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History, Strategy and Status of IAU Actions

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Abstract. A brief account is given of how environmental challenges to astronomy have grown and diversified and how the IAU has addressed the problem. In the 1970s and '80s, appeals and Resolutions of increasing urgency were addressed to governments and other authorities. In the 1990s, interdisciplinary organisations such as ICSU and UNESCO were enlisted as allies. The present Symposium marks the beginning of a new phase, where direct collaboration with United Nations Member States is sought through the UN Committee on the Peaceful Uses of Outer Space.

1. Introduction

Observation is the lifeblood of astronomy. Progress in our understanding of the Universe derives from observations of ever greater breadth and depth. Over the past half-century, the breadth has increased by the expansion of the observable wavelength range from traditional visible light to the entire electromagnetic spectrum from γ-rays to long-wavelength radio waves, and immensely greater depth has been reached with larger telescopes and ever more sensitive detectors. The richness of our current picture of the Universe, from the grand design to the detailed physics, was unimaginable a century ago. Yet, the unsolved problems are as challenging as ever and we must push on.

Unfortunately, this is no longer a matter of just improving telescopes, instruments and detectors, or even of placing observatories in space or in dark sites. The limits to what we can do are increasingly set not by our own tools, but by man-made noise at all frequencies and engulfing the globe.

These problems are reviewed in detail in the remainder of this volume. Ground-based light pollution has already driven dark-sky astronomy off more than one continent, to the detriment of astronomy, the environment, wildlife, and budgets alike. Meanwhile, developments in space have not only brought us UV, X-ray and γ-ray astronomy and the *Hubble Space Telescope*, but also a barrage of space debris, satellite trails on astronomical images, Iridium flashes and GLONASS beacons, and ceaseless mobile telephone chat everywhere.

It is a key responsibility of the IAU to gather experience of these problems from all over the world and promote rational solutions, and the IAU has done this for decades. In the beginning, problems were mostly local and a few local authorities, governments and space agencies controlled the scene. Recent years

have, however, seen an explosion of activities, particularly in space, fueled by a deliberate policy of privatisation and deregulation of trade.

An effective defence of astronomy in this political environment requires an appropriate update of our strategy. Holding the present Symposium in Vienna at the time of UNISPACE III is part of this revision. After a brief review of the growth of the challenges and the (re)actions of the IAU, I shall outline our current strategy and some tentative directions for the future.

2. How the Problem Evolved and What the IAU Did

Older volumes of the IAU Transactions reveal, often strikingly, how the environmental impacts on astronomy and the reactions of the IAU, have evolved both qualitatively and quantitatively. Very schematically, one can discern three distinct phases in these developments.

2.1. "The Good Old Days"

The proliferation of urbanization and of electric lighting coincided with the increasing recognition of the importance of clear and stable air providing sharp, unobscured views of the heavens. This led to the foundation of some major observatories on mountaintops, e.g. the Lick and Mount Wilson Observatories. But while they still enjoy good seeing, their dark skies are now gone: astronomers are familiar with the pictures of Los Angeles as seen from Mount Wilson early and late in the 20th century, but these are just the most striking examples of a problem that has become global in the meantime - see elsewhere in this volume.

The IAU reaction followed a dual strategy: To identify sites in the world of high potential quality for astronomy for decades; and to help develop measures that would ensure that they remained pristine. For this, IAU Commission 50, *"Identification and Protection of Existing and Potential Observatory Sites"* was created at the XVIth General Assembly in Sydney in 1973. Its first President, Merle F. Walker, described its plan of action thus (Walker 1976):

> The role of the Commission in the protection of existing sites is intended to be three-fold: (1) In collecting and disseminating information regarding site protection measures being considered or that have been adopted. (2) In recommending types of protection actions to be taken. (3) In supporting protection measures for specific sites.

