ASSESSING VULNERABILITY TO SOCIAL AND ENVIRONMENTAL CHANGES IN WEST AEGEAN COASTAL SIDE OF TURKEY

Senem Kozaman*

Abstract

After 1980's as a result of neo-liberal policies in development strategies of Turkey, coastal areas exposed a massive pressure on its environmental resources. Attractiveness of natural amenities and due to encouragement with regulations for tourism sector development caused population growth and agglomeration of real estate investments in these areas. Also, this process has triggered degradation of environmental values. Paradoxically, the coastal management policies and protection mechanisms gained significance for the sustainability of natural resources.

All these mechanisms have revealed the importance of understanding and assessing the vulnerability of these areas with regards to continuing trends of environmental and social change and natural resource consumption that restricts sustainability. From this point of view, this research is focused on the evaluation of vulnerability to these changes in Aegean cost side of Turkey; Izmir - Aydın - Muğla Provinces.

Assessment of vulnerability is based on the definition of IPCC that identify the vulnerability as a function of exposure, sensitivity and adaptive capacity. With a basic analytical framework, it's assumed that vulnerability will increase as the sensitivity rise and decrease as adaptive capacity evolves. Another assumption is built on the concept of sensitivity. It is defined as the changing trends in social and environmental indicators (land-use change, population growth, water and energy consumption, waste generation etc.) that demonstrate pressure and threat to socio-ecological system. Furthermore, exposure component is excluded from the evaluation. Adaptive capacity index is based on normalization of social, economic, environmental, pyhsical, institutional capital indicators and arithmetic means of these components. This framework will help to understand, compare and exhibit a geographical pattern of vulnerability in the study area.

1. Introduction

With the impact of anthropogenic activities, natural resources are consumed in an irrepressible way. Emerged environmental degredations as a result of this consumption, have been converted to problem areas from local to global scales. The production from nature means changes in nature and some irreversible changes caused and also may cause climate change, loss in biodiversity and soil fertility over time (Turner, 2010).

In this context, sustainability science has emerged as a branch that investigate human-environment issues and maintain substantial interests in questions of the relationship between human and biophysical environment. Ecological systems and human systems are dynamic, interdependent systems. As a result of this relationship to provide sustainability and to reduce critical issues the interaction between human and nature should be analyzed.

Furthermore, as the system exposed to stress, pressure and uncertainty new concepts have revealed as vulnerability and adaptive capacity in the literature of sustainability science. Briefly vulnerability concept which is the main topic of this research, is usually defined as the the degree of susceptibility to be harmed from pressure and stressors (Adger,1999 and Adger, 2006.)

*Yildiz Technical University, Urban and Regional Planning Department, senemkozaman@gmail.com

Vulnerability, as a concept, was applied to examine the combination of physical, social, economic, and political components that influence the degree to which an individual, community or system is threatened by a particular event, as well as their ability to mitigate these threats and recover if the event was to occur (Cutter et al., 2003).

Furthermore, adaptive capacity described as the ability of a system to adjust to actual or expected stresses or to cope with the consequences of this stresses. And also it is formulized as a function of information, technology, education, wealth, skills, infrastructure, access to resources and management capabilities of the institutions in that system (O'Brien et al.,2004; IPCC,2007).

Researches that examined the vulnerability of systems to stress and changes represent the concept with respect to drought, crop failure and famine, and vulnerability to sea level rise within the context of climate change respectively. Yet the evaluation of the impacts of non-climatic environmental and socio economic changes to vulnerability of the systems are rarely take into consideration (Smit and Wandel 2006; Brooks, et al.2005; Chazal et. al.2008; Berry,2007). On the other hand, some researchers suggested to focus not only on those related to climate change but also understanding the causes and evaluation of vulnerability to social and environmental stresses like land use change, pollution, resource consumption (Lahsen, 2010; Huang et al. 2011, Metzger et al., 2006; Schröter et al., 2005).

In this context, Huang et al. (2011), present an analytical framework for the assessment of vulnerability of coastal community to land use change and associate indicator system to assess and compare vulnerability of communities to land use change in coastal areas in China. In the study, vulnerability Index is assessed and compared among different communities based on the quantification of adaptive capacity and sensitivity. These indices are evaluated by the use of some socio-economic attributes of the community and their views on management and environmental change. Similarly, in some geography and ecology studies focused on the concept of "social vulnerability", underline demographic, socio-economic, cultural, and political features of communities and the role of institutions that influence vulnerability (Adger,1998; Cutter et al., 2003;Engle,2011).These studies have emphasized the importance of social conditions that make humans and communities vulnerable.

