



Megacities - *our global urban future*

Earth sciences for society

Prospectus for a key theme of the International Year of Planet Earth



www.yearofplanetearth.org



What is this brochure for?

This brochure is a prospectus for one of the main scientific themes of the International Year of Planet Earth.

It describes, in accessible terms, why this particular theme has been chosen - why the research that the Year hopes to support under this theme is of such vital importance to our understanding of the Earth System, and to society at large.

The prospectus was written by a panel of world experts assembled by the Science Programme Committee of the Year.

To find out more...

To find out about the other research themes being pursued, please consult www.yearofplanetearth.org (where all our publications can be found).

What to do next...

If you are a scientist wishing to register initial interest in possibly making a research proposal under this theme, please go to www.yearofplanetearth.org download the appropriate Expression of Interest (Science) form, and follow the instructions on submitting this to the International Year.



By 2015 the world may contain

as many as 60 megacities,

housing more than 600 million people

Emerging urban dimensions

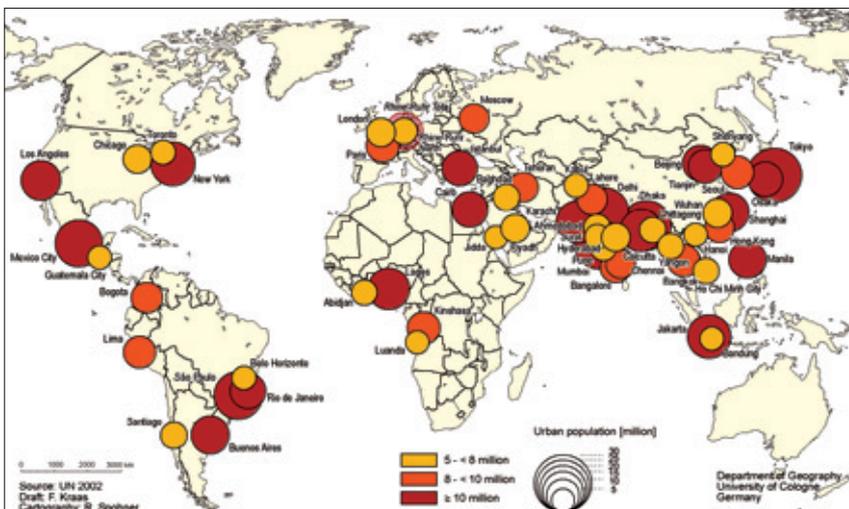
In 1950 30% of the world's population lived in cities. In 2000 it was 47%. By 2007 3.3 billion people - more than half of the world's population - will be living in cities. The total may even reach 60% by 2030. Such rapidly increasing urbanization, particularly in developing countries, creates many opportunities and challenges.

"Megacities" are defined as urban areas with more than five million inhabitants. Scientists estimate that by 2015 the world may contain as many as 60 megacities, together housing more than 600 million people. They are where much of the worldwide process of urbanization is taking place.

This brochure sets out how teams of geographers and Earth scientists can contribute to a better understanding of megacities, with a view to improving their management and hence attain a greater degree of sustainable development. This requires wise use of human and natural resources while, at the same time, reducing the risk megacities pose and enhancing the quality of life for all those who live in, or are impacted by, megacities.

Megacities are more than just large cities. Their scale creates new dynamics, new complexity and new simultaneity of events and processes – physical, social and economic. They host intense and complex interactions between different demographic, social, political, economic and ecological processes. Megacities undergoing economic boom times often generate considerable opportunities, as well as strong pressures for change accompanied by environmental degradation. In the developing world, megacities grow faster than their infrastructure. This uncontrolled urban sprawl can foster high traffic volumes, high concentrations of industrial production, ecological overload, unregulated and disparate land and property markets, insufficient housing development and, in some cases, such extremes of poverty and wealth living side by side that social unrest may follow.

Map of Megacities worldwide in the year 2015.



Who is behind the International Year?

