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DEVELOPING A SYSTEM OF SUSTAINABILITY INDICATORS FOR THE LAKE BALATON REGION

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Abstracts: Studied area is the Lake Balaton region, where we had to go back to re-clarify issues as we were trying to find suitable indicators. This initiative showed that developing an indicator system is a fairly demanding process. However, indentifying local trends and linking them to policy-making are crucial, because lack of comprehensive information accessible in a timely manner can severely constrain successful adaptation efforts. Although our work represents only an initial step, the indicator system developed in the project will hopefully inspire concerned citizens and organizations in the region to take interest in this issue and continue working on indicators beyond this project.

Introduction

In order to help society translate sustainability from theory into practice, we need tools that can help to define and track progress towards social, environmental and economic goals and priorities. In many jurisdictions, sustainability indicators are becoming an integral part of the policy agenda, often developed through participatory processes involving both specialists and non-specialists and drawing from the knowledge possessed by each group (REED et al. 2006; 2008, KING et al. 2000). In general, indicators are characterized as quantitative information to help explain changes in key system attributes over time.

Traditional measures of performance were often limited to economic indicators. Economic output, employment, the rate of inflation are some of the typical measures that have been included on socio-economic report cards, often mistaken, implicitly or explicitly, as overall measures of progress. By now, there is a well established literature that points out that these indicators provide only a narrow perspective. By design, they often miss key (positive and negative) externalities, and provide only limited view of why particular trends are occurring and do not necessarily reflect the situation of a particular industry, society or area (HART 1999, SIRGY et al. 2006).

Broadening the narrowly defined set of economic indicators, sustainability indicators have been developed with a primary aim to measure progress at the local, national or international level towards socio-economic and environmental goals. In this view, sustainability indicators are key levers not only in the sense that they help diagnose problems and understand their underlying causes, but also in that they help identify sustainable solutions, define goals for the future, help monitor progress to determine whether goals and targets are met, hold decision-makers accountable to their commitments, and motivate people to take action. Developing such a comprehensive set of

sustainability indicators that directly speak to local situations, issues and trends can only be possible with active participation from local communities contributing to the identification, evaluation, and selection of relevant indicators (BOSSEL 2001, FRASER et al. 2006).

Lake Balaton is one of Hungary's and the wider Central European region's most treasured natural assets. It is also a region with tremendous tangible and symbolic value to both Hungarians and the many international guests visiting the lake every year. Lake Balaton, like all natural ecosystems, is continually evolving due to the combined effects of natural and anthropogenic change. Like many natural ecosystems around the world, anthropogenic impacts are playing an increasingly important role in the state and dynamics of Lake Balaton and the life of people that depend on it for their livelihoods and wellbeing. While changes in the past when the area was sparsely settled could be more easily tolerated, changes today can have major repercussions. To help improve the understanding of the social, economic and environmental forces of change that are shaping the Lake Balaton region, the *Lake Balaton Integrated Vulnerability Assessment, Early Warning and Adaptation Strategies* project (Balaton Adaptation Project or BAP, in short) was launched in 2005[1]. Within the framework of this project a set of indicators were developed to help answer the following questions:

– What is happening to the environment and the socio-economic system in the Lake Balaton region based on the most relevant facts?
– What are the main forces of change?
– How do global and local forces of change combine to contribute to the region's vulnerability?

This paper provides an overview of the indicator system development process, based on existing data. The indicators were developed in collaboration with both the expert community and key stakeholders in the Lake Balaton region. First, we outline key steps of the indicator system development process followed by the characteristics of the selected indicators. We also provide selected examples of economic, social and environmental indicators and their interactions in the Lake Balaton region. Finally, we conclude by discussing major challenges encountered during the indicator system development, data collection and analysis process.

The process of developing an indicator system

While indicators are only means to an end – the end being more intelligent decision-making – the process of developing them is important in its own right, since it can help make people's worldviews, knowledge and opinions explicit and build ownership of results (MEADOWS 1988 in BOSSEL 2001). There is no gold standard for designing an indicator system development process, but there are some best practices and principles that can be taken into account (DITOR 2001)[2]. Furthermore, there are many partially overlapping criteria to aid the selection of appropriate indicators.

[1] The BAP project is a collaborative effort of the Lake Balaton Development Coordination Agency (LBDCA), the United Nations Environment Programme (UNEP) and the International Institute for Sustainable Development (IISD). The project is supported by the Global Environment Facility (GEF) and managed by the United Nations Development Programme (UNDP).

[2] See e.g. the Bellagio Principles. < http://www.iisd.org/measure/principles/progress/bellagio.asp>

Based on these notions, the following were taken into account when designing the process and our approach for the Lake Balaton region:

Participation: If indicators are grounded in a participatory process and reflect the views expressed, there is a better chance they will be accepted and used. During the project, we conducted a number of participatory sessions with local experts, practitioners and members of civil society to identify a set of key indicators that could be employed in an analysis of local trends, including social, economic and environmental processes.

Precedents: There is now a vast amount of available literature on indicator systems[3]. Although earlier attempts have been made to develop a comprehensive indicator system for the Lake Balaton region under the National Environmental Assessment Programme (KÉP) of the Hungarian Academy of Sciences, expectations that the Balaton segment of the project would be completed have not been realized[4].

Conceptual framework: Before selecting indicators, a conceptual framework needs to be defined that basically sets out the main sustainability issue categories and their interconnections, within which more specific issues and indicators will be identified. In the case of this project, the conceptual framework adopted is based on economic, social and environmental categories. This framework is consistent with the capital accounting framework, which is widely accepted in the sustainable development literature and practice and serves, at least in the environmental domain as a basis for developing an extended set of national accounts by statistical agencies around the world (e.g. BARTELMUS 1999).

The process of indicator development included the following steps:

Issue selection: Once there was agreement on the conceptual framework, we focused on identifying priority issues during a facilitated focus-group session. Examples include lake-water quality, biodiversity, condition of the riparian zone, unemployment, demography, awareness, etc. The long initial list of issues identified was then iteratively collapsed into shorter lists of priorities either by eliminating issues of marginal importance or merging similar ones. The issues were clearly defined.

