RSPG Report and Opinion # 6

RADIO SPECTRUM POLICY GROUP

REPORT AND OPINION ON

¨a Coordinated EU Spectrum Approach for Scientific Use of Radio Spectrum¨

FINAL – 25 OCTOBER 2006

0. Summary

Many fields of science depend on the use of radio spectrum. In its large majority, this spectrum could also be used for other radio applications, leading in certain cases to pressure and with this, to concerns about the long-term availability of spectrum for scientific use. RSPG therefore decided to draft a report and an opinion to the EC. The report includes an extensive overview of the scientific use of spectrum and distinguishes between those using passive and active radio techniques. Furthermore, the status of the radio spectrum used by scientific services is described.

In spectrum management it is becoming more and more important to estimate the value of different use of spectrum. In the case of scientific use of spectrum this may be quite difficult, as the benefits can relate to the society as a whole, may be difficult to foresee and may be realised over a very long period of time. Therefore, comparison with the economic benefits of services in the commercial field is often difficult.

The report gives examples of attempts to quantify the economic and societal value of scientific use of spectrum. These examples show that they are significant. Further attempts to describe in qualitative and quantitative terms, the benefits of these services should be made.

The consultation of National administrations on the effective use of spectrum by scientific services shows that only a small portion of spectrum is used by scientific services and that exclusive use is exceptional. In bands below 3GHz, only 15 MHz is exclusively allocated to meteorological services and 45 MHz to passive services.

Due to the specificity of exclusive bands mainly using passive techniques, they have been considered separately from shared bands.

Most of the bands used by scientific services are shared with other services. For example, on data transmission services most of the bands are shared with fixed and mobile services and on space science active sensors bands with radio navigation and radiolocation.

The results of the public consultation are given in section 7. Some of the comments received during the public consultation, proposed clarifications of the report whereas others provided extensive explanations on their activities.

The RSPG Opinion is in section 9. In particular, the RSPG urges Member States to respect their obligations under No. **5.340** of the Radio regulations and recommends the EC, when preparing spectrum measures, to support the needs of the scientific services in these particular bands. For other bands, the RSPG emphasizes the need to assess the impact of a potential decision on both scientific uses and other services when increased levels of sharing are being considered. Such an assessment should, according to the RSPG, contain in a proportionate manner the steps that are listed.

1. Introduction

This paper represents the Radio Spectrum Policy Group's (RSPG) progress report to the request from France and The Netherlands for an Opinion on spectrum used by scientific services (document RSPG05-67 and RSPG 05-82).

Many fields of science depend on the use of radio spectrum. This spectrum could also be used for other purposes, which in certain cases leads to pressure on the spectrum used by the scientific community. These developments have led to concerns about the long-term availability of spectrum for scientific use. Although these alternative applications may represent significant economic value, scientific usage of spectrum also has significant social and economic benefits.

The RSPG agreed to formulate an opinion on the scientific use of spectrum in order to get an overview of all important aspects of the spectrum-based activities of the scientific community and to issue recommendations.

2. Overview of Scientific Use

2.1 Introduction

Spectrum is used by several scientific services. These services use radio emissions to register naturally occurring physical phenomena or to communicate information between different locations. The following services are identified in the Radio Regulations: the Meteorological Aids Service, the Earth Exploration Satellite Service (EESS), the Meteorological-Satellite Service, the Space Research Service (SRS), and the Radio Astronomy Service (RAS). Also the Space Operation Service, the Radiolocation Service (RLS) and the Radionavigation Satellite Service are used for scientific applications[1].

This chapter gives a description of the various scientific activities. It is to be noted that these activities do not always coincide with the definitions of services used by the ITU in the Radio Regulations.

2.2 Meteorology and climatology

Weather forecasting is based on continuous global measurements of the state of the atmosphere. Computer models, using this data, calculate the atmospheric development for the forthcoming days. These measurements include ground-based and satellite-based active and passive observing systems. Furthermore meteorological radars as well as Wind-profiler Radars perform an important part in the meteorological observation processes. Currently there are approximately 100 wind-profiler radars (about 30 in Europe) and several hundreds meteorological radars (more than 160 in Europe) that perform precipitation and wind measurements. These radars play a crucial role in the immediate meteorological and hydrological alert processes, for example in providing valuable information for society on flash floods or severe storms.

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[1] These latter three services also cover applications not related to science.

Under the auspices of the World Meteorological Organisation (WMO) a worldwide exchange of meteorological data takes place. Beside radio spectrum that is required for the measurements and observations, meteorology also uses radio spectrum for the transmission of observed data.

Space-borne passive sensing of the earth's surface and atmosphere is of increasing importance in operational and research meteorology. It contributes also to the scientific understanding, monitoring and prediction of climate change and its impacts. Space-borne observations and their processing in numerical models are to a great extent attributable to the impressive progress made in the recent years in weather and climate analysis and forecasts[2].

Meteorological systems are also used to monitor changes in climate and the environment. Mankind is faced with a variety of environmental phenomena which require careful investigation and analysis. Meteorological systems gather long-term measurement data in support of studies on changes in climate and environment. Computer models derive the most likely scenarios for the development of changes in the climate. Thus, these measurements are essential background information to develop climate scenario's needed for the development of national and global policies concerning global change.

The prime importance of the specific radiocommunication services for meteorological and related environmental activities required for the safety of life and property, the protection of the environment, climate change studies and scientific research has been recognised in Resolution 3 (Cg-XIV) of the WMO[3].

2.3 Earth Exploration Satellite

The main goal of the Earth Exploration Satellite Services (EESS) is to monitor the changes of the earth and of the atmosphere, besides the activities described above (2.2) this also contains monitoring of and understanding the earth's environment[4]. In order to such measurements a wide variety of set frequencies is needed, including passive and active sensing, sending information from satellites to the earth (telemetry) and to control the satellites (telecommand). The long-term collection of data (many decades) provides the basic building blocks to address environmental issues.

Increasing concerns about environmental change have been raised at intergovernmental conferences (such as the Kyoto climate conference) and have led to the establishment of international (both European and global) programme's such as the ad-hoc Group on Earth Observations (GEO) and Global Monitoring of the Environment and Safety (GMES) (See chapter 4 for more information).

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[2] Including warnings for dangerous weather phenomena as heavy rain, storms and cyclones.

[3] See Annex 3

[4] For example: Stratospheric ozone depletion, middle atmosphere chemistry, tropospheric pollution, land surface monitoring, sea ice monitoring and glaciology.

2.4 Radio Astronomy

Astronomy provides knowledge of our planet Earth, other planets of the solar system, our own galaxy as external galaxies revealing our place in the Universe. Radio Astronomy is a significant part of astronomical science which permits to reach the extreme limits of the universe. New discoveries are regularly made.

For this it is necessary to operate many radio observatories with different instruments and locations, including in space, and to be able to observe at many different frequencies[5].

Radio waves of natural origin are extreme weak and their detection requires large reception surfaces (antennas) and the most sensitive receivers. This sensitivity also increases the interference potential for a passive operation. The combination of frequencies fixed by nature and weak signals asks for a well-protected environment.