From this perspective some researches focused on individuals or groups rather than focusing on the pyhsical stress of the system or the causes of this pressure. They argued that social, economic and political structure is much more considerable than the causes of stress resources (disaster etc.). Yet, more recently some researches consider both physical and also social aspects of the vulnerability of a system (Schroter et al. ,2005;Engle,2011).

In general, the rhetoric obtained from the researches is that the interaction of socio-economic and environmental changes influenced the sensitivity geography of the local. Indeed, population growth, urbanization and migration pressures caused increase in environmental degradation, pollution, climate change and also leads to human-induced problem areas that effects each geography according to their characteristics in different forms and degrees.

Similarly as an anthropogenic factor, land use change presents unique challenges to local community, especially for those who depends their livelihood on the land. As a result of changes in land use and resource consumption, social vulnerability can turn into ecological vulnerability as a result of damage

and pressure. Huang et. al (2011), underline the importance of considering land use change as a result of urbanization and industrialization in coastal vulnerability.

Lubell et. al. (2009) claimed that "sustainability paradox" wherein richer, environmental interests promote the preservation of environmental amenities and resources while at the same time it accelerates residential development in a settlement. Similarly, the abundance of natural resources triggers socio-economic developments as an attractive element that rises viability in coastal areas, thus natural values are damaged as the artificial development increases. On the other hand disequilibrium in development, forced to seek optimal solution for achieving sustainability. Therefore, to ensure a balance between the components of sustainability is crucial.

In this context, the purpose of this paper is to identify the vulnerability of the settlements to social and environmental changes in İzmir-Aydın-Muğla provinces located in coastal Aegean side of Turkey.

Sensitivity and adaptive capacity concepts are evaluated by the use of indicators to determine the vulnerability of settlements. Instead of climate change, disasters and other natural pressure factors, human-induced land-use change, water and electricity consumption change trends, population growth etc. were included in the evaluation of vulnerability. Before the assessment results, literature review about the concepts and methodology will be discussed in next chapter.

2. Vulnerability, Exposure, Sensitivity and Adaptive Capacity Concepts

Vulnerability and its assessment has been used in different disciplines yet there is a continuing diversification in the definition of the concept (Adger, 2006; Smit and Wandel, 2006;Gallopin,2006).

Adger (2006) defined the concept of vulnerability as *"a powerful analytical tool for describing states of susceptibility to harm, powerlessness, and marginality of both physical and social systems, and for guiding normative analysis of actions to enhance well-being through reduction of risk".*

In the literature over the last decade, social scientists have focused on the reseraches concerning the role of socio-economic and political structures and processes that affects the vulnerability of communities and these researches seek to determine components and indicators of vulnerability and identified exposure to pressure and stress, coping and recovering capacity from the consequence of a stressor as the key components. (Luers et. al. 2003)

Similarly, IPCC (Intergovernmental Panel on Climate Change) in the Third Assessment Report (TAR) defined vulnerability as a function of exposure, sensitivity and adaptive capacity (Schneider et al.,2001; Posey,2009). Exposure is the extent of a physical harm by an environmental or social change that affects the system. Sensitivity indicates the degree how the system is affected or response after being exposed by a stressor and adaptive capacity refers to the ability of a system to cope or accommodate with the impacts of stress (Smit et al., 2001; Adger, 2006). For reducing vulnerability adaptive capacity is considered as a key element and a desirable - positive attribute of a system (Eakin and Luers, 2006;Posey,2009).

Adger (et. al.,2007) defined adaptive capacity as the ability or potential of a system to respond or cope with change and stress factors and the consequences. Smit et. al. (2001), also described the

term as the ability of a system to prepare for stresses and changes or adjust and respond to the effects caused by the stresses (Smit et al., 2001).

Nelson and others (2007), considered ‘‘adaptation’’ as *‘‘the decision-making process and set of actions undertaken to maintain the capacity to deal with future change or perturbations to a social-ecological system without undergoing significant changes in function, structural identity, or feedbacks of that system while maintaining the option to develop’’*. Lambin (2005), denote that limits of capacity are defined by social capital, trust, state-citizen relationship with an emphasis on the capacity of individuals and groups. Therefore, the concept of capacity; depicted from resources, technology, social networks and values, is the synthesis of the mechanisms that determine the relationship between human and nature.

Vogel (2011) claimed that adaptive capacity will depend on presence and distribution of the attributes below:

- Natural, economic, social and human resources,
- Access to desicion making processes, institutional resources,
- Public awareness, available technology.

