DPSIR applied to 4-large Turkish coastal cities: Mersin, Antalya, İzmir and Kocaeli

La méthode DPSIR appliquée à quatre métropoles côtières turques : Mersin, Antalya, İzmir et Kocaeli

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Abstract

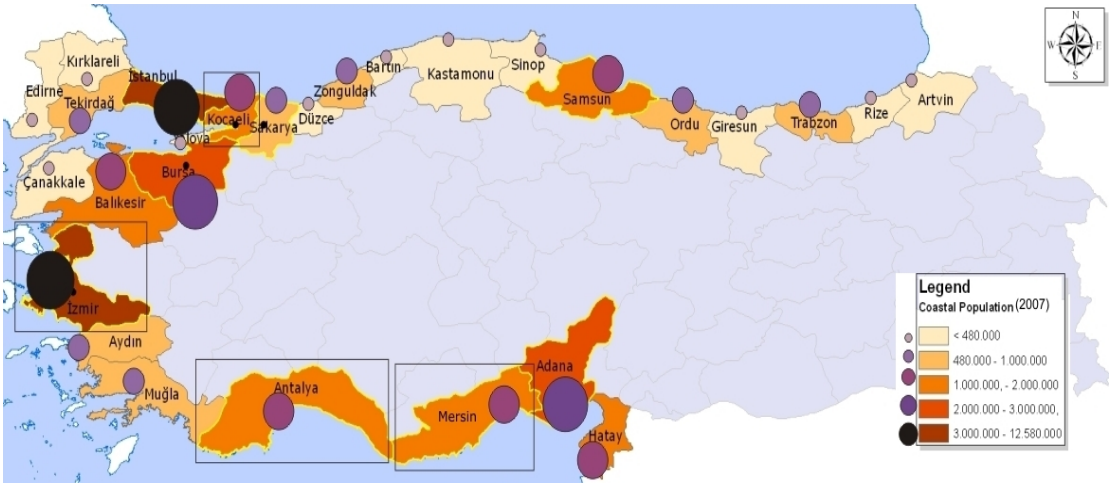
Turkish coastal areas are under the pressure exerted by inputs of organic material, nutrients, and chemical pollutants derived from intense urbanization, industrial, maritime, and agricultural activities. The relative contribution and effects of diffuse sources are not yet clearly known. Monitoring activities, established by the Ministry and the Municipalities of few large cities, are extremely useful to understand the status of the coastal seas. Concurrently, impact variables of ecological status provide very clear indications of pollution effects and recovery and are therefore recommended for monitoring. Investments are made and planned to support the treatment of municipal and industrial effluents of coastal cities; inputs from rural settlements, touristic spots, and un-organized industrial areas are yet difficult to estimate and control. Legislative tools to control pollution and protect the marine environment are available; more efforts are needed to implement them.

Résumé

Les zones côtières turques subissent des pressions exercées par les apports de matières organiques, d'éléments nutritifs et de polluants chimiques issus de l'urbanisation intense, des activités industrielles, maritimes, et agricoles. La contribution relative et les effets des sources diffuses, sont encore mal connus. Les activités de surveillance, mises en place par le ministère et les municipalités de quelques grandes villes, sont extrêmement utiles pour comprendre l'état de la mer côtière. En complément, les paramètres d'impact sur l'état écologique fournissent des indications très claires sur les effets de la pollution et la restauration des milieux. Ils sont aussi recommandés pour le suivi. Des investissements sont réalisés et prévus pour le traitement des effluents industriels et municipaux des villes côtières. Les apports de l'habitat rural, des sites touristiques, et des zones

industrielles peu organisées sont encore difficiles à estimer et à contrôler. Des outils législatifs pour lutter contre la pollution et protéger l'environnement marin sont disponibles, des efforts supplémentaires sont nécessaires pour qu'ils soient bien appliqués.