The technique of very-long-baseline-interferometry (VLBI) provides a tool to gather data on the detailed structure and positions of astronomical sources, but it also has applications in many other fields of research. VLBI using sources in the sky has also been used to measure the mechanisms of the global climate and to do high-resolution positioning of spacecrafts. In addition, astronomical VLBI is being used for determining the detailed structures and the motions of tectonic plates for geodetic research and to determine accurate positions on Earth.

2.5 Space research

Satellites in the Space Research Service (SRS) are used to explore outer space for scientific purposes. This exploration covers studies on the structure and history of the universe and its dynamics. Depending on the specific scientific objective, these satellites can perform their observations while orbiting around the Earth or travelling across the solar system to explore its elements. Observations from the Space Research satellites range from microwave to optical.

Since these observations are not made in the direction of the Earth and in particular the active sensing is only performed on other planetary bodies than the Earth, no real interference issues are normally associated to the SRS passive or active applications.

Similarly to the EESS case, also for the SRS radio transmissions are used to downlink the satellite data to the Earth station and to control the satellite from the Earth station.

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[5] Each molecule radiates on a certain frequency band. For example hydrogen radiates at 1420.4058 MHz), these frequencies are determined by the physical structure of the molecule. Radio Astronomy receives naturally occurring signals from celestial objects, in order to use the signature and power of the radiation for interpreting the physics and chemistry of the gas and its spatial structure. The Doppler effect causes a general shift towards lower frequencies in the spectrum when observing specific spectral lines from sources that are moving away from us at very high velocities.

2.6 Radiolocation

Apart from Meteorological radars as described above, other scientific applications make use of the Radiolocation service to determine positions of various types of objects. In particular, the detailed surface and terrain characteristics of planets and asteroids are determined using radar astronomy.

2.7 Space Operations

The Space Operations Service allocations can be used for controlling and monitoring any space system. These allocations can therefore be used for scientific space applications, but also for other telecommunication space applications (commercial, military, etc.). It is to be noted that the ITU regulations impose to use telecommunication payload bands for controlling and monitoring the satellite during nominal operations. The use of these bands for space telecommunication services is therefore normally limited to the LEOP (Launch and Early Orbit Phase) and to the emergency situations; however, in deep-space mission, routine ranging and telecommand transmissions are needed during the whole life of a mission

3. Use of the Spectrum: Passive and Active Techniques

3.1 Introduction

The spectrum is used by scientific services for two types of measurements. Passive techniques are used to measure radiations that occur naturally, i.e. using "receiving-only techniques"[6]. Active techniques employ electromagnetic emissions for scientific purposes.

In addition to the spectrum used for these measuring/detection techniques, spectrum is also needed for data communication for certain services.

3.2 Passive techniques

Passive measurements or passive sensing require the measurement of naturally occurring radiations, usually of very low power levels, which contain essential information about the physical process under investigation and involves the use of receive-only techniques, with no transmitters involved.

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[6] Colloquially the verb 'listening' is erroneously used for this activity. The passive observing systems receive electromagnetic radiation, while listening would imply detecting sound (acoustic) waves.

All matter is continually radiating electromagnetic waves and as each molecule in the atmosphere or each surface property has unique frequency characteristics, it can thus be recognised from their spectral signature. Consequently, there are no alternative spectral options available for these specific measurements and therefore these frequency bands are an important natural resource that requires protection.

Of interest are radiation peaks indicating the presence of specific molecular species, or the absence of power at certain frequencies indicating for example the absorption of the signals by interstellar or atmospheric gases. The strength or absence of signals at particular frequencies is used to determine whether specific gases (molecules, moisture and pollutants being obvious examples) are present and if so, in what quantity and at what location. A variety of environmental information can be sensed in this manner. Signal strength at a given frequency may depend on multiple parameters, which makes it necessary to use several frequencies at the same time and at the same location to match the multiple unknowns. The use of multiple frequencies is the primary technique used to measure specific characteristics of the Earth surface.

Already low levels of interference received at the input of the passive sensors may degrade passive sensor operations since, in most cases, the sensors are not able to discriminate between these natural radiations and man-made radiations. In this respect Radio Regulations footnote 5.340[7] offers the passive services protection to deploy and operate their systems in the more critical frequency bands. Even a little interference in a ‘passive’ frequency band may have far-reaching impact on the overall quality and the interpretation of the measurements of global components in the Earth atmosphere and in astronomical data.

3.3 Active techniques

This active use of spectrum consists of active sensors (measuring the reflection of signals generated by the sensor itself) and communication (data and feeder links) between different sections of the system. The active services can be sub-divided on the basis of the type of usage. A distinction can be made between meteorological bands, Earth-to-space bands, space-to-Earth bands, space active sensors bands and ground based sensor bands (see Table 1). In astronomy, radar techniques are used to image the surface of planets and other nearby objects such as asteroids.

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[7] This footnote of the Radio Regulation states that ‘All emissions are prohibited in the following bands’, followed by a list of frequency bands.

Table 1, Different types of scientific use.

			Scientific Usage
Scientific Spectrum	Passive services		Radio Astronomy (2.4)
			Earth exploration satellite (2.3)
			Space research (2.5)
	Active services	Ground-based radars	Radar Astronomy (2.6)
		Meteorological bands	Meteorology and climatology (2.2)
			Radiolocation (2.6)
		Earth to space data transmission bands	Space operations (2.7)
			Earth exploration satellite (2.3)
			Space research (2.5)
		Space to earth data transmission bands	Space operations (2.7)
			Earth Exploration satellite (2.3)
			Space research (2.5)
		Space science active sensors bands	Earth Exploration satellite (2.3)
			Space research (2.5)
		Ground based sensors	Meteorology and climatology (2.2)

Based on these categories and sub-categories, the RSPG consulted Administrations on the use of the related frequency bands by scientific services and the sharing of these bands with other services. The consultation was organised during the first quarter of 2006 and its result is presented in section 6. The questionnaire is contained in annex 4.

4. Economic and Societal Value

4.1 Introduction

In spectrum management it is becoming increasingly important to estimate the social and economic value of different usage of spectrum. In the case of scientific use of spectrum it might not be as straightforward as simply weighing up the quantified costs and benefits when considering alternative usage. This is because the benefits of scientific use can be difficult to quantify as they can relate to the society as a whole, may be difficult to foresee and may be realised over a very long period of time. This chapter gives an indication that the economical and societal returns of scientific usage of spectrum are significant.

4.2 Benefits of meteorology

Direct economic and social benefits can be associated with general benefits deriving from improved weather forecasting capabilities as well as specific benefits such as support to civil aviation, shipping, land transportation and savings resulting from the timely preparation for adverse weather conditions. An illustration of the value of meteorology has been given by the WMO[8]: "Studies in the United States have shown that the value of improved seasonal weather forecasts to farming in the south-eastern quarter of the country alone amounts to some US$ 145 million a year".

