Planet Earth in our hands

Earth sciences for society

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International Year of Planet Earth 2007-2009

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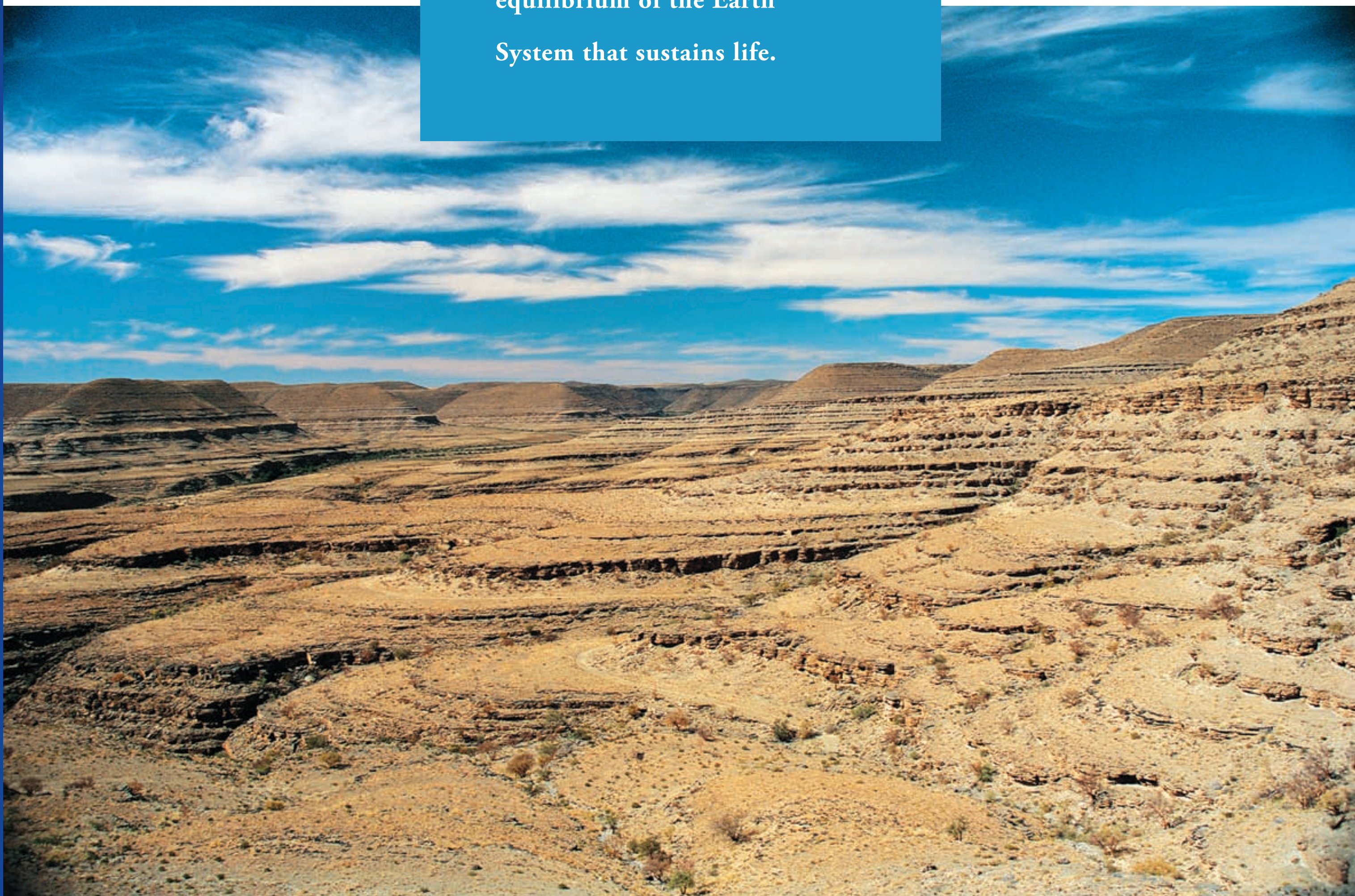
Keeping our balance

Earth scientists are today's key players in managing and building a sustainable world. For our children's sake we must be able to use the wealth of Earth's resources without wasting what cannot be replenished, and maintaining the dynamic equilibrium of the Earth System that sustains life.



