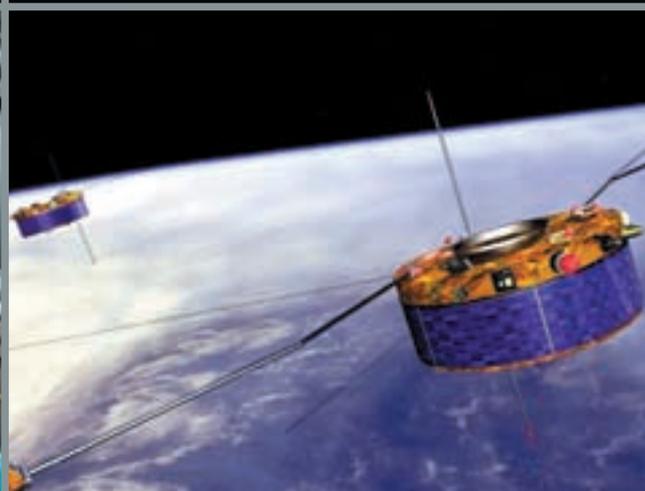
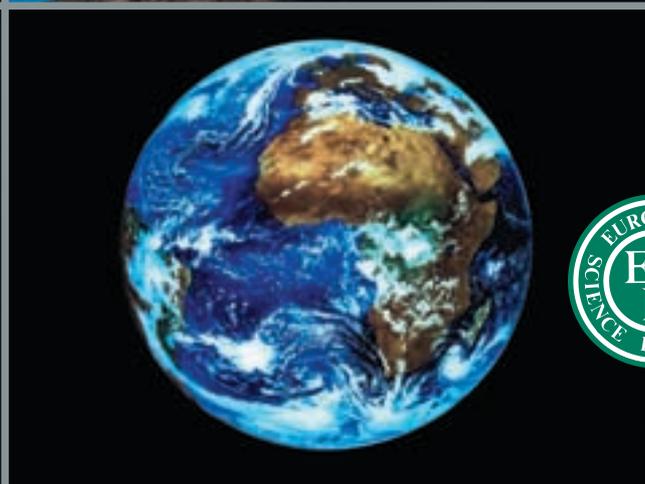
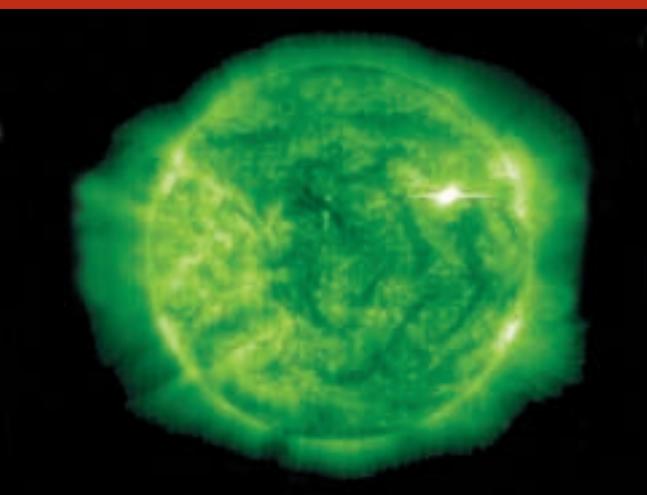


An ESSC-ESF position paper

Future of Europe in Space Research

ESF Recommendations to Ministers of ESA Member States



October 2001

The European Science Foundation (ESF) acts as a catalyst for the development of science by bringing together leading scientists and funding agencies to debate, plan and implement pan-European scientific and science policy initiatives.

ESF is the European association of 67 major national funding agencies devoted to scientific research in 24 countries. It represents all scientific disciplines: physical and engineering sciences, life and environmental sciences, medical sciences, humanities and social sciences. The Foundation assists its Member Organisations in two main ways: by bringing scientists together in its scientific programmes, EUROCORES, forward looks, networks, exploratory workshops and European research conferences, to work on topics of common concern; and through the joint study of issues of strategic importance in European science policy.