Furthermore, Engle (2011) defined the relationship between these concepts with a simple depiction as shown in the Figure 1. When the capacity of a system - which is shaped by human action and affecting both social and biophysical factors of the system - is high, it mitigates the intensity of exposure and reduce the vulnerability level.

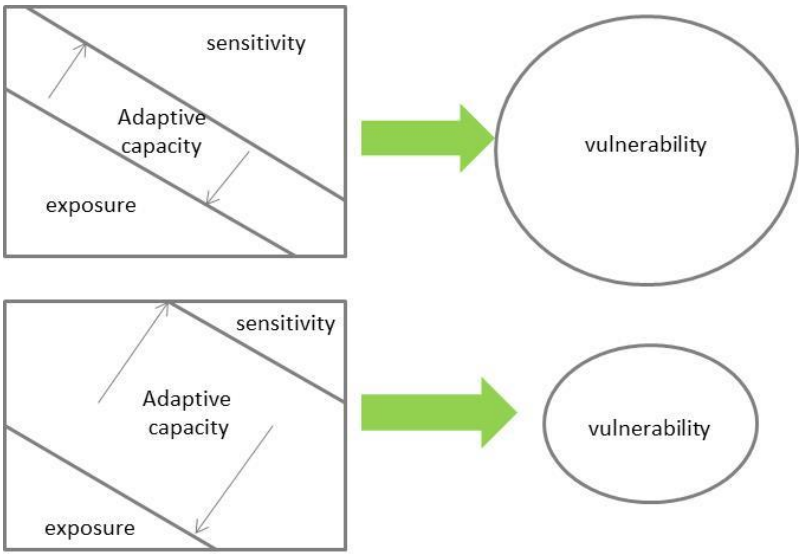

Figure 1. The role of adaptive capacity in influencing vulnerability (Engle,2011)

Despite the criticisms to the researches that depends on the measurement of capital, many of them frequently used capital components (environmental, physical, social, economic resources, etc..) in the evaluation of adaptive capacity. Because, ability of a society to respond or cope with change, is based on its capacity to control or access to resources. Communities with lack of resources are considered as the most vulnerable ones that exposed to the negative effects of change. Human and social capital is important as well as natural, physical and economic resources. By the guidance of this literature review, the following section explains the analytical framework and methodology of this paper.

3. Methodology

Due to vulnerability is a theoretical concept, the aim of this paper is to make this concept operational with a method of evaluating and comparing indexes and to observe it with mapping. As Hinkel (2008) cited from Schnell et al. (1999) and Bernard (2000) the transition of theoretical concept to operational, so the method is then called the operational definition (Schnell et al., 1999; Bernard, 2000). In the case of vulnerability concept, the operational definition is generally defined as the methodology of a vulnerability assessment.

As mentioned earlier, in this paper it's aimed to determine the vulnerability of settlements against environmental and social stressors. Vulnerability is characterized by shock, stress and susceptibility to degradation or system capacity to adapt change and such factors. One of the main objectives in determining the vulnerability is to identify priority areas or communities for the implementation of actions to reduce damages that will affect as the result of stressors.

In this context, the method of indexation in vulnerability assessment approaches are taken into consideration and described below:

3.1 Vulnerability Index

Most of the studies in literature that described vulnerability as the function of sensitivity, exposure and adaptive capacity, considered external forces such as disasters. Yet internal pressure factors, human induced changes like land-use change, social changes also find place in some researches (Huang, et.al, 2012; Luers,2005).

In this paper, vulnerability assessment is based on the definition of IPCC that relate vulnerability with adaptive capacity, sensitivity and exposure.

As depicted in Engle's scheme, Huang et.al (2012) also constructed vulnerability based on the Equation (1) that the vulnerability index is (VI) in proportion to Sensitivity Index (SI), and in contrast to Adaptive Capacity Index (AI).

$$VI = \frac{\mathrm{SI}}{\mathrm{AI}} \tag{1}$$

As similar to Huang's work, in this study except the definiton of IPCC, exposure is not included in the equation. Thus, sensitivity is taken into consideration as the changing trends of exposure. More precisely, indicators of sensitivity index indicate the trend in social and environmental changes that comprise land use change, resource consumption changes and social changes.

Under the assumption of social, environmental and resource use changes are the main variables that determine sensitivity, areas that most exposed to these stressors were examined with Equation (1). And if the trend continues the adequacy of adaptive capacity of these settlements also will questioned.

3.2 Sensitivity Index

As mentioned above, for the determination of the vulnerability against environmental, social and natural resource change, trend in these changes are considered as sensitivity. Due to the lack of data produced by Turkish Statistical Institute (TUİK), old statistical data of 1990 and 2000 are used in the research. The growth rates of the selected indicators are calculated for ten year period.

