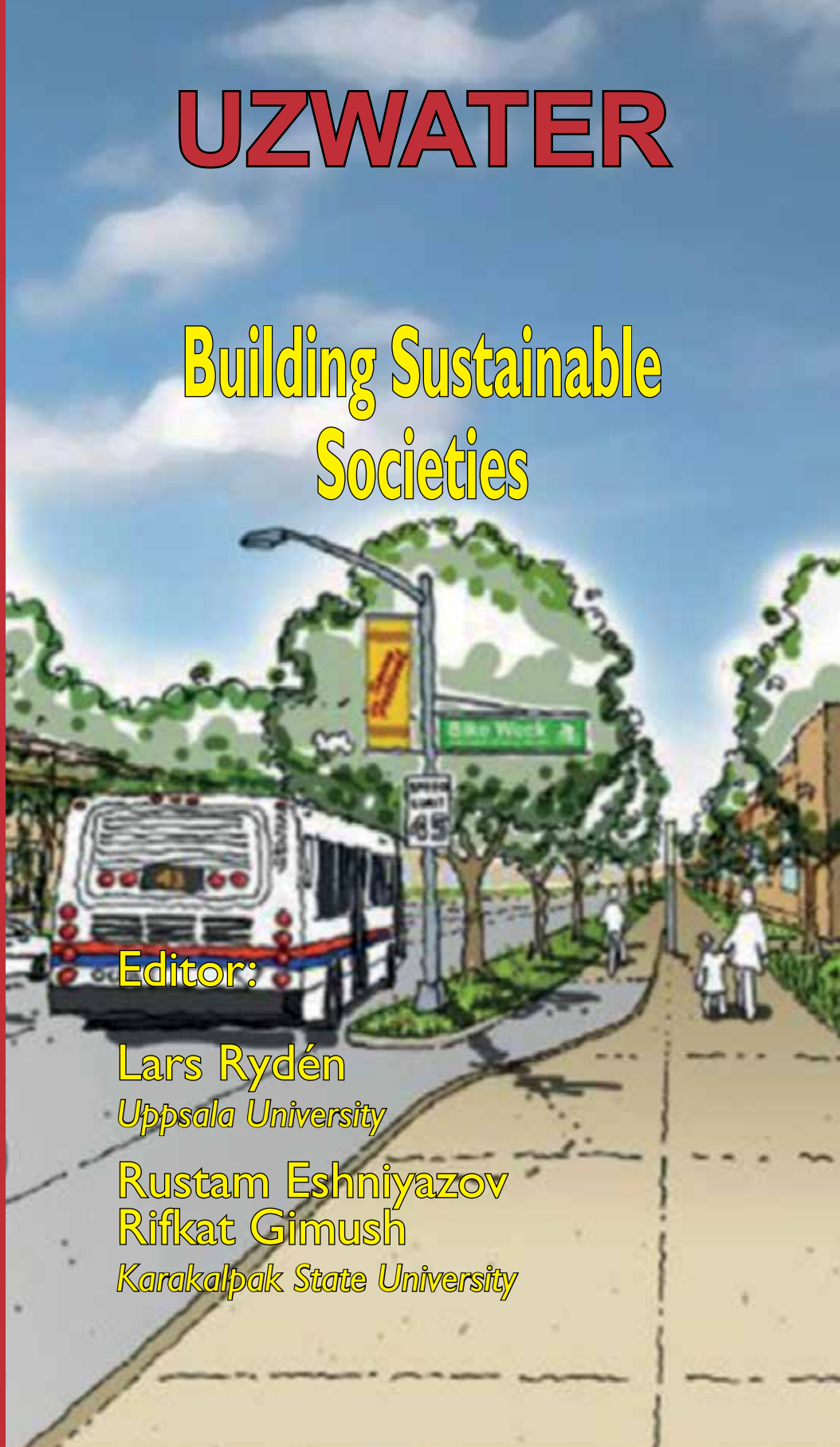
UZWATER

Building Sustainable Societies



Editor:

Lars Rydén
Uppsala University

Rustam Eshniyazov
Rifkat Gimush
Karakalpak State University

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This compendium is produced for a master level course in the UZWATER project. It consists of some newly written material as well as previously published texts extracted from freely available books, reports and textbooks on the Internet, dominated by publications from the Baltic University Programme. The sources used for each chapter is listed at the end of the chapter.

Content Overview

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Content

Chapter 1
Building Sustainable Societies – the Human Dimension

1.1 How many people can the Earth support – population growth

Fear for unending population growth – the population explosion – has since long been a main concern for those thinking about the future of humanity. The Englishman Thomas Malthus in *An Essay on the Principle of Population* from 1798 alarmed the world that food and other resources soon would not be enough for everyone and started a serious discussion on which political actions were needed to curb population growth. Today this discussion seem to be most active in the United States, where environmental impact is much perceived as the result of being too many, not that each one uses too much resources.

During most of human history world population grew very slowly. On average a woman during her short life got 6 children of whom 2 survived to adulthood. These in turn reproduced to get two children etc. The number of children per fertile woman is called *fertility rate*. For constant population the fertility rate should be 2.1, called *replacement rate*. This was close to the value for the human race for most of our history. But from about 1700, the beginning of industrialization, it started to grow dramatically. Family size became much larger and the population explosion became a fact. From the 18th century global population growth accelerated, with shorter and shorter doubling times, 1 billion in 1800, 2 billion in 1927, 4 billion in 1974 and 7 billion in 2011 (Table 1.1).

Population in the world is currently growing at a rate of around 1.14% per year. The average population change is currently estimated at around +80 million per year. But it is declining. Annual growth rate reached its peak 2.19% in 1963. It is currently going down and projected to continue to do so. It is estimated to be less than 1% by 2020 and most experts expect it to end by about 2050 at a world population of 9-11 billion. However other results have also been published. According to UN Population Division world population will reach about 10.9 billion in 2100 and continue growing thereafter. Other experts dispute that and find that birth-rates will fall below replacement rate in the 2020s. Population growth will continue to the 2040s by rising longevity but will peak below 9 billion by 2050.

Table 1.1 Highlights in world population growth (Source http://www.worldometers.info/world-population)

0.2 billion in	year 0 (estimate)
1 billion in	1804
2 billion in	1927 (123 years later)
3 billion in	1960 (33 years later)
4 billion in	1974 (14 years later)
5 billion in	1987 (13 years later)
6 billion in	1999 (12 years later)
7 billion in	2011 (12 years later)
8 billion in	2024 (13 years later; according to UN estimates)

A most entertaining and informative film on population growth is *Don't Panic* by Hans Rosling at Gapminder.

Will the resources of the world be sufficient for 9 or so billion inhabitants? Is the *carrying capacity* enough? Most researchers believe that enough food for all will be possible. One will however have to decrease food loss, and improve agricultural productivity in many areas, not the least in Africa. However, we see land prices increase steeply in many parts of the world as an indication that the food production issue is expected to be critical.

1.2 The population transition

A generation or two ago the so-called developing countries had many children per fertile woman often about 6, and a population growth approaching 3%, while in developed, industrialised countries the figure was closer to 2.1 children, i.e. the replacement rate. Since then a dramatic change has taken place. Especially in Asia, birth rates of many countries have dramatically decreased. High birth rates today only remain in Africa (Figure 1.1). In all of Europe the birth rates are lower than replacement rate and in some countries much lower, e.g. in southern Europe (Figure 1.2). In Central and Eastern Europe population decline is typical both because of low birth rates and emigration. In Europe thus the development has already come to peak population and in fact population would be decreasing faster if not for immigration.

The reduction of fertility is a universal phenomenon, but occurs at different rates in different countries. Fertility patterns are closely linked with social and cultural norms and family structures. A change in fertility requires a dramatic

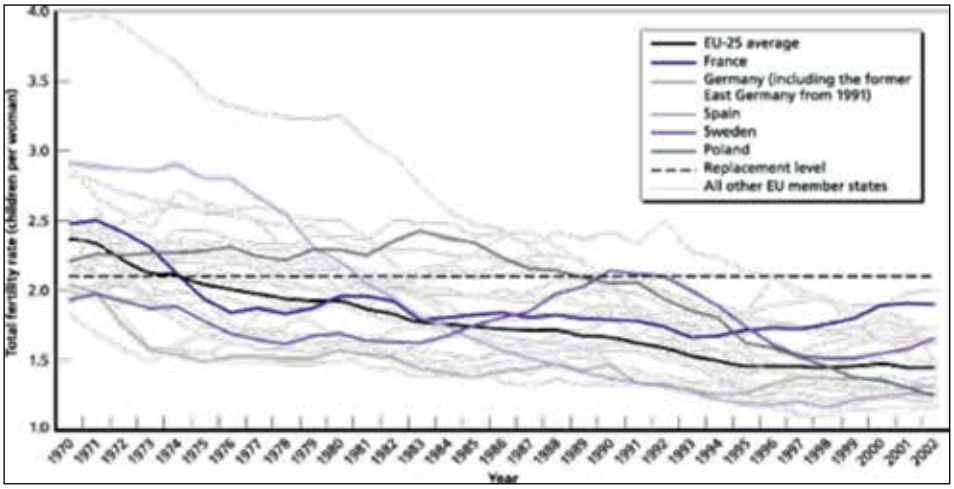

Figure 1.2 Fertility rate development in Europe. (Source: Europe – Population Decline in European Cities https://jellyfishkunn.wordpress.com/2012/10/26/blog4-europe-population-decline-in-european-cities/)

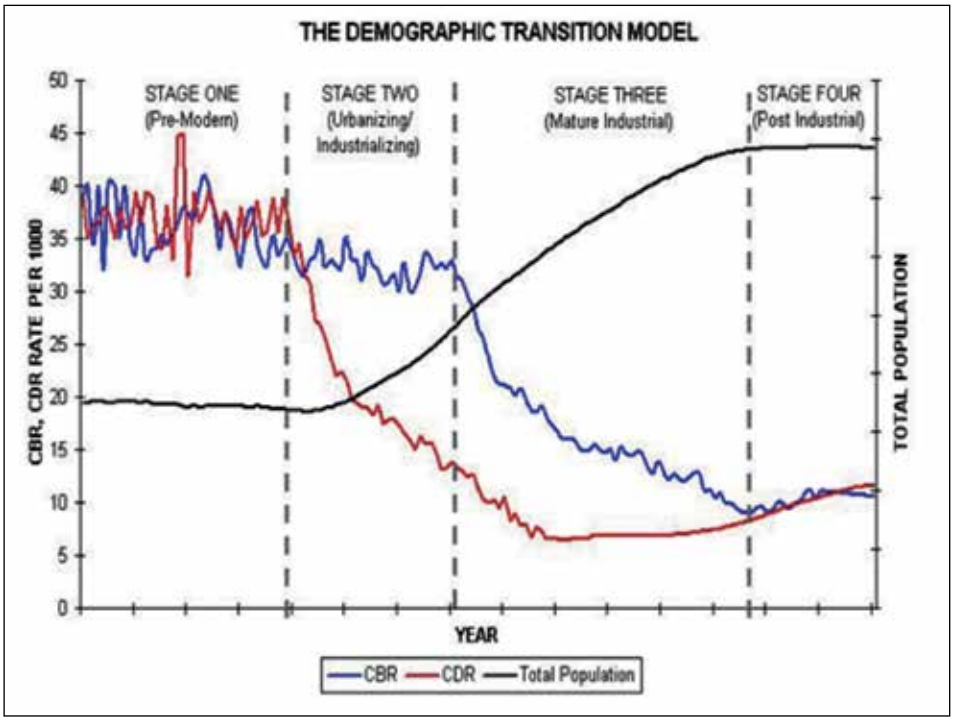

Figure 1.3 The demographic transition. (Source Keith Montgomery. http://pages.uwc.edu/keith.montgomery/Demotrans/demtran.htm

shift in social structures and in mentality, notably in the status of women, which plays an important role in the determination of fertility patterns.

Thus in individual parts of the world this development from a small population to exponential growth to finally levelling off at a higher level has already taken place. It is called the *population transition* (Figure 1.3). It begins when health improves, life expectancy increases and birth rate dramatically decreases. After some time family size will shrink. An important reason for this is decreasing child mortality. It will thus not be necessary to have many children to be taken care of at an older age; as children go to school, they are also more a cost than a help in the household; and finally that families choose to have fewer children for improving their own lives. Of course basic family planning means have to be available to make these changes possible. These insights also point to what is needed to curb population growth.

Why then, if the fertility rate is no longer larger, why does world population continue to increase? This is a consequence of the population composition. Most people in the world are children; they will grow up and have children in turn. But not more than two and for this reason the number of children in the world will not increase. We have come to peak child. But the number of adult will increase since children will grow up and have a longer life than before.

The situation in Uzbekistan is described in Table 1.2. As we can see the demographic transition is a fact also here. After 2008 the fertility rate is below replacement. As expected the population is still increasing but rather slowly – at present by 0.93%.

In individual countries *migration* is in many cases very important, and contributes much more to population increase or decrease, than birth rates and mortality. Thus in many parts of Central and Eastern Europe populations are decreasing because of *emigration*. For example more than a million Polish citizens have moved to UK to find work. On the contrary, the *immigration* to the Nordic countries, especially Sweden, and Germany is large. For Sweden in 2014 it was 70 000, mostly refugees from the Middle East. To be compared to the entire population of just less than 10 million.

Table 1.2 Top row Population growth and bottom row fertility rate (number of children per fertile woman) in Uzbekistan. Source: http://www.indexmundi.com/g/g.aspx?c=uz&v=24.

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1.6	1.6	1.62	1.63	1.65	1.67	1.7	1.73	0.97	0.94	0.94	0.94	0.94	0.94	0.93
3.09	3.06	3.03	3	2.97	2.94	2.91	2.88	2.01	1.95	1.92	1.89	1.86	1.83	1.8

The migration in the world is today larger than it has been since the end of World War II, spurred by conflicts in the Middle East and in Africa, and countless numbers of refugees.

1.3 The aging society

An effect of improved health status of the population is that *life expectancy* is increasing. Life expectancy at birth globally was 68.3 years in 2010. Japan had the largest life expectancy in the world of 82.6 years. In many African countries is around 40 years. In Sweden in 2011 life expectancy at birth was 83.7 for women and 79.8 for men (Table 1.3). Life expectancy is increasing with about 3 months per year in Europe, mostly because mortality at higher age is decreasing. Life expectancy was only 39.4 years in 1880, but increased to 68.2 years by 1950 – an increase of 28.8 years. In the subsequent 40 years, life expectancy went up only a further 7.2 years (Figure 1.4).

If this continues living to 100 years of age will be common in the near future. But there are signs pointing to a possible halt of this development. Public health is decreasing in many countries. Main reasons include obesity, diabetes, and cardiac arrest, all consequences of changing living styles and eating habits.

One or two generations ago in all societies there were typically very may more young people than elderly. The population pyramid had a large base and a thin top. Today this is true only for some poor countries (Figure 1.5).

As a sustainable society in the long term cannot have a steadily increasing population, we will have an *ageing society.* A much larger share of the population will be retired, that is, older than retirement age, in many countries around

Table 1.3 Life expectancy at birth 2011 – from the top 20 (Source CIA Factbook 2011)

Japan	83.91
Singapore	83.75
Hong Kong	82.12
Australia	81.90
Italy	81.86
Canada	81.48
France	81.46
Spain	81.27
Sweden	81.18
Switzerland	81.17

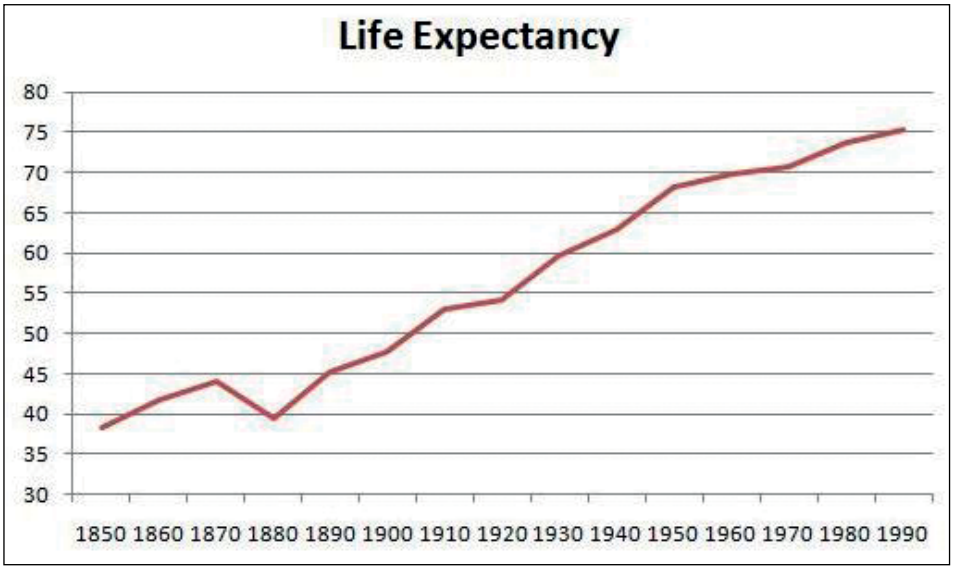

Figure 1.4 Life expectancy in EU. The greatest improvements in mortality occurred between 1880 and 1950. Here is life expectancy at birth between 1850 and 1995 (series Ab644):

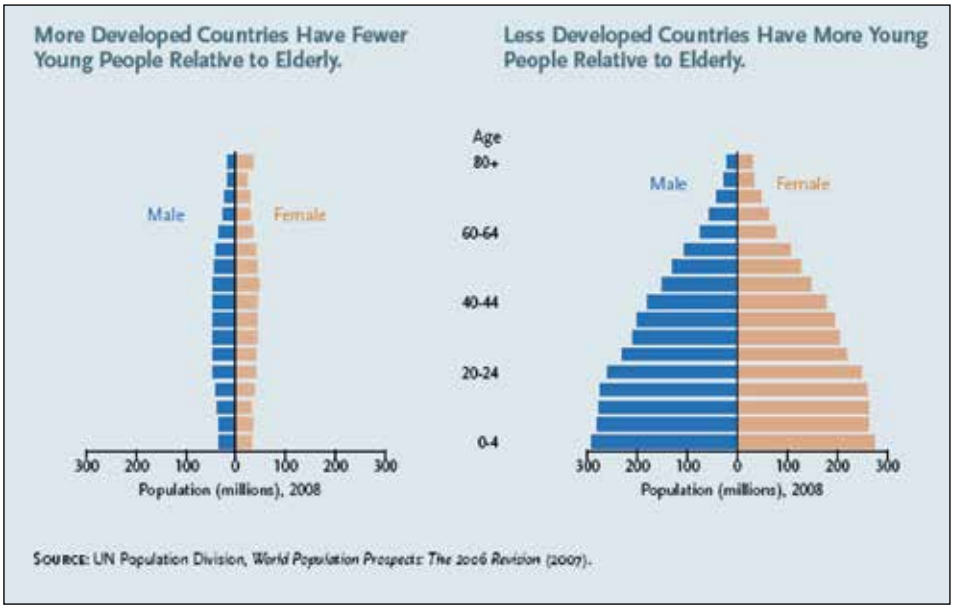

Figure 1.5 Population pyramids for more and less developed countries. (Source: The UN Population Divisiona)

65. A common heard concern is that fewer (in working age) will have to support many more (retired). Another concern is that costs for elderly care will increase dramatically. Very few countries have a policy to manage this question; many governments rather stimulate families to have more children or support immigration. But this is only to postpone the problem, which will reappear but at a much higher total population. We will finally be in a situation when fewer in working age will have to support many more in retirement.

Some argue that it may not be a problem. According to macroeconomic modelling the average working hours in a sustainable economy should decrease substantially compared to the norm today. We will not need so many working hours!

So how then can elderly contribute in a sustainable society? Earlier this was not a problem at all. When state guaranteed pensions were introduced the retirement age was equal to average life expectancy, that is, pensions were not a large cost for the country. Today the pension age is debated. Typically people stay healthy many years into retirement. Therefore some think pension age should be much higher, at least 70. There are efforts to encourage elderly to stay at their working places voluntarily, often on part time and with less heavy jobs.

Others see that healthy elderly may contribute voluntarily. Elderly, who has a considerable experience, may help young people voluntarily. Examples include business angels, elderly business leaders helping younger to get started. We have also seen healthy elderly taking care of less healthy elderly. It seems clear that in a future sustainable society the so-called voluntary sector will be larger and more important than today.

In some countries we start to see one more demographic phenomenon: The gender balance changes. Human populations always have a surplus of boys, since there are more boys born, about 107 boys to 100 girls. But at higher ages this changes to its opposite. This is because adult males tend to have higher death rates. The reason includes more frequent accidents, more heart failures etc. Thus, even if there are proportionally fewer girls than boys born, at higher ages women were in excess. But because of much better health care in some countries we now start to see that the life expectancy of men and women are almost exactly the same, and then at older age there are more men than women.

1.4 Human welfare and dignity

We need to discuss not only how many people the planet can support but also how we all can lead a decent life. After the atrocities of the Second World War an intense discussion began on how to establish general principles for a dignified hu-

man society and acceptable human conditions. The most important result of these efforts was the United Nations Universal Declaration of Human Rights adopted by the UN General Assembly in 1948. It serves as a document establishing which values should not be violated regardless of circumstances.

The General Declaration of Human Rights have been followed by several other documents e.g. on children's rights, workers' rights etc. The UN system has thus played, and still plays, an important role in establishing a global ethics.

There were however forerunners to this development. These include most importantly The American Declaration of Independence of 1776 and the manifests of the French Revolution of 1789. The Declaration of Independence says that "all men are created equal, that they are endowed by their Creator with certain inalienable rights that among these are Life, Liberty and the pursuit of Happiness". Each human individual should thus be respected and his/her integrity protected regardless of physical, ethnic or social belonging. In various documents, most importantly the Universal Declaration of Human Rights, we have established

- religious freedom (right of belief)
- political freedom (right of speech);
- sexual freedom
- equal rights between genders
- equal rights between different ethnic groups and
- equal rights for minorities

Human rights have not been implemented fully in any country, and differences between countries are large. Especially it should be mentioned that minority rights are violated repeatedly as majority groups attempt to secure their own power and privileges, which in worst case can lead to ethnic cleansing. Gender rights are violated in many cultures where it is not customary that women decide for themselves, for their future, choice of husband or profession, and violence against women are common. The respect of the UN Convention of human rights is surveyed by the Human Right Committee of the United Nations or in Europe by the Council of Europe. However these institutions do not have power to follow up complaints about violations of human rights.

The responsibilities of the governments for protecting human rights of their inhabitants have been spelled out in the International Covenant on Economic, Social and Cultural Rights (ICESCR), which went in force 1976. The Covenant commits its parties to work toward the granting of Economic, Social, and Cultural Rights (ESCR) to individuals, including labour rights and the right to health, the right to education, and the right to an adequate standard of living. In 2011, the

Covenant had 160 parties. The covenant should be seen as a political agreement on basic duties of a modern welfare state.

1.5 The millennium development goals

The next major effort to stimulate the implementation of acceptable conditions for the human population, the eight so-called millennium development goals, MDGs, was established by the United Nations in year 2000, to be achieved in year 2015 (Table 1.4). The MDGs set a description of which kind of world would we should strive to build. Today, in 2015, the results of 15 years of efforts to reach these goals start to be seen. It is clear that there is a mixed success.

The MDGs are eight quantifiable goals to improve the life for the poor of the world. They should be able to live a life that is considered self-evident for most of us: not to be hungry, go to schools and have access to clean water.

Goal 1: "The proportion of people living in extreme poverty should be halved at the global level." The proportion of people living in extreme poverty has been halved at the global level. The world reached the poverty reduction target five years ahead of schedule. In developing regions, the proportion of people living on less than $1.25 a day (the extreme poverty level) fell from 47% in 1990 to 22% in 2010. About 700 million fewer people lived in conditions of extreme poverty in 2010 than in 1990. Still close to 1.4 billion people live in extreme poverty.

Goal 2: "Achieve universal primary education." Between 2000 and 2011, the number of children out of school declined by almost half – from 102 million to 57 million. However, progress in reducing the number of children out of school has slowed considerably over time. Stalled progress means that the world is unlikely to meet the target of universal primary education by 2015. 42% of children out of school live in countries of conflict. To be poor, live in a conflict area or being a girl increases the risk of growing up without education.

Table 1.4 Millennium Development Goals

Goal 1:	Eradicate extreme poverty and hunger
Goal 2:	Achieve universal primary education
Goal 3:	Promote gender equity and empower women
Goal 4:	Reduce child mortality
Goal 5:	Improve maternal health
Goal 6:	Combat HIV/AIDS, malaria and other diseases
Goal 7:	Ensure environmental sustainability
Goal 8:	Develop a global partnership for development

Goal 4: "Reduce child mortality." Worldwide, the mortality rate for children under five dropped by 41% – from 87 deaths per 1,000 live births in 1990 to 51 in 2011. Despite this enormous accomplishment, more rapid progress is needed to meet the 2015 target of a two-thirds reduction in child deaths. Increasingly, child deaths are concentrated in the poorest regions, and in the first month of life. Child mortality has decreased from more than 12 million in 1990 to 6.9 million in 2011. Thus 14,000 fewer children die each day. Successes are due to vaccination programs, treatment for malaria, and access to clean water, to mention some main factors.

Goals 3 and 5: These address the situation of women in the world; they will not be reached. In general the situation of women seems to be a less important area for very many countries.

Goal 7: This goal is the only one which addresses expressly the protection of the environment. This goal will not be met. In particular the protection of the world's climate has been a failure.

In spite of these misgivings the MDGs have been perceived as a success. This is very much the result how the goals have been defined and follow up. There have been indicators to quantify the goals and a request to report these indicators. The reports are published worldwide. The total results have been an inspiration for governments to work on the goals to be able to successfully compete with the rest of the global society.

1.6 The role of the state – democracy and peace building

How should a society be organized politically to approach sustainability? The basic document, which addresses this question, is the Agenda 21 from the 1992 Rio UNCED Conference. Here the importance of democracy, with participation and involvement of all stakeholders in a society, is underlined. *Participatory democracy* is thus seen as the political system under which it is possible to approach and govern a sustainable society. Democracy is also the system, which more than other systems guarantee the human values described in the Universal Declaration of Human Rights. There are good reasons to choose democracy. Historical experience shows that strongly centralised authoritarian systems sooner or later disregard environmental protection, good resources management and human rights to protect its own power. Examples of such mismanagement are to be found both in history and in present regimes all around the world.

Democracy as a social invention has a long history but modern democracies did not exist until about 100 years ago. Since then, with setbacks under the first

and second World Wars, as well as in connection with the decolonisation in the 1960s and early 70s, democracy has been introduced in a growing number of states. Today more than half of the world population live in formal democracies with universal suffrage. Difficulties when going from an authoritarian system (autocracy) to democracy includes that the citizens should take responsibility, even if there is no such tradition and many rather want a "strong leader" to take care of them. On the way to democracy to reduce corruption is typically a slow and difficult process, while free media is often in the forefront.

For sustainability democracy design is crucial. The traditional *representative democracy*, limited to voting, has not been able to respond to all demands of sustainable development. It lacked the elements of participation, listening, mutual understanding and changing views in the political process, which is present in *participatory* or, more often, *deliberative* democracy. This on the other hand characterises *governance*. Governance asks for less bureaucracy and an increased distribution of responsibilities of realisation, economy and maintenance in societal issues; it is more entrepreneurial, stresses competition, markets and customers, and measures outcomes. This transformation of the public sector, the authorities, may be summarized as *less government but more governance.*

Democracies vary in distribution of power between the local and central levels. Sustainability politics typically stresses the role of the local level, and has *Local Agenda 21* as the basic document. To be successful the local level needs three competences: legal, economic and expertise. The local level should thus have enough power to regulate on the local level, exemplified by the planning monopoly, enough economic strength to execute necessary reforms, which requires a strong local taxation, and finally the expertise needed to monitor and plan for a sustainable future. City networks such as the European Sustainable Cities and Towns Campaign asks for a strong local level development and the role of good governance, illustrated by the Aalborg commitments.

Democratic government and implementation of the principles of democracy has been monitored in various ways. A most interesting and relevant report is published by the World Justice Project, WJP, as an "effort to strengthen the *rule of law* for the development of communities of opportunity and equity". The rule of law includes four principles: that government and its officials are *accountable* under the law; that the *laws are clear*, publicized, stable and fair; that the process by which the laws are *enforced* is accessible, fair and efficient; and that *access to justice* is provided by competent, independent, and ethical adjudicators. A less detailed report on the rule of law it the Transparency International's list of degree of corruption in states. This list appears every year.

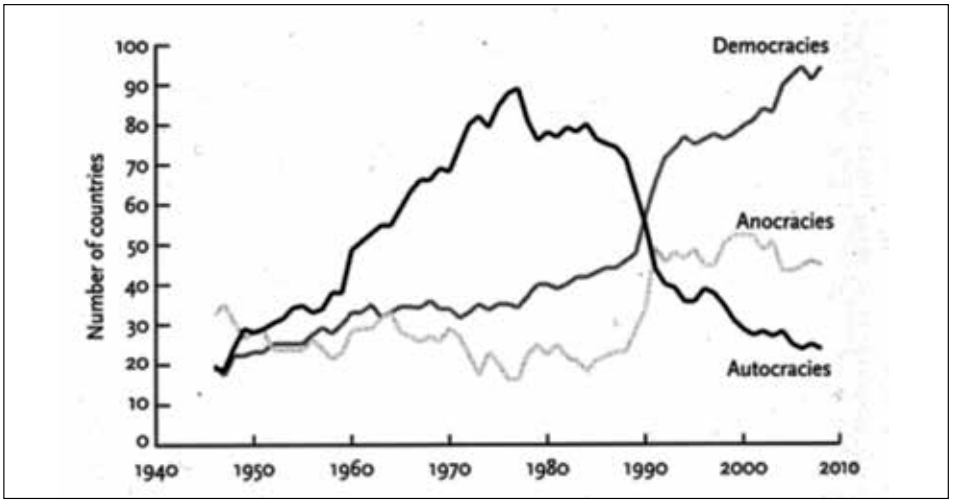

Figure 1.6. Democracies, autocracies and anocracies from 1946-2008. Only states with populations greater than 500 000 are included. (Source: Marshall and Cole, 2009)

In a less detailed way we may characterize states as *democracies, autocracies and anocracies* (states which have an incoherent mix of democratic and autocratic traits and practices) (Figure 1.6). We see that the number of states characterized as democracies is growing. The development seems to be rather stable as we have many examples of autocracies which turn into democracy, but very few cases of the opposite.

Fund For Peace (FFP), an NGO working to prevent violent conflict and promote sustainable security, has divided states in sustainable, stable, weak and *failed states* (Figure 1.7). FFP describes failed state as "states which lost control of its territory, or of the monopoly on the legitimate use of physical force therein; erosion of legitimate authority to make collective decisions; inability to provide public services; inability to interact with other states as a full member of the international community."

The right to free exchange of ideas, to assemble and to organize is essential for the democratic process. Civil society refers to all individuals and organizations in a country that is not state or authority. *Civil society* organizations are referred to as Non-Governmental Organizations, NGOs, or Civil Society Organizations, CSOs. Many people see the topics of sustainable development, protection of nature, and the fight against climate change, as existential questions. Here the right to organize to influence political as well as other processes in society is essential. Such organizations play a very important role in the changes we see.

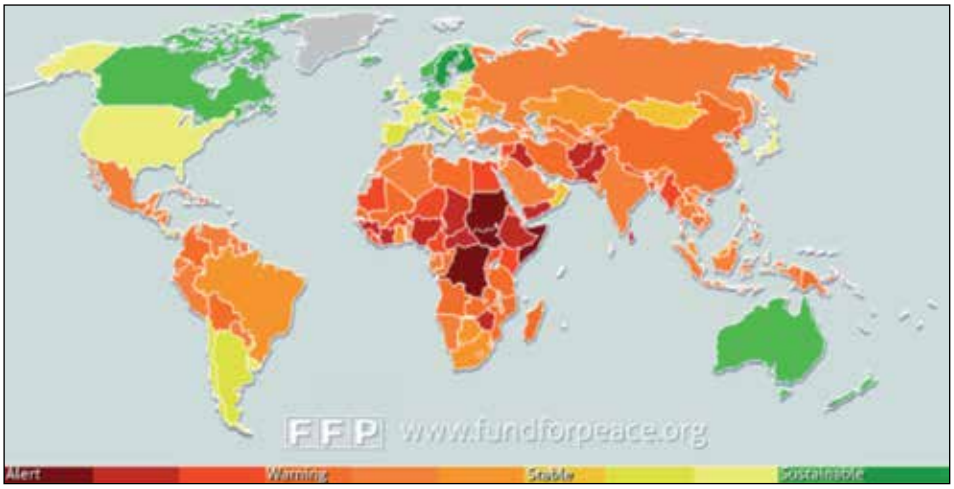

Figure 1.7 Failed States Index 2013 by Fund for Peace (source Fund For Peace)

The possibilities to influence have increased tremendously with the access to new information technologies.

1.7 A culture of non-violence and peace

Sustainability obviously requires that we do not have wars or large scale conflicts. We may be discouraged by reading the news every day, in which media report on violence and the conflicts going on somewhere in the world. But seen over a longer timespan violence has been in decline over millennia. In fact the present is the most peaceful time in the history of the human species! The decline of violence is found in many domains, including military conflict, homicide, genocide, torture, criminal justice, treatment of children, homosexuals, animals and racial and ethnic minorities. In his book *The Better Angels of Our Nature* the Canadian psychologist Steven Pinker reports on this in detail, after having spent many years in collecting data and statistics.

Pinker points to six processes which have reduced violence:

The Pacification Process
The Civilizing Process
The Humanitarian Revolution
The Long Peace
The New Peace
The Rights Revolutions

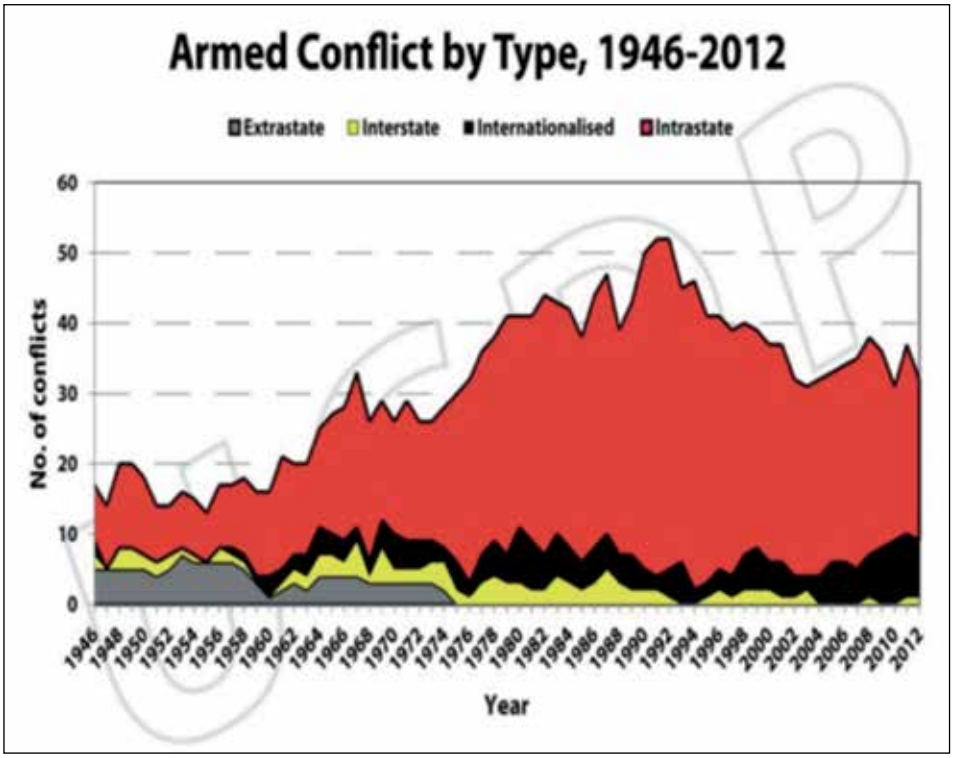

Figure 1.8 Armed conflicts 1946-2008. (Source Conflict database, Uppsala University 2013).

The first organized movements to abolish slavery, duelling, judicial torture, superstitious killing, sadistic punishment, and cruelty to animals, together with the first stirrings of systematic pacifism he calls he Humanitarian Revolution. It started in large scale not until early 1900s.

After the end of World War II the great powers and the developed states in general, have stopped waging war on one another. This Singer calls the *Long Peace* (Figure 1.8). In fact for some years there was no "classical war", wars between states, on the planet. Today we have the Russian-Ukrainian conflict. Since the end of the Cold War in 1989, organized conflicts of all kinds – civil wars, genocides, repression by autocratic governments, and terrorist attacks – in spite of setbacks have declined throughout the world. This is called the *New Peace*. It is the result of a growing revulsion against aggression on smaller scales, including violence against ethnic minorities, women, children, homosexuals, and animals.

Singer is careful to point out that this development does not prove that it will not be different in the future. The very long term perspective he has and the sta-

tistics provided still gives the hope that human society is very different today than some years back, and will continue to be so. There are after all reasons for hope. The development we see in the world today is far from pointing to any country as sustainable. However some areas in the world show that it is possible to develop a society with respect for human rights, with well-functioning states with little corruption and where rule of law dominates over rule of power, where the inhabitants can feel reasonable secure for their future and personal life, thereby approaching a culture of sustainability.

Chapter 1 sources:

Section 1.1 Lars Rydén The Baltic University Programme on–line course on Sustainable Development Chapter 8a. Demography and population change http://www.balticuniv.uu.se/index.php/8a-demography-and-population-change

Section 1.2 Based on Keith Montgomery The Demographic Transition. http://pages.uwc.edu/keith.montgomery/Demotrans/demtran.htm

Section 1.3 – 1.4 Lars Rydén

Section 1.5 Lars Rydén based on http://www.un.org/millenniumgoals/

Section 1.6 Lars Rydén The Baltic University Programme on–line course on Sustainable Development Chapter 9a. Governance and democracy http://www.balticuniv.uu.se/index.php/9a-governance-and-democracy

Section 1.7 Lars Rydén based on Steven Pinker The Better Angels of Our Nature. A history of violence and humanities. Pinguin Books 2011

Chapter 2
One Planet Life

2.1 The increasing resource flow

Sustainable development is about how we – humanity – can live on the resources that our planet provides for us. Therefore the study and understanding of resource flow and resource use and management is the core of sustainability science. Our resource consumption has increased over the entire history of mankind, but the planet is the same, not any bigger. How can we as humanity adjust to the resources available to us?

The American historian John McNeill undertook to write a global environmental history for the 20th century. He started assuming that the environmentalists were exaggerating. Yes, there were environmental problems, but there has always been. "Nothing new under the sun" he told them when he started his project. But when he published he had changed his opinion and the title of the book became "Something new under the Sun". Not surprising! During the 20th century the human population had increased 4-fold, from about 1.5 billion to 6 billion. In addition, the economy per capita had also increased 4-fold. Thus the resource use on the planet had increased about 16-fold during 100 years. Obviously it cannot go on like that.

He examined a series of resources and the result was similar (Table 2.1): Global economy increased 14 times, industrial production 40 times, that is per capita income increased about 4 times. It is also noteworthy that energy use increased about as the economy, which is explained by the fact that economy is tightly coupled to energy for countries which are still developing. Emission are also tightly coupled to energy use since energy use is completely dominated by fossils and thus causes much of the emissions. Here carbon dioxide, CO_2, and SO_x is mentioned but it is also possible to mention NO_x or Hg, mercury. As people get a little richer they increase meat eating, reflected in the number of pigs, in this period about 2-fold, which is also a pressure on our environment and requires more resources. We can also see that the production from the environment is increasing and fields have expanded and forests shrink.

In Western Europe and the USA the strongest resource growth was after WWII, roughly between 1955 and 1975. During less than one generation re-

Table 2.1 Global Development 1900-2000. Source: John McNeill, Nothing new under the sun, 2001

global population	increased	4x
global economy	increased	14x
industrial production	increased	40x
energy use	increased	16x
carbon dioxide emissions	increased	17x
sulphur dioxide emissions	increased	13x
ocean fishing catches	increased	35x
number of pigs (=meat eating!)	increased	9x
forests	decreased	20%
agricultural fields	increased	2x
Blue whale	decreased to	0.25%

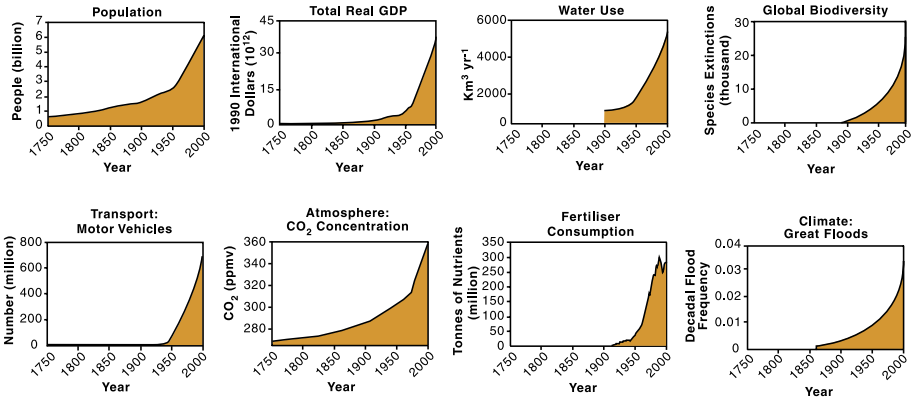

Figure 2.1 Exponential growth in a number of parameters illustrates the sharply increased use of resources. Source: International Geosphere-Biosphere Programme http://www.igbp.net/global-change/greatacceleration.4.1b8ae20512db692f2a680001630.html

source consumption increased almost 3-4 fold for very many products: metals, fertilisers, fossil fuels etc. During this period our societies went from fairly sustainable to affluent societies, affluent meaning with a large resource flow.

The change was much faster in the end of the century than in the beginning. In fact increase was most often measured in% of previous year! If this%age growth is constant we have exponential growth! This means constant doubling time. This gets very soon out of hand. Exponential growth may be illustrated by anything from the number of McDonald restaurants in the world to the consumption of paper.

It is also during this period that the landfills (garbage piles) of Europe increased tremendously! Around 1980 concern grew about what to do with the mountains of household waste. This was due to an increasing linear resource flow. The resources went from extraction to production, consumption and waste in a straight line! It is simply a recipe for resource wasting! To make this more sustainable we need to have cyclic resource flow. Recycling is an important part of sustainable development.

2.2 The large size of the resource flows and its consequences

The resource flow on our planet is very large. Material Flows Analyses, MFA, carried out in several countries in Western Europe show that flow of solid material is about 60-80 tonnes per capita and year. The figure is slightly smaller in e.g. Poland (about 50 tonnes) but much larger in the USA (about 80 tonnes). Materials in the largest amounts are bulk material (for building purposes), fossil fuel (energy purposes) and macro nutrients (mostly agriculture).

An estimate of the material flows on the planet as a whole (The Global Footprint Network, 2012) indicates that it is close to 50% more than the carrying capacity. This over-use of the resources corresponds to the use of fossil fuels, deforestation, over-fishing and so on. Resource use has increased during the entire history of mankind, but was far below the available resources up to about 100 years ago. During the 20th century resource use increased about 20 fold in many categories, for example, energy, and much more in some, for example, macro nutrients (McNeill, 2000). The carrying capacity of the planet was passed probably around 1980.

Material flows should decrease not only because resources are over-used but because resource flows as such lead to severe environmental problems. Most material flows in industrial countries are *linear*. The material flows directly, so to speak, from the sources to the waste heap. The material set in motion accumulates in the environment and cause problems. The most severe of these include:

- Global warming caused by fossil fuel combustion which leads to accumulation of carbon dioxide in the atmosphere.
- Eutrophication due to accumulation of nitrogen and phosphorous from agriculture in water bodies.
- Acidification of forests and lakes due emission of sulphur oxides from combustion of fossil fuels.
- Toxic effects of metals accumulating in the environment, e.g. mercury and lead.
- Toxic effects of man-made substances accumulating in the environment, such as PCB.

As a rule the flow of non-renewable resources causes environmental problems long before they are depleted at the source. The environment is not able to handle large amounts of a substance that is not part of the normal set-up. As the resource flow continues, it leads to an accumulation of the substance, and sooner or later it will become detrimental to the environment. The large anthropogenic material flows of resources are not similar to the natural flows. Ecosystems, as a rule, recycle resources and all material are used for new purposes.

The carbon cycle has a special role in this resource flow. The carbon of the planet is found in the atmosphere as carbon dioxide, dissolved in ocean water, bound in biomass, and stored in the lithosphere as carbonate minerals. Although the atmosphere holds only 0.036% of CO_2 this substance is a key component in the physics of the planet since it interacts, as explained, with the heat balance. It is also essential to all living cells as it is used when new biomass is built up in carbon dioxide fixation.

Carbon dioxide fixation removes carbon from the atmosphere and respiration returns it back. In respiration organic molecules are oxidised with oxygen to provide energy to living cells. The by-products are water and carbon dioxide.

All kinds of combustion and decay processes add to this flow. Today, the comparatively immense utilisation of fossil fuels seriously disturbs the balance between natural processes. Modern combustion practices cause the concentration of carbon dioxide to increase. This increase is the key factor behind the enhanced greenhouse effect. The people of the Earth now consume 6 gigatonnes carbon/year, a mass that exceeds the mass of all the metals used by mankind during the period of time by a factor of ten! In addition, the handling of many fossil fuels involves flows of other matter than pure carbon, particularly sulphur (see below), which adds to the turnover of matter and many profound environmental stresses.

2.3 The Limits to Growth

The society has to operate within the boundaries of a global ecosystem which has – very definitely – a *finite capacity* to supply resources and to absorb the discharges. The same argument holds for the full variety of services that are offered by the ecosphere in providing clean air, good quality and quantity of water, clean and usable top soil and sustainable conditions for agricultural and industrial production, transportation and living. The sustainability scenario also has to affect the economical and the administrative systems which should be considered as subsets of the total natural system in which humanity dwells together with other species.

It is important that the natural resources utilized for the society are restricted to magnitudes that do not over-burden the environment. "Ecology worries about resource flows, since these are what contribute to environmental impacts" (Spangenberg et al, 1997). It is conceivable that the natural systems can pass a critical point where they will break down and fail to support what they have supported in the past. The world population is growing and the total physical activities of that population is growing even more.

In 1972 a research team at the Massachusetts Institute of Technology (MIT) on commission of the Club of Rome published the ground breaking study *Limits to Growth*. It is a study of global resource flows. They found that the resource flows increased exponentially and that very soon the world would reach a state of *overshoot*, that is, a state where it would use more resources than the planet could produce.

When *The Limits to Growth* was published in 1972, economists, along with many industrialists, politicians, and Third World advocates raised their voices in outrage at the suggestion that population growth and material consumption need to be reduced by deliberate means. But nothing that has happened in the last 40 years has invalidated the book's warnings. It was not until the early 2000 that economists (see e.g. Wall Street Journal) accepted the fact that there are limits to (physical) growth.

The world can respond in three ways to signals that resource use and pollution emissions have gone beyond their sustainable limits. One way is to disguise, deny, or confuse the signals. Generally this takes the form of efforts to shift costs to those who are far away in space and time. An example would be to buy air conditioners for relief from a warming climate, or to ship toxic wastes for disposal in a distant region.

A second way is to alleviate the pressures from limits by employing technical or economic fixes. For example, reducing the amount of pollution generated per mile of driving or per kilowatt of electricity generated. These approaches, however, will not eliminate the *causes* of these pressures.

The third way is to work on the underlying causes, to recognize that the socioeconomic system has overshot its limits, is headed toward collapse, and therefore seek to change the structure of the system. A computer model of the world resource flow can be used to test some of the simplest changes that might result from a society that decides to back down from overshoot and pursue goals more satisfying and sustainable than perpetual material growth.

There are many thoughts about what steps towards a more sustainable society would look like. *Some people think that a sustainable society would have to stop*

using nonrenewable resources. But that is an over-rigid interpretation of what it means to be sustainable. Certainly a sustainable society would use nonrenewable gifts from the earth's crust more thoughtfully and efficiently.

The authors to the Limits to Growth suggest a few general guidelines for what sustainability would look like, and what steps we should take to get there:

- Extend the planning horizon. Base the choice among current options much more on their long-term costs and benefits. Today we suffer from "short-termism". Companies think about their near future, even the coming months, and politicians about the next election. But that is too short a time frame when discussion the limits to growth.
- Improve the signals. Learn more about the real welfare of human population and the real impact on the world ecosystem of human activity.
- Speed up response time. Look actively for signals that indicate when the environment or society is stressed. Decide in advance what to do if problems appear.
- Minimize the use of nonrenewable resources.
- Prevent the erosion of renewable resources.
- Use all resources with maximum efficiency.
- Slow and eventually stop exponential growth of population and physical capital.

The Limits to Growth team continues: *The necessity of taking the industrial world to its next stage of evolution is not a disaster – it is an amazing opportunity.* How to seize the opportunity, how to bring into being a world that is not only sustainable, functional, and equitable but also deeply desirable is a question of leadership and ethics and vision and courage, properties not of computer models but of the human heart and soul.

Sustainability does not mean zero growth. Rather, a sustainable society would be interested in qualitative development, not physical expansion. It would use material growth as a considered tool, not a perpetual mandate. Neither for nor against growth it would begin to discriminate among kinds of growth and purposes for growth. It would ask what the growth is for, and who would benefit, and what it would cost, and how long it would last, and whether the growth could be accommodated by the sources and sinks of the earth.

The question of how to create a sustainable future is the most urgent to find answers to for anyone who has been confronted with the results of the Limits to Growth studies. This is discussed at some length in the movie "The Last Call" released in 2013 by the Italian producer Enrico Cerasuolo (http://www.lastcallthefilm.org/). Here the researchers of the Limits to Growth study give their points of view.

2.4 Overshoot

Today humanity uses the equivalent of 1.5 planets to provide the resources we use and absorb our waste. This means it now takes the Earth one year and six months to regenerate what we use in a year. Moderate UN scenarios suggest that if current population and consumption trends continue, by the 2030s, we will need the equivalent of two Earths to support us. And of course, we only have one. Turning resources into waste faster than waste can be turned back into resources puts us in global ecological overshoot, depleting the very resources on which human life and biodiversity depend.

The result is collapsing fisheries, diminishing forest cover, depletion of fresh water systems, and the build-up of carbon dioxide emissions, which creates problems like global climate change. These are just a few of the most noticeable effects of overshoot.

Overshoot also contributes to resource conflicts and wars, mass migrations, famine, disease and other human tragedies – and tends to have a disproportionate impact on the poor, who cannot buy their way out of the problem by getting resources from somewhere else.

Global trends, however, hide the huge variability that exists at the regional level. Europe and Middle East/Central Asia experienced the largest increase in their per capita Ecological Footprint (+1.2 and +1.1 gha per person, respectively), but while Europe's population growth was relatively slow (+29%), population grew 330% in Middle East/Central Asia. North America had a smaller increase in

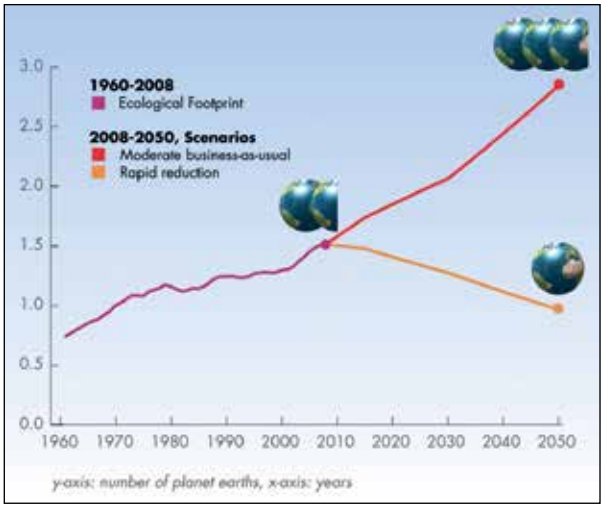

Figure 2.2 The World's Ecological Footprint. Today humanity uses the equivalent of 1.5 planets to provide the resources we use and absorb our waste. This means it now takes the Earth one year and six months to regenerate what we use in a year. Moderate UN scenarios suggest that if current population and consumption trends continue, by the 2030s, we will need the equivalent of two Earths to support us. (Source: www.footoprintnetwork.org)

per capita consumption (+ 0.6 gha per person) and a 63% growth in population. At the other end of the spectrum, Africa saw its per capita Ecological Footprint decline (-0.1 gha per person), while its population increased by 255%. In the Asia-Pacific region, per capita Ecological Footprint increased slightly (+0.6 gha per person), while population grew by 136% (Figure 2.3).