Definition of indicator selection criteria: To aid indicator selection, a set of criteria was used. There is no gold standard for indicator selection criteria, but there are many common ones that appear across many different sets (e.g., DITOR 2001). The most important ones for our exercise were the following:

- Validity: is the indicator scientifically valid and does it describe the underlying issue / phenomenon accurately?
- Measurability: is the indicator actually measurable?
- Data availability: are data likely to be available? We did not automatically eliminate indicators with no available data, but preferred to focus on those that already had data.
- Cost: can we access data without incurring extra cost?
- Understandability: is the indicator understandable by our intended audiences?

[3] http://www.iisd.org/measure/compendium/

[4] The KÉP project was completed in 2007 (VÁRI et al., 2008).

Generating and refining the set of indicators: We established three working groups focused on ecological, economic and social indicators and held a series of both small and larger group discussions to generate and refine an initial set of indicators. The indicator development process for the Lake Balaton region took place between 2006 July and 2007 December. In total, 11 regional stakeholders and ca. 10 experts took part in the process. We envisioned limiting the number of indicators to around 40, because we believed longer indicator sets produce diminishing returns and they would significantly complicate the communication of results or ability to update with new data in the future. For all indicators, we provided a basic definition, applicable unit of measurement and period covered (see Table 1). The list of selected indicators is fairly diverse, which is inevitable if we would like to reflect on complex trends in the region leading to changes in local vulnerability.

Data collection and processing: Data collection involved identifying and contacting primary data holders, and acquiring the raw data where available. In cases where data were not available or were too expensive to obtain, we tried to identify second-best alternatives. As expected, data collection was difficult and slow, because data were often in scattered sources, of poor quality, and in the wrong format. Data compilation required extracting the required series, storing them in a simpler Microsoft Excel template and plotting the required charts. Finally, we narrowed down the indicator's list to 32 indicators.

Indicator analysis: Indicators were analyzed based on a common template using the following questions:

- How is this indicator defined?
- What is happening in the region?
- How is society responding?
- What could be anticipated in the future?

To increase the accessibility of the collected data to local users, the analysis of trends will also appear in electronic format in an innovative new database. The database not only provides everyone easy access to the results, but also keeps the information in one place where it can be updated on an ongoing basis as new data and observation results become available[5].

[5] www.balatontrend.org (to be available from Fall 2008)

Table 1. Overview of the Lake Balaton region indicator system

Issue	*Indicator*	*Basic definition*	*Unit of measurement*	*Period*
Ecological				
1. Lake-water quality	1.1 Composition of algal biomass	Percentage of blue-green (nitrogen fixing) algae biomass compared to total algae biomass	Percentage of blue-green algae to total algal biomass	1998–2006
	1.2 Water-quality index	Water quality on a five-level scale (1=best, 5=worst). The index is an average of 5 indicators: BOD, COD, TP, PO4, TN and Chl-a	Average water quality on a five-level scale (1=best, 5=worst)	1968–2006
2. Pollutant loading from the watershed	2.1 Phosphorus load	Total phosphorous load as yearly averages for the whole lake from 1975 until 2006	Tons per year	1975–2006
	2.2 Erosion potential	Erosion potential aggregated on the basin level as follows: Northern, Southern and Zala catchments in 2005. It shows four grades of soil erosion in the following categories: 1) non or insignificantly eroded areas; 2) weakly eroded areas (less than 30% of the original surface layer is eroded); 3) moderatelyeroded areas (30–70% of the original surface layer is eroded); 4) strongly eroded areas (more than 70% of the original surface layer is eroded)	Percentage of eroded land in four categories	2005

Contd. Table 1.

Issue	*Indicator*	*Basic definition*	*Unit of measurement*	*Period*
3. Hydrological conditions of the lake and watershed-water quantity	3.1 Water level	Water level based on daily averages calculated at two points: Balatonakali and Tihany	Lake average in cm	1996–2005
	3.2 Precipitation level	Changes in precipitation as an indicator of climatic and hydrological conditions in the region. They present daily precipitation levels during the monitored years	Mm	2002–2006
	3.3 Groundwater level in karst aquifers and wells	Water level in monitoring wells at three measurement points in the Northern and Southern parts of the lake. The indicator also presents the water level in karst aquifers at thee measurement points	cm below the surface	1991–2006
4. Biodiversity	4.1 Species composition of fish	This indicator describes fish harvests for all catches of fish and for carp only (*Abramis* sp.)	Kg	1994–2003
	4.2 Number and composition of wintering bird populations	Total number of wintering birds at Lake Balaton during the migratory season	Number of birds	Four migrating seasons from 2003–2004 to 2006–2007
5. Shoreline condition	5.1 Ratio between natural and built-up shoreline	Rate of change in built-up shoreline	Km	1970–2005
	5.2 Fragmentation of reed beds	Amount of harvested reed	Ha	1995–2005

Contd. Table 1.

Issue	*Indicator*	*Basic definition*	*Unit of measurement*	*Period*
6. Landscape structure and land-use	6.1 Land-use change	Amount of different land use types compared to total land-use	Percentage per land-use type	2005
7. Environmental infrastructure and material consumption	7.1 Sewage discharge	Total amount of sewage discharged into the sewage system	m^3	1991–2006
	7.2 Greenhouse gas emissions emissions per year	Total amount of greenhouse gas (for Hungary as a whole)	Gigagrams (Gg) of CO_2 equivalent	1985–2004
	7.3 Per-capita solid waste production	Total amount of waste generated, in tons. The indicator focuses on the largest tourist resort in the region, located around the town of Siófok	Tons	2000–2007
8. Transportation	8.1 Traffic intensity in lakeside municipalities	Number of vehicles (passenger cars, trucks and buses) on the major roads in the area	Number of vehicles	1990–2004
9. Climate	9.1 Water temperature	Water temperature from 2002 to 2006 measured at the Balatonakali station. The data show average and maximum water temperature	°C	2002–2006
	9.2 Wind speed	Average and maximum wind speed on a monthly basis	m/s	2002–2006
	9.3 Air temperature	Average temperature in the region. The indicator also presents monthly averages	°C	2002–2006

Contd. Table 1.

