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Proposal for an integrated risk index for the planning of recreational beaches: use at seven Mexican arid sites

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ABSTRACT

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An integrated risk index has been developed for evaluating tourist and recreational beaches. It includes an index of beach suitability for recreational use, an index measuring the user's perception and an economic index expressing the monetary value of the beaches. The contamination vulnerability was evaluated with one physical attribute that reflects indirectly the cleaning ability of the water body where the beach is located. Seven beaches in north-western Mexico were evaluated with this index. Two beaches have high recreational values but one is located in a semi-enclosed area with the contamination vulnerability causing the risk index to be high. In contrast, the other high-valued beach is on the open sea; therefore the risk index is medium. Three beaches have medium recreational values but only one has a high risk index because it is in the most enclosed area. Two beaches have low recreational values with one having a medium risk index because it is located in a large bay open to the sea. This model, although proved in arid beaches, can be useful for any other beach (temperate or tropical).

ADDITIONAL INDEX WORDS: *User's perception, beach indexes, contamination weight, beach planning.*

INTRODUCTION

Almost fifty percent of the Mexican coast is in arid climates. Although most of the well-known beaches are in tropical humid environments, recreational beaches in arid lands are becoming important in recent years because there is a national campaign to open new international tourism centres in Mexico's remote and less populated land; the arid coasts. Beaches in northwestern Mexico are mainly arid and are becoming popular and intensively visited by tourists and residents. Therefore, in Mexico certifying beaches is promoted (NORMA OFICIAL MEXICANA, 2006) for international competitiveness and to guarantee user's satisfaction and security. Integrated evaluations must consider environmental indicators that give value to the natural capital (ecological), social capital (the users' perception) and built capital (value of the infrastructure or services next to the beach), besides the contamination danger.

An interdisciplinary approach using two scales was used in a government-academic research project as a proposal for an integrated evaluation of these beaches.

METHODS

The model has three components and a contamination weight. Three concepts are important; a) vulnerability, the possibility that the recreational beaches as an ecosystem are contaminated, b) risk, the probability that the users may suffer damage to their health or real estate by contamination and c) danger, the intensity or the vulnerability to the contamination. We equated the risk index[(1)] to the group of vulnerability indexes that are dangerous.

$$RI = (VI,C) \text{ or } (BI,KI,MI,C) \rightarrow (1),$$

where

RI = Risk Index for recreational beaches,
VI = Value Index for recreational beaches,
BI = Beach Index; the beach ecological, infrastructure, and contamination characteristics reflecting the suitability for recreational uses,
KI = Knowledge Index; the user's perception of the recreational beach (perception measures beach user's opinion and attitude),
MI = Monetary Index; the value of the beach per square metre, taxes, and three-star hotel rates, and
C = Regional Contamination, the Vulnerability Weight.

To be comparable, all the numeric values were standardised with the modified nonparametric statistic of NIJKAMP and RIETVEL (1990). To select between two values we used a decision-making matrix (Table 1).

Table 1. Decision-making matrix to select between two RI ranks. RI = (VI, C).

Value Index for Popular recreational beaches (VI)				
Regional contamination vulnerability weight (C)		HIGH	MEDIUM	LOW
	HIGH	High	High	Medium
	MEDIUM	High	Medium	Medium
	LOW	Medium	Medium	Low

First, the beach index (BI) was obtained from a descriptive format taken in field work using 29 attributes of ecological beach features (physical and biotic), 38 attributes of infrastructure and services and seven attributes of contamination. The descriptive record valued the suitability for recreation describing the attributes on a scale from 1 to 5, where 5 meant the greatest value granted to the attribute for recreation. The value assignments were made starting from the characteristics of an "ideal" popular recreational beach that is a pleasant beach for most of the users according to previous international studies about perception of beaches (WILLIAMS et al., 1993; LEATHERMAN, 1997; MICALLEF and WILLIAMS, 2003). In accordance with these studies, the ideal beach has sand, the water is not deep, the temperature of the water is pleasant, it lacks dangerous animals, sand and water are clean, no bad odors or discharges, it is not dangerous and it has basic infrastructure and services (access, bathrooms, security, lifeguards, shade, and small shopping areas).