It maintains close relations with other scientific institutions within and outside Europe. By its activities, the ESF adds value by cooperation and coordination across national frontiers and endeavours, offers expert scientific advice on strategic issues, and provides the European forum for science.

European Space Science Committee (ESSC)

The European Space Science Committee is an ESF Expert Committee. Established in 1975, it covers life and physical sciences in space, Earth observation and space physical science. It considers issues of space research activities in Europe, with particular emphasis on the definition and organisation, collaboration and exploitation, and assessment of such research endeavours. The Committee investigates and presents the view of the scientific community in Europe and provides an independent voice on European space science policy.

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The SOHO solar observatory catches a solar flare on 26 November 2000 (ultraviolet image); BepiColombo spacecraft arriving at the planet Mercury (artist's impression); Ultraviolet image of the spiral galaxy M81 by the XMM-Newton observatory; Meteosat image of Europe and Africa; European "Columbus Orbital Facility (COF)" on the International Space Station; The CLUSTER quartet (artist's impression). © ESA

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Background

In February 1999, the European Space Science Committee (ESSC) of the European Science Foundation (ESF) published recommendations to the European Ministers in charge of space-related issues, in preparation for the Ministerial Council of the European Space Agency (ESA) Member States ⁽¹⁾. The ESF's ESSC was granted an observer status at that Council and made an oral statement to the Ministers, advocating the need to support the European space science effort through ESA's scientific programmes ⁽²⁾. ESA and the European Commission (EC) have since undertaken joint actions to define a "European Strategy for Space", providing a basis for the European Union's policy regarding the exploitation of space ⁽³⁾ and, drawing on the recognition that the rationale for space is changing, increasingly focusing on user needs in various areas, e.g., telecommunication, navigation systems, environmental monitoring. These needs have to be accommodated by various means, among which is the existence of a space infrastructure. In parallel, the need for a clear European space policy with the corresponding institutional means to enforce it, was also reaffirmed by the report by Carl Bildt, Jean Peyrelevade and Lothar Späth (known as the "Wisemen report") to the Director General of ESA ⁽⁴⁾.

European Space Strategy

The ESF welcomes this new approach which it had been advocating for several years ⁽⁵⁾. During this process the ESF's ESSC was invited to provide a contribution to this strategy document. Observations, concerns and suggestions that emerged during the discussions were provided by ESSC and approved by the ESF Executive Board. These recommendations were sent by the Secretary General of ESF ⁽⁶⁾ to Executives in the European Union, ESA, EUMETSAT and various national space agencies in Europe.

*The ESSC-ESF welcomes the practical implementation of the **Joint Strategy for Space** through the establishment of the joint EC-ESA Task Force and the Joint Space Strategy Advisory Group (JSSAG) in which the ESF has been invited to participate. To contribute to its discussions the ESSC-ESF produced an updated set of recommendations in preparation for the EU Research Council of June 2001 (see Appendix 2).*

The ESSC-ESF wishes to stress that involvement in first-class science is absolutely essential for the promotion of European interests and leadership, imparting a strong strategic drive to its technological and industrial system, as successfully demonstrated in the case of the United States. High-quality space science is a well-recognised asset of Europe's space programmes, and ESA's role is crucial to maintain this leadership. ESA has an excellent track record and can be regarded as a successful self-organisation of that research sector.

In the light of the upcoming ESA Ministerial Council to be held in November 2001 the ESF

wishes to contribute to this debate by offering the following recommendations.

Outreach

Science and its cultural and societal importance need continual communication and explanation in layman's terms, at the political level and for the general public. Space science in particular possesses a substantial public appeal and could be promoted in a visionary manner such as, "Space for improving knowledge, and enhancing the quality, of life on Earth".