Furthermore, "WMO has estimated that overall economic benefits of modern meteorological services typically outweigh the national cost of maintaining such services by a ratio of as much as 10 to 1." For Europe this would lead to the following figures: The total annual budget of European National Meteorological services and related organizations (EUMETSAT and ECMWF) is roughly between 1.8 and 2 Billions Euros. On the basis of the WMO calculation the economic benefits can be estimated between 18 and 20 Billions Euros per year.

Concerning natural disasters the WMO states, amongst others, that: "The economic impacts of natural disasters have worsened over the past few decades. Data from the International Federation of Red Cross and Red Crescent Societies as well as the Centre for Research on Epidemiology of Disasters reveal clearly that, during the period 1992–2001, about 90 per cent of natural disasters are weather and climate related and that the impacts of such disasters have been most pervasive during the past 10 years. During the same period, natural disasters worldwide have killed 622 000 people and affected over 2 billion people."

4.3 Benefits of climatology

Global Change is an important item on the international political agenda. The Kyoto protocol now being ratified, the yearly Conference of the Parties (CoP) of the UN Framework Convention on Climate Change (UNFCCC) continues to give worldwide political guidance. Based on inventories and recommendations developed by WMO's Global Climate Observing System, Parties are urged to implement climate monitoring systems that are essential to improve our understanding of climate change. This process has led to the establishment of the ad-hoc Group on Earth Observations (GEO), which developed a strategy to realise a Global Earth Observation System of Systems (GEOSS). In parallel to this the EU, in cooperation with ESA, started the Global Monitoring for Environment and Security initiative (GMES). Aiming at an operational system in a few years time, GMES is now being developed using EU Framework Programme funding. GMES should establish a network infrastructure all across Europe to facilitate information gathering for a wide variety of purposes. GMES is seen as the European contribution to GEOSS.

4.4 Benefits of natural hazard assessment

The UK Natural Hazard Working Group issued in June 2005 a Report to UK Prime Minister on "The role of science in physical natural hazard assessment". This report, the executive summary and Recommendations of which are in Annex 5, recognises the high value of scientific services in mitigating natural hazard and is now one of the reference documents of the "Group on Earth Observation" program.

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[8] The Sixth World Meteorological Organisation Long Term Plan (2004-2011)

In particular, it highlights an information from the World Bank that, during the 90's, an efficient warning systems could have decrease the economic impact of natural disasters by 240 Billions dollars and that it is reasonable to assume that the cost-effectiveness of anticipatory measures will apply at least as much to catastrophes of global extent as to local natural disasters.

Finally, this Report also states that "*The cost effectiveness of spending to mitigate economic losses is an important part of the argument for taking action on preparedness and mitigation, including early warning. However other potential consequences of a global catastrophe are manifold and incommensurable in economic terms, from large losses of life to threats to socio-political stability and security. We are faced with a stark choice when it comes to dealing with global geophysical events. Either take no action and incur the risks –potentially trillions of dollars of economic losses and millions of lives lost – or exercise precaution in the face of scientifically established global threats and take practicable measures to mitigate their impact.*"

4.5 Benefits from Radio Astronomy

Radio astronomy is a science whose progress is driven by the pace of technological improvements for the benefit of its research instrumentation. These instruments represent the most advanced radio technology existing today and are at the forefront of all associated technologies.

Radio astronomy has no control over the naturally generated radio signals that need to be detected. As a result radio astronomers have been forced to design and build antennas with the largest collecting areas, receivers of the highest sensitivity and with the lowest noise temperatures, and -in general- instrumentation that defines the state-of-the-art in signal reception and data analysis. The technical requirements of radio astronomy have directly or indirectly fostered technological **innovations** of very wide applicability. Examples are:

- Sensitive microwave receiving systems, including high-gain antennas, low-noise receivers, solid-state oscillators and frequency multipliers, cryogenics now available also on some of the most sophisticated telecommunication systems;
- Data correlation and recording technology, as a precursor of all types of modern digital techniques;
- Image restoration techniques that are extremely important on all environmental surveys;
- Time and frequency atomic standards, reaching the ultimate performance in measurement accuracy and precision (uncertainty levels of few parts in 10^{-16});
- Remote sensing, satellite navigation, position determination, and geodetics;
- Computer languages and software development

An application of radio astronomy that has direct economic and social benefits is the monitoring and forecasting of solar activities, which have a strong impact on ground based activities like wired transmissions, radio communications, power distribution and astronautics, and which are pre-requisite for manned space activities.

4.6 Public investments in scientific services

The facilities used by the science services represent billions of Euros of public investments on national or European basis. This includes the building of radio telescopes, scientific or meteorological spacecraft, and the deployment of scientific or meteorological and climatological stations all over Europe of which European companies are stakeholders.

On a general basis, costs for a single passive sensor instrument for radio astronomy, meteorology or Earth observation (both active and passive) can easily be in excess of 100 millions Euros. These costs are very often driven by the need to achieve front-line state-of-the-art system performance by means of completely innovative technical developments (including research). Because these instruments define the state-of-the-art, most are by their nature their own prototypes. The construction of these sensor instruments is very labour-intensive and requires specialized hardware.

The 6th and 7th Framework Programmes of the European Union actively stimulate the development of forefront scientific instrumentation and also provides partial funding for the hardware infrastructure.

5. Status of Radio Spectrum used by Scientific Services

5.1 Introduction

The allocation and protection of spectrum used by the scientific services is mainly regulated by the ITU Radio Regulations which is an international treaty.

Among the numerous ITU Radio Regulations footnotes related to the scientific services, two of these recognise the case of frequency bands used by passive services. Footnote 5.149 urges administrations to take all practicable steps to protect the Radio Astronomy Service from harmful interference in a number of specific frequency bands, Footnote 5.340 lists a number of essential frequency bands in which all emissions are prohibited,

It should be noted that the EC and ECC decisions on SRR 24 GHz authorised exceptionally and on a temporary basis, in-band emissions in the 23.6-24 GHz band[9].

5.2 Relationship between ITU Radio Regulations and the EU Treaty

From the beginning, harmonisation in the radiocommunications domain was achieved at the global level through WRC and incorporated in the Radio Regulations (RRs) of the ITU. These Regulations have the status of an international treaty.

This harmonisation meant that certain frequency bands were reserved for a certain use worldwide or regionally. The nature of the frequency usage determines whether and how much harmonisation is necessary. National allocation tables generally comply with ITU-RR and WRC decisions.

More recently measures to harmonise the usage of spectrum in the EU (EC Decisions) are taken on the basis of the Radio Spectrum Decision[10]. In order to avoid legal incompatibilities between provision of the RRs and the legal obligations under the EU Treaty and it's instruments the EU Members declare in the Final Acts of a ITU conference that: "The delegations of the Member States and future Member States of the European Union declare that the Member States and future Member States of the European Union will apply the revision of the Radio Regulations adopted at this conference in accordance with their obligations under the EC Treaty".[11]

With regards to scientific and meteorological services, there is currently a very high level of global harmonisation for active applications whereas, for passive bands, this harmonisation is obvious. It should also be noted that the scientific and meteorological communities coordinate among themselves to make the most efficient use of the corresponding frequency band.