High growth rate in social and environmental indicators were accepted as a pressure factor and also assumed that it increases the sensitivity of settlements to this pressure. Population growth, residential-building construction growth trend indicate social pressure factors, while forest and agricultural land loss, the growth in artificial land, increase in waste and water use are taken as environmental and resource utilization pressure factors.

Selected variables in the table below were converted to the small number of factor groups by the use of factor analysis.

Table 1. The variables used at the district level

	variables	years	source
Social pressure factors	Population growth rate	90-00	TUİK, 90 -00 General Population Census
	Residential construction growth rate	90-00	TUİK, 90 -00 Construction Statistics
	Building construction growth rate	90-00	TUİK, 90 -00 Construction Statistics
Environmental and natural resource utilization pressure factors	Agricultural and forest land use change	90-00	Ministry of Forest and Water Affairs, Land Cover Statistics, 90-00
	Artificial land growth rate	90-00	Ministry of Forest and Water Affairs, Land Cover Statistics, 90-00
	The amount of waste per capita growth rate	95-06	TUİK, 90 -00 Waste Statistics
	The amount of water taken daily per capita growth rate	95-06	TUİK, 90-00 Water Statistics

Sensitivity index is calculated by the arithmetic average of the values that obtained from the normalization of factor scores. The equation to normalize the values is based on the defined formula by Bell and Morse (2008) and this equation is also used in United Nations Human Development Index (Bell and Morse, 2008; O'Brien, 2005; Swanson, 2009):

$$\text{normalized indicator value} = \frac{[\text{district value to be normalized} - \text{minimum district value}]}{[\text{maximum district value} - \text{minimum district value}]} \quad (2)$$

3.3 Adaptive Capacity Index

The experts characterized capacity in terms of capitals which the community or system owned, controlled or have access. Within this framework, capital assessment based approach is used in the measurement of adaptive capacity.

Furthermore, in their researches Yohe and Tol (2001), Smit and Pilifosova (2002), Swanson et.al. (2009), Nelson et.al. (2007) consider social, environmental, economic, physical, human, and institutional capital in adaptive capacity assessment with the acceptance of the ability of a society to cope or respond to the negative effects of change depends on access or control of capitals.

Similarly, in this paper variables that indicate social, environmental, economic, physical, human, and institutional capital existence and level are taken into consideration.

These variables derived from a literature review and data that can be accessed from Turkish Statistic Institute have been evaluated (Table 2).

Table 2. Indicators of Adaptive Capacity[1]

Components	Indicators	Year
Economic capital	income per capita	2000
	dependency ratio	2010
	unemployment rate	2000
	Agricultural employment / other sectoral employment	2000
Social capital	social service workers / other employees	2000
	graduated from university / university age group	2010
	The number of associations per capita	2013
Environmental capital	forest area per capita (ha)	2006
	conservation area per capita	2013
	Water abstraction *per capita* (liters/capita-day)	2010
Physical capital (infrastructure)	Rate of population served by water supply network in total municipal population	2010
	Number of drinking water treatment plants	2010
	Rate of population served by waste service network in total municipal population	2010
	Rate of population served by sewerage service network in total municipal population	2010
	Rate of population served by drinking water treatment plants in total municipal population	2010
Institutional capital	Environmental expenditure of municipalities per capita	2010
	The existence of strategic plans and annual reports that shared in the internet by the municipality	2013

It's assumed that all the components have the same weight in adaptive capacity index. So, after normalizing indicators, tha adaptive capacity index is calculated with arithmetic average of capital components.

[1] Data were obtained from the Turkish Statistical Institute (TUİK), İzmir-Aydın-Muğla Municipality and Ministry of Forest and Water Affairs.

4. Findings

4.1 Case Study Area: West Aegean Side of Turkey: Aydın- Mugla and Izmir

One of the influential factors in a region's economic and social structure is geographical conditions. Aydin - Izmir and Mugla located in the West Aegean Region of Turkey are the provinces with rich amenities and due to its location and climatic conditions, agriculture and the tourism sectors has developed and as a result of this development, employment opportunities has attracted population. Furthermore, due to imbalance of economic opportunities between rural and urban areas of districts, leads to migration to urban areas and widens the gap between rural and urban areas. In the period of 1990-2000, these provinces were in the top immigrant receiving provinces in Turkey (Figure 2).

