Climate Change and the Cities of the Future:

Art, Technology and Economics in the face of Climate Change

ECF Working Paper 4/2009

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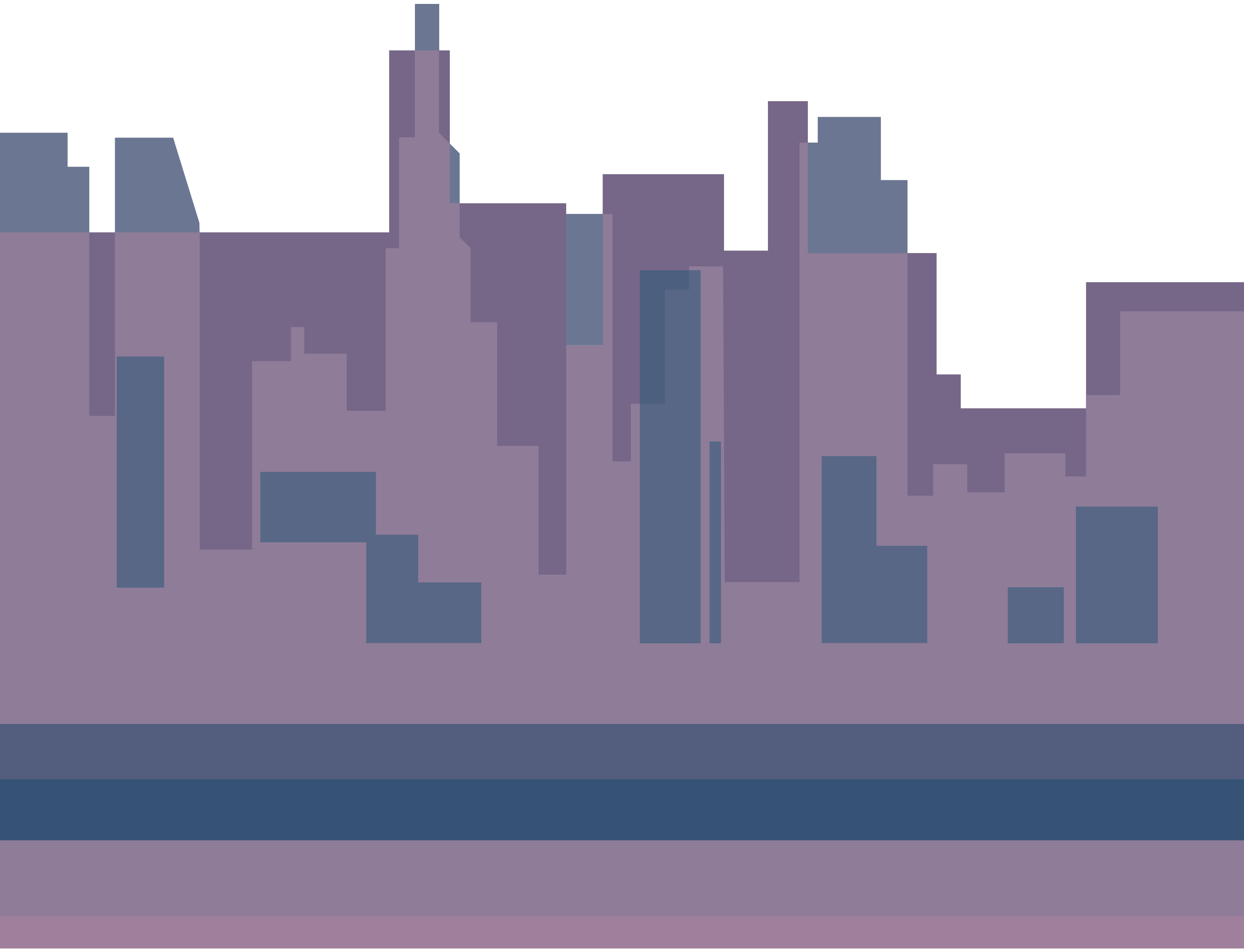

ECF Working Paper 4/2009

Preface

Antonio Ruiz de Elvira

In the tradition of the Annual Conferences of the European Climate Forum, the meeting in Alcala de Henares, 1-2 April 2008, focused on one particular aspect of the climate change problem that has attracted recent public attention. The topic "Climate Change and the Cities of the Future" was chosen as an appropriate theme in view of the close proximity of most major cities to the sea, the prospect of rising sea levels through climate change, and the increase in global urbanization, as expressed by the fact that today more than half of the world's population already live in cities. An additional reason for selecting this theme for a conference in Spain was the development in this country of interesting novel concepts in city architecture that have a direct bearing on climate change and the cities of the future.

The meeting, of which this publication is a partial summary, took place in the very old roman city of Complutum, and in its 500 years-old University. The University, the second oldest in Spain, was founded, and funded, by Cardinal Cisneros, archbishop of Toledo and regent of Spain, to provide a fully new educational model for the administrators-to-be of a new world. At that time (1499) the need for a new way of life and new forms of organizing the society were clear for Cisneros, but for very few other persons in the world. I believe we now face similar - although in detail very different - fundamental challenges.

The discovery of an entirely new and unknown continent changed forever the way of looking at the human environment. The opening of the mental doors that resulted from this opening of the oceans produced the renaissance, the acknowledgment that the "new" man was much more capable than the ancients, and that man's mind was able to overcome challenges simply not known by the men of old empires. From the opening of the seas came the reformation and the founding of science by Galileo, an entirely new way, again, of looking at the universe.

Today we find ourselves in a different predicament than the one for which Cisneros founded the University of Alcalá. Our world today is closed, every minute part of it is explored and we must find ways for many billions of people to live together on a crowded Earth. Today there exists one person for every two hectares - two football fields - of the solid, non-desert surface of the planet. Science has been such a success that man has started to forget the realities of life and the principles of nature. Indeed, the famous architect, Le Corbusier, regarded man as the "measure" of all things, forgetting nature.

Our global civilization faces two immediate challenges. First, the unabated burning of fossil carbon fuels is generating a rapid increase of atmospheric CO_2 that, together with the increase in other greenhouse gases such as methane and ozone, is producing a rapid increase of the global average temperature, and a still higher growth of the temperature in critical parts of the globe like the North Pole.

Secondly, we have created a society vulnerably dependent on a very high energy input, while at the same time we need to replace our present fossil-fuel based energy technology by renewable energy technologies in a time span short compared with the life span of existing energy capital investments. .

To meet these challenges, we are forced, like Cisneros, to design a completely new scheme of life. The set of articles in this Working Paper address various aspects of this challenge as it relates to the design of cities of the future, and the life of people living in future cities. Despite many stimulating concepts, it is clear from this collection that there exists today no general theory, no general frame within which we can clearly identify the path to a new solution. But we must nevertheless continue to strive towards this goal if we wish to continue existing as a civilized society.

Universidad de Alcalá and European Climate Forum

Reality and perspectives of climate policy in cities

Abstract

Based on a short historical retrospect on the evolution of city networks, the paper reviews the achievements of some of the forerunner cities in Europe. Even though these interim results of local climate policy look sobering, the paper argues for the recognition of the role of cities which is complementary to national policies and, in some areas, unique. E.g. urban planning determines basic factors for the carbon intensity of citizen's everyday life such as urban form and infrastructure for low-carbon mobility. The paper then analyses to what extent cities are currently exhausting their scope of action, and presents options how multi-level regimes can overcome obstacles towards more ambitious action at local level. Finally, the paper provides recommendations on how to improve the recognition of cities within the international climate regime, and proposes to consider the involvement of subnational governments into Non-Annex-I-country "mitigation actions" according to the Bali Action Plan.

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Looking closely: The significance of cities for climate policy

Currently, the scientific community and various international organizations such as International Energy Agency (IEA) and Organization for European Co-operation and Development (OECD) are exploring the potential contribution of cities to combat climate change. There is some debate on the share of GHG emissions that can be attributed to cities (see e. g. Satterthwaite, 2008). The figures produced by estimates based on the different approaches vary between some 40 and more than 70%. However, as long as activities of cities are not governed by a climate regime that builds on commitments and compliance, the detailed size of the contribution to global greenhouse gas emissions and the underlying methodology of attributing it to cities, is a rather symbolic question.

In any case, and whatever methodology is used, what really matters is the actual influence of cities on greenhouse gas emissions, i. e. their role as local governments and their policy options to mitigate climate change. If this aspect is put in the foreground, the distinction between urban agglomerations, cities and other settlements becomes less relevant, since we are talking about the local level within a multi-level setting of local, provincial levels (if present), national governments, and supranational entities.

If the local government role is in focus, the distinction between "cities" and towns or rural settlements becomes also less important, since we are speaking about local governments in general[1]. The experience with local climate policy indicates that small towns and even villages have also a broad variety of options at hand to cut greenhouse gases, and some of them, collaborating within micro-regions, have already achieved zero carbon emissions or are very close to climate neutrality. After all, 50% of the population is still living in rural areas, and in absolute terms, the rural population is still increasing. Moreover, the majority of the urban population lives in smaller cities and not in the megacities which often appear in the

[1] However, in the following, I will continue to use the term "city", just because it's shorter and more common.

mind's eye when talking about cities at global scale. In this respect, it is relevant which sectors causing greenhouse gas emissions can be influenced by local governments, and the attribution of the emissions to the individual city should reflect this scope properly.

CO_2 emissions are the main issue for cities and most local action plans focus on them. Many cities address also methane, whereas the fluor gases included in the Kyoto basket play a minor role in local policies. In principle, local governments, if they have the necessary powers, can influence 100% of energy related CO_2 emissions and apply a vast variety of policy instruments. Instruments such as the local carbon tax introduced by the city of Boulder, Colorado, provide an incentive for all energy consumers in Boulder to cut their CO_2 emissions (Boulder, 2006). However, the scope of potential policies is shaped by the specific competence of local governments and the national policy framework in the various countries, and thus cities' influence is limited in some sectors.

In any case, cities have a direct influence on their own buildings, facilities and fleet. Distinguishing between various "modes of governance" (Bulkeley/Kern, 2006) to get a clearer picture on the options of local climate policy, this sphere can be addressed by the "self-governing" mode. Energy management of buildings, stricter energy codes for new buildings, strategic investment planning, conversion of the fleet to low-carbon fuels, and climate-conscious procurement are some examples of measures cities can undertake. Moreover, many local governments are also land owners and can introduce agriculture and forestry management practices that reduce greenhouse gas emissions and enhance carbon sinks. However, municipal facilities often account for less than 5% of the overall energy consumption.

In some fields, cities have a unique role, namely through urban development and spatial planning. Land use patterns, spatial structures and urban form are decisive in defining the future carbon intensity of the society. Moreover, in some countries, local governments decide on the allocation of sites for renewable energy installations and can define obligations for renewable energy supply and energy efficiency of buildings going beyond national standards. Traditional forms of authority are used here, thus it can be called "governing by authority".

"City as supplier" or "governing by provision" is the third mode and includes services such as energy supply and public transport, and financial means. To what extent cities can use this mode depends largely on their (often declining) influence on energy and transport companies, e. g. whether they are owners or shareholders of local utilities. Unique options are, e. g., the expansion combined heat, cooling and power production, the use of waste heat for district heating, utilisation of landfill gas, and waste management.

In order to address sectors such as existing buildings and affect consumption patterns of citizens, a wide range of rather "soft" policies can applied by cities. In this mode of "governing through enabling" cities work with housing companies for energy efficient buildings, motivate, inform and educate citizens etc.

In any case, national and local policy spheres are intertwined, and in many sectors, action by local governments can ensure effective implementation of national regulation, or can complement and enhance national policies with accompanying measures and own initiatives, or can seek to introduce more ambitious regulations going beyond national legislation, if national rules are considered inadequate. In the latter case, local governments can play a pioneering role for policies that are usually in the domain of national governments. E.g. the city of Aachen in Germany was the first to introduce a feed-in tariff system stimulating investments in renewable electricity, which, several years later, was the role model for the national regulation defined in the Renewable Energy Sources Act. Another example is the "solar ordinance" of the city of Barcelona. Such a regulation requiring renewable installations for new buildings was initially foreseen in the city of Berlin some 15 years ago, but was never implemented due to legal constraints. Several years later, the city of Barcelona took up the idea and was able to implement it as the "Barcelona solar ordinance" requiring new buildings and buildings undergoing major refurbishment to use solar thermal energy to cover 60 per cent of their running hot water demand. Many other cities in Spain followed this example, and in 2006, a similar, though less ambitious, regulation was introduced in Spain at national level as part of the national building code. Subsequently, some other countries, including India, Korea, China and

Germany and United Kingdom introduced similar requirements, are planning to do this, or at least mandated cities to do so.
In some cases, local governments step in after national policy abandoned useful actions, e.g. in Japan, hundreds of cities continued to provide subsidies for photovoltaics after the expiration of Japan's national subsidy in 2005, or in Canada, a successful energy audit programme was resumed by cities after national government funding was abruptly phased out.

Looking back: City climate policy commitments and networks

Recently, new city networks, e. g. the C-40 network, working with the Clinton Climate Initiative and involving 40 major cities around the world, have emerged and draw much attention on their pledges to tackle climate change. While the scientific community is currently discovering local climate change policy as a research topic, it tends to be overlooked that many cities, in particular in Europe, have already started to enter voluntary commitments to tackle climate change some 20 years ago (see e.g. Alber at al., 1996). These were based, e. g. on the "Toronto target" of 20% CO_2 reduction by 2005, or defined in a collaborative effort together with other cities, adopting a declaration such as the Climate Alliance Manifesto from 1990.
Around 1990, three major transnational city networks were founded:
The Climate Alliance[2] (Climate Alliance of European Cities with Indigenous Rainforest Peoples/Alianza del Clima) is focussing on mitigating climate change, and, initially, the members entered a commitment to cut CO_2 emissions by half until 2010 compared to 1990 levels. The motivation to adopt such an ambitious target was to point to mid- and longer-term climate policy requirements, rather than the feasibility to attain it. As it became evident during the 1990s that the target could not be achieved by most members, a mandate to influence national and international policy processes was adopted in order to work for more ambitious targets and forceful policies at all levels. Currently, the network has some 1300 members, representing 51 million inhabitants in 16 countries. The target has been modified in the meantime: today, the members strive for 10% reduction of their CO_2 emissions every 5 years, and the initial halving of CO_2 emissions is to be reached by 2030. Moreover, in the long run, members go for a per capita value of 2.5 tonnes CO_2 equivalent.
The second network is ICLEI[3] (former International Council for Local Environmental Initiatives, today Local Governments for Sustainability), which is aiming at sustainability in a broader sense and started their Campaign "Cities for Climate Protection" (CCP) in 1993. Cities participating in the campaign pledge to follow a structured standardised approach ("milestones") with some variations in various countries and world regions. Targets are set by participants on an individual basis. In Europe, a reinforced version of the campaign has been launched in 2007, encouraging participants to adopt more ambitious targets such as fossil-fuel-free city, rewarding successful participants with the status "city of ambition". CCP has some 700 participants' world-wide, representing 250 million inhabitants. ICLEI's policy is to work primarily with large cities. Of the CCP participants, more than 600 are from Annex I countries, and some 80 from developing countries. In the latter, the CCP campaign started only a couple of years ago, mostly with some pioneering cities.
The third network, Energie-Cités[4], originated from a Europe-wide city project funded by the European Commission. The network started with a focus on energy efficiency, and over time expanded its scope to include various aspects of climate change mitigation, in particular sustainable urban transport. Members don't enter a commitment; the network is rather seeking to deliver practical services and to influence EU policies and proposals in the fields of energy. Today, it has some 150 direct member cities in 24 European countries. Moreover, it collaborates with several affiliated national networks representing another 450 cities.
As common ground, all these networks are bottom-up initiatives whose main activities are sharing of experience, transfer of know how, capacity-building, organisation

[2] www.klimabuendnis.org
[3] www.iclei.org
[4] www.energie-cites.eu

of joint projects, and strengthening the role and recognition of local governments. With different intensity and target audience, they are also involved in lobbying to influence energy and climate policy at national and international levels.

One of the main drivers of the interest of cities to take a leadership role was the acknowledgement of their crucial role and capability to mitigate climate change. Moreover, cities were aware of the linkages and synergies between climate policy and sustainable development. The co-benefits of cutting greenhouse gases at local levels, such as costs savings, clean air, regional economic development and job creation, alleviation of energy poverty, accessibility and liveability of the city, played a major role to convince citizens and local policy-makers of an ambitious climate policy. Another motivation, in particular for collaboration in networks of pioneering cities, was the feeling that governments and the international community were acting too slowly on climate change. Thus, these initiatives were also aiming at achieving progress through concrete steps and practical action, and, moreover, had a political and symbolic role.

Not only cities, but also small rural and island communities started to form so-called "energy regions" to work towards 100% renewable energies from local resources. Some of these, e.g. the Austrian district of Guessing with some 27,000 inhabitants, have already achieved a high degree of energy autonomy. In contrast to large cities, the drivers of these rural activities are to a lesser extent climate change and local pollution, but rather economic reasons such as creation of added value and jobs. Currently, most of these regions are located in Europe (mainly Austria, Germany, Denmark, Italy, United Kingdom, Spain, Sweden). Whereas some German energy regions, due to the favourable national policy framework for renewable electricity, are covering more than 100% of their electricity consumption from local renewable sources, Austrian energy regions are more advanced in the use of biomass in various forms for heat and increasingly also for electricity generation from combined heat and power.

Interim results and achievements

While cities that have just started to tackle climate policy are still enthusiastic about the emissions cuts they will achieve in the future, after ten years or more of experience with local climate policy, the pioneering cities are already disenchanted. The first movers were mostly cities from Germany, the Netherlands, Austria, and Switzerland. Their achievements to date are more moderate than initially expected.

For example Hannover had adopted a CO_2 reduction target of 25% (by 2005 compared to 1990) as early as 1992, and, since then, made continuous efforts to develop their climate policy and implement numerous measures. Among others, Hannover established a climate fund spending 5 million EUR annually for emission reduction projects and a regional energy agency working with institutions and private companies, realised innovative low-carbon developments, improved their public transport system, and worked with schools to combine incentives for energy saving with environmental education. However, these efforts resulted in a reduction of CO_2 emissions of only 7.5 per cent during the period 1990-2005 (City of Hannover 2007).

In Heidelberg, one of the first cities in Germany to produce a climate action plan in 1992, the situation is even worse. In the energy sector, emissions have risen by 6 per cent between 1987 and 1999. The transport sector was excluded from the inventory, but would probably contribute with an additional growth of emissions (Stadt Heidelberg, 2000).

The city of Zurich determined a CO_2 reduction of 8.8% during the period 1990-2004. However, as some data were based on extrapolations and estimations, e.g. for heating oil, and fuel, the uncertainty is specified to be of the same magnitude as the emissions reduction. It must be noted that the methodologies used by these cities are not consistent, and comparisons between cities are thus questionable. E. g. Hannover included emissions from air travel which grew by more than 70% in the last 15 years, and thus ends up with only 1% overall reduction of CO_2 emissions in the transport sector. Therefore, while the time series of a city's emissions inventory is indispensable for monitoring progress, comparisons between different cities are questionable.

On closer inspection of these and other examples, and the underlying causes, some common characteristics can be found: First, most cities committed to climate policy have achieved substantial savings in their own facilities, sometimes more than 30%. Apparently, they are successfully working in the self-governing mode. As for governing by provision, cities can make a big difference it they are able to influence energy supply. In particular the expansion of district heating supplied by combined heat and power, and the fuel switch to gas generated the bulk of emissions reductions in many cities.

The largest emission reductions, in some cities, occurred in the industry sector, while others experienced considerable economic growth and, consequently, an increase of emissions from industry. However, the influence of cities on the energy efficiency of (large) private companies is limited, except from the decision where to set up a company. As for other private consumers, larger cuts were hampered by the continuous growth of the number of households (though the population of the above mentioned cities did not change much) and increase of the flat area per person, affecting the heat demand and dwarfing emissions reductions. Moreover, a substantial rise of electricity consumption of private households and small commercial consumers counteracted the efficiency improvements. Similar effects occurred in the transport sector, e. g. in Zürich, cars were 9% more efficient on average, while motorised traffic grew by 10%. Apparently, the governing through enabling mode has only yielded moderate results, although a large number of climate policy actions of cities are using this mode. More experience with these soft interventions is needed in order to improve their effectiveness but in any case, socio-cultural trends are still working against a change of behaviour towards sustainable and low-carbon consumption patterns. Moreover, the impact of soft interventions is hard to measure.

As for governing by authority, there are indications that cities don't fully exploit their powers, in particular in urban development and spatial planning. In many cases, the desire for economic growth and accommodating investors are prevailing. As climate policy is a cross-sectional task and requires mainstreaming, governing by authority for climate policy requires innovations for effective and adequate administrative structures. In some countries, cities even face obstacles in the form of legal constraints. E. g. in Germany, after the last amendment of the Federal Building Code, it still remains unclear whether local governments can stipulate more ambitious efficiency standards for buildings than national building codes (Klima-Bündnis/Ecofys, 2007).

Such "external" obstacles towards local action beyond the responsibility of local governments exist in many countries. First of all, the role of cities is often underestimated, and their contributions to cutting greenhouse gases are not sufficiently recognised, discouraging local policy-makers. There is also a lack of national guidance for local government, e.g. in the field of spatial planning. A number of cities is complaining, that they don't have the responsibilities and power required to exhaust promising options for climate policy at local level. Moreover, many cities lack of financial means and staff, in particular qualified experts for climate policy. In some countries, cities are chronically underfunded, and in any case, staff and investment costs for climate actions are in competition with other urgent purposes and tasks.

Finally, in some countries, weak national climate policies result in a lack of regulation, e.g. in the field of energy efficiency, leading to additional burdens for local governments who, if ambitious national regulations were in place, could put more emphasis on their specific responsibilities and unique fields of action.

Apart from the pioneering cities, there is a silent majority of local governments who have not even started to tackle climate change, except from a number of single actions which are implemented for other purposes and have some co-benefits for emissions reduction. The obstacles keeping them from getting involved in climate policy are mainly a lack of awareness, both of the urgency of the problem and the potential role they could play.

A growing group of local governments[5] have adopted voluntary commitments to climate change policy. However, they are implementing only singular actions without pur-

[5] In Europe, these are more than 1,500, and in the US, some 900 cities.

suing a comprehensive climate action programme. Their main obstacles are lack of staff and expertise, inflexible and inadequate budgetary structures and rules[6], and the inertia of institutions preventing innovation. In most cases, if there are competing interests, other priorities are prevailing that are considered to be closer than climate change.

Finally, there is a number of outstanding examples - local governments who are seriously committed to climate policy and are implementing ambitious programmes, however with mixed results, as indicated above. Though they are integrating climate policy in their decision-making to a certain degree, they fail to change important negative trends in terms of carbon intensity. Also for them, it is often difficult to defend climate policy against short-term economic interests and the need to economise.

Moreover, in many cities, there is a lack of enforcement, both of own programmes and of national regulations, e.g. building standards. This can be due to flaws in cross-departmental collaboration, resulting in a lack of accountability and coherence. Another problem is limitations of horizons, both in terms of space and time. After all, urban planning and in particular transport planning, must ensure collaboration and coordination beyond city limits, and urban patterns and built structures will last for at least decades, if not centuries.

Looking ahead: involvement of cities in multi-level climate regimes

In order to meet the challenges of climate change, cities need to undergo a profound transformation process, building upon existing structures and working towards a high efficiency, low-carbon, resilient, human- and climate-friendly city. In particular in Europe, with relatively compact settlements, existing structures can be slightly modified and combined with modern technologies for low or zero carbon emissions. A large share of existing buildings can be upgraded to low-energy or even passive house standard, solar energy can be integrated in building design, for example in the form of photovoltaic façades, new smart and flexible transport options are emerging, such as the new Minimetro in Perugia, and human-powered means of transport like bike couriers and new bike rickshaws are already becoming a serious alternative to motorised transport. Already through application and integration of available technologies, a major step forward could be made.

Therefore, the main challenge for local climate policy is found in the political sphere, in governance issues and in administrative structures and procedures. Here, innovation is most urgently needed. Local climate change policy is still too much relying on singular projects and initiatives, instead of being mainstreamed into day-to-day decisions-making and management. In this regard, the major unresolved question seems to be not so much the physical transformation process towards the city of the future, but rather the transition process towards the local government of the future with an effective urban climate governance and a well-defined role within the multi-level regime.

To further this transition process and overcome the aforementioned obstacles, enabling international and national frameworks are needed to involve cities who are not yet committed to climate policy, and to assist cities to implement more comprehensive and effective policies.

Policy frameworks for local action

There are several options, how local (and regional) governments could be involved in the climate regime. The modes of governance identified for cities are also applicable to structure climate governance in multi-level systems (Kern/Alber 2008).

Self-governing, in this context, refers to horizontal collaboration of cities at regional and national levels, in particular in metro-regions, and in transnational city

[6] E.g. with cameralistics they can't overcome the investor – beneficiary dilemma.

networks. An option that has been pursued for many years is voluntary commitments, such as the Climate Alliance Manifesto. However, for a city network, it is impossible to ensure compliance. Moreover, under the Kyoto Protocol's cap and trade system, such ambitious voluntary commitments are virtually obsolete. Today, local governments are just doing part of the work of their national governments, without reaching any additional greenhouse gas emissions, because if they would, their government would be able to sell excess carbon credits or be less active in other areas. Unless carbon credits are withdrawn from the market, the Kyoto cap is both an upper limit for national total greenhouse gas emissions, and a limitation preventing additional reductions, too.

In order to strengthen and enhance local action, city networks have introduced quality labels and minimum requirements, such as the Climate Star awarding system of the Climate Alliance, and the European Energy Award. These schemes (symbolically) reward the local governments with a good performance, but do not provide tangible incentives, and are, thus, not able to overcome some of the obstacles hampering local action. Though city networks play an important role, they appear to be primarily networks of pioneers for pioneers (Kern/Bulkeley, 2009).

The other governance modes refer to the vertical relation between national and subnational governments. Governing through enabling includes stimulation and information, e. g. through publishing guidebooks and best practice examples. Some countries have already started ten years ago to promote local climate policy and provide guidance, e. g. Germany and Austria with guidebooks on local climate protection, more recently France with the "Memento des decideurs". In the United Kingdom, urban planning guidelines have been published by the government, recommending, and meanwhile even requiring local governments to make provisions to address climate change.

Governing through authority could, in principle, include legislation requiring local governments to draw up and implement climate action programmes. However, except from certain fields such as energy and transport planning, no government so far has introduced climate policy for local governments as a mandatory task. In principle, national governments could break down the national target into subnational targets[7]. In Italy, a debate on binding quantified targets for the regions had been emerging prior to the last elections. However, it is questionable whether it is fair to shift the full responsibility for compliance to subnational levels, unless they are provided with adequate means and power, and moreover, can participate at international negotiations with equal rights.