Initiated by the International Union of Geological Sciences (IUGS) in 2001, the proposed International Year of Planet Earth was immediately endorsed by UNESCO's Earth Science Division, and later by the joint UNESCO-IUGS International Geoscience Programme (IGCP). The Year also boasts a large number of Founding Partner institutions, which are listed on the inside back cover.

The main aim of the International Year - to demonstrate the great potential of the Earth sciences to lay the foundations of a safer, healthier and wealthier society - explains the Year's subtitle: Earth sciences for society.

Megacities are foci of global

risk and opportunity

Megacities contain a rich mix of coexisting people. There are commonly groups with their own distinctive ethnic, community, cultural roots, lifestyles and social milieux. Differences in economic development, social polarisation, quality of infrastructure and governance must be recognised and taken into account.

Such scale and dynamism, coupled with complex interacting processes and the sheer concentration of human capital make megacities incubators of huge growth and innovation. They are the focal points of globalisation as well as the driving forces for development; they harbour a wide spectrum of human skill and potential, creativity, social interaction and cultural diversity.

Megacities are also foci of global risk. They are increasingly vulnerable systems because they often harbour pronounced poverty, social inequality and environmental degradation, all of which are linked together by a complex system supplying goods and services. People from different socio-economic groups and corresponding political allegiances may become segregated geographically, creating disparities and conflict. Population density increases vulnerability to natural and man-made hazards. Thus, megacities, exposed to the global environmental, socio-economic and political changes to which they contribute, are both victims and producers of risk.

For many megacities, inadequate representative governance inhibits spatial planning, building control, the delivery of services (such as water supply, sewage disposal and energy distribution), and the establishment of general order (including security and disaster prevention). Existing administrations and their organisational structures may have been outgrown by the rapidly expanding city and may simply be unable to cope with the huge scale of their new responsibilities. In addition, of course, informal processes and activities can take on an important role in the development of megacities.

Megacities are ideal places for social, Earth, environmental and medical scientists to investigate the impact of socio-economic and political activities on environmental change and vice versa, and to identify solutions to the worst problems. For these reasons, megacity research has the potential to contribute substantially to global justice and peace – and thereby prosperity.



- **Quality of life for many residents in megacities is commonly low - for rich and poor alike** ●

Improving quality of life

‘Quality of life’ depends on individual perceptions, attitudes, aspirations and value systems. These differ with age, ethnicity, culture and religion, as well as lifestyles, education and cultural background. An individual’s priorities and attitudes to life depend heavily upon socio-economic background and cultural environment. Historic places, cultural sites or public spaces may give megacities a certain unique identity, heritage, and authenticity. As a result, such spatial capital contributes to social cohesion and makes people feel at home.

Nevertheless, quality of life for many residents in megacities is commonly low - for rich and poor alike. Air, water and soil pollution, water and energy supply shortages, traffic congestion, environmental health problems, limited green spaces, poverty and malnutrition, social security and public safety problems place many burdens and restrictions on people.

In the megacities of the developing world, city planning needs to adapt to diverse socio-cultural circumstances by including the often widespread and dynamic informal activities that enrich such communities. New visions and innovative management tools are now needed in order to enhance quality of life in an intercultural context.

Different population groups can help create different urban settings and quarters within megacities, with their own distinctive spatial features, problems and options relevant to urban planning and governance. The identification of “hot spots” of urban problems (such as insufficient water supply, poor health care or inadequate public safety) is important in planning strategy. In addition, such hotspots may influence economic activities in the private sector and encourage public participation. Power relations (those between different decision-makers and other ‘drivers’ involved in the process of city development - including national or local administrators, foreign or native investors, non-governmental institutions, citizens, etc.) are reflected in architecture, urban design or spatial access, and so have a bearing upon questions of spatial exclusion and social coherence.