A spectacular urban development took place from 1950 to 1995 in the Mediterranean coastal area (UNEP/MAP Blue Plan, 2006); where this has been more pronounced in the eastern and southern countries revealing that Turkish coastal area has also had a pronounced increase in urban population. Map 1 shows a classification of Turkish coastal cities according to 2007 population statistics (TÜİK, Turkish Statistical Institute). According to the National Law of Municipalities of Large Cities (5216/10.7.2004), areas of populations over 750,000 inhabitants are considered as large cities. Another criteria considered in this categorization is the level of economic development which is measured by a set of socio-economic development indicators (like urbanization ratio[1], employement, human development index[2], etc). Based on that, 3 Mediterranean cities were considered as large coastal cities namely; Mersin, Antalya and İzmir. It is also found relevant to include one of the three large cities of the Sea of Marmara in this study namely Kocaeli.



Map 1. Classification of Turkish coastal cities according to the population

[1] Urbanization ratio is defined as the ratio of population residing in the city centers and towns to the total population which includes rural population

[2] Human Development Index combines measures of life expectancy, school enrolment, literacy and income to allow a broader view of a country's development (http://www.undp.org.tr/newsDocuments/Country%20Fact%20Sheets%20TR.doc

MERSIN

Mersin administrative region constitute 8 coastal towns (Tarsus, Central town, Erdemli, Silifke, Gülnar, Aydıncık, Bozyazı, Anamur) and it has an overall (urban+rural) population of 1,595,938 (2007) inhabitants where approximately 50% of the population reside in the central town and 95% at coastal towns. Urbanization ratio of Mersin is 73% and the rate of population increase is 29%. The region is affected by two basins; Seyhan River basin (affects Tarsus and Central town) and Eastern Mediterranean basin which includes Göksu river and estuary. The development index of Central town and Tarsus is 1 and 2 whereas it is 3 and 4 for others.

Drivers: Urbanization, agriculture and industry are the major ones. The sectorial contribution of them (at the basin scale) in terms of phosphorus and nitrogen generation (National Action Plan, 2005) are; municipal: 41 %(N), 65 %(P) in Seyhan basin and 36%(N), 46%(P) in E-Med basin and agricultural: 54 %(N), 35 %(P) in Seyhan basin and 56%(N), 25%(P) in E-Med where industry have the tertiary importance. 221.3 km^2 (2004-2006 annual means, TÜİK) of agricultural fields exist in the region where almost 50% of the fields is located around Tarsus town. There are intensive industrial activities around the central town and Tarsus basically on fertilizer, food, textile, petroleum loading and chemistry. Harbour facilities in the coastal area of Mersin are also quite intensive having various commercial activities at 10 harbors/quays mostly located around the central town. Tourism is another driver for the region. The tourist number visited Mersin area is about 280,000/year (2004-2006) where more than 50% of them visited the Central town. Second houses -used as summer resorts- intensively built at the coastal strip of Mersin has created unfavorable conditions for the coastal environment.

Pressures: The direct inputs to the coastal area are via rivers (Seyhan, Berdan, Lamas and Göksu) and point sources (municipal discharges of Mersin-central town and other towns and industrial inputs). Inputs from diffuse sources (urban and land runoff) have not been estimated yet. It appears that the riverine and atmospheric inputs (wet+dry) of nutrients to the North-Levantine basin are at comparable levels (Tuğrul et al., 2006). The importance of atmospheric inputs for the North Levantine basin has also been clearly emphasized by various scientists (Krom et al., 2004, Markaki et al., 2003, in press).

State: Mersin coastal strip shows different water quality characteristics when eutrophication state indicators proposed by MED POL are evaluated (UNEP/MAP MEDPOL, 2003). Since the easternmost area of Mersin coastal waters is under the influence of major rivers (Seyhan and Berdan) and municipal wastes of Mersin, chlorophyll-a concentrations are quite high, surface water oxygen saturation is above 100% and the TRIX range is 5-6 throughout the year. Secchi disk depths of 1-3 m clearly show the high turbidity levels. It might be expected that the lower layer dissolved oxygen may drop to <80% saturation values at certain locations of the Bay. Area is under the threat of eutrophication. At the area extending from west of Mersin bay, through Erdemli, reaching to Silifke, chlorophyll-a concentrations are low (<1.0 μg/L), concentrations of nutrients are low and any oxygen depletion

has not been observed at the lower layer waters. SDDs[3] are high (>10 m) and the calculated TRIX values are usually below 3. This is also the case for the coastal area affected by the Göksu river since the water renewal time of this area is very short. Chemical pollution in biota has been monitored in the coastal waters of the region since 1998 within the trend monitoring strategy of MED POL (UNEP(DEC)/MED WG.282/3, 2005). The analysis of these data sets indicated that there was a general downward trend of trace metals in the coastal waters of Mersin-centre and Erdemli, however this data needs to be re-analyzed with longer term findings and considering the pollution reduction measures taken.