Secondly, the user's perception value (KI) was achieved by interviewing beach users on weekends and holidays from spring 2005 to summer 2006. The interview format followed international experiences (MORGAN et al., 1993; MCLEOD et al., 2002; PEREIRA et al., 2003) and was proved in a similar local beach as CHADWICK (1984) suggested. To measure the beach user profile we asked for age, school level, gender, marital status, occupation and origin. Recreational habits were recorded by asking about activities performed at the beach, seasonal preferences, motives and accompanying family or friends. The other set of inquiries got the user's opinion of the beach biophysical characteristics, the services available and infrastructure of the beach. To statistically define the appropriate number of interviews a probabilistic expression for infinite universes (N >1000) was used (IBARRA, 1998). To corroborate if the number of interviews was significant, the isovariance curve methods suggested by SOLANA-SANSORES and ARREGUÍN-SÁNCHEZ (1990) were used. The questionnaire was analysed by using SPSS® version 10.0. The value ranking was obtained by qualifying the responses into three categories: (Favourable-3, Regular-2 and Unfavourable-1). Again, preferences were valued by contrasting them against the "ideal beach" described above. Finally, the total values were adapted using the method of MICALLEF and WILLIAMS (2004), which is the average of all the attributes evaluated among the categories and thus comparable with any of the other indexes (CENDRERO and FISCHER, 1997).

The beach economic value (MI) is then defined by the market and private, public and institutional interests. It is a multiplier factor taken from three monetary values given by the presence of the beach (ESPINET-RIUS and FLUVIA-FONT, 2005; VILLARES et al., 2004). The indicators used were two taxes and two rates; a) a municipal ownership tax, b) a federal beach tax (ZOFEMAT) for general use, c) the average value of real estate per square metre for a two bedroom house and d) the average rate of a double room in a three-star hotel. Each value indicator differentiated values with and without beach front to a range of two blocks or 200 metres inland towards the urban area starting from the physical limit of the sandy part of the beach (except the value of ZOFEMAT that has no equivalent inland value). For comparison purposes the values were transformed to United States dollars (USD).

Finally, a regional contamination vulnerability weight (C) was designed to compare beaches on a regional scale (Table 2). It is based on an indicator that refers to closed, semi-enclosed, or open waterbodies because this simple physical attribute reflects indirectly the cleaning ability of the waterbody where the beach is located (ESCOFET, 2004; ESCOFET and ESPEJEL, 2004). Higher values like 12 (see Figure 1, where site 7 or Miramar is in the upper part of an almost closed Gulf and inside a semi-enclosed