Commission 50 quickly wrote off radio astronomy as a concern, as it was in the good hands of the (IAU-URSI-COSPAR) Inter-Union Committee on Allocation of Radio Frequencies to Astronomy and Space Research (IUCAF). Solar astronomy sites were thought to be in danger 'only' from atmospheric and radio wave pollution and therefore also not an immediate concern - which is probably still largely true. Commission 50 therefore restricted its attention exclusively to sites for optical dark-sky astronomy. It is an amusing sidelight on the development of astronomy that such sites were then referred to as "stellar sites"(!).

Commission 50 also had interesting organisational features, viz., the following quote from Walker (1976):

> Owing to the special nature of this Commission, the membership of the Commission consists of: (1) An Organising Committee, consisting of (a) individuals actively working in the field of site investigation and protection and (b) representatives of major national and international observatories. (2) National Representatives, appointed by the National Committees of member countries of the Union, who form the general membership of the Commission. To date, 25 countries have appointed delegates to the Commission.

Perhaps this structure should be revitalised for the future. Good contacts to the world's major astronomical research organizations will certainly be needed to develop technically sound proposals for international measures to protect astronomy. And contacts to national delegates to international organizations such as the United Nations or the International Telecommunication Union (ITU) will be vital for any real action to materialise (see later).

Commission 50 quickly set up a cooperation with lighting engineers as represented by the Commission Internationale d'Eclairage (CIE) - a hallmark also of the present Symposium - and recommendations for controlled lighting near observatories were developed. But the restriction of Commission 50 to "stellar sites" was short-lived. Already the XVIIth General Assembly in Grenoble in 1976 passed its Resolution 9 explicitly in defence of radio astronomy, while the more general Resolution 10 read as follows (Cayrel 1979):

> The IAU notes with alarm the increasing levels of interference with astronomical observations resulting from artificial illumination of the night sky, radio emission, atmospheric pollution and operation of aircraft above observatory sites.
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> The IAU therefore urgently requests that the responsible civil authorities take action to preserve existing and planned observatories from such interference. To this end, the IAU undertakes to provide through Commission 50 information on acceptable levels of interference and possible means of control.

Commission 50 then focused on each of the adverse effects listed in the first paragraph and proceed to develop specific recommendations on each of these. A landmark in the field was the joint IAU/CIE publication *"Guidelines for Minimizing Urban Glow near Astronomical Observatories"* (Cayrel & Smith 1980). These recommendations were heeded, e.g. by Tucson (Arizona, USA), which adopted lighting regulations that not only protected nearby Kitt Peak National Observatory from the full impact of the population growth of Tucson, but also led to better-quality lighting and substantial energy savings.

The second paragraph could no doubt be unanimously endorsed also by the General Assembly in 2000. In hindsight, it is easy to conclude that either these recommendations were not realistic, or the "responsible civil authorities" were not contacted in the right way, or were unable to resist commercial resistance to restrictions. It is harder to translate such insight into advice for the future.

In this first decade, optical and radio observatories were mostly affected by local sources of radiation that could at least in principle be controlled by local or national authorities. The IAU strategy, defined and implemented by

the Commission with the backing of the Executive Committee and the General Assembly, was to investigate conditions at observatories worldwide and to systematise and disseminate the data. Stock was taken and recommendations formulated at General Assemblies, often as Resolutions published officially in the IAU Transactions. Supported by these endorsements, the Commission worked to find solutions to existing or impending local problems through information, education and persuasion, often with notable success.

However, with the 80s, a new class of global threats appeared on the horizon: The 1982 report of Commission 50 (Smith 1982) ends:

> A proposal to place a network of very large solar power collectors in orbit round the Earth (the SPS system) has disastrous implications both for optical and for radio astronomy. If the system under study were eventually to be put into operation, reflected sunlight from the satellites, each of which might have 55 km^2 of solar cells, would remove all possibility of dark sky observations over large portions of the sky (Boyce 1980).
>
> The Commission brings this to the attention of the [IAU] General Assembly.