Issue	*Indicator*	*Basic definition*	*Unit of measurement*	*Period*
Economic				
10. Economic development	10.1 Settlement economic potential (SEP)	Per capita GDP in the region as compared to national and rural, corrected for inflation	Ft per capita	1994–2004
11. Employment and seasonality	11.1 Unemployment	Proportion of unemployed persons compared to the total number of economically active persons in the population	Percentage	1990–2006
12. Economic diversity	12.1 Share of tourism in the economy	Proportion of operating enterprises in the hotel and restaurant industry and the portion of companies in partnerships with the hotel and restaurant industry	Percentage	1999–2004
13. Tourism	13.1 Proportion of domestic versus foreign tourism	Number of foreign tourists compared to domestic visitors	Number of visitors	1990–2005
	13.2 Tourism during the main season	Number of foreign tourists compared to domestic visitors during the main tourist season (July and August)	Percentage	1994–2006
14. Agriculture	14.1 Area of cultivated vineyards	Area of cultivated vineyards	Ha	2002–2006
Social				
15. Subsistence and poverty	15.1 Percent of people who receive local government welfare aid	Number of residents who receive regular welfare (during a given year)/ number of residents older than 18	Percentage	1993–2005

Contd. Table 1.

Issue	*Indicator*	*Basic definition*	*Unit of measurement*	*Period*
16. Awareness	16.1 Number of civil society organizations per 1,000 residents	Number of environmental civil society organizations per 1,000 residents	Unit/1,000 persons	2000–2006
17. Demographic issues	17.1 Balance of migration	The difference in the number of people migrating to and from the settlement (in a given year) x 1,000 compared to the number of permanent residents	Unit/1,000 persons	1990–2005
	17.2 Rate of dependency	Number of residents younger than 14 and number of residents older than 60 compared to the number or residents aged 15–59	Percentage	1990–2005
18. Crime and security	18.1 Number of property-related crimes per 10,000 inhabitants	Number of reported property-related crimes x 10,000 compared to the number of residents (5-year average)	Unit/10,000 persons	2002–2005
19. Education	19.1 Percent of people who completed at least elementary school	Number of people who completed at least elementary school compared to the number of residents older than 18	Percentage	2002–2005
20. Public health	20.1 Life expectancy	The expected age at death calculated on the basis of mortality data of various age groups	Five-year averages	1990–2000

Examples for indicators

In the following, examples for indicators in each category are presented.

Ecological indicators

Ecological conditions around Lake Balaton are of interest to both tourists visiting the region and the local population. Given the central role of the lake, water quality and quantity in the lake itself are the most discussed ecological issues. Besides water quality, water level also emerged as an important issue in its own right, particularly since the sensitivity of Balaton to water level changes became clear in the early part of the decade.

Water level

How is this indicator defined?

This indicator describes the water level in centimetres based on daily averages from two standard water level monitoring points at Balatonakali and Tihany. Data are available for the period of 1997 to 2006 (Figure 1).

What is happening in the region?

Lake Balaton, with its surface area of 594 km^2 and 3.3 m average depth, is an extremely shallow lake with high sensitivity to changes in weather patterns, ecological impacts and management decisions. Direct water use in the Lake Balaton catchment can be assigned to four categories: 1) drinking water, 2) industrial supply, 3) irrigation, and 4) fish ponds. Interestingly, this direct use of lake water is negligible when considering the lake's entire water budget and the fact that a considerable part of drinking water supply to the area's inhabitants is drawn from groundwater. There are 13 facilities that extract drinking water from the lake, however, and two that extract water for irrigation. Given the small volumes involved, none of these direct uses exert significant pressure on the water and the soil balance of the lake (ISTVÁNOVICS et al. 2002; JORDAN et al. 2005; GLEN et al. 1998; BARCZI et al. 1996, 1999; PENKSZA et al. 2003).

Local climate is continental to sub-mediterranean and typically moderately wet, which significantly influences the lake's water level. A major impact on the lake ecosystem and the land use around it was the engineered lowering of water levels in the 1860s to reduce flood risks to shoreline infrastructure and to increase the area available for development. Water was drained through the Sió Canal in Siófok where a weir was constructed in 1863. In recent years, based on local regulations, water level should be in the range of 70–110 cm, allowing a range of 40 cm for adjustments.

How is society responding?

As shown on Figure 2, the period between 2000 and 2003 was atypical, with below-average precipitation resulting in water levels well below the lower regulatory limit. Based on 81 years of records, a long-term precipitation average is about 621 mm/yr, while the average precipitation was 557 mm in 2001 and 485 mm in 2002 (LARSEN 2005). During these years, lower-than-average precipitation combined with above-average evaporation resulted in a significant and sustained lowering of the water level. 2001 was the first year since the introduction of systematic water budget monitoring in 1921 that the natural water budget (i.e. precipitation+inflow-evaporation) of the lake became negative. Negative water balance continued for four years.

The sustained drop in water level initiated a discussion about potential responses, which generally focused on opportunities to bring additional water from neighbouring watersheds. Most of these options were considered unfeasible due to differences between the characteristics of external water sources compared to that in the lake, which might have had significant impacts on local biodiversity. However, more recent studies (ISTVÁNOVICS et al., 2002) have proven that the chemical water quality of those rivers considered for water transfer was better than the water quality of Zala river, the main tributary of the lake. Biodiversity issues related to water transfer are under intensive study at present, since former statements on this issue had little, if any, supporting data.

