LOCALITY

AND THE

(UN)SUSTAINABLE SETTLEMENTS

Edited by
László Bokor – Béla Munkácsy – Matej Nikšič

Published by
Frugeo Geography Research Initiative
Shrewsbury, 2014

Geographical Locality Studies – 2014 Volume 2, Number 1
“Locality and the (un)Sustainable Settlements”

Founder and Series Editor: László Bokor

C R E D I T S and P U B L I S H I N G I N F O R M A T I O N

Editor-In-Chief: László Bokor
Assistant Editors: Béla Munkácsy – Matej Nikšič

Authors: László Bokor – Béla Borsos – Katie Eccleston – Wojciech Goryl – Ádám Harmat – Katalin Kiss – Dániel Leidinger – Béla Munkácsy – Viktória Nemes – Matej Nikšič – Fanni Sáfián – Luca Rozália Száraz – Tamás Szelesi – Zoltán Wilhelm – Nándor Zagyi

Language Editor and Proofreading: Katie Eccleston
Independent Peer Reviewers and Advisers: János Csapó – István Dőry – Harinder Matharu – Róbert Tésits – Ceren Sezer – Karma Tshewang

Cover Design: László Bokor – Viktória Nemes – Tamás Szelesi
Cover Graphic and Portrait Art Work: Viktória Nemes
Inside Cover Photo Credits: László Bokor – György Mánfai – József Tóth, Jr.

Technically edited, typeset, improved, designed, published, and distributed by

Frugeo Geography Research Initiative, Shrewsbury, UK
www.frugeo.co.uk — info@frugeo.co.uk

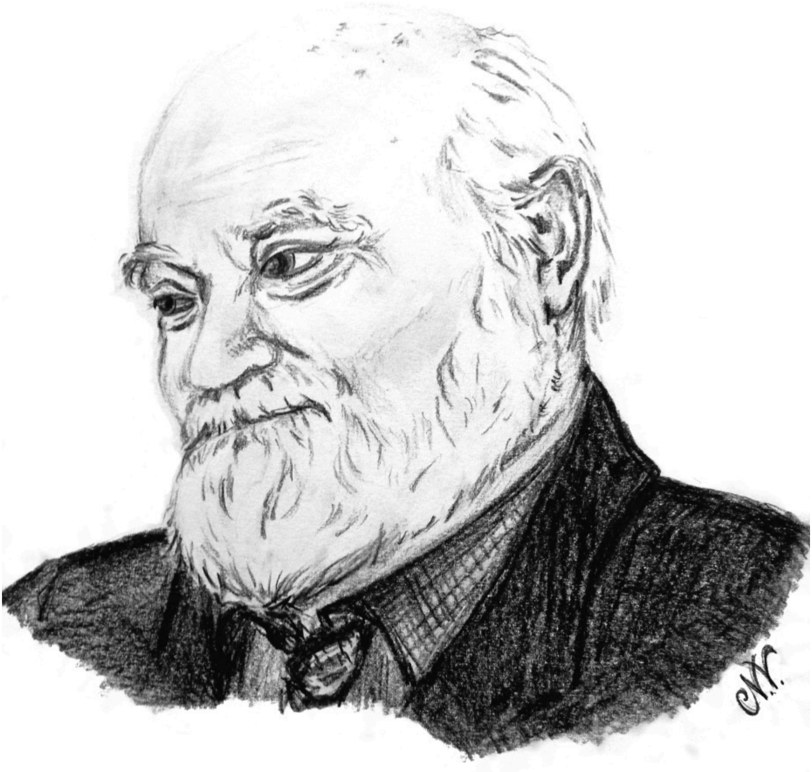
Produced in association with

Urban Planning Institute of the Republic of Slovenia, Ljubljana, Slovenia, www.uirs.si
Eötvös Loránd University, Budapest, Hungary, www.elte.hu
University of Pécs, Pécs, Hungary, www.pte.hu
Eco, Birmingham City University, Birmingham, England, www.bcusu.com/eco

Registered and published in the United Kingdom of Great Britain and Northern Ireland
Printed and bound in Hungary by Molnár Nyomda és Kiadó Kft., Pécs

British Library Cataloguing in Publication Data. A catalogue record for this book is available from the British Library.

ISBN 978-0-9576442-3-6 (Paperback)
ISBN 978-0-9576442-4-3 (eBook-PDF)
ISSN 2052-0018 (Print)
ISSN 2053-3667 (Online)



Dedication

The editors, authors, and all the professionals who contributed in this project dedicate this book to József Tóth (1940–2013), an inspiring geographer who throughout his life taught Earth Sciences to many of us.

Contents

Publisher's Preface

Dear Reader,

We are very pleased to be addressing you today. It is a special one for many reasons, but two of them are worth being mentioned: First of all, by publishing this second issue, we have achieved another milestone in the life of *Geographical Locality Studies (GLS)*; secondly, this is all happening on the day that *Frugeo Geography Research Initiative* celebrates its third birthday.

On the 18th June 2013, we were very proud to publish the first number *(Locality and the Energy Resources)* of a new-born geographical journal and since we have not stopped working hard to strengthen its quality, availability and recognition. It is a great achievement that, from now on, the GLS series and all of its articles are available to download free of charge. For this purpose particularly, we have redesigned *Frugeo's* website (www.frugeo.co.uk) too that now provides a more reliable service and access to our scientific papers. If you, however, prefer to buy a hard copy, it can be purchased through the webshop. The print copies are also available at the major online shops *(eBay*, *Amazon)* and can be read in a number of British libraries.

We have also kept the style, format and structure of the first issue. In continuation of the series's upgrowing traditions, each issue is now also dedicated to a famous person. This second number commemorates the life of *Professor József Tóth*, who was one of the best-known geographers. He processed the ranks of the Hungarian university education from *Szeged* to *Pécs*, all the way through to becoming a *Professor Emeritus* at the age of 70. He established research groups, research institute networks, university departments and a doctoral school. During his life, he had been a dean, the last rector of the Janus Pannonius University and, after the achievement of the university integration process, the first rector of the *University of Pécs*, then *Rector Emeritus*. His work was acknowledged by numerous certificates and awards. At the same time, we can ascertain that he did not necessarily want to leave a mark; instead he enjoyed to create and build. He could not stand passivity; whether he cut grapes, worked on a scientific paper, established a research centre, regulated a stream or organised a congress, he was looking for the satisfaction and gladness deriving from creation. Of course, his active life was passing by in the limelight of publicity. He also noted once: *"it is not enough to work hard, others should also know about your work"*. He suddenly died last year at the age of 73, but—in regards of the views of his life on education, science, research and general geography—his memory also pursues our works at *Frugeo*, therefore it impacts GLS, as well. In accordance with his original research topic, this second number introduces the reader to locality and sustainability by bringing examples from the *Earth's* urban sphere by analysing human settlements.

Frugeo aims for the *GLS* series to be recognised internationally as a journal with impact factor. We would like to carry on giving the opportunity to a wide-range of professionals (including students, teachers, lecturers and academics), the chance to have their article published in a high quality scientific journal. Also in the future, we will carry on expecting various articles from participants which may cover many different scientific subjects, fields and areas to keep the journal series a multidisciplinary of ideas to cover the diversity of geography.

Even though we are on our second number, we are seeing the benefits and improvements in this new issue concerning language, style of writing, engagement and the effort that everybody has put into their works for the upkeep of the aims and standards of *GLS*. According to this, we would like to thank the editors (*Béla Munkácsy* and *Matej Nikšič*), the cover designers (*Viktória Nemes* and *Tamás Szelesi*), the reviewers and advisers (*János Csapó*, *István Dőry, Harinder Matharu, Ceren Sezer, Róbert Tésits* and *Karma Tshewang*), *Görgy Mánfai* and *József Tóth Jr*. for the photographs, and the authors' contributions.

Shrewsbury, 20 November 2014

László Bokor – Katie Eccleston – Zoltán Wilhelm

Introduction

Nowadays, the human race is, more or less, aware of its inseparable interdependence with nature and its processes. This awareness comes either from a free will and is based on the ethical basis or is an act of force when humans are exposed to the unpredicted natural phenomena that is hard to control. Cities are the most complex systems set by humans and have strong influences on the natural processes. At the same time, they are vulnerable to these same processes and may suffer from them when they are not adequately adjusted. After decades of *modern planning*, when the cities were seen as *"self-standing machines"* run on the bases and to the account of the natural resources, the majority of the global planning practice entered a new era, the era of the so-called *sustainable planning*. This applies at least to the theoretical standing points of contemporary spatial planning. Any settlement is thus seen as a part of a complex environment where constitutive elements are related to each other and where the acting of one element consequently influences the others. The sustainable paradigm builds on the conviction that any resource within such a system shall be used to the extent and in a way that will not limit the potential functioning of any part of the system not only in the present, but also in the future.

In practice, the sustainable planning paradigm has been vaguely implemented so far. The awareness of the need to change our doing-business-as-usual is rising, but the majority of the businesses at a global level are still run on the old matrices. This fact is closely linked to the contemporary prevailing socio-economic global system that is embedded in the consumption paradigm. Even if in theory, we are more aware of the consequences that such a way of organising and managing our life in settlements cannot sustain in a long term due to the limited resources, the real change is still to come.

In the meantime, any discussion of the topic can further contribute to a change for the better. The contributors to the second issue of *Geographical Locality Studies* address a number of the aspects that are important when considering a more sustainable urban form and functioning. They reflect a variety of approaches to the (un)sustainable conception and management of the human settlements: energy efficiency, urban economy, urban mobility, communal space provision, ecological aspects as well as some methodological insights into the measuring and describing of the (un)sustainability of the concrete localities.

Wojciech Goryl and *Ádám Hamat* open the discussion by addressing the urban energy consumption. They argue that locally available biomass is an underused potential in the existing electricity production chain. On the case studies of *Poland* and *Hungary*, they illustrate the usage of the existing power stations to co-fire biomass with coal, which is strongly opposed by some stakeholders. *Béla Borsos* and *Béla Munkácsy* relate the energy-use issues to the mobility patterns of contemporary societies. They explain a case that happens at the level of local communities of the western world which try their best to lower their energy needs and provide it by renewable sources, but at the same time fail to practice sustainable mobility. The authors claim that new innovative solutions to reduce the need for mobility on itself shall be applied. *Tamás Szelesi* on the other hand describes a solution implemented in *Frankfurt* where the growth of the city demands an efficient public transportation system based on a so-called zero-emission technology and shows how important integrated urban and transportation planning is.

Fanni Sáfián, in her contribution, proposes the hypothesis that the community ownership over the renewable energy sources can bring additional benefits to the local economy. On the examples of *Austria* and *Denmark*, she illustrates an approach that can be beneficial also in terms of changing the lifestyle and can even generate a higher level of citizens' participation.

Matej Nikšič, in the case study of *Slovenia's* capital city, points out another dimension of a more sustainable form of a city to serve the community. He argues that the distribution of high quality public open space must not be left to a coincidental or market lead development but planned in order to provide an equal access to citizens. *Katalin Kiss* and *Nándor Zagyi* discuss the settlement sustainability issue in terms of socio-cultural and demographic measurements by providing the statistic data from Indian MSME sector and discussing its ability to contribute to the social integration of disadvantaged groups. While *Luca Rozália Száraz* opens another important issue related to open urban space by arguing that urban green spaces have important impacts on the air quality, outdoor thermal and human comfort and must, therefore, be well planned. The issue is getting even more important in a rapidly urbanised world where the right balance between the green and the built-up areas in the cities must be obtained.

Dániel Leidinger and *Ádám Harmat* relate to *Konrad Lorenz*'s work (1973) and list the reasons why the city as a phenomenon and the characteristics of urban life might be interpreted as unsustainable at their roots. They even compare the evolution, development and the operation of urban areas with the characteristics of a cancer-ill body. *László Bokor* and *Viktória Nemes* introduce another approach by developing a method to assemble the specific geographical information about locality and its sustainability. They propose the *Geographical Locality Index (GLI)* as a measurement of the sustainability of a certain locus, whether it is a single object or territory, *GLI* can measure both.

The contributions aim to encourage the reader's own point of view and generate reflections on the ideas of the (un)sustainability of urban forms. It is most likely that any reader has at least some kind of relation to a dozen of human settlements either by a professional affiliation or simply on the bases of the daily routines. No matter how you may relate to these topics, we wish a joyful and mind-provoking read.

Ljubljana, 20 November 2014

Matej Nikšič

Geographical Locality Studies
Frugeo Geography Research Initiative
MMXIII

reSearch

localiTy

natUre

inDependency

envIronment

enErgy

Science

ISSN 2052-0018 (print), ISSN 2053-3667 (online)
Geographical Locality Studies 2014 Volume 2, Number 1. pp. 230–261

LÁSZLÓ BOKOR
MSc, Geography researcher and teacher
PhD Aspirant at the Doctoral School of Earth Sciences at the University of Pécs
Proprietor of Frugeo Geography Research Initiative
Learn Team Leader at Eco, Birmingham City University, Students' Union
laszlo.bokor@frugeo.co.uk

VIKTÓRIA NEMES
BSc, Geographer
Geography masters student at the University of Pécs, Faculty of Sciences, Institute of Geography
nevi0321@gamma.ttk.pte.hu

Locality, Sustainability and the Ways They may be Measured

Abstract

The authors in this article try to assemble specific geographical information about locality. Their aim is to identify and understand the key factors of a local entity that may eventually help to work out a simplified measuring method to analyse a certain locus (for example a house or a town or anything that has a certain size and distinctive boundaries) accurately and with rationality. To achieve promising results, their approach goes through defining classic terms like space and time, locality, sustainability and the combination of the two latter ones (sustainable locality). Also, in regards of their aim of measuring sustainability, the initial step of creating the Need Model and Geographical Locality Index is now made.

Key words

Sustainable locality; Spatio–temporal perspectives; Measuring locality and sustainability; Geographical Locality Index (GLI); The Need Model

1. Introduction

It has been a while since the lead-author of this article first started shedding thoughts about how to start researching and explaining the real meaning of locality to fellow geography researchers which, at first instance, sounds profoundly easy, but on the other hand it requires a lot of reading up. It is an even bigger challenge to research the history of certain terms and definitions which are part of our everyday lives which supposedly should be easy to describe. That was the main reason for the preparation of this paper that the single authorship has been upgraded into a two-researcher project. Obviously, in this case, the approach of the authors is linked to the term or definition of locality that can most widely be understood and explained by the specific fields of *Earth Sciences*; therefore, this paper is going to dip into deep water.

2. Aims of the study

In this paper, the sustainability of the geographical sphere (natural and social ones) is analysed which is the continuation of the research that started in 2013 and the main objective of that was first published in *GLS 1* entitled *"The Energy Resources and Their Importance in the Local Environment"* (BOKOR, L. 2013). In regards to deepening this understanding, first of all the meaning of space and time and their relationship with locality are discussed. In the main part of this paper, all of those are linked to sustainable locality and how they are or can be measured, and, therefore, how the results are or can be compared with each other.

3. Research methods

The research presented in this paper has been part of a longer process, it is still in its preliminary stage and its background is majorly based on secondary sources that come from journal papers and scientific articles published in specific books and online. The basic information, however, forms the basis of this evolving knowledge development as the “borrowed” research results of other authors manifest in creating new approaches and methods. Therefore, this paper simply rejuvenates classic geographical terms and with that simplicity in it, it tries to bring many new thoughts and specific mechanisms to life. The primary researches, therefore, represent the establishment of a new measuring method, and its further development and testing by creating new concepts and techniques.

4. The science of space and time

When it comes to talking about geography (or more precisely *Earth Sciences*), its potential is obvious for us. It is known that everything that it involves may be researched through ‘space’—as its major advantage is being a spatial discipline. In special cases and circumstances, however, the research requires a bit more than analysing the space. In this case, the researchers’ horizons may be widened by involving the ‘time’ factor. Now it is surely known that geography is an evolving transdisciplinary perspective on spatial and temporal processes and events. The physical world appears to have these aspects, so the existence and nature of space and time (or space–time) is a central topic (MAUDLIN, T. 2012). According to COUCLELIS, H. (2005), the world represents the empirical perspective on the subject of space and time at geographical scales. Throughout history, humans have always had to deal with physical formations of certain sizes (dimensions) in space. For example, the land where humans live, the mountains, seas and rivers that surround them, and even, of course, the humans’ personal living spaces, for example the country, the city, the street or the house itself. It is known by every individual the approximate dimensions of their ‘personal universes’ and the exact sizes of their closest living spaces, for example the house, the living room, the garden, the bin, the shoe size, etc.

The space, however, between two locations, for example two cities, or the shortest routes going around mountains, or a bridge to build over a river may be described and measured by time, as well. But this ‘time’ may not only be minutes and hours; it may also be thousands and millions of years of faded (or buried) memories. The scientific field called *Geochronology*, in good association with *Geostratigraphy*, for example, is one of the ways to analyse the *Earth* in both space and time. *Earth Sciences* in a colloquial term, however, has got the same potential; therefore, any of these geo-scientific subjects may be used to measure locality by involving these factors.

5. Locality

At the initial step, it is worth taking a detailed look into an English dictionary (COLLINS, 1986) which defines locality as *"a neighbourhood or area"*, *"the site or scene of an event"*, and—which is probably the most important to us—*"the fact or condition of having a location or position in space"*. As a more geographical term, the word locality derives from the Latin "locus", meaning "place or area" (COLLINS, 1986). As phenomena and processes are allocated in space, locality is an eternal category (TÓTH, J. 2002). Regarding this information, locality may be a settlement (for example a city) where a certain number of people live. It is characterised by its natural/physical setting and the people who live in there. It is a spot that has a certain size (space) and a certain evolution (time). Locality may, therefore, also define areas of a lonesome mountain, a solitary tree, a flock of sheep or a car park, which all have the same conditions when geography comes to analyse their properties.

Locality, however, is not only a loose bit in this chain. It is pretty much part of the whole that can only be described by people at a certain space at a certain time. The city where they live, the house that they own, the people with whom they interact, is all part of the system and this certainty defines their locality. Stepping away from a person's specific space and time factors, locality may involve more than an individual or a group of people who somehow relate and are all connected to the same location. This gives a wider analytical possibility to locality as it itself is involving space and time and including the people who all give characteristics and standards to the place where they all live. It could be important in the development of a person's identity in the sense that the place where people live—where as a result of locally distinctive (biogeographycal, physical, historical) characteristics of a unique, local culture is evolved—plays a main role to develop one's identity (LIGHT, A. – SMITH, M. J. 1998). Through locality, there are styles and types that may be discussed.

To understand and gain knowledge about a locality, it is not enough to get acquainted with the place where one lives, but should have a wider view on the surrounding. If one understands and knows a local area, the links and also the differences may be discovered between the distinct areas, thus it is easier to distinguish the different localities. It is obvious that there is interdependence between localities, but they are not necessarily equal. Domination, subordination, influence and power need to be analysed; that way, therefore, the locality's "place in the world" can be realised (including its identity). In a locality, time and place are also important as well as the history of each locality, the history of relations, and the role of different localities (as roles change identity). If these relations are seen, it can be understood how the local is affected by the global and how the local actions at a local level affect the global. Localities have responsibilities on other localities like urban people have effect on other people, for example at remote locations (MASSEY, D. 1993). This way it can be realised that without locality there is no globality which, in recent times, has become more important (TÓTH, J. 2002).

In this geographical context, the meaning of 'locality', however, has to be torn apart as its conceptuality may be described by physical and human factors. Geography itself bears this; therefore, locality has it too. For example, human settlements were mostly established on sites where the differently strengthened locus formed energy centres (potential of energies), and where vital resources were given (for example water). This evolutionary progression also affected the development of settlements, and the natural sphere had been transmitted into a geographical sphere. The locality characterises a certain space within the geographical sphere (BOKOR, L. 2013).

Figure 1 – Maribor, Slovenia
Photographed by BOKOR, L. (2009)

Figure 2 – Mukachevo, Ukraine
Photographed by BOKOR, L. (2009)

Figure 3 – Rijeka, Croatia
Photographed by BOKOR, L. (2010)

Figure 4 – Bled, Slovenia
Photographed by BOKOR, L. (2011)

As it is described above, the photographs on the previous pages visualise this explanation *(Figure 1–4)*. They make it obvious that there are no human factors without the physical ones. The two have to co-operate and to interact efficiently to form a human settlement: the physical conditions and resources make possible to build an entire living space on a certain type of ground where the human methods exploit nature's potential.

6. Sustainability

The closing sentence of the last paragraph stated that *"human methods exploit nature's potential".* In normal circumstances, the method should represent the process known as *positive feedback* which can maintain sustainability. In biological systems, sustainability means how to endure and remain diverse and productive. Nature inherently strives to be sustainable at all times which, in fact, may also be adapted to human conditions. This can be approached from different aspects and angles which only depend on how it relates to the human sphere.

The word "sustainability" was a highly appearing term in RACHEL CARSON's *Silent Spring* (CARSON, R. 1962), but, as a definition, it was composed for the first time in 1987 in the *Brundtland Report* which was drawn up by the *World Commission on Environment and Development*, created in 1983 by the *United Nations Assembly*. According to this report sustainability is *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* (UN, 1987). This means enabling people, now and in the future, to achieve a satisfactory level of social and economic development whilst keeping their human and cultural heritages respecting the use of the *Earth's* resources in order to preserve the natural species and habitats.

According to the report, as such, in human relations, sustainability can be conceptually divided into three components:

- environmental sustainability,
- social sustainability, and
- economic sustainability.

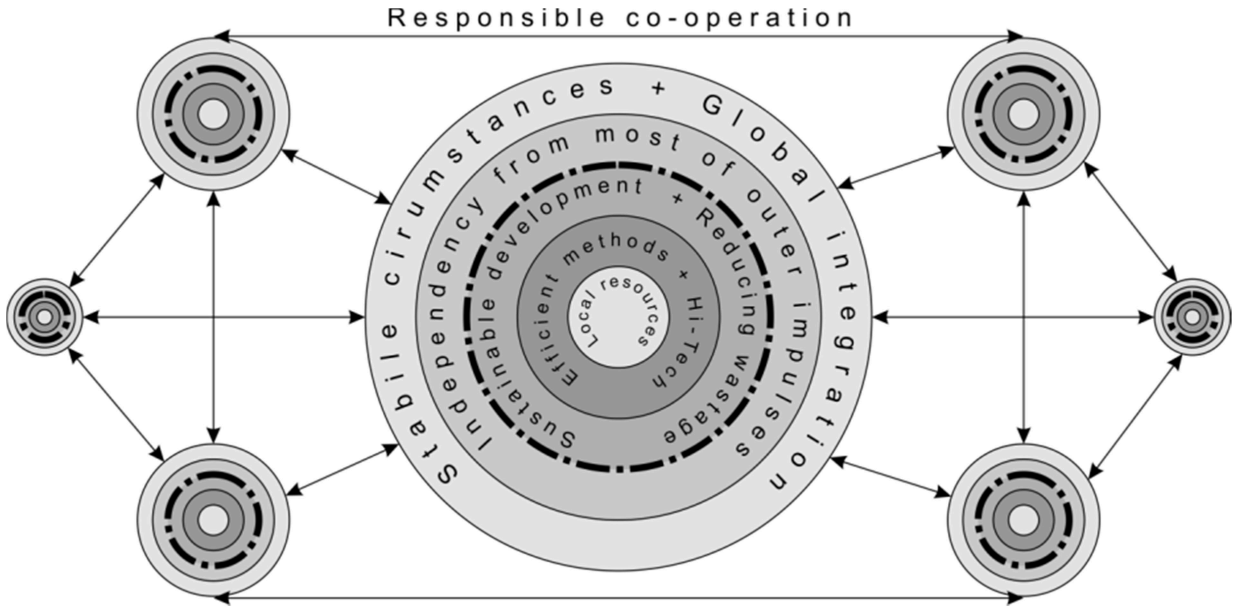


Figure 5 – The Sustainable Entity
Edited by B*OKOR*, *L. (2013)*

The *Earth* is a system and everything is connected with each other: environment, society and economy form the backbone of human sphere which is, obviously, geographically based on the *Earth's* physical conditions. To live sustainably, humans need to be familiar with certain rules of the planet and apply them to everything that they do at home and at work. If these careful instructions are followed, the communities in the human sphere can work together towards sustainability. The different local communities, however, may co-operate and work towards a better environment and sustainable region. This is perfectly presented by *Figure 5*.

7. Sustainable locality

From a human perspective, sustainability for our planet means that it can carry on doing what it was designed to do: provide fresh air, clean water, produce food, and allow everybody to have a high quality of life. In this context, sustainability for a fully operational locus (for example to a city) means that things can keep going and sustain themselves. Locality comes into focus here, as the only sustainable settlement may be the one which is using its own resources and maintains the environment where it is situated. Those resources are available in the space occupied by the settlement and which may be essential to its entire evolution and development (in time), and, in general, to keep its population alive. Here sustainability and locality are now linked to a settlement's physical condition and available natural resources.

The pictures showed earlier do not necessarily represent settlements managed with sustainable care; they have, however, been kept in existence for centuries. According to THE GREENS's website on *Sustainable Settlements* (2013), there are certain conditions that make a settlement sustainable:

- it is designed and built to minimise environmental harm and maximise social well-being,
- it has a reduced ecological impact on the surrounding environment,

- the new urban developments are environmentally, sound, public transport friendly and facilitate community interactions,
- planning minimises urban sprawl.

At the moment, not many places in the globe may be as sustainable as the above list states. The size and location of the settlement may be a crucial part of this story. However, this requires investigations as there are farms and eco-villages that have the same size as some small villages, but the difference between them may be significant. This normally depends on the type of settlement as single farms and independent settlements may be fully sustainable whilst dormitory settlements depend on the surrounding cities and their resources. Huge urban places, however, have the biggest impact on humankind as—according to *UN*— the majority of the population is now living in cities (UN, 2012); therefore, in this sense, it is worth analysing the city environment of *Las Vegas* in the *United States of America*, as it is possibly one of the least environmentally friendly and sustainable localities on *Earth*. It is a famous tourist destination and it is also known or/and heard by millions of people around the planet; therefore, there cannot be a better example than this.

7.1. Las Vegas

Las Vegas is situated *(Figure 6)* within an arid basin on the floor of the *Mojave Desert*, surrounded by dry mountains. Much of the landscape is rocky and dusty; the environment is dominated by desert vegetation and some wildlife. The peaks surrounding the city reach elevations of over 3,000 metres (~10,000 feet), and act as barriers to the strong flow of moist air from the surrounding area. According to the UNITED STATES CENSUS BUREAU, the city has a total area of 351.77 km^2 (135.82 sq mi) with a population of 603,488 (2013 estimate; 2010 census 583,756). The 2010 population of the *Las Vegas metropolitan area* was 1,951,269. (And never mind the estimated 40 million tourists who visit the city every year.)

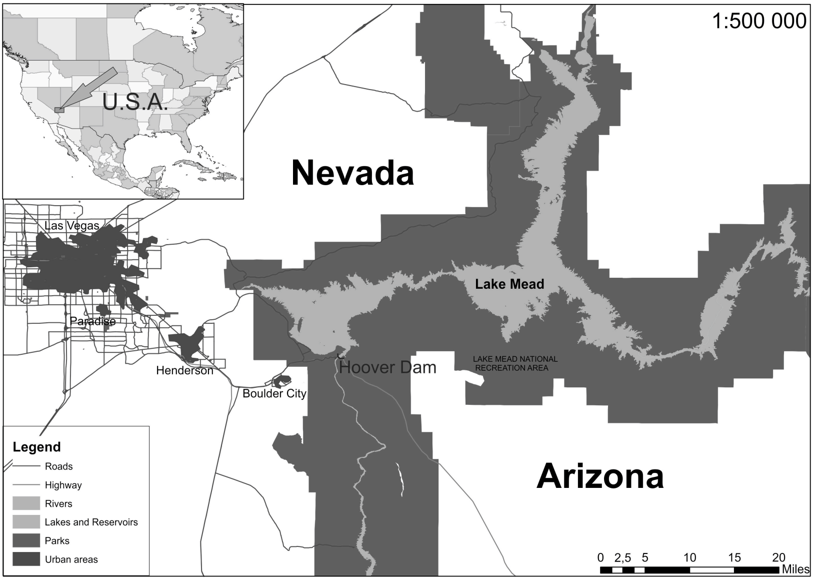


Figure 6 – The location of Las Vegas and its surroundings

Edited by SZELESI, T. (2014)

The *Las Vegas strip* (like the entire *Nevada*), home to the world's best known casinos where wastefulness is not just encouraged, but is a key part of the business model, is not only powered by the *Hoover Dam (Figure 7)*, but indirectly also by coal fired power stations (that are connected to the national grid *[Figure 8]*, but their locations may be anywhere in the *USA*).

The carbon dioxide emission of the city is huge. Since it lies in the middle of a desert, it is lacking in water resources, too. The water that is consumed comes from the *Colorado River* and the limited aquifers underneath the desert. The booming *Las Vegas Valley* and the *Reno–Sparks–Tahoe* area are bursting at the seams as new homes rapidly spill out into dry desert valleys. But cities cannot grow without water and energy resources. All in all, without even overanalysing the conditions, it can certainly be stated that *Las Vegas* and places similar

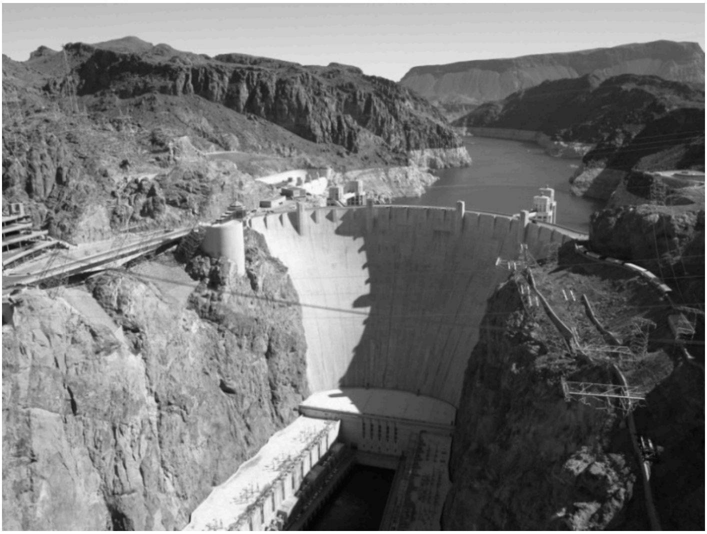


Figure 7 – Hoover Dam, USA
Photographed by SZELESI, T. (2014)

Figure 8 – Grid system from the Hoover Dam to Las Vegas, USA
Photographed by SZELESI, T. (2014)

Figure 9 – Las Vegas, USA
Photographed by SZELESI, T. (2014)

are the least environmentally friendly settlements that humans have ever designed, built and operated. And, unfortunately, many cities in the world are not in much better conditions, regarding their designs, inefficiency, ignorant and wasteful population *(Figure 9)*, and simply the fact that their resources are just not there where the settlement is located (see the fact associating with the energy resources). Therefore, a settlement like *Las Vegas* has its own, direct impact on the environment where it is situated, and it has a massive indirect effect on a much wider area which easily involves the entire middle part of the *USA*.

8. Large urban areas

According to *UN* prognostication, by 2050 an estimated 75% of the world's population will live in urban areas (UN, 2012). These urban areas are characterised by higher population density and vast human features in comparison to the areas surrounding it. According to their definitions, they may be cities, towns or conurbations, but the term is not commonly extended to rural settlements such as villages and hamlets. However, cities present the world's population with the best chance of reducing our ecological footprint. Urban areas are uniquely positioned to lead the greening of the global economy through improvements in transport, energy, buildings, technology, water and waste systems, as well as producing a wide range of economic and social benefits.

9. Dormitory settlements (also known as commuter village or town)

It suggests that residents sleep in these neighbourhoods, but normally work elsewhere; they also suggest that these communities have little commercial or industrial activity beyond a small amount of retail, oriented toward serving the residents. This type of settlement is strongly associating with the surrounding settlements, especially with the major ones. Just to remind us of the *Las Vegas* example, for example *Boulder City* is one of the biggest dormitory settlements in *Nevada* which is about 32 km (20 miles) away from *Las Vegas*. It bears very similar physical characteristics to *Las Vegas*.

10. Small-scale eco-villages and urban food grow

Eco-villages are intentional communities whose goal is to become more socially, economically and ecologically sustainable. Most range from a population of 50 to 150 individuals. Their inhabitants are united by shared ecological, socio–economic and cultural–spiritual values. Concretely, they seek alternatives to ecologically destructive electrical, water, transportation and waste-treatment systems. Many see the breakdown of traditional forms of community, wasteful consumerist lifestyles, and the destruction of natural habitat, urban sprawl, factory farming and the over-reliance on fossil fuels as trends that must be changed to avert ecological disaster and create richer and more fulfilling ways of life.

Nowadays, eco gardening and growing food are becoming more popular in large urban spaces, too. In *Western Europe*, there are many examples from large cities—like *Berlin (Germany)*, *Vienna (Austria)*, *Birmingham (UK – Figure 10)*—where local residents, schools and universities try to reduce their ecological footprint by putting more effort to urban gardening and also turning towards a healthier lifestyle.

Figure 10 – Edible Eastside in Birmingham, UK
Photographed by Bokor, L. (2014)

10.1. Auroville and its integrated green practices

When it comes to eco-villages or urban greening projects, there is however effective approaches that grow at bigger scale. It is very important how a modern settlement is founded or established, or how far its roots go back in time. It is probably the possibility and opportunity to use all the benefits of the Hi-Tech whilst it is still combined with traditions. In this sense, *Auroville* is not only a settlement, but it represents the modern way of thinking. As their own statement says: *"It is a growing international township near Puducherry on the Coromandel Coast in India and is an inspiring model for sustainable practices and ecologically-responsible living. Founded in 1968, Auroville is based on* *the vision of The Mother from the Sri Aurobindo Ashram and is endorsed by UNESCO and Government of India as an ongoing experiment in human unity. Over the years, Auroville has won international acclaim for its efforts in social and environmental sustainability. In the early 1960s and 70s, a small group of pioneering residents took up extensive tree planting to rejuvenate the barren land and harvest rainwater. Since then, Aurovilians have been constantly experimenting with new ideas and solutions in areas of forestation, organic farming, renewable energy, water management, waste treatment, building technologies and environmental awareness programmes among others. One of the unique aspects of research in Auroville is the fact that many ideas are put into practice." (Figure 12)*

Figure 12 – A sustainable locality as it is seen from Auroville
Source: AUROVILLE GREEN PRACTICES (N.A.)

11. The ways of measuring sustainability in a certain locus. The Need Model

Following the points above, when it comes to talking about *Las Vegas* and *Auroville*, there are highly noticeable differences between those two and, therefore, there are obvious differences between settlements in general. One absolute thing is, however, common: both of them are rooted in *Earth's* natural sphere, but the latter one uses its local resources and it represents a local community, whilst the other one uses resources from a much wider area which integrates the place with globalist perspectives *(Figure 13)*.

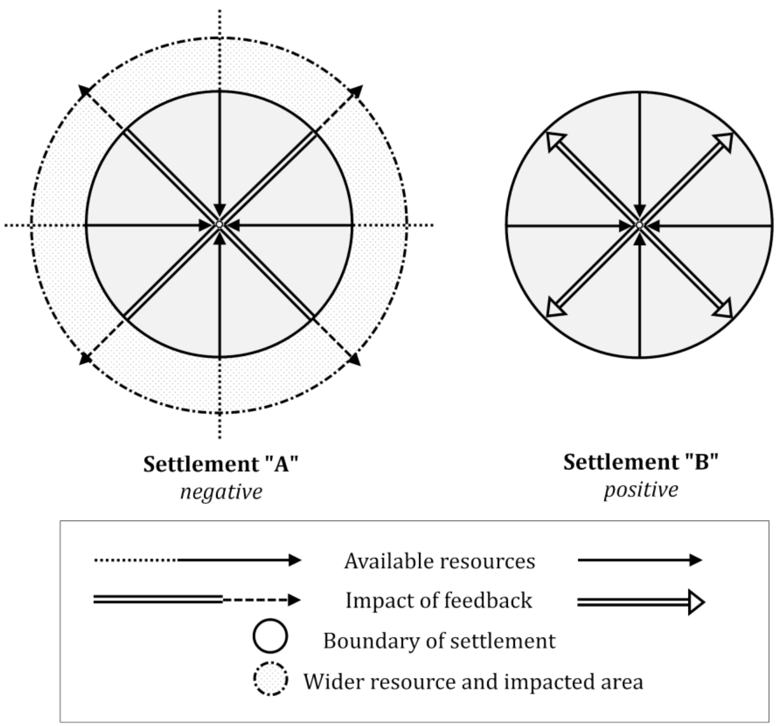


Figure 13 – Unsustainable ("A") and sustainable ("B") localities (e.g. settlements) depicted by the Need Model

Edited by BOKOR, L. (2014)

In whatever way each of them is structured as human living space is the distortion of the social sphere, it is the distortion of the society. How can the real differences in sustainability be seen between those two? How could it be measured and mapped? Regarding this figure, the type "settlement" can be changed to any other kind of locality, because measuring a certain sustainability means that it is measured at a specific location, which again may be anything that have boundaries (for example a house, a garden, a car park).

When defining sustainability and measuring a certain locus, highlighting the difference between the words "need" and "want" is also essential. Using the COLLINS (1986) dictionary as a reference, "need" is most commonly defined as "to be in want of" whilst "want" is "to feel a need or longing for". Unfortunately, the dictionary uses two fundamentally different terms as almost synonyms. These words are also described as something "necessary", but the major difference between the two is that "need" is essential for life (for example water, air), whilst "want" is something that may be described as a treat, but not needed at all for life (for example beer, air freshener). *Figure 13* depicts *"the Need Model"* which describes this difference and may reflect on personal (individual) life habits and standards. This Model, therefore, may be used for further comparison and will hopefully contribute to the development of measuring locality.

... how to carry out the measuring?

There are the specific numerical parameters that provide a way to quantify and measure the abstract idea of "sustainability". Indicators provide a way to assess how the community looks right now in comparison to one another. When it comes to measuring a certain locus, the indicators have to be taken into account; however, the physical parameters have a greater role than any other components.

Having explained terms and definitions through these examples noted above *(from section 4 to 11)*, analysing the sustainability of a certain locality has its difficulties, and it is even more challenging to define its rate of efficiency at one certain location. This section of the paper, however, tries to deal with this question and seeks solutions. The following hypothesis is now given: a certain location's sustainability regardless of its size can be measured and the same method can be used on other localities regardless of their sizes, too. In this article, therefore, a method is worked out and the major factors are taken into account only.

First of all, it has to be discovered that each locality in the geographical sphere is different; therefore, each of them would require a specific approach to be used. However, all of them rooted in the natural sphere what may allow to a certain method to be worked out to give a thorough analysis to each of them by involving the same geographical indicators or factors to be checked. So, it is a simplified method developed to use properties that may be found in every locality and these analytical parameters may form links to further calculations.This method is to analyse a certain locus which may be a garden, a house, a section of a street or streets, parts/districts of a settlement, but it may be used to analyse entire villages/towns/cities, counties, regions and even countries by amalgamating data of a needed number of analysed localities. It concentrates on the exploration of a locus's efficiency and sustainability, and highlights its physical potential and how these are exploited by the human population that live in that locality.

Sustainable locality measurement normally involves the sustainability of environmental, social and economic domains, both individually and in various combinations, but they are still evolving: they include indicators, benchmarks, audits, indexes and accounting, as well as assessment, appraisal and other reporting systems. They are applied over a wide range of spatial and temporal scales. In the sense of the above information, the following properties have to be thoroughly tailored to a certain locus to analyse its geographical parameters:

1. The potential of locality: physical properties,
2. The distorting effects of society: the human factors.

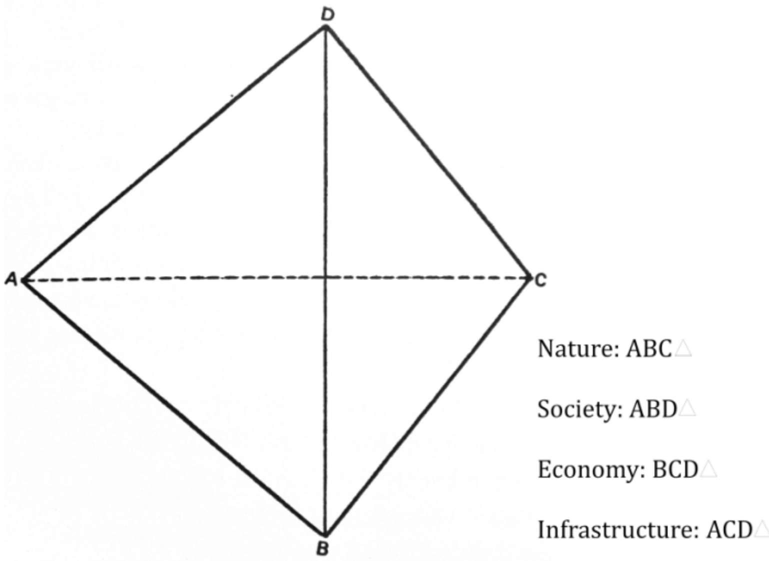


Figure 14 – The Tetrahedron Model
After TÓTH, J. (2002)

In a more combined way, the *Tetrahedron Model (Figure 14)* of TÓTH, J. (1981; 2002) may give more possibilities to analyse those parameters. The essence of the model is that the settlement is determined by four spheres: nature, society, economy and infrastructure which are in close connections with each other (ZSÓTÉR, B. 2008).

11.1. Physical properties

When it comes to analysing a certain location's physical conditions and given properties, the factors have to be checked in three dimensions:

1. Underground,
2. On surface,
3. Above surface.

The physical resources have to be checked within these three dimensions that eventually set up a realistic picture of the area; it gives an insight into the opportunities that may make the location sustainable in a measurable manner. Physical properties are often referred to as observables. They are not modal properties. For these the following factors have to be checked and their common values have to be compared and evaluated.

When a record is produced, the following topographical factors have to be taken into account and scored between 0 (not relevant at all), 2 (relevant) and 4 (very relevant), but the meaning of the scoring values depends on the factor taken into account *(Table 1)*.

Table 1 – The structure and observables of topographical properties

Designed and developed by Bokor, L. (2014)

Properties	Relevancy														
	Below surface					On Surface					Above Surface				
Latitude, longitude and elevation	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
Orientation	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
Climate	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
Water resources	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
Sunshine	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
Wind	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
Volcanic activity (geothermal resources)	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
Minerals and rocks	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
Soil types	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
Vegetation	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
Animals	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4

At this stage, weighing is not necessary to carry out a reliable analysis. They do not need to be rated, but the above scoring method may be worked out in the end (this would be the *Geographical Locality Index* or *GLI number*). This information will, however, be useful to compare localities and their given potential, but it will remain a subjective method, which is also descriptive, and it is based on observation and their evaluations. At this point, the second hypothesis may be stated:

the more physical properties (natural givens) are linked with one locus, the more sustainable potential it has or the more sustainable it can be.

The most effective way to test these hypotheses mentioned above is a classic, observational approach. This means that a physical geography map may be enough to identify sustainable potential and score a locus by taking the above factors into account. As the structure starts from the first onwards, it may become more complex and the points find their links and connections with the other factors in the group. For example, if a locus has a mountain range, its structure may indicate the presence of minerals, ores or other economically valuable resources (BOKOR, L. 2013); therefore, the research has to stick to the three observable dimensions *(Figure 15)*.

The generated index number *(GLI)* may be used to calculate and correlate a very simple amalgamation of data that allows the researcher to compare two or more locus with each other. This method (and the GLI number that the method generates in the end) is a combination of physical and human geographical factors/properties mentioned above; therefore, the old school research (structure) of regional geography has got a major role in here.

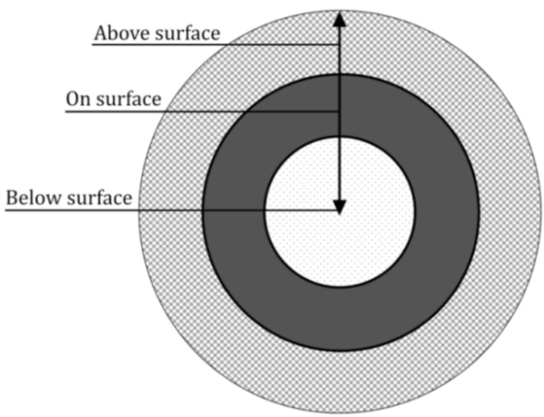


Figure 15 – Analytical dimensions of the physical properties
Edited by BOKOR, L. (2014)

All of this means that one number is produced by analysing physical and one number by analysing the human properties. In this sense, certain and given physical properties of a locus are correlated with each other. The more possibility is listed from a perspective, the higher the number is. This determines the given properties of a certain locality which means the higher the number is, the more sustainable opportunities the locus has. However, this number is distorted by the human factors which eventually determine a very simplified sustainability index of a location which can be measured by the *Need Model*. Clearly, two numbers produced: one which analyses the physical properties, and one which analyses the human distortion. The *GLI number* is the combined number of these two individual measurements.

11.2. Setting up a record

As it is mentioned earlier, the scoring values range between 0 (not relevant at all) and 4 (very relevant), but the meaning of them depends on the factor that is analysed. When the survey is carried out, 11 physical features are taken into account and are scored. These classic physical geographical factors are strongly connected with each other; therefore the scored relevance of one may affect the other.

The following 11 factors will be briefly explained by involving an example of a certain locus and a physical *GLI number (GLIp)* will be generated. When the survey is taken to gather data of physical factors, the human objects imaginarily have to be taken off and the analysed locus has to be seen without them. At this stage at the moment, the *GLI* only shows the sustainability of a certain natural locus. In fact, since it is a simplified index number, many places on *Earth* with organic formation and historical development should have the same or nearly the same physical *GLI (GLIp) number*.

The following example stands here to foster understanding to the three major factors:

a) latitude, longitude and elevation,
b) orientation, and
c) climate.

All of the other factors taken into analyse strongly associate with these three. According to WILHELM, Z. (2013), the exploitation of these forms a strong connection between nature (natural resources) and society:

d) water resources,
e) sunshine,
f) wind,
g) volcanic activity (geothermal resources),
h) minerals and rocks,
i) soil types,
j) vegetation, and
k) animals.

Sample location: 9730, *Kőszeg, Hungary*
GPS coordination 47°23'17.0"N, 16°32'33"E *(Main Square / Fő tér)*

Figure 16 – Kőszeg, town centre
Photographed by BOKOR, L. (2014)

11.2.1. Latitude, longitude and elevation

Longitude and latitude are numbers of a coordinate system that enables every location on the *Earth* to be specified. The elevation of a certain location is its height above or below a fixed reference point. It is strictly used when referring to points on the *Earth's* surface; therefore, the relevance of the underground and above surface might both be zero. But, the location of one particular city may be very important; regarding it is a seaside resort or an Alpine hut.

In regards of *Kőszeg*, the *Main Square* is at 273 m above sea level. In this sense, this information does not tell much to us, but seeing its certain GPS coordination, its exact location defined by latitude and longitude, it is known what external effects may have impact on it environment. *Kőszeg* lies in the conjunction point of mountains, rivers and plains which—in a temperate climate zone and at that elevation—indicates the best ground to establish a sustainably managed human living space. It is obvious that the scoring value will be the highest (4) in this case which is only checked in 1 dimension (on surface, the other two will both be zero).

11.2.2. Orientation

It is a location or position relative to the points of the compass. Its determination strongly associates with the elevation. It is very important when a house is built and where it is located. Orientation may help identify the position of a building with respect to the *Sun* which may have a key concept in building design. According to its relation to elevation, the relevance of the underground and above surface analyses might both be zero again.

In regards of the chosen example, *Kőszeg's* relation to its surrounding environment can be stated positive. It is located on the eastern side of the foothills of the *Alps* where, like a butterfly's wing, opens up a plain towards northeast from southeast, therefore, the place is protected from strong winds and heavy rain on the western side, whilst the Sunshine potentially reaches it which may be harnessed. This kind of orientation is the best possible, therefore its score is the highest (4). According to the position of the locus, orientation is checked only in a dimension (on surface, the other two will both be zero).

11.2.3. Climate

Climate is a measure of the average pattern of variation in temperature, humidity, atmospheric pressure, wind, precipitation, atmospheric particle count and other meteorological variables in a given region over long periods of time. This is probably the most complex among the analysed factors that highly defines some of the individual ones that is used to create the *GLI number* (for example wind and sunshine).

Kőszeg's specific local conditions are highly affected be the climate. The question that has to be asked is how the climate affects sustainability? How efficiently does it support a local community? In no doubt it can be stated that the underground and above surface dimensions will be taken out of analysation, therefore both of them will be zero. To get the right scoring value, however, a deeper analyse is required on the local climate conditions and on its impacts to uncover basic facts of agriculture, farming and so on. Although, speculatively now it can be stated that the geographical coordination of *Kőszeg* indicate supportive climate conditions, therefore this value can be 4, as well.

11.2.4. Water resources

Surface water is water in a river, lake or fresh water wetland. Surface water is naturally replenished by precipitation and naturally lost through discharge to the oceans, evaporation, evapotranspiration and sub-surface seepage. But water is a form that can be found in all three dimensions; therefore, it is very important to analyse all of them.

11.2.5. Sunshine

Sunlight is a portion of the electromagnetic radiation given off by the *Sun*. An area receives direct irradiance from the *Sun* of at least 120 watts per square meter. The central star of our solar system is the most important energy resource for the planets which is also the major factor to develop life on *Earth*. It has direct and indirect effects on most of the physical processes in nature. When it comes to analysing a certain locality, the factors directly affected by the *Sun* on the surface and above are taken into account only; therefore properties will not be analysed under the surface, so the score will be zero.

11.2.6. Wind

Wind is caused by differences in atmospheric pressure. When a difference in atmospheric pressure exists, air moves from the higher to the lower pressure area; therefore it has a direct effect on the environment above surface and a direct or indirect on the surface. It is important to take it into account as one of the most important natural forces that can be harnessed for its energy.

11.2.7. Volcanic activity (geothermal resources)

Different volcanic activities affect the area that is analysed. On the surface, direct volcanic activities can be seen in the form of volcanoes and post-volcanic activities (for example geyser, hot water basins). This activity strongly connected with the underground happenings. Volcanic activity may affect the atmosphere at a global level, but in this sense, it does not need to be taken into account when a certain locus is checked. The *Earth's* geothermal resources are strongly associating with volcanic activities, therefore, when a certain locus's resources are analysed, the under surface resources has to be scored too.

11.2.8. Minerals and rocks

A mineral is a naturally occurring substance that is solid and inorganic representable by a chemical formula. Rocks are majorly made of minerals. They together classify an area's sustainability through their availability underground and may have direct or indirect effects on the surface area. What only matters is their underground availability.

11.2.9. Soil types

A soil type, like the minerals and rocks underground, strongly impacts the surface environment and vice versa. According to minerals, soils form on different rock types, therefore minerals are strongly present in them. The major difference however, is that the soil types can only be taken into account to analyse at the surface level; therefore underground and above the surface will both be zero.

11.2.10. Vegetation

Vegetation assemblages of plant species and the ground cover that they provide. Their appearance and availability strongly depend on most of the factors mentioned above (for example minerals, soil type, climate conditions). Still, in this sense, only the surface is taken into account and it is analysed for the fact how they make the locality sustainable and how they contribute to its efficiency.

11.2.11. Animals

Again, the animal coverage of a certain area is strongly depend on most of the factors mentioned above, but this latter one involves the vegetation too as most of the animals depend on the food that is given by the environment. Animals indicate the same importance as the flora in general, thus how they make the locality sustainable and how they contribute to its efficiency.