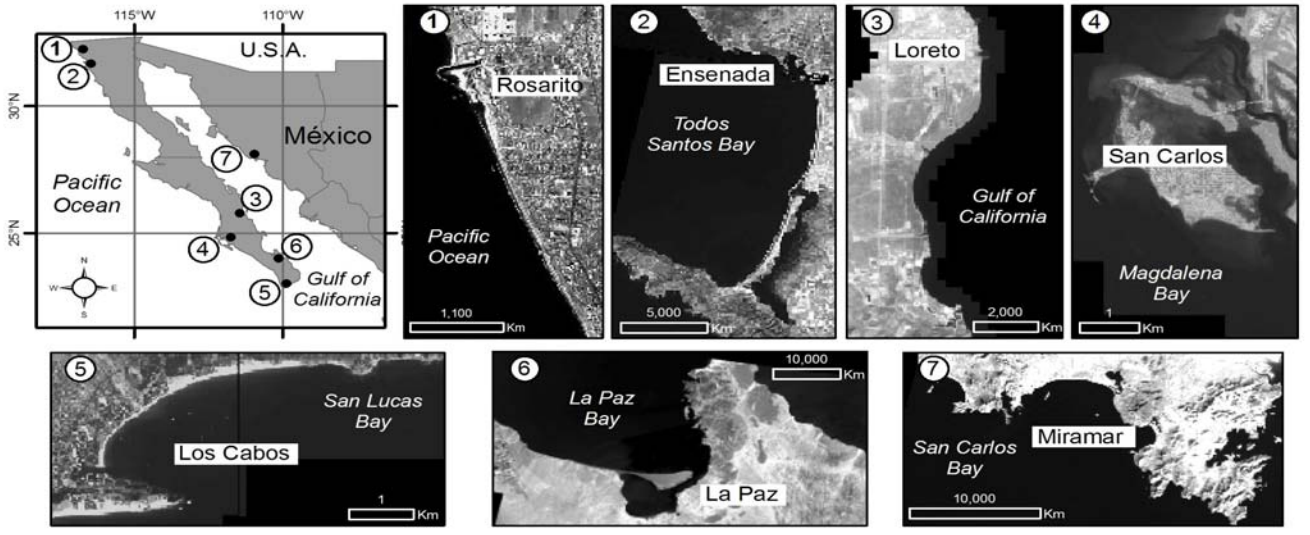

Figure 1. Study area, seven beaches of northwestern Mexico. The form and location of the beach were indirect indicators of the waterbody cleaning ability (see Table 2).

bay) meaning a higher vulnerability to contamination because of a lower water cleaning capacity in contrast to Los Cabos (site 5 in Figure 1) that is in an open site open to the sea.

Table 2. Calculation of the Regional Contamination Vulnerability Weight. The numbers between brackets are nominal values related to the location of the sites (see figure 1) and are multiplied together to yield a total value or weight. 1-2 = Low, 3-4 = Medium, 12 = High.

Sea Type	Location	System	Beach	Weight (C)
Pacific, open (1)	North	Bay (2)	Ensenada	2
		Open (1)	Rosarito	1
	South	Lagoon (3)	San Carlos	3
		Open (1)	Los Cabos	1
Gulf, closed (2)	High (3)	Semi enclosed (2)	Miramar	12
	Medium (2)	Open (1)	Loreto	4
	Low and Gulf mouth (1)	Semi enclosed (2)	La Paz	4

RESULTS

Beach suitability for recreation or Beach index (BI)

Three beaches have a high suitability for recreation based on the quality of their beaches, in physical terms and the infrastructure and services that offer urban and hotel areas (Table 3). In contrast, the rest have a medium value because although physical features are fairly good, they are incipient as tourist beaches (lack of infrastructure and services). Low ranked beaches are severely polluted (San Carlos) and Rosarito has no ordered beach use; motorcycles, horses, and drunks mix with the more peaceful tourists. With a little investment and government compromise for both, it would be possible to raise their quality to an optimum recreational beach.

Table 3. Recreational suitability of seven beaches in arid Mexico named beach index (BI). In brackets the resulting value.

Beach	Beach Index (BI)
Loreto	(0.85) High
Los Cabos	(0.75) High
La Paz	(0.70) High
Ensenada	(0.57) Medium
Guaymas	(0.68) Medium
Rosarito	(0.45) Low
San Carlos	(0.46) Low

Beach Users' Perception or Knowledge Index (KI)

La Paz and Los Cabos are the best perceived beaches (Table 4). Despite the bad odors of the algae from sewage runoff (La Paz users avoid those areas), the interviewees agree on the concept of an "ideal" beach, especially because there are shade and shops. Ensenada and San Carlos are not tourist beaches, though they have some favourable physical attributes. There is a perception of danger (an undertow current at Ensenada and garbage at both). Loreto has a medium value because of the presence of dangerous animals (there are many stingrays off the beach) and the lack of services. Miramar has a medium value because there are no services and people ignore other beaches and cannot make comparisons.

Table 4. Beach Users Perception of seven recreation beaches in arid Mexico (KI). In brackets the resulting value.