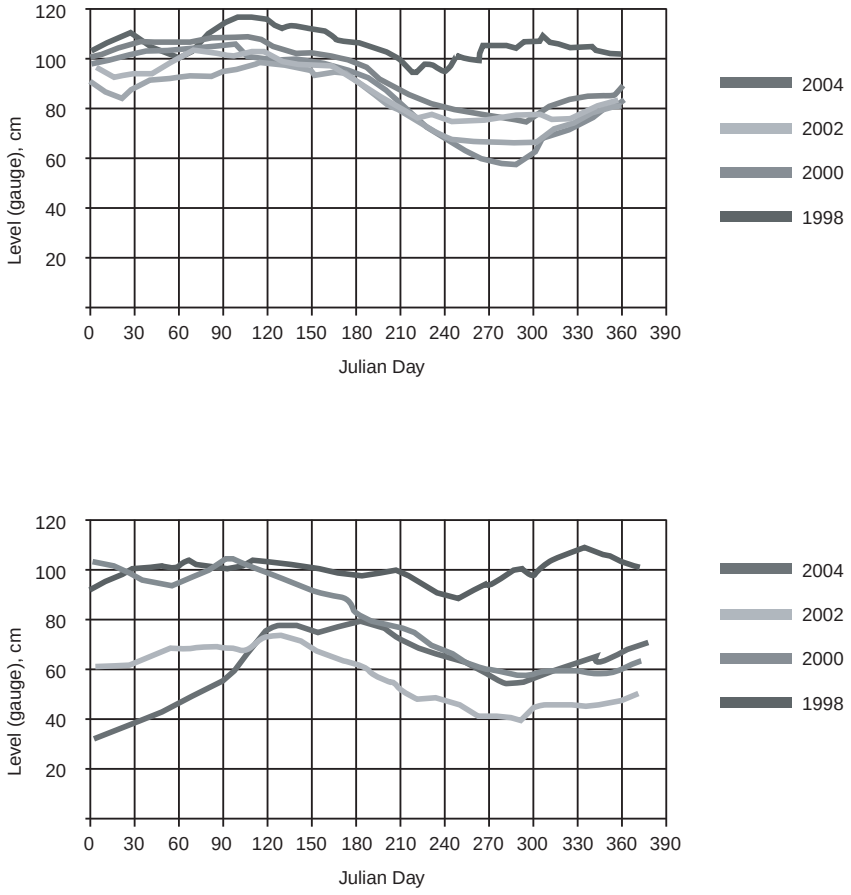


Figure 1. Changes in the mean level of Lake Balaton, 1997—2005

What could be anticipated in the future?

Increasingly frequent and severe water balance problems, such as the ones that occurred in the 2000–2003 period, would have significant impacts on biodiversity, particularly in the riparian zone and for aquatic species. Severe and enduring water-level problems would also affect revenues from tourism that is generated only during a very short tourist season.

Economic indicators

Lake Balaton's local economy is based on tourism activities that are strongly dependent on the quality of the local environment. For more than 100 years, the region has maintained its position as Hungary's best established holiday destination. As in other similar areas, tourism is characterized by a high degree of seasonality and systematic underreporting of tourism income. Transition from socialism to market economy over the 1990s and changes in weather patterns over the past few years have also had significant impacts on the number of tourists. The future of tourism and other economic issues such as economic diversity and agriculture have been a subject of many local and national dialogues. One of the key indicators that informs many of these dialogues is related to the share of tourism in the economy.

Share of tourism in the economy

How is this indicator defined?

This indicator describes the proportion of enterprises operating in the hotel and restaurant industry in terms of percentage and the proportion of companies in partnerships with hotels and restaurants from 1999 until 2004.

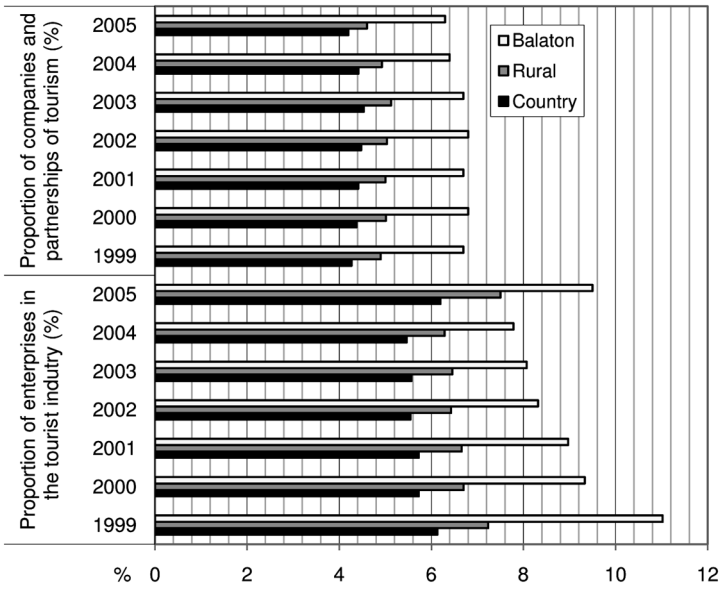
What is happening in the region?

After Budapest, the Balaton region has the second best developed tourism infrastructure in Hungary. The Balaton region has tourism as the highest portion of it's the economy overall and also the highest level (about 26%) of the country's total number of hotels, mostly concentrated around the lake. This number is actually even higher, as private accommodations are usually not included in the statistics. The average proportion of the hotel and restaurant industry in the region is about 9.2%; an additional 6.2% refers to industries developed around the tourist sector between 1999 and 2004. Although this is a relatively moderate share, tourism, including private accommodation, represents a major source of revenue and employment in the region.

In 2005, some 8,900 enterprises were operating in the tourism industry, a number that is gradually increasing, although it still falls below 1999 levels when according to records the area had 1,120 enterprises. Municipalities located around the lake are not always the direct beneficiaries, however, as only 13 to 15% of the revenues stay within the Balaton region (Figure 27). The reason for this is that of the small and medium-sized enterprises (SMEs), only 12 to 13% reported their revenues within the region, because they were registered elsewhere. These enterprises usually operate only during Lake Balaton's main tourist season.