12. Summary, conclusion and further researches

It is widely known that organic settlements were formed at specific locations where the potential of natural givens (e.g. water) met the human needs (e.g. drinking, farming). According to a land's basic physical properties (its geographical location, orientation and climate conditions), the sustainability of the human settlement that grows up on it will be strongly influenced and affected by a certain number of subfactors (the amount and quality of water that is available, the amount and length of sunshine, the strength of wind, the available geothermal resources, minerals and rocks, soil types, vegetation and animals). All of these factors and their properties may be analysed by a specific—but straightforward and simple—method which allows comparing location with each other. One certain settlement's sustainability can be measured with this method. The simplicity of the *GLI number* helps us create a reference number which in fact, in regards to the human settlements with organic formation and historical development, will have the same or nearly the same physical properties, but the quality and amount of them will determine its further sustainability.

Obviously, the physical factors are distorted by the human society (social sphere) and this effect has to be taken into account to draw up an accurate picture (to work out an accurate *GLI number*) on a locus's sustainability. Processing this number, the Need Model may be employed to discover the distorting factors and their impact.

Carrying on working with *GLI number* is a great way to address challenges too. Any further research will have to concentrate on fine tuning the analysis of the properties taken into account. When the physical factors are clearly identified and the measuring method gives a reliable index number, the research has to deal with the distortion effects of the society. Nevertheless, this human world is the key factor to see a settlement's true face of sustainability.

References

BOKOR, L. (2013). *The Importance of Energy Resources in the Local Environment.* In: BOKOR, L. – CSAPÓ, J. – SZELESI, T. – WILHELM, Z. (eds.) *Locality and the Energy Resources.* Geographical Locality Studies 2013 Volume 1., Number 1. – Frugeo Geography Research Initiative, Shrewsbury, pp. 14–29.

CARSON, R. (1962). *Silent Spring.* – Houghton Mifflin, 378 p.

COLLINS (1986). *Collins Dictionary of the English Language – Second edition (HANKS, P. ed.).* – Collins, London & Glasgow, p. 901–902.

COUCLELIS, H. (2005). *Space, time, geography.* In: LONGLEY, P. A – GOODCHILD, M. F. – MAGUIRE, D. J. – RHIND, D. W. (eds.) *Geographical Information Systems: Principles, Techniques, Management and Applications, 2nd Edition, Abridged.* – Wiley, pp. 29–38.

LIGHT, A. – SMITH, M.J. (1998). *Philosophy and Geography III. Philosophies of Place.* – Rowan and Littlefield Publishers, INC., Maryland USA, pp. 24; 128–129.

MAUDLIN, T. (2012). *Philosophy of Physics: Space and Time.* – Princeton University Press, Princeton (USA)/Woodstock (UK), 183 p.

NEWMAN, P. – KENWORTHY, J. (1999). *Sustainability and Cities: Overcoming Automobile Dependence*. – Island Press, Washington, 447 p.

TÓTH, J. (1981). *A településhálózat és a környezet kölcsönhatásának néhány elméleti és gyakorlati kérdése.* – Földrajzi Értesítő Vol. 30, No. 2–3, pp. 267–292.

TÓTH, J. (2002). *Általános társadalomföldrajz* I. – Dialóg Campus, Budapest–Pécs, pp. 86–87.

WILHELM, Z. (2013). *Water as a Natural Resource, Cultural Heritage and Tourism Attraction in India.* In: BOKOR, L. – CSAPÓ, J. – SZELESI, T. – WILHELM, Z. (eds.) *Locality and the Energy Resources.* Geographical Locality Studies 2013 Volume 1., Number 1. – Frugeo Geography Research Initiative, Shrewsbury, p. 97.

ZSÓTÉR, B. (2008). *The Stud Farm, from its Establishment till 1920 – Introduction to the History of Mezőhegyes with the Tetrahedron-Model.* – Scientific Papaers Agriculture, Editura Agroprint, Banat's University of Agricultural Sciences and Veterinary Medicine Timisoara Faculty of Agriculture, Timisoara, Vol. 40, No.3, pp. 383–387.

Electronic sources

AUROVILLE GREEN PRACTICES (N.A.). *Integrated Green Practices*. Auroville Green Practices [Online]. Available at <http://www.green.aurovilleportal.org/> [Accessed: 29 April 2014]

MASSEY, D. (1993). *Questions of Locality.* – JStore [Online]. *(pdf)* Geography, Vol. 78, No. 2, pp. 142–149, Available at <http://www.jstor.org/stable/40572496> [Accessed: 21 September 2014]

THE GREENS (2013). *Sustainable Settlements 2013* [Online]. Available at <http://wa.greens.org.au/policies/sustainable-settlements> [Accessed: 11 October 2014]

UN (1987). *Our Common Future – Report of the World Commission on Environment and Development.* United Nations [Online]. *(pdf) 247* p. Available at <http://conspect.nl/pdf/Our_Common_Future-Brundtland_Report_1987.pdf> [Accessed: 02 October 2014]

UN (2012). *World Urbanization Prospects – The 2011 Revision.* United Nations [Online]. *(pdf)* Economic & Social Affairs, New York, 50 p. Available at <http://esa.un.org/unup/pdf/WUP2011_Highlights.pdf> [Accessed: 30 September 2014]

UNITED STATES CENSUS BUREAU (2014). *Las Vegas (city), Nevada.* [Online]. State and County QuickFacts. Available at <http://quickfacts.census.gov/qfd/states/32/3240000.html> [Accessed: 09 July 2014]

ISSN 2052-0018 (print), ISSN 2053-3667 (online)
Geographical Locality Studies 2014 Volume 2, Number 1. pp. 262–282

DÁNIEL LEIDINGER
MSc, Geographer
PhD Student at Eötvös Loránd University, Faculty of Sciences, PhD School of Earth Science
Adviser at Aquaprofit Ltd.
daniel.leidinger@aquaprofit.com

ÁDÁM HARMAT
MSc, Geographer
PhD Student at Eötvös Loránd University, Faculty of Sciences, PhD School of Earth Science
harmatadam@caesar.elte.hu

City Modelling from a Sustainable Point of View

Abstract

The number of cities is rapidly growing throughout the world and the characteristics of city life are equally spreading. If it assumed that the biosphere is a single living entity, cities can be compared to the tumours in a cancerous body (LORENZ, K. 1973). They take material and energy from their surrounding areas and they charge them with the waste of their metabolism. The aim of this paper is to compare the evolution, the development and the operation of the urban area with a cancerous body. The result of this analysis will determine the main reason why the characteristic of city life can be deemed unsustainable.

Key words

Tumour-model; Sustainability; Urbanisation; Energy efficiency; Urban and rural spheres

1. Introduction

As a consequence of the growing number of urbanites and the destruction of nature caused by urbanisation, more and more attention is paid to the sustainability of cities. In the past decades, numerous studies have been published which examine the topic from a political, social or architectural point of view, or which focus on the use of energy and land resources.

The sustainability of cities—in terms of the growing number of urbanites and the urban population—is a fundamental question that is relevant for the sustainability of the whole society. According to some urban political ecologists, there is no such thing as an unsustainable city in general. Rather there are a series of urban and environmental processes that negatively affect some social groups while benefiting others (SWYNGEDOUW, E. – HEYNEN, N. C. 2003). On the contrary, our theory is that the sustainability of cities is controversial per se. To understand the authors' view, it is necessary to get over the barrier of the now dominant socio-economic perspective.

On a global scale, more than half of the *Earth's* population live in cities (CENTRAL INTELLIGENCE AGENCY, 2014), but these are only statistics. If the inhabitants who live in urban areas or in urban environment are added to this number, the rate is even higher. It can therefore be suggested that the majority of the world's population is urbanite or, in other words, lives in urban areas. The so-called developed world's urbanites live in urban environments outside of the cities. The lifestyle of citizens is more similar to the population of a city than to the traditional population of a village. For that reason, based on the sustainability of cities and on the urban lifestyle, it is possible to infer the sustainability of the majority of the modern civilised society. Thus, when asking whether the city is sustainable, we also inquire about the sustainability of the majority of modern society.

From the authors' point of view, the unsustainability of the present society relates to its level of urbanisation and civilisation. It is important to note that the concept "urbanisation" not only refers to the growth of the cities and their inhabitants but also the spread of the urban lifestyle. (In this study the two idioms—urbanisation and civilisation—are taken to be synonyms. It is considered generally that the cradle of civilisation is the first urbanised society. Also the idiom "civilisation" originates from the Latin idiom "civis", which means "urbanised citizen".)

Nevertheless, it is important to mention that in the last decades and even before, several authors have drawn attention to the unsustainability of civilised society, but not expressly in terms of the urban lifestyle (SPENGLER, O. 1918; MEADOWS, D. H. *et al.* 1972; WACKERNAGEL, M. – REES, W. E. 1996). According to the authors of this paper, if the issues related to the unsustainability of the city are examined that can help to understand the reasons why civilised society can be deemed unsustainable. To comprehend the unsustainability of the present cities, a city model was created which highlights the city and its relation to the natural environment.

This city model—with a biological analogy—has an unorthodox approach to the role of the city. To comprehend the unsustainability of the city, it is necessary to get over the widespread conception of nature. According to this general idea, nature is a kind of resource mass which is meant to ensure the growth of civilised society and its economy as well as to receive the litter produced by society.

Creating city models is not a new-fangled endeavour in sciences dealing with settlements (settlement geography, settlement sociology, architecture, etc.). In geography, it can be suggested that the best known city models are the classical urban structure models (*Burgess*; *Park*; *Ullman*) which model the spatial structure of the inside urban areas based on social and economic aspects (BURGESS, E. W. 1924; HOYT, H. 1939; HARRIS, C. D. – ULLMAN, E. L. 1945).

The common characteristic of classic urban structure models is their examination of the inside structures of the city, principally from an economic and social point of view. In the case of classic urban structures, the question of a city's sustainability does not arise. In contrast, the model examines the city and its network from a sustainability point of view. It describes the relation of the city and its surrounding (natural) area instead of the description of the internal structure of the city. It is an important aspect since the aim is to examine the city's sustainability from an environmental perspective; the main point is not the interests of the social group inside the city, but the relationship of the city and its natural environment, and how the city is affected by this. Based on this relationship, conclusions can be drawn about the sustainability of the city and its network, but also about the sustainability of the urbanised (or civilised) society.

2. Research methods

As it was mentioned above, the model presented in this paper represents the role of the city from an unusual approach, based on biological analogy. The main characteristic of the model is to set social and natural phenomenon against biological phenomenon. When the consequences of a given physical phenomenon are known, drawing conclusions becomes possible regarding the consequences of the examined social process.

The analogy which forms the basis of the model seems to be unorthodox; however it is not the first approach of this kind. Most studies dealing with cities interpret the city as a social phenomenon. In other words, their approaches are drawn from the social sciences. Nevertheless, it is important to mention that some social scientists—quite early—applied physiological parallels to represent social processes. For instance, *Karl Marx* and *Friedrich Engels* compared the material and energy consumption of society to the metabolism of an organism (MARX, K. 1861). Moreover, at the beginning, the expression 'metabolism' was the part of the social sciences terminology (POMÁZI, I. – SZABÓ, E. 2006.). Also, similar biological analogies can be found in *Dan Sperber*'s epidemiology of representations theory (SPERBER, D. 2000), or in *Baudrillard*'s studies (BAUDRILLARD, J. 1998). Among social sciences' studies, specifically the ones dealing with the city, a number of case studies can be found which represent the city or a part of it through a bioliogical analogy.

The main relevance of using biological parallels is to compare and represent the characteristics, the processes and the result of such social and natural processes.

It is important to emphasize that in the case of this study the point is not only to make a social phenomenon more understandable, but to erase the strict boundaries between the disciplines. In this case, the aim of this paper is to bridge the often wide gap between the social and natural sciences.

3. The interpretation of the natural environment

In terms of the model, nature is a compact living system where the entities mean not only the living individuals, but also their symbiosis. According to this point of view, the *Biosphere*, but also the entire *Earth* is an entity. This approach can found in the *Gaia hypothesis*, formulated by *James E. Lovelock* where the *Earth* is a self-regulating and complex system; in other words, a living being. *Lovelock* named this being after the stoic philosophers (LOVELOCK, J. E. 1979).

Through the model, the city and the role of the civilised urban society are examined based on this aspect. In this context, the main question is the following: what is the role of the city and the urban society in the *Biosphere's/Gaia's* perspective?

Lovelock even examines the role of the human being from *Gaia*'s perspective. *Lovelock* views the human being as a parasite which despoils the resources of the *Earth*—the body of the host—contributing to the weakening of the whole *Biosphere*. The authors of this study disagree with this point of view since the parasites come from outside the host's body and the base of their being is the parasitism. In the authors' opinion the human being is not an 'external conqueror'. Also, the understanding that his main action is to despoil the nature is against the authors' point of view.

Looking back to the history of humankind, societies can be found which were able to cooperate with the natural environment. Through their everyday activities they not only did not destroy their natural environment, but via a high level cooperation they could enrich it. The former ethnical group proceeding with floodplain agriculture in the *Carpathian Basin* is a relevant example. The group was a key factor in that biosphere and eventually without their action the whole valley would have been poorer. If humankind had not proceeded with flood-plain agriculture, the natural environment—the flora and the fauna—would not have become so colourful (ANDRÁSFALVY, B. 2007; MOLNÁR, G. 2004; MOLNÁR, G. 2009).

As the operation of the human body cell is not self-serving, but serves the body, it can be suggested that the actions of individuals and of humankind serve nature. In the authors' opinion, the society is an organic part of the *Biosphere/Gaia* (it can be comprehended as a group of cells) or, even more, it is not only a part but the key actor. The man who enriches his natural environment is similar to a coral polyp. This tiny animal builds a habitat, which provides the most diverse biome in the world for the surrounding living environment. If the coral polip would not be in the system, only poorer biomes could develop in this part of the ocean. The collaboration of humankind with the natural environment is similar to the key point of the given biome.

In spite of *Lovelock*'s view, the authors do not define humankind as a parasite. The present civilised urban society is rather an ill group of cells which lost its original role.

4. The Tumour-model

In his essay called '*Civilized Man's Eight Deadly Sins*' *Konrad Lorenz* writes the following related to the modern society: *"If we compare the old center of any European town with its modern periphery, or compare this periphery, this cultural horror, eating its way into the surrounding countryside, with the still unspoiled villages, and then compare a histological picture of any normal body tissue with that of a malignant tumour, we find astonishing analogies. (...) The similarities between the two processes are obvious. In both cases, the still sound parts contain highly differentiated and mutually complementary structures that owe their symmetry to information gathered in the course of a long evolution; whereas, in the tumour, or in modern technology, only very few ex-*

tremely simple structures dominate the picture. The histological picture of the completely uniform, structurally poor tumour tissue has a frightening resemblance to an aerial view off a modern suburb with its monotonous houses designed by architects without much art, without much thought, and in the haste of competition." (LORENZ, K. 1973).

To complement the above quoted text with the authors' point of view, it is not only the modern suburban cities, but the present cities which resemble a tumour in general—in terms of their physiognomy and operation.

Other authors also discovered this similarity. For instance in his work called '*The city in History: Its Origins, its Transformations, and its Prospects*', *Lewis Mumford* suggests a likeness between modern cities and a tumour (MUMFORD, L. 1961).

The similarity of a city to tumours is to be seen on aerial photographs of cities (as *Konrad Lorenz* wrote [LORENZ, K. 1973]), or on satellite images (and it also can be seen if a thermographic picture of a city is compared with a thermographic picture of a tumour). In addition to the similar physiognomy, resembling operations can also be observed. From the authors' point of view, the present cities in the *Biosphere*—and actually in the entity of "*Gaia*"—operate as the full-blown tumour of a biological individual. The aim of this paper is to present the model of the city through this analogy in details, and to conclude from this the sustainability of the city. According to this similarity, the city model is called the "*Tumour-model*".

The *Tumour-model* is basically a city model similar to the classical urban structure model that demonstrates the primal operation of a city, and its spatial connections. The model substantially differs from the earlier classical urban structure in three ways:

- While the classical urban structure models mainly focus on the internal relations in a city, in the *Tumour-model*, the emphasis is on the city and its environment (but it also examines the internal relations).
- The classical urban structure models examine the city through its socio-economic aspects, while the examination of *Tumour-*

model is based on ecological, energetic, and sustainability concerns. (Of course these contain the social and economic aspects as well.)

- The *Tumour-model* is based on a biological analogy.

4.1. The main conclusions of the model

I. The structure of a modern city is similar to a tumour. The above mentioned simplified framework characterises both phenomena which differ from the healthy parts—in case of the tumour, it differs from the healthy tissue; in case of the city, it differs from the territory untouched by the urban lifestyle *(Figure 1)*.

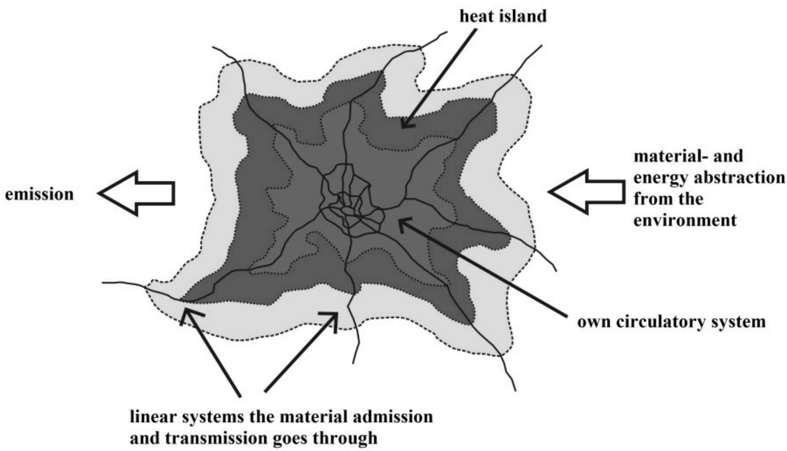


Figure 1 – The Tumour-model
Source: edited by LEIDINGER, D. – HARMAT, Á. (2014)

II. Beyond the visual similarities, there are also operational parallelisms:

a) Proliferation: The city, like the tumour, is the result of a kind of proliferation. The number of cancer cells grows continuously by the getting over the cell death and the continuous fission (WEINBERG, R. A. 2006). As a result, the tumour spreads out increasingly, cutting the still healthy tissues out. The recent modern cities have emerged as the results of the same process—more and more urban areas were grown outside the town centre, extending the whole urban area. As a matter of fact, this process is the annexation of the rural areas by the urban areas.

b) Material and energy abstraction from the environment: the tumour—in order to keep up the continuous growing (cell division)—despoils the nutrient through the vascular and lymphatic system. Therefore it weakens the whole body since it also exploits the life force from the further tissues of the body. Modern cities function through the same process in which the vascular and lymphatic systems are replaced by linear supply systems (for example: road and railway network, electricity network, pipeline network, etc.). In order to maintain the sustenance and the growth of the urban urbanites' consumption, nature is exploited at an increasing speed. It results in the enhancing dysfunction of the natural systems. It is important to note that the extraction of "resources" also occurs at the social level as the cities "exploit" the remaining population of the rural areas. This process leads to the degradation of this territory both in social and economic terms.

c) Polluting and toxic emissions in the natural environment: The city and the tumour poison the environment because of its metabolism and, at the same time, it exploits the resources. In the tumour it arises from the metabolism of the tumour cells, in the cities from the urban consumers' metabolism (the output of this phenomena is the environmental pollution). *Table 1* represents the metabolism of an urban society.

Table 1 – An example for the metabolism of an urban society: a daily mass balance of an average European city with one million inhabitants in the 1990s.

Source: VIDA, G. (2001)

Consumption:	**Emission:**
Fossil fuel: 11,500 tons	Carbon-dioxide: 25,000 tons
Water: 320,000 tons	Sewage: 300,000 tons
Food: 2,000 tons	Solid waste: 1,600 tons

d) In both cases—in a city and in a tumour—a heat island emerges. Moreover, the structure of this heat island has a high level of similarity. The background of this is the spatially concentrated and intensified energy consumption compared to the consumption of its environment (in the tumours in order to maintain the continuous fission, in the cities, for the sake of maintaining or rather increasing the consumption *(Figure 2)*.

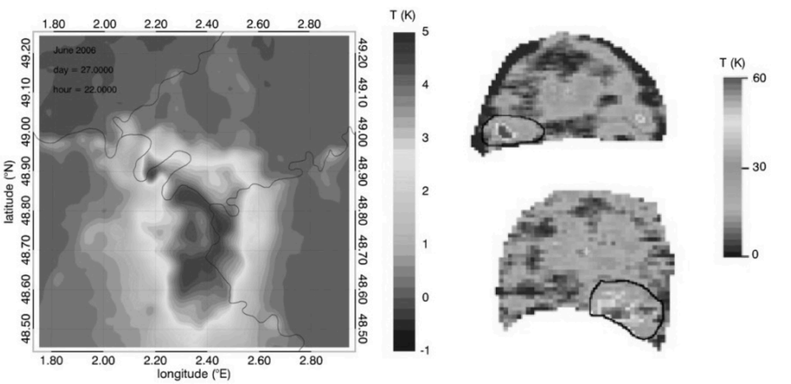


Figure 2 – Thermal image of a city and a tumour

Source: (left) VITO Urban Climate Lab (n.a.); (right) UMC Utrecht (n.a.)

e) Similarities in the evolution: at an initial stage, the tumour metabolises through diffusion which is not an efficient method since the tumour cells unload the excreta uneasily, and it is also more difficult to get access to the nutrient. The accumulating excreta poisons the cells, therefore the death rate grows among the tumour cells. Thus, they fission vainly, the tumour does not grow (some nodule can be in that so-called “sleeping” phrase for decades) (BALÁZS, A. 1984). This initial condition refers to that phase of urban development when solidification takes place inside the town walls due to the lack of any infrastructure (the concentration of the sewage and solid waste on the streets). During this phrase, the population is decimated by epidemics while the population density of the city grows slowly within newly built walls inside.

To overstep the initial phase, the tumour copies the nearby tissues, developing an internal circulation system. By doing so, it is more efficient to serve the metabolism: disposing the excreta is more efficient and getting access to the nutrient is easier. Afterwards, the tumours start growing rapidly (BALÁZS, A. 1984). In the city, the rapid growth starts when the walls are demolished and a more efficient infrastructure is built up (avenues, sewage network).

This period is the same as the boomtowns phenomena in the modern urbanism (BERG, L. VAN DEN *et al.* 1982; ENYEDI, GY. 2011). Its beginning is connected to the Industrial Revolution, when the growth of the urban population was inexperiencedly high in *Western Europe*, mainly as a consequence of the rural population’s movement to the urban areas. In other parts of the *Earth* this development took place in other time periods (there are places where it is still processing). Usually, within this development, not only do the already existing cities grow fast, but also new cities are born from scratch. Continuing this thread, the following development is the period of relative deconcentration (suburbanisation) which results the ongoing growth of the city body. In case of the suburbanisation of the population or the industry or the service sector, the occupied land is earlier unbuilt land which was untouched by the urban areas before. In the case of the model, these two periods of the city growth are regarded as the initial, sudden growth of the tumour centre after the "sleeping" period.

f) Metastasis: The cells of the malignant tumours infiltrate the surrounding tissues and get access to any other—often further located—part of the body via the vascular and lymphatic systems and form metastasis. In the history of urbanisation the same phenomena can be found: the population flowing out of the urban area generates new cities and urbanised areas on the undestroyed territory by the urban lifestyle, often far away from the city. A good example of these is the firstly established American cities, which were founded by *Europeans*. As *Wolf Schneider* wrote: *"The city, as the humankind '7000-years-old creation' firstly developed slowly, by degrees, then in a rapid movement"* (SCHNEIDER, W. 1963). Thus, untouched territories were occupied again and again, and the main part of society became urbanised. It not only means that new cities were established but also that urbanisation of the rural land (desurbanisation).

Throughout the history of urbanisation, civilisation establishes new cities connecting all the continents. However, the peak point of the metastasis is not that phase, but when the cities reach the occupied rural areas. At that time the rural societies undergo a fundamental change. As a result, the formerly rural settlements started to exist like cities. Thus they started to have the same symptom as a tumour. As the result of this process the rural population started to get increasingly separated from the natural environment, losing more and more information about it. Meanwhile, the operation of these settlements started to get increasingly similar to cities.

Nowadays, in the so-called "developed" part of the world, the inhabitants of the rural area depend on the same supply system as the urban population. As *Wolf Schneider* wrote in the 1960s: *"Our Earth started to get to be urbanised rural area, moreover, it maybe will change to be one urbanised–rural area"* (SCHNEIDER, W. 1963). It also means that the rural population use resources which from further territories similarly to how the urban population does. (Similar to the tumours which distract the resources; for example: nutrient, energy, from the further tissues of the body.) In the "developed" countries, without the big supply system the "rural" population would become dysfunctional, just like the urban population. Having an urban lifestyle, the urban society started to get increasingly disconnected from its natural environment, leading to a loss of knowledge about nature.

III. Similar reasons: The main cause of the evolution of the two phenomena—city and tumour—is the lack of information (LORENZ, K. 1973). As the cell which makes up the tumour loses the genetic information, which would make it a useful part of the organism, the urban society lose that knowledge which can qualify it to be the organic part of its natural environment. The estrangement from the natural environment leads to that condition when the new urban generations—like growing cells in the tumour—are born with this lack of information already. In the case of the city, the main character of the estrangement is the town wall. Although, in the past the walls could have more functions, in our case the main role is to set up a barrier between the urban inhabitants and nature. The town wall was an intense border and new rules began to prevail inside compared to the outside. Later in history, the town walls were mainly demolished, however, the wall infiltrated into the consciousness of the civilised society which defines the latter's relationship with its natural environment up to this day. This led to the present situation in which even outside the cities the urban perception—different from the healthy process of the natural environment—is more and more dominant.

IV. Similar consequences: As the still healthy part of the body decays through the growth of the tumour tissue, the natural areas, and, therefore, the whole *Biosphere* and also *Gaia* decay by the growing of the urbanised areas.

5. What led to the spread of the malfunction?

In a healthy body, cancer cells form every day. However, a healthy body (with a healthy immune system) is able to destroy them and keeps them under control. This is also noticeable on a higher organisational level, as on the level of the present society. Although there are deviant individuals—who ignore the existence of the natural law—a properly operating society system is able to filter them and also marginalise them from itself. However, in case of an inaccurate social system—in an effect of a social constraint – the "immune reaction" of the society can be turned off or can be blocked purposely which leads to the spread of the deviant behaviour patterns. The estrangement from the natural environment could occur in this way. This estrangement is the same as the information-losing process of the tumour cells. Through this process its operation becomes self-serving: the aim is not the reservation and enrichment of the surrounding natural environment—or in some religions: the continuation of the *Genesis*—but only the implementation of the short-term self-serving. In long term, this kind of operation not only results in the destruction of the environment, but of the whole living space—the higher individual living, the *Gaia*. In fact, it leads to the destruction of the society.

The greatest problem in line with the civilised society's loss of information could be that the individuals born into an urban environment are surrounded by faulty models—differing from or denying the healthy operation of the natural environment, just like the reproduction of tumour cells. In most cases, in an urban society's point of view the environment which denies that living nature is the "natural". As *Spengler* wrote, "the philosophers of different cultures are living in cities, which mean they don't even know how bizarre a city is" (SPENGLER, O. 1918). Consequently the urban environment predestinates the thinking and worldview of the individual. While the environmental education can help to reach great improvements in this matter, the urban population cannot gain empirical knowledge about the natural environment and the ways of cooperating with it. In the authors' opinion, ultimately this kind of "environmental determinism" results in the ecological blindness of the current civilised society.

6. The wall and the loss of information

From its beginning, one of the most important characteristics of the city has been the wall. Physically the wall had been surrounding cities even until the 19th century. The city wall had one more important role beyond the defensive function: it drew a border between in and out, the urban population and its natural environment. Even in cities without walls, like the ancient *Cnossos* or *Ekhet-Athon* had their borders clearly marked off (SCHNEIDER, W. 1963). On one hand the wall symbolises the relation of urban population with the natural environment, but on the other hand it means a sort of "geographical determinism" for the subsequent urban generations.

The man born inside the city wall has limited chance to receive knowledge about the natural environment compared to those who are born into an organic community, which life-style and education fits to their natural environment. From the model's viewpoint the urban society's growth is comparable to the fission of tumour cells. The newborn generations—like the tumour cells—lack the information about the outside environment. While the tumour cell loses information genetically, the urban society's loss of information is determined by social circumstances (lifestyle, environment, social establishment, worldview, etc.). This loss of information results in a "deviant" habit compared to the operation of natural environment. From *Biosphere*'s viewpoint the operation of the urban man can be considered just as self-serving as the operation of cancer cells from the healthy cells' or the entire organism's viewpoint.

The role of the walls has been re-evaluated during the 19th century. In the case of most cities, the city walls were demolished so they disappeared by physical means, but throughout the millenniums the wall has infiltrated the conscience of civilised man. And this wall is much more difficult to demolish than the physical one. It not only separates the city from its outside territories but it divides civilised man from natural environment.

Demolishing the walls was not meant to "return to nature", but to contribute to the faster expansion of the city and urban life, the limitless expansion of the world inside the wall. So in some sense the walls are still standing, only they infiltrated the conscious of civilised society.

7. Chance to the solution – quit from the condition of the loss of information

The *Tumour-model* represents the environmental exploitation of the urban society and the society living according to an urban lifestyle and points out its unsustainability. The aim of this paper has been to make a "diagnosis": The *Tumour-model* points out that as a tumour destroys the host body through continuous cell proliferation and formation of metastasises, the present process system of the civilised urban mankind is heading to the devastation of its basis of being, the *Biosphere*.

However, beyond the presentation of the model, it is also needed to mention shortly the chance of "healing". According to the authors, as a cancer body can recover, the *Biosphere* has the chance to recuperate. The authors see two ways of recovering:

- In the first case the urban lifestyle will be a common characteristic of the society's significant part, therefore the condition of the loss of information will still exist. The consequences of this condition are the further irresponsible destruction of nature. It leads to the ceasing of the basic "*Biosphere-service*" and to the drastic decline of the human population. This case can bring the opportunity for the *Biosphere* to recover in long term, if the civilised society does not destroy it completely. In such a situation, the remaining human population is forced to follow the natural pattern. However, their opportunities are much more limited than in the case of former societies which collaborated with nature, in terms of resources and knowledge. Such a collaborating society is the above mentioned former ethnical group proceeding with floodplain agriculture in the *Carpathian Basin*. A lot of examples can be mentioned for such a collapse on the local scale which happened before the globalised human population emerged (DIAMOND, J. 2005). Nevertheless, it is important to note that the urbanised society became a global phenomenon and its operation impacts the entire *Earth*. Therefore, the continuation of the malfunction might lead to a global-scale collapse instead of some local-scale one (MEADOWS, D. H. *et al.* 1972). Holding onto this analogy, it is possible that the Biosphere will collapse before the society does so. In this case, undoubtfully the society will collapse as well, but with the whole *Biosphere*.

- In the second case the civilised urban humankind tries to create conditions that help them to leave the condition of the loss of information. This means that the pattern of cooperation with the natural environment have to be found. If a request emerges for a change of lifestyle by the large part of the society (as the more and more limited access to resources and the extremity of the nature will force it), these patterns could result rapid changes in the whole society's relation to its natural environment. (Directly before the collapse or in the critical condition after the collapse, the society will not have any time for any healing experiment. By that time already formed and operative patterns will be needed.)

This recognition gave rise to the sustainable—or eco-city movements, which aim to minimise the emissions and the material and energy consumption in cities, conducted to reduce the negative environmental impact of the cities. Its three pillars—energy and material; water and biodiversity, and the urban planning and transport —include several actions which can reduce the ecological footprint of a city (LEHMANN, S. 2010). In some cases (like in the transportation or in the transit sector), cities are more sustainable than the rural areas, however, the reason is the above mentioned urbanisation of the rural areas. Although many cities can boast serious results in reducing the carbon footprint, but in the authors' opinion today's modern big cities—despite the impressive "greening"—the metabolism is on such a high level that in long term city cannot be considered sustainable. Whether any significant "greening" projects are in a city, the main cause which leads to the unsustainability of the urban lifestyle is the lack of information.

It can happen that the power supply of a city based on 100% renewable energy, or in a city which is interspersed with huge green parks, or which has a transportation system which is environmentally friendly, and so on, the urbanite people cannot quit the condition of the lack of information. Therefore in the case of the new generations there is a continuous risk that the urban society will behave like a cancerous tissue.

It is important to note that there are also good historical examples related to the avoidance of the collapse *(Tikopia, Tonga)*. Their common characteristic is that their community was able to recognise their destructiveness and self-destructiveness and made the right changes in their relation to their natural environment (DIAMOND, J. 2005). Connected to this, the eco-village rather can be a pattern than the sustainable city. They can be a good example for the urban population to follow. If the conception of nature they have can spread, then the sustainability of the whole society can be realised in a de-urbanisation movement.

The modern, civilised urban society's condition of "the loss of information" comes from its urban environment and the related lifestyle. The urban lifestyle leads to the ignorance of the knowledge which is needed to be in harmony with nature.

Another problem could be the long-time feedback of the natural environment. The consequence of the pollution which is connected to the human activity cannot be experienced in one life. Moreover, the urbanite people do not really know what can be considered as a natural environment since they became estranged from their natural environment. Furthermore, the energy and material flows of the modern globalised society spread all over the *Earth*, which makes them and their effects more complicated to overview. According to estimates the material flow of the modern civilisation is greater than the material flow of the geological processes (POMÁZI, I. – SZABÓ, E. 2006). At the present time the collapse of the big supply system would disable the "urban" area of the "developed" countries and the cities equally.

To leave the condition of the loss of information a global paradigmatic change is needed. To foster this understanding, operative pattern—which is in cooperation with the natural environment—is needed. The operative pattern—in everyday life—means to set up and support communities which operate sustainably and enrich the natural environment; independent from the big supply systems. And last but not least, it offers the opportunity of a happy and, therefore, attractive life for the outside world. The detailed analysis of this is the aim of a next study.

References

ANDRÁSFALVY, B. (2007). *A Duna mente népének ártéri gazdálkodása* – Equilibrium Kft., Budapest, 480 p.

BALÁZS, A. (1984). *Daganatbiológia* – Gondolat Könyvkiadó, Budapest, 194 p.

BAUDRILLARD, J. (1998). *Paroxysm: Interviews with Philippe Petit* – Verso, London 120 p.

BURGESS, E. W. (1924). *"The growth of the city: an introductionto a research project"* -Publications of the American Sociological Society, 18, pp. 85-97

DIAMOND, J. (2005). *Collapse*: How Societies Choose to Fail Succed – Viking, New York, 570 p.

ENYEDI, GY. (2011). *A Városnövekedés szakaszai – újragondolva - in* Tér és Társadalom 25. évf. 1. pp. 5-19.

HARRIS, C. D. – ULLMAN, E. L. (1945). *The nature of cities* - Annals of the American Academy of Political and Social Science 242, pp. 7-17

HOYT, H. (1939). *The structure and growth of residentialneighborhoodsin American cities* - Washington DC; Federal Housing Administration 178 p.

LORENZ, K. (1973). *Die acht Totsünden der zivilisierten Menschen* – Piper und Co. Verlag, München, 112 p.

LOVELOCK, J. E. (1979). *Gaia – A new look at life on Earth* – Oxford University Press. 148 p.

MARX, K. (1867). Kritik der politischen Ökonomie – Verlag von Otto Meisner,

MEADOWS , D.H. – MEADOWS, D. L. – RANDERS, J. – BEHRENS, J. (1972). *The Limits to Growth* - Universe Books, 1972, New York, 205 p.

MOLNÁR, G. (2004). *A Tiszánál* – Equilibrium Kft., Budapest, 192 p.

MOLNÁR, G. (2009). *.Ember és Természet – Természet és ember* – Kairosz Kiadó, Budapest, 174 p.

MUMFORD, L. (1961). *The City in History: Its Origins, its Transformations, and its Prospects* - Harcourt, Brace & World, New Your, 657 p.

POMÁZI, I. – SZABÓ, E. (2006). *A társadalmi metabolizmus* – L'Harmattan, Budapest, 194 p.

SCHNEIDER, W. (1963). *Babylon is Everywhere: The City as Man's Fate* – McGraw-Hill, London, 400 p.

SPENGLER, O. (1918). *Der Untergang des Abendlandes – Umrisse einer Morphologie der Weltgeschichte* – Braumüller, Wien.

SPERBER, D. (2000): A kultúra magyarázata – Osiris, Budapest

SWYNGEDOUW, E. – HEYNEN, N. C. (2003). *Urban Political Ecology, Justice and the Economies in Scale.* Antipode. 35 (5). pp. 898–918

VAN DEN BERG, L. – KLAASSEN, L.H. – ROSSI, A. – VIJVERBERG, C.H.T. ET AL. (1982). *Urban Europe. Vol. I. Study of Growth and Decline* – Pergamon Press, New York and Oxford

VIDA, G. (2001). *Helyünk a bioszférában*, Typotex, 132 p.

Wackernagel, M. – Rees, W. E. (1996). *Our Ecological Footprint – Reducing Human Impact on the Earth* – New Society Publishers, 176 p.

Weinberg, R. A. (2006). *The Biology of Cancer* – Garland Science, New York, 850 p.

Worldwatch Institute (2006). *The State Of the World* – W. W. Norton & Company, New York, 244 p.

Electronic sources

Central Intelligence Agency (2014). *The Wolrd Factbook.* Central Intelligence Agency [Online]. Available at: <https://www.cia.gov/library/publications/the-world-factbook/> [Accessed 10 July 2014]

Lehmann, S. (2010). *Green Urbanism: Formulating a Series of Holistic Principles – S.A.P.I.E.N.S.* [Online]. Available at: <http://sapiens.revues.org/1057> [Accessed 10 July 2014]

VITO Urban Climate Lab (n.a). *Urban Heat Island Research at VITO.* [Online]. Available at: <https://www.vito.be/EN/HomepageAdmin/Home/Subsites/UHI/Pages/uhi.aspx>[Accessed 10 July 2014]

UMC Utrecht (n.a.). *Thermal modelling.* Department of Radiotherapy, University Medical Center, Utrecht [Online]. Available at: <http://www.umcutrecht.nl/subsite/radiotherapy-research/Research-projects/high_field_mri/Thermal-modelling.htm> [Accessed 10 July 2014]

ISSN 2052-0018 (print)
Geographical Locality Studies 2014 Volume 2, Number 1. pp. 284–303

M A T E J   N I K Š I Č
PhD in Architecture, Researcher in Urban Design
Urban Planning Institute of the Republic of Slovenia
matej.niksic@uirs.si

Access to a Quality Open Public Space as an Urban Sustainability Measure

Abstract

The paper is a critical review of an open public space regeneration program in the city of Ljubljana, Slovenia. The point of departure is an assumption that an important measure of the sustainability of any settlement is the accessibility of quality open public spaces for its inhabitants, no matter where in the city they live. If the inhabitants are not given a chance to reach a quality open public space in a reasonable distance from their homes this hinders the quality of their living environments as well as social aspects of the sustainability of a city. The paper analyses a concrete approach to the open space improvements through the analyses of the strategic spatial plan for the network of public places as well as analysis of distribution of the financial investments into the public spaces across the 17 districts of the city of Ljubljana. It shows how an unbalanced distribution of the investments is gradually leading to a more qualitatively segregated city where the living conditions in the city centre are rapidly improving while the suburban areas and their public spaces are given no attention and are declining.

Key words

Open urban public space; Quality improvements; Accessibility; Quality of living; Ljubljana

1. Open public space distribution as a measure of sustainability of a settlement

The on-going urbanisation processes demand contemporary cities to grow both in qualitative and quantitative terms. The qualitative growth most often relates to the improved quality of life in the city and is not necessarily reflected in the enlargement of physical structures. While quantitative growth implicates an increase of the physical structure of the city, i.e. a spread of urban structures within the urbanised areas as well as further into the landscape.

In the processes of a qualitative growth of the cities, open public spaces play many important roles, from social and cultural to economic and ecological, which have been thoroughly debated by scholars (MADANIPOUR, A. 1992; SORKIN, M. 1992; TIBBALDS, F. 1992; WORPOLE, K. 1992; KATZ, P. 1994; CASTELLS, M. 2000; GEHL, J. 2010). The appearance of open public spaces decisively influence the perception of one's living environments and thus the perceived quality of life (NIKŠIČ, M. 2008).This is closely related to their functional and physical appearance of particular public spaces, but also their physical accessibility and connectedness into a legible network. LOTFI, S. – KOOHSARI, M. J. (2009) claim that the physical accessibility of public space is one of the key assets of good urban environments and directly influences the quality of urban life.

The balanced distribution of a quality open public space and related accessibility does not come by itself. It has to be grounded in a deliberate urban planning. ROSE, A. – STONOR, T. (2009) claim that after the end of the era of modernist zoning the spatial accessibility has become one of the new conceptual pillars of the urban planning policy. Within this paradigm contemporary urban planning strives to provide well distributed and easily accessible open public spaces across the city's territory for a number of reasons.

YOON, H. – SRINIVASAN, S. (2014) raise the question of fair distribution of public spaces throughout the city by studying the distribution of privately owned but publicly accessible public spaces in relation to publicly owned public spaces. They urge for a comprehensive rather than discrete implementation of both types of public spaces in order to balance the distribution of the public space throughout the city and reduce the overall average distance of the nearest public space for both working and living populations. Similarly, HACKENBROCH, K. (2013) in her discussion of hierarchies of publicness talks about informal and formal public spaces that attract the diversity of the users and ensure equal citizenship. On the other hand, AKSENOV, K. E. (2012) on the case of post-soviet metropolis reports on the shrinkage in accessibility of public space as a result of owners' decision to control the access to their housing premises. Lessening of the access of the public space proves to be emblematic for transitory societies in the course of the privatization of public space not only in the western world but across the globe (LANDMAN, K. 2006).

GILES-CORTI, B. *et al.* (2005) studied the balance between built-up and open cityscapes and its influence on the access of the open spaces from the densely built-up areas. A study showed that the level of usage of public open spaces increases with growing levels of access—people with good access to public open spaces will more likely use them on a regular basis which among others has good influences on public health. According to LIU, J. *et al*. (2010), based on a study of recreational areas in peri-urban *Beijing*, showed that spatial distribution of recreation public spaces is influenced by many factors, among which the attractiveness of the area in terms of cultural and natural heritage, the needs and preferences of users, availability of cost-affordable lands and not least the spatial governance are the most influential. They pointed out the role of spatial policies that can make the distribution of recreation areas around the city more balanced in spatial terms. Among other criteria ZHANG, X. *et al.* (2011) also names the spatial distribution of the parks across neighbourhood areas as one of the basic assets for the residents to access potential public spaces.

LOTFI, S. – KOOHSARI, M. J. (2009) claim that the measures of accessibility of services has a defining role in terms of urban equity, and plead for the living environments with easy access to key services. Public space is thus seen not only as an urban amenity on itself, but also a medium that allows the access to other services. PINCH, S. (1985) relates this aspect to the travel costs which tend to increase with distance and argues that the spatial distribution of amenities affects the distribution of wealth among urban dwellers.

The structure and detailed design of open public space network strongly influences the mobility patterns in the city too. As MCCORNACK, G. R. *et al.* (2008) showed, one's decision to walk is closely related to perceived environmental attributes. The study revealed the importance of the existence of the linkages that connect the living environments with the areas where the demanding services are located.

CROMLEY, E. K. – MCLAFFERTY, S. L. (2002) point out another important aspect. They provide evidence that proximity does not guarantee utilisation, even less so with the development of information technologies. Some other studies show that the significance of physical distance is lessening with the move of economic and social activities into the digital world (MITCHELL, D. 1995; COUCLELIS, H. 2000; TALEN, E. 2003). In pre-digital world the accessibility was generally predicted on physical distance and mobility was the mean to overcome it. LOTFI, S. – KOOHSARI, M. J. (2009) raise the question; how do new virtual places influence the importance of physical accessibility and suggest that it decreases it, but also claim that there are many social acts based on physical means which continue to take place in a physical space and demand a good access in physical terms. They also accentuate the importance of subjective measuring of accessibility—even if an objectively measured level of accessibility is high, the subjective can be low which in urban environments is most often related to the fear of crime. This once more highlights the importance of the detailed design of public spaces which must not be perceived as abandoned, dark or unattractive (PAIN, R. 2000; KOOHSARI, M. J. *et al.* 2012). STABILINI, S. *et al.* (2013), in their studies of the changing notion of proximity through time, point out that urban quality is to a greater part not only an issue of quantity of services and open spaces, but also of accessibility to them in both temporal as well as spatial terms.

The theoretical review indicates that accessibility of public space is one of the key assets of quality urban environments but might be threatened by constraints such as incomprehensive city planning, privatisation and land-development tendencies, transport related pressures and lack of awareness of the importance of the issue among stakeholders in a city planning processes. The following chapter offers an in-depth insight into a concrete case study of *Ljubljana*, a mid-sized city of about 280,000 inhabitants in *Slovenia* which lately put much emphases on the (re)development of public spaces in a rather peculiar way.

2. Open public space strategic plan and regeneration program for Ljubljana

The city of *Ljubljana* is the capital city of the *Republic of Slovenia*. It is governed by a central city administration which is organised into 10 departments. The total municipal area of 275 km^2 is divided into 17 districts (*Figure 1* and *Table 1*). They are legal entities under public law represented by the district councils, elected by qualified voters having permanent residence in each neighbourhood. The district councils deal with the matters within the competence of the city municipality which concern a district. They also adopt positions, opinions and proposals, launch initiatives and submit proposals to be adopted by the city council, discuss and process proposals submitted by residents and other members of the district community, and submit these proposals for decision to the competent city authority (CITY OF LJUBLJANA, 2014). In conducting public affairs within city municipality, each district cooperates with the city departments, the general city administration, other districts and organisations founded by the city. Districts carry out activities within the competence of the city which to a large extent relate to notifying residents in a locally adapted manner of district activities and other matters of relevance to the district, of cultural, sports and social programs, and of environmental and spatial planning activities. These can be carried out in co-operation with the registered and informal associations of residents (for example by collecting proposals and setting up co-operation between districts).

Figure 1 – The division of the territory of Ljubljana into 17 districts
Source: Mestna občina Ljubljana (2014)

Table 1 – The 17 districts of Ljubljana and their size
Source: Urban Planning Institute of the Republic of Slovenia (2014)

District	Surface in hectares
Bežigrad	724
Center	507
Črnuče	1,810
Dravlje	1,111
Golovec	827
Jarše	906
Moste	340
Polje	2,210
Posavje	905
Rožnik	835
Rudnik	2,548

Sostro	8,856
Šentvid	1,583
Šiška	736
Šmarna gora	1,443
Trnovo	718
Vič	1,438
Total (Municipality of Ljubljana)	27,497

One of the burning issues is the development of the quality public space across the whole territory of the city. Even if the strategic plan for the city of *Ljubljana* has developed a comprehensive approach to the provision of open public spaces all across the city (GOLIČNIK, B. – NIKŠIČ, M. 2007), there is a big discrepancy between the planned and actual development.

The strategic urban development plan (UIRS, 2007) envisioned an open public spaces system at a city scale with the main aim to establish an inter-connected and legible network of high quality open public spaces that will be accessible to all, safe, recognisable, respectful to cultural heritage and natural assets and well-maintained. The general objectives of the plan are:

- maintenance of existing and development of new, easily accessible public spaces, namely in the areas out of the city core;
- prioritising un-motorised users in new designs of public spaces;
- preservation and maintenance of green elements of public spaces; and
- addition of activities and variety to public spaces to reflect the status of *Ljubljana* as a capital city of a nation.

The strategic plan structures the network of public spaces into three main categories at a conceptual level: areas of public space, linear public spaces and particular locations of public space which all together constitute an interlinked spatial structure spread across the whole territory of the city as shown in *Figure 2*. So-called areas of public space are functionally specific areas of the city where the public space provision is densified, for example university campus areas, shopping mall areas, etc.

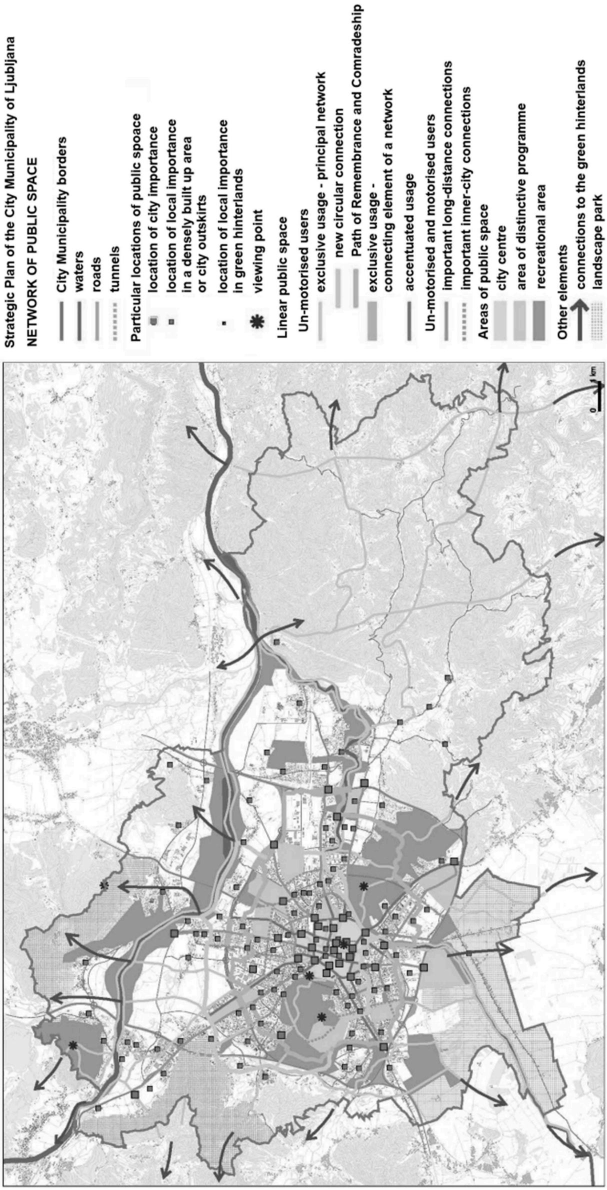


Figure 2 – The network of public space as defined in the Strategic Spatial Plan of the Municipality

Source: Šašek Divjak, M. et al. (2010)

So-called linear public spaces serve as the connectors of various parts of the city and are classified into different categories according to the level of (un)motorised traffic they hold—from exclusively un-motorised users public spaces to the public spaces where motorised and un-motorised users are sharing the same lines. So-called particular locations of public space are spatially clearly bordered ambiences that hold a specific historic, symbolic, spatial or functional value for the city or its parts (neighbourhood, district, etc.). The strategic plans outlines some important pre-conditions that have to be fulfilled to implement the whole network, for example establishment of an efficient public transportation, simultaneous (re)design of important public buildings and the open public spaces attached to them, intensification of public functions along the build edges of public spaces and establishment of a strong management model to interrelate conception, implementation and maintenance of the network of open public spaces.

In 2007, the city adopted another document called *Ljubljana 2025* (ŠUMI, N. 2007; KOŽELJ, J. 2014). The document is a vision which the *City of Ljubljana* adopted as a part of the process of renewing the city planning documentation. It was highly needed to adequately adapt the planning practice to a fundamental change of a social and economic model from socialistic planned model into a neo-liberal marked oriented model in early 1990s after a disintegration of the previous federal state of *Yugoslavia* (BOLE, C. 2013; STEFANOVSKA, J. 2014). Among others, the document specified how city will grow, where new developments will take place and what the key urban development goals of the future are. A provision of a direct access to a quality open public space was identified as one of the key objectives and measures of the sustainable development of the city in this document.

