline change has distributional justice implications when actions are taken for coastal development or defense by one group that will adversely or disproportionally affect another distinct group (Stallworthy 2006). It has procedural justice implications when certain groups are left out of or involved in coastal defense policy decision-making (Cooper and McKenna 2008; O'Connor et al. 2009).

Once the relevance of EJ to shoreline change is established we can identify a situation where it applies. This study asks: (1) What is the demographic makeup of populations expected to bear the brunt of coastal erosion in the city? And (2) Do eroded (at risk) areas make up a significant portion of public open space resources available to these populations? Answering these questions can help guide policy options for determining the burden of response to coastal erosion including compensating residents for the loss of open space.

Environmental Justice and Changing Shorelines

Some researchers have related concerns about justice and equity to management of coastal and riparian flood risks (e.g., Johnson, Penning-Rowsell, and Parker 2007) and to soil erosion in general (e.g., Zimmerer 1993). Poirier (1996) brought to light EJ concerns in his account of how members of communities of color are denied access to public beaches and waterways. His narrative shares conceptual underpinnings with EJ concerns about the provision of outdoor recreation and greenspace (e.g., Smoyer-Tomic et al. 2004; Sister, Wolch, and Wilson 2010) and about the design of these amenities (Byrne and Wolch 2009).

An important connection made between environmental justice and shoreline change is within the context of Hurricane Katrina. Rydin (2006) links the damage from the 2006 hurricane that devastated New Orleans to broad issues of governance and urban politics that created a segregated and dislocated city destined for the disaster that befell it. The potential contribution of EJ in this context includes posing ethical questions about responsibility for coastal protection and disaster preparedness.

Beach erosion results in "loss" or degradation with a cost to bear which is dependent on use perceptions and valuation of nature and public amenities (Zimmerer 1993; Byrne, Wolch, and Zhang 2009). Questions about who is exposed to such loss, who pays for remedies, and whose amenities are threatened, are important. The loss of publicly available beach through erosion reduces availability of these amenities and therefore appropriate for analysis within a distributional justice framework.

Remedies to shoreline change are fraught with externalities at various spatial scales. Actions taken to avoid erosion in the form of hard coastal protection structures will be advantageous in one stretch of coastline while they aggravate and accelerate erosion in others (Werner and McNamara 2007; Smith et al. 2009). This can be compared to the emitting of CO_2 that is advantageous to some and damaging to others. Although unraveling issues of causation is beyond the scope of this article, in the shoreline change context, externalities observed at a regional scale result from corrective actions taken at a local scale.

Climate justice is a relatively new EJ subset (e.g., Harris and Symons 2010). Claims of climate injustice are increasingly common as more and more communities face accelerated erosion related to rising seas. For example, in Happisburgh, England, grassroots organizers have recently established the Coastal Concern Action Group that lobbies for aid to communities facing erosion problems. The group describes the sufferers of what it frames

as the government's unjust support for a policy of retreat (abandonment) as the first wave of "climate change migrants" (Warren 2008).

Most previous works relating erosion to EJ have not proactively considered the characteristics of population most likely to be impacted by coastal changes together with the specific effects they will suffer, although the importance of such work has been noted (McLaughlin, McKenna, and Cooper 2002). Among these effects erosion can have benefits for society too. In some cases erosion liberates sediment for the coastal system that leads to accumulation elsewhere thus maintaining beaches, barriers, dunes, or creating aesthetically pleasing landscapes. The many facets of shoreline change highlight the importance of conducting socioeconomic and demographic analyses at local and regional scales in light of human-induced geomorphological processes and policy response (e.g., Werner and McNamara 2007; Smith et al. 2009).

At a national scale, Stallworthy (2006) juxtapositions public and private coastal protections in the face of impeding sea-level rise resulting from climate change and argues that an EJ analysis can help resolve ensuing conflicts. Similarly Cooper and McKenna (2008) use social justice principles to advocate for the adoption of national-level policies for coastal erosion management. These two works lead to questions addressed in the subsequent sections of this article.

Environmental Justice in Israel

Shmueli (2008) characterizes environmental equity as "a far reach" in Israel because it is a country with severely limited land area, overriding security concerns, and a significant minority population. She focuses on relations between the Arab and Jewish Israelis involving land allocation using case studies from inland areas in the Galilee (north) of the country. In his book, *Pollution in the Promised Land*, Tal (2002) devotes a chapter to EJ in Israel centering on the allocation of water and land resources among Arab settlements as compared to their Jewish counterparts.

But environmental injustices in the country run deeper than the Arab–Israeli conflict. In an article on EJ claims in the Israeli courts, Fish (2005) identifies three axes of difference and vulnerability. The first is locational; those in the periphery are exposed to externalities caused by those living in the center of the country (e.g., through waste disposal practices). The second is based on ethnicity which on a countrywide scale, lies between Arabs (i.e., non-Jews) and the majority Jewish population. However, this axis also includes inter-group conflicts involving the large immigrant population. These occur between newcomers and established populations and between those immigrating from various countries or regions. Finally, there is the axes of class that becomes exacerbated as the gap between rich and poor grows (Israel Central Bureau of Statistics 2009).

