

## SUSTAINABLE CITIES – RESPONSE TO URBAN ENVIRONMENTAL PROBLEMS

**Ksenija Poredoš**, B.Sc. Geography  
Geodetic Institute of Slovenia  
Jamova cesta 2, SI-1000 Ljubljana  
e-mail: ksenija.poredos@gis.si

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### Abstract

Urban areas have considerable impact on the environment, which is reflected on the global level, but at the same time face many environmental problems. Sustainable cities proceed from the need to improve the quality of city life and incorporate all components of sustainable development. On the example of Waitakere city, New Zealand, the article studies the main environmental problems and analyses measures introduced by the city for the improvement of the state of the environment in the city.

**Key words:** urbanization, urban geography, sustainable cities, sustainable development, DPSIR

## SONARAVNA MESTA – ODZIV NA URBANE OKOLJSKE PROBLEME

### Izvleček

Urbana območja imajo velik vpliv na okolje, ki se odraža globalno, hkrati pa tudi sama znotraj svojih meja doživljajo mnoge okoljske probleme. Sonaravna mesta izhajajo iz potrebe izboljšanja kvalitete mestnega življenja in vključujejo vse komponente trajnostnega razvoja. V prispevku smo na primeru mesta Waitakere, Nova Zelandija, preučevali njegove glavne okoljske probleme in analizirali ukrepe, ki jih mesto izvaja za izboljšanje stanja okolja.

**Ključne besede:** urbanizacija, urbana geografija, sonaravna mesta, sonaravni razvoj, DPSIR

## I. INTRODUCTION

In 2008, the world attained an unremarkable, but important threshold: more than half of the world population or 3.3 billion people lived in urban areas for the first time in the history of mankind. It is expected that the number will increase to nearly 5 billion people until 2030 (State of world population, 2007; 2010). The world is thus becoming increasingly urban; people move to cities to find employment, education possibilities and a higher living standard. That is why we have to place cities, as the home of half of the world population, to the forefront of our most urgent environmental challenges. As extensive areas of a considerable concentration of the population, where different factors and interests interact, cities represent an open mass-energy and spatial ecosystem, which requires adequate development guidelines to tread the path of sustainability as successfully as possible.

### I.1. Environmental problems of modern cities

Although there are many social and economic advantages of urbanization, there are also several environmental problems. Cities occupy less than 3% of the Earth's surface, but a considerable concentration of the population, industry, different activities and energy use is located there. All this lead to extensive local pollution and environmental degradation. Environmental imprints of cities also extend much beyond their urban border; cities have an extraordinary impact on the neighbouring rural, regional and global ecosystems. Urban environmental problems above all include unsuitable water supply, waste water, solid waste, energy supply, loss of green and natural areas, expansion of the city area, soil and air pollution, traffic, noise, etc. (Urban issues, 2010).

Today, the network of cities and other built-up areas is very dense and the pressures on the environment increasingly exceed self-cleansing capabilities. The higher the density of urban population and the size of urban areas, the more frequent the feedback effects and multilayer consequences of different interferences in the environment (Plut, 2006, p. 27). The most concerning are the quality of air, noise and traffic burden. Economically developed countries have reduced environmental problems related to industrial production, residence and basic infrastructure in cities, while problems of consumption (more waste) and traffic problems have increased. Cities use more and more natural resources, produce more waste and emissions, which in turn affect the regional and planetary environment. Air and water pollution as well as waste are the main environmental problems in most cities (Plut, 2006).

Figure 1: Twin Streams info board on the shore of Oratio stream (photo: K. Poredoš)  
 Slika 1: Info tabla projekta Twin Streams pri reki Oratio (foto: K. Poredoš)



## 1.2. Sustainable cities

The main question is how a favourable development of cities, which will not reduce the quality of environment and overly exhaust natural resources, can be assured. Sustainable cities are cities, where social and economic goals are implemented along with environmental and energy goals and thus assure the durability of urban changes. These cities attain an efficient use of natural resources, reduction of ecological imprints and an adequate quality of living conditions for their population. Sustainable urban development is based on the demand for environmental protection and the protection of natural resources.

The primary goal of environmental sustainability is the maintenance of stocks of natural capital by reducing the need for the use of land, energy, production of emissions and the limitation of inter-regional substance exchange (Plut, 2007). The long-term sustainable urban goal is the reduction of city mass-energy currents, use of resources and space per inhabitant, reduction of ecological imprints and increased use of regional resources. The urban development must be adapted to the capabilities of ecosystems (Plut, 2006).

A sustainable city represents a long-term development perspective, which unites different planning strategies. To assure sustainable development, the protection strategy must be linked to the efficiency of the urban system in the management of resources and assurance of equal access to resources (Koželj, 2007). Actually, many cities all over the world (around 200) committed themselves to the attainment of sustainable development. There are success stories, which can serve as an example.

## 2. METHODOLOGY

Two methods were considered in the geographic and environmental study of Waitake-re city: the functional region geographic model and the DPSIR model. Regional models should reflect the basic characteristics of regional systems, especially the regional structure, organization and mode of action, regional processes and mechanisms of connections as well as processes and levers of management. The geographical environment must be considered as an intertwined spatial system that consists of the natural and socio-economic subsystems (Plut, 2004, p. 39).

The DPSIR model (driving forces – pressures – states – impacts – responses) for the research of the environment and environmental resources is designed as a chain of casual links and represents a comprehensive model of studying the environment from the point of view of sustainable orientation of spatial development (Plut, 2004, p. 46). The model presents and analyses activities, which cause pressures, pressures respectively burdens and impacts on the environment, the current state of the environment, impacts on people, ecosystems and the nature and the reactions of the society on environmental problems. Indicators within the framework of the DPSIR model, which was developed by the European Environment Agency, help comprehend the cause-effect and, above all, mutually influencing relations in the environment. The model consists of:

- Driving forces: all social-economic factors and activities that result in the increase or reduction of pressures on the environment;
- Pressures: these are direct anthropogenic burdens and impacts on the environment (emissions, use of natural resources, etc.);
- State: shows the current state and the development of the phenomena in the environment (pollution level of air, water sources, availability of natural resources, etc.);
- Impacts: effects of the altered environment on the health of people and other living beings;
- Responses: answers of the society to environmental problems.