In order to concretise *Ljubljana 2025* vision, 93 projects across the city were identified by the mayor's office and relevant city departments. One of them and the biggest one related to the improvements of the public spaces was the public space regeneration program. It foresaw a 20 million Euros (~16 million GBP) investment into the improvement of the public realm in the centre of the city with the following objectives: improvement of the quality of open-air life along the *River Ljubljanica*, enhancing sociability in this space and to stimulation of the economy in the city centre. The project dealt with the most central open spaces of the city along the *Ljubljanica*. The implementation of the programme started in 2006 and was more or less finished by 2012. Due to a successful implementation of this project, *Ljubljana* earned the 2012 *European Prize for Urban Public Space*, a biennial award established to recognise public space projects in *Europe (Figure 3–4)*.

Figure 3 – New walk-ways along the River Ljubljanica as a result of a public space improvement programme
Photographed by NIKŠIČ, M. (2013)

The jury (PUBLIC SPACE, 2012) prized the approach that put different design teams to work together, concentrated available resources in specific operations and managed to co-ordinate between different developers and authors. The improved accessibility of the embankments and a unitary character of open space were pointed out as key qualities that can attract users to the city centre and counteract the effects of urban sprawl.

Figure 4 – The improved access to the river in the city centre after the implementation of the public space improvement measures
Photographed by NIKŠIČ, M. (2013)

While the improvements of the *River Ljubljanica* sequence increased the quality of the public spaces at locations along the river and its nearby vicinity, the quality of public spaces in other parts of the city stayed unaddressed to a large extent. This is closely related to the decision making mechanisms within the city municipality's governing structure that (do not) distribute the financial resources for the public space improvements across the city. The public space improvements agenda is centralised both in terms of decision making (top-down leaded processes) as well as spatially (the majority of the investment within a small area of the city centre). In order to illustrate this situation and address a topical question of the influence that a distribution of sources for the improvement of open public spaces has on the quality of life across the city, more detailed analyses of public investment into public space were done.

3. Distribution of financial sources for public space improvements

The *Municipality of Ljubljana* has a well-established and freely accessible web database where all the projects financed and implemented by the municipality are listed and mapped (PROJEKTI MOL, 2014). The projects are classified into seven categories:

- infrastructure and traffic;
- culture and tourism;
- health and social care;
- upbringing and education;
- sport;
- environment; and
- others.

They can be inspected by the time-tags related to year of implementation (from 2006 on) and also by a location within one of the 17 city districts. The data that is publicly accessible for each of the projects are the following:

- the location within the municipal territories;
- the period of implementation;
- a short description of the objectives of the project; and
- a full amount of money invested in a particular year.

Based on these data the distribution of financial sources earmarked for the improvements of the public spaces across the city territories from 2006 on has been analysed. In a first step all the data were classified into two categories. The projects related to the improvements of the open public space were classified into the first category where an important criterion was that the project had to contribute to the improved physical, functional or perceptual dimension of the open public space for a non-motorised user. According to this first criterion, all the improvements of the road infrastructure that were for example solely improving the physical conditions of road infrastructure (like repaving the road with new asphalt, etc.) were not classified into first category, but into the second category where all other projects with no relation to public space improvements were placed. The data for the implemented projects in the period from 2007 to 2012 were taken into account in these analyses.

Analyses showed that a total of 705 projects were completed in the 2007–2012 period in *Ljubljana*. 148 or the 26% of all projects were implemented within the central district of the city. 70 projects out of all 705 projects were directly or indirectly related to public space improvements (ranked in group one according to the criterion mentioned earlier)—and 79% of these 70 projects were located in the city centre district *(Table 2)*.

The analysis of the financial investments in the studied period showed that for all the projects related to public space improvements, in the city of *Ljubljana* about 67 million Euros (~53 million GBP) were spent in the period 2007–2012. 40 million Euros (~32 million GBP) out of this sum which is 65% of the whole expenditure on the projects in the central district of the city.

The data show that even if the central city district occupies only 2% of the whole territory of *Ljubljana* and accommodates about 9% of city population, it is given an outstanding and favourable position when the redevelopment and upgrading of public space is debated. This statement is based on the following facts:

- 26% of all city's projects take place in the central city district;
- 79% of all projects related to public space in the city were implemented in the city centre district and
- 65% of city's financial investment into public space was channelized into the city centre district.

The disproportion between these percentages and the percentage of the citizens that live in the central districts speak for themselves.

Table 2 – The comparison of the values related to the project investments between the central city district (district Centre) and the whole city of Ljubljana.*

**District centre covers 2% of the total city territory and hosts 9% of the total city population.*

Item index and name (€ = Euros)		***Item value in***				
		2007	***2008***	***2009***	***2010***	***2011***
A	Total No. of projects – whole city of Ljubljana	123	188	218	125	51
B	Total No. of projects – district Centre	22 (18% of A)	34 (18% of A)	49 (22% of A)	28 (22% of A)	15 (29% of A)
C	No. of projects related to infrastructure and traffic – whole city of Ljubljana	77	47	51	36	19
D	No. of projects related to infrastructure and traffic – distr. Centre	12 (16% of C)	15 (32% of C)	12 (24% of C)	8 (22% of C)	8 (42% of C)
E	No of projects related to public space – whole city of Ljubljana	12	15	19	13	11
F	No of projects related to public space – district Centre	12 (100% of E)	15 (100% of E)	12 (63% of E)	8 (62% of E)	8 (73% of E)
G	Financial investment into infrastructure and traffic – whole city of Ljubljana (MIO €)	24,267	21,783	28,527	42,545	59,896
H	Financial investment into infrastructure and traffic – district Centre (MIO €)	2,860 (12% of G)	3,628 (17% of G)	9,969 (35% of G)	11,084 (26% of G)	27,475 (46% of G)
I	Financial investment into public space – Ljubljana (MIO €)	9,181 (38% of G)	3,877 (18% of G)	12,576 (44% of G)	13,677 (32% of G)	28,259 (47% of G)
J	Financial investment into public space – district Centre (MIO €)	2,124 (23% of I)	3,356 (87% of I)	3,590 (29% of I)	8,324 (61% of I)	27,109 (96% of I)

4. Discussion

The case study of *Ljubljana* opens some important generic as well as site-specific questions related to a spatial distribution of quality public spaces across the city.

The power of strategic planning proves to be limited when the strategic objectives are not concretised and fully integrated into action plans. *Ljubljana* has got a comprehensive and well-thought citywide network of public space in its strategic spatial plan, which—in theory—allows citizens in any part of a city to access easily quality public spaces. Due to the political decision making related to investment policy, this ideal is not met unfortunately. When the majority of the financial sources dedicated to the public space improvements go into a small partition of the city (the central city district in the case of *Ljubljana*), the majority of the city's territories stays poorly serviced in terms of public space provision. Even if *Ljubljana* is not too strongly prone to some typical practices of transition societies of *Eastern Europe*, such as privatisation of space and limitation of access to some privileged user groups, the level of accessibility to a quality public space is decreasing for a majority of population due to an unbalanced public space investment policy.

This results in a situation where a typical public space of out-of-city-centre locations look either abandoned or forgotten and in any case uninviting to use due to the run-down or non-existing street furniture, abundance of parked cars and above all complete lack of any conceptual approach to the improvement of public space. Public spaces at none-central locations are thus subject to mere technical improvements needed for a basic functioning of a city such as re-asphalting of streets, garbage cans disposition etc. which does not improve the experience of public space users.

Such an approach affects the quality of life of a great majority of the population, therefore it is somewhat surprising that civil society movements that already claim certain citizens' rights related to the living conditions in the city stay rather inactive in this field and do not ask the city administration and managing structures to change their approaches to the distribution of high quality public spaces in the city. On the other hand, the absence of official city's programmes to address the issue of improved quality of public spaces in the suburbs generates some bottom-up initiatives that contribute to better public space with one-time interventions or events to the suburban public spaces (NIKŠIĆ, M. 2014). They may be the generators of a new approach to the public space regeneration that will be much more user based and respective to the needs of local populations.

Another important question in these processes is the local self-management model of the city governance. The reorganisation of the decision making process which introduced a strong central city administration with 17 district sub-administrating entities in 1994 proved to incapacitate the local communities to have a say and an active role in a development of their territories. Giving them purely formal tools of influencing the city's decisions, but none of the implementation tools to proceed with concrete actions (including the investments into the locally important public spaces) puts local communities in a subordinated position. This is in an opposition to the sustainable development approaches where emphasis are made to strengthen communities' role in city's decision making by rising community's rights as well as obligations in locally relevant matters. A total command of the central city administration contributes to passiveness (or perhaps inactive role) of the population and strengthens the general conviction that not much can be done to change things for better. And that might be the most harmful aspect of such an approach in a long term. A new decision making scheme that would pass the right to decide the investments to the local communities themselves would not only contribute to a more spatially balanced rise of the quality of public space across the whole city's territory but also activate the human potential that particular communities hold, and thus strengthen their social cohesiveness. The existing model of a supra strong central city authority that manages the city budget in its totality too often follows the pure market logic where the fulfilment of the needs of local community is not an obvious objective. This disconnects the public investments from the actual needs of the local populations across the city to a great extent.

5. Conclusion

There is growing evidence across the world that the quality of public space in the city is closely related to the economic prosperity of the city as a whole; the higher the economic performance, the higher the investments that can be channelled into the improvements of city's public space and consequently the better public space that can be achieved. The argument goes in the opposite direction too; places with a higher standard of a public space are more attractive for potential users and higher numbers of potential consumers in an area of a city can support the performance of its local businesses. Therefore, it is of a vital importance where the public money dedicated for the public space improvements goes. The investment into a public space most often contributes to the improved quality of life in wider surroundings of such an intervention; therefore, it is not appropriate to implement the practices that evidently discriminate the rest of the city in favour of beautification of some selected (central) areas. Only a balanced approach that strives to improve the quality of the environment and life across the city in a balanced manner can achieve the targets of the sustainable city development. If the living conditions across the city will get too dissimilar the city as a whole may lose its attractiveness as a place to live and work and consequently as an economic entity in a long term too. There is still time for *Ljubljana* to get aware of this fact and rethink its public space improvements programme to bring benefits to the local communities out of the central city area, too.

References

AKSENOV, K. E. (2012). *Trends in the accessibility of public space in the post-Soviet metropolis. Shrinkage or expansion?* – Pleiades Publishing, Regional Research of Russia, Vol. 2, No. 4, pp. 329–338.

BOLE, C. (2013). *Ekonomska preobrazba slovenskih mest / Economic transformation of Slovenian Cities.* – Založba ZRC, Ljubljana

CASTELLS, M. (2000). *The rise of the network society, the information age: Economy, society and culture.* – Blackwell, Oxford

CITY OF LJUBLJANA (2014). *Statistical Yearbook Ljubljana 2013.* – City of Ljubljana, Ljubljana

COUCLELIS, H. (2000). *From Sustainable Transportation to Sustainable Accessibility. Can We Avoid a New Tragedy of the Commons?*

CROMLEY, E. K. – MCLAFFERTY, S. L. (2002). GIS and public health. – New York: The Guilford Press.

GEHL, J. (2010). *Cities for people.* – Island Press, Washington

GILES-CORTI, B. – BROOMHALL, M.H. – KNUIMAN, M. – COLLINS, C. – DOUGLAS, K. – NG, K. – LANGE, A., DONOVAN, R.J. (2005). *Increasing walking. How important is distance to, attractiveness, and size of public open space?* – American Journal of Preventive Medicine, 28, pp. 169–176.

GOLIČNIK, B. – NIKŠIČ, M. (2007). *Delovno gradivo ob pripravi usmeritev za razvoj omrežja javnega prostora za Strateški prostorski načrt MOL.* – Neobjavljeno, Urbanistični inštitut Republike Slovenije, Ljubljana

HACKENBROCH, K. (2013). *The Spatiality of Livelihoods: Negotiations of Access to Public Space in Dhaka, Bangladesh.* – Franz Steiner Verlag, Stuttgart

KATZ, P. (1994). *The new urbanism: Toward an Architecture of Community.* – McGraw Hill, New York

KOOHSARI, M. J. – KARAKIEWICZ, J. A. – KACZYNSKI, A. T. (2012). *Public Open Space and Walking. The Role of Proximity, Perceptual Qualities of the Surrounding Environment, and Street Configuration.* – Sage: Environment and Behavior

KOŽELJ, J. (2014). *The Vision of Ljubljana.* In: MIHELIČ, B. – KOŽELJ, J. – GAJŠEK, M. (Eds.) *Ljubljana. Portrait of the City.* – City Municipality of Ljubljana, Ljubljana

LANDMAN, K. (2006). *Privatising public space in post-apartheid South African cities through neighbourhood enclosures.* – GeoJournal, 66, pp. 133–146.

LIU, J. – WANG, R. – CHEN, T. (2010). *Factors of spatial distribution of recreation areas in peri-urban Beijing.* – Journal of Geographical Sciences: Volume 20, Issue 5, pp. 741–756.

LOTFI, S. – KOOHSARI, M. J. (2009). *Analyzing Accessibility Dimension of Urban Quality of Life. Where Urban Designers Face Duality Between Subjective and Objective Reading of Place.* – Soc Indic Res, 94, pp. 417-435.

MADANIPOUR, A. (1992). *Design of urban space: An inquiry into a socio-spatial process.* – Wiley, West Sussex

McCornack, G. R. – Cerin, E. - Leslie, E. – Du Toit, L. – Owen, N. (2008). *Objective versus perceived walking distances to destinations. Correspondence and predictive validity.* – Environment and Behavior, 40/3, Sage publications

Mitchell, D. (1995). *The end of public space? People's Park, Definitions of the Public, and Democracy*. – Annals of the Association of American Geographers, 85, pp. 33–108.

Nikšič, M. (2008). *Connecting urban microambients into recognizable whole: Structure of open urban public space in mental image of users.* – Doctoral thesis. Ljubljana: University of Ljubljana

Nikšič, M. (2014). *Times of economic hardship and the birth of quality public space. Not necessarily an unlikely marriage.* Conference proceedings. – Future of Places, Buenos Aires

Official gazette of RS (1994). *Zakon o ustanovitvi občin ter o določitvi njihovih območij* / Law on the establishment of municipalities and definition of their territories, IV / 60.

Pain, R. (2000). *Place, social relations and the fear of crime. A review.* – Progress in Human Geography. 24, pp. 365–387.

Pinch, S. (1985). *Cities and services.* – Routledge & Kegan Paul, London

Rose, A. – Stonor, T. (2009). *Syntax – Planning urban accessibility.* In: Christ, W. (Ed.) *Access for all. Approaches to the built environment.* – Birkhauser, Basel, Boston, Berlin

Sorkin, M. (1992). *Variations on a theme park: The New American City and the end of public space.* – Hill and Wang, New
York

Stabilini, S. – Zedda, R. – Zanettichini, L. (2013). *Accessibility ofPublic Spaces and Services. Theoretical Remarks, Practices and Instruments from Urban Time Planning.* – Urban and Landscape Perspectives, 15, pp. 119–135.

Stefanovska, J. (2014). *Planning the post-socialist city. Urban transformations and changing centralities after socialism.* Doctoral thesis. – University of Ljubljana, Ljubljana

Šašek Divjak, M. – Bizjak, I. – Dimitrovska Andrews, K. – Goličnik, B. – Gulič, A. – Jakoš, A. – Kerbler, B. K. – Mihelič, B. – Mladenovič, L. – Mujkić, S. – Mušič, B. – Nikšič, M. – Praper, S. – Savanović, G. – Gantar, D. – Sendi, R. – Šuklje Erjavec, I. – Cotič, B. – Hočevar, M. – Juvanc, A. – Kavaš, D. – Koman, K. – Kos, D. – Panjan, J. – Prelovšek, A. – Šantej, B. – Slaček, M. – Trček, F. – Uršič, M. – Žura, M. – Golobič, M. – Kozamernik, J. – Stanič, I. – Gubina, F. – Gubina, A. – Marc, D. – Stojič, Z. – Fister, P. – Gaberščik, B. – Gabrijelčič, P. – Koželj, J. – Mušič, V. B. – Pogačnik, A. (2010). *Občinski prostorski načrt MOL: strateški del* / Municipal spatial plan of City municipality of Ljubljana. – Urbanistični inštitut Republike Slovenije, Strategic part, Ljubljana

ŠUMI, N. (ed.) (2007). *Vizija Ljubljana 2025. Glasilo Mestne občine Ljubljana*. Newsletter of City Municipality of Ljubljana; 8, 9 – XII.

TALEN, E. (2003). *Neighborhoods as Service Providers. A methodology for evaluating pedestrian access.* – Environment and planning B: Planning and design, 30, pp. 181–200.

TIBBALDS, F. (1992). *Making people friendly towns: Improving the public environments in towns and cities.* – Longman Press, Harlow, Essex

UIRS (2007). *Strateški prostorski načrt Mestne občine Ljubljana, dopolnjeni osnutek* / Strategic spatial plan of city municipality of Ljubljana, amended draft. – Urban Planning Institute of the Republic of Slovenia, Ljubljana

ZHANG, X. – HUA. L. – HOLT, J. (2011). *Modelling spatial accessibility to parks. A national study.* – International Journal of Health Geographics

WORPOLE, K. (1992). *Towns for people: Transforming urban life.* – Buckingham University Press, Buckingham

YOON, H. – SRINIVASAN, S. (2014). *Are they well situated? Spatial Analysis of Privately Owned Public Space.* – Urban Affairs Review, Sage, Manhattan, New York City.

Electronic sources

MESTNA OBČINA LJUBLJANA (2014). *Četrtne skupnosti MOL.* Mestna občina Ljubljana [Online]. Available at: <http://www.ljubljana.si/si/mol/cetrtne-skupnosti/> [Accessed 29 July 2014]

PROJEKTI MOL (2014). *Seznam projektov, Št. Projektov: 758.* Ljubljanski Projekti [Online]. Available at: <http://ljubljanski.projekti.si/projekti.aspx> [Accessed 26 September 2014]

PUBLIC SPACE (2012). *Preureditve nabrežij in mostovi na Ljubljanici.* Public Space [Online] Ljubljana (Slovenia), 2011. Available at: <http://www.publicspace.org/en/works/g072-preureditve-nabrezij-in-mostovi-na-ljubljanici/prize:2012> [Accessed 27 August 2014]

ISSN 2052-0018 (print), ISSN 2053-3667 (online)
Geographical Locality Studies 2014 Volume 2, Number 1. pp. 304–325

BÉLA BORSOS
PhD, External Research Fellow
University of Pécs, Faculty of Sciences, Institute of Geography
dioliget@t-online.hu

BÉLA MUNKÁCSY
PhD, Lecturer
Eötvös Loránd University, Faculty of Science, Institute of Geography and Earth Sciences, Department of Environmental and Landscape Geography
munkacsy@elte.hu

Locality, Mobility and Energy Sustainability in Settlement Planning

Abstract

The paper looks at causes and effects of mobility needs and key fields of energy use with a view to the Jevons paradox and the rebound effect. They may be the results of the faulty paradigm which claims that both mobility and energy use are ways of development. Issues like correlations between distance and the appropriate means of transport, organisation of family, business and personal life, travelling shorter distances and less frequent travel, distant learning, teleworking, reduced shopping, transformation of community life are rarely considered. Intermediate solutions include switch to public transport or alternative means of transpor. The same line of thought is applied to the relation of energy use with climate, culture, habits and comfort, various heating solutions and the respective role of production, trade and services. In a special case study, the eco-village of Gyűrűfű is also analysed. Here, the transport needs should be further reduced, while other energy intensive sectors—for example residential heating and power generation—are being developed into a full-fledged sustainable solution using solar systems and biomass installations.

Key words

Locality; Mobility, Energy use; Jevons paradox; Eco-villages

1. Introduction

Since the physical limits to the growth, human society has been demonstrated beyond doubt by system scientists (MEADOWS, D. H. *et al.* 1972; 1992; 2004), discussions are afloat on how to differentiate quantitative growth from qualitative development, and what kind of boundary conditions a truly sustainable society should observe. Sustainability in this sense is, a social formation of the human race which can adapt to the changing environmental factors with flexibility, without inevitable collapses as it happened throughout history all too often (PONTING, C. 1991; DIAMOND, J. 1995). According to ecological footprint analyses, energy use is the most problematic of such boundary conditions, since currently there is disequilibrium in the rate of use and rate of availability of various energy forms, including renewables (LEGGETT, J. 2005) and their environmental impacts are also thought to be far beyond the limits. Some suggest to decouple increased energy use from economic growth, but it is not quite clear how this could be accomplished on a large scale (DAUNCEY, G. 1987). In the present paper we deal with energy issues—directly or indirectly—pertaining to human communities. It seems a crucial area, as in the EU 44% of the final energy is used in buildings (domestic, tertiary or industrial buildings) and 33% is consumed by the transport sector. Moreover, both areas play an increasing role in energy consumption and environmental stresses (EC, 2013).

Creating sustainable human settlements is arguably a challenge for the 21st century. The key issue is energy use in all aspects: construction, employment, transport of goods, passenger traffic, heating, cooling, social organisation, etc. have a price tag in terms of energy. One of the approaches considered for setting up ecologically sound solutions is the concept of intended communities (HAJNAL, K. 2004) in a better known term eco-villages (BANG, J. M. 2012). The proper design of such intentional communities requires competent systems thinking if it is to be a success in terms of sustainability (BORSOS, B. 2013).

2. Theoretical background

It has been observed that energy policies introduced in the past decades to save energy had no significant effects on the overall energy use of society. As one of the most environmental-conscious communities, the European Union has introduced several policy measures to decrease environmental effects of it, yet overall transportation and CO_2-emissions grew by 15% during the last 20 years (EC, 2013). The more energy efficient solutions we use, the more energy will be needed for further economic growth. The phenomenon is known as the *Jevons paradox* and the *rebound effect* (POLIMENI, J. M. *et al.* 2009). However, most authors only state the problem and cite a wealth of evidences to substantiate their claim, but fail to suggest any solution or have only ideas with limited scope to combat the problem. For instance, it has been shown that money saved on energy efficiency will be spent on other uses, also implying energy consumption. Economic regulatory measures (taxation, selective preference to sectors, etc.) however have only a very narrow impact range (ANTAL, M. – VAN DEN BERGH, J. 2014). The old dilemma here is still whether we prefer technology versus frugality at any price, or are there any reasonable scenarios where the two can be combined (ELGIN, D. 1981). The correlation between economic growth in terms of products and services and related energy use goes far beyond the scope of this paper and implies economy theory just as well as philosophical issues such as why do we need more and more energy, increased mobility all the time? Do they really enhance the quality of our lives? Do economic growth and energy use correlate so strongly indeed? What are the causes and effects of mobility needs in communities?

3. Transport

The faulty and damaging paradigm is that most economists and decision makers consider growing mobility as an inevitable drive of development. Correspondingly, *European Union* or national level regulations do not have *any* objective to limit the extent of transportation needs in the first place. Moreover, some of them like export subsidies even assist freight transport deliberately. As a general consequence, they contribute to increasing freight transport at EU-level and at the level of the member states. As for the modal distribution, three quarters (75.5%) of all freight was transported on roads—as it is the most handy solution—in 2011. Also transport traffic became three times more intense in *Hungary* between 2000 and 2010, mostly as an adverse effect of the country's accession to the *European Union*. In terms of personal transportation, the car, valued for freedom, comfort and pleasure, became the dominant solution with continually growing annual mileage. Passenger cars accounted for 84.1% of inland passenger transport in the EU–27 in 2011 (EC, 2013).

The freedom and comfort provided by passenger cars have their price tag as, according to comparisons and life cycle assessments (LCAs), car is the most damaging and resource demanding way of transport (MACKAY, D. 2009; DAVE, S. 2010). This is the reason why a number of regulations focus on the mitigation of associated environmental impacts. However, in order to reach the proper results, it is not enough to improve technical solutions, influencing the human factor is crucial just as well. It is ever more necessary to give up our demands on individual transport and promote public transportation, car pooling and community based solutions such as car sharing. The distance to be covered should be a decisive factor in shifting to appropriate and less polluting means of transport like cycling. Moreover, in order to reach shorter distances and less frequent travel, it is important to reorganise the life of families and businesses. For this purpose there are widely accepted and well-proven methodologies such as distant learning, teleworking, reduced and concentrated shopping which may become more widespread in the near future (KEMP, M. 2010). Such changes are not a function of technological changes any more, but a question of awareness and willingness, changes in personal attitudes.

Since the main environmental impact is connected to their energy use, it is important to examine the life-cycle energy consumption of different means of transport. As DAVE, S. (2010) calculated, walking and cycling (including electric bicycles) are associated by far with the least consumption of energy. The most significant element of the energy mix with regard to cycling is infrastructure, namely around two-thirds of the whole energy usage is connected to building and maintaining the components of the road network. Electric bikes have power consumption as well, but it is around 0.5% of the whole energy consumption throughout their life-cycle. Compared to an ordinary bicycle, production of electric motors and batteries for electric bikes increases their overall energy usage by 10%.

According to the analyses (MACKAY, D. 2009; DAVE, S. 2010), an efficient and well-managed public transportation system also has relatively low per capita energy consumption. Generally, trains are best in this field. About 50% of their consumption is related to operation when they use 3–9 kWh/100 seat-km. We also have to add that electric trains perform significantly better in terms of energy efficiency than diesel trains. Around 30% of the whole life-cycle energy consumption is associated with infrastructure. Buses in average consume 30–35 kWh/100 seat-km in real life operation (67,600 km/year for 12 years) which accounts for about 75% of their whole life-cycle energy usage. Looking at disadvantages of public transportation, the biggest problem emerges, if public transport systems are run inefficiently and underutilised. In fact, per capita energy consumption in half-empty buses can be 8–10 times higher than their average; therefore, it exceeds that of even the least efficient SUV *(Figure 1)*.

Sometimes, good intentions seem to be marred by harsh reality: the *Centre for Alternative Technology (CAT*) in *Wales* was set up as a research, education and demonstration centre for environmentally sound energy use (SHEPHERD, A. 2014). However, visitors are pouring in by fossil fuel powered cars and there is only a slight chance that upon returning to their respective homes they will change their lives in reaction to what they have seen in *Wales*. Thus, the entire effort is more of a tourist attraction triggering even more mobility. Unfortunately, many eco-villages also attract thousands of visitors, sometimes from large distances; therefore they play a similar role. On the other hand, for instance, transport needs can be drastically reduced by insisting on local food from nearby agricultural areas—even when the settlement pattern is not specifically a sustainable one (SPECTOR, R. 2002).

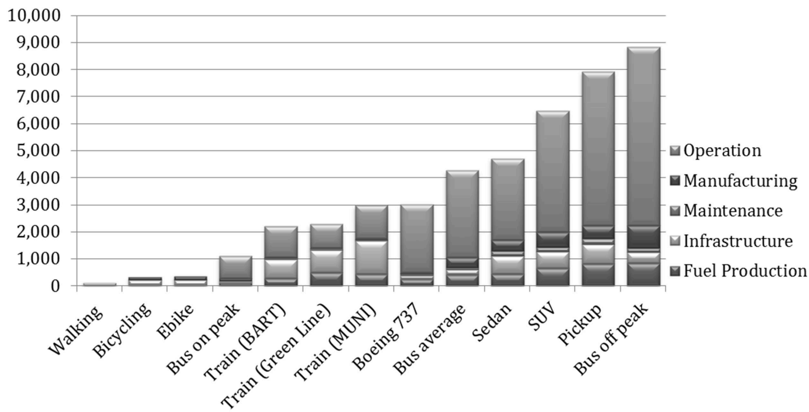


Figure 1 – Energy input per passenger-miles (kJ/PMT) for various transport options throughout complete lifecycles

Source: DAVE, S. (2010)

4. Energy

There is also a widely held but faulty paradigm concerning energy consumption in general: it claims that our standard of living depends on an ever-increasing amount of energy we use—to heat our bigger homes to higher temperatures, to provide more transport and to produce increasing quantities of manufactured articles in the western style of life (TODD, R. W. – ALTY, C. J. N. 1977). There are several other cultures worldwide, but the spread of western lifestyle destroys traditional local societies. As a result, local living strategies and traditional knowledge disappear and ultimately overconsumption, depletion of natural resources and contamination of the environment occur.

The process involves the gradual vanishing of traditional local clothing and building solutions. In tropical *Asia* and *Africa*, managers in business districts wear Anglo–Saxon-style jacket and tie and work in huge glass and steel palaces. The trend wears down traditional values, and triggers energy needs. Fully clothed businesspeople need decreased room temperature inside these greenhouses which can be achieved by powerful air-conditioning installations only (BARRETT, M. 2007). In contrast, underdressed people during the long and chilly evenings in colder climates often claim increased inside temperature which can also be reached only with extra fuel use and extra environmental burden (OKUKUBO, A. 1984). The problem was first recognised in *Japan*, and a "Cool Biz" campaign was introduced in 2005 as a logical consequence. Government ministries were to set air conditioner temperatures at 28°C in the summer period of the year and special dress code was advised without jackets or ties. The measure was a success, and after the *Fukushima nuclear accident* the government launched the even more ambitious "Super Cool Biz" campaign in 2011 to cope with energy shortages (BBC, 2011).

These examples draw attention to the fact that challenges of energy management are by far not only technical issues and strongly relate to human behaviour.

The human factor is involved in the choice of heating systems in *Central Europe*. Modern residential buildings have much bigger floor area and more rooms than those in the past. In densely populated areas, to heat these new and more complex buildings, district heating and central heating systems are used. For convenience, the same temperature is expected to be present in all premises. Heating all rooms requires more energy even when differences in insulation systems are considered than the traditional approach with standalone heating installations like tiled stoves and mass stoves which generally heated only the most frequently used living areas of a building. Zoned heating is not consistent with the requirement of ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) on the uniformity of temperature, seen indispensable to personal comfort. However, a competing concept emphasises *thermal comfort*, a mental condition contributing significantly to occupant satisfaction with indoor environment.

Thermal comfort is also a cultural condition, related to inside temperature in general. Trends in the *United Kingdom* are well documented in this field. According to MACKAY, D. (2009), the average wintertime temperature in British houses in 1970 was 13°C. It was estimated to be 16°C in 1990 and had increased to 19°C by 2002 (DTI, 2006). The rising tendency, coupled with the growing demands of residents, is seen everywhere in the industrialised world. However, higher temperature results only partly from burning more energy, it also has to do with better insulated buildings and less loss of heat. Houses built before 1900 are 2°C colder on average than those built since 1980 (WILKINSON, P. *et al.* 2001). The explanation is provided by a change in the regulation. After 1969, it was compulsory to build homes with heating systems capable of maintaining temperatures of 18°C in living areas and 13°C in the kitchen and passageways (BOARDMAN, B. 1991). Current *EU regulations* will change energy performance of buildings in the *UK* further–the *UK* is being the only country which strictly adopted all the relevant EU rules (VERMANDE, H. M.– HEIJDEN, J. 2011). One of these rules is the new *Energy Performance of Buildings Directive* (Directive 2010/31/EU) which requires to move towards nearly-zero energy buildings by 2020 (2018 in the case of public buildings).

Irrespective of regulations, one should put on more clothes rather than rise indoor temperatures, if s/he wants to avoid feeling cold. Thermal comfort can vary by person and therefore people can adapt to their own individual levels of warmth as required (KEMP, M. 2010). The simple but efficient stove systems mentioned earlier can store thermal energy and put out the heat for 8–36 hours. They cannot maintain a certain temperature, but a relatively small range of temperatures (SZALAI, P. – MUNKÁCSY, B. 2008).

More efficient heating technology and better insulation may ensure financial savings. Funds thus liberated may be put to good use like further energy saving investments, or—better still—they do not need to be earned in the first place. Unfortunately, such money can also be spent on further energy consuming services or products, starting the rebound effect—depending on their owners' awareness.

5. Seeking a more sustainable solution

A number of reviews and analyses argue (IDA, 2006; IDA, 2009; ALLEN, P. 2013) that our energy demand in the future should be drastically cut to a level which can be provided by local renewable energy sources. In this context, complete re-arrangement of the food industry and ensuring safe and sufficient, good quality local food supply seems to be one of the major challenges. Also, settlement patterns should be reconsidered in terms of efficiency, efficacy and long term sustainability. From this point of view it may be of interest to have a look at a relatively new concept, the revival (and revitalisation) of rural settlements on ecological principles.

6. A case study of Gyűrűfű: a rural setting

Gyűrűfű is an eco-village site set up in the southwest of *Hungary* at the location of a former traditional village community *(Figure 2)*. Since its foundation in 1991, this project has been subject to a number of studies, student projects and papers dealing with sustainable human settlements, or, for that matter, eco-villages (for a summary see BORSOS, B. 2007). Some conclusions can be drawn from this case study with regard to the subject of this current paper as well.

6.1. Transport

In terms of energy, design of the community focused on four areas to the extent possible: building, heating, electricity and mobility. Energy considerations pertaining to the construction activities have been covered extensively elsewhere (BORSOS, B. 2005). There are a number of distinct features which distinguish attempts of sustainable human settlements in rural setting from those in urban environment: on the one hand, some energy intensive human activities/needs have environmentally sound solutions here readily at hand: construction materials and methods, food supply, space and opportunity for alternative solutions to water supply and waste water management (reed bed systems, septic tanks, composting facilities, etc.) are available without the need for extensive transport, but a greater need for mobility seems to be inevitable for other purposes: kids to school, daily/weekly shopping, commuting to work, to cultural events, social entertaining, social ties and relations, family, friends, etc.

At any rate, it must be stated that a rural setting, as an offset, requires more movement. Additionally, local agricultural production does not solve the problem of shopping traffic. In the case of *Gyűrűfű*, the much publicised community supported agriculture model (CSA) (FISHER, A. 2002) does not seem to work. Inhabitants decide for themselves whether or not they set up a little kitchen garden which usually does not produce enough for selling and the design of the village site,

Figure 2 – The quality of the access road does not encourage easy cycling in Gyűrűfű

Photographed by BORSOS, B. (2014)

coupled with poor quality land is unsuitable for any larger scale cropping operations. Livestock husbandry is one viable option, currently not utilised to the full extent. Car-pooling works better in reducing traffic needs, and a village van for kids solves the problem of commuting to school. Bicycle use is somewhat problematic due to the quality of the access road and the distances which need to be covered *(Figure 2)*, nevertheless some of the residents eagerly and consciously deploy this means of transport as well. Maybe the spread and development of electric bicycles will improve the applicability of cycling. The closest villages and railway stations are 7–9 kilometres from *Gyűrűfű*, which means that they can be reached within 25–30 minutes by bicycles. Another 30 minutes needs to reach *Pécs*, the biggest city in the area *(Figure 3)*.

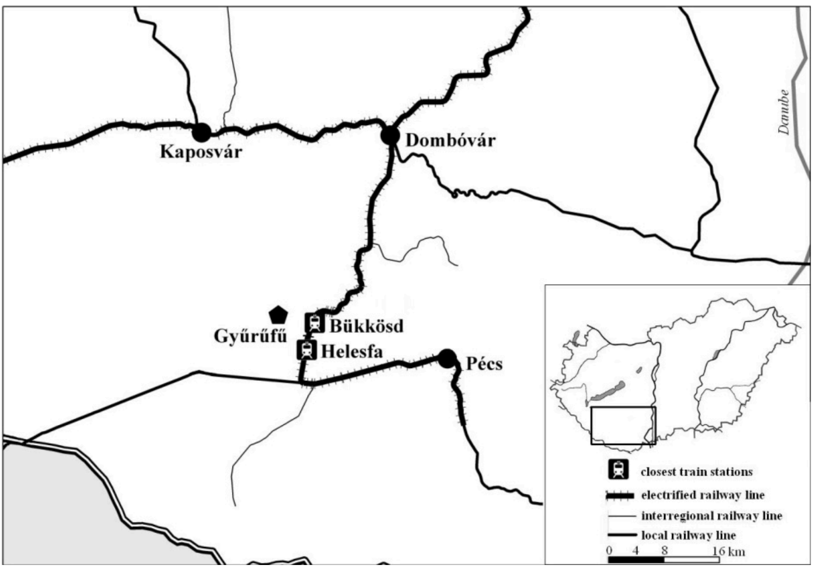


Figure 3 – The location of Gyűrűfű eco-village
Edited by HARMAT, Á. (2014)

On the other hand, there are other, more efficient ways to decrease the needs for transportation. Employment, teleworking and internet use for banking and e-government depend on individual life situations, but are promising directions in lessening mobility needs.

Planning strategy was completely different in some other eco communities. One of the most important planning factors was accessibility in the case of Danish eco-villages *Dyssekilde* and *Hjortshøj*, as they have their own train stations, which also means a superb connection to central cities. According to the railway time table *Dyssekilde* can be reached from *Copenhagen* by train in 45 minutes, while *Hjortshøj* is situated an 18 minutes train ride from *Aarhus*, the second-largest city of the country. A completely different approach can be defined in the case of *Gut Karlshöhe*, as their eco-community exists within the metropolis of *Hamburg*.

6.2. Electricity

Electric power needs at *Gyűrűfű* initially have been covered entirely through the national grid. Even though various design plans were considered for replacing fossil fuel/nuclear derived electricity from long distance transmission lines with local hybrid solutions (BORSOS, B. 1991), these attempts proved later on to be either impractical or prohibitively expensive. Therefore, the village site was supplied commercially, and energetically sound design considerations were restricted to passive solutions such as construction and building engineering technology to minimise electricity needs (BORSOS, B. 2005). However, as technology developed, costs have sunken to an acceptable level and together with government subsidies allowed the installation of solar photovoltaic panels in the past two years. Currently, there are three arrays in operation. Further development is still possible and desirable. The cost of solar systems keeps on plummeting, in the U.S. prices fell by 60% since 2011 (MEARIAN, L. 2013).

National average household electricity consumption in *Hungary* is around 1,100 kWh/person/year (MOSONYI, GY. 2011). The overall use in one cluster of the houses at *Gyűrűfű* is 18,000 kWh a year. This can be seen as a moderate consumption, if system characteristics and the consumption patterns are taken into account. The following factors need to be imputed when assessing electric power consumption in this cluster:

1. The local public utility company installed a medium voltage level transformer station (20 kV/0.4 kV) equipped with a bi-directional electric power meter for net residential metering. This is the only interface with the national grid, and this measured the consumption of 18,000 kWh in a year before the installation of the solar systems.
2. The 10 houses of the cluster are quite far apart, and are supplied from this station with the help of an approximately 600 metres long re-used second hand underground cable. In other words, the consumption figure includes the network losses of the village's own grid.
3. In the ten lots, there are about 20 permanent residents, who stay there throughout the year and most of the time. They do not include non-permanent residents (secondary school, university students 6 people) who are there only part-time, seasonal inhabitants (one family), and most importantly, guests and visitors (an average of 10–15 people, which may range up to 30 or 40 in certain times of the year) attending the guesthouse, the horse riding school and the forest school, all located within the same cluster, in season from early spring to late autumn.
4. Since there is no other public utility service installed in the village (gas, district heating, water, sewer systems, etc.), electricity is also used for non-typical residential uses like household water works, pumps from wells, and at some places electric water heaters in summer (during the winter, hot water is generated by biomass heating).
5. Many people keep livestock, do crafts and other works which require power machines (workshop machinery, stable lighting, milking equipment, electric plane, circular saw, lawn mowers, etc.) all of which actually in intensive use.

6. Most people do not commute on a daily basis: many of them have their offices, workplaces in the same house where they live; therefore, they use electricity during daytime, as well.
7. If you analyse the structure of electricity consumption like this, you will see that average figures and statistics may easily conceal many factors which may or may not increase or decrease the mean values.

Thus, at the time being, the local grid is served by the national transmission network at a single feeding point and by the three solar systems on the community house and two private houses (each with a capacity of 6.0, 5.2 and 7.0 kW, respectively). Careful design allows the three systems to generate more electricity than actually needed; therefore, surpluses are sold to the national grid. This could be achieved by optimum orientation—which is also true for the village as a whole—of both houses and the solar arrays, the site and the Mediterranean influence which comes from the south in that part of the country. Modelled production of the system gives a theoretical output of 21,000 kWh a year. However, since there is only one meter to the service provider at the transformer station, surplus electricity from the solar systems is first taken by other consumers in the cluster which also include the small dairy operation, a mixed farm and the guesthouse. Inside accounting is made on an annual basis by private power meters (RÁCZ, A. *ex verb.* 2014).

Taking into account all the aforementioned circumstances, the per capita consumption does not seem to be high; although, it is difficult to state an actual figure. Also, it would be possible to improve efficiency, mainly by the replacement of the underground cable, where network losses are relatively high.

6.3. Heating solutions

As for the energy solutions, all of the residential heating and much of hot water production is accomplished in the village by various biomass installations. Most appliances are different types of individual wood fired ovens, fireplaces, some equipped with central heating systems.

Using in part garden refuse, prunings and coppiced wood, partly firewood from the community-managed or other neighbouring forests, the carbon balance of these solutions is pretty much zero. However, they have some other—minor, at the time being, manageable—adverse implications: first of all, biomass is a resource available locally in a limited quantity and inconsiderate extraction may lead to shortages or quality impairment (at the current population size this is not a threat). Secondly, the price of wood increases as big power plants in the region *(Pécs)* switch to “renewable” sources such as timber (SZENDREI, J. 2005). As a results, the price of firewood for household has also skyrocketed from HUF 4,400/m^3 (11.2 GBP) in the year 2000 to HUF 12,000/m^3 (5.1 GBP) in 2004 (BORSOS, B. 2005). Last but not least, poorly managed fire burning appliances may entail harmful and pollutant emissions.

Due to the potential for relative fuel scarcity and some of the environmental considerations associated with biomass based heating installation alone, as a prospective future development, the application of solar collectors, heat pumps or even a district heating system may be considered.

Solar collectors present the most obvious and matured solution which can be easily combined with biomass systems and may cover the whole domestic hot water demand from March to October, without any kind of air pollution. In fact, most houses in *Gyűrűfű* already use one such system or another.

Heat pump technology has developed in recent years. *Life Cycle Assessment (LCA)* shows both economic and environmental benefits over some other solutions of heating (REY, F. J. *et al.* 2004). However, the environmental burden of the whole life cycle is mostly connected to the power consumption of heat pumps which means that the way of the power production is a decisive factor. Unfortunately, the Hungarian national power generation system with its significant (40–50%) nuclear share is amongst the most worrisome arrangements in the *European Union*. On the other hand, connected to smarter and greener local power production systems, heat pumps have the benefits of meeting three different kinds of domestic heat requirements with the use of the very same equipment: room-heating in winter, domestic hot water generation throughout the year and, finally, if poor orientation of the building or increased summer heat due to climate change require, cooling in summer. A good solution can be a combined system with on-the-spot electricity generation by either FIO (i.e. hooked on the grid with "feed-in-obligation", a scheme with preferential takeover price for small scale power generating installations run on renewable energy resources) or standalone solar PV installations. It may provide a long term, state-of-the-art autonomous local solution for most energy needs encountered in an eco-village.

District heating is by now a widespread technology with greatly improved efficiency rates; therefore, it might be considered in compact small eco-villages—but not for *Gyűrűfű* which is too scattered for such a system. Small scale district heating systems can be fuelled by local biomass or solar or ambient heat (like geothermal), or better still, by a combination of those. Supplemented with pollution control technologies it also provides a great possibility to establish a clean, efficient and cheap design (ERICSSON, K. 2009; NIJJAR, J. S. *et al.* 2009). In Danish eco-communities, like *Svanholm* or *Hjortshøj*, there are pilot programs to integrate Stirling-engines into these heating systems to create electricity, as well. Hopefully, the current problems, including the destructive resonance, will be overcome soon.

Although, no proper calculations were made in terms of per capita energy use in the eco-village, it can be predicted with confidence that the overall energy consumption and the environmental impact (ecological footprint, if you like) of residents here is a lot less (or smaller) than those of an average Hungarian. While mobility needs still should be reconsidered and further ways of lessening them or making them more environmentally sound are required, the thoughtful original spatial design and the newly opened potentials in terms of solar power and thermal heating definitely improve the overall sustainability of the project.

7. Conclusions

In a comparison of the global trends in energy use and mobility, the faulty paradigms of growth as an inevitable conditions precedent of human welfare cause severe rebound effects worldwide. Conscious design patterns with an intention to decouple human settlements from this vicious circle are necessary to benefit from improved efficiency of energy and transportation systems. The way out should be less energy use and less mobility, associated with raised individual awareness and innovative new solutions both in terms of technology and social organisation (and the merger of the two).

The role of locality should be revisited. An example of doing so is the emerging trend of eco-villages. The case study of *Gyűrűfű* demonstrates that, at least in terms of energy use and the *Jevons paradox*, small scale sustainable settlement patterns might be a way out of the trap. In the case of this sparsely populated eco-community, sustainable transportation and mobility seem to be the major challenges and continues to be the most difficult problems. According to our findings, reduction of demand, finding or creating local solutions, improving local food production or establishing local services may be some of the answers *(Table 1)*.

According to the experiences in *Gyűrűfű*, the current per capita household energy consumption can be reduced to a third by efficiency and sufficiency measures. In order to exclude the adverse consequence of the rebound effect, the combination of these two solutions may only be the solution. The decreased energy demand can be covered easily with local renewable sources, in Hungarian circumstances with various combinations of biomass and solar applications. In the medium term, use of more sophisticated ambient heat applications, such as heat pumps can help the integration of renewable energy solutions into the regional energy system.

As a direction for further study, the assessment of the eco-village's overall energy consumption over the long term would be a useful benchmark for comparison with other lifestyles. The size of such a sustainable local community including the spatial structure and settlement pattern also seems to be an interesting research topic, especially from the viewpoint of regional interdependence.

Table 1 – SWOT analysis of the pros and cons in energetics of ecologically sound attempts to create sustainable human settlements in rural setting on the example of the Gyűrűfű eco-village

Strength	Weaknesses
• Building technology • Local services (construction materials, firewood, space, recreation, local community) • Residential heating (no fossil resources) • Building engineering solutions (water, sewer, waste) • Arable land for local food production • Solar system	• Due to rural setting more need for mobility (jobs, administration, shopping, culture) • No alternatives to car/truck use • Long distances to be covered • Electricity needs from the grid • Harmful effects of firewood
Opportunities	**Threats**
• CSA (community supported agriculture, currently underutilised) • Self-sustenance in terms of basic human needs • Replacement of electricity from the grid by autonomous solar systems • Lifting threats of firewood depletion by heat pump installations run on solar power • Reducing mobility needs by teleworking, internet-based administration (e-government) and e-shopping • Increasing efficiency in all energy systems	• Long term depletion of firewood sources • Economic costs of modern installations • Continuous need for transport and passenger traffic • Environmental costs of high-tech renewable solutions such as heat pumps, solar panels and batteries • Unknown long term effects of geothermal systems with deep bore probes

8. Acknowledgement

The authors are deeply indebted to all members of the *Gyűrűfű* community who shared their experiences in and gave insights into the issues discussed herein. Special thanks to *Anette Rácz* for her contribu-

tion with the electricity consumption figures and *Ádám Harmat* for his contribution with the preparation of the map.

References

ALLEN, P. (ed.) (2013). *Zero Carbon Britain – Rethinking the Future*. – Centre for Alternative Technology, 214 p.

ANTAL, M. – VAN DEN BERGH, J. (2014). *Re-spending rebound: A macro-level assessment of OECD countries and emerging economies.* – Energy Policy Vol. 68 May 2014, pp. 585–590.

BANG, J. M. (2012). *Eco-villages: A practical guide to sustainable communities*. – Floris Books, 288 p.

BOARDMAN, B. (1991). *Fuel Poverty: from cold homes to affordable warmth.* – Belhaven Press, 267 p.

BORSOS, B. (1991). *Tulajdonképpen: mi is az az ökofalu? – Öko*, 2 (2), pp. 37–41.

BORSOS, B. (2005). *Alternatív energetikai megoldások lehetőségei a fenntartható településfejlesztés vidéki példáin: Gyűrűfű – esettanulmány.* In: *Tanulmányok Tóth József tiszteletére.* – PTE Földrajzi Intézet Pécs, pp. 111–120.

BORSOS, B. (2007). *Az ökofalu koncepciója és helye a fenntartható település- és vidékfejlesztésben.* – Pécsi Tudományegyetem, Természettudományi Kar, Földtudományok Doktori Iskola, Manuscript, 207 p.

BORSOS, B. (2013). *The Eco-Village Concept in a Model Experiment in South-West Hungary*. – *Journal of Settlement and Spatial Planning*, 4 (1) pp. 69–76.

DAUNCEY, G. (1988). *After the Crash: The Emergence of a Rainbow Economy.* – Green Print, 320 p.

DIAMOND, J. (2005). *Collapse. How societies choose to fail or succeed*. – Viking, Penguin Group, New York, 575 p.

EC (2013). *EU Transport in Figures.* Statistical Pocket Book 2013. – European Commission

ELGIN, D. (1981). *Voluntary Simplicity, Toward A Way of Life That Is Outwardly Simple, Inwardly Rich*. – William Morrow and Company, New York, 303 p.

FISHER, A. (2002*). Community food security: a promising alternative to the global food system*. In: KIMBRELL, A. (ed.) *Fatal harvest: The tragedy of industrial agriculture.* – Island Press, Washington, Covelo, London, 367 p.

HAJNAL, K. (2004). *A fenntartható fejlődés elméleti modellje és a fenntartható településfejlesztés elméleti kérdései*. – Pécsi Tudományegyetem, Földrajzi Intézet, Manuscript, 184 p.

LEGGETT, J. (2005). *Half Gone: Oil, Gas, Hot Air and the Global Energy Crisis*. – Portobello Books Ltd., 320 p.

KEMP, M. (ed.) (2010). *Zero Carbon Britain 2030 – a new energy strategy*. – Centre for Alternative Technology, 384 p.

MACKAY, D. (2009). *Sustainable Energy – Without the Hot Air*. – UIT, Cambridge, 383 p.

MEADOWS, D. H. – MEADOWS, D. L. – RANDERS, J. (1992). *Beyond the Limits – Confronting Global Collapse and Envisioning a Sustainable Future*. – Post Mills, Vermont Chelsea Green Publishing Company, 300 p.

MEADOWS, D. H. – Meadows, D. L. – RANDERS, J. – BEHRENS, W. W. (1972). *The Limits to Growth – A report for the Club of Rome's project on the Predicament of Mankind*. – Washington, Potomac Associates. London, Earth Island

MEADOWS, D. H. – RANDERS, J. – MEADOWS, D. L. (2004). *Limits to Growth – The 30-Year Update*, Chelsea Green, 338 p.

POLIMENI, J. M. – MAYUMI, K. – MARIO, G. – BLAKE, A. (2009). *The Myth of Resource Efficiency: The Jevons Paradox (Earthscan Research Editions).* – Routledge, 200 p.

PONTING, C. (1991). *A green history of the world. The environment and the collapse of the great civilisations.* – Sinclair-Stevenson, London, 430 p.

RÁCZ, A. (2014). *Energy consumption figures in Gyűrűfű.* (Personal communication, April 2014)

REY, F. J. – MARTIN-GIL, J.– VELASCO, E. – PÉREZ, D. – VALERA, F. – PALOMAR, J. M. – DORADO. M. P. (2004). *Life Cycle Assessment and External Environmental Cost Analysis of Heat Pumps*. – *Environmental Engineering Science*; 21 (5), pp. 591–605

SHEPHERD, A. (2014). *Voices from a disused quarry: Celebrating 40 years of the Centre for Alternative Technology*. 48 p.

