CHEMICAL POLLUTION OF COASTAL WATERS IN THE IZMIR BAY, AEGEAN SEA

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During last 30 years in Izmir area (Aegean Sea basin), an industrial growth caused serious environmental contamination of both waters and landscapes. Coastal water pollution caused by the increased industrialization, particularly of Izmir Bay, has been detected recently. Urbanization has impressive rates in Turkey, increasing from 18.5% in 1950 until 62% in 2000. Such uncontrolled urban expansion leads to gradual decrease of fertile landscapes and agricultural areas along the Aegean coasts and increases the pollution of waters. The chemical contamination in Izmir bay (mercury originating from Gediz River and inactive mining sites in Karaburun Peninsula) comes to the shelf waters. Consequently, the detected content of mercury in selected plankton organisms exceeds the acceptable standards as a maximal limit in living creatures. As a result, it has been reported that pollution in Izmir's overall surface water, chemical quality of groundwaters, lakes and rivers has deteriorated. An increase of water contamination caused by the industrial discharge posed a serious threat to environmental conditions in Izmir area. The ecological threats of water pollution has been documented by many reports, manuscripts and articles reviewed in this paper.
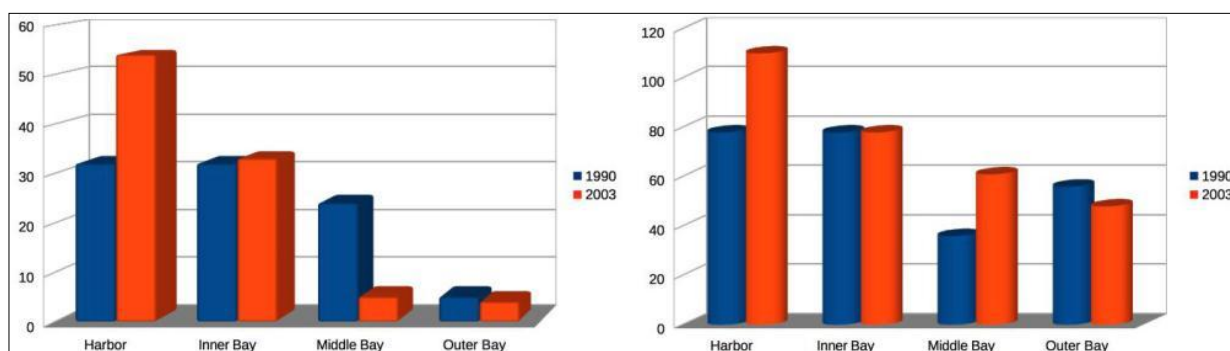

Fig 1. Left: cadmium (Cd) (10 mcg/kg dry matter). Right: lead (Pb) concentrations (mg/kg dry matter). Both graphs: sediment samples of İzmir Bay in 2003 (red), 1990 (blue). By [21].

There are many social factors and excessive anthropogenic activities involving interaction of humans with the environment, which make city of Izmir environmentally unfriendly place. These are production of damaging waste products such as chemicals and

wastes, discharging pollutants, litter and garbage, excessive exploitation of non-renewable resources, changes in land use types, reduced biodiversity level, fragmentation of the landscapes. To develop scenarios of possible land use changes in coastal landscapes one can use combination of GIS modelling and landscape metrics, spatial settings of landscape patterns, compositions and configurations: number, total edge and shape of patches, landscape diversity and area, nearest neighbor distance, interspersion, contagion metrics. Land, size and isolation and other characteristics of landscape patches within the city can differ in several years, providing the same environmental conditions, i.e. human effects on the ecosystems remain at the same rate and intensity. The importance of landscape patches can be illustrated by the findings of several landscape studies [21], [11] where it is argued that large patches have been identified important for the ecosystems, since they assists to the maintenance of the populations and biodiversity, and are equivalent or better suitable for the protection of various biodiversity components. The low percentage of areas covered by tree canopy and areas of impervious surfaces in urbanized areas trigger environmental consequences, e.g. decreased air quality and carbon, storm water runoff [4]. As most of the urban city centers is used for buildings, roads and pavements, this results in changes of surface temperatures and heat output. The greenhouse effect and the ozone depletion are one of the examples of the consequences of such processes as uncontrolled urbanization and industrialization. Ever since the development of the concepts "sustainability" and "environmental awareness" in early 1980s, the concerns about the environmentally-friendly and eco-styled cities were introduced at the local and governmental level for policy and city planning. The importance of the GIS and remote sensing tools for study Earth landscapes and environmental monitoring has received since then much attention along with development of Earth observation satellite systems in 1970s. The use of satellite images and GIS methods is actively applied for environmental studies since then, which is demonstrated by multiple research papers [3], [17], [23], [22], [27], [9], [10], [18], [20]. The use of the Landsat scenes for geospatial analysis is caused by data suitability and accessibility. Many reports on modelling land cover types and vegetation coverage use support of the Landsat and other RS data [7], [16].