## 3. URBANIZATION OF NEW ZEALAND

In a relatively short period, New Zealand developed from a predominantly rural to a predominantly urban nation, which is why it is still facing challenges and opportunities of cities. The New Zealand urban population exceeded the rural population already in 1911 and cities in New Zealand recorded constant growth over the last 150 years, while the population was increasingly moving north over the last 75 years.

According to the New Zealand Statistical office, New Zealand today has a population of 4,385,880. It is one of the most urbanized countries in the world; 87% of its population lives in 138 identifiable urban centres, 75% of the population lives in 16 main urban areas and around 33% in the Auckland urban region alone. Similar urbanization levels were recorded in Australia and the United Kingdom, while lower were recorded in the USA and Europe. Due to lack of international standard classification of urban and rural area, comparisons between countries are difficult. New Zealand, Australia and United Kingdom use

the population number 1,000 and more to define the level of urbanization, but there are differences: New Zealand defines the main urban areas as the areas with 30,000 or more inhabitants (Historical context, 2010).

Throughout the 20<sup>th</sup> century, the character of urban areas in New Zealand changed. The main urban areas grew fast and often assimilated smaller centres surrounding them. The move of the population from South to the North Island began as well. At the beginning of the 21<sup>st</sup> century, the population of Auckland grew rapidly: the built-in areas expanded drastically and incorporated the surrounding rural areas. In 2001, the population of Auckland was around 78-times higher than in 1878 and today totals 1,462,000. Until the end of the 20<sup>th</sup> century, 16 out of 20 main urban areas were located on the North Island. The main urban areas today cover 5,078 km<sup>2</sup>, 1.9% of the territory of New Zealand, and more than 70% are located on the North Island. The average density of the population of large urban areas is 522.8 inhabitants/km<sup>2</sup>, which is considerably higher than the national average (14.2 inhabitants/km<sup>2</sup>). The highest density (2,326.2 inhabitants/km<sup>2</sup>) is recorded in the centre zone of Auckland (New Zealand: An urban/rural profile, 2010).

## 4. GEOGRAPHIC CHARACTERISTICS OF THE CITY OF WAITAKERE

Waitakere city has a special location as the westernmost part of Auckland metropolitan area, the largest in New Zealand, and is one of the four important cities in the region. It covers an area of 367.4 km<sup>2</sup> and extends to the Brigam Bay and the Rodney district in the north and to the rivers Whau and Auckland in the east. In the west, it is limited by the wild West Coast and the Tasman Sea and in the south by the Manukau Bay. Waitakere is a coastal, relatively young and rapidly growing city. It was formed with the merger of Waitemata city with smaller cities Henderson, New Lynn and Glen Eden in 1989, when the reorganization of local government was carried out all over New Zealand (Greenprint, 1999).

Over the last ten years, Waitakere grew permanently and is currently the fifth largest city in New Zealand. It had a population of 155,565 in 1996 and the number of inhabitants increased with an average annual growth of 1.7% until 2001 and thus reached a population of 168,750. In 2003, the city had 185,000 inhabitants, 195,300 in 2008 and 208,100 in 2010. Waitakere grows faster than initially foreseen. It is anticipated that the growth level will remain unchanged and will thus increase to 303,000 inhabitants in 2050. Based on this forecast, it is expected that the population will double until 2066 (People, 2010; Environment strategy, Short version, 2008). The population of Waitakere city thus represents 14.2% of the population of the Auckland region and 4.7% of the population of the entire New Zealand.

The regional characteristics of Waitakere city from the east to the west include densely populated, strongly transformed lowland, rural areas with a smaller population density, the untouched mountains of Waitakere Ranges and the coastal environment with different levels of settlement and development (The city's environment, 2010).

## 5. STATE OF THE ENVIRONMENT

The city of Waitakere has to deal with different environmental problems, just like other cities. A study of measurements and records, which are regularly published by the Waitakere municipal council as part of the reports on the state of Waitakere city (The state of Waitakere city, 2002), revealed that the most common pollutants in the city are:

- Carbon dioxide – the main source of carbon dioxide in Waitakere are motor vehicles, while burning coal and wood are problematic as well;
- Chlorofluorocarbons – the main source of CFC in Waitakere are older refrigerators and cooling fluids in air conditioned vehicles;
- Carbon monoxide – the main source of carbon dioxide in Waitakere are vehicles. Carbon monoxide pollution is also caused by heating during winter months. Data revealed that the levels of carbon dioxide were ‘excellent’ or ‘good’ in 99% of measurements. The data thus did not raise concern, but constant monitoring of carbon monoxide remains important. However, high levels of carbon monoxide were recorded in Waitakere on several specific locations with bad air circulation and dense traffic.
- Small firm particles – the main source of small particles are diesel vehicles and household heating, which, considering the results of measurements, have an important impact on endangering the lives of people in the city;
- Nitrogen oxides – the most obvious consequence of the current level of air pollution in the city and the most concerning fact for the community is the fog, which is especially noticeable in calm winter days. This fog often appears as low clouds and is more noticeable during the winter, when household heating contributes to the overall smog level. The fog occasionally has an unhealthy brownish colour due to the presence of nitrogen oxides, which are produced by motor vehicles. The measured levels of nitrogen oxides are in general ‘good’ or ‘acceptable’ from the point of view of human health, despite its impact on the quality of air visibility. Regular observations of visibility in Waitakere confirmed that the brown fog was a regular phenomenon and is related to traffic, household heating and occasionally with point sources, like rural focal points or burning waste in backyards;
- Aerosols, sprays – Waitakere has several agricultural activities, which take place outside and sometimes also within the urban area. Farmers often use chemical herbicides and pesticides. Wind and inadequate spraying methods spread aerosols through the surrounding areas. These substances represent a health problem for some individuals, especially those living close to agricultural land;
- Noise – the Waitakere city council receives around 6,800 complaints about noise per year. Some residents experience the problem due to the proximity of roads, railways. The acceptability of the noise level increased due to a high concentration of the population and different forms of transport.