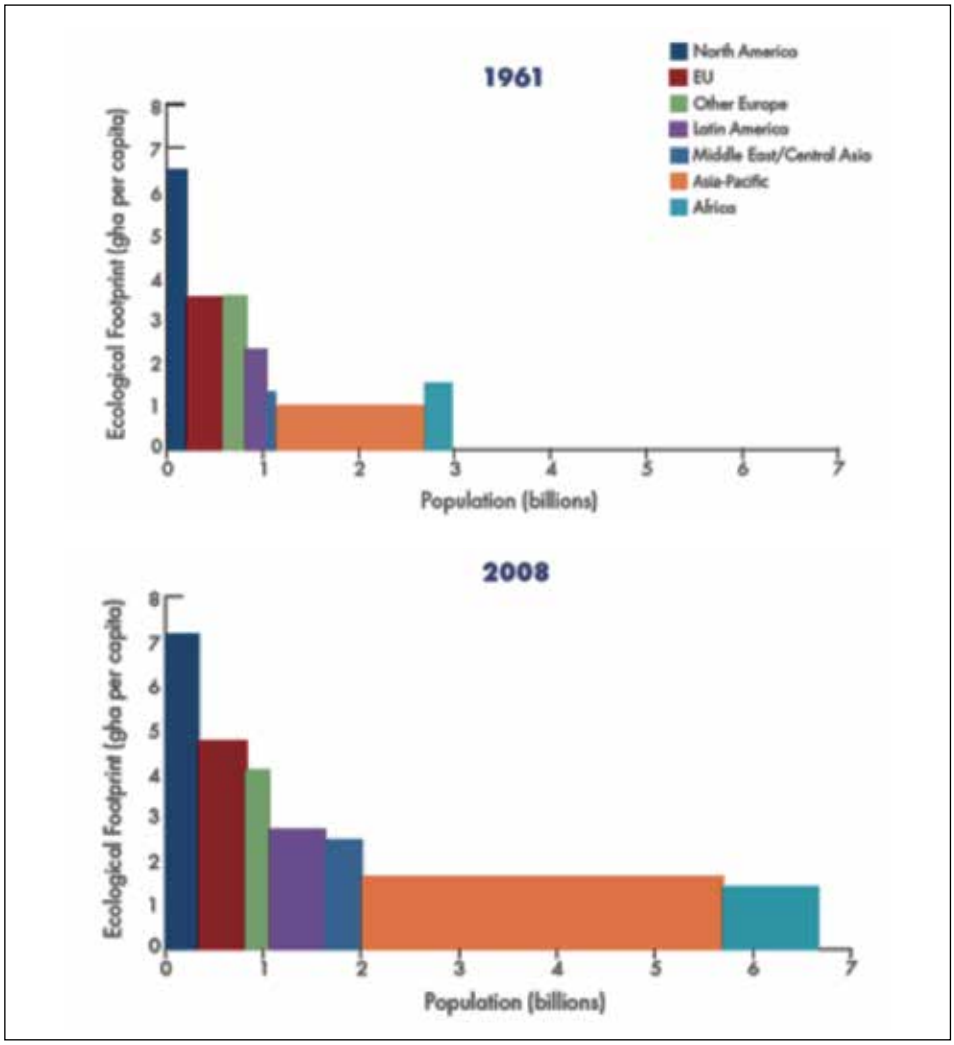

Figure 2.3 Ecological Footprint and population by world's regions in 1961 and 2008.The area within each bar represents the total Ecological Footprint for each region. (Source: www.footoprintnetwork.org)

Figure 2.4 tracks the per-person resource demand Ecological Footprint and biocapacity in Uzbekistan since 1961. It shows that Uzbekistan has an overshoot, and use about 2 planets. (Source www.footoprintnetwork.org)

The total Ecological Footprint of a country is a function of the average consumption pattern of each individual, the efficiency in production and resource transformation, and the number of individuals in the country. Biocapacity is determined by the available biologically productive land and sea areas and the capacity of these assets to produce resources and services useful for humans (this is determined by the prevailing technology and management practices implemented in these areas).

2.5 Resource flows and human wellbeing

The transition to a sustainable society requires that we live a *one-planet-life.* We need to reduce our consumption of resources to those available in the long term, to the carrying capacity of the planet. This will certainly include a number of technical adjustments, such as houses needing less heating, and cars not running on fossil fuels. But it will also require changes in lifestyles. An example is the Swedish family, which experimentally got all the technical devices in a new house (low energy house with solar panel for hot water and PV cells) to live a low carbon life. When it was time for ski vacation the air trip to the Alps was not allowed within the carbon budget. They had to take the train to the Swedish mountains. Not necessarily worse, but a change. Nor was it possible to use the private car for commuting to work, but rather public transport and biking, and they had fewer dinners with steaks, and had to be more careful with waste sorting. Still their carbon foot print was more than 1 tonne per year and capita.

Basic human needs have been much researched. The model proposed by American psychologist Abraham Maslow already in the 1940s includes five levels of needs: first physiological needs, such as food, water and air; next the individual's safety and security such as personal security, financial security, health and

well-being; thirdly social needs including feelings of belongingness, friendship, intimacy, and family; fourth, the need to be respected and to have self-esteem and self-respect; and finally self-actualization: "What a man can be, he must be". Viktor Frankl, with experience from the holocaust, later added self-transcendence, spiritual needs. Chilean philosopher Manfred Max-Neef, as well as others, have later criticized the level structure and argued that fundamental human needs are non-hierarchical.

From a sustainability perspective it is relevant to observe that none of these needs refer to having many things, consumerism, or travelling over the world, or other parts of modern life which consumes many resources. Also in research on energy use it is clear that what people appreciate the most consumes least energy. Thus being with friends and family or the loved one does not cost much energy, while daily commuting to work, which takes much energy, is not popular. The world's carrying capacity may then be enough for all of us. Mahatma Gandhi in a famous statement once said: "The world has enough for everyone's need, but not enough for one person's greed", when talking on a society based on Sarvodaya – the well-being of all.

The recently developed happiness research stresses that numerous studies have clearly shown that subjective well-being and material wealth are only loosely coupled. *Perceived well-being* in western industrialised countries peaked around 1970 or so, while economic development and resource use has continued to increase without resulting in any increase in perceived well-being. Immaterial factors which contribute to quality of life – such as leisure, having meaning and purpose, relationships, social participation and self-fulfilment – become more and more important.

There are several indices to monitor human wellbeing. Most established might be the United Nations Human Development Index, HDI, which includes the three indicators child survival, purchasing power and education. Values of HDI are available for most countries in the world. A sustainable society is seen as a society where human well-being is high enough (HDI > 0.8) and ecological footprint low enough (<.1.8 global ha/cap) (See www.footoprintnetwork.org). Other more developed indices include the Weighted Index of Social Progress, WISP, by Richard Estes to measure the amount of well-being in different societies, which uses up to 40 different indicators.

To measure of the development of a country most countries use the Gross Domestic Product GDP, which is the total economic turnover, but several alternatives have been proposed. The Genuine Progress Indicator, GPI measures whether a country's growth, increased production of goods, and expanding services have

Figure 2.5 UN Human Development Index 2011, quartiles; dark blue = very high, white=low. (Source Wikipedia: Human Development Index)

actually resulted in the improvement of the well-being of the people. In GPI negative costs, such as costs for environmental impacts, are subtracted from GDP. The Gross National Happiness, GNH, proposed in Bhutan already in the 1970s based on Buddhist ideals suggests that beneficial development of human society takes place when material and spiritual development occur side by side to complement and reinforce each other. The four pillars of GNH are the promotion of sustainable development, preservation and promotion of cultural values, conservation of the natural environment, and establishment of good governance. Both GNH and GPI are based on the assumption that subjective measures like well-being are more relevant and important than more objective measures like consumption.

2.6 Practical steps towards a one planet life

There are a number of organisations of civil society which have contributed to the efforts to reduce resource consumption and improve sustainability by explaining how to do it. Best known may be the World Wildlife Fund, WWF. WWF has produced a guidebook and also a calculator which allows you to estimate the footprint you cause by your lifestyle. They write:

"If we carry on living the way we are, pretty soon we are going to need to find a second planet to meet humanity's growing demand for energy and natural resources. According to WWF's Living Planet Report we are increasing consumption of resources and the amount of wastes (including carbon emissions) we produce so fast we may need that second planet in less than 30 years.

Figure 2.7 The WWF Pocket Guide to a One Planet Lifestyle. (http://d2ouvy59p0dg6k.cloudfront.net/downloads/opl_ebooklet.pdf)

But we don't have a second planet yet where we can harvest new resources from or dump our wastes on. And even if we had one, would it be ethical to do it? The fact is: we only have one precious and beautiful planet. What we need to do now is learn how to live on this single planet sustainably.

There are small steps we can all take that help make a big difference. And you will find them right here in WWF's Pocket Guide to a One Planet Lifestyle. In this e-book you'll find handy tips on how to slash your carbon footprint while saving money by reducing your cost of living.

You can also access new WWF tools to help you calculate your personal footprint, measure the positive effects of your lifestyle changes, find low-carbon alternatives to travel, and get help on how to find energy-efficient appliances or a green electricity supplier."

WWF has published the WWF *Pocket Guide to a One Planet Lifestyle***.** Here they say: "Wouldn't it be great if we could all live in a way that was more environmentally-friendly and which, at the same time, was cheaper, give us more time to spend with friends and family and meant we were healthier? WWF has researched a set of 'Ten Top Tips' with suggestion about small changes we can make to the way we live, work and play which could help make big difference to our planet – and to the quality of our lives.

In the pocket books there are hundreds of small actions each one can do to reduce his or her footprint. There are also indications how one can work in a municipality or in a company.

The UK based organisation *Bioregional* works for the same goals in a slightly different way. They write (http://www.bioregional.com/about-us/):

"Bioregional champions a better, more sustainable way to live. We work with partners to create better places for people to live, work and do business. We want to see thriving regional economies where we meet more of our needs from local, renewable and waste resources, enabling people to live happy, healthy lives within the natural limits of the planet, leaving space for wildlife and wilderness.

Box 2.1 The ten principles of one planet living according to Bioregional

Health and happiness – Encouraging active, sociable, meaningful lives to promote good health and well being

Equity and local economy – Creating bioregional economies that support equity and diverse local employment and international fair trade

Culture and community – Respecting and reviving local identity, wisdom and culture; encouraging the involvement of people in shaping their community and creating a new culture of sustainability

Land use and wildlife – Protecting and restoring biodiversity and creating new natural habitats through good land use and integration into the built environment

Sustainable water – Using water efficiently in buildings, farming and manufacturing. Designing to avoid local issues such as flooding, drought and water course pollution

Local and sustainable food – Supporting sustainable and humane farming, promoting access to healthy, low impact, local, seasonal and organic diets and reducing food waste

Sustainable materials – Using sustainable and healthy products, such as those with low embodied energy, sourced locally, made from renewable or waste resources

Sustainable transport – Reducing the need to travel, and encouraging low and zero carbon modes of transport to reduce emissions

Zero waste – Reducing waste, reusing where possible, and ultimately sending zero waste to landfill

Zero carbon – Making buildings energy efficient and delivering all energy with renewable technologies

We call this *One Planet Living*. Calculate your impact and get a personal action plan with the One Planet Living footprint calculator

The concept of One Planet Living builds on sustainability work carried out over the past few decades but specifically grew out of Bioregional's work to build the BedZED eco-village in south London. Living and working at BedZED and analysing its impacts drew us clearly to the conclusion that to achieve sustainability, we need to make it easy, attractive and affordable for people everywhere to lead whole sustainable lifestyles – not just green buildings, but wider infrastructure and products and services as well – all wrapped up in a simple and clear story which people can understand.

Since its creation in 2003, One Planet Living and its ten principles show in practice that a simple way for us to plan, deliver, communicate sustainable development and a green, circular economy is possible.

Rooted in the science and metrics of ecological and carbon footprinting, 10 One Planet principles are used to structure thinking and inform holistic action. These principles stemmed from Bioregional's experience of working on BedZED, a pioneering eco-village in South London, UK. Together, the principles provide a holistic framework to help organisations and project teams examine the sustainability challenges faced, develop appropriate solutions and communicate the actions being taken to key stakeholders such as colleagues, the supply chain, clients, customers and local and national government."

Chapter 2 sources:

Sections 2.1-2.4. Lars Rydén and Natalya Akinshina (editors). Uzwater book Sustainable Use and Management of Natural Resources (http://www.balticuniv.uu.se/index.php).

Section 2.5 Lars Rydén: Baltic University Sustainable Development course 8c. Social sustainability, happiness and the one-planet-life. (http://www.balticuniv.uu.se/index.php/introduction)

Section 2.6 WWF Pocket Guide to a One Planet Lifestyle (http://d2ouvy59p0dg6k.cloudfront.net/downloads/opl_ebooklet.pdf) and Bioregional One Planet Living (http://www.bioregional.com/about-us/).

Chapter 3
The Ethics of Sustainable Development

3.1 Sustainable development is a normative concept

Sustainable development is not only about how we adapt our societies and our lives to make it possible for us to develop and thrive for many generations into the future. It is also about values, justice and ethics. In this chapter we will analyse which these values are, how they are expressed in different contexts and how they can be implemented in real life.

The discussion on values was imbedded in the concept of sustainable development from the very beginning. From the mid-1980s to mid-1990s a series of documents and reports were published which today constitute a platform for work on sustainable development. Virtually all of them make reference to the importance of a *new ethics*. Most explicitly perhaps the World Commission on Environment and Development express themselves in their report (1987) *Our Common Future*:

> *"We have attempted to demonstrate how human survival and well-being may be dependent on our capacity to successfully transform the principles behind sustainable development into global ethics."*

The chairperson of the Commission, Mrs. Gro Harlem Brundtland, expressed herself in a similar way when opening the World Conference on the Changing Atmosphere in 1988. She said that to come to grips with the environmental dilemma requires that "we develop… a new holistic ethics in which economic growth and environmental protection go hand in hand around the world."

Similar references are found in e.g. the *Agenda 21* document, the *Rio Declaration*, the *Caring for the Earth* publication from the IUCN, and the *Convention on Biological Diversity*.

There is no doubt that the leaders in the work for environment and development considers ethics central to success. But it is not obvious what actually they would specify as central values in such an ethics. Perhaps it was clearer when the chairman for the environmental committee in one of the municipalities in Sweden gathered all truck drivers in the city for a discussion about diesel quality. His

argument was that, "I would like to see that our municipality is a place where our kids and everyone would be able to live a good life." They all knew that the kids were more than anyone else exposed to air pollution from cars. After the meeting everyone promised to use green diesel even if it was slightly more expensive.

His ethics was that we do not have the right to make the air in the city unhealthier if it can be avoided. Then we protect ourselves, our children, our neighbours and other people we know and meet. The concept of sustainable development takes us one step further. It requires that we respect also the coming generations and their needs and requirements in life. It might seem very natural to be concerned about the next generation, but in fact in the context of ethics it is a new principle. Basic ethics are often concerned with how we deal with our currently living fellow human beings within a close geographic area.

Environmental change, especially regional and global environmental change, requires that we expand this perspective considerably. Our car driving may influence fellow humans on the other side of the Earth if the carbon dioxide produced enhances global warming. It may also influence my grand grandchildren or anybody's grand grandchildren if global warming continues for a hundred years, which it certainly will. This situation is new or at least it is new to our immediate experience.

The reference to future generations is also implicit in the definition of sustainable development that was put forward by the World Commission on Environment and Development (WCED, 1987): "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"

This is often understood as the ethics of sustainable development. Sustainable development starts with the concept that we have moral duties towards future people. But the ethics of sustainable development is not able to answer all questions with regard to environmental protection and use of natural resources, and it does not address some of the fundamental concerns.

3.2 A new ethics

The background to the new concern for ethics is a fear that people have already caused, or are in the process of causing, large damage to the Earth and all humans, animals, and plants living on it to such an extent that we could even endanger the possibility to continue to live on Earth in the future. A part of the picture is that a large number of species are already extinct due to human activities. Edward O. Wilson, the American researcher who introduced the concept of biological diversity, estimates that humans have increased the rate of extinction of species

up to 1,000 times! We might ask: Do we have the right to do this? What are in fact our rights? Are we allowed to take resources from others? Are we allowed to take resources from future humans? Are we allowed to take resources from other species of animals? Are we allowed to exploit other species for our purposes at all, and if so, in what way is it ethically acceptable to do so?

All these questions are dealt with in the field of ethics. It is important. It seems obvious that we need to agree on what is acceptable do before planning to do something.

Ethics are concerned with the values that form the background to our decisions of what to do. It should thus be important to specify these values, but nevertheless it is seldom done. Ethics is often said to be in the answer to a question about what we *should* do or *ought to* do. However in everyday discussions this question may have several kinds of answers, not all of them referring to ethics. Thus we may instead answer with reference to the *legal* requirements, what is legally allowed or prescribed; we may answer with reference to what people normally do, that is what is *socially* accepted or prescribed; or we might even refer to what we simply *intuitively* would consider the right thing; as scientists it is even more common to answer in terms of how we best carry out a task to achieve a certain set goal – this is an *instrumental* answer.

But we may also answer with reference to specific values that we want to respect. Then it is a truly *ethical answer*. For example we might say that "I do not want to do this because I do not like to hurt anyone." The value is not to hurt anyone. Going back to the environmental field, suppose that you are asked if you are going to sort your household waste and say "yes." If the next question is why, what is your answer? Do you refer to the legal requirement, or the opinion of neighbours, or to some value? If so, which value?

There are rather large investigations on why people get involved in sustainable development. Answers vary between individuals of course. Some say that they would like to live without the risk of being poisoned by pollutants; some refer to that they would like to be able to walk through a beautiful forest also in the future; some say that they would like also their kids to be able to swim in the sea. Sometimes we hear that people would like the tropical forest to exist on the other side of the world even if they might never be able to visit it.

The values expressed in these answers are

- preservation of health,
- preservation of nature,
- concern for others, especially future generations, and so-called
- existential values.

The basic question here is in which way these values influence the kind of life we choose to live, the lifestyle, or the kinds of policies that are pursued in the institutions of our countries. To be more aware of the connection between ethics and actions is crucial. Then it will be clearer to us why we do things and perhaps also how we should do them.

It is clear that not all actors in a society give the same weight to each one in this set of values. This is often at the root of different views on what kind of measures for sustainable development should be carried out. Discussing the basic values can help to sort out the different goals and preferences.

The set of values that we hold is often referred to as our *morality*. Typical sets of values are the *Ten Commandments* in the Bible, and the *UN declaration of human rights*. These are concerned with relations between peoples and how people should be respected, the integrity and rights of people. A similar accepted set of values for our relationship to the environment does not exist, although it is needed.

Ethics refer to which kind of set of values we have and how we reflect upon them and how we apply them. In environmental ethics we may, e.g., distinguish between anthropocentric ethics where humans are given rights, and biocentric ethics where other living beings are given rights, as we will see below.

Ethics and morality are in turn parts of a *worldview* or *philosophy*. If we have a philosophy where all animals are considered to be "machines" as the 17th century philosopher Descartes said, we would certainly not argue for a biocentric ethics. This is not common any longer, at least some animals are seen to have the capacity to suffer, just like humans. There is, however, much dispute regarding if animals are conscious and if so to what extent.

Ethics requires that we are *responsible* for actions taken. This presupposes that there is a free will, a possibility to choose between different alternatives. The philosophical question of the role of free will has always been with us. How do you think about this?

The new component as compared to traditional ethics is that our actions may have huge consequences far away from where we live and for people we will never meet. This is why the new ethics asked for is not simple and requires much reflection and discussion.

3.3 Ethical conflicts

The most obvious cases where we can see ethics in action is when a conflict between different values occurs. An example is the development of hydropower. A large hydropower station requires traditionally that a dam is built in a large river

and that a reservoir often several tens of kilometres forms upstream. As a consequence the flow of water in the river is curtailed (destroying waterfalls), the flora and fauna of the river is influenced, and people living upstream have to move out of the area where the reservoir is formed. These negative developments are balanced by the prospect of producing large amounts of renewable energy which will constitute a resource and blessing for perhaps millions of people far into the future.

Should power stations be built or not? Obviously, *engineers* cannot answer the question. They only know *how* to build, not *if* it should be done. Obviously, *biologists* do not know; they can only tell about the consequences of various alternative actions, e.g. which ecosystems will be damaged or even become extinct. *Economists* do not know either. They can just tell about the costs of moving a population and the income from future electricity production.

Proposed power stations are political issues and the outcome will depend on the values of those who take part in the decisions. Some of the decision-makers will value the new electricity most and say yes; some will value the natural flow of the river and the wild country more and say no; others again will say no because of respect for the individuals that otherwise would be forced to move out from the valley where the new reservoir will form.

It is quite seldom that a value has such an absolute character that a decision goes in a definite direction only because of it. In general, there is a compromise where several values are respected to a degree but not absolutely. However, at the end of the 1990s, biological diversity and respect for the existence of species became an absolute value in certain situations. The expected consequence of extinction of a species could itself stop a project.

The building of hydropower stations has in real life repeatedly become very controversial, sometimes with violent action as a consequence. Action groups that block work by machines, and demonstration against such projects in the capital of the country, are not unusual. A large intrusion in nature of this kind often violates important values to many individuals. In Sweden, the continued expansion of hydropower was discontinued when the parliament in the 1960s passed a law that protects the four remaining large rivers in the north of the country from exploitation. Today the development of small-scale hydropower seems to be a possibility to use the power of running water without changing nature very much.

Practically all decisions about environmental protection has this dimension of conflict between values although it may not always be so clear. When installing equipment for cleaning flue gases for example there is a conflict between saving money (assuming no fine exist for pollution) and reducing pollution. When protecting an area there is also a conflict between economic interests, e.g. timber

production, and conservation interests. In general there is a conflict between exploitation of nature for the purpose of humans and preserving it either for humans or for its own sake. To handle all these conflicts in a reasonable way we need to specify the values that form the platform for our decisions.

3.4 Human-centred, anthropocentric, ethics

You may have noticed that most arguments in the previous sections refer to human needs: the need for electricity, the wish to have access to beautiful nature, a good swim in the sea, or the pleasure to know that the tropical forest on the other side of the world is flourishing. Since human interests are in the centre of such an ethics it is called *anthropocentric ethics*. In fact, all the ethics western civilisation grew up with are anthropocentric ethics. Respect for fellow human beings is basic in many policy documents, e.g. the United Nations Declaration on human rights.

Anthropocentric ethics also characterises the policy documents of sustainable development, the Rio Declaration, the Biodiversity Convention, as well as the Brundtland Report. It is more or less explicitly stated that natural resources and the environment should be protected to make it possible for people to lead a good life.

These ethics may be expressed in several ways. Either as the *rights* of a group or an individual, as the *duties* of other groups or individuals. If we consider that the rights or duties are equal among the groups or individuals we talk about *equity* (sometimes equality) between them. An ethics that is formulated in terms of rights, duties and equity is called an ethics of *justice.*

The justice between humans takes two forms. It is either the justice between humans living here and now, so-called *intra-generational* justice, or justice between us and future generations, so-called *inter-generational* justice. These ethical principles are clearly referred to in the negotiations carried out in the UN system. Thus in the negotiation on climate change each country is at the start given equal rights to emit greenhouse gases, or rather each person on Earth is given an equal share of emission rights. This is thus a principle of equity. In practice many political concerns are taken into account and the end result is a compromise.

Even if the question of *inter-generational ethics* is new in the field of environment it is not in human sphere. Consider the relationship between parents and children. Most of us would agree that it is the duty of parents to take care of their children, to nourish them, educate them and prepare them for life. But what about the elderly? Do the children have duties towards their parents? This is per-

ceived differently in different societies. In an economic context we can ask if one generation should use up all resources or leave some for the next generation that is, to inherit. The right to inherit is very old. For the whole society the corresponding question is if to use resources for investment or for spending. If a society decides to invest in railways, e.g., next generation can use them, but if instead the resources are used for improve the schooling, or nutrition, it is not possible. The most long-term issue today is the nuclear power. The nuclear waste is dangerous for at least 100 000 years. Very many generations into the future will have to deal with the nuclear waste produced by us for cheap electricity. Is this right? What is your opinion?

Also the principle of *intra-generational ethics* is very old. The question of how to divide the resources in a family, in a society and in the world has always been urgent. How is it done in a family, by the parents between the children? In a normal family all children are taken care of and get the support they need. In a society it is not so obvious. Some have much more than others. In particular some individuals are often considered less productive and are left without help. They are not profitable. But in a family a child is not thrown out from the home because he/she is not profitable. Also in a society no one should be left without support. If so we have a welfare society (also called a "peoples home"). For sustainable development this principle of responsibility for everyone should be expanded to include all of us living on the planet. It is a more difficult morality to implement.

Principles of equity are referred to in many contexts regarding environmental protection. However, in practice the world is becoming more and more unequal. In general, poor countries are becoming poorer, and richer countries richer. Also within countries inequity is increasing. We have a long way to go before achieving an equitable world. Climate negotiations continue but they are far from reaching an agreement that resources should be shared with future generations. If present trends continue, the situation looks bleak for future generations. Reserves of oil and gas are rapidly being depleted, wilderness areas are becoming smaller and smaller, and biological richness and diversity are quickly declining.

3.5 Nature-centred, biocentric, ethics

There are two large groups of environmentalists, often referred to as conservationists and preservationists. The goal of *conservationists* is to conserve the environment for use by present and future generations, much as described above. *Preservationists* on the other hand want to protect the environment against present and future human exploitation. The solution of environmental problems accord-

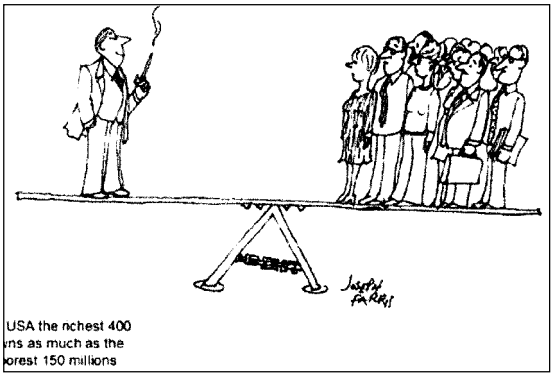

Figure 3.1 In the book *The spirit level. Why more equal societies almost always do better* by Richard Wilkinson and Kate Pickett (2009) the authors demonstrate that more unequal societies are less healthy, less secure, and less sustainable. Drawing by Joseph Farris.

ing to preservationists is not that we need to use natural resources more efficiently or more sustainably but rather that we have to respect nature and its integrity.

The biocentric, or life-centred, ethics is not new and has been argued for throughout history. The famous Swiss physician, scientist, and musician Albert Schweizer was respected for his life-long stand. In 1949 he wrote:

"The great fault of all ethics hitherto has been that they believed themselves to have to deal only with the relations of man to man. In reality, however, the question is what is his attitude to the world and all life that comes within his reach. A man is ethical only when life as such is sacred to him, that of plants and animals as that of his fellow men, and when he devotes himself helpfully to all life that is in need of help… The ethics of the relation of man to man is not something apart by itself: it is only a particular relation which results from the universal one" (Schweizer, 1949).

A more strict definition of a biocentric environmental ethics would be:"… the view that living beings, and only them, has internal value and are morally significant, that is, can be treated morally right or wrong, and humans have moral obligations towards them" (Stenmark, 2000).

A *strong biocentric ethics* argues that man does not constitute a higher form of life than everything else alive. Instead humans are members of a global life community in the same sense as all other forms of life. From this follows a series of duties, namely 1) not to hurt other living beings; 2) not to limit or violate the freedom of other living beings; 3) not to misuse the trust of another being; and 4) a duty to compensate those who have been treated in a morally wrong way (principle of justice or compensation).

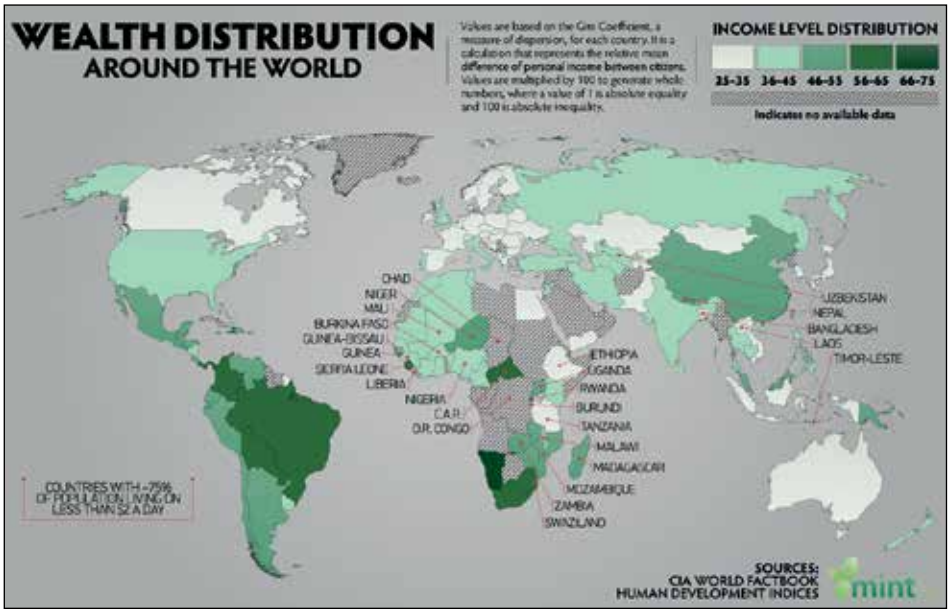

Figure 3.2 Wealth distribution around the world. Based on the Gini coefficient where 1 indicates complete equality and 100 absolute inequality. (Source: CIA World Factbook http://visual.ly/wealth-distribution-around-world)

But one may also adopt weaker forms of bioethics. A special form is the so-called *weak biocentrism* (Stenmark, 2000). This form of bioethics holds that actions should be judged based on how they influence other living beings, but with preference for humans and other sentient beings. This standpoint is in many countries codified in animal welfare politics and law. Bioethics are also part of the regulations for ecological farming, where it is required that animals are able to behave naturally.

It is not common to consider all individuals of all species to be equal. Instead one argues that humans have human rights, but others have their rights: dogs have dog rights, etc. Often human rights are considered a higher right than those of other species. However in this group there are those who hold that species or ecosystems are objects of moral consideration and need to be respected. This form of ethics is called *ecocentric ethics*. One way to define this ethics is, "the view that in addition to all living beings, also species, ecosystems, rivers, mountains has a value of their own and are morally significant, that is may be treated in a way that is morally right or wrong, and man has moral obligations towards them" (Stenmark, 2000).

Figure 3.3. The Earth Charter, where ethics of UN conventions is enlarged to include also nature, is developed by a network of involved individuals from all over the world. Important strongholds in the development are found in e.g. Boston, USA, Moscow and Buenos Aires. Their website is an important meeting place. http://www.earthcharter.org

A proponent for this view was the American scientist and writer Aldo Leopold. He developed what he called a "land ethics," and he writes that "land ethics simply enlarges the boundaries of the community to include soil, water, plants, and animals or collectively: the land" (Leopold, 1949). Earth is seen as a living being which may be healthy and may be damaged or in fact treated morally right or wrong as it has integrity, a value of its own. A healthy Earth is, says Leopold, able to provide all living beings with water, nutrients, and everything else they need. It is a "fountain of energy" and therefore is part of the living system and should be respected.

A form of ecocentric ethics is accepted if we hold that species and ecosystems have a value of their own. If this value is second to that of humans we talk about a *weak ecocentrism* (Rolston, 1988). A general acceptance of any form of ecocentrism would have a large influence on environmental policy. We may adopt the rule that the original ecosystem should be left with enough space to continue to thrive.

Protection of biological diversity would have a higher priority. Today it appears that biological diversity is only considered to have an instrumental value; It is protected because it may be a useful resource to man at some point in time. In fact it would in principle be possible to calculate the value – in economic terms – of an ecosystem or species as compared to other economic values developed (such as a hydropower station) as the ecosystem or species is lost. With an ecocentric ethics the building of the hydropower station might simply be morally non-defendable, even if it is economically advantageous.

3.6 A hierarchy of values

Some values are more basic than others. Obviously survival is a very basic value while enjoying good food is less central. When it comes to rights of others there seems to be a similar hierarchy. Values of environmental ethics could be seen as part of such a hierarchy.

In the domain of human relations respect for the same group, such as family, extended family and later the ethnic group was first established. Much later came respect for other humans in general. Slavery was not abolished in Russia and in the United States until the 1860s (and it still exists in some countries!). Voting rights and early democracy respected the rights of men but not until much later the right of women to vote. When it comes to many areas of society still today there is a lack of respect for other ethnic groups (e.g. anti-semitism and the ethnic wars in the 1990s), women (abuse of women), and children (abuse of children, children soldiers, and working children).

A policy to implement and defend human rights is pursued in many countries by the Council of Europe and the United Nations. The catalogue of common rights are expanding, and the more recent one is a Convention on the Rights of Children. This work in fact constitutes an effort to develop a global ethics, as asked for by the Brundtland Commission. Can such a global ethics include in a more clear way the sustainability values discussed above? Some of the documents referred to initially do this, e.g. in the Rio Declaration. The values discussed in these documents are all anthropocentric but have expanded from traditional ethics into intergenerational ethics.

The next step might be an ethics that declares that also the non-human part of the ecosphere has an integrity to be respected. The *Earth Charter* process aims to produce such a document. The Earth Charter has been in preparation for several years in an effort where interest groups from all over the world take part. The intention was originally to have the charter accepted by the United Nations General assembly in 2001. It is seen as an ethical foundation for sustainable development, and could be understood as an enlargement of the Declaration of Human Rights, or a basic document for a global environmental ethics. The text is available at the Website www.earthcharter.org.

3.7 Sustainable development and justice

As described in this chapter sustainable development is a development of justice, where the rights of our fellow humans, future humans and other species are to be respected. We talk about three kinds of justice:

Justice between us living now
Justice between us and future generations
Justice between us and the rest of the living world.

The modern fight for justice started after the end of WW II with the Universal Declaration of Human Rights. However it has not stopped with that. Within the UN system new principles of justice and rights have developed during the whole period since then. This includes e.g. migrant workers' rights and more recently children's rights. As an example we can see that the United Nations Convention on the Rights of the Child (often called CRC or UNCRC).It is a human rights treaty which sets out the civil, political, economic, social, health and cultural rights of children. The UN General Assembly adopted the Convention and opened it for signature in 1989 (the 30th anniversary of its Declaration of the Rights of the Child). It came into force September 1990, after it was ratified by the required number of nations. UN has established a Committee on the Rights of the Child (CRC) with independent experts to monitor and report on the implementation of the Convention.

All these new conventions on rights are developed in a similar way. Many of them have protocols on special issues. The CRC thus has an Optional Protocol on the Involvement of Children in Armed Conflict. All of them are collected in the UNTC – United Nations Treaty Collection – which reports which member countries have signed and ratified each of the treatises and include comments from each of the countries. See https://treaties.un.org/pages/viewdetails.aspx?src=treaty&mtdsg_no=iv-13&chapter=4&lang=en

In this way the United Nations has played an important role in developing a global ethics. However many other forces and changes in our societies have contributed to the acceptance and implementations of the rights. The Canadian psychologist Steven Pinker has described these developments in a fascinating way in his book *The Better Angels of Our Nature*, (Steven Pinker, 2011) which he calls the rights revolution (Figure 3.4).

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Chapter 4
International Cooperation and the United Nations

4.1 Why international cooperation is necessary for sustainable development

Environmental impacts do not know any borders. This is obviously the case for pollutants transported by wind and water, and especially so for the greenhouse gases which distribute themselves all over the atmosphere of the planet. For this reason nations have to cooperate to meet environmental challenges. This has been recognised since the first years of environmental concerns. If we want to expand the agenda to include also other dimensions of sustainable development it is easy to see that also these are borderless in a similar way. Economic growth and establishment of a sound economy in our world requires international cooperation, and so does much of development of the social aspects of a society.

In spite of these insights it took quite a time for international cooperation for protection of the environment to get started. The first global conference on this subject was in Stockholm, Sweden, in 1972. It was followed by the establishment of the United Nations Environmental Programme, UNEP. The very first global convention, the Ramsar convention for protection of wetlands and biodiversity, had just recently been established in 1971.

The first real work on cooperation in the then still young European Economic Community started with the First Environmental Action Programme (EAP) in November 1973, the second EAP drawn up and adopted in 1977. The institutional build up can be counted from 1989 when Environment got its own Directorate General (corresponding to a ministry) in DG XI. The following year, 1990, the European Environment Agency was established and during the coming decade in the 1990s several of the basic Directives on the environment was initiated and established. Today it is fair to say that the European Union is there just as much for the reason of protection of the environment as for economic cooperation.

Both globally and on the European scale the environmental protection work has been expanded to include other parts of sustainable development and is in fact a cooperation to make the world more sustainable. On the global scale it happened with the 1992 UNCED conference in Rio de Janeiro. The EU got its first strategy for sustainable development during the summit in Gothenburg, Sweden, in 2001.

Both on the global scale and on the European scale today in 2015 we talk about the global agenda and European agenda as programmes for what to achieve the coming years. It is in words that make us believe that the international co-operation is established and considered self-evident and unquestionable. In this chapter we will describe how this has developed and which the most important issues are today.

4.2 The first initiatives – the Stockholm conference

The origins of present day international co-operation on environment and sustainable development go back to the late 1960s, when Sweden took the initiative to place the issue of environment on the agenda of the United Nations. The background was an increasing awareness in the scientific community about the serious nature of the negative environmental side-effects of the technological and scientific advances after the Second World War. The initiative also reflected a realization that environmental problems did not stop at national borders, nor did regional cooperation suffice to deal with them. Sweden thus proposed that a global United Nations Conference be convened to increase awareness about the implications of this situation among governments and the public at large and to identify those problems which could only, or best, be solved through international co-operation.

The United Nations Conference on the Human Environment convened on 5 June 1972 in Stockholm. This day in June is now yearly celebrated as the World Environment Day. The motto of the Conference was "Only One Earth," a revolutionary concept for its time. The conference was attended by 113 countries at the ministerial level and by representatives of many international organisations.

There were also world leaders present, among them Prime Minister Indira Gandhi of India, who set the stage for future international deliberations by emphasizing the close interrelation between mass poverty and the environment. Secretary General of the Conference was Maurice F. Strong of Canada. Twenty years later he was also Secretary General of the follow-up conference in Rio de Janeiro, the United Nations Conference on Environment and Development

The Stockholm Conference was very much about sustainable development although it was not called that in those days. It was very clear for the participants that economic and social issues were part of the environmental agenda. The conference adopted a Declaration and an Action Plan, which established the basis for a new era of international co-operation on environmental issues. As a direct result of the Conference, the United Nations Environment Programme (UNEP) with location in Nairobi, Kenya was established by the General Assembly of the

United Nations. UNEP was to be a catalytic instrument in the United Nations to promote the results of the Conference.

The Declaration and the Action Plan with 109 recommendations for international action provided the basis for the rapid development of international environmental law in the 1970s and the 1980s. In this connection, principle 21 of the Declaration, has special significance. It states that:

"States have….the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of the other States or of areas beyond the limits of national jurisdiction."

From few in the 1960s, today more than 200 global conventions are in place. These are legally binding instruments, containing commitments by States. They have to be ratified by the legislative organs of each signatory State. Each convention is governed by a Conference of the Parties (COP) and is serviced by a secretariat. UNEP has a special role in most cases to provide administrative and other kinds of support. The undertakings in the conventions are often amplified by special protocols that contain more detailed and, at times, time-bound commitments.

Another significant result of the Stockholm Conference was the establishment of environment ministries and agencies in more than 100 countries. It should also be noted that the Conference marked the beginning of an explosive growth of the number of non-governmental and intergovernmental organisations dedicated to environmental preservation. An estimated 100,000 such organisations were formed in the 20 years after Stockholm and before the Rio Conference.

As the globalisation process accelerated in the last 25 years of the 20th century, the Stockholm Conference was used as a model for a series of similar United Nations events to try to come to grips with interlinked and related problems of a cross-sectorial nature such as population, the food crisis, urbanization, human rights, social development, and gender. While achieving progress, they also demonstrated an inadequacy of the established sectorial institutional structure of the United Nations system – a mirror of administrative organisation at the national level – to deal with all these challenges in a comprehensive and holistic way.

4.3 The Brundtland "World Commission"

Various reasons, among them the oil crises, contributed to a certain loss of momentum in the 1970s. At the time of the tenth anniversary of the Stockholm Conference in 1982, the question was how lost ground could be regained. One answer was the establishment by the General Assembly of a special, independent Com-

mission of eminent persons under the chairmanship of the then Prime Minister of Norway, Gro Harlem Brundtland. When the conclusions of the Brundtland Commission were published in 1987, the political climate was more receptive.

Economic prospects in the industrialised world were more positive. Also, several serious global problems, particularly the destruction of the ozone layer, were by then high on the political agenda in many countries. The serious ozone problem was the subject of a convention signed in Vienna in 1985, later supplemented by the Montreal Protocol in 1988. This agreement foresees the phasing out of ozone-depleting substances and has now largely been implemented. A decrease of the influence of ozone degrading substances, a slowly shrinking ozone hole, has been noted since the early 2000.

The Brundtland Commission developed conceptually the relationship between environment and development, the crucial issue which Indira Gandhi highlighted in Stockholm and where divisions between North and South had not diminished. Developing countries –the South – generally emphasised that satisfaction of basic development needs must have priority. It was poverty and underdevelopment that caused the environmental problems. If they were successfully dealt with, a sound and sustainable environment would follow. The North wanted environmental protection. Sustainable development was, politically speaking, a compromise.

The Commission emphasised the importance of economic growth and promoted the concept of "sustainable development", by which is meant a growth that satisfies today's needs without jeopardizing the needs of future generations.

The Commission further underlined that safeguarding of the environment should not be seen as a sectorial interest, but as an integrated component in all economic and social development. The report recommended a sound management of natural resources, energy saving and a population size in harmony with the productive potential of ecosystems. At the same time it argued for a strong increase in capital flows to developing countries, improvements in terms of trade for these countries and other measures to reduce the gaps in living standards between rich and poor countries. The report acquired considerable importance as the hitherto best analysis of the relationship between development and environment and as a guide for further negotiations.

4.4 The Rio Conference on Environment and Development

Sweden took up the recommendation of the Stockholm Conference to convene another conference on the human environment. This time, on the advice of the Brundtland Commission, a shift in emphasis was proposed to clearly underline

the relationship between environment and development. In 1989 the General Assembly decided to convene in 1992 the United Nations Conference on Environment and Development (UNCED). It was not possible to use the new concept sustainable development because influential developing countries, while recognizing the importance of limiting pressures on the ecosystems, feared reductions in their freedom of action. By maintaining a certain dualism it could easier be made clear that the responsibility to take action against environmental destruction primarily rested with the industrialised countries, which, in their view, had caused the problems in the first place.

In spite of the progress generated through the processes set up in Stockholm, the global conditions were much worse in 1992. World population had increased by 1.7 billion to more than 5 billion. Almost 500 million acres of trees had been lost in the preceding 20 years. Chemical substances had damaged the ozone layer and deserts were rapidly expanding. The climate change problems had also begun to receive serious attention.

The Rio Conference was meticulously prepared, just as its predecessor 20 years earlier. Again, innovative approaches were developed. At Rio, the nongovernmental presence was much stronger. Also, it ensured a significant informal involvement of private business leaders. This was a sign to come.

In contrast to Stockholm, the Rio Conference was a summit, attracting some 120 Heads of State of Government. Altogether, 178 countries participated. In an important change of direction, the United States which had played a leading role 20 years before, this time took a defensive position.

The Conference became a success. It adopted three documents, the Rio Declaration, Agenda 21, and the Statement of Forest Principles.

The Declaration represents a delicate balance of principles considered important by both developed and developing countries. Among them are the principles of common and differentiated responsibility for dealing with global environmental problems, the polluter pays principle, and the principle of precaution and liability.

Agenda 21 is a detailed blueprint for action into the 21st century, contained in 40 chapters. This time, the agreement also covered action at the national level reflecting the recognition that all states have a responsibility to contribute to arresting the negative trends. This was a significant breakthrough. An attempt was made to measure the cost of recommended actions, to demonstrate the urgent need for additional financial resources, particularly to developing countries. As part of the overall political agreement between industrialised and developing countries, the former – with the expressed reservation of the United States – reaf-

firmed their commitment to reach the accepted United Nations target of 0.7% of GNP for Official Development Assistance (ODA).

"Humanity stands at a defining moment in history. We are confronted with a perturbation of disparities between and within nations, a worsening of poverty, hunger, ill health and illiteracy, and the continuing deterioration of the ecosystems on which we depend for our well-being. However, integration of environment and development concerns and greater attention to them will lead to the fulfilment of basic needs, improved living standards for all, better protected and managed ecosystems and a safer and more prosperous future. No nation can achieve this on its own; but together we can – in a global partnership for sustainable development." (Agenda 21, the introductory words).

The Forest Principles reflect a first global consensus on forests arrived at in spite of emotional controversies between Northern countries, who favoured moving in the direction of a legally binding instrument to stop deforestation, and some Southern countries, who did not want their freedom of action curtailed.

In the preparations for the World Summit on Sustainable Development in Johannesburg in 2002, marked by the dramatic implications of the swift globalisation process, it was clear that success to a large extent depends on governmental interaction with the private sector and civil society.

4.5 Local Agenda 21

The 40 chapters of Agenda 21 are several referring to the groups which should be supported to implement the Agenda. These include NGOs, Local Authorities, indigenous peoples, farmers, women and children and youth. Agenda 21 is thus a very participatory strategy. The local level – the municipalities – are key actors. It is at the local level that sustainability is created and sustainable communities are built. The role of the state is rather to establish the rules, that is, making the right laws, and often financing the projects which each city, town or rural community develop. For this reason Local Agenda 21, as recommended in chapter 28 of the document, has been established as a separate line of action.

Thousands of municipalities around the world have adopted their own Local Agenda 21. In Sweden all 291 municipalities developed a Local Agenda 21 in the 1990s, mostly because the state guaranteed funding. In other countries it was much less, but still thousands of municipalities have adopted a Local Agenda 21, most of them in Europe.

Box 4.1 United Nations

The United Nations was formed in 1945 in the aftermath of the Second World War. It is an intergovernmental organisation, IGO, for world peace and security. Its activities are based on a Charter, which contains 111 articles. Main objectives of the UN are safeguarding world peace and security, equal rights and self-determination of all peoples, and human rights and liberties.

With time a large number of more special functions and objectives of the organisation have developed, including those connected to development and environment. Today UN has three main directions: Peace and security, development and human rights.

The UN system has more than 30 special committees, programmes, and organs for various purposes, each with its assisting organs, commissions, etc., referred to as the UN family of organisations. Among them are for example the World Health Organisation, WHO, the UN Development Programme, UNDP, the Food and Agricultural Organisation, FAO and the UN Environment Programme, UNEP just to mention a few. Its ECOSOC, Economic and Social Council, has six regional commissions including ECE, or Economic Commission for Europe. It works through some forty special organisations, e.g. the mentioned UNDP, the UN Commission on Human Rights and the UNICEF, the UN Children's Fund.

In 2015, the UN had 193 member states. Its Secretariat, headquarters, located in New York, is led by a Secretary General, whom since 1997 is Ban Ki-moon, the formerly Minister of foreign affairs of South Korea.

The organisation, ICLEI has developed a special role in supporting cities and towns around the world to work on local sustainability plans. ICLEI, which was originally called the International Council for Local Environmental Initiatives, was founded in 1990 by 200 local governments from 43 countries meeting at the World Congress of Local Governments for a Sustainable Future at the United Nations in New York. Today, more than 1,200 cities, towns, counties, and their associations in 84 countries are members of ICLEI, which now is called Local Governments for Sustainability.

ICLEI has played a special role in Europe as it has been organising the Sustainable Cities and Towns campaign, a European Union project to support local sustainable development, but it is active in the entire world.

Most Local Agenda 21 projects, especially in the beginning, have focused on information to the inhabitants of the cities on sustainable development. Very often the cities developed a set of indicators for sustainable development and used them to show the citizens how the city is developing. These used to be about 20 indicators in very different fields, from environment to economy and social issues. After some years it is possible to get an idea about how the city develops and take action to improve.

4.6 World summit in Johannesburg 2002 and the Rio+20 conference 2012

The next big meeting was the World Summit on Sustainable Development, WSSD, in Johannesburg, South Africa in 2002, ten years after Rio. It was the first UN conference where the phrase 'sustainable development' was in the name of the meeting. It did not become quite the same main event as the 1992 Rio conference. Instead of new agreements between governments, the World Summit was organized mostly around almost 300 "partnership initiatives", with non-governmental organizations, NGOs, also called civil society organizations. Science and business were given main roles, and the discussion was now about concrete details on how to work. We will mention three such agreements.

First the Johannesburg Declaration, a main outcome of the Summit, was much focused on relieving the social situation in the world, with a focus on the poor and needy in the world. The Declaration in a way mirrored the Millennium Development Goals, then already established at the United Nations and by themselves being a global agenda.

Secondly, Education for sustainable development, ESD, was an important point on the agenda. Just months after the conference the UN general assembly decided on the Decade for Education for Sustainable Development to be 2005-

Figure 4.1 An event at the UNCED Rio Conference 2012.

2014. This decade has now passed and the main results were summarized at a World Conference in Nagoya, Japan, in November 2014. In the report we read "In a world of 7 billion people, with limited natural resources, the need for holistic, transformational education systems is urgent. It is now widely recognized that simply ensuring access to education is an insufficient objective; the content and purpose of education is an increasing concern. Following the World Conference on Education for Sustainable Development stakeholders are continuing to make commitments to support the Global Action Programme (GAP) on ESD. The Global Action Programme seeks to generate and scale-up ESD actions. It is intended to make a substantial contribution to the post-2015 agenda." The GAP will be led by UNESCO, and thus efforts for education sustainable development will continue to be a global concern.

Thirdly a main focus was on sustainable consumption and production. This was much a cooperation with the business community and well developed in the Plan of Implementation from the Johannesburg Summit.

In June 2012 the global society met in Rio again for the UN Rio+20 conference on sustainable development (UNCSD2012). This time the focus of the conference was green economy, reflecting that the economy is top priority in most countries today and environmental concerns need to be included in economic development. The final document from Ro+20 is called The Future We Want. A main component is the agreement to develop as set of Sustainable Development Goals (SDGs). These were intended to follow the Millennium Development Goals (MDGs) and be a main focus in the UN work from 2015 when the MDG process ends. The 17 MDGs were adopted by the UN General Assembly on 25 September 2015.

4.7 The climate issue

At the Rio conference, two global conventions were opened for signature, the Convention on Climate Change and the Convention on Biological Diversity. These were followed a few years later by the Convention on Desertification.

As the perception of global threats to the environment became stronger in the 1980s, the climate change issue came increasingly into focus. Several international conferences were held, and towards the end of the decade, UNEP and WMO (World Meteorological Organisation) took an initiative that had a major impact on subsequent events. They created jointly the Intergovernmental Panel on Climate Change (IPCC), which issued its first assessment report in 1990. The Panel is composed of the world's most competent climate scientists, but it has

also sought to incorporate representatives of governments and experts in the social sciences. It has to be recognized though, that it is in the framework of natural science that the Panel has commanded greatest authority. The purpose of the Panel has not been to carry out research on its own, but to monitor and evaluate existing research, adding its own conclusions and presentations for policy-makers. In this respect, the Panel has been very successful. Under the guidance of its first Chairman, the Swedish scientist Bert Bolin, the assessment reports of IPCC have greatly influenced the climate negotiations and been instrumental in launching the Framework Convention on Climate change (FCCC).

The IPCC first assessment report appeared in the autumn of 1990. It stated that the process of global warming, created by what was known as the greenhouse effect through the accumulation of carbon dioxide and other greenhouse gases in the atmosphere, could lead to an increase of temperature in the Earth's atmosphere by 1.5 to 4.5 degrees centigrade towards the end of the 21st century. This could possibly cause a sea level rise of between 25 and 95 centimetres, which would obviously have catastrophic effects for small islands and low-lying coastal areas.

These findings have been contested by some scientists; and the IPCC itself underlines the many fundamental uncertainties that still exist. Nevertheless, the IPCC statements carry great authority as the mainstream opinion by the great majority of climate experts. The following assessment reports, of which the most recent is the fifth Assessment Report, AR5, has been published in 2013 and 2014. The data supporting the conclusion that the climate change is due to emissions of greenhouse gases from society has become even more solidified.

As each convention also the FCCC has its Conferences of Parties (COPs) yearly. The most famous of these are the 1997 meeting in Kyoto, Japan, when the so-called Kyoto protocol was accepted. A protocol is a more detailed agreement on who should do what and when. It is not until there is a protocol that the real work begins. Thus the 1997 meeting was of key importance. Through this and several other meetings the FCCC is approaching to become a legal global regime. The next key COP was number 15 in Copenhagen. Everything was prepared for signing a global agreement on reduction of greenhouse gas emissions, but the meeting failed to agree on such an agreement. Instead the "Copenhagen Accord" was signed, but it was not a protocol like document. It states that the goal for the partners to the Convention was to limit emissions to the effect that the mean global temperature should not increase more than 2^{o}C. Now we are approaching the COP 21 in Paris where there is a new effort to sign a global agreement on limiting emissions. It remains to be seen what can be achieved. But time goes by and the situation becomes ever more serious.

