

# Assessing and Monitoring Geocological Status of West Turkish Landscapes for Sustainable Development: Processes, Activities and Problems

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- 1 Introduction
  - Study Area: Izmir Region
- 2 Environmental Settings
  - Urbanization
  - Environmental Problems of the Marine Areas: Izmir Bay
  - Marine environmental problems
  - Water contamination in Izmir Bay
  - Izmir Bay: Environmental Pollution of the Sea by Sewage
  - Water contamination in Izmir Bay by heavy metals: Pb
  - Water contamination in Izmir Bay by heavy metals: Zn
  - Water contamination in Izmir Bay by heavy metals: Cd
  - Water contamination in Izmir Bay by heavy metals: Cr
  - The Interactions Between Aquatic and Terrestrial Components of the Ecosystems
  - Landscape Change as a Sequential Process with Impact Factors
  - Soils and Vegetation: Close Interconnection
  - Water and Vegetation: Ecological Interactions
  - Anthropogenic Impacts on Izmir Region: Agriculture and Industrial Development
  - Impact of Tourism on the Izmir Region
  - Conclusion on the Environment of Izmir Region
- 3 Questions
- 4 Methods
- 5 Data
  - Data Selection
  - Data Conversion
- 6 Software: Erdas Image
  - Creating Color Composites
  - Masking Study Area
  - Clustering
- 7 Results
  - Results: Maps of Land Cover Types (1987 and 2000)
  - Results: Table of Land Cover Types
- 8 Conclusions
- 9 Thanks
- 10 Bibliography

## Study Area: Izmir Region



Izmir region is a special part of Turkey, which has unique landscapes with a variety of types of vegetation, different landforms and conservation areas.

The vegetation within the Aegean coastal region is complex, characterized by high biodiversity and presence of the unique forms (endemics).

## Environmental Settings

- Izmir is the 3<sup>rd</sup> largest and most populous city in Turkey, an industrial city, significant both as a center of trade and industry, and as a major seaport of strategic importance.
- The region has a high ecological significance and at the same time is experiencing a strong anthropogenic load.
- A well-developed transport network, intensive shipping, the presence of factories and industrial centers, densely populated areas, intensive agricultural activity-these are the features of modern Izmir
- The region of Izmir is a highly dynamic and rapidly developing region of western Turkey.
- Urbanization rate is high: increase from 18.5% (1950) to 62% (2000)
- The urban areas located on the coastal area of the Aegean Sea
- Population: ca 4 M people have impact on the environment through enormous demographic, cultural and economic pressure

# Urbanization

- There are ongoing processes of urbanization in western Turkey.
- Besides natural population increase, there is a tendency of local population migration coming from eastern regions westwards (for education and employment).
- Such migration leads to the congested, overpopulated quarters in large western metropolises with dense construction of multistoried buildings.
- Even small coastal towns nowadays become more urbanized and gradually enlarge in size.
- As a consequence, this leads to the loss of natural and agricultural lands and changes in local landscapes and increased anthropogenic pressure

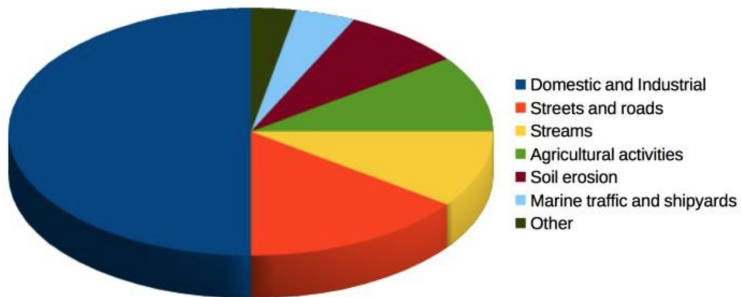
## Environmental Problems of the Marine Areas: Izmir Bay