In Israel, the allocation of open space is a complex issue with strong socioeconomic connotations (Fish 2005). Wealth-related inequalities have increased over the years and are significant over the last decade (Israel Central Bureau of Statistics 2009). Front and center are questions of how the government will manage common property and public goods through the protection of existing open spaces and natural landscapes for quality of life that serves the rich and poor. The value of coastal property has not been left out of this debate. Tal, a prominent Israeli environmentalist, captured this dilemma at the height of public controversy: "The privileged few can now purchase prime pieces of Israel's coastline. The general public is left with the eroded leftovers" (Tal 1996, 55).

Although the takeover of public coastal amenities by real estate developers catering to private interests has been a topic of concern in advocacy and public policy circles (Papay 2007), the distributional consequences of coastal erosion or subsequent policy responses

have not yet been addressed. The limited land resources, high rate of open space conversion and expected effects of global climate change, highlight the importance of such perspectives.

The Israeli Case of Shoreline Change

Israel has 190 kilometers of Mediterranean shoreline that consists mostly of natural stretches of white sandy beaches, cliffs, a few natural bays, and some rocky tidal zones. The country's coastal problems are as acute as its natural coastline is impressive. They include relentless pressure for urban residential and touristic development and national infrastructure expansion, which all portend the loss of public access, a plethora of use conflicts, and exacerbated erosion.

All but the most northern part of Israel's coastline lies within the Nile Delta littoral cell (Zviely, Kit, and Klein 2007). Alongshore transport moves sand eastward across Egypt's Sinai Peninsula and then northward (see Figure 1). Along 70 kilometers from the southern border with Gaza to the beaches of Hadera in the north, a coastal cliff rises up to 50 meters above sea level (Zviely and Klein 2004). The cliff is a significant element of the landscape in the seaside cities and towns in the country's south and center including Netanya. It is made up of alternating layers of eoliniate sandstone (locally called "kurkar") and reddish sandy loam (called "hamra") (Gvirtzman et al. 1983). Besides providing aesthetic beauty, the cliff serves as a natural barrier between residential and industrial areas and the sea and it contains significant cultural and recreational amenities (Davidovitch 2009). However, the cliff is eroding and collapsing. Estimates of its rate of retreat vary (Zviely and Klein 2004). The UNEP Mediterranean Action Plan reports the rate in the central area of the country as 15–22 cm on average (UNEP 2001); a more recent estimate sets the rate between 0.5 meter and one meter per year on average (Bein, Edelman, and Cohen 2009).

Indirect human interventions (e.g., emissions of CO_2) have brought about climate change resulting in accelerated sea-level rise and greater storm action that affect the cliff (Melloul and Collin 2009) and direct human interventions further aggravate conditions. Sand mining until 1963 and coastal construction have led to the narrowing of some of the beaches along the Israeli coastal through physical material removal or by changing the local morphological regime (Zviely, Kit, and Klein 2007). Foundational alterations such as the removal of talus aprons have left the cliff exposed to wave and water action (Klein and Zviely 2001; UNEP 2001).

The building of coastal structures south of Haifa began with construction of the Port of Ashdod in the early 1960s.[2] A volume of a few million cubic meters of sand is estimated to have been trapped since then by the ports and other structures along Israel's Mediterranean shores including power plants and tombolos thus causing the narrowing of beaches directly north of these structures (UNEP 2001). Narrowing depletes the recreational value of bathing beaches (Whitehead et al. 2008), which are quite limited to begin with. During the years 1980–2008 the country's populations grew from approximately 4 million to 7.4 million inhabitants while the number of designated bathing beaches decreased by eleven (State Comptroller 2010).[3] Only 13 km out the 70 kilometers in the center of the country are designated public beaches while the rest are reserved for military uses, infrastructure, and urban or rural residential or commercial development (Papay 2007).

Coastal erosion is now a national, high-profile problem in Israel with fiscal, social, and legal repercussions (State Comptroller 2010). Three persons have been killed by erosion-related cliff collapse since the late 1970s; one of them as recently as 2009 (Unknown 2009). This fatality occurred in Netanya due to the collapse of part of the cliff. The immediate causes of coastal cliff collapse are: wave action cutting into the base of the