Governing through provision seems to be the most promising mode, given that most cities complain about a lack of financial means for voluntary tasks such as climate policy. A number of countries have set up funding programmes, e. g. the Green Municipal Fund in Canada, managed by the Federation of Canadian Municipalities (FCM), which provides financial assistance to local sustainability programmes and supports the national "Partners for Climate Protection", a network of 164 Canadian municipal governments that have committed to reducing greenhouse gases and acting on climate change. Such comprehensive funding programmes seem to be more effective than individual project funding provided by many governments for low-carbon technologies. Sweden has a long record of providing funding for local sustainability, and, since 2002, offers the KLIMP programme, managed by the Environmental Protection Agency. As a precondition for receiving project funding, a local climate strategy needs to be in place. In 2002, in the Netherlands, the most far-reaching arrangement in the field of climate change was concluded between the national government, the province and the cities, represented by the national association of local governments. The "Klimaatcovenant" (Climate Covenant) includes a methodology for local climate scans and the preparation of climate action programmes, an assistance programme to transfer know-how, and a funding programme. In order to receive funding, a city has to present and implement a comprehensive action plan based on a "performance card" comprising tasks, targets and actions in the various sectors. The city then receives funding in the form of a specific amount per inhabitant or land area that can be used for any kind of costs related to implementing the plan, e. g. for staff costs. Results of the first phase were some 300 climate scans, 250 implementation plans, and

[7] As for Europe, only the sectors which are not covered by the ETS.

250 subsidy requests of municipalities granted. A follow-up arrangement was concluded in 2007, involving 37 million EUR between 2008 and 2011.
In order to support the mainstreaming of climate policy and to provide incentives for cities to undergo the massive changes required in the near future, multi-level arrangements seem to be a promising option, based on approaches that link effective local government action to funding, such as the Dutch Klimaatcovenant. Such arrangements could involve several levels, local, regional, national, and European Union, and could be based on measurable achievements, at least for some fields where quantification is feasible and meaningful[8], and on verifiable action in other key fields. Such schemes could even involve the international level, or, vice versa, the United Nations Framework Convention on Climate Change (UNFCCC) process could offer a framework for such arrangements and could provide funds to reward cities with a verifiable good performance within such a scheme, in particular in developing countries.

Local governments as part of the international climate regime

In the UNFCCC and Kyoto Protocol processes, local governments play a minor role and find themselves in the group of observers, which are mainly non-governmental organisations. Within this large group, involving environmental and business organisations, indigenous peoples, researchers, and trade unions, local governments have their own constituency (LGMA - Local Government and Municipal Authorities), providing them with the limited opportunities of certain interventions and consultations. As opposed to the CSD process[9], there is no multi-stakeholder approach involving "Major Groups".
The networks Climate Alliance and ICLEI, the only observers from the side of local government who have continuously participated in the process, have been lobbying for a stronger role of local government. They argued that city networks are not non-governmental, but rather local government organisations, whose members, as elected bodies, have a strong legitimation and the powers to provide substantial contributions to the objectives of the Convention and the Kyoto Protocol.
Therefore, first of all, the visibility of the role and actions of local governments should be improved. To this end, the inclusion of local (and regional) level activities in national communications should be mandatory. The Guidelines for Annex I National Communications under the Convention allow for the reporting of subnational policies and measures. However, only a small number of countries mention such activities, often lacking comprehensiveness, continuity and structuredness. Since it is impossible to mention every policy and measure undertaken by subnational governments, it would be helpful to define a standard format and agree on guidelines for these reports. The format should include the number and role of local and regional governments within the state, a survey and an assessment of local climate policy (e.g. main areas of work, percentage of active local governments in relation to defined activity levels, measurable results), national actions to promote, support and guide local climate change policies and programmes, and multi-level arrangements, if they are in place. Furthermore, the UNFCCC Secretariat should put more emphasis on this level of action in their assessments of national reports, e.g. within their in-depth reviews of national communications, and include a section on local and regional actions in their Compilation and Synthesis Reports.
A second option is to directly involve more local governments. For them to participate with full rights, however, is hampered by the UN system that considers states as "black boxes" and avoids a closer look at domestic issues and interference in national policies. As a small step forward, national governments should invite local and regional representatives in their national delegations. In recent years, some governments already started to invited selected cities, however, whether they were really involved in the negotiations is unclear.
Another option is putting local climate policy on the agenda of the UNFCCC process, e.g. at thematic workshops on mitigation and adaptation. Successful local approaches and climate governance, options for national governments to promote local action, and models of

[8] Quantification could be based either on greenhouse gas emissions reductions, or on performance indicators covering the relevant sectors.

[9] Commission for Sustainable Development, the follow-up process to the Earth Summit in Rio in 1992.

multi-level arrangements should be topics when talking about the implementation of commitments under the international regime.

Excursus: Can local climate policy benefit from the carbon market?

The Kyoto mechanisms and national and regional emissions trading schemes such as the EU Emission Trading Scheme (ETS), which have established a global carbon market, definitely have an impact on local governments and their climate change policy.

First, ambitious voluntary commitments in place at local and regional levels have lost their meaningfulness under a cap and trade system as explained above.

Second, European local governments who own, or hold shares of utilities that operate power stations with a capacity exceeding the threshold level defined in the European Emissions Trading Directive, are participants in the ETS.

Third, local governments can voluntarily take part in the carbon market. At the moment, they can invest in Joint Implementation (JI) or Clean Development Mechanism (CDM) projects, or can host such projects. Some city networks are encouraging their members to participate in these mechanisms, and have investigated voluntary approaches to emissions trading. In Italy and France, there are efforts to promote local government participation in the carbon market[10] and to allow for "domestic projects". These are emissions reduction projects similar to JI projects, taking place, however, in the home country of the investor instead of abroad as required by JI. If such domestic projects would be eligible under the ETS scheme, generating carbon certificates would be easier, since investors usually have more insight into domestic options for cutting greenhouse gas emissions. Local governments could then seek for investors to fund their mitigation projects and receive carbon credits in return. However, double counting[11] of emissions reductions would need to be effectively excluded and additionality[12] would need to be guaranteed.

Using these mechanisms, the carbon market can well provide an incentive to deploy low-carbon technologies if local governments are willing to take the risks connected to the volatility of carbon certificate prices. However, project based mechanisms provide incentives only for single projects that produce measurable results in terms of emissions reductions. Carbon finance can not stimulate the transition processes mentioned above, the mainstreaming of climate policy into the local policy, and various policy options that are particularly important for local governments, such as urban planning geared at low-carbon structures, since these processes and policies do not generate measurable results in the short and mid term.

The most far-reaching option would be to include local action into the international regime. As for national-local arrangements, the core element would be a binding commitment of the local government on the one hand, and the provision of funding and incentive schemes on the other hand.

A crucial question is whether such arrangements could be based on quantitative targets. There are strong indications that this would not be effective, since they could lead either to "local hot air" (e.g. if a large company closes down, it has major impacts on a city's overall emissions) or could be too restricting for the city's development in terms of population and economy. Moreover, there are methodological problems with quantification, since the effect of trans-border activities (e.g. traffic crossing the city borders, "imported" electricity) can be substantial.

In this respect, there are analogies to the question of how to involve developing countries in the international regime for the post-2012 period. For many non-Annex-I countries[13], quantitative emissions reduction targets can not be the solution, either. For them, as for cities, the linkages between climate policy and the need for sustainable development is the key. These linkages connecting greenhouse gas emissions reduction, clean air policy, and social and welfare issues are most obvious at local level as mentioned above, both for local governments in industrialised, and in developing countries.

At international level, a number of proposals to involve non-Annex-I countries with new types of commitments have been tabled that are addressing these linkages, e.g. the Sustainable Development Policies and Measures (SD-PAM) approach. At closer look, this proposal is very similar to the advanced arrangements between national and local governments, insofar as they involve a basic

10 Italy: Kyoto Club (www.kyotoclub.org), France: Caisse des Dépôts. (www.caissedesdepots.fr/spip.php?article630).

11 Therefore, such projects would be restricted to non-trading sectors, and their emissions reductions would need to be excluded from national inventories.

12 Avoiding giving credits for projects that would have happened anyway.

13 Countries that are not subject to a Kyoto target.

agreement, a pledge for the implementation of specific policies and measures or of a portfolio of measures, and a funding scheme.

It might be possible to learn from, or adapt, or even, in some cases, apply such an arrangement for cities, which, after all, are governing large amounts of greenhouse gas emissions that often exceed those of small nations. The UN framework, if not directly involved, could at least strongly stimulate such arrangements, or create framework arrangements involving countries whose local governments are in a similar situation regarding their emissions and economic development.

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Saint Petersburg the northern mega-city: scenarios of future, environment and climate change

Saint Petersburg – the northern mega-city

Saint Petersburg is the largest northern city in the world with a population of about 4,6 million people. Its position on the latitude 60º North, less than seven degrees south of the Arctic Circle, leads to a huge variation in the length of day with the season , ranging from 5:53 to 18:50 hours. It causes twilight to last all night in early summer, from June to mid-July. This remarkable phenomenon is known as the White Nights and has a special significance for the city. During this time there is an annual international cultural event, the White Nights Festival, which consists of a series of classical ballet, opera and music concerts.

Saint Petersburg is a city of the Northwestern Federal District of Russia, located on the Neva River at the east end of the Gulf of Finland on the Baltic Sea (Figure 1). The Neva River flows out of Ladoga Lake, the biggest lake in Europe. The shallow Neva Bay is separated from the eastern part of the Gulf of Finland by Kotlin Island and a dam, which is now under construction. Saint Petersburg is the second largest Russian city after Moscow, as well as an important industrial, scientific and cultural centre. It is also an Administrative Centre of the Northwestern Federal District of the Russian Federation and plays the role of the marine gate of Russia due to its strategic position, the closest to the European Union.

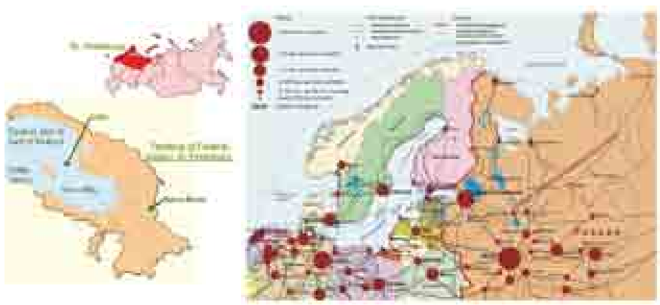

Figure 1. Saint Petersburg in the Russian Federation and the Baltic Region

City planning system

During 2003-2006 Saint Petersburg's planning system was established for the production of short-, mid- and long-term forecasts for the economic and social development of the city. The major goal of this system was to achieve a transition from a chaotic to a well-ordered city development. The system considers several possible scenarios for Saint Petersburg's future development with the goal of determining the optimal development path.

The long-term city planning system consists of:

1. Concept of a socio-economic development
2. Strategic Plan
3. General Plan

1. The Concept of a socio-economic development is a major element of the long-term city planning. This document contains general ideas of the life quality standards expressed by macroeconomic indices and scenarios of Saint Petersburg's development. The current concept is based on the forecast of a socio-economic development of Saint Petersburg until 2025.

A strategic analysis showed that the city development is most likely to follow three major scenarios:

- Commercial-transport scenario. Saint Petersburg will become first the largest commercial-transport channel between Russia and EU; 50% of total Russian freight to and from the EU will flow through this channel
- Industrial scenario. Saint Petersburg will also become a large industrial centre. The major branches will be shipyards, food industry, energy and power-machines
- Innovation management scenario. A special large-scale program will be developed to promote innovation activity aimed at the conversion of Saint Petersburg into a world-wide centre of innovation. The activities will be carried out in several branches, such as high-precision mechanics, optics, electronics, biotechnology, medicine, software, general equipment, transport technologies, etc. Saint Petersburg, together with Moscow, will manage Russian and foreign companies, attracting considerable financial capital and enhancing the communication and banking facilities to a high quality level.

2. The Strategic Plan consists of a set of legal regulations including goals for the socio-economic development of a mega-city, measures and actions to achieve these goals, main directions for the city administration activities, register of state functions of Saint Petersburg, and a General Plan. Main directions for the city administration activities are the development of life standards, allocation of the resources needed to achieve these standards as well as corresponding administrative and financial measures. The register of state functions consists of provisions aimed at the implementation of life standards.

3. The General Plan of Saint Petersburg identifies the spatial elements required for the socio-economic development. It is currently being discussed at the City Council and together with Saint Petersburg's community; its final approval may take place sometime this spring. This will be the 20th plan since 1712 when Domenico Tresini drew up the first plan for the young city. The European concept of city as an open space is emphasized as main basis in the new plan; according to the authors, Saint Petersburg should have a recognized position among the large European cities. The new plan therefore aims to achieve the general European environment quality standards for cities.

Saint Petersburg environment – floods

The environmental issues take an important place in the city planning system. Pollution of both atmospheric air and the Neva Bay is critical for Saint Petersburg, but we will not consider these issues in this paper. Instead, we will analyze an important natural phenomenon which has caused damages to Saint Petersburg already for three hundred years: the long-wave floods, and the extent to which they may be affected by global warming.

The elevation of Saint Petersburg ranges from sea level to its highest point of 175.9 m in the Duderhof Heights in the South. However, the major part of the historical city center is less than 4 m above sea level and has suffered from flooding more than 300 times in its past history. Floods in Saint Petersburg occur at the Neva River delta and the eastern part of the Neva Bay, flooding part of the city territory. The floods are generated by cyclones in the Baltic Sea with a prevalence of west winds. Cyclones can create a slow, long, Kelvin wave, with a phase velocity matched to the cyclone propagation speed that travels into Neva Creek, where it meets the natural Neva river flow moving in the opposite direction. Seiches, wind tides and other factors also contribute to the floods. The water level rise is enhanced by the shallowness of the Neva Bay (depth 2.5÷6 m; 1 m in the costal area), the flat bottom topography and the narrowing of the Gulf of Finland near the Neva delta.

At the beginning of the 18th century, the central part of the city was flooded by a water level rise of only 130 to 150 cm. At present, a flood is defined as a water rise of more than 160 cm above the sea level (a special gauge is located near the Gorny (Mining) Institute). Floods with a water level rise up to 210 cm are classed as dangerous, floods between 210 cm and 299 cm as especially dangerous, and floods above 300 cm as catastrophic.

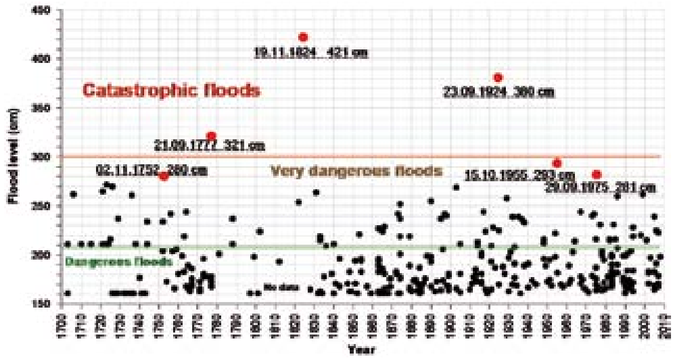

Figure 2. History of Saint Petersburg floods

Saint Petersburg flood history is shown in Figure 2. Since 1703 there were 333 floods according to the extended list of K. Pomeranets (306 – according to the official data of the Hydrometeorological Service). The most disastrous floods occurred on November 1824 (421 cm), September 1924 (380 cm), September 1777 (321 cm), October 1955 (293 cm) and September 1975 (281 cm). Figure 3 shows a photograph of the flood of 9th January 2005 that reached a level of 239 cm (classification: "very dangerous"). The most recent flood occurred on 3rd February 2008, with a height of 190 cm.

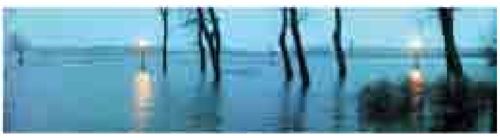

Figure 3. Flood in Saint Petersburg, 9 January 2005

Statistically significant changes in the flood level since 1703 are not found; only a small positive trend of ~1 cm/100 yr can be detected. However, there is a significant increase in the flood frequency at the 95% confidence level of about 1.1 floods per year over a period of 300 years.

An analysis of the flood distribution over the 18th, 19th and 20th centuries shows an increase of the total flood occurrences in the 19th century and a more significant increase in the 20th century (138 floods against 100 and 79 floods over the 19th and 18th centuries, respectively). A comparison of three 37-year periods at the beginning of the 20th century, the end of the 20th and the beginning of 21st centuries shows a significant increase in the flood occurrence during last three and half decades (about 54%). The increase of the flood occurrences during the winter months is even more drastic – by a factor of four. Winter floods represented ~20% of the total number of floods in the 18th and 19th centuries and 31% in the 20th century. The significant increase of total flood occurrences as well as the number of winter floods during the last 37 years may be caused by global warming, but this hypothesis needs additional investigation.

To protect the city from floods, the construction of a special dam was begun in 1979, but was stopped ("frozen") during the "Perestroika" (1990s). The construction has meanwhile been renewed and now extends 25.4 km westwards from the north coast of the eastern part of Gulf of Finland to Kotlin Island, and southwards from Kotlin island along the boundary between the eastern part of the Gulf of Finland and Neva Bay (see Figure 1). The dam has six water-exchange gates, including two in the north and south for shipping, which are closed during the floods. The dam is part of a ring road around Saint Petersburg.

The construction of the dam may lead to a decrease of the water exchange between the eastern part of the Gulf of Finland and Neva Bay (about 10÷20%), disturbing the natural water circulation in the Gulf. The potential detrimental impact on the ecology of Neva Bay has generated extensive discussions in the scientific and ecological community of Saint Petersburg.

Sea level rise would raise the absolute level of floods in Saint Petersburg. During the 20th century the global average sea level rise was about 15 cm, which caused no significant problems for the city. According to the estimates of the Intergovernmental Panel on Climate Change (IPCC), the projected global average sea level rise may be about 20÷60 cm by the end of this century. This would be critical for Saint Petersburg if no dam is constructed. But, hopefully, a dam will be constructed, which will be sufficient to protect the city also in this case. However, the Greenland ice sheet, the "wild card" of the climate system, may start melting faster than presently estimated. The additional sea level rise, of several meters in the long term, would be critical for Saint Petersburg even with completion of the dam.

Mean climate and climate variability of Saint Petersburg

Mean climate and climate variability of Saint Petersburg Saint Petersburg is characterized by a humid continental climate of the cool summer subtype, due to the moderating influence of the Baltic Sea cyclones. The distinctive feature of Saint Petersburg climate is its weather variability caused by the frequent air mass changes (continental, marine and Arctic air masses). The temperature changes induced by air mass exchanges exceed the daily amplitude and can reach 20°C and more.

Winter lasts approximately 3,5 months. The recorded absolute minimum air temperature is -35,9°C, measured in 1883. The average climate parameters over the period 1961-1990 were the following:

- mean annual air temperature: +5ºC
- number of days per year with temperature above 0ºC: 232
- coldest month: February (-8 to -8.5ºC)
- warmest month: July (+17.4 to +18°C)
- annual precipitation: 517~557 mm.

Jones and Lister derived annual temperature anomalies for Saint Petersburg. Since the end of the '70s positive temperature anomalies prevail, attributed to the ongoing global warming. Starting from 1988 most of the winters were anomalously warm in Saint Petersburg. As a result, since the early '80s the snow cover depth has been decreasing despite an increase of precipitation at a rate of approximately 1.1 cm per year (see Figure 4). Before that, from 1965 to 1982, the snow cover depth increased at a rate of about 1.2 cm per year. The decrease of snow cover depth during the last two decades may be explained by the relative increase of rain and wet snow instead of snow in the winter precipitation, as well as by enhanced snow-cover melting.

Precipitation in Saint Petersburg has been increasing for both warm and cold periods of the year at least since the end of the 19th century (see Figure 4). The increase is most pronounced in the cold half-year, at approximately 8 % per decade, as compared with about 3% per decade in the warm half-year.

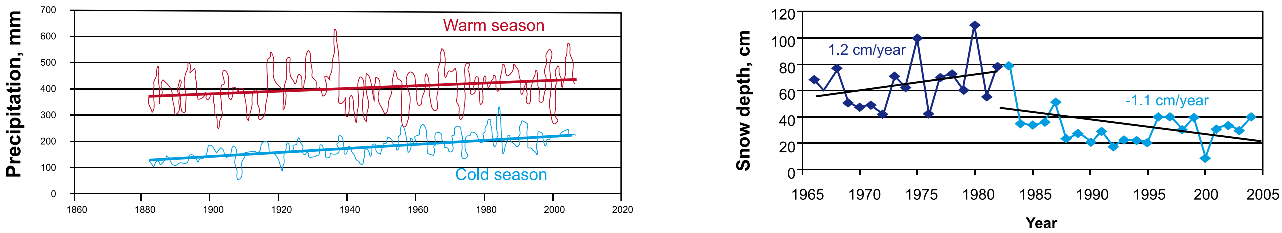

Figure 4. Changes in annual precipitation (left) and snow depth (rigth) tor Saint Petersburg.
Voeikov Main Geophysical Observatory, Saint Petersburg

Climate change projections for Saint Petersburg for the 21st century

The latest generation of climate model simulations has been recently completed for the IPCC in order to provide input to the Fourth Assessment Report (AR4). We used a total of 12 IPCC A2-scenario simulations for our analysis.

The simulations with some of the models include several ensemble members. We considered two key parameters for Saint Petersburg: surface air temperature and precipitation, for both July and January (Figure 5). The model

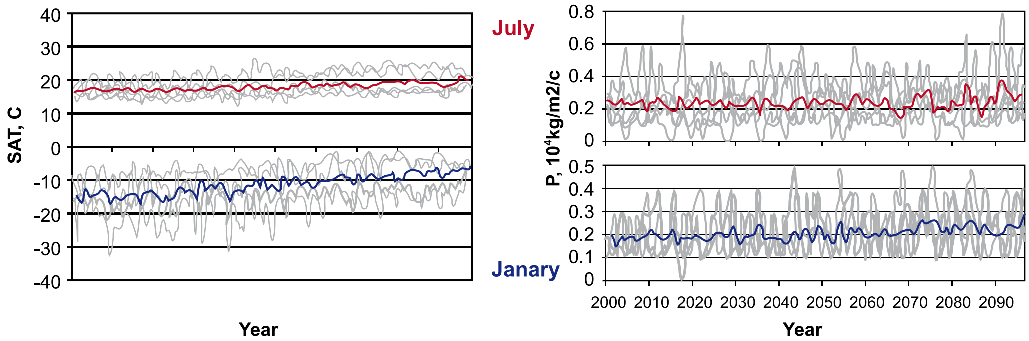

Figure 5. July and January projections of surface air temperature and precipitation for the 21st century in Saint Petersburg (12 IPCC models; A2 scenario).
Bold curves – model means.

runs exhibit a large dispersion about the means (indicated by bold curves), especially for precipitation and winter air temperature.

The climate projections indicate a significant increase of both parameters at the end of this century, especially in winter. The precipitation increase is 20% in summer and 50% in winter. Surface air temperature increases about 3ºC in summer and about 9ºC in winter. Thus, the climate in Saint Petersburg later in this century will be warmer and more humid.

What are the potential consequences of global warming for Saint Petersburg? First, there will be a decrease in the duration of the heating season, as indicated in the annual cycle of the surface air temperature for the periods 2001-2010 and 2090-2099 derived from IPCC A2 scenarios (Figure 6). The city heating in Saint Petersburg is turned on when the day and night average temperature is below 8ºC. The model simulations show that the temperature increase will lead to a decrease of the heating period by about one month towards the end of this century. This will lead, in its turn, to less energy consumption and CO_2 emissions.

Another consequence of milder winters is an increase of the frequency and duration of thaws. Precipitation will be mostly in the form of rain and wet snow. As example, in the last two winters in Saint Petersburg there was very little snow, which facilitated the city cleaning, and the winter traffic. Other potential consequences are more difficult to predict and deserve a specific investigation

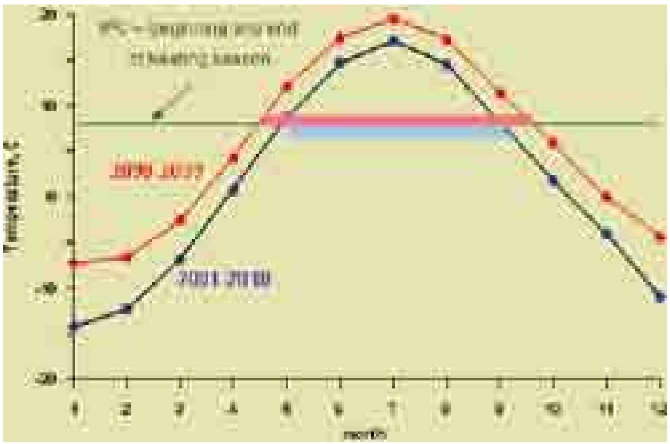

Figure 6. Duration of a heating period in Saint Petersburg at the beginning and the end of the 21st century. The blue bar shows the duration of period without heating for the beginning of the century (2001-2010); the pink bar shows the same for the end of the century (2090-2099)

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XXLight City

Climate change and the role of architecture

Abstract

The surprising growth of urban settlements we experienced since the Industrial Revolution runs parallel with the astonishing waste of resources and of energy. This new situation has modified the conditions of human settlements. We need a deep change of perspective in order to consider the city of the 21st Century and we need to revise all the urban theories and practices on the light of the new events in order to limit the waste of natural resources and the massive pollution of the planet.

After consolidating a new theoretical foundation that can give us a new scale of priorities upon which to base the future of humanity, we should find the path to balance Nature and City. The first and most decided way of reencounter with the environment implies the clear will of compacting the city, of controlling its indiscriminate extension and invasion of the territory. The change of habits, the revision of transportation systems, the goal of energy and material saving in architecture and the help of technology are some of the questions we should consider now.

As a sample of this new way of acting is the model of Vertical Garden City, a bio-structure done by the architects Rosa Cervera and Javier Pioz that develops a city in vertical overcoming the skyscraper's typology. The Sustainable Vertical Garden City is a new interpretation of the joint role that architecture and urbanism should play in the formulation of an eco-habitat, which is the balance between Nature and technology, and whose interests are opening doors to progress without closing the window into our origin and environment, an environment that it is also a fascinating world of high technology. The Vertical City is a proposed eco-habitat able of environmentally rationalize land use, able of saving material through a more efficient structure inspired in natural structures, able of saving energy through the use of natural resources such as the sun, the air, water and humidity, and able to adjust its height, requirements and use to the different scales of urban and economic development of the city where it is located.

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Instant City

The development model that modern society has coded as the basis of progress is one of "steady growth", a model that is identified with the concept of "goodness" and that signals as negative any question that does not imply steady expansion. This is readily recognized by looking at the interests that governments, firms and institutions reveal each year when they announce the growth rates they have forecast, supposing that any number lower than the former year's is a failure.

This philosophy of unlimited expansion, which we have built into the industrial and post-industrial society, decisively influences the form of human settlements and more concretely, what we understand traditionally by cities. In fact, during the last three decades, an urban growth regime, unknown in human history, is underway; a growth that changes, without doubt, all the parameters that have been used to model cities. Since the last years of the 20th century the city has ceased to be the traditional place of common gestation and progressive building of society, in the form of historic layers that sum the contributions of successive human generations, into which old and new, preceding and actual, inherited and imagined inputs are continually blended.