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[9] This band is mentioned in Footnote 5.340 as one of the bands in which all emissions are prohibited.

[10] Radio Spectrum Decision 676/2002/EC, 7 March 2002.

[11] Declaration # 6, Final Acts WRC-03, Page XXXIV (English version)

5.3 Sharing Conditions

Exclusive use by scientific services is only necessary in a few cases. In general the scientific services achieve a significant degree of sharing with other services, and among themselves.

i) *Sharing in space science passive sensors bands*

A limited set of bands is purely passive and for these bands all emissions are prohibited according to footnote 5.340. The remaining issue in these bands is the compatibility with unwanted emissions received from active services allocated in adjacent or nearby bands. Possible inclusion in the Radio Regulations of regulatory unwanted emissions limits is being studied under WRC-07 Agenda Item 1.20.

The other passive bands are typically shared with FS/MS, in some cases also with FSS. For some of these bands the ITU has defined sharing criteria that resulted in recommendations or regulatory limitations. One of the main sharing risks relates to possible future decisions to use these bands for high-density commercial applications that would change the assumptions under which the sharing feasibility and conditions were determined. As an example, the case of the bands 10.6-10.68 GHz and 36-37 GHz are currently studied under WRC-07 Agenda item 1.2.

Due to specific physical characteristics, no frequency band used by passive services can be substituted by other bands. Interference that could impact a given "passive" frequency band could have an impact on the overall measurement of atmospheric components; this is in particular important for meteorology and climatology.

ii) *Sharing in space science active sensors bands*

Nearly all the space science active sensors bands are shared with radiolocation; in some cases the bands are shared also by radionavigation. Many years of coexistence without interference problems have confirmed the compatibility of these services in the bands allocated. A potentially critical sharing situation might develop in the range 5250-5350 MHz, where the decisions by WRC-03 only discourage but do not prohibit outdoor usage of wireless LAN. This part of the band is used for Synthetic Aperture Radar (SAR) imaging and supports the main GMES space element.

iii) *Sharing in space science data transmission bands (Earth-to-space, space-to-Earth)*

In general, there are no difficult sharing situations in most of the bands used for space science data transmission. For the Earth-to-space emissions, the fact of having ground stations in relatively remote and naturally shielded sites limits any possible interference to terrestrial services. Also the possibility of interference by terrestrial systems to the receiving ground station (space-to Earth transmission) is strongly limited by the remote location of these stations. As for the satellite part, by respecting the Article 21 limits, the space-to-Earth transmissions do not interfere with terrestrial systems. On the other hand, the high power required to reach the satellite receivers ensures that typically no interference is suffered by the space science satellites from terrestrial systems.

iv) *Sharing in radio astronomy bands*.

Sharing scenarios have been investigated for radio astronomy operations but have only been implemented on an ad-hoc basis. The sharing with other then passive services must be done on non-interference basis. In practice, By necessity the most sensitive observations are done at certain observatories and in certain bands the early morning hours may have less interference from when many of the terrestrial transmitters that are off the air, and from certain telecommunication satellite systems. This type of time sharing of active service bands on a non-interference non-protection basis is common practise. A specific problem with time-sharing for radio astronomy stations is that observations of celestial objects rely on sidereal time, which drifts by 2 hours per month as compared with solar time. In general, the European radio telescopes are significantly over-subscribed.

6. The Analysis of the Responses Received From Administrations to the Questionnaire's

The amount of spectrum used by scientific services is only a small portion of the total amount of available spectrum. Exclusive use is exceptional, in most cases the spectrum is shared by different users.

On meteorological services, three bands are exclusively allocated to this service according to the RR (401-403 MHz, 403-406 MHz & 1690-1700 MHz) representing 15 MHz out of the 158 MHz allocated to this service with a primary status below 3 GHz and the 440 MHz between 3 and 20 GHz. Below 3 GHz, around 300 MHz is allocated to this service with a secondary status. However, few countries allocated part of this spectrum band to other services, sometimes even with a primary status. Other countries did not allocate some of the bands allocated to meteorological services in the ITU-RR to any service and therefore the bands appear as being not used.

Eight bands are exclusively allocated to passive services (25.55-25.67 MHz, 1.6605-1.6684 GHz, 1.4-1.427 GHz, 2.69-2.7 GHz, 10.68-10.7 GHz, 15.35-15.4 GHz, 31.3-31.5 GHz, 50.2-50.4 GHz). The band 23.6-24 GHz is temporarily allocated to SRR in national allocation tables according to the EC Decision and despite footnote 5.340. This represents 45 MHz in bands below 3 GHz and 668 MHz out of approximately 4 GHz allocated to this service with a primary status in bands below 50.4 GHz. As indicated above some exceptions can be seen in the list of bands and some countries did not allocate some of the bands allocated to passive services in the ITU-RR to any services and therefore the bands appear as being not used.

On earth to space data transmission bands, only one band is exclusively allocated to this service according to the RR but not in reality (34.2-34.7 GHz). This represents 500 MHz out of around 1.7 GHz. The bands allocated to this service are generally shared with fixed and mobile services which have the same primary status.

On space to earth data transmission bands, no band is exclusively allocated to this service according to the RR. The bands allocated to this service are generally shared with fixed and mobile services which have the same primary status.

On space science active sensors bands, the bands allocated to this service according to the RR are shared with radionavigation and radiolocation. And in some cases these bands are also shared with SRR, SRDs and ISM.

On ground based sensor bands no band is exclusively allocated to this service according to the RR. The bands are shared with EESS-RAS-SR only, with the exception of SRR in the band 23.6-24 GHz which is temporarily allocated to SRR.

From the above it appears that 60 MHz is exclusively allocated to scientific services below 3 GHz and 1668 MHz in total even though some part of this spectrum is in reality shared with other services in some countries.

The Radio Astronomy Service strongly depends on the exclusive bands for sensitive observations. In addition, a number of RAS bands have a shared allocation in which observations are possible under controlled circumstances and using coordination procedures. RR Footnote 5.149 enumerates 46 spectral bands that used for research by the RAS but are shared with others operators and are under control of national administrations.

7. The Public Consultation

Comments were received from 11 organisations representing meteorology domain, the scientific community including radio astronomy and two specific industry sectors (automotive and broadcasting). Some of the comments proposed clarifications of the report whereas others provided extensive explanations on their activities which can be downloaded from the EU server:

http://rspg.groups.eu.int/consultations/index_en.htm

It should be underlined that the main controversial issue is related with the interpretation of the ITU RR footnote 5.340. On one hand, the scientific community considers that the footnote 5.340 lists a number of essential frequency bands in which **"**all emissions are prohibited**". **The community notes that the EC and ECC decisions on SRR 24 GHz authorised exceptionally and on a temporary basis, in-band emissions in the 23.6-24 GHz band, but with this occasion CEPT and EC did promise that "*shall make sure that any such temporary authorization of 24 GHz SRR systems is exceptional and can not be used as a precedent for possible introduction of other transmitter devices in bands where RR footnote 5.340 is applicable, for temporary or permanent use*". On the other hand, the automotive industry considers that it is not correct to say that sharing is not possible in these bands and is indeed possible on a non-interference basis, and claimed that in recital 8 of the Decision 2005/50/EC, footnote 5.340 may be applied in conjunction with article 4.4 of the ITU RR.