Planet Earth in our hands

The human race needs its planet. We depend upon it completely, because we evolved from it, remain forever part of it, and we continue to exist courtesy of the self-sustaining Earth System.

The Earth is unique not only in our Solar System but, as far as we know, in the accessible universe. It is not just the only living planet – it is the only planet we know, or may ever know, that evolved life.

The Earth provides so many riches, about which we have so much more to learn – as new research techniques are brought to bear. The more we learn, the more we understand that we must nurture the Earth as we would our children, for future generations' sake.

The changing world of Earth science

Traditionally, Earth scientists study the rocks and soils of Planet Earth, and try to understand the planet's history and structure. We try to decipher from the record of the rocks all the things that have happened since its origin, with the rest of the Solar System, 4.6 billion years ago. We try to understand processes that created minerals, hydrocarbons, metals, soils, aggregates (sand, clay and gravel) and even the building blocks of life itself. From this we come to understand the extreme age of the world, and of life, and the tiny moment for which human beings have existed – and perhaps will exist - on its surface.

Earth scientists are on a quest for knowledge, but this is knowledge we desperately need. All humanity's raw materials and nearly all its power must come from the Earth – and it is Earth scientists who find it, but the world economies that manage it.

The men and women in Earth science today – pure and applied – constitute the largest living database of information about the past and present of planet Earth that has ever existed. We are also stewards of knowledge for planet Earth. Humanity's survival – and that of life itself – depends on maintaining a functioning Earth System.
For that reason, activities that interfere with this often delicately balanced system are a matter of global concern. Earth science is now at the forefront of understanding how the Earth System works, and stewardship is an issue right at the forefront of policy – exemplified by the Johannesburg Summit (2002), the work of the International Council for Science (ICSU) and its World Summit on the Information Society (2003).

Today, Earth scientists' work has come to encompass the fundamental interactions between land, life, water and air in making up the total Earth System. Earth science now not only seeks to explain the Earth's past, but also helps predict and manage its future.

Humans in the landscape

Throughout Earth's history plants and then animals have become geological forces – think of the Great Barrier Reef, or worldwide deposits of coal.

Earth Scientists are on a quest for pure knowledge, but this is knowledge we desperately need

Humans are now perhaps the most geologically significant species ever, certainly from an environmental impact point of view. As a species too we have dramatically altered our environment to the point where in many corners of the world we can no longer observe 'natural' landscapes.

For example, we now move more material around the Earth's surface than all natural agents of erosion. Meanwhile our species is depleting soil, water and fuel resources, causing floods and droughts, producing waste and "greenhouse" gases - disturbing the planet's dynamic equilibrium. Yet, offering our growing population a secure and prosperous future requires ever more intensive searches for nutrients, energy, water, ores and building materials; but also sustainable management of existing resources.

These resources continue to be found as Earth sciences develop new techniques and better understanding of what are ultimately finite reserves. All predictions of the exhaustion of such resources have so far proved wildly wrong. There is, as yet, no reason to believe that the Earth will not continue to support our needs – as long as we manage those resources sustainably. How can we explore and benefit from the planet's resources without disturbing the delicate balance often observed in Earth Systems? We need to integrate our knowledge of the spheres…

How the "geosphere" interacts with the other spheres of the Earth's surface. These spheres are artificial academic distinctions; they interact completely within the single entity that is the Earth System.

Fresh groundwater

Water is the ultimate resource. Without water, life could not have evolved or be sustained upon our planet. Although 70% of the Earth's surface is covered by it, only 2.5% of all water is fresh – of which most is precariously locked in glaciers and permanent snowfields. This leaves only 0.26% of the planet's water available to support humankind. Of this tiny 0.26%, nearly all (>90%) is held in soil as groundwater, in the pore spaces of rocks beneath our feet.