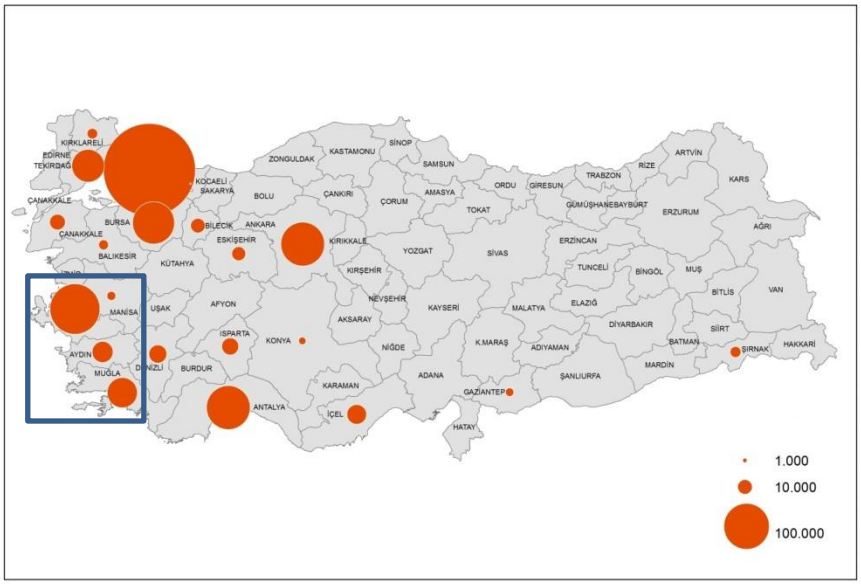

Figure 2. Net immigrant number received in 2000 (TÜİK, 2000)

Migration, tourism and urbanization could turn to significant threats for sustainable development in coastal side of Aegean Region. In İzmir, %5 of the agricultural land had been lost between 1990-2000. In Muğla and Aydın, 5023 ha. and 3645 ha. agricultural lands and 3594 ha.and 1368 ha. forest lands had turned to artificial areas (Figure 3).

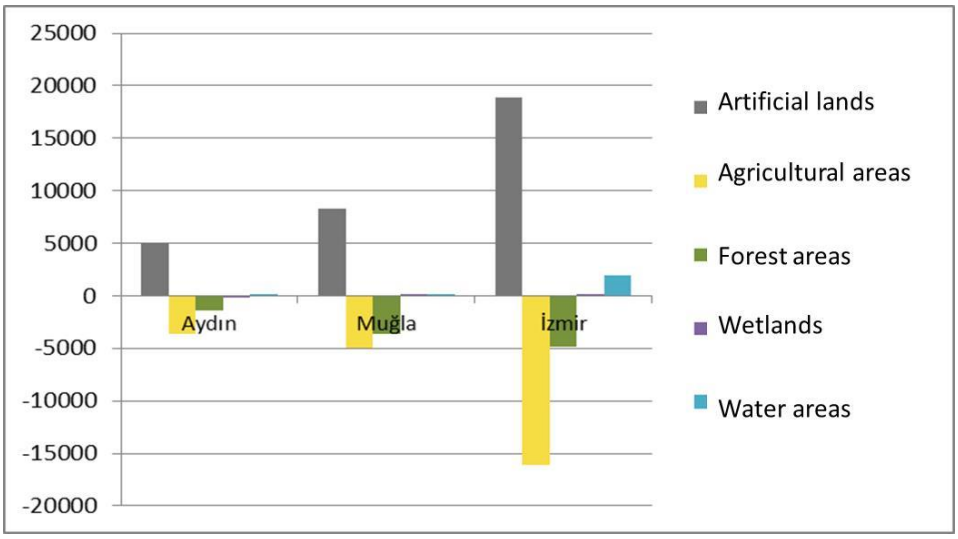

Figure 3. Land use change between 1990-2000 in İzmir-Aydın and Muğla Provinces

4.2 Sensitivity Index Measurement

As mentioned in Table 1, 7 parameters are taken into consideration and social, environmental change indicators are converted to small number of factor components by the help of principle component analysis (Table 3, Table 4).