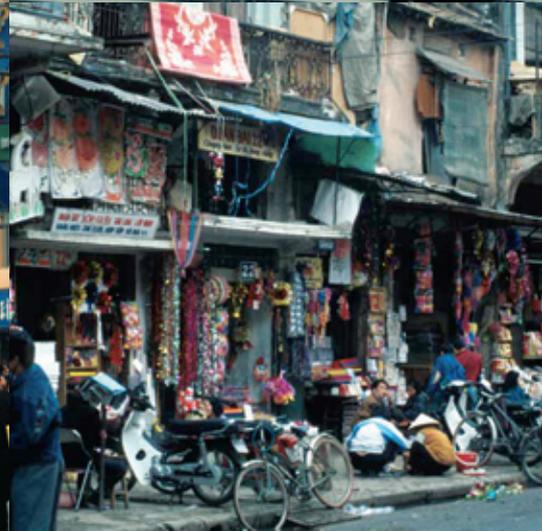


“Sustainable development”

The term ‘sustainable development’ came from opposition between those who supported policies preserving the ‘sustainability’ of the Earth’s environment and those who advocated economic development. Environmentalists acknowledged that economic development was necessary (in part to avoid imposing the costs of environmental protection on those least able to afford them) but also because economic stagnation often reduces support for environmental protection efforts.
(continued...)

Key research questions (1)

- a) What do residents of specific megacities understand by quality of life and what are their particular concepts, desires and needs?
- b) What are the formal and informal drivers and pressures behind planning processes? Who has the power to decide on priorities, funding, and options? Is that power legitimate?
- c) How can “quality of life” be monitored, taking into consideration the uniqueness of values within socio-cultural systems?
- d) How will megacities become more competitive, creative and attractive human environments, as well as safer places for people to live?



● **To be sustainable, development**

must be treated as investment,

not consumption ●

Sustainable megacities

How can we achieve more sustainable and safer megacities that make more balanced use of resources?

Megacities require human and natural resources for energy, industry, construction, infrastructure and maintenance. Megacities need these in quantities that have severe impacts both locally and globally – a megacity's so-called "ecological footprint". The success of a megacity is likely to be measured in terms of its economic productivity, social equity and environmental diversity; the latter, which involves diverse land use as well as natural and artificial biotopes, renders megacities attractive and more stable. However, the consequences of success and of high population densities include pollution, energy consumption and waste. These lead to local and wider global environmental impacts that need to be carefully understood, managed and often reduced.

Megacity sprawl commonly encroaches on areas with difficult ground conditions, subject to geohazards, such as flooding or landslides. This makes both initial development and long-term maintenance more expensive. The effects of global environmental and socio-economic change can magnify the risks and impair quality of life for many people.

Increasing population density can give rise to increased risks to people and property in the face of environmental and man-made hazards. Vigorous economic activity generates individual and societal prosperity and material well being (although often at the price of greater personal, social and environmental stress). However, in times of economic downturn, the consequences of unemployment, loss of social cohesion, collapse of social security and environmental dereliction, can be dramatic for large and concentrated populations.

To be sustainable, development must be treated as investment, not consumption. Only in this way will capital be available for future re-investment. Authorities must control the fabric and land use patterns within a megacity to minimise adverse environmental effects - both for the city itself and the hinterland upon which it depends. This requires integrity in resource, logistics (traffic) and waste management, with cost-effective recovery of value, recycling of wastes and materials, and, as far as practicable, reduction of risks to health.

Likewise, those who advocated economic development recognized a parallel between the protection of environmental endowments and the concept of protecting capital in a sustainable economy. A viable economy must live off its income without a net reduction in capital over time. Similarly, a population must live within the carrying capacity of its ecosystem, which represents a form of natural capital.

An aerial photograph of a city skyline, likely New York City, showing numerous skyscrapers and a construction site with a red crane in the foreground. The sky is blue with scattered white clouds. A solid red vertical bar runs along the left edge of the image.