Most groundwater begins as rain that sinks into the ground and collects within permeable rocks, or "aquifers" (especially sandstone and limestone).

Our burgeoning population and its various polluting activities pose serious threats to this small volume of fresh water. Moreover, as the people of Bangladesh have found out, not all groundwater is drinkable. Once a groundwater source is polluted, it becomes a potential hazard to the very humans who rely upon it to live.

Spheres within spheres

In the past, scientists tended to split the Earth System into “spheres”. But we have now reached the point where - having mentally taken the world apart - we must put it back together, to see how it actually works as a whole.

To solve global environmental problems we need multidisciplinary research. To take just one pressing example; we cannot work out a global budget for “greenhouse” gases in the atmosphere without considering the solubility of those gases in water (hydrosphere), the carbon dioxide locked up in the wood of the world’s great forests (biosphere), in the soil (pedosphere) or those rocks in the “geosphere” that bind carbon in deposits of limestone, coal, oil, gas, or methane hydrate. Nor can we ignore volcanoes, which also produce huge quantities of natural greenhouse gases.

Nor, indeed, can we simply stop burning fuel. A world power shortage would have human consequences as terrible as runaway global warming. For Earth scientists, understanding those “carbon sinks” is also vital to finding the resources that all countries desperately need to help their people towards a better life.
Burning fossil carbon has powered the progress of civilisation and improved the living standards of humanity immeasurably – but only by incurring environmental costs that are unsustainable in the long term.

Earth sciences are in the forefront of detecting these changes, and finding ways of mitigating them before it is too late. For example, experiments are now under way to turn polluting coal – which contributes to global warming if burned – into pure hydrogen, without even removing it from the ground. Other research may pave the way for large quantities of waste carbon dioxide to be re-injected into the rocks from where the fuel originally came.

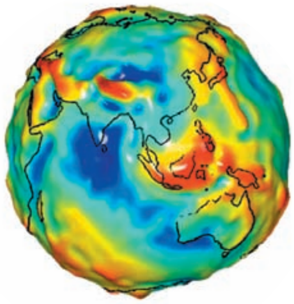
In Poland, greenhouse gas extracted from the atmosphere is safely sequestered in the geosphere by being injected into coal beds 1km below the surface in a pioneering experiment.

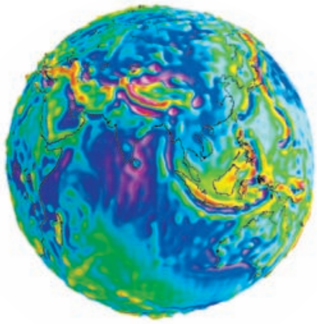
Earth sciences for development

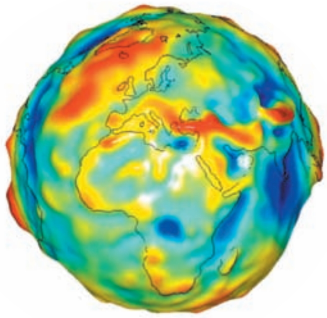
Earth science is essential to understanding this complex, balanced Earth System on which we all depend. But it is all too easy to take the Earth’s resources for granted. All civilisations depend upon supplies of energy and raw materials.

To take an example from humanity’s oldest continuous civilisation, in North China, as early as 6000BC, “salt wars” were fought over Lake Yuncheng. Five thousand years later the Chinese began using iron. Due to taxes on salt and iron (both state monopolies) the Chinese were able to create a great empire that, around 100BC, was larger and more advanced than that of the Romans. Three hundred years later, the Chinese people succeeded in piping gas from those mines to their stoves, using bamboo - the first known use of natural gas.

It is all too easy to take the Earth's resources for granted







Amazing GRACE

Several recent developments will improve our ability to observe the dynamic Earth. For instance, high precision gravity measurements by satellites such as GRACE (Gravity Recovery And Climate Experiment) will improve our understanding of mass flows on Earth – such as magma in its crust, water in oceans and melting icecaps on the poles. GRACE will enable Earth scientists to predict floods in lowlands by allowing them to monitor more accurately the degree of saturation in upstream catchment areas, for example. In future, space satellites will be able to monitor and detect earthquake activity in areas where no ground stations exist.