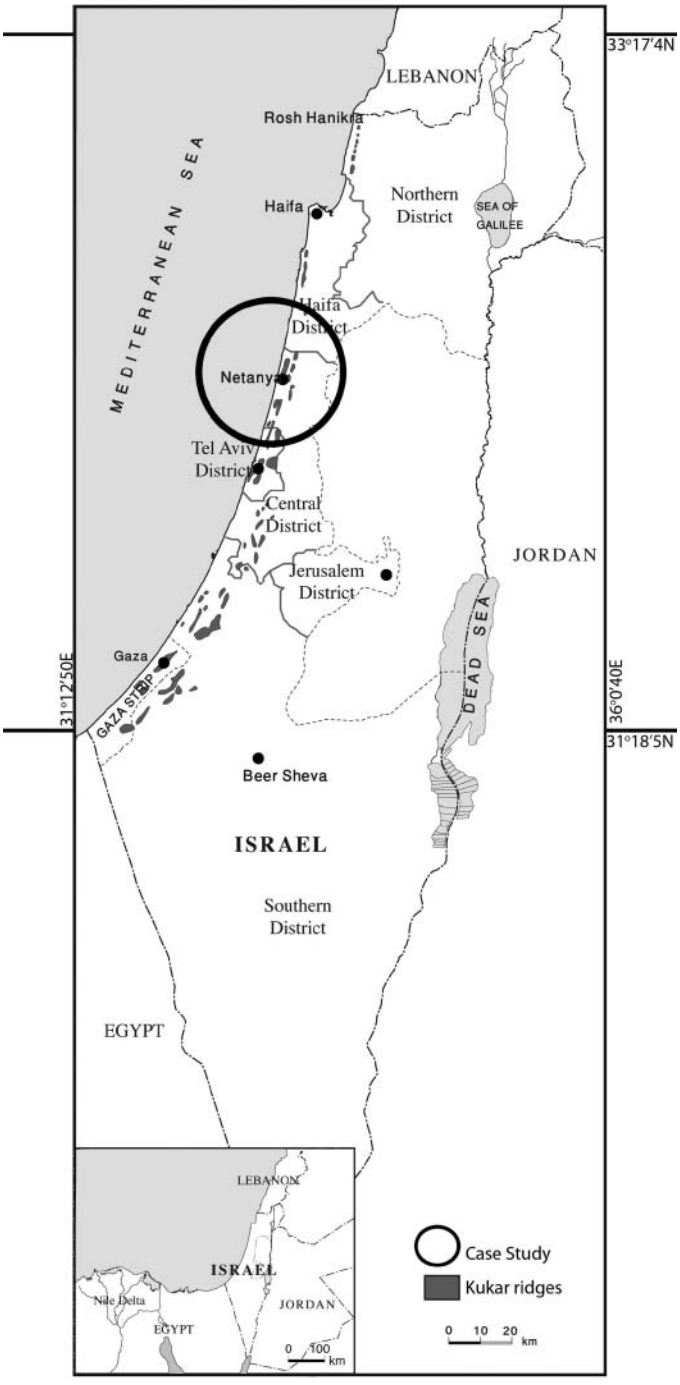

Figure 1. Map of Israel with case study site.

cliff, destabilization from the seepage of surface runoff (including irrigation water) combined with problems of natural slope, cliff-top development and the blockage of sediment transport which narrows base-beach width (Bein, Edelman, and Cohen 2009).

The National Policy Response

While planning authorities and municipalities are aware of risks and dangers of building near and on cliffs they continue to intensely develop and invest in these areas offering vastly improved recreational and landscape amenities such as beach visitor facilities, promenades, and parks. This, in turn, has attracted even more private investment and building along the coast (Davidovitch 2009). One of the major criticisms of the 65-page report of the State Comptroller on response to cliff collapse has been the ineffectiveness of municipalities in Israel to implement appropriate, comprehensive, long-term plans for coastal defense (State Comptroller 2010).

On a national level, in April 2010 the government adopted the policies proposed in the report on responses to the cliff collapse prepared by Bein, Edelman, and Cohen (2009) (Israeli Prime Minister's Office 2010). These include: (a) not allowing any further development along the cliff; (b) restricting the issuance of building permits derived from approved plans that pertain to the coastal area until there is a comprehensive plan approved for coastal defense; (c) promoting new plans that prohibit development in areas where it was previously proposed or allowed, and (d) abandoning and destroying existing buildings as needed using provisions for takings by eminent domain. In the last case, compensation would be provided for these purposes through the Planning and Building Law of 1965.

Bein, Edelman, and Cohen (2009) raise the question of responsibility and advocate localized coastal protection in areas where there is eminent danger. But they also acknowledge the spatial and temporal complexities of beach erosion and cliff collapse. They propose the creation of a Coastal Authority or a mechanism to be implemented by coastal municipalities that will examine and address the connection between development and sediment transport along the entire coastline. Although the report gives an estimation of the costs of physical defense necessary to curb cliff collapse, it does not address questions of fiscal responsibility other than to report that the public expects the government to "foot the bill" for coastal defense.

Following the adoption of the report's recommendations, in May 2010 the Israeli government commissioned an inter-ministerial committee composed of the Ministry of the Environment, the Prime Minister's Office, and the Interior Minister to address coastal erosion and cliff collapse. This committee's mandate is to develop a comprehensive plan that would determine fair compensation for land owners required to give up their land as well as the areas and techniques for coastal protection (City of Netanya 2010b). So far the committee has failed to come to a consensus. The City of Netanya has not yet taken any definitive action for coastal protection (see later section) while development and price increases for real estate along the coast continue despite the dangers involved (State Comptroller 2010).

Local Coastal Erosion—The Netanya Case

The City of Netanya began as an agricultural center. After its founding in 1929, planners and city officials viewed it as the future urban hub of the Sharon region in the country's center (see Figure 1). In 2008, it had approximately 179,000 residents while in 1995 the population was 164,800 representing 7.9% growth during these years. The city's target population for

2020 is 320,000 inhabitants. Today its municipal borders encompass 29.3 km^2 (Israel Central Bureau of Statistics 2009).