- Contribution of pollutants in Izmir Bay
- During the last decades a large number of studies have been reported on the environmental, physical, chemical and biological properties of Izmir Bay
- Inner Izmir Bay surface sediments are seriously polluted and contain significant concentration of heavy metals in Ag, As, Cd, Cr, Cu, Hg, Mo, Pb, Sb, Sn, V, and Zn, well above their preindustrial background levels and notable quantities of PCDD, PCDF and PAH.
- Traces of mercury originating from Gediz River and inactive mining sites in Karaburun Peninsula are discharged into adjacent shelf waters Mercury content in plankton exceeds acceptable standard level

## Marine environmental problems

- Monitoring changes in the landscape - important tool for assessing ecological stability Spatial analysis of multi-temporal satellite images using GIS is the most effective tool
- Research demonstrated how landscape changed in a given period (1987-2000).
- These include satellite images of Landsat. Image processing was performed using classification.
- Results showed landscape changes which proofs anthropogenic impacts
- The described above anthropogenic and climatic factors impact environment and cause destruction or loss of landscape elements.
- Landscape changes are detected in Izmir area It is therefore necessary to increase measures on nature protection and environmental monitoring of the Aegean Sea area.

# Water contamination in Izmir Bay



Contribution of pollutants in Izmir Bay

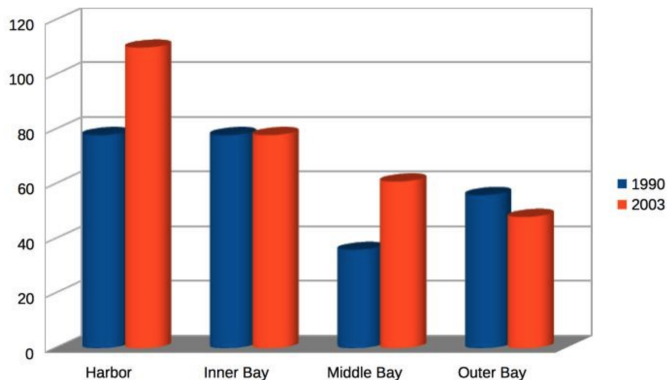


## Izmir Bay: Environmental Pollution of the Sea by Sewage

Parameter	Sewage	Streams	Total	Sewage, %	Streams, %
Flow rate (10 <sup>6</sup> m <sup>3</sup> /year)	188	732	920	20.4	79.6
COD (ton/year)	110,000	280,000	390,000	28.2	71.8
BOD (ton/year)	29,000	122,000	151,000	19.2	80.0
Suspended solid matter (ton/year)	20,000	87,000	107,000	18.7	81.3
NH <sub>3</sub> -N (ton/year)	6,800	16,700	23,500	28.9	71.1
NO <sub>2</sub> -N (ton/year)	51	136	188	27.1	72.9
NO <sub>3</sub> -N (ton/year)	381	1,052	1,433	26.6	73.4
Total N (ton/year)	7,232	17,888	25,121	28.7	71.3
Total P (ton/year)	488	820	1,308	37.3	62.7
Cadmium (ton/year)	0.699	0.218	0.917	76.2	23.8
Copper (ton/year)	3.420	23.860	27.280	12.5	87.5
Lead (ton/year)	8.060	4.985	13.045	61.8	38.2

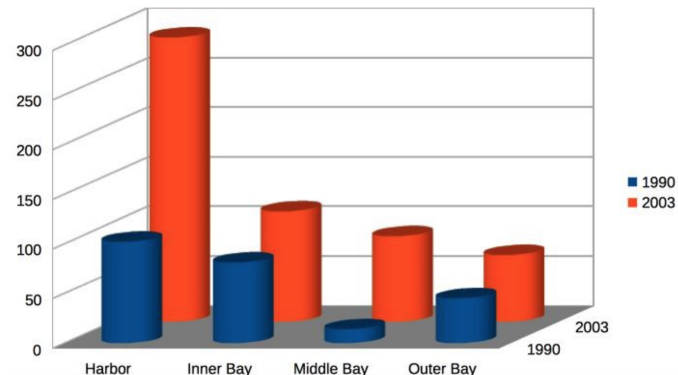
Pollution loads of Izmir sewage and streams. Source: Gürü et al., 2006.