Radar interferometry - an extremely sensitive altitude observation technology capable even of detecting the Moon's tidal pull on the continents - will soon be able to detect land movements before damage to built structures has become apparent. Other emerging satellite technologies can use disturbances in the ionosphere to detect earthquakes – including under the oceans.

The challenge facing Earth science is to combine all these new data, and use them to visualize, explain and predict flows of ice, water and magma, the movements of tectonic plates and ocean currents, the activity of faults and volcanoes, the rise and fall of the crust and – ultimately – the Earth's response to human activity. This will then enable them to forecast more accurately - and then mitigate – geological and environmental hazards facing people all over the world.

Rocky riches – and horrors

In 1980, mining of diamonds, uranium, copper, lead, zinc, tin, silver and cadmium accounted for 50% of Namibia's gross national product and 75% of exports. Since 1960 the Republic of Congo has exploited the riches in its subsurface. In that year the first oilfield was taken into production at Pointe Indienne. By 1984 Congo had seven oil fields that together accounted for two thirds of its income. The lives of over 100 million inhabitants of the State Republic of Bangladesh, in South Asia, are also largely controlled by geological phenomena, since the discovery in groundwater of high levels of natural arsenic exceeding World Health Organisation guidelines. Arsenic causes skin lesions, poisoning and cancer. Continuing research is showing that natural geochemical processes liberate the toxic element from buried river sediments, so that it now occurs in water drawn from tube wells that (ironically) were constructed in an attempt to reduce disease from the use of polluted surface water.
Earth scientists are urgently striving to find alternative water sources, and to develop affordable alternative technology methods of extracting arsenic from existing water sources.

Building high, building deep

Apart from finding riches in the Earth's crust, Earth scientists also make it possible to build great structures on or in its surface.

About 70% of the world's population lives in coastal areas - on sandy, clayey and muddy soils at sea level. The geotechnical knowledge of Earth scientists is essential in establishing cities, building industries and constructing dams. Nowadays, as urban populations rise, geotechnical engineers are helping to build safe underground structures like the Channel Tunnel (linking the UK with the rest of Europe), or to construct indoor (underground) cities in China, Korea and Canada.

In the near future, humans will be making greater use of the subsurface for living, moving, storage and environmental mitigation. To do this will require knowledge of the Earth System's response. Subsidence due to mining or lowering of the groundwater table by water extraction, and earthquakes induced by exploitation of natural gas are just a few examples of how human activities in and on the crust may cause adverse effects for which we need to be ready.

We now move more material around the Earth's surface than all natural agents of erosion

Damming the tide

In Holland, every person can be said to own one metre of dam, 20,000 kilometres of which protect two thirds of the country from flooding. The Dutch government has recently planned several new residential areas in polders at depths varying between 4 and 7m below sea level. Keeping the streets dry will require additional pumping to lower groundwater in the peat and clay on which the new homes are being built. But this causes subsidence - at a rate of c. 1cm per year – which is more than the figure by which average sea levels are rising.

Earth scientists predict that in the next century only massive investments in water management will prevent the Delta metropolis of Amsterdam, Rotterdam and The Hague from drowning.
In the next few decades, their knowledge of the geological formations and groundwater flow, the behaviour of the Rhine, Meuse and North Sea, as well as geotechnical aspects of pumping, building and tunnelling, will all be essential to design and implement safe, sustainable scenarios for Holland's future.

An International Year of Planet Earth

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 IYPE.

Who is involved?

The United Nations General Assembly in New York, has proclaimed the year 2008 to be the United Nations International Year of Planet Earth. The year's activities span the three years 2007-2009. The International Year of Planet Earth (IYPE) is a joint initiative by UNESCO and the International Union of Geological Sciences (IUGS). Twelve founding partners, 26 associate partners and a growing number of international partner organizations from all continents and representing all major geoscientific communities in the world, have embarked on this initiative. The Year also enjoys the full political support of 191 UN countries. Early 2008, National committees will have been established in some 70 countries and regions in the world.