Box4.2 Conventions and their structure

Rules for global conventions are legally binding agreements, containing commitments by states, which make part of international law. How a convention is set up, supervised and ratified, as well as how states join a convention and leave it is today regulated in the so-called 1969 Vienna Convention. Conventions that are considered part of customary law becomes binding to all states, and conventions are thus a forceful part of international law. The United Nation Secretary General serves as the depositary of international conventions.

Global conventions are the results of extensive, often several year long, negotiations between many, often up to some 100, states. After the negotiators have come to an agreement the text of the convention is signed by representatives of the governments and later ratified by the legislative organs of each signatory state, most often the parliament. When the specified number of ratifications have been reached the convention enters into force.

Today more than 200 global conventions are in place. Each convention is governed by a Conference of the Parties (COP) which meets regularly. It is serviced by a secretariat which handles the legal procedures, e.g. to oversee that the participating states follow binding commitments, and a secretariat that work with the practical implementation.

The undertakings in the conventions are often amplified by special protocols that contain more detailed and, at times, time-binding commitments. Very often further resources, such as technical committees, research laboratories, etc., are set up to work with the issues of the convention, such as monitoring, forecasting, etc.

The secretariats and other mechanisms of the global conventions are normally financed through obligatory contributions by the parties according to a scale of assessment of the United Nations.

4.8 The Agenda 2030 – a global SD agenda with 17 goals

For the coming 15 years the international agenda will be dominated by the 17 sustainable development goals (SDGs) adopted by the United Nations General Assembly on 25th of September 2015. It is called Agenda 2030. These goals follow after the 8 millennium development goals (MDGs), which have been in focus since the millennium assembly in year 2000 (See Chapter 1). Several of the MDGs were fulfilled while some were not. The strong points were on economic development and education. The weak points were women's situation and health (See further Chapter 1). A very important part of the MDGs were that the international community were gathered around them and the efforts the countries did to show good results. Another good point was that the goals were quantitative and thus could be measured and reported. This way to cooperate will continue with the SDGs.

The sheer number of goals – 17 – have been criticized as being too many and too complicated. But we probably need to accept that the interdisciplinary and inter-sectorial character of sustainable development will not be covered by a small number of goals. It is simply a part of the systems approach, which include social,

Box 4.3 The Sustainable Development Goals.

Goal 1. End poverty in all its forms everywhere
Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture
Goal 3. Ensure healthy lives and promote well-being for all at all ages
Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
Goal 5. Achieve gender equality and empower all women and girls
Goal 6. Ensure availability and sustainable management of water and sanitation for all
Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all
Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
Goal 10. Reduce inequality within and among countries
Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable
Goal 12. Ensure sustainable consumption and production patterns
Goal 13. Take urgent action to combat climate change and its impacts*
Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development
Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
Goal 17. Strengthen the means of implementation and revitalize the global partnership for sustainable development

economic and ecological aspects of development. Still the Secretary General has responded to the criticism by proposing a "flower" of the SDGs, which collects the goals in 6 thematic groups (Figure 4.3).

The goals have a clear focus on human social conditions. Thus the first five goals deals with poverty, hunger, health, education, and equity; then follows water, energy; next are economy, infrastructure and industrialism, and economic inequality; then urban development, consumption and production, and climate change; then marine and land areas and ecosystems; finally goals 16 and 17 address peaceful and inclusive societies and international cooperation. It is noteworthy that securing peace comes in the very end and that democracy and freedom is not mentioned at all. Of course there has been many compromises between the

Figure 4.3 The SDGs shown as a flower with 6 petals, for the 6 aspects People, Planet, Dignity, Prosperity, Justice and Partnership. (source: UN).

194 nations which have adopted the goals and some wordings have been carefully avoided and many compromises accepted.

The SDGs were written by a so called Open Working Group (OWG) with a very broad participation from all over the world over a two year period. It is said to be one of the most open and inclusive processes ever organised. The OWG delivered its first proposal in October 2014 and the final proposal on August 2nd 2015, when all nations agreed.

The SGDs have a total of 169 targets. All of these are on the list of what to achieve the coming 15 years! Obviously some countries have already achieved several of the targets and in practical work there will be less than 169 issues to deal with. Still there are many. The biggest worry is to which extent we will see a cooperation within countries over the many traditional borders between the administrative departments in governmental offices.

It is the Division of Economic and Social Affairs of the United Nations Secretariat, UN DESA, which will administer the global process to achieve the SDGs. All the goals and targets are easily available on the website of the UN DESA.

The quantification of the SDGs will require a list of indicators to monitor the process. This will by necessity be quite complicated. However there is already such work in all nations and in the EU, the OECD etc. In the EU it is the Statis-

tical Office which carry out such work. The indicators of the SDGs are not yet established and are expected in the spring of 2106.

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Chapter 5
Monitoring Sustainable Development

5.1 How to measure sustainable development

For any activity we undertake it is important to measure it so we know if we are on the right track. The saying is that "what is measured in managed" indicating that if we do not measured we will not work to reach our goals. To measures if a society or its different parts – from individuals to the entire human population – is approaching or distancing itself from the ideal of sustainability is not always to easy. Different measures are used and most of them look at a special property or character, not sustainable development as a whole.

It is thus really very difficult to get an overall measure saying where we are in this efforts to approach sustainability. For these reason one uses *composites measures*, consisting of parts which are weighed together in some agreed way. Each of these parts look at a special part of the system. They are then shown in a circular diagram or any form of spider web looking picture to illustrate the situation (Figure 5.1). The advantage with this approach is that we immediately see strong sides and weak sides in development.

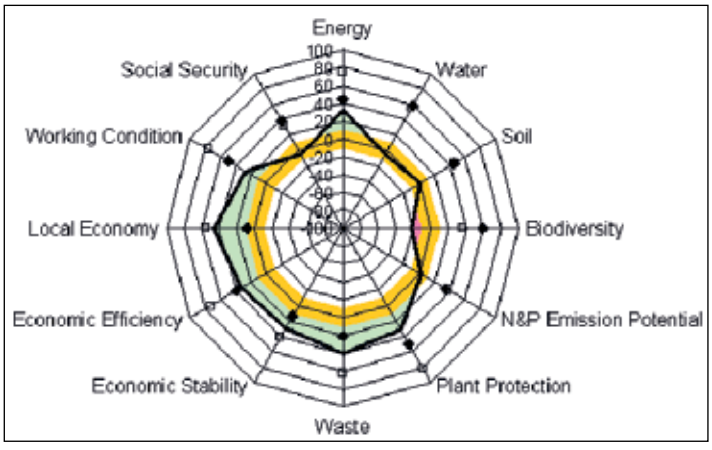

Figure 5.1. Sustainability polygon of the 14 pilot case study farms. Displayed are mean values of the State, Driving force and Degree of Sustainability of the14 assessed farms. The bold line connects the values of the Degree of Sustainability of the twelve indicators.

It is possible to make a weighted mean of all the different parts to calculate an overall measure. Such an overall measure is most often much less useful than the diagrammatic illustration, but it gives a figure for the total achievement.

In a project regarding how cities work with sustainable development issues we attempted to make a list of all measures used. These are called *indicators*. Indicators are measuring one special property, e.g. air pollution or unemployment or health of the inhabitants. They may thus still be complicated. For example air pollution consists of concentration of a number of chemical substances, gases, each of which needs to be measured separately. Still air pollution used to be reported as one indicator by many cities.

If many indicators are used to construct a single number, by addition or as an average or any other way, it is called an index (plural i*ndices*). There are many well know indices which have been used for a long time. Thus United Nations Human Development Index, HDI, is based on economic standard, education and child mortality. HDI is reported for all UN member countries since many years.

When measuring sustainable development one also needs a *framework* to know which the components of SD to measure. The best established framework is the so-called three dimensions of sustainability, *the ecological, economic and social dimensions*, also called "the triple bottom line". But there are several others. One much used framework is the *compass* developed by Alan AtKisson (Figure 5.2). The four directions of the compass, North, South, East and West, are then used for Nature (ecological), Society (social), Economic and Wellbeing (also social). This framework has the advantage of separating the social dimension in two components one regarding the society and the other the individual.

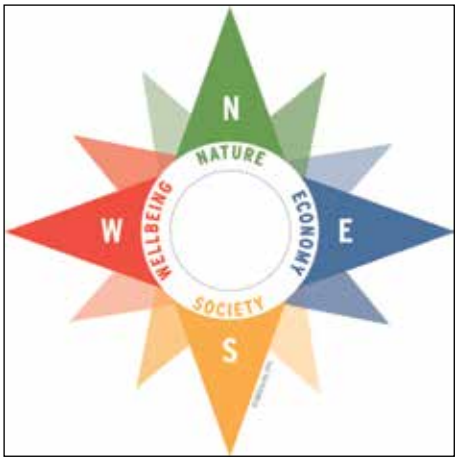

Figure 5.2. The Sustainability Compass is a tool for orienting people to sustainability. The Compass helps you bring people together around a common understanding of sustainability, and a shared vision for getting there. It also helps you monitor progress along the way.
N is for all of our natural ecological systems, ecosystem health, nature conservation and resources.
E is for the human systems that convert nature's resources into food, shelter, ideas, technologies, industries, services, money and jobs.
S is for the institutions, organizations, cultures, norms, and social conditions that make up our collective life as human beings.
W is for our individual health, happiness, and quality of life. .

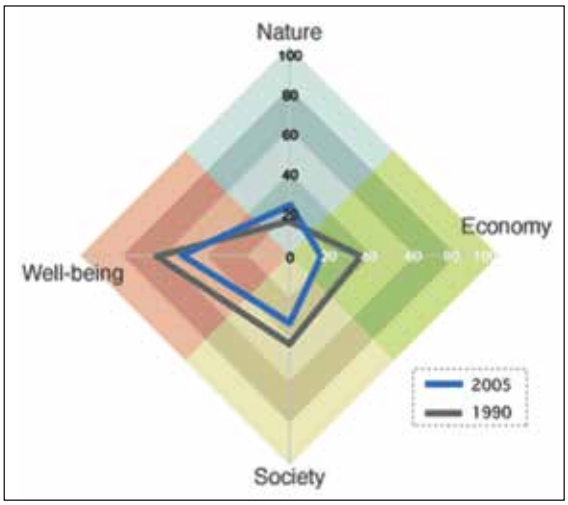

Figure 5.3. Monitoring Japan indicators for sustainability. The compass was used as a framework, and for each direction of the compass 5 core indicators were reported, i.e. a total of 20 core indicators were used to measure the sustainability of the Japanese society. from 1990 to 2005.

An important aspect of the use indicators is that we need a *reference point*, a value for a perfect indicator, or the value of the indicator when it indicates sustainability. Sometimes these values are easy to find, e.g. when it comes to resource use we need to be within the resources available to us, or for air pollution we need to be within the levels which do not cause harm on people of the environment. In other cases it is more difficult to find the proper value of the indicator which signifies a sustainable society. These include e.g. unemployment or education (how many years?). In these cases one way is to use *benchmarking*. Then we use an agreed value, a benchmark, taken from a good example or after a discussion among those concerned. If we have such a reference value the indicator can be expressed in%age of the value for complete sustainability. This is the way we see indicators presented most often.

An example of a careful monitoring of sustainability was some years ago made in Japan by a consortium of universities, companies and NGOs in the Japan for Sustainability project. The result shown in Figure 5.3 was based on several years of work and included values from 1990 to 2005. The compass was used as a framework, and for each direction of the compass 5 core indicators were reported, i.e. a total of 20 core indicators. Each of these were based on datasets of on the average 10 parameters. Thus a total of 200 datasets were used to measure the sustainability of the Japanese society.

In the city survey the cities had on the average about 60 indicators, many of them using large datasets. Most were about environmental concerns but there are also economic and social indicators.

5.2 Which are the best indicators for sustainable development?

There are two kinds of measures for sustainable development. One is the physical resource use, that is, the physical support we need for food, shelter etc. The other side is how to live a good life within this resource base. This is the social and economic side of sustainability. The two sides are often measured as ecological footprint for the first and human development index for the second. We will see more of this below.

Measuring resource flows is a basic element when monitoring sustainability, since we need to live on the recourses available. There are also a large number of measures available and used for this purpose. Resource flows are measured for *products and services*, as well as different "consumers" of products and services such as persons, companies, municipalities, countries and the whole world. With similar methods also *environmental impacts* are measured for the same categories.

The measurements of the resource flow or environmental impact of a product or a service should ideally include flows and impacts made over the entire *lifecycle* of that product or service. This is a difficult and complicated task, called Life Cycle Assessment or LCA. LCA requires that we define the borders of the impacts and then list everything which is connected to or used for the product or service examined. LCA is a special skill, using special software and access to large databases. Here we will only emphasise that a product or service may have very different impacts in the different stages of its life. For some products it is the resource extraction which dominates, in other cases it is the use of the product which consumes much resources and finally it may also be at the end of life, the wasting stage.

Here we will only say that when such a measurement is made a number of impacts are reported, such as human health, ecosystems health, biodiversity decrease, air pollution, water pollution, acid rain, etc. Each one can then be discussed or evaluated separately.

But it is not only living within the resource base but also living a good life. For this we need so called *progress indicators*. The present "standard" measure for progress, Gross Domestic Product or GDP, is not acceptable as an SD indicator. There is nothing in GDP which measures sustainability. On the contrary a measure of growth is in itself problematic since in a limited world nothing – at least physical – can grow forever. In addition there are only weak links between GDP and wellbeing. Thus if one really wants to measure wellbeing GDP is not what we need.

A most ambitious effort to reform the calculation of an indicator of economic welfare was made by economist Herman Daly and theologian, John Cobb. Daly and Cobb named their proposed substitute for GDP the *Index of Sustainable Economic Welfare* (ISEW). They took into account the all flow of services to hu-

Box 5.1 Proxy measures of environmental impact and resource use

It is possible to summarise resource flows or impacts in a single measure, that is, to *use a single dimension* to summarise a complicated multidimensional effect? Such one-dimensional measures are called *proxy methods*. Proxy methods are those where a single dimension is used to reflect the total environmental impact of a product or service.

Very early on, *energy consumption* was used to estimate the total impact of a product. Cramer et al. [1993] used the reduction of energy consumption to assess the improvement of a product over its predecessors. In a life cycle perspective it is important to include energy use in all stages of a product or service, extraction of resources, large e.g. for aluminium, production stage, use phase and waste phase. All other kinds of impact are then assumed to be roughly proportional to energy use. Here the dimension in kWh or Joules.

Money can also be used as a proxy parameter for environmental impact. The costs of controlling and reducing impacts are added up using the target values in permits according to environmental authorities. Money is also used as a parameter in the EPS (Environmental Priority Strategies) method then using the willingness-to-pay for avoiding the impacts to estimate the costs. Here the dimension is USD or Euros.

In the MIPS (Material Input Per Service unit) method *material flows* caused by the production, use and wasting of a product or service are used as a proxy parameter. The MIPS method has been carefully evaluated and it is argued that the material flows are roughly proportional to toxic flows and other impacts, which should make MIPS a valid proxy method. MIPS is a Material Intensity (MI) concept, a measure of the quantity of materials consumed to provide a certain service. MI indices show how much water, air and abiotic resources are needed on average to produce a unit amount of a certain material. Here the dimension is kg.

Surface area use is the proxy method used for ecological footprints. In this method a calculation is made of the area in nature used for a service or a product. This method is today the most widely used proxy method for estimating the total impact of a person, household, a city or a country. Here the dimension is so-called global hectares, gha. The Ecological Footprint has emerged as one of the world's leading measures of human demand on nature.

For footprint the space available for each one of us, the global biocapacity, as a global mean is about 1.80 gha. The reference value is thus available. Such reference vales have also been constructed for environmental impact and is the called environmental space. It is not much used. Instead authorities I each country have legally established limits for pollutants which should not be exceeded to keep a healthy environment.

manity from *all* sources, not only the current output of marketable commodities, they deducted spending whose purpose is defensive or intermediate and not welfare-producing and finally they accounted for the creation and losses of all forms of capital by adding the creation of man-made capital and deducting the depletion of natural capital. ISEW data exists for a number of countries in the world.

A more recent measure, the *Genuine Progress Indicator* (GPI), is estimated in a similar way as the ISEW but also includes factors such as the cost of underemployment, the loss of leisure time, and the loss of old-growth forests. GPI is a

metric that has been suggested to replace, or supplement, gross domestic product (GDP) as a measure of economic growth. GPI is designed to take fuller account of the health of a nation's economy by incorporating environmental and social factors which are not measured by GDP.

Human welfare have been measures since 1990 by the United Nations as the *Human Development Index, HDI*. HDI consists of three indicators – life expectancy at birth, educational attainment, and real GDP per capita. The index is calculated as the geometric mean of these three values. Normalisation procedures are used to get a number between 0 and 1. Other similar indicators have been used, such as child mortality (survival during the first five years) which also reflects the welfare in a society. Wellbeing can also be measured as perceived wellbeing, that is, simply by asking people.

5.3 The Ecological Footprint

Human activities consume resources and produce waste, and as our populations grow and global consumption increases, it is essential that we measure nature's capacity to meet these demands. The Ecological Footprint has emerged as one of the world's leading measures of human demand on nature. Simply put, Ecological Footprint Accounting addresses whether the planet is large enough to keep up the demands of humanity.

The concept of the *Ecological Footprint* was introduced by Mathis Wackernagel and William Rees at the University of British Columbia in the late 1980s and early 1990s. The idea was to reduce all ecological impacts of a product or service to the surface area in nature that was necessary to support its use /production. They argued that any production or other service in society is dependent on one or several *ecological services*, and that each of these required a small area in nature. The sum of these areas constituted the footprint of that production or service.

By measuring the Footprint of a population – an individual, city, business, nation, or all of humanity – we can assess our pressure on the planet, which helps us manage our ecological assets more wisely and take personal and collective action in support of a world where humanity lives within the Earth's bounds.

The Ecological Footprint is now in wide use by scientists, businesses, governments, agencies, individuals, and institutions working to monitor ecological resource use and advance sustainable development.

The Ecological Footprint is an accounting tool that measures one aspect of sustainability: How much of the planet's regenerative capacity humans demand to produce the resources and ecological services for their daily lives and how

Figure 5.4. Land use categories comprising the Ecological Footprint (see Borucke et al., 2013 for additional information on the calculation methodology for each of these categories).

much regenerative capacity they have available from existing ecological assets. It does so by means of two indicators:

Ecological Footprint measures the biologically productive land and sea area – the ecological assets – that a population requires to produce the renewable resources and ecological services it uses.

Biocapacity tracks the ecological assets available in countries, regions or at the global level and their capacity to produce renewable resources and ecological services, including our forests, pastures, cropland and fisheries. These areas, especially if left unharvested, can also absorb much of the waste we generate, especially our carbon emissions.

In economic terms, assets are often defined as something durable that is not directly consumed, but yields a flow of products and services that people do consume. Ecological assets are thus here defined as the biologically productive land and sea areas that generate the renewable resources and ecological services that humans demand. They include (Figure 5.4):

- cropland for the provision of plant-based food and fibre products;
- grazing land and cropland for animal products;
- fishing grounds (marine and inland) for fish products;
- forests for timber and other forest products;
- uptake land to sequester waste (CO_2, primarily from fossil fuel burning);
- space for shelter and other urban infrastructure

5.3.1 Footprint of the world and footprints for nations and cities

A country's Ecological Footprint of consumption is derived by tracking the ecological assets demanded to absorb its waste and to generate all the commodities it produces, imports and exports (Figure 5.4). All commodities (or CO_2 waste) carry with them an embedded amount of bioproductive land and sea area necessary to produce (or sequester) them; international trade flows can thus be seen as flows of embedded Ecological Footprint.

Both Ecological Footprint and biocapacity results are expressed in a globally comparable, standardized unit called a "global hectare" (gha) – a hectare of biologically productive land or sea area with world average bioproductivity in a given year.

While the Ecological Footprint quantifies human demand, biocapacity acts as an ecological benchmark and quantifies nature's ability to meet this demand. A population's Ecological Footprint can be compared with the biocapacity that is available – domestically or globally – to support that population, just as expenditure is compared with income in financial terms. If a population's demand for ecological assets exceeds the country's supply, that country is defined as running an ecological – or more precisely, a biocapacity – deficit. Conversely, when demand for ecological assets is less than the biocapacity available within a country's borders, the country is said to have an ecological – or biocapacity – reserve.

Today humanity uses the equivalent of 1.5 planets to provide the resources we use and absorb our waste. This means it now takes the Earth one year and six months to regenerate what we use in a year. Moderate UN scenarios suggest that if current population and consumption trends continue, by the 2030s, we will need the equivalent of two Earths to support us. And of course, we only have one. Turning resources into waste faster than waste can be turned back into resources puts us in global ecological overshoot, depleting the very resources on which human life and biodiversity depend.

The result is collapsing fisheries, diminishing forest cover, depletion of fresh water systems, and the build-up of carbon dioxide emissions, which creates problems like global climate change. These are just a few of the most noticeable effects of overshoot.

Overshoot also contributes to resource conflicts and wars, mass migrations, famine, disease and other human tragedies and tends to have a disproportionate impact on the poor, who .....?????

Global trends, however, hide the huge variability that exists at the regional level. Europe and Middle East/Central Asia experienced the largest increase in their per capita Ecological Footprint (+1.2 and +1.1 gha per person, respectively),

but while Europe's population growth was relatively slow (+29%), population grew 330% in Middle East/Central Asia. North America had a smaller increase in per capita consumption (+ 0.6 gha per person) and a 63% growth in population. At the other end of the spectrum, Africa saw its per capita Ecological Footprint decline (-0.1 gha per person), while its population increased by 255%. In the Asia-Pacific region, per capita Ecological Footprint increased slightly (+0.6 gha per person), while population grew by 136% (Figure 5.6).

The total Ecological Footprint of a country is a function of the average consumption pattern of each individual, the efficiency in production and resource transformation, and the number of individuals in the country. Biocapacity is determined by the available biologically productive land and sea areas and the capacity of these assets to produce resources and services useful for humans (this is determined by the prevailing technology and management practices implemented in these areas).

Biocapacity varies each year with ecosystem management, agricultural practices (such as fertilizer use and irrigation), ecosystem degradation, and weather, and population size. Footprint varies with consumption and production efficiency. Where a dotted line is shown, interpolation estimates have been used in place of highly unlikely outliers in the results.

In today's world, where humanity is already exceeding planetary limits, ecological assets are becoming more critical. Each country has its own ecological risk profile: Many are running ecological deficits, with Footprints larger than their own biological capacity. Others depend heavily on resources from elsewhere, which are under increasing pressure.

In some areas of the world, the implications of ecological deficits can be devastating, leading to resource loss, ecosystem collapse, debt, poverty, famine and war.

The Ecological Footprint is a resource accounting tool that helps countries understand their ecological balance sheet and gives them the data necessary to manage their resources and secure their future. National governments using the Footprint are able to:

- Assess the value of their country's ecological assets
- Monitor and manage their assets
- Identify the risks associated with ecological deficits
- Set policy that is informed by ecological reality and makes safeguarding resources a top priority
- Measure progress toward their goals

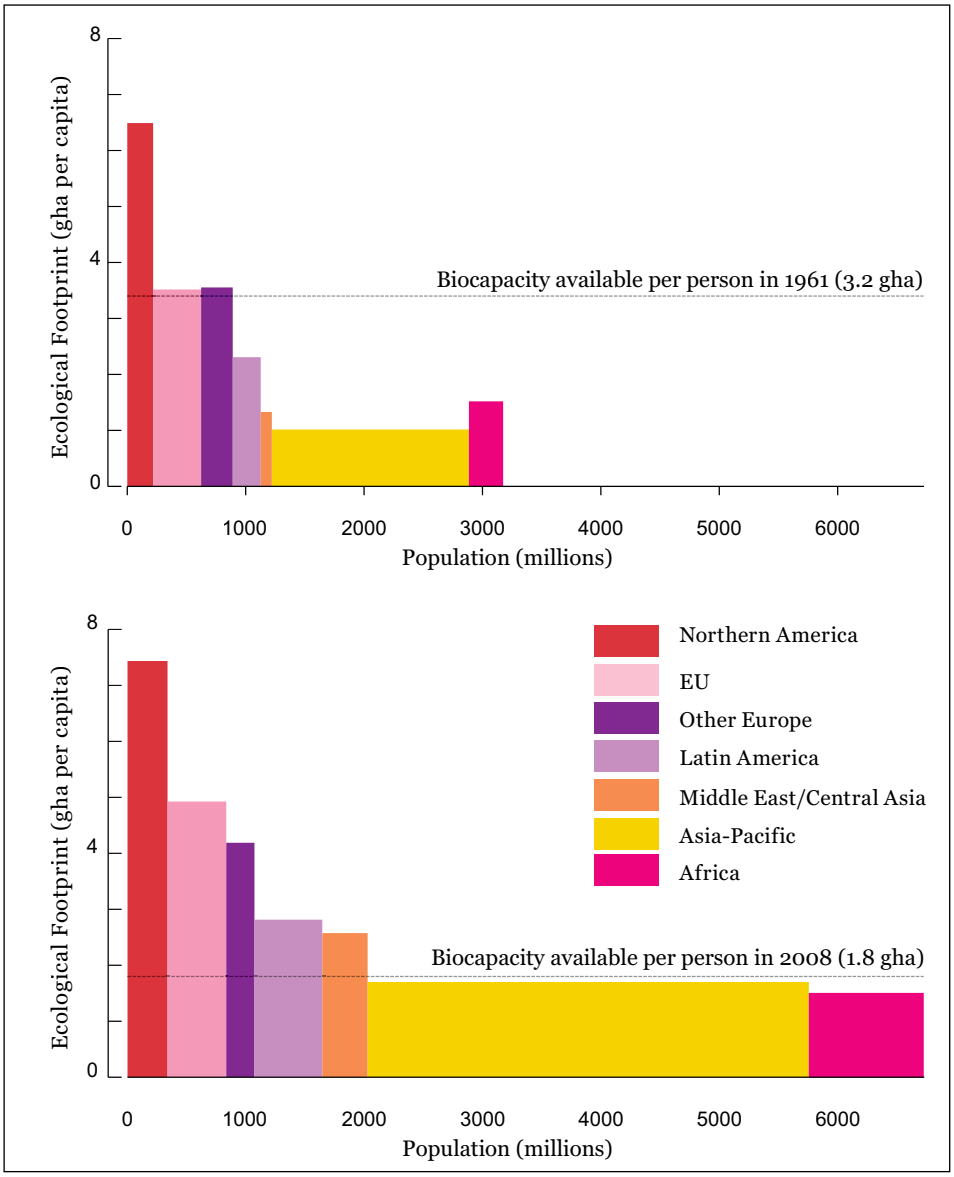

Figure 5.6. Ecological Footprint by region, 1961-2008, highlighting the change in average footprint per person and population change. Biocapacity represented by horizontal bar. Source: WWF Living Planet Report 2012. - See more at: http://www.whydev.org/tag/human-development/page/2/#sthash.w9qxySpx.dpuf

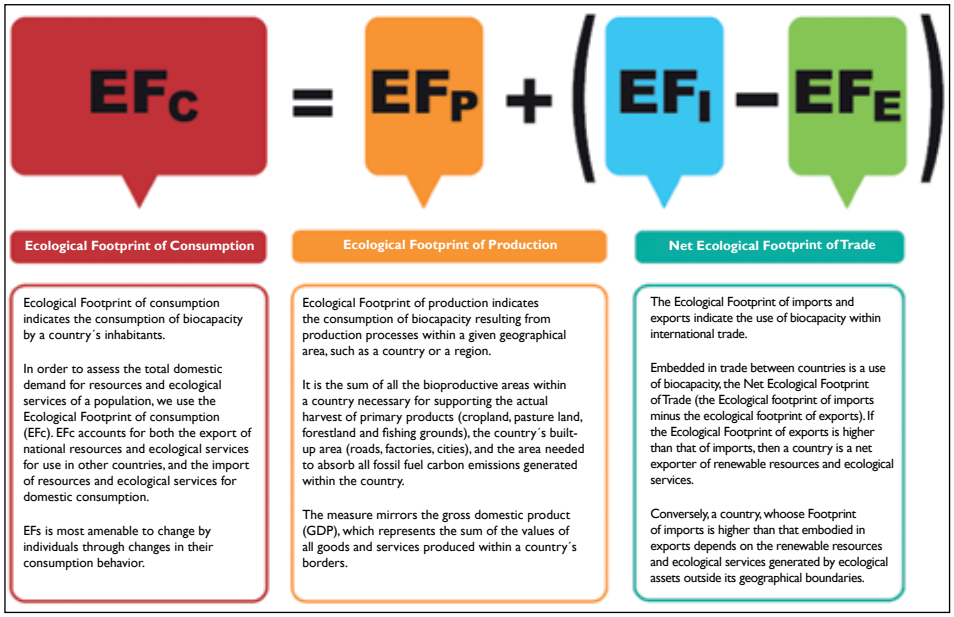

Figure 5.7. Tracking production, consumption and net trade with the Ecological Footprint: The Ecological Footprint associated with each country's total consumption is calculated by summing the Footprint of its imports and its production, and subtracting the Footprint of its exports. This means that the resource use and emissions associated with producing a car that is manufactured in China, but sold and used in Italy, will contribute to Italy's rather than China's Ecological Footprint of consumption.

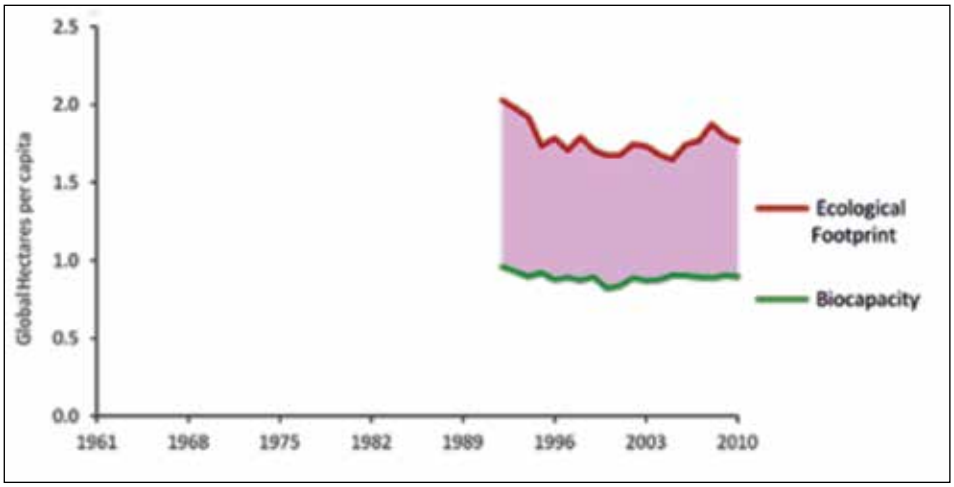

Figure 5.8. The Ecological Footprint of Uzbekistan..

It is almost certainly the case that countries and regions with surplus ecological reserves -not the ones relying on continued ecological deficit spending – will emerge as the robust and sustainable economies and societies of the future.

Today, more than 80% of the world's population lives in countries that use more resources than what is renewably available within their own borders. These countries rely for their needs on resource surpluses concentrated in ecological creditor countries, which use less biocapacity than they have. By comparison, in 1961, the vast majority of countries around the globe had ecological surpluses. Those numbers have slowly dwindled; meanwhile, the pressure on the remaining biocapacity reserves continues to grow.

5.4 The Sustainable Development Goals – a new global agenda

For the coming 15 years the international agenda will be dominated by the 17 sustainable development goals (SDGs) adopted by the United Nations General Assembly on 25th of September 2015 (See chapter 4). These goals follow after the 8 millennium development goals which have been in focus since the millennium assembly in year 2000. Several of the MDGs were fulfilled while some were not. The strong points were on economic development and education. The weak points on women's situation and health (See Chapter 1). A very important part of the MDGs were that the international community were gathered about them and the efforts the countries did to show good results. Another was that the goals were quantitative and thus could be measured. This way to cooperate will continue with the SDGs.

The sheer number of goals – 17 – have been criticized as being too many and too complicated. But we probably need to accept that the interdisciplinary and inter-sectorial character of sustainable development will not be covered by a small number of goals. It is simply a part of the systems approach, which include social, economic and ecological aspects of development. Still the Secretary General has responded to the criticism by proposing a "flower" of the SDGs, which collects the goals in 6 thematic groups (Figure 4.3).

The goals have a clear focus on human social conditions. Thus the first five goals deals with poverty, hunger, health, education, and equity; then follows water, energy; next are economy, infrastructure and industrialism, and economic inequality; then urban development, consumption and production, and climate change; then marine and land areas and ecosystems; finally goals 16 and 17 address peaceful and inclusive societies and international cooperation. It is noteworthy that securing peace comes in the very end and that democracy and freedom is not mentioned at all. Of course there has been many compromises between the

193 nations which have adopted the goals and some wordings have been carefully avoided and many compromises accepted.

The SDGs were written by a so called Open Working Group with a very broad participation from all over the world over a two year period. It is said to be one of the most open and inclusive processes ever organised. The OWG delivered its first proposal in October 2014 and the final proposal on August 2nd 2015, when all nations agreed.

The SGDs have a total of 169 targets. All of these are on the list of what to achieve the coming 15 years! Obviously some countries have already achieved several of the targets and in practical work there will be less than 169 issues to deal with. Still there are many. The biggest worry is to which extent we will see a cooperation within countries over the many traditional borders between the administrative departments in governmental offices.

It is the Division of Economic and Social Affairs of the United Nations Secretariat, UN DESA, which will administer the global process to achieve the SDGs. All the goals and targets are easily available on the website of the UN DESA.

The quantification of the SDGs will require a list of indicators to monitor the process. This will by necessity be quite complicated. However there is already such work in all nations and in the EU, the OECD etc. In the EU it is the Statistical Office which carry out such work. The indicators of the SDGs are not yet established and are expected in the spring of 2105.

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Chapter 5 sources:

Sections 4.1, 4.5 and 4.8 written by Lars Rydén

Data on EU from Lars Rydén Chapter 2 Development of EU Environmental Regulation in "1. Environmental Policy – Legal and Economic Instruments" (Børge Klemmensen, Sofie Pedersen, Kasper R. Dirckinck-Holmfeld, Anneli Marklund, and Lars Rydén.eds) Baltic University Press (2007).

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Chapter 6
The Challenge of Sustainable Habitation – Urbanisation

6.1 The challenge of sustainable habitation

Where we live and the way we live, habitation, is for each one of us at the core of our physical and social well-being. It is a question of home and workplace.

A home is, in the first place, a flat or a house, but also, in a wider context, it means neighbourhood, village, city and community. Habitation refers both to the more narrow perspective of housing, and also to the larger context of community life.

In the context of sustainable development habitation has a special role. Our home is the hub around which our use of material resources and energy turns. Our home and community are also the places where each one of us most easily and uncontroversial may influence our lifestyle and resource use. It is the obvious starting-point for the path towards sustainability.

Habitation has, like many other aspects of our society, undergone dramatic changes in the last one or two generations. The most important of these changes is a massive movement from the countryside to cities, urbanisation. The latest great expansion of towns and cities has taken place since the 1950s. In Europe, the proportion of the population living in cities doubled between 1950 and 1970. The cities have not only swallowed the entire population increase but also a major proportion of those who earlier lived in the countryside. In Europe today the degree of urbanization, city-dwelling, has reached some 70% in the east and 85% in the west.

This change is not without problems. Huge suburbs of the growing cities are troubled by, for example, transport difficulties. The buildings themselves in these suburbs are often of low quality and planning does not always address the social needs of the inhabitants.

The forces behind this major change in our societies are manifold. A predominant part of the picture is a population increase that has coincided with the growth of industries, which require a concentration of workers and are therefore located in the cities. Agriculture, on the contrary, as dispersed as the land itself, has decreased its demand for workers.

The changes have often weakened or even destroyed old cultural and social patterns and formed new ones. Urbanization coincided with the development of the welfare state in the West and the socialist state in the East. Social care is no longer the obvious responsibility of the family, and the various generations do not as often as they used to live in proximity to each other.

Changed habitation patterns are, in the West, part of the growth of the affluent society. It has resulted in a much increased living space per capita, as well as an increasing number of households comprising only one or few persons. Many families have two places to live in: a summer house in addition to a permanent home. In the East, many country houses have been turned into dachas for the city inhabitants.

6.2 A history of urbanisation

During practically all of its 7,000-years of history – since the foundation of Eridu, Ur and other early urban-like settlements around Euphrates and Tigris in present Iraq – the cities of the world were always closely intertwined with agricultural-, fisheries- and herding ecosystems. And through the millennia – old cities and conglomerates of Neolithic villages in pre-historic Americas, in ancient Turkey, along the Nile, by the Indus delta and in early Yangtze cultures – the urban and rural were perceptionally, geographically and functionally integrated – hence featuring the fundamental essence of a sustainable urban principle. Even during modern time's industrialization, our current city cultures were in principle physically co-evolving with its life-support hinterlands and micro-regions.

The first habitations in northern Europe and Asia, soon after the melting of the inland ice some 8,000 years ago, were small settlements at places where food and other provisions were easily accessible, in particular along coasts and rivers.

Figure 6.1. The Green Crescent in Mesopotamia by Euphrates and Tigris in Current Iraq. Three of the many cities in the ancient Sumerian state are considered by archeologists as some of the oldest urban formations in the world – Eridu is estimated to be 7,000 years old. Note that the cities were directly linked to the river and its fertile river delta landscapes. (Map developed and edited by Per G. Berg.)

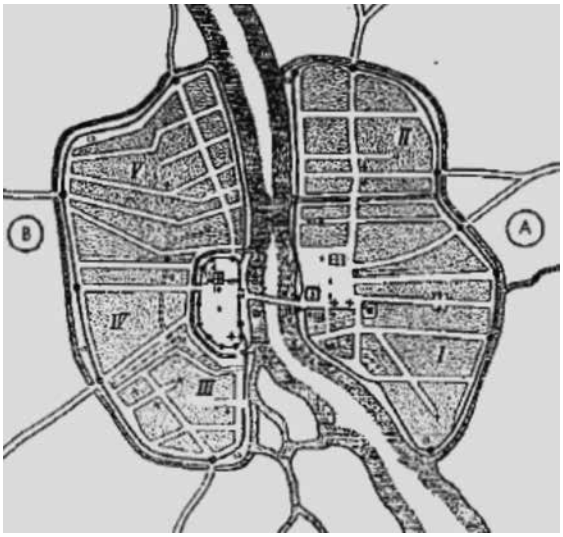

Figure 6.2 Novgorod during Hanseatic times, in the 14th century (Ennon, 1972)

These small groups of settlers were essentially self-sufficient. In many cases habitation had a seasonal, or even nomadic, pattern.

It was the agricultural revolution which led to a more residential life pattern. Agriculture allowed an area to support up to a 50 times larger population. Now many villages developed. Our first preserved houses stem from the iron age, about 600 AD, and farms are known from the Viking age, 700 – 1050 AD. The fields were cultivated and the cattle were found in the immediate vicinity of the farms. Villages and farms continued to be the dominating form of habitation up to our century.

The first towns in northern Europe, places for trade and commerce, with a few thousand inhabitants, emerged in the 9th century together with the Viking trade. Hedeby at the German-Danish border, Polotsk in Belarus, Novgorod in Russia and Birka west of present Stockholm were such early centres of trade.

The first major city expansion in Europe occurred during the 12th and the 13th centuries. The medieval cities, surrounded by a rampart, a city wall, developed as strongholds in the process of nation building. These cities were centres of power for the surrounding land and they controlled trade in the region. Lübeck, Kalmar, Visby, Tallinn, Vilnius, Gdansk, and Krakow are some of these medieval cities.

In the early 19th century still only some 3% of the population in Europe lived in cities. It was now that industrialisation, which required centralisation of resources, became the driving force for a new wave of urbanization. The fast increasing population was absorbed by the growing cities and the need for work-

ers in factories. At the same time the fruits of industrialization, such as transport technologies – the railway and thereafter the car – and energy, in particular electricity, allowed cities to grow in size. With the development of railroads, industrial cities were established also inland. Agriculture, forestry and fishery on the contrary, required a shrinking part of the population and many young people left farms, forests and the sea to find their future in the growing cities.

Another strong driver for urbanization was population growth. During the 19th century and up to the First World War, a growing part of the population couldn't find life support and therefore emigrated to the Americas, e.g. to the United States. Globally the population roughly doubled during the 20th century – this time swallowed by the growing cities. From the 2000s the urban share of the population in the West has typically reached 85% while in the East just above 70%.

The last wave of urbanization in Europe occurred from the 1950ies to the 1970ies. Cities grew through suburbanization, in parallel with depopulation of the country side. Large areas for housing in multi-storied apartment buildings were built in the outskirts of cities at the same time as city centres were adapted or rebuilt in a rather drastic way to allow for car traffic. Since the late 1970ies the pace of urbanization has steadily abated, while in the early 2000 it seems to have increased again and is expected to reach 85%. Now we see that remote smaller towns and communities are depopulated while larger cities become even larger. An opposite weaker sub-trend is *re-ruralisation* – when families move to the surrounding countryside to find primary production jobs and a new lifestyle.

For the world as a whole, currently the largest wave of urban growth in human history is taking place particularly in the developing countries. Since 2008, more than half of the world's population – 3.5 billion people – live in towns and cities. By 2030 the projections are 5 billion people in cities, mostly in Africa and Asia (UN Habitat, 2007).

6.3 Primary drivers and dark clouds of urbanisation

The first urban structures were built as market places for food and commodities, trade and labour, business, and communication. Functionally the first cities were *densely populated* settlements and legally they became organizational entities with exclusive *rights*. Socio-politically they got the preconditions for the establishment of a military protected ruling class, living on the primary production *surplus*, created by the farmers outside and the craftsmen inside the fortified towns. The densely populated towns, eventually nurtured emergent cultural systems and art. Even today people and business move to cities to find jobs, trading

partners and housing. And both the traditional and the new sustainable city with its mixed-use, short-distance, walkable structures – could save time, money and resources for travel and transport, service and cultural experiences. Living in cities also permitted individuals and families to take advantage of its human diversity, excellence in art, traditions, the magic of the city, sports and education and of specialized market commodities.

Through an efficient, egalitarian and democratic governance, cities may also deliver broad education to all its inhabitants, an inclusive participation in the development of communities, a high quality health care and other public and commercial services for all citizens and a versatile transit system. Inside the cities, commodities, convenience and culture may be exchanged more efficiently than in sparsely populated areas simply because of scale and proximity. If this is the positive vision of the city, the reality in the world cities is however a growing slum formation, social degradation, violence, drug abuse, poor and unhealthy housing, decreasing job opportunities, car-invaded streets or long-distance uncomfortable travel to work.

The *suburban* problems typically include segregation, high unemployment and social unrest. The intrinsic drawbacks in *all modern urban areas* are also always a relative deficit of nature, clean air, healthy environments, ecosystem services and basic life support with energy, water, food and matter. Modern urbanization has resulted in deepening social polarization. This may be seen as the price for concentration and economic efficiency of manufacture – social polarization, constantly reproduced in the most developed countries, between backward and advanced areas, between the central areas of cities and suburbs; occurrence of adverse ecological conditions and thereof deterioration of a condition of health of the urban population, first of all of poor people.

In summary we may say that urbanization is caused by scientific and technical developments, changes in the structure of productive forces and character of work, deepening of the interdependence between many kinds of activities, as well as development of information and communications. Features of urbanization include:

- remaining social structures and groups of the population, division of labour which fix the population size where they live and the integration of rural and urban and shrinking socio-economic functions of villages.
- the activation of a social-spatial communication system which cause the complex system of cities and towns with a high concentration of cultural activities – science, culture, information, – and management, an increase of their role in a national economy.
- a polarization of regional economic planning and, as a consequence, social development inside the countries.

Presently the share of urban population in industrial western states, e.g. Great Britain, Belgium, Netherlands, Denmark and Germany, seems to stabilise around 80-85%. In metropolitan agglomerations of USA, Great Britain, Australia, France, Germany and Japan we see an outflow of the population from the centre of agglomeration to their external zones.

We also see a change of ethnic structure of cities owing to incessant by migration from developing world, and a high birth rate in families of migrants, considerably reducing the share of the "title" population of cities and the accommodation of new workplaces in external zones of agglomerations and beyond.

Urbanization thus, as a socio-economic process, takes two forms: *Hyper-urbanization*, consisting in formation of zones of uncontrollable development of urban settlements and overload of the natural landscape (the ecological balance is broken); and *False urbanization*, inherent to less developed countries, when there is "pushing out" of the population from village areas because of relative agrarian overpopulation. In Uzbekistan hyper-urbanization dominates.

Urbanization promotes an increase of productivity of work and allows us to better solve many social problems of society. This is the positive side. The darker negative sides of urbanization are seen when it is uncontrolled and the accepted measures do not provide sufficient influence.

6.4 Sub-urbanization, Agglomerations, conurbations and megapolisies

In the modern world the intensive process of formation of the new forms urban proceeds with agglomerations, conurbation, megalopolises, and urban regions.

Agglomeration is congestion of the occupied settlements incorporated in one whole intensive economic, labour and welfare connections. It is formed around of large cities, and also in densely settled industrial areas. So in Russia in the beginning of XXI century has developed about 140 big city agglomerates. There lives 2/3 of the population of the country, concentrated are 2/3 industrial and 90% of scientific potential of Russia.

Conurbation includes several growing together or closely developing agglomerations (as a rule 3-5) with the rather advanced largest cities. For example, in Japan there are 13 conurbations, including Tokyo, consisting from 7 agglomerations (27,6 million people).

Megapolis is the hierarchical on complexity and scales system of settlements consisting of the large number conurbations and agglomerations. Megapolises have appeared in the mid XX century. In a terminology of UN megapolis is settlements with the population not less than 5 million inhabitants. Thus 2/3 of ter-

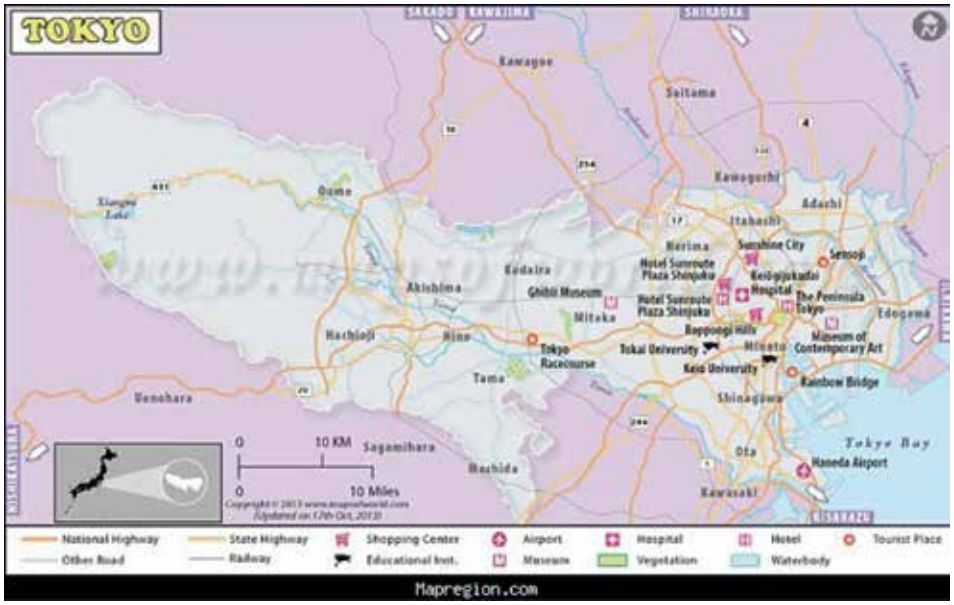

Figure 6.3 Megapolis. The larger Tokyo map (from 2007. http://mapregion.com/tokyo-map.html). The 23 wards of Tokyo in 2013 claimed a population of 9.05 million, but the metropolis had a population of 13,282,271. The greater Tokyo metropolitan area, which is spread over 3 prefectures, is even much larger with a population that's estimated at close to 35 million. That means the greater Tokyo area is home to 25% of Japan's population, and it's the most populous metropolitan area in the world. (http://worldpopulationreview.com/world-cities/tokyo-population/)

ritory of mega polis can be not built up. So, megapolis Tokaydo consists from Tokyo, Nagoya and Osaka conurbations by extent about 800 km along coast. The interstate settlements, for example mega polis of Great lakes (USA – Canada) or Donetsk-Rostov system of agglomerations (Russia – Ukraine) are migt be megapolises. In Russia it is possible to name as megapolis the Moskow-Nizhniy Novgorod area of settlement.

An *urban region*, which is formed by a net of megapolisies, is considered as even more complex, large-scale and is territorial by extensive system of settlement. To appearing urban regions we can include London – Paris-Rur, Atlantic coast of Northern America, etc. The basis for allocation of similar systems are the cities with a population of more than 100,000 inhabitants. Larger cities with a population of more than 1 million people are becoming more numerous. In 1900 there were only 10 of these while today there is more than 400 such cities. Cities with a million-sized population develop in agglomerates and promote creation

of more complex settlement and town-planning systems – conurbations, megapolisies and super large settlements – urban regions.

Sub urbanization (fast growth of a suburban zone around of the large cities), which first attributes have appeared even before the Second world war, has touched first of all rich part of population and it was in the form of their escape from social problems of the large city.

The urban process in USSR was connected to fast concentration of manufacture in large cities, creation of new numerous cities in areas of new development and according to moving of huge parts of the population from village to city and its high concentration in large urban settlements.

6.5 Urbanisation in Uzbekistan

In modern Uzbekistan the urban process is connected to a number contradictions, which government and the society, not unsuccessfully, tries to direct to a better side. The tasks of the transition to urban life are mainly solved: there is a new municipal governing structure, a system of state authority is generated, the structural transformation of the economy to market economy works, and a civil society is successfully growing. There is an already ongoing process for steady economic growth.

The urban process, however, forces us to consider two long-term aspects of development: the growth of the population, and, secondly, increasing deficiency of water and land resources.

The population of Uzbekistan steadily grows. Some researchers estimate the population of Uzbekistan to be from 30 million up to 50 million by 2050 [2]. The estimates of the Centre of Economic Research (reference) will be 29,3-33,4 million, of which 22,2 million will be urban, by 2025 and about 44 million by 2050.

Not less intense the situation are deficiency of water and land resources, especially as there is a lack of land suitable for agriculture. According to statistics each hectare irrigated land can provide for 8,2 people, a figure high even in an international comparison. However during the last 25 years the irrigating area per person was reduced from 0,22 to 0,12 ha, as population is increasing much faster than the area of irrigating lands.

Under the cautious forecasts of the experts Center of Economic Researches by 2025, assuming preservation of the present areas of farmland and an increased productivity of labour, the number engaged in agricultural sector will be reduced from present 3 million to 2 million people. In intermediate term Uzbekistan may meet a problem of increased unemployment in the countryside. This will influ-

ence negatively incomes and the standard of living of village families and in the long-term result in social decline. The superfluous labour in the villages, in search of jobs, naturally, will then be pulled to the cities, with their industries with demand for both high and low qualification workers. The problem of unemployment on the countryside is thus partially solved by migration to cities. 30% of the population of Uzbekistan is ready to set-off to find a living, a very high level of migration. Annually from 15 up to 40% of all families, have one or more family member who is a labour migrant.

But there are not many cities with expanding industries in Uzbekistan. The majority of small and average size cities have difficulties in the transition to market economy. The number of industrial enterprises decreased, and with them work opportunities and labour market. A special difficult situation are seen in two category of cities – district centres, for which a decline is connected to the disorder of agriculture in the surrounding areas, and mono-functional industrial centres largely dependent on a single working place such as a coal mine. Such cities are very economically dependent. The recession of manufacture, especially cessation of work of such enterprises, leads to increased unemployment and a growing number workers without salary, and also undermines the urban budget as tax receipts decrease. It is serious since about 13% of the inhabitants of the Republic or 38% of all urban population live in such small and average sized cites with up to 70 thousand inhabitants. The population of the most part of cities of the Republic is from 12 up to 30 thousand inhabitants. There are no large industrial cities, which play a major role in modernization, and constitute centres of migration flows.

The labour migration represents natural and objective process positively influencing development of industrial centres. Creation of the new enterprises and extending construction always feel the need in a labour force. As any other process, it is also possible to regulate the migration. The accepted measures on perfection of institute of a registration hopefully will be the effective mechanism of regulation of migration in urban processes.

It is necessary to emphasize, that migration of the village population is in many respects an irreversible process and does not give in to suppression. Aspiration of the peasants to move to the cities is quite understandable as the conditions of living and work in cities are better.