The industrial growth triggered environmental contamination in Izmir area. Uncontrolled urban expansion leads to the decrease of fertile landscapes. The detected content of heavy metals coming to waters through rivers exceeds the acceptable standards. Threats of water pollution have been documented during the last decades: the waters are polluted critically in the inner part and significantly in centre proving Izmir Bay to be one of the most polluted Mediterranean estuaries.
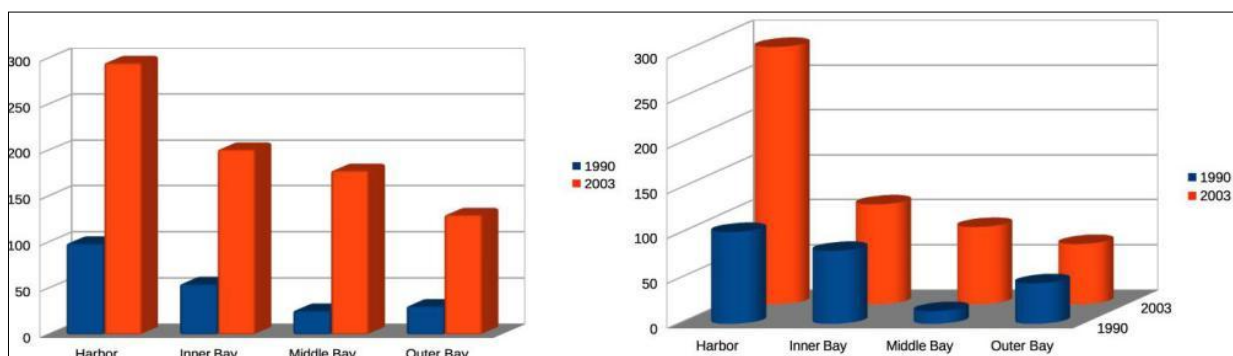
Fig 2. Left: chromium (Cr) concentrations. Right: zinc (Zn) concentrations. Both graphs: sediment samples (mg/kg dry matter) of İzmir Bay during 2003 (red bar) and 1990 (blue bar). By [21].

The comparison of diagram charts (Figures 1 and 2) demonstrates the increase in concentrations of major heavy metals detected in the waters of Izmir Bay, 1990–2003. It shows increase of lead in harbor and Inner Bay, increase of cadmium as well in the harbor and inner Bay regions. Respectively, chrome and zinc concentrations increased throughout the Bay in a given time period. The concentrations of elements showed significant differences between harbor, inner middle and outer bays with higher levels in the inner Bay including untreated sewage waters [21]. Nearly all industrial waste coming to Izmir Bay is untreated, discharged either through the domestic sewage network or through the few small rivers. These elements are caused by the anthropogenic input into Inner Bay. Heavy metal and organic compound concentrations are the highest in the innermost region of Inner Izmir Bay and sharply decrease near the Yenikale Entrance [1]. This well illustrates the degree of the contamination in Izmir area. As water and terrestrial areas are closely connected within ecosystems, hydrological disturbances cause landscape degradation. Water erosion is the most important trigger factor for soil degradation. Furthermore, according to EEA reports [13], there is a high degree of soil erosion in west Turkey caused by complex impact of various factors: climate, geological and topographic ones. Climate change together with human impacts cause degradation of the semi-natural vegetation which leads to the soil degradation, and causes erosion.

These processes cause changes in local landscapes affecting sensible vegetation in the coastal zones. For example, certain geological conditions make land soils prone to erosion. Together with geomorphological conditions (e.g. step slopes) it intensifies erosion and leads to the land degradation. Changes in chemical and physical properties of soils are caused by the anthropogenic land overuse: cultivation, overgrazing and harvesting leadsing to the gradual soil deterioration and land depletion [14]. Intensified by the destruction of the vegetation land cover

and types, it increases desertification in the Mediterranean basin. Soil and vegetation degradation are deeply interconnected, as the quality of soils reflects the state of upper vegetation: bare soils are destroyed more quick and intensive than those covered by forests. Impacts of modified land cover types on soils are caused by the extensive agricultural activities, triggering degradation and destruction of soils in highland Turkey [8]. The quality and structure of soils deteriorate along with conversion of natural landscapes into cultivated lands. This demonstrates close interconnection between parts of the ecosystem and the negative effects on the land use change on natural landscapes [12]. Other sources of environmental threats include wastes and radionuclides [2] that originate from natural sources, e.g. leaching from minerals and pollutants, e.g. nuclear power plants, explosions and accidents. Such ecological contamination has direct impact on the sustainability of ecosystems.

The situation of chemical contamination, current environmental conditions of Izmir Bay, effects of industrial threats on the surrounding landscapes caused by chemical and organic pollutants as well as water pollution were reviewed and analyzed in the current work. Undoubtedly, water pollution and its ecological impact causes worries and challenges in western Turkey. The waters of Izmir Bay are polluted critically in the inner part, significantly in its central part, and more or less satisfactorily in the outer part of the bay. This confirms that Izmir Bay is claimed to be one of the most polluted estuaries in the Mediterranean Sea. Since hydro- and oceanological settings play vital role within the ecosystem structure, the polluted coastal and shelf waters cause serious environmental consequences in the region. Current paper reported environmental threats in the ecosystems based on studies of numerous related documents and GIS analysis and reviewed ecological threats in the ecosystem of Izmir area using related reports and GIS.

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