## Water contamination in Izmir Bay by heavy metals: Pb



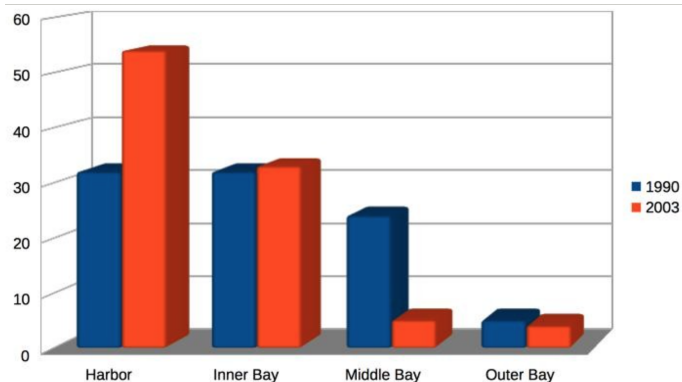
Visualized graph of the concentrations of lead/plumbum (Pb) as mg/kg dry matter in sediment samples taken at Izmir Bay: July 2003 and 1990.

## Water contamination in Izmir Bay by heavy metals: Zn



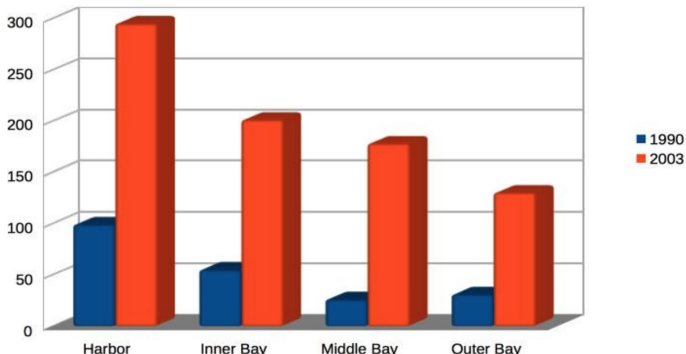
Visualized graph of the concentrations of zinc (Zn) in sediment samples (mg/kg) dry matter at Izmir Bay: July 2003 and 1990

## Water contamination in Izmir Bay by heavy metals: Cd



Visualized graph of the concentrations of cadmium (Cd) in sediment samples (10 mcg/kg) dry matter at Izmir Bay: July 2003 and 1990.

## Water contamination in Izmir Bay by heavy metals: Cr



Visualized graph of the concentrations of chromium (Cr) in sediment samples (mg/kg) dry matter at Izmir Bay: July 2003 and 1990.

# The Interactions Between Aquatic and Terrestrial Components of the Ecosystems

- Water and terrestrial areas are closely connected within ecosystems, hydrological disturbances cause landscape degradation.
- Erosion is the most important trigger factor for soil degradation.
- According to the reports (EEA, 2010), there is a high degree of soil erosion in west Turkey, which is caused by complex influence of various factors: climatic settings, topographic relief, geological settings.
- Climate change together with human impacts cause degradation of the semi-natural vegetation which leads to the soil degradation, and causes erosion.

# Landscape Change as a Sequential Process with Impact Factors

- Soil-hydrological processes cause changes in local landscapes.
- In turn, it affect vegetation, especially in the coastal zones with sensible ecosystems.
- For example, certain geological conditions makes land soils prone to erosion.
- Together with geomorphological conditions (e.g. step slopes) it intensifies erosion and leads to the land degradation in the Aegean Sea area.
- Intensified by the destruction of the vegetation land cover and types, it increases desertification in the Mediterranean basin.