As Aldo Rossi wrote, the city is/was that place in collective memory where we are able to recognize the past's presence through absence signs, and where presences and absences become axes and nodes of the urban structure in past-present-future evolution. Today we are observing a phenomenon that leaves us unarmed and devoid, not only of tools but also of arguments to act effectively on the city.

Amount and speed

There are two questions that negatively act on the contemporary urban growth, and that modify/change the building of the city: the first one is related to quantity and the second one, surprisingly, to speed.

With respect to quantity we are all aware of the steady increase that we enjoy or suffer since the industrial (or rather, the energetic) revolution; a growth that is expressed in the number of people, production, consumption, etc. All of these changes imply changes in the scales of cities and in the distribution of inhabitants within a territory. The world population has increased exponentially during the last two centuries, as a consequence of the availability of energy and industrial development. The number of people on Earth at the end of the 18th century was about 800 million, at the start of the 20th century it was 1150 millions and only hundred years later it had increased by a factor of five to over 6000 million. As this process has not leveled off, but on the contrary keeps on growing, we, today (8 years later), are 6200 million, on our way to 8500 million (in the optimist forecast) by 2050, or 12500 million in the pessimistic estimate, when, with diminishing energy availability, population growth will stop.

Putting it another way, these estimates tell us that in 300 years the population has grown by a factor between 13 and 18, something that has never happened in human history before. Or in still another way, someone who is seventy years old today could say: "when I was born, two thirds of today's world population didn't exist".

On the other hand, the industrial society did reorganize land use, with a progressive reduction of the rural population and rural places of habitation, while increasing, at the same time, the urban population. Thus the number of cities of more than five million inhabitants has grown from 11 in 1955 to 35 in 1995, and is on its way to 55 in 2015.

The same process of de-ruralization is the reason that the percentage of population living in urban zones has increased from 30% to 60%. The increase of the urban population is driven by the dual process of the general population increase and the migration of people from the country to the city. The city is becoming hypertrophied to the point that the word for city in its usual meaning is becoming obsolete.

As a second cause we spoke of speed as the source of a change in the concept of city. This parameter, by its effects, is much more significant than the increase in quantity. Speed is not something that acts exclusively on human settlements, but is one of the driving parameters of the present age, up to the point that it can be regarded as a central characteristic of today's world.

Speed, from the viewpoint of the time employed in covering space, that is, linked to the physical world, has caused us to change the concept of distance, as distances have shrunk psychologically as the times needed to cover them have diminished. Distances are no longer measured in spatial units, but in minutes or hours. Thus we can say that speed has changed not only the concept of distance, but also the concept of 'place', in particular the unique place that we experience as the global world.

Speed linked to change has evolved in parallel with a miniaturization process that is the main characteristic of today's technology: very small and very fast. Thus computers and cybernetics, microelectronics, nanotechnology, etc. have changed the world model towards one where speed has gained such a high value that without it we could not conceive of the interwoven net of information, knowledge, distribution, etc. that governs the planet today. Also, at everyday level, speed has permeated so deeply into society that the latter does not understand, nor accepts, long term strategies, but on the contrary, considers the immediate as a positive measure of benefits and capabilities.

From these considerations it is logical to think that the effect of speed has a bearing on the formulation of the concept of a contemporary city, by giving us data that until recently would have been unbelievable and that, still today, though real, seem to us to be a fantasy.

What once was the trait or specific legacy of the city, that is: to have been built and measured in generations and generations, needing several centuries or millennia to rise from its origins and allowing it to be considered a city, is no longer relevant. Cities today can build to their completion, although not in finality, in a time span of 25 years, by only one generation of people - something that was impossible in the past and possible only in the present. The best example of what we call "Instantaneous City" can be found in the United Arab Emirates. What 25 or 30 years ago was only desert sand, in regions of difficult geographical and climatic conditions, are now surprising cities filled to the brim with buildings of gigantic dimensions, with fully developed urban structures, and with such an energetic activity that they are now world reference points.

The situation is not that in the last 25 years a settlement has been started that in the next centuries will develop into a significant city; on the contrary, we have to say that, without regard to what could be the future of the city, the passing of several centuries has been concentrated into a single coup of action by a unique human group. Thus the cities of Dubai and Abu Dhabi have just celebrated their 30 years birthday, but have the appearance of cities of long standing.

This situation generates strong internal contradictions in that the extensive urban and economic development does not parallel the development of other socio-cultural aspects. We find incomprehensible situations: for example the past fusing itself with the future without any realization of the present. Thus, in a region in which 40 years ago there was no electricity, 30 years later mobile phones were extremely abundant - a fusion without precedent of a pre-industrial epoch with a hyper-developed technological age. Evolution has become abrupt and in jumps, without transit and without time for rest, in a vertiginous and sudden way that destroys the gradual building of the historic city.

If we compare the contempory data with the growth rates of cities throughout history, and not only with these, but even with the faster ones that we have experienced since the Industrial Revolution, we realize that we are facing a process of gigantic spatial scale, and of an extremely small time scale - a completely new phenomenon for humanity: brutal changes in record time. This defines the concept of today's Instant City: Cities, or large neighborhoods or urban spaces that are not built by accumulation of chronological, historical, cultural or epic layers, but that are made instantaneously. The concept of historical memory, with the almost genetic gathering of socio-cultural heritage, has lost its validity. Today's cities and urban entities built "at once".

In this model of the instant city, the planning and building times that until now have been valid in urban theories are not longer applicable. We should recall the elaboration time of a general plan, the social agents involved in it, the numerous intermediate controls, etc. In the case of a city of fast development, the decision making are essentially instantaneous and execution times are minimal. This implies that either the city is planned with an unprecedented speed by a reduced group of social agents with an exceptional capability for decision making, or it is designed by a larger group with an extremely effective internal coordination enabling extraordinary time savings, or it is simply not planned at all, and the development happens haphazardly, driven by various random socio-economic forces.

It is clear that this new situation, which we call the Instant City, undermines and disqualifies the usual processes of planning practices and urban building. The procedures and tools of contemporary urban theories are no longer sufficient to guarantee the new model of a city. In order to configure the new city of the 21st century in the face of a new reality, we need a new process of thinking about the city.

Large City - Light City

An inescapable consequence of the creation of the instant city is the limited type of its objects and the dearth of variety, both things present in the multiple layers of cities of slower development. Cities built by isolated unique social groups are normally motivated only by mercantile and economic goals, remaining void of cultural meaning. The results are very modern cities, spectacular cities, but uninteresting cities without identity. The global interchangeability of urban models and architectonic prototypes is typical of today's globalized world. This is not new, but has evolved from beginnings already in the 20th century. It is made evident by the "international style" that characterizes a common way of doing things that has developed far removed from the local culture.

The contemporary city of large scale, governed by the circumstances of its hasty making, is on the one hand wonderful in its scale and feats, with urban developments and buildings of a dimension that would have being unimaginable some decades ago, but on the other hand completely superficial in its results. This superficiality is amplified, as foreseeable, by beautiful and impressive wrappings that could belong to any culture, to any place, to any social group, leaving it soulless. In this sense the Large City is a Light City. An interchangeable mobile city that could be in any country and that in all of them would fulfill its assignment. This phenomenon is particularly clear in Asia, where the whirlpool of growth has confused or rather fused the different ways of creation into a single style that we could call modern-Asiatic, which is equally valid for the development areas of China, India, the Southeast or the United Arab Emirates.

One of the ways by which the city tries to recover its lost identity, to distinguish itself from so many others like it is, by its icons. A highly symbolic emblem can help to recover its lost personality. This helps us understand the world phenomenon of architectural shows that are so common today. It is only through highly emblematic buildings that the city can distinguish itself from the reigning national homogeneity, and thus these buildings try to be spectacular, inventing surprising forms to make them unique.

Urban consumption and ecological consciousness

The surprising growth of urban settlements runs in parallel with the surprising waste of our resources and of energy that these demand, generating an imbalance between the availability of products from nature and the capability of the human being to plunder the environment.

The concept of an ecological footprint has given us the insight that the city extends beyond its physical limits, when we take into account the energy and other resources extracted from beyond the city. Although it need not be so, today, the ecological footprint is much larger than the city itself, since society is more developed and powerful, generating shocking differences in consumption between developed countries and countries still on their way to wealth. In the same way we find that mega cities, since they have simply upscaled the historic city designed for a moderate population, have skyrocketed the use of land, energy and general resources. This is also a consequence of the non linear property of complex systems like cities: a city n-times larger than a smaller city uses much more than n-times the resources of the smaller city.

The awareness that humanity is throwing away the heritage at a dizzying speed which the Earth needed millions of years to accumulate is something really new. It was not until the sixties of the last century that it was generally realized that the environment was being degraded by the demographic explosion and economic development at an unacceptable rate. In fact, the trigger for the current ecological disaster was the emergence of the welfare state after the Second World War, when the economic and human means for building a prosperous and free society produced a happy life model that, once started, revealed itself as unstoppable.

The barbarous attacks against the environment have been continuous: phosphates from laundry products and fertilizers, mercury from fuels and lead from the oil industry polluted the sea waters; both oxides of carbon, CO_2 and CO, emitted from the exhaust pipes of vehicles, from chimneys and from oil refineries, have been distributed in the atmosphere, with dangerous and unpredictable effects on the climate; oil spilled into the sea have damaged marine plankton; gases in spray bottles and from freezers have affected the ozone layer; nuclear radiation and residuals of the nuclear industry and the effects of nuclear explosions have added further challenges for the environment. Global heating is already detectible.

However, all these consequences were accepted as part of the advanced society, in exchange for reaching degrees of comfort and welfare unknown until then. As soon as film producers exported a prosperous and happy life model the entire planet wanted to copy these achievements, starting a large-scale attack against the Earth resources.

The first space travels, the first time that human beings could leave the Earth, made us conscious of the limited size of our planet and of its frailty within the Universe, promoting the first movements to protect certain regions of great natural value and a number of endangered species. Today, in the first years of the 21st century, that ecological awareness has extended to all scales, making us conscious that the city is one of the biggest sources of energy consumption, land use and pollution.

For this reason we must proceed to revise all the urban theories and practices in the light of new events, in order to limit the waste of natural resources and the massive pollution of the planet.

XXI Century City: towards a new city model

The 21st Century City: towards a recycled city

We need a fundamental change of perspective in order to consider the city of the 21st century. The inherited models have been proven as inadequate, the speed of events and the consequences of past behavior, that we are now able to contemplate, force us to a new approach that enables us to generate habitats in dynamical equilibrium with the natural environment.

To do that we must first consolidate a new theoretical foundation, or what amounts to the same, we must build a new philosophy that can give us a new scale of priorities upon which we can base the future of humanity. Without a full knowledge of today's conditions and without the subsequent conviction of the need for decisive action, we are at risk that the proposed solutions could be modal or shallow and inadequate. However, this task will be the subject of another investigation. Today we want to provide, in the light of a new society living in the 21st century, some alternatives that can help us minimize the use of natural resources and the assault on the environment caused by urban settlements.

e-Society: Digital City - Sensor City

The last two and a half centuries have been times of advances and changes without precedent in the activities of humanity. These innovations, some of them astonishing, for example, the trips to the moon, have been accepted step by step. However, with respect to some values human beings remain strongly attached to old traditions, and the necessary changes demand a huge effort to be accepted, and take a long time to be realized. This is the case for the city. The inheritance, in many cases, of millennia of urban structure, and some timeless aspects of social organization and human relationships, make it difficult to introduce radical changes. However, we are living in a time in which the opportunities created by technological innovations are so great that they allow us to address some of the urban situations in which the environment is adversely affected today such that, applying these innovations, they could easily be corrected.

The contemporary world is built on two structures, one of them physical, the other virtual. This situation represents both a significant novelty and a great potential relative to earlier epochs. The first layer belongs to matter, to physical reality, to the sense of touch; the second to the immaterial world, the digital and IT revolution. Both structures live together and both are indispensable. For this reason, when we rethink the city, we have to think at the same time in both layers.

One of the biggest problems of today's city is its physical extent: the number of built square meters, the number of kilometers of communication ways and the number of kilometers of electrical cables, ducts and collectors. This increase of material use clearly causes a degradation of the environment, as it involves the use of land, a change of land use, and thus a destruction of ecosystems, as well as an increase of energy use, growing exponentially, with an associated increase in pollution.

Thus, it seems logical to plead for a significant reduction in the amount of physical matter used. That is, to design a process for the contraction of cities, instead of their extension. An urban system appropriate for the 21st century should be much more directed towards the inner city than to the outskirts. (But see the ideas of Ruiz de Elvira in this volume). This implies that the concept of recycling should be applied not only to products, but to the city as whole. To reuse what already exists, increasing its efficiency and adapting it to new needs, is one of the future city scenarios. If we understand the city as an open system, not final in time, but rather as one of the stages in the succession of chronological layers through which the city evolves, a new way will be opened to act decisively in the development of the pre-existing city, in contrast to today's tempting approach of ex-novo cities of unlimited extension.

In addition to material saving, that is, of built square meters, we propose an expansion of the virtual layer. Fewer kilometers of roads and a wider information bandwidth is a realistic alternative for a society that has reached technological maturity. The exploitation of new means of digital communication is a feasible alternative path. In this manner we could speak of a city of virtual connections instead of cities dedicated to vehicles, reversing the trend of the second half of the 20th century. The savings would be spectacular, as much in energy and emissions as in time. This point of view is much more in accord with today's global world, where time zones have lost their meaning and working through the net is standard.

Digital society is determined by speed, a speed inversely proportional to size, or in other words, directly proportional to the degree of miniaturization. That is, faster is smaller. By using nanotechnology it is possible to access information in real time and to act independently of physical distance. The world of satellites and fibre optics has made it possible to eliminate traditional electric cables as the last vestiges of matter. The virtual world has the potential to minimize the impact on the physical world such that, if used systematically, it will speed up our activities and reduce our travel. Any future urban planning should insist on laying down a net of digital connections, rather than leaving the task to uncoordinated private initiatives.

In addition, if we succeed in reducing the space used by vehicles we can revert the public space to the citizen, thereby reversing today's trend of using up to the 80% of the public space for cars, leaving only a meager 20% for people. Thus we would be able to speak of a digital city, a strategic city with a weak hierarchy, organized like a 3-D topological net of connections and, of course, supported by a system of public transportation that would be a structural element of the city.

Technology can provide us, moreover, with further contributions to energy savings by continuous monitering and control of energy use a network of sensors controlled via artificial intelligence could produce high urban efficiency, in what may be termed a sensor city. Thus we could activate several resources that would support energy savings: on the one hand, the specific knowledge of our activities, helping us to be aware of their consequences, on the other hand, computerized support for reducing energy use.

Living with Nature – Learning from Nature

The present city of the 21st century is based on urban structures belonging to 19th century models, and it is built with buildings corresponding to the 20th century. Both situations are inadequate to solve the new problems with which society is confronted.

In formulating the city of the 21st century we regard the recovery of the equilibrium between Nature and city as mandatory. This does not mean an old fashioned return to small towns where this balance is achieved merely by size. The world of the 3rd millennium is a world of masses of citizens, and it is clear that its model is the big city. Therefore we must incorporate nature in the city and attain an ethic attitude with respect to the world in which we live.

The first and most decisive way to reintroduce the environment is the clear will to compress the city, to control its indiscriminate extension and invasion of territory. That is, saving soil and giving it back to Nature, with the objective of generating an efficient, compact city. The positive consequences of a dense city are manifold: minimization of motorway roads and streets; promoting pedestrians, thereby increasing life quality; increasing the density of activity, and therefore communication and social activity; simplification of the overall structure through public transport, lessening of the segregation into social layers, etc. All of these yield clear benefits through the minimization of the impact on the environment, the savings of consumption and emissions and the improvement of the urban milieu, taking thereby the first step to an eco-sustainable city.

Once we have established this basic and fundamental hypothesis, of saving land, we can act in manifold ways to achieve a balance of city and nature. Among the obvious actions is the beneficial incorporation of vegetation within the city. To accomplish this we need to achieve a reasonable balance between density and sponginess, that is, between an efficient use of land and the occupation density of buildings that would allow nature to be a permanent part of the urban landscape, to be enjoyed by the citizens. If in addition to this, we consider the city as a 3-D network, with an underground level and layers above zero elevation, new possibilities open up for the generation of green zones and public spaces.

Thus, in addition to parks and boulevards that we find in the historical city at zero elevation, we propose an occupation/invasion of nature at all possible layers. This would achieve a profitability of many otherwise useless surfaces, which normally become, through there uselessess, degraded and are converted into residual sites of the urban landscape. Roof surfaces, walls, elevated planes, backyards, would all provide new areas for conquest by nature.

This policy, together with the use of clean and renewable energies, would promote not only energy savings and the control of emissions, but also the citizen's quality of life in an enriched environment.

There is another interesting view to our relation with nature We can learn a lot by the analysis of mechanisms nature has developed to maximize life at minimal cost. That is, by looking at nature as a system of high technology, we might be able to translate or reinterpret its mechanisms of coexistence and energy savings. Thus, we could discover order and systemic alternatives compatible with the modern world complexity, and we could find solutions for optimizing resources without losing benefits. Supporting ourselves in patterns of proven efficiency, that accept change and variation in following growth and environmental changes, and that seek always to save energy and resources,. is a road that we need to explore to design an eco-sustainable city. Following this path we could find the desired equilibrium between the needs of human beings and the preservation of the environment.

Vertical Garden City: a sustainable bio-structure

The project of the Vertical Garden City was born as a result of an ambitious research work undertaken by Cervera & Pioz in the early 90s, who were trying to explore the possibilities offered by the application of Bionic Science to architecture. The results of the study of natural structures and their translation into the field of building made possible the birth of a new model of vertical structure that allowed us to go beyond the prototype known as a skyscraper and to conceive a new concept of a Vertical City.

The concerns of the urban development of contemporary mega-cities, which stretch without limit along their territory, were one of the starting points for developing alternatives to the current out-lived urban models through the concept of the compact city. To this urban concept was added the new options provided by research on bionics, leading to a proposal to conquer vertical space as a mode of coexistence with our environment.

The development of the contemporary city is dominated, on one hand, by the legendary American model of horizontal urbanism, with cities habitable only thanks to the use of the car by every adult citizen, and, on the other hand, by the interests of the market, which strives for strictly economic profits in a very short time.

If we add these factors to the growing overpopulation it is easy to envisage an almost total occupation of the territories that "can be occupied" (i.e. all the territory that is habitable and accessible by wheel) by the present generation, leaving very few decisions and choices to those who come after ourselves. We therefore need new alternatives. One of them is the compact city that focuses on high density instead of uncontrolled expansion. The occupation of vertical space is inevitable, and it is only a matter of time that increasing significance will be given to the city that grows in height. In fact, large cities, since the beginning of the twentieth century, are structured on several levels. We may remind ourselves that in many European cities a large part of urban activity usually runs beneath ground level (subways, underground garages, interchanges, shopping centres, etc.) or that in Asian cities (as in Hong Kong) streets run in parallel at various levels above ground level.

From this point of view, the question was whether we could propose a model of increasing height without implicating the negative aspects that we associate so far with such constructions. Building vertically should not imply overcrowding or degradation, nor should it imply inhuman building-designs unsuitable for everyday life, and still less a symbol of corporate power. From these considerations was born the new concept of the Vertical City. A concept that is technically feasible thanks to a new structural model, which we call bio-structure, which is able finally to overcome the height limits of current building procedures.

Vertical Garden City is thus not a skyscraper, but an urban space that is developed vertically, similar to the way in which the city develops horizontally. That is why it is conceived as an open space with a significant role given to empty spaces and to external public areas, putting an end to the "glass box" model, with the repeated stories of the prototypical skyscraper. Questions have been raised on many occasions about the skyscraper due to its lack of human scale and height, which "takes us off" from the land. However, the problem is not only its size, but also the model. It was therefore imperative to create an innovative proposal, midway between architecture and urbanism, representing a safe and humanized vertical construction, and where the interior space plays a major role by framing the activity of citizens in a harmonious manner.

However, the approach of developing a large vertical structure faces big problems due to the constraints of construction techniques. The problem is that the greater the height of a building, the bigger the amount of space that is occupied by the structure itself and all the necessary support systems, which has a direct impact on the amount of free space able to be used. A skyscraper that exceeds 500 m in height can have up to 60% or 70% of its gross area occupied by various technological and auxiliary areas rendering it unusable. When a high-rise construction surpasses a limit of 500 meters in height the proportion of usable space is reduced exponentially, making it unprofitable to build the tallest skyscraper without a fundamental change of model.

The challenge to be faced in the vertical conquest of space is not to beat height records, but to redefine with dignity the life in large communities. The social commitment is to develop an innovative model of vertical construction that is able to unify in a new philosophy of life the revolutionary technological concepts that enable us to exceed the limit of the 500 meters height, using new "bio-ecological" models in town planning and architecture. The new model of vertical structure is a coherent response to the current overcrowding of our present mega-cities, towards which most of our cities will sooner or later evolve.

A new vertical architectural model, which is able to exceed the 500 meter height limit and able to develop, in turn, a new generation of eco-vertical habitats for super populations, needs to be based on a new urban-architectural concept, on a new structural approach and a new construction model. It is precisely here that the analysis of biological structures in nature comes into play, as the separate field of interactive complex systems, thereby opening the way for the contribution of Bionic Science to the project of the Vertical Garden City.

The analysis of different systems of biotechnological growth of plant species and organic structures enables us to find and develop innovations in many fields: building support structures, air conditioning, the use of natural resources, movements of people, driving fluids, seismic protection and wind systems, fire prevention, and so on. These findings were used to define a new techno-structural, sustainable bio-structure, whose versatility allowed, in turn, the development of a new generation of skyscrapers and a bio-organic alternative to the approach of super cities: the vertical urbanism.

The numbers of the Vertical City are doubtlessly striking: 1,228 meters in height (equivalent to more than twice the height of the Petronas Towers in Kuala Lumpur, three times that of the Empire State Building and four times the height of the Eiffel Tower), located at a lake 1 km. in diameter; capacity for 100,000 people; 2,000,000 square meters distributed between the tower and the base, the equivalent of 300 stories, 368 elevators that move vertically and horizontally connecting the 12 vertically independent neighbourhoods, multiple uses from housing to offices and hotels, as well as commercial spaces and equipment areas of smaller scale, etc. These are some of the data that inform us of the magnitude of the enterprise. However, what is sought is not to beat amazing records but to open the door for a different way of seeing and understanding Nature. The Vertical Bio-Structure is not a mega-building, it is an infrastructure that allows the development of a vertical city. That is why the design concept is very different from that which would apply to any more or less conventional building. In fact, we should hardly talk about design, but rather about planning, organization and structure.

The first estimates made for the structure of a building of over 500 meters height already showed the limitations of current systems, and this is even more the case if we think of mega-structures that clearly exceeded that size. The application of studies of the structures of natural species and the way in which they face up to challenges and find solutions was a key step in our development of the concept of Bio-Structure. The hyper-structure starts from a collaborative system of multiple elements and is supported by a development of fractal geometry, just as in Nature. The structure evolves from an elliptical base of variable dimensions, which reaches its maximum size at 210 m. x 169 m. and is organized in a series of concentric rings, three interior and one exterior, consisting of "column-streets." These "column-streets" are designed with the concept of "emptiness", that is, not massive, but structured in their interior, composed of folded sheets of high-performance concrete, which increases the stability and strength while at the same time decreasing the weight.

The columns provide not only the entire primary structural system, but also, thanks to the concept of their interior "emptiness", the vertical lines of communication. Hence the name "column-streets", since they are the "highways" of communication for the complex interior, providing an extensive network of elevators and other connection and circulation facilities. In fact they play a role very similar to that of roads and streets in a horizontal development of the city, that is, they form the primary infrastructure system.

One of the main innovations, as compared to the usual prototypes of skyscrapers, is the dissolution of the rigid structural reinforced concrete cores in the three inner crowns of "column-streets" plus the outer resistant "ring-skin". To ensure the connection to the structural primary rings, it was necessary to generate a structural fabric that weaves together the whole system. This was based on fractal geometry: a simple law enabling the structure to multiply as required in response to the load to be carried. It led to the design of a three-dimensional mesh as a "structural whole", a system that is large, lightweight, flexible, deformation-resistant, and at the same time extremely durable and stable. An important quality provided by fractal geometry is the ability to adapt the structure if new contingencies arise, or in cases, very common in hyper-structures, since they are experimental prototypes, that the calculation model does not correspond exactly to the reality that is constructed.

This three-dimensional mesh is implemented in both the horizontal and the vertical section, in the form of a series of linear elements of moderate scale generate structures of different vertical elements, that we call neighbourhoods, forming "domes" and "inverted domes" that together, in pairs, open the space in the inner part, generating, in addition, the resistant fabric of the peripheral "ring-skin". Several groups of these domes, which in no case are massive but are "wired", form the vertical neighbourhood.

The building is created within the existing structure with complete freedom, always in accordance with the overall planning, which designates the uses and allocations of each area. Thus, it makes little sense to talk about design in this project, because it depends on own culmination process of its individual stages and on the future plans of the developers and designers. In some ways, illustrating this with an analogy, we could say that once the structure is built, the buildings develop freely within the parameters, planning areas and regulations that have been established, as in the case of the horizontal town, where freedom is subject only to urban regulation and to the appropriate techniques and art.

The structure is fully symmetrical based, upon the elliptical plan of the variable horizontal section; however, the building does not fill up the entire area, since one of the main concepts of this project is to build a city and not just a building. This provides different ways of occupying the structure, always taking account of some inner-city areas and some outer-city areas. The two "cities" never complete the ellipse, leaving some large building "segments" and open spaces between them, and, in fact, occupying opposite positions in order to ensure maximum penetration of natural light and air to the inner spaces. In addition, the rings of cities are rotated and shifted vertically relative to each other in each segment, so that even if the structure is fully symmetrical, the building is not.

The reason for this helicoidal displacement of building mass along the entire height of the Bio-Structure is to compensate the areas of matter and empty space with respect to greater and lesser exposure to sunlight. This alleviates the expansion and contraction challenges arising from the heating and cooling by the sun, which, in a structure of this size, are enormous. In addition, while accepting that the structure should normally be symmetrical for other reasons, we produce a fragmentation of wind forces. To achieve this it is necessary to avoid the concept of the facade as a continuous surface or sheet, firstly, by an asymmetrical distribution of building mass along the tower and, secondly, by a three-dimensional mesh structure of the outer resistant-ring that, thanks to the "wired" elements of resistant "dishes" or "domes", fragments and dilutes the impact of the wind forces.

The organization of the Vertical City in vertical "neighbourhoods", independent of each other, with an open distribution of buildings, allows the existence of urban areas in which gardens have a special role, to be enjoyed by the citizens, spaces similar to those in a traditional city of horizontal development. It is the existence of these public spaces and gardens in a spongy built tissue, made feasible by the advanced technical structure that distinguishes the project as a city rather than a building.

The structuring of the city into neighbourhoods provides some large areas for transfer and exchange at the base of each neighbourhood, with attractive gardens and some large ponds. At the same time, the realization of a project of this magnitude is made easier by the division into districts, which enables a progressive phase planning depending on future needs and capabilities. Following the guiding philosophy of the project, the principle of minimization, the Vertical City can be fragemented even during the actual constructive process: once a neighbourhood is finished, it can be occupied, generating income and contributing to the next phase of construction.