SPECTOR, R. (2002). *Fully integrated food systems: regaining connections between farmers and consumers*. In: KIMBRELL, A. (ed.) *Fatal harvest: The tragedy of industrial agriculture*. – Island Press, Washington, Covelo, London, 367 p.

SZALAI, P. – MUNKÁCSY, B. (2008). *A tömegkályha – a biomassza energetikai hasznosításának hatékony megoldása.* (The mass stove – an efficient method of biomass energy) In: MUNKÁCSY, B. (ed.) *Az energiagazdálkodás és az emberi tényező*. pp. 58–72.

TODD, R. W. – ALTY, C. J. N. (1977). *An Alternative Energy Strategy for the United Kingdom*. – National Centre for Alternative Technology. Machynlleth, Powys, 43 p.

Electronic sources

BARRETT, M. (2007). *Energy, Carbon Dioxide and Consumer Choice.* – Sustainable Environment Consultants [online]. *(pdf)*, 110 p. Available at: <http://discovery.ucl.ac.uk/3504/1/3504.pdf> [Accessed: 10 April 2014]

BBC (2011). *Japan promotes 'Super Cool Biz' energy saving campaign.* – BBC News [online]. Available at: <http://www.bbc.co.uk/news/business-13620900> [Accessed: 10 April 2014]

DAVE, S. (2010). *Life Cycle Assessment of Transportation Options for Commuters.* – Massachusetts Institute of Technology (MIT) [online]. *(pdf)* 16 p. Available at: <http://files.meetup.com/1468133/LCAwhitepaper.pdf> [Accessed: 10 April 2014]

DTI (2006). *Energy: its impact on the environment and society.* – National Archives [online]. *(pdf)* Department of Trade and Industry, United Kingdom, 40 p. Available at: <http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file32546.pdf> [Accessed: 13 April 2014]

ERICSSON, K. (2009). *Introduction and development of the Swedish district heating systems – Critical factors and lessons learned.* – Lund University [online]. *(pdf)* 54 p. Available at: <http://miljo.lth.se/fileadmin/miljo/personal/KarinE/Swedish_district_heating_case-study_KEricsson.pdf> [Accessed: 23 April 2014]

IDA (2006). *Danish Society of Engineers' Energy Plan 2030* – Ingeniørforeningen i Danmark [online]. *(pdf)* 65 p. Available at: <http://ida.dk/sites/climate/introduction/Documents/Energyplan2030.pdf> [Accessed: 30 May 2008]

IDA (2009). *Danish Society of Engineers' Climate Plan 2050* – Ingeniørforeningen i Danmark [online]. *(pdf)* 191 p. Available at: <http://ida.dk/omida/laesesalen/Documents/UK-Future%20Climates%20Background%20Report.pdf> [Accessed: 5 February 2014]

MEARIAN, L. (2013*). Solar power installation costs fall through the floor.* – Computerworld online [online]. Available at: <http://www.computerworld.com/s/article/9244836/Solar_power_installation_costs_fall_through_the_floor> [Accessed: 10 April 2014]

MOSONYI GY. (2011). *A növekedés esélyei egy nemzetközi energetikai vállalat szemszögéből. (Chances for growth from a viewpoint of an international energy company).* – Central European Business Centre[online]. *(ppt)* Available at: <www.cebc.hu/ppt/xxi_vezer/mosonyi-gyorgy.ppt> [Accessed: 12 October 2014]

NIJJAR, J. S. – FUNG, A. S. – HUGHES, L. – TAHERIAN, H. (2009). *District Heating System Design for Rural Nova Scotian Communities Using Building Simulation and Energy Usage Databases.* – Transactions of the Canadian Society for Mechanical Engineering [online]. *(pdf)* In: Transactions of the Canadian Society for Mechanical Engineering. Vol. 33. No. 1. 14 p. Available at: <http://www.tcsme.org/Papers/Vol33/Vol33No1Paper5.pdf> [Accessed: 13 February 2014]

OKUKUBO, A. (1984). *Comparative Study of Clothing and Thermal Comfort in England and Japan with a View to Achieving Clothing Habits More Conductive to Health.* – University of Surrey [online]. *(pdf)* 463 p. Available at: <http://epubs.surrey.ac.uk/2103/1/353311.pdf> [Accessed: 12 April 2014]

SZENDREI, J. (2005). *A biomassza energetikai hasznosítása.* (Biomass for energy production). – Debreceni Egyetem [online]. *(pdf)* Agrártudományi Közlemények, 2005/16. pp. 264–272. Available at: <http://www.date.hu/acta-agraria/2005-16/szendrei.pdf> [Accessed: 7 July 2014]

VERMANDE, H.M.– HEIJDEN, J. (2011). *The Lead Market Initiative and Sustainable Construction: Screening of National Building Regulations.* – European Commission [online]. *(pdf)* Delft University of Technology, 110 p. Available at: <http://ec.europa.eu/enterprise/sectors/construction/studies/national-building-regulations_en.htm> [Accessed: 13 April 2014]

WILKINSON, P. – LANDON. M. – ARMSTRONG, B. – STEVENSON, S. – PATTENDEN, S. – MCKEE, M. – FLETCHER, T. (2001). *Cold Comfort. The social and environmental determinants of excess winter death in England 1986–96*. – Joseph Rowntree Foundation [online]. *(pdf)* The Policy Press, Bristol, 34 p. Available at: <http://www.jrf.org.uk/sites/files/jrf/jr101-determinants-winter-deaths.pdf> [Accessed: 13 April 2014]

Legislations

Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of building

ISSN 2052-0018 (print), ISSN 2053-3667 (online)
Geographical Locality Studies 2014 Volume 2, Number 1. pp. 326–354

L U C A R O Z Á L I A S Z Á R A Z
BSc, Expert in Applied Environmental Studies
Human ecology masters student at Eötvös Loránd Universty
Environmental researcher at the Metropolitan Research Institute, Budapest
szaraz.luca@gmail.com

The Impact of Urban Green Spaces on Climate and Air Quality in Cities

Abstract

Every urban landscape is significantly different from any other environment. These urban landscapes having green spaces decreased are mainly made of artificial surfaces which have unique physical attributes unlike any other landscape surface. The combination of dominant artificial surfaces and decreased vegetation creates an urban climate which influences the air quality, outdoor thermal and human comfort. Although, half of the Earth's population live in cities, the importance of urban air quality and climate issues do not have a high impact on urban planning processes despite the fact that urban weather and climate is essential for human well-being.

The main objective with the present study is to investigate how urban green spaces impact on the air quality and the microclimate in cities. Each section examines an urban climatic process and how this process differs in an urban environment which includes vegetation. The final section discusses how urban green spaces can help ease the local consequences of climate change..

Key words

Urban climate; Urban air quality; Urban green space; Urban landscapes; Environmental planning

1. Introduction

Urbanisation has a major effect on landscape surfaces: it is replacing vegetated areas with mostly impervious artificial surfaces (GILL, S. E. *et al.* 2007). It has been recognised since the early 1800s that the main characteristics of vegetation interacts with climate (BONAN, G. B. 2002), for example plants can provide ecosystem functions like shading and cooling through evapotranspiration (GILL, S. E. *et al.* 2007). However, the impact of impervious urban surfaces (cities) on climate significantly differs from those of vegetated (countryside) areas. These differences modify surface energy balance through change in absorption and reflection of solar radiation (BOWLER, D. E. *et al.* 2010). Beside energy, they also tend to alter the water cycle between land and atmosphere. Impervious urban surfaces block water from infiltrating the soil, and vegetation also cannot intercept water, if it is absent. This less effective rainwater interception and storage generates more runoff and reduces evapotranspiration in urban areas (BONAN, G. B. 2002; GILL, S.E., *et al.* 2007).

These effects of the urban environment lead to altered climatic conditions in cities which may have negative impacts on the well-being of urban dwellers (BROWN, C. – GRANT, M., 2005). Present demographic forecasts show that human populations are becoming increasingly urbanised: Today, in the second decade of the 21st century, approximately 50% of the global human population lives in cities and this rate is expected to rise in the next 50 years. Therefore now—with the well-known urban air pollution—negative impacts of urban climatic conditions will also affect more and more people around the globe (BOTKIN, D. B. – BEVERIDGE, C. E. 1997; GRIMM, N. B. *et al.* 2008). With the predicted effects of climate change, urban climatic conditions are becoming an even more pressing problem. Regional consequences of changing climate can be more serious in an urban area, particularly the problem of increasing temperature, but several studies have showed that anticipated negative impacts of climate change in urban areas can be eased by properly vegetated areas (GILL, S. E. *et al.* 2007; BOWLER, D. E. *et al.* 2010).

Before further investigation of the subject, the definition of urban green spaces should be clarified: *"Urban green spaces are public and private open spaces in urban areas, primarily covered by vegetation which are directly (e.g. active or passive recreation) or indirectly (e.g. positive influence on the urban environment) available for the users."* (BAYCAN-LEVENT, T. – NIJKAMP, P. 2009). However, the definition of urban green spaces differs from country to country; therefore, this is not a categorical declaration of the concept, merely one which was carefully selected for this paper. Since this review is primarily written for city planners, non-governmental organisations, scientists and other actors who contribute to urban spatial planning and implementation to help them understand more accurately how the climatic system works in cities, and how vegetated surfaces can ease the arising problems caused by urban climatic conditions. Planning and implementation usually approach the concept of green spaces from the aspect of users; therefore, the author of this article finds this definition the most appropriate for this paper.

2. Aims of the study

This paper is an overview that summarises part of the currently available literature on urban climatic conditions, urban air quality, and the expected impacts of climate change on urban climate and, furthermore, how these conditions can be altered by urban green spaces. With expectedly increasing problems in the urban climatic environment, urban climatic conditions should be an issue of higher importance in urban planning. The main purpose of this study is to help urban planners, governments and other specialists who will form the spatial future of urban environments to have a better understanding of the urban environment and the importance of vegetated areas in it. This knowledge could be useful in practice and it might contribute to the right decision making while developing a surface which may modify local urban climatic conditions. The article might become useful for some research groups as well, especially ones doing research on urban spatial planning (for example the *European Commission Seventh*

Framework Programme, Project Green Surge[1]) and working with scientists with many different areas of expertise.

The article presents the behaviour of energy exchanges and flows, advection characteristics, humidity, precipitation and runoff in urban environment, and it also discusses urban air pollution, the heat island phenomena and the expected effects of climate change in cities. Each section of the article shows how different vegetated areas might alter these examined climatic properties.

3. Research methods

This study overviews findings of several researches on urban climatic conditions, impacts of urban vegetation on these unique climatic conditions and, moreover, how climate change interferes with these. This paper does not contain any empirical research results. The aim is to give a proper overview on the main findings and expert opinions of the most relevant literature on the discussed subjects.

To find proper and the most relevant studies in these topics, search engines were used, in particular *Google*[2] and *Google Scholar*[3] Many different kind of search key words were used—because the article concerns several areas of different disciplines—such as "urban climate", "urban atmosphere", "urban heat island", "air pollution in cities", or "climate change in cities", "climate change adaptation in cities", "impacts of evapotranspiration", "ecology of cities", "climatic effect of urban vegetation", "urban green areas" and "urban greening to cool cities". The articles were searched for on several websites, mostly on *ScienceDirect*[4] and *SpringerLink*[5]. Each list of references was also thoroughly examined for every study that proved to be a useful material for this literature research paper. The articles which cited the actual paper were searched for, too.

---

[1] http://greensurge.eu/
[2] www.google.com
[3] http://scholar.google.hu/
[4] www.sciencedirect.com
[5] http://link.springer.com/

Since this study is a review, results are seen under the section 'Discussion'.

4. Discussion

Unique climatic conditions in urban areas are results of the built environment formed by varied artificial surfaces that have different water and energy receipts and losses from those of rural areas. Quality, quantity and geometrical characteristics of the built surfaces have significant impact on local climatic conditions, as well. The urban climate is also characterised by the lack of vegetated areas and the continuous and intensive anthropogenic activity like indoor heating and cooling (SMITH, C. – LEVERMORE, G. 2008). This environment results in a climate which is specific to urban areas. Cities on the northern hemisphere have average 2°C higher temperature, 12% less solar radiation, 8% more clouds, 14% more rainfall, 10% more snowfall and 15% more thunderstorms annually compared to the conditions of rural environments (TAHA, H. 1997).

4.1. The planetary boundary layer above cities

With the surface altered and climatic conditions modified, the planetary boundary layer above cities is changed, as well. The structure of this layer is primarily determined by the heterogeneity and physical attributes of artificial surfaces and the geometry and density of the built environment (ARNFIELD, A. J. 2003). The urban environment results in a unique boundary layer above cities. This is a sub-layer of the planetary boundary layer (PBL) and is called urban boundary layer (UBL). To properly examine its structure, see *Figure 1*.

The urban boundary layer (UBL) is characterised by strong turbulences enhanced by the roughness of city surface and long wave radiation emitted by urban surfaces (ARNFIELD, A. J. 2003). The lowest layer of the UBL is called urban canopy layer (UCL) which is located between the ground and the rooftop levels (ARNFIELD, A. J. 2003; COLLIER, C. G. 2006). In the UCL the airflow and energy exchanges are determined by microscale, site-specific characteristics and processes (ARNFIELD, A. J. 2003). The urban canyon (UC) is a special type of UCL which has tall buildings tightly next to each other along both sides of the street. Air-flow and energy exchanges are defined here like in the UCL, but the flows are mostly horizontal (ARNFIELD, A. J. 2003).

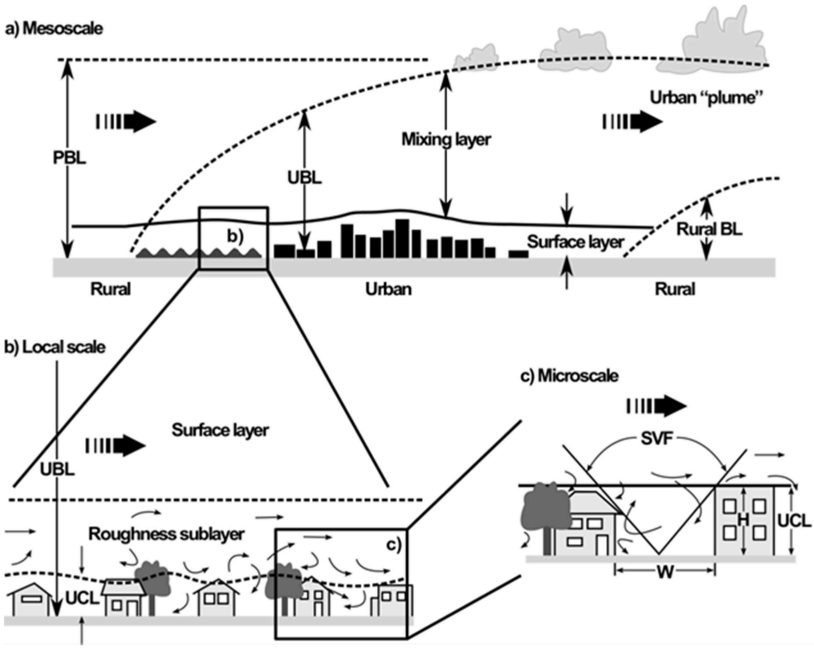


Figure 1 – Structure of the urban boundary layer. SVF is the sky view factor

Source: COLLIER, C. G. (2006)

The next layer upwards is the roughness sub-layer. The most determinative here is not the height and vertical temperature gradient of urban elements, but the horizontal distance scale determined by inter-element spacing. Strong vertical shear, large turbulence intensities and local advection resulting from extreme heterogeneity are common in this layer (ARNFIELD, A. J. 2003). The significance of individual roughness elements decreases above the roughness sub-layer because of the blending effect of turbulent mixing (ARNFIELD, A. J. 2003). In this layer, air and energy flows are determined by the cumulative effects of a larger part of the urban surface; therefore, the height of turbulent fluxes is constant (COLLIER, C. G. 2006).

The urban mixed layer (UML) fills the rest of the UBL upwards. Individual buildings and streets alone do not have much impact on the flows and structure of the UML; these are rather determined by mesoscale urban processes and elements. With low wind velocity the UML may string out above rural areas downwind of the city even for hundreds of kilometres long, and therefore it is usually called urban "plume" (COLLIER, C. G. 2006).

The microclimatic conditions of urban areas and the climate of entire cities are defined by physical interactions and processes between the urban surfaces and the layers presented above (ARNFIELD, A. J. 2003; COLLIER, C. G. 2006).

4.2. Energy exchanges and flows in urban environments

On the *Earth's* surface, the main source of energy in the climatic system is the *Sun*. Incoming solar radiation reaches the atmosphere and, as it passes through, some of it may be absorbed by molecules in the air, some of it is scattered in all directions. The scattered radiation is called diffuse and the non-scattered is called direct solar radiation (BONAN, G. B. 2002).

As incoming solar radiation reaches the surface, it is either absorbed or reflected back to the atmosphere. The amount of radiation that reaches the surface depends on the cloud coverage, air pollution and the shading objects on the surface (BONAN, G. B. 2002).

The cloud coverage is a very important factor of how surface and near-surface air temperature develops that and it has opposite effects during the daytime and at night. During the daytime part of the incoming solar radiation is absorbed and reflected by the clouds, therefore the surface cannot absorb as much long wave radiation as without or with a less extent cloud cover. On the other hand, nocturnal cloud cover leads to an opposite effect, it absorbs the long wave radiation emitted by the surface, hence keeps a significant amount of heat near the surface (RAMANATHAN, V. *et al.* 1989).

The amount of incoming short wave radiation that reaches the surface in urban areas is typically 2–10% lower than in rural areas. This is primarily caused by higher pollutant concentration in the city air. Aerosol particles—which low atmospheric pollution is rich in—are bigger and have darker colour than other particles in the atmosphere and, therefore, have a significant shading effect. The other main reason of the lower amount of short wave radiation in the urban boundary layer is that less radiation can be reflected from the surface. This happens because most urban surfaces have significantly lower albedo values than rural, vegetated surfaces (OKE, T. R. 1982). *Table 1* shows albedo values of a few typical urban surfaces.

Table 1 – Some typical albedo values of urban surfaces

Source: NAGY, I. (2008)

Surface type	**Albedo**
Street asphalt	0.05–0.02
Concrete wall	0.1–0.35
Concrete wall covered with white paint	0.71
Brick wall	0.2–0.4
Freestone	0.2–0.35
Window glass when incoming radiation's incidence is >60°	0.08
Window glass when incoming radiation's incidence is 10°-60°	0.09–0.52

In the urban boundary layer, significant part of incoming long wave radiation is absorbed by atmospheric pollutants and city surfaces then re-emitted into the air (OKE, T. R. 1982). Due to lower albedo values, urban surfaces can absorb more long wave radiation than green spaces (TAHA, H. 1997). There is also surplus long wave radiation emission from urban surfaces which is derived from anthropogenic activity like indoor heating. Emitted radiation can be absorbed by air pollutants and re-emitted to the atmosphere once again (OKE, T. R. 1982).

In the urban canopy layer, conditions slightly differ from those of the urban boundary layer due to the geometry of surface elements. There are complex shading and reflection patterns which depend on the height of buildings and the orientation of streets. This can create radiative trapping within the canopy layer and result in more solar radiation absorption than expected based on the albedo and the reflectivity of surface materials (BONAN, G. B. 2002).

Table 2 presents how urban and rural environments differ in surface albedo values. This table shows the mean monthly albedo values of different types of urban and—for comparison—rural land-coverage in February, April, July and September. The values are based on satellite data analysis.

Table 2 – Mean monthly albedo values of different types of urban and rural land coverage.

Category names: CDWN – city downtown, HDR – high density residential, COUT – outlying city, MDR – medium density residential, LDR – low density residential, PFOR – forested park, FDEC – deciduous forest, FEVG – evergreen forest, WFOR – forested wetland, WNF – non-forested wetland, AG – agriculture, RANG – range, PNF – non-forested park, L – lake
Source: BREST, C. L. (1987)

	Urban area			**Suburban area**		**Tree vegetated area**				**Non-tree vegetation**				**Water surface**
	CDWN	**HDR**	**COUT**	**MDR**	**LDR**	**PFOR**	**FDEC**	**FEVG**	**WFOR**	**WNF**	**AG**	**RANG**	**PNF**	**L**
Feb.	0.089	0.089	0.118	0.126	0.118	0.121	0.108	0.095	0.093	0.078	0.143	0.116	0.200	0.028
Apr.	0.105	0.100	0.130	0.137	0.137	0.150	0.140	0.125	0.117	0.103	0.142	0.145	0.201	0.02
July	0.117	0.114	0.144	0.150	0.156	0.167	0.177	0.163	0.169	0.192	0.177	0.187	0.203	0.017
Sept.	0.106	0.105	0.134	0.138	0.137	0.145	0.147	0.135	0.137	0.143	0.169	0.152	0.203	0.023

Radiative trapping and the amount of radiation that reaches the surface greatly depends on the *Sky View Factor (SVF)* which measures the fraction of the sky that can be seen from ground level. For an infinitely long street sky view factor is

$$\psi = \cos(a)$$

where *a* is the angle defined by

$$\tan(a) = 2\frac{H}{W}$$

where *H* is building height and *W* is street width (BONAN, G. B., 2002). *Figure 2* shows sky view factor of three types of urban area.

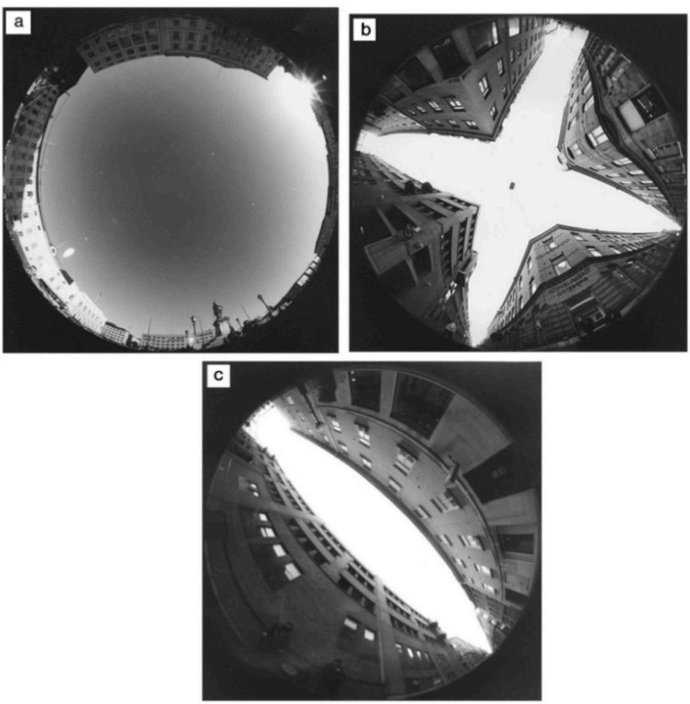


Figure 2 – Three 180° fisheye photographs of particular sites of Göteborg and their SVF.

(a) Open square, SVF=0.93; (b) street intersection, SVF=0.47; (c) street canyon, SVF=0.29

Source: ELIASSON, I. (2000)

Another significant aspect of urban energy balance is the ratio of latent and sensible heat. Ratio of latent heat fluxes decreases with the increasing ratio of artificial surfaces (OKE, T. R. 1982; BONAN, G. B. 2002) because these surfaces are impervious and cannot keep as much water in the local climatic system as vegetated surfaces can (GRIMM, N. B. *et al.* 2008).

4.2.1 Energy exchanges and flows in urban environments with vegetated areas

One of the significant impacts of vegetated areas both on urban and rural climate is that surfaces planted with trees have less diffuse and direct solar radiation income than open spaces with herbaceous plants, asphalt or other artificial surfaces. Direct radiation values differed more between tree-covered and open spaces than diffuse values; therefore, trees have greater influence on direct radiation income (TOOKE, T. R. *et al.* 2011).

Part of the incoming solar radiation which impinges upon vegetated surfaces is absorbed by them.

Plants use some of this absorbed energy for photosynthesis which process has a heat lowering effect on the air nearby. However, the efficiency of the energy transformations of photosynthesis is relatively low; so it has an effect of no significant consequence on air temperature (GIVONI, B. 1991).

Most of the absorbed solar radiation is used in evaporation (GIVONI, B. 1991) which occurs when unsaturated air and any kind of wet surface, thus also leaf surfaces come in contact. The other significant energy consuming phase transition that comes into question about vegetation is transpiration. It occurs since plants move water of the soil actively into the air through their leaves (BONAN, G. B. 2002). The intensity of transpiration depends mostly on photosynthesis since it happens only when the microscopic pores (stomata) are open on leaf surfaces which CO_2 absorption occurs through. These stomata are only open during the daytime when surrounding climatic conditions are optimal for photosynthesis (BONAN, G. B. 2002).

Evapotranspiration, as being an energy consuming process, has a significant effect on local air temperature while it increases the ratio of latent heat in the local climatic system (BOWLER, D. E. *et al.* 2010). The intensity of evapotranspiration is determined by the stomatal physiologies, the air temperature (when it is too hot or cold, stomata are nearly or utterly closed), humidity of the atmosphere (low humidity increases evapotranspiration) and by wind velocity. Low wind velocity is welcome as it dispatches the air with high humidity above the leaves and brings less humid air, therefore evapotranspiration can be increased. However, too high wind velocity can desiccate the leaves, hence when this condition occurs, stomata are closed (BONAN, G. B. 2002).

One of the most determining factors what controls the intensity of evapotranspiration is the amount of water that vegetation can absorb from the soil. In urban environments most of the rainwater cannot infiltrate the soil, therefore anthropogenic watering can be a crucial element of increasing latent heat ratio (ARNFIELD, A. J. 2003).

Trees and bigger shrubs also have a passive cooling effect on local climate other than evapotranspiration: they block part of incoming net solar radiation from the surface through shading (SHASUA-BAR, L. – HOFFMAN, M. E. 2004). The rate of this cooling effect depends on the type and density of vegetation, geometry of built-up areas, albedo, and nearby traffic load (SHASUA-BAR, L. – HOFFMAN, M. E. 2004).

The shading effect of trees can be measured by the sky view factor of the vegetated surface. Tree canopy can significantly reduce an area's SVF *(Figure 3)* (COHEN, P. – POTCHTER, O. – MATZARAKIS, A. 2012).

When the energy budget of an urban area is studied, albedo of the urban surfaces has to be examined. Low albedo values in cities can be aided by paying attention when picking colours of buildings and surfaces. For example during constructions and renovation the colour of outside walls and other surface materials should be chosen to raise albedo values where needed (SHASUA-BAR, L. – HOFFMAN, M. E. 2004). Vegetated areas can also ease this problem by having higher albedo values than those of the average built environment. Areas covered with mostly herbaceous plants like spontaneous vegetation or cultivated lawns have higher albedo values than areas overgrown mainly with trees (ROBINSON, S. L. – LUNDHOLM, J. T. 2012).

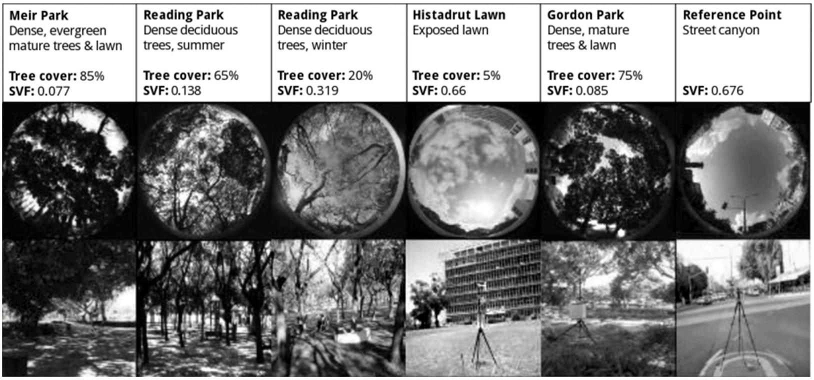


Figure 3 – Some typical urban green spaces with their rate of tree-coverage and sky view factor in Tel Aviv

Source: COHEN, P. – POTCHTER, O. – MATZARAKIS, A. (2012)

Urban green spaces can have a great influence on local climatic energy budget through evapotranspiration, shading and providing higher albedo values. By only evapotranspiration, vegetation can result in a temperature 2–8°C lower in vegetated areas than in their surrounding urban, built environment (TAHA, H. 1997). Even small tree-covered areas and areas overgrown mainly with herbaceous plants can have an average 2–3°C cooler air temperature than their surroundings (HUANG, Y. J. *et al.* 1987).

Areas planted with trees can have the lowest SVF values and evapotranspiration capacity and they have higher albedo than the average surrounding built elements; therefore, they have the most significant cooling effect among urban green areas. The more extensive an area is and the more densely planted with trees it is, the greater its local cooling effect is (BONAN, G. B. 2002; SHASUA-BAR, L. – HOFFMAN, M. E. 2004; ROBINSON, S. L. – LUNDHOLM, J. T. 2012). Furthermore, trees are less sensitive to drought than grasslands; therefore, they cannot lose their ability to evapotranspirate as easily as open spaces planted with herbaceous flora can (GILL, S. E. *et al.* 2007).

4.3. Advection characteristics in the urban atmosphere

Direction and speed of wind in an urban climate are determined by the regional wind patterns, but it can be significantly altered in the urban environment (BONAN, G. B. 2002). When moving air reaches the city it meets roughness elements that are mainly buildings. They wake turbulences and decrease wind speed due to their large surfaces (COLLIER, C. G. 2006). Moreover, street geometry determines the wind direction (SMITH, C. – LEVERMORE, G. 2008) and is able to create areas with higher wind speed and eddy circulations (ELIASSON, I. 2000). However, relatively low wind speed can cause bad ventilation which can lead to unhealthy air quality in the city (ELIASSON, I. – UPMANIS, H. 1999). Street orientation can provide a great deal of help in avoiding poor ventilation. To reach this goal, optimal street angle to the prevailing wind direction should be 45° (SMITH, C. – LEVERMORE, G. 2008).

Temperature differences between the city and the surrounding rural or suburban areas and inside the urban environment can induce weak airflows (ELIASSON, I. 2000) which can turn into local circulations (BONAN, G. B. 2002). *Figure 4* shows two typical urban air circulations.

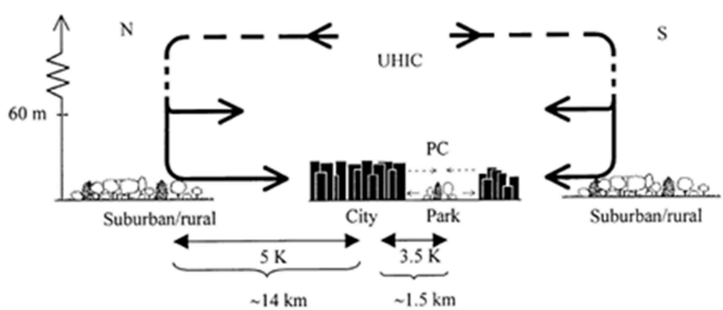


Figure 4 – Urban heat island circulation (UHIC) or country breeze and park circulation (PC) or park breeze

Source: ELIASSON, I. – UPMANIS, H. (1999)

Warmer air rising from the urban climatic system is replaced by cooler air from the surrounding rural area; therefore, circulation is induced in the urban boundary layer. This circulation is called country breeze (ELIASSON, I. 2000; BONAN, G. B. 2002) or urban heat island circulation (UHIC) (ELIASSON, I. – UPMANIS, H. 1999; COLLIER, C. G. 2006). Park breeze or park circulation (PC) is an outflow of cool air from parks towards the surrounding built areas (ELIASSON, I. – UPMANIS, H. 1999; ELIASSON, I. 2000).

4.3.1. How vegetated areas affect advections in urban atmosphere

Urban green spaces can affect local wind patterns such as speed by physically blocking the airflow. The extent of this impact depends mostly on the type of vegetation and on planting patterns. Green areas planted mainly with herbaceous vegetation allow the best ventilation conditions. These areas are disadvantageous where average regional wind speed values are high, especially in cold climates. Bushes mostly affect the airflow near the ground surface while trees impact on higher levels of airflow in the urban boundary layer (GIVONI, B. 1991).

An area with grass and scattered, isolated trees can concentrate the airflows in the canopy layer, while it improves ventilation near the ground level. This can be considered a rather positive effect in hot regions. Densely planted trees and shrubs, however, can significantly reduce wind speed. This can be quite advantageous under cold, windy climatic conditions (GIVONI, B. 1991).

Parks have lower average air temperature than surrounding built urban areas due to their impact on the local climatic system *(Chapter 2.1)*. In the urban canopy layer this temperature difference can induce an air circulation called park circulation or park breeze *(Figure 4)*. The circulation creates a weak airflow from the vegetated area towards the built-up areas (ELIASSON, I. – UPMANIS, H. 1999).

The park breeze is usually best developed between 2–3 hours after sunset and may reach a distance less than approximately 250 metres from the side of the park (ELIASSON, I. – UPMANIS, H. 1999).

4.4. Humidity of urban air and how urban green areas affect it

The decreased level of evapotranspiration and the low ratio of water absorption, which is normally caused by built surfaces, result in an urban air condition low in moisture. Beyond the ratio of urban green spaces, the humidity of air depends also on incoming solar radiation and city ventilation (NAGY, I. 2008).

Intensity of anthropogenic activity in urban areas can also influence the amount of water vapour in the local air system, since burning of fossil fuels increases the air humidity (SOUCH, C. – GRIMMOND, S. 2006). Evapotranspiration increases the humidity of air through active and passive vaporization (GIVONI, B. 1991; BONAN, G. B. 2002). However, the amount of moisture in the air affects the intensity of evapotranspiration, since, with the amount of water vapour in the air increasing, the water potential—which is a negative suction—decreases. Water is moving from higher to lower water potential; the greater difference between those two values is, the more intensive evapotranspiration is (BONAN, G. B. 2002).

4.5. Precipitation and runoff in urban environments

Urban climatic conditions can alter the characteristics of precipitation in the urban environment. The urban heat island circulation brings air rich in moisture—and has lower temperature than the surrounding rural areas do—in the place of the rising hot, dry urban air. However, the urban atmosphere can be highly polluted and have high concentrations of particulate condensation nuclei. These two conditions combined may result in increasing precipitation and greater cloudiness and fog in the urban environment (ELIASSON, I. 2000; PICKETT, S. T. A. *et al.* 2001; BONAN, G. B. 2002). Average annual precipitation can be higher in cities by 5–10% than in their surrounding rural areas (PICKETT, S. T. A. *et al.* 2001).

Some studies have shown that probability of precipitation is increasing during the week and it reaches its maximum at weekends. This is caused by higher concentration of air pollutants in the urban atmosphere from increased activity of manufacturing and transportation on workdays (PICKETT, S. T. A. *et al.* 2001; BONAN, G. B. 2002).

In cities surface runoff is increased from average 10% to 30% (PICKETT, S. T. A. *et al.* 2001). Rainwater turns to runoff in a higher rate due to reduced vegetated surface areas and the high rate of impervious surfaces like rooftops, streets or parking lots. The rainwater from surface runoff is quickly collected by sewers and other artificial drainage systems and transported into river channels. Thus it eliminates most of the precious water from the urban climatic system (BONAN, G. B. 2002). When intensive precipitation occurs, for example during thunderstorms, the drainage system can fill up quickly, therefore the chance of flood increases (BOTKIN, D. B. – BEVERIDGE, C. E. 1997). Furthermore, the quality of this collected runoff water can be very poor because it accumulates pollutants from buildings, roadways, and parking lots through its way to the drainage system (GRIMM, N. B. *et al.* 2008).

4.5.1. The impact of urban green areas on precipitation and runoff

Urban green areas may increase the probability of precipitation by emitting moisture into the urban atmosphere by evapotranspiration (GIVONI, B. 1991; PICKETT, S. T. A. *et al.* 2001).

In vegetated areas precipitation falls upon foliage, leaves and soil. These surfaces collect most of the rainwater that falls upon them, and when surrounding climatic conditions are suitable, evapotranspiration occurs (BONAN, G. B. 2002). Therefore, vegetated surfaces are more effective in rainwater storage and decreasing runoff than built-up areas. Its efficiency, however, depends on the type of soil and the vegetation that covers it (BONAN, G. B. 2002; GILL, S. E. *et al.* 2007). Trees can hold much more water than shrubs and herbaceous plants and they are the most effective in rainwater storage on sandy soils that water can infiltrate faster (GILL, S. E. *et al.* 2007).

In addition, vegetated areas intercept precipitation, hold water temporarily and return it into the climatic system due to evapotranspiration. These qualities of vegetated surfaces reduce surface runoff also by increasing infiltration into the soil (CAMERON, R. W. F. *et al.* 2012).

4.6. The urban heat island

The *urban heat island (UHI) phenomenon* means that cities often have higher air temperature than their surrounding rural areas (OKE, T. R. 1982). The value of this temperature difference is defined by urban geometry, surface characteristics, urban extent, intensity of anthropogenic activity and further regional climate factors (KIRCSI, A. *et al.* 2005; MCCARTHY, M. P. *et al.* 2010). The main suggested causes of the urban heat island are summarised in *Table 3*.

Table 3 – Suggested causes of the urban heat island

Source: OKE, T. R. (1982)

Layer	**Altered energy balance terms leading to positive thermal anomaly**	**Features of urbanisation underlying energy balance changes**
Canopy layer	Increased absorption of short wave radiation	Canyon geometry – increased surface area and multiple reflection
	Increased long wave radiation from the sky	Air pollution – greater absorption and re-emission
	Decreased long wave radiation loss	Canyon geometry – reduction of sky view factor
	Anthropogenic heat source	Building and traffic heat losses
	Increased sensible heat storage	Construction materials – increased thermal admittance
	Decreased evapotranspiration	Construction materials – increased 'water- proofing'
	Decreased total turbulent heat transport	Canyon geometry – reduction of wind speed
Boundary layer	Increased absorption of short wave radiation	Air pollution – increased aerosol absorption
	Anthropogenic heat source	Chimney and stack heat losses
	Increased sensible heat input-entrainment from below	Canopy heat island – increased heat flux from canopy layer and roofs
	Increased sensible heat input-entrainment from above	Heat island, roughness – increased turbulent entrainment

Built-up areas— that mainly form urban environments—can store a large amount of heat due to their high tendency to absorb thermal radiation and their generally low albedo (GRIMMOND, C. S. B. – OKE, T. R. 1999; SMITH, C. – LEVERMORE, G. 2008). Additionally, radiation emitted by built surfaces is reflected or absorbed again by buildings and air pollution, thus net losses of heat by long wave radiation remain low in urban areas and may increase the local air temperature (SOUCH, C. – GRIMMOND, S. 2006; SMITH, C. – LEVERMORE, G. 2008).

Intensity of the urban heat island is increased further by lower wind speeds, less evapotranspiration due the high rate of built surfaces, and anthropogenic activity. Air conditioning, industrial activity and transportation are additional heat sources in urban environments; furthermore, these activities induce weekly cycles in urban heat island intensity (WILBY, R. L. 2008).

Intensity of urban heat island is usually negligible during the day, but after sunset it reaches its maximum shortly (PICKETT, S. T. A. *et al.* 2001; SMITH, C. – LEVERMORE, G. 2008). Approximately 2–3 hours after sunset air temperature of the city can be up to 5–10°C warmer than in the surrounding countryside (Pickett, S. T. A. *et al.* 2001).

The UHI intensity decreases with increasing wind speed and cloud cover, and it is best developed in the warm seasons of the year during anticyclonic conditions (WILBY, R. L. 2008). The effect of UHI may be the contrary, if urban areas have higher rate of irrigated vegetation than surrounding areas do, for example in arid or semi-arid climates. Under these conditions urban air temperature may be cooler during the daytime than in the surrounding countryside (WILBY, R. L. 2008; SCHWARZ, N. *et al.* 2012).

Vegetated surfaces may help ease the problems caused by the urban heat island due to their advantageous impacts on the local climatic system. Further investigation in the subject can be found in *Chapter 8*.

4.7. Air pollution in cities

The atmosphere above urban areas is usually rich in air pollutants due to the intensive anthropogenic activities like burning fossil fuel and industrial activities (BERRY, B. J. R. 1990). In cities, transportation seems to be the most important source of air pollutants such as nitrogen monoxide (NO) and nitrogen dioxide (NO_2). This results in a higher level of tropospheric ozone (O_3) in the atmosphere of the city (MAYER, H. 1999). The concentration of ozone in the urban atmosphere is also determined by the emission of volatile organic compounds (VOCs) (WILBY, R. L. 2008). The O_3 in the atmosphere is produced in chemical reactions from precursors like nitrogen oxides and VOCs (DICKERSON, R. R. *et al.* 1997; MAYER, H. 1999). With high concentrations of ozone, and under certain climatic conditions, photochemical smog can develop which can cause several types of health problems for every being and dweller of the city (DICKERSON, R. R. *et al.* 1997; WILBY, R. L. 2008).

Aerosols are also important air pollutants due to their dangering effects on human health. These are solid or liquid particles not larger than 1–100 nm, and they are made of organic compounds, loose soot and other materials mostly derived from anthropogenic activities (SALMA, I. *et al.* 2012).

Air pollution can reduce incoming solar radiation by up to 20%; therefore, it can have a significant impact on local climatic conditions (ARNFIELD, A. J. 2003).

As mentioned in *Section 1*, when urban plume occurs, it can carry the pollution downwind above the surrounding rural areas (COLLIER, C. G. 2006).

4.7.1 Impact of vegetated areas on urban air pollution

Urban green spaces can influence urban air quality by filtering part of the pollution from the air. The capacity of the filtration increases with the amount of leaf surface, therefore deciduous trees are the most, while evergreen trees and grass are least efficient. With the positive effects on wind conditions, vegetated areas are able to strengthen city ventilation, thus they improve urban air quality (GIVONI, B. 1991).

However, urban green spaces planted with trees and shrubs are the most efficient in decreasing air pollution; grassy open spaces are still more efficient than open spaces covered with artificial surfaces. Little grass leaves make practices in the airflow near the surface drop down, causing a so-called 'lattice-effect'. If trees and shrubs were added to these urban grasslands, a larger volume of air would slow down and settle more of its dust supply (GIVONI, B. 1991).

Although, urban green spaces can significantly enhance urban air quality, in small areas they might cause more harm than good. For example, areas planted with willows or oaks can radically increase VOC (for example *isoprene*) concentration locally (WILBY, R. L. 2007).

4.8. Impacts of climate change in cities and how urban green spaces can help

Every city is exposed to the predicted effects of climate change and these may be more intensive in the urban environment than in rural environments. It is likely that the frequency of hot nights in urban areas is going to be increased by the urban heat island (MCCARTHY, M. P. *et al.* 2010). This can have serious consequences during heat waves, and the frequency of those will also expectedly increase. In rural areas the extended vegetated surfaces allow the air to cool down significantly during the night. However, this positive process is obstructed in cities by the urban heat island (WILBY, R. L. 2007; MCCARTHY, M. P. *et al.* 2010). These conditions increase the thermal stress of urban dwellers and may cause a growth in the rate of mortality during heat waves (MCCARTHY, M. P. *et al.* 2010).

It has commonly been presumed that the risk, intensity and frequency of extreme weather conditions—like heat waves, intense precipitation, destructive thunderstorms and floods—are increased by the changing climate. Due to their thermal and other physical characteristics *(Sections 1–6)*, the urban environment might face the most severe effects of these changes (WILBY, R. L. 2007).

Urban green spaces might affect ease the anticipated negative effects of climate change in cities. Vegetated areas can reduce urban air temperature due to incoming direct and diffuse solar radiation absorption (GIVONI, B. 1991), shading (SHASUA-BAR, L. – HOFFMAN, M. E. 2004), and evapotranspiration. This latter one has the most significant effect on latent and sensible heat flux ratio and with proper vegetation the gradient of sensible and latent heat flux could be greatly reduced by it between rural and urban areas (AVISSAR, R. 1996).

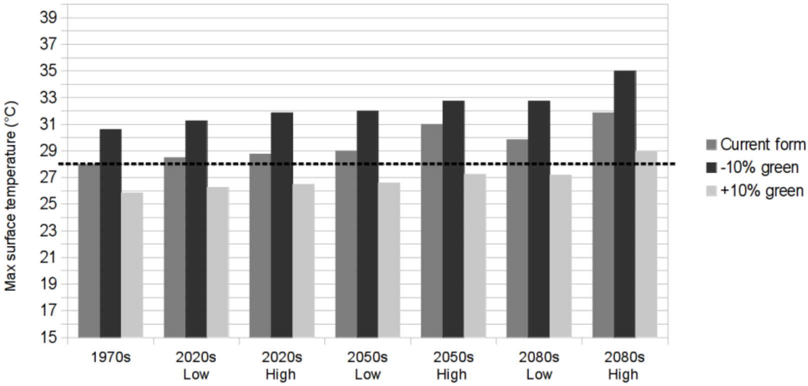


Figure 5 – Maximum surface temperature in high-density residential areas, with current form and when 10 per cent green cover is added or removed. Dashed line shows the temperature for the 1961–1990 current form case.

Source: GILL, S. E. et al. (2007)

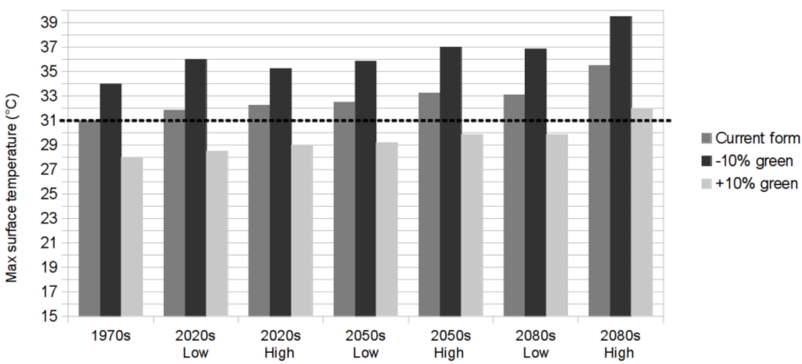


Figure 6 – Maximum surface temperature in town centres, with current form and when 10 per cent green cover is added or removed. Dashed line shows the temperature for the 1961–1990 current form case.

Source: GILL, S. E. et al. (2007)

Figure 5 and 6 demonstrate the probable impacts of increased and decreased green areas on estimated maximal surface temperature till 2080 with high and low global CO_2 emission scenarios in two urban areas.

Vegetated areas might help form sufficient ventilation for the city (GIVONI, B. 1991) and when the park breeze phenomenon occurs, it might decrease the air temperature in the built-up environment around vegetated areas (ELIASSON, I. – UPMANIS, H. 1999).

Urban green areas also increase the moisture in the urban atmosphere (GIVONI, B., 1991; BONAN, G. B., 2002) and decrease the probability and negative effects of serious floods (CAMERON, R. W. F. *et al.* 2012). To achieve the best impacts of urban green spaces on urban climatic conditions and the probable effects of climate change, type and structure of green areas should be selected carefully. In hot, arid climates the best course of action is to plant large parks dense with deciduous trees and shrubs. In these regions positive effects of shading and evapotranspiration are very welcome, and the wind speed lowering effect of this kind of vegetation is not likely to cause any discomfort (GIVONI, B. 1991). However, when the natural water supply is limited, vegetated areas have to be watered artificially to prevent the reduction of evapotranspiration intensity (GIVONI, B. 1991; GILL, S. E. *et al.* 2007). Additionally, wind protection might have crucial effects on urban thermal comfort in arid regions where cold winters are common (GIVONI, B. 1991).

Shade and wind are important in hot, humid climatic regions, therefore providing shade and minimising blockage of the wind should be the most crucial aspects in planning green areas in these regions. To reach this goal densely planted deciduous trees with soils covered with herbaceous plants should be the dominant type of vegetation (GIVONI, B. 1991).

In cold climates access to sunlight and protection from wind should be in the focus when planning green areas. High and dense line of evergreen trees with belts of evergreen shrubs planted here along the border of open green space might provide little shading and sufficient protection from the cold, dry winds (GIVONI, B. 1991).

5. Conclusion

The aim of this review was to give introspection about the state of urban climatic conditions. These might result in an unpleasant and unhealthy environment for city dwellers and with the probable causes of climate change these could indicate that cities are going to face serious problems in the future. The article is also entitled to show that with properly formed urban green areas these problems can be significantly eased. However, to gain the most needed impacts from urban green areas, understanding of urban ecological systems and the urban structures is crucial (PICKETT, S. T. A. – CADENASSO, M. L. 2008).

Today many different actors and decision-making processes alter the face of urban environments; however, to develop an urban area could be quite challenging due to its wield complexity. One single alteration—for example changing the colour of an outside wall of a building, or cutting some trees in a park to have a bit more open green space for social usage—could lead to various types of consequences such as altered climatic conditions. Furthermore, spatial planners and decision-makers have to consider many different economic and social interests as well. As it can be seen, several different areas of expertise are needed for spatial alterations in cities; however, all the required ones are rarely involved in urban spatial planning and implementation. This article might give some necessary information about urban climate and the impacts of urban green areas to various kinds of actors in urban spatial development.

Acknowledgements

I am especially grateful to *András Takács-Sánta* at *Eötvös Loránd University* who followed through my research and provided a great deal of help to find the most efficient research methods.

References

AVISSAR, R. (1996). *Potential effects of vegetation on the urban thermal environment.* Atmospheric Environment, 30(3), pp. 437–448.

BAYCAN-LEVENT, T. – NIJKAMP, P. (2009). *Planning and management of urban green spaces in Europe: comparative analysis.* Journal of Urban Planning and Development, 135(1), pp. 1–12.

BERRY, B. J. R. (1990). *Urbanization*. In: TURNER, B. L. – CLARK, W. C. – KATES, R. W. – RICHARDS, J. F. – MATHEWS, J. T. – MEYER, W. B. (Eds.) *The Earth as transformed by human action – Global and regional changes in the biosphere over the past 300 years.* Cambridge University Press, pp. 103–119.

BOTKIN, D. B. – BEVERIDGE, C. E. (1997). *Cities as environments.* Urban Ecosystems, 1(1), pp. 3–19.

BOWLER, D. E. – BUYUNG-ALI, L. – KNIGHT, T. M. – PULLIN, A. S. (2010). *Urban greening to cool towns and cities: A systematic review of the empirical evidence.* Landscape and Urban Planning, 97(3), pp. 147–155.

BREST, C. L. (1987). *Seasonal albedo of an urban/rural landscape from satellite observations.* Journal of Climate and Applied Meteorology, 26, pp. 1169–1187.

CAMERON, R. W. F. – BLANUSA, T. – TAYLOR, J. E. – SALISBURY, A. – HALSTEAD, A. J. – HENRICOT, B. –THOMPSON, K. (2012). *The domestic garden – Its contribution to urban green infrastructure.* Urban Forestry & Urban Greening, 11(2), pp. 129–137.

COHEN, P. – POTCHTER, O. – MATZARAKIS, A. (2012). *Daily and seasonal climatic conditions of green urban open spaces in the Mediterranean climate and their impact on human comfort.* Building and Environment, May, 51, pp. 285–295.

DICKERSON, R. R. – KONDRAGUNTA, S. – STENCHIKOV, G. – CIVEROLO, K. L. – DODDRIDGE, B. G. – HOLBEN, B. N. (1997). *The impact of aerosols on solar ultraviolet radiation and photochemical smog.* Science, 278(5339), pp. 827–830.