How is society responding?

Increasing competition and the short main recreation and tourist season provide a signal to the local tourist industry to reduce its reliance on tourism as a major source of revenue. There are other sources of revenues available to local entrepreneurs, however, including extending the season by providing conference and spa tourism and expanding local vineries, local agricultural production and small and medium sized companies benefiting from being in the vicinity of Budapest. As these activities are developed, they should adapt to local conditions and take into account the overall development of the tourist industry in other parts of the world.



Source: KSH (Central Office of Statistics)

Figure 2. Proportion of hotel and restaurant enterprises in the economy (%) and the portion of companies in partnerships with the hotel and restaurant industry (%) between 1999 and 2004.

What could be anticipated in the future?

Tourism is a strong driver of the local economy and it has a significant impact at the national level as well. This heavy dependence on a single sector during the main summer season increases the region's vulnerability to the impacts of climate change and creates serious challenges for managing tourism. Diversification of tourist attractions, extending the short peak summer season and better incorporating tourism into local development priorities are ways that could both provide economic resilience and increase the quality of life of local residents e.g., by spreading traffic intensity more evenly. Such measures may also help spread climate risk in the sense that an extended tourist season is less likely to be sensitive as a whole to the effects of extreme climatic events.

Social indicators

In the Lake Balaton area, like in other parts of the country, certain groups of people or certain communities may be more vulnerable to changes than others. For example, people living in poverty and/or lacking appropriate knowledge and skills tend to have a lower degree of resilience and coping capacity than those with access to financial resources and education. Children, the aged, the disabled, the seriously ill, and the socially isolated are also more vulnerable than young or middle-aged, healthy, and socially connected groups. Communities with strong social cohesion and civil society and high levels of awareness and security are likely to be more resilient, as well. Indicators chosen to express social vulnerabilities are related to the above issues. In the following, one demographic indicator central to social vulnerability, the balance of migration is introduced.

Balance of migration

How is this indicator defined?

This indicator describes net migration calculated per 1,000 residents from 1990 to 2005 (Figure 3).

What is happening in the region?

Over the past decade, the balance of migration has fluctuated in the Balaton region**.** In the early 1990s, it was negative, at approximately -5‰ per year. As the political transition process progressed, however, the migration balance turned slightly positive, at 10 to 17‰ per year in the period between 1993 and 2003. During the last couple of years, net migration has returned to negative, dropping to -5‰ once again.

Demographic processes are spatially uneven. On the one hand, as a result of a low birth rate, there was a natural and significant decline in the population of settlements near the lake between 1990 and 2001, whereas population numbers in settlements further away from the lake shore showed modest growth. On the other hand, in-migration has created a positive balance in the region, primarily in lakeside communities, where large numbers of the elderly have settled. Simultaneously, a significant number of young people left the region over the past decade, and as indicated earlier, the birth rate is also relatively low, below even the already low national average. Consequently, the region is characterized by a rapidly aging population (OLÁH 2006).

The size and direction of migration is primarily determined by economic and social factors. Before 1990, the region had a relatively high level of population influx. The main reason for the rapid development, particularly that of industrial centres, was that they attracted the young workforce from neighbouring agricultural areas, and later on, from more distant ones (GORLACH and KOVÁCS 2006).

After the political transition, the region's economic structure underwent significant changes. Industrial and agricultural production dropped steeply and lost jobs could not be compensated for by the expanding service sector. Employment opportunities in tourism fluctuated from season to season. These forces led to the out-migration of young people, which along with the in-migration of retirees to some areas, contributed to the significant ageing of the population (GORLACH and KOVÁCS 2006; PUCZKÓ and RÁTZ 1998, 2000, JORDAN et al. 2005).

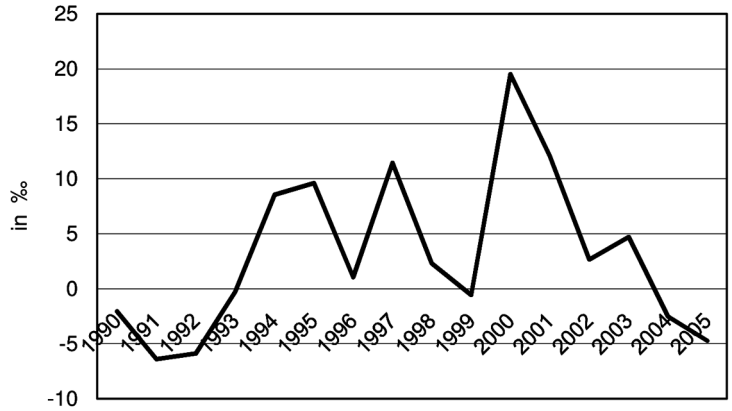
The balance of migration shows major territorial differences. In 2005, the highest positive balance was 62.7‰, and the highest negative balance was 57.3‰. A general observation is that in-migration was relatively characteristic of settlements closest to the lake and of towns, whereas out-migration was typical of settlements further away from the lake and of smaller settlements.

How is society responding?

For the most part, young people moving out of the region have higher levels of qualification and they are driven to leave by "push" rather than "pull" forces. According to recent surveys, the main reason for out-migration is the lack of jobs that ensure a reasonable year-round income as well as a dearth of affordable housing (OLÁH 2006). Economic expediency is also the main reason for in-migration. The majority of new residents are retirees who choose to settle permanently in their second homes in holiday resorts and to sell their former homes or give them to their children. Other groups of

elderly in-migrants, including a large number of foreigners, have been attracted by the region's favourable environmental conditions and its thermal spas.

What could be anticipated in the future?
It is likely that if the country's economy strengthens, the migration balance will recover. In-migration from foreign countries could be significant but is likely to be accompanied by a significant aging of the population (HABLICSEK 2003). It will be important to address the different needs of the growing number of aging inhabitants as they will be increasingly in need of health and social services. This is likely to create new jobs and decrease unemployment.