Outreach Programme

The Outreach Programme of the International Year is faced with a particular challenge of scale. With a potential \$10m to spend, it is inconceivable that it could operate in a prescriptive way. No individual or committee can think of enough wise ways of spending such a sum globally. So the Outreach Programme will, like the Science Programme, operate as a funding body, receiving bids for financial support - for anything from web-based educational resources

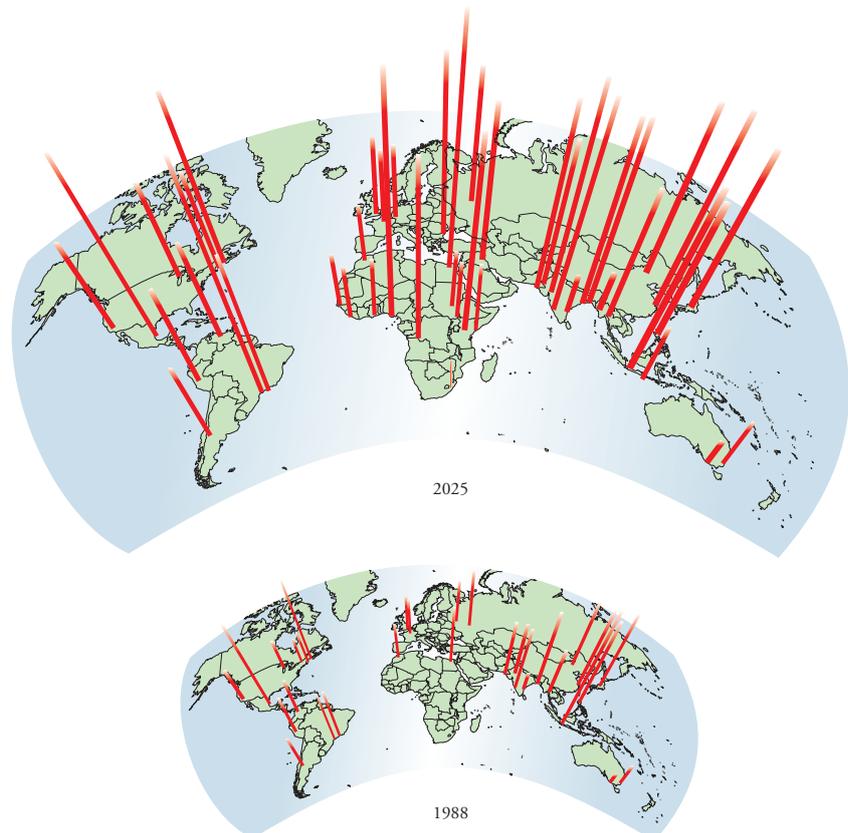
to commissioning works of art that will help reinforce to the general public the central message of the year. It will enable things to happen locally under the umbrella of an international scheme, lending profile and coherence.

A special Outreach Prospectus in this series (number 11) is available for those who are interested in applying for support.

Key research questions (2)

- e) Is it inevitable that expanding megacities will generate an increasingly disproportionate ecological footprint?
- f) How could better urban design, construction, maintenance and management practices reduce this footprint?
- g) Which drivers and pressures in megacity development contribute to, or hinder, more stable, efficient and sustainable development? How can the interaction of administration, private sector, public and informal activities be improved?
- h) Can megacities provide greater internal efficiency than smaller cities if they are planned and managed properly, or are they inherently unsustainable in the longer term? How can life in a highly urbanised area be made as sustainable as life in a sparsely populated rural area?
- i) In what ways are the sustainability and quality of life of megacity residents impaired or improved compared with residents in other areas? How can adverse trends be reversed? How can risks be reduced to an acceptable level?

Megacities and population growth, 1988 - 2025





Science programme

A panel of 20 eminent geoscientists from all parts of the world decided on a list of ten broad science themes - Groundwater, Hazards, Earth & Health, Climate, Resources, Megacities, Deep Earth, Ocean, Life and Soils.

The next step is to identify substantive science topics with clear deliverables within each broad theme. A 'key-text' team has now been set up for each, tasked with working out an Action Plan. Each team will produce a text that will be published as a theme prospectus like this one.