Netanya's 11 km-long shore is the highlight of its thriving holiday industry complete with bathing beaches, resort hotels, and two nature reserves. In its 19 hotels, stays increased from 483,000 in 2007 to 532,000 in 2008. Netanya's non-tourist industry is divided between four industrial parks largely located on the city outskirts, away from the coast. The average monthly wage of residents is approximately that of the national average (City of Netanya 2010a).

Residents of Netanya include many immigrants. After 1990, many newcomers arrived from Eastern Europe (mainly from Ukraine) and from Ethiopia. From among 71,000 residents born abroad (past immigrants) in Netanya in 2008, 8.5% were from Asian countries (including Eastern Europe), 27% were from African countries, and 63% were from Western Europe, the Americas, or Oceania (City of Netanya 2009).

In Netanya there is the problem of cliff collapse and beach loss (Bein, Edelman, and Cohen 2009) which contrasts with extensive development along the top of cliffs in Netanya, evidence of heavy investment in tourism and recreation facilities. The severity of erosion, the risk to public infrastructure, life, and property make Netanya a good case study. Also the municipality is a relative front runner among Israeli coastal cities in addressing these problems.

Netanya's shoreline has three major sections from north to south. The first extends from the city limit to the two breakwaters located nearest to the city center. Here the erosion rate is approximately 0.3 m/year. The second section is the area around and between the breakwaters. In the past, erosion of approximately 0.2 m/year was measured for this section, but since construction of the breakwaters, retreat has stopped almost completely. The third section is south of the breakwaters where erosion occurs at an average rate of 0.4 m/yr (Ephrati and Madpis 2005). This section includes segments of the beach where erosion is highest (Segment J) and high (Segments H and K) (see Table 1). There are some buildings and recreation facilities here and intensive use of the areas right to the edge of the cliff (see Figures 2 and 3). The top area of the cliff is a promenade that serves as a major public park including recreation, sitting, viewing, and general leisure services.

Methods

This analysis explores coastal erosion in Netanya based on: (1) the demographic and socioeconomic makeup of the population that will be most affected based on proximity to erosion "hotspots"; and (2) the availability of alternatives that can make up for lost recreational park land and open space. For the latter measure, I calculated the portion of shore area expected to erode within five years provided no action is taken and if current trends continue. Then I related this to the quantity of area available for comparable uses, both existing and planned.

For the former measure I use multi-variant linear regression analysis to model the relationship between resident-population characteristics and proximity to sites of high rates of erosion. This allows characterization of those living near erosion hotspots as either "strong" or "weak" populations. I define strong populations as non-immigrant populations with a high standard of living and wealth. They also include higher percentages of working age adults (less children and elderly) than in other areas. By contrast, vulnerable or "weak" populations are groups of residents with large percentages of immigrants, lower standards of living, more unemployed, low income earners, and comparatively larger percentages of elderly and youngsters.

Table 1
Shore segment erosion rates

Segment	Approximate latitude[a]	Estimated erosion rate	Qualitative rate[c]
A	694850-695133	.27 m/yr	High
B	694330-694850	.30 m/yr	Very high
C	693970-694330	.25 m/yr	High
D	693500-693970	.18 m/yr	Lowest
E	693080-693500	.27 m/yr	High
F	692558-693080	.22 m/yr	High
G	692187-692558	.27 m/yr	High
H	691700-692187	.39 m/yr	Very high
I	691535-691700	Protected (retaining wall)	Erosion on sides of wall
J	689909-691535	.60 m/yr	Highest
K	689000-689909	.34 m/yr	Very high
L[b]	688309-689000	.27 m/yr	High
M[b]	687168-688309	no cliff/unused	
N[b]	685696-687168	unmeasured	
0[b]	684813-685696	unmeasured	

Adapted from Madpis (2005).

[a]Since some of the segments did not match up I took a midpoint between two non-adjoining endpoints as new segment endpoints to form continuous coverage along the shore.

[b]These segments are around the former Netanya landfill that is slated for removal. Erosion rates were not measured for three of these four segments because according to Madpis (2005) the area is undeveloped and damage to "life or property" is not foreseen.

[c]Qualitative rates are in relation to overall quantitative erosion rates.

One hundred meter grid squares serve as the units of analysis for the regressions. Data (variables) on the populations is associated with a point indicating the center of the grid squares (centroid). The dependent variable indicates each centroid's distance from a 100-meter buffer area[4] surrounding the segments of greatest erosion (see Table 1). The rest of the variables (explanatory or independent) indicate the demographic and socioeconomic characteristics of inhabitants in a statistical area[5] (SA) and distance of the centroid from alternative available open space.

Each centroid's demographic and socioeconomic indicator values are taken from the SA that contains it. The Israel Central Bureau of Statistics (ICBS) uses SAs as the smallest geographic unit of analysis in municipalities of at least 10,000 inhabitants. Their small size allows both homogeneity and a reasonably fine-grained expression of socioeconomic and demographic sampling indicators (Israel Central Bureau of Statistics 2000).[6]

Demographic Variables

Two variables indicate the age of important population groups in proximity to the erosion hotspots: *percentage of young* (<20 years old) and *percentage of elderly populations* (>70). In addition to being non-workers, the young and the elderly are more likely to make use of open space that is accessible to them by walking or public transport.

Figure 2. Northward view of the eroding coast over Segment J (highest erosion) and Segment H (high erosion) with recreational structures in the distance. Cliff height ∼ 30 m.