Its purpose is to focus on the relationship between humankind and Planet Earth, and to demonstrate that geoscientists are key players in creating a balanced, sustainable future for both.

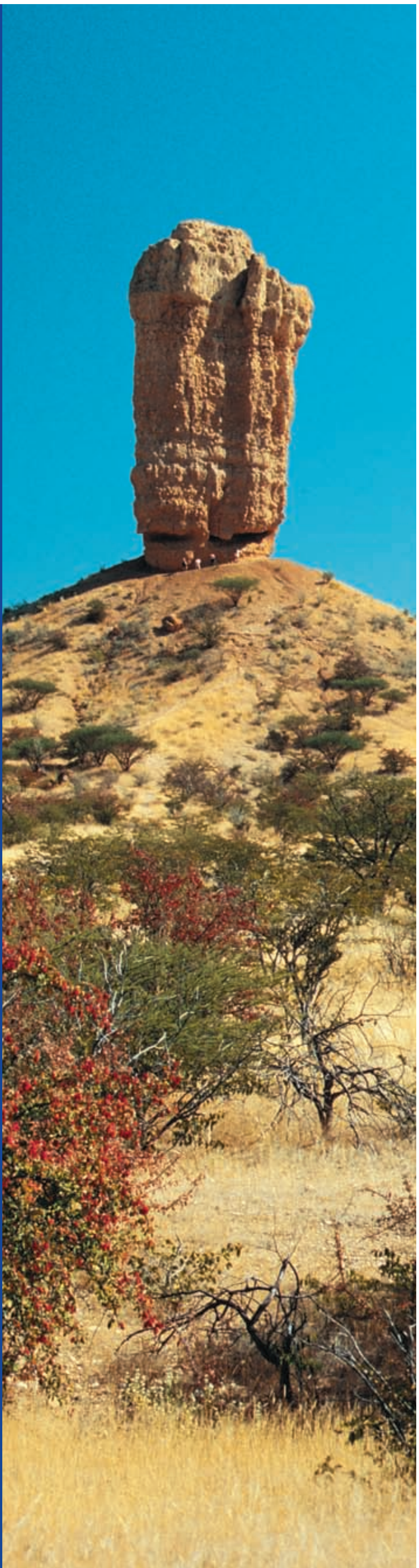
According to UN Guidelines for the proclamation of international years, suitable subjects should be "of priority concern to political, social, economic, cultural, humanitarian or human rights"; of concern to "all (or a majority of) countries, regardless of economic and social system", and should "contribute to the development of international co-operation in solving global problems", paying special attention to those affecting developing countries.

World summits on sustainable development during the last decade have stressed the urgent need for action to conserve and sustain the Earth System (Johannesburg summit, Rio de Janeiro summit, Agenda 21, the ICSU World Summit on the Information Society, etc.). IUGS, representing the Earth science community worldwide, therefore decided to take a lead in the International Year of Planet Earth.

Organisation

Until 2006, the IYPE was a joint project of its initiators, IUGS and UNESCO. It was led by a Management Team that guided the process of the selection of the ten science themes as described on pages 13 and 14, and was responsible for the rapidly expanding level of support. On 16 March 2006, the International Year of Planet Earth was registered as a not-for-profit 501 (c) (3) Corporation in the State of Delaware (USA). It consists of three units: the Board of Directors who is responsible for the Year's strategy, the Secretariat who implements the strategic decisions by the Board, and the Advisory Bodies, consisting of Senior Advisers, Goodwill Ambassadors and Patrons.

The Board is composed of a Chair and a Vice Chair and the leaders of the two main lines of action in the IYPE: the science and the outreach programmes. The Initiators (IUGS and UNESCO), and the 12 Founding partners all have a seat on the Board, whereas the Associate and International Partners share a seat. The National Committees are represented in the Board through 7 Regional Representatives. The Secretariat is based in the premises of the Norwegian Geological Survey (NGU) in Trondheim, Norway (iype.secretariat@ngu.no).