Such plans, if not yet implemented, remain alive and well: UNISPACE III featured a whole Workshop on (sic!) "Clean and Inexhaustible Space Solar Power" (UN 1999, p. 148). "The Good Old Days" were indeed over for good ...

2.2. Two Decades of Proliferating Problems: A Mounting Struggle

The 1980s and 1990s saw accelerating growth of adverse environmental impacts on astronomy, qualitatively, quantitatively and geographically. At the XIXth General Assembly in Delhi in 1985, G. Swarup reported on "Radio Noise Surveys for India's Giant Meter-Wavelength Radio Telescope". Not even in a developing country was it now obvious that radio quiet areas could be found.

The 1988 Commission report (van den Bergh 1988) lists a number of successful actions by the Commission to prevent or reduce interference from light pollution at a number of observatories worldwide. But the centrepiece of the report is a compact "Litany of Horrors" that merits quotation *in extenso*:

> During the period 1985-1987 activities of the Commission centred on dangers posed to all branches of observational astronomy by light pollution, radio interference and "space junk". A proposal to orbit a ring of satellites to celebrate the centenary of the Eiffel Tower was withdrawn following intense pressure by the French and international astronomical communities. Representations were also made to the US Department of Transportation regarding the environmental impact of the proposed launch of cremated human remains into Earth orbit by the Celestis Corporation of Florida. The proposed launch of huge satellites to convert sunlight into electricity for cities and industries on Earth by the USSR is also a source of grave concern. [...]
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> The principal concern of radio astronomers during this reporting period is related to the transmissions from USSR GLONASS satellites

> interfering with observations of the OH spectral line near 1612 MHz. Reports of serious interference have been received from observatories worldwide. At the latest count (June 1987), nine satellites in this system are transmitting at frequencies in the range 1603.125 - 1614.375 MHz, but the system is still evolving. Periodic monitoring of the system status continues. Written enquiries have been made to Soviet officials to get more information on the system and to try and open a dialogue to mitigate some of the problems. To date these inquiries have not been successful.
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> *[An agreement has since been reached to gradually replace the ageing GLONASS satellites with 'cleaner' successors - from about 2006 ...!]*

The IAU Transactions through the end of the 1990s contain an unbroken string of Resolutions on the environment. The XXth General Assembly in 1988 passed a particularly poignant set: Resolution A2 recalled the long series of previous resolutions and requested action from all in positions of influence, ICSU (now the International Council for Science) in particular; and Resolutions A5-A7 were urgent calls for protection of the most important frequency bands for radio astronomy, in particular those of the OH lines (McNally 1990).

Commission 50 clearly concluded that Resolutions and contacts to local authorities were not effective enough. It decided to organise an international conference on "Light Pollution, Radio Interference, and Space Debris", in Washington, DC, in August 1988, just after the XXth General Assembly. The Executive Committee approved the meeting as IAU Colloquium 112 (Crawford 1991).

The Colloquium marked a shift in strategy in that *(i)* a dedicated IAU conference on the subject was organised for the first time; *(ii)* it was co-sponsored by our sister Unions CIE, COSPAR (the COmmittee on SPAce Research) and URSI (Union de Radio Science Internationale); and *(iii)* proceedings were published which could serve as a comprehensive reference for further initiatives. In all three respects it set a precedent for the future which is still followed. Other books appeared, notably a report by a Study Group of the NATO Committee on the Challenges of Modern Society (Kovalevsky 1992), covering light pollution, radio interference, pollution by satellites, space debris and aircraft, and - an important first - legal avenues for the protection of observatories.

As a further strategic move, Commission 50 and the Executive Committee decided that even debating and publicising the issues together with other Unions was also not having adequate impact. Accordingly, a high-level Conference on "Adverse Environmental Impacts on Astronomy" was organised jointly by UNESCO, ICSU, the IAU, and COSPAR and held at the UNESCO Headquarters in Paris in July 1992. The Proceedings were published in a beautiful volume entitled *"The Vanishing Universe"* (McNally 1994).