Table 3. Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sum of Squared Loadings		
	Total	(%) of Variance	Cumulative (%)	Total	(%) of Variance	Cumulative (%)	Total	(%) of Variance	Cumulative (%)
1	3,117	44,533	44,533	3,117	44,533	44,533	2,053	29,331	29,331
2	1,110	15,854	60,387	1,110	15,854	60,387	1,880	26,863	56,194
3	1,049	14,981	75,368	1,049	14,981	75,368	1,342	19,173	75,368

Table 4. Rotated Component Matrix

FACTOR	VARIABLE	COMPONENT		
		1	2	3
Artificial change	DWELLING	,912	,160	-,074
	BUILDING	,910	,164	-,096
Environmetal change	AGRICULTURE_FOREST	-,113	-,856	,041
	ARTIFICIAL	,177	,826	-,069
	POPULATION	,577	,613	-,314
Resource use change	WASTE_PERCAPITA	-,071	,033	,827
	WATER_PERCAPITA	-,106	-,189	,734

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 4 iterations

The results of the analysis including spatial distribution of sensitivity index values are shown in Figure 4. According to the distribution of sensitiviy caused by the pressures of artificial, environmental and resource use change, the highest affected areas concentrated in coastal side. Particularly, the sensitivity indices of Karaburun, Çeşme, Seferihisar, Kuşadası, Didim, Bodrum, Datça, Ortaca and Aydın districts are differentiated from others.

Due to the pressures created from environmetal changes are concentrated in Çeşme, Urla, İzmir Merkez, Kuşadası, Didim and Bodrum, while pressure caused by the artificial change have highest index values in Seferihisar, Aydın Merkez, Didim, Bodrum, Marmaris, Datça, Ortaca, Dalaman and Köyceğiz. As, resource use change pressure is high in Karaburun, Çeşme, Seferihisar, Kınık, Karpuzlu, Yenipazar, Kiraz, Kuyucak and Datça districts.

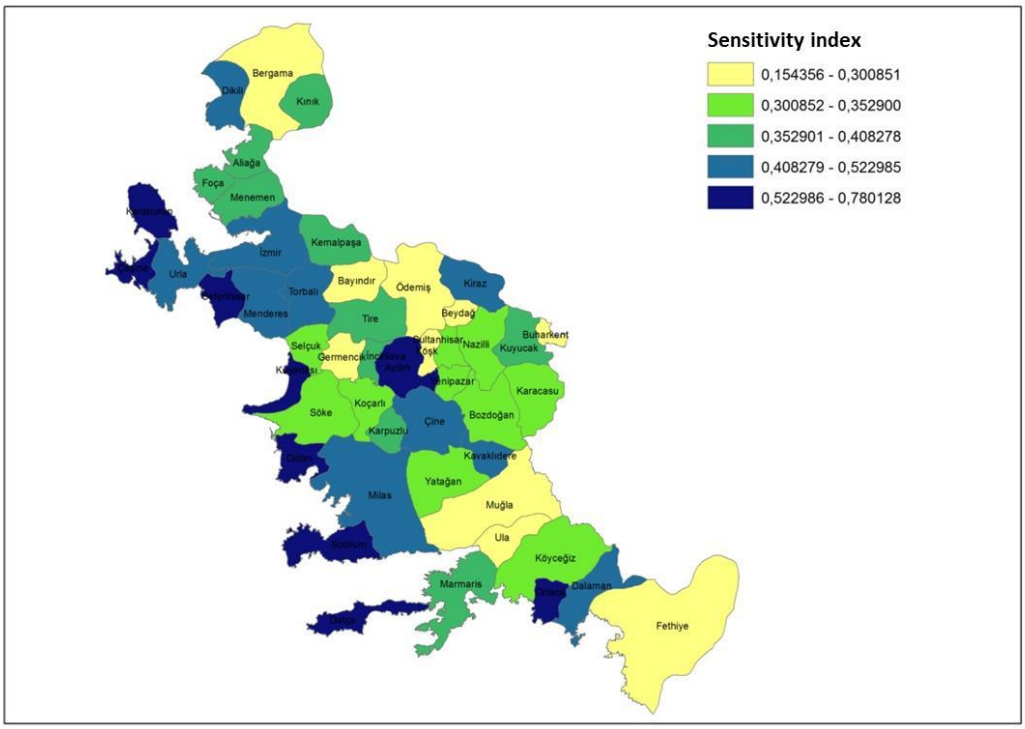

Figure 4. Sensitivity indices of districts (quartile ranking)

4.3 Adaptive Capacity Measurement

Indicators defined from the components that will allow us to monitor adaptive capacity of the districts are normalized with the help of the formula and converted to indices. Each indicator that has been normalized are grouped according to the main components of adaptive capacity and the arithmetic mean of the values are calculated to obtain social, economic, environmental, physical, and institutional capital index values.

Then the adaptive capacity index was calculated for each district by taking the average of component index values. When we examined the general distribution in the inner part of the provinces (the rural settlements located in the inner part of Aydın, İzmir and Muğla) have low adaptive capacity values than the coastal areas of the case study area.