The IYPE website **(www.yearofplanetearth.org)** was launched in 2003, several flyer's were published, a Business Plan and 12 brochures produced. This first brochure ('Planet Earth in our hands') is in its third edition.

Costs & income

As Initiators, IUGS and UNESCO have been the main financial contributors to the preparatory phases of this operation. From 2003 onwards an increasing number of Founding Partners and sponsors began to invest in the initiative. Until the end of 2006, more than half a million USD was collected and primarily spent to cover the costs of the 12 IYPE brochures, flyers, website and promotion activities.

During the first year of the IYPE triennium (2007) almost 1,5 MUSD was collected, mainly to finance the Global Launch Event and the Secretariat. For the full triennium, the IYPE Corporation would need 5 MUSD for the international operations and activities. On national levels, significantly higher budgets (25-40 MUSD) are needed until the end of 2009, which are supplied by national resources (mainly from government and industry).

UN Proclamation and the way ahead

To achieve its aims and ambitions and to collect public and in particular political support, the United Nations system was approached.
That process went through various stages, starting at UNESCO where the United Republic of Tanzania successfully launched the initiative in the Executive Board in April 2005, followed by the General Conference in October. In December 2005, the General Assembly of the United Nations adopted Resolution 192 and proclaimed 2008 as the International Year of Planet Earth.

UN Proclamation ignited significant moral, political and increasingly also financial support to the International Year of Planet Earth. This is demonstrated by the rapidly growing number of nations that established their own National IYPE Committees, from none in March 2006, via 25 in October 2006 to 56 in November 2007. It is anticipated that 70 nations will eventually have such a National Committee for IYPE in place by early 2008. All National Committees are working hard to realize their public outreach and science plans in 2008 and 2009. Much of their effort is devoted to fundraising. On an international level, most attention is given to coordination of the national and international activities and to organizing major international launch events. A Closing Event is planned for the end of 2009. The international activities will terminate by mid 2010 when a report on the International Year of Planet Earth will be delivered to the United Nations. Several national National Committees announced to continue their outreach activities after the triennium is ended.

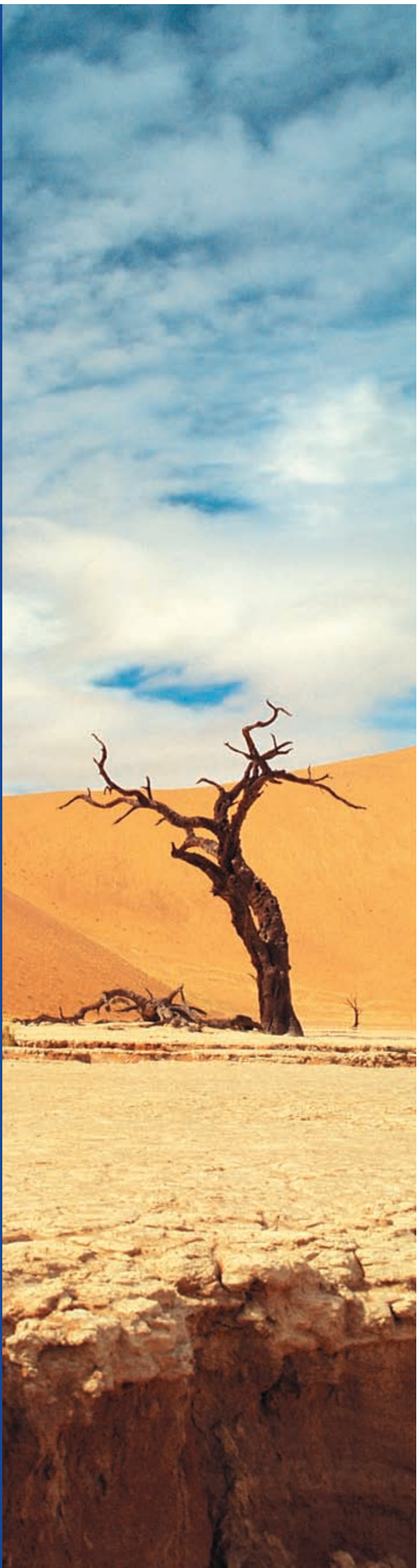
To solve global environmental problems we need multidisciplinary research