This Conference became a landmark, not only by its high profile and the fine book, but also by defining a set of high-level strategic goals and laying out a specific plan for pursuing these. One possible strategic step envisaged was that some major observatories might be given a status similar to the "World Heritage Sites" which enjoy special national and international protection. Another was to create a Working Group on Adverse Environmental Impacts on Astronomy within the ICSU family. Finally, and in retrospect most importantly, the IAU was advised to apply for Permanent Observer status with the UN Committee

on the Peaceful Uses of Outer Space (UN-COPUOS) through which the existing international Space Treaties have been negotiated.

Eventually, the World Heritage Site model proved unsuitable for the problems of astronomy. The ICSU Working Group was created but never given official status or a specific mandate, and it quietly expired in 1997. The IAU did, however, get Permanent Observer status at COPUOS from 1995, a crucial step forward. D. McNally represented the IAU at the Committee and steadily nourished its understanding of and interest in the environmental problems for astronomy until 1998, when the present writer succeeded him.

2.3. Exploding Developments in Space: New Strategy Needed

Regardless of the Paris meeting, a spate of potentially devastating new space projects soon appeared. Already in 1993, Commission 50 reported on the (eventually unsuccessful) test of a 300-square metre solar sail called 'Znamya' ('Banner') from Space Station MIR, intended to illuminate locations on Earth for industry and disaster control (Murdin 1994). A new test in 1999 also failed, but very ambitious plans exist and must be followed with great attention.

Also in 1993, Space Marketing Inc. (Georgia, USA) proposed to launch a "Space Billboard" some 1 kilometre in dimension. Not only would its brightness and size rival the Moon, with obvious consequences for astronomy, but it was estimated that more than 10,000 space debris fragments per day would be created. A similar project was proposed for the 1996 Olympic Games (Isobe 1997).

The most tragi-comical episode of the period was probably the so-called "Star of Tolerance", two very large tethered balloons in low orbit which would be brighter than the brightest planet and beam benevolent messages to nonstop festivities on Earth - all to celebrate the 50th anniversary of UNESCO, the intended sponsor of the project. While veiled in verbose disguises as a humanitarian effort, the project was in reality a space advertising and gadget marketing business. Although appearing only shortly after the 1992 joint meeting, it was apparently given quite serious consideration before being abandoned by UNESCO. It would have been dismaying indeed to see UNESCO championing the commercial pollution of space for raw profit!

These bizarre and potentially damaging projects were, in the end, cancelled after strong protests from the international scientific community, represented by both the IAU and ICSU. With their comical aspects, they still took place in a world where launches were provided exclusively by space agencies under government control, thereby providing some degree of public transparency and accountability.

In the current climate of globalisation, privatisation, and deregulation of business, including the space industry, both these restraints are gone and we should expect neither warning nor means of appeal. Clearly, a proactive defence strategy must be developed, using the channels through which existing rules and treaties have been formulated and negotiated. Thus, while the XXIIIrd General Assembly in Kyoto in 1997 featured yet another general discussion (Isobe & Hirayama 1998), specific marching orders were given in Resolution A1 of the General Assembly, proposed by the Executive Committee (Andersen 1999):

> The XXIIIrd General Assembly of the International Astronomical Union,
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> Considering that
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> proposals have been made repeatedly to place luminous objects in orbit around the earth to carry messages of various kinds and that the implementation of such proposals would have deleterious effects on astronomical observations,
>
> and that
>
> the night sky is the heritage of all mankind, which should therefore be preserved untouched,
>
> Requests the President
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> to take steps with the appropriate authorities to ensure that the night sky receive no less protection than has been given to the World Heritage Sites on Earth.