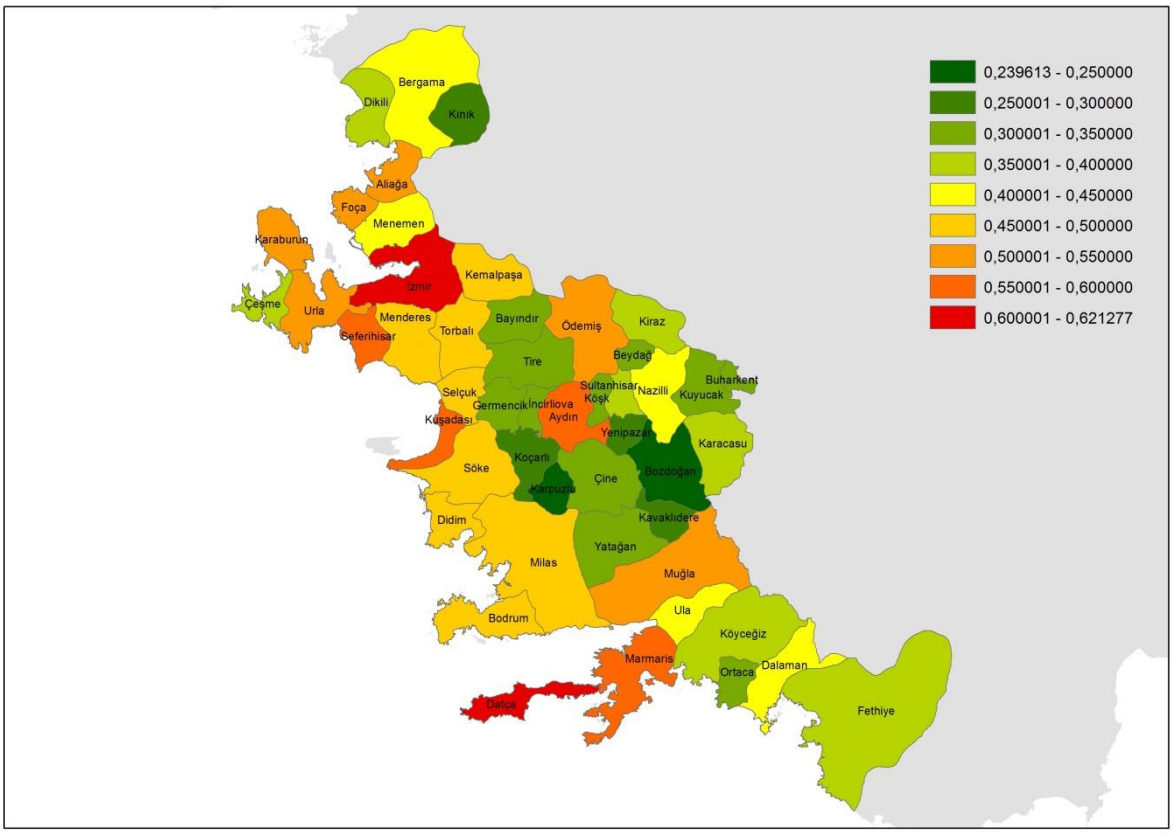

Figure 5. Spatial distrubution of adaptive capacity index values

Each settlement capacity values are compared according to the components. In general it's observed that settlements with high adaptive capacity scores also have higher values compared to other settlements in institutional, social and physical capital which is based on adequacy of infrastructure. Furthermore, the weakest components are social and institutional capacity in settlements with low adaptive capacity.

4.5 Analysis of Vulnerability

Vulnerability of settlements to artificial pressure factors were calculated from the proportion of sensitivity index values and adaptive capacity index values. Adaptive capacity is a factor that can reduce vulnerability emerged from the sensitivity of systems or communities. The spatial distribution of vulnerability index values due to the socio-ecological changes is shown in Figure 6.