8. Conclusions

Many of the scientific activities are organised at a global level and, therefore, spectrum related issues must be considered globally since unilateral European Decisions may have worldwide impact on related frequencies use and measurements. This is, for example, the case for GEOSS.

Due to the specificity and uniqueness of passive bands there are no alternatives to gather the same information. Therefore these passive bands are unsuitable for migration and any potential interference would lead to the loss of the given molecular channel.

With regards to active services, the current extensive use of some of the bands should be considered prior any migration. As for other services, certain bands have specific characteristics (propagation, related antenna size) that do not allow a migration to a different frequency.

It should also be noted that certain measurements, for example EESS sensing, current data are compared with historical data. For these long term measurements and trends long-term consistency of measurements is essential.

Much of the radio astronomy operations have been concentrated and have been placed outside major metropolitan areas. Because of increased sensitivity of the instrumentation, these stations have become increasingly vulnerable to increased spectrum use and expansion of commercial operations into new frequency ranges.

Because the frequencies used in astronomical research are determined by fundamental physics, there is no choice in frequency and sharing of the bands is not possible.

With regards to new generation radio telescopes, the locations are carefully chosen in order to reduce the impact of man-made noise. The selection process for the SKA telescope is largely based on remoteness. Similarly, the location of the ALMA telescope in the high Andes in Chile was based on the height and remoteness. The ALMA lower receiver band is 30 GHz. This band (highest sensitivity) must be protected with the most interest. Geographical sharing of frequencies for ground based operations would only be possible when appropriate coordination distances are used that have been determined with terrain dependent propagation models. Because of the frequency dependence of the propagation, only geographical sharing would be possible for terrestrial frequencies above 60 GHz.

Scientific usage of spectrum has considerable societal weight and economic value. It might be difficult to quantify the benefits of scientific use as they can relate to society as a whole, may be difficult to foresee and maybe be realised over very long periods of time. In this opinion examples have been presented of some attempts at quantifying the benefits. Further attempts to describe in qualitative and quantitative terms, the benefits of these services should be made.

Therefore it is recommended that the cost and benefits should at least be described and the types of cost and benefits be spelled out so that an informed comparison can be made, between the qualitative description of the benefits and the quantified costs.

9. Opinion of the RSPG

9.1. Scientific use of radio spectrum covers a variety of services which are identified in the Radio Regulations as the Meteorological Aids Service, the Earth Exploration Satellite Service (EESS), the Meteorological-Satellite Service, the Space Research Service (SRS), the Radio Astronomy Service (RAS), the Standard Frequency and Time Signal Service and the Standard Frequency and Time Signal-Satellite service, the Space Operation Service, the Radiolocation Service (RLS) and the Radionavigation Satellite Service. In some cases, these may also cover other applications not related only to science, but the purpose of which is for both scientific and operational usage.

9.2. Scientific use of spectrum has a considerable societal value. Most of the data retrieved from the use of the so-called “scientific bands” are directly dedicated to the benefit of every citizen as they relate in particular to meteorology, climatology, environment, civil security and fundamental research. Most of the associated investments are coming from public funds.

9.3. Most of this societal value is incommensurable in financial terms, as they relate to preventing large losses of lives or threats to socio-political stability and security. However, scientific use of spectrum also has a direct impact in many economic areas, which can be estimated, and in producing economic spin-offs in technology and economic developments in energy, transportation, agriculture, communications, medicine, etc. An assessment of the overall benefits of scientific uses of spectrum needs to be taken into account and complemented, as appropriate, using the guidelines set out below, in order to facilitate future decisions by administrations which may impact on such uses.

9.4. The importance of inter-governmental commitments, among which the GMES initiative (Global Monitoring for Environment and Security), is a European priority, as is the World Weather Watch program of the World Meteorological Organisation, which rely on the availability of observations on every point of the Earth. This requires spectrum harmonisation at a global level, which is already achieved and should be maintained. Members States should take appropriate measures to ensure the availability and adequate protection of this globally harmonised spectrum in all countries, since unilateral European or national decisions may have worldwide impact on the quality and availability of data.

9.5. Exclusive allocations to scientific services are needed only to a limited portion of the spectrum, corresponding to unique frequencies. The RSPG considers that these represent essential natural resources and urges Member States to respect their obligations under No. 5.340 of the Radio Regulations, which prohibits all emissions in the corresponding frequency bands. The RSPG recommends the EC, when preparing appropriate measures on spectrum, to support the needs of the scientific services in these particular bands.

9.6. In all cases not covered by No. **5.340**, scientific use of spectrum achieves a significant degree of sharing with other services, as well as with other scientific uses, with varying degrees of limitations:

- in most of the bands allocated to satellite active sensors, no limitations are imposed on other services;
- in the bands allocated to radio astronomy and to SRS/EESS/METSAT for data communication purposes, limitations to other services only apply in the vicinity of a few geographical sites;
- Passive sensing from satellites requires worldwide protection, and limitations on other services are more significant.

9.7. The current and expected pressure on spectrum may lead to consider increased levels of sharing between scientific uses and other services, in all cases not covered by No. **5.340**. In such cases, the impact of a potential decision on both scientific uses and other services should be duly assessed. Such assessment should, in a manner proportionate to the potential impact:

- identify the **objectives** of a proposed decision and identify a **range of options**;
- draw up a list of different groups of **stakeholders** likely to be affected;
- identify the social and economical **impact of the various options** on the interests of stakeholders;
- take into account **commitments/obligations** in international initiatives/agreements;
- identify and, where possible, quantify the **costs and benefits** flowing from the impacts which each option would have, ensuring that any assumption are clearly recorded and that appropriate time scales have been considered ;
- Assess the **risks** associated with each option, including adequate procedures to ensure that the spectrum is appropriately managed.

Annex 1

Earth observation

The past decade has seen increasing public concern about the Earth, its environment and mankind's impact upon it. Global threats such as climate warming, stratospheric ozone depletion, tropospheric pollution and increasing number of extreme weather events, have left us more concerned than ever about the need to monitor and understand what is going on in the Earth's environment. There are many aspects of the complex evolving Earth System that we still do not understand.

These concerns have led to the establishment of international (both European and global) programme concepts, including both space- and surface-based systems, to measure on a routine basis all major elements of the global climate system.

Some of the earliest initiatives, including METEOSAT and SPOT, have already developed into long-term applications programmes integrated into regular operational use. For example, the fleet of geostationary Meteosat satellites that is observing the weather in real-time is providing a reliable stream of data ever since the launch of the first Meteosat in 1977, helping to significantly improve weather forecasting.

Earth observation from space using microwave remote sensing is a critical tool in this task because of the all-weather/ day-night capabilities, unique view and high revisit rate that it provides. ESA's European Remote Sensing satellites (ERS-1,-2), Odin satellite (a Swedish, French, Finnish and Canadian project) and ENVISAT carrying a multitude of instruments have made major contributions in areas as diverse as global and regional:

- ocean observations;
- atmospheric composition and chemistry;
- sea ice monitoring;
- glaciology and snow cover investigations;
- land cover monitoring;
- Investigations into the dynamics of the Earth's crust (seismology and volcanology).