## Soils and Vegetation: Close Interconnection

- Soil and vegetation degradation are deeply interconnected: 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 soil is caused by the extensive agricultural activities which cause serious degradation and destruction of soils in highland Turkey.
- Quality and structure of soils deteriorate along with conversion of natural landscapes into cultivated lands.
- This demonstrates close connection between various parts of the ecosystem and negative effects of the land use change on natural landscapes.



## Water and Vegetation: Ecological Interactions

- Water shortage causes deforestation of precious forests communities, desertification, soil erosion and land degradation in Karuburun Peninsula
- Karuburun Peninsula is an important part of Izmir ecosystems, well known as one of the major undisturbed sites in western Turkey with precious biodiversity structure, aesthetic landscapes and unique environment.
- Other sources of environmental threats: radioactive wastes and radionuclides that originate from natural sources.
- Sources include e.g. leaching from minerals and pollutants, e.g. nuclear power plants, explosions and accidents.
- Such ecological contamination have direct impact on the sustainability of ecosystems.

## Anthropogenic Impacts on Izmir Region: Agriculture and Industrial Development

- Non-controlled anthropogenic pressure also has potential negative consequences.
- Human influence is reflected in physical landscapes, e.g. land use types or spatial landscapes heterogeneity
- Positive factor: industrial development definitely has positive influence on the local economics and tourism development
- Negative factor: anthropogenic land overuse and industrial development trigger processes of changes in chemical and physical properties of soils.
- Other factors: cultivation, overgrazing and harvesting lead to gradual soil deterioration and land depletion

## Impact of Tourism on the Izmir Region

- Apart from the industrial anthropogenic activities, Izmir region is being intensively visited by tourists, due to the touristic attractiveness of the Izmir region, its natural settings, favorable climate conditions and scenic landscapes, geothermal water springs
- Example of negative effects of tourism on the environment is threat for seal population (*Monachus Monachus*) and sea turtles (*Caretta caretta*) which comes from the tourism and local uncontrolled fishery (Veryeri et al., 2002).

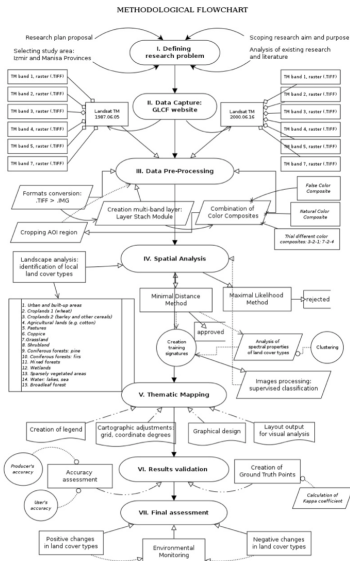
## Conclusion on the Environment of Izmir Region

- As a result of multiple factors, this region is recently being under pressure from both climate changes and from anthropogenic activities
- Hence, local landscapes are affected by industrialization, uncontrolled urbanization and high anthropogenic pressure (e.g. overgrazing) leading to landscape changes
- The urbanization triggers gradual decrease of the fertile landscapes and agricultural areas along the Aegean coasts
- As a result, natural and semi-natural landscapes disappeared drastically in the course of 20<sup>th</sup> century
- 20<sup>th</sup> Century is a period of the most intensive urbanization in Turkey

## Research Questions

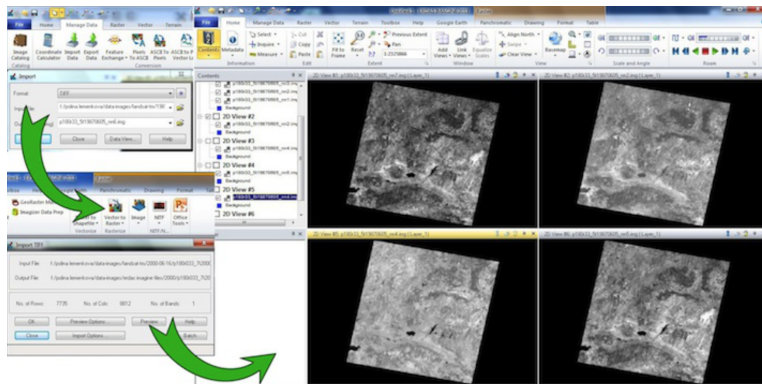
- Did landscapes change within the test area of the Izmir region in the last 13 years (1987-2000)?
- If there are changes, what types of land cover were before, and what is now ?
- Calculate exact changes in pixels and ha (or km)
- How we can use remote sensing data in combination with Erdas Imagine software and apply GIS methods towards study problem, methodologically ?