Internal migrants search for jobs first of all in Tashkent and cities included in an orbit of the large Tashkent agglomerate – Almaliq, Angren, Akhangaran, Yangiuyl, Chirchik. That is Uzbekistan is a country with one large megalopolis, consisting of plenty of small cities and absence of large cities by the size from

Box 6.1 Urbanisation in Uzbekistan

Uzbekistan is industrial-agrarian the country. The population of Uzbekistan as for January 1, 2015 was 31,255,000, an increase of 532,700 or 1,7% from 2014. Uzbekistan had in 2010-2014 a high population increase and, as a consequence, a large part of the population is children and youth. In 2013 the population increase was 2,2%. However the birth rate is quickly reduced and the high share of children and youth is decreasing while elderly is increasing.

The urban population by the beginning of 2015 was 15,746,800 or 50,8%, and the village population 15,278,700 (49,2%). In Uzbekistan's 120 cities and 115 towns lives 51% of all population. In the table 6.1 the data on a population of the largest cities of Uzbekistan are given.

Table 6.1 **Number of the inhabitants in the largest cities of Uzbekistan** (Add source:

No	City	Number of the inhabitants, thousands
1	Tashkent	2 352,9
2	Samarkand	509,0
3	Namangan	475.5
4	Andijan	403,9
5	Nukus	295,2
6	Bukhara	275,2
7	Fergana	264,9
8	Karshi	254,6
9	Kokand	233.5
10	Margilan	215,4
11	Angren	175,4
12	Djizak	163,2
13	Chirchik	149,4
14	Urgench	137,3
15	Termez	136,2
16	Navoiy	134,1
17	Almalik	121,1
18	Shakhrisabz	100,3

Source:

500 thousand inhabitants and higher. In Uzbekistan there are deficiency of cities, especially large cities, capable to become the regional leaders. All this can result in gradual loss of importance of cities, as centres of development, attraction of surpluses of a manpower from village, and at the end can have an effect on prospects of modernization of Uzbekistan.

Figure 6.4. Houten bicycle town. This little suburb to Utrecht, the Netherlands, has been optimized for bicycles, which has led to that 80% of all (person kilometres) internal mobility is with bikes and the cars are lead around the community. Remarkable features of the town is its nuanced soundscape, few accidents and a high air quality. Photo: Varis Bokalders.

To solve the unemployment problem in villages the state supports programs of development of village including measures on creation of small industrial manufactures for the processing of agricultural products, development of animal industries, expansion of household work, development in the area of services etc.

6.6 The principles of sustainable habitation

What is a good city? Cities were during most of its history environmental disasters, with air pollution, contaminated waters and epidemics. During industrialization, life expectancy in cities was much lower than in the countryside. The post-industrial era featured an improved sanitation, hygiene and housing standards but was instead followed by a new plague: excessive motorism again fouling the air, polluting the waters and contributing to accidents and an increased crime rate.

In city planning all through history – there has been a struggle for understanding and implementing a functional and attractive urban environment for its citizens creating wellbeing, security and support. For its life-support, all dense human habitats must handle challenges of energy-, water- and food provision for its inhabitants as well as an efficient waste and waste-water management. For any urban human habitat, also its wealth distribution, accessibility for citizens to public transport and other public and private services, culture, parks and waterfronts are important issues. The social aspects of a city are equally important, such as high quality relations between citizens, good education, strong local communities, a sense of security and what classic urbanist Jane Jacobs referred to as a "caring citizenship" (Jacobs, 1961). If the ambition is to include *all the citizens' needs and demands* – also mechanisms for public participation are crucial for creating the good city.

Cities are today clearly not in line with the goals of sustainable development. For cities to become sustainable, they need to develop a strong awareness of the ways they affect the world. They must create their own control systems, acting like thermostats, continually monitoring their global and local environmental impacts. Responding to this feedback, real 'ecocities' would take all the necessary measures for global and local ecological rebuilding into their grasp. They would reorganize their transport, energy, food, and sewage systems for maximum efficiency and minimal environmental impact. Ecocities would acknowledge the limits of the Earth's carrying capacity by nourishing the well-being of their local hinterland. Global dependence would be replaced by more sustainable local living.

The strategies for ecologically sound urban development are different in the developed and in the developing world. After several decades of grappling with urbanization in the developing world, there is now a broad measure of agreement on what it takes to manage cities successfully. Six crucial elements can be identified (Buckley 1996):

- *decentralization*. Local municipal authorities should be given the power to govern cities, with full support from central government.
- *community participation*. Local democracy and collective participation are essential to good city management.
- *economic opportunity*. Strong effort should be made to stimulate the local economy so as to create jobs in both formal and informal sectors, and thus reduce poverty.
- *infrastructure*. Public-private partnership should be used to put in place efficient systems for roads, water, energy supply, public transport and waste management.
- *land rights.* These should encourage private investments, while protecting the environment, security and public health.
- *municipal finances*. These should be transparent, with local property and land taxes and coherent.

In an urban context sustainability means a wide range of things. Some of these are:

- resource budgeting
- energy conservation and efficiency, renewable energy technology
- long-lasting built structures and reuse of old ones
- proximity between home and work and efficient public transport systems
- waste reduction and recycling, organic waste composting, and a circular metabolism.

6.7 Conditions for sustainable urbanisation – urban-rural interaction

Today it is clear that the fossil fuelled *urbanization* is one of the main drivers of global change. Also a massive depopulation and decomposition of *local rural functions* and *livelihoods* – and the effects of the modern industrialized agriculture – adds to severe planetary reverberations: more frequent droughts, floods, changes in atmospheric concentrations of gases and greater variations in temperature and moisture across the planet. A common denominator for this development is an ongoing *separation of urban and rural* development. This separation is partly geographical and physical – as a quite recent breach in the place-bound co-evolution of urban and rural systems. The separation is also partly functional and conceptual as our civilization has now lost its overview, control and understanding of resilient life support (food, fuel and fibre) and its relation to present human culture.

The full separation of urban and rural has mainly been a post-modern invention of the last 70 years – through globalized markets for labour, food, fibres, fuel and minerals. And even more: this current time era with food specialization and extreme international trade now may have reached its peak. And the necessary *sustainability transition* in our current civilisation – fuelled by the climate-, environmental- and resource crises of the globe – today features a modern re-integration of urban and rural structures.

The two approaches to making the cities more sustainable are firstly improved integration between urban and rural and secondly greening the cities themselves. In an envisioned more robust future human culture, *the cities* will probably not be exclusively urban, but also encompass rural functions and a high consciousness about its life-support systems. For new rural human habitats – reformed for global survival – *the countryside* will most possibly link more efficiently to urban communication, urban transport systems and urban culture. Such partly new human habitats may be called *Resilient Citylands*.

During its 250-year history probably starting with Coalbrookdale in Western England – newly industrialized cities received its basic life support from its embedding productive fields, forests and waters. The industry cities grew initially along railway settlements as star rays into the surrounding landscape. In the opposite direction, fibre and energy yielding forest-, productive farmland- and fish-rich water landscapes reached inward towards the centre of cities in the form of green-blue wedges. The urban and rural interlocked structures were *co-evolving* all the way until the beginning of the 1930-ies in central Europe and until the 1950-ies in the Nordic countries. Already in the beginning of the 20-th century attempts were made in England to extract the magic, the labour markets and the cultural excellence out of the unhealthy, coal smoke-stricken cities and com-

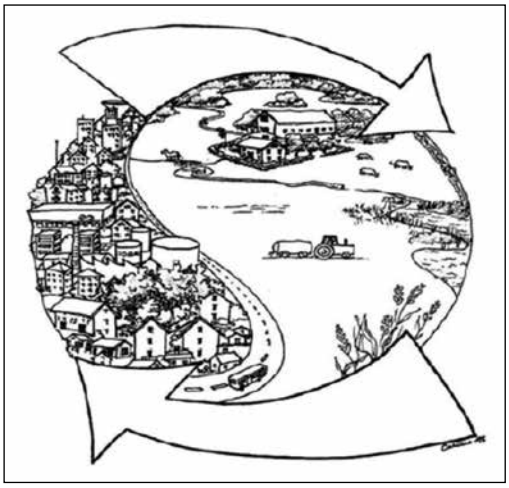

Figure 6.5. Urban-rural interdependency. Future sustainable cities will in a range of scales co-evolve with its local and regional hinterlands. Illustration: Carina Lindkvist.

bine it with the healthy nature outside the city in Ebenezer Howard's *garden city movement* (Howard, 1902). Even in our own time, in the most radical examples of emancipation of nature from the urban fabric – the American sub-division – was paradoxically created as an effect of human private cravings for *both* the city *and* nature (Mumford, 1961). As the continuous villa-mats spread out throughout the private motorism-fuelled and land consuming suburbs – eradicating any natural or cultivated landscapes – wealthy citizens a few decades later desperately sought the new frontier and started to settle in *edge-cities*, in the new urban fringe between wilderness and urban structures.

The practice of intertwining built and green/blue structures is now gradually degraded in Nordic cities but in our time this is instead developing in central European cities: Stockholm's *green wedges* and Copenhagen's *green finger plan* is now inspiring Paris, London, Berlin, Rome and Barcelona to find a new integration between urban and rural: For the *health* and *recreation* of its citizens; for improving the *ecosystems services* and even increasingly for slowly expanding the *primary production* in, near and over the free land areas surrounding the city.

6.8 The emergence of ecocities

Major approaches to achieve urban sustainability has for the past decade been to address its energy efficiency, the form of the city and the organization of its mobility. The simple hypothesis is that if the city is *densified* – there will theoretically be shorter distances between dwelling and various functions.

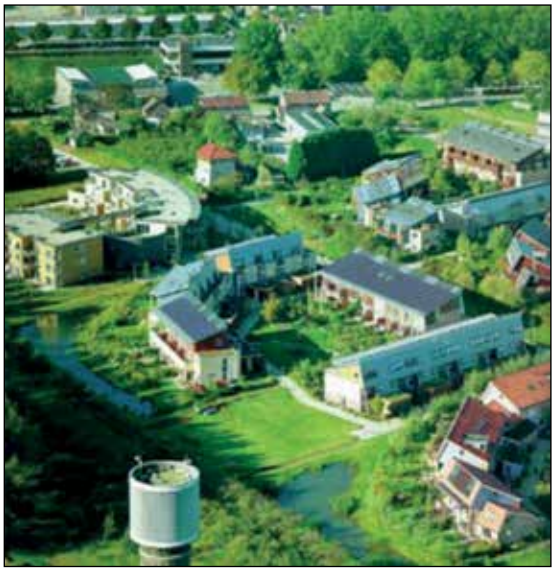

Figure 6.6. Culemborg cityland outside Utrecht. This Dutch best practice community has succeded in intertwining blue and green structures in different scales for primary production, ecosystem services and recreation. This community has also developed a high diversity of small enterprises in the area. Photo: Courtesy of Varis Bokalders.

Initially the critics identified the *modernistic project* as the main problem and the *compact city* as the main remedy for creating the sustainable city. This is – however – nuanced in more advanced ecocity architecture and planning where advantages and drawbacks of *both* models are discussed (Ibid). In times of fast expansion and growth of cities, waves of unreflected densification are typically the universal strategy to cope with a growing population, with a growing resource turnover and with the need for a higher capacity of the city machinery.

A series of modernistic waves can be distinguished: e.g. within the first industrialization wave during the 19th century; at the expansion of suburbia and the car-society after 2nd World War – and today at the turn of the new millennium when *densification* is an economically motivated strategy for the transformation into resource efficient cities. *The Ecocity projects* (2003-2008) in seven EU cities from Northern Tampere in Finland to Southern Barcelona in Spain have all emphasized that dense is better for the environment.

But the compact European city also exhibits "qualified density", a "balance of centralization and decentralization" and presupposes that apart from houses – also green areas, squares, commercial plazas and other public spaces are included in the densification strategy.

Therefore, important part-goals for the formation of ecocities are also *short distances, mixed-use planning, integration of infrasystems* and a city for *all in-*

habitants (Ibid). On the move in international ecocity planning is also the Gehl Architects call for *cities for people*, with human scale and human psychologically adapted streets and functions as key drivers for the new cities. And the potentially most radical transformation is from the *car dependent hardscape city* to the *walkable green city*. This transformation is currently underway in a range of European cities: e.g. in southern Germany, in Holland and Denmark.

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Chapter 7
Spatial Planning and Urban Development

7.1 The aim and origins of spatial planning

Spatial planning refers in short to "the methods used by the public sector to influence the distribution of resources and activities in spaces of various types and scales". Spatial planning includes all levels of land use planning, that is urban and rural planning, regional planning, environmental planning, national spatial plans, and planning on international levels.

There are numerous definitions of spatial planning. One of the earliest comes from the *European Regional/ Spatial Planning Charter* (often called the 'Torremolinos Charter'), adopted in 1983 by the European Conference of Ministers responsible for Regional Planning (CEMAT). It reads

Regional/spatial planning gives geographical expression to the economic, social, cultural and ecological policies of society. It is at the same time a scientific discipline, an administrative technique and a policy developed as an interdisciplinary and comprehensive approach directed towards a balanced regional development and the physical organisation of space according to an overall strategy.

This definition sets spatial planning in a broad and interdisciplinary context. Spatial planning challenges in this way the understanding of planning focusing merely on land-use planning and on blueprints. Indeed, spatial planning includes strategy building and is closely intertwined with regional and environmental policies. Even the term European spatial planning is ambiguous and probably best understood as territorial policy-making on European level.

Planning and management is one important instrument for implementing sustainable development. There are high demands and expectations on spatial planning to support the society with physical structures to make it possible for people to act and live in a more sustainable way. During the last decades there has been a growing awareness and international agreements at both UN and EU level for the protection of the environment. In addition the predictions of climate change requires activities to decrease environmental burden and at the same time adapt the physical environment to the effects of climate change. The environmental and

climate issues were first in the 1970-1980's defended mainly by environmental NGOs. Today these issues have entered into the official agendas, regulations and rules. The concept of sustainable development is often included in all official planning documents and it is uncomplicated to find cohesion at the general visionary level. On the detailed planning level, when the visions are to be concretised, it is more challenging to achieve consensus between actors with a manifold of sector interests and values.

7.2 Planning on municipal and local level

The local level is most often the key level for planning of physical structures. The planning area can be comprehensive for the entire local authority territory, as for example is obligatory in Sweden. It can also cover the entire urban territory for a city, a part of a city, a housing area or just a block. It is a local authority task to plan for the use of land and water. It can be made by a *comprehensive plan,* a general document for a larger territory. It relies on, and sometimes is requested by, the legislation of the country. A comprehensive plan is a plan for the entire area for which the local authority (most often the local authority, but in some countries regional authorities or even regional offices of state authorities) is responsible. It should identify future land use regarding e.g. building sites, transport infrastructure, agriculture, and forestry. The comprehensive plan should have a long term perspective. In most countries the comprehensive plan, in contrast to the detailed plan, is not considered law and thus is rather a policy document.

A *detailed plan* is binding document for detail land use. The detailed plan identifies the suitability of a site for development and give the exact location and character and design of buildings, infrastructure etc. The detail plan gives the formal rights and responsibilities for authorities and developers of a smaller territory. This may concern continuous development or a new single individual building. The detailed plan is accompanied by permits for the entrepreneurs to start building. The detailed plan is considered to be national and local regulation.

Detailed plans and projects are worked out only when there are public or private actors interested to make future changes in urban or rural areas. There must be enough public or private interests and funding as a driving force for the planning. That is to say that everything that happens in the future cannot be foreseen and planned in advance. The role of legislation and protection planning is one way to defend public values and common interests when private and individual interests plan for new developments.

7.3 Planning processes

Planning practice deals traditionally with how to distribute the use or protection of land and water areas. A main part of planning concerns localisation and shape of new or regenerated built up areas or infrastructure. Planning also deals with protection of valuable areas or resources as example heritage and natural environments. In later decades to these physical issues are in many cases added economic and social issues. Plans are based on, and adopted by, political bodies and worked out by professional planners. Knowledge and interests from other actors, as stakeholders and citizens, are involved in democratic planning processes.

Basic data for the planning processes includes a prognosis on existing conditions and development of areas regarding e.g. the physical situation, buildings, vegetation, infrastructure, demography, mobility, and economic activities together with estimations of the future development.

- A rational planning process starts with
- collecting *basic planning data*,
- conducting a *planning programme with a vision*, and
- formulating *the planning goals*.

Next step is to find alternative proposals of the future development of the planning goals based on the background and interests of the actors and stakeholders. The planning process is a way to clear out different interests and values between the actors and give stakeholders and interest groups opportunities to influence, criticize or at least receive information on the future plans.

The drivers for planning are firstly public actors. These have the task to distribute land for suitable purposes, establish comprehensive built up and infrastructures, such as communications networks, green structures, schools, children and elderly care, wastewater treatment plants, or to establish protected territories. Other drivers are often public or private actors concerned and interested in various development aspects or projects. These may be buildings, housing areas, commercial centres, energy projects, industries etc. The planner needs to identify problems, and establish a platform to address conflicts of interests between actors and stakeholders, and at best allow for exchange of ideas how to address such conflicts.

In the planning process, planners are able to determine a wide range of interconnecting issues that affect an area. Each step of the process can be seen as interdependent, and may be reiterated as needed. The steps are executed in order or in parallel as best fit the purpose. While spatial planning is complex, in practice it never follows a technical rational procedure from goals to results. The planning

practice processes can then be described as a spiral where each round takes in new basic data and knowledge to reach a higher level of the planning outcome.

The final plan consists of a written document with objectives, visions and description of the plan together with attached maps and other illustrations as needed. Maps are normally available in computer format, a so-called Geographical Information System, GIS, (or on urban level, Local Information System, LIS, with very high resolution) or AutoCad. A GIS map consists of several, even a large number, of layers, each with a special kind of information, such as roads, buildings, water networks etc. Statistics of different properties of the area, which have been collected in preparatory steps, may be added to the GIS.

The planning team must first address the issues and context at stake. (For a comprehensive plan, as mentioned, this is a political issue.) These may be requests for new habitation, industrial production, areas asked to be set aside for nature protection, energy production, etc. If habitation is expanded, social services need to be included, such as schools, health services, areas for commercial services etc, and access to the area through roads. Requests for developments from private and public interests are often part and drivers the process. The local authority may have policy goals, scenarios or "visions" for the long-term development. The visioning process of a community will be discussed further below.

Data for the area to be planned typically describe environment (e.g. air pollution), traffic development, demographic trends, economic developments, social conditions, etc, but of course data should be collected regarding any relevant topic in the planning process. These data may be used as indicators as is described below. The information gathered and the stated goals are used to identify trends and make forecasts and write a first planning proposal. A typical comprehensive plan begins by giving a brief background of the current and future conditions. Following the background information are the community goals and the way in which these goals may be implemented into the community. Comprehensive plans may also contain separate sections for important issues such as transportation, housing, culture heritage, outdoor recreation etc.

Next step is to propose actions to implement the plan, projects or an entire program for each of a number of selected issues. In some areas alternative plans may be drafted, especially with regard to budget options. The programs and plans should during the entire process be communicated with other actors, stakeholders and interest groups. This may be done through exhibitions, published reports, hearings etc. The plan may as well be distributed to the most relevant stakeholders to give them opportunity to comment on the proposed plan

Figure 7.1. Gaming as way to do planning. In 2009 a group of farmers and other stakeholders in western Poland took part in a game organised by teachers and students of AGH University in Krakow as an innovative way to evaluate different way to develop the watershed. Photo: Piotr Magnuszewski.

7.4 Urban and rural planning

Planning work typically always addresses economic development and demographic trends, although these two aspects of development may be the least easy to actually plan. Aspects which may be planned in detail includes nature protection, infrastructure and buildings. In between these extremes there is e.g. school development, which is also very much "planneable", as schools have to be made available for new groups of children. In the rural context agriculture, forestry and nature protection are among the most important to address in planning work. Still agriculture is much dependent on policy decisions.

The urban areas are growing all over the globe hosting approximately 50% of the population. Urban areas are complex systems of buildings integrated with infrastructure. That is the main reason why most planning activities are made within the urban areas. Urban – that is city and town – planning is an integration of the disciplines of land use planning and transport planning, to explore a very wide range of aspects of the built and social environments of urbanizations. Urban planning is a synergy of the disciplines of urban planning, architecture and landscape architecture. Another key role of urban planning is urban renewal, and re-generation of inner cities with changing use of buildings and areas, as for example new development of brownfields.

The quality of public spaces, urban man-made landscapes and architecture and urban development plays an important role in the living conditions of the urban populations. These so-called soft locational factors are important for attracting knowledge industry, businesses, a qualified and creative workforce, and

for tourism. Therefore, the interaction of architecture, infrastructure planning and urban planning must be increased in order to create attractive, user-oriented public spaces and achieve a high standard in terms of the living environment. Urban development is the sum of all the cultural, economic, technological, social and ecological aspects influencing the quality and process of planning and construction. Urban development and regeneration include preservation of architectural heritage. Historical buildings, public spaces, green structure and their urban and architectural value are of great importance.

The urban green structure includes parks, gardens, avenue trees, wild green nature, and cemeteries. Nature and other green areas in a town or village are important for its social well-being, for its ecology, air and water, as well as for making a city attractive. Green areas in cities and towns are connected to each other and generate entireness – a green structure – independent of ownership or maintenance. They are also important parts of a city's building history, identity and character. A green structure function as lungs and kidneys for the urban areas while it contributes to urban biodiversity, preserves a good local climate, good air environment and provide space for ecological ways to clean storm water. Green areas also give possibilities for leisure and various out-door activities, as it provide informal meeting places, arenas for concerts, theatre, exhibitions, manifestations etc.

7.5 Urban policies of Uzbekistan

The effective development of a city as an industrial centre, requires an advanced infrastructure. The city need first of all a stable supply of water, gas and electricity, management of wastewater and efficient urban transport. Also it is necessary to note, that the migration creates additional loading on all municipal economy.

All economic reforms in Uzbekistan for twenty-four years of independence, and in particular for last ten years, are based on strategy of transition from agrarian-industrial to industrial-agrarian state. The Program of the accelerated modernization consisting in stimulation industrial-innovation development, increase of export opportunities and reduction of import, growth of the incomes and increase of well-being of the population. The industrial development will raise demand for a labour, and because of this will increase internal migration in cities. Taking into account these factors, the Program is closely related with urban processes in the country.

Thus, the development of cities, as centres of industrialization, on the basis of consolidation of opportunities of the state, business and science have become

an important part of the politics of economic and political modernization of the country, and also social transformation of the society.

Problems of socio economic *development* of Uzbekistan are in many respects related with tasks in the *General circuit of moving in the territory of the Republic of Uzbekistan*, concretizing and deepening them. This *General circuit of moving* is developed in the performance of the order of government of the Republic with attraction of the interested ministries and departments, and the active participation of experts. It constitutes the basic document combining a multitude of information on the basis of which a deeper analysis of all systems of life-support is made and the practical recommendations for realization of state politics of moving and urban on long-term prospect are given.

The effective use of the *General circuit of moving* requires that the results are supported by the regional and urban long-term strategy/programs of socio economic development.

Recently in practice of development of city-planning documents the system of interrelated of strategic socio economic planning of regions and urban development with long-term forecasting by horizon reflecting a special-purpose designation of concrete territory is applied. Therefore in the general plans of recent years the strategy of long-term development of cities is reflected, the conducting branches of manufactures connected to specificity of regions are shown. This situation is aggravated also by that under the order of Government of the country the general plans of all cities and urban settlements are developed.

The realization of purposeful urban strategy of the country assumes perfection of the existing approaches to management of cities and planning by urban development, at which the system of priorities of development is precisely reflected in the technical project on designing and to be defined by the documents of a strategic type.

The used strategy of support of the regions – leaders and activation of development of their industrial potential within the framework of urban politics and industrial-innovation development, pursues the purpose of transformation them in leaders of development of all country, so also they would lead less developed areas. It will allow appreciably to prevent differentiation of territorial development of the country and to ensure its macroeconomic stability.

Besides applied is the strategy, at which alongside with realization of the concept of cities as “poles of growth” (or “frame units” – according to *General circuit of moving*) and regions – leaders, the program of stimulation of development of small cities and urban settlements is necessary, especially in those places, where there is a basic migration of the village population. In these settlements la-

bour-consuming manufacture should be develop with the purpose of maintenance of workplaces for the village inhabitants.

7.6 The city-planning code of Uzbekistan

Urban planning and development in Uzbekistan is adjusted on the basis of the city-planning code of the Republic of Uzbekistan, which is by the Law of Republic of Uzbekistan authorized 04.04.2002 353-II [3]. In this code the participants are determined and the procedures of city-planning are considered. The code contains chapters devoted to objects and the subjects of town-planning activities, powers of state bodies in the field of town-planning, and structures of the town-planning documentation. In the code the information about state town-planning cadastre, the development of the territory of the Republic and use of territories of the occupied items and suburban zones are defined.

The code differentiates the powers of the different bodies of state authority of the Republic, and the bodies of local self-management in the field of town-planning, including the accomplishment of territory of the occupied places.

The powers of the bodies of state authorities in the field of town-planning concern:

- Preparation and statement of the documents of territorial planning;
- Documentation and plan of the territories for accommodation of objects of capital construction of state importance in cases stipulated by the Code;
- Establishment of the procedure of state building supervision and organization of scientific – methodical maintenance of such supervision;
- Realization of state building supervision in cases stipulated by the Code; The powers of bodies of state authority of the subjects of Republic of Uzbekistan in the field of town-planning activity concern:
- Preparation and statement of the documents of territorial planning of Republic Karakalpakstan and viloyats;
- Documentation and plan of the territories for accommodation of objects of capital construction of regional importance in cases stipulated by the Code;
- The regional specifications of town-planning design etc. The powers of bodies of local self-management of settlements in the field of town-planning activity concern:
- Preparation and statement of the documents of territorial planning of settlements;
- Statement of the local specifications of town-planning designing of settlements;
- Statement of rules of land tenure and building of settlements;

- Statement prepared on the basis of the documents of territorial planning of settlements of the documentation on a lay-out of territory, except for cases stipulated by the Code;
- Distribution of the sanctions on construction, sanctions to input of objects in operation at realization of construction, reconstruction, overhaul of objects of capital construction located in territories of settlements etc.

Thus, the questions of a complex accomplishment are decided at all stages of town-planning and architectural – building designing and are realized in complete conformity with the developed projects. The basic ideas of a complex accomplishment are defined by the projects of a detailed lay-out of inhabited territories, and specific decisions, volumes, cost are in the projects of building of separate inhabited complexes. General principle of formation of inhabited territories is the maintenance of the maximal convenience to the population in satisfaction of its welfare and household needs at rational use of resources and urban grounds. This principle is realized by formation of inhabited complexes of a different territorial level.

Within the framework of the city-planning code the general plans are formed. A General plan is in a general sense a design document, on the basis of which is carried out a planning, building, reconstruction and other kinds of town-planning development of territories. The basic part of the general plan is a scale image received by a method of graphic imposing of the drawing of projected object on the topographical, engineer-topographical or photographic plan of territory. Thus the objects of design include the area with the separate architectural structure, and territory of the whole city or area.

The general plan is the scientifically proved perspective plan of development of city (with reference to old city – its reconstruction and further development) or any other settlement. According to the city-planning code of Uzbekistan is one of the basic documents of territorial planning.

Terms of realization of the general plan are stipulated in the special document – plan of realization of the general plan accepted not later than 3 months from the date of the statement appropriate genplan, and make, as a rule, about 20 years.

Any general plan contains the analytical block and block of the design offer. Each of them, in turn, includes graphic materials submitted as maps (circuits), and text part. Among the obligatory circuits in structure of genplan by the city-planning code are stipulated:

- the circuit of objects electro-, heat, gas- and water supply of the population in borders of city;
- the circuit of highways of general usage, bridges and other transport engineering structures in borders of the occupied items;
- the circuit of use of territory of municipal education with display of borders of grounds of various categories, other information on use of the appropriate territory;
- the circuit of borders of territories of objects of a cultural heritage;
- the circuit of borders of zones with the special conditions of use of territories;
- the circuit of borders of territories subject to risk of occurrence of extreme situations natural and technogenetic character;
- the circuit of borders of zones of negative influence of objects of capital construction of local importance in case of accommodation of such objects;
- the circuit of planned borders of functional zones with display of parameters of planned development of such zones;
- the circuits with display of zones of planned accommodation of objects of capital construction of local importance;
- maps (circuit) of planned borders of territories, the documentation on which lay-out is subject to development in the prime order;
- the circuit of existing and planned borders of grounds of an industry, power, transport, communication.

The general plans of cities and settlements in various countries are various under the name, structure, functions and legal status. The reconstruction, building and development of territories of a number of large cities conducts without any uniform document on planning and zoning of territory. As well as in many countries of West, general plan as the legal document carries recommendatory character, that is not a source of the town-planning right.

The intensive urban process in Uzbekistan is conducted with high birth rates and both high share of children and teenagers in structure of the population. The main urban reason is the industrialization of economy. The feature of urbanization in Uzbekistan is, that the growth of the urban population goes basically at the expense of large cities. The state politics since the first years of independence consists in wide and address support of the village population (giving land to village families for their own need, maintenance of high rates of construction of water networks on a village, gas supply of the villages). Due to structural transformations on a village the favourable conditions of development peasant and farms are created.

7.7 Sustainable development in planning and management

To plan for more sustainability of a city or a region is a complex issue. The processes can either be seen as a systematic process based on environmental scientific knowledge or a communicative process between actors and stakeholders involved in the planning. Here it will be treated as a systems approach to manage sustainability dimensions in planning processes or as a way to assess plans. Only few planning projects have been carried out systematically with regard to sustainable development.

An example of a national level project is the Japan for Sustainability (JFS) project, published in 2007. It was carried out over a two year period by a group of university researchers, interest organisations (NGO) and some companies. No authority, neither on state nor on local level, was part of the group. The report is interesting since all the typical stages are included and a result calculated. Sustainable development processes for municipalities, companies or other organisations have also been reported but most often with a less complete or systematic approach. Even if there is no scientifically established method of how to conduct a complete planning process using sustainability principles, there is enough experience, that one may safely say that a best practice has been established. Alan Atkisson's ISIS may be the best way tried out in several cities, companies and other organisations. ISIS stands for

Indicators Measurement and Assessment of Sustainability & Related Performance
Systems Understanding Linkages, Dynamics, and Leverage Points
Innovation Creating and Diffusing Change: Using a Cultural Systems Approach
Strategy Commitment to Integrated Implementation and Follow-Through

It is possible to describe most planning processes using a 6 (or 9 in some versions) step procedure, consisting of the following.

1 Agree on *what is sustainable development* (the concept) among those concerned. This phase should at best also include awareness of the importance of systems thinking and the awareness of limits, since these are fundamental for understanding sustainability.
2. Agree on a *framework* to be used to describe and work with the "system" (the city, area or society to be planned). There are several such frameworks; the classical – ecological, economic, and social – is seldom sufficient for a planning project.
3. Agree on a *vision* for the area in a future time, such as 20-50 years ahead.
4. Decide on a number of parameters to be followed, *indicators*, to measure and monitor sustainability.

5. Decide on which parts of the society or system to address, and in a process of innovation, find ways to improve these and *design a number of projects*.
6. *Run projects* often over a period of some 2-3 years. The whole process is then reiterated for continuous improvement.

The six steps may be carried out in a different order (e.g. some starts with the indicators). Additional steps not listed above include agreements, especially on the political level, but also with citizens. After the six steps the process and the results are evaluated. Most often this leads to a reconsideration of each step in the process including the definition of sustainability, the vision, the indicators and finally what to address to improve sustainability, that is, what projects to run in a following round.

7.8 Sustainable development in practice

To work in practice with sustainable development it is basic to

1. Understand systems in general
2. Understand sustainability in general
3. Distinguish between "development" and "growth" in goal-setting, that is, understand the physical limits of the system.

It is easy to find several hundred definitions of sustainability in the literature, all of which are somehow related to the situation in which they were developed. However a group which intends to work in a multi-year planning activity needs to develop their own understanding. The Brundtland Commission concern for next generation (intra-generational equity) is often included, and the inter-general equity (fair distribution of resources) also. It is also possible to have simple versions, such as "Create welfare within existing resources", but they tend to be less useful in practical work.

To increase sustainability of a region or a city one needs to know towards what goals one is heading. *Goals* should be realistic and possible to reach during the planning period. The goals are discussed and set up mostly in the planning process. *Prognosis* are quantitative predictions of probable future development. *Scenarios* are based on values and interpretations of a future development and a way to outline a future filled with a manifold of uncertainties.

Scenario technique is a way to create images of the future. A scenario is a systematic prescription of a future situation and of a possible development from the situation today forwards to the prescribed situation. Scenarios are often giving a

simplified image of the whole and of the connections between different sectors in the society, with contribution from many knowledge fields. To present various possibilities of development often alternative scenarios are worked out. Scenario technique is a method of forecasting.

Visioning is an important part of the process. The plan or the vision may be exhibited to the public and discussed broadly; the vision, just as a plan, does not have legal status but rather is a policy document. A vision is evaluated using a number of sustainability goals. Visions normally are restricted to a few areas of special interest for sustainability. A case is the city of Göteborg, the second largest city in Sweden, whose vision included five areas

1. Sun city (energy)
2. Urban structure (includes green areas)
3. Transport (traffic infrastructure, public transport)
4. Food (e.g. includes health and wellbeing)
5. Recycling (includes waste management)

The Global Community Initiative, GCI, have a long experience from visioning procedures. They always include the community as broadly as possible in the process, e.g. results available as the process continues, through exhibitions, in campaigns, or in festivities. Especially in an US context, where the local authorities are less strong than in Europe, it is important to have support from many stakeholders, including the private sector. The experience is that people often get enthusiastic about discussions on the long term future of their community, and that differences in opinions become less strong when it deals with a very long term perspective.

To work with sustainability management is to work with a system (the society and its land). For this purpose a good and useful systems description, called *framework*, is needed. The classical system description – ecological, social and economic aspects or dimensions – is much used but not so good for practical work, although it has been adopted by the business world as ”the triple bottom line”.

A more developed framework for sustainability includes Atkisson’s compass (See Figure 7.2.) with N (North) Nature (the ecological or environmental aspects) S (South) Society (the society part of the rather diffuse “social” aspect) E (East) Economy (the economic aspects) W (West) Wellbeing (the human part of the social aspect). The Compass makes the rather unclear “social” dimension a little less unclear.

Another frame was developed in the Baltic University Urban Forum project. In the project it was concluded that for local authorities sustainability is best made operational as resource management, and five resources were defined

Figure 7.2. The Sustainability Compass is a tool for orienting people to sustainability. The Compass helps you bring people together around a common understanding of sustainability, and a shared vision for getting there. It also helps you monitor progress along the way.
N is for all of our natural ecological systems, ecosystem health, nature conservation and resources.
E is for the human systems that convert nature's resources into food, shelter, ideas, technologies, industries, services, money and jobs.
S is for the institutions, organizations, cultures, norms, and social conditions that make up our collective life as human beings.
W is for our individual health, happiness, and quality of life. .

1. Material resources – all material flows in the municipality, water, energy and waste
2. Urban space resources – all area to be planned in the municipality
3. Human resources – all inhabitants in the municipality
4. Societal resources – the city administration and all its services, institutions
5. Economic resources – companies and all other economic units

It is noted that these resources are not exchangeable and they are all limited. Sustainable development is here understood as *proper management of limited resources*!

Regardless of the frame used at some level each aspect of the system has to be allocated to one of the parts, partly in an arbitrary way. The resource system or frame allows this to be done in a slightly more systematic and inclusive way.

7.9 Sustainability indicators and project management

It is essential to have adequate information on current developments and trends for the system in question. This information is given by so-called *indicators*. Choice of indicators is a serious question, as much effort is invested in following the indicators. They thus need to be important and meaningful, and relate to the vision.

There is no end to the number of indicators one may find. It is instructive to look at the economic pages in a daily newspaper; it is filled with hundreds of fig-

ures, all of which may be called economic indicators. Similarly one may compare to a medical diagnosis, which again may have many different figures, depending on the medical problem. Some are general, like body temperature, while others are special. In the same way a sustainability planning team needs to ask what indicators they need.

Typically a set of environmental, economic, and welfare measures are used. A typical European municipality has some 60 indicators in common use.

The indicators are related to the framework chosen. Thus, if the three dimensional (environmental, economic and social) system is chosen, one needs indicators for each of these. If the Compass is used, there will be four classes of indicators, and if the Urban Forum resource management system is used there will be five sets of indicators. The Japan for Sustainability project, which used the Compass, reported 5 basic indicators for each of the four directions of the Compass. Each of these had 10 datasets to be calculated. That is the whole project used 20 indicators and 200 datasets.

Indices are composed of several component indicators. Some indices are well established. Ecological footprints (consisting of six indicators) are monitored according to an established method, and there is an understanding what the sustainability value is (1.8 gha/cap). For social aspect of SD the human development index (three indicators are combined) is used; an acceptable level of that is, according to the United Nations, 0.8.

It is important that the indicators are measured over a time period. Then a trend is given and one sees how it is changing. Some indicators which rely on standard measures, such as many environmental and economic data, are often available over a long time. Others need to be either constructed from historical data or monitored in a new project.

It is essential that the "sustainability values" of the indicators are available. This is the value that the indicator would have in a sustainable society, that is, in the vision. The discussions needed to do this are typically very useful to deepen the understanding of what sustainability is and what one needs to do to achieve it. Of course, it should be added, that the values given are provisional. They will be reconsidered at least each management cycle.

The final goal is to implement the sustainability plan. This corresponds to the implementation of a spatial plan and one need to follow the legal process required. Nevertheless there is some specific characteristics typical for the sustainability process.

Indicators are often used in so-called *back casting*. Here the values for the present and the future vision are plotted and the track "from future to present" is

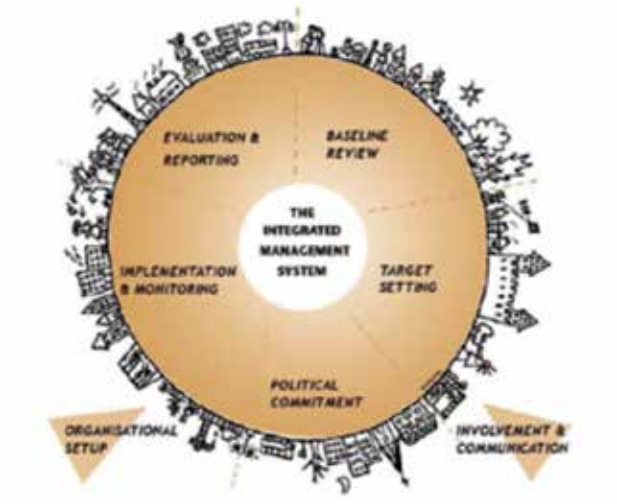

Figure 7.3 The MUE25 cycle is a variant of the classical Deming cycle (Plan-Do-Check-Act) It was used in the Managing Urban Europe project (MUE25) for Sustainable Urban Development. The model is equally useful for managing sustainable rural development. (Source: http://www.localmanagement.eu/index.php/mue25:introduction).

indicated by a line. This process allows us to establish intermediary goals for a specific year in the future, typically three years ahead, e.g. in energy use, traffic change etc. Back casting has been used in air pollution work and reaching the Kyoto protocol for reducing emissions of greenhouse gases.

A creative way to address what to do is to ask for the best "levers" in the system. What needs to be changed to get many more beneficial changes as a consequence? This is where system thinking is needed. For example improving public transport will also reduce air pollution if private car use decreases. In the more advanced versions of systems analysis computer models are used, but one gets very far by just drawing the systems and all interdependences on a piece of paper. This forms the basis of a strategy for changing the system and to spur innovations, that is, creative solutions for what to do.

There are many interesting ways to make the planning work interesting and more inclusive. One is to play games on a system which is designed according to the area to be planned. A more theoretical method is to model the system in question and calculate different scenarios. Modelling science today allows considerable detailed studies with environmental, economic and social parameters to be followed into long term future.

In order to successfully implement the projects one needs to have support from all the concerned levels in the society. Some projects, e.g. the Managing

Urban Europe 25 (MUE25), focused on this aspect. They defined a *management cycle* consisting of five steps

1. Baseline review (present value of indicators)
2. Target setting (the visioning process)
3. Political commitment
4. Implementation and monitoring (project work, and following the indicators)
5. Evaluation and reporting

The MUE25 cycle is a variant of the classical Deming cycle (Plan-Do-Check-Act), but includes specifically political commitment. It should also be added that the way to work is very similar to the environmental management systems, EMS, already adopted by hundreds of thousands of companies and quite many authorities.

The projects are implemented typically over a 3 year period. Then a new turn starts with review of vision, indicators, targets etc. Continuous monitoring and adaptation is needed and in particular the indicators need to be monitored.

Chapter 7 Sources:

Sections 7.1-7.4 and sections 7.7-7.9 Kristina L Nilsson and Lars Rydén Chapter 18 Spatial Planning and Management in Ecosystem Health & Sustainable Agriculture, Book 3 Rural Development and Land Use (Editors: L. Rydén and I. Karlsson, eds).

http://www.balticuniv.uu.se/index.php/boll-online-library/825-ehsa-3-rural-development-and-land-use

pp 205-206 (Section 7.1), pp 208-209 (Section 7.2), pp 213-215 (Section 7.3), pp 215-216 (Section 7.4), and pp 220-224 (Sections 7.7, 7.8 and 7.9).

Section 7.5-7.6 Rustam Eshnijazov and Rifkat Gimush based on Градостроительный кодекс Республики Узбекистан . “Народное слово”, N 95 (2917), 7 мая 2002 г. City-planning code of the Republic of Uzbekistan, Magazin: “Narodnoe slovo” N95 (2917), 7/05/2002

Chapter 8
Homes, Buildings and Sustainable Architecture

8.1 A house is a home

A central issue in creating a sustainable society are *the buildings*. These are not only the homes, workplaces, culture and much more for the inhabitants and therefore a key issue for social sustainability, but they are also key components in the resource flow of a city. They go from simple shelters to large and well-functioning houses.

In the global south access to a decent home is often the most critical concern. A decent house to live in is a crucial element for public health, personal integrity and security. Alarmed by the terrible conditions in the growing million-sized cities of the third world, the United Nations formed in 1978 the Human Settlements Programme (*UN-Habitat*) as an agency for human settlements and sustainable urban development. Its goals are to promote socially and environmentally sustainable towns and cities and provide *adequate shelter for all*.

In the industrial countries almost everyone has a decent home, but there is still much to be done to improve the performance of buildings. Energy performance goes from passive and low energy houses to badly functioning buildings. Especially in countries where fossil fuels dominate energy supply it is important that the energy performance of buildings is improved.

Houses may become very old and the reuse and retrofitting of them are important skills for sustainability. In the best case buildings may contribute significantly to create its own physical resources. Solar panels on roofs may produce much of the hot water needed, and solar cells some of the electricity necessary. Management of water and waste in homes are equally critical for sustainable performance.

Buildings are also a central issue for culture and aesthetics of both cities and countryside. They are used to express the character of the society and also the importance and power of its owners. All over the world buildings from our past are protected as parts of our cultural heritage. Many of them are places of worship, churches and mosques, or in other cases, castles, mansions, libraries, con-

cert halls etc. Culture is a central element in a sustainable society and its "homes" should be cherished.

For good reasons the building sector is quite well regulated by society and each country has its own administrative routines and laws for this. In general this is managed on the local level, that is, by the municipality administration.

In this chapter we will deal with buildings and how the construction sector can be more sustainable. It will in first place relate to the environmental aspect of sustainability. Other aspects, i.e. social and economic, will be taken into account when assessing the impacts of possible future actions, but the main focus will be on the reduction of the environmental impact of buildings. Given that energy efficiency of buildings in the use stage is already addressed by existing policies, the focus of this initiative is on resources such as materials (including waste), water and embedded energy. It will address resource use and related environmental impacts all along the life-cycle of buildings, from the extraction of building materials to the demolition and recycling of materials (end of life). Residential and non-residential buildings will be covered, excluding industrial ones and infrastructure (for example roads).

8.2 The building sector

The building and construction sector is a large and important sector in all countries. It accounts for a major part of all material flows and a sizable part of the economy. In the European Union the construction sector generates almost 10% of GDP and provides 20 million jobs, mainly in micro and small enterprises (2012 data). Construction is also a major consumer of intermediate products (raw materials, chemicals, electrical and electronic equipment, etc.) and related services. In addition the construction sector also significantly influence the development of the overall economy, especially for the development of cities.

In Uzbekistan the total housing fund of the Republic is more than 450 million m^2. The area of public buildings of budget sphere and spheres of services adds up to more than 110 million m^2, from which the most part are buildings of educational institutions.

Ongoing economic reforms, continuation of structural transformations and modernization of the economy, have ensured an annual stable GDP growth in the country. This also includes the investments in the construction sector (Figure 8.1 and 8.2). During the period 2009-2013 building of houses increased from 7,527,600 m^2 to 9,185,800 m^2, i.e. by 22%. Data for the building of hospitals, polyclinics and secondary schools confirm that the period was a very intense

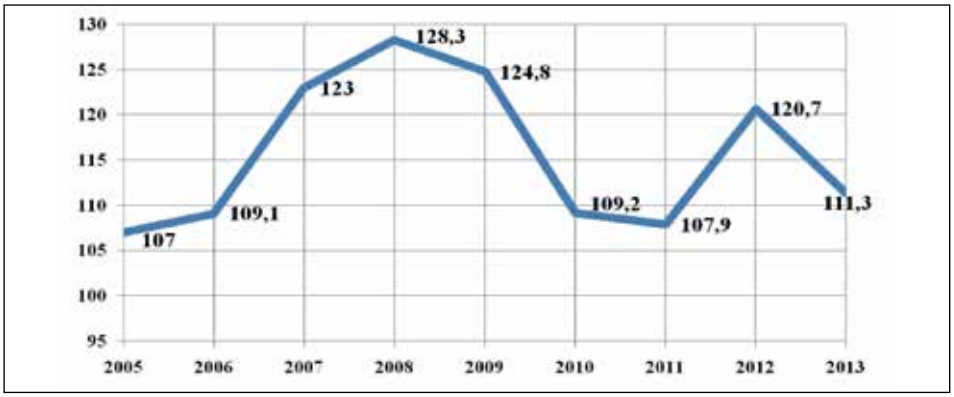

Figure 8.1 Change of investments in the building sector in Uzbekistan 2004-2014. Average annual growth rate in %.

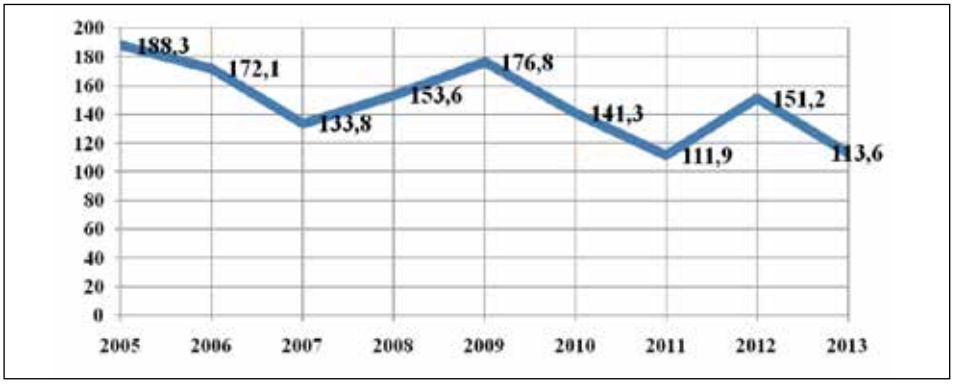

Figure 8.2 Changes of investments in construction for 2004-2014 (in the comparable prices in % by the previous year)

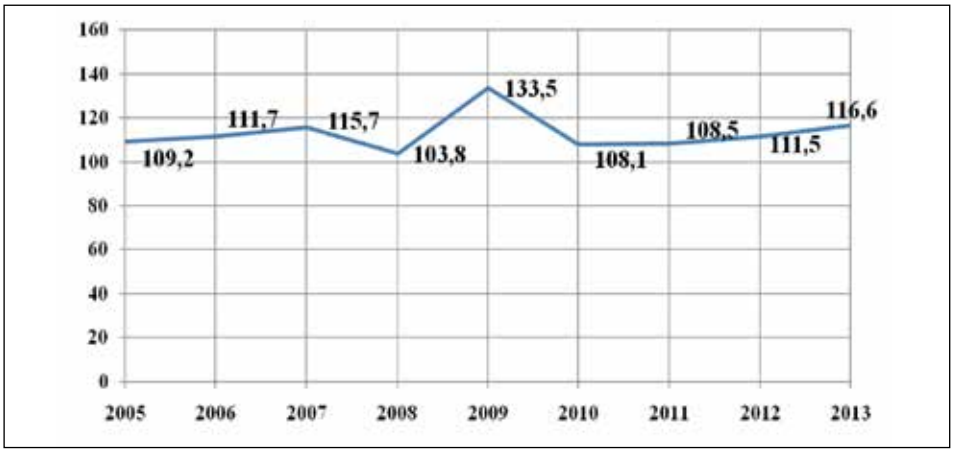

Figure 8.3 Rates of growth of a share of building works in GDP

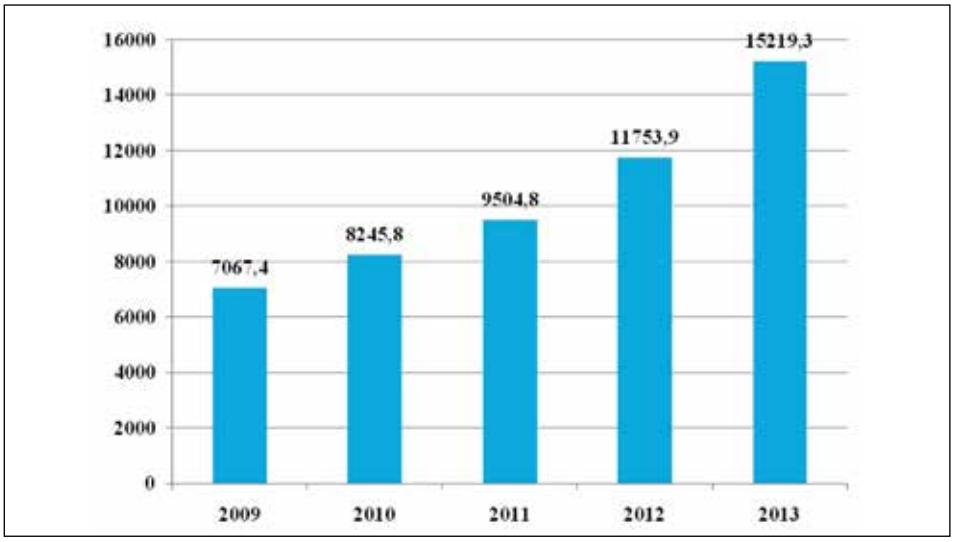

Figure 8.4. Dynamics of construction work in the period 2009-2013 (billion sum)

building period. Comparing GDP growth and growth in the building sector shows that it increased faster than GDP and thus that a disproportionally large part of added GDP was used for construction (Figure 8.3 and Figure 8.4).

The basic part of houses and public buildings in Uzbekistan is constructed on out-of-date building norms and does not correspond to modern planning, technical and aesthetic requirements or internal arrangement and furnish of buildings. Especially the insufficient insulation of buildings causes much energy losses on heating and conditioning.

Conditions for the construction sector applies the "Uzbek model" of economic reform, and is therefore adapted to market economy. In comparison with other CIS countries in many respects it corresponds to modern requirements.

The construction sector also use modern scientific and technical achievements when it comes to resource- and energy saving, and the "know-how" of building materials and products. In this way we see a reduced consumption of materials, and a decreased use of fuel and energy resources in the manufacture of building materials.

In parallel with the construction of new buildings we see a reconstruction and renovation of houses and public buildings, in particular objects of education and public health services, to bring their conditions to modern standards.

8.3 Building materials

A large variety of materials are used for the construction of buildings. The choice of material is important for sustainability. Prevailing aspects includes firstly the impact from the production of the material, and secondly how the house functions with the material. E.g. many different kinds of plastic emits toxic gases a long time after the building. Another drawback is that plastic materials are very flammable and a fire in the building may become very violent and again emit toxic gases. Material choice is also connected to the aesthetic aspects of the buildings and the future owners may prefer some material rather than others.

The most commonly used material for construction is *concrete*, consisting mainly of cement (about 14%) and sand. This is however problematic from the point of view of sustainability. The concrete industry is responsible for some 5% of global CO_2 emissions. 50% is from the chemical process and 40% from burning fuel. Cement is produced when calcium carbonate is heated to very high temperature to produce lime (CaO) and carbon dioxide. 900 kg of CO_2 are emitted for the fabrication of every ton of cement.

A second important material in many countries, especially in northern Europe, is *wood*. Here there is a very long tradition of building wooden houses and it dominates the countryside. In cities in particular however, since long, multi-apartment houses, especially multi-storey houses, have been constructed in concrete. For a long period building wooden houses in cities was even forbidden just to

Box 8.1 Uzbekistan decrees for the building sector

The important role in development of the branch has the Decree of the President of Republic of Uzbekistan from March 24, 2005 ¹ ÏÏ-3586 “About a deepening of economic reforms and acceleration of development of an industry of building materials “.