Active remote sensing in the microwave region offers several advantages over visible region sensors and passive microwave sensors. Besides being uniquely sensitive to several land/ocean/atmosphere variables (e.g. plant moisture and cloud height), active sensing can, for instance, penetrate the surface and vegetation, operate on an all-weather and day/night basis. Active sensors differ from passive sensors in that they illuminate the object under observation and respond to the reflected energy.

For most of the EESS (active) sensors, the operating frequency range is linked to the geophysical parameters to be observed. For instance, to enable measurement of clouds and precipitation, the wavelength needs to be small enough to reach the required sensitivity.

To illustrate one of the applications, Figure 1 shows an artificially coloured ERS-1 SAR image, covering an area of 75 km x 75 km. It shows the Teles Pires river in Brazil and a regular pattern of deforestation is clearly visible in the rectangular patches of destroyed forest extending over areas as large as 20 kilometres. More recently, spaceborne SAR imagery was used to detect illegal logging activities in Indonesia after which action was taken to arrest and detain the responsible persons.

Figure 1: Brazil Deforestation (copyright ESA 1992)

Passive microwave radiometry is a tool of fundamental importance for the EESS. The EESS operates passive sensors that are designed to receive and measure natural emissions produced by the Earth surface and its atmosphere. The frequency and the strength of these natural emissions characterize the type and the status of a number of important geophysical, atmospheric and surface parameters (land, sea, and ice caps), which describe the status of the Earth/atmosphere/oceans system, and its mechanisms:

- Earth surface parameters such as soil moisture, sea surface temperature, ocean wind stress, ice extension and age, snow cover, rainfall over land, etc;
- Three-dimensional atmospheric parameters such as temperature profiles, humidity profiles, total water vapour content and concentration profiles of radioactively and chemically important trace gases (for instance ozone and chlorine monoxide).

Microwave techniques render possible observation of the earth’s surface and its atmosphere from space orbit even in the presence of clouds, which are almost transparent at frequencies below 100 GHz. This “all-weather” capability has considerable interest for the EESS because more than 60% of the earth's surface is overcast with clouds. Passive microwave sensing is an important tool widely used for meteorological, climatological, and environmental monitoring and survey (operational and scientific applications), for which reliable repetitive global coverage is essential.

Annex 2

Radio Astronomy

The purpose of the Radio Astronomy is to do fundamental research on the nature of the universe in which we live. This research seeks to answer some of the biggest questions we can ask, such as how did the universe begin (or did it begin), how big is it, how old is it, and how will it end (or will it end)? As the science that provides the framework knowledge of where we, and the planet on which we live, fit into the environment of the universe, astronomy is a vital part of the culture of all mankind. From the dawn of civilization, astronomy has provided important stepping stones for human progress. Our calendar and system of timekeeping came from astronomy. Much of today's mathematics is the result of astronomical research. Trigonometry was invented by Hipparchos, a Greek astronomer. The adoption of logarithms was driven by the needs of astronomical calculations. The calculus, the basis of all modern science and engineering, was invented by Sir Isaac Newton for astronomical calculations. Astronomy provided the navigational techniques that allowed sailors and aviators to explore our planet (and today allow spacecraft to explore our solar system). Astronomy's appetite for computational power drove the development of many of the earliest electronic computers. The space age, which brought us the communication and weather satellites upon which we depend each day, would have been impossible without the fundamental knowledge of gravity and orbits discovered by astronomers. Radio astronomers led the development of low-noise radio receivers that made possible the satellite communications industry. Image-processing techniques developed by astronomers now are part of the medical imaging systems that allow non-invasive examination of patients' internal organs. At today's observatories, the needs of astronomers for better instruments continue to drive developments in such diverse fields as electronics, mechanical engineering, and computer science.

Astronomy has much yet to contribute to human knowledge and progress. From the airplane to the transistor, from radio to lasers, the developments of the Twentieth Century were based on fundamental knowledge of the physics of matter and energy. Astronomy offers scientists from a wide range of backgrounds with a nearly infinite variety of cosmic "laboratories" for observing physical phenomena. It is unlikely that any laboratory on Earth will ever produce matter as dense as that of a neutron star, temperatures as hot as those inside a supernova, or gravity as strong as that of a black hole. Yet, astronomers can study the physics of such extreme conditions routinely with modern radio telescopes. Closer to home, using the technique of very-long-baseline-interferometry provides a primary tool gather valuable data on the drift of Earth's continents and the mechanisms of global climate and to do high-resolution positioning of spacecraft.

Adapted from the National Radio Astronomy Observatory, Charlottesville VA, USA http://www.nrao.edu/whatisra/valueofastro.shtml

Technological Contributions from Radio Astronomy

Radio Astronomy has long-term cultural and scientific returns, but it also provides benefits in the shorter term:

(a) The development of *very-low-noise receivers* with system temperatures as low as 4 K and frequencies extending from a few MHz to 1500 GHz. These have wide applications in radio technology.

(b) *Thermography of the body* by use of millimeter radio techniques (~45 GHz).

(c) The detection of *cancer* at centimetre wavelengths (~10 GHz) with modern radiometers and using a method of mini-aperture synthesis (interferometric triangulation).

(d) Computerized *x-ray tomography*, which employs methods originally developed for mapping radio sources.

(e) The detection of *forest fires* by their microwave radiation.

(f) Development of *radio sextants* for marine navigation, allowing accurate determinations of positions at sea even on overcast and rainy days. A recent application is the use of radio interferometry for emergency position determination of mobile phones.

(g) *Forecasting of earthquakes* by VLBI measurements of fault motion by a determination of the apparent positions of small radio sources.

(h) Determination of many geophysical parameters such as *continental drift, polar wandering, latitude measurements*, and *variation in the earth's rotation*, with the use of connected elements and VLBI techniques.

(i) Experimental verifications of Einstein's *General Theory of Relativity* and the phenomenon of gravitational lensing using radio interferometry, and verification of the existence of gravitational waves, and precise confirmation of Einstein's *General Theory of Relativity*, from timing measurements of binary pulsars.

(j) Testing *theories of the origin of the Universe* by observing the 3 K background radiation, the relic of the primeval fireball or Big Bang.

(k) Major contributions to navigation -including that of spacecraft- and timekeeping resulting from pulsar observations and very-long baseline interferometry (VLBI)..

(l) Adoption of radio astronomy interferometric methods to develop *passive remote-sensing* techniques for measuring the temperature of the earth's atmosphere, surface properties, and the distribution of water vapour, cloud water, precipitation, and impurities such as carbon monoxide.

(**m**) Monitoring and prediction of solar activity, and its impact on human activities: telecommunications, power distribution and astronautics.

Monitoring of solar activity and reliable solar forecasting have a strong impact on many ground based activities such as wired transmissions, radio communications, power distribution, and astronautics. These activities are a pre-requisite for manned space activities.