Other International Years

The International Year of Planet Earth joins a prestigious list of UN-proclaimed international years, beginning with World Refugee Year (1959/1960). In 1957/1958 an International Geophysical Year, preceding the UN series, ignited many new developments in our understanding of the Earth. In 1998, the United Nations proclaimed the International Year of the Ocean, the International Year of Mountains (2002), and the International Year of Freshwater (2003). The International Year of Planet Earth is accompanied by the International Polar Year, the electronic Geophysical Year and the International Heliophysical Year (all 2007-2008). In September 2005, these four International Year initiatives signed a Declaration for close cooperation.

The IUGS-UNESCO initiative fully complies with the requirements of the UN and has translated these into its Aims and Objectives (see next page).

Earth scientists are today’s key players in building a sustainable world



Aims & objectives

The International Year of Planet Earth aims to “demonstrate the unique and exciting ways in which Earth sciences can help future generations meet the challenge of ensuring a safer, healthier and more prosperous world”.

Implementation of these aims will be realized in the first place through a massive outreach programme on raising public and political awareness of this role for the Earth sciences in 70 nations and in all continents: 'The Greatest Geo-Show on Earth'. This will also be done by co-sponsoring national and international science projects dedicated to the IYPE themes for which geoscientists are invited to submit proposals.

Through the International Year of Planet Earth 2007-2009

Earth scientists of the world will demonstrate how they are working to:

- Understand and keep intact for future generations the rich record of our planet’s history, knowledge of its structure and function and of its self-sustaining dynamic equilibrium.
- Make sustainable use of Earth’s richness and diversity for the benefit and prosperity of all peoples.

Governments will be urged to pay greater attention to the Earth sciences.

A science programme, concentrating on globally important issues facing all nations, will promote multidisciplinary research towards a fuller understanding of the Earth System.

The International Year supports research projects within the following ten programmes. Each programme will be described in a separate brochure in this series (www.yearofplanetearth.org)

1 Groundwater – *reservoir for a thirsty planet.*
Nearly all the potentially drinkable water on the Earth exists as groundwater. New techniques of exploration and production, and improved understanding of the dynamics of natural water reservoirs, are helping Earth scientists find this most precious of all commodities.

2 Hazards – *minimising risk, maximising awareness.*
The Earth can be a dangerous place, and is often made more dangerous by human intervention. Crucial to minimising the hazard potential from different geological threats facing people all over the world, is the accurate assessment and communication of risk.

3 Earth & Health – *building a safer environment.*
Everyone who lives in a polluted city appreciates that where you live affects your health. Much, if not most of the control over whether an environment is healthy or not lies beneath your feet – the environmental geochemistry of your habitat.

4 Climate – *the "stone tape".*
Understanding climate trends, so vital to our stewardship of Planet Earth, relies heavily upon the preserved record of sedimentary rocks of many types. By studying this precious natural record, using proxy indicators for different aspects of climate, Earth scientists are now understanding in increasing detail how the climate works and how it has behaved in the past. However, these records are rare and precious and must be conserved before development destroys them forever.

5 Resource issues – *towards sustainable use.*
Earth scientists have consistently confounded gloomy predictions about the exhaustion of resources, by improving their understanding of the Earth and of how potentially useful minerals (including industrial minerals and metals) accumulate. However, this does not absolve the world of responsibility to use these resources intelligently, or to find new, cleaner ways of liberating their energy.

6 Megacities – *our global urban future.*
Urban areas, often concentrated on narrow coastal strips, are running out of space and the price of land is sky-high. More and more, architects will wish to switch from building high to building deep. This is more expensive in the short term, but much more sustainable in the long term. A physical change to how an urban landscape develops has many direct impacts (e.g. socialization, emotionally, physically) on those who live within such conurbations. A better understanding of the urban environment and its impact on our species – and indeed other species - has huge implications for society.

continued

Mineral wealth

Minerals can only be mined where they occur, of course, and for this reason every country's mineral needs and resources are different. Many countries, particularly in the develop-ing world, are largely or wholly dependent upon their geological riches - from Gulf states like Kuwait dependent on oil and gas, to Namibia with its diamonds.