A review of measurements and records of annual reports (Annual report, 2000–2009) for the Waitakere city revealed that water consumption by households totalled 190 l/person/day in 2001, 192 l/person/day in 2002, 168 l/person/day in 2004, 168 l/person/day in

2007 and 175 l/person/day in 2009. The quantity of used water per person in Waitakere thus dropped around 35% in Waitakere in the last 18 years – consumption constantly fell since 1991, when it totalled 243 l/person/day. This means that the overall quantity of water, which Waitakere needed, barely increased during this period despite a 40% growth of population in the same period.

When establishing the pollution level of water sources, lakes, wetlands, estuaries and bays in the city, we found that there were many causes. Among them are:

- Inadequate handling of the rainwater effluents from roofs, roads, parking lots and other solid surfaces, where dirt, waste, faeces and pollutants like oil, lead, copper and zinc are present;
- Soil and sediments from erosion areas and rough soil;
- Waste effluents caused by the entry of rainwater into sewage canals due to heavy rain;
- Waste dumped into water courses and water systems;
- Release or accidental spill of toxic substances;
- Effluent of chemical fertilizers and herbicides/pesticides from farms, horticulture or other areas;
- Waste/bacteria from animal farms and wild animals (opossums);
- Poorly functioning cesspits that are emptied into water courses, especially on hard clay ground.

Recent studies revealed that around 80% of pollutants in the water courses of Waitakere city are contributed by rainwater effluents and effluents from roads represent 20%. Waste waters contribute between 0 and 10%. High levels of zinc, copper and lead were measured in urban parts of water courses, mostly due to polluted rainwater from roads and industrial areas. Many urban water courses also recorded low oxygen levels. The increased levels of waste waters in urban water courses are the result of floods of sewage systems and faeces.

Soil pollution in Waitakere appears as the result of industry, storage, use and removal of chemicals and dangerous substances and, also, due to bad agricultural practice in the past. The removal of vegetation and soil is a degradation factor related to new construction (The state of Waitakere City, 2010).

Waitakere city reflects the trend of falling numbers of local crop and animal species in New Zealand. The following species are extinct:

- 10 crop species in Waitakere Ranges;
- 15 bird species and one mammal from urban areas and foothills;
- 11 bird species and one mammal from Waitakere Ranges.

Only 9% of the original vegetation cover remained in urban areas and in the foothills. In the period between 1993 and 2000, 30% of the vegetation disappeared in some areas, some due to the development of the city, but the majority due to the number of people, who cut only two or three trees (The state of Waitakere City, 2010). The higher population number and rapid development are visible in the loss of habitats. Urbanization brings more weed and insects, which then compete with local biodiversity. Climate change also represents a threat.

*Figure 2: Neat walking paths in Falls Park, Henderson (photo: K. Poredoš)*

*Slika 2: Urejene poti v parku Falls Park v Hendersonu (foto: K. Poredoš)*



## 6. DRIVING FORCES

The main part of expansion of Waitakere city occurred during the last 20 years with urban growth that spread from Henderson, Te Atatu and New Lynn to urban outskirts. The northern part of the city grew rapidly as a consequence of development of the north-west highway in the 1950's. Waitakere again records growth due to immigration, economic growth, further widening of highways and the development of public transport, while people are coming to the Auckland region from other parts of New Zealand as well (The state of Waitakere City, 2010). The growth level in Waitakere was thus higher than the regional average in the last couple of years. Waitakere grew fast and the growth pressures will most likely continue. In the past, the settlement of the growing number of residents was enabled by the widening of urban area to the north and west. This development pattern occurred all over the Auckland region and is known as 'urban sprawl' (uncontrolled widening of the city area), but is not sustainable due to several environmental and economic reasons.

Economic activities in Waitakere have relatively few environmental impacts in terms of pollution and waste production. This trend is strengthened by the domination of the service sector. The industrial sector does not include any large chemical or processing activities. Horticulture and food production have local impacts, but are minor activities and on the decline. Small, but important shipbuilding uses toxic substances, but participates in the program of the city council for the minimization of consequences (The state of Waitakere City, 2010).



A dispersed pattern of travelling is characteristic of Waitakere. Around 55% of workers travel to work outside the city. The time of travelling increased as well, people travel more than before, and most travelling is carried out by personal vehicles; 70% of workers drive to work by car and the number continues to increase. Public transport is not very popular at the moment. Many people think it is uncomfortable and/or relatively expensive and do not use it, a minority use it occasionally and only 7% use it every day. Traffic overcrowding, which increases the time of travelling, reduces the efficiency of car use and increases emissions, represents a large problem as well (Environment strategy, short version, 2010).

We established that the second largest source of emissions in Waitakere is solid waste, which is deposited at dumping sites and represent 20% of overall emissions in the city. Regarding the data included in the annual reports of the Waitakere city council, the quantity of waste (including inorganic, but excluding recycled) per citizen totalled 156.6 kg in 2000, 145.5 kg in 2002, 152.4 kg in 2004 and 120.9 kg in 2008. Waste per household in Waitakere can be easily compared to other cities in the region, especially Auckland, where citizens produce more than 900 kg of waste per household per year – the number in Waitakere revolves around 450 kg.

Data shows that the main energy consumers in the Auckland region are households, traffic, metal processing and trade. Of the energy used in households, about half is used for traffic (petrol and diesel for cars) and the rest is used for heating water and rooms, cooking and lighting. About 47% of homes are heated with electricity, 25% with wood and 20% with liquefied gas. The rest uses coal, gas and other energy sources. Over the last 10 years, a 20% increase of gas heating was recorded as well as a 9% reduction of heating with electricity and 5% reduction of wood use. Except from a small share of energy produced from wind and sun, all the energy is imported to Waitakere. This includes electricity, petrol, diesel and natural gas.

## 7. RESPONSES OF THE STATE AND THE CITY TO ENVIRONMENTAL PROBLEMS

### 7.1. New Zealand and sustainable development

The global program of Agenda 21, which New Zealand adopted after the Rio conference, defines a framework for focusing on sustainable development. Unfortunately, the central government did not pay a lot of attention to the agenda and only some local authorities adopted it.