The natural flow of air inside the complex is one of the basic principles of this project, not only guaranteeing a human-friendly eco-habitat, but also reducing energy consumption. It would be impossible to create this mega-building using only a global heating-cooling system or an artificial lighting system. The natural penetration of air helps to create an interior microclimate from which it is possible to generate a more efficient and low-energy-consumption comfort in the different inner surfaces. The prevailing philosophy in the supply and consumption of energy is to use natural resources as far as possible (sun, wind, air and humidity) and to minimize the use of non-natural resources by a continuous process of compartmentalisation, generating sub-sectors from which the different buildings can be provided with energy services.

Another interesting aspect of this project is the network of lifts, devised as a network of transport in metropolitan cities, allowing the efficient connection of all levels of the Vertical City. As opposed to the common typology of skyscrapers, which tends to concentrate the vertical elements of communication, partly as a result of large-resistant core areas, the transport and communication paths in this project, making use on the new technology, are distributed.. The provision of lifts inside the "columns-streets" avoids large concentrations of people and, therefore, the endless waits of rush hours, which is one of the major problems of large buildings. The network of elevators is hierarchical, with express elevators to communicate directly with the interchange areas at the base of each neighbourhood; with local elevators that distribute passengers from the base of a neighbourhood to each level, with elevators for exclusive maintenance use and for emergency services of various kinds, with lifts for security, etc. The lift network system constitutes a complex infra-structure project for the distribution of flows of people and goods. Thus, in this high-rise vertical mega-structure the car is replaced by elevators and rolling escalators, providing a modern form of public transportation system.

The project of the City Bionic Tower is complemented by a complex of horizontal developments at its base, completing the gross built up area. A first ring, of about 400 meters in diameter, provides the necessary structural basis of the extended foundation. The huge pressures and loads that must be supported by the base of the Vertical City rule out the use of traditional stakes or slab foundation systems. One of the biggest concerns was the behaviour of the proposed Vertical Garden City with respect to seismic forces. To resolve this problem it was decided to extend the area of the foundation well outside the area of the base. From there the tower is supported, again following the laws of fractal geometry, at various levels by a multiple structure of similar forms, like huge "bicycle wheels". The Bio-Structure is thereby suspended in a similar way to trees floating in a nest of roots. Thus, the Tower is rooted in the soil through numerous micro-structural "filaments" that, at the same time become hallways and corridors of interconnection among different areas and levels of the tower.

A concentric outer ring surrounding the first ring provides the major interchange and communication services between the tower and the rest of the city or surroundings. Its size is determined by the environmental or site conditions. An artificial lake is placed between the two rings to increase the anti-seismic protection of the foundation through a combination of water and thin membranes, with a fractal organization similar to the internal structure of crystals. This mixed structure is very efficient at absorbing vibrations and dissipating energy transmitted from earth-quakes.

The Sustainable Vertical Garden City is a new interpretation of the joint role that architecture and urbanism should play in the formulation of an eco-habitat, a healthy balance between nature and technology. The purpose is to open a door to progress without closing the window on our origins and environment, an environment that it is also a fascinating world of high technology. The Vertical City is a proposed eco-habitat of rationalized land use, saving energy through the use of natural resources such as the sun, air, water and humidity, and capable of adjusting its height, requirements and use to different scales of urban and economic development at its planned location.

The project of the Bio-Structure has at present reached such a high profile and international support that the day does not seem far away when we will see the realization of the first example of this new generation of Vertical City. In this paper we have tried to present some of the reasons and arguments that have made the Vertical Garden City a recognized world reference, on which research is being conducted at several universities to devise future scenarios that find answers with dignity to the serious problems of overpopulation, with the attendant uncontrolled development of most of the present mega-cities.

The digital smart city: Optimizing transport with information On-going activities at Telefónica I+D

Abstract

Telefónica Investigación y Desarrollo (I+D) is the innovation company of the Telefónica Group. Owned 100% by Telefónica, this subsidiary was formed it 1988, with the aim of strengthening the Group's competitiveness through technological innovation.

Since it was founded in March 1988, its results have been directed at creating value for the clients of the Group, developing high-quality telecommunication products, services and systems. In this way, it helps meet their present needs, and, at the same time, creates innovative solutions in anticipation of future challenges. At present, Telefónica I + D employs over 1000 persons, of whom 93% hold a University degree.

Based on the criterion of geographical distribution and client proximity, there are currently four different main offices: Barcelona (2001), Granada (2005), Huesca (2004), Madrid (1988) and Valladolid (1999). In June 2002, its first subsidiary, Telefônica Pesquisa e Desenvolvimento, opened for business in Sao Paulo (Brazil), followed by the Mexican branch in Mexico D.F. (2004).

Telefónica's innovation process, which is largely based on the activities of Telefónica I+D, is based on four fundamental lines of work: infrastructures, development of new services, the deployment of the so-called "personal digital environment" and a series of common elements which play the role of for the

technologies

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rest of activities. These for lines contribute to the internal evolution necessary to face the future challenges of the changing Telecom and IT panorama.

The company has also in depth expertise in formal methods, object oriented design and programming systems, software engineering tools, real time systems, data bases and knowledge bases, A.I. tool kits, knowledge representation and reasoning, man machine interface, and software tools for network simulation. The company has a computer centre, a micro software development tools group, and special laboratories, such as an optical transmission one, Smart Home one, Human Factors, or a video services laboratory.

All the activities in Telefónica I + D are carried out conforming to an in house Project Development and Management Methodology, which has been awarded an ISO 9001 Certification since 1994, updated to the new ISO 9001:2000 in 2001. Telefónica I+D respect to the environment is reflected on the creation of an Environmental Management System, awarded the ISO 14001 Environmental Certification since 1998 and a large amount of prices to innovation and excellence. Telefónica I+D is aware of the impact of its activities in terms of social and environmental impact in the markets where it operates, its Management System and Strategic Plan define and provide the guidelines for corporate responsibility and sustainability.

Motivation

Traditionally, the transportation sector has special requirements and need for:

- Reducing accidents;
- Enhancing efficiency of traffic management and control of pollution.

These two very important aspects of any transportation mode, especially for the car industry, are actually being addressed by the EC action i2010, the so-called Intelligent Car Initiative. Specifically, i2010 is the EU policy framework for the information society and media. It promotes the positive contribution that information and communication technologies (ICT) can make to the economy, society and personal quality of life, as is reflected in the official i2010 strategy site.

Telefónica I+D's position on this strategy is to put efforts towards research in investigating how communications will play the role within this area. Concretely, it is foreseen that in the near future vehicles will be intelligent, will be inter- and intra-connected (vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I)), will produce less pollution and will be able to drive stand-alone

Research activity areas

Once being identified this innovative and research areas, Telefónica I+D has launched a new working department known as the Ambient Intelligent Services Group specially devoted to investigate and develop new solutions for becoming these ideas true, and at the same time putting the edge in development of new intelligent services specially adapted to the automotive industry for in-car environments.

The Ambient Intelligent Services Group has identified four main areas of research in which the focus activity will be to develop and evaluate emerging technologies that will support new services in the near future.

The following table shows the four main research activity areas in which the Ambient Intelligent Services Group will concentrate its efforts.

Research Activity Area	Description
Digital Smart City	In any developed society, population in cities will continue growing and bringing new problems and challenges that will require new innovative solutions. By using and applying ambient intelligent technologies to the Digital Smart City concept, it will open new market opportunities for Telefónica, and solutions for the near future problems from the citizens.
Framework for Development of Intelligent Environment Services	Framework for supporting a easy and quick way to develop and launch new services, its provision and management, promoting relationships to resources related to ambient intelligence
Communications-based Services for the Automobile	Services in foreground 2010, starting with security and safety (eCall), advanced driving assistance (ADAS), infotainment, comfort, traffic management, advanced technical assistance, etc...
Professional Intelligent Environments	Use and promote the basic enabling technologies and concepts from Ambient Intelligence to developing services for professional environments for boosting the degree of acceptance (administration, distribution sector, etc...).

Table1. Research Activity Areas at the Ambient Intelligent Services Group

The Connected Car

Telecom operators have just started to consider the car as a "connectable" device, that is, it can be equipped with communication and computation equipment for converting its environment in an "intelligent environment".

However much work have to be done before cars are able to offer new services based on the capabilities of our mobile phones, since the specific environment conditions bring along new challenges, arising from a new transmission channel to new development platforms supported by car equipments.

The next figure shows the main areas in which the Ambient Intelligent Services Group has started to investigate and adapt communication and computation technologies for achieving the goal of "connecting" the car to the public telecom networks.

Among the most important areas that have been identified, one of the most relevant is the in-car hardware equipment (car-PC, development platforms such as OSGi, and intelligent sensors that will collect relevant data for processing and analysing such as cameras pointing at the driver's face to infer their activity). Another relevant research area is the multimodal interfaces, that is, how the information is collected, displayed and offered to the driver (voice technology is experimenting a big advancement in the automotive industry during the last years).

Figure 1. The Connected Car Vision

But the most important areas in which Telefónica I+D is concentrating its efforts are the services (development of new innovative services) and the communications, both internal (to communicate internal devices) and external (to communicate the car with the network infrastructure and/or another cars). Specifically on the communications area, special technologies are being developed because the car environment has special transmission characteristics that are not found in other well-known environments. For example, car may move at different speeds and may required different quality of services depending on the service requirements (video transmission, alarms transmission, etc...).

Optimizing transport with ICT

Optimizing transport by information and communication technologies requires the development of a model, where information flows from sources, is processed and the relevant information is sent to potential users, both final customers and/or third parties.

The following figure shows the information workflow including all the phases and identifying the main actors in the process.

The Sensitive City captures and collects relevant traffic information by different means (car-counters, intelligent traffic signs, information panels, cameras, external sources, etc...) as well as from information coming di-

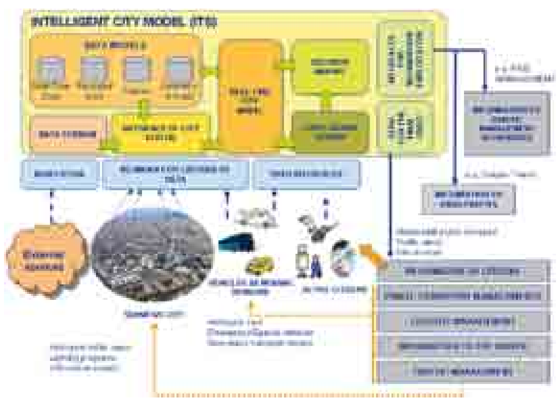

Figure 2. Information Workflow in Intelligent Transport Systems (ITS)

rectly from vehicles and citizens. This information is then adapted by data fusion schemes and and processed according to the developed data models (describing traffic behaviours, geographical areas, etc...). After processing this information, a forecasting about the prediction on the traffic conditions is then sent to the users, traffic management authorities, third parties and end-customers. Also logistic management companies may benefit from this information by re-routing their vehicles along more efficient routes.

At the end, this information is again used as a new input for the system, since traffic conditions would have changed and will serve as new information for re-calculating the whole processing. Moreover this information is permanently being actualized as the sources are updated and new relevant information comes from the sensors dispersed in the Sensitive City, all working according to the real time traffic conditions.

Innovative Services

Service	Applications
Advanced Driving Assistance (ADAS)	• Intelligent Navigator: route optimizing using real-time data, etc.. • Intelligent cruise control • Detection of lane change • Tele-warning information from traffic signs (active) • Information about the roads status and meteorological information • Petrol stations recommendations, based on on-line information about autonomy, distance to stations, distance to final destination, petrol prices,...
Seamless Traveller Support	• Global assistance services for the traveler "door-to-door". This new type of services calculates the best possible route according to the different transportation modes available (train, bus, private car, plane,...) and according to the specific traffic situation in that moment, as well as taking into consideration the preferences of the customer and its profile.
Remote Maintenance and Technical Assistance	• Tele-diagnosis and periodic car revision. • Remote firmware actualization.
Services for the Administration	• Optimization of the control mechanisms, detection of rules violations, fine management and vehicles recuperation when stolen. • Automatic vehicle identification. Allowing controlling all the vehicles that are circulating certain areas or roads equipped with this system. • Remote information monitoring. Allowing obtaining information from the control operations center, such as related to obligatory vehicle revisions, etc... without having to stop the vehicle if not required. • Infraction detection. Speed limit areas, access to non-authorized roads, prohibited maneuvers, etc.. This service will be able to detect the infraction and process the correspondent fine all automatically • Detection of stolen cars. The use of this telematic system will allow remote detection of stolen cars.
Global Traffic Management	• Traffic optimization. Monitoring and re-routing of vehicles in congestion situations by decision in the management center. • Support to emergency vehicles (e.g. "Blue-lane")
Advanced Fleet Management	• Monitoring and control of professional vehicles fleets • Support to multi-modal circulation of goods and customers between different countries (traceability)

Table 2. Innovative services for optimizing traffic management

At the same time, the Ambient Intelligence Services Group is working towards the development and integration of new innovative services that will assist in optimizing today's traffic management schemes, both from the personal and from the administration point of view.

If those new innovative services are able to deliver valuable information to the end user's about the current traffic situations, it will help people to optimize their driving paths. At the same time this information would help traffic authorities to manage the traffic conditions more efficiently. The following table shows a list of new innovative services in which Telefónica I+D is considering and developing for these goals.

Conclusions

Telefónica I+D is working towards the development of solutions and technologies that will help in optimizing today's transport schemes by minimizing pollution and maximizing transport efficiency. This is possible by using the available ICT infrastructure, therefore helping in making our environment more sustainable in the future.

Climate Change and the Cities of the Fu
a common challenge requiring commo

Abstract

The creation of the cities of the future and the solution of the climate change problem are closely independent, since the majority of the human population live in cities, and cities represent the major source of greenhouse gas pollution. And both problems require a long-term vision. It is argued that a hierarchy of system dynamic models is needed to analyse these issues, beginning with simple models that capture the most important processes, and progressing to more complex models once the basic dynamics of the processes have been clearly understood. The necessary ingredients of such models are illustrated for the case of climate change, including climate policy instruments (carbon price, subsidies, regulation and technological transfer from industrial to emerging and developing economies) and the processes of information transfer from science to the public and policy makers via the media. Some simulation examples are given.

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n solutions

Klaus Hasselmann
Max Planck Institute for Meteorology Hamburg
and European Climate Forum

Commonalities of climate change and the cities of the future

Climate change and the cities of the future cities have many features in common. Both involve long time scales, from decades to centuries - or even millennia, if one considers the long memory of the deep ocean that governs sea-level rise or the historical heritage of cities, such as cathedrals. But not only the time scales, also the underlying processes governing climate change and the evolution of cities are closely interrelated. Thus, policies concerning climate change and city planning are necessarily interdependent, and should be optimally designed to be mutually supportive.

The close interdependence follows from the simple fact that anthropogenic climate change is induced by humans and affects humans, and that more than 50% of people live in cities. Moreover, a still larger proportion of the CO_2 emissions that are responsible for most of global warming are emitted in cities, while, conversely, cities are more than proportionally affected by the more serious consequences of climate change, such as sea-level rise, the degradation of water quality and migration pressures from people seeking to escape the depravations of climate change.

This year's annual ECF conference in Alcala therefore provides a welcome opportunity to discuss the joint problems of long-term climate policy and city planning within the framework of ECF, a forum that was explicitly created to bring together scientists, stakeholders and policymakers to exchange views and analyses of common problems related to climate change.

In the following, some of the key problems that concern both climate change and city planning will be discussed from the general viewpoint of systems dynamics modeling. We argue for an iterative approach: After identification of the basic processes that are regarded as important in determining the dynamics of the system, we represent these within the framework of a model hierarchy, beginning with a simple model at the lowest model level that includes only the dominant processes, and successively introducing further processes at higher model levels, until one reaches a level of complexity beyond which the model details can no longer be reliably verified against the available data. Once the model hierarchy has been established and adequately tested against data, numerical simulation experiments can then be carried out to assess the implications of alternative policy options, using different model levels, if necessary, to establish the relative importance of different processes.

Processes that need to be represented in the model hierarchy include:

- the transformation of scientific information from the world of academia to the public and policymakers via the media and other dissemination mechanisms, for example, through the UN Intergovernmental Panel on Climate Change (IPCC) (IPCC, 2007), Al Gore's film "An inconvenient truth", Sir Nicholas Stern's Report on the Economics of Climate Change (Stern, 2007); or the activities of various civil society organizations and business councils committed to sustainable development.
- the differentiation between genuine scientific information, with unavoidable attendant uncertainties, and biased disinformation generated by special-interest groups;
- the available present and possible future technological options for mitigating climate change and developing the cities of the future, including present and future costs, estimates of R&D investment requirements, realization time scales, etc.
- various available policy instruments for mitigating climate change and creating attractive and sustainable cities of the future;
- the anticipated business response to government policies;
- the overall impact of the combination of all of the above processes on the general socio-economic evolution.

In the model hierarchy to be discussed later, we shall consider these processes in their natural chronological sequence, as listed above. However, as background for the discussion, it is convenient to consider first some key processes. We shall restrict the discussion in the following to the example of climate change, returning again in the last section to the general relation between climate change and the cities of the future.

Closing the wedge between the greenhouse gas emissions for the business as usual (BAU) and sustainable emissions scenarios

The challenge of climate policy is to devise and implement policy instruments that, on a global scale, will lead to the introduction of enhanced energy efficiency and renewable energy technologies that will close the wedge (Figure 1) between the emission curves for the Business as Usual (BAU) and sustainability scenarios. The BAU path corresponds to a roughly three-fold increase of greenhouse gas emissions (mainly CO_2) by the end of the 21st century, with an associated global temperature increase of the order of 3ºC or more, while the sustainable emissions path would limit the estimated temperature increase since the beginning of industrialization to less than 2ºC, a warming level that is generally regarded as just acceptable to avoid dangerous climate change.

There is wide-spread agreement that the technologies for closing the wedge exist. The relevant policy questions to be asked are: which technologies should be supported, in which time frame, and through the application of which policy instruments? Figure 1 shows as example a possible sequence for the introduction of the various technologies, based on current estimates of the present and future costs of the technologies, and assuming that the necessary policy instruments are implemented.

It has been shown in many investigations that the most economical method for reducing greenhouse gas emissions is to increase energy efficiency. This can be achieved at near zero or even negative cost, and has therefore assumed to be implemented first. However, since energy use and the associated CO_2 emissions can not be avoided entirely, but can only reduced by a finite factor, in the long term enhanced energy efficiency is unable to counteract the continual growth of emissions, which is driven by the legitimate welfare aspirations of the developing countries.

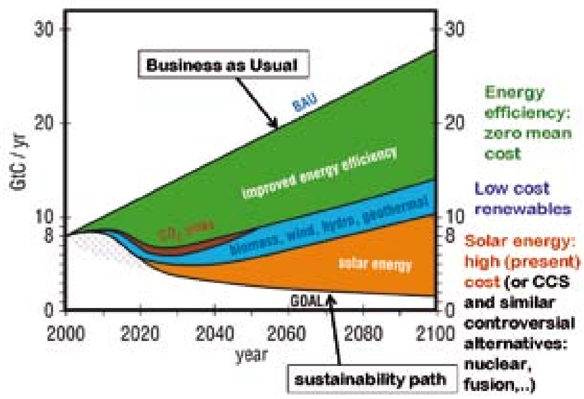

Figure 1: Filling the wedge between projected BAU emissions and sustainable emissions path ($\Delta T \leftarrow 2^{\circ}C$)

In parallel, but with some delay, the lowest-cost renewable technologies are then assumed to penetrate the market. However, all of these - CO_2 sinks through reforestation, biomass, wind energy, geothermal- and hydropower - have only finite abatement capacities and are therefore similarly unable to satisfy the growing long-term energy demands of the world's population. Three quarters of the world population lives in the developing countries, but the same three quarters produces only one quarter of the present global greenhouse emissions. This imbalance can be redressed and the world's long-term energy demand satisfied only by exploiting solar energy, a virtually unlimited energy source. An area of about 200 km x 200 km in the world's deserts could provide sufficient energy to satisfy the world's energy demands indefinitely. However, the present-day costs for the large-scale introduction of concentrated solar power, including the necessary infra-structure in the form of high-voltage direct-current grids, storage back-up, computerized control of energy use, etc, are higher than the costs of other renewable energy technologies. Thus one must consider also the policy instruments required to achieve an optimal balance between short-term investments in low-cost renewable technologies and the indispensible long-term investments in solar energy. (Other technologies, such as carbon caption and storage, advanced nuclear energy, and fusion, are either unproven, or controversial for other reasons, and will not be discussed in this brief overview.)

Governments have available four basic policy instruments to mitigate climate change:

1. The internalization of the future damage costs of climate change through the imposition of a price on CO_2 emissions, either in the form of a carbon tax or through an emission trading (cap-and-trade) scheme ("stick" policies).
2. Subsidies for technologies (such as concentrated solar power) that are not yet competitive in the market place, even with the introduction of a carbon price, but are nevertheless needed in the longer term ("carrot policies").
3. Emission regulations for sectors that are not exposed to or are not sufficiently responsive to market forces (e.g. automobile emissions, building insulation, lighting, household appliances, ..)
4. Financial and technological transfers from developed countries which have high per capita emissions to emerging and developing countries with low per capita emissions, for example through the allocation of the same per capita emission rights for all countries in a global cap-and-trade scheme (which would generate income for countries with low per-capita emissions through the sale of surplus emission rights to countries with high per-capita emissions).

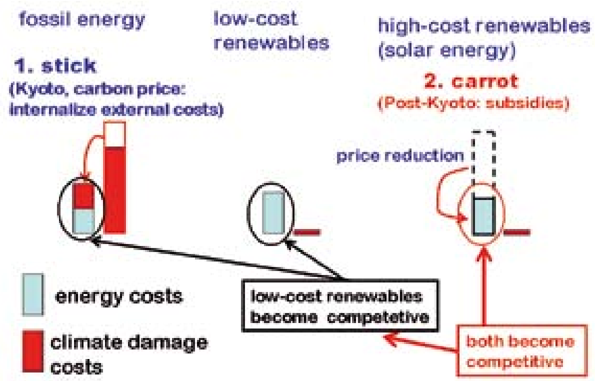

Figure 2: Role of stick and carrot policies in introducing low-and high-cost renewaves into the market place

Figure 2 illustrates the impact of a combination of the first two policy instruments, carbon prices and subsidies. A carbon price "stick", as implemented in the Kyoto cap-and-trade scheme (although ineffectively, through the free allocation of too many permits), internalizes the external climate damage costs of fossil fuels, resulting in a higher real fossil-fuel price that enables the lower-cost renewable energy technologies to become competitive. However, higher-cost technologies, such as solar energy, remain uncompetitive unless supported additionally by subsidies ("carrot" policies). Although criticized occasionally as distorting the market, subsidies are essential societal investments that are justified economically by the longer term time horizons of public investments (low discount factors) as opposed to the shorter time horizons of private investments (high discount factors).

Unfortunately, not all sectors of the economy are sufficiently exposed to market forces to respond to market instruments. Thus the affluence of many automobile owners cushions them against switching to low-fuel vehicles in response to the higher fuel costs imposed by a carbon tax. Similarly, limited economic incentives or information barriers hinder the wide-spread voluntary introduction of efficient household appliances, low-energy light bulbs, building insulation, etc. In these cases, appropriate regulations are needed, and have proven to be effective without imposing hardships.

Finally, figure 3 illustrates the need to augment national policies to reduce emissions with international agreements on financial and technological transfers from countries with high-per-capita emissions to countries with low per-capita emissions. A comparison of the estimated per-capita BAU CO_2 emission paths of the industrial countries USA and EU+Japan with the corresponding BAU emission paths for the emerging economies China and India demonstrates clearly that to reduce the global emissions to levels consistent with the global mean sustainability trajectory of Figure 2, the industrial countries will need to reduce emissions much more strongly than the emerging - or still more, the developing - countries. But the emerging and developing countries will also need to reduce emissions significantly, even before the per capita emissions of all countries have begun to significantly converge. This will presumably be acceptable to countries which still have significantly lower per-capita emissions only if the industrial countries are willing to support the abatement efforts of these countries with major transfers of capital and technology.

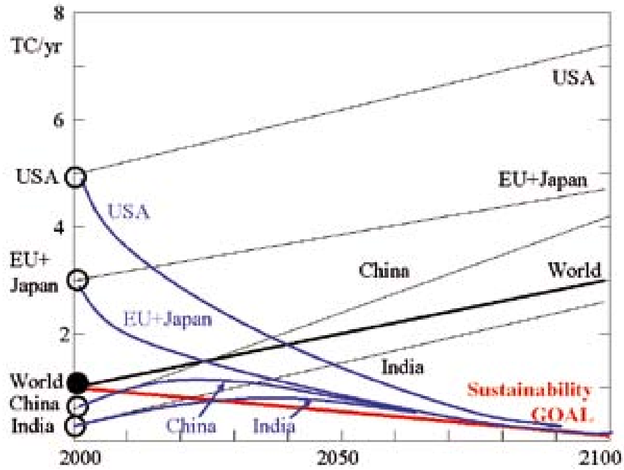

Figure 3: Estimated linear per capita emission projections for industrialized and emerging economies, together with convergence and contraction paths required to achieve sustainability.

An integrated view

How should these basic climate policy instruments be implemented? Can system dynamics modeling provide a better insight into our understanding, and thereby contribute to a resolution, of the institutional, societal and political problems encountered? And can we learn from the experience in striving to mitigate climate change for the inter-related problem of creating the cities of the future?

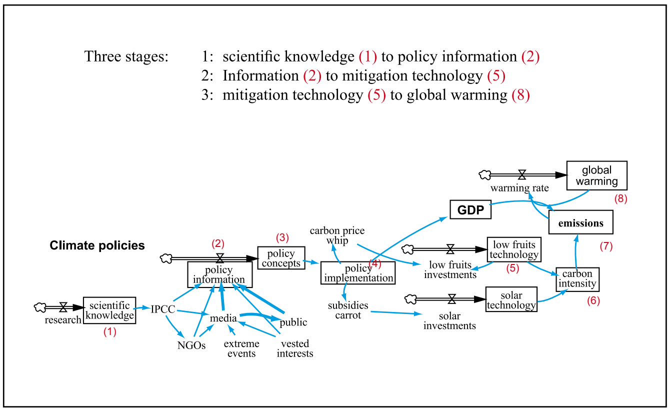

Figure 4: A Vensim model sketch of the climate-policy obstacle course: from scientific knowledge (1) to reduce global warming (8)

As already argued, the complexity of the dynamics of climate change, and its dependence on the individual strategies of many different actors, calls for the creation of a hierarchy of dynamic multi-actor models. An outline of a possible model hierarchy, based on the original Multi-Actor Dynamic Integrated Assessment Model (MADIAM) of Weber et al (2005), is given in Hasselmann (2008). In the present brief overview we restrict the discussion to a simplified version of the basic MADIAM model, which we now extend, however, to include additional non-economic actors representing the important processes of information transfer and the formation of policy concepts that precedes the actual implementation of policies.