ELIASSON, I. – UPMANIS, H. (2000). *Nocturnal airflow from urban parks-implications for city ventilation.* Theoretical and Applied Climatology, June, 66(1–2), pp. 95–107.

GIVONI, B. (1991). *Impact of planted areas on urban environmental quality: a review.* Atmospheric Environment, 25(3), pp. 289–299.

MAYER, H. (1999). *Air pollution in cities.* Atmospheric Environment, 33(24–25), pp. 4029–4037.

NAGY, I. (2008). *Városökológia*. Dialóg Campus Kiadó, Budapest–Pécs

OKE, T. R. (1982). *The energetic basis of the urban heat island.* Quarterly Journal of the Royal Meteorological Society, 108(455), pp. 1–24.

PICKETT, S. T. A. – CADENASSO, M. L. – GROVE, J. M. – NILON, C. H. – POUYAT, R. V. – ZIPPERER, W. C. – COSTANZA, R. (2001). *Urban Ecological Systems: Linking Terrestrial Ecological, Physical, and Socioeconomic Components of Metropolitan Areas.* Annual Review of Ecology and Systematics, 32, pp. 127–157.

RAMANATHAN, V. – CESS, R. D. – HARRISON, E. F. – MINNIS, P. – BARKSTORM, B. R. – AHMAD, E. – HARTMANN, D. (1989). *Cloud-radiative forcing and climate: results from the earth radiation budget experiment.* Science, 243(4887), pp. 57–63.

ROBINSON, S. L. – LUNDHOLM, J. T. (2012). *Ecosystem services provided by urban spontaneous vegetation.* Urban Ecosystems, 15(3), pp. 545–557.

SHASHUA-BAR, L. – HOFFMAN, M. E. (2004). *Quantitative evaluation of passive cooling of the UCL microclimate in hot regions in summer, case study: urban streets and courtyards with trees.* Building and Environment, 39(9), pp. 1087–1099.

SALMA I. – BORSÓS T. – NÉMETH Z. (2012). *A légköri aeroszol jelentősége és hatásai.* Magyar Kémiai Folyóirat, Közlemények, 118, pp. 107–114.

SCHWARZ, N. – SCHLINK, U. – FRANCK, U. – GROẞMANN, K. (2012). *Relationship of land surface and air temperatures and its implications for quantifying urban heat island indicators: An application for the city of Leipzig (Germany).* Ecological Indicators, 18, pp. 693–704.

SMITH, C. – LEVERMORE, G. (2008). *Designing urban spaces and buildings to improve sustainability and quality of life in a warmer world.* Energy Policy, 36(12), pp. 4558–4562.

TOOKE, T. R. – COOPS, N. C. – VOOGT, J. A. – MEITNER, M. J. (2011). *Tree structure influences on rooftop-received solar radiation.* Landscape and Urban Planning, 102(2), pp. 73–81.

Electronic sources

ARNFIELD, A. J. (2003). *Two decades of urban climate research: A review of turbulence, exchanges of energy and water, and the urban heat island.* Wiley Online Library [Online]. International Journal of Climatology, 23(1), pp. 1-26. Available at: <http://onlinelibrary.wiley.com/doi/10.1002/joc.859/pdf> [Accessed 19 March 2014].

BONAN, G. B. (2002). *Ecological Climatology: Concepts and applications.* NCAR Earth System Laboratory [Online]. Cambridge University Press, Boulder, Colorado. Available at: <http://www.cgd.ucar.edu/tss/aboutus/staff/bonan/ecoclim/index-2002.htm> [Accessed 28 March 2014]

Brown, C. – Grant, M. (2005). *Biodiversity and human health: What role for nature in healthy urban planning?* University of the West England [Online]. Built Environment, 31(4), pp. 326–338. Available at: <http://eprints.uwe.ac.uk/7856/2/Biodiversity__human_health_post_print.pdf> [Accessed 10 March 2014]

Collier, C. G. (2006). *The impact of urban areas on weather.* Wiley Online Library [Online]. Quarterly Journal of the Royal Meteorological Society, 132(614), pp. 1–25. Available at: <http://onlinelibrary.wiley.com/doi/10.1256/qj.05.199/pdf> [Accessed 10 March 2014]

Eliasson, I. (2000). *The use of climate knowledge in urban planning.* Resource Efficient Urban Planning [Online]. Landscape and Urban Planning, 48(1–2), pp. 31–44. Available at: <http://planning.cityenergy.org.za/Pdf_files/planning/spatial_land_use/sustainable_land_use/Climate%20Knowledge%20Urban%20Planning.pdf> [Accessed 19 March 2014]

Gill, S. E. – Handley, J. F. – Ennos, A. R. – Pauleit, S. (2007). *Adapting cities for climate change: The role of the green infrastructure.* Urban Spaces [Online]. Built Environment, 33(1), pp. 115–133. Available at: <http://urbanspace.rec.org/files/Article_Gill_Adapting_Cities_for_CC.pdf> [Accessed 25 February 2014]

Grimm, N. B. – Faeth, S. H. – Golubiewski, N. E. – Redman, C. L. – Wu, J. – Bai, X. – Briggs, J. M. (2008). *Global change and the ecology of cities.* Landscape Ecology & Sustainability Lab [Online]. Science, 319(5867), pp. 756–760. Available at: <http://leml.asu.edu/jingle/Web_Pages/Wu_Pubs/PDF_Files/Grimm_etal-2008-GC+Ecology%20of%20cities.pdf> [Accessed 15 April 2014]

Grimmond, C. S. B. – Oke, T. R. (1999). *Heat storage in urban areas: local-scale observations and evaluation of a simple model.* The University of British Columbia [Online]. Journal of Applied Meteorology, 38(7), pp. 922–940. Available at: <http://circle.ubc.ca/bitstream/handle/2429/35940/Oke_AMS_1999JAM922.pdf?sequence=1> [Accessed 25 February 2014]

Huang, Y. J. – Akbari, H. – Taha, H. – Rosenfeld, A. H. (1987). *The potential of vegetation in reducing summer cooling loads in residential buildings.* American Meteorological Society [Online]. Journal of Climate and Applied Meteorology, 26(9), pp. 1103–1116. Available at: <http://journals.ametsoc.org/doi/pdf/10.1175/1520-0450%281987%29026%3C1103%3ATPOVIR%3E2.0.CO%3B2> [Accessed 10 March 2014]

KIRCSI, A. – BOTTYÁN, Zs. – SZEGEDI, S. – UNGER, J. (2005). *The relationship between built-up areas and the spatial development of the mean maximum urban heat island in Debrecen, Hungary.* Wiley Online Library [Online]. International Journal of Climatology, 25(3), pp. 405–418. Available at: <http://onlinelibrary.wiley.com/doi/10.1002/joc.1138/pdf> [Accessed 15 April 2014]

MCCARTHY, M. P. – BEST, M. J. – BETTS, R. A. (2010). *Climate change in cities due to global warming and urban effects.* The University of Manchester [Online]. Geophysical Research Letters, 37(9), pp. 1–5. Available at: <http://www.sed.manchester.ac.uk/research/cure/research/scorchio/publications/McCarthy_10_GRL.pdf> [Accessed 25 February 2014]

PICKETT, S. T. A. – CADENASSO, M. L. (2008). *Linking ecological and built components of urban mosaics: an open cycle of ecological design.* Wiley Online Library [Online]. Journal of Ecology, 96(1), pp. 8–12. Available at: <http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2745.2007.01310.x/pdf> [Accessed 15 April 2014]

SOUCH, C. – GRIMMOND, S. (2006). *Applied climatology: urban climate.* Constructed Climates [Online]. Progress in Physical Geography, 30(2), pp. 270–279. Available at: <http://www.sciencetime.org/ConstructedClimates/wp-content/uploads/2010/08/SouchGrimmond20061.pdf> [Accessed 19 March 2014]

TAHA, H. (1997). *Urban climates and heat islands: albedo, evapotranspiration, and anthropogenic heat.* Pontificia Universidad Javeriana [Online]. Energy and Buildings, 25(2), pp. 99–103. Available at: <http://www.javeriana.edu.co/arquidis/educacion_continua/documents/Urbanclimates.pdf> [Accessed 15 April 2014]

WILBY, R. L. (2007). *A review of climate change impacts on the built environment.* Urbanization and Global Environmental Change [Online]. Built environment, 13 March, 33(1), pp. 31–45. Available at: <http://ugec.prod.gios.asu.edu/docs/NYCworkshop/Summaries/Wilby2007BE.pdf> [Accessed 15 April 2014]

WILBY, R. L. (2008). *Constructing climate change scenarios of urban heat island intensity and air quality.* Climate Knowledge [Online]. Environment and

Planning B: Planning and Design, 35(5), pp. 902–919. Available at: <http://climateknowledge.org/downscaling/Wilby_Climate_Urban_Heat_EnvPlan_2008.pdf> [Accessed 15 April 2014]

ISSN 2052-0018 (print), ISSN 2053-3667 (online)
Geographical Locality Studies 2014 Volume 2, Number 1. pp. 356–385

TAMÁS SZELESI
MSc, Teacher of Geography and Environmental Sciences
PhD Aspirant at the University of Pécs, Faculty of Sciences, Doctoral School of Earth Sciences
szelesit@gmail.com

The Development of Fixed-rail Public Transport in Frankfurt

Abstract

Despite the economic crisis in the 2000s, the number of newly built homes has duplicated in comparison with the period between 1980 and 2001. One can find both green zone and brown zone investments among the recently developed residential areas; the traffic infrastructure is designed to catch up with the development of those new ones. In some cases, the latter one even gets ahead. Several districts of Frankfurt provide good examples for other European cities to show the way in which the mentioned two closely related fields can be jointly investigated. 90% of the development of traffic infrastructure concentrates on zero emissions having the establishment of tram and subway systems (Light Rail System and Stadtbahn), in scope along with purchasing transport vehicles. As the continuity of the period until 2021, the emphasis is put on the renovation of tram lines as well as building cross-town traffic network resulting in the increase of the number of passengers and less transfers on different lines. This article looks into the historical development of the Frankfurt transport system and summaries its infrastructural improvement.

Key words

Traffic & urban development; Zero emissions; Passenger traffic; Frankfurt am Main; Go green

1. Introduction

The system of the *Frankfurt* fixed-rail public transport is top ranked at European level in terms of its organisation, technical standards and pricing policies. By connecting the public transport of the suburban areas with the city centre, the tram has been gaining great popularity with the help of integrating various networks of fixed-rail traffic. The large-scale preparation plans of subway system establishment (*Light Rail Sytem* and *Stadtbahn*) were highly influenced by the newest express lines (*Commuter Train System* or *S-Bahn*) and the change of the economic environment. After the year 2000, experts have faced new challenges by building new residential areas and the process of re-urbanisation. The present study attempts to introduce both the historical background and the correlation between the most important projects of urban development and newly built in-town fixed-rail traffic systems. Nevertheless, the study also highlights the author's personal proposals to build such an effective public transport system similarly to that of *Frankfurt* for which *Geographical Locality Studies* provides an excellent platform for the author to present this German city's efficient and pioneering system as a good example of sustainable urban transport.

2. Research methods

The history of *Frankfurt's* public transportation goes back a long time. Although, there has been a continuous development and expansion, there is a very little information that has been documenting the changes. The majority of these are kept and preserved by the *Frankfurt Tramway Society (Historische Straßenbahn der Stadt Frankfurt am Main e.V.).* The author of this article in this research has identified the most significant changes after the year 2000 and has collected all the data from first hand resources. Putting these changes into focus and analysing them are a crucial part of the modern city planning of *Frankfurt*, because they strongly affect the future layout of transport routes. The amalgamation, organising and setting up a chronological order of all the collected information and data in this article are published for the first time.

3. Historical background and development of lines

The development of *Frankfurt* public transport can be classified in different chronological stages. The investigation of great changes in the system can help figure out those important turning points which are linked with historical events, political terms and changes triggered by the growth of the city. Nowadays, the latter two phenomena are still defining factors. The length of the present study does not allow an in-depth research; however, it is essential to review the history in order to have a better understanding of current improvements and the process of urban development.

The first horse tramway was brought into use in 1872 ensuring the east–west connection between the downtown (*Hauptwache*, later *Konstablerwache*) and *Bockenheim* (independent city until 1st April 1985). The expansion of the network was improving; by 1980 the total length was 30 kilometres. The appearance of electricity in public transport initiated important changes in terms of both technical standards and system structure. The one-meter-gauge *Frankfurt–Offenbach* tram-way *(Frankfurt–Offenbach Trambahn Gesellschaft – FOTG) (Figure 1)* was opened in two steps in 1884. This line was the first one of its kind in *Germany*. Nowadays, the line is still a prominent part of the system, but the length has been shortened and terminates at the border of the suburban area of *Offenbach* (HANNA-DAOUD, T. 2000).

According to HANNA-DAOUD, T. (2000), the first local steam-traction train line in *Frankfurt* was opened in 1888 (with locomotive and passenger and goods wagons) between the northern area of the downtown *(Eschenheimer Tor)* and *Eschenheim*. The company *Frankfurter Lokalbahn AG (FLAG)* established an isolated *Oberursel* unit in 1899. The *Eschenheim* line had been electrified by 1908 where a part of it operates underground since 4th October 1968 becoming the core of the A line (A-Strecke) handling the most traffic including the *Oberursel* isolated area.

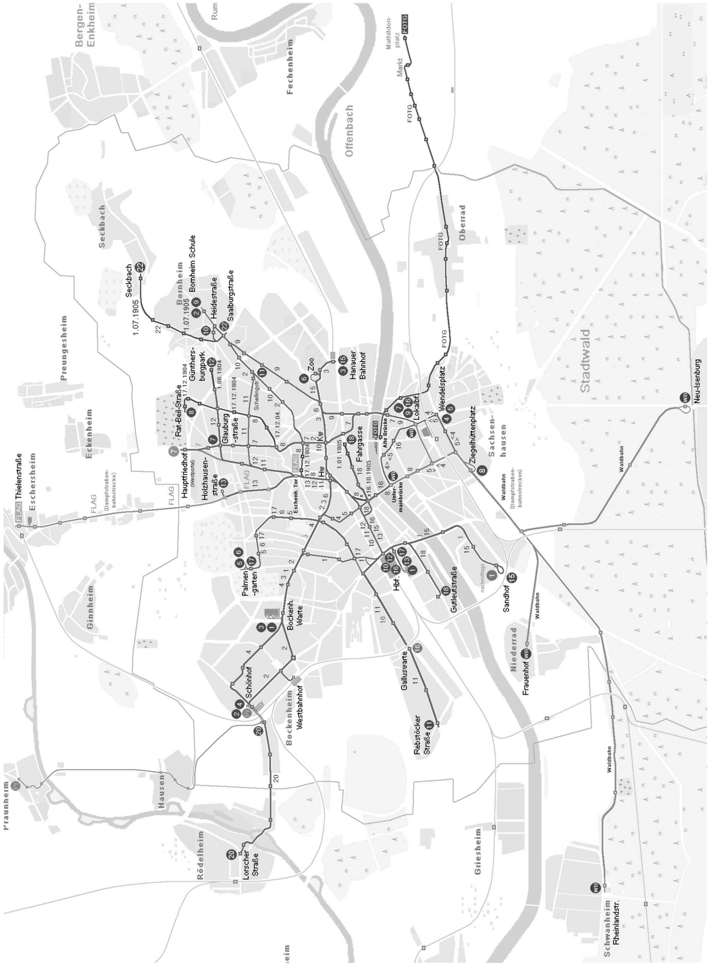


Figure 1 – Isolated traffic lines before integration. Map of the tram system from 1905. FLAG on the north, FOTG on the east, WLB on the west and south.
Source: RODMANN, *B. (2013)*

Between 6th February 1889 and 18th April 1889, the steam-traction forest line (WLB – Waldbahn) *(Figure 1)* was built in two steps in the southern area of the *River Main* which was quite similar to *FLAG* in operation. This line provided a connection among *Frankfurt Sachsenhausen*, *Niederrad*, *Schwanheim* and the city of *Neu-Isenburg*. At the beginning, passenger traffic was not so prominent and the majority of the transport of goods included the one from the mines of *Niederrad* and *Schwanheim* which was used in city constructions. By the exhaustion of these mines, the amount of transport of goods had decreased. In contrast, passenger traffic developed a lot as even six-carriage passenger trains were needed at weekends and on bank holidays (HANNA-DAOUD, T. 2000).

WLB became part of the tram system through multiple steps until 1929. Various modifications were implemented in its route adjusting it to the city's expansion (western part of *Goldstein*, *Niederrad*). The tramline heading to *Neu-Isenburg* has maintained its popularity even after 100 years, and the forest is still an attractive tourist destination (*Frankfurter Stadtwald*—5785 hectares of area).

Much ahead of its age, a new three kilometre line was opened on the 1st January 1897 operating with battery-supplied engines, connecting the railway station (which is now the central station) and the *Gallus district*. The line can be regarded as an experiment as it was extended on the 1st September 1910 as far as the western border of district *Gallus* (practically the border of *Frankfurt*). The overhead electricity supply was also introduced on this line. In harmony with other parts of the tramway network, the one-meter gauge *Frankfurt–Offenbach* line was reorganised in 1906. The tramline in *Offenbach* was also built by that time; however, the connection between the two systems was established on the 28th December 1910. By 1914, towns in the northern part of *Frankfurt* had been integrated into the transport system. The branch-railways from *Bonames*, *Niedereschbach*, *Bad Homburg (Taunus)* were integrated in 1910, and other branch-railways from *Niederursel*, *Bommersheim* became part of the system in 1913. The already mentioned isolated system of *Oberusel* was also integrated in 1913. The tramway system was fully built in the northern area of *Main* connecting *Riederhöfe* (port) and *Bergen-Enkheim* (HORST, M. – CLAUDE, J. 1972).

During the *World War I*, public transport development came to a sudden stop. In 1923, the *Offenbach* leadership denounced the separation from the *Frankfurt* system in lack of proper treatment on expenses; however, the line was reconnected to the system due to public pressure. In the eastern part of the *Osthafen* port, three thousand people were employed in the *Casella chemical industry* thanks to its improved traffic infrastructure. To meet passenger demands, a separate line (Linie F) was opened in July 1926 and then it was integrated on 31st October into the city tramway system in 1928 (HANNA-DAOUD, T. 2000).

At the turn of the 20th century, *Berkersheim* (a little town with a population of 399) was also integrated in the tramway system in 1925. *Berkersheim* had been a part of *Frankfurt* from 1910. It is an interesting fact that *Berkersheim* was inhabited only by 3,643 people even in 2012. In 1978, the tram traffic was limited and then terminated due to its unused capacity in the village-like city, and was replaced by buses heading to the newly built (1977) *Preungesheim* subway line U5. This fact would not be much of an interest, although the planning of the *Riedberg* subway line U9 could have been a warning sign for engineers designing city traffic (HÖLTGE, D. – KÖHLER, G. H. 1992).

The system was expanded between World War I and World War II adding *Griesheim* and *Nied* to the system consecutively in 1930 and 1936. By the end of *World War II* on the 25th March 1945, aerial bombings had been causing tremendous damage in buildings and to the traffic infrastructure. Retreating German troops exploded all the bridges on the River Main, but that could not stop the marching in of the *American Army*. The tramway system was stopped for two months and the restoration procedures at first were initiated on the east-west axle of *Nied*, *Griesheim*, *Hauptwache*, *Konstablerwache*, *Bornheim*. By 1949, all bridges on the *Main* had been restored, and, then—until 1952—the tramway system was gradually rebuilt. Furthermore, in 1952, the system was expanded to the west as far as *Höchst* (SCHWANDL, R. 2008).

The expansion of the system had been practically finished by 1963. By this time, the terminus of the supplementary lines had been in *Offenbach*, but the one heading to the market place *(Marktplatz)* was still existent until its final termination (1996). The most prominent transformations were triggered by building the subway system from 1968. At the first stage, the subway line was built as far as *Nordweststadt* as a central part outside of the city centre. Also, as the number of subway carriages increased from 1971, the system was further expanded primarily to the northern agglomeration area (in the direction of *Bod Homburg* and *Oberursel*) (KRAKIES, J. – NAGEL, F. 1989).

At the end of the 1970s, the existence of east–west subway line 'B' (*Preungesheim*-*Hauptbahnhof*, B-Strecke) served the main terminus of the tramway system in various city parts (*Nordend Ost*, *Seckbach*, *Preungesheim*, *Berkersheim* lines on the east and *Griesheim*, *Gallus*, *Rödelheim* lines on the west). The new public traffic conception *(FVV – Frankfurter Verkehrsverbund)* brought changes in public transport and opened new ways for further development. As the 'C' line (*Zoo-Hausen*, *Heerstrasse*, C-Strecke) was opened at the end of the 1980s (following the line of the first horse tramway), city centre tram lines had their terminus primarily there (*Westend*, *Bahnhofsvirtel*, *Bockenheim*, *Hausen*) (KRAKIES, J. – NAGEL, F. 1989). The tunnel for the express train (S-Bahn) was built in three stages (1978: between *Hauptbahnhof* and *Konstablerwache*; 1989: *Konstablerwache* and *Südbahnhof*; from 1994 to 1997: *Mühlberg* and *Offenbach*) (DIRMEIER, W. 2002).

By the end of the 1990s, the public transport system had become more distinct. The extension of the line 'C' to district *Enkheim* in 1992 can be regarded as the most important change of the decade. Engineers utilised the already used tramway infrastructure resulting in the separation of *Bergen* district from the system. By the integration of several pricing units in city public transport, the *Rhine–Main Transport Union* was founded making the transport easier for passengers between the agglomeration and *Frankfurt*. The complicated pricing control was replaced by a matrix-based pricing policy in each area. Underground express railway crossing *Offenbach* was built in 1996, so that the former *Frankfurt–Offenbach* tramway line was shortened only to the city border of *Frankfurt* due to city plans and the decreasing number of passengers (MUTH, F. 2007).

There are four distinguishable stages in the historical background:

1. Before *World War I*, certain lines had been expanded; therefore daily commuters could get to their jobs more easily within the city and in the suburban area. Isolated traffic systems were integrated resulting in a complex network.
2. Between the two world wars, those districts and important industrial units benefited the most that did not have tramway system. After *World War II*, a re-structuring process of transport of inner districts was implemented and the damaged infrastructure was quickly restored. As a result, a stable system was constructed by the middle of the 1960s which can be observed as the golden age of the *Frankfurt* tramway system.
3. From the beginning of the 1970s until the middle of the 1990s, the establishment of the subway and express train lines transformed the public transport to a great extent as a consequence of suburbanisation. This process triggered the termination of less popular downtown lines; however, the process also contributed to the popularity of bus lines.
4. After the year 2000, re-urbanisation processes brought new challenges to *Frankfurt*. City development and public transport became inseparable and operated together. It is important to investigate the relationship between designing public transport and urban planning which will be introduced through examples in the following sections.

3.1. 2001: the 'D' line

The underground line 'DI' was opened on the 10th February 2001, connecting the *Hauptbahnhof* (central station) and *Bockenheim*. The line connected three popular and busy places: the central station, market *(Fair and Exhibition Centre – Messe)* and the university *(Unicampus Bockenheim)*. The construction of the 'DI' line meant the birth of the new line 'D', but due to its shortness it currently functions as an extended part of the 'B' line. When the construction started between 1989 and 26th November 1993, the removal of the contaminated soil and subsoil water was necessary as an ink factory *(Brönnersche Farbenfabrik)* had been situated there previously. The line is really busy where four-carriage trains pass in every five minutes in rush hours.

The tunnel was designed based on the 1964 plans establishing a junction at *Messe* station for the line up to *Rebstock* through *Theodor-Heuss Alle (Figure 2)*. This plan never came about and the idea was finally dropped as the *Rebstock* tramway line built in 2003 (FAZ, 2003).

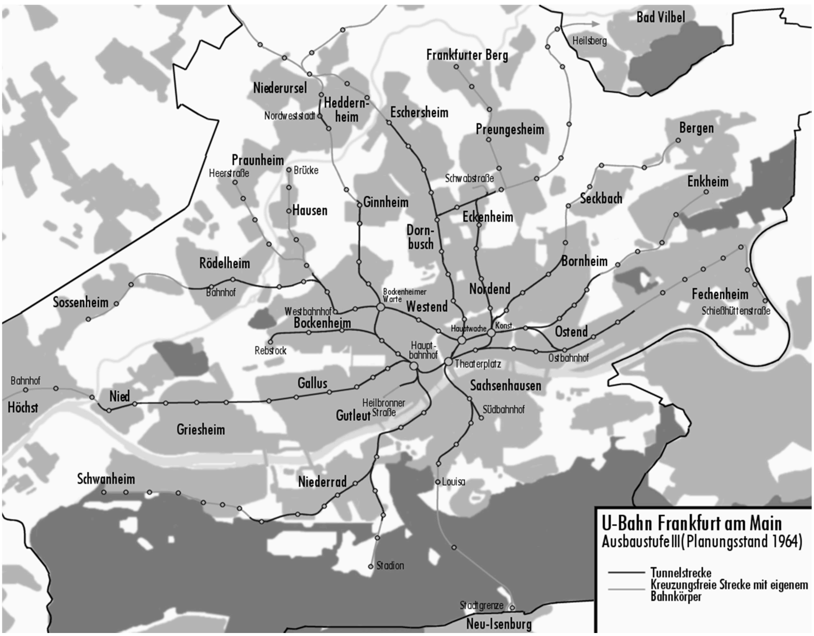


Figure 2 – Frankfurt Light Rail. Construction phase 3. Planned network of 1964. Darkened lines indicate the underground ones. Lighter grey lines indicate separated surface ones including suburban train lines.
Source: GROSS, P. (2006)

There were various plans to extend the line 'DII' northwards line *(Figure 3)*, but it was rejected by the ruling green-black government due to financial concerns in 2006. As a result of the public pressure, the project in 2009 was still alive called as the *Ginnheim Curve (Ginnheimer Kurve)* (GÖPFERT, C–J. 2010).

Figure 3 – The workability of plans to lengthen the line 'DII' based on public initiation.

Source: GINNHEIMER KURVE (2013)

There was a dedicated website designed to introduce the plans including all its positive aspects. Some major points are:

- The integration of the *Unicampus Westend* university district (27,000 employees and students) into the fixed-rail system released the crowdedness (and also replacing) of bus lines 36 and

75. There have been eight new blocks built on the Campus area since 2006 and residents of the university district have gradually moved there from *Bockenheim*, thanks to the extension of the line (LEITZBACH, K. 2013).

- Better access to the *National Bank (Bundesbank)* (HENTSCHEL, D. 2011).
- The improvement of the public transport of densely populated *Platenstrasse* area (population of 21,000) which was already been given fixed-rail system in 1963. Following the former tramway line, transportation involved bus lines again connecting the central station and *Ginnheim*. In the external parts of the line, buses passed in every five minutes due to the transfer availability to subway line 'A' *(Miquel-/Adickersalle)*.
- Releasing the crowdedness of the inner parts of line 'A' *(Heddernheim-Südbahnhof)*. According to surveys, the number of passengers travelling on one way exceeded 12,000 at *Holzhausen* station between 7am and 9am.

Based on preliminary calculations, over 55,000 passengers would have travelled on the line. In order to protect the *Palmengarten* area and inner green areas *(Grüneburgpark)*, two-thirds of the line would have been built underground causing considerably higher construction expenses. Thanks to great publicity, the government approved of the plans again in 2011 as per the green-back coalition agreement. (KOALITIONSVERTRAG, 2011)

The question of constructing the line under the *River Main* in the southern area of the central station arose in the 1970s. Therefore, the station was designed accordingly and the previously abandoned track way now functions as a practice place for fire workers. Based on plans, the above surface part of the line would have started at the university hospital building' *(Universitätsklinikum)* and engineers would have utilised those non-functional tracks. The express train system of south western districts changed considerably in the 1964 plans. The number of passengers and environment protecting measures would not demand a new line (DIII). The transportation is fully covered by the tram lines 12, 15, 21 and also temporary ones 19 and 20. The planning of future western and southern districts is out of scope; it is important to protect green areas, and also the price of rental homes and private housing in the area would be considerably lower due to the heavy noise load of the passing planes as the airport is very close (ROGGENKAMP, H. 2000) *(Figure 4)*.

3.2. 2003: Rebstock

Rebstockpark is not a separate district, but one of the parts of *Bockenheim*. However, it is geographically isolated thanks to the nearby highways A648 and A5, and, also the tracks of the former goods-station. This 100 hectares area was the first airport of *Frankfurt* (until 1936), then the public park *(Volkspark)* was opened there in 1962 followed by the aqua park *(Rebstockbad)* in 1982. After the year 2000, the city underwent some major changes. The market town *(Messe)* was given a parking lot of 5,400 vehicles. As per city plans in the 1990s, 5 to 10 story buildings were built as residential areas of 4,500 people and places of employment for a further 5,500. The construction process includes an elementary school which is expected to be completed by 2016 (W&W AG 2012).

Rebstockpark did not necessarily demand the establishment of the fixed-rail traffic; however, it was of great interest in the plans. In 1988, it was decided to reuse the *Bockenheim industrial area* and to build a centre of offices along with homes and green areas. Between 1995 and 2006, a new residential district was opened known as the *City West*. In the area next to the highway A648, there are several hotels, insurance companies and banks besides various enterprises giving employment to 18,000 people. *Voltatrasse* can be regarded as the ridge of the residential district with population of 5,000. Until 2003, public transport demands in the area were surved by bus lines 50 and 33.

The establishment of the fixed-rail public transport between the two areas was decided upon excessive preparatory works and research. Based on 1964 plans, the terminus of the line crossing *Altstadt* (the elder district) was also in scope (GROSS, P. 2006). Therefore, 1986 can be regarded as the turning point in *Frankfurt* public transportation. The opening of the subway line 'C' caused the termination of several central tram lines (*Bockenheimer Landstrasse* and *Hauptwache*) and it resulted in remarkable protest from the public (KYRIELEIS, S. 1996).

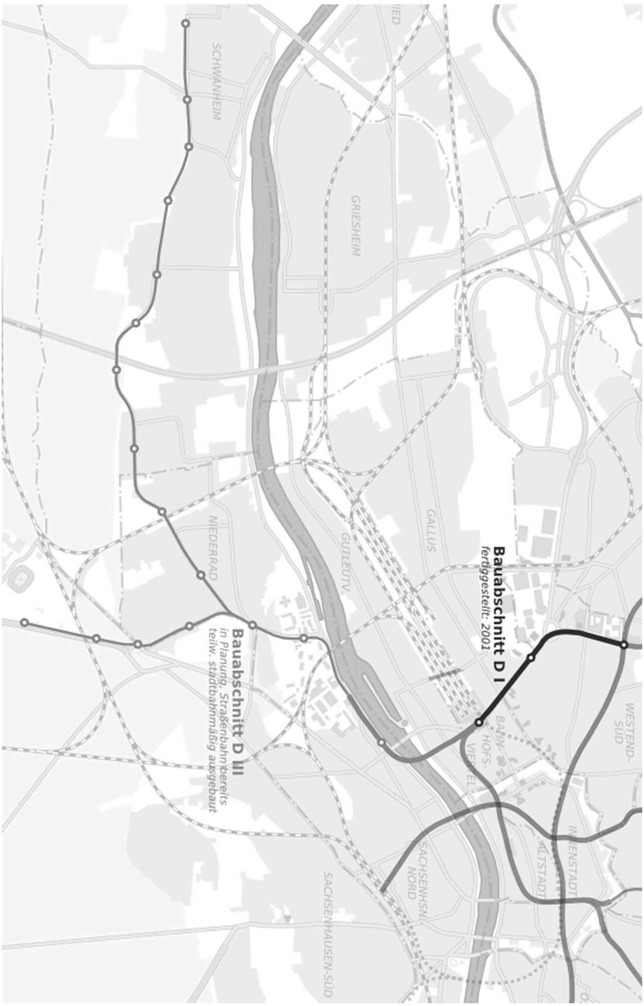


Figure 4 – The plans of the subway line DIII in the southern area of Main

Source: PLANUNGSVERBAND *(2006)*

Also, the inflated prices of establishing the subway line made the tram option as the preferred one. The 2.4 km, mostly single-way *Rebstock* line (17) with five stops, was opened in December 2003, connecting two areas. In the spotlight of protecting the central alley *(Hamburger Alley – Figure 5)*, a single-track tram line was built in 135 meters in this street (KÖHLER, I. 2006).

Figure 5 – Single-way tram line in the green area at Hamburg Alley
Photographed by SZELESI, T. (2014)

Overcoming the initial difficulties, the line well accomplished its purpose; the tram departed in every 10 minutes then it was changed to 7.5 minutes (originally in every 15 minutes). The new era started in 2014 as the tram line 17 became a cross-city line *(Rebstock and Neu-Isenburg)* after 11 years.

The intersection of the line ‘DII’ at *Messe* stop could have given the opportunity to build both underground and surface subway line bases on the *Stuttgart* and *Hannover* plans (these long-range ideas were also included in the plans of the line ‘U5’). However, it would have also meant the termination of the tram line 16 and the establishment of the DII at the same time with unpredictable expenses.

3.3. 2010: U9 Riedberg failure

In the 1990s, it was decided to build a residential district in the northern area of *Frankfurt*. *Riedberg* is still not a separate district, but part of *Kalbach*. The investments for green areas were launched in 2001 on the former 266 hectares plough-land. As per the long-term city development conception*, Goethe University* embraced 56 hectares, also parks and green areas embraced 92 hectares and on 60 hectares there were residential properties. Calculations expect the growth from 13,000 to 15,000 of inhabitants, 3,000 places of employment and 8,000 alumni by 2020 (SCHULTHEIS, J. 2008).

Thanks to the comprehensive city plans, drafts already included the conception of public transport. According to previous estimations and calculations, the integration into the fixed-rail traffic seemed to be the best conception. The establishment of the line crossing *Riedberg* (south western and north east directions) was among city plans from the beginning.

Subway line constructions started in 2008 and the completed line was opened in 2010. This one does not belong to the system of the *Oberursel* and *Homburg* line ‘A’, but it is part of stage IV of the line ‘D’ *(Figure 6)*. The line ‘U8’ provides direct connection with the downtown and the line ‘U9’ links together *Niedereschbach* and *Ginnheim*. Due to the impact of the crisis, the number of newcomer residents decreased. The biggest fall back happened in a number of private properties, but there was a small increase in the number of rental homes (as the expansion of the campus was planned). The latter did not mean an increase in the number of passengers as the majority of tenants lived and/or studied locally. The progression of re-urbanisation stopped the process of the migration to newly built suburban areas. Prices of rental homes in the suburban areas were the same in the centre; therefore the discomfort of commuting and its price stole the great popularity of the area. The *Rhine–Main Public Transport Federation* launched a pilot project in 2013 in cooperation with the company controlling rental homes. Home owners of 229 were offered government-supported (66%) travel passes. The project became unsuccessful. Even the assembling of the tram carriages was changed on the 'U9' in the 2013 scheduling. In 2014, the running time was shortened to a large extent to reduce expenses; at weekends there is no traffic after 10 pm and the first tram departs at 7 am in the morning on Sundays.

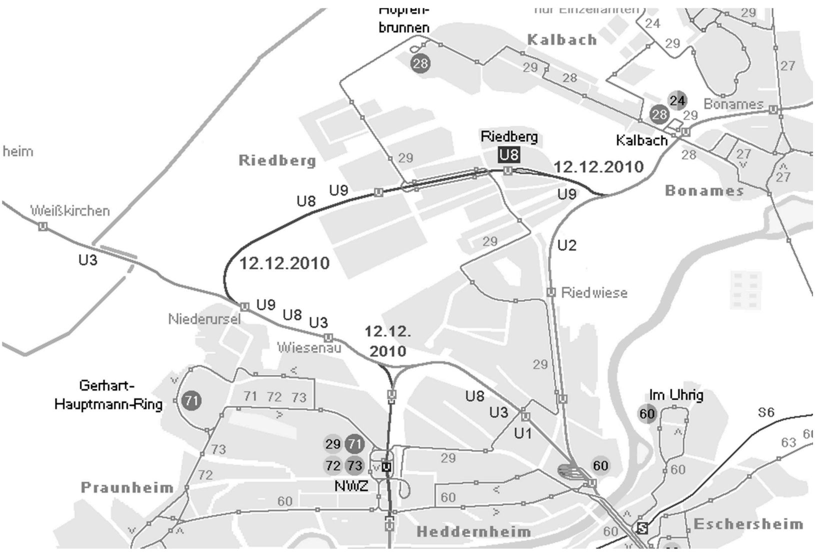


Figure 6 – The subway line 'D IV' crossing Riedberg
Source: RODMANN, B. (2011)

The *Riedberg case* proved that hierarchy indeed existed within the system of the public transport, too. Based on economic conditions, the establishment of the fixed-rail traffic was a viable solution. The company *TraffiQ* ordering public transport services got into a peculiar situation due to the negative impact of the economic crisis, newly built rail-way infrastructure and the satisfaction of already existing demands. Suspending the traffic would have triggered the full stop of investments and would have led to migration from the area. After the first three unsuccessful years, the reduced number of departing vehicles meant and immediate solution in 2014. Recently (2014) launched building projects in the western area of *Riedberg* maintain long-term plans for the fixed-rail system.

3.4. 2011: tram line 18 – Frankfurter Bogen and the New Atterberry residential district

The 72 hectares area between highway A661 and the eastern part of *Preungesheim* is called the *"Frankfurt Arch"* residential area *(Frankfurter Bogen)*. Between 2004 and 2014, new homes were built in three steps for 5,000 residents within green zone investments along with social infrastructure (kindergarten and day-time home). On the edge of the arch-shaped residential area includes not only blocks, but detached houses and row houses, too. There have been built five to eight story blocks in the inner areas. In the beginning of 2014, 90% of the area was used for new buildings; however, the number of residents is still much below expectations resulting in empty homes. The shopping mall is planned to be opened in 2016 (KYRIELEIS, S. 2012).

The former area of *Kurhessen barracks* was rapidly used for building new homes between 2003 and 2006. Firstly, it was called *Wermacht* under *National Socialist* ruling. Then, the *American Army* named it as *New Atterberry*. Brown zone investments were remarkably important as they involved not only the organisation of the area, but also its protection (restoring damaged parts). Furthermore, based on studies by *Frankfurt* government, it could be possible to build homes for 8,000 to 10,000 residents within additional green zone investments (AS & P, 2010). The plans would have a negative impact on the environment and most importantly, the natural airway of the city would be terminated. Moreover, investments would partly influence traffic of the highway A661 resulting in a possible money loss.

Plans of establishing the tramway along *Friedberger Landstrasse* were designed in 1996. The budget of the plans was passed by the general assembly, but designing was not finished until 2006 due to the building of the subway line DII. The government urged the start of the works, but the constructions started only in 2008 due to preparatory duties of public utilities.

The 3.5 km section was opened in December 2011. Interesting fact that the dedicated lane for public transport in the street *Friedberger Landstrasse* was also used by buses (VGF, 2011). For sustainable reasons, the tram line 18 was planned to be as an alternative for the bus line 30 departing outside of rush hours in inner parts of the city *(Figure 7)*. The days of the formerly most popular bus line are numbered as the government does not intend to cover its expenses (LINHART, P. F. 2005).

Based on preliminary estimations, 13,000 passengers were expected on a daily basis. However, utilisation exceeded 14,000 in 2012 and exceeded even 16,500 in Q3 of 2013 (TraffiQ, 2014). The line's capacity is still not fully used so that further city plans could be possible in the long term. It can be regarded as the most successful public transport project in the few years costing 55.1 million Euros (~44 million GBP).

3.5. 2014: tram line 17 – Stressemannalle – Neu-Isenburg

The connection between *Neu-Isenburg* and *Frankfurt* central station (fast connection in 18 minutes) was already among plans in 2006 by *Traffic Committee of the City Council*. The ways to cover its expenses were on schedule on the 11th October 2013 and the constructions started in December 2013 *(Figure 8)*. The line 17 has its final station next to *Frankfurt* central station. From December 2014, travelling will be available to *Neu-Isenburg* on the newly built 1.1 km tramway on *Stressemannalle*. The whole process of constructions also included the renovation of the road. The number of parking lots will be increased and 46 new trees will be planted as a replacement of the previously felled 23 of those. The major part of the track-way will be grass-covered (around 70%) as increasing green areas is of high importance in the plans.

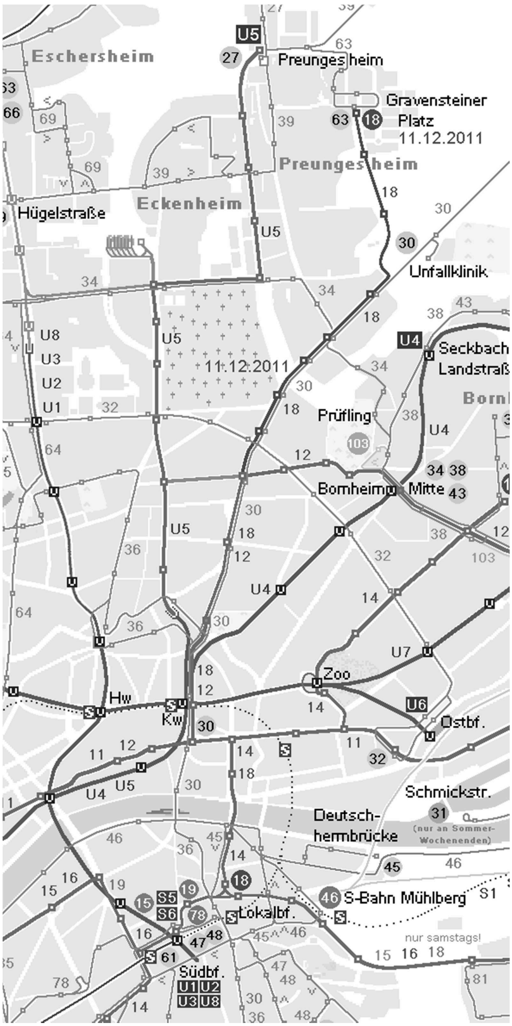


Figure 7 – Tram line 18 opened in 2011 - Gravensteiner Platz – KW: Kostablerwache – Lokalbahnhof

Source: Rodmann B. (2012)

Figure 8 – Building of tram line 17 is in progress
Photographed by SZELESI, T. (2014)

Demolishing the 680 m² playground on the *Stresemannalle* triggered overheated debates and tension in the preparatory planning phase. As a compromise, the playground was rotated by 90 degrees and was expanded with an extra 120 m² of public space.

Heimat Siedlung residential area *(Sachsenhausen)* was crossed by the newly built modern line. Based on plans, 1,072 homes and 50 shops were built between 1927 and 1934 (STADT FRANKFURT, 2012). The connection with *Sachsenhausen* centre *(Schweitzer Platz)* was provided by *Waldbahn's* east-west line in the first two years. Then, the integrated and electrified line to *Neu-Isenburg* provided the connection with the residential area. The area was fully built in by the end of the 1950s so that the direct connection with the downtown came into plans. Buses 35 and 69 (had been in operation since 1960) on the north-south line were replaced by the new tramway from 2014. The better accessibility of the area by public transport may result in increasing home prices in the suburban *Heimatsiedlung* residential area *(Figure 9)*.

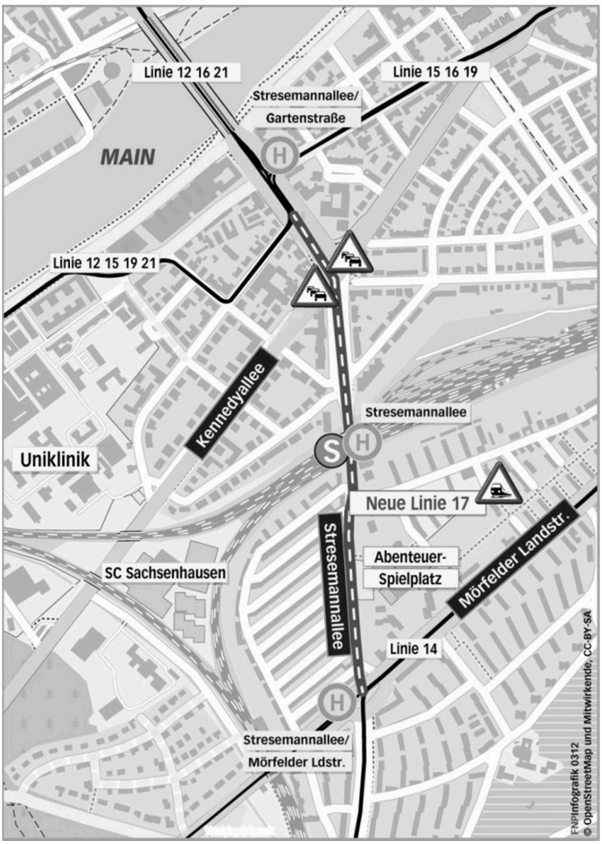


Figure 9 – The building of the tram line 17 on the Stresemannalee
Source: FNP (2012)

3.6. 2021: U5 Europaviertel

The central goods railway station was situated in the western area of Frankfurt between 1888 and 1998 and then the area was abandoned for seven years. Renovations were started in 2005 and they are planned to be finished by 2019. The 900,000 m^2 of area gives job to 30,000 and 8,000 to 10,000 homes. On the eastern side of the area, the market district provided a place for exhibitions and a shopping mall *(Skyline Plaza)* and also a skyscraper was built called Tower 185. On the western side, residential area is planned along with social institutions. To satisfy passengers' demands, the district was given a bus line in 2009 which was expanded to residential districts on the western outer areas. The express train crosses the area in north–south direction, but the two stops (*Messe* and *Galluswarte*) are situated far from each other. The fixed-rail traffic has also a separate lane (to both directions) on the east–west avenue *Europa Alle*. Since significant number of passengers was expected, the establishment of the subway line was decided.

The settling of the line was obvious; however, both underground and surface constructions were involved in plans. If the whole line had been built underground, extremely high expenses would have been rejected by the City Council. Besides the expenses, the high level of underground water would also have meant construction issues. Finally it was decided to build an underground station on the front edge of the former goods railway station and then the rest of the 2.7 km line was about to be built on the surface which would also be the western expansion of the subway line U5 at the same time. There was a 53,000 m^2 green zone area planned *(Europagarten)* with recreation purposes. The new subway line would cross this area. In order to protect the homogeneous surface, new fixed rail lines were designed based on the situation and position of crust blocks (also a new method in *Germany*, IN FAHRT, 2014) *(Figure 10)*.

The financial background of the establishment of the subway line was voted on October 2013 and the first preparatory works of the public were initiated in January 2014. As the whole construction process requires 6 to 7 years, including the testing periods, passengers may first use the expanded U5 line in 2021. Construction expenses have been estimated to be 217 million Euros (~173 million GBP), but additional 50 million Euros (~40 million GBP) have been estimated in further calculations.

Figure 10 – The conception of the subway line U5 crossing Europa Alle. The underground stage (Europagarten) can be seen in the foreground and the residential area with the business district in the background.
Source: In Fahrt (2014)

3.7. An opportunity: Kleyerstrasse

After the year 2000, the district *Gallus* underwent significant changes. There have been office blocks and residential properties built on the former areas of the factory *(Adlerwerke)*. This progress can be observed, if you have a look at *Kleyerstrasse (Figure 11)*. An additional 4,500 homes are to be built in the next 5 to 8 years. In December 2013, tram traffic was temporarily stopped due to a low number of passengers and has recently been replaced by bus line 52 on the same route departing more frequently. The tram traffic can be continued again in case of a higher number of passengers (investigated by *TraffiQ* responsible company for maintaining public transport). However, this would require higher extent of infrastructure development including the establishment of the double-track tram-way traffic on street *Rebstöcker*. It is also considering that the line may be expanded as far as *Sondershausen Street* which was also a conception accepted between 1912 and 1944 (HOFFMANN, M. 2011). Also, there are 800 homes in the area having the potential for further investments (*Mönchhof* residential and labour zone).

Figure 11 – The changing Kleyerstrasse. Will tram traffic be revived?
Source: HORST, H. (2013)

4. Conclusions

The ambitious plans for fixed rail traffic were changed to a large extent by the end of the 1990s. Primarily, the most popular and crowded lines were planned to be replaced by higher capacity subway lines. Also, in the beginning, the termination of under-utilised tram lines came into focus (also avoiding parallelism), bus lines coming from various directions would have replaced them. After the year 2000, fixed rail traffic was established only on well utilised lines after careful preparations; popular and attractive areas were integrated into the network of public transport.

The development of subway lines has been limited due to high expenses of railway infrastructure and underground constructions. The development of tram-way traffic has been flourishing since 2000. The tendency of the building public transport network across the city is constant besides the integration of newly built residential areas in the framework of brown zone investments. This way, it is possible to establish a decentralised network of fixed rail transporting with the minimum number of transfers.

Regarding green zone city planning, bus lines need to have priority to any types of fixed rail traffic. Only those crowded, over-utilised bus lines might be replaced. The establishment of subway lines can be reasonable in regards to the number of passengers.

It is worth considering the traffic opportunities and their combinations similarly to 1964 conceptions in cases of big cities like *Budapest* regarding its population and agglomeration area (similar data to that of *Frankfurt*):

- planning transport lines crossing the city;
- multiple tram-way lines centred in one point departing frequently so that suburban areas are also integrated in the network of fixed rail public transport;
- integration of agglomeration areas into the tram-way or subway system;
- the possibility of the integration of various suburban train lines (like in *Budapest*);
- connecting tram way system with the train lines like in Karlsruhe with the help of direct integration of farer agglomeration areas into the city public transport.

The above listed items make the public transport only technically easier both in suburban areas and inside the city. It is also an important condition that there has to be a clear pricing system contributing to traffic planning. It is necessary to have economically effective pricing policies including the possible transfer among different areas. In the spotlight of these, it would be unnecessary to purchase multiple tickets resulting in cheaper and more attractive public transport.

The sustainable development is practically possible with the help of local fixed rail public transport system. The protection of environment is the most important factor having influences on various investments. All the projects and proposals are designed to consider the demands of the future generations in terms of development. Hence the system of fixed rail traffic is prone to contribute highly to future demands.

5. Evaluation of sustainability

The development of fixed-rail public transport system is one of the most important factors in the aspect of settlement sustainability, because they are able to cover huge urban and agglomeration areas without a significant impact on the environment. This transportation method on a daily service basis is considered as zero emission. In *Europe*, the tram service is now living its renaissance whilst also in the bigger cities of the world plan tramway developments (e.g. in *Shanghai*, *China*). It can be observed that the grandiose and expensive underground development is gradually being replaced by the light rail transit system which is an efficient combination of the underground and tram ways. Since the official opening of the first *Light Rail System (Stadtbahn)* in 1968, a unified and efficiently controllable public transport system has been developed. In the 1990s, the original plans of the Stadtbahn were abandoned, but a new grandiose network development and rationalisation began which has been carried out in many small or large stages. As part of the project, not only the tram network has been altered and renovated, but also many frequent bus routes have been replaced. Commuters who previously depended on their cars have also now changed to public transportation. According to survey results, the usage of tram and light train increased by 2.17% from 2012 to 2013 (VGF Geschäftsbericht 2013, 2014). Thanks to the investments and developments, the public transportation has become faster, more comfortable and engaging.

6. Future research possibilities

The expansion possibilities within the agglomeration of the dynamically developing zero emission public transport system of *Frankfurt* has been the basis of a number of researches and debates. According to these, it is worth putting more effort into analysing the suburban railway that runs between the western agglomeration and the airport, known as *Regionaltangente West*. The advantage of the combined suburban speed-train and fixed-rail urban train systems may help lighten the routes crossing the city. Specialists' arguments about the total cost and return of the investment are unsettled, and the impact of the new system on *Frankfurt's* public urban transportation lies down the foundation of a new research on the topic too.