# Methodological Flowchart





## Data Conversion



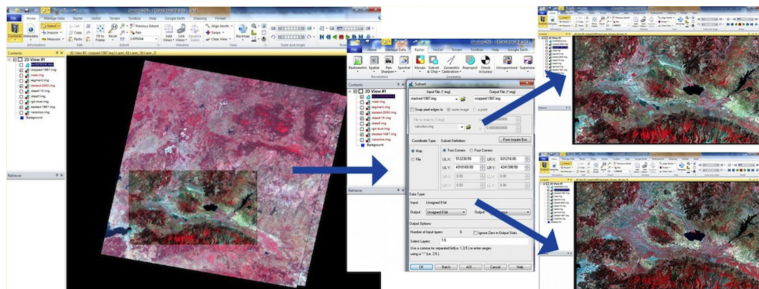


# Creating Color Composites

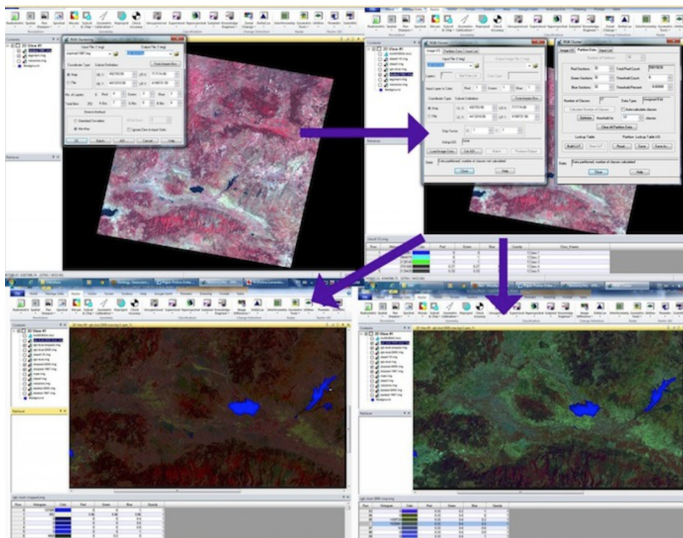
The diagram illustrates the workflow for creating color composites in Erdas Imagine:

- LAYERSTACK Conditional:** A flowchart showing two input rasters (INPUT RASTER #1 and INPUT RASTER #2) feeding into a central circle labeled "Variable LAYERSTACK using Spatial Modifier system", which then outputs to an OUTPUT RASTER.
- Layer Selection and Stacking:** A screenshot of the software dialog where multiple raster files are selected and stacked in a specific order.
- Process List:** A screenshot showing the execution progress of the layer stacking process.
- 3D View #1:** Two screenshots showing the final color composite result, which is a false-color image of a landscape.

# Masking Study Area



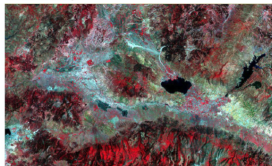
## Clustering



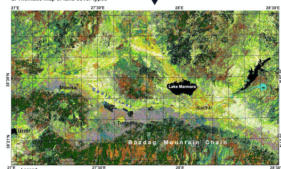
# Results: Maps of Land Cover Types: 1987 (left) and 2000 (right)

LAND COVER TYPES IN PROVINCES MANISA AND IZMIR, WESTERN TURKEY.  
Supervised classification applied to Landsat TM image, 1987.