Source: KSH (Central Office of Statistics)

Figure 3. Balance of migration in the Balaton region (‰), 1990–2005

Key challenges to long-term sustainability in the Lake Balaton region

The Lake Balaton area has had a unique and eventful history in economic development and water management. Communities quickly adjusted to political and environmental change over the last 100 years, thus shaping the social, economic, and natural environments we see today. Unplanned development, high density of tourists concentrated in a very short peak tourist season, water-quality deterioration and disruption of the natural fishery, however, have now placed the region and its inhabitants under high social and economic pressure. In the short term, people benefited economically from rapid industrial development, but in the long run, ecosystems have suffered and there is now a dangerous socio-economic dependency on only one sector of the economy-tourism.

Lake Balaton is at a turning point in its development and decisions and actions taken today can help determine the future sustainability of the area. The indicator system and trend analyses identified areas of key vulnerability around the lake. The following issues are based on the socio-economic and environmental changes drawn from the analysis of indicators.

Changes in water levels

Lake Balaton's historical long-term water budget has been positive: tributary inflow was roughly equal to evaporation (900 lake mm/year), and outflow almost equal to direct precipitation (600 mm/year), since water use is only 30 to 50 mm/year. Water budget figures have been less favourable over the last 20 years and particularly unfavourable during the 2000–2003 period (no outflow, see also Figure 1). Climate change may result in an increase in water temperature and drop in lake water level. Higher water temperature increases the risk of planktonic blue-green algae blooms, while low lake level favors the bloom of filamentous benthic algae in shallow water and, together with stronger winds, higher resuspension frequency of the bottom sediments resulting in more intensive phosphorus exchange with the sediment. Low lake level also favors higher macrophyte production rates that interfere with bathing and sailing.

Figure 4 compares water temperature and the amount of phytoplankton estimated through the concentration of chlorophyll-a in the Keszthely basin at higher than 16 °C water temperature. The figure shows that there is very low correlation between algal concentration and temperature (R^2=0.016), which is due to time lags needed to create all the necessary preconditions for algal blooms including food supply, light, temperature and lack of consumer organisms. When taking into account the impact of temperature from the previous week and the level of algae from the following week[6], we concluded that water temperature probably influences algal blooms in the lake, although the extent of the correlation is uncertain.

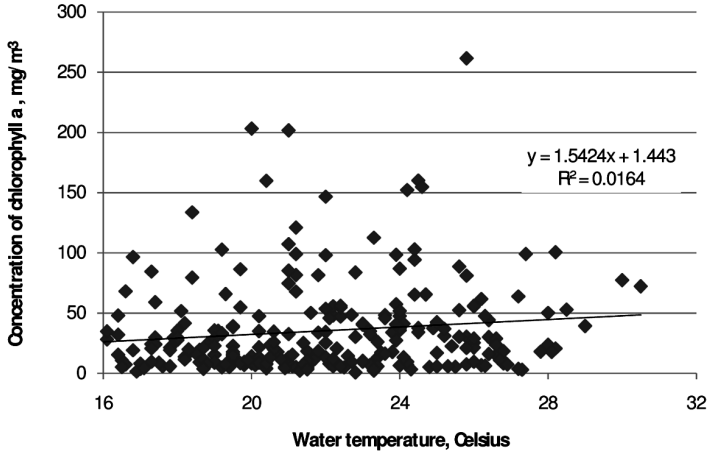


Figure 4. Correlation of algal concentration and water temperature under warm conditions (1984–2006, Keszthely, middle zone of the lake)

Note: Because of only weekly data collection of chlorophyll 'a' concentration, we try to account for the impacts of two (T_{w2}) and one (T_{w1}) week ago temperatures on the algae growth. The calculated temperature based on the three consecutive measures of temperature is called transformation of temperature [T_{tr} = (T_w+5.5T_{w1}+4.5T_{w2})/11]. After using this equation to calculate the correlation, the correlation is a bit stronger (R^2=0.16) compared to using only the weekly temperature, but the regression is rather weak to stipulate a significant trend. We can state that we can expect increased algae growth with the increasing temperature however the extent of the growth is uncertain.

[6] Chlorophyll is measured weekly.

Shoreline development

The state of the shoreline surrounding the lake has a significant impact on the lake's ecology and water quality. However the region has been subject to rapid changes in shoreline development including expansion of paved surfaces, agricultural land-use, and increased reed-bed fragmentation with significant impacts on biodiversity. As infrastructure continues to develop along the lake's shore, protecting high quality reed ecosystems must be a permanent priority. The dominant species in reed beds is common reed [*Phragmites australis* (Cav.) Trin.], but narrow leaf cattail (*Typha angustifolia* L.) has been expanding in some areas of Lake Balaton, to the detriment of the original ecosystem.

Socio-economic changes in the region have contributed to modifications in fish stocks. Serious research efforts are needed to address the population dynamics of fish species and to suppress foreign and invasive species. Figure 5 presents the relationship between the ratio of shoreline development and fish catches from 1970 till 2000. There is an absence of reliable information about shoreline development prior to 1970, although a preliminary comparative analysis or aerial photographs from the early 1950s with recent satellite images clearly demonstrate the growth of built-up areas at the expense of habitat.