References

AS & P: Albert Speer & Partner (2010). *Verflechtung von Bornheim und Seckbach.* – Stadt Frankfurt am Main, 49 p.

Dirmeier, W. (2002). *Über zwei Jahrzehnte S-Bahn-Betrieb in der Region Rhein/Main.* – Eisenbahnen in der Region Frankfurt RheinMain, Darmstadt, pp. 122–129.

Gross, P. (2006). *Frankfurt Light Rail – Construction phase 1, 2, 3. Planned network of 1964.* Stadtbahnausstellung: 50 Jahre U-Bahn-Bau. 2013.

Hanna-Daoud, T. (2000). Nahverkehr in Frankfurt. Trambahn, U-Bahn, S-Bahn, Omnibus, Eisenbahn. Strassenbahn-Nahverkehr special. Nr. 7. GeraMond, München 2000, 114 p.

Hentschel, D. (2011). *Kommt die U-Bahn-Station Bundesbank?* – Bundesbankmagazin, 2/2011. p. 24.

Horst, M. – Claude, J. (1972): *Hundert Jahre Frankfurter Straßenbahnen 1872–1899–1972.* – CH-Villingen, 223 p.

Höltge, D. – Köhler, G. H. (1992). *Straßen- und Stadtbahnen in Deutschland.* – Band 1: Hessen, 358 p.

In Fahrt (2014). *Das VGF Netz wächst.* In Fahrt 03/2014, pp. 9–13.

Krakies, J. – Nagel, F. (1989). *Stadtbahn Frankfurt am Main: Eine Dokumentation. (2. Auflage.*) – Frankfurt am Main, 336 p.

Koalitionsvertrag (2011). *Koalitionsvertrag CDU + Die Grünen 2011–2016.* – Frankfurt am Main, p. 16.

Köhler, I. (2006). *Handbuch Strassenbahn.* – Fahrzeuge, Anlagen, Betrieb, München. 192 p.

Kyrieleis, S. (1996). *"Schienenfreie Innenstadt" – Seit 10 Jahren verschwindet die Tram aus der City*. In: Klärwerk – Umweltzeitung für Rhein-Main, Nr. 23, p. 4.

Kyrieleis, S. (2012): *Straßenbahnlinie 18 fährt zum Frankfurter Bogen.* In: Stadtverkehr 3/2012, p. 38–42.

Linhart, P. F. (2005). *Frankfurter Linien - Ein Omnibusbetrieb wird 80*. Last & Kraft - Nutzfahrzeug-Oldtimer-Magazin 1/2005. – Stuttgart, p. 42–58.

Muth, F. (2007). *Mehr Strecken für "Mainhattan"?* In: Straßenbahn Nahverkehrs Magazin 6/07, p. 24–29.

Roggenkamp, H. (2000). Frankfurter ABC – Die U-Stadtbahn. In: Nahverkehr in Frankfurt [= Strassenbahn Nahverkehr Special Nr.7 Ausgabe 2/2000, München, p. 69–75.

Schwandl, R. (2008). *Frankfurt Stadtbahn Album.* – The Frankfurt Light Rail Network, Berlin, 144 p.

VGF Geschäftsbericht 2013 (2014). *Fahrgastzahlen im Überblick.* – Henrich Druck + Medien GmbH, p. 21.

Electronic sources

FNP (2012). *Tram-Lücke wird geschlossen.* Framfurter Neue Presse [Online]. Available at: <http://www.fnp.de/lokales/frankfurt/Tram-Luecke-wird-geschlossen;art675,388330> [Accessed 10 September 2014]

Frankfurter Allgemeine Zeitung (2003). *Linie 17 fährt bald zum Rebstockbad.* Frankfurter Allgemeine Zeitung [Online]. Available at: <http://www.faz.net/aktuell/rhein-main/frankfurt/strassenbahn-linie-17-faehrt-bald-zum-rebstockbad-1130543.html> [Accessed 10 September 2014]

Ginnheimer Kurve (2013). *Streckenverlauf für Stadtbahnstrecke DII.* Ginnheimer Kurve [Online]. Available at: <http://www.ginnheimer-kurve.de/Projekte/GK/Streckenverlauf> [Accessed 10 September 2014]

GÖPFERT, C. J. (2010). *Stadt will Tunnelstrecke zwischen Bockenheim und Ginnnheim untersuchen. Frankfurter Rundschau* [Online]. Available at <http://www.fr-online.de/frankfurt/u-bahn-system-stadt-will-tunnelstrecke-zwischen-bockenheim-und-ginnnheim-untersuchen,1472798,4908304.html> [Accessed 10 September 2014]

HOFFMANN, M. (2011). *Kleyerstraße (Rebstöcker- bis Sondershausenstraße) ein Kuriosium.* Train spotter [Online]. Available at: <http://www.train-spotter.net/html/kleyer.html> [Accessed 10 September 2014]

LEITZBACH, K. (2013). *Ein Dossier zum Ausbau des Frankfurter U-Bahnetzes.* FFM Journal [Online]. Available at: <http://www.ffm-journal.de/dossier-%C3%B6pnv-visionen/> [Accessed 10 September 2014]

PLANUNGSVERBAND (2006). *Planning of the Track D of Frankfurt U-Bahn.* Region Frankfurt [Online]. Available at: <http://www.region-frankfurt.de/index.php?mNavID=1.100&sNavID=1136.15&La=1> [Accessed 10 September 2014]

RODMANN, B. (2011). *Linienplan 2011.* [Online]. Available at: <http://www.elcitaro.de/Netzplaene/Netz%202011.png> [Accessed 10 September 2014]

RODMANN, B. (2012). *Linienplan 2012.* [Online]. Available at: <http://www.elcitaro.de/Netzplaene/Netz%202012.png> [Accessed 10 September 2014]

RODMANN, B. (2013). *Linienplan 1905.* [Online]. Available at: <http://www.elcitaro.de/Netzplaene/Netz%201905.png> [Accessed 10 September 2014]

SCHULTHEIS, J. (2008). *Endstation Riedberg.* Frankfurter Rundschau [Online]. Available at: <http://www.fr-online.de/rhein-main/u-bahn-endstation-riedberg,1472796,3135078.html> [Accessed 10 September 2014]

STADT FRANKFURT (2012). *Heimatsiedlung*. Frankfurt Online [Online]. Available at: <http://www.frankfurt.de/sixcms/detail.php?id=3865&_ffmpar%5B_id_inhalt%5D=2461100> [Accessed 10 September 2014]

traffiQ (2014). *Linie 18 kommt an: Über 16.000 Fahrgäste täglich.* traffiQ, Busse und Bahnen für Frankfurt [Online] 03.02.2014. Available at: <http://www.traffiq.de/1.de.startseite.html?_show=118069> [Accessed 10 September 2014]

VGF (2011): *Frankfurts-Tram-Netz wächst: Eröffnung der Linie 18.* <http://www.vgf-ffm.de/de/aktuellpresse/news/einzelansicht/news/frankfurts_tram_netz_waechst_eroelffnung_der_linie_18/> [Accessed 10 September 2014]

W&W AG (2012). *WHS baut erneut im Frankfurter Rebstockpark.* W&W AG [Online]. Available at: <http://www.ww-ag.com/de/presse/unternehmen/presse_informationen/12_07_26__whs_baut_erneut_im_frankfurter_rebstockpark__.html> [Accessed 10 September 2014]

ISSN 2052-0018 (print), ISSN 2053-3667 (online)
Geographical Locality Studies 2014 Volume 2, Number 1. pp. 386–410

F A N N I   S Á F I Á N
MSc, Geographer
PhD Student at Eötvös Loránd Universty, Faculty of Sciences, Doctoral School of Earth Sciences (Geography–Meteorology Programme)
safian.fanni@gmail.com

The Synergies of Community Ownership, Renewable Energy Production and Locality – The Cases of Güssing and Samsø

Abstract

In order to mitigate the consequences of climate change and to reduce energy dependency, new key words of energy planning are local renewable energy sources and energy autonomy. However, renewable energy projects should be implemented in a fast, successful, but also beneficial way for the locality. This paper presents the concept and the main forms of community ownership. According to our hypothesis, the presence of community ownership generates numerous additional benefits for the local economy, society and renewable energy development. Analysing the literature and the cases of Güssing, Austria and Samsø, Denmark help to recognise how to promote a successful local renewable energy project and what kind of additional benefits may be earned by applying the appropriate ownership model and project outline. Community ownership, compared to local ownership forms, can generate a higher level of citizen participation, acceptance of renewable energy projects and change in lifestyle.

Key words

Community ownership; Renewable energy; Local benefits; Güssing; Samsø

1. Introduction

In recent years, the urgent need for a radical change in lifestyle and consumption patterns of the so-called 'developed' countries has been scientifically proven (INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, 2007; STERN, N. 2007; MOTESHARREI, S. *et al.* 2014). One of the main problems causing numerous global and local issues, such as decrease of biodiversity, disappearing habitats, climate change, health damage, political conflicts, etc., is the quantity and quality of current energy production and consumption. Regarding quantity, a radical decrease is needed to reach a sustainable level of energy production and consumption through higher efficiency and sufficiency. In case of quality, an urgent shift from fossil to renewable energy sources would enable to fulfil the real human energy needs with tolerable environmental impacts (INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, 2014).

It is important to notice that these changes cannot be fully realised by focusing only on the energy sector. Moreover, to reach truly sustainable solutions, all three pillars of sustainability—environmental, social and economic—have to be considered, from which social and ecological are often underrated. Meanwhile, contextual settings, like the socio–economic framework—including values, political will, level of democracy, legal settings and regulations, etc.—has to be altered to promote and ensure a thorough and rapid change to sustainable energy systems (MENDONCA, M. *et al.* 2009).

The change of dominant energy sources were also slower processes in history, taking around 50 to 60 years in case of coal or oil, and, presumably, renewable energy sources would not be exceptions from this trend (SMIL, V. 2014), if socio–economic framework were still unnoted and unaltered. Furthermore, planning and implementing renewable energy projects within the same settings can even hinder the spread of sustainable solutions. Renewable energy projects carried out by profit-oriented large companies, without proper relationship with the local residents can cause the so-called NIMBY (Not in My Back Yard) phenomenon (DEAR, M. 1992; BURNINGHAM, K. *et al.* 2006). It arises local resistance towards renewable energy investments which makes the spread of renewables even more difficult and moderated, as it occurred in many situations e.g. in the *United Kingdom* or the *Netherlands* (CASS, N. – WALKER, G. 2009; SCHREUER, A. – WEISMEIER-SAMMER, D. 2010; WARREN, C. R. – MCFADYEN, M. 2010).

However, in other countries like *Germany* or *Denmark*, a widespread and explosive development of renewable energy technologies and production has been experienced. Behind these processes, a high level of residential acceptance of renewable projects (and renewable energy sources in general) was pointed out (BROHMANN, B. *et al.* 2007; WARREN, C. R. – MCFADYEN, M. 2010; MUSALL, F. D. – KUIK, O. 2011). By numerous successful examples, local community ownership was found as a key factor (SCHREUER, A. – WEISMEIER-SAMMER, D. 2010).

According to the author's hypothesis, community ownership is a missing link from the international practice of renewable energy projects, providing sustainable local socio–economic settings related to renewable energy sources, thus creating a sustainable local framework of energy production. Probably this is not the only solution, but one of the most successful operable ones. Therefore, the aim of this paper is to give an insight into community ownership and its significance in renewable energy production and local benefits through the examples of *Güssing* and *Samsø*.

2. Aims and research methods

The aim of this paper is to investigate the significance of community ownership in renewable energy projects in order to create local sustainable energy solutions while maximising benefits for the locality. Therefore, the following research questions have to be answered:

- How can community ownership spread the use of renewable energy, hastening energy transition of localities?
- What benefits can be earned by the locality from community ownership and how can they be maximised?
- What are the key factors of successful community renewable energy projects?

To find answers for these questions, the research work was based on two main methods: literature review and analysis of two case studies.

Regarding literature research, a broad spectrum of review papers and case studies were processed connected to community ownership or community energy projects. They were mainly originated from Europe, focusing on the *United Kingdom*, *Denmark*, *Germany* and *Austria*.

For the case studies, *Güssing (Austria)* and the island of *Samsø (Denmark)* were chosen as successful local renewable energy projects, but each with different community ownership solutions. Besides scientific reports, papers and studies, also the international and local media (news, articles, and websites) were investigated; furthermore, study trips were carried out.

Samsø was visited in May of 2011, where several interviews were carried out with the members of *Samsø Energy Academy*. The interviews were made by two working groups (including the author) of the *Sustainable Energy Planning and Management MSc Program* of *Aalborg University*, *Aalborg*, and partly published by CANET, A. *et al.* (2011).

Two interviews were carried out (and recorded) in November of 2012 in *Güssing* with *Katalin Bődi*, Project Coordinator of *Renewable Energy Centre* (in Hungarian), and *Peter Vadasz*, mayor of *Güssing* (in English). The interviews were made by the author and *László Magyar*, who published the interview questions and partly the answers in his MSc thesis (MAGYAR, L. 2013).

The following chapter clarifies the main concepts of this paper.

3. Theory – community ownership

Since various conditions can be laid down depending on different geographical places (countries), interest groups and time; and also community ownership forms have different models; the definition of community ownership varies by literature and projects. The definition of 'community ownership' used in this paper was outlined by a review of various approaches, presented in the following sections.

3.1. Community and community energy

An often applied definition by WALKER, G. (2008) distinguishes 'communities of interest' and 'communities of localities'. In the first case, the members of a community are living geographically dispersed, for example as individual investors of a renewable energy project. 'Communities of localities' refer to people living in a certain geographical area, which may know each other, but may have diverse interests as well.

TAKÁCS-SÁNTA, A. (2012) argues that (ecological) local small communities could play a key role in forcing bottom-up sustainable transitions. Besides locality and shared interest, he emphasises frequent personal interaction and joint actions for common aims. Since these communities are in fact companionships, he maximises their geographical scale up to micro-regions.

As this paper's aim is to find the way how locality can benefit from renewable energy production and community ownership, it is important to present the concept of 'community energy' as well. According to the DEPARTMENT OF ENERGY & CLIMATE CHANGE (2014) of the *United Kingdom*, community energy means "projects or initiatives shared an emphasis on community ownership, leadership or control where the community benefits". WALKER, G. – DEVINE-WRIGHT, P. (2008) suggest a method to further define the term community energy project through two dimensions of it: process (who develops and runs the project, or who has control or influence over it) and outcomes (who, and in what geographical and social distribution does gain the benefits of a certain project). They define 'ideal' community energy project as one being fully led by local people (open and participatory process) and where all benefits are gained by the local community (local and collective benefits). The other extreme is closed and institutional in process where the benefits are mostly distant and private, which are usual characteristics of conventional renewable energy investments of large companies.

On the basis of the above mentioned, and considering the aim of maximising the benefits of a locality from renewable energy projects, the word 'community' will imply in this paper all residents living in a certain locality (settlement or micro-region) who may be affected and benefited from a certain renewable energy project. All residents influenced by a local renewable energy project can take an active part in the process of a project as a member of a small local community or have a passive role just in gaining benefits.

In this paper, the term 'community energy' means renewable energy project led by a local, small community. The word local is significant besides community since it can ensure the environmental sustainability of a project. Local people are more likely to know and appreciate local values and resources and plan for long-term utilisation solutions for the community rather than short-term individual financial benefits. Moreover, as the social side of sustainability, a project should empower participation and activity of local residents where the collectiveness of benefits is as wide as possible. To meet these requirements, besides to an appropriate project design, a suitable ownership form has to be chosen. In particular, the existence of local investors does not ensure the local spread of benefits of a renewable energy project (e.g. local farmers can buy wind turbines individually). As WALKER, G. (2008) points out regarding local communities, different community ownership forms can ensure different degrees of inclusiveness and collectiveness.

3.2. Renewable energy ownership forms and community ownership models

Before the introduction of the possible community ownership models, the dominant ownership forms are shortly presented by countries—namely *Denmark*, *United Kingdom* and *Austria*—with particular regard to geographical (socio– cultural) contexts such as national specialities and success factors.

In *Denmark*, most of the wind turbines are owned by local residents, communities, farmers or landowners (DEPARTMENT OF ENERGY & CLIMATE CHANGE, 2014). In the middle of the 1990s 80% of the wind power capacities were built by citizens-led projects and only 20% by conventional power companies. In 2004, more than 150,000 people were members of wind co-operatives in *Denmark* (BIRCHALL, B. 2009 cited in BUTLER, J. – DOCHERTY, 2012).

This high level of public participation originates in cultural and historical reasons. Next to the Danish traditions of forming co-operatives, there was a strong anti-nuclear and alternative energy movement in the 1970s, where the topic of renewable energy, energy autonomy and local ownership were discussed (LUND, H. 2010). The innovative technical and also ownership solutions, therefore the integrated spatial planning, the learning-by-doing attitude and the bottom-up strategy were also important factors of success (SCHREUER, A. – WEISMEIER-SAMMER, D. 2010).

The Danish legislation also favours locally owned renewable energy development. The new *Renewable Energy Act* of 2009 (DANISH PARLIAMENT, 2009) includes four new schemes supporting local renewable energy initiatives, from which the option-to-purchase scheme should be highlighted. This scheme states that when a more than 25 m high wind turbine is erected, the investor is obligated to offer at least 20% of the shares to the local (living maximum 4.5 km from the site) residents or the affected municipality (DANISH ENERGY AGENCY, 2014). Furthermore, *Denmark* has a very successful feed-in tariff system, and a strong and wide political will on the side of renewable energy development—including an official governmental plan of a 100% renewable-based energy strategy by 2050 (DANISH GOVERNMENT, 2011).

However, the trend of the dominating community-owned wind turbines seems to change, because since 1995, the majority of repowering and new wind turbines installed are owned by individuals and energy companies (DANISH ENERGY AGENCY, 2009) in different partnership forms (DEPARTMENT OF ENERGY & CLIMATE CHANGE, 2014). These wind turbines are usually larger both in size and capacity—and, therefore, also more expensive—reaching a size which is not affordable to local cooperatives any more (SCHREUER, A. – WEISMEIER-SAMMER, D. 2010).

In the *United Kingdom*, corporative ownership dominates the renewable energy sector. Since an early political choice supported large-scale renewable energy investments and local energy activism had weak traditions, small companies or community ownership forms could not be involved in renewable energy projects (SCHREUER, A. – WEISMEIER-SAMMER, D. 2010). Furthermore, due to the large investments from outsider companies with projects providing a low level of communication and local influence, the NIMBY effect often emerged (MUSALL, F. D. – KUIK, O. 2011). Even in the last decades, unfavourable legislation, lack of tax incentives or cooperative law set back the development of community energy projects (SCHREUER, A. – WEISMEIER-SAMMER, D. 2010).

However, since 2000, the government of the *United Kingdom* has actively started to encourage and support community energy initiatives through numerous support schemes, funding programmes and communication about community energy benefits (WALKER, G. 2008; COMMUNITY POWER, 2013; SEYFANG, *et al.* 2013). Since that, more than 500 ongoing or completed projects were recognised in the *United Kingdom* at the end of 2004 (WALKER, G. 2008). These initiatives form effective networks, especially in *Scotland* where numerous organisations support the development of community renewable energy production (BUTLER, J. – DOCHERTY, P. 2012; HARNMEIJER, A. *et al.* 2012; CARSS, R. 2013). A significant further boost can be expected from the first *Community Energy Strategy* of the *UK*, published in January 2014 by the DEPARTMENT OF ENERGY & CLIMATE CHANGE (2014).

The most usual community ownership forms in the *United Kingdom* are co-operatives (especially for small-scale hydroelectric power projects), community charities, development trusts (particularly in *Scotland*) and shares owned by a local community organisation (WALKER, G. 2008; WALKER, G. – SIMCOCK, N. 2012).

The development of community energy in *Austria* has been significantly driven by biomass projects, namely BDH (biomass district heating) systems from the 1980s. The emergence of the BDH systems was a result of local initiatives of rural areas and the policy aim to support agriculture and forestry (MADLENER, R. 2007). Therefore, capital grants, loans and know-how were ensured for co-operatives, typically organised by farmers (SCHREUER, A. – WEISMEIER-SAMMER, D. 2010).

In the field of wind energy, the GmbH & Co. KG (a private limited partnership with a limited liability company) model and private investor-owned wind portfolio companies are typical, similarly to *Germany* (SCHREUER, A. – WEISMEIER-SAMMER, D. 2010).

In the above examples, according to different geographical, socio–economic and cultural settings, a wide variety of ownership models can be found in the renewable energy sector. The main dimensions of differences are: individual or collective investors; community of interest or locality; producing energy for feed-in (electricity) or for local consumption (heat); scale of investment; full control over a project or just participation through shares; full ownership or co-ownership with a professional investor; and sense of ownership (TLT SOLICITORS, 2007; SCHREUER, A. – WEISMEIER-SAMMER, D. 2010; BUTLER, J. – DOCHERTY, P. 2012; CARSS, R. 2013).

However, focusing on ownership forms providing renewable energy development and benefits for the locality, three main groups of ownership forms can be drafted.

1. Purely community-owned ownership forms: co-operatives; public limited companies; community charities; development trusts, etc.
2. Partly community-owned ownership forms: community ownership of certain turbines or shares; community investment in joint venture; public limited company enabling shares of large, professional investors, etc.
3. Local ownership forms: shares or ownership of local authorities; of local municipality; farmers; local small businesses, etc.

Compared to the first, the 'ideal' group of fully community-owned local renewable energy projects is usually led by local small communities; the second group may partly be open for larger, for-profit investors, while the third shifts to more institutional or even individual, but still local ownership forms. The reason why all these ownership forms are considered here as community ownership forms is that fully community-owned projects are in several cases not possible, suitable, viable or feasible (yet). On the one hand, cooperatives and other community-owned projects have numerous barriers (mainly depending on countries) like access to capital, access to suitable land, lack of awareness and recognition of these ownership models and their benefits (e.g. by authorities or banks), associations with 'socialist' images in *Eastern European* countries, etc. (HUYBRECHTS, B. – MERTENS DE WILMARS, S. 2014). On the other hand, co-operative ownership is not a universal solution for every case. In larger projects, the requested capital cannot be gathered by the local community, therefore inviting investors or creating partnerships can enable to finance the project. Besides the capital, professional experience in technology and project management, co-operative ownership form is more known and acceptable also from the aspect of banks. This can be an advance for commercial partners, if the community can ensure not to shift towards a for-profit direction, where some community benefits can be lost (HUYBRECHTS, B. – MERTENS DE WILMARS, S. 2014). While the ownership forms of the third (local ownership forms) group do not ensure several benefits which could be offered by stronger local communities, locality still provides more benefits (e.g. because of local incomes and supply chains) than conventional investments coming from outsider companies. Also, in some cases where the small local community is a part-owner only, numerous benefits can be ensured through this way, as well; furthermore, some authors highlight the importance of sense of ownership rather than the actual legal form of ownership (SCHREUER, A. – WEISMEIER-SAMMER, D. 2010; WARREN, C. R. – MCFADYEN, M. 2010). However, it can be said that the success of a project, the spread of the benefits and the satisfaction of the participants are depending both on the ownership model and the project design and implementation.

3.3. Benefits of community ownership

Producing community energy, especially in a fully community-owned form creates much more, than just electricity or heat. Compared to a commercial renewable energy investment by a large outsider company, community-owned energy production changes the local socio–economic context in a way that it develops the locality, strengthens local community and promotes the further use of renewable energy sources. Although, these benefits can usually have multiple effects, in the followings, a collection of the possible benefits of community-owned energy production is listed by effects on sustainability and renewable energy production, locality and the local community.

3.4. Benefits for renewable energy production and sustainability (environmental benefits)

- Creating acceptance by the local community for a project. The 'community' label makes the project easier to implement and problems might be solved faster (WARREN, C. R. – MCFADYEN, M. 2010; MUSALL, F. D. – KUIK, O. 2011; HARNMEIJER, A. *et al.* 2012; WALKER, G. – SIMCOCK, N. 2012).
- Creating awareness in environmental issues such as renewable energy sources and local values (WALKER, G. – SIMCOCK, N. 2012). This may cause acceptance and support of further renewable energy projects (WARREN, C. R. – MCFADYEN, M. 2010; HARNMEIJER, A. *et al.* 2012; COMMUNITY POWER, 2013; DEPARTMENT OF ENERGY & CLIMATE CHANGE, 2014; HUYBRECHTS, B. – MERTENS DE WILMARS, S. 2014).
- Raising awareness about (energy) consumption patterns and the individuals' daily life (WALKER, G. – SIMCOCK, N. 2012). Furthermore, the members of a community usually accept more easily the advices from their own community regarding energy consumption and lifestyle (TAKÁCS-SÁNTA, A. 2012; COMMUNITY POWER, 2013; HUYBRECHTS, B. – MERTENS DE WILMARS, S. 2014).
- Decreasing energy consumption (WALKER, G. – SIMCOCK, N. 2012). Several renewable energy co-operatives helped their consumers to reduce their overall energy consumption; some of them were able to reduce it by 20–30% (COMMUNITY POWER, 2013; HUYBRECHTS, B. – MERTENS DE WILMARS, S. 2014).

- Decreasing CO_2-emissions of the community (WARREN, C. R. – MCFADYEN, M. 2010; RAE, C. – BRADLEY, F. 2012; COMMUNITY POWER, 2013).
- Creating innovative solutions and piloting new approaches. Communities can set diverse examples to other communities about innovative solutions in project management, ownership forms, renewable energy integration, smart metering and new technologies, etc. (HARNMEIJER, A. *et al.* 2012; DEPARTMENT OF ENERGY & CLIMATE CHANGE, 2014).

3.5. Benefits for the locality (economic benefits)

- Generating local income. Local ownership forms help to return investments in a number of ways, e.g. selling the electricity that is produced (HARNMEIJER, A. *et al.* 2012; WALKER, G. – SIMCOCK, N. 2012; COMMUNITY POWER, 2013; LI, L. W. *et al.* 2013).
- Creating local employment. The installation and maintenance of the energy producing unit as well as project management or providing local sources from agriculture or forestry increase the number of local jobs (RAE, C. – BRADLEY, F. 2012; BUTLER, J. – DOCHERTY, P. 2012; WALKER, G. – SIMCOCK, N. 2012; DEPARTMENT OF ENERGY & CLIMATE CHANGE, 2014).
- Regeneration of local economy. Spending extra income and taxes on local goods and services can also boost the local economy (WALKER, G. – SIMCOCK, N. 2012).
- Providing cheaper and more reliable energy. This can help on areas suffering from energy or fuel poverty (BUTLER, J. – DOCHERTY, P. 2012; RAE, C. – BRADLEY, F. 2012; COMMUNITY POWER, 2013; DEPARTMENT OF ENERGY & CLIMATE CHANGE, 2014; WALKER, G. – SIMCOCK, N. 2012).
- Mobilising non-market resources (HUYBRECHTS, B. – MERTENS DE WILMARS, S. 2014).
- Creating eco or energy-tourism in an area with visitor facilities (WARREN, C. R. – MCFADYEN, M. 2010; BUTLER, J. – DOCHERTY, P. 2012; LI, L. W. *et al.* 2013).

3.6. Benefits for the local community (social benefits)

- Strengthening community cohesion and deepening local social capital (WALKER, G. – SIMCOCK, N. 2012; COMMUNITY POWER, 2013; DEPARTMENT OF ENERGY & CLIMATE CHANGE, 2014). The participants of a project get to know each other and work for a common aim which can generate further successful co-operations as well.
- Local control. The local community is able to influence the site, scale and other characteristics of a local project (WALKER, G. 2008; DEPARTMENT OF ENERGY & CLIMATE CHANGE, 2014) in a democratic decision-making process (HUYBRECHTS, B. – MERTENS DE WILMARS, S. 2014) which can ensure a higher level of satisfaction of the participants.
- Increasing community engagement and participation (RAE, C. – BRADLEY, F. 2012).
- Strengthening local identity of the community; building pride in them (WARREN, C. R. – MCFADYEN, M. 2010; MUSALL, F. D. – KUIK, O. 2011; LI, L. W. *et al.* 2013).
- Engendering trust in the project and the stakeholders (HUYBRECHTS, B. – MERTENS DE WILMARS, S. 2014).
- Developing new skills and self-confidence (DEPARTMENT OF ENERGY & CLIMATE CHANGE, 2014). Project participants of the community—and also from a wider circle—may improve their project management, communication, etc. skills regardless age or education.

4. Practice – case studies

To present how the theories of the above mentioned work in practices, two case studies are presented in this chapter: initiatives on the island of *Samsø* in *Denmark*, and the district of *Güssing* in *Austria*. Both initiatives are internationally known examples as of successful projects, reached through different ways.

4.1. Samsø

Samsø (Figure 1) is a 26 km long and 7 km wide island situated in the *Kattegat*, close to the geometric centre of *Denmark* with a decreasing population of 4000 local residents, traditionally living from farming and tourism (ANDERSEN, T. R. *et al.* 2013). In 1997, the *Danish Ministry of Energy* announced a competition for the most realistic plan for a 100% renewable energy self-sufficiency strategy of an island, to be realised in 10 years (ANDERSEN, T. R. *et al.* 2013). *Samsø* won the competition, winning around one million Euros for preliminary studies and project materials (JØRGENSEN, P. J. *et al.* 2007).

Figure 1 – The situation of Samsø in Denmark and in Europe.
Edited by SÁFIÁN, F. (2014)

Søren Hermansen, an environmental studies teacher undertook the leadership of the project, and later became the director of the *Samsø Energy Academy*, established in 2006. He put a huge effort to reach and activate local citizens through numerous local meetings, discussions, later seminars about renewable energy options, while the popularity, trust and interest were growing regarding the project. Soon after the start, energy cooperatives, local energy companies, *the Samsø Energy Company* (from 2005: Agency), and *Samsø Energy and Environment Office* were established (JØRGENSEN, P. J. *et al.* 2007; RADZI, A. 2009).

Several energy saving programs were launched. Regarding heat consumption, five programs were run including renovation grants for pensioners, free energy appraisals, demonstration of alternative insulation materials made by local carpenters, etc. Electricity saving programs promoted several energy saving options and applications and to change electrical heating to other solutions. Despite the huge efforts, however, between 1997 and 2005, heat consumption increased by 10%, while electricity consumption stagnated (JØRGENSEN, P. J. *et al.* 2007).

Next to the existing district heating plant in *Tranebjerg*, three new systems were established, often with the help of extremely active local groups initiating new plants, collecting new consumers, and several times changing the details of the original master plan. The new plants are based on locally produced renewable energy sources: straw, wood chips and solar heat. One is owned by the energy utility company *NRGi*, one by its consumers in a cooperative ownership (run by a cooperative association including members of the company and consumers elected by the municipality and the consumers) and one by a local energy company (run by a local committee consisting of members of the company, the consumers and an island council member). In the case of the latter two, changes of heat prices are approved by the municipal council, providing the lowest heat prices on the island (JØRGENSEN, P. J. *et al.* 2007; RADZI, A. 2009; ANDERSEN, T. R. *et al.* 2013).

In order to produce the island's electricity needs from local renewable energy, 11 on-shore wind turbines were erected in 2000, each of 1 MW. The project has a wide local acceptance due to the option of local ownership. Finally, 9 turbines are owned by local farmers and two of them by a cooperative of 450 local residents (JØRGENSEN, P. J. *et al.* 2007; ANDERSEN, T. R. *et al.* 2013). To offset the transportation's mainly fossil energy consumption, 10 offshore wind turbines were planned 3.5 kilometres away from *Samsø* of a total of 23 MW. The municipality owns 5 turbines, 3 was bought by large investors, and the last two is owned by small local investors through 1,500 shares in two companies (JØRGENSEN, P. J. *et al.* 2007).

Since the aim of 100% self-sufficiency based on (mostly local) renewable energy sources had already been fulfilled by 2005, the overall project is considered to be successful—even if it means only an offset of fossil energy use of some sectors. The district heating systems provide 43% of the heat consumption and approximately half of the all-year houses invested in renewable energy applications for heat production. While some parts of the master plan failed to be realised, some initiatives in transportation and agriculture sector (e.g. farmer producing rape oil) were also successful. The average investment of the whole project was around 14,300 Euros (~11,414 GBP) per capita, from which public subsidies accounted for approximately 1000 Euros (~800 GBP), while an estimated 1300 Euros (~1,040 GBP)per capita remains on the island, previously spent on electricity or fossil energy sources (JØRGENSEN, P. J. *et al.* 2007).

4.2. Güssing

The town of *Güssing (Figure 2)* with around 4000 inhabitants is the capital of *Güssing* district (with an estimated population of 26,394 in 2014), situated next to the South Eastern boarder of *Austria*. Due to its peripheral situation and poor infrastructure, in the 1980s, this was the poorest district of Austria with high migration and unemployment rate and 70% of the workers commuting (VADASZ, P. – BŐDI, K. 2012). The economic situation of the town was very problematic: *Peter Vadasz*, town council member (later mayor of *Güssing*) and *Reinhard Koch* engineer pointed out, that as the largest expenditure *Güssing* spends 6 million Euros annually for importing electricity and fossil fuels, while this amount of money could remain locally. In 1990, the town council accepted their new policy proposal with the unconventional aim of starting a municipal business for local renewable energy production, aiming the phasing-out of all fossil fuel consumption in the long-term.

The transition process was accelerated when *Peter Vadasz* who was elected to the mayor of *Güssing* (MARCELJA, D. 2010).

Figure 2 – The situation of Güssing in Austria and in Europe.
Edited by SÁFIÁN, F. (2014)

Already since 1989, energy saving investments have been made in public buildings such as insulation, changing windows or implementing better monitoring and maintenance practices, actively communicated to the local residents. As a consequence, after a few years, energy expenses of the public sector decreased by 40–50% (VADASZ, P. 2012, VADASZ P. – BŐDI K. 2012).

When planning the transition to local renewable energy sources, local wood seemed to be the most significant energy source, since 45% of the district is covered with forests. To solve the problem of the fragmented forest parcels, 5200 forest owners established the *Forest Association of Burgenland (Burgenländischer Waldverband)* and signed a contract with the municipality to deliver and process wood fuels for local energy production. Therefore, wood chips from local forestry and industrial wastes ensured cheap and local renewable sources for self-sufficiency (SIKOR, T. 2008).

In 1991, a biodiesel plant was opened from the initiative of the government of *Burgenland* in co-operative form, producing a larger quantity of biodiesel per year than the fuel consumption of the local transportation. In 1992, the first small district heating plant was built near to *Güssing* which was followed by dozens of similar biomass-based local district heating systems in the district. The initiatives were mostly led by the municipality, in some cases by local individuals or farmers, owned by co-operatives of local farmers or the municipality (EUROPEAN CENTRE FOR RENEWABLE ENERGY, 2011; SIKOR, T. 2008). Before these investments, information campaigns were carried out to present the advances of the district heating systems to the rather sceptical local residents. Furthermore, investors also tried to ensure heat demand by connecting public buildings and industrial consumers to the district heating system (VADASZ P. – BŐDI K. 2012). In 1996, the biggest CHP (combined heat and power) plant of *Austria* was built in *Güssing in terms of capacity*. It is owned by the municipality in 80% (BŐDI, K. *ex verb.* 2014.), supplying more than 600 households, all public buildings and existed and new companies in *Güssing*, creating more local job opportunities. In 2001, a new CHP power plant was built as the first in the world applying an *Austrian* innovation of the fluidised bed steam gasification technique, enabling to produce synthetic gas, liquid fuel or hydrogen. With the establishment of the *European Centre for Renewable Energy* in *Güssing*, further researches and experiments were encouraged, and also eco-tourism was generated from all over the world (MARCELJA, D. 2010; EUROPEAN CENTRE FOR RENEWABLE ENERGY, 2011). The investments were mostly financed and supported by the local municipalities, the state of *Burgenland*, after 1995 by the *European Union*, and since 2003, by *Austria* through new legislation favouring green electricity production (MÜLLER, M. O. *et al.* 2011).

The development of renewable energy in *Güssing* enabled to reach 71% of self-sufficiency in 2010 regarding private households, public buildings and industry. Without considering industry and services, since 2001, the town is producing more electricity, heat and fuel, than it consumes; gaining extra profit which is reinvested in renewable energy development. The annual net municipality income is more than 9 million Euros (£7.2 Million) from energy production, while energy sales reache 14 million Euros (£11.2 Million) per year (MARCELJA, D. 2010). Regarding the whole region of *Güssing*, the level of self-sufficiency was approximately 50% in 2006 (KOCH, R. *et al.* 2006, VADASZ, P. 2012). More than 50 new companies and 1,100 new jobs were created (MARCELJA, D. 2010). However, while energy production became local and renewable-based, there is no information about changes in consumption patterns of the residents, meaning that the renewable energy production is just offsetting the fossil fuel consumption, especially regarding transportation. Furthermore, bio fuel production and selling paused in *Güssing* due to financial barriers (BŐDI, K. 2014).

5. Discussion and Conclusion

Both of the case studies are considered as successful initiatives, having numerous characteristics in common. Both *Güssing and Samsø* are isolated areas in a geographical and/or socio–economical way, therefore focusing on local energy sources was obvious in their case. Problematic economic and social arrangements forced the local governments to invest in a fundamental change and participants to create innovative solutions. Both communities had a charismatic "local hero" who has been able to take over and see through the whole concept and manage different community interests, scepticism of citizens and conflicts between stakeholders. Also, they had a transparent and detailed plan, created with professionals, and well-communicated to the local people. Community ownership forms, supportive regulation environment and available funds also played an important role in the development process. These common things can be said to be keys of success of local renewable energy projects.

As a consequence, the gained benefits are also similar in the two localities: significant renewable energy production; cheaper energy (regarding district heating: by 30% in *Güssing*, according to RADZI, A. 2009), and more stable energy prices (in some cases decided by the municipality); impressive decrease in CO_2-emissions; keeping incomes and values locally; new jobs and enterprises; stronger local economy; innovative solutions; and eco-tourism.

However, there are also some important differences, from which the issue of the community ownership should be highlighted. Both projects were originally started as top-down initiatives. However, they partly evolved into several bottom-up actions locally, which were more widespread and more active in the case of *Samsø*. This may be a result of a higher level of communication and involvement of local people, encouraging them to take part in the planning, decision and implementation stages. The other reason is that in *Samsø* project developers ensured the opportunity for local residents not only to have influence on the project, but also to be owners of renewable equipment. This generated an essential element to ensure active participation and support: the economic interest of residents. In *Güssing*, mostly the municipality and local farmers' cooperative own the energy producing units, with a significant beneficial effect on the partners of the local fuel supply chains in the agriculture and forestry sectors. In *Samsø*, numerous households have shares in wind turbines, district heating power plants or individual renewable energy equipment. Therefore, they are more supportive and active regarding renewable energy investments and participation on community-related issues. Furthermore, forming small local communities (e.g. in form of organisations) through working on common aims can help to spread new ways of thinking, lifestyle and energy consumption efforts in the community (TAKÁCS-SÁNTA, A. 2012), which was the case in *Samsø* as well (RADZI, A. 2009). Therefore, it can be stated, that community ownership, renewable energy development, stronger local communities and participation of citizens are strengthening each other and the creation of further benefits for the locality.

According to the main groups of ownership forms presented in section 3.2, *Güssing* can be said to have rather local than community energy, while *Samsø* has good examples for fully or partly community-owned energy production. As it was discussed above, the most of the benefits are the same in both projects, since in the case of *Güssing*, a very transparent, well-communicated and opened project outline was created and implemented, with an effort to involve local citizens. However, this intention could have been more efficiently fulfilled with the application of community ownership.

Acknowledgements

I would like to thank *Katalin Bődi (European Centre for Renewable Energy, Güssing)* for being available for the interview and for her further answers online; *Michael Larsen (Energy Academy, Samsø)* for the up-to date information and statistics; and *László Magyar* for the opportunity to carry out interviews together in *Güssing*.

References

ANDERSEN, T. R. – BURR, M. S. – FINNBOGASON, S. K. – JOHANNESSON, M. – ZANETTI, S. L. (2013). *Samsø – a 2.0 Perspective: From the Renewable Energy Island to the Fossil Fuel Free Island.* 11 p.

BROHMANN, B. – FEENSTRAB, Y. – HEISKANENC, E. – HODSOND, M. – MOURIKB, R. – PRASADE, G. – RAVENB, R. (2007). *Factors influencing the societal acceptance of new, renewable and energy efficiency technologies: Meta-analysis of recent European projects.* – European Roundtable for Sustainable Consumption and Production, Basel, 18 p.

BURNINGHAM, K. – BARNETT, J. – THRUSH, D. (2006). *The limitations of the NIMBY concept for understanding public engagement with renewable energy technologies: a literature review.* Beyond Nimbyism: a multidisciplinary investigation of public engagement with renewable energy technologies, Working Paper 1.3. 20 p.

BUTLER, J. – DOCHERTY, P. (2012). *Securing the Benefits of Wind Power in Scotland: A new concept for community benefit provision.* – Vento Ludens Ltd & Docherty Consulting Ltd. 78 p.

CANET, A. – GITHII, P. – GUILLAMET, T. – KONSTAS, S. – SÁFIÁN, F. (2011). *Feasibility Study of the Introduction of Electric Vehicles in Samsø.* – Aalborg: Aalborg University, 78 p.

CARSS, R. (2013). *Community and locally owned renewable energy in Scotland, June 2012*. – Edinburgh: Energy Saving Trust, 29 p.

CASS, N. & WALKER, G. (2009). *Emotion and rationality: The characterisation and evaluation of opposition to renewable energy projects.* – Emotion, Space and Society, 2, 62–69.

COMMUNITY POWER (2013). *The Benefits of an Energy Revolution.* – Community Power Project, 11 p.

DANISH ENERGY AGENCY (2009). *Wind Turbines in Denmark.* – Copenhagen, 31 p.

DANISH GOVERNMENT (2011). *Energy Strategy 2050 – from coal, oil and gas to green energy.* – Copenhagen: The Danish Ministry of Climate and Energy. 65 p.

DANISH PARLIAMENT (2009). *Promotion of Renewable Energy Act (translation)*. – Online: GlobalDenmark Translations, 27 p.

DEAR, M. (1992). *Understanding and Overcoming the NIMBY Syndrome.* – Journal of the American Planning Association, 58, 288–300.

DEPARTMENT OF ENERGY & CLIMATE CHANGE (2014). *Community Energy Strategy: Full Report.* – London, 107 p.

EUROPEAN CENTRE FOR RENEWABLE ENERGY (2011). *The Development of Renewable Energy in Güssing.* – Vienna, 8 p.

HARNMEIJER, A. – HARNMEIJER, J. – MCEWEN, N. – BHOPAL, V. (2012). *A Report on Community Renewable Energy in Scotland.* – SCENE Connect Report. Sustainable Community Energy Network; Wageningen University, Netherland; University of Edinburgh, Scotland

HUYBRECHTS, B. – MERTENS DE WILMARS, S. (2014). *The relevance of the cooperative model in the field of renewable energy.* – Annals of Public and Cooperative Economics, 85., 16 p.

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (2007). *The Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* – Geneva, Switzerland

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (2014). *Climate Change 2014: Mitigation of Climate Change.* – IPCC Working Group III Contribution to AR5.

JØRGENSEN, P. J. – HERMANSEN, S. – JOHNSEN, A. – NIELSEN, J. P. – JANTZEN, J. – LUNDÉN, M. (2007). *Samsø - a Renewable Energy Island: 10 years of Development and Evaluation.* – Samsø: PlanEnergi and Samsø Energy Academy, 60 p.

KOCH, R. – BRUNNER, C. – HACKER, J. – URSCHIK, A. – SABARA, D. – HOTWAGNER, M. – AICHERNIG, C. – HOFBAUER, H. – RAUSCHER, W. – FERCHER, E. (2006). *Energieautarker Bezirk Güssing. Berichte aus Energie- und Umweltforschung.* – Güssing: Bundesministeriums für Verkehr, Innovation und Technologie. 178 p.

LI, L. W. – BIRMELE, J. – SCHAICH, H. – KONOLD, W. (2013). *Transitioning to Community-owned Renewable Energy: Lessons from Germany.* – Procedia Environmental Sciences, 17, 719–728.

LUND, H. (2010). *Renewable Energy Systems: The Choice and Modeling of 100% Renewable Solutions.* – 275 p.

MADLENER, R. (2007). *Innovation diffusion, public policy, and local initiative: The case of wood-fuelled district heating systems in Austria.* – Energy Policy, 35, 1992–2008.

MAGYAR, L. (2013). *A bicskei járás megújuló energiákra épülő energiagazdasági terve a rendelkezésre álló potenciálok és földhasználati viszonyok tükrében.* MSc Thesis – Eötvös Loránd University, 79 p.

MARCELJA, D. (2010). *Self-sufficient Community: Vision or Reality? Creating a Regional Renewable Energy Supply Network (Güssing, Austria).* In: VAN STADEN, M. & MUSCO, F. (eds.) *Local Governments and Climate Change. Advances in Global Change Research (39)* – Springer Science + Business Media B.V., pp. 217–228.

MENDONCA, M. – LACEY, S. – HVELPLUND, F. (2009). *Stability, participation and transparency in renewable energy policy: Lessons from Denmark and the United States.* – Policy and Society, 27, pp. 379–398.

MOTESHARREI, S. – RIVAS, J. – KALNAY, E. (2014). *Human and nature dynamics (HANDY): Modeling inequality and use of resources in the collapse or sustainability of societies.* – Ecological Economics, 101, pp. 90–102.

MUSALL, F. D. – KUIK, O. (2011). *Local acceptance of renewable energy: A case study from southeast Germany.* – Energy Policy, 39, pp. 3252–3260.

MÜLLER, M. O. – STÄMPFLI, A. – DOLD, U. – HAMMER, T. (2011). *Energy autarky: A conceptual framework for sustainable regional development.* – Energy Policy, 39, pp. 5800–5810.

RADZI, A. (2009). *100% Renewable Champions: International Case Studies.* In: DROEGE, P. (ed.) *100% Renewable: Energy Autonomy in Action.* – London; Sterling, VA: Earthscan, pp. 93–165.

RAE, C. – BRADLEY, F. (2012). *Energy autonomy in sustainable communities—A review of key issues.* – Renewable and Sustainable Energy Reviews, 16, pp. 6497–6506.

SCHREUER, A. – WEISMEIER-SAMMER, D. (2010). *Energy cooperatives and local ownership in the field of renewable energy technologies: a literature review.* – Research Reports, RICC, 4.

SEYFANG, G. – PARK, J. J. – SMITH, A. (2013). *A thousand flowers blooming? An examination of community energy in the UK.* – Energy Policy, 61, pp. 977–989.

SIKOR, T. (2008). *Public and Private in Natural Resource Governance: A False Dichotomy?* – London, Stering, Earthscan, pp. 155–165.

SMIL, V. (2014). *The long slow rise of solar and wind.* – Scientific American, 282, pp. 52–57.

STERN, N. (2007). *The economics of climate change: the Stern review*. – Cambridge University Press

TAKÁCS-SÁNTA, A. (2012). *Kevesebb idiótát! Hogyan törhetne át az ökológiai politika?* In: PÁNOVICS, A. – GLIED, V. (eds.) *...Cselekedj lokálisan!* Társadalmi részvétel környezeti ügyekben. – Pécs: PTE ÁJK – IDResearch Kft. / Publikon Kiadó, pp. 33–39.

TLT SOLICITORS (2007). *Bankable Models Which Enable Local Community Wind Farm Ownership: A report for the Renewables Advisory Board and DTI.* – London: Department of Trade and Industry, 48 p.

VADASZ, P. (2012). *Welcome to Güssing, 31 May 2012: An example for sustainable energy supply.* – Güssing: Europäisches Zentrum für Erneuerbare Energie Güssing GmbH.

VADASZ, P. – BŐDI, K. (2012). *Interview with Peter Vadasz (major of Güssing) and Katalin Bődi (European Renewable Energy Centre).* In: MAGYAR, L. – SÁFIÁN, F. (eds.). Manuscript.

WALKER, G. (2008). *What are the barriers and incentives for community-owned means of energy production and use?* – Energy Policy, 36, pp. 4401–4405.

WALKER, G. – DEVINE-WRIGHT, P. (2008). *Community renewable energy: What should it mean?* – Energy Policy, 36, pp. 497–500.

WALKER, G. – SIMCOCK, N. (2012). *Community Energy Systems.* In: SMITH, S. J. (ed.) *International Encyclopedia of Housing and Home.* – Oxford: Elsevier, 194–198.

WARREN, C. R. – MCFADYEN, M. (2010). *Does community ownership affect public attitudes to wind energy? A case study from south-west Scotland.* – Land Use Policy, 27, pp. 204–213.

Electronic sources

DANISH ENERGY AGENCY (2014). *Local citizens' option to purchase wind turbines shares* [Online]. Available at: <http://www.ens.dk/en/supply/renewable-energy/wind-power/onshore-wind-power/local-citizens-option-purchase-wind-turbines> [Accessed: 14 April 2014].

ISSN 2052-0018 (print), ISSN 2053-3667 (online)
Geographical Locality Studies 2014 Volume 2, Number 1. pp. 412–437

W O J C I E C H   G O R Y L
MSc, Eng. Power Engineer, PhD Student
AGH University of Science and Technology, Faculty of Energy and Fuels, Krakow
The Krakow Institute for Sustainable Energy
wgoryl@agh.edu.pl

Á D Á M   H A R M A T
MSc, Geographer
PhD Student at Eötvös Loránd University, Faculty of Sciences, Doctoral School of Earth Science
harmatadam@caesar.elte.hu

The Characteristics of the Biomass Sector in Poland and Hungary

Abstract

Biomass is a limited resource and should be used in a possibly optimal way. It is argued that for many countries in Europe, especially Hungary and Poland, the best use of the existing potential is to produce electricity and heat by small co-generation plants and/or to secure space heating for buildings in rural areas from the locally available biomass. Presently, a hot debate is taking place in Hungary and Poland about the use of biomass for power generation in existing coal power stations (co-firing biomass with coal). Many politicians and experts strongly oppose this way of meeting the environmental goals of reduction of CO2 emissions. The arguments are of technological, logistic and foremost of economic nature. In this contribution, many arguments against the use of biomass for only power generation is presented. The aim of this paper is to set two ways of bio-mass power generation against each other with analysing the biomass sectors of the two countries mentioned above.

Key words

Biomass; Cogeneration; Local use of biomass; Heat; Electricity

1. Introduction

One of the biggest—still unsolved—problems of the humanity is the issue of the global energy systems. The exhaustion of fossil fuels and the intensifying climate change put more and more pressure on them to place these systems on new bases. Furthermore, the energy systems of the Central European countries are based on imported fossil fuels; hence, they are questionable from an environmental point of view, as well as from an economic and social one. However, the utilisation of their renewable energy sources is only incipient and often unsustainable. The aim of this study is to analyse the most significant renewable energy sector (RES), which is the biomass, its operational problems in *Poland* and *Hungary*, and give suggestions for their solutions.

2. Situation of the renewable energy sectors of Poland & Hungary

Energy production from renewable energy sectors in Poland has been growing: from 4,321 ktoe (181 PJ) (7%) to 7,449 (312 PJ) ktoe (10.4%) in 2004 and 2011, respectively (EUROSTAT, 2014a). In 2012, renewable energy sources in Poland contributed 11% to gross final energy consumption was which constituted 8,478 ktoe (356 PJ) *(Figure 1)*.

This increasing trend is driven by the need to achieve the targets set by the *European Union*. It is seen, that solid biomass has the largest share (82%) of the chart in the gross final energy consumption in *Poland*, followed by biodiesels (7%), wind (5%), hydropower and biogas (2%).