Space science investigations and results carry a large potential for public outreach and education in the natural sciences.

*Exciting discoveries in space science and its applications should be exploited vigorously **so as to stimulate young people to take up education in the natural and engineering sciences.** This aspect of our space endeavours should figure prominently in any European strategy document.*

Space Science Programme

The ESA mandatory science programme has been an outstanding success and its stature is firmly established on the world scene. This stature largely derives from a careful strategic planning of all the constituent elements which make up the Horizons 2000 programme. This programme is community defined and driven and provides balance and coherence over a wide range of space science topics. Not only has it greatly enhanced Europe's visibility in space science on the world scene, but it has

actually established the global leadership of Europe in specific space science disciplines. The following recommendations address two main issues, i.e. the mandatory aspect of the programme and the level of resources in the coming years.

Mandatory character

The mandatory character of the science programme has been, and still remains, the very foundation on which credible and rational strategic planning needs to be built. It safeguards a firm long-term commitment of the scientific community based on visibility, clear prioritisation and scientific impact. It is also the only way in which true harmonisation with space science endeavours in individual member states can be accomplished. Moreover, just as importantly, it puts Europe's space science commitments firmly on the world map as a benchmark for other agencies, in particular for the US NASA programme.

*The ESSC wishes to strongly emphasise that **continuation of the mandatory character of ESA's science programme** constitutes a key boundary condition for preserving Europe's present stature in space physical sciences; it is a prerequisite for future success.*

Level of resources

The steady reduction in purchasing power of the ESA science programme since the Toulouse meeting in 1995 has now almost eliminated the flexibility for new initiatives while at the same time the programme risks are considerably increased. If similar reductions are further extended, they will jeopardise European independence in future space science missions, and also severely threaten the return on past investments.

The ESSC is convinced that now, after six years of budget erosion, and given the importance of space science to the strategic development of the European Union in key areas, restoration of the purchasing power of ESA's mandatory science programme is of critical and imminent importance.

The current long-term programme is based on the planning assumption that the purchasing power would indeed be restored from 2002 onwards, which would enable it to pursue excellent and world-beating scientific objectives. On the other hand, failure to do so will require the introduction of draconian measures leading ultimately to the disintegration of the programme and the loss of European leadership in key scientific fields.

The speed and the continuity with which the large and competitive European user community can be served by ESA's Science Programme has already slowed down to a critically low level.

*The ESSC-ESF lends strong support to the request by the ESA executive to **raise the resources of the science programme to the level needed to restore its purchasing power over the coming years**. This would enhance the speed of mission execution to such a level that new initiatives can be embraced in a timely manner so as to secure scientific excellence for Europe until the end of the second decade of this century.*

Life and Physical Sciences in Space

The EMIR-2 extension programme which was decided in Brussels reached a level of subscription of only 48 M Euros at 1998 economic conditions. Balanced progress is at present difficult to achieve due partly to that relatively low level of ESA Member States' support for the provision of experiments within this ESA optional programme. An appropriate level of national funding for flight experiments is thus needed to permit the preparation of accepted experiments in a reliable and cost-effective manner.

Therefore, the ESSC-ESF welcomes the initiative proposed by the ESA Executive to implement a "European Programme for Life and Physical Sciences and Applications utilising the International Space Station – ELIPS" ⁽⁷⁾. This programme would be based on the "European Research Plan for Life and Physical Sciences and Applications in Space" ⁽⁸⁾ which was reviewed by ESF earlier this year ⁽⁹⁾, and it would lend stability to the programmes in this area of research.

The ESSC-ESF was pleased to recognise that the ESA Executive has presented an updated version of this Research Plan and corresponding ELIPS proposal to the Ministers, which take into account most of the ESSC-ESF recommendations.

The ESSC-ESF approves the scientific contents, strategy and operational measures proposed by ESA in its updated Research Plan and corresponding ELIPS proposal.