Beach	Opinion	Attitude	Perception value
La Paz	(0.7) Medium	(1) High	High
Los Cabos	(0.7) Medium	(0.8) High	High
Ensenada	(0.01) Low	(0.5) Medium	Medium
Loreto	(1) High	(0.3) Low	Medium
Miramar	(1) High	(0) Low	Medium
Rosarito	(0) Low	(0.3) Low	Low
San Carlos	(0.5) Low	(0.3) Low	Low

Beach economic value or monetary Index (MI)

From all the analysed beaches (Table 5), Los Cabos is the only destination for international "great tourism", planned according to the national tourism office. Together with Rosarito the multiplier effect is well represented. La Paz and Loreto are on their way to develop a great tourism policy and Miramar has medium value because of the absence of houses and hotels next to the beach. It is a colony of the city of Guaymas with an abandoned project of a marina and hotel. If and when this is developed, the value will surely increase rapidly. The low economic values of San Carlos and Ensenada are related to the low value of the other two indexes.

Contamination vulnerability (C), regional value to weight indicators

Miramar beach has the lowest cleaning ability because it is located in the northern Gulf of California, an enclosed bay as part of an enclosed sea (Table 2, Figure 1). Rosarito, Ensenada and Los Cabos have the greatest cleaning ability of all beaches because they are on the Pacific Ocean and exposed to the open sea. San Carlos, Loreto and La Paz have medium vulnerability because they are located where, despite an open sea, the beach is in a protected environment (a bay or protected by islands).

Integrated regional value (VI) for seven beaches in arid Mexico

The beaches with the highest VI are La Paz and Los Cabos. Los Cabos could be the best beach but the local users or those not staying in nearby hotels have no access to the services and infrastructure that these offer. Because the access to the beach is restricted, there are neither bathrooms nor garbage cans and

Table 5. Economic value of seven recreation beaches in arid Mexico (MI). In brackets the resulting value. 0-0.09 = Low, 0.1-0.5 = Medium, 0.6-1 = High

Beach	Municipal Land-Tax	Hotel prices	Houses prices	Federal Tax	Integrated Economic Value
Rosarito	Medium	Medium	High	Medium	High
Los Cabos	Medium	High	High	High	High
La Paz	High	Low	Medium	Medium	Medium
Loreto	Low	Low	High	Medium	Medium
Miramar	Medium	Medium	Low	Low	Medium
San Carlos	-	-	-	Low	Low
Ensenada	Low	Medium	Low	Low	Low

therefore it is not perceived by the interviewed users as the best. In La Paz the access to the beach is free and the infrastructure can be used although this is scarce. The low value of Ensenada and San Carlos is a consequence of a low value in all the indexes, except in Ensenada where the value of the recreational suitability is medium because though it is a beach with garbage it is not polluted. Loreto has a medium value because it has a high recreational suitability but medium values in the perception and the economic indexes. This is because of the absence of services and because the most valuable area is not the beach itsel, but the ocean view.

Table 6 can be read in two ways; comparing columns C and VI or only index RI. VI can be high, but if it has high contamination vulnerability (C) it would be losing the value of the real estate and services. The risk of losing the good perception of the beach users and losing its present economical value could be a warning for beach decision makers and their decisions as to where to act, especially when our interviewees point out the necessities for the beach users and their desires. If the beach has a high cleaning capacity, a low vulnerability to the contamination and a high VI, the beach has less risk of losing its value in spite of the presence of polluting events.