Compared with *Poland*, the Hungarian RES has the same sharply growing share in energy production: in 2004, 950 ktoe (40 PJ) were produced by the RES (5.1% of the total gross final energy consumption), in 2011, 1,857 ktoe (78 PJ) (9.1 %), which is 95% of growth. The main background cause of this increase is also the compulsory EU target. In 2012, the above mentioned ratio was 9.6 % (1,965 ktoe, 82 PJ). As in *Poland*, the solid biomass has the largest contribution (70.5%), which is smaller than in Poland by 12%. However, the potentials of the

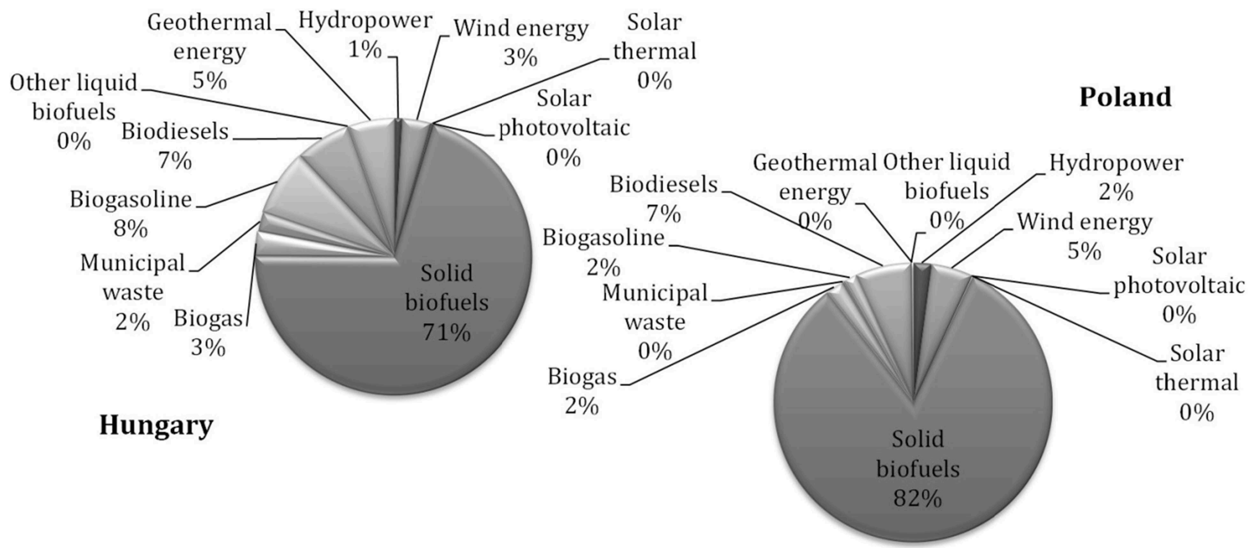


Figure 1 – The share of renewable energy sources (RES) of gross final energy consumption in Hungary (left) and in Poland (right)

Source: EUROSTAT (2014a); Edited by BOKOR, L. (2014)

other renewable sources could afford a more balanced energy mix (MUNKÁCSY, B. 2011). This amount is by 12% smaller than in *Poland*. On the other hand, in *Hungary*, the share is by 6% and 5% higher for biofuels and geothermal energy, respectively. The differences for other RES sectors between the two countries are below 2% (EUROSTAT, 2014a).

3. Potentials and forecast

Estimates of the potential of biomass vary depending on the assumptions concerning—for example—the acreage available for energy crops plantations, the permissible degree of extraction of wood from the forests, competition for straw for other uses, such as cattle bedding, mushroom production, etc. The technical potential of solid biomass in *Poland* is estimated at about 19–24 Mtoe/year (800–1000 PJ) (MINISTRY OF ENVIRONMENTAL PROTECTION, 2000; MINISTRY OF ECONOMY, 2007), although there are also lower estimates at the level of 2.4 Mtoe (100 PJ) (MINISTRY OF ENVIRONMENTAL PROTECTION 2000). On the other side, the *European Environment Agency* (hereinafter EEA) estimate (EUROPEAN ENVIRONMENTAL AGENCY, 2007) gives higher values: 14.5 Mtoe/y (608 PJ), 24.1 Mtoe/y (1,011 PJ) and 30.4 Mtoe/y (1,271 PJ) in 2010, 2020 and 2030, respectively.

The dominance of biomass in energy production is predicted to continue. According to the government document *Energy Policy of Poland until 2030* (MINISTRY OF ECONOMY, 2009) solid biomass will constitute the highest share in energy production (electricity and heat) from RES in the future, reaching 7.3 Mtoe/y (306 PJ) in 2030. Electricity generation by wind will follow with 1.5 Mtoe/y (63 PJ), and by biogas (electricity and heat) with 1.4 Mtoe/y (59 PJ).

The theoretical potential of solid biomass in *Hungary* is about 4.85–7.83 Mtoe/y (this estimate also includes the biogas potential, as calculated by the *Hungarian Academy of Science*) (IMRE L. – BOHOCZKY F. 2006). The technical potential is 3.96 Mtoe/y (also includes the biogas potential as calculated by the *Ministry of Environment and Water*) (FARAGÓ, T. – KERÉNYI, A. 2003). However, according to the analysis by the Hungarian *Eötvös Loránd University* research group, *Department of Environmental and Landscape Geography*, the technical potential is higher: 4.01 Mtoe/y (5.92 Mtoe/y if biogas is included) (HARMAT, Á. – MUNKÁCSY, B. 2011).

In the case of *Hungary*, the *EEA* estimates are lower than the national ones: 1.2 Mtoe/y, 2.2 Mtoe/y, and 3.1 Mtoe/y in 2010, 2020 and 2030, respectively (EUROPEAN ENVIRONMENTAL AGENCY, 2007).

According to the *Hungarian Renewable Energy Action Plan* (MINISTRY OF NATIONAL DEVELOPMENT, 2010), in 2020 solid biomass will contribute 0.23 Mtoe/y (9.63 PJ) and 1.225 Mtoe/y (51.29 PJ) for electricity and heat energy production, respectively. We can clearly observe that this target value is far below the estimated potentials, thus in long term a greater degree of utilisation is possible. In 2020, the planned renewable energy mix will be more balanced: the biomass will contribute 62% to power generation, heating–cooling and transport, followed by geothermal energy (17%), heat pumps (6%), wind and biogas (5–5%), solar energy (3%) and hydropower (1%).

4. Unsustainable use of biomass

The energy sectors of the two countries reflect their common history. In the socialist era, the self-sufficiency model appeared in the energy sector through the construction of the big coal-fired power stations that were established on local coal resources and dominated by delivering natural gas and refined crude oil from *Russia* (in those days from the *Soviet Union*). Both energy systems were centralised and characterised by large scale power stations. Nowadays, in both countries, the dominant part of the biomass-based electricity is still produced in those big power stations, by adding biomass to coal which decreases the overall efficiency of power generation and has a serious impact on the environmental, social and economic aspects. Moreover, those highly centralised systems generate energy hundreds of kilometres away from the consumers as opposed to the distributed power generation concept which will be discussed below.

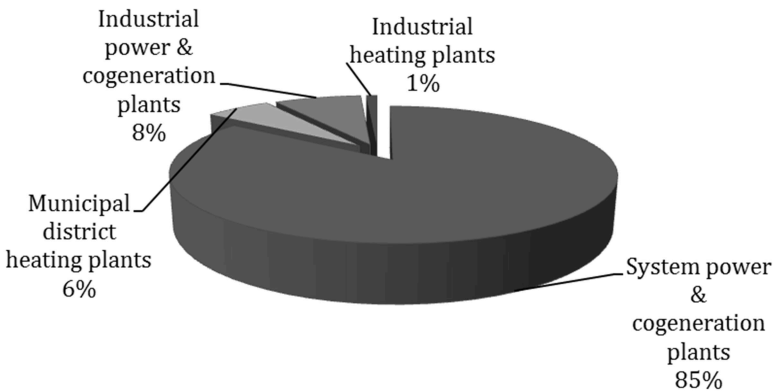


Figure 2 – Actual use of biomass for energy purposes in Poland

Source: GUS, 2013.

The chart in *Figure 2* illustrates the structure of the use of biomass for energy purposes in *Poland*. As it is seen, the lion's share constitutes power generation from biomass (93%) while heat plays a minor role. The dominant technology in biomass-based power generation is co-firing biomass with-coal in the existing pulverised coal boilers in the existing power stations. This policy and practice are increasingly criticised by environmental NGOs, experts and academics, both in *Poland* and *Hungary*, as well as in other European countries. This criticism is particularly strong in *Poland*, because of the scale of the investments in co-firing. One should mention, in particular, the spectacular Greenpeace demonstration during the COP19 in *Warsaw* in 2013 (GREENPEACE, 2013) and of *Greenpeace Poland* in *Turow Power Station* (GREENPEACE, 2012). The criticism is also expressed by the *Polish Biomass Association* POLBIOM, the members of which are experts in energy use of biomass. Furthermore, academics present strong arguments against biomass-based power generation and, in fact, against the use of biomass in installations requiring large deliveries of the biomass fuel. Serious reservations addressing this issue were expressed by industry representatives, in the presentations during the 2011, 2012 and 2013 editions of the *Forum of Biomass Combustion*, for example by representatives of *AGH University of Science and Technology* in *Krakow*, *Czestochowa University of Technology* or *Silesian University of Technology*.

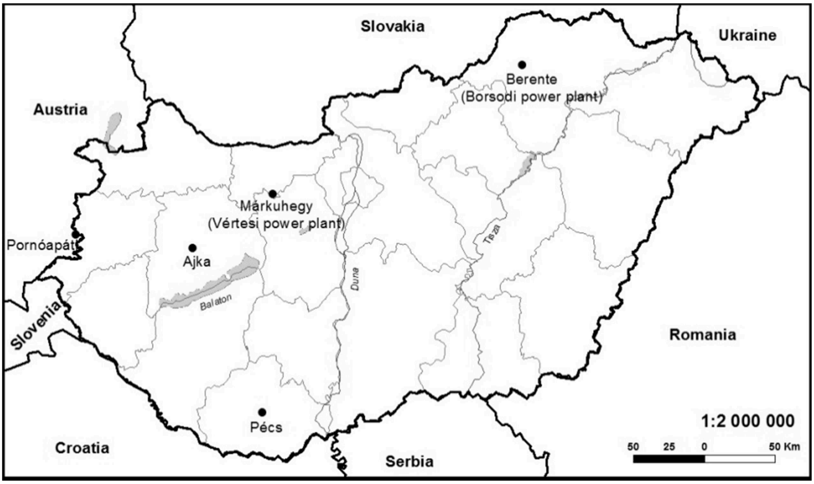


Figure 3 – Hungary and the places mentioned in this paper
Edited by HARMAT, Á. (2014)

The idea of using biomass to replace a fraction of coal in power generation sector is justified in terms of reducing emissions of carbon dioxide and sulphur dioxide to the atmosphere. The *European Union* directives put special emphasis on emissions from the power sector[6]. In *Poland* the main technology that has been chosen was adding bio-

[6] There are the same two directives in both (Polish and Hungarian) cases:
a) The Large Combustion Plant Directive 2001/80/EC (LCPD) is important in reducing emissions of SO_2, NOx and dust from combustion plants having a thermal input capacity equal to or greater than 50 MW.
b) Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity from renewable energy sources in the internal electricity market. The Member States which joined the EU in 2004 must apply the provisions of Directive 2001/77/EC on producing electricity from renewable energy sources. Their Accession Treaty sets national indicative targets for the proportion of electricity produced from RES (RES-E) in each new Member State the result of which is an overall objective of 21% for the EU–25.

mass to coal in the existing power plants, because it seemed to be the cheapest way to meet the targets imposed by the *European Union*. In *Hungary*, another reason was the stricter air quality standards. In 2004, three old coal-fired power plants (*Pécs*: 50 MW; *Borsodi:* 30 MW; *Ajka*: 20 MW *[Figure 3]*) should have been closed down because their air pollution would have been over the limit. Therefore, the power plants were converted to co-firing biomass with coal, instead of installing flue-gas cleaning system (PAPPNÉ, V. J. 2010).

From economic point of view the co-firing made sense, because building new installations from scratch could be avoided and the reporting effect could be achieved relatively quickly. This approach was stimulated by a system of the so-called green certificates (which is still in place), in which additional gratification is paid to "green" electricity producers in form of tradable certificates. For instance, in *Poland*, in this way for each MWh of "green" electricity the power generating companies received about three times more money than for the "traditional" (black, coal-based) MWh. On top of the price of a "black" MWh (ca. 35 EUR) they were rewarded by 70 EUR/MWh in form of green certificates. Incidentally, it should be noted that those costs are internalised in the electricity tariffs and are ultimately covered by the final electricity consumers.

There are three main problems in co-firing biomass with coal: 1. transportation of large volumes of biomass, 2. technological problems on the generation side and, last but not least, 3. cost of the "green" electricity.

4.1. Transportation of large volumes of biomass

Regarding transportation, one should note that, compared with coal, biomass is characterised by lower calorific value (about 50%) and lower bulk density (20–50%). Thus, the amount of energy contained in a given volume of biomass is only about 25% of the corresponding energy contained in the same volume of coal (GULA, A. *et al.* 2012). This obviously translates into the consumption of liquid fossil fuels and corresponding emissions, as well as other environmental and economic costs related to the life cycle of vehicles, attrition of roads, etc. This effect can obviously be minimised, if the biomass were used locally, i.e. possibly close to the place where it is produced. Moreover, the location of a coal power station is based on the easiest access to the fossil fuels. Therefore, its location is not suited to the biomass resources in its vicinity.

Decreasing the distance of biomass delivery to the location where it is used puts a limit on the output capacity of the energy production facility. This concerns, in particular, the use of biomass for electricity production, where the economics of power generation favours units of capacity of order of tens to hundreds of MW. Obviously, such units require large amounts of biomass which has to be transported from distant locations, such as from *America* or *South East Asia* (SLOWINSKI, P. 2011). On the other hand, according to the literature, the maximum economically justified transport distance with trucks is 15 km and 50 km for straw and wood, respectively (KPMG, 2010). In fact, current structure of biomass supply in *Poland* is: 70% domestic deliveries, 15% regional import (*Ukraine, Russia, Czech Republic, Slovakia*), 15% over sea import (WNUK, G. 2013). In *Hungary*, the international trade is also significant. As much as 7.9% of the produced firewood was exported in 2008, mainly to *Italy, Austria* and *Slovakia*, while 4% was imported from *Ukraine*, *Romania* and *Slovakia* (REGIONAL CENTRE FOR ENERGY POLICY RESEARCH, 2009).

One can conclude that, due to the energy consumption and emission during the biomass transportation, big capacity units are not the best solution from the environmental (and macroeconomical) point of view.

For illustration, let us consider an example of a hypothetical (still realistic) power plant of 400 MW located in *South East Poland*, which plans to add 5% of biomass for co-firing. This would require deliveries of ca. 500 tons of biomass per day. If one assumes that biomass comes from domestic sources located in the average radius of 100 km and considering, the kind of road in the area, this biomass would have to be transported by trucks of 10 tons load. Thus, in total, they would have to make 5,000 km each day, one way. It is perhaps shocking to realise that this is a distance from *Moscow* to *Lisbon*!

Meanwhile, as the exhausting of the fossil fuels, more co-firing power plants are converted exclusively to biomass firing. At the end of 2014, the last underground Hungarian coal mine, *Márkushegy* will close down. In parallel with the closure, the capacity of 240 MW-power-station will be supplied by biomass only. This expansion assumes the growth of the supply zone and the degradation of the forestry (ZÖLDTECH, 2013).

Transporting biomass from such distant sources is only one of the factors that bring dubious environmental benefits. The phytosanitary risk is another problem which recently attracts more and more attention (SMITH, A. L. *et al.* 2013). Namely, with the transported biomass there is a risk of transmitting plant diseases, pest species, fungi, bacteria, insects, etc., as well as seeds of invasive plants.

4.2. Technological problems on the generation side

Regarding the technological problems, adding biomass (especially agricultural biomass) to coal increases slagging and fouling due to the content of alkali compounds in biomass. Slagging and fouling hinder heat transfer in the smoke pipes and superheaters. Moreover, the flow of hot exhaust gases heating the upper parts of the superheater is also hindered by a layer of the fouling material fallen on the lower parts. Additionally, electricity consumption of the fans forcing the airflow increases due to higher aerodynamic resistance. When biomass is added to coal in pulverised coal boilers, the milling of biomass increases electricity consumption by 10–15% (SIWEK, T. – PANAS, K. 2011). Consequently, addition biomass to coal decreases the overall efficiency of power generation (SCIAZKO, M. *et al.* 2006), leading to decreasing the overall resource consumption. Moreover, the content of chlorine and sulphur in biomass increases corrosion of metal elements of the generation equipment, creating serious operational and maintenance problems (KROL, D. *et al.* 2010; SIWEK, T. – PANAS, K. 2011). Because the content of chlorine and sulphur in the agricultural biomass is higher compared with woody biomass (JENKINS, B. M. *et al.* 1998), corrosion of the boilers[7] and emissions of sulphur oxides are correspondingly higher. Furthermore, as practice shows, biomass creates fire hazards (also known in the case of coal) due to explosive properties of biomass dust or self-ignition of biomass stocks (BRADLEY, M. 2013). Only in *Poland* two biomass explosions occurred recently: *Dolna Odra* January 2010 (DRABINSKA, U. 2012), *Turow* August 2012 (PAP, 2012)—*Figure 4*.

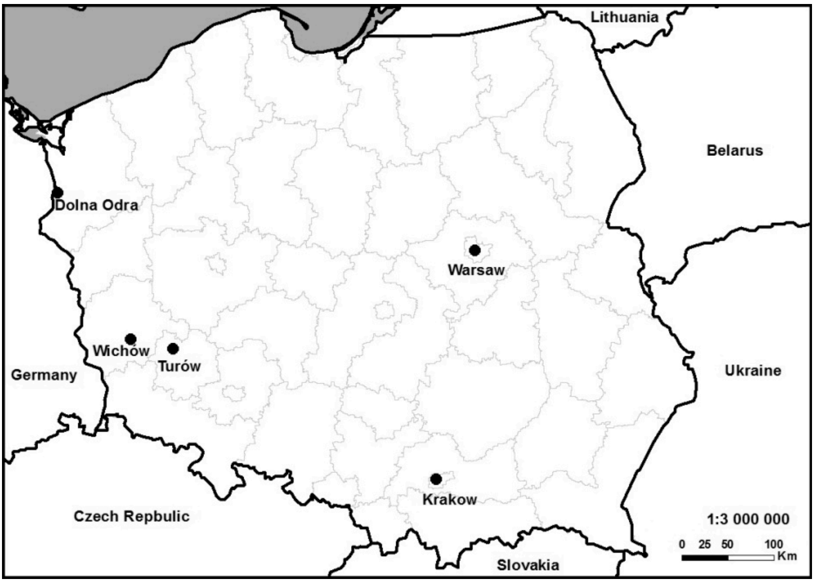


Figure 4 – Poland and the places mentioned in this paper
Edited by HARMAT, Á. (2014)

Another type of technological issue is efficiency of power generation in thermal power stations, where ~25–30% of the energy input is converted into electricity, while the remaining energy is released as

[7] This concern primarily the elements of the equipment exposed to high temperatures. In case of heat-only boilers where the temperatures are much lower the problem is much less significant and, as experience shows, it is not observed in practice. This is one of the reasons why we are advocating using biomass for heating purposes as discussed below in this article.

heat. It is a huge amount in a typical power station, and only a tithe fraction of it can be used as district heat, while the rest is usually emitted to the environment as an unutilised waste (FODOR, B. 2012).

4.3. Cost of the "green" electricity

To meet the assumed "green" electricity target *Poland* would have to produce 10 TWh/y of electricity from biomass (POLAND, 2005). Having in mind the aforementioned problems, one may wonder why power generation companies have invested so heavily in the co-firing technology. As mentioned above, this is due to the hefty support they have been receiving in form of green certificates. One should realise that the 70 EUR/MWh for the assumed 10 TWh/y amounts to 700 million EUR annually. In fact, the price of green certificates is changing depending on supply/demand situation in the certificates market. In 2011, according to information given at the Polish Parliament hearing (SZWED, D. 2012), energy companies received "only" 1.7 billion PLN (ca. 400 million EUR) due to aforementioned market variations. In 2012 (CZOPEK, P. 2013) the price of green certificates dropped to about 60 EUR/MWh and to 30 EUR/MWh in March 2013 (WNP, 2013). Actually, it is about 50 EUR/MWh. However, the Polish government plans (MINISTRY OF ECONOMY, 2014) to reduce the subsidies by introducing weight factors of 0.50 and 1.00 to co-firing and dedicated biomass power generation, respectively. In the authors' opinion this is a move in a good direction, because as shown in (GULA, A. – BARCIK A. 2009; GULA, A. 2011; GULA, A. – GORYL, W.– CIESLAK, J. 2012; GULA, A.– WAJSS, P. – GORYL, W. 2012) using the same amount of biomass for heating rural holdings would bring at least the same CO_2 reduction effect at much lower total subsidy cost (below 8% compared to biomass based power generation). In fact, the reduction would be much higher, because of avoided emissions in biomass transportation and processing.

Hungary uses the feed-in-tariff system for supporting RES. However, the result is the same, as it can be experienced in the case of the tradable green certificates system in *Poland*. Regarding the Hungarian feed-in-tariff system, there is almost no difference among feed-in-tariffs of the various renewable technologies, only the most competitive technologies could spread—the wind and the co-firing biomass. The technologies which have higher cost (modern biomass power plant, solar power plant) are not competitive with the present feed-in-tariff prices. Nevertheless, shortly the co-firing power plants will be removed from the supporting system, because their acceptance time—which determined by the *Hungarian Energy Office*, based on their payback time—will expire. This will lead to the reduction of the co-firing based power generation. A draft of the new supporting system was prepared in 2011 (called *METÁR*) which gives preference to smaller, decentralised biomass units. According to the draft, strict quality and spatial sustainability limits will be introduced for the supply of the wood fuel, and the maximum capacity will be restricted: in the case of biomass the limit is 10 MWe, and 20 MWe if the waste heat is used in district heating. The planned effective date of the new regulation has been postponed several times, and it is not likely that it will be introduced in the near future as taking into consideration the tendency of the Hungarian Government's nuclear power-supporting energy policy. As a result of this uncertainty, the investment in the RES has come to a stop (FODOR, B. 2012).

5. Towards a more sustainable use of biomass for energy

As one can see, the present energy utilisation of biomass is largely unsustainable. Considering the fact that a lion's share of the biomass is used in large scale power stations requiring deliveries from large distances, biomass should mostly be used for energy purposes in local scale units within decentralised energy systems, where electricity is generated by many small energy producers, close to where it is used, rather than at large power plants located far from the consumers. As mentioned above, in this way transmission losses and also the effects of possible outages of the power grid would be minimised. Additionally, under these conditions the energy production would be more efficient, since the waste heat could be used in a larger extent, due to proximity of the consumers.

Taking into consideration these facts, it is unquestionable that biomass—if to be used in a more sustainable way—should be used for energy purposes in local scale units within decentralised energy systems based on local biomass resources.

5.1. Benefits of decentralised energy systems

Compared to the centralised energy systems, the following advantages of decentralised systems can be mentioned:

- Environmental benefits: Through a more efficient energy utilisation, the demand for the firewood would decrease, contributing the conservation of biomass resources. This would lead indirectly to decrease of pollution and other environmental benefits, such as avoiding land degradation associated with coal mining, or the conservation of freshwater resources, since the large scale power stations require vast volumes of water for their operations.
- Economic benefits: In centralised energy systems there are expenses, which make them more expensive, compared with the decentralised systems: The cost of the high-voltage transmission and distribution networks is one of the major costs within the centralised electricity system. The centralised generation is inflexible with respect to sharp changes of energy demand. Hence, the output capacity must be oversised to counter this problem. Countries, where the RES has a significant role, the renewable energy systems are owned largely by communities. In that case, the community—who is the most appropriate decision-maker—is best suited to choose the most optimal and reasonable investment. Also, the resulting profit stays in the local place. In addition, in a case of a small biomass power plant, the entrepreneurs dealing with the production and supply of the firewood are able to join the energy market which leads to an indirect economic prosperity in a wide social scale.
- Security and supply benefits: In *Hungary*, according to the governmental statements, the rate of the energy dependence—the

net imports divided by the sum of gross inland energy consumption plus bunkers—was 52.3 % in 2012. However, energy production from the imported nuclear fuel in the statistics is qualified as inland production. Therefore, the real energy dependence is 62%. In this way, the energy supplies considerably depend on the energy policies of the foreign countries—mainly of *Russia* which is the main exporter of the natural gas, the petroleum and the nuclear fuel. The above argument applies also to Poland, although the corresponding number is only 30.7%, due to Poland's significant coal reserves (EUROSTAT, 2014b). In a decentralised energy system, the resources are available where they are used. Therefore, from the point of view of fuel supply it is a more secure system.

- Social benefits: Decentralisation contributes to the spatial convergence, since the cost of the energy production would be localised regionally more equally, thereby reducing the urban–rural development differences. In addition, the decision-making shifts down to the local scale, according to the subsidiarity principle which is one of the fundamental principles of the sustainable spatial development (GREENPEACE, 2005).

To achieve the realisation of the above mentioned benefits via building up a decentralised energy system, a fundamental change in the energy policy is needed. This should be supported by the government. Instead of this, the Hungarian government signed an inter-state agreement on co-operation with a Russian involvement in a new nuclear power station, with a 2400 MW built-in capacity. Nevertheless, at the local scale, with bottom-up initiatives we can move closer to a decentralised energy production. In the chapter below two good practice examples from *Poland* and from *Hungary* are presented.

5.2. Biomass heating boiler in a rural holding in Wichow, Poland

In many European regions, notably in *Poland*, there is a significant demand for space heating. This could be largely satisfied by biomass, primarily in rural areas, where biomass is locally available, in particular as agricultural residues. In *Poland* the main agricultural residue is straw which is often burnt uselessly in the fields. At the same time, it could become an environment friendly fuel for heating the rural holdings, if burnt in dedicated biomass boilers.

A concrete example is described and analysed below which is a small scale biomass installation for heating a typical rural house. The farm used for the case study is located in the village of *Wichow* in *Western Poland*. The village is a good representative of rural *Poland*. It is situated in flat agricultural area with dominant cereal production, so that straw is amply available. The area of the considered farm is 8 hectares used mostly for wheat production. On average about 10–15 tons of straw is harvested annually.

The building in question is a one storey, detached house of 200 m^2 inhabited by 4 residents. The building is relatively well insulated with modern double-glazed windows. Until 2010, the house was heated using a coal boiler, which in October 2010 was replaced by a dedicated straw fired boiler of 40 kW (EKOPAL RM 5) produced by *MetalERG Ltd*., a Polish private company. As straw burns quickly the heat is accumulated in a water tank of 5 m^3 and fed to the heaters by a controlled circulation pump. The cost of investment was ca. 5,000 EUR. The boiler is designed to match the needs of the farmers who harvest the straw in form of standard compressed cubical (80x40x40 cm) bales. It is suitable for farmers having their own straw in sufficient quantities and storing it after harvest in or near the house. The operating costs are then several times lower compared to coal and the payback time is about 4 years.

The only fuel which is used in the boiler in this farm is wheat straw which is harvested from the fields within the radius of about 1.5 km around the house. The bales are stored in a barn located next to the house. Therefore, the cost of the biomass fuel is practically free for the farmer.

Below, three different energy supply options in this farm are considered: (i) coal boiler for heating (heating season) plus electric water heater (whole year), (ii) biomass boiler (heating season) plus electric water heater (whole year), (iii) biomass boiler (whole year) for heating and domestic hot water preparation. The first option was in place until 2010, the second was until 2013 and the third is the present situation.

The output capacity of the previous coal boiler was 22 kW with 82% efficiency. The fuel was culm and hard coal. The boiler consumed ca. 6 tons of coal every year. Domestic hot water was provided by a 2 kW electric 50 litres water heater. In 2013, the electric water heater was replaced by a well-insulated 120 litres accumulation tank connected in parallel to the existing 5 m^3 tank of the biomass boiler system.

Our analysis showed that using coal (Option 1) is much more expensive (1,480 EUR/y) compared to the use of the biomass Options 2 and 3 (320 EUR/y and 80 EUR/y, respectively). The cost of provision of domestic hot water in Option 3 is so low, because now electricity is not used for DHW preparation. The payback time for Option 2 is 4.3 years. For Option 3, additional 250 EUR must be spent to cover the cost of the 120 litres heat exchanger and circulation pump. The corresponding payback time becomes 3.75 years.

As it can be seen above, conversion from coal to biomass in a farm with own straw resource can dramatically reduce the CO_2 emissions in a very cost effective way. Emissions from different options are presented in *Figure 5*. The CO_2 emissions in Option 1, 2 and 3 are 12,850 kg/y, 2,100 kg/y and 430 kg/y, respectively which means reduction by a factor of 6 and 30 for Options 2 and 3, correspondingly.

It should also be noted that biomass contains much less sulphur than coal. Thus, in the emissions of SO_2 are 69 kg/y, 16 kg/y and 14 kg/y, respectively. Also, less NO_2 is emitted to the atmosphere (Option 1: 20 kg/y, Option 2: 12 kg/y, Option 3: 11 kg/y). The situation is different in the case of CO (273 kg/y, 92 kg/y and 99 kg/y, correspondingly), where the lowest emission is for Option 2. This is due to the fact that in Option 3 straw is burnt also in summer leading to a small increase of CO emissions from the biomass boiler.

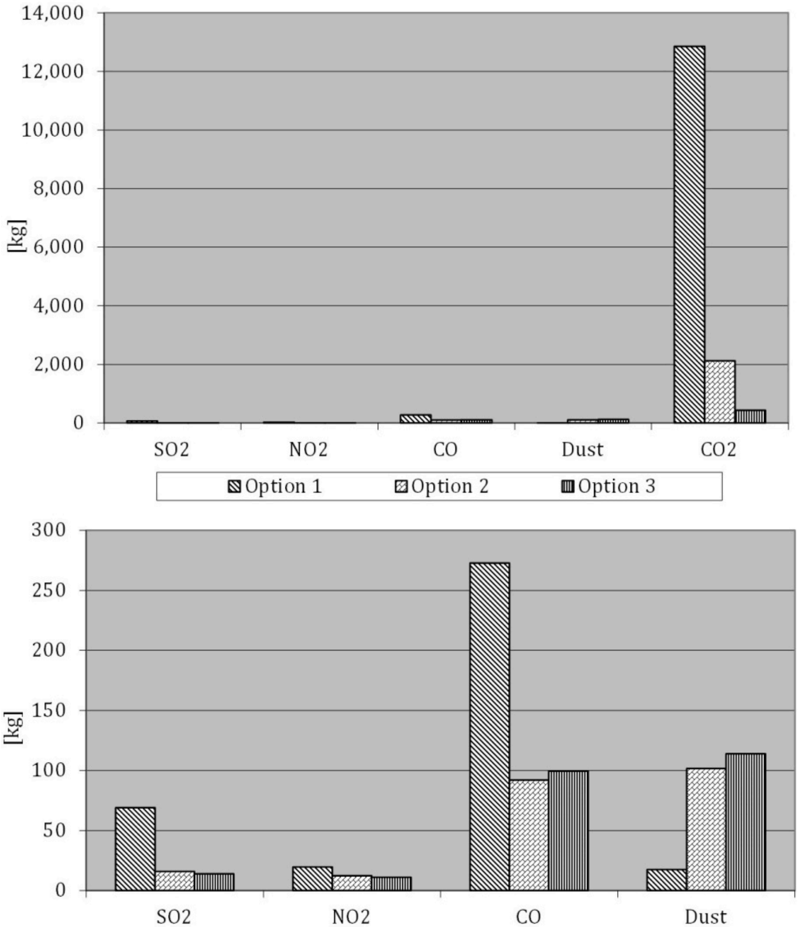


Figure 5 – Emissions from different options (bottom – rescaled, without CO_2)

Edited by GORYL, W. – HARMAT, Á (2014)

It should be noted that biomass combustion leads to relatively high dust emissions. In Option 1 (18 kg/y) dust emission is 6.5 times lower than in Option 3 (114 kg/y). It is necessary to use filters or dust precipitators to meet the standards. However, in sparsely populated rural areas the concentration of dust does not present a big problem, due to sufficient ventilation of the terrain. Recently, the *AGH University of Science and Technology* in *Krakow*, *MetalERG* (biomass boiler manufacture) and *DBFZ Deutsches Biomasseforschungszentrum gemeinnützige Gmb*H (from *Germany*) received a *KIC InnoEnergy Programme* grant to design and build a new straw feeding, filtering and drying system. Such system should significantly reduce the dust emissions to the atmosphere, which is also considered in the analysed holding.

In conclusion, a typical Polish farm of ca. 6–10 hectares, can satisfy its heating needs by using biomass supplies from an area of a small radius (about 2–5 km), so that the "embedded" transportation emissions are much smaller than is the case for large units such as power stations. Additionally, energy needed for densification of biomass to lower the transportation costs, are avoided. Therefore, such installations should be favoured when granting investment subsidies. It is very important to note that in the exploitation phase no subsidies are needed, because local (often own) biomass fuel is cheaper than coal, oil or gas.

However, in the Polish conditions a 5,000 EUR investment is very expensive for a typical farmer. To boost the demand for small biomass boilers financial support for farmers is needed. As mentioned above, this could be taken from the subsidies being given to co-firing by diverting only a small fraction (up to 8%) of those to cover a part of (ca. 40%) of the investment cost of conversion from coal to biomass (GULA, A. – WAJSS, P. – GORYL, W. 2012).

5.3. Biomass based village heating in Pornóapáti, Hungary

The local government of the municipality of *Pornóapáti (Figure 3)*—a Hungarian village next to the Austrian border—came to a decision concerning the heat supply system of the village at the beginning of the

2000s. Considering the good practise of the biomass heat plant of the neighbouring Austrian village, *Bildein*; the village (with 380 inhabitants) chose to build a 1.2 MW biomass heat plant instead of building up a natural gas network.

The total cost of the construction was 1,661 million EUR (~1,325 million GBP) (including the price of the pipeline system). The project was supported by the *Hungary–Austria Phare CBC Programme*, by the *Austrian Environmental Fund*, by the *West Transdanubian Regional Development Agency* and by the *Ministry of Interior Affairs*. A wide collaboration of international organisations was required for the project and, furthermore, the understanding and willingness of the village citizens were also necessary. The operation of the heat plant started in 2005.

The annual heat demand is entirely covered by the 2 biomass boiler with nominal capacity of 2*600 kW. 32.5 m^3 water is circulated per hour in the pipeline system which length is 3,900 running metres. The produced useful heat in the past years was between 4,100–4,800 GJ/heating season, the energy efficiency of the whole system (multiplying the efficiency of the boiler, and the efficiency of the heat transfer) is 50–52% (NÉMETH, K. 2011).

At the beginning, 86 residential and 11 public consumers connected to the heat pipeline. However, at this time the number of consumers is 67, and only 40 consumers used the district heating constantly during the last heating season. To detect the background of the reduction interviews were made in the village. According to the interviewees, there are two main reasons of the disconnections. On the one hand, the level of the heating service was exceptionable. The lack of the repairs in case of malfunctions and the outages during heating seasons were frequently experienced issues. In the absence of the relevant experience, during the construction sizing failures were made by the building contractor. On the other hand, the most frequently mentioned problem was the price of the heating service. Generally, the inhabitants who work and have fixed income use the district heating, but the pensioners and the unemployment inhabitants prefer to provide their own firewood, and use their individual heating. The new mayor of the village hopes that this negative process will stop since the operating company have been changed, and the inhabitants do not have the opportunity to collect logging waste in the area of the local forestry at a low price any more. Also, around 20 kW of solar panels have been installed on the roof of the heating plant which will reduce the operating costs.

The biomass consumption is between 380 and 420 tons per heating season. Three/four companies supply the heating plant with woodchips from the nearby forestry and with by-products from the building industry. The nearness of the Austrian border makes the purchase more difficult as in the other part of the border the price of the woodchips is double that of the Hungarian price. Therefore—considering the financial status of the municipality—the woodchips are generally purchased only for the next few weeks, thus there is no time for them to get dry and reach the maximum heating value.

The most significant environmental effect of such a small-scale biomass heat system is that it can replace the low-efficient, high-emission individual heat systems to an environmentally well-regulated central system. Thanks to the biomass heating plant, the annual CO_2 emission decreased by 1,168 tonnes and the heat demand of the village can mostly be supplied with local sources. According to the calculation of NÉMETH, K. (2011), if the natural gas network had been built up, the cost of the heating between 2006 and 2009 would have been 24,500 EUR – 29,500 EUR more. However, its economic benefit is overshadowed by the fact that more and more consumers disconnect from the heat network and change to individual heating because of its expensiveness. During the period under review, around 17,500 EUR stayed in the local area annually, contributing to the local economic development.

Pornóapáti is the first smaller municipality in *Hungary* which decided to create a new village heating system based on biomass. This project contributes to the environmental protection, the local economic development, and also improves the community's social thinking and their sense of common responsibility for the environmental values. Therefore, it is a good example for other small municipalities. However, considering that the available funds for this kind of project are limited and there are some known experienced operational difficulties, supporting the local use of renewable energy sources is inevitable by the state.

6. Conclusion

Due to the inappropriate support mechanism both in *Poland* and in *Hungary* biomass is used mostly in co-firing with coal in big-scale power stations in a centralised energy system which leads to huge technological problems (slugging, chlorine corrosion, fires, etc.) on top of costs and emissions of biomass transportation at large distances as well as huge amounts of heat which remains unused in thermal power plants. Since the energy density of biomass is low, its energy utilisation is transport intensive. Therefore, utilisation of biomass is most efficient if used locally, in small scale units, in frame of a decentralised energy system. Although both countries' energy policies do not support this kind of initiatives, we can make small steps against the big and powerful opponents. This was demonstrated by two examples described above. Such bottom-up projects illustrate the principle "think globally, act locally".

Acknowledgments

Wojciech Goryl is a scholar within *Sub-measure 8.2.2 Regional Innovation Strategies*, *Measure 8.2 Transfer of knowledge*, *Priority VIII Regional human resources for the economy Human Capital Operational Programme* co-financed by *European Social Fund* and *Polish state budget.*

References

BRADLEY, M. (2013). *Biomass Handling and Storage Challenges*. European Biomass to Power Conference, Krakow, Poland 10–11 April 2013.

CZOPEK, P. (2013). *Policy and Legislative Implications on Growth*. European Biomass to Power Conference, Krakow, Poland 10–11 April 2013.

EUROPEAN ENVIRONMENTAL AGENCY (2007) *Estimating the environmentally compatible bioenergy potential from agriculture.* – EEA Report, No. 12/2007, Coppenhagen, Denmark, p. 133.

FARAGÓ, T. – KERÉNYI, A. (2003). *Nemzetközi együttműködés az éghajlatváltozás veszélyének, az üvegházhatású gázok kibocsátásának csökkentésére.* – Ministry of Environment and Water, University of Deberecen, Debrecen–Budapest, Hungary, p. 70.

FODOR, B. (2012). *A megújuló energia térnyerésének ösztönzési lehetőségei*. Ph.D. thesis. – Gazdálkodástani Doktori Iskola, Corvinus University of Budapest, Budapest, pp. 95–119.

GULA A.–BARCIK A. (2009). *Renewable Energy – Biomass*. In: *Outline of the Present Status and Perspectives of the Polish Energy Sector*. Krakow: AGH University of Science and Technology, pp. 247–262.

GULA, A. (2011). *Biomass Energy: Heat or Power Generation, Small or Large Scale?* In: AGH University of Science and Technology, *Forum of Biomass Combustion*, Czestochowa, Poland 20 April 2011, pp. 96–105.

GULA, A. – GORYL, W. – CIESLAK, J. (2012). *Examples of Successful Biomass Heat Based on Straw in Poland – and Future Perspectives*. In: AGH University of Science and Technology, 20th International Conference Vykurovanie, Stara Lubovna, Slovakia 27 February–2 March 2012, pp. 297–301.

GULA, A. – WAJSS, P. – GORYL, W. (2012). *Is Using Biomass for Power Generation a Good Solution? The Polish Case.* – Electrical Review, 88(5a), pp. 198–203.

GUS (POLISH CENTRAL STATISTICAL OFFICE) (2013). *Energy from renewable sources in 2012*. – Warsaw, pp. 64–65.

HARMAT, Á. – MUNKÁCSY, B. (2011). *A biomassza energetikai hasznosításának jövőképe*. In: Erre van előre! Egy fenntartható energiarendszer keretei Magyarországon Vision 2040 Hungary 1.0.– Környezeti Nevelési Hálózat Országos Egyesület, Szigetszentmiklós, pp. 87-104.

IMRE, L. – BOHOCZKY, F. (ed.) (2006). *Magyarország megújuló energetikai potenciálja*. – Az MTA Energetikai Bizottság, Megújuló Energia Albizottsága, Hungarian Academy of Science, Budapest, Hungary.

JENKINS, B. M. – BAXTER, L. L. – MILES, T. R. JR. – MILES, T. R. (1998). *Combustion Properties of Biomass*. – Fuel Processing Technology, 54(1988), pp.17–46.

KROL, D.–LACH, J.–POSKROBKO, S. (2010). *O niektórych problemach związanych z wykorzystaniem biomasy nieleśnej w energetyce*. Energetyka i Ekologia, 1, pp. 53-62. [In Polish].

MINISTRY OF ENVIRONMENTAL PROTECTION (2000). *Strategia rozwoju energetyki odnawialnej*, Warsaw, pp. 9-10.

MINISTRY OF ECONOMY (2007). *Możliwości wykorzystania OZE w Polsce do roku 2020*, Warsaw, pp. 20-26.

MINISTRY OF ECONOMY (2009). *Polityka energetyczna Polski do 2030 roku, Załącznik II*, Warsaw, p. 12.

MINISTRY OF ECONOMY (2014). *Propozycja Ustawy o OZE*, Warsaw, p. 32. [In Polish].

MUNKÁCSY, B. (2011): *A megújuló energiaforrások ponteciálja Magyarországon*. In: Erre van előre!: Egy fenntartható energiarendszer keretei Magyarországon Vision 2040 Hungary 1.0.– Környezeti Nevelési Hálózat Országos Egyesület, Szigetszentmiklós, pp. 79-120.

NÉMETH, K. (2011). *Dendromassza-hasznosításon alapuló decentralizált hőenergia-termelés és felhasználás komplex elemzése*. – Ph.D. thesis, Állat- és Agrárkörnyezet-tudományi Doktori Iskola, University of Pannonia, Keszthely, Hungary, pp. 63-79.

PAPPNÉ, V. J. (2010). *A biomassza, mint energiaforrás hasznosítási lehetőségei, különös tekintettel Magyarországra*. – Ph.D. thesis, Földtudományi Doktori Iskola, Eötvös Loránd University, Budapest, p. 149.

POLAND (2005). *Poland: Baseline scenario: "Detailed results of Primes model ver. 2 Energy Model"*. National Technical University of Athens Paper, November, Athens, p. 30.

SCIAZKO, M.–ZUWALA, J.–PRONOBIS, M. (2006). *Wady i zalety współspalania biomasy w kotłach energetycznych... Energetyka i Ekologia*, 3, pp. 207-220. [In Polish].

SIWEK, T.–PANAS, K. (2011). *Negative impact of co-firing biomass on heating surfaces of steam boilers*. Polish Journal of Environmental Studies, 4A(20), pp. 267–270.

SMITH, A.L.-KLENK, N.-WOOD, S.-HEWITT, N.-HENRIQUES, I.-YAN, N.-BAZELY, D.R. (2013). *Second generation biofuels and bioinvasions: An evaluation of invasive risks and policy responses in the United States and Canada*. Renewable and Sustainable Energy Reviews, 27, pp. 30-42.

SZWED, D. (2012). *At the Polish Parliament Hearing*, 29 February 2012, Warsaw.

WNUK, G. (2013). *Impact of Market Changes*. European Biomass to Power Conference, Krakow, Poland 10-11 April 2013.

Electronic sources

DRABINSKA, U. (2012). *Kwestia współspalania biomasy z węglem w ustawie o OZE*. Available at: <http://ziemianarozdrozu.pl/artykul/2197/kwestia-wspolspalania-biomasy-z-weglem-w-ustawie-o-oze> [Accessed 10 April 2014].

EUROSTAT (2014a). *Primary production of renewable energy.* Available at: <http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&plugin=1&language=en&pcode=ten00081> [Accessed 05 April 2014].

EUROSTAT (2014b). *Energy dependence*. Available at: <http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tsdcc310&plugin=1> [Accessed 8 April 2014].

GREENPEACE (2005). *Decentralising Power: An energy revolution for the 21st century. - Greenpeace*, pp. 15-40. Available at: <http://www.greenpeace.org.uk/files/pdfs/migrated/MultimediaFiles/Live/FullReport/7154.pdf> [Accessed 10 April 2014].

GREENPEACE (2012). *Skończyć z oszustwem – Nie spalajmy lasów!*. Available at: <http://www.greenpeace.org/poland/pl/wydarzenia/polska/skonczyc-z-oszustwem/> [Accessed 10 April 2014]. [In Polish].

GREENPEACE (2013). *COP19: Kto rządzi Polską?*. Available at: <http://www.greenpeace.org/poland/pl/multimedia/Kto-rzdzi-Polsk-Akcja-na-Ministerstwie-Gospodarki/> [Accessed 10 April 2014]. [In Polish].

KPMG (2010). *A biomassza, mint erőművi tüzelőanyag keresletének, kínálatának valamint árának 2010-2020 időszakra vonatkozó éves előrejelzése*. KPMG Tanácsadó Kft. Available at: <http://www.mekh.hu/gcpdocs/201006/meh_biomassza_arprognozis_2009_2020.pdf> [Accessed 03 April 2014].

MINISTRY OF NATIONAL DEVELOPMENT (2010). *Magyarország Megújuló Energia Hasznosítási Cselekvési Terve 2010-2020*. Available at: <http://www.kormany.hu/download/2/b9/30000/Meg%C3%BAjul%C3%B3%20Energia_Magyarorsz%C3%A1g%20Meg%C3%BAjul%C3%B3%20Energia%20Hasznos%C3%ADt%C3%A1si%20Cselekv%C3%A9si%20terve%202010_2020%20kiadv%C3%A1ny.pdf> [Accessed 01 April 2014].

PAP (POLISH PRESS AGENCY) (2012). *Zakończyło się dogaszanie pożaru w Elektrowni Turów*. Available at: <http://energetyka.wnp.pl/trwa-dogaszanie-pozaru-w-elektrowni-turow,175149_1_0_0.html> [Accessed 9 April 2014]. [In Polish].

REGIONAL CENTRE FOR ENERGY POLICY RESEARCH (2009). *Erdészeti és ültetvény eredetű fás szárú energetikai biomassza Magyarországon*. Corvinus University of Budapest, Regional Centre for Energy Policy Research, Budapest, pp. 30-36. Available at: <http://unipub.lib.uni-corvinus.hu/116/1/wp2009_5.pdf> [Accessed 03 April 2014].

SLOWINSKI, P. (2011). *Sprawy zaszły za daleko? (Posłuchaj)*. Polish Radio Wroclaw. Available at: <http://www.prw.pl/articles/view/17423/Sprawy-zaszly-za-daleko-Posluchaj> [Accessed 27 May 2014] [In Polish].

WNP (2013). *Zielone certyfikaty na poziomie 120 zł/MWh*. Available at: <http://energetyka.wnp.pl/zielone-certyfikaty-na-poziomie-120-zl-mwh,194036_1_0_0.html> [Accessed 22 March 2014]. [In Polish].

ZÖLDTECH (2013). *Szénről biomasszára vált a Vértesi Erőmű*. Avaible at: <http://zoldtech.hu/cikkek/20130125-Vertesi-eromu-biomassza> [Accessed 03 April 2014]

ISSN 2052-0018 (print), ISSN 2053-3667 (online)
Geographical Locality Studies 2014 Volume 2, Number 1. pp. 438–460

K A T A L I N K I S S
PhD, HR advisor
Fortis 21 Financial and Human Resource Organiser Ltd.
kisskati@fortis21.hu

N Á N D O R Z A G Y I
MSc, Geographer
PhD Aspirant at University of Pécs, Faculty of Sciences, Doctoral School of Earth Sciences
zana@gamma.ttk.pte.hu

Principal Characteristics of the Indian Micro, Small & Medium Enterprises (MSME) Sector and Its Importance in Rural Development

Abstract

The spread and strengthening of the small business sphere in the rural areas of India could have a significant role in order to decrease the spatial and social differences derived from sociocultural and demographic reasons. In the first part of our study, by the analysis of the related statistical databases, we try to find the answers for what kind of results could it achieve in terms of the social integration of disadvantaged groups so far. Following this, within the framework of a short retrospect, we demonstrate the historical roots and traditions of the village business sphere's governmental programme, then we provide a thorough overview of the production and labour force positions of the enterprises taking part in the Khadi & Village Industries Program. Finally we refer to the transcending significance from the economic force of rural handicraft in terms of the revival of business promptitude and sustainability.

Key words

India; Small enterprises; Spatial and social disparities; Rural industries; Sustainable economy

1. Introduction

Within the corporate sphere, the micro, small and medium enterprises (MSMEs)— besides the fact that considering their number they are in majority, independent from economic development level and economic culture—represent a significant role in every country or region of the world both taking into consideration their employee numbers and economic performances (share of gross domestic product). Exactly the same situation can be found in India, having the second most populated labour force market with 482 million persons (CENSUS ONLINE 2011a) and the third greatest economy of the world (4,692 billion USD) considering the GDP on purchasing power parity (CIA ONLINE 2013), where the small sized entrepreneurial sphere—besides the increase of production and employment—could play a highlighted role in the strengthening of sustainable economy by decreasing poverty, raising up the role of the rural areas and decreasing the social inequalities (MISHRA, S. 2012).

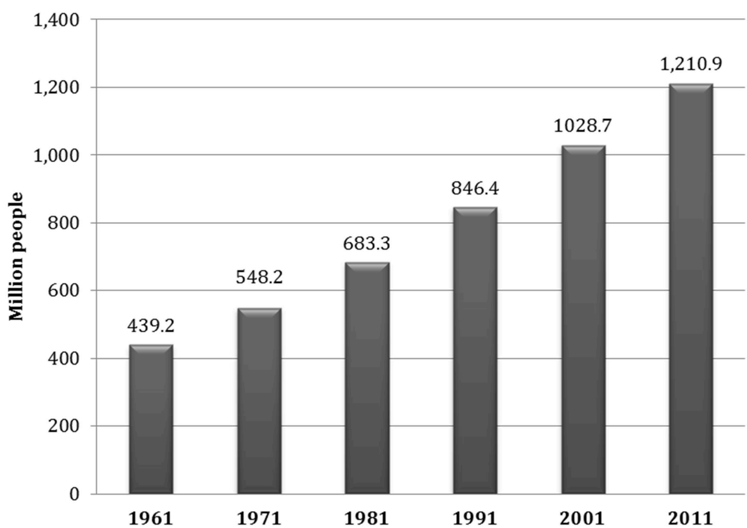


Figure 1 – Change of population in India in the last fifty years

Sources: CENSUS ONLINE 2001, 2011a

All of these would be highly important in such a country where the population in the past 50 years has almost tripled *(Figure 1)* with 100–180 million persons per decade, and, except for the last decade, increased by more than 20% *(Table 1)*. The unemployment, due to the demographic stress—based on the estimate of the 2012–13 representative survey carried out by the Ministry of Labour & Employment (MLE ONLINE 2013)—is very high at the age groups between 15–29 (especially concerning women) *(Table 2)*. However, it is also important to mention that the database on unemployment available from the official statistical sources (Annual Employment and Unemployment Survey Reports) is under-calculated, because of the over-generated employment at the public sphere (SPINAK, J. 2004), so it seems these numbers are much higher in reality.