With the purposes of creation of an effective system of stimulus for realization by the enterprises of the industry of building materials of constant modernization, technical and technological re-equipment of own manufacture, attraction of modern technologies, equipment the Decision of the President of Republic of Uzbekistan from June 1, 2007 ¹ ÏÏ-646 “About the Program of modernization, technical and technological re-equipment of the enterprises of an industry of building materials for the period 2007-2011 years “ is accepted.

For the most complete saturation of a home market with wall materials, satisfaction of growing demand of the population, realization of housing construction, especial in a countryside, President of Republic of Uzbekistan sign the Decision from June 19, 2009 ¹ ÏÏ-1134 “ About additional measures on stimulation of increase of manufacture and improvement of quality of wall materials “.

protect cities against fire. Since some 20-30 years this has however changed. Today a wooden house is safer for fire than a modern concrete building, mostly because of its relatively large amount of plastic material in the latter, around e.g. doors, windows etc.

Wood is a more sustainable building material for several reasons. First wood is a renewable resource and the production does not contribute to GHG emissions. Secondly it is less heavy than concrete and thus the transport is less fuel demanding and wears less on roads. The construction itself is easier and faster because of the lighter weight and thus cheaper. Today the building of houses in wood up to 14 stories have been built. Still, the wooden house market remains relatively small, very much due to a rather conservative attitude in the construction sector.

The building heritage of Uzbekistan has a long and deep experience of the use of local raw materials, especially *clay and loam*. Loam is a mixture of moist clay and sand, and often straw, used especially in making bricks and foundry molds. Modern researches proves that the use of loam as raw material for constructing of walls has a number of advantages:

- Maintenance of comfortable warm and humid conditions in the building;
- Economically advantageous in comparison with any other materials;
- Easy availability of loam and simple technology for processing and use;
- No problems on recycling wastes when demolishing the buildings;

Small costs of transport and construction, especially important for building on remote sites.

The loam raw material was frequently exposed to preliminary processing: to washing which lasted for one year; In raw material the enriching additives for improvement of one or other properties were included; On very important objects was spent level-by-level treatement by open fire half dry clay designs; The one-piece connections of a wooden skeleton similar under the constructive decision with joints were created, that raised reliability of designs at dynamic loadings during earthquakes.

Thus, in all stages this kind of material has essential advantages from the viewpoint of energy saving and resource saving and maintenance, as well as to meet the requirements for environmental protection. For the present development of Uzbekistan this type of construction has also beneficial side effects, such as maintenance of employment and creation of workplaces on clay mines and building sites. Wall designs from loam is in many respects also well adapted to the regional, in summer very hot, climate.

Box 8.2 Governmental decisions on building materials

With the purposes of satisfaction of need and saturation of the consumer market by modern building materials by Government of the Republic has paid special attention to development of manufacture of building materials.

June 1, 2007 the decision of the President of Republic of Uzbekistan from. [1]PP-646 " About the Program of modernization, technical and technological re-equipment of the enterprises of an industry of building materials for the period 2007-2011" was accepted, where the modernization of all large enterprises on manufacture of building materials was provided.

The special attention is given to increase of vital conditions of the village population, providing of high quality building materials for the accessible prices, creation of manufactures of building materials on country sides.

For the most complete providing of a home market by wall materials, satisfaction of growing demand of the population, realization of housing construction, especially in a countryside, the President of the Republic signed the decision PP-1134 from 19.06.2009 "About additional measures on stimulation of increase of manufacture and improvement of high quality wall materials ".

The basic purpose of the given document is the increase of quantity of manufacture high quality wall materials at the expense of creation new and modernization of the working enterprises, introduction of modern energy saving technologies ensuring reduction of production costs and decrease of the price of ready goods. In this way most efficiently provide home market with wall materials and satisfaction of growing demand of the population on this product, especially in countryside.

Clay construction in Uzbekistan use three different systems: "sinch" (wooden skeleton with clay by filling), "pakhsa" (clay wall) and construction using "clay bricks". Each of these are used in special conditions. In seismic stable areas *sinch*, is used. These have two types: one-layer and two-layer, when the wall is formed of two layers with an air cavity ensuring high heat-shielding qualities. The application of constructive system should be defined depending on purpose of a building and seismic condition of the territory.

In order to safeguard the access by the market to modern building materials in Uzbekistan the Government of the Republic has given special attention to the development of manufacture of building materials (See Box 8.2). There is no doubt that the development of the economy of the Republic and for the improvement of well-being of people the construction sector has a special role.

It is obvious that the creation of manufacturing on the basis of own raw material which substitutes import develops the economic independence of the country. Uzbekistan has its own experience on developing localization, which shows what advantages we get from it, especially when reducing external risks, building in-

ternal demand and providing the market with necessary consumer goods and furnishing products. Using created competence, economy and currency reduces the problems of unemployment. The program for social and economic development of the regions of Uzbekistan for 2013-2015 on manufacture of building materials in 2013 carried out 1,458 projects on production of building materials from local raw material and components for 269,0 million US dollars. As a side effect more than 21 000 new workplaces were created. In the total volume of construction works the cost of building materials make an essential part (55-70%).

For the last years more than 30 new kinds of building materials has been produced. It has allowed an essential reduction of the import of these materials. Simultaneously together with other building materials the finishing materials have begun to be exported.

8.4 Energy efficiency of buildings

Keeping the wanted inside climate in buildings requires the largest part of the running costs of a house and corresponds also to the largest environmental impact in the use phase in the life cycle assessment (LCA) of a house.

The building sector is one of the key consumers of energy in Europe where energy use in buildings has seen overall a rising trend over the past 20 years. Currently the most common energy requirement for heating in the residential sector is in the order of 150 kWh/m^2/year. The average specific energy consumption in the non-residential sector is almost twice that amount 280 kWh/m^2 (covering all end-uses) which is at least 40% greater than the equivalent value for the residential sector. In the non-residential sector, electricity use over the last 20 years has increased by a remarkable 74%.

In 2009, European households were responsible for 68% of the total final energy use in buildings. Energy in households is mainly consumed by heating, cooling, hot water, cooking and appliances where the dominant energy end-use (responsible for around 70%) in homes is space heating. Gas is the most common fuel used in buildings while oil use is highest in North & West Europe. The highest use of coal in the residential sector is in Central & Eastern Europe where also district heating has the highest share of all regions. Renewable energy sources (solar heat, biomass, geothermal and wastes) have a share of 21%, 12% and 9% in total final consumption in Central & Eastern, South and North & West regions, respectively.

We expect an increase in the energy use in the housing sector for two reasons. First the general tendency is to seek larger floor spaces over time, secondly the

increasing population. This emphasise the urgency for improving the energy performance of our buildings.

Energy performance depends on a number of factors such as the performance of the installed heating system and building envelope, climatic conditions, behaviour characteristics (e.g. typical indoor temperatures) and social conditions (e.g. fuel poverty). Data on typical heating consumption levels of the existing stock by age shows that the largest energy saving potential is associated with the older building stock where in some cases buildings from the 1960s are worse than buildings from earlier decades. The lack of sufficient insulation of the building envelope in older buildings was also reflected through the historic U-value data which comes with no surprise as insulation standards in those construction years were limited.

Today the building of *low-energy houses* have increased very much in the EU. The additional cost for increasing the energy performance of buildings is not very high – from 0 to a few percent – and this investment is rapidly paid back by lower energy costs. A low energy house has an energy use for heating of less than 50 kWh/m^2 and year. This fits with the EU Directive for Energy Performance of new Buildings, the EPBD which require nearly Zero-Energy Buildings for all new constructions by 2020. The member countries report that their aim for nearly Zero-Energy residential buildings is the maximal primary energy consumptions ranges between 33 kWh/m^2/y in Croatia to 95 kWh/m^2/y in Latvia with a majority of the countries aiming at 45 or 50 kWh/m^2/y.

The most advanced of these buildings are the so-called passive houses. A passive house will in principle receive all heating energy required from the people in the house (a person emits about 70 W) and equipment such as computers, lamps, washing machine etc. Thus no heating would be needed, but in practice there a small heating may be needed. The German certification for passive houses sets a maximum of 15 kWh/m^2/y. Even if passive houses are not yet so common, low-energy houses are.

Passive houses are built to have very small energy losses. Heating is achieved by using the outgoing ventilation air in a heat exchanger to heat the incoming air from outside. Thus the ventilation is a crucial element. The fan driving the ventilation system has a low energy motor. During extreme cold there is a battery for electric heating of the incoming air. This air may also be filtered if required.

A passive house may be built with a number of different materials, such as concrete, wood, clay etc. The walls insulates the house efficiently and makes it tight, that is, no leakages are accepted. Walls are often 40 cm thick, and ceiling 50 cm thick, and the ground more than 30 cm. Windows are insulating ($U < 0.80$

Figure 8.5 Building a passive house. The wall has extremely good insulation.

W/m^2), often 3-glass windows, and the doors and windows mounted to avoid any leakage. Construction of a passive house requires the highest quality, both in the construction itself and the material.

The inside climate in a passive house is very comfortable, a statement supported by years of experience of passive houses. Even during quite cold weather it is nice inside. If it is very warm weather incoming solar radiation needs to be shadowed. The colder night air should be used to decrease inside temperature, and the extreme insulation then keeps the temperature moderately low during the day. When air conditioning is used it requires much less energy than in a standard house, due to the insulation. In some houses the system is used to cool the house with ground cold using a small heat pump.

Norway, German and United Kingdom will all have passive house standards for all new constructions from 2016.

8.5 Energy efficiency of buildings in Uzbekistan

Also in Uzbekistan it is important to use less material and less energy both during the construction and operation of buildings. Taking into account that almost half of all energy used in the country is for buildings, an urgent problem is to increase

Box 8.3 Foam concrete

Contemporary foam concrete also widely used in housing construction (in building of one or two story cottages) as wall construction instead of brick walls. At the same time according to construction norms in stone buildings for brick walls it is necessary to use the cement mortar not below M75, on concrete stones and hollow blocks, including from light concrete of density not less than 1200 kg / m^3 , to use mortar M 50 and higher.

One of more effective and simple ways can be development of the constructive - technological decisions seismic stable and energy efficient buildings using foam concrete with minimally allowed small durability and according to lowered density (within the limits of 200-300 kg /m^3) as warming material, and as bearing load construction - layer of a brick, monolite light or heavy ferro-concrete. It is more efficient to use as bearing construction foam concrete blocks with density 1000-1200 kg / m^3, which will allow in addition to increase heat-shielding parameters of walls.

For low storeyhouses and public buildings (up to 3 stories) more efficient the development of complex designs of walls as bearing layers foam concrete blocks with density up to 600 kg /m^3, and as warming material is layer of monolite foam concrete with density up to 300 kg /m^3. It will allow essentially to raise heat-shielding parameters and essentially lower own weight of buildings.

For realization of this hes is necessary to conduct researches on:

- on definition of a probably allowable level of minimal density and durability of heat-shielding foam concrete, sufficient for fixing its structure between bearing layers of a constructional material in wall, and also technological feasibility of physic-mechanical parameters;
- on development of the constructive - technological decisions of walls with useof foam concrete with low density.

Thus it is important the maintenance of a combination of small density with the high durability of such foam concrete.

Getting foam concrete of high mechanical durability is one of the important technological tasks of present. The analysis of the factors influencing mechanical properties of this composite material shows that the level of defectness of partitions between foams, which determines durability of the concrete, essentially depends on properties of cementing materials with other conditions being the same.

The perfection of norms of seismic stable construction with application of rules [6] will allow to ensure also energy efficiency and in sphere of manufacture of constructional materials (concrete, cement, steel) at the expense of their economy and decrease of seismic loading due to application of the facilitated protecting designs.

Application of foam concrete is most perspective in the coverings of roofs of industrial buildings. Such coverings are recommended to be projected from panels combining bearing, warming and also waterproofing functions.

The application of smooth roofs consisting of bearing panels and warming small plates from foam concrete with density 400-600 kg /m^3 according to TSh 64-15207505-02, stacked in two and more layers on bearing panels or overlappings of the top floor is recommended also. It is permittible also application of smooth roofs consisting of bearing panels and warming one layer plates of light and cellular concrete with density no more than 600 kg /m^3.

Most efficient is laying out smooth roofs by using efficient warming materials or cellular concrete, in particular, monolit foam concrete. Preferable is laying out monolithic warming layer from foam concrete on which is stacked monolithic foam concrete with density no more than 600 kg /m^3 and durability not less than 0,8 MPA by thickness of 40-50 mm being the basis for a waterproofing carpet.

For increase of durability and reduction of shrinkage deformations of foam concrete of low density it is recommended to use straining cement or expanding additives, and also disperse reinforcement with introduction of mineral or synthetic fibres.

their energy efficiency. However, at present residential and public buildings in the country are not meeting adequate and modern requirements of energy use. At present up to 45% of energy is lost through the outside walls, and up to 22% through the floors and roof. It is thus clear that energy efficiency is a task of huge importance.

The main ways to improve energy efficiency in buildings are:

- Optimization of the architectural, spatial-planning decisions;
- Optimization of insulating constructions;
- Perfection of engineering systems and equipment;
- Wide use of alternative sources of energy and, first of all, solar, as Uzbekistan is located in a zone favorable for this purpose.

Each of these directions will contribute to a reduction of energy use in buildings. With the purpose to improve the insulation standard in the designs of buildings periodic reconsideration of the requirements of building norms has been carried out from 1997. The 1997 Uzbekistan Building norm requires that effective insulating materials should have an index of thermal conductivity λ_0= 0,1 Вт/(м·°С) while traditional wall materials have λ_0 = 0,21-0,56 Вт/(м·°С). These new standards are 2-3 times stricter than the norms of the Soviet period. Building norms regarding insulation was made compulsory in 2011.

Implementing the modern requirements on insulation only by increasing the thickness of the outside walls and roofing is almost impossible and not practical. For traditional materials without additional insulation a brick wall would have a thickness more than 1,26 m to meet the new standards; with a single layer of cellular and light concrete of a density 800-1,200 kg /m^3 it would be 0,40-0,94 m; if the roof insulating material keramzit was used the thickness would be 0,44-0,55 m. This would cover only the second level of insulation of buildings at 2,000-3,000 grad-day of the heating period.

Insulation only from traditional materials is thus economically and technically impractical. It will in addition result in an essential increase of the use of material and energy. Besides the increase of the thickness of insulating designs can result in a big increase of the weight of buildings and structures, not advisable for reasons of seismic loading. In turn it allows to lower seismic loading on buildings which is in direct dependence on own weight of buildings and structures. We need to develop research on effective heat protecting materials and multi-layer protecting designs, using local materials. Walls built from traditional materials (brick, cellular concrete with density 800-1400 kg /m^3, etc.), with both bearing

and insulating functions in single layered designs, needs additional heat isolation with use effective isolating materials.

The introduction of essentially new approaches to design of buildings opens an opportunity to decrease the weight of walls at the expense of insulation properties. The seismic norms for multi-stored frame buildings for filling of walls is used cellular blocks, stones, brick with density limits of 1,600-1,800 kg /m^3. Because of the new requirement of increased thickness it is not feasible to use such materials. We can instead use e.g. foam concrete blocks with density 600 kg /m^3 and with index of thermal conductivity λ_0=0,08-0,11 Вт/(м·ºС). This ensures normative insulation properties while preserving the wall thickness at 0,4 m (1,5 bricks). In this design the weight of walls will be up to three times less and thus improve not only insulation of the but also seismic quality of buildings.

The achieved level of insulation of buildings according to the new Uzbekh building norms exceeds those of the Soviet period by 1.4-4 times. At the same time they are on the average two times lower than in the EU. Therefore it is necessary to continue researches on perfection and development of normative-methodological base of designing and construction energy efficient buildings in correspondence with the development of a national economy, necessity of stimulation of development of industrial base effective materials, in particular, from local raw materials and especially from wastes of manufacture.

8.6 Local resource flows – local energy

Houses and other buildings are nodes in a constant flow of energy, water and waste. In the countryside, where houses are comparatively isolated, and especially so in former times, these flows were managed in the household without much connection to the rest of society. Today when urbanisation in the world has increased to over 50% it is quite different. Most houses are connected in different ways to the cities´ management of energy, water and waste. This is in general good for resource efficiency and reduced environmental impact. Thus very many houses in cities get their energy from district heating, water from an urban water network, and delivers its waste to the city´s waste management trucks. Obviously also these common facilities may be more or less sustainable e.g as to their dependency and use of fossil energy resources.

More recently the options of managing the resource flows independently has increased substantially. For *heating* the house the owners may install a heat pump and extract it's heat locally, using a comparatively small amount of electricity. In many cases it is a better economy than being connected to a district heating

network, which of course in practice is a monopoly. Another option is to install a solar panel on the roof to produce the hot water locally. Depending on conditions it is a more or less interesting alternative. In southern Europe, the Mediterranean countries, it is very common and used year around. In northern Europe it is possible to use solar panels to produce hot water part of the year, often March to October. Another option is to use biofuels for a local boiler, such as wood chips or pellets. A drawback is that this solution requires much management but economy is often good. In all these cases the house is heated by circulating hot water.

Also electricity may be provided locally. Solar (photovoltaic) cells can be used to the incoming solar radiation to produce the electricity needed. The weak point is that it is difficult to store the electricity produced. Rechargeable batteries do not have enough capacity and are comparatively expensive. A solution we start to see in some countries is to use batteries from electric cars: as they start to decline in capacity they are good enough for a house but not for a car where capacity per weight is crucial. The more common solution is that the national grid of the country is connected to the house and buys back the electricity which is not used directly. This solution is typically the best in countries with much hydroelectricity, since hydroelectric plants can be used to store electricity.

Solar electricity is still fairly expensive. In many countries the state electric company accepts to buy extra electricity produced to a fixed price and thus the economy can be calculated precisely. It is managed so that the meter runs backwards when there is an excess and as usual when electricity is coming from the grid.

Many countries offer state subsidies to promote the installation of solar cells on the roofs of houses, especially residential buildings and private homes. It is also very popular to do this. Thus both in the European Union and in the United States there is a dramatic increase in the number of house with PV cells on the roofs.

Other solution for local electricity production, such as small scale wind power or small scale hydropower, are possible but not common and if so mostly for groups of houses on the countryside.

All these solutions increase sustainability and are expected to increase in the longer term as they become safer, cheaper and easier to manage.

Uzbekistan is rich by an energy resources for development of small power production. This includes the use of energy of the small rivers in foothill areas, wind energy in regions with steady wind parameters and almost everywhere the use solar energy.

By the level of energy provision Uzbekistan is self-sufficient. The main drawback is the lack of an understanding of the importance of improved energy efficiency, certainly related to mentality from the past command economic sys-

Figure 8.6 Installing solar cells..Source: Wayne National Forest Solar Panel Construction

tem. It should be added that in communist economic natural resources, including energy, was considered free which of course they are not. Our development of in the housing sector will necessarily lead us better energy efficient buildings and a wider use of alternative sources of energy for the creation of comfortable conditions in buildings.

8.7 Refurbishing and maintenance of the existing stock of buildings

A building may easily become 100 years of age and many buildings are much older. It is clear that during their lifetime maintenance, and even rebuilding is necessary. Reasons include physical deterioration and wearing of the building, change of function of the building or because the requirement on the buildings from the authorities may be upgraded or changed.

Renovation of the building stock is also a main concern in the world, not the least for energy reasons. Because the potential for cost-effective energy savings is so high, the buildings sector has become a priority area for the European Union. Several legislative initiatives have been introduced for building renovation. The 2010 Energy Performance of Buildings Directive (EPBD) introduced

Figure 8.7 Apartment houses, 11,000 m^2 in Sweden renovated using the Energy Performance Contracting in 2003. Energy reduction was 36% In this project.

the requirement of implementing energy efficiency measures for major renovations in order to encourage more ambitious renovation. The EPBD also asked EU Member States to introduce cost-optimal energy performance requirements that can be used for new buildings as well as for renovation activities. The 2012 Energy Efficiency Directive complements the EPBD by encouraging ambitious renovations for the renovation of national building stocks by April 2014, as well as to renovate 3% of the building stock of central governments annually to a high energy performance level.

As an example we may take the Swedish building and service sector. It uses 150 TWh annually (38% of Swedish Energy use, 2011 data). 8.5 TWh can be reduced by (profitable) energy efficiency projects. This corresponds to ca 7-8 00 million Euro in annual energy costs.

- The most common retrofit actions include:
- Sealing air holes and gaps in the building envelope
- Sealing & insulating structures like attic access stairways & whole house fans
- Installing new windows or sealing existing windows.
- Adding insulation.
- Sealing ducts.

Upgrading heating and cooling systems, appliances and lighting by replacing them with energy efficient equipment, compact fluorescent lamps, or LED lamps.

Adding heat recovery ventilation or other means to control and upgrade fresh air ventilation.

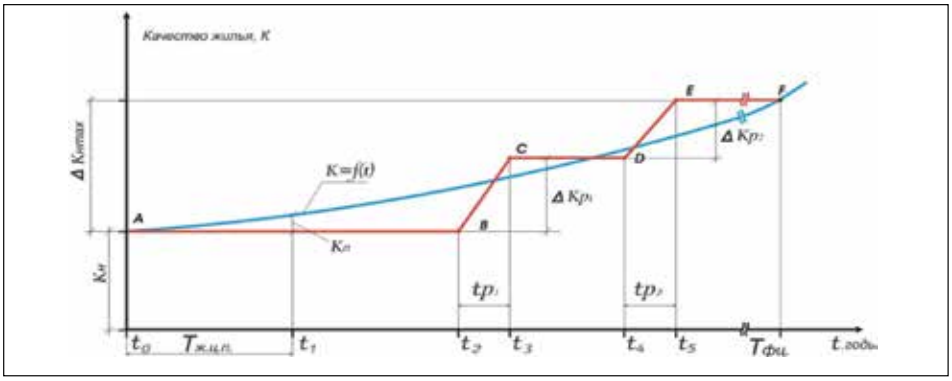

Figure 8.8 Dynamics of change of quality (comfort) of house in time – a Curve of growth of the consumer requirements to housing. (K) - - change of consumer qualities of the constructed habitation. (A,B,C, D,E). KH- Initial degree of quality of a house. Kp1,Kp2- Growth of quality of habitation after 1 and 2 reconstruction. tp1, tp2 - Duration of realization of reconstruction

Controlling moisture

Among the many projects running for this is Energy Performance Contracting (EPC), a cooperation model for improved energy efficiency in the building sector. So far after many years of work EPC has achieved a 22% reduction of energy re-education in the apartment house sector and 55% reduction for industry buildings.

Also in Uzbekistan the refurbishment and reconstruction sector is big, as the housing stock needs to upgrade quality and comfort. The initial degree of comfort of a house corresponds to the requirements at the initial design decision. During the lifetime of a building reconstruction may be required several times.

Reconstruction is labour-consuming process connected to significant material, financial and temporary expenses. It is also connected with social losses, i.e. so called temporary eviction.

The quality of design, for example larger living space, increase the cost of the building. The construction and operation of apartment houses is presented on 3 basic possible variants:

1. The reconstruction receives an additional degree of quality (most typical);
2. The initial degree of quality is maximal, reconstruction not needed;
3. Some additional quality and with reduction of durability.

The offered approach will ensure more objective account of the modern factors at designing apartment houses and will allow to reduce unproductive expenses, which are available now.

The similar phenomena take place and for industrial objects, but here reason of reconstruction is the high variability of industrial technologies.

8.8 Sustainable architecture

In some areas the construction of houses to be as sustainable as possible has been attempted since many decades. This include especially the so-called eco villages. As described houses in these areas are characterised by careful choice of building materials, good energy efficiency, or clever ways for toilet waste, e.g. urine separating toilets. But they may also include careful attempts to achieve good social sustainability. For example they may be constructed to allow to set apart a small apartment in the house for a growing family.

Sustainable architecture developed especially during the 1990s include also clever ventilation of the house, especially self-ventilation, as well as proper use of the house location. Thus typically the windows towards the south were larger and windows towards the north were small or even lacking, that is in colder climate. Some houses were built in slopes to use the protection of the ground.

Very important was also how daylight came into the house. Thus in some parts of the house there was often two stories high ceiling to allow daylight to illuminate the room in a pleasant way. The very high ceiling in these parts of the house were typically towards the south. Green plants inside contributed to a good atmosphere both physically and mentally, and arrangements were made to improve air quality as well as sound quality, when noisy equipment was minimised. In public buildings the too often typical noisy AC equipment was thus avoided by clever arrangements to achieve a good inside atmosphere without fans and air ducts.

Sustainable architecture of course also dealt with the design of houses, but in this respect it was not so different from conventional architecture. The special focus was most importantly addressing the functions of the buildings.

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Chapter 9
Green Structures in Sustainable City Development

9.1 The benefits of urban greenery

The urban green structures is a component of urban space, the surface area a city is built on. The other components of urban space are the built structures and the transport structures of the city. Urban space includes all area for which a city has planning responsibility and monopoly, both in a master plan and detailed plans.

Urban planning is a single integrated concern, as for each part of a city the three alternatives mentioned are all possible – it may become a (green) area, a street (traffic) or give place for a building. Still it is not always that management of urban space is integrated. City departments dealing with parks and green areas are not necessarily well coordinated with city departments dealing with traffic, or with those authorising building permits. This leads to sub-optimisation, even conflicts. *Integration of urban planning*, a main sustainability strategy, is too often neglected.

The green area in a city is a limited and expensive resource. In Europe it is larger than one normally is aware of. Several studies report about 50 %, then including not only parks but also green edges of streets and traffic corridors, private gardens, and a multitude of bushes, trees small lawns etc. Studies show that the availability and character of green structures are important when people choose where to move when leaving a city for another. Such green areas provide opportunities for recreation, social contacts, playgrounds, concerts and other cultural events etc. all contributing to a rich and attractive city life.

It is important that these areas are available on a daily basis. Some sustainability studies use the indicator "distance from nearest green structure", using 300 meters as the norm, which should not be surpassed. To promote *availability of the green structure* is an important sustainability strategy. It is supported by research showing that individuals feel better and in fact have fewer sick days if they can spend some time in green areas, and are able to see a green area outside the window where they live.

Green structures usually are taken to include areas with surface water, or *blue structure*. Also these blue water areas are attractive to the inhabitants of a city. To

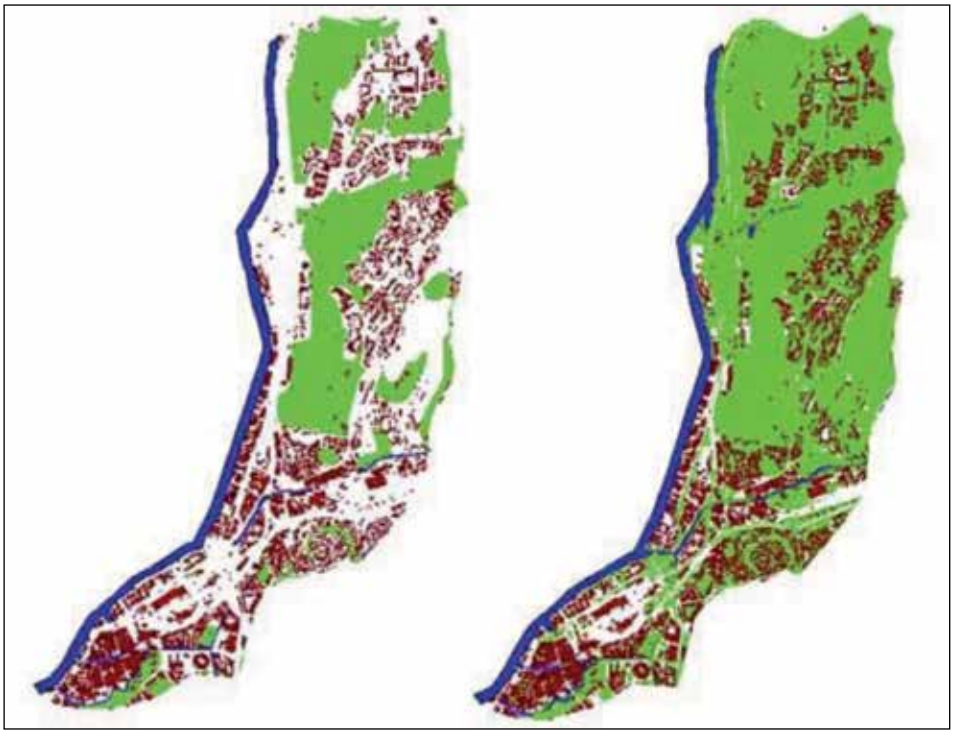

Figure 9.1. Green Gothenburg. The maps show substantial quantitative differences between the formal green structure (left map) and the actual green structure (right map) in a part of Göteborg, Sweden. Source: Urban Green Structure - A hidden resource Elisabet Lundgren Alm, Chalmers University of Technology. http://www.balticuniv.uu.se/buuf/

live by a waterfront is very popular as reflected in prices of homes and apartments. Many cities make their waters more visible and accessible, e.g. by bringing into light previously hidden small streams, or removing obstacles to make rivers and waterfronts easier to reach. Many cities have seen their citizens in large numbers spend lunch hours, afternoons, etc socialising along newly arranged riverfronts.

Greenery also has a function in protecting and conserving *biodiversity*. Today cities are often more biodiverse than rural areas, as they are more varied, provide food easily and offer much shelter. To promote biodiversity by carefully arranged green areas is another important sustainability strategy. This function is also contributing to easily accessible opportunities to learn about nature, not the least for school children, apart from the fact that biodiversity is a sustainability value in itself.

Figure 9.2. Urban green structure is especially important for children and elderly people, as these groups often are reduced to stay in the city while other groups easier can go to bigger nature areas outside the cities. Source: Urban Green Structure - A hidden resource Elisabet Lundgren Alm, Chalmers University of Technology. http://www.balticuniv.uu.se/buuf/

Green areas do also provide *ecological services* of many other kinds. Thus wetlands and shallow surface water in general function to reduce eutrophication (nitrogen and phosphorus overload), and in general clean the water. A special category of surface water is storm or run off water in a city. To arrange wetlands, and channel storm water in surface canals is also a sustainability strategy, of which several cities have very good experiences. Such artificial wetland areas also promote a rich bird life and, if carefully managed, opportunities for beautiful plantations.

The expectation that green areas and parks "clean the air" seem not to have much scientific ground. Green/blue corridors across the urban landscape may, however provide a *ventilation function* in some cases. This is particularly true for cities with a river passing through the entire cityscape. Green corridors may also support biodiversity in the comparatively small scale that a city provides.

The monetary value of these ecosystems services of cities have been studied in several recent research projects and found to be considerable. To insert the rural in the urban is thus one way to decrease the ecological burden of cities.

In conclusion, the green areas of a city are important for making the city an attractive and rich environment for its inhabitants. This is main concern in sustainable urban development.

9.2 Functions and history of urban greenery

During the last 300 years greenery within towns have been developed mainly for aesthetic, social and hygienic purposes. Inspired by English, German, French town planning the concept of city park was introduced all over the world only in

XIXth century, although already in XVIIth century residential squares furnished with centrally located gardens for residents started to be introduced in French and English cities. The most famous Parisian green residential squares: Place de Vosges, Place Vendôme and London's: Bedford, Red Lion, Leicester, Soho Squares and some other serve until today as popular recreational urban places.

In 1898 E. Howard introduced *Garden City concept*, in which greenery and advantages of a country life played significant role. He envisioned a new city for thirty thousand inhabitants. In his scheme the Garden City is laid out in a circular plan divided into six wards (neighbourhoods) by six main streets. A circular space at the centre contains a park surrounded by public buildings such as the town hall, concert and lecture hall, theatre, library and a hospital. Around this Central Park of 6 hectare is the "Crystal Palace" – a wide glass arcade with shops – divided by radial boulevards. Beyond this is the residential area containing 5,500 house lots of 7,5x30m in size, allowing for a density of about 37-42 dwelling units/ hectare. Each house is provided with a garden. Circular avenues give further definition to the plan. One of these, Grand Avenue, contains sites for school and churches in a park-like setting. The outer ring of town is a permanent agricultural greenbelt of 2,000 hectares devoted to small farms.

In 1926, geographer Sernander was the first, who suggested preservation of green habitat corridors from the city centre to nearby green recreation areas and nature reserves. The approach to greenery in the city changed dramatically from that time.

Urban green structure today can be defined as all land of the urban landscape that is neither covered nor sealed, including parks, playgrounds, sport fields, allotments, private gardens, green space of housing districts, industrial properties as well as along streets and rail roads etc. Ulf G. Sandström refers to the green structure in an urban environment as to all non-hard and non-built areas, including surface water areas and a of 1-2 km zone between town and countryside, that are more or less connected to each other. The structure should be organised with an overruling strategy, i.e. it must be possible to recognize a system in the structure. Accordingly a green infrastructure is a network of patches of natural character including surface water and greenways, penetrating an urban built-up area.

The concept should not be limited by administrative considerations; i.e. both public and private lands are included in a green infrastructure. The City Architect Office in Lund, Sweden, supports the approach stating that: "green structure include both the landscape and its nature in the city neighbourhood as well as all non-hard ground in the city. This means that the green structure in a local government plan includes not only determined green areas but also non-hard areas in

housing areas, day nursery gardens, school yards, institutions and sports grounds, cemeteries, verges, green squares, allotments and adjacent sectors of the landscape. Also non-hard ground without any value for recreation, e.g. safety zones for traffic or industrial establishments, belongs to this category."

An EU research team *Green structures and Urban Planning* (2000) supports the above definition by classifying the green structure as follows:

- Paved city spaces with plants: courtyards & patios, roof gardens & balconies, tree-lined alleys, promenades, city squares and schoolyards
- Parks, gardens and sports grounds: public parks, pocket parks, gardens, public sports grounds, public recreation areas and public playgrounds
- Burial places: crematorium, burial ground and churchyard
- Private open spaces: institution grounds, residential home grounds, health services grounds, private sports grounds, private estate grounds, local authority services grounds and commerce grounds
- Domestic gardens: house gardens, allotments, communal semi-public gardens and communal private garden
- Farmland and horticulture: arable, pasture and orchard
- Transport corridor verges: canal sides, rail sides and roadsides
- Water margins: wetland, riversides and lakesides
- Water: still water, running water
- Woods: woodland, timber/bio-fuel woodland, wild wood and semi-natural woodland.Green structure in the sustainable city fulfils multiple functions and influences:
- Urban climate: noise moderation, air cleaning, surface water treatment, wind and snow, sun protection
- As an indicator of environmental changes
- Cultivation of energy plants
- Biodiversity: protection of valuable urban species coming from rural biotopes, acts as spreading green corridors
- Social and cultural values: health: recovery and rehabilitation, beauty and comfort, space for passive and active recreation, setting for cultural heritage and education
- Urban design: provides digestible city structure connecting different scales and parts of the urban landscape.

9.3 The classical green structure – parks

A park is an area of open green space provided for recreational use, usually owned and maintained by a local government. Parks are meant to resemble savannas or open woodlands, the types of landscape that human beings find most relaxing. Grass is typically kept short to discourage insect pests and to allow for the enjoyment of picnics and sporting activities. Trees are chosen for their beauty and to provide shade.

Parks have been there since the origin of cities but earlier mostly made for the nobility. For example La Alameda de Hércules, in Seville, Spain was built in 1574, within the historic center of Seville. It was later made public. The earliest purpose built Public Park, although financed privately, was Princes Park in the Liverpool suburb of Toxteth in 1842. The creation of Princes Park showed great foresight and introduced a number of highly influential ideas. First and foremost was the provision of open space for the benefit of townspeople and local residents within an area that was being rapidly built up. Secondly it took the concept of the designed landscape as a setting for the suburban domicile.

Parks, just as buildings or cities, are more or less famous and some are world heritages. Among the best know we find *Central Park, New York*, at the center of Manhattan in New York City, USA. This famous urban park, opened in 1857, is has 35 million visitors each year and spans over 300 ha. *Hyde Park in London*, England, a large city park in central London, famous for its Speakers' Corner, is a beautiful green lung in the center of the busy city. *Monsanto Forest Park, Lisbon*, Portugal is a heaven for nature lovers with trees covering much of the park, and efforts have been made to manage both plant and animal species. *Luxembourg Garden, Paris*, France, the second largest park in Paris, is the garden of the French Senate, which is itself housed in the Luxembourg Palace. It has beautiful lawns, formal gardens and fruit orchards, statues and fountains, but there are also jogging paths, tennis courts and fitness equipment.

Parks can be very small, so–called pocket parks just a few m^2, up to rather large forest areas, forest parks. Parks are often there for beauty, e.g. rose gardens or other plantations, for nature such as botanical gardens, for manifestations such as park of liberty, for performances e.g. concerts and theater. But most often they are recreation areas with an urban character and requires intensive development. They provide space for active recreation playgrounds: ball fields, swimming pools, gymnasiums, and skate parks. Passive recreation – rustic picnic areas, benches and trails – emphasizes the open-space aspect of a park and allows for the preservation of natural habitat.

9.4 A Post-Soviet case study – the parks of St Petersburg

St Petersburg is statistically a green city, with a large number of parks, gardens, squares, boulevards, green areas and urban forests, but the last decades of transition in Russia have affected the park situation economically, culturally and socially. Many parks are deteriorating due to lack of finances and the number of green areas is decreasing rapidly in favour to urban development.

By the time for the foundation of the city, parks and gardens surrounding the palace was a symbol of great status. In St Petersburg parks and gardens were established in and outside the city. Peter the Great started the tradition in 1704 and established the Summer Garden in baroque style by his summerhouse on the bank of Neva. The magnificent garden, designed by the Dutch landscape architect Van Rozen, was the starting point for the park culture in St Petersburg, followed by the imperial summer residences outside St Petersburg in Peterhof, Pavlovsk and

Figure 9.3. The mikro-rajon, the dwelling concept of Soviet Union in 1960-1990, involved a high ratio between green space and built up space. The open green space was seldom designed but planted and cared for by the new residents. A backyard in Kupchino, micro-district in the southern part of the city. (Photo. Ulrika Åkerlund).

Pushkin as well as the noble mansions like Tavrichesky and Oranienbaum. They were all built with great parks in baroque and landscape style.

Even though St Petersburg is most famous for its historical parks and gardens, 80 percent of the urban green areas were established during Soviet time 1917-1991. During this time St Petersburg, or Leningrad as it was renamed in 1924, expanded threefold. Hence most of the current urban green resource was established during the communist era, and is still characterized by the communist ideology and Soviet planning methods, in which green areas had three major functions; providing space for sports and recreation, sanitation (cleaning the air from industrial emission) and as memorial to Soviet history. The Soviet elements of the urban green resource, with a similar design, can today be found in any post-soviet city, from Tashkent to Minsk.

One of the classical Soviet urban green elements is the Park Kultury i Otdykha (park of Culture and Recreation), which illustrates the finest example of communist public parks. In the Soviet urban society, should devote spare time to sports and cultural activity in order to keep their body and mind fit. Hence these parks were designed and equipped with sports facilities as well as conveniences for specific cultural activities such as pavilions for reading, playing chess, theatre stage for performances and cafés.

Another typical kind of Soviet park is the lesopark (forest park). The term appeared in 1924 and was suggested to be "forest located not far away from the city" in order to be reservoirs of clean air in the industrial city and to be a place for recreation. According to their location, forest parks are classified as urban, suburban or semi-urban. Leningrad was the pioneer in planning of forest parks. The project of "Nevski" forest park was the first in the country (1936), but most forest parks were however not established until the 1960-1980's. The largest urban forest park in St Petersburg is Park Sosnovka (The Pine Park), in the northern part of the city. Its 302 ha of mixed forest was once located on the urban fringe, but is now totally surrounded by large roads and city districts of multi-family houses. Although a forest park is usually less well equipped with functions and facilities than a park of culture and recreation, they can have the same number of visitors as regular urban parks.

Development of the new modern Soviet urban society from the 1950's onwards was based on the concept of the mikro-rajon, literally meaning micro-district. The basic idea was to create smaller units of dwelling areas outside the city centre, entities where people had close to services, transports and recreation. Inspired by the Western architects and city planners, large blocks of houses, built in prefabricated elements, of five, nine and 15 storeys were put out on the Len-

Figure 9.4. Subbotnik, a public cleaning day in Tavrichesky Garden, organized during a Danish project (Photo. Cecil Konijnendijk).

ingrad wetlands. Each micro-district could house 6,000-15,000 people. Not all micro-districts were built according to the plan, leaving open space and vacant lots between the houses, designated as pustyr (literally vacant lot or non-built up space). In some cases the vacant lots have been invaded by nature and turned into wild areas and the local residents use the space for recreation. Together with the large backyards between the houses the vacant lots comprise a significant share of the urban green resource.

One of the main questions of the parks' future is for whom and what are the parks for? What function will the park fill in the future, and is then proposed restoration or development suitable for this purpose? To only return to the historical plan or to turn former public facilities into money generating activities, with a direct impact on the existing green areas, seems unlikely to be sustainable solutions.

Using the urban green space as social space is very common in St Petersburg today. This might be explained by several factors. There simply was a lack of private social space in the Soviet society and people met in parks and gardens. Another factor could be considered as the Russian heritage with the Russians having a close relationship to nature and especially to the forest, picking mushrooms, berries etc. The educational potential in parks is large as they often are located close to schools and kindergartens. In Moskowsky Park Pobedy and Park Sosnovka attempts were made to encourage teachers to use the park as a classroom for ecological and biological education.

Even though St Petersburg is developing, the apartments are still rather small and the tradition of using the parks, gardens and forests as an arena for social

and cultural activities, sports and recreation is still alive. Pensioners continue to gather in the Pensioners' Pavilion in Park Sosnovka playing cards a cold November day. Men meet by the Chess pavilion in Moskowsky park Pobedy, playing chess a sunny day in February. Children are skiing on the artificial mounds in Tavrichesky Garden, and teenagers can be seen hanging out, in parks all year round. Public cleaning days, subbotnik (deriving from the Russian's Saturday, expression for voluntarily working day), are still organized in parks and gardens and in the yards, gathering people.

The key to sustainable green development might not lie within keeping the number of square meters green space per inhabitant, but in an enhancement of the quality of the green areas and a proper distribution of green space throughout the city. A recent study in one of the micro-districts in south St Petersburg show that although the neighbourhood is very green, people would like to have more green areas. Improved planning, pustyry acknowledged as potential green space and not only as future land for exploitation, and suitable design and management could raise the quality level enormously.

9.5 Green buildings – the new wave

Plantation on buildings is not a new thing. On the contrary buildings from hundreds of years back often had plantations on the roofs and even some plant species, *Sempervivum tectorum houseleek*, adapted to roofs have names referring to this function. Greenery on walls and facades, e.g. with *Virginia creeper*, similarly is a classical way of making a building more beautiful and plants used are equipped with structures which cling to the walls. The new wave of green buildings are different in the sense that the greeneries are added to achieve a series of advantages from climatic services to food production – and in the middle of the city!

Green roofs are constructed for multiple reasons – as spaces for people to use, as architectural features, to add value to property or to achieve particular environmental benefits, for example, storm water capture and retention, improved species diversity, insulation of a building against heat gain or loss.

Vegetation on green roofs is planted in a growing substrate (a specially designed soil substitution medium) that may range in depth from 50 mm to more than a metre, depending on the weight capacity of the building's roof and the aims of the design.

Green roofs have traditionally been categorised as 'extensive' or 'intensive'. Extensive green roofs are lightweight with a shallow layer of growing substrate

Figure 9.5 Green facades in Sydney Australia (Source: https://upload.wikimedia.org/wikipedia/commons/a/aa/%281%29Central_building_Broadway_Sydney-1.jpg)

of less than 200 mm deep, requiring minimal maintenance. They generally have lower water requirements and use small, low-growing plant species, particularly succulents. 'Ecoroofs' or 'brown roofs' are terms used to describe these extensive green roofs. Roofs that are designed and planted specifically to increase local plant diversity and provide habitat (food and shelter) for wildlife are known as 'biodiverse green roofs'.

Intensive green roofs are generally heavier, with a deeper layer of growing substrate, and support a wider variety of plant types. Because they can support a heavier weight, they are readily accessed by people. Intensive green roofs need more irrigation and maintenance than extensive roofs, and are highly engineered landscapes, often built directly on structures with considerable weight load capacity, such as car parks. 'Roof garden' is used particularly for sites where less space is dedicated to the vegetation and growing substrate and more to hard infrastructure such as decking.

A *green wall* is comprised of plants grown in supported vertical systems that are generally attached to an internal or external wall, although in some cases can be freestanding. Like many green roofs, green walls incorporate vegetation, growing medium, irrigation and drainage into a single system. Green walls differ from green facades in that they incorporate multiple 'containerised' plantings to create the vegetation cover rather than being reliant on fewer numbers of plants that climb and spread to provide cover. They are also known as 'living walls', 'bio-walls' or 'vertical gardens'.

Green walls provide an attractive design feature, but also add to building insulation by direct shading of the wall surface. They create cooler microclimates and improve local air quality, and provide the possibility of growing plants in locations that would not normally support vegetation. A wide range of plants is used on green walls, usually herbaceous, though some small shrubs can also be suitable.

The provision of adequate light is an important consideration, particularly when planning an interior green wall, where artificial lighting may be necessary.

A well-designed green wall system will fulfil both design and functional aims by providing growing conditions suitable for the selected species, have a long lifespan, require minimal component replacement, and have achievable demands for maintenance.

A *green facade* is created by growing climbing plants up and across the facade of a building, either from plants grown in garden beds at its base, or by container planting installed at different levels across the building.

Climbing plants can attach directly to the surface of a building, or they can be supported on a structure independent of the building. The use of climbers that anchor themselves to a structure by twining stems or twining tendrils enables a green facade to be installed in front of solid walls or some other structure, to create a partition, privacy screen or sunshade. The degree of density of the façade coverage can be managed to suit the required function. For example, a facade designed to shade a building wall would ideally have greater foliage density than a screen installed near a window that is designed to allow at least partial views to the environment beyond the facade.

Green facades are often installed because they provide an attractive look to a building wall, or they may be used to block out a view, or to provide shade for a building. Green facades can create a cooler microclimate immediately adjacent to a building, primarily through direct shading of the building facade, but also from cooling from plant foliage (transpiration of water through the leaves), and evaporative loss of water from the growing medium.

All climbing plants will provide some retention of stormwater, shading of the building, protection of its surface, and capture of airborne particulate matter and volatile gaseous pollutants. These benefits will be greater for evergreen species that retain foliage cover year-round.

The distinction between green walls and green facades is not always clear. As the design and use of plants on vertical surfaces expands, systems become harder to define. For instance, a ‘hybrid living wall’ system has been created in Adelaide that uses both green wall and green facade technologies. This blurring

of definitions is akin to the already acknowledged difficulties in classifying green roof types, where new designs merge what were previously considered different categories.

9.6 Green roofs as urban ecosystems: ecological structures, functions, and services

There is a range of benefits that can potentially be provided by green roofs, walls and facades. Some provide benefits to the public at large and some only benefit the building owner or occupants. It is important to recognise that the following benefits are only realised if the roof, wall or facade is planned and constructed well and has the supporting management required to sustain it.

Green roofs (roofs with a vegetated surface and substrate) provide ecosystem services in urban areas, including improved storm-water management, better regulation of building temperatures, reduced urban heat-island effects, and increased urban wildlife habitat. Green roofs can lengthen the lifespan of a traditional roof surface. They protect a roof's waterproof membrane from solar radiation and add insulating materials (vegetation, substrate and other layers) to reduce severe temperature fluctuations on the roof surface.

Stormwater management. Green roofs absorb and retain rainwater and can be used to manage stormwater run-off in urban environments. They can also filter particulates and pollutants. Stormwater run-off can be reduced or slowed because it is stored in the substrate, used by or stored in the foliage, stems and roots of

Figure 9.6 Green buildings in Tongyang South Korean (Source: https://upload.wikimedia.org/wikipedia/commons/5/58/Tongyang_-_downtown_-_apartment_complex_-_CIMG9860.JPG

plants, and also evaporates directly from the substrate. Additional water storage capacity in green roof systems can be provided through incorporation of a water retentive layer or drainage layer at the base of the green roof.

Several factors influence the extent to which a green roof can reduce the volume of water runoff into the stormwater system, including depth and properties of the growing substrate, type of drainage layer used and roof slope. Plants and drainage systems are important considerations in the design of a green roof for stormwater management.

Improved thermal performance. A significant benefit of green roofs, walls and facades is the potential for reducing building heating and cooling requirements. Green walls and facades can reduce heat gain in summer by directly shading the building surface. Green roofs reduce heat transfer through the roof and ambient temperatures on the roof surface, improving the performance of heating, ventilation and air conditioning. While there is great potential to cool buildings, research data and the results of modelling studies vary greatly in relation to the extent of the difference in temperature and the energy savings that are predicted for buildings with green roofs versus conventional roofs.

Cooling a city – urban heat island effect. Hard surfaces in urban environments, such as concrete, brick, glass, asphalt and roofing, have a high thermal mass, collecting the sun's heat during the day and re-radiating it slowly back into the atmosphere. This contributes to a rise in ambient temperature in cities, creating large, stable masses of hot air (urban heat islands), especially during periods of calm, still weather.

Temperatures can be reduced by covering a roof or wall with a layer of vegetation that shades building materials which would otherwise absorb heat. Evapotranspiration provides cooling effects, as water is evaporated from the soil and plants and plants transpire by taking water in through roots and releasing it through leaves. Energy from the sun that would otherwise heat the roof or wall surface and increase ambient air temperatures is instead used in the evapotranspiration process, resulting in latent heat loss that lowers surrounding air temperatures. When green wall and facade plants are grown on a support system that leaves a gap between the wall and the planting, hot air moves up by convection through the space between the wall and the vegetation, providing passive cooling.

A city-wide strategy to implement green roofs, walls and facades could help mitigate some of the negative consequences of urban heat islands, and consideration should be given to appropriate plant selection and substrate depth to maximise cooling potential.

Creation & preservation of habitat & ecological biodiversity. Green roofs can contribute to and enhance biodiversity by providing new urban habitats and specific habitats for rare or important species of plants or animals. Green roofs can also provide a link or corridor across urban 'ecological deserts' and assist in migration of invertebrates and birds. Designing for biodiversity requires consideration early in concept development with regard to plant species, food sources, habitat values, access points and building heights.

Aesthetics, open space and urban food production. The liveability of cities is increasingly dependent on the availability of and access to green open space. Green roofs, walls and facades can increase amenity and provide opportunities for food production, recreation, relaxation or commercial ventures. In dense, rapidly growing urban areas, the contribution of green roofs, walls and facades to overall green space should not be underestimated. In inner-city areas especially, most space is occupied by buildings and related infrastructure and the opportunities for new parks and gardens is extremely limited. Green roofs, walls and facades can be used for multi-level greenery designs that connect with ground level green spaces.

Cleaning the air. Green roofs, walls and facades can contribute to the removal of gaseous pollutants from the air, although their effectiveness varies with plant species and area of cover. Plants with a high foliage density or with textured leaf surfaces that trap small particles also assist in removing particulate pollution, through dry deposition on the foliage or through rain wash. On a larger scale, green roofs, walls and facades can help to reduce overall environmental heat gain (re-radiation of heat from building materials with high thermal mass), in turn improving air quality as less photochemical pollutants are produced at lower air temperatures.

In interior environments, plants have been shown to have a significant capacity to reduce volatile organic compounds from the air. Carpets and other soft furnishings and office equipment are common sources of these gaseous pollutants; inclusion of vegetation, such as a green wall, can help to improve the air quality of the indoor environment.

9.7 Urban agriculture, urban farming

Urban agriculture or urban farming is the practice of cultivating, processing, and distributing food in or around a village, town, or city. Urban agriculture can reflect varying levels of economic and social development. In the global north, it often takes the form of a social movement for sustainable communities, where

organic growers, 'foodies,' and 'locavores' form social networks founded on a shared ethos of nature and community holism. These networks can evolve when receiving formal institutional support, becoming integrated into local town planning as a 'transition town' movement for sustainable urban development. In the developing south, food security, nutrition, and income generation are key motivations for the practice. In either case, more direct access to fresh vegetables, fruits, and meat products through urban agriculture can improve food security and food safety.

The cultivation may either be made in traditional lots around the houses or on the houses. Such lots have a long tradition in the East and start to be very popular also in the west. People grow their own vegetables fruits and berries not only for economic reasons but as well to have more tasty food and often more healthy that the alternatives offered in the supermarket.

Greenhouses attached to the residential buildings is an interesting possibility. Such greenhouses often also have an important social function as people, not the least the elderly, here find a place for meeting, having a cup of tea and talking while they are mending the plantations often vegetables.

Green buildings offer a number of options for growing vegetables, fruit, berries and flowers on roofs, walls and facades. A system for hanging plants on walls (and also e.g. in greenhouses) can be made without using soil at all. Just a pot of water with the needed nutrients. Such pots can be easily mounted on walls. Some system for the plants to support themselves may also be needed, although for example some of them may simply just hang.