New Zealand was engulfed by global competition, which transfers decision-making centres from countries to cities as well. This gives local communities an important opportunity to assure creative local solutions. The sustainable development of urban environments in New Zealand was marked by a lack of vision, lack of concern ('urban denial') and the history of many (smaller) beginnings and only a few ends (The cities and their people, 2010). The long-term council community plan (Long-term council community plan – LTCCP) from 2002 appointed local authorities for 'supervisors' of sustainable

development. In the 1990's, several local authorities were actually in the forefront of efforts for the promotion of sustainable development. Recognizing the need for increasing urban sustainability, the eight largest cities participated in the Big Cities Project, which wanted to measure, control and improve the quality of life (Cheyne, 2010).

Several local authorities were interested in Agenda 21, too. Many local authorities also participated in the State of the Environment Monitoring. Others committed to the Healthy Cities Program, which introduced a multi-sector approach similar to the approach connected to the concept of sustainable development. Many local authorities considered sustainable principles, although they did not necessarily use the terminology of sustainable development or of Agenda 21. Academicians, environmental NGOs and the business sector (there is, for instance, a strong New Zealand Business Council for Sustainable Development) were interested as well.

The central government became aware of the goals of sustainable development only in 2000. It supported an accelerated regional development and sustainable economic development and indicated to regional differences and unequal economic growth. Interest in environmental durability as well as for a more sustainable approach to social issues increased as well. The assumption of the model of social development, which emphasizes investments into human and social capital as means of economic growth and independence, was included later. The new government expressed strong support to a more integrated approach for the adoption of decisions and confirmed that long-term intertwinement of campaigns of all sectors was necessary for the attainment of desired social, economic and environmental results. From 2000 on, the central government cooperated with the local authorities and the economic sector. In August 2002, before the World Summit on Sustainable Development in Johannesburg, the government published the Program of action for sustainable development (Cheyne, 2010).

## **7.2. Responses of the Waitakere city to environmental problems**

Bob Harvey, the mayor of Waitakere city, introduced the vision of an 'eco city' in the mid 1990's and Waitakere later gained international recognition for its dedication to sustainable development. The city adopted Greenprint (1999), a document described as the "first example of a strategic plan with a holistic approach". Greenprint is the local Agenda 21 of Waitakere city. After the adoption of Greenprint, Waitakere gravitated towards the stimulation of sustainability through urban planning, which integrated social, economic and environmental efforts. The priority of the city council was to show how sustainability can be attained. The city did it through its own internal processes and connections and by incorporating sustainable technologies and forms into its development. It tended to the assurance of a partnership between the city council, organizations of communities and the central government (Cheyne, 2010). With the adoption of Agenda 21, the city council committed to put the Agenda 21 into the focal point of all its decisions. It had to make sure its procedures were in conformity with Agenda 21 as well as stimulate and help other organizations in and outside the city in the adoption and fulfillment of these procedures and processes (Greenprint, 1999).

The city council developed five *strategic priorities* and nine *strategic program platforms* for the management of all its work programs. Priorities are exact needs, which the city council has to consider in all its activities. One of the priorities is also sustainable development. Platforms consist of a package of similar activities for the development of different aspects of the city and include (Environment strategy, part II, 2008):

- *Green network* – city parks, vegetation and water courses form a green network, which provides a home for animals and recreation areas to people. It helps with the management and cleaning of rainwater; the efforts of the community for the protection of land, natural vegetation, wild animals and ecosystems are encouraged as well as the provision of an adequate recreation access of the public to water courses and green areas all over the city;
- *Three waters* – it has to be assured that all three areas of water management (rainwater, waste waters and water supply) are efficient, reliable, high quality and the impacts on the environment for the protection of resources for future generations must be minimized on the long term;
- *No waste* – waste management will result in the use of waste as useful resources; services of efficient and quality waste gathering and supervision of environmental and safety impacts of waste dumping will continue;
- *Sustainable energy and clean air* – supports energy efficiency, sustainable supply, reduction of emissions and clean air;
- *Strong communities*;
- *Urban and rural villages* – The goal is to create attractive urban areas, which stimulate growth and economic development with minimum impacts on the environment;
- *Active democracy*;
- *Strong innovative economy* – encourages local employment and economic growth in city centres and, also, cooperates with companies and strengthens environmentally responsible activities;
- *Integrated transport and communication* – determines fast, effective services for the entire city; transport systems are integrated, innovative and environmentally responsible.

The state of the environment as well as results attained by the city through different campaigns and projects are presented below according to environmental components and main activities. The results were acquired with the review, analysis and evaluation of all annual plans and annual reports, the long-term community plans (2003–2013 and 2006–2016), strategic plan and the analysis of conferences and data submitted by the city council.

Through its campaigns, the city council tries to turn Waitakere city into a city with low carbon content, meaning the city is practically without emissions; as much CO<sub>2</sub> as the city produces, is absorbed by trees and plants. The air quality in the city is good in general and the goals, which dictate that the measurements of emissions should not exceed national standards, are fulfilled. Environmental standards were exceeded only with PM10 twice, in 1999 and 2006, but otherwise the annual averages revolve at around the same

level (circa 16  $\mu\text{g}/\text{m}^3$ ). Data collection for  $\text{NO}_2$  began in 2003.  $\text{NO}_2$  emissions remained at around the same level ever since and have never exceeded environmental standards, just like CO, the quantities of which are falling since 2001. Education programs and incentives as well as different programs, which stress energy saving, stimulate cleaner production in companies and enable citizens free services of consulting and testing of emissions of vehicles, are all part of efforts to improve air quality.

Next to all other campaigns, the city council also raises awareness and encourages citizens to do something for the reduction of climate change. It encourages citizens through brochures and the internet to replace light bulbs in their homes, to use cars less, walk or bicycle more as well as use public transport more often, recycle more, use hot water more rationally, install solar water heaters, avoid products with too much packaging, plant trees, insulate their homes better and cooperate with authorities in the adoption of decisions.