3. A New Start: COPUOS and UNISPACE III

From this starting point a new strategy had to be developed. To highlight the odds we are up against, recall that the telecommunications industry *alone* plans to launch some 1,700 satellites over the next decade, and forecasts of the total turnover of the space industry in that period hover around 10^{12} US$. The total investment in astronomy in the wildest dreams of astronomers pales by comparison. In a world that hails free market forces as the best (self-)regulatory mechanism, restrictions on activities in space will clearly not be easily accepted.

But if government officials can be convinced that space is *not* "just another place to do business" but a finite, non-renewable resource that could go the way of the rain forests, the unpolluted atmosphere, or the seas unless "environmental impact assessments" and corresponding international norms are extended also to space, we may have a chance. The place to meet these officials is COPUOS.

The most urgent task of the Scientific and Technical Sub-Committee of COPUOS (S&T for short) in early 1998 was the preparation of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), a special meeting of COPUOS open to all UN Member States and Observers. This, on the one hand, meant that little time could be spent elaborating on the environmental concerns of astronomers. But in return, UNISPACE III would offer a unique opportunity to bring these concerns directly to the attention of the major governments of the world through their senior officials in space related matters. Further, everybody was urged to help organise topical satellite meetings and workshops for the UNISPACE III "Technical Forum".

The opportunity to address this audience in a format and with a programme of our own choosing, earning goodwill at the same time, was clearly not to be missed. The cooperation of COSPAR, the UN Office of Outer Space Affairs (OOSA), and the Press would be important to strengthen the message. Accordingly, contacts were made with a few key enthusiasts to form the core of the SOC for this meeting. A programme was drafted, suitably weighted towards the space activities which present the greatest long-term dangers to astronomy

and the most vital need for internationally concerted action, and which were the focus of UNISPACE III itself. I am grateful to Woody Sullivan, Jim Cohen, and the indefatigable Dave Crawford for rising to this challenge at short notice.

The meeting was proposed as a full Symposium and unanimously approved by the Executive Committee as IAU Symposium 196: "Preserving the Astronomical Sky". Co-sponsorship of COSPAR and UN-OOSA as well as URSI, CIE, IDA, and others was obtained and is gratefully appreciated. Two Press Officers, Richard West (ESO) and David Finley (NRAO) were also recruited and greatly helped to enhance the attention given to the meeting.

Another satellite meeting was also held in parallel: a "Special IAU-COSPAR-UN Workshop on Education in Astronomy and Basic Space Science". The Workshop was very valuable in reviewing our educational activities and drawing general lessons from our experience so far. It also discussed possible opportunities for cooperation between the IAU, COSPAR, and the "Regional Educational Centres for Space Science and Technology" being set up under the auspices of the UN. Most of the papers given there are published elsewhere (Isobe 1999; UN 1999, p. 119).

The Workshop was very useful in its own right, but also helped to portray astronomers as people who not only seek to put restrictions on useful space activities, but also care about one of the greatest concerns of most UN Member States, *Education.* Lack of a scientifically trained workforce is one of the greatest impediments to rapid progress in the space applications which governments consider beneficial for their countries. Astronomy - which interests everyone - may help to recruit more young people into space science.

This volume contains the Proceedings of IAU Symposium 196; hopefully it will remain useful for our colleagues in the coming years. But the Symposium also had another task, unique in the IAU context: to produce a set of concise recommendations to UNISPACE III itself, to be considered by the Conference and hopefully included in its recommendations to the UN General Assembly and, when eventually approved there, to the governments of the world.

The recommendations of the Symposium were issued as a separate paper (A/CONF.184/C.1/L.2). The paper is reprinted in this volume (Appendix A) and also in Annex III of the Final Report of UNISPACE III (UN 1999, p. 111). Also noteworthy in the same publication are the papers from the Workshop on Space Debris (p. 130) and not least the Workshop on Space Law in the Twenty-First Century (p. 122), which presents a remarkable set of detailed, legally well-founded, and strongly-worded statements on the need for international "traffic rules" in space in order to preserve the space environment. The vigorous support of our colleagues in the legal field is as gratifying as it was a revelation to at least the present writer.