Table 1 – Decadal growth of population in India

Sources: CENSUS ONLINE 2001, 2011a

Census decades	Decadal growth	Decadal growth (%)
1961–1971	108,924,881	24.8
1971–1981	135,169,445	24.7
1981–1991	163,091,942	23.9
1991–2001	182,316,397	21.5
2001–2011	182,117,541	17.7

Table 2 – Unemployment rates of different age groups in India (per 1000)

Source: MLE ONLINE 2013

Age Groups	Males & Females	Males	Females
15 & above	47	40	72
15–17	183	181	192
15–24	181	163	244
18–29	130	113	191
15–29	133	117	191
30 & above	10	7	19

Indirectly, the high rate of women employed in part-time or occasional labour also refers to this above mentioned fact; which is, in India (completely different from the developed western economies) regularly not the result of the employees' free decision but rather the consequence of the significant amount of latent unemployment. While this ratio among all the employees is 40.4% opposite to the 17.7% of men, the ones involved in non-agricultural and household industries, so among the ones less concerned with the pressure of seasonality, constituting 41.6% of all the employees this value is 29.7% and 12.3% respectively (CENSUS ONLINE, 2011a).

The extreme spatial differences (WILHELM, Z. *et al.* 2010; WILHELM, Z. 2011; WILHELM, Z. *et al.* 2011) appearing in the income and life quality relations, similar to any other countries of the developing world, necessarily generate a domestic migration of great masses from the rural areas to the urbanised regions. The expectations of those unqualified people migrating to cities who expect for work, higher wages and better life quality are realised however very rarely, so in general they become the dwellers of the environment wrecking slums clogging together the unemployed and under paid population with extreme social pressure, getting out of the scope of the city authorities and security forces, or in an even worse scenario they will increase the number of the homeless. While the number of these latter class—leastwise according to the census data—in 2011 were under 1.8 million persons, which is 0.15% of the total population of India (CENSUS ONLINE, 2011a), the 65.5 million mass of people living in the slums comprise more than one-sixth of the total urban population (17.6%), but their ratio at the 45 cities with more than 1 million dwellers exceeds the average in 24, and in every fifth of these settlements they represent more than one-third of the total population *(Table 3)*.

Table 3 – Indian cities having more than one third rate of slum population

Sources: CENSUS ONLINE 2011a, 2011b

City (M. Corp.)	State	Population	Slum	Rate of Slum Pop.
Jabalpur	Madhya	1,054,336	483,626	45.9
Visakhapatna	Andhra	1,730,320	770,971	44.6
Vijayawada	Andhra	1,048,240	451,231	43.0
Mumbai	Maharashtra	12,478,447	5,206,473	41.7
Meerut	Uttar Pradesh	1,309,023	544,859	41.6

Raipur	Chhattisgarh	1,010,087	406,571	40.4
Nagpur	Maharashtra	2,405,421	859,487	35.7
Agra	Uttar Pradesh	1,574,542	533,554	33.9
Hyderabad	Andhra	6,809,970	2,287,014	33.6

In our days, on the level of responsible thinking, it is becoming obvious that the sustainable development of the economy cannot be possible in the global context even in a mid-term time scale with the quantitative increase of the traditional, non-renewable resources. In this respect, besides the spread of diversification and the expansion of the alternative methods, one of the solutions could be the progress of the effectiveness. Widening the interpretation of sustainability and so involving the human workforce into the resources it seems to be obvious that in many cases the increase of the extensive resources utilisation—in accordance with the laws of the market economy—would be the most appropriate. And so it should be carried out in a way that not the public sphere (consuming the economic value surplus) but the private sphere (producing the economic value surplus) should be strengthened. It is outstandingly true to the overpopulated but economically developing countries, where in order to prevailing the viewpoints of sustainability not only the expansion of the labour force would be needed, but the provision of the lagging social classes (with low level of income) with a productive labour in an ever growing scale to be able to raise their life standards. According to the essence of our topic, so that the importance of the Indian micro, small and medium sized enterprises could be determining in this respect as well, further on, after the introduction of the structural basics of the country's SME sector, first we investigate in what scale it contributes to moderate the social inequalities.

2. Research Method

The research in this paper is based on a comparative analysis of statistical data. In the course of that, it has been taken stock of the results of the latest Indian MSME Census (MSME CENSUS ONLINE 2011) carried out for the fourth time, and figures published in the governmental Planning Comission's evaluation study (PLANNING COMMISSION ONLINE 2001), and these ones have been compared to relating Indian census data. By means of this method, the role of the MSME sector and the Village Industries Programme played in the integration of socially disadvantaged, mostly rural population, and along with it, in the strengthening of rural development and sustainable economy are presented.

3. The major structural characteristics of the MSME sector in India

Opposite to the EU regulations, the basis for the classification by the size group of enterprises relies on the number of employees, the annual revenue or the total assets and the measure of the co-owners' share, in India the firms are classified by the value of the invested materials into the manufacturing or service activity. The Micro, Small & Medium Enterprises Development Act (GAZETTE ONLINE 2006) about the organisational-judicial background of the support and development of the small enterprises coming into force in 2006, independent from the number of employee, the economic performance, the corporate form and the owners, binds the certain size categories to relatively high value limits *(Table 4)*.

Table 4 – Classification of Indian MSMEs by quantity of investments

Source: GAZETTE ONLINE, 2006

Category of size	Enterprises engaged in	Enterprises engaged in
	Investment in plant & machinery	Investment in equipment
Micro Enterprise	< 2,500,000 INR	< 1,000,000 INR
Small Enterprise	2,500,000–50,000,000 INR	1,000,000–20,000.000 INR
Medium Ent.	50,000,000–100,000,000 INR	20,000,000–50,000,000 INR

According to the prognosis of the Ministry of Micro, Small and Medium Enterprises 2012–2013 report, in the period commencing the base year of 2006–2007 of the Fourth All India Census of Micro, Small & Medium Enterprises, the complete Indian MSME sector produced a considerable increase concerning the number of functioning enterprises, the number of their employees, the market value of the fixed assets and the amount of the gross output *(Table 5)*.

Table 5 – Change of the main quantitative indicators of Indian MSME sector
Source: MSME ONLINE 2013

Indicators of MSMEs	2006–2007	2011–2012	Rate of growth
Number of working	36.2 million	44.8 million	23.8
Number of employees	80.5 million	101.3 million	25.8
Market value of fixed assets	8,685.4 billion	11,769.4 billion	35.5
Gross output (INR)	13,513.8 billion	18,343.3 billion	35.7

Table 6 – Rate of enterprise size categories by the main quantitative indicators
Source: MSME CENSUS ONLINE 2011

Indicators of MSMEs	Rate of micro	Rate of small	Rate of medium
Number of enterprises	94.9	4.9	0.2
Number of employees	70.2	25.2	4.6
Value of fixed assets (INR)	37.7	49.8	12.5
Gross output (INR)	44.2	45.1	10.7

As the results of the MSME census within the scope of the enterprises recorded and registered by the competent governmental offices (District Industries Centres of the State Governments or Union Territory Administrations), according to the expectations, the MSME sector primarily consists of micro enterprises providing an income source for 70% of the employees of this sphere. However, considering the value ratio of their fixed assets and product reissue, they have a huge disadvantage compared to the small and mainly middle sized enterprises *(Table 6)*. A little more than two-thirds of the enterprises (67.1%) carry out peculiarly producing, processing industry activities—nine out of ten cases in the framework of proprietary enterprises. Regarding the state-wise composition of MSME performances (for example: density of enterprises *[Figure 2]* or the value of gross output per entrepreneurial units *[Figure 3]*), similarly to that of other Indian social characteristics considerable, but varied disparities can be found.

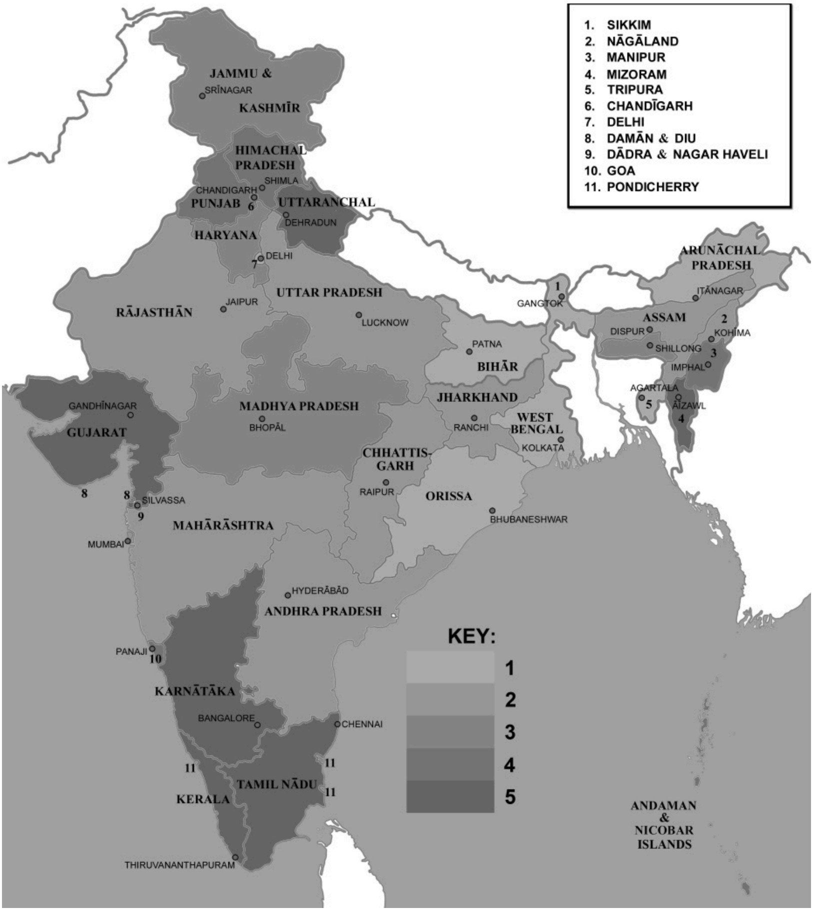


Figure 2 – State-wise disparity in density of working registered MSMEs (Number of MSMEs per 100 thousand inhabitants)
Key: 1: < 50; 2: 50–99; 3: 100–149; 4: 150–200; 5: > 200
Sources: MSME Census Online 2011, Census Online 2011a

The comparative advantage of the city against the rural areas is obvious in this sense. Although, the increase of the rural population lags behind the city (in the last census decade it was 12.3 and 31.8%) and so its ratio is continuously decreasing; according to the data of the

2011 census, the rural people still constitutes more than two-thirds (68.8%) of the total population of India (CENSUS ONLINE 2011a). On the contrary, only 42.5% of the registered MSM enterprises and merely 39.5% of the employees were villagers (MSME CENSUS ONLINE 2011).

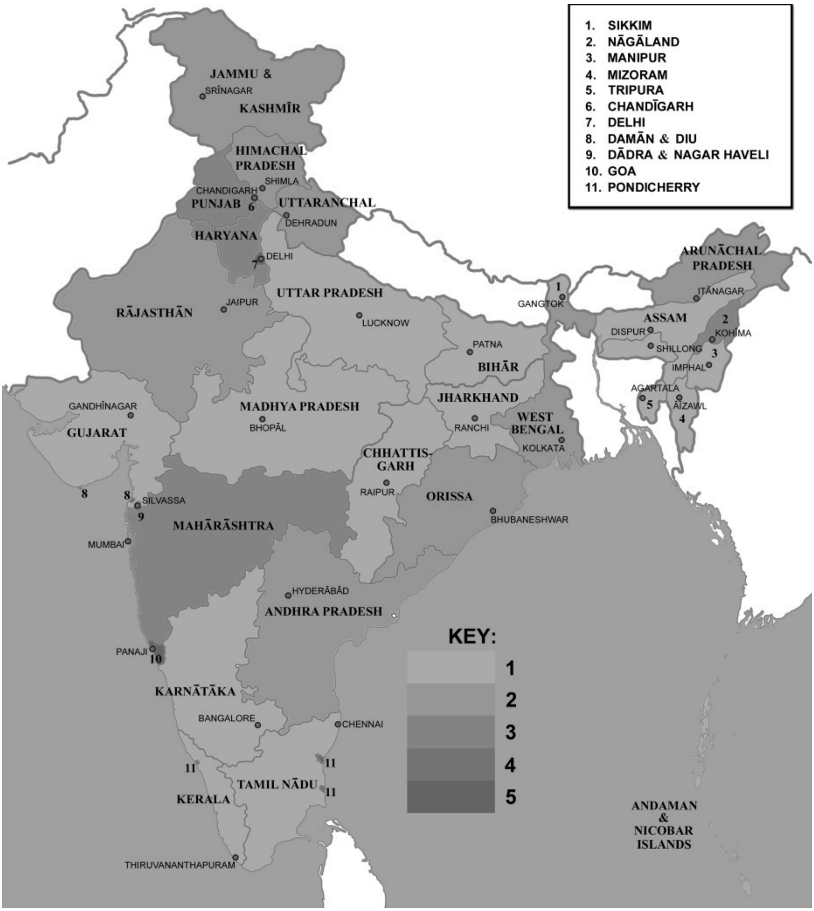


Figure 3 – State-wise disparity in value of gross output per MSME units (million INR)

Key: 1: < 5; 2: 5–9.9; 3: 10–14.9; 4: 15–24.9; 5: > 25

Source: MSME CENSUS ONLINE 2011

The disadvantage of women against men is even more obvious; the ratio of both the female employees and the female-owned enterprises is far lower (4–6 times) than the male population's same indicators *(Table 7)*.

Table 7 – Gender composition of MSME owners and employees compared with work participation rate among main workers

Sources: Census Online 2011a; MSME Census Online 2011

	Males	Females
Rate of MSME owners (%)	86.3	13.7
Rate of MSME employees (%)	79.6	20.4
Work participation rate of main workers (%)	53.3	25.5

And it is still a rather considerable difference when we take into consideration the broadly two times more over-representation of the male main workers. We can establish something similar conclusions at the comparison of the share of the ones belonging to the scheduled castes and scheduled tribes out of the total population and at the comparison of the owner and employee ratio experienced at the MSME sector *(Table 8)*.

Table 8 – SC- and ST-wise composition of MSME owners and employees compared with share in total population

Source: Census Online 2011a; MSME Census Online 2011

	Share in MSME owners (%)	Share in MSME employees (%)	Share in total population (%)
Members of scheduled castes (SCs)	7.6	11.8	16.6
Members of scheduled tribes (STs)	2.9	5.3	8.6

While the villagers in point of these social groups' owner and employee status seemingly possess a somewhat more advantageous situation, this advantage is far smaller than what we would expect from their presence at the rural labour force *(Table 9)*.

Table 9 – Rural-urban composition of MSME owners, employees and main workers by the main disadvantageous social groups

Source: Census Online 2011a; MSME Census Online 2011

	Share in MSME		Share in MSME		Share in main	
	Rural	Urban	Rural	Urban	Rural	Urban
Females	15.3	12.4	22.4	19.2	81.3	18.7
Members of scheduled castes (SCs)	10.2	5.4	14.2	10.2	79.3	20.7
Members of scheduled tribes (STs)	4.0	1.9	6.2	4.7	92.4	7.6

Taking into consideration the members of the most important Indian religious communities, among the MSME owners we can state that the Christians and Sikhs, being already in an advantageous situation, in relation to social-economic concerns compared to the complete population have a nearly two times higher presence, while the Muslims are unequivocally under represented especially among the urban population *(Table 10)*.

Table 10 – Distribution of MSME owners and the total population by the main religious communities

Source: Census Online 2001; MSME Census Online 2011

	Share in MSME owners (%)			Share in total population in 2001		
	Total	Rural	Urban	Total	Rural	Urban
Hindus	81.2	80.6	81.7	80.5	82.3	75.6
Muslims	9.1	9.1	9.1	13.4	12.0	17.3
Christians	4.1	5.3	3.1	2.3	2.1	2.9
Sikhs	3.3	2.8	3.7	1.9	1.9	1.8

So taking into consideration the geographical incidence of the MSME sector among the backward social classes, villagers, women, members at the bottom of the scheduled castes and scheduled tribes or even among the Muslim population, we have to see that the small entrepreneurial sphere has a lot to recover in terms of decrease of social inequalities.

4. The Khadi and Village Industries Programme (KVIP)

However, it is worth analysing a special segment of the Indian MSME sphere, one of the high priority elements in order to accomplish the objectives of the Indian entrepreneurial and regional development policy of the government's initiatives the Khadi and Village Industries Program, and the social integration accomplishment of the small enterprises functioning in its organisational framework. The primary task of this initiative is the non-agrarian marketable village employment realised with a relatively small capital investment, in many cases the increase of self-employment and by the active support of the decentralisation of the industrial production, education, technological transfer, marketing activities, research & development and financing, the contribution to the realisation of the assumptions of sustainable economy (MSME ONLINE 2013).

The roots of the programme trace back to the beginning of the 20th century when one of the tools of the Indian liberator struggles, the *swadeshi* became a mass movement. This campaign gaining its name from the meaning of the compound word, "one's own country" (KURIAN, G. T. 1976), gathered momentum with a protest rising after the 1905 split of Bengal to one Hindu and one Muslim majority part of the country, *Western* and *Eastern Bengal*, protesting against the *British India* policy which intended to divide the uniformly interpreted or imagined Indian nation (ANTONOVA, K. A. *et al.* 1981).

Its basic aim is the initiation and strengthening of the modern national manufacturing industry, besides which, however, it patronised the wide spread allocation of the traditional craftsmanship production, as well. The success of the movement having strong masses from the population was that they connected this with the boycott of the English products, making its effects felt in greater and greater areas of the colony in a way that their import decreased by 1906 with 15-50% (BALOGH, A. 1979). The swadeshi and the boycott actuated with an inspiring effect on every layer of the society from the Brahmins to the home servants and the ones buying British products were descended upon with ostracism and very often with bolting out from the cast as well.

The spiritual leader of this movement was *Sri Aurobindo*, originally called *Aurobindo Ghose* (1872–1950), poet, philosopher and outstanding representative of the Indian liberty concept, who published in the *Bande Mataram* in numerous instigating articles and studies his ideas on the methods of swadeshi and passive resistance and who was arrested because of this in 1907 (BASU, D. K. 2006). The development of the domestic industry, the preference of the industrial products manufactured at the subcontinent and the rejection of foreign products received a formal political support as well, since by the decisions of the National Congress, providing the basis for the all Indian organisational base for the fight for the national autonomy rights, declaratively stood up for these aims (BESANT, A. 1915).

Nevertheless, we cannot identify the swadeshi and the "buy Indian" movement with the aim to create an autarchy-based economic structure (SHARMA, J. N. 2013); however, their elements still survived in that part of the Gandhian constructive programme, in order to ease the physical and intellectual poverty of the rural areas, which, built on the philosophy of self-sufficiency, aimed to produce homemade the *khadi*, the cotton cloth serving the basis for the clothing of the villagers, made from domestic sliver on charkha from braided strand on manual weaving loom for own use (GANDHI, M. K. 1941, KUMAR, S. 1984).

Although, at the beginning the khadi movement had to face with numerous problems, so it had to tackle with the lack of raw material, instruments and professional competence, about which Gandhi, who played an active role in the work of manual spinning and weaving himself *(Figure 4)*, gives a sensitive report in his Biography (GANDHI, M. K. 1982).

Finally, this initiation not even proved its viability, but also had fruitful effects on the environment conscious alternative economy and the idea of the human-scaled economy based on autonomous small ventures (SCHUMACHER, E. F. 1973). Moreover, it also obtained a highlighted role in the fight for acquiring political autonomy (ROY, S. 2006) and its symbolic significance is shown that the *charkha* was also put on the so called "Swaraj Flag" pronounced official by the *National Congress* in 1931.

Figure 4 – Gandhi spinning on charkha (unknown location, late 1920s)
Source: ONEFINALBLOG ONLINE (2013)

These ambitions of *Gandhi*, who can also be respected as the "fore-father" of rural development, are still alive, and due to one of his closest fellow fighter, the Bengali *Rajendra Prasad* (1884–1963) having outstanding merits in establishing khadi weaving and in general the boost of village handicraft, being the first and up till now the only president through two voting periods, in the independent India now they constitute a part of the official economic policy (PRASAD, Y. 2006). The Khadi and *Village Industries Commission Act*, 1956 on setting up a governmental body, the *Khadi and Village Industries Commission* (KVIC), responsible for the organising and management of the labour for rural industry development came into effect during his presidency as well.

According to its name, the KVIP is divided to two sub programmes. Within the framework of the *Khadi Programme* they produce exclusively textile products (wool, cotton, silk and muslin drape), but the *Village Industries Programme*, being much more significant taking into consideration its production value and the number of employees as well, covers a wide range of production activities (mineral based industry, forest based industry, agro based & food processing industry, polymer & chemical based industry, rural engineering & biotechnology industry, handmade paper & fibre industry and service industry). However, it is very important to stress that the small enterprises belonging to the KVI sector cannot deal with producing, preparing or selling such materials which are basically opposite to the health and environment conscious approach and the spiritual heritage of Gandhi. These are for instance the meat industry products, the different health injurious excise goods (alcoholic beverages, tobacco, stimulants) and materials made of not or hardly reusable plastics.

The *Central Government* provides annually growing funds for the KVI sphere from a detached monetary source serving the establishment of new businesses and develop and modernise the existing ones in the form of non-refundable subsidy and credits; while at the turn of the Millennium it was 4 billion rupees (about £40 million), in the 2011–2012 business year it reached 17 billion (ANNUAL REPORTS ONLINE, 2003–2013). The results of the rural development are indicated by the continuous, annual 6–6.5% increase of the sector's income from product and services disposal and the number of the employees. And this result shall not be dispraised even if we are aware of the fact that, taking into consideration the complete Indian economy, the relative performance of the KVI sector can practically be negligible, since its labour force share is only 2.5% (CENSUS ONLINE, 2011a).

Finally, concerning the latter years, the two sub programmes' correlated product turnover and employment data of the businesses is also worth analysing. From these we can clearly see, as we referred to it earlier, that the significance of the businesses within the framework of the *Khadi Programme* is marginal at both cases *(Table 11–12)* and as a consequence of the low world market price of the textile products their sales performance, so the size of product sales per one employee, is much smaller than concerning the same values of the businesses of the Village Industries Programme.

Table 11 – Relative importance of KVI subgroups by sales of products

Source: Annual Reports Online 2003–2013

Business years	Sales of products (billion INR)		Comparative share of KVI subgroups by sales of products (%)	
	Khadi	Village Industries	Khadi	Village Industries
2006–2007	6.6	188.9	3.4	96.6
2007–2008	7.2	208.2	3.3	96.7
2008–2009	8.0	219.5	3.5	96.5
2009–2010	8.7	232.5	3.6	96.4
2010–2011	9.2	248.7	3.6	96.4
2011–2012	9.7	258.3	3.6	96.4

Table 12 – Relative importance of KVI subgroups by number of employees

Source: Annual Reports Online 2003–2013

Business years	Number of employees (million)		Comparative share of KVI subgroups by number of employees (%)	
	Khadi	Village Industries	Khadi	Village Industries
2006–2007	0.9	8.0	10.1	89.9
2007–2008	0.9	9.0	9.1	90.9
2008–2009	0.9	9.5	8.7	91.3
2009–2010	1.0	9.9	9.2	90.8
2010–2011	1.0	10.4	8.8	91.2
2011–2012	1.0	10.9	8.4	91.6

However, since in the case of these latter ones the volume of the sales and the number of the employees increases at the same rate, so their performance is stagnating, but in the scope of the former ones the annually increasing employee number with only a few tens of thousands go hand in hand with a sensible amount of turnover increase, so their sales performance demonstrate an increasing tendency *(Table 13)*.

Table 13 – Performance in sales by KVI subgroups
Source: Annual Reports Online 2003–2013

	Value of sold products per employee (INR)	
	Khadi	Village Industries
2006–2007	7,300	23,600
2007–2008	8,000	23,100
2008–2009	8,900	23,100
2009–2010	8,700	23,500
2010–2011	9,200	23,900
2011–2012	9,700	23,700

Taking into consideration the results of the KVIP in receiving a life quality improvement at the rural population with low social status we (lagging any newer database) have to rely on the results of a governmental institution, the *Planning Committee*'s sample survey for the 8th 5 year plan (1992–1997) (Planning Commission Online, 2001). The survey, which statements are based on the data of 730 households in 18 Indian states' 176 KVI units, has been initiated by the Government because of the doubts that were raised in connection with the social-economic effectiveness and raison d'étre of the KVIP. The facts related to the attendance of the lagging social groups in the KVIP and their life quality improvement can be summarised in the followings.

In a social point of view 74% of all the households belong to a disadvantageous positioned community, tribe or cast or other backward classes. Since their ratio from the total population, following a continuously decreasing tendency, is around 65% today we can say that their participation ratio in the KVIP is adequate to their population share or even slightly overrepresented. 34% of the employees were illiterate and a further 27.5% had only elementary qualification and more than 90% was living and working at the same district. Out of these data we can univocally see that the ones taking part in the programme mostly belonged to the disadvantaged social classes with low levels of income belonging to the local population.

The share of the analysed households' income from the activities carried out within the framework of the KVIP was 52.7%. In the case of the ST/SC/OBC population this value was slightly higher (55.5% opposite to the 46.6% of the others) so considering their living they relied more on the KVIP. Since there was no considerable difference between the two groups' total average income it also means that the KVIP income per person at the backward families was nearly 20% higher. Nevertheless these wages were not considered to be high even compared to the rate of wages of the 1990s, it is anyway a considerable fact how great role they have in moderating the deprivation of the involved families. Namely, the data of the survey confirm that lagging the income provided by the KVIP a bit more than $^{2}/_{3}$ of the families would achieve a life quality which is under the poverty line.

Realising the above mentioned, it is obvious that, even at present, we should not judge the real importance of this rural enterprise development initiative according to the absolute economic performance. Rather in the case of the social closing up defined as the basic momentum of sustainability and mainly in the case of the khadi subprogramme based on those results which could be achieved during the war of independence, nation building and the taking of the roots of the unified Indian nation concept and in the practical utilisation of the entrepreneurial and innovation abilities always present in the local community members. For this latter the couple of years earlier launched new product on the market provides an excellent example in order to advance the spread of the environment conscious and sustainable economy, the manual spinning wheel, the so called e-charkha *(Figure 5)* which is also appropriate to produce electricity. The machinery, developed together by KVIC and a small business in Bangalore producing energy saving equipments, besides that it is able to throw 2400 m strand in two hours working time, during the operation, with the support of the rotated components and connected generator, such an amount of electricity can be produced which is sufficient to run the

1 watt accessory LED light and a small transistor radio for seven and a half hours (KVIC ONLINE, n.a.).

Figure 5 – Conventional and modified e-charkha
Source: FLEXITRON ONLINE (n.a.)

5. Summary

In the overpopulated *India*, facing with the demographic pressure, where the social and spatial inequalities occasionally take extreme measures, in order to raise up the rural regions and improve the chances for the integration of the disadvantaged social groups, it would be essential to enhance the governmental efforts aiming to develop small businesses. Although, the value of the product reissue of the MSME sector and the number of the employees, in the view of the total Indian economy, is rather considerable and, moreover, it increases annually, according to the conclusions of our research, the countryside, the women, the most disadvantaged positioned castes, the members of the tribal community and the Muslims also being in a disadvantaged position concerning the social-economic indicators, are well perceptively under represented both among the owners and the employees.

According to its accentuated occupation in rural development, in this respect, it can have a much higher significance, at least in the long run for the decades long Khadi and Village Industries Program, which also holds a brief to the attendance and spread of the Gandhian spirit for constructive and environment conscious social development by the predomination of the aspects of sustainability. Besides that the performance and labour market positions of the khadi branch, carrying out the production of the textiles, providing the raw material for the traditional Indian costumes, is rather nominal compared even to the complete MSME sector, its catalysing role in the social integration, the entrepreneurial and innovation promptitude in the revival of the rural areas can be perceived even at present.

References

ANTONOVA, K. A. – BONGARD-LEVIN, G. M. – KOTOVSZKIJ, G. G. (1981). *India története*. – Kossuth–Gondolat, Budapest, 613 p.

BALOGH, A. (1979). *Társadalom és politika a gyarmati Indiában (1905–1947).* – Kossuth, Budapest, 293 p.

BASU, D. K. (2006). *Aurobindo, Sri*. In: WOLPERT, S. (ed.) *Encyclopedia of India.* – Thomson Gale, Detroit etc., Vol. 1, pp. 75–77.

GANDHI, M. K. (1982). *An Autobiography or The Story of My Experiments with Truth*. – Penguin Books, Harmondsworth, 454 p.

KURIAN, G. T. (1976). *Historical and Cultural Dictionary of India*. – The Scarecrow Press, Metuchen, 307 p.

PRASAD, Y. (2006). *Prasad, Rajendra*. In: WOLPERT, S. (ed.) Encyclopedia of India. – Thomson Gale, Detroit etc., Vol. 3, pp. 328–331.

ROY, S. (2006). *"A Symbol of Freedom": The Indian Flag and the Transformations of Nationalism, 1906–2002*. – Journal of Asian Studies, Vol. 65, No. 3, pp. 495–527.

SCHUMACHER, E. F. (1973). *Small is Beautiful: A Study of Economics as if People Mattered*. – Blond & Briggs, London, 288 p.

Sharma, J. N. (2013). *Alternative Economics: Economics of Mahatma Gandhi & Globalisation*. – Deep & Deep Publications, New Delhi, 196 p.

Wilhelm, Z. – Rudl, J. – R. Bank, K. – Gálosi-Kovács, B. – Benovics, G. – Déri, I. – Piszter, G. (2010). *Területi különbségek vizsgálata Indiában / The Survey of Spatial Disparities in India*. – Földrajzi Közlemények / Geographical Review, vol. 134, No. 3, pp. 299–312.

Wilhelm, Z. (2011). *The Survey of Spatial Disparity in India with the Application of the SENTIENT Index* – Hungarian Geographical Bulletin / Földrajzi Értesítő, Vol. 60, No. 1, pp. 45–65.

Wilhelm, Z. – Pete, J. – Nemes, V. – Zagyi, N. (2011). *The Survey of Spatial Disparity in India with the Application of the SENTIENT Index with Special Focus on Religious Composition.* – Human Innovation Review / Humán Innovációs Szemle, Vol. 2, No. 1, pp. 56–76.

Electronic sources

Annual Reports Online (2003–2013). *Annual Reports of MSMEs*. – Ministry of Micro, Small and Medium Enterprises [online]. Available at: <http://msme.gov.in/msme_ars.htm> [Accessed: 26 April 2014]

Besant, A. (1915). *How India Wrought for Freedom: The Story of the National Congress Told from Official Records* [online]. Theosophical Publishing House, Adyar etc., 709 p. Available at: <https://archive.org/details/howindiawroughtf00besa> [Accessed: 18 April 2014]

Census Online (2001). *Tabulations Plan of Census Year 2001* [online]. Census Digital Library. Available at: <http://www.censusindia.gov.in/DigitalLibrary/TablesSeries2001.aspx> [Accessed: 20 April 2014]

Census Online (2011a). *Population Enumeration Data (Final Population)*. – Ministry of Home Affairs, Office of the Registrar General & Census Comissioner, India [online]. Available at: <http://www.censusindia.gov.in/2011census/population_enumeration.aspx> [Accessed: 20 April 2014]

Census Online (2011b). *Provisional Population Totals Paper 2 of 2011: India (Vol II)* [online]. *(pdf)* Ministry of Home Affairs, Office of the Registrar General & Census Comissioner, India Available at: <http://www.censusindia.gov.in/2011-prov-results/paper2-vol2/data_files/India2/Table_2_PR_Cities_1Lakh_and_Above.pdf> [Accessed: 21 April 2014]

CIA ONLINE (2013). *India*. – The World Factbook [online]. Available at: <https://www.cia.gov/library/publications/the-world-factbook/geos/in.html> [Accessed: 18 April 2014]

DUBEY, A. (2014). *Globalization & Its Impact in Small Scale Industries* [online]. *(pdf)* Global Journal of Multidisciplinary Studies, Vol. 2, No. 2, 9 p. Available at: <http://www.gjms.co.in/index.php/gjms/article/download/35/61> [Accessed: 18 April 2014]

FLEXITRON ONLINE (n.a.). E*-charkha: The Humble Gandhi Charkha is now e-charkha* [online]. Tripod. Available at: <http://flexitron.tripod.com/echarkha/DSC01017.JPG> [Accessed: 30 April 2014]

GANDHI, M. K. (1941). *Constructive Programme: Its Meaning and Place* [online]. Navajivan Publishing House, Ahmedabad, 31 p. Available at: <http://www.mkgandhi.org/cnstrct/cnstrct.htm> [Accessed: 18 April 2014]

GAZETTE ONLINE (2006). The Micro, Small and Medium Enterprises Development Act, 2006 [online]. *(pdf)* The Gazette of India, 11 p. Available at: <http://www.egazette.nic.in/writereaddata/2006/E_31_2011_065.pdf> [Accessed: 22 April 2014]

KNOWLEDGE MANIA ONLINE (2013). *The Flag of India*. [online]. Knowledge Mania: It's all About Knowledge!! Available at: <http://knowledgemaniaa.blogspot.hu/2013/08/the-flag-of-india.html> [Accessed: 30 April 2014]

KUMAR, S. (1984). *Az önellátás filozófiája*. In: ENDREFFY Z. – KODOLÁNYI GY. (eds.) Ökológiai kapcsolatok [online]. Népművelési Intézet, Budapest. Available at: <http://mek.oszk.hu/02200/02278/html/12.htm> [Accessed: 18 April 2014]

KVIC ONLINE (n.a.). *Khadi: Release of e-Charkha* [online]. *(pdf)* Khadi & Village Industries Comission, Ministry of MSME. Available at: <http://www.kvic.org.in/PDF/e_charkha.pdf> [Accessed: 27 April 2014]

MISHRA, S. (2012). *Small Scale Industries: Striving and Thriving in the Era of Globalization* [online]. *(pdf)* International Journal of Enterprise Computing and Business Systems, Vol. 2, No. 2, 17 p. Available at: <http://www.ijecbs.com/July2012/5.pdf> [Accessed: 18 April 2014]

MLE ONLINE (2013). *Report on Third Annual Employment and Unemployment Survey (2012- 2013) Volume 1* [online]. *(pdf)* Ministry of Labour & Employment, Labour Bureau, Chandigarh, 249 p. Available at: <http://labourbureau.nic.in/EUS_2012_13_Vol_1.pdf>

[Accessed: 19 April 2014]

MSME ONLINE (2013). *Annual Report 2012–2013: Micro, Small & Medium Enterprises* [online]. *(pdf)* Ministry of Micro, Small and Medium Enterprises, New Delhi, 361 p. Available at: <http://msme.gov.in/WriteReadData/DocumentFile/ANNUALREPORT-MSME-2012-13P.pdf> [Accessed: 22 April 2014]

MSME CENSUS ONLINE (2011). *Fourth All India Census of Micro, Small & Medium Enterprises 2006–2007* [online]. *(pdf)* Development Comissioner, Ministry of Micro, Small & Medium Enterprises, New Delhi, 303 p. Available at: <http://fisme.org.in/document/FinalReport010711.pdf> [Accessed: 22 April 2014]

ONEFINALBLOG ONLINE (2013). *Mandela. Yes. MLK. Yes. Gandhi. No*. – Onefinalblog: Honestly, it touches me, and I share it with you [online]. Available at: <http://onefinalblog.wordpress.com/2013/06/24/mandela-yes-mlk-yes-gandhi-no/> [Accessed: 30 April 2014]

PLANNING COMMISSION ONLINE (2001). *Evaluation Study on Khadi and Village Industries Programme* [online]. *(pdf)* Programme Evaluation Organisation, Planning Comission, Government of India, New Delhi, 94 p. Available at: <http://planningcommission.nic.in/reports/peoreport/peoevalu/kvic_fin.pdf> [Accessed: 06 June 2014]

SPINAK, J. (2004). *A Macroeconomic Analysis of the Indian Economy* [online]. MIT, Sloan School of Management, 16 p. Available at: <http://web.mit.edu/profit/India%20and%20Outsourcing%20Papers/Final%20Paper%20for%20India%20Class%20-%20Joshua%20Spinak.doc>[Accessed: 20 June 2014]

Information for New Authors

Frugeo Geography Research Initiative invites ambitious researchers to join the success of our projects and be an original and significant contribution to the human knowledge of *Earth Sciences* and also *Environmental Sciences*. We provide publication possibilities to academics who already own a *PhD degree*, and we would also like to give the chance and opportunity to *PhD Students,* and even *MSc/BSc Students,* to help them gain recognition, points and credits, and assist in their scientific life getting an easier start on the sometimes difficult path of publishing.

We provide place and opportunity for publications to researchers, although we do accept only outstanding papers; therefore, a published work in one of our upcoming books has to bear high standards, must be well-researched, well-illustrated and well-written in an engaging style that can call the attention of anyone who reads it. It must be something interesting, topical and must contribute to the development of any geographical (scientific) disciplines.

Our books will cover many different types of geographical subjects; therefore, we try to encourage and approach anyone who acts on the fields of Earth or Environmental Sciences, including those whose subject specialism is neither of the above (e.g. arts, business, health sciences), but would be able to contribute an article to a set topic of a specific issue.

The subsequent numbers of *Geographical Locality Studies* will offer a wide range of titles where, we believe, every researcher will find the best that suits him/her and will have the opportunity to contribute to it. For the upcoming titles and publishing possibilities, please keep an eye on our regularly updated website (www.frugeo.co.uk) or contact us (info@frugeo.co.uk).

In order for an article to be published, the author(s) will need to follow our instructions and must achieve the expected standards of *Geographical Locality Studies*.

1. Manuscripts have to be prepared by

- one individual author, or by
- two co-operating authors.

2. They have to be written in

- British English, and
- the majority of the paper in Passive mode.

3. The following types of papers are considered for publication:

- Original articles in basic and applied research;
- Critical reviews, surveys, opinions, commentaries and essays.

4. The papers have to have

- Abstract (1000–1200 characters with spaces);
- 5 key words;
- Introduction;
- Aims of the study;
- Research methods;
- Results;
- Discussion;
- Conclusions;
- Acknowledgements;
- Reference list or/and bibliography (This has to be prepared by using Harvard referencing. See examples on Frugeo's website.).

5. How to register?

If you wish to contribute in one of the upcoming GLS projects, please send an e-mail with the following information provided to:

info@frugeo.co.uk

- Title;
- Full name and date of birth;
- Highest academic degree;
- Workplace / Institution;
- Position;
- E-mail address;
- Contact telephone number;
- Paper's working title;
- Along with your registration, please prepare an abstract no longer than 1000 characters with spaces and include at least 5 key words.

6. What are the fees and what are they for?

To keep our standards and quality high, and also to ensure the books will surely be published and distributed, we charge a certain amount of participation fee which is broken down into three groups:

- Group A is for an Academic, who already has a PhD degree;
- Group B is for a PhD Student, or for a Candidate of PhD (PhD Aspirant);
- Group C is for an MSc/BSc Student, or for a researcher with MSc/BSc degree;
- Groups AB, AC and BC are for co-operating authors with different academic backgrounds.

Participation fees as of 2014 in GBP

- A: £100.00
- B: £75.00
- C: £50.00
- AB: £87.50
- AC: £75.00
- BC: £62.50

We expect the fee paid in *Pound Sterling* (Great British Pounds). Payment can be made securely through *PayPal*. Payment requests are always sent out as e-mail links by *Frugeo GRI*.

The fee covers and guarantees that

- every paper will be read by professional and fully independent reviewers (peer reviewers);
- they will be proof-read;
- the authors will be given as much extra help as possible;
- the book will be published;
- the book will be available in a print copy as well as online;
- the online edition will remain free of charge;
- it will be distributed, and
- every participant will receive a printed copy at no extra fee.

The authors must bear in mind that the fee is

- non-refundable, and
- it can only be paid by one author individually or as a share by two authors together.

The above prices are for individual papers that are written by one or two authors. We do not accept works written by more than two authors. Participants only need to pay when the Editors have read and approved the first version of the submitted document and have confirmed and reserved a place for the authors in our book. However, papers will not be published, if we do not receive the fully completed articles by our set deadline. If the authors miss the last day of submission, the opportunity to publish in our book and the participation fee will either be lost.

7. Frugeo GRI membership

Everyone who joins the GLS project and pays the fee, regardless of the group and the amount, will automatically become the member of the Frugeo Community for a 1-year-period (the membership is worth up to £50.00) which will give the opportunity to all the participants to request services (e.g. translation, proof-reading) from Frugeo GRI for a discounted rate (30% off all services except for subsequent participation fees).

8. Amazon.co.uk voucher prize draw

We would also like to encourage our participants and make them motivated; therefore, every time a new number of *GLS* is published, all the participating authors will be given the chance to win our top-prize of £100.00 Amazon.co.uk gift voucher (or 2 x £50.00, if the article is written by two authors). All the manuscripts that we will accept in our book will go through the editors and peer reviewers who will independently and individually score them. The best one and its author(s) will receive our gift voucher via e-mail that can be used on www.amazon.co.uk. Certain terms and conditions, however, apply. Please make sure you are aware that *GLS* editors and their co-authors are not entitled to enter the prize draw.

If you would like to be considered for our offer or if you have questions regarding the publication possibilities or the *GLS project*, please contact us instantly.

We look forward to hearing from you!

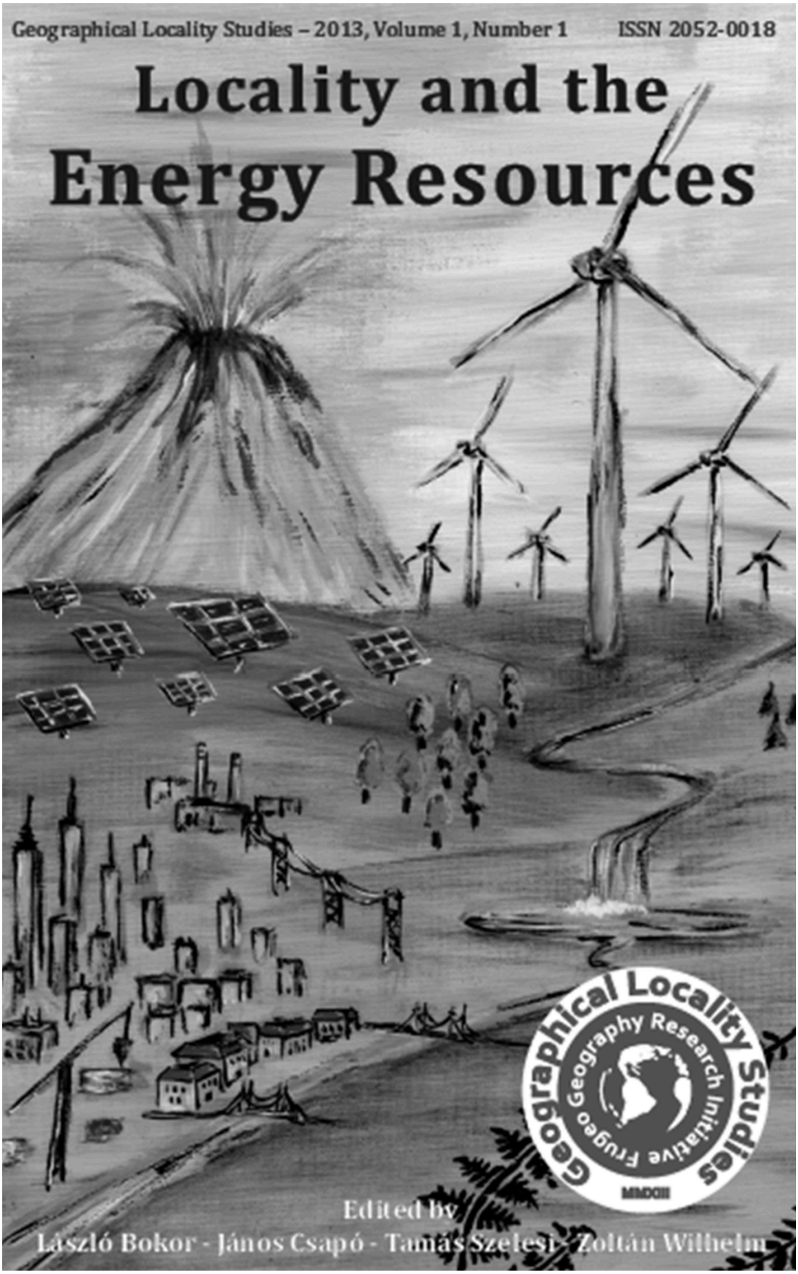
Frugeo Geography Research Initiative
Shrewsbury, United Kingdom
www.frugeo.co.uk
info@frugeo.co.uk
+447971704928

"Locality and the Energy Resources"
June 2013, Volume 1, Number 1
Edited by László Bokor, János Csapó, Tamás Szelesi, Zoltán Wilhelm

Paperback: 216 pages
ISBN 978-0-9576442-0-5 (Paperback)
ISBN 978-0-9576442-1-2 (eBook-PDF)

The first number of Geographical Locality Studies anatomises the possibilities of local utilisation with regard to natural energy resources. In this present issue, we have given publicity to 12 studies which have all been written by 13 expert Hungarian researchers and higher education lecturers. Their task was to shed light on global examples and introduce specific, locally achievable methods, solutions or ideas which could be used anywhere else on the planet. By doing so, the ideas could be transplanted, adapted and could give birth to foundations for newer, more efficient and revolutionary techniques, technologies and developments. The written masterpieces can be classified into three categories: a) articles that support general knowledge on the topic; b) selected Asian examples that foster such understanding; and c) a selection of Hungarian cases.

This present co-operation, however, is not only a gathering of academics who try to bring recognition to themselves, but it is also meant as a surprise to one of our special friends and colleagues. *Klára Bank*, who is a professor at the *University of Pécs*, *Institute of Geography*, has reached her 60th birthday this February. She has been a pioneer and a significant contributor to the development of *Geography of Energy* and also *World Regional Geography*. When it comes to the chosen authors' specifics, the aim of *Frugeo Geography Research Initiative* has been to find and work together with experts who have exclusively known the respected and honoured person and, therefore, been familiar with her achievements on these specific scientific fields. By this book, we would like to erect a simple but long-lasting memory and acknowledgment for her invaluable effort, support and motivation which are felt by generations.


Geographical Locality Studies – 2013, Volume 1, Number 1
ISSN 2052-0018
Locality and the
Energy Resources
Geographical Locality Studies
Geography Research Initiative
Frugeo
MMXIII
Edited by
László Bokor - János Csapó - Tamás Szelesi - Zoltán Wilhelm

"Student-led sustainability by BCUSU"

Student-led sustainability which promises to make a real change to how we all think about, connect with and preserve our natural surroundings. *Eco* by *Birmingham City University* (BCU) seeks to take this zero-waste philosophy even further by embedding it into students' lives and homes, using a mobile sustainable café to establish a presence across the institution's eight campuses. The café is the central focus of a four-themed project: *grow*, *create*, *reuse*, and *learn*.

Grow and EcoGarden

Landscape Architect students, together with students from the *Faculty of Health*, have joined *Eco* to design a productive horticultural garden that serves as a centre of well-being, too. Over recent years, there has been an increased awareness in the healthcare community to develop functionally efficient and hygienic environments that also have stress-reducing characteristics. When *EcoGarden* is finished, not only will it be one of the first well-being centres in a *United Kingdom* university, it will also grow produce for *CafÉco*—the mobile café which will visit all BCU campuses *(see pictures)*.

Create

Upcycling has become extremely popular over the last couple of years, whether that is upcycling old clothes, furniture, appliances or rubbish. Something really can come from nothing! The *Create team* runs workshops to show you how to make your unwanted items into something you will love again. The workshops show you how to create small items, such as IPad cases from unwanted jumpers and t-shirts and from the many bags and boxes of items that we hope are donated to our *Reuse team*.

Students of the *Birmingham Institute of Art and Design* (BIAD) are also creating larger upcycled items from unwanted items of furniture. If you have a vision of what you would like your unwanted item to be turned into, but have no idea how to do it, our Create team can help you.

Reuse

The *Reuse team* are here to encourage and show everyone how to re-use anything that they are considering throwing out. We are aiming to collect 15 tonnes worth of used clothes, books and bric-a-brac from being sent to landfill by August 2015. We are working with students, local community schemes and primary schools to help show people how easy it is to turn something they consider rubbish, into something of value.

Learn

Learning and debate are the fundamental parts of *Eco* and form a back-bone to all other aspects of the project. We provide everyone with relevant information that can improve understanding in all of the *Eco* topics, including sustainability, consumerism, conservation, energy efficiency, waste reduction, food production and plenty more. We are running regular workshops and debates on all these topics; keep an eye out on our *EcoCalendar* to find out when!

Found out more about Eco and how to get involved

We have lots of ways to get involved, from donating unwanted items, planting produce, or simply buying a coffee from *CafÉco*. For more information visit *Eco's* website, post onto our *Facebook* wall or come around to one of our events and get involved!

Website: http://www.bcusu.com/eco/
Facebook: https://www.facebook.com/ecobybcusu

Project manager, Harinder Matharu, helping out at Edible Eastside
Photo source: Eco

CafÉco, the portable café
Photo Source: Eco

Grow team volunteering for Aston Villa in Birmingham

Photo Source: Eco

Eco-grown vegetables at Roots & Renewal

Photo Source: Eco

CALL FOR PAPER – REGISTER YOUR PAPER TODAY!

"Locality and the Impact of Human Consumption on the Environment" 2015, Volume 3, Number 1

Editors: László Bokor, Katie Eccleston, János Csapó, Harinder Matharu

Society takes for granted an excessive amount of what seems like ordinary day to day needs. These habits occur every day and can be seen all around us, whether it is recycling your coffee cup every time you buy a take-out or choosing to drink loose tea leaves instead of buying tea bags at home. The high majority of people would not think twice about reusing a cardboard cup or putting their tea leaves on to a compost heap; instead, these things are mindlessly thrown away without a second thought to the people who have made these necessities and to the amount of energy that has been invested into them. Not only are these habits having a negative impact on the environment, but they are turning us into a wasteful society.

In this third issue, *Geographical Locality Studies* (GLS) is navigating us to the field of human consumption and is looking into the habits of society's luxury commodities that have major impacts on both the natural and human environment. Amongst the most popular routines are coffee, tea, chocolate, sugar, tobacco, honey and household utilities, e.g. textiles and furniture. In this number, GLS will highlight the global issues behind these above consumerist necessities and address solutions in maintaining human awareness on major environmental problems. The various articles that *Frugeo Geographical Research Initiative* expects from our multidisciplinary participants may cover many different scientific (and non-scientific) subjects, fields and areas, e.g. biology, water sustainability, ecology, architecture, manufactory, energy efficiency, food production, labour exploitation, fair trade, tourism, etc. These varieties of disciplines will allow us to capture a clearer picture on the issue and a better approach in understanding how the different consumerist habits affect the environment. This will allow us to find solutions and methods in getting the people more aware of how they can change their daily routines to reduce the damaging effects to the planet.