In addition the ESF recommends fostering the use of the International Space Station (ISS) as a European large research infrastructure in support of space research by:

- exploring the potential for enhancing scientific knowledge using the ISS (i) as an infrastructure to provide a unique environment for research; and (ii) as a facility for astronomical, solar and Earth observations;
- defining the benefits for European industry in application-oriented research on the ISS (or other Earth-orbiting satellites) in, e.g. biotechnology, health research, industrial processes, energy and environment;
- providing optimal use of the ISS to the European scientific and industrial community by funding the ISS as a European large research infrastructure, including the European access to, as well as the provision and utilisation of payloads on, the ISS;
- studying the role of European use of the ISS in a future international multidisciplinary approach towards human exploration of the solar system.

This support could be achieved, e.g. through the Sixth Framework Programme's ⁽¹⁰⁾ second avenue of approach in implementing the European Research Area, namely "Structuring the ERA" which includes, inter alia, human resources and researcher mobility and research infrastructures.

Earth Science Programme

The ESA proposals for a continued programme in Earth observation and the approval by the Ministers meeting in Brussels of an envelope programme to support underpinning research were very welcome and fully responsive to earlier ESSC recommendations. The excellence of the science proposed by ESA has emerged from the highly effective peer-review process used in selection. Thus all four of the Core Earth Explorer missions have generated very strong interest among the scientific communities of the Member States.

A unique approach to climate monitoring for global environment and security in Europe is vital. Again, this must recognise the roles of ESA and EUMETSAT as the vehicles for R&D and operations respectively.

*What is now needed is for the EC to develop a funding regime to **support an operational programme of climate (and biosphere) monitoring and global security from space** by bringing together the interests of Directorate General Research with that of other user Directorate Generals such as Agriculture and Environment.*

The ESSC-ESF, recognising the need for an integrated approach towards Earth observation in order to establish long-term operational observing systems and appropriate structures to deal with the collection of observations, the data analysis and the dissemination of products, recommends that the following items receive high priority in planning a GMES implementation strategy.

- Applications in Earth Observation, as promoted by the EC, are not simple to implement; they can derive only from a solid and thorough scientific understanding of the observations. This has only just begun to develop and activities related to technological research, development of data products, model validation and data archives require substantial EC support in the short-term.
- The GMES initiative ⁽¹¹⁾ currently being undertaken by the various relevant actors is a positive step towards answering that concern.

The ESSC-ESF has recently produced a series of focused recommendations concerning the GMES initiative which are provided as Appendix 3 to this document.

Planetary Exploration Initiative

The ESSC-ESF noted the report on the call for ideas for the ESA Planetary Exploration Initiative (the Aurora programme), and particularly the ample response from the scientific community regarding that call for ideas. The ESSC-ESF considers that this again signifies the energy and creativity of a very active European space science community, which continually seeks opportunities to accommodate new ideas given the limited budgets available. The ESSC-ESF recognises that manned exploration of objects within the solar system is an upcoming theme full of scientific implications. While this is a potentially exciting new field of scientific endeavour, it needs to be carefully aligned with the Science Programme proper, specifically regarding the upcoming planetary missions and related landers, which include Rosetta, Mars Express and BepiColombo.

*The ESSC-ESF wishes to emphasise that a **higher level of coordination** between initiatives, having potential scientific implications such as this one, and ESA's Science Programme, is mandatory in terms of programme strategy.*

Near Earth Objects (NEOs)

Following recommendations put forward in the report of the UK Task Force on Potentially Hazardous Near Earth Objects ⁽¹²⁾, the ESSC-ESF established an *ad hoc* group to consider this question in both a European and broader international context with special reference to the possible role of European Agencies. In line

with the first recommendations from this *ad hoc* group, the ESSC-ESF wishes to bring this issue to the attention of European policy makers.