Race is a complex issue in Israel. As mentioned, most environmental racism literature about Israel addresses the Arab minority (Tal 2006; Shmueli 2008). There is no Arab population registered as living in Netanya and the non-Jewish population is small (∼7%) (Israel Central Bureau of Statistics 2009). Therefore I use variables indicating ethnic background and nativity: *percentage of new immigrants*, *percentage of African origin*, and *percentage of African or Asian*[7] *origin.* Among immigrants, those from North African and Eastern European (Asian) countries typically experience disadvantages in Israeli society when compared to those of Western European or American origin including inequality in economic well-being and discrimination (Lewin-Epstein, Elmelech, and Semyonov 1997; Amit 2010). For this study, new immigrants arrived within five years leading up to the 1995 Census. Origin is determined by parents' birthplace. For example, "percentage of African origin" indicates the share of total population in the SA whose parents (of heads of households) are African born.

Socioeconomic Variables

Six variables serve as proxies for the socioeconomic condition of residents: *population density*, *housing density, percentage unemployed*, *income per capita*, *percentage on income maintenance, home price*. All of these are based on information from the ICBS except the latter which is from an interactive on-line appraisal database supplemented with information from a free-lance assessor. Housing density, income per capita, percentage unemployed and percentage on income maintenance are based on the "rank" of the SA. The ICBS uses a

Figure 3. Close-up eastward view of cliff erosion affected by surface runoff held back by retaining wall within Segment K (high erosion). Cliff height: ~ 20 m.

statistical method called cluster analysis to rank the SAs from 1 to 20. It organizes the SAs into subsets (i.e., ranked clusters) such that the variance among values is minimal within a cluster and maximal between clusters (Israel Central Bureau of Statistics 2000).

I assigned a categorical value for each of the variables by SA cluster rank for the four socioeconomic indicator variables to compensate for the fact that the census data is fifteen years old.[8] While the particular value for each of these four variables will have changed over the years, the SA cluster rank has likely remained the same due to the homogeneity of the SA and the stability expected from year to year within and among the clusters (Israel Central Bureau of Statistics 2000). The categorical ranking (1 = strong; 2 = medium; 3 = weak) of each variable represents an equal division of the range of all possible values from among all the clusters, divided numerically. For example, 1995 average income per capita ranges from 567 New Israel Shekels (NIS) per month in SAs ranked as belonging to cluster 1 to 5126 NIS per month in those ranked 20. I divided the total income range equally (567-5,126 NIS) into three sub-ranges. Accordingly, a hypothetical SA in Netanya belonging to cluster 18 falls in the medium range (2) because the average income per month for SAs in this cluster nationwide is 3,382 NIS per month and the upper limit for the medium range is 3,607 NIS per month.

The last of the independent variables used in the regression analysis is *distance to alternative open space.* It refers to open space that can serve as replacement for lost beaches. I define these "alternatives" as areas designated as woods, public open space or sport, culture, and recreational areas at least 1,000 m^2 in size.[9] I calculated centroid distances

from such polygons using the Point Distance function of ArcMap 9.3. A consolidated Geographic Information Systems (GIS) layer from 2002 is the source of information about land uses. This is an aggregated data layer at a resolution of 1:50,000 cm by the Central Bureau of Statistics based on the Israel Mapping Agency's National GIS Program.

The Access Zone

The impact of erosion on resident populations who use the beach and coastal cliff, depends on the distance of populations to the focal points of risk or loss ("hotspots"). The value of these areas to local residents is based on their accessibility. Planning literature describes accessibility as a combination of distance to destination and ease of reaching it (Handy and Niemeier 1997; Hewko, Smoyer-Tomic, and Hodgson 2002). I model the relationship between populations and land uses within a reasonable maximum distance from the erosion hotspot within which residents have relatively easy access to the beaches and coastline for recreation and related amenities.

Approaches to defining and measuring accessibility conceptualize access as the relationship between an origin and a destination. These approaches incorporate the idea that residents farther from an amenity, such as a library or park, will use the facility less those who live closer. From an economic perspective, the distance users must travel imposes costs that reduce the value of the service and therefore its utility (Lindsey, Maraj, and Kuan 2001). In their article discussing local accessibility and transportation patterns, Handy and Neimeier (1997) report that 15 to 30 minutes is a reasonable travel time for driving; they describe studies for which accessibility is measured by analyzing activities within 15, 20, and 30 minutes of large concentrations of population and jobs. These time ranges give an indication of the time that a person would be willing to spend on travel; I use the median 22.5 minutes for an upper limit walking time.

If a person walks at a comfortable pace about 5.4 km an hour (based on an average rate of younger and older walkers of approximately 90 meters/minute), then 2,025 (90×22.5) m should determine the upper limit of accessibility areas from the destination for walking (Knoblauch, Pietrucha, and Nitzburg 1997; Crawford 2009) leading to an "access zone" of 2 km. Therefore centroids of interest fall up to 2 km distance from hotspots of erosion. Forty-six SAs out of a total of 54 in Netanya are totally or partially within the access zone that contains 1,517 centroids (observations) total.