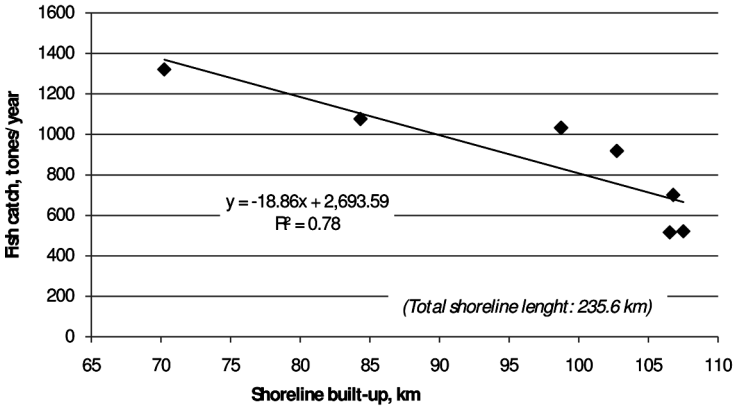


Figure 5. Changes in fish catches in relation to shoreline built-up (1970–2000).
Source: Balatoni Fishing Co., Pannon University: Bercsényi Miklós)

It is obvious that commercial fishing is affected by a number of factors, including the introduction of alien species, changes in the food supply, pesticide use, water releases through the Sió canal and development that modifies land use patterns. Despite the diversity of potential impacts, there is a significant negative trend and strong correlation between the reduction of fish catches as shoreline development expansion. This strong relationship could likely be caused by the loss of habitat needed for reproduction that is usually close to the shore in the reed. Presently, it seems that ecological as well as economic objectives can be best served if commercial fishing is limited in the lake and the fishing company concentrates on stocking of autochthonous and removing invasive

species, while closely coordinates with broader development objectives often centred on shoreline development for tourists' resorts.[7]

Changes in local economic performance and tourism

Tourism has long been the Lake Balaton region's economic mainstay, with lakeshore and resort areas heavily dependent on it as their principal source of income. Among the region's small and medium scale enterprises in the tourism industry (see also Figure 2) only 12 to 13% reported their revenues within the region. Many are registered elsewhere (in Budapest and the county centers, for example), which accounts for a considerable outflow of revenues. Regional and local development policies are needed to influence regional business activities so that revenues can be linked back to local systems in support of their development. Tourism in the region is highly seasonal with the majority of visitors arriving during the 6 to 8 week summer season and it is still mass tourism in nature. Although the annual number of arrivals is not particularly high due to the very short tourist season, the destination, especially the transportation infrastructure is overcrowded during July and August.

This strong focus on the summer season has created seasonality in local employment since the major job opportunities are only available during the summer season. Based on the collected datasets, the annual fluctuation in the unemployment rate is about 2%. Figure 6 shows the close relationship between the changes in the unemployment rates after the main season and guest nights from 1991 till 2005. There is a strong correlation between the amount of tourist nights and following unemployment; however other factors including seasonal workers from other regions and overall level of economic development in the region and the country could have impact on this seasonality, as well.

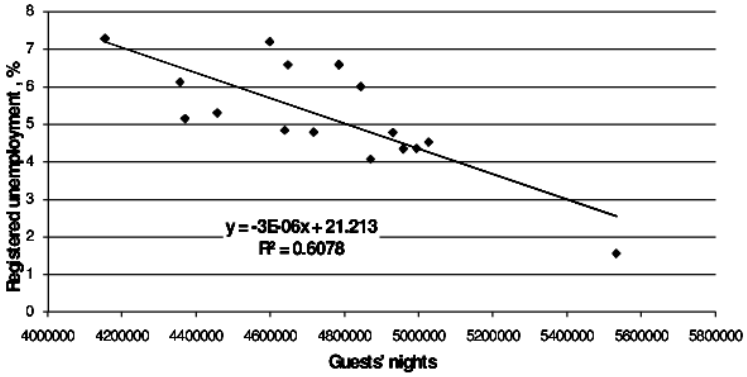


Figure 6. Changes in unemployment rates in September in relation to the guests' nights in facilities around Lake Balaton

[7] Furthermore, one of the region's challenges is the high cost of compensating landowners for taking environmental protection measures, since much of the shoreline is privately or institutionally owned and attractive area for development.

Furthermore, different access to benefits from the tourist industry between lakeside communities and municipalities in the hinterland play significant role in the economic status of the local communities. In terms of location of the guest nights, less than 10% of total guest nights benefit communities away from the shore. In 2005, 92% of guests stayed at lakeside communities. Especially towns with spa tourism have much higher local GDP, reaching even 2.5-times higher than others, especially after 2000. Some developed towns such as Balatonfűzfő and Balatonföldvár have experienced a drop in their GDP since 1994. Major destinations for summer holidays including Siófok, Balatonfüred and Keszthely have higher local GDP compared to other towns. However, they don't show any significant increase during last decade. Towns away from the shoreline have lower GDP about 35-65 % compared to main tourist destination (Figure 7). Although, tourists stay longer in the inland destinations, than they do at the lake front. Diversified strategies are needed that explore opportunities to promote tourism development in lakeside communities and promote cooperation among communities.

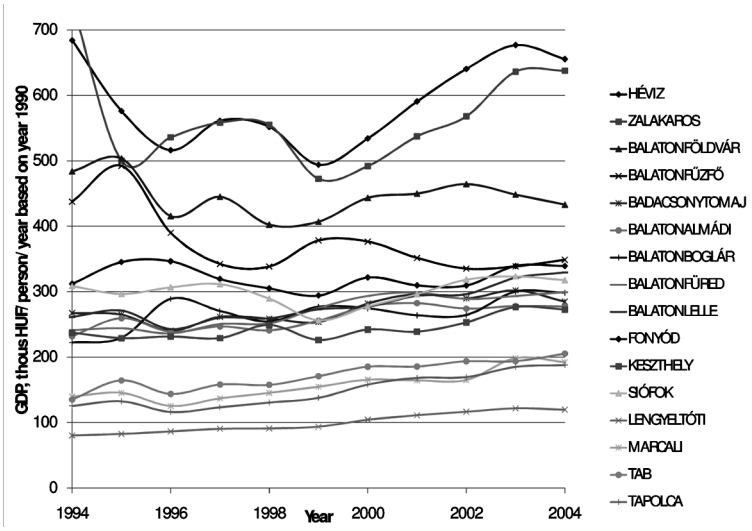


Figure 7. Local GDP at the different communities around Lake Balaton

Demographic trends in the region are characterized by an aging population and the out-migration of the highly educated younger generation. Between 1997 and 2002, the Balaton region's population fell by only 0.4%, while at the national level, Hungary's population declined by 1.7% over the same period (see also Figure 3). The Balaton area is one of the country's most popular destinations for re-settlement, especially for the elderly. Maybe the relatively high unemployment rates with its fluctuations lowers to attractiveness of the region for young people. Figure 8 presets that there is positive feedback between unemployment rates and immigration to the region. It seems that over the next few years and decades, targeted policies will be needed to address the special needs of the aging population and keeping active population in the region and promote year-around employment.