4. The Final Report of UNISPACE III and the Follow-Up

The work of IAU Symposium 196 formally ends with its recommendations to UNISPACE III and the publication of the present volume. But this is a continuing process and a never-ending battle. Put mildly, not all recommendations in IAU publications have led promptly to visible progress. The Editors have therefore asked me to add a section on what happened after the Symposium.

One recommendation was to set up a Working Group under IAU Commission 50 to address all scientific, practical, educational, and policy aspects of the problem of light pollution. This WG has been established, chaired by Dr. Malcolm Smith, Director of the AURA observatories in Chile, and is addressing its charge with vigour.

Measures to constrain global, long-term adverse developments in space must be approached by a two-step procedure. First, appropriate recommendations should be made by UNISPACE III to create a formal basis for action. Next, these recommendations must give rise to concrete proposals for action that can be considered, and hopefully adopted, by COPUOS and applied by Member States. The following records what was done, but also illustrates the rules and procedures of the UN system.

As a Permanent Observer, the IAU made a brief statement at the opening of UNISPACE III, of course making strong reference to our recommendations. But to have any force the recommendations must be made *by COPUOS itself*, i.e. be included in its Final Report. This is not straightforward: COPUOS works by consensus, which implies that no text which is voted against by any Member State survives in the Report. Lengthy preparations were therefore necessary in COPUOS and its Sub-Committees for UNISPACE III.

Thus, while it was at first mildly puzzling to an astronomer to find a draft of the Report of UNISPACE III at the COPUOS S&T meeting in February 1998 - 17 months before the conference actually began! - it was obvious by the next meeting in February 1999 that negotiations on the substance of the outcome of UNISPACE III were already in full swing, paragraph by paragraph. It was clearly time to try to have the right things said, using the right of Observers to comment while, of course, being unable to vote. However, when our proposals for inserted or modified text became too explicit and insistent we were politely, but firmly, reminded that "observers may express opinions, but not make proposals" - a subtle, but significant distinction.

There were two lessons: *(i)* to progress in the UN system one must work with the national delegates to convince some of them to adopt a proposal (and others to not veto it), and *(ii)* to do that, one must be known in advance, present when needed, and well prepared. This strategy was followed all through the two weeks of UNISPACE III, and while some cherished recommendations were unable to overcome the resistance to placing any barriers on the commercial development of space, others survived in good health. Some even returned through the back door, apparently looking less suspicious when proposed by lawyers ...

The final document of UNISPACE III is called *The Space Millennium: The Vienna Declaration on Space and Human Development*, and is addressed to the governments of the World through the UN General Assembly (UN 1999, p. 1-4). Its preamble refers to astronomy already in its second paragraph and reaffirms the statement in the original UN Space Treaty that,

> "Outer space should be the province of all humankind, to be utilized for peaceful purposes and in the interests of maintaining international peace and security, and in accordance with international law ...".

Its central recommendations form Chapter I.1(c) (**my emphasis** added here):

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"(c) Advancing scientific knowledge of space: action should be taken:

(i) To improve the scientific knowledge of near and outer space by promoting cooperative activities in such areas as astronomy, space biology and medicine, space physics, the study of near-Earth objects and planetary exploration;

(ii) To **improve the protection** of the near-Earth space and outer space environments through further research in **and implementation of** mitigation measures for **space debris**;

(iii) To improve the international coordination of the activities related to near-Earth objects, harmonizing the worldwide efforts directed at identification, follow-up observation and orbit prediction, while at the same time giving consideration to developing a common strategy that would include future activities related to near-Earth objects;

(iv) To protect the near and outer space environments through further research on designs, safety measures and procedures associated with the use of nuclear power sources in outer space.

(v) To ensure that **all users** of space consider the **possible consequences** of their activities, whether ongoing or planned, before **further irreversible actions** are taken affecting future utilization of near-Earth space or outer space, especially in areas such as **astronomy**, Earth observation and remote sensing, as well as global positioning and navigation systems, where **unwanted emissions** have become an issue of concern as they interfere with bands in the electromagnetic spectrum already used for those applications."