A series of Implementation Groups will then be created to set the work under the ten programmes in motion. Every effort will be made to involve specialists from countries with particular interest in (and need for) these programmes.

For more information - www.yearofplanetearth.org

Several megacities appear to have reached their physical and managerial limits

Space invasion

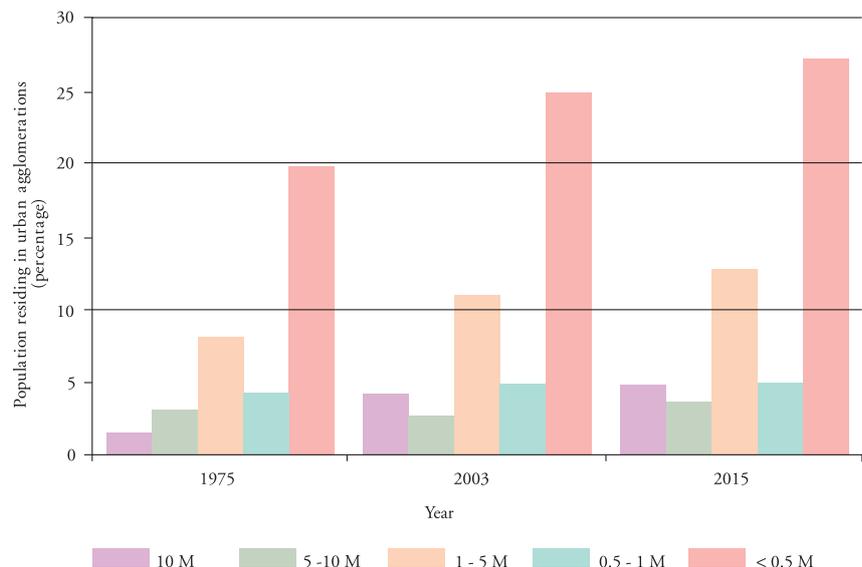
How can we use space better - above and below the surface?

Several megacities appear to have reached their physical and managerial limits and others will do so sooner or later. When megacities run out of space, urban land prices become prohibitively high, leading to intensification of land use with development of more high-rise buildings and underground space. The skyscrapers of old and new world megacities demonstrate that we operate not in two dimensions, but in three. Many cities that have experienced dynamic growth involving expansion and rapid construction of 'skyscrapers' demonstrate the influence of the fourth dimension (time) on the functioning of megacities.

Surface development requires sound foundation conditions. Skyscrapers, elevated roads and railways, communications, electrical and energy corridors and many places where people live, shop, relax and work are built on and above this surface. Concentrated compact developments may reduce quality of life, and areas may become more vulnerable to natural and man-made hazards. Some infrastructure and development related to environmentally unfriendly or other undesirable activities at the surface could be placed underground, thereby significantly improving the quality of living space at ground level.

Underground space may also provide a safer environment for some public and commercial activities as well as providing shelter from inclement weather conditions. However, such developments may affect the natural balance in underground systems leading to hazards that may prevent or constrain development in the future.

Development requires sound planning and land use management, supported by knowledge of subsurface conditions and processes, as well as their interactions with urban land use and management. Planning can be improved by 3D visualization of the surface and subsurface, including its resources and hazards; employing high-resolution remote sensing, and by using modern simulation techniques.



What does the International Year's logo mean? The International Year is intended to bring together all scientists who study the Earth System. Thus, the solid Earth (lithosphere) is shown in red, the hydrosphere in dark blue, the biosphere in green and the atmosphere in light blue. The logo is based on an original designed for a similar initiative called Jahr der Geowissenschaften 2002 (Earth Sciences Year 2002) organised in Germany. The German Ministry of Education and Research presented the logo to the IUGS.