The radio astronomy service is an integral part of astronomical research that is being done in almost all countries around the world. The results of this research are all in the public domain and have invaluable social and cultural value because it helps define the place of mankind in the universe and to determine the history of the solar system, our Galaxy and the whole universe.

Trends in Radio Astronomy

Current trends in radio astronomy are towards even higher sensitivity at all frequencies. Since current receivers are reaching the quantum limit and cannot be further improved, there is a drive towards larger collecting areas and the use of broader operational bandwidths. International efforts are underway to construct new generation radio telescopes that have significantly larger collecting surfaces. Examples are: 1) the Square Kilometre Array project, which seeks to build a giant radio interferometer with a total collecting area of a square kilometre and baselines up to 3000 km operating in the 100 MHz – 25 GHz frequency range, 2) the Low Frequency Array (LOFAR) in The Netherlands, a radio interferometer with a total collecting surface of 100,000 m^2 and baselines up to 450 km operating in the 30 – 250 MHz frequency range, and 3) the Atacama Large Millimetre Array with 64 antennas operating from 30 to 850 GHz on a 5 km high plateau in the Andes.

In the development process towards larger sensitivities, the actual use of frequencies will not change significantly. The existing bands allocated to the RAS that enjoy protecting status will continue to be used for long-time integrations to detect weak signals of interest. Because these bands have been chosen for physical reasons and for the presence of important spectral lines, the continual protection for these bands is essential for the continuation of radio astronomical research in a large number of key areas.

Annex 3

World meteorological organisation

RESOLUTION 3 (Cg-XIV)

RADIO FREQUENCIES FOR METEOROLOGICAL and related environmental ACTIVITIES

The congress,

Noting

(1) The Sixth Long-term Plan.

(2) Resolution 3 (Cg-XIII) – Radio-frequencies for meteorological activities.

(3) The current radio frequency allocations and regulatory provisions related to the Meteorological Aids, Meteorological Satellite, Earth Exploration-Satellite and Radiolocation (weather and wind profiler radars) Services in the Radio Regulations of the International Telecommunication Union (ITU).

(4) The outcome of ITU World Radiocommunication Conferences (esp. WRC-2000).

(5) The agenda of the forthcoming ITU World Radiocommunication Conference (WRC-2003).

Considering

(1) The prime importance of the specific radiocommunication services for meteorological and related environmental activities required for the safety of life and property, the protection of the environment, climate change studies and scientific research.

(2) The crucial importance of the allocation of suitable radio-frequency bands for the operation of surface-based meteorological observing systems, including in particular radiosondes, weather radars, wind profiler radars.

(3) The crucial importance of the allocation of suitable radio-frequency bands for the operation of Meteorological and Research & Development satellites, including remote sensing, data collection and data distribution links.

Stressing that some radio-frequency bands are a unique natural resource due to their special characteristics and natural radiation enabling spaceborne passive sensing of the atmosphere and the Earth surface, that deserve adequate allocation to the Earth Exploration Satellite Service (passive) and absolute protection from interference.

Expresses its serious concern at the continuing threat to several frequency bands allocated to the Meteorological Aids, Meteorological Satellite, Earth Exploration-Satellite and Radiolocation (weather and wind profiler radars) Services posed by the development of other radiocommunication services.

Requests the Commission for Basic Systems to pursue the continuous review of regulatory and technical matters related to radio-frequencies for operational and research meteorological and related environmental activities, in coordination with other technical commissions and in liaison with other relevant international bodies, in particular the Coordination Group for Meteorological Satellites (CGMS).

Urges all Members to do their utmost to ensure the availability and protection of suitable radio frequency bands required for meteorological and related environmental operations and research, and in particular:

(1) To ensure that their national radiocommunication administrations are fully aware of the importance of and requirements for radio frequencies for meteorological and related activities, and to seek their support in the ITU World Radiocommunication Conferences and Radiocommunication Sector (ITU-R) activities.

(2) To actively participate in the national, regional and international activities on relevant radiocommunication regulatory issues and, in particular, to involve experts from their Services in the work of relevant regional radiocommunication organizations and of the ITU Radiocommunication Sector (ITU-R), especially ITU-R Study Group 7 on Science Services.

(3) To adequately register with their national radiocommunication administrations all radiocommunication stations and radio frequencies used for meteorological and related environmental operations and research.

Appeals to the International Telecommunication Union and its Member Administrations:

(1) To ensure the availability and absolute protection of the radio-frequency bands which, due to their special physical characteristics, are a unique natural resource for spaceborne passive sensing of the atmosphere and the Earth surface; In this regard, the exclusive 23.6-24 GHz passive band that is associated with a water vapour absorption line is of crucial importance for weather, water and climate research and operations.

(2) To give due consideration to the WMO requirements for radio frequency allocations and regulatory provisions for meteorological and related environmental operations and research.

Requests the Secretary-General:

(1) To bring this resolution to the attention of all concerned.

(2) To pursue as a matter of high priority the coordination role of the Secretariat in radio frequency matters, especially with the Radiocommunication Sector (ITU-R) of the International Telecommunication Union, including participation of WMO in

ITU-R Radiocommunication Study Groups, conference preparatory meetings and World Radiocommunication Conferences;

(3) To facilitate the coordination between National Meteorological and Hydrological Services and their national radiocommunication administrations, particularly in preparing the ITU World Radiocommunication conferences, by providing appropriate information and documentation.

(4) To assist the Commission for Basic Systems in the implementation of this Resolution.

Annex 4

RADIO SPECTRUM POLICY GROUP
Consultation of Administrations
ON
Spectrum used by Scientific Services

INTRODUCTION

The consultation of Administrations on spectrum used by scientific services aims at collecting detailed information on the use of spectrum allocated to scientific services in each EU Member State. For this purpose, the annexed questionnaire has been prepared. The collected information will be used when preparing the RSPG opinion or any other relevant output of the Radio Spectrum Policy Group (RSPG).

The RSPG endorsed **a request for an RSPG Opinion on scientific use of spectrum[12].** This initiative was motivated by the growing concern of the scientific and meteorological communities about their spectrum-dependent activities. The RSPG agreed to establish a working group which is co-chaired by the French and Dutch delegations, i.e. respectively Mr. F. Rancy and Mr. F. Bos.

The results of the first round of discussions with participation of the scientific community focused on initial issues in order to get the work in motion, including the scope of scientific services to be addressed (pure science requiring passive services / science with commercial outputs / services that provide infrastructure support); the distinction between active and passive services, sharing options and protection criteria applicable to various categories of users/services; the definition of “scientific services”; aspects linked to cost / benefits analysis; synergy with other Community programs.

RSPG members are requested to ensure that information on the national situation will be made available in due course in order to allow the working group to assess this information.

With these objectives in mind, scientific service spectrum has been divided in the following categories:

1. Meteorological
2. Earth to Space
3. Space to Earth
4. Space active sensors
5. Passive
6. Ground-based Sensor

Each category used in the questionnaire may include several services and specific emphasis is placed on bands which are underlined in yellow and for which European projects have been deployed.