1. Landsat TM initial image



2. Thematic map of land cover types



Legend		Auxiliary technical data:	
Color	Code	Code	Description
Blue	1	1	Water
Green	2	2	Forest
Yellow	3	3	Barren land
Orange	4	4	Urban areas
Red	5	5	Open fields
Cyan	6	6	Low vegetation
Light Green	7	7	High vegetation
Dark Green	8	8	Very high vegetation
Light Blue	9	9	Low water
Dark Blue	10	10	High water
Light Yellow	11	11	Low bare land
Dark Yellow	12	12	High bare land
Light Orange	13	13	Low urban
Dark Orange	14	14	High urban
Light Red	15	15	Low open fields
Dark Red	16	16	High open fields
Light Cyan	17	17	Low low vegetation
Dark Cyan	18	18	High low vegetation
Light Green	19	19	Low high vegetation
Dark Green	20	20	High high vegetation

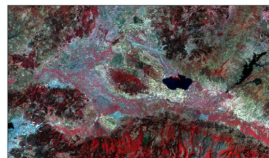
Classification type: Supervised classification, Minimal Distance method

Land cover classes: 19 types

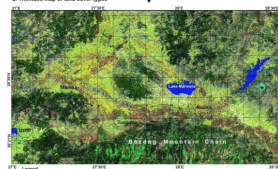
Area: 1600 and 16000 hectares, western Turkey

LAND COVER TYPES IN PROVINCES MANISA AND IZMIR, WESTERN TURKEY.  
Supervised classification applied to Landsat TM image, 2000.

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Light Blue	9	9	Low water
Dark Blue	10	10	High water
Light Yellow	11	11	Low bare land
Dark Yellow	12	12	High bare land
Light Orange	13	13	Low urban
Dark Orange	14	14	High urban
Light Red	15	15	Low open fields
Dark Red	16	16	High open fields
Light Cyan	17	17	Low low vegetation
Dark Cyan	18	18	High low vegetation
Light Green	19	19	Low high vegetation
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Classification type: Supervised classification, Minimal Distance method

Land cover classes: 19 types

Area: 1600 and 16000 hectares, western Turkey

## Results: Table of Land Cover Types

Тип растительного покрова	No pixels, 1987	No of pixels, 2000	Area(ha), 1987	Area (ha), 2000
Луга (Grasslands)	411879	795422	2141	4134
Городские территории (Urban areas)	1443590	1797360	7504	9342
Хвойные-1 (сосны)	1253627	1711708	6516	8898
Хвойные-2 (еловые)	871502	921977	4530	4793
Рощи, подлесок (Coppice)	1058062	134659	5500	700
Водно-болотные угодья (Wetlands)	51041	27721	265	144
Пахотные земли 1 (пшеница)	458425	643684	2382	3345
Пахотные земли 2 (ячмень, злаковые)	220975	850931	1149	4423
Смешанные леса	790421	242800	4109	1262
С/х угодья	24344	925968	127	4813
Пастбища	815377	283646	4238	1474
Области с редкой растительностью	165250	1137789	859	5914
Широколиственные леса	1716519	1098428	8923	5710
Кустарники	1260254	350603	6550	1822

## Conclusions

- Monitoring changes in the landscape - important tool for assessing ecological stability
- Spatial analysis of multi-temporal satellite images using GIS is the most effective tool
- Research demonstrated how landscape changed in a given period (1987-2000).
- These include satellite images of the Landsat Thematic Mapper (TM).
- Image processing was performed using classification by means of Erdas Imagine.
- Results showed landscape changes which proofs anthropogenic impacts
- The described above anthropogenic and climatic factors impact environment and cause destruction or loss of landscape elements.
- Landscape changes are detected in Izmir area
- Presented research contributed towards the environmental monitoring in the Aegean Sea area.

# Thanks

*Thank you for attention !*

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