Key research questions (3)

- J)** How can we ensure that surface, particularly high-rise, development is well located and safely constructed? How do we ensure that surface and underground development are well integrated so that they complement each other, ensure future sustainable land use, and harmonize with good urban design?
- K)** What long-term policies, for both surface and underground urban development, can be developed to maintain a balance between economic, social and environmental demands? How can we safeguard surface and ground water resources? How can we secure food and energy supplies?
- L)** How can we measure and manage the economic and societal value of the surface and subsurface in megacities, in the context of diverse socio-cultural and political perceptions? What are the visions for, and models of, future megacities? How can visualization, decision support systems and scenario methods* be improved to help with decision-making? What particular new observational and monitoring systems and predictive techniques do we need above and below ground?

**"Scenario methods" is a term used by social scientists to describe methods of evaluating qualitatively possible future scenarios according to different sets of assumptions such as, for example, what the future might hold for a megacity if the economy boomed, there was a policy of liberalisation and no earthquake, as opposed to a different scenario characterised by slow economic growth, high immigration as a result of earthquakes in neighbouring provinces, and conflict in some areas leading to political destabilization.*



How will these questions be addressed?

Within the International Year of Planet Earth, examples of balanced and safe urban management will be identified and promoted in association with local administrations, organizations and residents in major, though contrasting megacities worldwide. These examples may serve as models for the future.

Understanding of socio-economic issues and known constraints upon development will be shared with urban authorities and other stakeholders. Planning and management systems will be critically reviewed to assess their ability to support or hinder sustainable megacities. Existing surface and underground land-use practices and future aspirations will have to take account of a range of potential constraints. These might include relocating or deferring urban construction so as to avoid rendering valuable assets inaccessible including, for example, high quality aggregates or mineral resources. This will help identify good practices, pitfalls, and pragmatic compromises between social and economic needs.



● Scientific findings need to be

communicated if sustainable

megacities are to be a reality ●

The International Year of Planet Earth will provide an opportunity for multidisciplinary consideration of the key issue of sustainability of megacities. This requires cross-disciplinary collaboration between social, economic and natural scientists. An important first step will be to identify and establish groups willing to collaborate on evaluating the problems and advantages of megacities and identifying approaches to improved efficiency and quality of life in them. It is important to recognise the cultural diversity both between, and within, megacities across the globe - there can be no "one size fits all" solution. The question of whether or not megacities threaten or enhance sustainable development can be addressed.

What will be produced?

The megacities science programme of the International Year of Planet Earth will identify transferable 3D planning tools, GIS analyses, spatial decision support and monitoring systems that will support long term management of megacities. The focus will be on ways to optimize the positive, ameliorate the negative impacts of development on social and natural environments, and enhance prospects for multiple land use.

Publications, reports, software, multimedia visualizations and exhibitions will be produced in order to show application of principles to other urban areas. This programme will include conferences, workshops, seminars and summer schools for scientific exchange and capacity building, as well as for education to raise public awareness of the issues in megacities.

Education potential

The scientific results and findings need to be communicated to a wide range of stakeholders if sustainable megacities are to be a reality. Awareness is rising, but understanding needs to be broader and our ability to manage the complex systems represented by megacities requires better skills. The media and (real-time) Internet will be used to reveal the inner workings of megacities to the wider public – including policy makers, regulators and fund providers.

In addition, simplified models and teaching kits for educational establishments and public awareness will be developed.



Conclusion

Geographers and Earth scientists have long contributed to the understanding and management of complex megacities through their knowledge of Earth processes as well as their ability to find and exploit natural resources. They have a unique understanding of how socio-economic and natural systems operate at scales ranging from global to local.

Teams of geographers and Earth scientists have a role to play in the sustainable management of megacities. Indeed, they have a duty to bring their understanding to bear. Their input can ensure deeper understanding of the complex socio-economic processes, wise management of human and economic resources and reduction of risk from natural, man-made and man-enhanced hazards.

What should you do next?

If you wish to propose a research or outreach project related to this Key Theme, visit www.yearofplanetearth.org and complete an Expression of Interest form.



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