DISCUSSION

The beach suitability index incorporates both natural and constructed attributes of the seven beaches as done for several other beaches worldwide (WILLIAMS et al., 1993; LEATHERMAN, 1997; MICALLEF and WILLIAMS, 2003). The perception was documented as others have done at several beaches (MORGAN et al., 1993; MCLEOD et al., 2002; PEREIRA et al., 2003). The beach economic value has been used by ESPINET-RIUS and FLUVIÁ-FONT (2005), VILLARES et al., (2004), and CERVANTES and ESPEJEL (2006) and the novelty is the use of all of the indexes together and the addition of a regional weight dealing with water cleaning ability which looks for large area comparisons. The integrated index VI (Table 6) expresses the complex system of a beach (JAMES, 2000) and it can be used as an index to design regional planning policies when contamination weight is added (RI). In the pressure-state-response scheme from OECD (1995), BI from VI corresponds to a state indicator and the others indicate pressure. This scheme can motivate the planning organisation and be helpful to prioritise planning policies as responses to such pressures. If the responses are approached by policies of command and control to minimise events of contamination, the impacts will be being solved with answers that are only palliatives. If planning responses are given on the indicators of pressure, according to OECD (1995) the beach decision makers and stakeholders will be planning for the sustainable development of a beach.

When comparing the seven recreational beaches of arid north-western Mexico we find that they have an RI with a medium value except Ensenada that is low and Miramar and La Paz that is high. This is so, because although Ensenada has a low and Miramar a medium VI rank, Ensenada is a beach located in an area that has a high cleaning ability and Miramar has just the opposite, being in an almost closed environment (the north of the Gulf of California) and inside a bay (as La Paz). In planning terms, the beach of Miramar is of high priority and risky situations should be avoided in terms of contamination. For the time being, this beach does not have a high VI. If it had, the RI would be higher and there would be devaluation of its economic, human and natural capital. Los Cabos is the only beach with a high VI. Fortunately it also has a high cleaning ability, therefore a low C.

CONCLUSIONS

This model integrates diverse values describing recreational beaches for the first time in Mexico. Each index alone reflects important issues for beach planning authorities. The beach suitability index (BI) expresses, for example, the natural qualities of a beach together with the lack of infrastructure and services. If this index is used together with the Knowledge Index (KI), which reflects the beach user's perception of the natural qualities of the beach and the opinion of the needs of infrastructures and services, the beach planners can prioritise actions to satisfy most beach users. The monetary index (MI) reflects the economic private and public value of the beach. MI can be used by private investors as an indicator to make a better investment selecting the most

Table 6. Rank values forming the Indexes for recreational beaches

Beach	Beach index (Recreation suitability) (BI)	Knowledge Index (Users' perception) (KI)	Monetary Index (Economic value) (MI)	Value Index for recreational beaches (VI)	Contamination weight (C)	Risk Index for recreational beaches (RI)
La Paz	High	High	Medium	**High**	Medium	**High**
Miramar	Medium	Medium	Medium	**Medium**	High	**High**
Los Cabos	High	Medium	High	**High**	Low	**Medium**
Loreto	High	Medium	Medium	**Medium**	Medium	**Medium**
Rosarito	Low	High	Low	**Medium**	Low	**Medium**
Pto. Carlos	Low	Low	Low	**Low**	Medium	**Medium**
Ensenada	Medium	Low	Low	**Low**	Low	**Low**

valuable beach. The government authorities can use MI as an indicator of what is economically valued and orient actions to improve those beaches with a low MI.

The assemblage of indexes (VI) reflects all the possible values of a beach. VI could be a useful tool for local beach planners because authorities can orient investments in infrastructure or services and prioritise actions to certify the best beach and work towards certification of the others. Either they can select to work with improving the infrastructure or enhancing the natural attributes to get a better economic value or improve the beach user's perception.

Adding a regional pollution weight offers the possibility of comparing seven beaches in terms of regional planning. For infrastructure projects in the region, the authorities can prioritise, for example, the installation of a water treatment plant because in some places it is more needed than in others (see Miramar against Los Cabos). At the former, the waterbody in front of the beach has the worst cleaning capacity of the region whereas Los Cabos has the best. Local evaluations are also possible by adding local weights to all the indicators. These weights can be taken from the user's perception as Cervantes and Espejel (pers.com.) propose. This model, although proved at arid beaches, can be useful for any other beaches (temperate or tropical).

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