Figure 4 summarizes the resultant time-delay chain, extending from the creation and dissemination of scientific information transfer, to the formation and implementation of policy, to investments in abatement technologies, to the resultant reduction in CO_2 emissions and global warming, and to the net impact on GDP growth. A realistic assessment of the impact of science on climate change mitigation action requires an investigation of the mechanism of each of the eight transfer processes indicated in the model sketch. In Figures 5-7, these have been broken down into three stages: Stage I: from scientific information input (1) to the formation of climate policy concepts (3) (Figure 5); Stage II: from climate policy concepts (3) to investments in mitigation technologies (5) (Figure 6); Stage III: from mitigation technologies (5) to global warming (8) (Figure 7).

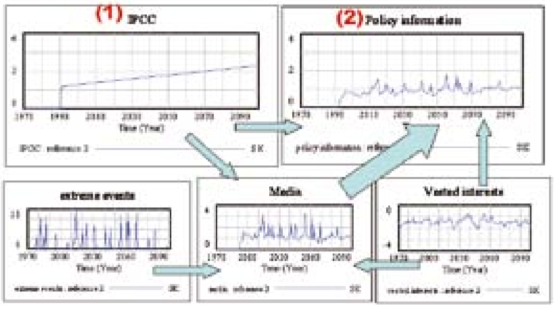

Figure 5: Stage I: From scientific knowledge (1) (IPCC) to policy information (2) via the media, vested interests, extreme events, etc.

The individual panels of Figure 5, Stage I, show, qualitatively: the linear increase in scientific information provided by IPCC since its creation in 1990, the dissemination of this information to policy makers and to the media, its contamination by disinformation, fed to the media by vested-interest groups opposed to climate policies, together with the superposition of further noise, generated by the media themselves, through the amplification of sales-enhancing pseudo-debates on the reality of climate change, and, finally, the dissemination of this net information packet to policy makers and the public.

The following Figure 6 depicts the delay cascade, Stage II, in which the information received by policy makers (2) leads, despite the superimposed noise, to the formation of first policy concepts (3), which are then implemented, after further delays (4), producing the necessary investments in low-cost technologies (low-hanging fruits) and in higher-cost technologies, in particular solar energy. The investments in low-cost technologies are assumed to flatten after about fifty years due to their finite abatement capacity, while the investments in solar energy, as an unlimited energy source, continue to rise (cf. Figure 1).

Figure 7, finally, shows Stage III: the impact of the investments in emission reduction technologies on CO_2 emissions and global warming, as well as on GDP. The chosen scenario is optimistic, the global warming above the pre-industrial level remaining below the 2°C level of dangerous climate change. A sensitivity analysis of the relative impact of stick versus carrot policies reveals that both are needed. A stick policy (carbon price) is the most economical method for the short term introduction of low-cost renewable

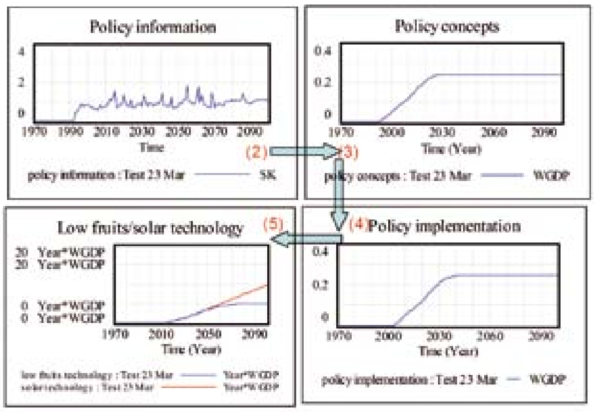

Figure 6. Stage II: The delay cascade, from policy information (2) to mitigation technology (5)

Technologies, but carrot policies (subsidies) are essential for the market infusion of higher-cost technologies such as solar energy, as discussed earlier. The impact of the relative stringent abatement measures of this scenario on world GDP is nevertheless minor, of the order of only 1%, representing a delay in economic growth of only about one year over a period of many decades. The estimated impacts on GDP depend on many uncertain parameter assumptions, but are consistent with previous estimates (e.g. Hasselmann et al, 2003, Stern, 2007), which generally lie within the range of -1% to +4% of GDP.

Implications for the role of science in the creation of the cities of the future

It is useful to revisit the three stages of the climate policy delay chain, from the dissemination of scientific information to the final impact of climate policies on global warming and GDP, in order to infer from the analysis of the past and projected future development of climate policy some important lessons for the analogous problem of developing effective policies for the creation of the cities of the future.

A first lesson is that for the effective dissemination of scientific knowledge on anthropogenic climate change, the creation of an authoritative UN panel of internationally recognized experts was essential. Scientists had been warning of the immanent dangers of climate change caused by the rising emissions of greenhouse gases since the early nineteen seventies, but the problem achieved the appropriate media, public and political attention only after the regular publication of the IPCC reports, beginning in 1990. The first IPCC report already had a strong influence on the first Earth Summit in Rio de Janeiro, 1992 (the UN Conference on the Environment and Development). The creation of a similar UN panel to study the problem of the world's mega-cities and propose solutions for the cities of the future could have a similar beneficial effect.

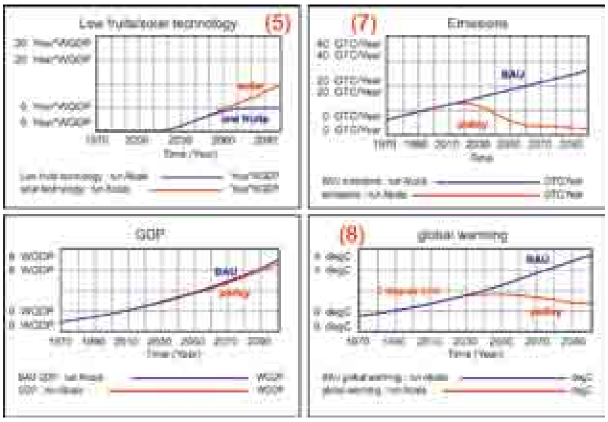

Figure 7: Stage III: From mitigation technology (5) to global warming (8). Also shown (bottom left panel) is the (minor) impact on GDP

A second lesson is that the dissemination of analyses by internationally recognized experts is not sufficient. The role of the media is essential in gaining the attention of the public and, thereby, of politicians wishing to be re-elected. The media, in turn, will normally highlight a problem only if there exists already a core public interest in the problem. In this context, the activities of civil society organizations (NGOs, etc) can play a crucial role. The mechanisms by which important public problems gain the attention of policy makers and are finally addressed through effective policies were only roughly outlined in the model indicated in Figure 2; they clearly deserve further study, particularly with respect to the interrelation of the problems of climate change and the cities of the future.

A third lesson is that prior to the implementation of effective policies, comprehensive analyses and inter-comparisons of all technological alternatives are needed. Competing alternatives need to be jointly assessed within a broad analysis framework, including the diverse societal impacts and the anticipated short- and long-term economic costs, with due consideration of the different discount factors appropriate for private and public investments, and allowing for the anticipated cost reductions through learning-by-doing and the economics of scale. Normally, these analyses are presented by individual interest groups advocating particular solutions. This makes it difficult for non-expert policy makers to form a balanced judgment. The creation of an internationally recognized expert panel with the mandate of carrying out comprehensive non-biased assessments would alleviate this problem - in analogy with IPCC Working Group 3 on Mitigation in the climate case (although it has been argued by Hasselmann and Barker, 2008, that the impact of IPCC WG 3, or an additional advisory body, could be significantly enhanced through a closer interaction with policy makers).

Finally, the efforts to implement effective international policies for mitigating climate change and for the creation of sustainable cities of the future would be mutually reinforced if a stronger case were made by scientists, with the support of civil society organizations and the media, of the intimate interdependency of these two major problems of society.

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The human dimension – the Bergen exa
How Bergen aims to live with and not ag

Abstract

With a population of 250,000, Bergen is Norway's second largest city and the capital of western Norway, the leading region for all significant Norwegian export industries. It is participating in Cities of the Future, a national programme around land use and transport, heating, consumption patterns and waste and adaptation to climate change. It has joined and signed the Covenant of Mayors as well and has committed to going beyond EU targets for CO_2 reduction in emissions through enhanced energy efficiency and cleaner energy production.

Bergen has conducted analysis, unique in the national context, looking at the city's risk of and vulnerability to floods, powerful winds, high tides, large waves, extreme precipitation and earth and rock slides. This knowledge will be employed to reduce the potential consequences of accidents and disasters. It will play an important role in urban planning and in processing building applications.

mple
ainst the environment

Lisbeth Iversen
Commissioner for Climate,
Environmental Affairs
and Urban Development
City of Bergen

Bergen is Norway`s second largest city, covering 460 square kilometres and with a population of 250.000. Bergen is lush and green, with mountain areas located 10 minutes from a lively city centre. Bergen has the longest urban tradition in Norway, and the harbour Bryggen is on UNESCO`s list of World Heritage Sites. Furthermore, Bergen is a narrow city with a rich cultural heritage threatened by the effects of climate change and heavy traffic.

The setting of the city has led to a clearly demarcated city centre with the mountains as a permanent backdrop and the sea never far away. The tightly packed and narrow structures give the impression of a continuous carpet covering the landscape and weaving together the spaces between the mountains. The buildings are experienced as homogeneous, without any out-of-scale individual houses. The municipal master plan proposes to make this pattern an overriding principle for new buildings, which will be required to fit into the cultural-historical landscape and conform to the heights of existing buildings.

The urban spaces and city squares (called "almenninger", meaning "commons") are a product of a mediaeval town plan, of European urban traditions, sea transport, the West-Norwegian landscape, shortage of ground space, density of population and the Bergen urban culture. The "almenninger" are physical expressions of a public right of access, and the physical space can be perceived as an example of the right of every individual to participate in processes relating to the development of the city.

The historical qualities of the urban spaces are the city's greatest asset and form the basis for city life, experiences and identity. The blend of residential houses, shops, offices and businesses makes the urban spaces busy thoroughfares, places to linger and venues for numerous activities all day long. The locations and qualities of the urban spaces are the backbone of the city's movement pattern. These qualities should serve as a model for urban structure in the densification areas.

Some of Bergen's major challenges are:

- Preserve and pass on the historical heritage of local, national and international value
- Maintain Bergen's particular identity without strangling the living modern city - the economic centre of the Norwegian west coast

The sea is rising as a consequence of rising water temperatures and ice-melting on land. At the same time the ground is rising due to the ice that weighed down Fenno-Scandinavia during the last Ice Age. At present, the increases in sea and land levels are almost in balance along the coast of western Norway. However, with global warming the sea is expected to rise between half a metre and a metre more than the land towards the end of this century. In time, this will pose a serious challenge to the existing infrastructure and it will also be necessary to design new infrastructure to cope with the steadily rising sea levels.

Bergen has suffered deadly rockslides and floods threaten our World Heritage Site Bryggen. The threat is increasing, and we survey and map risks with regard to wind, rainfall and flood in order to use this knowledge as a planning tool.

In Bergen we integrate our climate and environmental plans and combine land use and transport planning in the Municipal Area Plan. Transport efficiency, densification and a sustainable city structure with room and space for people are key words.

The Bergen programme for transport, city development and the environment is a combined transport policy which coordinates all public transport, environment and road projects. It is a joint financial venture between the State, the County, the Municipality and the inhabitants (toll roads) and helps improve the quality of life for our citizens.

New energy around Damsgårdssundet – a public and private Action Plan, is an example of the transformation of a run down industrial area close to the city centre. Action is taken with regard to seven dimensions:

- Democracy, participation and responsibility
- Infrastructure: quality, environment, energy and universal design
- Housing programme
- School as the heart of the community
- Industrial and cultural development, work places
- Health and welfare
- Competence

In order to successfully reach our aim for a future in accordance with our environment, we need integrated, coordinated, social and environmental programmes combined with human rights; we need to finance our plans and develop a social economy.

Today, mankind faces huge challenges with respect to future climate changes and their consequences. Local air pollution and greenhouse gas emissions are part of our everyday life and play a prominent role in deciding the premises for our future. Both the United Nations (UN) and the European Union (EU) have highlighted the focus on sustainable development in a number of different issues and international agreements.

Sustainable development has been on the specialist and political agenda for many years, with an overall focus on the economic, social and environmental aspects. Despite this, neither the targets for greenhouse gas reductions nor international, national and local climate targets are being met. The UN Climate Panel states clearly that if we are to prevent a worst-case scenario we need binding agreements and action within the next 10-20 years.

However, whatever happens, we will not be able to avoid climate change, and adaptation to the changes will therefore be an important factor to be considered with regard to sustainable development.

In today's situation, the individual has no guaranteed right to sustainable decisions being made either through either national or international governance. Fragmented political responsibility at all levels exposes coming generations to uncertainty, insecurity and a lack of sustainable decisions that guarantee the future of our planet.

The Principle 16 of the Rio Declaration that the polluter should pay applies to individuals, businesses, organisations and many others, but not to states. Under today's rules, cross-border pollution is tolerated and states have no liability beyond any agreements they might have signed. "The Bergen Charter of Climate Change and Human Rights" wishes to add a new dimension to the UN and EU principle of sustainable development – the human rights dimension. This would mean extending the sustainability principle to include not only economic and social development and environmental protection but also human-rights aspects. The Convention must focus on the "public right", the right of the individual to an extended accessibility concept – the right to a society which focuses on democracy, social economy, air that we can breathe and the worth of the individual. Education, dissemination of knowledge and information about these rights must play an important role in the Bergen Charter.

The legal work on the convention will be exemplified by means of a concrete urban development case from Bergen – a management model in which these aspects and dimensions are duly represented. An extension of the model from the Damsgårdssundet project, with a clear human rights profile, may be a good place to start. In Bergen, we have a local expert milieu engaged in research into central topics that are relevant to the work on a new human rights convention with a holistic academic superstructure.

The City of Bergen wants to establish collaboration with similar case projects in other cities and countries.

Towards a definition of ecocites for the ur

"The god thou servest is thine own appetite"[1]

According to the United Nations (UN), for the first time in human history, in 2008 the majority of the people will live in cities[2]. This revised version of the UN Report on Global Urbanization was produced in 1988. Its main purpose was to assess the original predictions, in which they estimated the year in which more than 50% of the world population would live on cities. The report original forecast that this would be around the year 2007. They were correct.

The urban age has now started (Burdett, 2002). Yet, the revised version of the UN report also revealed in more detail how this increase of the population in urbanized areas had been more dramatic in Latin America than in any other part of the world. According to the forecast, by 2050 this region will be the most urbanized of all parts of the planet[3].

With this in mind experts from the fields of urban planning, engineering, urban economist and urban geographers are raising the question as to which should be the model to follow in the urban century. Whilst the main overall issue seems to be the notion that depleting natural resources works against economic growth, there are other concerns –not so evident - in that the majority of these new cities will appear in the developing world, especially in Asia and Latin America.

Moreover, what has no historical similarities in this emergence of hundreds of large cities is that it appears that this urban century will generally be based in areas with less well provided basic services, such as sanitation and water supply. Also, the rate of urban growth in these regions depends to about 60% on natural growth; the remaining 40% is due to migration and spatial expansion.

[1] Christopher Marlowe, Doctor Faustus (W.W. Norton & Co, New York, 2005, p. 20)

[2] World-urbanisation prospect-UN2007, executive summary, pp. 1

[3] Ibidem; pp 4-9

ban century

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Not surprisingly given its low fertility levels, the tight controls that kept migration in check until the 1980s, and the subsequent unleashing of migration, China presents something of an exception.

Thus, one can argue that this century, despite all the current disproportionate debate as to whether urbanization will be good or bad, offers perhaps a new opportunity to tackle what appears to be the key question: how much does the environment matter? And, can we sacrifice economic growth?

A new approach or resurgence of old good ideas

Depending on the angle to tackle it, the answer seems to lie in the re-thinking of cities. One of the new approaches to this issue has been tackled by urban ecology. In contrast to the apparent aversion of American ecologists to the urban milieu, urban ecology was an active pursuit in Europe and Australasia in the 1970's–1990's. Early work on urban metabolism in Hong Kong presaged the more recent extensions in the field of industrial ecology.

European urban ecology set important groundwork for understanding the effects of urbanization on biodiversity and individual species' responses to urban environmental change that continues today with conservation efforts.

In the U.S., urban sociologists of the 1920's used the term "urban ecology" to describe their work, but their intent was to apply analogies from the ecology of the day to understanding human behavior and environment in cities. This fruitful avenue for research continues today with very interesting approaches to human–environment interaction in the fields of political ecology, urban sociology, and urban geography.

Some have maintained that a new urban ecology was ushered in with the establishment of the long-term ecological research urban program and other research supported by the US National Science Foundation, since these efforts focus on cities as ecosystems and address not only ecology in cities, but the ecology of cities. Whether or not urban ecology is a new field, inarguably it has seen dramatic advances over the past decade.

More recently this field found a new breath as its concepts filtered into the term eco-city –first coined by Richard Register in 1987 in his book "Ecocity Berkeley: buildings cities for a healthy future", as a possible model for a city in which the main priority is to feed and power itself, with minimal reliance on the natural environment in which it is located and with the smallest possible ecological footprint for its residents.

Is the sustainable city an option?

Whatever the particular circumstances of a city, though, its vitality is likely to be affected by technological change – at least this has been the case over the last thousand years (Rowe, 1974; Benevolo, 1971). Just as improvements in farming brought about the surpluses that made possible the first fixed settlements, so did improvements in transport make possible the development of trade on which the prosperity of so many cities depended during the industrial revolution. It is not surprising then that with the current global awareness of climate change, the ecology of cities has now become the new testing ground, and the search for a new leap in technology has begun.

While a central issue is likely to be the optimization of the use of natural resources and how to cope with the sheer size and scale of the current urban expansion, the main point is still about how to tackle the migration from rural to urban environments in the future.

It can be argued that this change of scale and size of urban development mostly consists of poor people migrating in unprecedented numbers. It is thus largely a phenomenon of poor and middle-income countries; the rich world has put most of its urbanisation behind it. One major exception could be China. The eastern giant will face the biggest migration from rural to urban environment a single country has ever witnessed. Even the large migration to the U.S. in the 18th century was one fifth of the estimated phenomena China will have to cope within the next twenty five years.

Thus, the importance of environmental protection in economic development, or at least to decouple it, has become one of the main priorities for the Chinese government. In this context, the main cities in this country are trying to innovate with their planning programs and designs to cope with the massive rural migration they will face in the next 25 years, as well as attempting to reduce the eco footprint of their cities.

Urban geographers and planners ask whether compact or less dense distributions of people have the greater environmental impact. Assuming equal population size, is it more environmentally sensible to have high-rise, tightly packed, urban environments or suburban ones? Is a rural – or suburbia - lifestyle compatible with sustainability? The answer depends upon relative income and resource consumption by the residents in question. As illustration, consider per capita CO_2 emissions. In many developing countries, a great disparity exists between the rural poor and relatively well-off urban populations. In these cases, the urban population often exhibits greater per capita consumption of heating or auto fuel, larger homes, and smaller households. In wealthy nations, such as the U.S., suburbanization and exurbanization, resulting in land change in the sparsely populated areas between cities, is a major land-use trend. In this case, the rural population may have the wherewithal to build large homes and commute long distances to workplaces, so that their impact in terms of CO_2 emissions would be greater than an urban population with access to public transportation or shorter commuting distances. Certainly, urban form can affect transportation and mobility patterns, and more dispersed patterns can lead to higher energy consumption (Fig.1)

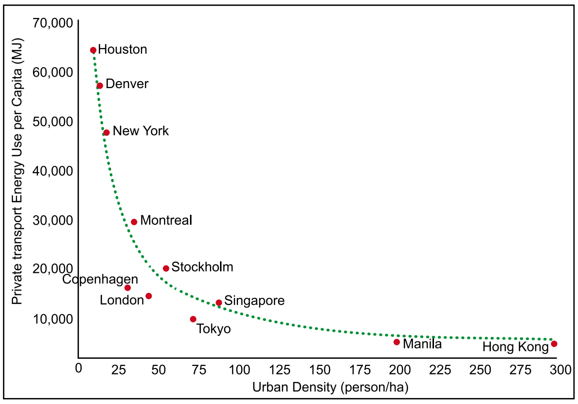

Figure 1: Newmann and Kenworthy, "Sustainable Urban Form: The Big Picture" (2000), in Williams, Burton, Jenks, Achieving Sustainable Urban Form, E & FN Spoon, London, 2000, pp. 109/120

To argue that the label eco attached to the city design process is going to be enough to improve the relationship between the urban and the natural environment is to miss the point. In the case of the early examples of such terms applied to urban design such as urban ecology – as a field specialized to study this relationship – it has been shown that good small scale interventions do improve the overall lifestyle and use of natural resources. But to use the term ecocity as new way of approaching the whole concept of cities could have implications beyond the spatial design itself.

Two examples of ecocities: Dontang and Wanzhuang

An alternative model for city design has emerged during the last decade focusing on the way the main elements of the city interact. How can their relationships become more effective and optimize where the resources for food, energy and water consumption are coming from?

In simple terms, an integrated urbanism that traces the connections between what the city needs to operate and what the dwellers need for living. Two recent designs Arup has been working on - Dongtan ecocity near Shanghai and Wanzhuang near Beijing – demonstrate this think process for city design.

The plan for Dongtan is a city composed of three "villages". The proposal aims to combine elements of traditional Chinese design with the latest green technologies, The underlying concept seeks to integrate the emerging city pattern with a more efficient land use instead of that the low density suburban sprawl that is typical in the surroundings of any mayor city. Its energy will come from renewable sources such as wind turbines and bio-fuels derived from agricultural waste. Most of the city's rubbish will be recycled. Because of its compact layout, the design promotes pedestrian and cycle mobility rather than car usage.

Figure 3: Illustrative view of the south village
Arup/Oaker

Figure 2: Dongtan flexible flood protection strategy for each village
Arup

Even if all this sounds too optimistic, the concept underlying Dongtan's design is to pursue a convincing urban pattern and city life that has proved so successful in some European cities such as Barcelona or Berlin. As urban designers and engineers, Arup can only hope that their advice will be realized in practice by the developer of Dongtan . Key to this will be that the layout of the proposal is one of the first of its kind to include a flooding risk-free strategy while minimizing the potential loss of developable land. (Fig. 2)

Lang Fang is the capital of Hebei province 45 minutes southeast of Beijing. Wanzhunag is located geographically equidistant between Beijing and Tianjin within the Hebei Corridor. The area comprises three clusters of existing villages with an existing population of 80.000 people. As part of a government initiative, the villages adjacent to Lang Fang were identified as the expansion area into which the city would grow within the next two decades.

An original plan drawn up by the government was to create a new satellite district that would have "eaten up" the villages and created a new centre hub for the city.The emerging proposal from Arup was to create an ecocity alternative based on a clean, attractive and healthy community, with a low-carbon footprint while preserving the natural environment.

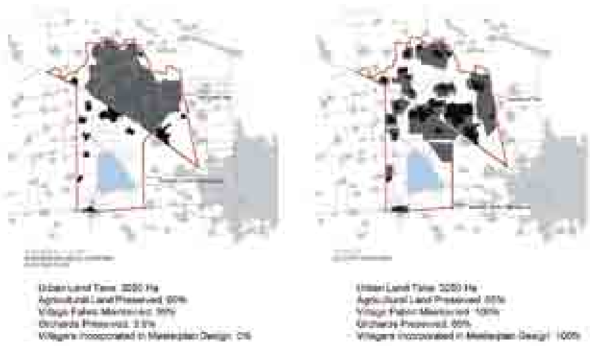

Figure 4: Comparison between Langfang government plan and Arups
Arup

The concept underlying the design proposal was based on the retention of the existing village's fabric, on the value of the diverse natural landscape and on the strategic location within the province main train line (fig. 4).

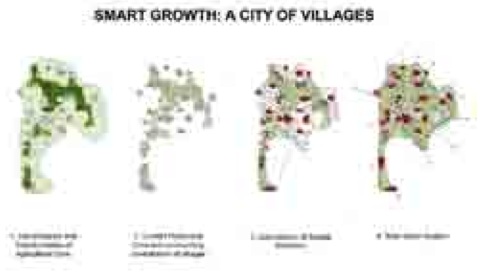

Figure 5: Wanzhuang ecocity concept sketches
Arup

In both designs the aspiration is to further decarbonisation in association with urban development. By reducing the estimated total carbon emissions by one part in five, the emissions could be stabilized to the levels of the 1990's. Wanzhuang and Dongtan aim to contribute to this goal by setting environmental standards in the energy consumption of buildings – dependent on an efficient use of city urban fabric -, by promoting the use of public transport and by optimizing the infrastructure of the city utilities to make them more life-cycle cost efficient (Fig. 6).

While the design imperative in Dongtan was to reduce the environmental impact while still allowing the city to accommodate the expected increase on population, the imperative in the city design and development strategy of Wanzhuang was to try to maintain the exiting population on site while incorporating the existing agricultural production as an economic viable option

The plan for Wanzhuang is to create an intelligent growth system that will be developed around the existing villages. In the centre, a larger part of the site will retain its current agricultural use and landscape character. These expanded villages will have close access to this agricultural "park" where cycle routes and footpaths will bring the new citizens closer to the local agricultural culture. Each village has a different character, and the plan is that the new development embraces this given distinctiveness throughout the area (fig. 5).

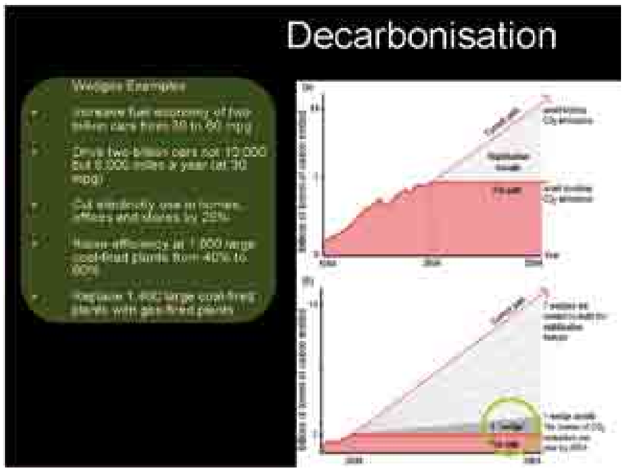

Figure 6: Stabilisation triangle (a) CO_2 in billions of tonnes of carbon equivalent (GIC) from 1954-2054 (b) the stabilisation triangle in detail
Pada and Socolow, 2004

Can architecture and urbanism tackle climate change?

In the context of the depletion of fossil fuels –to which we can now add its scientifically proven role in global warming and climate change - there is an emerging ecological consciousness, which brings back to mind issues raised a few decades ago that were almost forgotten with the economic boom of the late 1990's.

In fact, global warming and its direct relationship with CO_2 emissions had been in discussion since the 1950's; In 1953, for example, Dr Gilbert N. Plass, from the John Hopkins University, predicted already that by the year 2080 the rise in global temperature would be on average 4% - not far above the latest predictions of the Intergovernmental Panel on Climate Change (IPCC).