Impact: Macro zoobenthos of the Bay was studied during 2005 to assess ecological status of the shallow zone of the Mersin Bay (Tuğrul et al., 2006). Abundance and biomass data of zoobenthos were examined by multivariate analyses and Bentix index (Simboura & Zenetos, 2002) to determine pollution levels of the nearshore waters of the Bay. Bentix scores showed that all the visited stations were moderately polluted and the area is both physically and ecologically disturbed.

Response: The treatment status of municipal waste waters generated in the towns of Mersin is quite poor and the wastes are discharged without secondary treatment (except 3 towns) with marine disposal systems. The biological treatment plant for the Mersin central town is being constructed and will be ready for the end of 2009. Silifke, Tarsus and Aydıncık have already established biological treatment plants. Compliance monitoring as well as state/trends monitoring are important tools to plan and monitor response actions. Therefore, it is required by the National MED POL Programme to monitor the compliance of discharge values to the set limits in the national legislation (By-Law on Water Pollution Control, 31/12/2004). The region is hosting a Specially Protected Area (SPA), Göksu Deltası, with 226 km^2 protected area for both marine and estuarine species.

ANTALYA

Antalya administrative region constitute 10 coastal towns (Gazipaşa, Alanya, Manavgat, Serik, Antalya-centre, Kemer, Kumluca, Finike, Kale, Kaş) and it has an overall population (U+R) of 1,789,295 (2007) inhabitants where more than 50% of the population reside in the central town and 94% at coastal towns. Urbanization ratio of Antalya is 84% and the rate of population increase is 46%. The region is affected by two basins; Antalya basin and Western Mediterranean basin having 13 small rivers and a few major lakes. The development index is 1&2 for the central town, Serik, Manavgat, Alanya and Kemer where the tourist income is maximum and 3 for the other towns which are smaller and dependent more on agriculture.

Drivers: Urbanization, agriculture and tourism are the major ones. The sectorial contribution of them in terms of P and N generation are; municipal: 40 %(N), 66 %(P) in Antalya basin and 25%(N), 55%(P) in W-Med basin and agricultural: 58 %(N), 31 %(P) in Antalya basin and 71%(N), 44%(P) in W-Med. 129.4 km^2 (2004-

[3] SDD : Secchi Disk Depth

2006) agricultural area exist in the region. Tourism is another important driver for the region. The number of tourists visited Antalya region is about 7,011,225/year (2004-2006) where this figure increased to 9,093,071 in 2008. Use of summer houses is also common. Harbour facilities in the coastal area of Antalya are ongoing at 8 commercial harbours/quays. Besides, 8 marinas exist in the region to serve for yatch tourism.

Pressures: The direct inputs to the coastal area are via small rivers and municipal point sources. Neither the inputs from land and urban runoff nor atmosphere have not been estimated for the region.

State: The system is open to interactions with open waters of the Mediterranean and the water renewal is rapid. Concentrations of nutrients as well as the chlorophyll values are low (always less than 1 μg/L). Secchi disk depths are above 5m and the lower layer oxygen saturation values are greater than 90%. The river discharges are also small. All these indicate that the system is not considered under the eutrophication threat. However, the large number of coastal touristic facilities may create local disturbances especially in the vicinity of Manavgat and Alanya towns because the area is quite shallow. Since the region is not used for industrial facilities, chemical pollution is not expected and not visible. Effects of agricultural activities on the coastal waters are not known.

Impact: Losses of habitats and biodiversity have not been recorded in the area. Harmful phytoplankton species were not also reported.

Response: The wastewater treatment facility in the central town is at tertiary level and at primary level in five towns. The region is hosting 3 SPAs; Belek, Kaş-Kekova and Patara where all the measures required by the National Law (No: KHK/383/13 Nov 1989) are applied. The protected area is totally about 600 km^2 hosting coastal and forest endemic species as well as archeological heritage. There are good practices of eco-torusim in the region that is planned to be expanded with new projects.