*The ESSC-ESF endorses the conclusions of the UK Task Force and believes that **the threat posed to humanity by NEO impacts is real and similar in character to other risks of low probability but high consequence which governments take very seriously, e.g. earthquakes and volcanic activity.***

- The immediate need is to identify in full the population of NEOs with scale sizes that are potentially hazardous. Europe, in a fully international context, should play a major role in dealing with this issue in a scientifically sound and cost-effective way.
- Agencies such as ESA and ESO must play very significant roles in this activity, both through the use of ground-based telescopes for discovery, accurate orbit determination, physical characterisation and follow-up observations, and through space-based assets for *in situ* observations.
- Both ESO and ESA have the specialist expertise to deal with the very large quantities of data which will result from NEO searches. CERN is also expert in handling such quantities of data. European developments of the “data grid” will be of considerable relevance in this area.
- The broad multidisciplinary nature of the NEO problem requires the expertise of a range of physical and social sciences in addition to those supplied by astronomy and space disciplines; ESF could play a most valuable enabling role in the deployment of such expertise.

Space Weather

Space weather issues are of global relevance. While it appears necessary to develop an independent European capability in this area, the proposal for a European effort in space weather should thus be seen as ultimately motivated by the wish to make a strong contribution to the global goal. There are still many important topics which lack detailed scientific understanding before accurate predictions become possible, and many open questions about the Sun and Earth's environment whose investigation will help to advance space weather prediction. However the understanding of the basic physical processes involved in the creation of a space weather service, and the knowledge of the most critical parameters to be monitored and of the respective measuring techniques, are sufficiently far advanced that the time appears to be ripe for a first practical step.

The ESSC-ESF supports the launch of a European space weather initiative; a decision to begin a modest study programme is recommended.

The establishment of a space weather service is not a scientific subject by itself; its relevance to science is the increasing concern over space weather effects. An assessment has to be made of related economic issues, and the distinction between the initiative and the ESA science programme needs to be clearly and simply described, as is the case with the Aurora programme. There is an obvious need to identify the economic case by, e.g. engaging the EC to support this initiative through the initiation of a discussion at the level of the ESA/EC Task Force and of the JSSAG.

At a later stage it will be necessary to consider the eventual operational execution of the space weather programme by industry and/or EUMETSAT.

Appendix 1 ESSC members in 2001

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Appendix 2

ESSC-ESF specific contribution on the EC-ESA joint strategy for space

Background

In November 1999, the European Space Science Committee (ESSC) of the European Science Foundation (ESF) published recommendations to the European Space Agency (ESA) and to the European Commission (EC), advocating the development of a European space science policy ⁽⁵⁾. ESA and EC have since undertaken joint actions to define a "European Strategy for Space", providing a basis for the European Union's policy regarding the exploitation of space ⁽³⁾ and, drawing on the recognition that the rationale for space is changing, increasingly focusing on user needs in various areas, e.g., telecommunication, navigation systems, environmental monitoring. These needs have to be accommodated by various means, among which is the existence of a space infrastructure. In parallel the need for a clear European space policy, with the corresponding institutional means to enforce it, was also reaffirmed by the so-called "Wisemen report" to the Director General of ESA ⁽⁴⁾.

During this process the ESSC-ESF was invited to provide a contribution to this strategy document. Observations, concerns and suggestions that emerged during the discussions were provided by ESSC and approved by the ESF Executive Board. These recommendations were sent to Executives in the European Union, ESA, EUMETSAT and various national space agencies in Europe, by the Secretary General of ESF ⁽⁶⁾.

In its recommendations the ESSC-ESF stressed the fact that science and its cultural and societal importance need continual communication and explanation, in layman's terms, at the political level and for the general public. Space science in particular possesses a substantial public appeal and could be promoted in a visionary manner such as, "Space for improving knowledge, and enhancing the quality, of life on Earth". Space science investigations and results carry a large potential for public outreach and education in the natural sciences. It was thus emphasised that the exciting discoveries of space science and applications should be exploited vigorously to stimulate young people to study the natural and engineering sciences. This aspect of our space endeavours should figure prominently in any European strategy document.