Alternative Public Amenity Land Uses

This part of the analysis compares beach and cliff-top park area expected to be lost through erosion to the general amount of land available for similar uses (e.g., open space, recreation, beach) within an area of 1 km, 2 km and within the total city limits from the erosion hotspots. I calculated the total amount of public amenity land use accessible from three different sources: (1) a compilation of approved detailed and outline plans current to 2006 prepared by the City of Netanya's Planning Department; (2) an existing land use survey compiled in a GIS database from 2002; and (3) planned land uses according to the National Outline Scheme for the Mediterranean Coast (NOS 13) for the Netanya area approved in 1983. NOS 13 applies to the coastal areas and includes most of city of Netanya. It designated some areas for various levels of protection, outlined the uses allowed in the near-shore land area (i.e., tourism, agriculture, beaches, etc.), and established a 100-meter landward setback line within which development is strictly prohibited.

Table 2
Open space (OS) loss results

Alternative Measure	Planned public OS & sport/recreation based on compilation of plans[a] (2006)	Land uses public OS & sport/ recreation (2002)	NOS[b] 13 bathing beaches & Public OS (1983)
Available w/in 1 km of "hotspots"	1461468 m^2	217874 m^2	497877 m^2
Percent loss w/in 1 km	0.8%	5.6%	2.4%
Available w/in 2 km	2344537	745999	582297
Percent loss w/in 2 km	0.5%	1.7%	2.1%
Available w/in Netanya in m^2	3550081	1162762	615858
Percent loss w/in Netanya	0.3%	1.2%	2.0%

[a]Approved by 2006; includes land uses listed as bathing beach; public open space; public open space w/ sport; park; landscape reserve; beach.
[b]National Outline Scheme 13.

The land use categories are slightly different in each of the three data layers (see Table 2) as a result of the different purposes and level of detail of each. I calculate the future loss over a period of five years, assuming that no new measures to stop erosion are taken and that the current trends continue (Table 3).

Results

Demographic and Socioeconomic Characteristics Analysis

Study results indicate that populations living close to the erosion hotspots are generally younger or older than those living farther from erosion spots. They are composed of less new immigrants, live at lower density, have higher income per capita, have more options for alternative open space (other than beaches) and their homes are worth more. But their residents have higher rates of unemployment and the percentage of elderly living in these areas is not highly correlated with unemployment. Ethnic origin (African or Asian) was dropped from the model because the results were not statistically significant (p-value $>$ 0.05).[10]

Table 4 compares the "expected" signs to the actual signs of the constants included in the model. Expected signs are based on an environmental justice paradigm: populations living close to environmental and natural hazards are disadvantaged, generally weaker groups, as defined herein. If coastal erosion could be viewed from a "typical" environmental justice perspective, we would see all or most of the signs matching between the two columns (expected and actual).[11]

Only four of the nine variables used in the regression analysis fit the expected relationship, namely those indicating age and immigration status. The few matches between the

Table 3
Estimated 5-year beach and cliff loss

Segment[a]	Length of segment	Yearly loss in square meters (m^2)[b]	Estimated loss in 5 years in m^2
A	286	77.22	386.1
B	526	157.8	789
C	373	93.25	466.25
D	485	87.3	436.5
E	444	119.88	599.4
F	533	117.26	586.3
G	376	101.52	507.6
H	498	194.22	971.1
J	1673	1003.8	5019
K	939	319.26	1596.3
L	711	191.97	959.85
Total		2463.48	12317.4

[a]Only those segments for which erosion was measured (see Table 1) are listed in this table and used in the analysis.
[b]This calculation uses the estimated erosion rate from Table 1.

Table 4
Regression results. Independent variables with their expected relationship to distance from erosion hotspots. Shaded variables fit with expected characteristics of populations living near environmental hazards

Variable[a]	Type	Expected sign	Actual sign
Young population (<21 y.o. in SA)	Continuous	negative	negative
Elderly population (>69 y.o. in SA)	Continuous	negative	negative
Density in SA (m^2 per person in SA)	Continuous	positive	negative
Housing density	Categorical	positive	positive
Income per capita	Categorical	positive	negative
Unemployment	Categorical	negative	negative
New immigrant population	Continuous	negative	positive
Distance to alternative open space[b] (m)	Continuous	negative	positive
Home price per m^2 (average for SA[d] in NIS[c])	Continuous	positive	Negative

[a]The results of the regression analysis using all data showed p-values ≤ 0.05 unless otherwise indicated.
[b]Only open space greater than 1,000 m^2 was considered.
[c]New Israeli Shekel.
[d]Statistical area.

two columns suggest that coastal erosion in Netanya is not a typical environmental justice hazard. There are not significantly weaker populations living in proximity to the hazard. These results suggest that the eroding beaches of Netanya are an amenity attractive enough to draw relatively strong populations despite their being a hazard.

To summarize those likely to be most impacted by coastal erosion due to proximity, are not particularly weak or disadvantaged populations when compared to those farther away. They do consist of higher percentages of young and elderly and include more unemployed persons living in smaller housing units. However, their homes are worth more, indicating the demand for living in proximity to beaches and the shore. Further, overall populations living closer to the hotspots enjoy more general space (built and unbuilt) as indicated by the density variable. Also, there are less new immigrants in these areas than there are farther away.