The objective of the questionnaire is to collect information on the allocation made to scientific services and to other radiocommunications services in each national table on the bands listed in the questionnaire. For this purpose it will be useful to know if the bands allocated to scientific services are effectively used in Europe for other purposes than scientific use, are shared with other services and to what extent such use has been, could of should be harmonised. The questions are the following and comments added in italic characters:

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[12] Chairman’s Report of RSPG #7, 16 June 2005 (RSPG 05-91)

1. Is the band allocated to a scientific service in your country? Which one(s)?
   For some scientific services an allocation is needed in all EU countries, but for others it may be needed only in some countries. Updated information is therefore useful to obtain a clear view of the current situation.
2. With which status?
   It is important to know if the status given at national level corresponds to the status given in the RR.
3. Is the band shared with another service? Which one(s)?
   In the RR, most of the bands allocated to scientific services are shared with other primary services. It is important to know the situation at national level and what is the situation in practice?
4. With which status?
   Same comments as above
5. How is sharing with scientific services ensured?
   It is important to know if the sharing between scientific services and other services is consistent.
6. If possible, provide information on the number of stations.
   It is an important element on the sharing between scientific and other services which therefore has been considered separately.

The responses will be considered by the WG at its meeting on 5 and 6 April and their synthesis will be presented at the RSPG#10 on 11 May 2006.

The deadline for responding is therefore the 13th of March 2006. Please send your responses to Erik Moll (H.G.Moll@minez.nl) and Jean-Yves Montfort (montfort@anfr.fr).

Annex 5

The Role Of Science In Physical Natural Hazard Assessment
Report to the UK Government by the Natural Hazard Working Group

Executive Summary

The Prime Minister's request

1. Following the tragic Asian tsunami on 26 December 2004, the Prime Minister asked the Government's Chief Scientific Adviser, Sir David King, to convene a group of experts (the Natural Hazard Working Group) to advise on the mechanisms that could and should be established for the detection and early warning of global physical natural hazards.

2. The Group was asked to examine physical hazards which have high global or regional impact and for which an appropriate early warning system could be put in place. It was also asked to consider the global natural hazard frameworks currently in place and under development and their effectiveness in using scientific evidence; to consider whether there is an existing appropriate international body to pull together the international science community to advise governments on the systems that need to be put in place, and to advise on research needed to fill current gaps in knowledge. The Group was asked to make recommendations on whether a new body was needed, or whether other arrangements would be more effective.

Observations and Recommendations

3. There is a renewed commitment in many countries and international organisations to undertake disaster reduction and to put early warning systems in place. Many programmes have been established or are proposed to address the threat posed by physical natural hazards.

4. However, these programmes are as yet insufficiently co-ordinated; there is an evident need for a more strategic and sustainable global approach. Greater linkage of national and international programmes is needed in order to use resources better, prevent duplication and ensure effort is focussed on gaps in the global infrastructure.

5. The Group endorses the view expressed at the Kobe World Conference on Disaster Reduction (Jan 2005) that there is a clear need for a sustainable and effective global multi-hazard early warning system building on existing capabilities and frameworks. In this context we welcome the developing Global Earth Observation System of Systems (GEOSS) and recognise the high level of effectiveness of the World Meteorological Office (WMO) hydrometeorological warning system under the coordination of the United Nations.

6. A disaster management system requires continual investment, effective governance and integration into relevant development planning processes, all aimed at reducing the vulnerability of the population to natural hazards. The UN plays a key role in these areas. However there is duplication of effort between UN

agencies, and the International Strategy for Disaster Reduction (ISDR), while generally well conceived, currently lacks the capacity and resources to play its designated role effectively, in particular to improve knowledge about disaster causes and options for risk reduction.

7. Early warning systems must be part of the broader disaster management system. Essential elements of early warning include forecasting and prediction, assessment, preparedness, effective means of communication, appropriate technology and maintenance. The robustness of these elements depends significantly on sound scientific and technological assessment of hazards, and of possibilities for risk reduction. However despite progress made in the field of science, technology and research on natural hazards it appears that scientific knowledge is often poorly applied to disaster risk management policies and programmes.

8. Before the December 2004 tsunami there was sufficient weight of scientific knowledge which, had it been effectively communicated to decision makers, should have resulted in better preparedness. There should also have been a better way to communicate the scientific experts' evidence on the risks of further events in the same region. In the event there was indeed a further major earthquake on the same fault line in March 2005, south of the initial one, though not, fortuitously, a further tsunami.

9. We are clear that there is an urgent need to improve the integration of scientific knowledge of physical natural hazards into the management of early warning. Robust communication lines between the scientific community and decision-takers must be established and strengthened to ensure effectiveness.

Key Recommendation

We recommend the establishment of an International Science Panel for Natural Hazard Assessment. The Panel would enable the scientific community to advise decision-takers authoritatively on potential natural hazards likely to have high global or regional impact. It would facilitate individual scientists and research groups pooling their knowledge and challenging each other; it would address gaps in knowledge and advise on potential future threats. It would address how science and technology can be used to mitigate threats and reduce vulnerability.

10. Our recommendation to establish such a Panel is intended to fill a gap in existing efforts to address the threat posed by natural hazards. It should not replace or duplicate existing frameworks or institutions. The Panel should sit comfortably within the overall UN disaster management framework and have close links with relevant agencies and initiatives to ensure that its findings are applied.

11. Having looked at the costs of bodies operating in a similar capacity to the proposed Panel, we are confident that its costs would be minimal compared with the benefits in terms of cost effectiveness of soundly based preparedness and mitigation measures. These measures would, in turn, bring enormous benefits both in terms of reduced economic costs and human lives lost by preventing a hazard becoming a disaster. If integrated into the framework of an existing relevant international organisation we anticipate costs would be in the region of £0.5m – £1m a year.

12. With regard to existing early warning mechanisms we are impressed by the global operational warning system used by the hydrometeorological community. This system is mature and has proven to be effective. The WMO system is supported by 187 countries and operates 24 hours a day throughout the year. However for most other natural hazards there is no single internationally recognised authority or official warning process. There is therefore a real risk of ineffective, inaccurate and conflicting warnings.

Recommendation 2

We recommend consideration of the possibility of developing the WMO framework to provide an authoritative co-ordinated warning system for other natural hazards. To do this it would need to establish effective working relationships and operational communications with other relevant bodies, including the Science Panel recommended above.

13. The Group is confident that the cost of implementing this recommendation would be small. Extending use of the WMO framework in this way would require minor upgrades of some existing systems and some additional staff. It clearly represents good value for money when set against the alternative of establishing a new, parallel early warning system.

14. For any early warning system to be effective it is essential that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation. Institutional capacities must be established to ensure that early warning systems are well integrated into government policy and decision-making processes and emergency management systems at both the national and local levels. Such early warning systems should be subject to regular system testing and performance assessments.

Recommendation 3

We recommend that governments and international bodies prioritise national capacity building for hazard risk management. In particular greater support should be given at the national level to the improvement of scientific and technical methods and capacities for risk assessment, monitoring and early warning.