The ESSC-ESF thus welcomes the practical implementation of the Joint Strategy for Space through the coming into force of the joint EC-ESA Task Force and the Joint Space Strategy Advisory Group (JSSAG) to which the ESF has been invited to participate. To contribute to its discussions the ESSC-ESF wishes to stress the following points.

Coordination and synergy

- A global strategy for space in Europe must take into account the current role of the various players (ESA, EC, EUMETSAT, national space programmes) and provide an approach to redefine roles and responsibilities.
- As a minimum, to avoid wasting resources and to maximise return on investment, practical methods for programme coordination (and harmonisation) at the European level are vital. These need to be defined including an authority structure for their implementation.
- Any European strategy must recognise the different roles of the various actors. While the EC is concerned, through the EU Framework Programme, with industrial competitiveness and

policy support which impinge on aspects of space activities, ESA and the national space programmes have developed excellent operational and research activities. There has to be a synergistic approach taken by the EC rather than one in which it seeks to redefine institutional responsibilities in space.

Networking science

- Networking of scientists is essential to meet the challenges of developing innovative disciplines in space, such as biotechnology and exo/astronomy. This should be accommodated and encouraged through existing networks such as ESF and well-focused use of the EU Framework Programmes.

Scientific programmes in space

Involvement in first-class science is absolutely essential for the promotion of European interests and leadership as it would exert a strong strategic drive on its technological and industrial system, as successfully demonstrated in the United States. High-quality space science is a well-recognised asset of Europe's space programmes, and ESA's role is crucial to maintain this leadership. ESA has an excellent track record in space science and can be regarded as a successful self-organisation of that research sector.

- It is therefore strongly recommended that this excellence be recognised by European decision-makers, and that the scientific "roadmaps" (Horizons 2000, The Living Planet, Life and Physical Sciences and Applications) developed by the ESA Directorates be considered as basic elements in underpinning any European Strategy for Space.

Global Monitoring for Environment and Security (GMES)

A unique approach to climate monitoring for global environment and security in Europe is vital. Again, this must recognise the roles of ESA and EUMETSAT as the vehicles for R&D and operations respectively. What is now needed is for the EC to develop a funding regime to support an operational programme of climate (and biosphere) monitoring and global security from space by bringing together the interests of Directorate General Research with that of other user Directorates General such as Agriculture and Environment.

- The GMES initiative ⁽¹¹⁾ currently being undertaken by the various relevant actors is a positive step towards answering that concern. The ESSC-ESF has recently produced a series of focused recommendations concerning the GMES initiative (see Appendix 3).
- Applications in Earth Observation, as promoted by the EC, are not simple to implement; they can only derive from a solid and thorough scientific understanding of the observations. This has only just started and activities related to technological research, development of data products, model validation and data archives require substantial EC support in the short-term.

Large research infrastructures for research in space

Physical and life sciences and applications in space will in the future mainly be funded in the context of the International Space Station (ISS) to which European space and research Ministers have committed themselves. Having done so, it is important that such an investment is used sensibly and effectively.

- The ISS needs to be recognised and funded as a large research infrastructure in support of space science, e.g. through the Sixth Framework Programme's ⁽¹⁰⁾ second avenue of approach in implementing the European Research Area, i.e. "Structuring the ERA" – Human resources and researchers mobility; Research infrastructures.

Near Earth Objects (NEOs)

Following recommendations put forward in the report of the UK Task Force on Potentially Hazardous Near Earth Objects ⁽¹²⁾, the ESSC-ESF established an *ad hoc* group to consider this question in both a European and broader international context with special reference to the possible role of European Agencies. In line with the first recommendations from this *ad hoc* group, the ESSC-ESF wishes to bring this issue to the attention of European policy makers.