Alternative Amenities Analysis

The impact of beach loss experienced as loss of a recreational amenity may be decreasing over time as more land is dedicated to open space alternatives. According to existing land uses from 2002, the beach loss was relatively significant (e.g., 5.6% of all comparable open space in the 1 km buffer) when compared to open spaced designated in plans approved by four years later. The rate is high in all three of the areas analyzed: at 1 km and 2 km distance from erosion hotspots, and within the entire city.

When comparing the 2002 layer to the 2006 compilation of plans, it is important to note that the former shows existing uses while the latter indicates uses planned. The third source used for this analysis, NOS 13, shows very little difference between the three areas (ranging only from 2.4% within one kilometer and 2.0% loss of total open space within the entire city). Most of NOS 13 focuses on designating land for open space and beaches in close proximity to the shore which is why there is little difference between the zones. Also, the impact is lower than we find according to a more detailed and current calculation of open space alternatives (2.4% of open space allocated in NOS 13 to 5.6% loss according to land uses in 2002). This likely reflects intensive, non-recreational development occurring in recent years throughout the near-shore areas of city (beyond the 100-meter setback line).

Discussion

Based on the Netanya analysis coastal erosion fits neither of the two common paradigms about the creation of situational outcomes characterized as environmental injustices (see earlier section). The first posits that environmental hazards decrease property rates such that low income, disadvantaged populations either are left in the vicinity of the hazard because they cannot move away or move close to a hazard because it is all they can afford. The second paradigm posits that environmental hazards are sited from the get-go in areas of poor and minority populations because perpetrators of these hazards look for low cost locales and areas where populations have little political clout to remedy hazards or to go after hazard perpetrators to hold them responsible (Been 1994; Szasz and Meuser 2000).

For shoreline change, the question is how hazards affect resident populations drawn initially to an area for non-hazard-related reasons. With coastal erosion we have a clear hazard and impending loss, but also on-going amenities (beach, seascape views, etc). Study findings suggest that incentives of living near the shoreline and enjoying coastal recreational and aesthetic amenities are greater, or at least equal to, the disincentives of living in close

proximity to the hazards of erosion; however, this finding needs to be closely monitored over time.

For the time being, discussions going on among engineers and politicians in Israel do not involve the public in any way. Potential property owners and residents may not be aware of natural and climate change-related processes occurring that turn a resource amenity into a hazard. This hinders their making well-informed choices about where to live and recreate. If the first EJ paradigm holds true, the population characteristic-erosion hotspot relationship in Netanya will change as erosion becomes more acute and residents become more aware of hazards and loss. It will also depend on policy responses, as suggested by McLaughlin, McKenna, and Cooper (2002) and Cooper and McKenna (2008).

Public policy response to coastal erosion provides opportunities to counter the elements of discrimination framed by EJ paradigms as described by Taylor (2000) in ways that engender aspects of procedural and corrective justice. To complement the recommendations adopted by the government as described earlier, policymakers should tax amenity-enjoying properties. Because those living close to erosion hotspots in Netanya are not particularly weak or disadvantaged, this may be a viable policy option. Revenues could be ear-marked for monitoring of coastal change, funding the dissemination of information about erosion to the public and could help institute comprehensive regional (rather than local) coastal planning. The responsibility of educating the public about physical processes occurring and especially for the need to consider comprehensive regional (as opposed to local) solutions should be taken on by local and national authorities. This in turn would likely generate public pressure to get those contributing to coastal shoreline change (e.g., through coastal construction) to take part in remedies.

Specifically in Netanya, in regards to funds collected for corrective actions, there should be a division made between obligations of residents from "core" older neighborhoods and newer or future ones. This is because severe property-threatening erosion is a relatively recent phenomenon in Israel. Newer residents could be better informed. In Netanya, old neighborhoods are better protected by longstanding breakwaters and they are farther from external offshore structures built to the south.

On a global or regional scale, in discussions about sea-level rise resulting from climate change, equity is a concern (see Stallworthy 2006). Those most likely to be emitting gases that contribute to climate change (i.e., those of the first world), are those most likely to be able to adapt to its consequences.[12] Questions on a local level mirror those posed on the larger scale: should those enjoying coastal amenities and well-off enough to be able to adapt to consequences of erosion, be helped by public funds? This question has become part of the debate in Israel as the government develops a comprehensive policy for addressing the risks and costs of erosion and cliff collapse (see earlier section).

The alternative amenities analysis part of this study addresses a question that has been neglected by the debate in Israel even though it involves the related investment of public funds. Findings show that the provision of alternative open space is not a problem although it is not clear from this research if planners consider the expected loss of beaches and recreational open space. The compensatory provision of open space is a type of corrective justice although the value of beaches and cliff-top parks as a unique type of open space and recreational resource, must be acknowledged.

The expert report (Bein, Edelman, and Cohen 2009) submitted to the Israeli government calls for physical coastal defense (beach nourishment, hard defenses,[13] and surface runoff treatment) for priority areas of the eroding cliffs (i.e., those in urban areas, near single-family homes, and around archeological sites). However, actions taken in one place in

the form of compensatory beach nourishment or hard coastal defense such as a sea wall or breakwater will have far-reaching impacts both temporally and spatially as natural sediment flows are interrupted (Klein and Zviely 2001; Stallworthy 2006; Smith et al. 2009).