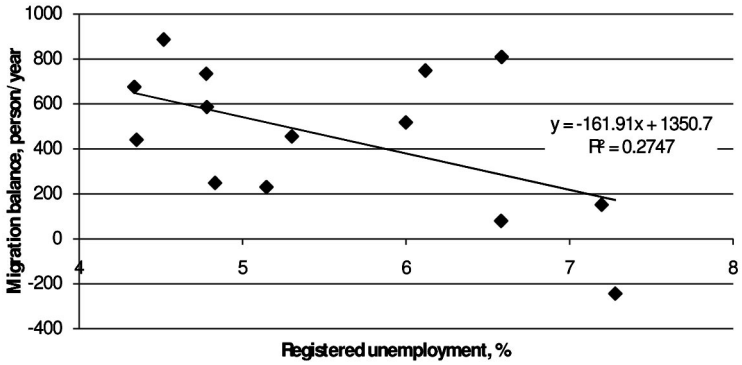


Figure 8. The relationship between migration balance and unemployment from 1992 till 2005

Lessons learned

The development of indicator systems normally requires an iterative process of reconceptualization and refinement of issues and indicators themselves. This has also been the case for the Lake Balaton region, where we had to go back to re-clarify issues as we were trying to find suitable indicators. There is also a need to periodically review and adjust "completed" indicator sets. This is required because issues and priorities will shift in the Balaton region over time and also because new and better indicators may become available. Indicator development is always a compromise between what is desired and what is feasible, and as such the resulting indicator set is never perfect—as is the case in this project. But the point is not to make indicators perfect; rather, it is to make them reflect real issues in the area, to catalyze positive, collaborative action, and help monitor impacts of such actions.

Lake Balaton has a long history of scientific research and monitoring making it one of the best studied lakes in the world[8]. Although this may be the case, the abundance of scientific data is in stark contrast with the paucity of systematized, regularly updated trend information available to the general public and decision-makers in an easy-to-access format. Information is not only scattered across countless agencies creating ownership of public data. Often such data obtained through publicly funded work is available only if one is willing to pay a considerable amount *again* to some agency.

The purpose of creating this indicators system was to create a platform to compare environmental, economic and social trends in an environmentally sensitive area with heavy dependence on tourism. However, compiling cross-cutting datasets presents many problems: there are many data gaps, few consistent time series, and data collected at considerable expense are frequently left to sit in formats that make it useless for anyone except the most dedicated expert and very much limits comprehensive analyses between economic, social and environmental domains.

When local trends are analyzed, longer time series covering a few decades are crucial for such assessments. Despite numerous discussions with local monitoring and data

[8] See for instance Lóczy 1896.

collection agencies, most of the gather data are from the early 1990s. It is understandable, that some economic and social data become almost incomparable due to transition from the socialist regime, however issues such as number of tourists, education level, life expectancy and environmental data seem to be less dependent on the societal transitions but even in these case that data were available only from the early 1990s.

To be effective in promoting sustainability in the region, policy making has a crucial role. However, policies should not only be simple aiming for finding solutions to current pressing problems and negative trends identified through indicator analyses, but they should be centred on promoting resilience, setting-up institutional arrangements, networks and capabilities to facilitate interaction between stakeholders and thus foster learning and adjustments as society evolves[9]. Building on the information that could be generated from sustainable development indicator systems to promote such polices, it is necessary:

– To carry out a more profound analysis of the socio-economic conditions on the ground by using sustainability indicators systems;
– To shift from "top-down" governance towards a regional/local policy and decision-making that could better address specific local and regional situation and needed capacities;
– To promote task orientation, with clear and enforced definition of responsibilities for actors involved in practical application of the decisions, including data collection and accessibility; so what is adopted in the policy realm will be implemented on the ground;
– To link the indicator system with development measures' implementation to monitor the induced changes and impacts of these measures on the region.

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[9] See for example: Kaljonen et al., 2007

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FENNTARTHATÓSÁGI INDIKÁTOROK RENDSZERÉNEK KIFEJLESZTÉSE A BALATON RÉGIÓRA

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Kulcsszavak: gazdasági indikátorok, társadalmi indikátorok, turizmus, Balaton

A Balaton Magyarország és Közép-Európa egyik legfontosabb természeti értéke, a tavat magába foglaló régió pedig kiemelkedő gazdasági, turisztikai, kulturális és szimbolikus jelentőséggel bír. Mint minden ökoszisztéma, a Balaton is folyamatosan változik a természeti és antropogén hatások következtében, s ez kihat a körülötte élő emberek életkörülményeire is. Míg korábban, amikor a tó környéke még viszonylag ritkán lakott volt, a változásokat az ökoszisztéma és a társadalom könnyebben elviselte, manapság ezek egyre súlyosabb következményekkel járhatnak. E hatások jobb megértése céljából egy nemzetközi kutatási projekt keretében fenntarthatósági indikátorrendszert fejlesztettünk ki, amely a természeti környezet, a gazdaság és a társadalom legfontosabb folyamatainak nyomon követésére alkalmas. Az indikátorrendszer kidolgozásában a téma szakértőin kívül bevontuk a Balaton régió legfontosabb érintettjeinek képviselőit. A cikk vázolja az indikátorfejlesztés fő lépéseit és eredményeit. Néhány kiemelt környezeti, gazdasági és társadalmi indikátor részletes ismertetése mellett példákat mutatunk be az indikátorok közötti interakciókra is, majd összefoglaljuk a fejlesztés és adatgyűjtés során felmerülő főbb problémákat és kihívásokat.