- The ESSC-ESF endorses the conclusions of the UK Task Force and believes that the threat posed to humanity by NEO impacts is real and similar in character to other risks of low probability but high consequence which governments take very seriously, e.g. earthquakes and volcanic activity. The immediate need is to identify in full the population of NEOs with scale sizes that are potentially hazardous.
- Europe, in a fully international context, should play a major role in dealing with this issue in a scientifically sound and cost-effective way. Agencies such as ESA and ESO must play very significant roles in this activity, both through the use of ground-based telescopes for discovery, follow-up and physical characterisation, and through space-based assets for *in situ* observations.

ESSC-ESF specific recommendations on science issues related to Global Monitoring for Environment and Security (GMES)**Background**

The importance of the Global Monitoring for Environment and Security (GMES) initiative for the European Space strategy has been officially recognised by the European Research Council and the ESA Council meetings at ministerial level, on 16 November 2000 ⁽¹³⁾. The European Commission (EC) and ESA have been invited to provide a common framework for this initiative and to formulate concrete implementation proposals by the end of the first semester of 2001.

The aim of the workshop organised by ESSC in Brussels on 26-27 March 2001 and funded by ESF was to bring together policy makers at European and national levels, concerned with GMES issues, and leading scientists in the field of Earth Observation (EO) from Space. At the planning stage of a European GMES initiative, the purpose of such a forum was to clarify what is already scientifically achievable to meet the long-term policy or societal information requirements of governments, and to identify those critical monitoring requirements which require further scientific research before these information requirements can be met. Recommendations were formulated to present the science issues underpinning the establishment of a European GMES strategy.

This workshop included some 40 participants from the scientific community, ESA, the EC, EUMETSAT, ECMWF, WMO, national meteorological offices, national representatives, and industry. It followed the space symposium on "Monitoring and Protection of the Environment", organised by the French Ministry of Research, in Lille, in October 2000, and the GMES workshop on "Defining the role of EO in the environmental policy-making development and implementation processes" organised by the Swedish Environmental Protection Agency and by the Swedish National Space Board, in Stockholm, in March 2001 ⁽¹³⁾.

Recommendations were discussed during the workshop and are presented below, along with a definition of the GMES concept. These recommendations are grouped in seven sections: Scale; Role of science/scientists; Integrated approach; Long-term data supply; Partnership; Structure; and Outreach.

Definition

- GMES is a new, integrated approach to the routine acquisition of environmental data on the global scale, using both space-based and ground-based monitoring systems, to provide the management information necessary for sound decision-making by governments whenever and wherever the natural environment impacts on human society and constrains public policy.
- The continuous and coordinated acquisition of data envisaged in a GMES system is needed in a wide variety of contexts including: the routine operational forecasting of environmental conditions over land, sea and in the atmosphere; the monitoring of sudden changes to the environment in critical circumstances such as earthquakes, flooding and other natural disasters; the detection of human impact on the environment; and the long-term monitoring of global change enabling the forecasting of climate trends.

Appendix 3 ESSC-ESF specific recommendations on science issues related to Global Monitoring for Environment and Security (GMES)

Recommendations

Scale

- To understand, predict and manage the response to environmental events or changes which are essentially local or regional, it is essential to have access to observations at the appropriate resolution and models which define conditions at a regional, e.g. European, dimension, and at a global level.
- Potential components of GMES already exist, for example as new data product initiatives, analytical tools and local/regional/global environmental forecasting structures. These services should be supported in order to maintain and improve their products and to provide a demonstration of GMES capability.
- World-wide monitoring of the environment will be achieved most effectively and efficiently through international collaboration which should involve substantial contributions to a global observing system; although Europe should also ensure that it maintains the capacity for independent measurement of those global environmental parameters that are geopolitically sensitive.