For animals it is often more complicated in a city. Beehives are used to produce honey and in some cases hen are kept to provide eggs. Larger animals than that are normally not allowed in a city area. Pollinating insects are needed for fruit trees and berry bushes. Bees are excellent but bumble bees is an alternative. Places for bumblebees to live can be constructed from e.g. bamboos or any other small hollow tubes of the right size. Flowers are part of the system and are not only beautiful but also an essential component in the ecosystem which allows for fruit and berry production.

Different ways of urban farming are shown in figures 9.7- 9.9.

9.8 The strategic boundary zone between town and country

One of the new features of resilient citylands is the built/ green-blue interface zone between more urban and more rural functions. Nordic cities had traditionally, and still have, a very long green/blue interface line between settlements

Figure 9.7 Urban greenhouse established in the Mistra urban cultivation project. Source: http://www.mistraurbanfutures.org/sv/node/1274

Figure 9.8 On their way from hay in Kstovo close to Nizhny Novgorod Russia. Photo Vladimir Menkov https://en.wikipedia.org/wiki/Urban_agriculture#/media/File:Kstovo-hay-1536.jpg "

Figure 9.9 Growing Tomatoes, Leeks, Strawberries, Cucumbers and more on a wall for the Los Angeles Food Bank, USA. (Source: http://www.greenroofs.com/content/green_walls005.htm

Figure 9.10. Cultivation in the new fringe zone. In many suburban areas there is a direct contact with forests, fields and water and yet there is very little attempts to make use of the production values and other values related to urban farming. In this example large green areas have been transformed into productive land. Source: Per G Berg and Lars Rydén Chapter 11 Urbanisation and Urban-Rural Cooperation in Ecosystem Health & Sustainable Agriculture

and human cultures on the one hand and glades, meadows, forests, parks, arable fields, lakes, seas and rivers on the other. Throughout the history of civilization, edges between town and nature have proved to be the most preferred locations for habitation. For citylands the edge line is expanded to a wider zone: in this zone will be the important district green areas for neighbourhood recreation (district parks, play grounds, sports grounds, orchards, stables for sheep, cows, horses and pigs); in this zone there could be room for urban agriculture with green houses and community gardens, where fruit and vegetables can be grown for urban and sub-urban dwellers; in this zone there is room for clean companies and clean micro-production; in this zone there is land for industrial combines, refining the primary produce into food, fuel, fibre, boards and other building material; in this zone there is room for new recycling of waste industry; and in this zone there is room for the new generations or renewable energy (wind and wave power, Photovoltaics and solar heat collectors and bioenergy cultivations) and energy carriers (storage of bioenergy and electricity).

The future town-country relationship will therefore rely strongly on the organization and design of both inner boundary zones of the cities (settlements turning towards parks and community forests, fields and waters), but also between settlements and the outer nature, and between built areas and outer cultural

landscapes. Preliminary theoretical research and map studies of the morphological dynamics of city growth indicate that a long and winding interface zone between urban and rural functions are strategic for creating resilient citylands accessible for many citizens to experience urban and rural recreation, urban and rural culture and urban and rural production.

Furthermore, supplementary small-scale, peri-urban production systems for food and bioenergy and urban agriculture may play a more important role than previously.

It is reasonable to assume that world trade will continue to play a role in life support of world cities, but a relocation to relatively more local eco-cycles – where a larger proportion of basic bio-production and consumption may occur – seems to be a logical consequence of global change, the need for food security and local labour markets supplementing the global. An advancement of current knowledge about urban-rural: soil-plant systems; resilient crop production systems; forest ecosystems; microbial systems; ecotechnology systems; and resilient food systems in different scales will play key roles in the long-term survival and development of the renewed cities, countrysides and citylands in the future.

9.9 Biodiversity

Greenery in cities is not only important to humans. It contributes considerable to biodiversity. Thus birdwatchers have reported that Berlin – that has a very high percentage of green areas – has the largest number of bird species in Germany (Oberdorfer, 2007). It is also notable that many species which were earlier only found in the countryside today is increasingly moving to the cities for finding food, which is less accessible in industrialized agriculture, that "too" efficiently takes care of the harvest. For children and adolescents, the parks, green playgrounds and plazas in cities are more easily available than far away countryside. It is a highly valued resource for getting children acquainted with nature, for learning about nature protection and for play and moving the body.

The links between green areas in the city play here of crucial role. First of all undisturbed green connection including water is significant for transfer of plant material, which supports wildlife. It can be maintained in form of green corridors, which can consist of all forms, mentioned in classification of green structures. Green roofs might appear efficient for nesting, open water bodies for fish, home gardens and allotments for animals and plants. Secondly the undisturbed green connection equipped with pedestrian, bicycle routes is valuable for health of city dwellers, because of their restorative qualities. Besides that it can help to create

a preferred, more psychologically acceptable urban environment at a whole city scale.

Traffic infrastructure is here a difficulty. In some cities and countries links between green areas have been created as tunnels or bridges for wild life over or under streets and busy roads. They are important for frogs, hedgehogs, does and badgers, all animals which tend to be killed on roads. But they are also important to the traffic which is made safer if conflicts with wildlife are avoided.

Importance of greenery along streets, in squares and all other urban interiors should be obvious not only because of aesthetical reasons. Creation of well-connected urban green structure adds valuable new qualities to an urban environment. Maki addresses linkage as the most important characteristic of the urban exterior space, stating that: "Linkage is simply the glue of the city. It is the act by which we unite all the layers of activity and resulting physical form in the city… urban design is concerned with the question of making comprehensible links between discrete things. As a corollary, it is concerned with making an extremely large entity comprehensible by articulating its parts."

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Chapter 10
Mobility and Urban Traffic Infrastructure

10.1 Mobility is increasing

The growth of traffic is dramatic all over the world. For both transport of people and of goods the development is going in a non-sustainable direction. Car and lorry traffic becomes an increasingly larger part of the transport system. In Europe the transportation of people has increased 25 % over the last 25 years. On the average people make three shorter trips daily, mostly by car, which add up to some 40-50 km/day.

The increasing traffic is a result of growing economies and more material welfare. The growing traffic in turn is itself also producing growing economies and more material welfare. Such a self-reinforcing system with positive feedback is not sustainable in the long run and it is necessary to take action to control it. While other sectors in the economy have reduced its energy use and emissions, it has increased in the transport sector.

There are many strong interests in the society connected to the traffic system. What can be achieved in the cities and towns, the municipalities, to approach a more sustainable traffic system? The total transport system can be discussed either as an issue of the movement of people or transport of goods, or in terms of distances.

All strategies have to take in consideration that municipalities are competing with each other. Every city tries to attract people and business by offering an efficient infrastructure and possibilities for transport. It is important to identify what kind of need there is for transports. A large logistic-oriented company needs efficient transport solutions, while a human power orientated consultant company rather needs efficient IT-communication, attractive workplaces and an attractive city as a whole to live in. The city may therefore, in that sense, be planned in a zoning system, where the transport oriented companies will get good access to the national and international transport system, while others can be located in more densely built areas, not so favourable for car traffic.

Some cities are focusing on transport intensive solutions, which they believe are crucial to place their own municipality in “the middle of the world” to attract

new business. There is anyhow no guarantee that a good geographical position is enough. On the contrary it is sometimes not necessary at all. Regions and even countries, which are far away from the main transport corridors, can be economically very successful, for instance Ireland and Iceland.

Thus there is one category of strategies, which may be described as the 'large city' working with transport oriented solutions on the world market, while another group of strategies are aiming towards a 'small city', to improve the quality of life for inhabitants and visitors.

In the small city the methods, which are discussed here, can be implemented very systematically. The small city strategy is not only resulting in a more sustainable city from a narrow environmental point of view. It is also giving much better quality of life and more attractive cities to live in and for people to visit. To attract new business to the city is not anymore only about offering good investments solutions. It is also important to create an attractive city where the enterprises can offer co-workers a good place to live in.

Even if the possibilities for the municipalities are limited, because of the very complex situation of interests and stakeholders in the system, some important political tools are available to implement a more sustainable traffic strategy. These are shortly described below. The strategies to reduce traffic includes several principles, which will result in actions in several steps:

- Reduce the need of travel.
- The urban areas can be organised to decrease distances by reducing urban sprawl.
- The city should be multifunctional in a way that many visit points are close to where people live.
- Look at streets as a design element in the city rather than transport corridors!

10.2 Urban planning and car free areas

The design of our cities is a product of all previous urban planning. Older cities were certainly not built for cars and adapting to the presence of cars in old streets and on squares and piazzas intended for people to meet, has come at a high costs. Air pollution is sometimes unbearable. Around 7 million people globally are estimated to die from air pollution every year, a large share of them children and elderly, not to mention the millions more killed in accidents involving motor vehicles. Also here children and elderly are overrepresented.

Congested streets is a problem also for car drivers and open places and pavements completely filled by parked cars is not nice for anyone. More recently

Figure 10.1 The pedestrian car-free zone in Bielsko Biala Poland. Photo: Gaj

inhabitants and politicians have sought for other ways and an increasing number of cities around the world are trying out car-free initiatives, such as car-free days or car-free areas.

Many older cities in Europe, Asia, and Africa were founded centuries before the advent of the automobile, and some continue to have car-free areas in the oldest parts of the city -- especially in areas where it is impossible for cars to fit, e.g. in narrow alleys. The city of *Venice* serves as an example of how a modern city can function without cars. This design was unintentional as the city was founded over 1,500 years ago, a long time before the invention of the automobile. Visitors who drive to the city or residents who own a car must park their car in a carpark outside of the city and then proceed either by foot or train into the city. The predominant method of transportation in the city is by foot, however most residents travel by motorised waterbuses (vaporetti) which travel the city's canals.

An existing city can be made a car-free by strategic closures of streets to car traffic and by opening streets and squares to exclusive pedestrian use. Hamburg, Germany's second largest city, is currently making waves by developing a network of routes for pedestrians and bikes that link parks and open spaces together. This "green network" will span 40% of the metropolis, transforming Hamburg into a more human-friendly environment, while also playing a role in absorbing CO_2 and bringing the city closer to its goal of an 80% reduction in greenhouse gas emissions by 2050. There are thousands of large and smaller cities in Europe and the world, which have developed car-free areas to their benefit.

The largest parts of contemporary cities have developed after 1945, when a modernistic urban planning, emphasizing functionality, practical transport roads, light and space gave rise to the thinly populated urban structures we see in many

Box 10.1 International Making Cities Livable Council Transportation Planning Rules

The transportation planning rules below only seem to be simple, their application is indeed a difficult job. But often simplification helps in the discussion and enforcement of environmental requirements.

Rule 1: Make every effort to accommodate the real needs of people. Do not forget the children, the elderly and the disabled. Prepare your plans and programs in cooperation with the public concerned. Urban planning and transportation planning is a social, psychological, economical, ecological, architectural and engineering job.

Rule 2: The prosperity of a city does not depend on private car traffic, but on accessibility in general, on the amenity of its streets and open spaces and – to put it more succinctly – on its genius.

Rule 3: Transportation and land use must be balanced. Mixed land use must be achieved to reduce journey distances. High density with mixed land use is effective from a transportation point of view. But don't go beyond the limits of the rule.

Rule 4: Mathematical modeling of traffic behavior and traffic volumes is an important preparation for the decision making. But don't stretch it beyond its limited validity.

Rule 5: Observe the environmental ranking of transportation modes: walking is preferable to cycling, cycling is preferable to public transport, and public transport is preferable to private car traffic.

Rule 6: Urban Streets are open spaces for the general public. Consider all functions of the street – social life, strolling around, providing access to buildings, as well as being a transportation facility for pedestrians, cyclists, public transit and private car.

Rule 7: With increasing density the needs of traffic regulations and their enforcement grow rapidly. Strict area-wide parking restrictions are the most effective measures to control traffic.

Rule 8: Most important, especially in high density areas, is urban design and architecture according to human scale. The design quality of a street helps to compensate for the environmental impact of car traffic.

Rule 9: The ground level of streets has to be primarily designed for pedestrians and cyclists, including wide sidewalks, bike lanes, and crossways over the driving lanes.

Rule 10: Provide more plantings and trees within the streets, including façade and roof planting, thus opening the sealed street surface, improving street climate and visual impression and hiding bad architecture.

Source: Hartmut Topp, Professor of Transportation Planning at the University of Kaiserslautern, Germany.
http://www.livablecities.org/blog/ten-simple-rules-urban-transportation-planning-hartmut-topp

places today. This has resulted in the dominance of the car, segregation of people, a loose urban fabric, and barriers which need to be overcome.

Today we see a counter force to the dominant car-adapted structures. Efforts are made to get the quality of the city centres grow from the core to the outskirts of the city. This could be realised by establishing so-called strategic passages – thoroughfares – to form a kind of skeleton. This will allow a living city, with increased pedestrian and bike traffic, to develop. In the same way as the modernistic urban planning once dominated, we see today densification and connectivity as equally important concepts in urban planning. It will allow the urban space to include meeting places to reconnect the inhabitants. The traffic infrastructure should include contacts between the strategic passages and with the surrounding built environment and green areas and support the experience of both cultural and physical connectivity.

10.3 The car parking dilemma

The increased preference for cars has obvious consequences for how our cities, villages and countryside looks like. The mobility infrastructure is a key feature of our societies. Trafficscapes are dominating our outdoor environment especially in cities but also in countryside. In cities this is mostly negative for culture and the architecture, possibilities to meet and social relations. In cars people are isolated and do not interact. “Reclaim the cities” is a counterforce; the increased number of car-free city centres as well.

It is believed that more cars will produce a growth in mobility and more trips per person per day. This was based on the observation that with increasing motorization, the number of possible trips per person per day increases. This was so impressive that large amounts of urban space were converted into parking space. But the reality is different. Mobility is always related to a purpose, and if the purpose does not change, mobility does not change. As the number of trips by car increases, the number of trips on foot, by cycle and by public transport decreases. The number of trips per person per day remains constant.

The system as it stands today can be influenced by appropriate measures as demonstrated by the case of Eisenstadt in Austria, where scientific system-related transport principles, taking real human behaviour into account, have been successfully implemented. In 1975, the city was crowded with cars. While 10,000 cars passed through the city centre each day, only 6,000 pedestrians were counted (Figure 10.2). Today there are between 26,000 and 40,000 pedestrians per day, and no cars, and both mobility and business in the city centre have increased

Box 10.2 Mobility and connectivity – key words for the 21st century

Governments and urban planners need to think mobility ahead of traffic when designing the infrastructure of tomorrow. Smart mobility solutions can be a steppingstone for growth – mobility is the end, infrastructure the means. Infrastructure in its totality – whether roads, railways, bicycle paths or fibreoptic cables – should serve as a means of enhancing mobility in society connecting people and goods, knowledge and innovation, cities and regions. We need to put the concept of mobility at the top of the agenda. Mobility is required not only for developing efficient liveable cities but also for attracting top talents and investments.

The basic infrastructure across Europe is generally satisfactory. The weak point is short-distance *connectivity*, also known as *the last-mile barrier* – people's need to get to public transport, the train station, for example, from their homes and offices and vice versa. Connectivity is more important than mobility. Because connectivity can maximise the use of all our various transport systems and cover the majority of those short-distance trips, which are the core of liveable, sustainable cities.

Source: Morten Lund interviewing Neel Strøbæk, Ramboll's Group Market Director of Planning & Urban Design. http://www.ramboll.com/megatrend/feature-articles/mobility-and-connectivity

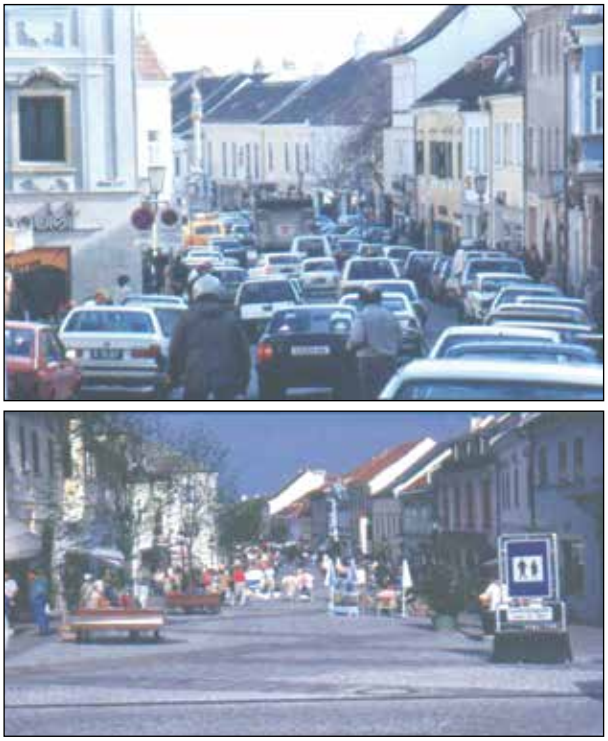

Figure 10.2 The city of Eisenstadt before and after the project to change. After the change there were 30,000 pedestrians per day. Source: Herman Knoflacher, Vienna Univ of Technology.

(Figure 10.2). A number of measures were necessary to change this human behaviour: besides developing a pedestrian area in the city centre, parking management was also needed. Now, cars are parked in garages instead of on the streets, traffic-calming methods have been introduced around the city centre and the city taxi has been introduced.

One of the most important goals of transport policies is the prioritization of public transport – but this does not work if much of the population has cars parked in front of their homes or in garages and the public transport stop is several hundred metres away. And if the destination is organized in the same way, public transport has no chance against car traffic. Under these conditions, everybody will try to buy a car and increase the degree of motorization, thereby exacerbating the problem. The solution is a total reorganization of the existing parking situation everywhere (not only in cities). Instead of the individual optimization of human activities and car parking, strong incentives should be provided to park cars in garages that are only as accessible as public transport stops – at all origins and destinations.

If a transport structure was provided that gave people a genuine choice between cars and public transport, better environmental conditions, more flexibility and opportunities for nearby jobs, and recreational activities and social contacts, it would take no time to switch from intelligence-free planning to intelligent planning, taking into account real system behaviour. About 70 per cent of urban space would then become car free. This is a tremendous benefit relative to the costs of restructuring the existing unsustainable system. With the space recovered, new urban activities would develop from this equality of choice between cars and public transport. If we take real human behaviour into account, the effect is bigger, as around 80 per cent of the urban structure could become multifunctional.

10.4 Mobility management

To increase sustainability in urban traffic municipalities have a full orchestra of different methods to influence the development in a chosen direction.

Land use planning. Organise the urban area in a way, which make it possible to reduce transports needs and make transport modes more sustainable. Prioritise parking for bikes instead of cars in the city centre. Create service close to large residential areas. New residential and multifunctional areas are built close to the city centre. The maximum distance from the city centre for the main new infrastructure should be about 5 km, which will make it easy to reach by bike. The grid of streets is made as in the pre-car period to reduce the need to drive car

long distances. Food shopping should be as close to residential areas as possible. In the central part of the city a very large number of parking places for bikes are organised.

Produce sustainable infrastructure. Use the public investments in a sustainable way. Build more bicycle lanes, tracks to trams and buses and less roads for cars. Use existing infrastructure more efficient instead of building new. Support alternative fuel stations. The infrastructure investments are concentrated to get good conditions for logistic orientated business and otherwise create a non-car orientated systems with an excellent grid of bicycle lanes and an effective public transport system. Investments, which support alternative fuels, are encouraged. The permitted maximum speed of cars is reduced to 30 km/h in many parts of the urban area. Implement local rules in the traffic systems, which prioritise a more sustainable traffic in the everyday traffic situation. The accessibility for cars are reduced by building a multitude of bicycle lanes. The rules in the traffic give pedestrians and bikers good shelter. Try to influence the regional road planning for more cost effective investments.

Public procurement. Use the economic power in the municipality as a good purchaser that is demanding environmental behaviour from its contractors. The municipality has a large part in the transport sector by running residential areas, public service, infrastructure, etc. In the management of this they use and choose sustainable solutions and put demands on the contractors that that should act in environmentally responsible when making business with the municipality. A public procurement (purchase) policy is implemented.

Public awareness. Campaign about participation in creating a more sustainable traffic system. Campaign for environmental lifestyles. Campaigns are made all the time to get more bikers, to more customers to public transport. Environmental goals have been approved. Develop bicycle renting system to increase the total supply of bicycles. Give status to peoples who are using public transport and bikes. The leadership of the city, who takes the bus or bike to work, are good examples.

Public transport. Participate in running a successful public transport system. The municipality subsidise through tax money the public transport system. Develop transport systems which fill the needs for different travellers; high speed, safe, comfortable etc. Give priority to the public transport vehicles by separate lanes and give green lights quicker in crossing, are components in agreements when purchasing public traffic.

Distribution of goods. Be engaged in the distribution of goods. Participate in the development of collected distribution. The municipality has a project, which

Box 10.3 Mobility Management Centres

Mobility Management is becoming an established method to promote sustainable transport. The traditional core of mobility management is so-called soft measures. These include all kind of user services, such as information, coordination, education, etc. These soft measures are combined with, and increase the value of, hard projects, that is, infrastructure developments such as building roads, bridges, bike roads, tram lines etc. The soft measures are targeting the mobility behaviour of the inhabitants of a city or region, while the hard projects are addressing the structure in which they move around. A core objective of Mobility Management is to reduce car use and thereby car traffic.

Mobility management is typically introduced, developed and run by medium-sized cities. It is found all over Europe. A coordination and support programme is the European Platform on Mobility Management, EPOMM (www.epommweb.org/).

A Mobility Centre is the operating unit at the urban/regional level. A Mobility Centre is typically providing services to the inhabitants, the public, through individual access for personal visit, phone, fax, e-mail, information terminals or online services. The customers are not only individuals, but, equally much companies, authorities, schools, hospitals etc. A Mobility Centre gives Mobility Management a public face and promotes a new way to deal with mobility in a city both for public and the market.

The Mobility Centre is often placed in an easily reachable place in the city, and may thus receive customers in office hours, like a shop. It often provides some free services, such a free-of-charge bike maps, or time tables for municipal transport, but may also sell tickets for municipal transport, including month cards or other corresponding rebate tickets.

The traffic in a city consists of the totality of traffic to and from a large number of sites, such as work places, shopping areas, schools etc. The task for the Mobility Management Centre is to improve, make more sustainable, the traffic to and from all these sites. The Centre may work to this end with specific measures, such as traffic to and from a specific work place. But it may also work with general measures, which will support good municipal traffic in general, such as improving bus traffic, or promote biking.

A Mobility Management Centre typically works with some 30 projects at a time. These, ordinarily soft projects, have to be coordinated with what the city works with in terms of infrastructure developments. These “hard projects” may be either large investments, such as bridges, roads, or tram lines, but more often a collection of smaller scale investments, such as parking places, bike roads, bus stops etc.

One way is to promote car sharing. Car sharing may be that individuals, who travel to the same working place, get to know each other and organise driving together. Finding friends for car sharing may be organised by a Mobility Centre. A car pool is a different way of sharing cars. Car pools are organised common use of a number of cars. They are advantageous for individuals who use a car less often, but needs it sometimes for trips for example to far away shops for buying furniture, delivering waste, or to visit family not easily reachable by public transport,

Box 10.3 Mobility Management Centres

A Mobility Centre is a core element for mobility management in Prague. The concept is oriented towards the public transport system, which is the basis for a sustainable city development in Prague. The following services is offered to the general public:

- Comprehensive individual time tables and multi modal transport information
- Sales and reservations
- Event information and reservation
- Internet and phone accessibility

Other typical mobility management projects include.
Promote use of *distance technologies*, ICT to avoid travel all together. A centre may e.g. set up a place where there is access to video conferencing for meetings, or provide short courses on how to do it, and how to run and get access to the best equipment. Another typical use is distance education and thus being able to study without travelling very often.

Deliveries of goods, transports to and from shops, is often a quite unsustainable part of city life and may be improved in several ways. One is to coordinate it by establish in the outskirts of the city a central to which distance transport – typically rather large trucks – delivers the goods. Then a smaller and environmentally better lorry, it may be electric or run on biogas, takes the goods to all shops in the city in one delivery. Shopping malls outside cites cause a considerable amount of car traffic and if the local and centrally placed shops are supported with easy delivery of goods, this may be quite important for reducing car traffic and also for keeping the centre of cities live and interesting.

Promotion of biking by keeping biking roads in good shape and well maintained, including e.g. good pavement good lightening, proper signs at biking roads, prompt snow removal after snowing, and good parking places for bikes, and finally biking schools for children.

Promotion of public transport either by harder projects, such as improving bus stops, but also by soft projects such as campaigns for using trams or buses, research to find out what is good and less good in the existing public transport, and improve whatever is not working well.

Large events to which several thousand or tens of thousands of spectators attend, such as rock concerts or sports events etc, are typically characterised by a smaller or larger crisis in car traffic. The international 'SMASH-EVENTS' project aims at developing a standard for integrated environmental management for large events like cultural events, music festivals, exhibitions, etc. (http://www.smash-events.net/index.phtml?sprache=en).

Source: Lars Rydén *Mobility Management* in Traffic and Transport Baltic University Urban Forum publication Urban Management Guidebook IV, pp 7-10 http://www.balticuniv.uu.se/buuf/

tries to change the distribution of goods in the city to a common distribution system. Create environmental zones in some parts of the city.

More efficient use of vehicles. Engage in developing car sharing systems and other methods to have more transport per vehicle. The municipality-owned housing company runs a car sharing system. Offer education to all drivers in eco-driving. Demands on contractors to use sustainable transport systems and vehicles. Give status to peoples who are using public transport and bikes. The leadership of the city takes the bus or bike to work and are good examples. Give privileges to cars, which are environmental friendly by e.g. cheaper parking, more access to parking.

All these tools and method are of course dependent of the willingness from the leadership of the municipality. If there exist a will, there are possibilities to change the direction of the society, as we know from experience in many places around the world. In many cases the steps are small but if small steps are produced in the same direction the results will be accountable. Implement actions, which are supported by the majority e.g. after surveys. In Swedish cities like Malmö, Linköping, Sundsvall and Örebro all surveys have shown that people want a less car-friendly city centre.

10.5 Municipal road safety

Ever greater mobility comes at high price. Every year 1.3 million people are killed worldwide as a result of road accidents and up to 50 million are injured. More than half of all road traffic deaths occur among young adults ages 15-44, and many are children. Road traffic crashes rank as the 9th leading cause of death and account for 2.2% of all deaths globally.

The Nordic countries belong to the countries in Europe which have the highest road safety performance. The countries in Central and Eastern Europe have still a long way to go to reach a similar safety level. Vision Zero constitutes the basis for road safety policy in Sweden since 1997. In 2013 number of killed in traffic was 264 lowest figure since 1944, in spite of manifold more cars of the roads.

Pedestrians and cyclists are particularly vulnerable groups in the road traffic. In the Nordic countries some 10-15% of the annual fatalities on the roads are pedestrians. In the other countries more than 30% of the annual fatalities are pedestrians. Thus pedestrians is a key target group for policies and measures to improve the road safety situation, especially in Central and Eastern Europe. Approximately 10% of the fatalities are cyclists.

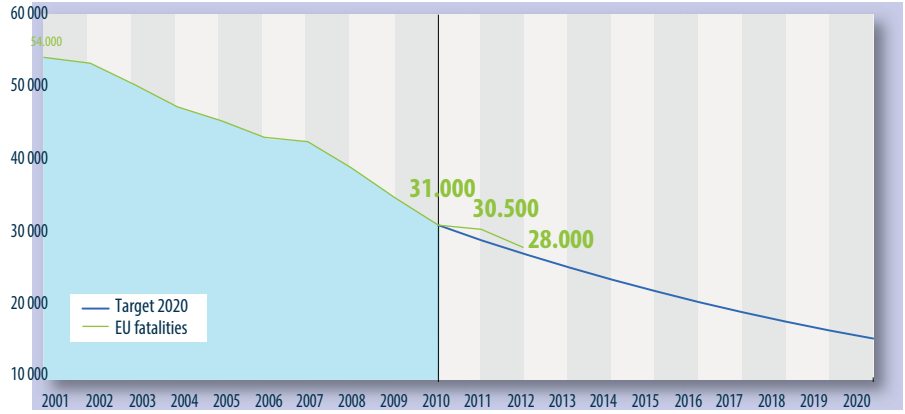

Figure 10.4 Road fatalities in the EU since 2001. Source: EU

The accidents in the road traffic cause considerable economic losses to society due to costs for medical treatment, material losses and loss of production. In the European Union the loss is about 2% of GDP.

In most accidents in the road traffic, *speed* is an important risk factor. High speed contribute to accidents and the severity of injuries are directly related to the speed. Excessive speed is the main cause for road accidents. The Transport Research Laboratory in the UK has shown that a reduction of the average speed by 3 km/h would save 5,000-6,000 lives in the EU area. Furthermore, the number of accidents would be reduced by 120,000-140,000 and 20 billion Euro would be saved.

The consumption of *alcohol and drugs* is another risk factor. In the European Union, drinking and driving is responsible for more than 10,000 deaths each year. Increased consumption of alcohol in society tends to worsen this problem.

Failure to wear a seat belt or crash helmet is a major aggravating factor in accidents. If the rate of seat belt use could be increased everywhere to the best international rate, many thousands of lives would be saved each year.

Many serious road accidents at the roads involve *long-distance trucks*. A collision between a car and a truck often leads to fatalities or serious injuries. The number of long-distance trucks have been growing rapidly in the past decade, especially in Central and Eastern Europe. It should be emphasized that the risk factors that contribute to accidents interact in complex ways.

At the local level, it is important that priorities and targets are laid down in a municipal programme for road safety. It is important that such a programme be communicated to all relevant actors at the local level.

Possible measures for a municipal road safety programme include the following:

- Reduction of the speed limits to 40 or 30 km/h in urban areas
- Separation of pedestrians and cyclists
- The establishment of safe pedestrian crossings
- Speed reduction devices at "black spots" or "black areas" in the cities
- Construction of roundabouts
- Find solutions to travel without increasing the numbers of private cars
- Car free areas in city centres

Perhaps the most important driving force for improved road safety at the local level is the power of the good example. Once a good example is in place, other cities tend to become interested in the solution.

In the past decade, the authorities in Stockholm decided that the speed was to be limited to 30 km/h in all built-up areas. The main reason for this decision is that pedestrians and cyclists are likely to survive a collision with a car when its speed is about 30 km/h. If speed is higher, for instance 50 km/h, the chances for the pedestrians and the cyclists to survive are significantly lower.

Everyone who travels in Sweden will notice that there are a large number of roundabouts (circulation places). Roundabouts, which have been commonplace at intersections in the cities, have a traffic calming effect. The consequences of a collision is considerably less severe in a roundabout than in a normal intersection. This is due to lower speeds and different angles of impact. Furthermore, a calmer traffic leads to less emissions of air pollution from the car traffic.

In June 2005 the Ministry of Transport of the Czech Republic launched a project aiming at improving the road safety situation in urban areas. The project support road safety activities of municipalities by providing information on best examples and possible solutions. The project covers three types of 'interventions': education, enforcement and engineering.

The Swedish municipality of Helsingborg use several ways to increase the safety of children in the traffic between home and school.

- Increase the number of children walking or biking to school, which will reduce congestion and air pollution and provide an opportunity more physical exercise for children. 'Walking school bus', that is children walking together with a parent, has been successfully implemented.
- Promote of the use of safety equipment such as helmet for bikers and, safety belt in cars.

Figure 10.5 The Old Market Roundabout in Bristol, England. CC Photo: Adrian Pingstone.

- Physical changes in traffic environment to increase the safety of school children in the traffic, particularly near the schools, e.g. speed reduction measures.
- Integration of 'traffic' in the ordinary school subjects and support teachers to find pedagogical ways to integrate traffic in ordinary school subjects.

The Swedish city Göteborg has invested in a number of speed reduction measures since 1990. Today it has the best road safety performance of all cities in Sweden. The number of fatalities and seriously injured persons was reduced by 60% in a decade.

10.6 Biking in cities

In general biking does not represent a very large share of transports in our cities. The number of trips on bikes was in the west of EU about 10% (12% in Sweden 2003), and they are certainly much less in the East. It could be increased considerably. In some cities biking is much larger, up to 30 or 40%. To move over part of the local transport to bike has a large potential for improving urban environment and quality. There are however a number of obstacle which have to be removed. These include

- insufficient road, parking and other infrastructure for bikes
- insufficient maintenance of bike roads
- lack of a biking culture
- insufficient road safety in general and for bikes in particular

Figure 10.7 Biking in cities depends on good biking paths. Here in Vienna Austria (Source: Hermann Knoflaucher)

But the most difficult problem to deal with is probably habits and knowledge. People who did not use a bike for their entire life will have difficulties to change their habits. The understanding of the conditions and advantages of biking is low in the general population.

The bicycle makes sense in cities. With rising urbanization, our cities need modern mobility solutions, and moving around on two wheels proves time and again that it can offer results.

Investment in bicycle infrastructure is a modern and intelligent move. Plenty of research shows the social, economic, environmental, and health benefits of urban cycling. Studies from Denmark tell us that for every kilometer cycled, society enjoys a net profit of 23 Eurocents, whereas for every kilometer driven by car we suffer a net loss of 16 Eurocents. It is easy to understand. Biking has no emissions. Infrastructure for biking (bike paths and parking) is cheap and small and it is healthy for the individual. Many bikers like to be "outdoors", rather than inside a car or bus. Mean speed of biking is about 20 km; 6 km takes 20 minutes.

Biking in cities are on the increase, also in large cities e.g. Paris and London, where also an extensive system for renting bikes have been introduced. In Copenhagen and Amsterdam it is established since long. In Stockholm 150,000 commute daily to the workplace by bike, a figure expected to double in ten years. There is a huge untapped potential for biking in cities in Central and Eastern Europe.

The top 20 biking cities are presented in the Copenhagenize Design Company's Index of the most bike-friendly cities in the world. In 2011 it ranked 80

global cities, in 2013 150 and in 2015 122 cities with a population over 600,000. (Copenhagenize Design Company is an urban design consultancy advice cities and governments on working toward a more bicycle-friendly urban landscape, infrastructure, planning, and urban design).

Amsterdam is ranked number 1, the top biking city in the world. In Amsterdam the society provide a safe environment to ride in. Here, everyone bikes: the young, the old, the tourists, including pregnant women. Most car drivers here are also cyclists, which enables them to better anticipate the behaviour of cyclists in traffic. Driving instructors teach new motorists to use their right hand to open their door, which forces the driver to turn, putting them in a better position to see if a cyclist is approaching from behind. Amsterdam is by no means perfect. Cycling fatalities do occur – estimates say about six a year.

10.7 New technologies for sustainable urban transport systems

There are many shortcomings of the conventional car. It has a combustion motor. In a conventional car the combustion motor is very inefficient. Typically some 18% (petrol) or 22% (diesel) of the energy in the fuel is used to move the wheels. The rest becomes heat. Further the car depends on fossil oil, which leads to CO_2 emissions. It is comparatively heavy, often close to one tonne; air pollution caused by cars is serious; Cars are noisy especially at higher speeds; Cars take much space, especially in cities. We need to shift technology completely to create a sustainable urban transport.

A first step is to change the fuel use. The biofuels include biogas, bio ethanol and biodiesel. In some situations the use of biofuels may be the best alternative. When food waste and other organic waste in a city are used for biogas production it may be sufficient for all city buses, thus establishing a sustainable recycling system. Biogas buses cause much less air pollution and are less noisy. Large-scale production of bio ethanol is only sustainable if it is not using fossil fuels during production or it is competing with other more important uses of the crop. Bio ethanol is today the dominant bio fuel but is not considered to be a long-term solution. Similar considerations are valid for bio diesel, although biodiesel from forest waste is sustainable. Both are today mixed in standard fossil fuels to decrease CO_2 emissions from traffic.

Another possibility is to change the energy to electricity. In an electric car the efficiency is much higher, at best case closer to 80-90%, which is, about four times as much as the combustion engine. That is why in a sustainable transport system electric cars are expected to be an important component. Electric cars may

Figure 10.8 Space required to transport 60 people by car, bus and bike.

use batteries or fuel cells. An intermediate system is the hybrid; it uses fuels to produce electricity very efficiently.

The electric car is on the increase. In the Netherlands one expects 200.000 e-cars in 2020 and 1,000,000 e-cars in 2025. A nationwide network of charging points is being built and a growing sector of electric cars related products & services produced.

The fuel cell car is only in its beginning but is assumed to be the very best alternative in the long-term. The fuel would then by hydrogen gas produced from water and solar electricity.

A large part of the energy consumption in cars is caused by friction between the tyres and the road. That is why rail traffic is energy-wise so much better than road traffic. Electric vehicles on rail, trains and trams, is the most energy-efficient way to move both people and goods on land. A well-functioning metro, tram and local train systems are important components of a sustainable transport system in a city.

Train traffic is also the best alternative for freight traffic on land. Fast trains have the possibility to replace much air travel without much time loss and with

increased comfort running from city centre to city centre, with a dramatically reduced environmental impact.

In public transport emissions per person kilometre is drastically reduced both when bus is used, and even more so in train or tram.

Traffic infrastructure would be much better with more public and less private transport, and congestion would diminish. Good public transport avoids waiting and time lags. Halfway between private and public transport is car sharing when a group of people, have a so-called car pool. Car sharing has many advantages: cars are used more, the maintenance of the cars is better organised. Car sharing is increasing in big cities, and the number of cars in big cities are decreasing in many countries.

10.8 Public transport

Public transport is the classical way to make transport and mobility efficient both economic and resource wise. It requires less urban space when we travel together and there are more person kilometres covered per kWh of energy used. If public transport is on rail it is particularly energy efficient. If the electricity is used and it comes from renewable sources, such as hydropower, it does not contribute to GHG emissions and climate change. It is also almost entirely free of air pollution and comparatively silent.

Large cities solution to the dilemma of urban traffic spells public transport. Public transport include city buses, trolleybuses, trams (or light rail) and passenger trains, rapid transit (metro/subways/undergrounds etc) and ferries. It can be very

Figure 10.9 Transireno busses. A famous case of very efficient introduction of public transport are the TransMileno buses in Bogotá, Colombia. They are running on a very tight schedule and thus waiting time is short, and they have priority over private cars and thus are very fast. Source: https://en.wikipedia.org/wiki/Public_transport#/media/File:TransMilenio_01.jpg

efficient. In many large cities it is almost meaningless for a private household to own and use a private car as other options are cheaper, faster and more comfortable. It is clear that in large western cities car use is on its way down since about 2000. When cars are needed, e.g. for trips to the country side, car leasing is a better possibility.

Local public transport companies are very often owned by and run by the municipality, but more often today it is "outsourced" that is the municipality byes the service from a private company. They run on a specified timetable. Only if the use is very high does public transport become profitable. But in many cases municipalities run buses etc to areas where few live and thus ticket fare does not at all cover real costs. The fare for public transport is most often decided on by the municipality. Sometimes only a small part of the costs are covered by ticket sales. Some cities have introduced a zero fee and thus you may use city buses for free. It does increase the use of buses but not that dramatically. Other negative factors are too important for a sector of the inhabitants. These include access, waiting times, and comfort.

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Chapter 11
Water in Cities

11.1 Water and sustainability

Water is basic to life and a most valuable resource we should cherish, protect and use wisely. This is a main concern in urban sustainable development.

Water can be perceived both as a material resource and as a component of urban planning and urban space. These two aspects are linked and need to be both considered when designing strategies for sustainable water management. It should be noted that the European Union Water Framework Directive, the first of the EU framework directives, has integration and a systems approach as its main objective. As a material resource water flows is seen together with energy flows and material flows carried by the water. As a component of urban space surface water is seen together with green structures (the blue and the green) and the built structure.

As always integration is the first and most important aspect of a sustainability strategy for water management. Integrated water management is best organised according to drainage basins or river basins. Cities may be anywhere along such river basins, but very often large cities are found at the outlet, the delta, of a river basin.

These cities are thus much dependent on river basin management. It includes water for irrigation in agriculture, water used for hydropower and its consequences, traffic on water, water for recreational purposes, and water for conserving a natural environment and biodiversity. Most often water for industries, cities and agriculture represent competing uses of water and also the uses which leads to the most serious water pollution. All these aspects interact.

In northern Europe water is a comparatively rich resource, especially in the north. In Central Asia it is the opposite, water is a scarce resource. But water saving measures are important everywhere in order to reduce the costs – material, energy and economic costs – connected with the extraction of fresh water, water use and treatment of used water. Water saving is thus one basic sustainability strategy. A water efficient society is one where the technical equipment using water (piping, faucets, toilets, showers etc) is well designed and does not run when

not used. Efficient water use means that that natural water streams (ground and surface water) is not unnecessarily distracted and thus available for its original functions.

A main problem is that surface water is being polluted, with all its consequences. This pollution comes not the least from cities in which a well-functioning wastewater treatment is lacking. Keeping the water clean is an important sustainability strategy. Clean water is a precondition for much of the services that the water is providing us with: well-functioning ecosystems are necessary for fishing, water for households, for recreation, for industries and for agriculture.

Used water and wastewater has normally a higher temperature than when it was extracted. This temperature difference may be used in various ways, e.g. heat pumps. Using warmer water temperature as an energy source is thus one sustainability strategy for a water-efficient society.

Water, and in particular wastewater, is also a carrier of material, such as nutrients. That material may be extracted and used. This may be done in wastewater treatment plants (WWTP), when the sludge is used for agriculture or soil remediation. Using the material carried by the water is again a sustainability strategy in a water-efficient society.

We have to think of providing the city with water; up to about 200-400 litres per day and capita. The largest consumption of water for domestic purposes takes place in the bathroom. Consequently we need to get rid of equal amounts of wastewater. A sewage treatment system with technological solutions is employed to remove the disposal from the city. The rainwater runs underground in sewers to be disposed of, while it is essential to notice it as a resource to be recycled and reused. Recycled wastewater can be used in the WC or for gardening.

It is obvious that water was appreciated both for its function and its form. In ancient times fishing, transport and defence considerations were in most essential and rivers were also a source of energy and provided potable water. It is has not changed. Water is equally important today. We undeniably need water to live.

11.2 Water as a component of urban space

Water has always been an element integrated in human societies and human life. The first civilisations grew up on riverbanks, on floodplains and in deltas. The seasonal fertilisation of the areas allowed a sustained crop production and development of agriculture. The Indus River, the Mekong River, the two-river country at the River Euphrates and the Tigris and the Nile Rivers are all examples of rivers that have fostered civilisations, some of them as long as 10 000 years ago.

Water is a much appreciated component of urban space. Surface water should thus be made visible and accessible whenever possible. Waterfronts, water streams and surface arrangements, channels, for streaming storm water are therefore resources to be carefully managed. In general the creation of an attractive blue (water) area is a strategy developed in many cities. Artificial surface water in parks or in the surroundings of a city is often appreciated and much used recreational areas. These areas also function as wetlands with the capacity of natural water purification to be used e.g. for storm water. Such areas also support a rich plant and animal life.

Streets and squares are the main components of urban space. Streets are perceived as kinetic phenomena always associated with movement – in contrast to squares, which are static –with relaxation and celebrations. The influence of water on the form of streets and squares is of great significance. Some streets in the world – in Copenhagen, St. Petersburg, Amsterdam, Bruges, Venice, Bangkok, etc. – are designed as man-made waterways, canals. The flow of water along them enhances their kinetic qualities and strengthens their connection with the outside world. Their currents, in contrast to asphalt lanes, carry the imagination beyond the town, into the sea.

The well, spring or pump was always the social focus in a settlement. The women living close by went there to fill their buckets and bottles with water, and stayed to talk to neighbours. Similarly, riverbanks used for cleaning or washing clothes became public space for socialising. All this is, of course, gone in modern life, although its symbolic value may remain in other contexts, just as the sanctified "holy" well, the natural centre for worship and spirituality, remains in the use of water in religion.

Water, in its wide variety of forms on the largest and smallest scales, is an attractive material, enriching the form of urban spaces. In the city, it is used not only as functional water, as canals, reservoirs and drainage systems, but also for purely decorative reasons such as fountains, cascades and pools. In the light of psychoanalytic evidence, frequent contact with water may bring a person closer to the unconscious processes in his/her life and has a positive therapeutic effect connected to its religious meaning. Moorish, Indian, Persian and various other cultures have appreciated the cooling and aesthetic features of water underlying its symbolic significance.

Water has its own identity and very special qualities of movement and variation under the influence of wind and light. It changes colour and texture according to weather conditions. In the past, fountains were often accompanied by sculptural compositions.

Figure 11.1. In the summer residence of Peter the Great, Peterhof, outside St. Petersburg, a multitude of fountains delight visitors (photo: Stephen J. Danko).

Fountain design, the direction and rate of flow of water is very important. The jets of water are most spectacular when they appear luminous, so the fountains should be located between the spectators and the sun. Fountains may, in addition to conveying decorative functions, have an ecological role through their possibility of aerating the water.

Water affects not only sight, but also other senses through its sound, smell and texture. If these qualities are used intelligently, water has the potential to influence and modify the form of urban space. By communicating sensory clues, it can create a focal point and give distinct quality to a part of a city. In this context, water has a magnetic charm and the ability to become the centrepiece of urban interior design.

The sense of hearing conveys the shape of space. The sound of falling or running water may hypnotise the observer and block out unwanted sounds, creating an additional subspace, characterised by its own melody. The designer can use water as a device to change the perception of small, enclosed urban interiors. Liquid parts of squares in the middle of crowded cities may create special spaces characterised by emptiness, too rare sometimes, in the urban landscape. The resi-

dential parks, playgrounds and city forests associated mainly with recreation also play important roles in re-establishing the ecological balance.

The storage of storm water is one of the significant issues. The ecologically oriented design of urban development can reduce costs and be beneficial to the environment. Parking lots, cemeteries, parks, playgrounds and even flat roofs can, in addition to their basic function, be designed to provide temporary storage for rainwater and snow. The city forests, wetlands and garden plots, which create low-maintenance landscapes, so much needed in the city, serve the same hydrological function.

Water in all its forms may be exposed and preserved in the shape of small ponds, pools, reservoirs and streams. The aboveground lakes and canals in residential areas provide not only distinctive visual amenity, but can serve as permanent retention containers, improving water quality. The fountains in the water can cool the environment on hot summer days.

There is a common practice that in the urban setting, running water – brooks and streams – are paved over and forced underground and water reservoirs are covered and fenced. These practices may be questioned on some grounds. The rainwater can be allowed to gather from rooftops into small pools or be collected in open gutters where it can flow above ground along pedestrian paths. As water attracts birds and animals, it may enhance the formation of wildlife corridors. The natural surface drainage is appropriate for low- to medium-density developments and local streams, lakes or retention ponds may collect its water. This alternative to traditional storm sewers has proved to be more economical and more beneficial to water quality.

Water is an important element of contemporary cities. It significantly influences the urban structures and natural processes of all of them, not only of those located along waterfronts. It should be remembered, however, that regardless of its function – not to cause distaste or disaster – water requires constant care, maintenance and conservation.

11.3 Water crisis and water stress

During the 20th century the demand for water in agriculture, industry, energy and households has continuously increased with increasing economic development and an ever larger population. Increasingly larger areas were irrigated, larger reservoirs for hydropower built and ever larger cities increased their demands for water. Today close to 60% of the 227 largest rivers of the world are changed by dams, water withdrawal constructions, and irrigation purposes.

As a result we are living with an increased scarcity of fresh water. A water crisis is already here in many parts of the world and will be even more serious and more widely felt. The long-term consequences of this development have not been analysed systematically and possible measures were not carefully considered. But it is obvious that we have improve water management, reduce water consumption and increase the efficiency of water use.

In the world more than 40% of the population of the world lives in areas with more or less water shortages. It is supposed that by 2025 two thirds of the population of the world (about 5.5 billion people) will experience shortage of water. An increasing number of regions, especially in Northern Africa, but also in Western, Southern and Central Asia, will be confronted with water deficiency.

The terms "water stress" and "water crisis" are increasingly in use. According to UN:s World Water Assessment Programme (WWAP), water stress is a situation of shortage of water of satisfactory quality and quantities for maintenance of needs of the people and environment, and water crisis the current widespread and chronic lack safe drinking water. Access to clean water is the most important factor to reduce child mortality, in particular caused by diarrhoea. With the Millennium development goals it has improved considerably over the last 15 years.

With industrial development increased water use are caused by fast growing cities, industries and social infrastructure. In the OECD countries most of the water is spent in the industrial sector and municipal services. The modern economic estimations show that cost of the further development water management infrastructure "as usual" for water supply, water drain, sewage, an agriculture and protection of an environment will require large expenses [2].

The access of water is determined by the recirculation of water in the natural hydrological cycle. Surface water evaporates to the atmosphere, precipitates as rain or snow and then flows in rivers and brooks to the sea. Some of the water are stored as underground water in smaller or larger aquifers. The volume of water which is precipitating in a drainage basin of a river system over the year is the water resource available. This volume of water has to be shared between nature and society. The rule of thumb is that up to about 15% of the water can be withdrawn from nature without consequences for the ecosystems. The volume of water per person, obviously, is reduced with increased population density: more people means less water per person in a given territory.

Good access to fresh water is found in Europe, Southern and Southeast Asia, and the Americas. Arid and semiarid regions, territories with monsoon climate, and regions with a high population density have more serious problem with water shortage and a higher percentage of water withdrawal. Thus monsoon climate causes a

Box 11.1 Aral Sea catastrophe

As a consequence of overuse of a water from the two Central Asian rivers, Amu Darya and Syr Darya, especially for cotton cultivation, these rivers have ceased to reach to Aral Sea. As a result the area of water of the Aral Sea began to reduce quickly.

The construction of dams and water structures on Amu Darya and Syr Darya rivers began on large scale from 1960 and already in 1981-1990 the flows of the rivers to the Aral Sea had decreased from 60 up to billion a m^3 per year, and then practically has stopped. By November, 2002 the water level of the Aral Sea had fallen in comparison with 1960 with 23 m and was 30.47 m above sea level. The area of a reservoir has decreased from 66 to 15 thousand km^2, and the volume of water from 1060 km^3 approximately up to 100 km^3. Actually sea has broken up to number of independent reservoir. From kuasi clean water reservoir Aral has turned to salty lake with salt content of 90 per mille in western part and up to 160 per mille in eastern part of the large sea. It has resulted in destruction of fauna, the sea became practically lifeless, the number of kinds plankton was considerably reduced, has survived only two kinds of fishes - flounder and aterina in western part of the large sea. In western part of the large sea on depth 22 m the layer of acid (H_2S) infection is found out, that represents a new problem for Aral.

However Aral Sea ecological catastrophe is not the only and not the first catastrophe of such kind. The water flows in Syr Darya and Amu Darya rivers are thus dramatically reduced, but so are the water flows in Colorado River, in North America, the Huang He River better known as the Yellow River in China, the Nile in Africa, as water has been used for irrigation and also hydropower. The consequences of all these development are less serious than for the Aral Sea, as they terminated in the Oceans, while for the Aral Sea completely dependent on Syr Darya and Amu Darya has been drained.

Source: Rustam Eshnijazov and Rifkat Gimush.

significant quantity of precipitations to occur during summer monsoon followed by a shortage of water in the winter Specific water use per person vary enormously from less than 20 m^3 per person on year up to more than 8,000 m^3, corresponding to 50 to 20,000 litre/day/capita, figures which influences the size of GDP.

In developing countries the shortage of water is felt first of all in the agricultural sector. Even if one often consider the problem to be caused by insufficient economic resources it is really one of natural water resources. The excessive use of water for irrigation has several negative consequences, most seriously a reduction of the area of agriculture. In arid and semiarid zones we also see an increased salinity of agricultural fields. In Uzbekistan already 20% of irrigated fields have salt deposits. If in past, the main factor limiting global trade of grain was shortage of land, it is now also shortage of water.

Huge volume of consumption of water by mankind and fast growth of this volume (only in 20th century water use has increased six times and more than

twice has exceeded rates of growth of the population) have not led to rationalization of water use and development of water saving technologies. Of all water in agriculture 60% goes to unproductive evaporation and drains back to rivers and underground waters as polluted water. Consumption of water in cities and industry are also extremely unproductive. In developing countries as a result of outflow in systems of water supply, because of illegal connections to these systems and inefficient use up to 50% of water which is taken away from sources is lost. In many developed countries this percent also is high enough.

To improve the water situation we need to have

- more efficient use of water in irrigation;
- development of an ecologically safe industry, which does not pollute water;
- protection and maintenance of ecosystems;
- better understanding of the economic value of water;
- water resources under public control;
- better understanding of the key role water plays in the production of energy;
- better understanding of the importance of water in a fast urbanizing world;

11.4 Climate change risks

Climate change leads to dramatically changed precipitation patterns. These developments are studies in the climate models and the predictions are available for large parts of the world. In general terms we may say that dry areas get even drier while wet areas get more rain. But already now we are experiencing changes as extreme weather events get less unusual. Thus we have seen big floods in many areas. In Europe the large rivers Rhine, Odra and Wisla have experienced floods in the last decades. It has led to flooding of large central areas of the cities along the rivers. Consequences have been serious for the inhabitants, such as destroyed homes, and for the cities themselves as streets, river banks and public buildings have been destroyed. Several large scale floods have occurred in the Monsoon countries, e.g. Pakistan and Indonesia.