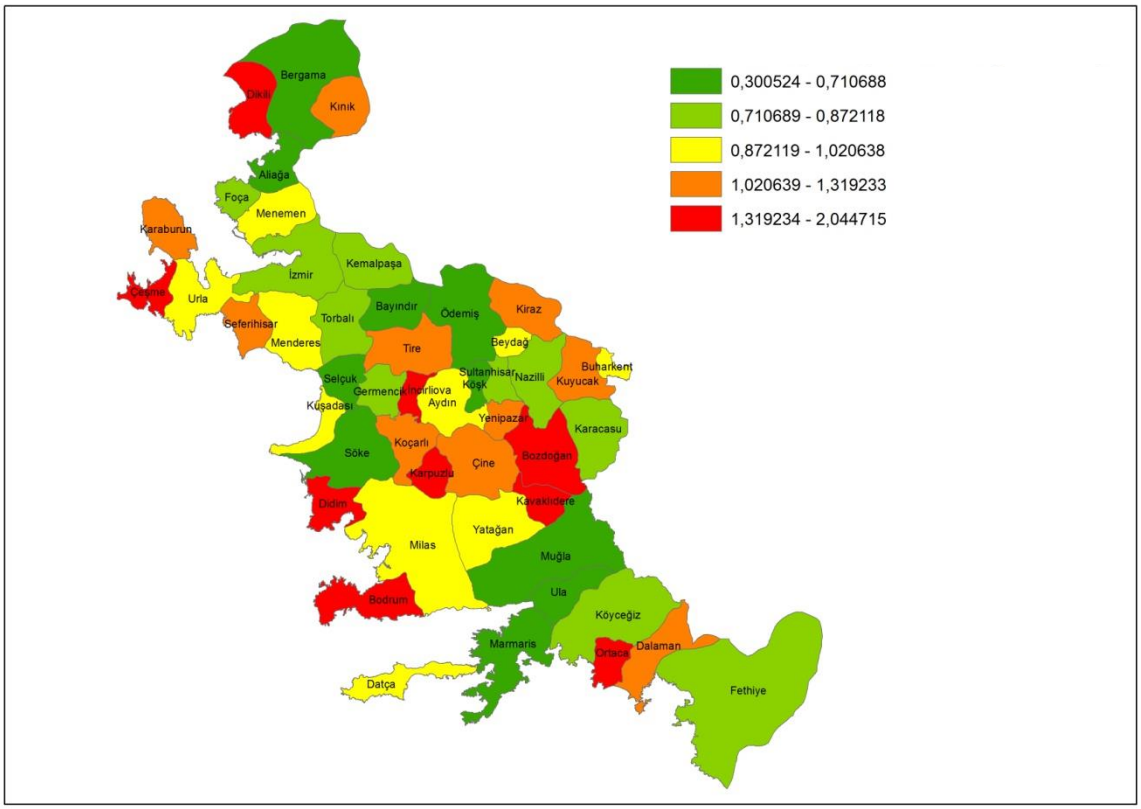

Figure 6. Vulnerability Index Values

Regarding to the analysis of most affected areas from environmental and social changes, the most vulnerable district is Çeşme where the agricultural and forest loss is high and institutional and environmental capital is low yet economic and physical capital is above average. Kavaklıdere, Karpuzlu, Didim, Ortaca and Bodrum districts are the other vulnerable settlements after Çeşme. Overall distribution of values revealed that the coping capacities of settlements should be questioned under the pressure of urbanization, population and migration growth. Despite the high sensitivity of settlements such as Datca and Izmir, high adaptive capacity values reduce vulnerability. If the resource consumption trend will continue, this trend will create a pressure on rural settlements like Bozdoğan, Çine, Kavaklıdere, Yenipazar, Tire, İncirliova, Koçarlı, Kuyucak, Kiraz, and Kınık. In addition economic development which is one of the components of sustainable development is also weak in these settlements.

Conclusion

Although statistical data at the national level limits the currency of the research, it is important to analyze and compare the vulnerability of settlements.

As a result of the research, there are of two major problem areas revealed from analyzes. The first problem area is the coastal areas where tourism activities are concentrated. Despite the high adaptive capacity index values, unbalanced development pressure will lead to environmental degradation in settlements such as Dikili, Çeşme, Didim and Bodrum. The second problem area is in rural sides of the region where adaptive capacity is low and resource consumption change trends will lead to environmental losses that can be turned to stressors for the communities hard to cope with.

Indeed, livelihood of rural areas mostly depends on the availability of natural resources. Therefore, rural districts are sensitive and will be the most affected areas from environmental change.

Furthermore, there are studies claiming that enhancement of adaptive capacity against stressors may not differ substantially from general development goals. Additionally, these researches emphasized that human and social capital have dominant roles in ensuring welfare and also reinforced the degree of respond and coping capacity against uncertainty and unexpected risks (Lutz,2010) .

Therefore, in order to ensure sustainability, and to eliminate the negative effects of growth, primary intervention areas have to be determined to enhance adaptive capacity and coping skills against change. During development process of such sectors like tourism or industy, pressures on forests and agricultural areas emerged from artificial activities, thus it will affect the local population and agricultural employment negatively.

In the process of change, the inadequacy in social, physical, economic, human and institutional capital, transition to the new system state can be problematic. For this reason, in the initial stages of unexpected changes; political interventions, reinforcement acitivities are crucial in order to increase the adaptive capacity of the local.

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