İZMIR

İzmir administrative region constitute 12 coastal towns (Selçuk, Menderes, Seferihisar, Urla, Çeşme, Karaburun, İzmir-centre, Menemen, Foça, Aliağa, Bergama, Dikili) and it has an overall population (U+R) of 3,739,353 (2007) inhabitants where more than 70% of the population reside in the central town and 86% at coastal towns. Urbanization ratio of İzmir is 98% and the rate of population increase is 24%. Development index is 1 for the central town and Aliağa and 2 for other towns. The region is affected by two basins; K.Menderes River basin and Gediz River basin.

Drivers: The major drivers in the region are urbanization, agriculture, industry and tourism. The sectorial contribution of these drivers in terms of P and N generation are; municipal: 72 %(N), 87 %(P) in K.Menderes basin and 28%(N), 52%(P) in Gediz basin and agricultural: 27 %(N), 13 %(P) in K.Menderes and 57%(N), 43%(P) in Gediz. Contribution of industrial N, P in Gediz is, respectively, 15%, 5% and negligible in K.Menderes. Agricultural area is 104 km^2 (2004-2006) in the

region where 75% of it is in Selçuk, Menemen and Bergama towns. Industrial activities are heavily established in Aliağa, Central town and Menemen, at moderate level in Bergama and Menderes and nearly absent in other towns. The number of tourists visited İzmir region is about 452,000/year (2004-2006), about 70% of them visited two towns; Çeşme and Selçuk. Harbour facilities in İzmir are ongoing at 13 commercial harbors/quays. 3 marinas exist in the region serving for yatch tourism.

Pressures: The direct inputs to the coastal area are via rivers, municipal and industrial point sources.

State: Information is given by F. Küçüksezgin in the same volume.

Impact: Benthic ecosystem disturbances and changes in İzmir Bay as a result of environmental pollution were well documented by various scientists. When the data obtained during 1996-97 is evaluated with historical findings, a deteriotion in benthic ecosystems was observed and basing on a Bentix evaluation on 1995-96 data, ecological status was found to be distintly changing from poor to good conditions from inner to outer Bay (Doğan et al., 2004, 2005). Diversity and evenness index values of soft bottom zoobenthos were high in the outer part of the bay, whereas azoic conditions occurred in the polluted inner part, particularly in summer and autumn of 1997 and 2001 but not in 2002 during which polychaetes other than its pollution indicator species were also observed. (Doğan et al., 2005, Ergen et al., 2006). In paralel to the new findings in 2002, species sensitive to pollution were also recorded in a study of 2004 (Çinar et al., 2006) in the innermost Bay indicating the recovery of the ecosystem after the 'Grand Canal Project of İzmir Municipality' became operational by the year 2000. However, a sudden increase in the number of exotics was also reported from the inner part of İzmir Bay coinciding with the improvement of water quality of the area (Çınar et al. 2006, 2008). The environmental instability occured by 2000 and intense maritime traffic make the area more susceptible to invasion by exotics. Occurences of harmful phytoplankton species/blooms in the İzmir Bay have been reported (Koray 2004).

Response: Grand Canal Project of İzmir Municipality is considered as a great step towards response to the cronic pollution problem started even at 60s. A full waste water collection and treatment system at tertiary level is operational since 2000. 5 towns have treatment facilities at secondary level (biological treatment) and at primary level in other towns. There is one SPA in the area, Foça, also a reserve for Mediterranean monk seals.

KOCAELI (İZMIT)

Kocaeli administrative region consists of 7 coastal towns (Kocaeli Center, Körfez, Karamürsel, Gölcük, Derince, Gebze, Kandıra) having an overall population (U+R) of 1,437,926 (2007) inhabitants where about 70 % of the population reside in two towns; Kocaeli central town and Gebze. Six of the towns are at the eastern coast of the Marmara Sea where one town lays by the Black Sea coast. Urbanization ratio of Kocaeli is 52% and the rate of population increase is 19%. The region is in the

Marmara basin sharing the same basin with İstanbul Metropolitan area. The development index of Gebze, Körfez and the Central town is 1, 2 for Gölcük and Karamürsel and 3 for Kandıra.