For those who have lived some time already before the end of the 20th century, this comeback has a sense of déjà vu and brings back things that are still, in a way, reminiscent of an idealism that succeeds at a very small scale.

With a renovated optimism of hope that outweighs the pessimism of reason, the green agenda – in which the ecocities are a key component of the discourse – presents itself more as a renewed civil ethical discourse than as an alternative tool to city planning. Yet it can be argued this label is now successfully attached to a politically correct instrument in the PR between governments, institutions and corporations.

It is because ignorance of the political meaning of this agenda and its underlying economics still drive urban development, that sustainable city design is still perceived today more as an alibi for good intentions than a concrete program in architecture and urban design, which at the core of the profession is still the attempt to transform the natural environment. Nevertheless, this could be the last chance to achieve the urban transformation that our planet desperately needs.

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Megacities challenges, a stakeholder perspective; a research project conducted by GlobeScan and MRC McLean Hazel, sponsored by Siemens, 2007.

The Social and Personal reaction to risk

Abstract

This paper's description of Social and Personal reaction to "risk" starts from the classical threat perspective, aimed at damage and loss prevention. In part this is because the term "risk" has become associated with "events" and "fortuity", an incomplete vision of uncertainty.

World changes are enormous and we notice impacts quicker every time with increasing uncertainty and under situations where the present risk is unknown; rarely do we pay enough attention to the positive impacts and true opportunities of "risk".

The aim of this research work is to adapt personal and social reactions to deal with such new risk and uncertainty models. The text revises basic concepts of risk, hazard and crisis and uses psycho cognitive theory and experience from a research conducted on crisis as disasters and catastrophes as well as on large changes or radical innovation.

The conclusions stress the importance of training and education as well as the role of citizens and international private – public cooperation.

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Introduction

This paper is part of a study on Radical Innovation, Risk and Crisis. Crisis produce disruption of existing situations that impact: people, organizations, corporations, sectors, regions. We learned that important patterns remain hidden or invisible. We often accept that they fall into the category of the unavoidable or unpredictable. Unavoidable means sometimes resistance towards a major crisis. It prevents us from predicting or preventing the negative outcomes or from profiting from the positive outcomes.

Disasters or catastrophes have astonishing likeness to personal and social resistance towards crisis and radical change. The text explores the regular patterns found.

The paper's main objective is to explain our vision of the associated concepts and findings, to promote a discussion and to share experiences or recommendations.

Words and Experience

Plutarch (75 A.D.) (Figure 1) wrote: "For it was not so much by the knowledge of words that I came to understand things, as by my experience of things I was enabled to follow the meaning of words". The reader will be able to find a meaning to this experience through the pathways of social and personal resistance explained in this paper.

Nietzsche (Figure 2) said that originality is...seeing something that has no name yet and that cannot be named even if it is just in front of our eyes. The name of things makes them visible...Original people made the names...

Figure 1. Plutarch (Latin: Lucius Mestrius Plutarchus[1] Greek: Μέστριος Πλούταρχος; c. 46 AD - 120 AD), was a Greek (though of Roman citizenship) historian, biographer, essayist, and Middle Platonist

Figure 2. Friedrich Wilhelm Nietzsche (October 15, 1844 – August 25, 1900)
German philosopher and classical philologist.

Social or personal resistance to change is in front of our eyes every day! It refers also to the visibility of future natural disasters and radical changes... but maybe we cannot describe them? This study's purpose is to help us unblocking this word, describing the experience, avoiding amnesia of past situations...

Risk and Crisis

Risk and Uncertainty

Even in usual dictionaries, the word risk had different uses in the past and was often confused with hazard. Risk probably comes from the Latin word "resecare"; it also means: to cut off, to tear, and to plough the waves. One of the more common uses is to wreck a ship by hidden or submerged rocks ("resecare": "secare" is to cut, in Catalan language the equivalent word "segar" has identical meaning).

The term risk includes concepts such as: exposure to or suffering possible harm, loss or injury. We use terms such as danger, destruction, peril, hazard, jeopardy, imperilment, or endangerment and a possibility of danger or harm we call chance, hazard, and gamble. Most of these concepts identify damage elimination as the unique or main concern, avoiding the direct mental effort of considering opportunities. Risk is a two-sided stick; the same stick contains creation and destruction on opposite sides...

Uncertainty is: lack of certainty, doubt, questioning, wonder, suspicion, mistrust, disbelief, doubtfulness, dubiousness, incertitude, equivocalness...

We can draw a chart (see Figure 3) using a square with extremes of highs and lows for the two concepts: risk versus uncertainty. The side of low risk / high risk and low uncertainty has instruments such as avoidance, transfer or mitigation. We either insure, accept, or manage risks. Knowledge enhances both high uncertainty and low risk .

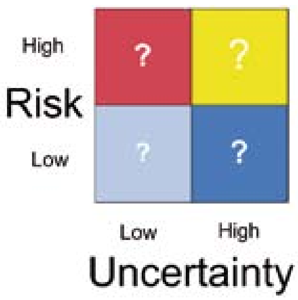

Figure 3. Risk and Uncertainty

The two highs can represent big challenges in two ways: a simple lack of our knowledge or ignorance of what is in "front of our eyes".

A more precise definition of risk is: a combination of probability (likelihood of the incident) and severity (the magnitude of the damage or loss of people's lives, property and environment – or elements at risk are damaged or lost).

There are confusions between hazard and risk. Hazard is the inherent potential of a material or an activity to harm people, property, or the environment. Hazard does not have a probability ingredient (chance), in contrast to risk.

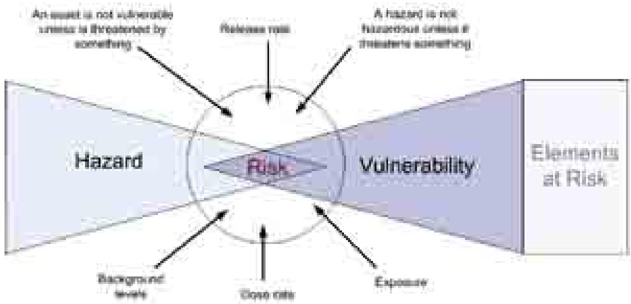

Figure 4 .Relationship between hazard, vulnerability, and risk associated concepts (Alexander, 2002)

In defining vulnerability we find (Alexander, 2002) an overlap between the concepts of hazard, vulnerability and risk, as indicated in figure 4. Hazard is expressed as danger: natural, technological and social. We associate risk with the likelihood of impacts. Vulnerability is the susceptibility of people, things and the environment to losses attributable to a given danger - a given probability that a hazard will manifest itself at a particular time, place, in a certain way and magnitude. A natural disaster is linked to the threat of a natural danger and to the existence of vulnerable assets or elements at risk: personal, social, economic… Thus, hazards are triggers to vulnerability.

Probability assessment is a cornerstone of quantitative analysis, but "probability does not exist" (Bruno de Finetti, Preface of The Theory of Probability, in Granger Morgan, M., Henrion, M., 1990). The likelihood or probability of something is a measure of "uncertain belief", the expression of a "compatible set of beliefs, values, models, and decisions".

Our first observation is that Risk (and Risk Management) depends strongly on our psycho cognitive processes. And the question is: Do human psycho cognitive sciences have responses to manage to deal with crisis? The paper's aim is to redefine that question based on our own vulnerability.

Crisis

In most dictionaries crisis means critical moment, turning point, sudden or decisive change, etc.. Radical innovations have identical properties, big changes, too; risk management must identify the potential crisis.

Our vulnerability becomes obvious in crises, life and death; three taboos in our civilization. Societies use taboos and myths to create areas of consensus – or non-discussion - that structure our relations; they can also paralyse us and prevent us from seeing the way.

This study looked for important and relevant crises. We analysed disruptive scenarios: big impact cases threatening and disorganizing daily or normal life. There are events, like aggression, such as a bomb explosion, that affect our psyche and alter our mental and somatic processes. We recognise that we are often unable to foresee or predict disasters and catastrophes; in disaster intervention, people that suffered injuries are first subject to medical treatment. We send the sick to the doctor but we do not send the others in seemingly good or normal health to the doctor. We find people that appear in normal condition, however, only specialists can recognize their symptoms.

In real crises the author observed certain unexplained patterns that were similar: radical changes, affecting an individual or a bigger group of people; radical innovations, too, had likenesses to the previous observation. Could an understanding of these patterns and the creation of proposals help us to surf on the wave of destruction and creation? We studied the human factor in the different phases of disasters and catastrophes. Interviewed people from WWII and other wars and crisis military psychiatrists from the World Psychiatric Association, as well as people from emergency departments gave excellent comments. Clearly, many normal people can suffer post-traumatic stress – a category difficult to define - that impacts their cognitive processes.

Besides the direct impact of terrorist attacks, car accidents, industrial accidents, natural disasters or other injuries, society produces a victimization process. Victimization is due to the society's lack of a satisfactory response. When it occurs, it creates a sense of guilt and blocked memory, passed on to those injured, preventing them from rapid recovery.

Again, we are all of "human nature" and mental processes may prevent ourselves to respond in the right direction. In groups of more than twenty postgraduate students we questioned who of them was currently facing a major crisis in the tasks they are at work with The bigger the group the longer we usually wait for the first response; denials or "no-crisis", "it is or was someone else's problem" are the normal response,. Few exceptional people immediately recognize they are in crisis. Recognising and communicating typical personal situations (loss of job, divorce, accidents, surgery…) immediately increases the number of students that accept a crisis. Finally, they may even accept sharing their feelings and emotions.

Crisis situations need the support of people who must preserve their own immunity - distance is essential. Practitioners understand that training, gives better results than education, essential is "on the spot" intervention, ,when exposed to a disruptive situation.

Reactions in Crisis

Visions of Crisis

People and social groups have used different visions in cases of risk or crisis situations. The first personal or social response was to consider the disasters as "Acts of God" and they simply survived thanks to their special relation with their environment. When administration or the modern state came to exist, a "new God-administration" took care of the responsibility and liability. People and social groups unlearned their old beliefs through these experiences. The Administration had to respond. A possible approach is to prepare the citizen to respond, but, crises represent extraodinary situations of distress.

Knowing and Risk

Crisis, radical innovations or change have the "power of the situation" (Ross & Nisbett, 1991). The work of Kahneman describes how we judge under uncertainty; how we predict and evaluate evidence (we may assume that Kahneman considered people placed in normal life...). It also considers how we make choices under risk situations and other important questions and responses, and has inspired the statements that follow regarding cognitive systems, our capability to adapt, and the importance of intuition (Kahneman, 2003, pp. 1449-1475).

According to the author we have two modes of thinking and deciding, which correspond to reasoning or intuition. Reasoning is deliberate and effortful; intuitive thoughts, in contrast, come spontaneously to mind. Most of our actions and thoughts are intuitive; a plausible judgement often just comes to mind. Figure 5 summarizes the importance of perception. System 2 operations are slower, serial, etc. and as the author shows, they are potentially rule-governed. System 1 operations are governed by habit and are emotionally charged and thus difficult to modify. We act under normal conditions like most of the bounded risk scenarios suggest but in the case of a significant disruption, emotions and habits must be adapted. As an example: experienced decision-makers working under pressure - emergency team members, like fire-fighting teams... rarely need to decide between differing choices, only a single alternative comes to their mind.

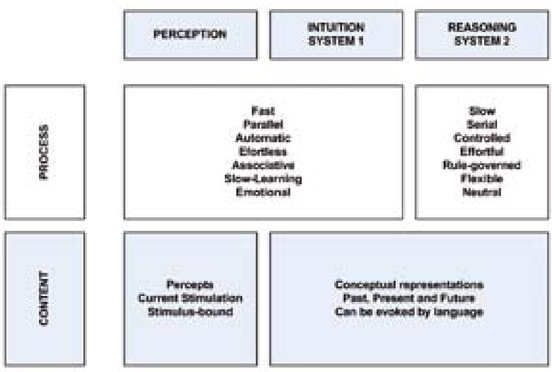

Figure 5. Three Cognitive Systems
(Kahneman, 2003, pp. 1451)

Adapting oneself to disruptive environments, radical change needs a cognitive system adapted to that environment which includes a long-term process of skill acquisition, capable of responding effectively to surprises. We also cannot ignore emotions, feelings and beliefs. Our heuristics that once made our risk management solutions reliable, can lead to severe and systematic errors. Skilled decision makers "do better when they trust their intuition than when they engage in detailed analysis" (Kahneman, 2003, p. 1469).

Optimism affects risk taking, and fear in predictions of harm, and the tradition of separating between belief and preference in analysis is psychologically unrealistic (Kahneman, 2003, p. 1470). Our research places people away from normal or routine daily life decisions; the focus is on events that have the potential to lead to exceptional or big impact situations.

About resilience to crisis

Human resistance to big change or crisis is inherent in the human mind, taboos used to produce social consensus, and preventing us from discussing failure in full depth, which becomes apparent through behaviours that are hard to explain.

The relation between uncertainty and risk or hazards depends on the potential and limits of human nature. Decision-making involves a consideration of the future, which is hidden amid a cloud of uncertainty. Human creativity is, above all: human, and therefore dependent on chance: good or bad luck can make a big difference in our human activities. We needed to understand how the human being supports risk's two-sides: destruction and creation. Is creativity and the flow of ideas and our power to shape innovation affected by our vision of destruction? How? Why is our certainty so often blurred?

From Dr. José Luis Pérez-Iñigo Gancedo, military psychiatrist (private communication), we learned about the process of facing our own death. Note your own reaction. The cycle of sorrow or grief is different for different people in different situations, the crisis caused by risk and hazard is an unusual environment, and crisis triggers a process of sorrow or grief. The details are different from the usual, and then even minor details can become important to resolve the problem. Leaders and organizations prefer to support the "no-change-option" that plainly avoids going through the grief process of the crisis.

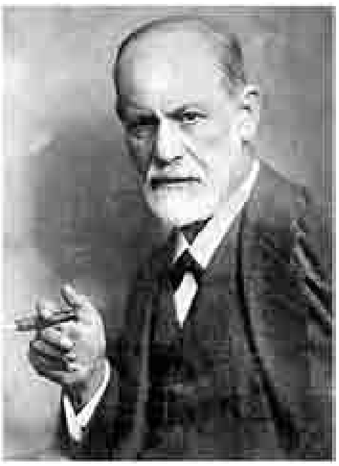

Figure 6. Sigismund Schlomo Freud (Sigmund Freud) Freiberg, 6th of May 1856 - London, 23rd of Sept.1939, Psychiatrist who founded the psychoanalytic school of psychology

Consider the following citation of Freud with the following key replacements:: in the bracket (...) the word death is replaced by the word "crisis" or "radical innovation or change", and . in the bracket (-----) the word "mortality" is replaced by destruction. Both destruction and creation are part of the same crisis: "The unconscious doesn't know (...) and no one believes in its (-----). Our own (...) is unimaginable and when we try to imagine it we realize that we survive as spectators".

Crises, if they are acute, cause a grief or sorrow process. Grief means affliction, agony, distress, melancholy (more enduring), sadness and depression, which can also arise because of a loss or from other causes. First, human beings start a **denial process**. We at first do not accept our own crisis or the crisis of the activity, etc. It is a denial of reality and it decreases when we share our feelings with other people. Denial protects the individual from experiencing the intensity of the loss; it is reduced when the person is aware of the loss.

Denial can block our ability to solve the crisis. The next stage is named **annoyance or anger**. We are angry because the crisis is unfair. It happens generally when people feel helpless and without the capability to act. Guilt feelings also appear when feelings are expressed; anger is transferred to other people. It finally improves or decreases when social support is available. When we are angry, emotions also block essential perceptions.

There follows a **sense of guilt** for everything done or not done before the loss, and after that **"negotiation"** (we make offers to return to the previous situation; we think about what could be done better; we imagine things or situations that would no longer be possible).

Depression also appears (we experience the sensation of a big loss; alternating changes of low and high spirits and a sense of loneliness; and, after, understanding the nature of the loss, sleeplessness and loss of appetite problems, and a feeling of abandonment).

Acceptance helps to resolve the crisis. Reality is accepted and we face it; from that point onwards progress begins, it does not mean happiness, but the feelings are reordered.

Hope: A certain point is reached where memories are less painful and we can look towards the future.

The persons involved must fully understand this process; the author's experience in real cases is: first symptoms appear in minor details. At the same time "immunity" of decision-makers is essential as it affects their capabilities. We learned that not "solving" a crisis to the final stage blocks the possibility of "facing" future crises. We should ask for leaders who are experienced in cases of both success and failure - both are important.

Closing remarks

It is important to understand that crises or complex changes may also turn into process of grief or sorrow. We need to evaluate fear and opportunity. Future paradigms have different traits from past paradigms (Kuhn, 1962): "... We must constantly adjust our lives, our thoughts and our emotions"(Vernon, 2003, p.465).

People and societies can promote different reactions to risk, disasters, and crisis:

- People that ask what happened after it has happened;
- People that look at what is happening as passive observers, they view life as it goes on outside their window;
- People that define programs, create systems as networks, question, commit, interact, and overcome the resistance to change...

Governments, the private sector and people must work together to provide the social support necessary for people to react and transit through a crisis. The OECD Large-Scale disasters recommendations (OECD, 2004) summarize:

- Governments can – and must – be better prepared to mitigate the economic and social impacts of disasters by better planning and coordination across government responsibilities.
- Public trust, as well as consumer and investor confidence is key element to ensure rapid and systemic recovery; these elements need to be strengthened through credible communication and effective action of both the public and private sectors.
- Governments need to work more closely in partnership with the private sector, which has key roles to play in disaster prevention, preparedness, response and recovery.
- Major disasters and harmful events can have multiple international dimensions, and these call for more systematic international co-operation.

Education and training for crisis will be part of our future research: "Human history becomes more and more a race between education and catastrophe... Yet, clumsily or smoothly, the world, it seems, progresses and will progress". (H.G. Wells: The Outline of History, 1920)

Herbert George Wells (21 September 1866 – 13 August 1946), better known as H. G. Wells; English writer most famous today for the science fiction novels

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New Cities against the Climate Change

Abstract

We propose here a new theory for urban planning with the intent of provoking a heterodox debate. The traditional idea of a city was to select a piece of two dimensional spaces and provide it with a wall (physical or virtual) inside of which some number of people could be concentrated. The development of this idea leads to megacities reaching 15, 20, 30 million persons living together in a congested space.

While at some time this idea could have saved some energy, it is proposed here that today, but still more tomorrow, these giant conurbations are an obstacle to that goal and, much more importantly, to the production of energy via renewable technologies. Megacities generate, inevitably, huge traffic jams and consequently lead to a loss of energy and time. The idea that a megacity saves transport energy derives from the implicit concept that a large number of people must come together to provide work. This is no longer true. Today and in the future all work and coordination can be done in medium sized cities connected through networks.

Furthermore, medium sized cities, in contrast to megacities, can generate within themselves all the energy they use and do not require complex systems for water treatment.

Problem

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Opening a heterodox debate: Should the city of the future be open/extended or compact?

In the usual treatments of urban planning the idea of compact cities is always maintained to be the system for organizing human life that demands the minimum use of energy. However, this assertion is not so self-evident. The idea derives from the comparison between European and some American cities like Los Angeles in California and Houston in Texas. My intent with the present pages is provocative: to produce a renewed discussion on these ideas, which, although taken as granted, cannot be accepted as correct without further research. In the 21st century we cannot continue with traditional notions and social constructs, like the concept of cities, produced thousands of years ago.

Extended or compact cities? The general opinion among urban geographers and urban planners favours the second option. In the present paper we will argue that this opinion is the product of background ideas anchored in past boundary conditions and that the first option deserves more serious consideration.

The boundary conditions for cities have been the cost of transport, the use of land, and the cost of infrastructures. The use and dissipation of stored energy do not enter into the large majority of the urban studies and treatises (Blakely, 2007; Campbell, 1996). One of the reasons usually mentioned against the extended cities is the amount of energy spent on transport within the city. For instance Stone et al.(2007) argue that compacting cities reduces pollution and energy use. Their study is based on the notion that the number of citizens in a certain region is constant, or grows by a constant factor. In that case, putting all these citizens inside high rising buildings connected by metro or buses may reduce pollution and CO_2 emissions.

One of the problems in this reasoning is that the calculations do not take into account that compact cities attract a plethora of commuters each day coming from other towns nearby. If we keep compacting the city for newcomers, we arrive at cities like Mexico City or Sao Paulo that are perfect examples of pollution and high greenhouse gas emissions. If you calculate the amount of energy spent in New York without taking into account New Jersey and Connecticut, you get a completely wrong answer. The reality, as seen in Madrid, Paris, London, Sao Paulo, St. Petersburg, etc. is that the compact, hierarchical cities produce daily a tidal-like system of entrance/exit for hundred of thousands of cars. Where is the energy saving of compact cities if we add to them their area of influence?

Some cities have been built trying to take into account environmental problems. In Madrid, Arturo Soria designed a Linear City in 1890, with the idea of connecting many of them together in a friendly way of living. His theories were published in Spanish in the newspaper El Progreso and for some 35 years in a self published journal "Ciudad Lineal". The idea could be seen as a precursor of the concepts of open cities, though at that time Soria was not concerned with problems of energy.

In the decade 1920 Ebenezer Howard started the project of Welwyn Garden City, (Welwyn, 2009) with the idea of bringing men again into contact with some form of nature, at least with gardens and agricultural land. But the idea was limited in extent to the wellbeing of its residents, without taking into account the problems of organizing millions of people living together and not only enjoying their leisure time but commuting to work.

The desire to restrict the use of cars has motivated many cities of the world to promote the use of public transportation. Curitiba in Brazil, Portland in Oregon, USA, and Freiburg in Germany are pioneers in organizing life -inside- the city with a reduced impact on environment (Walljasper, 2001, Rabinovitch and Leitman, 1998).

However, neither the ideas of Soria with his concept of a linear city, nor the example of Welwyn, nor more recently the exercises of Curitiba, Portland and Freiburg seem adequate to the huge problems confronting human beings in countries like Brazil, Mexico, India and China, where the solution to the huge pressure of people fleeing the countryside for a new life incorporating daily novelty has been, as always, and showing a completely lack of imagination, to store them into beehives of huge densities. The designs for more humane cities are reserved only for wealthy citizens, but these also must share their daily problems of traffic jams to get to work, where they are also all crowded together in hierarchical structures.

There appears to be no urban theory accounting for the problems of increased population, the environment and energy generation and use. The published literature addresses only how to optimize a faulty concept: The old idea of a city. As in other disciplines, such as economics, a huge amount of published work deals with trying to solve a series of problems within an accepted framework that is not put to question.

My proposal here is to extend the ideas under which the above mentioned examples of environment-friendly cities were organized into a general system of urban planning, rejecting the old framework of a city as a walled location separated from its environment.

What is a city? It is an agglomeration of persons living together in a delimited area. Cities grow by a mechanism of positive feedback, concentration developing following a more or less random fluctuation, and then sucking up resources from other places. As soon as a centre has some advantages it keeps collecting people, and growing without limits.

Big cities are no better at their job than smaller ones. They do not provide a higher life quality, nor do they provide for more jobs or entertainment. They simply keep growing without bringing any advantage to their citizens, and at the same time sucking up enormous quantities of energy. Some writings favour the concept of compact cities, giving as reason that in them you don't need to move people around. But reality (or at least the data collected on that subject) shows that big cities attract huge intensities of goods traffic (to provide goods for consumption) and a daily tide of citizens moving in traffic jams from all parts of the city, and its suburbs, to all others parts. A car driving in traffic jams can emit three times more CO_2 to the atmosphere than when driving the same distance smoothly.

A medium sized extended city can combine the desirable degree of anonymity of a big metropolis with the nearness to relations and friends of a small town. In big cities the entertainment facilities have often become very difficult to enjoy. A big-sized city like Madrid does not feel the need to have more than one classical art museum, or two symphonic orchestras, and therefore 5 million people need to compete to visit the only one of the first or get one of the only 2000 seats for the second. A city of one million with 1000 seats for one orchestra has at least an advantage of 5/2 against the bigger city. Although one can, of course, also cite large cities, such as London, where the entertainment and cultural facilities are commensurate with their size and undoubtedly represent one of the factors contributing to the above-mentioned positive feedback, size does not necessarily translate into enhanced free time opportunities.

As soon as we cover a surface with a network of non-hierarchical medium-sized cities the issue of expending energy in traffic disappears. For the main traffic can only be inside the city. The majority of citizens of a city will have no motivation to work in a different city than the one in which they live, since in a non-hierarchical system, no city will offer more than another. Exactly the opposite happens in compact cities, in which millions of suburbanites must travel every day to the central hub.

If we were to cover the planet with medium sized cities, say with cities with densities of 1.500 inhabitants/sq. km. (San Diego, California), we would require a total city surface of 5 millions sq. km, or something like a 5% of the land surface of the temperate zones of the Earth. Thus, there is no danger that this would convert the planet into a giant city.

Living in medium sized cities with dwellings no higher than four floors allows for a nice contact with a domesticated nature and short distances to agricultural and forested land and non human occupied parks (we have to acknowledge that there will hardly be pristine nature anywhere in the planet. The most we may expect are human cared for small or big parks).

Energy use by traffic among medium sized cities would be greatly reduced. In addition, medium sized cities, with buildings of four stories and 15 m wide streets, can generate, via photovoltaic and solar thermal energy, all the electrical and thermal energy they consume. This is no longer possible for higher buildings and compact cities.

Another traditional objection against extended cities is the cost of water conduits. However, today water conduits are made of plastic rather than copper and no longer represent a significant cost factor.

The potentially higher cost of electrical cables for extended cities also disappears as soon as many of the local needs for electricity are provided via in situ solar energy.

As a bonus, extended cities also solve the water treatment problem. Sewage treatment is a problem only for big cities. Sewage purification is essentially the work of bacteria that need free water surfaces. In contrast to compact cities, extended cities can readily provide such water surfaces.

Energy

Today's energy easy availability is a free gift that is disappearing. As with most gifts, it has been used without consideration of the future. The present cities have been built over many past decades without any consideration of energy waste. As fossil energy was abundant and seemingly cheap, it did not enter into the consideration of either architects or urban planners, who designed highly energy inefficient buildings and towns (Hall, 1995).

Today energy is no longer cheap. The real price of fossil energy (as opposed to the price we pay today at the gas station) is so high, when the cost to future generations through climate change is taken into account, that we must switch as soon as possible to other energy sources (IPCC, 2007, Stern, 2007). The only long term viable alternative is the capture of the energy coming from the sun, in ways much more efficient than the photosynthesis used by the plants. Today we can do it via photovoltaics, using the direct conversion of light frequencies into electricity by the direct resonant excitations of electrons; via thermo solar methods, by the bulk motion of molecules, or after the surfaces have captured energy, by convection of the air and the wind.

Cities were designed a long time ago, and the idea of the city comes from the times when energy was, first, stored in compact granaries, and later, in the 19th and 20th centuries, produced in central facilities. For that we needed a big ratio of volume to surface: We needed compact systems.

Tomorrow energy will be produced by surfaces capturing solar radiation. The storage will be done in small quantities. Therefore, for the 21st century and the next ones we need high ratios of surface to volume. Solar radiation is highly diffuse. It makes no sense to try concentrating it to distribute it afterwards to an extended surface. We need to change ways of thinking derived from thousands of years of concentrated energy.