Role of science/scientists

- While scientists should contribute at several levels in its development and applications, GMES is primarily an information tool for policy-makers, who will set the priorities which underlie scientific support activities required to ensure the quality of the information, products and services to be delivered by GMES, on the basis of consolidated user requirements.
- GMES must be viewed as a service-oriented rather than a scientific activity, although scientists will undoubtedly use GMES-acquired data in frontline research and in research that will be applied to the needs of GMES end-users.
- GMES is a fruit of recent scientific and technological achievements in the field of Earth observation, and provides an opportunity for society to reap the benefits of previous research investment.

Integrated approach

- Monitoring on a global scale is impossible without the use of Earth observing satellite systems, but GMES also requires data from surface and *in situ* sensors, models which interpret the diverse data types and information systems which integrate them for convenient use.
- A concerted strategy needs to be implemented to optimally exploit the existing science and technology and to promote further developments when requirements cannot be met.
- The GMES approach is based on scientific understanding of the whole Earth system. It will benefit from research that links Earth system science to the social sciences in the search for means of measuring and modelling mankind's impact on the natural environment, and vice versa.

Long-term data supply

- The acquisition of a reliable and continuous record of the present state of our environment is a legacy which society should leave for the benefit of future generations. It should be viewed

as a public good, owed to future generations, to better understand the anthropogenic impacts made on planet Earth.

- The forecasting of future environmental trends, based on a reliable historical record, is essential for developing a sustainable European economic lifestyle. To achieve this, GMES must record a continuous series of environmental data products, derived from state-of-the-art software and instruments, maintaining continuity of specification for the foreseeable future by ensuring intercalibration of datasets.
- It is not within the present remit of either science funding bodies or space agencies to support long-term environmental monitoring activities; a European political initiative is long overdue to meet this need with new funds.
- The scientific community, as represented through the relevant international global environmental change research programmes, such as the IGBP and the WCRP, is working through the IGOS partnership to develop effective long-term monitoring strategies for Earth system observation. The strategies are based on a long-term relationship between the scientific research and observation communities so that these strategies evolve in synergy with rapid changes in scientific understanding and observation technologies.
- Structures and organisations (e.g. EUMETSAT and ESA's Earth Watch missions) are already in place which could supply long-term data and products if commissioned to do so, while the EC's Sixth Framework Programme could, in the shorter-term, support the RTD studies needed to establish a European global environmental monitoring programme.

Partnership

- GMES should represent the European contribution to global monitoring. This requires discussions on the division of tasks between nations and continents in order to avoid overlaps and gaps. Active European involvement in IGOS is advisable.
- Industry, both providers of the observing systems and users of the data, should be an essential part of GMES. In particular, service-providing value-added companies are the clients of GMES products and should therefore be a driving force of the GMES concept and join the scientific community as they shape the scope of GMES.
- Industry should provide guidance on the feasibility of options when attempting to design a system to meet the identified requirements.
- New stakeholders of GMES, from both the public and private sectors, need to be identified, invited to help specify the GMES requirements and encouraged to invest in GMES. For instance the insurance sector will benefit from improved long-term forecasting made possible by GMES and should be challenged to contribute to the long-term investment required.
- Federations of beneficiaries of GMES need to be forged, such as EuroGOOS which speaks for the needs of the marine operational sector.

Appendix 3 ESSC-ESF specific recommendations on science issues related to Global Monitoring for Environment and Security (GMES)

Structure

- Existing facilities (satellites, ground segments), networks and software tools can form the basis of the GMES start-up phase.
- A clear data policy including data archiving and maintenance needs to be formulated, building on existing experiences and data sharing agreements, e.g. ECMWF/NASA/NOAA, CNES/SPOT IMAGE, etc.
- The existing European data links are clearly not adapted to the scope of the data exchange required for GMES, although emerging e-science facilities should support it.

Outreach

- The benefits to society of GMES are evident to the Earth observation science community, but they still need to be communicated to the public, politicians, policy-makers and agencies that will benefit most. Outreach is therefore a vital precursor of a successful GMES programme.

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