Developed countries like the United Kingdom, Norway or the Netherlands would be severely damaged economically without revenues from oil and gas. However, countries can be equally dependent as consumers. During an average 70-year life, each Western European person uses up 460 tonnes of sand and gravel, 39 tonnes of steel, 100 tonnes of limestone and more than 360 tonnes of fuel. Nearly everything in our homes is mineral in origin - cookers, computers, batteries, radios, compact discs, ipods cosmetics, toothpaste, medicines, china, glass, plastic, paper, insulation – even tomato ketchup, chocolate and other food-stuffs!

7 Deep Earth – *from crust to core.*

All of the Earth's long history and evolution right up to its current condition is really but scum on the surface of a vast, heat-driven engine. Consisting of a central nickel-iron core (an inner solid core and outer liquid core, generating most of the Earth's magnetic field) and the mantle, which though solid nevertheless convects and moves the planet's crustal plates, this motor is what makes our planet "alive".

8 Ocean – *abyss of time.*

The oceans, which began to be scientifically explored 200 years ago, hold the key to how the Earth works. Although our improving knowledge of the oceans has revolutionised our understanding of the planet as a whole, much more remains to be discovered – not only in the use of oceans to the benefit of humankind, but also in preventing disruptions around the continental margins where so much of the human population is concentrated.

9 Soil – *earth's living skin.*

Soils are truly wonderful. They are major support systems of human life and welfare. They provide anchorage for roots, hold water long enough for plants to make use of it, and embraces the nutrients that sustain life – otherwise the Earth's landscape would be as barren as Mars. Soils are home to a myriad of microorganisms that accomplish a suite of biochemical transformations – from fixing atmospheric nitrogen to the decomposition of organic matter – and to armies of microscopic animals as well as the familiar earthworms, ants and termites. In fact, most of the land's biodiversity lives in the soil, not above ground.

10 Life – *origins of diversity.*

The biosphere is the "living sphere" of planet Earth. It is the most remarkable characteristic of our planet, and makes Earth unique within the planetary system. The evolution of life and biosphere began perhaps as early as 4.2 billion years ago, but by 2.7 billion years ago life had started to have a significant effect on the atmosphere, oceans and lithosphere. It is the joint aim of research by palaeontologists and biologists worldwide to understand the multiple factors that control the processes of life - past, present and future.

Outreach

The Outreach programme will interact with all educational levels worldwide. Through UNESCO, all national committees will be asked to co-operate in producing and disseminating Outreach programme material to the necessary educational levels. Information material will be produced in printed form, on CD-ROM and on www.yearofplanetearth.org.

Public relations activities will encourage the involvement of newspapers, magazines, journals, radio, TV and the film industry. Earth science institutions, organisations, societies etc. will assist.

This brochure, *Planet Earth in our hands*, is the first in a series of 12. Numbers 2 to 12 describe the ten major themes of the Science Programme. Number 11 highlights the objectives of the International Year's Outreach Programme.

Editing	Dr Ted Nield, (Geological Society of London) & Dr Phil Manning (University of Manchester), and Dr. Eduardo de Mulder (TNO), with Prof. Edward Derbyshire & from original text by Dr Henk Leenaers, (Netherlands Institute of Applied Geoscience TNO) & Dr Henk Schalke.
Illustrations	Henk Leenaers Ted Nield Dirk J. Wiersma Ministry of Transport, Public Works and Water Management, The Netherlands TNO www.geolsoc.org.uk
Design	André van de Waal, Coördesign, Leiden

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UNESCO
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International Year of Planet Earth

IYPE Secretariat
Geological Survey of Norway
N-7491 Trondheim
NORWAY
T + 47 73 90 40 00
F + 47 73 92 16 20
E iype.secretariat@ngu.no

www.yearofplanetearth.org