Cities are energy guzzlers. But they can be converted into net energy producers. Cities have surfaces and that is what is needed to capture solar energy. To do that, we must change the concept of compact hierarchical cities. When energy is released in concentrated form the need is for big volumes with small surfaces, to reduce the losses of energy. But today energy generation needs big surfaces. Buildings can be almost perfectly thermally insulated, so energy loss is much less important than energy generation. To be able to capture energy the relation surface/volume must be large and therefore we cannot design buildings higher that four storeys. To receive light the streets must be wide. That implies extended cities with medium densities. As the transport of goods and people can be managed via IT and the energy required can be produced locally in the roofs and façades of the buildings, the cost of transport is not an important consideration in city design. Hui (Hui, 2000) analyzes the use of energy in Hong Kong. He affirms that there it is possible to produce low energy demanding buildings also for high rising and high density buildings. No doubt it is possible, but what is not possible with these compact buildings is to generate enough energy from solar sources for self sufficiency.

The second law of thermodynamics is inescapable. While we can get energy from the sun, we must, in any case, reduce the energy we use. During the last fifty years we have dissipated huge amounts of energy by procedures as wasteful as locating room heaters in sections of walls of reduced thickness under windows, or by heating and cooling air, a fluid with a negligible heat capacity. There exist, however, in the available technology, much better ways to control temperature. Particularly in buildings we can easily and cheaply isolate walls, roofs and windows, and we can heat and cool solid surfaces that have a much higher heat capacity that the air. The energy sources for these thermal processes should be the roofs and façades of the buildings, used for the capture of solar energy. Solutions are in the market and the only need is to incorporate them extensively into the building industry.

Transport

We can split the transport problem into three separate questions.

Freight between cities

Today freight transport is carried out in a very high proportion with trucks. In addition to normal fuel consumption, trucks typically accelerate and decelerate every several kilometres, increasing fossil consumption. On the other hand, a well-designed freight train system needs only to accelerate its trains during the first minutes until reaching cruise velocity. As trains cannot climb steep grades, train lines are made almost horizontal, reducing the energy needed for climbing. Container trains today experience some air drag due to aerodynamic resistance between wagons, but that can be strongly reduced using aerodynamic covers (Greiving and Kemper, 1999).

Freight is distinct from passenger traffic in that it is always the same. Usually the same amounts of goods travel from the same origin to the same destination day in, day out. Therefore it can be easily automated. Moreover, big containers can incorporate also smaller ones that can be redistributed with computer support with very little energy waste.

The energy required for freight transport can be further reduced by arranging cities in ordered networks designed to maximize local production.

Passenger traffic between network cities

A well organized city network can substantially diminish the massive daily tide of passenger traffic between today's cities, with their resultant traffic jams. First, with a well organized distributed work system, offices for firms can be located such that there is very little need for workers to work all at the same place and all at the same time. Today there is no problem in arranging conferences via computers, and much of the work in firms doesn't really need the physical presence of employees in the same location.

Next, traffic between the cities of a network can be organized very efficiently via a dense network of trains (Berlin) and/or a dense network of system efficient electrical/hydrogen buses.

System efficiency is, like all this paper, a rather provocative concept. It is often understood that a system is efficient if each of its elements is efficient. This works very well for linear systems. But in non linear systems the global efficiency of the system is not the sum of individual efficiencies, as the interactions between the parts can, and usually do, modify that result. This may be illustrated by an example: Today's city bus lines are often designed to optimize the performance of each individual bus. Each bus makes labyrinthine circuits inside cities or in the suburbs, to get the biggest number of passengers per trip. The result is that the times spent by users of buses are usually much longer than if they use their private cars (even taking traffic jams into account). The result of this time increase is that public transport systems (in many cities) are not efficient for their final objective, namely to reduce the use of these private cars, although each one of their individual components can be highly efficient.

Further, many of the traffic jams around cities (producing a huge waste of energy) arise from an old and non-corrected idea: That the traffic goes around the city, when the reality is that in today's hierarchical cities the traffic is nearly always directed towards the extended city centre. Cities have been surrounded by concentric rings of multi-lane highways that remain for hours during morning and afternoon in a state of stop and go. The origin of these jams is the very few entry points to the city from the ring highways. The solution is obvious, and was found years ago in the internet: The only way to avoid jams is to make cities permeable, that is, providing the rings with exits/entrances every hundred meters, exit and entrances that branch again and again like the internet or the capillary blood system of higher animals.

Traffic within the city

This traffic can be organized very well via the metro, electric cars and bicycles. In medium sized cities, bicycles are not only not a problem but are a part of the solution. Young and not so young people can often move so much more rapidly with bicycles than with private and public transport that this can become, if the city is organized appropriately, the preferred means of transport. Amsterdam is a good example. For old and impaired people small electric cars are a sensible solution. As an added bonus, electric cars are a very promising method for storing energy generated by photovoltaic generators.

One aspect of transport within cities is the very old and unresolved problem of parking. Streets should be used for commerce and entertainment. That implies short stops by bicycles and cars. This is very difficult if the streets allow citizens to employ their public space as private parking sites. New cities and renewed old ones must ensure that long term parking is not allowed on streets. Garages and/or parking spaces have to be provided. This is quite feasible if buildings, as proposed here, are not higher than four storeys in wide streets.

City and city network design

Today's cities, both old and new (we regard cities like Los Angeles that were started some hundred years ago as old) were built following very ancient ideas. When built, the only way for easy communication was the direct contact between human beings. Therefore the idea was for persons to travel away to earn their livings and back again every evening to gather together. Today the needs have changed but not the old ways. People live away from the centre of compact cities but travel in a daily tide to the centre, to do there what they can perform much better far away from it. The solutions sought are all based on the same initial and boundary conditions of the old problem. Physical city walls have been taken away, but, with the new times, virtual walls still remain. The idea of a wall is that it has doors. Cities continue having very few doors, resulting in the huge jams of cars and people that daily waste two to three times the energy (and corresponding amounts of time) that would be needed for their travel if the cities had no walls.

We must research and change these two very old unquestioned background concepts: daily personal communication in hierarchical institutions and centralized cities. Today the need for face to face communication for business reasons can be reduced to once per week, performing the needed coordination via e-mail, phone and video conferences. Much of the work can be done by distributed units spread over countries and continents. When needed, personal travel can be done via public transport, and for the remaining cases of the transport of goods and people by car, cities can be given hundreds of entrance/exit points connected not via concentric rings but via capillary networks similar in structure to the circulatory system of mammals and the net. A new system of land use management in support on these concepts is urgently needed (Studley, 2005).

Conclusion

We are facing an exciting and challenging task. Radical new ideas and solutions must be developed and tested. Energy, the basis of wealth creation, can be conserved and generated within cities, but the cities must be designed such that the energy is indeed not wasted, but increased through the activities of people - thereby increasing both their wealth and quality of life.

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The Nature of Cities

Nature vs Shelter

Nature and shelter are in opposition to each other by design. History of mankind shows that humans have always sought shelter to protect themselves against the adverse elements of nature. When humans became sedentary, exploiting nature more systematically, they also built their own habitat against the dangers from nature and species, including rival humans.

There is an inherent tension between the characteristics of the built environment and nature, the former subjected to inertia and the latter performing powerful, spontaneous and unpredictable changes. However, a closer look at this contradiction shows that the manmade environment is also subjected to entropy, to slow but steady degradation. Even its inert materials will eventually transform and decay. This is due in part to its interaction with the natural environment, but also to its use by humans and their ever changing demands. Conversely, the weather obeys certain laws of nature and is predictable in principle if not in specific place and time.

Understanding the long term process of decay of the built environment and its interplay with variables imposed by designers to work in the opposite direction is limited and requires more experimentation. Similarly, more scientific knowledge is needed to produce better explanations of weather systems and their behaviour. Within the confines of such imperfect knowledge, could connections be engineered between climate change and cities to establish a mutually beneficial relationship with positive feedback between the natural and manmade environments? In particular, can art, technology and economics mediate between climate change and the built environment and contribute to more sustainable design, construction, maintenance and transformations of cities.

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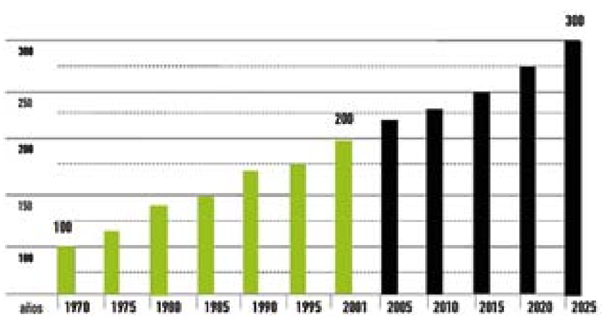
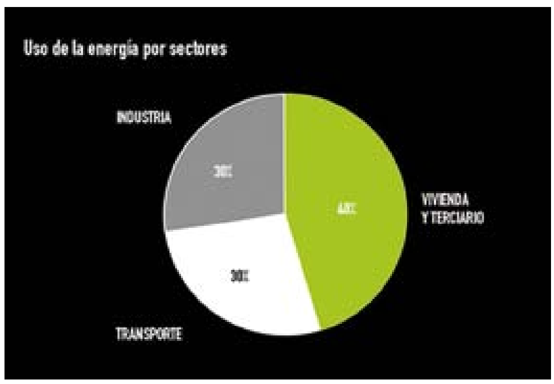
The challenge of climate change in the city

The challenge of climate change has reached designers as well. Conventional wisdom has estimated that in 2006 the contribution of the built environment to global warming through energy consumption - residential and commercial buildings and traffic combined - was in the order of 36%, if generation and transmission losses of 27% are included in the 15 TW of total energy consumption. Industrial production – agriculture, mining, manufacturing and construction compounded – consumed 37%. Without including energy generation losses, net energy consumption of end use per sectors accounts for 40% of the residential and service sectors, while transport and industry consume 30% each.

The amount of energy consumed in cities by these sectors is not measured directly and needs to be imputed from other data streams. The proportion will vary according to the degree of urbanisation which is steadily increasing, at the highest pace in the developing world. Moreover, certain activities do not take place strictly speaking in cities. Air, rail, road freight and passenger transport, the transmission of energy supplies such as oil and natural gas, extraction and production of cons-



World energy consumption (index=100: 1970).



World energy consumption by sector: industry (30%), transport (30%), housing and services (40%)
EIA: energy information administration

truction materials, industrial production have most of their end use in cities where they are ultimately consumed. Even if productive activities such as manufacturing are located outside cities, they are connected with logistic nodes and ultimately with cities from where workers commute. They also tend to generate cities around them in the longer term to accommodate the work force and to provide services for them, thus contributing to the urbanisation process and its own latent energy content. The trend to decentralise back offices of large companies, or to create remote large scale logistic nodes, science parks, university campuses, specialised financial, media and other compounds with high land consumption on cheap sites outside built up areas contribute to urbanisation. They will eventually form part of urban regions or constitute new built up concentrations in their own right. Conversely, waste stemming from energy consumption in cities may affect areas outside cities but should form part of the city equation.

Compounding such activities connected to cities, the gross energy consumption of cities amounts easily to two thirds of total consumption. Consequently, they also contribute a substantial amount of adverse effects to climate change. With sustainable planning cities can identify potential areas of intervention and produce strategies for the reduction of green house gas emissions at city level and target sectoral interventions. They can also raise awareness and provide incentives to change consumer behaviour. By implementing such actions cities can make a positive contribution to climate change.

Yet, well rehearsed arguments refute the causal relationship between polluting human activities and climate change, invoking historic fluctuations between ice ages and desertification, as well as the far more important impacts of natural sources, such as volcanoes, wildfires, methane and radon emissions. For subscribers to sustainability, this is not an argument against alleviating polluting effects of cities.

Measuring energy consumption and pollution in cities

Even if consensus could be achieved on the importance of curbing the adverse effects of human action on climate change, especially in large concentrations such as cities, many difficulties persist of how to measure the contributing factors and to conceptualise their impact on climate change, in combination with each other and over time.

Energy and the environment are two sides of the same coin. Measuring energy consumption and pollution are selected to illustrate some of these technical difficulties. Usually it is considered easier to capture energy consumption in quantitative measurement terms than pollution. Not for lack of trying, it is notoriously difficult to construct and calibrate an all inclusive energy life cycle equation, say in terms of joules, ranging from extraction, production, transmission, distribution, retail, consumption, waste, recycling, to final disposal of residues and decay, without double counting while taking into account effects which cancel each other out. Pollution can be measured separately per type of pollutants, and how it is produced by buildings according to their various types of uses, industrial processes, transportation, and construction, as well as by energy generation and transmission, each in their most appropriate units of measurement.

It has to be kept in mind that interventions put into place to increase energy efficiency or to curb pollution have to be included as well in the energy consumption and pollution equations and may cancel out intended positive effects. Moreover, energy consumption does not necessarily relate directly to pollution output. In both energy and pollution accountancy, there are interactive effects, trade offs and mutually reinforcing aspects, although they may be difficult to identify. Also, the selected units of measurement affect the measurement process which, in turn, is itself a potential contributor to energy consumption and pollution. Complex as this data is, it does not include qualitative aspects. They may not be relevant for measuring the behaviour of material things such as buildings, but are crucial to understand the factor of human behaviour in this equation.

Assuming that such complex quantitative data can be mined in different units of measurements, a common denominator has to be selected to establish the combined effect of energy consumptions and pollution in cities, requiring transposition and calibration of the raw data.

Implications for climate change

Should it be possible to collate energy consumption and pollution databases for whole cities, they would have to be transposed to impute their combined effect on climate and climate change. Yet, the relation between energy consumption and pollution and their presumed adverse effects on climate change may not be the same at various levels of interaction, i.e. at the level of a single building, a neighbourhood, or a city as a whole. Another point is that the way pollution finds its way into nature relies on a separate set of assumptions and assessment. Some, but not all aspects are empirically measurable, notwithstanding adverse effects on the built fabric itself or on human health, for example.

Normally measurements of such models are translated into money units. That in itself implies some arbitrariness linked to specific moments in time. Moreover, establishing quantitative measures of energy consumption and pollution for separate sectors, for example construction, is bound to produce overlaps. None of the sectors produce effects on climate change alone, providing they can be identified, notwithstanding qualitative dimensions of energy consumption and pollution emission in cities. Most critically, these measurements do not include behavioural data, that is to say how users may change their strategies about energy consumption and pollution, an aspect which would be far more difficult to model and impute than data on material matters.

Finally, even if the whole process of measuring and evaluating energy consumption and pollution and their effects on climate is put into money terms and account is taken of the limited data availability and reliability, the chances of such a comprehensive monitoring system being put into place are very slim. There are many reasons for that: technological limitations, unforeseen secondary effects on the behaviour of the built environment as well as of its users, costs of reducing energy consumption and pollution, let alone the difficulties of attributing and distributing the costs of such an undertaking, and above all political acceptability. Even if the 'polluter pays' principle could be applied, a crucial argument against such massive expenditure would be the uncertainty of causal relations between pollution and climate change.

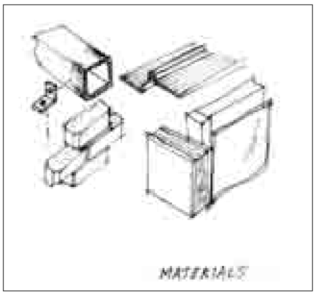
Interdependence between cities and climate change

Some kind of relationship between cities and climate change is commonly accepted. In the absence of a comprehensive and reliable database, more realistic and piece meal ways may have to be adopted to deal with these adverse effects in practice. As Eric Beinhocker has established, people take everyday decisions with very imperfect and incomplete information, contrary to the assumptions of traditional economics. Unlike scientists who devise theories and verify them, the professionals of the built environment design for implementation and use. They have to resort to their limited practical experience and imperfect knowledge when deciding about measures to curb energy consumption and pollution emissions through their utilitarian designs of buildings and cities and can, at best, test their assumptions in the real world. Thus, while science builds on logic and rationality, design has to resort to intuition and imagination, precedents and best practice from the real world.

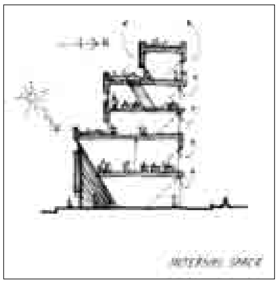
If the universe is a single entity, cities form an inherent part of it. Cities are thus both causes of climate change and at its receiving end. Where gains and losses reside in this complex system of interaction is without a doubt beyond the mathematical capacity of planners and designers. Nevertheless, this does not justify a 'do-nothing' position. Many city leaders who are committed to the principles of sustainability, tend to isolate specific groups of assumed effects on climate change and have to accept that, at best, they are able to sub-optimise interventions to reduce energy consumption and curb environmental pollution. Thus, when cities are preparing pre-emptive or retroactive instruments to curb adverse effects on climate change they cannot cope realistically with the full complexity of energy consumption pollution and their interaction in cities. They may have to be tackled by discrete interventions, at different levels, measured separately: at the level of individual buildings and their uses; in specific urban areas which accommodate single or mixed urban activities and groups of people; more ambitiously at the scale of the city as a whole; or the city region with its hinterland which is at the receiving end of the city's environmental footprint.

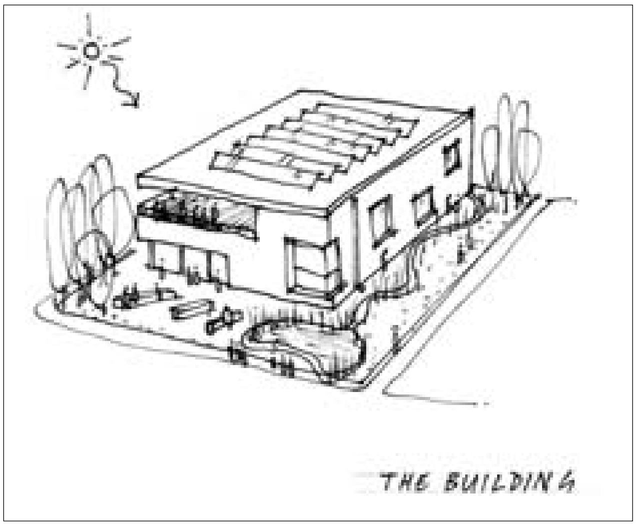
Impact of individual buildings and users on climate change

At the level of individual buildings, it may be possible to make normative assumptions about the effects of their energy consumption on the environment. Such equations are being produced for residential premises by many governments which are committed to reducing environmental impacts as a basis of their sustainability policies. For the purpose of this example, the cumulative or contradictory effects of individual buildings on climate change which entail another round of far more complex and uncertain assumptions and equations are omitted.



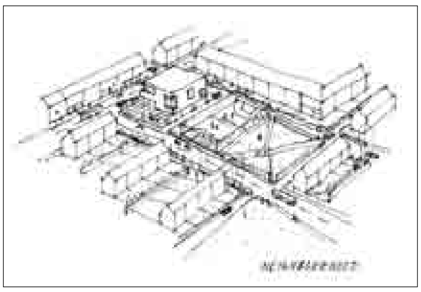
There are two sets of variables to consider which make up the combined effect of the built environment and its use on energy consumption and related pollution on climate change: the interaction of the building with the environment, and the behaviour of its users. A closer looks shows that even the impact of an individual building on energy use depends on a complex set of variables: geographic – climatic location of the building, the type of building and/or dwelling, its configuration, openings, level and type of insulation of each part of the building (roof, walls, windows, doors, level on the ground, etc), its energy consuming appliances and many more aspects. The other part of the equation is the behaviour of those who use the premises and how they consume energy. The number and types of users, the time of their presence in the building, the pattern of their energy use, etc. form part of the variables. A lot of assumptions are included in the assessment of the interactive behaviour of the dwelling and individuals using it. While the former may be considered relatively stable over a given, albeit relatively short period of time, the assumptions concerning the behavioural pattern of household energy use encompasses far more unknowns. This example illustrates the complexity of the even smallest unit of energy consumption in cities.





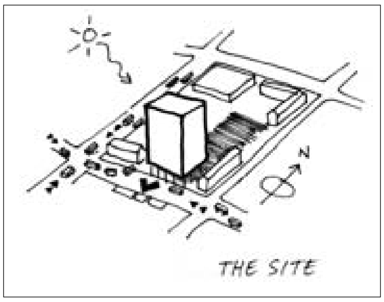
Impact of cities, their hinterland and ecological footprint on climate change

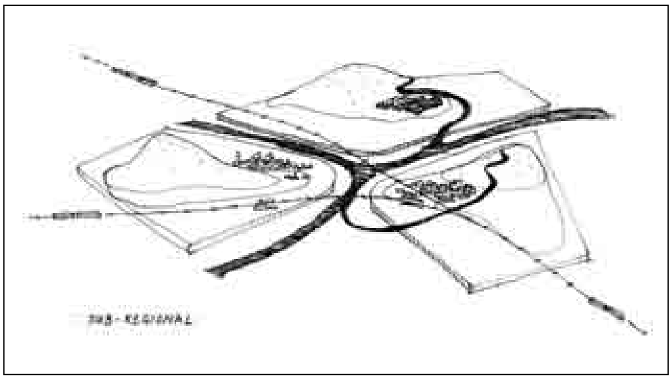
At the other end of the spectrum planners ought to identify, understand and possibly measure the effects of cities and their uses on climate change. Resorting again to the two main variables of energy consumption and pollution, a model could be constructed encompassing the key contributions to these two factors citywide. This would include all the buildings by type of use, spaces between the buildings, transportation corridors, natural features, etc., each with its pattern of uses and users. Moreover, these factors would have to be observed over



time, at different moments of the day, the weak, the seasons, as well as in the longer term. It would also have to take account of external changes in the economic, social, political and technological spheres, notwithstanding the transformation of the environment itself.

Considering just the complexity of citywide transportation models which aim to capture the contribution of the principal modes of transportation to energy consumption and pollution it is not surprising that not many attempts have been made to build such a model of ecological behaviour for a whole city region, let alone to calibrate and run it, and use its results to evaluate their effects on climate change. The complexity of such a model would defeat even a very powerful computer and the mathematicians who would have to program it. What this example aims to show is that the chances are slim to obtain even simulated scientific knowledge about the ecological impacts of whole cities. Moreover, any urban policy decisions have to, and do rest on other criteria, such as budgetary and political considerations. Nevertheless, the enormity or sheer impossibility of such a task should not prevent political decision makers or the professionals of the built environment from attempting to reach even an imperfect understanding of the ecology of cities and their consequences in order to act responsibly.





Scales of eco-designs: building materials, interior, building, neighbourhood, urban area, sub-region.
Author: Matt Bell CABE (Commission for Architecture and the Built Environment)

Action with imperfect knowledge

Waiting for the perfect understanding of cities is not an option when devising urban strategies. This is no different from dealing with climate change and sustainability generally. Action is needed now despite imperfect knowledge. Positions as regards knowledge differ between scientists and designers as the latter are involved in utilitarian activities, expected to produce designs for buildings and cities which can be constructed and used.

Scientific knowledge and vocational know-how

The question is how to establish the best knowledge base for decisions which tend to affect large parts of urban society and often have long term repercussions. Scientists approach such a problem with observation and analysis based on theoretical models. Unlike science, design is a vocational occupation. However, there are continuous attempts to develop architectural and planning 'theories'. Design uses rationality side by side with intuition, imagination and creativity. In this sense designers resort to a broad spectrum of instruments, including art, technology and economics, or rather husbandry – for imaginative, progressive city making and, nowadays, for the careful management of urban resources.

Akin to scientists, designers make assumptions, select specific approaches or models, follow various schools of thought or principles, as well as fashions or dictates. With the entrance of architecture, urban design and planning into university education during the 20th century, designers have been developing their own, albeit often hybrid 'theories'. Architectural theory has taken the shape, inter alia, of prescriptive and exclusive modernism, the Athens Charter, situationism, postmodernism, deconstructivism and no doubt other 'ism' to come. Planning followed the dual track of large scale architecture or the more abstract spatial allocation, distribution and management of activities, borrowing iterative and tautological modelling techniques by fitting reality to mathematics. In-between emerged urban design, originally weaving across the sectoral approaches of architecture and planning, but with ambitions to become a new discipline itself, dealing with the public realm, spaces between buildings, buildings as backdrop, urban landscapes and open areas.

Engineering and the social sciences also influenced designers. They drew on semiotics and linguistics to explain form, and on a-spatial urban sociology, environmental psychology and economic geography to understand the behaviour of urban communities. From structural and civil engineers who operate at the forefront of the knowledge base they borrowed iterative processes and empirical verification. However engineers are able to focus on more narrow material problems. For example, when venturing into unknown territory of hybrid materials for structures which have to accommodate mechanical forces, they studied the long term contradictory behaviour of creeping and shrinking of reinforced concrete from which they devised new pre- and post-stressed technologies.

Designers, like engineers, are doers not theoretical analysts, but they are faced with increasingly complex problems in the real world. Thus, spatial planners tend to borrow models and mathematical representations from the natural sciences to produce simplified conceptual tools. In planning, for example, gravity models were devised for urban transportation systems during the massive expansion of car ownership. In an effort to tame the polarising effects of the urbanisation process, Boolean algebra was borrowed to simulate computer based city networks. In architecture the golden section was inspiring ideal proportions, Euclidean geometry became the standard tool for traditional design representation, and homology was borrowed from biology for three dimensional modelling of urban design. Like all analogies, such transfers of models of thinking have limited veracity and may thwart practical solutions and empirical verification, and some critics have discarded architectural and planning theories as "scientism".

Regardless, the professionals of the built environment are constantly changing their approach to the design of buildings, urban development schemes and whole cities in the light of new findings. For example, reacting against the shackles of modernism, and following ideas in philosophy and literature, some designers started to embrace the eclectic approach of postmodernism "where everything is possible and almost nothing is certain" which invaded schools of architecture and design studios alike. In the belief that computer technology is capable of providing a universal fix they defied the laws of gravity. They designed dreams which found their way into architectural magazines, while leaving the built reality and the effects of economic cycles to the material world of developers and the construction industry.

What design and science have in common is that controversy, chaos and threats are likely to generate innovative ideas. While scientists are seeking further solace in new theories, designers tend to resort to art, technology and economics.

Realistic representation of the "City – Climate Change" interplay

There is an obvious need to converge numerous fragments of understanding in order to make sense of cities, how they interact with nature and their effect on climate change. Back to basic principles, cities are physical spaces created by, and accommodating activities driven by socio-economic forces which, in turn, are constrained by the built environment. These interactions may be intelligible up to a certain scale – human? – Planners tend to simplify their conceptual framework by selecting stable and predicable patterns to represent assets and weaknesses of cities as a basis for policy formulation and implementation. Beyond a certain scale, the complexity of cities defies rational explanation and understanding by conventional analytical tools. Clearly, new models of "thinking the city" are needed.

Manuel Castells' idea of nodes and flows is one way out of the static perception of cities, traditionally reinforced by the representation of separate aspects of the built environment in two dimensional plans, fragmented into different activities, housing, workplaces, retail and leisure facilities, etc, transportation and traffic, together with succinct plans of the spatial distribution of socio-economic data, such as population, economic activities and income levels.