On the other side there has been serious and several years long droughts in other parts of the world. In Australia a 9 year long drought in large parts of the country has destroyed agriculture and caused extensive forest fires. In western United States there is presently a very serious draught and cultivation of vegetables, which is the traditional production in the area, is in deep trouble. In 2013 almost a third of the American crop production was destroyed by lack of rain.

Cities may have serious problems caused by flooding. The first action taken by cities is to stop building close to water fronts. Some build open spaces to make

Figure 11.2 Dry detention pond. Benthemplein water square in Rotterdam, the Netherlands. Photo during dry weather. Can accommodate nearly 2 million litres of water during rain.

them able to handle excessive volumes of water if needed. Secondly increasing number of cities equip themselves to be able to block water in flooding. Others try to influence upstream neighbouring countryside to be increase their possibilities to manage large water volumes e.g. by constructed dams and wetlands.

11.5 Who owns the water?

Water is *a local resource* which can in practice not be bought from outside. If there is no local water nature turns into a desert and no one lives there. The few places in a desert where there is some water green plants and even trees grow to form an oasis. Oases rely on underground rivers or aquifers, where water can reach the surface naturally by pressure to form a spring, or by man-made wells. In former times they allowed nomads to travel long distances in the desert to arrive to a lifesaving oasis at the end.

The situation of using only local water has some exceptions. Local water refers to water from the same drainage basin. In many cases *water from a neighbouring basin can be used* by digging a canal, build a piping system or other means of transfer of water from one basin to the next. It is done on large scale for example for Los Angeles, one of the largest cities in USA. Here we see a water use of more than 100%. As mentioned above when water use is not dependent on recycling it is below 15% and at best 3-4% of the yearly accessible water, that is water from precipitation in the basin.

Recruiting water from very far away by long distance pipes or even transport of ice bergs have been discussed but never implemented as far as we know. In practice a more realistic solution to the problem of water shortage is more efficient use of locally available water and not import of water from far away.

One more way to get around the problem of water scarcity is *the use of fossil water*. Fossil water is found in underground aquifers or "lakes" often thousands or even millions of years old. If used they will of course be emptied at some point just as any non-renewable resource. One large-scale case of fossil water is the Nubian Sandstone Aquifer System. It is the world's largest known fossil water aquifer system located underground in the Eastern end of the Saharan Desert. It contains an estimated 150,000 km^3 of groundwater. Libya is presently extracting an estimated 2.37 km^3 per year mostly for irrigation.

Of course it is of great economic importance. Another case is the city of Tucson with 800,000 inhabitants in Arizona USA where the municipality is using fossil water for the city, now rapidly being emptied, to complement surface water use. The city is building a huge pipeline to import water from the – already overused – Colorado River. Tucson is situated at the northern end of the Sonoran desert. Their water problems illustrate the dilemma of living in a water-scarce landscape.

If water is such a precious resource one may ask: *How much does water cost*? *Who owns it*? Traditionally one sees water as a common resource – a global common – just as the air we breathe. It is constantly needed for each one of us to survive. To control water is thus to control life in a society. Normally the municipality, the city, is in control of water. The city builds the system for distribution of water, takes care of the wastewater and charges the inhabitants for these services. That is for services, not the water itself! The municipality may get an income by selling these systems to a private company and agree on the conditions for providing the services. It has been done in several cities in Europe, one example is Tallinn in Estonia. But this is not market economy. The company has a monopoly and the result of such business has been very much criticised by researchers. It is even worse when it is done in poor countries, as here the inhabitants may not afford to "buy" water on the conditions of the private company.

The normal situation is that the municipality establishes a *water company*, often the same as the one taking care of waste and sometimes energy supply. The municipality may run the company, or just own it. The price of water is then established by the city and normally per volume used. In reality the costs is more or less the same, regardless of volume, since it is completely dominated by cost of the infrastructure and maintenance of infrastructure rather than proportionally to the volumes treated in the system. But volume price is considered important to

Figure 11.3. The transport of pipe segments for the Great Manmade River in the Sahara desert, Libya: a network of pipes that supplies water from the Nubian Sandstone Aquifer System, (Photo: Jaap Berk, The Netherlands, https://commons.wikimedia.org/w/index.php?curid=12200100

stimulate water saving by the customers. *The city thus does not ask for a tax for water but paying a charge.*

The municipality *may also regulate the use of water* and thus restrict e.g. washing of cars or irrigation of lawns. It is normally done in many countries in times of less rain. Obviously it may be done also in other situations, by season e.g., if needed.

Thus with the obvious exception of drinking water in bottles we do not normally important water. Fresh water is prevailing natural resource, even in the regions least supplied with fresh water; as a rule, there are superficial water sources and deposits of underground waters, sometimes considerable deposits, also in Central Asia.

11.6 Water supplied by municipalities

Municipalities have the responsibility to supply water to households, smaller industries connected to the central network (large industries normally have their own water supply), and public services (schools, hospitals etc.), as well as own use and compensation for losses. In Europe the household consumption of drinking water is about 100-200 litres per person per day.

Water for treatment and subsequent public consumption is normally supplied from surface water bodies (rivers, lakes and reservoirs) or from groundwater aquifers. Groundwater is more likely to be of better quality than surface water and accordingly, treatment costs will be considerably lower. Treatment will be able to remove e.g. some metal ion. In agricultural areas groundwater may contain ni-

trate. If the nitrate concentration exceeds 50 mg NO_3^-/l, the particular groundwater source must be abandoned since there is practically no economic possibility to treat nitrate-contaminated water.

One way to increase the amount of groundwater is to infiltrate surface water. This is called artificial recharge of groundwater. The method can be used to increase the amount of groundwater for a small town and can also be applied on a larger scale.

Surface water is normally pre-treated with screens and sometimes a pre-disinfection step is included to facilitate further disinfection. Chemicals are added to quickly coagulate impurities, and the following steps are flocculation and floc separation. Disinfection agents are added to remove remaining pathogens. In the last treatment step, chemicals such as lime, sodium carbonate and/or sodium hydroxide are added to yield water with as low corrosive properties as possible. There is an increasing interest in using slow sand filters to reduce natural organic matter (NOM) in consumption water. A slow sand filter is primarily intended for biological treatment of the water, but it must also possess physical and chemical removal capacities to work satisfactorily. The slow sand filter reduces odour and taste that are caused by organic matter.

Active carbon may be used to remove various organic micro-pollutants and foul taste in the raw water. In recent years membrane technology, especially in small plants, has been introduced as an effective way of removing pollutants without having to add chemicals.

The treated water is then pumped to the distribution net.

The water distribution network should meet the criteria of good delivery security and good water circulation. Three main kinds of networks are available:

(1) *Branch networks* in which every point in the water distribution net is supplied from only one direction. The system involves fairly low investment expenses. One disadvantage is that in cases of operational stoppage a relatively high number of users may be without water supply.
(2) *Circulation networks* in which every point in the system is supplied from two or more directions. The circulation system is somewhat more costly in initial investment expenses but has a higher level of water delivery safety.
(3) *Combinations* of branch and circulation networks

There are many ways to reduce the water consumption in a city without neglecting crucial functions of the water supply. One may reduce leakage from water distribution networks, make industrial process more efficient, making faucets and water-consuming equipment in households, schools and the like (washing ma-

chines, dishwashers, low-flushing toilets etc.) work better. In households in some western countries there has been a slightly increasing tendency towards reduction in water consumption per capita, brought on by more efficient faucets and other installations.

Outside this direct water distribution system one may e.g. introduce artificial groundwater production (to reduce evaporation), make irrigation more efficient (to reduce evaporation) and introduce reuse and re-circulation of treated wastewater.

The introduction of individual water measuring devices and raised water prices also reduces the consumption of water. Cold- and hot-water consumptions are dependent on each other and measures to reduce hot water consumption may also affect cold-water consumption. The potential for saving water for daily household use is large, and ranges from 100 to 200 litres. By installing new water saving faucets, water use for cleaning and personal hygiene can be reduced by 20-40 litres per person and day. Faucets with separate taps for hot and cold water can be substituted for one-tap faucets where temperature and flow are regulated using the same tap, which makes it easier to regulate the water temperature, thus saving water that otherwise would have been "wasted" while finding the right temperature.

The highest amount of water savings, 20-35 litres per person and day, can be achieved by installing new low-volume-flushing toilets. A 20-yearold toilet bowl uses about 8-9 litres per flushing. A modern toilet bowl often uses 6 litres and a water- saving toilet uses less than 3 litres. Installation of new water-saving dishwashers can reduce water use by 20-30 litres per person and day and modern washing machines reduce water use by 10-20 litres per person and day.

11.7 Urban wastewater treatment

In earlier times, the purification of wastewater was simply neglected, resulting in terribly polluted and badly smelling rivers and seasides. By the middle of the nineteenth century the Thames River was so polluted due to the rapid expansion of the population, that all fishes were eradicated. The concern for rehabilitation of the river caused the installation of improved sewage treatment and aeration equipment. As a result, in the revived Thames River, 86 species of freshwater and marine fish had been identified in 1975. In Stockholm, it is possible today to swim in the centre of the city and regularly large salmons are caught along riverbanks in the centre, proving the success of several decades of work with wastewater treatment.

Figure 11.4 Sedimentation – biofiltration system. A large stormwater wetland in Massachusetts, USA

Wastewater is a mixture of toilet water, grey-water, industrial wastewater, drainage water, and, in a combined system, also storm water. The composition of wastewater is a mixture of pollutants coming from the different sources. Domestic wastewater contains grey-water from washing dishes, washing and bathing and toilet water urine and faeces. A major part of the nutrients originates in the urine. Grey-water contains nutrients in small amounts, with the exception of phosphorus. The average amount of grey-water is about 150 litres per person and day. The phosphorus content of grey-water depends on the use of phosphate detergents. When no phosphate detergents are used, the phosphorus content is estimated at 0.15 g/p/d. When mainly phosphate detergents are used, the content is estimated at 1.0 g/p/d.

The content of industrial wastewater can vary greatly and depends on the type of industrial process used. For instance, mercury may be released from dental practices. Source control and demand of treatment of process water have gradually decreased the pollutants originating from industrial wastewater. In general, there has been a decrease in the metal contents due to less metal use in society, such as a change to lead-free gasoline, a stop in the use of mercury thermometers, and a ban on cadmium in paints and in finishing. Wastewater from restaurants and offices has a composition more similar to domestic wastewater.

Drainage water is water from house foundations and groundwater leaking into the sewer pipes. The water originates from rainwater that has infiltrated the

soil. Since the soil acts as retention storage, the flow variations are not as large as for the storm water.

Wastewater is normally collected by a systems of pipes and treated in a waste water treatment plant (WWTP). There the wastewater is undergoing a three step procedure to be clean enough to be emitted into a recipient a river or lake.

The treatment often starts with a *mechanical step* where objects and solids are removed by filters or sedimentation. The second *biological treatment step* relies on the microorganisms in different treatment processes, the most common called the "activated sludge process". It is done in aeration basins, stabilisation ponds or aeration lagoons. Here organic material is oxidised to carbon dioxide and water and a sludge is produced containing microorganisms and non-biodegradable suspended solids. The produced sludge is removed for further sludge treatment. In a sustainable system the sludge should be returned to agricultural soil as fertiliser. It contains most phosphorous and quite much of the nitrogen in the wastewater. It may also be used for fermentation to produce biogas. In that case the fermentation residue is an excellent fertiliser. Presently sludge often has too much pollutants, in particular heavy metals, from the wastewater to be suitable for agricultural soil. That can only be improved by upstream management a task which has been successful in many cities in Europe.

In a third *chemical step* chemical precipitation is a widely used process for the removal of phosphates by the addition of iron and aluminium salts or lime, metals by the addition of hydroxide, carbonate or sulphides, and finally colloids and colour. The chemicals are added to a rapid mixing tank and cause coagulation and flocculation. The coagulated particles form flocs which are separated by sedimentation, flotation and/or filtration.

In cities conventional treatment technologies, described above, is the most common method to treat wastewater. In rural areas, however, the conventional treatment technique is too expensive and requires too much energy input. Other treatment techniques, such as ground infiltration, have therefore been developed.

Ecological engineering, or eco-technology, is a low cost and low-tech solution to reduce the pollution load on streams, lakes and seas. Ecological engineering applies the principles of species symbiosis and cycling and regeneration of substances in an ecological system. Before the wastewater can be discharged into any of these facilities, it must be pre-treated. Domestic wastewater is pre-treated in a septic tank where faeces and urine are separated. Urine, and possibly also the grey-water, can then be directed to an onsite treatment facility. Storm water should be pre-treated using a screen in the inlet to the treatment facility.

There are different natural technologies: onsite infiltration systems, slow-rate land application systems, rapid infiltration land treatment systems, overland-flow treatment systems, wastewater stabilisation pond systems, floating aquatic plant systems and wetlands. Facultative ponds, floating aquatic plant systems, mostly with water hyacinths or duckweed, and wetlands are characterised by continuous flooding and therefore develop an anaerobic sediment and soil layer. The ponds have a typical depth of 1.2-2.5 m. They can be designed as passive lagoons or as highly sophisticated systems. Common for these ponds is that they maintain a natural aerated surface layer over a deeper anaerobic layer. This treatment system is efficient to reduce organic content and nitrogen. Phosphorus is only removed to a very small extent. The water plants can be harvested and used for fertilisation or for biogas production. The ponds themselves may be part of a green area in the outskirts of the city.

11.8 An urban sustainable water cycle

An individual person needs only one m3 of water per year for drinking, approximately

100 m^3 for his or her household needs and roughly 1,000 m^3 per year to produce the food he or she needs to eat. In addition an average of about 50 m^3 are needed for municipal water used for general purposes and 200 m^3 on average for industrial water. These figures are indicative for semi-arid conditions and vary considerably in different regions.

To produce these volumes of water in a situation of water scarcity we need to consider water recycling. If water is scarce the water might have to be 'reused,' which means going through several rounds in an ever narrowing water cycle requiring more and more refined methods of treatment. In urban water management this might be quite expensive. In industry it is taken to the extreme in the closed factory, where the same water is used indefinitely.

It is the social equivalent of the natural hydrological cycle. E.g. villages throughout a river stretch use water from the same stream, or water transpired by the plants is released as precipitation useful to plants in neighbouring fields. The runoff water into a river in a farm area might be used later for preparing drinking water for the city downstream. Groundwater used for domestic purposes is released to a river and reused downstream or is infiltrated to the benefit of the vegetation.

What this implies is that, with a systems view of water resources, the outflow in the system always constitutes someone else's inflow. Among the creative

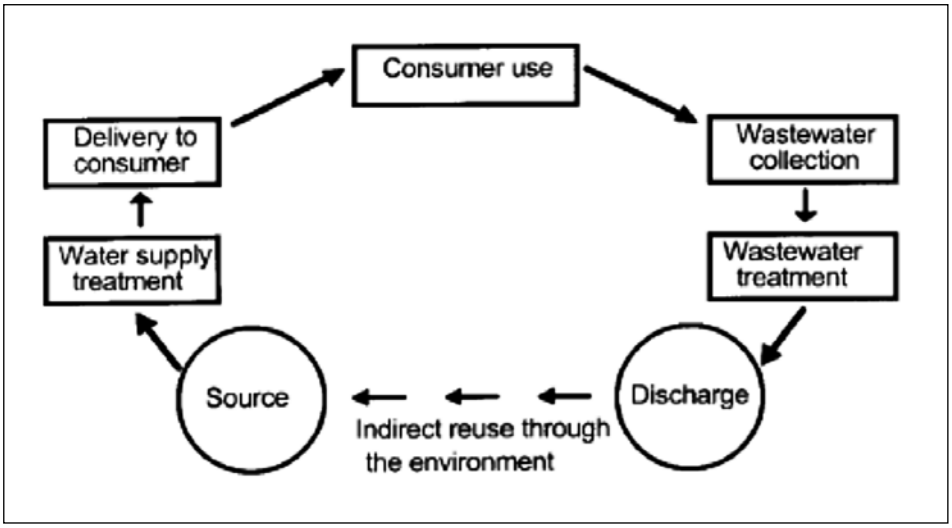

Figure 11.5. The hydrological cycle in society. Source: Bengt Hultman in Sustainable Water Management Book 1 The Waterscape p 24 http://www.balticuniv.uu.se/swm/

ideas stemming from this implication is the suggestion that industrial water intake should be put downstream of the industry's outlet, creating a self-regulating system in which the industry would be highly motivated to keep water quality high. The rational realisation of the idea is, of course, to create closed-system processes.

Another perspective is illustrated by the 'urban' or 'societal' water cycle which points out that water used for one purpose may soon be reused for another. After treatment, freshwater is normally transported into urban areas via water pipes in order to secure a high water quality. Treated wastewater is typically discharged into large receiving waters in order to avoid severe local pollution problems. However, in some regions, the wastewater quantity should instead be regarded as a possible resource for increasing the groundwater level, for irrigation use or other purposes. Obviously, this requires even more efficient wastewater treatment.

Outdated technologies that require massive volumes of water are still in use in many places, but as a rule, industries in the Western world use efficient methods of water saving and recycling. In urban areas water use in buildings is the key issue. The choice of water-consuming devices (toilets, showers, washing machines and dishwashers) has great impact on water and sewage handling. Other technical factors, which could be influential in domestic use, include separation

of grey water from black water and the use of garbage disposers. In addition, consumer behaviour has a major impact on domestic water and wastewater handling.

The challenge to managers of water systems is to find the best way to satisfy the demands of the water users and of those expressed in the political arena. Earlier, the choice of water, wastewater and runoff water handling was mainly determined by function efficiency and acceptability of cost. This choice was affected by factors such as climatic and topographical conditions, population density and convenience. Today, the choice of system must also take the long-term environmental impact and conservation of resources into consideration.

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Chapter 12
Local Energy Strategies

12.1 Local energy

One of the largest difficulties for sustainable development today is the overwhelming dependency of most societies on non-renewable fossil energy supplies. The consequences of the large use of fossil carbon are twofold – first that supplies will come to an end; secondly that the end product builds up and cause environmental damage. The end product of the combustion of fossil carbon is foremost carbon dioxide causing climate change – one of the most serious problems of our time – although there are also a number of other serious pollution problems appearing long before global peak oil has been reached and passed.

So far the efforts to establish a carbon-free economy, not dependent on fossil coal, oil and gas, have been mostly discussed as a global problem and in need to be solved as part of a global agenda, most recently confirmed at the COP 21 conference in Paris in December 2015. Here we will on the contrary ask to what extent it may instead be seen as a local problem and be solved locally. The possibilities to fulfil local energy needs by local renewable energy supplies are of increasing importance. As an alternative or complementing strategy it was much discussed in Paris.

The potential of local energy supplies turns out to be large and important. Renewable sources do not, however, need to be local in any precise meaning. They may often be national, as for example large hydropower plants, or even be used by several neighbouring countries as is assumed in the *Desertec* project now attracting huge investments for solar electricity in northern Africa, mostly Tunisia. Here, however, we will refer to local as mostly municipal, sometimes regional, or even smaller scale: energy-independent houses or households or neighbourhoods in cities will be considered part of the local energy supplies of municipalities.

The possibilities look very good. Typically a strong policy for local energy production creates substantial numbers of job opportunities and thus contributes to the local economy, provide social and environmental benefits, improve energy security, and reduce emissions of greenhouse gases.

The transition to a more sustainable world has so far often focussed on energy issues. It seems that the declared *reasons* for developing local energy supplies are dominated by the communities' intention to increase their *energy safety*. In particular the approaching peak oil with an expected increased competition for fossil carbon based energy (especially oil) is feared. Often the cost of buying external energy, or a feared future sharp increase of costs, is also a reason for developing local energy sources, and a part of developing energy safety. For municipalities and regions (and nations) the climate argument is always or almost always there, but more as part of the initial discussion and not so visible in the actual planning of local resources. The exchange of fossil carbon for renewables is then seen as a mitigation step to combat climate change.

12.2 Strategies

The child has many names: Communities which declare their intention to develop local energy supplies may work for Energy independence, Energy autonomy, Energy Self-Sufficiency, Energy self-reliance or to become Fossil fuel free. As a *strategy* option in the literature on sustainable development it is most often referred to as "Distributed generation" or "Distributed production".

What are the strategies used? In a Baltic University project with 20 cities and towns we noticed four different strategies:

- Replacing, to use renewable instead of fossil fuels
- Reducing, to use less energy
- Rescaling, to use a different scale, larger or smaller
- Recycling, to use materials which are recycled, an integrated approach

Surprisingly *rescaling* turned out to be the most common sustainability strategy. Both *upscaling* (e.g. from individual heating of houses to district heating) and *downscaling* (e.g. from district heating to heat pumps) are common strategies.

Developing local energy supplies as a whole may be seen as a down-scaling strategy going from international, import dependent, energy provision to the strategy of managing energy needs on the local scale. It is seen all over the world. With the German post-Fukushima energy policy – *Energiwende* – this transition towards local supplies has become national policy. It seems in the first place be caused by the determination to end the use of nuclear power, there are 21 nuclear power stations in Germany, more than decreasing the use of fossil sources of energy – the development of coal based electricity production is still strong. But the

effects are nevertheless that local energy supplies through e.g. solar cells, biogas stations, wind power etc are increasing dramatically.

We also see some more principle discussions on the role of local energy supply. It is promoted in the recent full length film "The fourth revolution – on energy autonomy" by Carl Fechner in Germany (Fechner, 2010). In this film he reports from societies in Denmark, Germany, Bangladesh and Zambia all on their way to improve their life by using local energy sources. The web-based newsletter *Local Energy* (see localenergynews.com) declares that

"higher energy prices and uncertainty of supply are driving communities toward renewables, but the understanding of how to implement renewable energy such that local benefits are maximized is still in its infancy. Therefore *Local Energy* helps communities develop stronger, healthier economies based on local self-reliance in energy. There is a growing awareness that continued reliance on energy supplies from outside the local community – especially oil and gas – poses significant economic risks."

With the presently dramatically reduced oil prices the economic argument is not so strong in the short term. Still energy security is interesting. Several networks of municipalities and/or regions promote local energy initiatives all over the world. Examples illustrating this include the USA based *Post carbon cities* which advice cities how to tackle the problem**.** The Sustainable Cities and Towns campaign, though ICLEI (local authorities for sustainability) and with support from the German Government runs the *Local Renewables Initiative* which supports and strengthens local governments in promoting sustainable energy in the urban environment (See local-renewables.iclei.org). Activities exist in Europe, but are also important also in India and Brazil. The Australian Government support the *Solar Cities* network for a sustainable energy future with the aim to reduce greenhouse gas emissions, promote energy efficiency, adapt to climate change impacts and help to create a global solution (See greenhouse.gov.au/solarcities/).

Let us come back to the strategy options. There are many ways to deal with energy management. A general rule is that *demand management* is better than supply management. This is the ***Reducing*** strategy option. Thus much work is done today to reduce energy use in the consumption phase. Low energy light bulbs, especially LED lighting, is 5 to 10 times more efficient than conventional bulbs. As lighting uses – at least in Europe – about 28% of electricity in an average household, a fivefold reduction is important. It is also important that machinery such as freezers, washing machines etc is energy efficient. Standby should

Figure 12.1 A low energy light bulb, LED using almost 10-fold less electricity than a corresponding conventional bulb.

be avoided, and simple rules, like not lighting garages and toilets when nobody is there, contribute much. In the EU new directives supporting these changes are introduced.

On the supply side the main task is to move from fossil to renewable energy. This is the *Replacing* strategy option. As already has been described this is ongoing in all countries. At present Sweden has the highest share of renewable energy in the EU, about 51%, followed by Finland and Latvia. The main reasons are good supply of hydropower and much increased use of biomass.

Finally the *Recyling* strategy option refers to the possibility that energy management becomes a part of the general material and resource management. Proper waste management saves much energy. Thus it costs about 6 times less energy to produce steel from scrap iron compared to virgin ore, a figure that is 30 times for copper and 50 times for aluminium. Recycling paper saves energy as cutting trees is reduced and the production itself saves energy. Household waste incineration (waste to energy step) is equally important. The sludge from the waste water treatment plants also contain much energy, now mostly used for the production of biogas. The higher temperature of the wastewater may also be used in a heat pump at the WWTP. Thus water, energy and waste management should ideally be integrated.

12.3 Urban energy uses

How much energy do we really need? This is the issue of *energy sufficiency*. At present in our societies energy use is close to 100 times the metabolic energy (everyday food for one person), even if it varies quite much between countries, sectors and individuals. Even if energy is necessary it may be used more effi-

ciently. *Energy efficiency* is as well a key task in energy management. Main users of energy in our societies are the transport sector, the building sector and food production. Several countries have in addition some energy-intensive industries.

The energy provided to the city is of three kinds: *Heat* to keep buildings warm and nice during cold days; *electricity* to run all kinds of machinery, to provide lighting etc; and finally *fuel*, e.g. for transport.

In district *heating*, where a single power plant is providing hot water to the entire city though a system of pipelines, is by far the most efficient way to heat most cities. It is also a better system for cleaning flue gases, obviously better than a multitude of single-house boilers. It also offers co-generation: that is the plants may produce both heat and electricity with an efficiency of fuel use up to some 85%. Too district heating may also be added district cooling from the same power plant. Its sustainability then depends on the fuel used. Waste incineration may account for a considerable part in most cities. Other fuels include peat and bio-fuels such as wood chips. The buildings are also important as they may be more or less energy efficient as well as providing their own heat (see below). Other sources of electricity may be either local (e.g. solar cells) or distant (e.g. large hydropower plants).

The building sector has been very successful in reducing energy needs (See also chapter 8). The most efficient houses today are the passive houses. These use much less energy (15-25%) for heating and sometimes even have their own supplies of electricity and hot water. Passive houses have efficient insulation, heat exchanger for ventilation, and use heat from persons and machinery. Even if passive houses are not common low energy houses start to be so. These are slightly more expensive to build but much less expensive to use. Also retrofitting of present buildings is possible and profitable. Energy use in the building sector could, according to the sector, be reduced by 20% with profitable investments.

The food sector has several shortcomings which lead to energy wasting. Food waste is large (some 20-30% of edible food in the EU) in many places. This can be reduced by simple means, such as better planned shopping, proper storage and taking care of leftovers. This refers both to producers, retailers and households/restaurants. Different food has very different carbon footprints. Meat production is by far most energy consuming and is causing much more of GHGs emissions in particular caused by methane production of ruminants, cows, sheep etc. Vegetables and potatoes have almost 100-fold smaller carbon footprints. But the trend in our societies is that meat consumption is increasing; In the EU 60-80% of the crops on our farmland are used for animal feed. Denmark has five times more pigs than people. Less meat consumption is an important step to reduce energy needs.

Box 12.1: Case study Güssing, Austria

Güssing a municipality of around 27,000 inhabitants close to the Hungarian border in Austria on the broder to Hungary and Czech Republic. It was a city where 70 % found work elsewhere, commuted, youth moved out and future did not look promising. All energy was imported fossil fuels and the yearly bill was close to Euro 9 million.

In 1992 Mayor Peter Vadasz together with an Reinhard Koch, an electrical engineer and native of Güssing from Vienna University of Technology decided that a change was needed. Koch develop a local industry in which forest biomass was turned into biofuel. In 11 years, Güssing became self-sufficient in electricity, heating, and transports. In the process 60 new companies with more than 1,500 new "green jobs" were created and commuting decreased to 40 %. On top of this Güssing now sells green energy outside the municipality to $28 million yearly and emissions of CO_2 decreased by more than 80%.

Figure 12.2 Wood gasifier in commercial operation in Güssing. Photo: Gerfriedc https://commons.wikimedia.org/w/index.php?curid=1402990

They are not alone in Austria. From Tyrol to Lower Austria, and from Salzburg to Styria, more than 15 regions are now energy independent with regard to electricity, heating and/or transportation. In addition, 66 regions of Austria are taking action to become energy independent in the future, which means that 1.7 million inhabitants (21% of Austria's population) will be able to consider themselves energy independent.

Sources: http://blogs.worldwatch.org/the-model-region-of-gussing-%E2%80%93-an-example-of-the-austrian-grassroots-strategy-for-energy-independence/ and https://en.wikipedia.org/wiki/G%C3%BCssing

The transport sector is by far the most difficult to improve. It is also the only sector where energy consumption is increasing and fossil fuels dominate. The first concern is to reduce travelling. For example many meetings may be replaced by video conferencing. Secondly improving public transport to reduce the role of the private car is important. Here we also see an important technical development. New bio fuels, such as biogas, biodiesel and bio ethanol are introduced. But in the longer term electricity should be introduced since the electric motor is at least 4 times better than the combustion engine for mechanical work; train and tram is even better since rail requires less energy than tyres. Of course the value of such changes depends on how electricity is produced (See further chapter 9).

In the industry sector there are many good examples on energy efficiency programs although much is left to be done. The *pulp and paper* industry, which is a high energy user, use the cellulosic fibres for producing paper while the lignin in the wood is turned into black liquor, a highly alkaline dark "soup" with a very high energy content. It is used for energy purposes in some factories, e.g. turned into biodiesel. The *cement industry* is using much energy and also emits carbon dioxide from the process itself (heating calcium carbonate). *Building in wood*, including multi-store houses and some other constructions, is now improving very much and some traditional uses of cement should be possible to replace. Such a change includes several energy efficiency steps from transport to the building site, the construction itself and maintenance of the building.

12.4 Mapping local energy

The conditions which make it economically and technically viable to produce energy in the smaller and local scale is rapidly developing. There are a large number of possible energy sources on the local level. In a small energy mapping effort in Uppsala County, Sweden, 18 different sources of energy were easily identified. A mapping activity may be the first proper step to take when deciding on which technologies to develop for local energy supplies. The local energy sources is divided into electricity, heat and fuel, even if it is understood that they overlap when it comes to use. For example a fuel may be used to produce electricity which may produce heat.

Electricity:

CHP Power plants with combined heat and power may use various solid fuels including energy forest, forest waste from local sources or waste from households and other sources of solid waste.

Box 12.2: Case study Freiburg

Freiburg is a large city on the border between Germany and France. In 1992 the military base in Vauban were turned into settlement area for 5,000 inhabitants. The new residents decided that it should become a new eco-development. The city introduced a regulation on energy-efficient houses, which required that new houses should not use more than 40 kWh/m2 per year. The houses should also produce their own energy and installed solar cells. In addition residents do not use cars very much. They walk and use bikes. It's all part of a green ethic built on decades of political will and citizen involvement.

The city of Freiburg is working to grow its green economy. The green city initiatives are seen as a factor in attracting green businesses to locate in Freiburg. There are about 1,500 green businesses employing about 10,000 people. Of those ten thousand, about 1,500 people are employed in the solar energy sector. About 50 % of electricity is produced by co-generation units that also provide heat through district heating systems. In addition to larger co-gen units, there are about 90 small CHP units around the city.

Solar energy is very visible around Freiburg. Currently 12.3 MW of solar capacity is in place, producing over 10 million kilowatt-hours annually. There are 5 medium sized wind turbines installed on the hills around the city. They produce 14 million kWh every year, more than produced by all the solar PV panels.

Figure 12.3 Solar cells on the roofs in district Vauban in Freiburg, Germany. Source: https://en.wikipedia.org/wiki/Vauban,_Freiburg

Sources: http://www.youtube.com/watch?v=IMnB6V5yG1I, http://postcarboncities.net/node/2680 and https://en.wikipedia.org/wiki/Vauban,_Freiburg

Solar cells may be installed locally either on individual houses or as a municipal undertaking on fields etc. The use of and installation of solar electricity is increasing rapidly, by up to 20 % annually in many areas. It seems as if photovoltaic (PV) has an advantage over concentrated solar power (CSP). The cost of installed MWh has decreased almost 4 times in 2 years, mostly due to massive production in China. Today the investment cost of installation of PV on the rooftop of a house in southern and mid Europe is paid back in 7-9 years. The installation is then expected to produce electricity for another 20 years, or more. The absence of mechanical parts in a solar cell makes it less sensitive to wear. Research on solar electricity is very intense and it is reasonable to expect new types of cells and lower prices as technology develops as the scale of production increases.

Municipal wind power may also be developed. Such a wind power station does not need to be placed in the area of the municipality. It may be anywhere and the electricity coming to the city over the ordinary grid. This is a common way for a city to secure its own source of renewable electricity. In the mapping however, places with proper wind speeds (more than on the average 7 m/sec) need to be identified.

Local hydro power, streaming water power and wave power rely on streaming water. Small scale hydropower may be suitable for only a few households or a whole community. There are many thousands of such small scale hydropower in northern Europe. Streaming water power rely on turbines placed under water in a river or stream or along the coasts. This is a technology under development.

The biggest dilemma with locally produced electricity is the difficulties to store electricity. Only for very limited use may an ordinary battery be sufficient, as we see e.g. in developing countries where the possibilities to use electric lights in the evening when they have a 1 m^2 PV on the roof has been a blessing in many families. New batteries will come, but the most realistic option today is to sell excess electricity to the national grid and get back during the dark hours. In practice then the large hydropower plants provide the storing capacity needed.

Heat

Solar panels to produce hot water may either be installed on individual houses or on larger scale for a whole neighbourhood. There are only few cases of this. In Kungsbacka, Sweden, 48 one-family-houses cover 70 % of its annual consumption of hot water from 900 m^2 of solar panel field, one of the largest installations in the world. The second largest seem to be on Aeroe in Denmark. In warmer countries, in the Mediterranean e.g., solar panels on individual houses for providing hot water for bathrooms and kitchen is very common.

Heat pumps is very common in northern Europe. Heat pumps may either be installed in individual houses or in larger scale for a power plant. Most often the heat is extracted from the ground but it is even cheaper to use a nearby water stream or otherwise from the ground. Heat pumps may also be used to provide cold from the ground. Some 100 meters below the surface temperature is only a few degrees above zero.

Power plants or individual boilers in houses may use local sources for incineration. Thus wood chips, pellets, solid waste may all be found locally. Also this is available in different scales.

For heating by far the best option is to build low energy houses and upgrade existing houses. But heating and cooling capacity is not a large problem for most municipalities to provide locally.

Fuel

Biofuels. For the combustion motor alternative bio fuels are needed. *Bio-ethanol* is produced by fermentation of organic crops. It is a so-called first generation biofuel. Most common today is to ferment corn (maize), and Brazil and USA are the largest countries for biodiesel. In Europe ethanol is now slowly out-phased and it does not any longer have state support. *Biodiesel* production is rapidly increasing using forest products including black liquor from pulp and paper factories, the so-called second generation biofuels, or from oil seeds. Biodiesel from oil seeds may be easily produced locally and in any scale.

Biogas is formed by anaerobic fermentation of organic waste. This may be manure from farms, food residues, and wetland plants such as reeds, slaughter house waste, or sludge from waste water treatment plants. The biogas may be used as natural gas, produced as a renewable alternative. Biogas production is rapidly increasing in all of northern Europe even if it seems as if Germany and Sweden have the lead in this development. The investments needed are in both countries supported by state subsidies. In the agricultural sector biogas is used for both heating and electricity in CHP facilities. In the cities in Sweden it is upgraded to vehicle gas and much used for public transport. In Germany this is less often the case and much biogas is fed into the national natural gas network.

Providing transport with other energy sources than fossil oil is the most difficult of the challenges of local energy supply. Future sustainable transport will certainly on rely electricity. It is well motivated for the simple reason that electricity is much better for mechanical work than fuel (about 4 times less energy is needed than in a combustion motor). Then the municipality needs to provide charging places for cars, e.g. on car parks. The development of batteries promises

that storing electricity rather than the very energy dense oil will be practically possible. At present the hybrid vehicle is the most energy efficient alternative.

Among the non-technical developments is a more efficient public transport network will decrease the use of the private car and thus also the need for transport fuels in general. This is a development since some time seen in larger cities. To this should be added the increased use of bikes. This development requires better biking paths in urban areas and better parking options for bikes. It is a development going on in many cities at least in northern and partly in Eastern Europe.

12.5 Energy resources in Uzbekistan

Energy production in Uzbekistan is almost entirely controlled by the state and completely dominated by fossil energy. There is almost no municipal production at the moment.

Uzbekistan has 45 power stations with total capacity of more than 12,400 MW. 16 of these belong to the government-joint-stock company *Uzbekenergo*. The total production and use of electric energy in the Republic is 56-57 TeraWh. This amounts to 50 % of all electricity production in Central Asia. 98 % of is comes from Uzbekenergo. A small production is also coming from independent thermal power stations of industries and some small-scale hydroelectric power stations.

The production of electric power is carried out basically on thermal power stations, including on Angren, New – Angren, Navoiy, Talimardjan and other stations. The largest power station in Uzbekistan and in all Central Asia is Syr-Darya TES with a capacity of 3,000 MW is running from 1966. The largest hydroelectric power stations of Uzbekistan includes Gissarskaya 45 MW, Farkhat 126 MW, Andizhan 190 MW, Charvak 600 MW, Chirchyk-Bozsy cascade of 1200 MW, that is a total capacity of 2,150 MW.

The energy resources of the country consists to 97 % of petroleum and gas, 2,3 % – coal, and only 0,7 % is hydropower. The largest companies of the country is UzTransGaz and Uzneftegas. Uzneftegas which provide 60-70 billion m^3 of liquid gas, NLG annually. Uzneftegas is the 11th largest company in the world on production of natural gas. Gas processing is carried out on Mubarek gas processing factory. This factory makes about 30 billion m^3 of natural gas and more than 570,000 tons of gas condensate per year.

Uzbekistan has the 7th largest deposits of uranium in the world with 4 % of known global deposits, and is the fifth largest producer (MAGATE). Presently

there are 40 known deposits, with a total amount of 185,800 tons. All uranium produced is exported.

12.6 Renewable energy in Uzbekistan

Feasibility of use of RSE proves that total potential of Renewable energy resources, consisting of hydropower, solar energy, wind power, bio mass amounts to about 51 billion ton o.e., the level of modern technologies allows the use 179 billion ton o.e., that three times exceeds current annual volume of consumption of fossil fuel. Taking into account presence of potential in sphere of development of RSE, in the country a number of measures on expansion of use of nonconventional sources of energy is underway.

With the purposes of providing diversity of power sector, introduction of renewable sources of energy and maintenance of growing needs of economy of republic in energy resources, last years is paid special attention to development of use of renewable sources of energy.

The researches and development in the field of *solar energy* have begun in Uzbekistan in the 1980s. The scientific and technical programs in this sphere covers a wide circle of tasks: fundamental and applied researches, laboratory and design works, creation of an infrastructure for the production of raw material and manufacture of the equipment, training of personnel for science and production, commissioning experimental sites etc. These steps have formed the basis for continuation of works in sphere of solar energy after Uzbekistan's independence. In Uzbekistan first solar photo-electric station is in operation. The produced electric power is fed into the national grid.

The development of a solar energy in the Central-Asian region is priority, as the geographical and climatic conditions of Uzbekistan is extremely favourable for development of energy of the sun. Uzbekistan has significant scientific and technical base, large volume of design and technological development on designing and use of a solar energy, and also highly skilled staff. In particular the project and scientific experimental centre NPO "Physics – sun" of the Academy of Sciences is now created and is being built. The financial support on realization of the projects in the field of solar energy in territory of Uzbekistan is curried by the Asian bank of development. The financing is carried out in the form of commercial crediting and private investment with the purposes of increase of competitiveness of a solar energy in comparison with traditional sources.

In early 1960-s in Uzbekistan worked more than 250 independent small and mini hydroelectric power stations with a total capacity of some 35 MW. There

are several advantages with small hydropower. As compared with the large hydroelectric power stations, the ecological damage from small hydroelectric power stations is minimal. Micro- and small hydroelectric power stations can provide power supply to remote and isolated areas. The construction of small and micro hydroelectric power station requires a rather small investments and payback time is typically about 5 years. However most of these small hydroelectric power stations do not work.

The small hydroelectric power stations is normally built as part of the infrastructure for irrigation, that is, dams, water collectors, protecting structures, and water pumping stations. It makes the construction rather inexpensive. The capital costs for an installation is 4-6 times less than for a building a plant on a new place.

12.7 Municipal energy policy

There are a number of ways in which a municipality can support its inhabitants and companies to use more local and renewable energy resources. These include *regulations*, such as making certain actions illegal, *economic measures*, such as taxing e.g. fuels or supporting actions by subsidies, and finally *information*. These different options often need to go together. Economic stimulus are important. There nothing better for getting a change. But knowledge and information should go with it and sometimes also regulations.

The first priority, however, should be to develop *all municipal routines* to be more energy efficient and use the right kind of energy. Some municipalise have introduced electric cars for all undertakings in the city which requires only small distances to be covered. Many municipalities in the Nordic countries use biogas for city buses. The buildings for the municipality need to be energy efficient and the use of lighting the best e.g. LED. Garages can have mechanisms which allow light only when there is someone in the garage. Finally a municipality is a very large customer and green procurement is an important strategy.

In general both industries and households are reluctant to invest in energy improvements, even if the investments are profitable and money is saved in only few years. Policies for supporting such investments are thus important. These include taxation on energy as well as subsidies for investments, or loans on good conditions. Several management systems are available for energy improvements. These include Environmental Management Systems, EMS, such as ISO 14001, but since also the energy management system ISO 50 001. It should be mentioned, however, that in many countries only the state can decided on many economic measures, such as taxes.

An option used by some cities is to offer households lower energy prices – a subsidy – for a period if they were able to reduce energy consumption according to a set goal. When the subsidy was taken away six months later the household continued to be energy efficient. The trick is to start a new behaviour. When it is there it may continue on its own.

A very efficient way to change people's behaviours is to secure feedback on what we do. Thus meters should be available wherever it is suitable. Smart meters empower consumers. Smart meters must not be designed just because distributors want to improve peak demand management. They must first and foremost help consumers to monitor their energy use in real time, thus enabling them to adapt their behaviour. This is why all "smart" meters should include a display unit, visible inside the housing or office block, that, if possible, shows electricity, gas, heat and water consumptions.

Chapter 12 sources:

Sections 12.1 – 12.4 Lars Rydén *Is Local Energy Supply a Main Road to Sustainability?* In "Sustainable Development, Knowledge Society and Smart Future Manufacturing Technologies" (W. Leal Filho, A. Ubelis, and D. Berzina, eds) Springer 2015, p. 19-31.

Sections 12.5-12.6 Rustam Eshnijazov and Rifkat Gimush based on …

Section 12.7 Lars Rydén based on *Energy management strategies* Chapter 2d in the Baltic University on-line course on sustainable development http://www.balticuniv.uu.se/index.php/2d-energy-management-strategies

Chapter 13
Urban Material Flows and Waste Management

13.1 Taking care of waste

Waste has always been a part of human life. Before the industrial age the farming society's waste management practices were well established. Waste was taken care of as a resource. In the cities, on the contrary, waste was more often just thrown out on the street. With increasing urbanisation this became impossible. Landfills developed, although with bad environmental consequences, such as leakage to ground water, bad smell and emission of gases. The bad smell of so-called pits in many industrial towns was terrible. In addition many did not use the organised places for waste, but threw their waste out anywhere.

During the last few decades waste management has been more organised. Improper deposition of waste leads to fines (when detected and registered). But bad habits still remain, especially when it is costly to get rid of waste. It is especially serious for example to leave old cars in the forests, plastic waste in the sea, or toxic waste in human habitats. Here cars and other metallic and plastic waste not only destroy nature and threaten wildlife, but also pollute. In a 2004 survey the national NGO *Keep Sweden Tidy* found one hundred thousand waste cars in the country. The Baltic Sea region-wide NGO *Keep Baltic Tidy* for several years has made efforts to keep waste away from beaches and the Baltic Sea. This is important especially for plastic. Plastic waste is not broken down at all, or extremely slowly, and thus accumulates in nature. In the oceans plastic waste is concentrated in enormous vortices and broken down to very small micro-fragments and finally consumed by marine life and fish. It is very destructive for marine life. Waste should thus not end up in nature at all. It should be taken care of in the society.

Proper waste management requires that waste be sorted according to fractions which are collected and treated separately. Experiences from sorting already collected waste are in general very negative. Instead, solid waste must be sorted by the producer, household or other business or organisations. Sorting of waste by households is now legally required in some countries and encouraged in others. However the infrastructure required for taking care of the sorted waste is lagging behind in many cases. All these factors are needed for proper waste management.

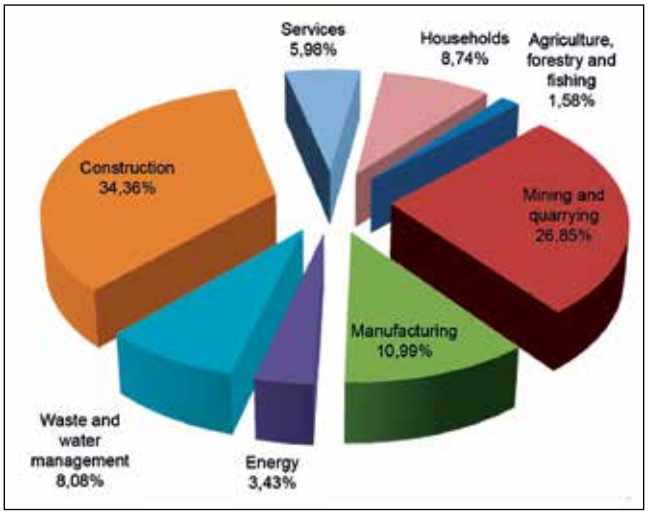

Figure 13.1 Share of waste generation by economic activities and households EU-27 2010. (Source EuroStat)

The reuse of products and recycling of materials is the preferred option for reducing waste streams. Again this can hardly be efficient unless the original user of the products helps to achieve this. Recycling is improving in many places, stimulated by increased market prices for such material as scrap metal, plastics, and paper.

In industry the use of waste is most efficient in so-called industrial symbiosis. Here the outflow from one factory is used as a resource in a second one. In some cases it is simple, e.g. steam produced at one site can be used as an energy source in another. In other cases it is more sophisticated, as when sulphur in flue gases in a power plant is used to produce gypsum boards for the construction industry. Also here there are good economic and environmental reasons to take care of waste as a resource properly.

However waste data only covers a section of the material flows in our societies. Data for natural resource extraction reflects the total resource flows in our societies. Only a fraction of the extracted resource continues to the production stage. Left behind is the so-called *ecological rucksack*. This typically corresponds to close to 90% of the resources extracted. Thus to produce one ton of products requires 10-30 tons of resources. The ecological rucksack is to a large extent reported as mining waste.

Domestic material consumption, which is the total of material used in the economy, was in the European Union about 25 000 tonnes annually per capita, with slightly smaller values for the less advanced economies. Domestic material

consumption had a small decrease in the last ten years. Much of this is probably explained by an increase in the service sector, requiring less resources, in the more advanced economies. Most of the changes are explained by changes in the *domestic material extraction*, that is, import and export is much smaller. The main components in the material flows are metallic materials (dominated by iron), non-metallic materials, mostly sand and gravel, biomaterials, and fossil energy materials. This large material flow is not sustainable. It has to be reduced in the future.

The economic value per amount of material flow, the resource efficiency, is very different in different economies. On the average it was EUR 1.52 per kg in the Baltic Sea region, with a very large variations. In 2013 Norway had the highest value with 2.63 EUR/Kg followed by Germany 2.17 and Sweden and Denmark 2.00 EUR/Kg. The three Baltic States and Poland have values between 0.4 and 0.7. There are thus large potentials for improvements for most countries in the region. The resource efficiency has in general an increasing tendency.

13.2 Urban solid waste management

Solid waste collection is one of many material flows in urban areas. Those material flows are connected to the urban infrastructure, where roads and pipes are used as media for the transportation of goods and wastes. Quantitatively it is an important flow, with typically more than a tonne per year per person. About two-thirds of this is industrial waste and a third comes from households, offices, shops and the like.

Household waste is about the same in the entire EU. The differences depend mainly on differences in packaging consumption. Industrial waste, however, differs from place to place, depending on the local industry and the local industrial history.

Some kinds of solid waste require special attention, such as hazardous waste, radioactive waste and other types of special wastes. Another case it the Soviet military withdrawal from Central and Eastern Europe after the end of the Cold War left behind enormous amounts of waste such as unusable equipment and buildings as well as forgotten landfill sites and dumps. A further case are the industrial sites which were closed, often long time ago, often very contaminated by left chemicals and other waste. These are called *brownfields*. The restoration of brownfields is a very complicated and expensive operation often requiring treatment of massive amounts of soil. The owner may be gone since long and cannot be held responsible. However if the city wants to use the land for habitation it

has to be done. Large sums of money are set aside for paying these grotesque environmental debts.

Waste classification systems refer to either attribute or source, most commonly source, which we shall use here. There is thus household (domestic) waste, industrial waste, commercial waste, etc. The by far largest amount of waste in our societies is mining waste which is landfilled. Other large categories of waste is from the building and energy sectors. Municipal waste is the most visible waste category.

The attribute system refers to some intention with the waste – composting, recycling, energy recovery or more prosaic sanitary landfilling with an acceptable leachate treatment.

The total amount of waste is difficult to estimate but figures in the EU are from 300 to 700 kg/capita and year. Poland reported the lowest figures, about 300 kg/capita and year, while western countries reported the higher values. The amounts have been slowly decreasing over the last ten years. This indicates that it is possible to reduce municipal waste. Between 2004 and 2012 the amount of waste excluding major mineral wastes generated per inhabitant in the EU was reduced by about 5.8%. The amount of hazardous waste generated among the EU-28 increased considerably between 2004 and 2012.

13.3 Waste management strategies

The need for good *urban hygiene* is the basic motive for solid waste management as well as for waste water collection and sewerage. There is traditionally a number of diseases that are spread by solid waste and waste water in urban areas with no proper sanitation. In industrial areas, chemical and radioactive hazards are added to the microbiological ones. This absolute need for sanitation is fulfilled by waste collection systems, which mainly are managed by public organizations such as municipalities. They can also be private and contracted out by the local authorities.

The *collection* systems are technically basically the same everywhere, but the management is developed in different ways. The hygiene strategy of waste management is a 'getting-rid-of-waste' strategy, and city metabolism the waste stream normally ends up in a landfill, which too often is a dump rather that a sanitary landfill.

Landfilling is a part of the hygienic strategy, but the treatment methods are of secondary hygiene interest. When the primary problem – urban hygiene – is solved, it is possible to face the local hygiene and environmental problems around the dumps; ground and surface water contamination and littering. Other

problems are connected with burning on open dumps, with rats, flies and birds or with gas and odours. Landfilling is used for more than 50% of the waste in many countries, but with large variations and it is decreasing. The lowest values in the EU for Germany and Sweden are about 1%. We may conclude that landfilling can be almost entirely out-phased as a management option. It is, however, still very dominant in countries where the alternatives have not been developed.

The next largest management option, *incineration*, is around 50% but with large variations and increasing in most countries. Incineration was once seen as the ultimate method for getting rid of waste, but instead there were important environmental problems connected with the flue gas. Today, the aspect of destruction and 'getting rid of' is focused on organic hazardous waste which, treated in an incinerator or at very high temperatures and long retention time, can be completely destroyed. Adequate thermal treatment of hazardous waste is a well-respected method for solving a part of the hazardous waste problem.

Incineration can be made with or without energy recovery. Incineration with energy recovery is dominating in Sweden to produce enough district heating. It is increasing in several other countries. Burnable municipal waste is thus a mostly renewable resource (although it has some plastic content) for district heating.

When the energy in the waste is used in the incineration plants to produce electricity or for district heating, the incineration plants convert the 'getting-rid-of' technology to beneficial technology. The possibility of producing energy is often the motive today for incineration. Therefore we often talk about 'waste-to-energy-plants' instead of just 'incineration plants'.

Waste collection, landfilling and incineration is the basic level of solid waste management. *Recycling* is the secondary level and thereby the second strategy. Data on recycling demonstrates that the%age of waste recycled is 30-60% in several countries in the EU.

13.4 Recycling

The need for recycling is obvious when consumption runs away uncontrolled. In the fast-rate consumption, affluent, society there will eventually be a lack of a raw material, and one way to serve the society with its needs is to recover the material from the waste stream. Societies with a slower rate of consumption can also be motivated to a recycling strategy. There can be high prices of raw materials or lack of money for international trading. The extra bonus of this strategy is the decreasing amount of waste going to the landfills. Therefore a number of western European countries have adopted the recycling strategy – more in order to save

volumes in the landfills than to save raw materials for more equal consumption in the entire world for future generations.

Biological treatment of organic waste in order to produce compost as a fertilizer or a soil enhancement product is, from a strategic point of view, recycling technology. Biological treatment methods are an old and well-known technology but, without conscious waste flow management, it is impossible to produce any marketable products.

The recycling strategy means that we are trying to see the residues from society as something that could be of some value instead of something we have to get rid of. This leads us to the conclusion that the needed materials should be uncontaminated – they shall not be mixed into the waste!