Drivers: The major drivers in the region are industrial activities and urbanization. There are intensive industrial activities ongoing in Gebze, Körfez and Central town. Harbour facilities in the coastal area of Kocaeli are also quite intensive having various commercial activities at over 40 ports mostly located around heavily industrilized towns. Heavy shipping activities in the Bay pose a continuous risk of oil contamination due to loading and unloading activities and accidents.

Pressures: The direct inputs to the coastal area are via rivers (Dilderesi, Sarı Dere, Kilez Deresi, Ağadere, Asardere, Hamzadere), channels (Eastern Channel, Pektim Channel) and point sources (municipal discharge more than 40 points, industrial inputs 15 points). The major discharges are located in the northern part of the İzmit Bay. More than 1500 industrial plants established in Kocaeli include petrochemistry, chemistry (solvent, pesticide, paint etc), pulp and paper, fertilizer, food and manufacturing industries. As a result of the ongoing treatment and waste minimization activities BOD loads arising from industries were decreased to 9,9 (90% reduction) tons /day in 2002. Since most of the industrial treatment plants only remove organic matter, industry originated nutrient loads are still a problem for the Bay coastal waters. The 1999 Kocaeli earthquake created a huge damage on environment, collapsing more or less all the treatment facilities in the Bay and created a refinery fire.

State: Continuous monitoring activities were organized in the İzmit Bay during 1999-2002 and 2007-onwards. Deep water oxygen saturation values were determined as about 20% in the Western part and below 10% (< 1mg/l) in the Central and Eastern Bays indicating worse environmental status towards the inner bay. Maximum chlorophyl-a values were observed in the range of 5-20 ug/l during these monitoring periods. 2007-2008 data provided TRIX values for surface waters between 4.1 and 6.8. Toxicity tests applied to the surface sediments were consistently found to be toxic throughout the Bay (Tolun et al. 2001). After the 1999 Kocaeli earthquake PAH concentrations varied between 240 –11400 ng/g in the coastal sediments of the Bay (Tolun et al. 2006) whereas these values were 120-8900 ng/g before this catastrophic event.

Impact: Mussel feeding rates and lysosomal membrane stability of blood cells (biomarker) were clearly decreased after the earthquake (Okay et al., 2001) due to shock loads of PAHs to the system. It was also found that LMS is decreased from outer to the inner bay. Harmful algal booms have also been observed in the Bay (Okay et al., 2001). In October 2007, massive musilage formations were seen in the Bay lasting until January 2008 and repeated again in September-October 2008. As a result of all these disturbances, there is no commercial fishing activity in the Bay.

Response: As stated above, industrial effluent treatment facilities have been established since 1990s. However, they are not yet at a satisfactory level especially for smaller companies where they are located intensively around few rivers (e.g.Dilderesi). The treatment status of municipal waste waters is at tertiary level in Gölcük and Karamürsel where the Central town and Körfez are currently running with secondary level treatment. Tertiary treatment is also planned for these towns.

In Gebze and Kandıra, there are no treatment facilities yet, a tertiary system is being planned for Gebze. In order to better control the pollution created by coastal industries and ships, aerial surveys are routinely performed by the municipality since the control points are too many at both sea and land. Penalties are applied when legislative measures are exceeded. DG Kocaeli of MoEF is also responsible of the control of implementation of these measures.

İzmit Bay is one of the test cases of the FP6 project, Science and Policy Integration for Coastal System Assessment "SPICOSA", in which support tools will be developed for the assessment of policy options for sustainable management of environmental issues considering ecological, social and economic aspects of coastal zone systems. This is also considered to be a pilot ICZM application for the country being recognized by different stakeholder groups of the region. There isn't a special regulation for ICZM in the country.

CONCLUSION

The pressure and deterioration created by unsustainable development activities are threatening fragile ecosystems of the Turkish coastal zones (more than 10 thousand km coastline including the islands) located near to the large cities. To employ an integrated coastal zone management program on a national basis seems a solution proposed to the overall problem. However, considering the dynamic nature of the coastal systems, to follow the casual chain framework analysis (DPSIR) would be a major challenge in developing national ICZM programs.

Among the examined cases, the most affected area is Kocaeli and oppositely Antalya coastal area is well protected. İzmir 'Grand Channel project' has been proven to be an efficient investment to improve the environmental quality of the İzmir Bay and its vicinity and therefore could be considered as a good example of management action.

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