Leaving aside mathematical modelling of cities, progress in computing has provided unprecedented tools of dynamic representation. Designers tend to use the visual capacity of computers to zoom into sites from above and tilt the images to obtain bird's eye perspectives as a basis for their designs. However, even such views are collapsed into the two dimensions of the computer screen and cannot translate the multiplicity of activities going on in cities, nor dynamically capture them in time.

Other tools are needed to represent the various states of cities and capture both static elements and those in constant flux or oscillation, as well as steady trends and unpredictable events which are throwing cities and their activities out of balance, time and again. In this context the relation between cities and climate change is an important issue. In recent and widespread changes of planning legislation climate change tends to be incorporated into wider sustainability objectives.

Sustainability, the way forward?

The question is whether sustainability is a substitute for environment-friendly urban development, capable of attenuating adverse effects of cities on climate change. Often cities - seen as parasitic spaces which concentrate and worsen adverse trends - epitomise unsustainability. This point of view corresponds to a static conception of sustainability, whereby human actions are environmentally neutral.

$$I = P \times C \times T$$

(P: population; C: level of consumption; T: level of technology; I: remains constant)

However, historically, environmental disasters tended to affect risk averse societies most and socially no such situation has lasted or can last indefinitely.
Thus the key to sustainability is innovation and readiness for change. In this case, cities are considered as places of innovation and change. As efficient drivers of the global economy they foster creative initiatives which generate technological inventions, including for the ecological management of the built environment. In this view the city is the natural home of sustainability.

If sustainability is defined as "economic conditions linked to resources capable of maintaining a specified level of wellbeing by unspecified means", cities are the privileged place of sustainability. However, the concept of sustainable development is ideological. The media tend to adopt an alarmist approach to climate change, but the middle classes, alongside various international stances were reacting against the adverse effects of urban growth by encompassing the quality of the environment in their perception of wellbeing.

Resorting to technology and economics

Corroborated by the enlightenment, humans adapted the environment to their wants instead of adapting themselves to its limits, extending them through economic growth and technological innovation to avoid collapses. This position expects technological fixes to overcome the problems of climate change without curbing consumption or lowering living standards, but by changing the resource base instead to survive. Innovation, both technological and economic, is a precondition of redressing diminishing returns of human exploitation of natural resources while maintaining the level of wellbeing. Such a process changes social structures and cultural values, not the reverse. This view does not endorse the possibility of behavioural change due to other motivations, including altruism, idealism or the power of convincing arguments to separate production and consumption processes from non renewable resources. There are no absolute limits to the growth of development models which imply major consumption of resources. The only limits are the social system on which each mode of production is based. When demand exceeds environmental capacity, the social system self-regulates either by adjusting demand to the limits, or more likely by adopting innovations to change the production process which changes the social system in turn.

Technological innovation can either increase the efficiency of the use of resources, or diversify the sources of resources and use hitherto unexploited resources [e.g. nuclear power]. This reflects a dynamic concept of resources and puts into question the notion of carrying capacity. Moreover, if mainstream behaviour is forced into such a static system, it tends to engender dysfunctionality and disobedience. The fallacy of indefinite static carrying capacity in this argument is that it prevents progress, increased wealth and wellbeing which advanced societies have generated over the last 150 years at an unprecedented intensity and speed. They are proof of the need of a pertinent economy and scientific and technological development as precondition of exploiting resources with increasing efficiency and ingenuity.

History shows that uncertainly has been the motor of innovative change, not wilful intentions. Cultural, ecological, mental and political diversity are the basis of human progress instead of imposed objectives as they provide greater chances to achieve substitutes of modes of production which have reached their limits. Thus the future is a desirable risk and dealing with it by resorting to economic and technological innovation stands the best chance to achieve dynamic sustainability.

Sustainable urban strategies

There exist five basic options of development strategies for cities which relate to dynamic sustainability, keeping in mind though that each innovative strategy resolves some problems while creating new ones. They do not amount to urban models and simply create the conditions for cities to evolve in response to changing conditions. Although innovation is unpredictable it is important to identify the necessary conditions for it, such as inventive individuals or groups, social processes capable of responding to change, initiating change as sole possible response to disaster.

OPERATIONAL CITIES

Urbanism as a tool of transformation of the city is an instrument of sustainability in itself, it is a source of innovation and change, and of stimulation. Sometimes, spaces of innovation seem to be concrete places, privileged environments which bring together specific conditions, Change and novelty is something which happens on other sites.

How human communities perceive themselves is one of the decisive factors in the emergence of innovation, and in their decisions and abilities to steer their destiny. Groups which perceive themselves as creative and in which new things occur is socially acceptable behaviour. They are the ones which have the best opportunities to overcome environmental and social conflicts. The processes of urban transformation, of introducing new elements which did not exist before, the arrival of new equipment and infrastructures and new forms of living in the city refer concretely to the fact that the possibility transforming itself is at the reach of everybody. All the need is the will to do it. Urban and spatial transformation are a challenge against resignation and stagnation which distances us from sustainability. In particular, the systems which enable citizens to intervene actively in the creation of their city and to grasp the opportunities to change its environment are most efficient in terms of a culture of innovation which enables them to establish the necessary conditions of sustainability.

RECYCLABLE CITIES

A large part of conflicts which keeps us away from sustainability and which produce situations of scarcity and exhaustion of resources are not so much that new options of development are undesirable but the way we adapt and pretend to maintain existing ones. This in itself is an unsustainable process. What generates innovation is the possibility to change and diversity our relation with our environment, yet nothing will work if instead of a strategy of substitution we opt for simple accumulation. The capacity to recreate our cities, maintaining what constitutes their personality, and to identify coherently the necessities and circumstances of each moment is an essential principle. Contrary to a museum city it is important to opt for a lively city which flows and transforms itself without dropping its identity or usefulness, although this may be considered less valid. The city of the future is built on the city of the past, without the latter having to disappear but being transformed instead. Innovation adapts the past to the new as well as integrating the new in the traditional past. Both the future and the past form constantly part of the present, mediating memory with intention which constitute the tools of sustainable development.

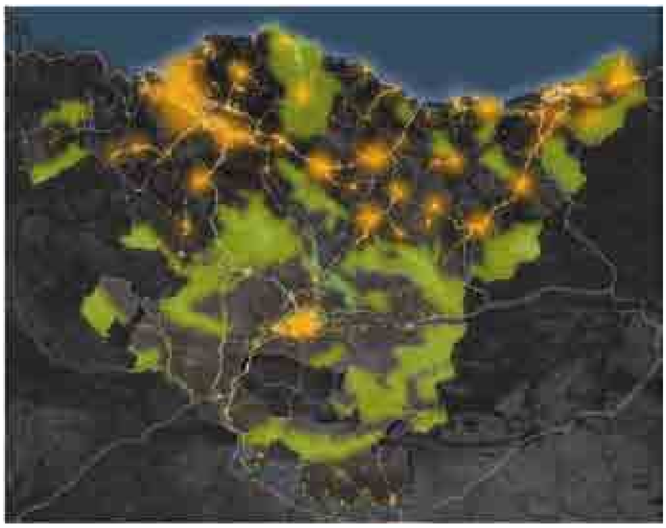
BEAUTIFUL AND ATTRACTIVE CITIES

Formal aesthetic and sensitive aspects of cities are often derided as secondary, superfluous or wasteful. However, the city as a pleasant experience is an important factor of sustainability and innovation. The beauty of a city is the expression of social optimism required to achieve more likely future wellbeing than without these values. It supposes essential sociability to overcome risk aversion which constitutes a handicap to innovation. The city as an attractive setting reinforces its unity and provides distinctive landmarks. It invokes a collective illusion of a common project, a prerequisite of a future which expresses a social system of different values, reflecting individual expressions as well as collective desires and material enjoyment. It creates an incentive to attract foreigners who introduce new ideas and information, opening the city to the contrasts and diversity which are the foundation of innovation.

INTEGRATED, OPEN AND POLYCENTRIC CITIES

Isolation, conservatism and lack of tolerance, the trend to adapt, to do things as they were always done is the prime obstacle to innovation and the most important factor acting against sustainability. Conversely, the city constitutes a space of interchange, communication and openness to novelty. The model of the sustainable city is the one which contributes at facilitating the emergence of these characteristics. Desirable urban spaces facilitate diversity of uses, activities and persons, instead of spatial segregation of uses and social groups. The feeling of belonging and collectivity, social cohesion, the possibility to establish contacts with other, different from us, with curiosity as something potentially enriching are essential concepts of sustainability which urbanism can put in our reach.

While seeking heterogeneity for each urban environment it is necessary to avoid global homogeneity. The city has to give rise to internal diversity, the possibility to divide into various distinct spaces without losing its unity, minimise the need of displacements while maximising their potential. Creating various areas of centrality, diverse urban environments and development potentials will generate growing complexity of urban functions and activities which take place in the city. The higher the complexity of the different initiatives, the more diverse their participants, the richer and more probable innovation will be. Increased variety of spaces will lead to greater distinctiveness and shapes. Such cities constitute a pluralistic system with a large points of departure, and increased probability to produce sustainable solutions.



From polycentricity to networked settlement structure:
regional strategy, Basque Country,
Fundación Metropoli

CITIES IN SYMBIOSIS WITH THEIR HINTERLAND

The city is not an independent place. Quite the reverse, it configures and defines the space in which it is situated. While the boundaries between the urban and the rural are increasingly blurred, nature no longer exists as such as it is [its boundaries are] continuously transformed or determined by human activities.

From concept to implementation: Eco-design

No matter how many conceptual frameworks can be construed with the sustainable city in mind, designers have to face the real world and experiment with these concepts, by trial and error. Examples are shown which have been implemented by designers who apply sustainability principles, and applications developed at the Fundación Metropoli. They range from single buildings to whole regions.

Eco-Buildings, Eco-Neighbourhoods

The purpose of climatic ecological design is to change behaviour of consumers from the bottom up into a more sustainable way of life. The problem is to get started at individual level. Such far reaching changes are difficult to implement and require also top down leadership, considering that the impact of individual sustainable action is often perceived as negligible and needs to be traded off against loss of comfort, convenience, habits while convincing people that their individual quality of life would thus improve.

Pictures of Ecobox and ecological design principles, under construction and finished building

The Sustainable Cities initiative in the UK has consolidated a number of sustainable design principles ranging from building materials to city regions and national sustainable strategies for sustainable development.
Designers have started a long time ago to experiment with, and produce ecologically designed buildings, and even whole urban quarters. Certain design principles have been drawn together from such experiments.

Community initiated ecocity Vauban, Freiburg Germany, aerial view, finished buildings and car free pubic realm

Sustainability by design principles

A consensus emerged internationally among ecological urban designers that 'sustainability by design' in urban areas had to fulfil a certain number of principles. In the UK the Urban Design Group and the Commission for Architecture and the Built Environment developed such criteria and tested them on a number of real places by commissioning university research.

- Character:a place with its own identity
- Continuity and enclosure: a place where public and private spaces are clearly distinguished
- Quality of the public realm: a place with attractive and successful outdoor areas
- Ease of movement: a place that is easy to get to and move through
- Legibility: a place that has a clear image and is easy to understand
- Adaptability: a place that can change easily
- Diversity: a place with variety and choice.

The Fundación Metropoli has devised its own version which it applied to its eco-city designs.

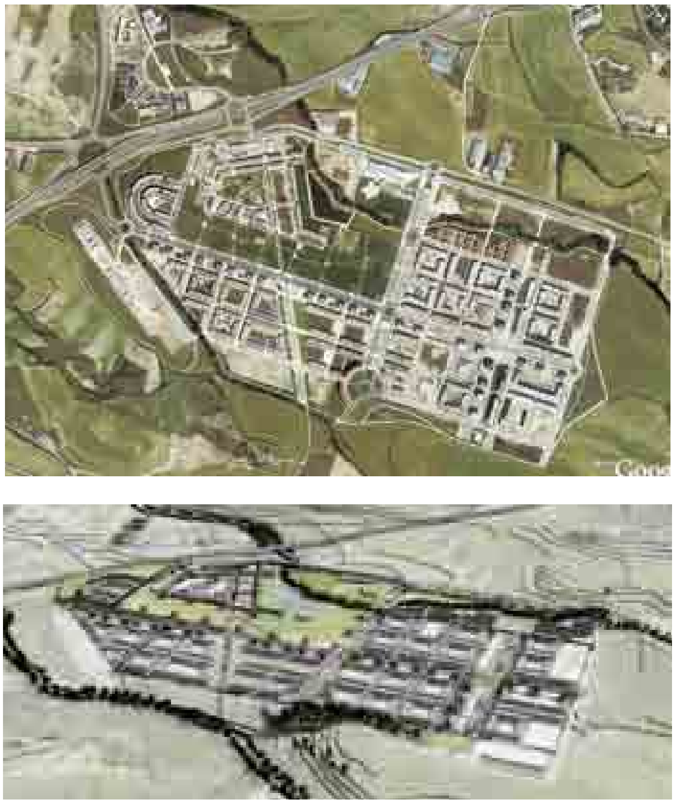
- compactness and sustainability
- shared mobility, public transport
- responsive dialogue with surroundings
- public realm, places of encounter
- combining living, working and leisure
- architectural diversity
- social cohesion, communal infrastructure
- bio-climatic architecture and urban design
- integration of new technologies
- identity of place.

In conclusion, the eco-dimension of ecological sustainable building is an example of the need for innovation in terms harnessing new materials, or new ways of exploiting existing materials, and of innovative building technology generally.

Eco-Cities, Eco-Regions

In recent times designers have started to include sustainability principles in urban development and management more generally. The Fundación Metropoli has compiled100 keywords to characterise eco-cities and designed a number of eco-cities applying these principles. Examples are: Vitoria-Gasteiz, Aranjuez, Aviles, Arte, the eco-linear city of Fengxian in Shanghai China and many others are under consideration. The eco-city of Sarriguren in Pamplona where the ten principles have been applied as performance specifications is being built and has just obtained the 7th European Urban and Regional Planning Award 2008 from the European Council of Spatial Planners (ECTP).

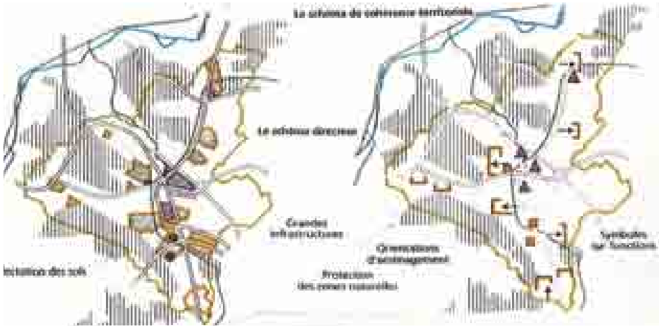
Drawing on existing scientific knowledge and design experience, designers have resorted also to other sources of inspiration to develop their own analytical and sustainable design tools. The arts were always close to architectural design, but many planners and urban designers started to work with artists more closely, not just as an add-on but increasingly during the conceptual phases of projects, with special attention to the public realm to which artists contributed innovative ideas and proposals for inclusive uses. Having an important technical content, both architecture and planning are constantly



Sarriguren, Pamplona, model and aerial view of built ecocity
Fundación Metropoli. Prize ECTP 2008

exploring and adopting new technologies, for design, as well as management and handling of information.

The planning world had to evolve in the light of globalisation. While budgets were always a consideration in concrete projects, sustainability principles elaborated by some branches of economics have also become a contributor to contemporary planning and design. Aware of the greater role of cities in international competitiveness, planners devised ideas of city networks and increased cooperation at regional level. This implied new systems of governance with light structures for voluntary joint ventures, involving the private and social sectors. Some countries incorporated this new, more flexible approach in planning legislation.



SCOT: (schema de coherence territorial) land use plan and new regional sustainable development plan: Plaine de France, Paris region, north.

Supra-regional strategies

Fundación Metropoli was an early pioneer of large scale strategies for spatial development in cooperation with city and regional governments. Over almost two decades it has been actively involved in development strategies for the Basque Country as a whole, using the strength of its complementary city network as basis for innovative development based on sustainability principles. As a consequence, Fundación Metropoli has been asked to contribute to regional development strategies of other Spanish autonomous regions: Galicia, Cantabria, Castilla Leon, La Rioja, Extremadura, Murcia, The Regional Authority of Valencia, The Baleares Islands, parts of Asturias, parts of Catalonia, as well as Alicante and other functional areas.

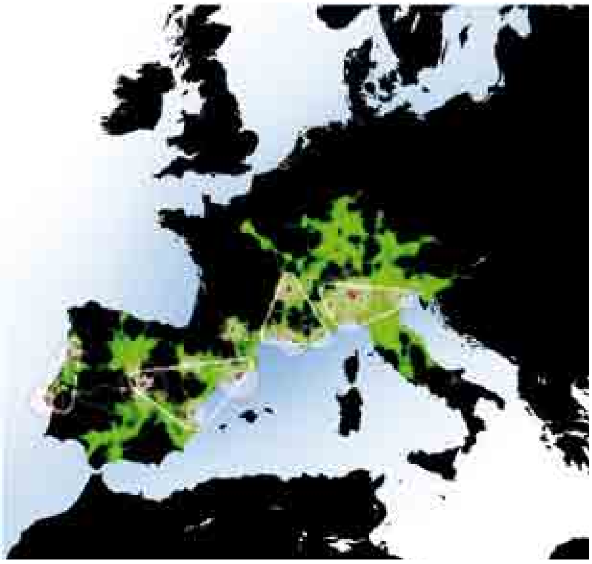
Landscape strategy Haro, La Rioja Spain, ecological regional development, Fundación Metropoli

Ecocity Vitoria Futura
Fundación Metropoli

In the light of these experiences, it was felt that there was a need to develop conceptual spatial development strategies at an even larger scale, in Europe beyond national boundaries.

Building the European Diagonal

More than fifty yeas ago the United States were first to establish extended urban regions with networks of cities, in the north east from Boston to Washington. They later extended the idea to nine other mega-regions, culminating in the 'America 2050' spatial concept. In Europe, the sole region of urban concentration capable of global competitiveness was considered the north-west, initially labelled as the 'red banana' which has become the 'pentagon', encompassing the largest metropolitan areas of London, Paris, Hamburg, Frankfurt, Brussels and Milan. Considering the growing leadership role of cities and urban concentrations which structure and organise the world economy, it was felt that the economic dynamic of southern Europe could be exploited more effectively in a broad network of cities ranging throughout southern Europe and branching out through cultural ties to Latin America, North Africa and the new expansion of the European Union to the east. Increasingly linked by transportation networks by air, high speed rail and roads, as well as by virtual communication networks, a common open mentality and a café society lifestyle envied by the north, the cities located in the Diagonal can benefit from pooling their knowledge of urban development and undertake common innovative strategies for a sustainable future by harnessing common assets.



Map of European Diagonal with 'Diamond's
Fundación Metropoli

The Fundación Metropoli took the initiative to explore the various opportunities open to key cities in the European Diagonal of knowledge creation and sharing, especially in the field of large scale sustainable spatial development in the light of the rapid economic expansion of this region. Seeking the cooperation of the leaders of these cities, without whom none of these ideas could be implemented, the mayors of five key cities subscribed to this idea which will be further developed with other city leaders through the notion of 'urban diamonds'. They will constitute smaller city networks, in Spain Madrid, Barcelona, Valencia, Zaragoza and other intermediary cities in that region. Together, their city governments, research institutions, development industries and green funds can launch concrete sustainable projects and shared experimentation of innovative spatial developments to harness potential synergies. Such networked cooperation corresponds to the principles of the European Spatial Development Strategy which is being endorsed in most European Union member countries. Sustainable development is a key issue for the southern Diagonal which is facing common ecological problems of desertification, drought, sea erosion, lack of indigenous energy sources and seasonal tourism with unsustainable impact on infrastructure and the natural environment. Benefiting from a large number of days with sunlight, they have great potential to undertake large scale projects of alternative energy generation supplying whole cities and thus can make a major positive contribution to climate change.

Integrated models of thinking

All these experiments with ecological principles and design, ranging from the scale of an individual building to metropolitan areas and whole city regions pointed to the need for new integrated models of thinking beyond formal design and planning. They require a holistic approach which forms the basis of the mission of the Fundación Metropoli.

Advancement of sustainable design by the Fundación Metropoli

The mission of the Fundación Metropoli is research, innovation and incubation in the field of the built environment. Its research ranges from advanced architecture to spatial development strategies for cities and regions. Its explorations focus on innovation as driver of sustainable development. In putting projects, networks of collaborators and funding organisations in synergy it participates in incubation and experiments with innovative ideas on the ground. To this effect it developed research methodologies, innovative 'agencies zero' anterior to implementation and a number of conceptual frameworks, especially for large scale sustainable development processes and it furthermore contributes to their dissemination in educational institutions.

Diagram of Fundación Metropoli strategy: research, innovation, incubation

ProyectoCITIES Methodology

The Fundación Metropoli has a long track record of creating and sharing knowledge about cities. It developed its own interactive analytical tool, the ProyectoCITIES methodology, to draw on knowledge embedded in the practical world.

The basic aim of the ProyectoCITIES methodology is to identify the competitive advantages of cities, and to reveal the unique profile of their urban realm, expressed as components and clusters of excellence. It was devised to identify the competitive advantages of cities and reveal their context-specific profile on which to base future design policies of innovation and creativity. Its originality lies in the interactive identification of combined quantitative and qualitative characteristics.

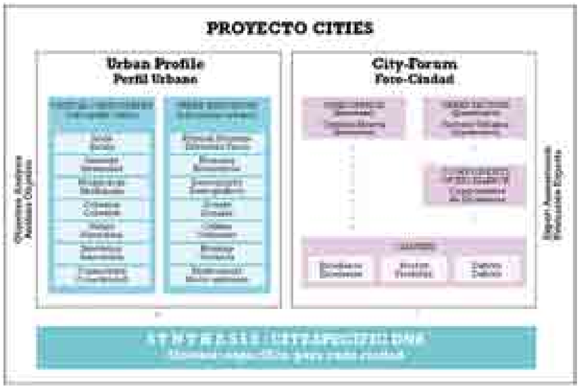
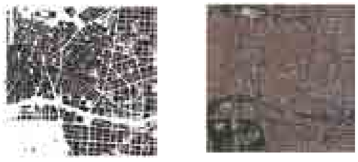


Diagram of ProyectoCITIES methodology, Fundación Metropoli

The methodology consists of two interdependent parts: the Urban Profile and the City Forum. The Urban Profile is identifying urban indicators and representing them in critical cartography with special attention to physical attributes. The interactive City Forum involves key players of the respective cities who identify their urban innovations which encompass economic, socio-cultural, governance and environmental aspects to identify the physical and functional structure of the city, urban society, local economy and governance. During brainstorming sessions and by means of extensive questionnaires and semi-structured interviews, they also address deficits and give their expert opinions about the future of their city.

More specifically, the urban indicators provide objective measurements which substantiate the urban reality of each city. They include data and trend extrapolations which quantify the physical, economic, demographic, socio-cultural, institutional, governance and environmental factors of a city. They complement the interpretative cartography and the factual information provided by the members of the City Forum which, in turn, form part of a more comprehensive weighted interpretation of the selected urban components of excellence and their cohesive clusters. Critical cartography captures the mutual influences between the physical form and structure of cities and their economic competitiveness, socio-cultural characteristics and environmental sustainability.

Critical cartography produces a set of interpretative graphics to clarify the underlying structure of cities and their metropolitan regions. The building blocks of critical cartography are scale, intensity, morphology, cohesion, nature, connectivity and positioning of innovative activities in cities. The aim of these representations is to reveal the distribution of urban activities, as well as the structural and spatial relations between different parts of the city. Critical cartography is also used to represent non physical factors, such as demographic, social and economic characteristics and to identify their spatial distribution, cohesion, inequalities and fragmentation at a glance. The diagrammatic nature of these graphics is able to project a synthetic perception of essential urban features, highlighting both assets and constraints.



Example of figure ground plans and aerial views
Madrid, Fundación Metropoli

The city specific 'DNA' - the unique profile of each city - is extracted from synergy between all the inputs generated by the ProyectoCITIES research. A synthesis combines results of the Urban Profile and the City Forum into "components of excellence". These urban elements qualify the characteristics of each city which make them attractive or successful from an economic, socio-cultural or environmental point of view. Special attention is attributed to the urban components which impact the physical form or structure of the city. From this empirical knowledge Fundación Metropoli devises "clusters of excellence" and strategic development priorities as a basis of innovative competitive policy formulation and spatial design to enhance them. Responsiveness to the outside environment, including climate change is an essential feature of the cities' DNA.

The ProyectoCITIES methodology has been applied successfully to over 20 cities located in five continents. It is being refined continuously and used in all the real live projects initiated by Fundación Metropoli in Europe, North Africa, Mexico and Latin America. This comprehensive body of knowledge, shared with over thirty cities from five continents formed the basis of a new integrated model of thinking. It is now finding its expression in the broader concept of ecosystems of innovation.

From innovation hubs to ecosystems of innovation

The Fundación Metropoli has been devising ideas of innovation hubs as drivers of urban, regional and supra-regional networks for some time. It is now exploring the notion of integrated ecosystems of innovation which go beyond statutory planning to deal with uncertainty, risk, turbulence, environmental impacts and general long term trends of evolution. This approach differs from both linear top down planning procedures and discrete isolated development projects. Aware of the contradictory nature of most development processes it resorts to systemic thinking seeking synergetic effects. It harnesses both opposition and tension, as well as dialectic interaction generating mutual benefits.

Current thinking at the Fundación Metropoli is addressing the concept of urban 'ecosystems of innovation'. It postulates that global competitiveness relies on an ecosystem of innovation in which cities play a major part. More than polycentric city cooperation, ecosystems of innovation are federating the key life forces in city regions to foster innovative processes in the knowledge economy, as well as in governance, operational institutions and sustainable development. The characteristics of urban ecosystems of innovation are currently being tested against a number of case studies from four continents.

A cluster of characteristics is already emerging in cities which act as ecosystems of innovation. They encompass life long learning, support of science and technology, attracting and fostering innovative production and services, evidence based policies, tailor-made institutions capable of dealing with change including innovative funding organisations, a competitive setting for trade, cultural excellence and a fertile ground for the arts. Most importantly, they also include a high quality sustainable urban environment, a public realm for civic expression, freedom of speech and tolerance, together with a welfare system for the inhabitants, public accountability and ethics which secure social order, safety and security, as well as openness towards, and networking with the world as a whole.

The study of cities which have been successful in regenerating themselves through sustainable innovation show that the notion of ecosystems of innovation applies to different urban scales. It can relate to initiatives in specific locations of intense innovative processes, such as science parks or experimental laboratories. The city can act as an ecosystem itself, and whole city regions can constitute ecosystems of innovation. What unites these experiences at different scale is that their long term perspective includes sustainability principles. These findings have repercussions on existing urban fabrics, their planning and the nature of governance in charge of spatial development. Work is in progress on these issues at the Fundación Metropoli which is always seeking to share its experimentation with other individuals or institutions aiming at similar long term sustainable objectives.

Judith Ryser, Gabriel Escobar, Madrid September 2008

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