The city's goal is to reduce average water consumption in households and find sustainable solutions for the management of rainwater and waste water. The quality of drinking water in the city is excellent. The city received the international award for the quality and taste of water in 2001. Several campaigns and projects were carried out so far. To reduce water consumption, the city council promoted and installed new technologies and devices for saving water, provided financial aid to schools and large users as well as households to assure more efficient water management, repaired leaking water pipes and focused on educating the community, where practical solutions for saving water were presented. All this resulted in the reduction of water use in households.

Water use in households totalled 175 l/person/day in 2009 and the quantity of used water fell around 35% in the last 18 years – consumption fell constantly since 1991, when it totalled 243 l/person/day. This means that the overall quantity of water, which Waitakere needed, barely increased despite a 40% growth of the population over the same period. For further reductions, responsible water management will have to be assured as well as the use of technologies for saving water. Most households in the city already have at least one device for saving water. Water loss in the water supply system was reduced to a minimum as well. It currently amounts to 64 litres per connection per day, the goal (at the most 75 litres) was thus attained and remains the same for 2016. It was attained through the programs for the discovery of water leaks in the water supply system and pressure regulation, while the speed and quality of repairs and pipe maintenance contributed to the result as well.

Many projects were carried out in the area of rainwater management as well. Different traditional and newly developed technologies for the improvement of quality of rainwater were introduced, procedures for handling rainwater were installed on some roads, programs of ecological schools and different programs for renewal of water courses were carried out as well. In the average, between 9 and 10 new systems for rainwater management, which increase its quality, were installed in the city every year since 2001.

Indicators, which show the number of different fish species in water courses and the percentage of the length of water courses that enable moderate or good habitats for fish species, were selected to check the quality of water courses. The number of species remains the same since 1999 (six species; at least ten species should live in the water courses

until 2016), while the length of water courses, which enable good habitats represented 69% of all water courses in 2004 and attained the set goal. An increase of 5% or more is expected until 2016.

The city also provided for waste water. Projects for the reduction of waste water surpluses were carried out along with the supervision of the infiltration of the sewage system, projects of management and removal of waste water and the sewage system infrastructure was upgraded as well. The city tried to assure the compatibility of systems for waste water management with initiatives of renewed use and recycling and the natural water cycle.

In the future, the city council plans to reduce water consumption in households by 25% until 2025 through the renewed use of clarified waste water, with the collection of rainwater in cisterns, with the promotion of more efficient devices for laundry, in kitchens, bathrooms, toilets, with the continuation of the programs for the prevention of water loss and with education programs. The city council supplies industry, schools, retail and agriculture with a free service of water inspection, which helps save between 20 and 40% of water, in some areas even more than 60%. Since households are big water users, the city council plans to offer similar services to them as well. In the future, an increase of the share of urban areas with rainwater management is planned as well. The percentage currently amounts to 20% and should increase to 28% until 2016.

The city council constantly encourages the incorporation of the community through different programs on private and public land, where restorations of vegetation and the planting of new plants and trees and broader protection and revival of areas take place. Until 2008, 17,082 residents participated in different projects of the Green network and the number increased to 33,911 in 2009. The goal is an additional 3,500 people per year until 2016. The city council wants to plant 100,000 autochthonous trees and plants every year (the number totalled 229,299 in 2008 and 167,000 in 2009) and improve the quality of water in water courses in urban areas. It also wants to improve the access to city parks, water courses and green corridors as well as introduce walking paths. The city currently has 573 parks and reservations, which occupy 1291 ha. There are 115 protected vegetation areas and many exceptional natural characteristics were identified. Coastal areas and water courses were green again and protected against erosion, while some connections and wetlands were set up anew. The northern part of the city is turning into an example of integrating the green network with urban development.

The urban strategy of Waitakere city is supporting the development program, which aims to protect the natural environment, while it develops city centres, which are compact, well connected and enable the combining of a residential and working environment. The strategy of growth hinders urban development outside the current urban area, which is defined with a metropolitan urban limit. At the same time, it also encourages and supports the intensification within city centres and along traffic corridors. Over the period of the next 50 years, the city set itself the goal to attain 60% of growth within, and 40% outside the current metropolitan urban limit of Waitakere city. It is on a good way at the moment: around 95% of new development took place within the urban area.

There are several reasons why the city, and later the region, decided to limit dispersed development and to try to attain a more compact form of the city. Compact cities are more

sustainable, because they are more efficient in the use of soil, traffic and infrastructure. Life in such a city offers people easier access to employment opportunities and supports the development of the public transport system (Managing city growth, 2010). However, it must be emphasized that this form is not always the best solution, because pressures increase along with increased density.

Waitakere was among the first cities to adopt the 5R approach for waste management. Composting 'green' waste at a transfer station was introduced in 1991, recycling cans were presented in 1992. In 1999, the decision was reached that the transfer station is preserved as a strategic tool for waste management. Considerable progress in the widening of the type of waste, which was renewed, was attained ever since. Waitakere decided in 1999 to be a city without waste and even now continues to develop innovative solutions for the reduction of dumped waste. The city council decided to be the owner and operator of main systems of waste management, because it believes that by controlling these systems it will play an important role in the attainment of goals of waste management and its reduction (Environment strategy, part II, 2008).

Household waste was reduced considerably – households of Waitakere city produce only half as much waste compared to other residents of the Auckland region. Waste gathered from commercial sources was reduced by 69%, what means considerably less waste on the dumping grounds. All closed dumping grounds were identified and managed with the aim to prevent or reduce harmful impacts on the environment. The main acquisition is the transfer station which advises on the management of waste, their separation and removal. Separate waste collection at the transfer station is possible for different types of waste: 'green waste', metal, wood, etc. Mixed waste is brought to the transfer stations, where it is emptied and materials for recycling removed. Ten vertical composting units at the transfer stations were also established and they can process 30 tons of green waste into compost every day. The increase of the share of waste to be recycled, composted or sent for renewed use at the transfer station, was attained in the same way.