Most recycling involves converting or extracting useful materials from a product and creating a different product or material. This is external recycling, or materials recycling; it takes care of the material in the recycled products. It may be extremely useful as with metals, and scrap recycled metals. For this reason recycled metals has a high value and is sold on a market. But also plastic, glass and paper is of value as recycled material. To use recycled material instead of virgin material in production saves the energy of extraction and it may be very much as for metals. Thus copper production from recycled material costs about 30 times less energy, and for paper it is estimated as 2.5 times less energy use compared to paper production from wood. A cellulose fibre may be recycled about 6 times, then it is too short to be used for producing paper and will be burnt.

In 2004 the paper recycling rate in Europe was 54.6% or 45.5 million tons. It is still much too low. Recycling must thus be based on source separation. For household waste this has to be done by the households. A number of large-scale domestic waste separation plants have been built, but none of them has been successful. The process of waste separation is too complex to be done automatically. However, there are a number of industrial residues and wastes that can be successfully separated in large-scale plants.

Non-recycled waste will be either treated or deposited. The purpose of the treatment is to convert the waste into a substance that can be inserted into a bio-geo-chemical cycle or deposited in a landfill. All kinds of treatment involve some kind of conversion. The term ‘destruction’ is often used, but one should avoid this term. It can in a way be used when referring to the decomposition of toxic organic substances; for example through incineration into oxides or other substances that are later discharged into water, air or earth. Acids, for example, let out in gases and smoke from industries, cars, etc. may be converted into salts through neutralization.

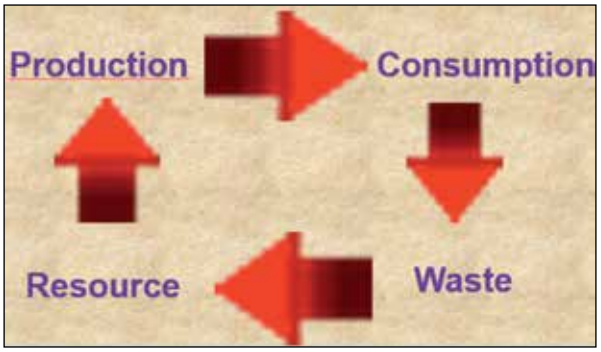

Figure 13.2 Circular Material flow.

Sanitary landfilling is based on the idea of isolation of the material dumped in the landfill. Therefore the landfill has to be isolated from the ground water which today is done with different kinds of sealing. In addition, one would like to see a plant that is not too ugly and which does not smell too badly.

The recycling strategy will after time develop into a waste minimization strategy. Handling waste in the household will result in a dramatic reduction of waste volumes. Society and its subsystems will be organized in a way so that as little waste as possible will be produced. This is the big challenge for the future. This is the big task for engineers and planners for the future.

13.5 Energy and waste

Energy management is a very important part of city flow management. Most of energy is produced through the burning of fossil fuels or as electricity from hydro or nuclear power. More sustainable strategies focus on energy saving and closing other flows in municipalities.

Incineration is the most important treatment method of household waste. Approximately 55% of the waste in Sweden is incinerated. This process enables an energy extraction of nearly 2.8 TWh. Waste incineration is increasing in the rest of the EU. An important reason is that fuel gas cleaning from waste incineration plants are since long working very well and waste incineration does not need to lead to air pollution. The energy is mainly used for district heating. Increasing district heating is a very good policy for cities and listed as the single most important step to take for cities in the EU. Household waste is a good fuel due to its large proportion of paper and plastic with a high energy level. Nevertheless, the maximum level of energy production in the EU is some 3% of present require-

ments. The best waste power stations are CHP, Combined Heat and Power, and about 40% of the energy content can be converted into electricity and the rest is distributed as heat, that is, these stations have an extremely good efficiency.

At least 50% of the domestic waste is food waste and other wet biodegradable waste products. By taking also paper, cardboard and other waste of biological origin into account, 70-80% of the domestic waste is biodegradable. Degrading or stabilizing organic material by biological treatment is a natural process that has been used by man since time immemorial.

There are two different kinds of process: aerobic degradation that takes place when oxygen is present, and anaerobic degradation that takes place when oxygen is not present. Bacteria, mould, fungi and other saprophytic organisms are active in these processes. They feed on garden waste, manure, latrine and other organic waste products and convert them into more stable products. In the aerobic processes, about two-thirds of the carbon serves as an energy source and is oxidized by microorganisms to form carbon dioxide. The remaining third is converted to cell biomass along with, for example, nitrogen. However, in the anaerobic processes, the carbon is mainly converted to biogas which consists of methane, CH_4, and carbon dioxide CO_2.

Biogas is an important source of energy for heating, fuels for buses, burning, etc. In Sweden biogas facilities have been built in very many cities to treat food waste and other material, e.g. slaughter house remains or fish residues, or even garden or farming organic material. The biogas is cleaned by removing CO_2 in water and getting almost pure methane for vehicle gas. In e.g. Germany the gas is instead fed into the national gas network.

It should be added that food waste is a serious waste category in almost all countries. In the EU close to 30% of food is wasted. Of course if it is fermented to produce biogas it is better than being landfilled, but it remains to say that far more energy is saved if it is not at all wasted. So much energy was needed to produce the food and only a small share is returned if it becomes biogas. The problem of food waste is seriously addressed in the EU. In February 2016 France introduce a law to make food wasting illegal. Not to be able to take care of food is mostly a lack of information.

The household level of energy management is the most important in energy saving strategies. Insulation of houses becomes more important as energy costs increase. The building of low energy houses is increasing. In 2019 EU will introduce a directive on near-zero-energy as a standard for new buildings. Combined with local energy production by, for example, solar heating panels and heat pumps based on geothermal energy, one might even arrive at a zero net energy

requirement at the household level. This would of course change municipal energy flow management drastically.

13.6 Sustainable consumption reduces waste – optimisation of products

Waste is the downstream end of the material flows in a society or city. It is the end-of-life of the product life cycle. To reduce waste we need to improve the use of products or the consumption culture we are living in.

The waste management hierarchy reads

Reduce – Reuse – Recycle

To make this real is a question of product design, product use and management. Products needs to be more solid to have a longer life, be easier to repair when needed, and easier to recycle, meaning that the different parts of the products should be possible to separate and recycle in the right category: metal, plastic etc.. Products should also be made of non-hazardous materials. To make such products is called *Eco design*. Design is thus not only a question of how a product looks like. It is equally important that it consists of the right materials, that it functions well, e.g. does not require much energy during usage, and that it is resilient as described above.

We may take this a step further and ask ourselves: Do we really need all products we have? Many times we may not buy a product but rather a service. For example we do not need to own a copying machine, but rather pay for the service to get a copy of a document. Or we may belong to a car pool and thus not own a car but rather pay for using a common car when needed. Very many pieces of equipment when owned privately are used very little during its life time. This has been shown to be true for very many tools. Thus having access to a piece of equipment, rather than owning it, is often the more sustainable alternative. Then we can avoid thousands of pieces underused. It is a way to reduce material flows. This is the *Reduce* part of the hierarchy.

Sustainable consumption may be summarised in a few rules:

- Enjoy friends rather than things
- Buy services rather than things
- Own together, use together
- Rescale to the proper level
- Municipalities are key actors with public procurement
- Governments: taxation are key policy tools

The implementation is seen as an increased *circular economy* and *economy of sharing* in our societies, and the result is increased *resource efficiency*. The European Commission's new, more ambitious circular economy strategy started in 2015. It wants to transform Europe into a more competitive resource-efficient economy, addressing a range of economic sectors, including waste (Moving towards a circular economy. European Commission 2015).

On the consumer side there are already many examples. Some have been mentioned already and there are many more: Rent a car rather than owning one – car pooling. Download music rather than owning CDs – Spotify. Download a book, read a "paper" on the Internet instead of having a physical copy.

The responsibility it not only on the consumer but also on the producer. Thus producers are increasingly requested to take care of their products after its end-of-life. Thus car producers are now legally responsible for taking back wasted cars. Of course they are then, for economic reasons, designed to make it easy to recycle all kinds of materials.

The strategy is called *Extended Producer Responsibility, EPR*. It requests producers to take responsibility of their products also for the end-of-life or wasting stage. This can be and are used for anything from beverage cans to cars. Several EU Directive requests companies to take back electric and electronic products, including batteries, from households after their use. A significant%age of cans, bottles and other packaging in general are returned when EPR is applied, e.g. by using a deposit for all or some of these products.

13.7 Cleaner Production – reducing industrial waste

Also in the production stage a considerable improvement has been done the last 20 or 30 years to find strategies and technologies to reduce environmental impact and side products from a production. These methods go together under that name *Cleaner Production*. Especially in some industrial sectors cleaner production, CP, has been extremely successful. The goal of CP is to improve the eco-efficiency in companies by implementation of technical or organisational actions. CP is good not only for the environment but also for the economy! Of course! You make products efficiently, not pollutants – inefficiently. By reducing the negative effects to the environment operating costs are reduced.

In traditional industrial production the pollutants in side streams such as flue gases, in effluents and as solid waste, so called End-of-Pipe methods were used. That is filters or other methods to remove pollutants were used. Cleaner Production works with process integrated – preventive – methods instead. Ideally one

Figure 13.3 Industrial symbiosis in the Danish city of Kalundborg. Seven industries and the city itself cooperates in a network where the waste from one unit becomes the resource for the next. Source: http://www.symbiosis.dk/en

wants to find production methods were the pollutants simply does not appear. Ways to do this includes Input-Substitution, Good Housekeeping, Internal Recycling, and Technological Optimisation/Change. In particular we should emphasis the importance of internal recycling. E.g. process water (or solvent) from a process is not leaving the factory with the wastewater but instead returned to the process, often after sometime of purification, and used again. In a traditional production process it is often very simple to find the first improvements to be done. It is called the low-hanging-fruits. They may be that tubes with hot liquid are not insulated, which is a wasting of energy, or that lamps are not turned off when not used. More advanced improvements have to do with changing chemistry of a production and often require more knowledge and investments.

Pollution was traditionally perceived as a problem for the environment, not the factory. Now most industrialists admit that pollution, on the contrary, was and is a problem for the industry. It is a sign of inefficient production and needs to be fixed by improvement in the production not the environment.

The change from a fossil based economy starting with oil and gas as resources for the production, to a more *bio-based economy* is more difficult but on its way. This is the input substitution phase in CP. Quite much efforts are made to find new ways to use forest material for production. A simple example is to build more wooden houses; of course wood is a renewable resource. New building methods allow multi-stories houses to be built in wood. Concrete has the disadvantage that during the process it produced CO_2. About 5% of global CO_2 emissions comes from concrete production.

13.8 Approaching a zero waste society

A generation back our societies and economies in Western Europe was built on a philosophy of wasting. At least 95% of the products were turned into waste and we had a linear flow of materials from the resource to the landfill. To build a sustainable society we cannot have a material flows based on wasting. We need, just as in nature, a society in which everything is taken care of, nothing becomes toxic, and all energy ultimately comes from the sun. This is in short a circular, restorative economy. This insight has been with us for some time and the first steps to build such a society have been taken.

The *circular economy* is a generic term for an industrial economy that is, by design or intention, restorative. Materials flows are of two types, biological nutrients, designed to re-enter the biosphere safely, and technical nutrients, which are designed to circulate at high quality without entering the biosphere.

Technical nutrients are strictly limited to non-toxic, non-harmful synthetic materials that have no negative effects on the natural environment; they can be used in continuous cycles as the same product without losing their integrity or quality instead of being "downcycled" into lesser products, ultimately becoming waste. Technical nutrients are man-made materials designed to be used again.

Biological Nutrients are organic materials that, once used, can be disposed of in any natural environment and decompose into the soil, providing food for small life forms without affecting the natural environment. The biological nutrients are non-toxic and can be simply composted.

The philosophy of the circular economy is that all wastes is a resource: "Waste is Food" and that "Diversity is strength". It is in line with the experience that diverse systems, with many connections and scales are more resilient in the face of external shocks, than systems built simply for efficiency. They are more resilient. The added obvious requirements in a circular economy is that all *energy must come from renewable sources*. As in life, any system should ultimately aim to run on 'current sunshine' and generate energy through renewable sources.

It is also clear that we need *Systems thinking.* The ability to understand how things influence one another within a whole infrastructure, environment and social context is present in nonlinear systems. The most developed form of using waste as a resource is in *industrial symbiosis*. Then the output from one factory becomes input to the next. There are already many examples. A simple case is when the steam and heat from a factory goes to district heating in the city in which it is located.

Figure 13.4 The life cycle of a product illustrates the philosophy of sustainable consumption and production, Goal No 12 in the EU SDGs. (Source UNEP).

In reality the use of a waste as a resource is often connected to a decrease in quality. This is called *down-cycling*. It involves converting materials and products into new materials of lesser quality. *Up-cycling* is the process of converting waste materials or useless products into new materials or products of better quality or for better environmental value. "What we need is upcycling- where old products are given more value, not less."

In the United Nations Sustainable Development Goals this is found as Goal No 12, *Sustainable Consumption and Production*. SDG 12 has a number of targets in industry, agriculture but mostly regarding consumption.

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Section 13.6-13.8 Lars Rydén

Chapter 14
Approaching a Sustainable Local Economy

14.1 The economy and its parts

A sustainable society require not only that the environment is taken care of properly and that the resource flow is sustainable and in balance with the resources available, but also that the inhabitants have can have a decent life socially and economically. Each individual and family needs to have an economy that guarantees good living conditions, food and social resources such as health care, education and care of children and elderly.

The economy of a society can be divided into several sectors. There is the formal part which consists of a business (sometimes called private) sector and a public sector a non-formal part, which consists mostly of the household sector.

The business part of economy of a society corresponds to the companies and other enterprises, which sells on a market. These may in turn be divided into primary and secondary sectors. The primary sector consists of industry, agriculture etc. which sells products on markets locally or globally. The secondary sector includes those who sell services needed in society, from school teachers to hairdressers, shopkeepers and nurses.

The relations between agriculture, industry and service changes in a society as it develops. Thus agriculture and industry increases its efficiency with time and requires less employees. Especially agriculture gets more efficient with time and in Western Europe only a few percent of the workforce is found in agriculture. In the most advanced economies 15-20% is in industry and thus the rest, or some 80%, is working in the service sector. The classical economic estimates says that there are about 7 individuals working in the secondary sector for each person employed in the primary sector, that is, the service sector accounts for up to 80% of the workforce.

The non-formal part of the economy is not so visible in statistics and reports. These include household work and cooperation between inhabitants not registered by authorities, such as exchange of help with physical repair and similar to babysitting and other services. The estimated value of the private part of the economy is not unimportant. Estimates in western countries are that each person

works about 4 hours per day in the household, which is not far from the average working hour in employment. Assuming similar costs per hour the household sector is approaching 50% of the economy. The figure depends on the share of population which is part of the labour market. In traditional economy much fewer married women worked outside homes and the share of household sector in the economy was larger. In many western countries today the share of women in the labour market is approaching the same as for men, close to 100%.

Finally there is a public domain in the economy. This consists of services offered by the authorities, the state, the region and the local level, the municipality, and the costs incurred by those services. The income for the public domain consists of taxes and to an extent charges coming from the business part of the economy. It is for a typical modern state 20-35% of the economy of the country, the higher value for a modern welfare state where the public domain has extensive responsibilities for welfare with schools and hospitals, but also costs for the authorities themselves.

The totally of all products and services in a society is reported as Gross Domestic Product, GDP. The GDP per capita is used as a measure of the welfare of a country. However one should notice that it is not a measure of welfare, it is just a measure of the economic turnover.

14.2 Developing economy on the local level

Any sector of a society, including a municipality, city, town or a rural community, needs to have part of its economy in the business or private part of the economy. These provide the foundation of the economic life, employment opportunities and provide tax money to the local authorities. Different cities or towns have different profiles depending on the resources available for the economy. Some have a larger agricultural sector, while others have more industry or service.

A more resilient economy requires that there is a diversity. If not, bad times for a single large enterprise and employer may lead to economic collapse and large local unemployment. In the socialist economy there were many towns and even regions with a very narrow specialisation. Such towns or regions existed and exists also in the west but not so prevailing.

The city itself may take responsibility for the development of the economy in its area. Thus city officials may try to diversify the economy by inviting companies to start in the city by offering good conditions. They may also support the development of new companies by so-called incubators. These are places where individuals with new business ideas can be offered a room, perhaps also a

Figure 14.1 The market is often the centre for the local economy. Siyab Dehkan Market, Samarkand, May 2015 (Source: Farhod Ahorov Samarkand).

computer with access to Internet, but even more important access to persons with experience of starting companies, called business angels. There are even cases of cities which offer loans on good conditions to such individuals to be able to invest in a new activity. The city thus works a bank.

A special group here are students newly examined form universities with good education knowledge often language skills but without money and contacts. There are in many places in the west incubators for this group organised by the university or university and city in cooperation.

14.3 Municipal economy and social services

The city has income from charges and taxes as a base of the local public economy. It is a very important part of the local economy. In the Nordic countries the local authorities have a uniquely strong position with possibility to decide in a number of areas and a large local taxation right. The largest share of tax money is paid to the local authority. In many other countries the right of local taxation is different and the local budget is set by central authorities, the state. It is less good for sustainable development, since in practice so many decision of importance for sustainability are local.

Regardless the municipality are responsible for several large sectors of the economy. It employs and runs the schools for children between about 6 and 18. It is also providing child care for children up to 6 years of age, in the form of day care, kindergarten or corresponding services in many countries, to make it possible for the parents to go to work. After 18 the young person is expected to either start working or continue higher studies, none of this the responsibility of the local authority. A large part of the population in the city thus depend on the school system and that it is working well.

After a person is retired there is again the municipality which has a responsibility in case some support is needed. There are thus elderly care for those not being healthy, homes for elderly when they are not able to stay home relying on themselves for the family members. It should be mentioned that retired individuals also are a resource. Above is mentioned business angels as one example.

The municipality is in thus in the social sector a very large employer with often thousands of people working for them. To the care professionals should be added all service personnel needed to take care of the facilities, such as buildings etc, cleaning, cooking and so on.

Other responsibilities of the city which requires a large number of employees and also large investments consists of managing the physical environment, that is, buildings, streets and parks. The city is also responsible for providing services for the material needs. Thus for supplying water, taking care of wastewater, taking care of solid waste, often providing heating of houses e.g. by district heating etc. These services are often the job of companies owned by the municipality, and the costs are paid as charges by the users, thus it is not based on taxes. Finally public transport may be an extensive activity, gain often run by a private company but regulated and owned by the city.

With all these activities the city is a very large customer buying extensive volumes of materials. The so-called procurement of the city is an important part of the tools for greening the economy of a city and also improving sustainability. The city authorities can make a big difference here for transition to more sustainable society. In many countries the transition towns movement, starting in England but now spreading over the world, has been very active for promoting such initiatives. Other organisations working for similar ends include ICLEI and xxx.

14.4 Development of the economy of Uzbekistan

Uzbekistan is a young Central Asian country, indecent since 1991. Economically it was one of the poorest Soviet republics, based on agriculture with a weak

industrialisation. On the contrary the natural resource of the country is rich. Uzbekistan had rich resources of metals, such as gold, copper, molybdenum and uranium, and there is a considerable export of metals currently estimated to be 3.5 billion US dollars annually. Significant untouched stocks of oil (proved stocks is 530 mln tons) and gas (more than 5 billion m^3) exist. The current production of gas contributes to the electric power supply. Other resources include sulphuric acid, nitric fertilizers, mineral lubricant oils and paraffin, cotton yarn and fabrics, tomato paste, dry fruits, fruits and grapes, wool production.

In agriculture the country has an advanced market of cotton. Uzbekistan is the sixth biggest producer and third biggest exporter of cotton in the world. The major agricultural products of Uzbekistan, besides cotton, is fruit, vegetables and grain (wheat, rice and corn).

Uzbekistan is ranked as one of fastest developing economics of the world (top 26). The GDP growth of Uzbekistan was 8.5%. Industrial production is growing by 9.0%, agriculture 5.7%, construction sector 33.1%, and services 12.9%, and retail 16.6%. In particular, as a result of the structural politics during 2000-2011, the share of an agriculture in the GNP of the country has decreased from 30.1 to 17.6%, industry increased from 14.2 to 24%, and services from 37 to 50.5%. Since 2004 the economy has had a steady rates of economic growth at a level 7-9% per year.

Till 1991 the economy of Republic of Uzbekistan was focused basically on maintenance by raw resources of former Soviet Republics. The basic part of consumer goods was imported. Since independence the foreign trade turnover has increased 31.2 times. We have seen a diversification of export. Especially the share of export of cotton fibre has decreased from 59.7% in 1990 to 9% in 2011. The share of the not raw materials in total amount of export now makes more than 70% against less than 30% in 1990. While changing the economy to a market system, the principle: "not having constructed a new house, do not destroy old" has been guiding.

The development of the economy addresses two very important issues. First an economy which is based on export of raw materials, natural resources, loses the possibilities to use those resources for further economic development itself. Thus instead of exporting cotton it is possible to develop an industry for textile clothing. Number of work opportunities would increase tenfold and it would be an important contribution to improved water management, since the extent of cotton cultivation could decrease. Cotton cultivation, which requires extensive irrigation and water use, is a main reason for the decline of the Aral Sea.

Figure 14.2 Rates of growth GDP of Uzbekistan (total internal product) in the comparable prices in % to the previous year. During 2005-2014 the stable average gain GDP was 8,2%.

The second issues is the fact that non-renewable natural resources will at some point be emptied and then the economy based on such resources will end. Presently this is going on in Norway where the oil wells are not producing any longer and the large company Statoil is losing thousands of jobs all around the country.

In the fossils fuel sector in addition there may be restrictions on what companies will be allowed to do. Already now many groups say "leave it in the ground! "The fossil fuels is contributing to the emission of greenhouse gases and it is thus not possible in the longer terms when creating a sustainable society.

14.5 Energy management and economic development

Energy management is very important for the economy. During all of industrial history energy use and economic growth have been parallel processes. So far it has been completely dominated by the use of fossil fuels. It has led to an enormous emissions of the greenhouse gas carbon dioxide and a serious impact on the global climate. It cannot go on and we have to reduce and even phase out completely the use of such energy sources. Uzbekistan which is a main producer of in particular natural gas is one of the countries where the economy will be seriously influenced by such a change.

It is typical that the local level, the municipalities have been in the forefront of the changes to renewable energy resources. There will obviously be difficulties socially in the shorter perspective, since large Uzbek companies will be forced to change. But it is not necessarily so in the longer term. There are several cities which already now have change and it has been to their advantage rather than a

Figure 14.3 Güssing Renewable Energy GmbH (GREG) was established in 2009 by experienced eco-visionaries and international entrepreneurs. GREG has its head office at the Technologiezentrum Güssing (Güssing Technology Center), Burgenland, Austria.

negative consequences. Many large international oil companies have changed their profile to be energy companies rather than oil companies. They have started to invest in wind power stations, hydropower etc. while they are selling the assets in fossil fuels. It goes together with some capital companies starting to *divest* in such business, e.g. several large pension funds. Without capital the big companies cannot continue.

On the local level a change to renewables will lead to local jobs in the sector, e.g. companies building solar cells on roofs or elsewhere, companies collecting biomass for power stations or companies producing biofuels and so on. In the agriculture sector there may also be farmers who produce biodiesel from oil seeds or other crops for biogas or bioethanol. This development should be compared to the previous situation when all the energy resources were bought from outside and a cost in the local budget. The conclusion described here are supported in a number of research reports.

There are several examples. In Austria the town of Güssing reports that between 1990 and 2000, it became self-sufficient in electricity, heating, and transports. In the process 60 new companies with more than 1,500 new "green jobs" were created and commuting to jobs elsewhere decreased from 80% to 40%. On top of this Güssing now sells green energy outside the municipality for 28 million USD yearly and emissions of CO_2 decreased by more than 80%. In cooperation with the University of Technology in Vienna they built a factory which used forest material for producing second generation biodiesel in a gasification technology. Many other towns in Austria are now following this example.

A second case is even more advanced. In Freiburg, Germany, the local authority made energy-efficient houses compulsory according to the law: the new regulation requires that new houses use no more than 40kWh/m^2 per year. This green city initiatives are seen as a factor in attracting green businesses to locate in Freiburg. There are presently about 1,500 green businesses employing about 10,000 people. Of those ten thousand, about 1,500 people are employed in the solar energy sector. About 50% of electricity is produced by co-generation units that also provide heat through district heating systems. In addition to larger co-gen units, there are about 90 small CHP units around the city. Solar energy is very visible around Freiburg. Currently 12.3 MW of solar capacity is in place, producing over 10 million kWh annually. There are 5 medium sized wind turbines installed on the hills around the city. They produce 14 million kWh every year, more than produced by all the solar PV panels.

Residents cycle and recycle, and the designs of two eco-developments – Vauban and Rieselfeld – are meant to make personal automobiles unnecessary. Solar panels on roofs bring in income for residents. It is all part of a green ethic built on decades of political will and citizen involvement.

14.6 Well-being and quality of life

The main goal of public development is the increase of well-being, the level and quality of life of the population. A main role for the population there is a quality and standard of living (health, education, dwelling, feed, social maintenance), and for manufacture is efficiency of work. For economic growth it is necessary to raise productivity, and for this purpose to improve health, a feed and other components of a standard of living, that in turn, is impossible without growth of efficiency of work. The economic growth has created base for increase of a level and quality of life of the population. In structure of the incomes the share of the incomes from enterprise activity is growing. From 1991 till now has increased from 10.6 up to 52 percent. Wages of the workers of state organizations, stipends for students, the pensions have increased for 2014 by 23.2 percent. The real incomes per person have increased on 10.2 percent. In Uzbekistan there is no sharp stratification of the population on a level of the incomes. Since 2000 till the present time the level of differentiation in the incomes of the population has decreased from 53.3 times to 7.8 times. The total area of housing fund has increased in 1.9 times.

Economists measure the economic output of a society using indicators such as *gross national product (GNP)* or *gross domestic product (GDP)*. While it is

widely recognized that such measures do not quantify human wellbeing, both economists and policy makers often assume that an increase in GDP corresponds to an increase in welfare. But an understanding of what GDP includes, and excludes, suggests that the relationship between economic production and welfare is more complex. We now turn to a discussion of the limitations of GDP.

Human well-being depends on consumption of goods and services, but on many other factors as well. We can distinguish between two broad categories of human activities: those which are "rewarded" by a payment – a monetary flow – and those which aren't. Only the first type is taken into account when computing national income. All the others – including domestic and family tasks, taking care of children and elderly relatives, volunteer community work, and leisure time activities such as reading, cooking, playing music, going to the beach – are not included in standard economic indicators.

There is a division inside the sphere of human activities between the monetary portion of activities and the non-monetary part. The gross domestic product measures only the first area and neglects the second. However, when measuring human well-being or welfare, it is necessary to take into account the entire scope of the human sphere.

How to measure human development? Basic needs have been defined in many different ways but seldom with a precision that make them operational. There is general agreement that food, water, health, education and shelter should be included. Many different indicators for these and other aspects of basic needs have been used by researchers who have tried to operationalize them. One of the first attempts was the Physical Quality of Life Index (PQLI) developed by Morris David in 1979. He took three crucial variables and made an index of them where each of them had the same weight. The variables were infant mortality, adult literacy rate and life expectancy.

Which of these indicators are best is not easily established. The largest problem is however how to weigh them together. Any index of basic needs (or human rights) must choose the relative weight of the included factors. This choice is based on the preferences (or the welfare function as economists call it) of the person who chooses.

The Human Development Index proposed by the UNDP, the United Nations Development Programme, has aroused considerable attention. It is a composite statistic of life expectancy, education, and per capita income indicators, which is used to rank countries into four tiers of human development. They are reported annually in the human development report by the UNDP. An important aspect is that the economic inequality in societies is large (and increasing) and therefore

the Human Development Report in 2010 introduced an Inequality-adjusted Human Development Index (IHDI). While the simple HDI remains useful, it stated that "the IHDI is the actual level of human development (accounting for inequality)," and "the HDI can be viewed as an index of 'potential' human development (or the maximum IHDI that could be achieved if there were no inequality)."

The traditional way of comparing economic levels between countries, GNP/capita can be compared with the Human Development Index. They are almost in the same order but the differences between countries are smaller if GDP/capita is adjusted for differences in purchasing power. One of the reasons is that GNP only measures production that is sold on the market and parts of total production, especially in developing countries, are therefore not included. The adjusted GDP/capita is therefore a better indicator for standard of living. Purely physical measurements, such as mortality of children under 5 years of age, are also used. Too much attention on GNP/capita does not adequately reflect the standard of living and ought to be complemented by other measures.

The Gross National Happiness (GNH) was introduced in 1972 by the small kingdom of Bhutan as a signal of commitment to build an economy that would serve Buddhist spiritual values instead of the western material development represented by GDP. The GNI has since, by a growing global happiness movement, evolved into a socioeconomic development model. The United Nations General Assembly in 2011 adopted unanimously the GNI, placing "happiness" on the global development agenda. GNI is today reported for a number of countries. The four pillars of GNH philosophy are: sustainable development, preservation and promotion of cultural values, conservation of the natural environment, and establishment of good governance.

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Chapter 15
Policies and Politics for Sustainable Development

15.1 Entering the political agenda

Steps towards a more sustainable world are of many kinds. Some are taken by individuals as private choices. Other are business decisions to improve profitability or find new markets for a company. Very many of these steps are, however, taken by politicians and are political decisions. This requires that a social, economic or environmental problem appear on the political agenda to be perceived as a problem by the policymakers. Actors who want changes in society thus have to introduce their concerns on the agenda. Sustainable development was introduced as a political concern after the raising environmental movement in the 1960s, followed by the Stockholm conference 1972 and finally the Brundtland Committee Report *Our Common Future* in 1987. After the Rio UNCED conference 1992 it was established on the agenda all over the world.

Many factors influence politicians when they make political decisions. These include their ideology on how to develop their country, region or city. There are pressure groups, which do their best to influence the politicians, and there are also business interests, budget limitations, and not the least concern about the voters. Politics that will severely decrease the odds to be re-elected have small chances. One may argue that it is not the politicians, which lead the development of society – the voters have to be ahead. Politics leading towards a transition to a sustainable society will, according to this view, start from below.

Politics is implemented as governments, parliaments and local authorities decide on new laws and regulations and economic measures such as taxes or subsidies (which are a kind of regulations). The decisions are implemented by authorities, among them Environmental Protection Agencies, Energy Agencies etc, which are given the administrative, financial and legal resources needed. Authorities work though information, legal regulations and economic subsidies or taxation. The implementation of politics is monitored by the authorities and in the final stage, if it is not followed, the police and court system will deal with this.

Different political parties and interest groups choose different strategies for sustainable development. Neo-liberal groups argue for *business as usual* and that the market forces will take care of it, e.g. the price of oil will increase as oil becomes scarce and then renewable energy will be competitive. Others argue that human ingenuity always solved problems when confronted with the necessity to do so. This *technological optimism* leaves the problem to the engineers. Those promoting green business as the solution argue for *ecological modernization* as the answer to the sustainability challenge. Another group asks for responsible policies and *respect for ethics and values*. All experience shows that none of these strategies will lead to sustainable development by themselves, but that all of them will contribute to an extent. One may see sustainable development as a strategy in itself with its own methods or subdivide the main types of strategies mentioned above into detailed measures.

The European Environment Agency uses a formalized description of the process in which an environmental problem appears and enters the political agenda, a process that may be generalized for the more general sustainability issues. The process is known as the Driver-Pressure-State-Impact-Response (DPSIR) framework. *Driver* is the activity which leads to an impact, such as an industrial process; *Pressure* is the consequence of that activity such as a pollutant released into water or air; *State* is the condition it leads to, e.g. an increased concentration of a pollutant in the environment: *Impact* is the consequence for example sick people or disappearance of a species; *Response* is what the authorities do to improve the state of the environment or society. This sequence of events should be followed by an evaluation and possibly planning for a new round of steps.

15.2 Making sustainability politics

Democracies vary in distribution of power between the local and central levels. Sustainability politics typically stresses the role of the local level, and has *Local Agenda 21* as the basic document. To be successful the local level needs three competences: legal, economic and expertise. The local level should thus have enough power to regulate on the local level, exemplified by the planning monopoly, enough economic strength to execute necessary reforms, which requires a strong local taxation, and finally the expertise needed to monitor and plan for a sustainable future. City networks such as the European Sustainable Cities and Towns Campaign asks for a strong local level development and the role of good governance, illustrated by the Aalborg commitments.

Box 15.1 The Aalborg Commitments

The 4th European Conference on Sustainable Cities & Towns was held in Aalborg, Denmark, in 2004.The purpose of the event was to develop a common understanding of sustainability, and as a consequence to develop a framework to be used at the local level that would better articulate how to embed sustainability across municipality sectors. By consensus of participants the Aalborg Commitments were agreed on.

The Commitments encompass a list of qualitative objectives organized into 10 holistic themes. The holistic nature of the Commitments allows decision-makers to adapt them to meet their own special local conditions.

In practical terms, the Commitments are effectively tools to be used in the strategic target-setting process. For example, signatories normally set time limits to achieve specific sustainability goals. A baseline review can be produced which can identify where it is necessary to set goals and strategies. The Commitments can then be further used to monitor the sustainability process.

Each of the commitments have a more detailed set of targets. These can be seen on the website http://www.sustainablecities.eu/aalborg-process/commitments.

The Commitments signatories form part of an extended network. National or regional associations often work together. Information on, for example, best practices is usually shared with the Commitments Secretariat via the Sustainable Cities web platform. By passing on information in this way, it allows signatories to learn from one another in order that they may better realize the goals they are seeking to achieve. The commitments have today some 1000 signatories. Its predecessor the Alborg charter, had 2500 signatories.

In a study on the success of sustainable development work in European cities it was clear that the most successful local authorities had implemented clear work strategies. First it was crucial that the head of the city administration as well as the politicians were concerned about sustainable development so the whole organization had a *strong support from the leadership*.

Secondly there was more integration between the different departments of the city administration not only in the environmental side but also between economic and planning departments, that is, they used *integrated sustainability management*.

Thirdly the successful cities more than the others had an active policy for learning, that is, they had implemented *institutional learning*, as a crucial work strategy. This requires coordination and planning; it is not enough that a few specialists are aware of the background and reason for work.

Democratic government and implementation of the principles of democracy has been monitored in various ways. A most interesting and relevant report is published by the World Justice Project, WJP, as an "effort to strengthen the rule of law for the development of communities of opportunity and equity". The rule of law includes four principles: that government and its officials are *accountable*

Box 15.1 The Aalborg Commitments

1. **Governance**
   We are committed to energizing our decision-making processes through increased participatory democracy.
2. **Local Management towards Sustainability**
   We are committed to implementing effective management cycles, from formulation through implementation to evaluation.
3. **Natural Common Goods**
   We are committed to fully assuming our responsibility to protect, to preserve, and to ensure equitable access to natural common goods.
4. **Responsible Consumption and Lifestyle Choices**
   We are committed to adopting and facilitating the prudent and efficient use of resources and to encouraging sustainable consumption and production.
5. **Planning and Design**
   We are committed to a strategic role for urban planning and design in addressing environmental, social, economic, health and cultural issues for the benefit of all.
6. **Better Mobility, Less Traffic!**
   We recognize the interdependence of transport, health and environment and are committed to strongly promoting sustainable mobility choices.
7. **Local Action for Health**
   We are committed to protecting and promoting the health and wellbeing of our citizens.
8. **Vibrant and Sustainable Local Economy**
   We are committed to creating and ensuring a vibrant local economy that gives access to employment without damaging the environment.
9. **Social Equity and Justice**
   We are committed to securing inclusive and supportive communities.
10. **Local to Global**
    We are committed to assuming our global responsibility for peace, justice, equity, sustainable development and climate protection.

Source: http://www.sustainablecities.eu/aalborg-process/commitments

under the law; that the laws are clear, publicized, stable and fair; that the process by which the laws are *enforced* is accessible, fair and efficient; and that *access to justice* is provided by competent, independent, and ethical adjudicators.

Business, which may be included in civil society or seen as a separate sector, has a key role. In a modern, western state this the private sector accounts for some 85% of the economy. From companies and employees taxes are paid to the authorities on national, regional and local levels, to make it possible for them to execute the policies agreed on in the country. Since the 1970s Western

Europe, and since 1990s Central and Eastern Europe, have undergone large-scale privatizations with enormous assets originally owned by the state transferred to the private sector, e.g. trains, mines, electricity, telephone and communications. More recently we also see social services become privatized, such as healthcare, schools, elderly care etc. This means that the attitudes and projects for sustainable development in the business sector are of key importance.

As a result national, regional and local authorities increasingly do not have enough political and financial power for planning and implementing plans. To plan for future changes and to be able to implement the plans, actors and stakeholders enter into different types of coalitions, public private partnerships (PPP). These include a mix of public and private actors, each capable of bargaining on their own behalf; partners are expected to bring something to the partnership, and share responsibility for the outcomes of their activities. Disadvantages include an unclear relation of responsibility between the population and their political representatives, and an increased risk of corruption.

15.3 The role of civil society

A key actor in environmental protection is the individual. In an open, free and democratic society the individual has several opportunities to exert influence. The most important ways are the following:

- Political vote. An important way of acting politically is to vote in elections at the local, regional and national level. Another way is to participate in referendums (for example, in 1980 Sweden had a referendum about the future of nuclear power). Political participation may also include activities such as writing open letters to the press and contacting politicians.
- Economic vote. As a consumer in a market economy, the individual can choose to buy the least environmentally harmful products, or, in other words, to "vote with the wallet." If so-called green products are not available in the shops, consumers might contact producers, environmental organisations, and consumers' organisations to discuss how these products could become available.
- Work for voluntary organisations. A third possibility for the individual is to join a non-governmental organisation, NGO, also called civil society organisation, involved in environmental protection and sustainable development.

In Agenda 21 it is emphasised that civil society organisations "play a vital role in the shaping and implementation of participatory democracy. Formal and informal

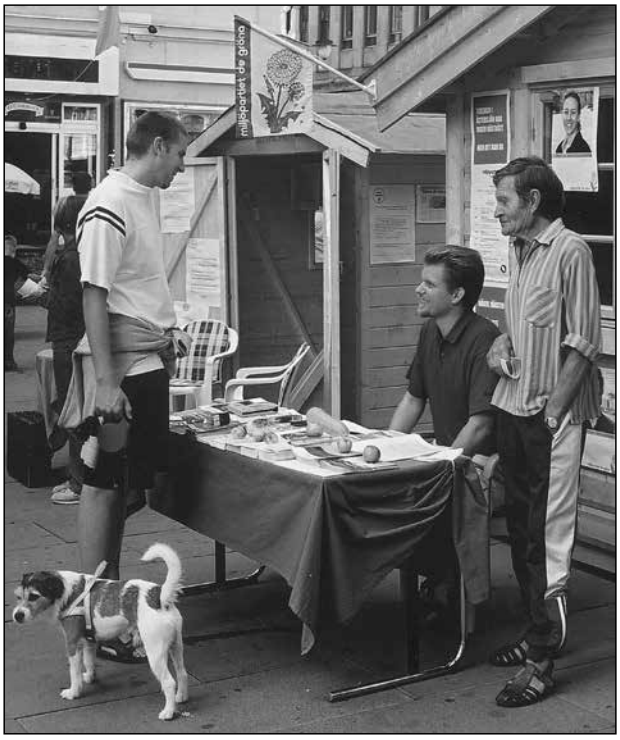

Figure 15.1. The Swedish Green Party campaigning for the 2002 elections to the national parliament, county council and city council. (Photo: Lars Rydén.)

organisations, as well as grassroots movements, should be recognised as partners in the implementation of Agenda 21". Today the same policy is valid for the implementation of the 17 SD goals.

It is important that local, regional and central environmental authorities actively stimulate citizen participation. One way of doing that is to provide the citizens with education. Another way is to ask them for advice and to delegate more and more tasks to them. The contacts between authorities and citizens should become more frequent. The policy-makers should constantly think about how they may better stimulate and help citizens' actions. As Bill Clinton once said: "We cannot ask Americans to be better citizens if we are not better servants".

Another key actor in the changes a society undergoes is science. Research at universities, academic institutions, and research institutes develop our knowledge and understanding of the world. Research financers, among them the state, largely select research priorities; during the last decade sustainability research have been well financed. The research results should be under constant discussion and criticism, and controversial results should at best provoke other scientists to try

to replicate, falsify or confirm. This is part of a sound scientific process. But it appears that when science results are uncomfortable enough some politicians do not want to face the consequence, they rather attack the science on which they are built, which appears to explain some climate denial.

In a living democracy it is far from enough to express your view when voting each four or so years. Media like TV, radio, and newspapers, sometimes described as the third power in a state (the other being government and the court system) has a key role in a living democracy. It allows for an ongoing public debate, proposals and arguments, as well as distributing the result of science and research. In the best case the media serves to educate the population on a daily basis, which is a key question for sustainable development. Where democratic institutions are defeated media is usually the first victim, as power holders want to control all information distributed in the country, another illustration of the connection between democracy and sustainable development.

15.4 The role of local and regional authorities

The conditions and the prerequisites for local and regional authorities vary greatly between countries. The Nordic countries have a long tradition of local self-government. Municipalities and counties are financially strong and they have already carried out investments in environmental infrastructure, such as sewage treatment plants, district heating and waste management. Municipalities in the Nordic countries are responsible for environmental issues on local level. The counties are solely responsible for regional environmental issues.

Regardless of the range of responsibilities resting with municipalities in different countries, one thing they have in common is that they work close to citizens and close to the problems and needs within their territory.

The Nordic countries and Germany have been quite successful in reducing emissions from the major pollution sources, but these solutions have not always been sustainable but rather large-scale, end-of-pipe solutions. The media and the popular movements have paved the way for a relatively high degree of awareness in environmental and democratic issues. It has been natural for municipalities in the Nordic countries to use Agenda 21 as a means of finding sustainable, small-scale environmental solutions and to come to terms with the high level of consumption.

In Germany the principle of local self- government for towns and villages is enshrined in the constitution, but the system differs from the Nordic countries in that Germany is a federal country with strong individual States or *Länder*.

Central and Eastern European states have more recently started to implement local and regional self-government. In most countries the municipal entities are too small to generate sufficient revenue to perform all tasks and to keep a broad base of competence. In many cases only the larger cities have resources enough to carry out environmental projects. There is still a great need for investments in infrastructure such as sewage treatment plants. These countries are less decentralised than the Nordic countries and Germany. Reforms in the territorial administrative division is under way in most countries and amalgamation of municipalities and creation of regional self-government levels can be expected.

There is no need for the Central and Eastern European countries to repeat the mistakes made by Western European countries. For example, the increasing consumption and use of packaged material is creating problems for municipalities which find that the existing refuse dumps do not have sufficient capacity. The deposit refund systems have disappeared for a number of goods, such as paper, after the transformation to a market economy. Some pioneers are trying to solve the problem by raising local consumer awareness and promoting separation of waste, recycling and composting. This is a relatively slow process, often hampered by the lack of infrastructure (for instance companies buying and recycling plastic and metal cans), lack of support from the national government and lack of central financial policy incentives.

15.5 Policy instruments

Broadly speaking, policy instruments are tools used by the policy-makers in their attempts to alter society. They address societal processes to change them according to the intention of the policy-makers. Technically, policy instruments are a set of techniques used by the executive power of a country, the governmental authorities. By them governments execute power to support or prevent social change.

Public policy instruments are generally divided into three classes:

- regulations,
- economic means, and
- information/moral suasion.

Regulation (also called command-and-control instruments) comprises a range of direct regulations such as standards, bans, permits, zoning use restrictions, etc. Direct regulations are institutional measures aimed at directly influencing the environmental performance of polluters by regulating processes or products used, by abandoning or limiting the discharge of certain pollutants, and/or by

restricting activities to certain times, areas, etc. Within countries belonging to the OECD, regulation has traditionally been the most commonly used policy instrument in environmental protection.

The second approach is the application of economic instruments to create environmentally appropriate behaviour. The main economic instruments could be categorized as:

- charges and taxes (effluent charges, product charges, tax differentiation),
- subsidies,
- deposit-refund systems,
- market creation (emissions trading, liability), and
- financial enforcement incentives (non-compliance fines, performance bonds). Economic policy instruments involve either the handing out or the taking away of material resources. In other words, economic instruments make it cheaper or more expensive to pursue certain actions.

The third approach is information and moral suasion aiming at changing an agent's behaviour on a voluntary basis. This could be accomplished via education, transfer of knowledge, training, persuasion, recommendation, and negotiation. One important instrument in this category is voluntary agreements between governmental agencies and private enterprises. This type of policy instrument is likely to gain importance in the future.

According to the OECD a shift towards prevention and sustainability will require governments to use instruments such as negotiation with stakeholders and joint agreement and action plans between sectorial ministries.

Four central concepts in environmental policy are:

- effectiveness,
- efficiency,
- cost-effectiveness, and
- equity.

Effectiveness concerns the extent to which a measure, such as an investment, succeeds in reducing environmental impacts in relation to the set policy targets. Efficiency has to do with the extent to which the costs of a policy are justified in terms of its effects and if it maximizes the effects minus the costs. A cost-effective policy seeks the least costly method of attaining a specific environmental quality goal.

Equity relates to the balance between costs and benefits across the parties concerned. Hence, it has to do with burden-sharing and fairness. It is difficult

(but not impossible) to design policies that combine the notions of effectiveness, efficiency, and equity.

One policy instrument which offers an interesting opportunity to achieve both effectiveness and efficiency is emission trading or marketable permits. This controversial instrument was invented in 1968 by the Canadian economist Dales. The main idea behind this mechanism is that firms with the lowest marginal abatement costs should abate their emissions more than firms with the highest marginal abatement costs. The first steps in an emission trading scheme are, in general, taken by the government which defines the emission levels for a particular region and then fixes an amount of permits which subsequently are either sold to the highest bidders at auctions or distributed for free, so-called grandfathering. At this stage the government opens up the game for the market forces. The polluters participating in the scheme start to sell and buy their permits. Emission permits will be bought by those firms which have the highest opportunity costs.

15.6 Which policy instrument to choose?

Each type of policy instrument has its strengths and weaknesses. A major advantage of regulations is that they are most suited to effectively prevent hazardous and irreversible effects. Furthermore, regulations frequently provide polluters with incentives to develop technology. Provided that there is effective enforcement, these instruments are able to achieve the desired environmental goals. The point is that enforcement is often problematic, because of the great number of control, administrative requirements, staff, legal procedures in case of non-compliance, and so on. A second drawback is that command-and-control instruments tend to become weakened by bargaining and negotiation between representatives of the polluters and the environmental authorities. Thirdly, regulations are expensive for society in that they are often not efficient in economic terms.

Economic instruments, such as environmental taxes and charges, minimise total abatement costs in that they constitute a permanent incentive to reduce pollution. Furthermore, they provide a source of revenue. However, a number of problems and uncertainties arise in connection with the use of these instruments. First of all, the rate of charges and taxes are not always set at a level that assures effectiveness in environmental terms. Secondly, charges and taxes may be inappropriate for controlling toxic and hazardous substances if the time lag is too long before use of the substances is curtailed. The best way to control these substances is by means of direct regulations and bans. Thirdly, there are distributive implications which must be taken into consideration when economic

Figure 15.2. Increasing car traffic has led to crowded streets air pollution and increased accidents. Local policy to reduce care traffic includes improved public transport, charges for entering the city centre, higher parking fees, and reduced speed limits. (Photo: Lars Rydén.)

instruments are used. For instance, energy taxes may have negative effects on poorer households.

Voluntary agreements also have their pros and cons. On the one hand they offer flexibility and transparency. On the other hand, control by environmental authorities over actual implementation is minimal.

It should be noted that in real life policy instruments tend to come in packages. For example, regulations are almost always followed by some kind of information. Moreover, the application of policy instruments tend to require some kind of organisational arrangements, such as authorities, legal bodies, etc. The existing organisation partly determines what is possible to do.

The choice of policy instruments is also connected to an "administrative culture" that is quite different if the command and control or information and suasion dominate. What we see is that the shift towards prevention approaches and sustainability requires that governments use instruments such as negotiation with stakeholders and joint agreements and action plans to a much larger extent than traditionally, both within the governmental offices, that is, between sectorial ministries, and between authorities and other stakeholders in society. This is even

more apparent on the local level, where often the municipalities are not economically strong enough to implement a policy and thus need to agree with other actors, especially the business sector, to achieve practical results.

15.7 Permits, inspection, and control

An important part of the implementation process is the process of legal decisions on permits to conduct an activity that is (potentially) harmful to the environment, and the following control that decisions and in general legal regulations are respected.

The decisions on permits are taken either by the local authorities or by special courts. In Sweden it is managed by the National Franchise Board. This is an administrative court in Stockholm which grants permissions (concessions) for 38 specified kinds of establishments. Also the 24 counties and the 289 municipalities grant permits for polluting activities.

The supervision of environmental performance is often divided between authorities, and often very different in different countries. The local and regional authorities, the environmental protection agencies or special authorities are in charge for different areas. In Sweden the National Food Administration is responsible for supervision of the municipal drinking water quality and the National Chemical Inspectorate is in charge of chemical safety. The local authorities both on the county and municipal level, are responsible for various other kinds of control, for example national parks.

Today there is in some countries a discussion on how to balance the need for inspection and control with consulting. Companies and other organisations for which environmental regulations importantly influence their activities may often fail to follow these regulations only because of lacking competence. The controlling authorities, hopefully with much larger knowledge and experience, have in this situation a possibility to help in many ways: monitoring schemes, proper changes in the production processes, needed investments, etc. Small companies that do not have a special person responsible for environmental matters may especially need help. A consulting function is often a very good way to improve performance and may not necessarily prevent the inspection function.

In Poland the function of inspection and control is collected in one authority. The Polish State Environmental Protection Inspectorate was established in the early 1980s with the main task of supervising compliance with environmental legislation. In the 1990s, the Inspectorate was given the right to interrupt environmentally harmful activities. The Inspectorate is also in charge of a comprehensive

Figure 15.3. New trams in Marseille France. (Photo Lars Rydén).

monitoring system and has been given the task of being a watchdog for 80 especially polluting industries.

15.8 The policy of running a city

There are very many actions which is included in how the city is managed which can be used for sustainable development policy.

The city is a *large consumer* of very many different kinds of material and services. This includes food served at open health clinics and schools. The choice of food and providers of raw material has important aspects of sustainability. Another example are the different vehicles which the city authority uses. All these can be more or less sustainable. The total purchase of a city is called *public procurement* and is an obvious means of the local authority to execute sustainability policies.

The city is also a main provided of *basic services* to the city inhabitants. This includes water provision and management of waste water, the collection and management of solid waste and often the provision of energy, e.g. electricity. Sometimes the city is also responsible for communication infrastructure such as Internet and broadband for TV and phone services. The city may set charges for

these services in a way that stimulates good behaviour among the inhabitants. Especially management of solid waste may be regulated is a way which increases recycling and reducing land filling.

The city may have a possibility to develop regulations on *new buildings*, and thereby request e.g. better energy performance, rules for green areas, access routes etc.

The city often have a decisive influence on *school politics*. It may thus request education for sustainable development.

The city has a large responsibility for *traffic and transport* in the city. This is a classical area for sustainability politics. It includes development of public transport, stimulating bike traffic by building bike paths, regulating car traffic and introducing rail traffic, such as trams and local trains.

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UZWATER

This compendium is produced for a master level course in the UZWATER project. It consists of some newly written material as well as previously published texts extracted from freely available books, reports and textbooks on the Internet, dominated by publications from the Baltic University Programme. The sources used for each chapter is listed at the end of the chapter. The compendia of the Uzwater project are produced exclusively for Master students free of charge at the participating Universities and is not to be sold or be freely available on the Internet.

The UZWATER project is an EU TEMPUS project. It includes 8 universities in Uzbekistan and deals with university education for sustainable water managment in Uzbekistan. Uppsala University and Baltic University Programme is one of the six EU partners in the project. Lead partner is Kaunas University of Technology.

The main objective of the project is to introduce a Master level study program in environmental science and sustainable development with focus on water management at the eight partner universities in Uzbekistan. The curriculum of the Master Programme includes Environmental Science, Sustainable Development and Water Management.

The Sustainable Development unit will include the basic methods used in Sustainability Science, in particular introduce systems thinking and systems analysis, resource flows and resource management and a series of practical tools for good resource management, such as recycling, and energy efficiency.

The specific objectives of the project are:

- to establish study centers at the partner universities in Uzbekistan
- to improve the capacity to train master students with expertise to address the severe environmental and water management problems of the country;
- to support the introduction and use in Uzbekistan of modern education methods, study materials, and e-learning tools;
- to encourage international cooperation at the partner universities;
- to strengthen capacities to provide guidance to authorities and the Uzbekistan society at large;
- to ensure the visibility and promotion of the Master Programme through web pages, printed material and cooperation with society;
- to ensure continuity of the Master Programme and long-term support of the project outcomes at partner universities beyond Tempus funding.

http://uzwater.ktu.lt