To prevent erosion the City of Netanya has developed a plan to build six breakwaters along the Netanya coastline.[14] This will affect important public uses within and outside of the municipal limits. It shows a lack of sensitivity to issues of equity on a large scale and in the long term as the city takes action to solve its own problem, thus creating externalities on a regional and national scale. Since plans are devised, promoted, and finally approved at the municipal level by local authorities, an EJ analysis such as the one conducted in this study should be made between cities. EJ should be considered at a regional, ideally at a sediment-cell scale although political realities are prohibitive. Further, a long-term response can be significantly different than one chosen for the short term. For example, in Britain, the case has been made for government support of coastal defense in the short term on environmental justice grounds where local populations are elderly retirees dealing with erosion. These populations cannot manage the long-term coastal defense options consisting of retreat or relocation (Cooper and McKenna 2008).

Some hard structures, such as retaining walls or rip-rap will be in direct and immediate conflict with the maintenance of beaches for recreational purposes although they may reduce erosion. A policy of retreat (abandonment) has associated externalities in the long term although it avoids or delays impacts. Letting nature take its course, allowing the erosion of bathing beach and recreational facilities, involves loss and risk to the general population. Planners, dealing almost exclusively with long-term time scales, should consider alternatives to the uses that will be lost using alternative amenities analyses similar to the one presented here.

Conclusions

Many environmental justice theories focus on environmental aspects of distributive justice as these are observed in outcomes; others focus on processes that lead up to and affect justice issues and decisions. This article has a distributive focus as its point of departure. However, on the basis of the empirical analysis *and* a review of national response to coastal shoreline change taking shape in Israel, I add process elements of knowledge-sharing and concerns about compensation to the distributional perspective.

Environmental justice calls for protection from and response to hazards irrespective of racial or socioeconomic makeup of proximal populations. This study finds that seashore dwellers in Netanya are generally mixed populations, not particularly strong or weak as defined herein. However, inequities may arise if protection of the amenities enjoyed by seaside residents is subsidized by the general public or if actions taken to protect residents of Netanya will affect other communities of weaker economic standing or other types of disadvantaged or disenfranchised communities. Another inequity may result if these populations, or future ones, lose the important recreation and open space amenities they now enjoy.

An analytical approach similar to that used in this study should be applied at appropriate temporal and spatial intervals to help decision-makers identify the EJ implications of coastal erosion and cliff collapse as they grapple with formulating a national policy response. Other cities may fit the EJ paradigm in that typically disadvantaged populations are living in close proximity to hotspots. Also as erosion hazards intensify, it will be important to monitor the relationship between socioeconomic/demographic characteristic of residents and the focal areas of these hazards.

Notes

1. Pulido (2000) uses the term environmental racism to highlight racial (as opposed to economic) disparities. She also explains that the term environmental justice is more inclusive. For this reason it used here unless racial disparities are emphasized.

2. The country's National Master Plan for the Mediterranean Coast calls for nine marinas to be built along the coast south of Haifa. Five of these exist today. Yaffo and Tel Aviv marinas were built in 1972 and large marinas in Ashkelon, Ashdod, and Herzliya were all built in the early 1990s.

3. Bathing beaches, where swimming is allowed, closed usually due to the inability of local authorities to maintain them with services required by law such as lifeguard stands and trash pickup (State Comptroller 2010).

4. Centroids within the 100-meter buffer have been deleted because the National Outline Scheme for the Mediterranean Coast completely prohibits construction within this distance from the waterline.

5. Statistical areas (SAs) are the smallest geographical division used by the ICBS composed along homogenic neighborhood lines. These are similar to census tracks in other countries.

6. I derived the data for four SAs for which socioeconomic data was not available by averaging together the values of the SAs that are adjacent to the missing area.

7. "Asian" in the 1995 Census includes those from countries of the former Soviet Union.

8. Although the ICBS has conducted a new 2010 Census, detailed socioeconomic data is not yet available at the SA unit level.

9. See Brown (2008) for a categorization of park sizes based on the U.S. National Park and Recreation Association's guidelines designed to promote adequate levels of recreation opportunities within urban areas.

10. In addition to the lack of statistical significance to determine the incidence of particular ethnic minorities living in proximity to coastal erosion in Netanya, the difference in beach use patterns between the ethnic groups in Israel in unclear. Other studies have shown the importance of understanding cultural and recreational practices to issues of distributional justice (Baas, Ewert, and Chavez 1993; Shaull and Gramann 1998).

11. A similar approach that compared expected to actual coefficient signs was used by Eberbach (2007) in examining the influence of environmental attributes related to coastal erosion on property values.

12. The EJ issues of concern at a global scale will be different from those at regional and local scales. The experiences of those in developing nations will be different from those in developed nations. For a discussion of how injustice is distributed differently in these cases see McLaren (2003) and Jacobs (2005).

13. Hard physical defenses are revetments, rip-rap, seawalls, breakwaters, bulkheads, jetties, groins, aprons, and various cliff base treatments.

14. The Central District Planning Commission reviewed the plan (No. 280) and called for the preparation of an environmental impact state in its interim decision (No. 200-1006) on May 22, 2010.

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