Several energy projects are underway in Waitakere, too. The city encourages the best practices of cleaner production and researches and fulfils possibilities of use of renewable energy sources for the city. The city council will continue its cooperation with different groups to stimulate the production of renewable energy for the city and promote investments. It will also try to reduce the need for electricity through energy efficiency initiatives. Some of the main achievements in this area include the installation of wind turbines and photovoltaic panels on public buildings, free services of stimulating the installation of solar water heaters, different workshops, forums, presentation of sustainable household programs to citizens, free consulting for energy efficient construction, research on the possibilities of use of renewable energy in the city and the encouragement of residents and companies to use techniques and devices for saving energy.

Traffic is responsible for 44% of emissions in Waitakere city. Nearly 90% of travelling is carried out with personal vehicles; in 1991, 87.1% of employees went to work with their personal vehicle and 89.5% in 2006. To the contrary, the number of passengers on trains and buses decreased in the period between 1997 and 2001. An 8.7% percent increase of the use of buses was recorded in 2002, compared to the previous

year and a 4.5% increase of the use of trains. A slower growth of the use of buses and trains were recorded in 2003 and 2004 (6%). In the period between 2000 and 2006, the number of cars, which use the system park and drive, increased. The number of kilometres driven with motor vehicles per resident fell from 1998 on and increased again only in 2005.

The main campaigns for the reduction of traffic-related emissions target the lowering of ‘single person’ travels with a car and the increase of vehicle efficiency. The city council actively supports a better passenger transport, reduces the possibilities of parking and thus encourages the use of public transport, walking and cycling and reduces the use of cars. All important investments into cycling and walking, transport management, safety programs and the promotion and use of alternative transport solutions, such as public transport and work at home, are necessary.

The city council has a new transport strategy, which has a vision of “a sustainable multi-modal transport system that is integrated with the use of soil and contributes to Waitakere as a sustainable city”. The demands of future transport development will be set by the city council in several ways. The council will continue to encourage walking and cycling by upgrading cycling and walking capacities in the transport system as well as assure increased safety and easier access. It will also provide for better bus services, stimulate development and improvements of roads as well as assure faster and more efficient buses. Improvements will be carried out also on railways and ship terminals. The service ‘park and ride’ will be even more stimulated. Within the city, the city council will try to open more jobs and thus reduce the need for travelling outside the city for work. Parking costs will be higher as well – this should increase the use of public transport. New technologies and improvements will be introduced into transport as well.

The city council’s program Cleaner Production cooperates with local companies on the improvement of energy efficiency and reduction of waste. The program is about the examination of production processes (production, construction) or services (trade, education, tourism) with the aim to increase the productivity and reduce impacts on the environment. The goal is thus the promotion of efficient use of resources (energy, water, materials) for the increase of profitability of companies and a creation of a more sustainable society for Waitakere city. Cleaner Production offers practical aid to companies or individuals (as consumers), who want to see how they are using resources, to develop more sustainable shopping habits or to avoid unnecessary resources rather than create waste. A group within the city council, responsible for the program, offers a series of services to companies, which want assistance. By helping groups of companies, solutions are developed that benefit the economy as well as the community.

There are several good examples of sustainable houses, which unite several concepts of urban durability, in Waitakere. The city developed the Sustainable Living Centre for raising awareness and educating the public. This is a standard house from the 1970’s, which was remodelled to represent the systems of sustainable management of water, energy and waste, which can be implemented in most of urban homes. The main goal of the centre is to show visitors practical tools and skills so that every visitor can understand what could be applied in his own home.

*Figure 3: Sustainable Living Centre: the house where the principles of sustainable living are shown (photo: K. Poredoš)*

*Slika 3: Sustainable Living Centre: hiša, kjer so predstavljeni principi trajnostnega bivanja (foto: K. Poredoš)*



The best example of implementation and consideration of environmental standards by local authorities is the building of the city council itself – Waitakere Central. This is an example of practical environmental design, which combines architecture, engineering, artistic and urban design for a clear presentation of sustainable principles of a sustainable city. Crucial for the development of Waitakere Central is its location in the centre of the city. The location enables employees and visitors several possibilities of sustainable transport. The public can combine a visit to the city council with a visit of the shopping centre. The city council offered its employees initiatives for public transport use, cycling, walking or joint transport with a private car. The number of parking places was reduced on purpose and those, who share transport, were given priority. Cycling is encouraged by safeguarded bicycle sheds and showers. The covered entry into the building is connected to railway platforms, bus and the road via a bridge. The city council and the owner of the railway network integrated new railway platforms and the station into the design of the centre.

The long, rectangular form of the wing reduces the area exposed to low east and western sun and the building is not overheating. The glass-covered northern side has metal window blinds to prevent overheating and reduce the glare, while at the same time natural light comes into the building. The cooler southern side is covered with bricks and has smaller windows to limit the loss of heat. The wide staircase, which is located on the northern side of the building, defines the border between the interior and exterior, allows natural light in and air circulation. A part of the electric



lighting had to be replaced with solar light to reduce energy consumption. The long, narrow floor, which looks to the north, takes advantage of daylight well. The electric network functions in a way that the lights are turned off when enough daylight enters the room.

The building also collects rainwater from the roof, efficiently uses it and then removes it responsibly. The rainwater is either collected from the roof and stored or flows from asphalt surfaces to planted areas, where it is filtered and its entry into the waste water system is slowed down. The collected water is stored and reused for flushing toilets and for architectural water elements. Plants grow on the roof in the substrate of clay balls on a waterproof membrane. The roof functions as a buffer for rainwater, filters it and at the same time enables insulation. There are six solar panels on the roof, which heat water for toilets, showers and the kitchens. The building of the city council encourages the revitalization of the city, supports sustainable transport, stimulates economic growth and summarizes the principles of sustainability of a sustainable city.

The second interesting feature in the city is the urban ecologic neighbourhood Earthsong Eco-Neighbourhood, which is the first and for now the only residential eco-community in New Zealand. It is based on the principles of permaculture and serves as a model for a socially and environmentally sustainable community. A small group of people formed the idea of an eco-community already in 1995. They bought a fruit garden the size of 1.67 ha in 1999 and the construction of the first 17 homes started in 2000. Houses were built from compacted soil, building wood and non-toxic materials, which unite passive solar principles (warm in the winter, cold in the summer). The construction of all 32 homes and the centre of the neighbourhood ended in 2006. The centre of the neighbourhood offers additional capacities, which residents share: eating room, living room, guest room, library, playing grounds for children, room for children and teenagers, laundry room, workroom, etc. The emphasis of the eco-neighbourhood is to satisfy the need for food, water and energy on the local level; this concept is especially useful for cities.

*Figure 4: Earthsong Eco-Neighbourhood: children playground in front of the neighbourhood's centre (photo: K. Poredoš)*

*Slika 4: Ekološka soseska Earthsong: center soseske z otroškimi igrali v ospredju (foto: K. Poredoš)*



*Figure 5: Earthsong Eco-Neighbourhood: houses with solar panels (photo: K. Poredoš)*

*Slika 5: Ekološka soseska Earthsong: pogled na hiše s solarnimi paneli (foto: K. Poredoš)*



The eco-neighbourhood Earthsong is a high quality, visually attractive physical environment, which unites advanced sustainable architecture and technology and an extensive sustainable provincial design. The entire design concept of buildings and the neighbourhood is based on architectural harmony and integration with the location. All buildings are oriented and designed for energy efficiency and the control of impacts on the environment with the use of the passive solar design. Construction materials and components are selected regarding their energy component, toxicity, environmental impacts, durability and the possibility of recycling. The centre for the recycling of metal, glass, plastic and paper is located close to the entrance. Rainwater is collected for use in households and gardens and solar panels are installed for warm water. The ecological neighbourhood Earthsong selected the location in Waitakere city due to the sustainable policy of the city council. The city council sees Earthsong as the main example of an environmentally, socially and economically sustainable community in New Zealand.

## 8. CONCLUSION

During the review of performed work, we established that the DPSIR method in combination with other procedures for studying was appropriate for analyses and presentations of environmental problems. However, the method does have some deficiencies. Some other elements would have to be included in the DPSIR model for more detailed and interoperable presentations – the method does not consider the sensitivity of the city environment, its components and self-cleansing capabilities.

Just like other systems, urban ecosystems are different. That is why it would be necessary to consider the macro- and microlocation specifics of the city in every study of environmental problems or the level of urban sustainability. For such studies, a model must be developed that includes the basic sustainable indicators and considers specific characteristics of each studied city arising from its geography. The method is also lacking a bigger emphasis on the urban environment (natural and social environment) as a whole. After the process of analyzing individual components, a general review of the urban ecosystem as a closely connected and elementary intertwined whole, in which a change in one part affects a series of changes in all other parts, would have to be carried out as well.

The study revealed that Waitakere relatively quickly perceived problems caused by the urban way of life. It was the first city in New Zealand to adopt the principles of Agenda 21 and created Greenprint, its own Agenda 21. With each successive year, it fulfilled its current strategies and created new ones for different areas. It introduced planning, which reviews acts for the attainment of the vision of a sustainable city and amends them every year. One of the advantages on the way to sustainable city is the fact that the city is young and that it quickly started with the introduction of changes, the population number still allows the mitigation of its impact on the environment. The location of the city is also a benefit; it is close to the urban centre of Auckland, but still far enough away, in its own environment, to study the effects of the urban way of life of a big city and to solve local problems in its geographic location.

A special example of a more complex and concrete settlement of environmental problems in Waitakere city are ecologically built houses and neighbourhoods. These combine several principles: sustainable management of water, energy, use of alternative energy sources, production of less waste, use of environmentally-friendly construction materials and the construction of houses and their design, which adapts to natural principles. Ecological neighbourhoods add another, social note, to the sustainable development. They are based on the creation of a safe and intertwined community, which cooperates and jointly adopts decisions concerning the neighbourhood. It stresses socializing and networking among residents. In an extreme form, it can also represent a 'repulsive' element. Although individualism and privacy are stressed in principles as well, it is certainly lower than in 'normal' neighbourhoods. Joint meetings, discussion of problems, search for solutions, joint campaigns, events and especially different rules, which have to be considered, can represent an unpleasant perception of life in such community, almost a commune.

A special example of Waitakere city is its city council, which supports the realization of a sustainable city. Its example of construction of the premises of the city council following ecological principles is satisfactory. In this way, it clearly presents the principles of sustainable construction and sets an example to every visitor.

Waitakere is thus an ideal example of how to introduce changes towards more sustainable urban life with an adequate vision, good planning and thoroughly implemented campaigns. The city is an example for itself, it follows and implements its vision and encourages every citizen through education and raising awareness that he can contribute a lot to the improvement of the state of the environment and to a more pleasant and clean city. The strengthening of individual responsibility and cooperation between the community and individuals will help the city to attain its vision of a sustainable city.

Urban sustainable development is not something new, but requires a deeper understanding of human ecology. Our understanding of cities as ecosystems is far behind challenges. Sustainable urban development reflects the growing scientific concern and demands thorough research on the impact of urbanization and concrete measures for their limitations. Some key indicators of sustainable urban development are thus clearly visible. Urban ecology, a foundation for sustainable urban development, insists that all elements of urban life are considered in the mutual relation. Sustainable development thus is not the end state, but a process in which all elements of urbanism are balanced and thus preserve the health of the environment and the mankind.

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## **SONARAVNA MESTA – ODZIV NA URBANE OKOLJSKE PROBLEME**

### **Povzetek**

V letu 2008 je svet dosegel neopazen, a pomemben mejnik: prvič v zgodovini človeštva je v urbanih območjih živela več kot polovica svetovnega prebivalstva, oz. 3,3 milijarde ljudi. Skupaj z mnogimi socialnimi in ekonomskimi prednostmi urbanizacije prihaja tudi do obilice okoljskih problemov. Dandanes je mreža mest in drugih pozidanih površin vse gostejša, pritiski na okolje pa vse bolj presegajo samočistilne sposobnosti. Ravno zaradi tega se čuti vse večja nuja po oblikovanju sonaravnih mest, ki bodo dosegala učinkovito rabo naravnih virov, zmanjšala ekološke odtise in zagotovila primerno kakovost življenjskih pogojev za svoje prebivalstvo. Trajnostno sonaravno mesto predstavlja dolgoročno razvojno perspektivo, ki povezuje različne strategije načrtovanja. Dejansko se je po celem svetu veliko število mest (okoli 200) obvezalo k dosegu trajnostnega razvoja. V prispevku smo s pomočjo funkcijsko-regionalnega geografskega modela in modela DPSIR preučili prvo sonaravno mesto na Novi Zelandiji, mesto Waitakere.

S preučevanjem smo ugotovili, da je Waitakere dokaj hitro zaznal probleme, ki jih povzroča urbani način življenja. Prvi na Novi Zelandiji je sprejel načela Agende 21 ter ustvaril svojo lastno Agendo 21, Greenprint (1999). Z vsakim nadaljnim letom je izpopolnjeval svoje obstoječe strategije ter ustvarjal nove za različna področja. Sprejel je načrtovanje, ki vsako leto preverja akte za doseg vizije sonaravnega mesta in jih dopolnjuje.

Prednost mesta pri dosegu vizije sonaravnega mesta je v tem, da je mesto mlado ter da je hitro začelo z uvajanjem sprememb, prebivalstvo pa še ni tako številčno, da se z ustreznimi ukrepi ne bi moglo omiliti njihovega vpliva na okolje. Ugodnost mesta ponuja

tudi njegova lega: je blizu mestnega središča Aucklanda, a še vedno dovolj stran, v svojem okolju, da lahko opazuje učinke urbanega načina življenja velikega mesta in v svoji geografiji rešuje lokalne probleme.

Poseben primer bolj kompleksnega in konkretnega reševanja okoljskih problemov v mestu Waitakere predstavljajo ekološko grajene hiše in soseske. Le-te združujejo več principov: trajnostno gospodarjenje z vodo, energijo, uporabo alternativnih virov energije, proizvodnje manj odpadkov, uporabo okoljsko prijaznih gradbenih materialov ter postavitev hiš in njihov dizajn, ki se prilagaja naravnim principom.

Ekološke soseske dodajajo trajnostnemu razvoju še drugo, družbeno noto. Temeljijo na ustvarjanju varne in povezane skupnosti, ki medsebojno sodeluje in skupaj sprejema odločitve, ki se tičejo soseske. Poudarja tudi druženje in tkanje vezi med sostanovalci. V svoji ekstremni obliki pa lahko s tem predstavlja tudi nekakšen 'odbijajoč' element. Čeprav je v principih poudarjena tudi individualnost in zasebnost, je zagotovo manjša kot v 'normalnih' soseskah. Skupno sestankovanje, pogovarjanje o problemih, iskanje njihovih rešitev, skupne akcije, dogodki ter še posebno razna pravila, ki jih je potrebno upoštevati, lahko za marsikoga pomenijo neugodno videnje življenja v taki skupnosti – skoraj komuni.

Poseben primer mesta Waitakere je njegov mestni svet. Le-ta se izrazito zavzema za doseganje cilja postati sonaravno mesto. Zadovoljiv je njegov primer izgradnje prostorov mestnega sveta po ekoloških principih. Na ta način zelo nazorno predstavlja vsakemu obiskovalcu principe sonaravne gradnje in hkrati predstavlja tudi zgled.

Waitakere je idealen primer, kako se da z ustrezno vizijo, dobrim načrtovanjem in vestno izpeljanimi akcijami narediti spremembe v smeri bolj sonaravnega urbanega življenja. Mesto je samo sebi zgled, sledi viziji in jo uresničuje, hkrati pa prek izobraževanja in ozaveščanja spodbuja slehernega prebivalca, da lahko prav on naredi veliko za izboljšanje stanja okolja in pripomore k bolj prijetnemu in čistemu mestu. Ravno ta krepitev individualne odgovornosti ter sodelovanje s skupnostjo in posamezniki bo pomagala mestu, da bo dosegel svojo vizijo sonaravnega mesta.

Urbani trajnostni razvoj torej ni nekaj novega, vendar pa potrebuje globlje razumevanje človeške ekologije. Naše razumevanje mest kot ekosistemov daleč zaostaja za izzivi. Sonaravni urbani razvoj odraža rastočo znanstveno zaskrbljenost in zahteva temeljitejše raziskave o vplivih urbanizacije ter konkretne ukrepe za njihovo omejevanje. Tako so se kot jasni že pokazali nekateri ključni indikatorji sonaravno trajnostnega urbanega razvoja. Urbana ekologija, temelj za trajnostno sonaravni urbani razvoj, vztraja, da se, v medsebojnem odnosu, upoštevajo vsi elementi urbanega življenja. Na tak način sonaravni razvoj ne bo končno stanje, ampak proces, v katerem so vsi elementi urbanosti v ravnotežju in tako ohranjajo zdravje okolja in človeka.

Pri pregledu opravljenega dela smo ugotovili, da je za analize in prikaze okoljskih problemov mest in iskanje njihovih ustreznih odzivov metoda DPSIR v kombinaciji z ostalimi postopki preučevanja primerna. Vseeno pa ima metoda pri tovrstnih preučevanjih tudi nekaj pomankljivosti. Za bolj podrobne in povezljive prikaze bi bilo smotno v model DPSIR vgraditi še nekatere ostale elemente – metoda namreč ne upošteva občutljivosti mestnega okolja in njegovih sestavin ter samočistilnih sposobnosti.

Tako kot ostali sistemi, se tudi urbani ekosistemi med seboj razlikujejo. Ravno zaradi tega bi bilo potrebno pri vsakem preučevanju okoljskih problemov ali stopnje urbane sonaravnosti upoštevati makro- in mikrolokacijske specifike mesta. Za tovrstno preučevanje bi bilo potrebno razviti model, ki bi zajemal osnovne sonaravne kazalce ter za vsako preučevano mesto upošteval tudi njegove specifične lastnosti, ki izvirajo iz njegove geografije. Metodi manjka tudi večji poudarek na urbanem okolju (naravno in družbeno okolje) kot celoti – po postopku analiziranja posameznih komponent bi bilo potrebno izvesti še generalen pregled urbanega ekosistema kot tesno povezane in elementarno prepletene celote, kjer sprememba v enem delu vpliva na vrsto sprememb v vseh ostalih delih.