We would have preferred stronger and more specific language, but this text in fact recognises that the environment already *is* suffering from the development of space ("*further* irreversible actions"). It also recommends research *and* concrete action against space debris, mentions the need for environmental impact assessments for *all* space activities (even if avoiding the term itself), and mentions the problems for radio astronomy as an international concern. That other disciplines are said to be in danger as well only strengthens our position.

The *Vienna Declaration* has been endorsed by the UN General Assembly and is now UN policy. But the Final Report of UNISPACE III also contains a Chapter II, "Background and Recommendations of the Conference", which was crafted as carefully as the Declaration itself. Paragraphs 57-74 (p. 28-30) deal with astronomy, and via space weather address global climate change. The Chapter then continues with quite graphic descriptions of space debris, satellite flashes, solar reflectors, and space advertising and 'celebrations', and finally recalls that the IAU and COSPAR are strongly opposed to these.

The conclusion is rather meek: "Attention should be given to preserving or restoring astronomical observation conditions to a state as close to natural by any practicable means." Our attempts to strengthen it were in vain, but the tone is clear, and it is followed immediately by the text: "The launch of reflectors for the illumination of parts of the Earth's surface also has a potential negative impact on biological diversity. Research should be undertaken prior to the launch of any such reflectors." Cordial thanks to our biologist allies!

Other key recommendations are in paras. 84-86 (p. 31, **emphasis** added):

> "**84.** It was recommended that:
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> *(a)* The United Nations continue its work on space debris;
>
> *(b)* The **entire** international "space-faring" community be invited to apply debris minimization measures **uniformly and consistently**;
>
> *(c)* Studies be continued on possible solutions to **reduce** the population of in-orbit debris.
>
> **85.** Member states should continue to cooperate, at the national and regional levels and with industry and through the International Telecommunication Union (ITU), to implement suitable regulations to preserve **quiet frequency bands for radio astronomy** and remote sensing from space and to develop, **as a matter of urgency,** practicable technical solutions to **reduce unwanted radio emissions** and other undesirable side effects from telecommunication satellites.
>
> **86.** Member states should cooperate to explore new mechanisms to protect selected regions of Earth and space from radio emissions **(radio quiet zones)** and to develop **innovative techniques** that will optimise the conditions for scientific and other space activities to share the radio spectrum and coexist in space."

The Final Report also makes several valuable recommendations on astronomical matters beyond our present scope.

In all, a gratifying number of IAU recommendations have now become part of the policy of the United Nations for future developments in space. With a view to the future it is especially encouraging that this was achieved through the cooperation of several key national delegations who, despite the natural pressure on them from commercial interests, have understood and recognised our arguments. For, as previous history has abundantly shown, words on paper do not by themselves produce action. For any binding agreements to be even thinkable, the cooperation of these delegations is indispensable.

It is most welcome, therefore, that the legal services of ESA have taken the initiative, at the request of the Member States, to begin formulating coordinated proposals which Member and Cooperating States could, in due course, present to COPUOS. The IAU has been asked, in cooperation with COSPAR and other relevant national and international organizations, to assist in formulating internationally agreed, practicable standards for permissible levels of pollution of all kinds. Our reply has, of course, been prompt and enthusiastic.

5. Epilogue

If one compares our past history with that of other major environmental issues - the pollution of the oceans, loss of the tropical rain forest, or growth of fluorocarbons and greenhouse gases in the atmosphere - the timescales for them to become critical are comparable. It is not surprising that solutions will take correspondingly long to implement, let alone become effective. An optimist might

hope that the well-known environmental calamities on Earth may have sensitized populations and governments to the fact that some mistakes are irreversible or at least take decades to repair. Not even an optimist could delude himself that we are anywhere near that goal yet; but maybe we are at least under way?

As a final remark, the delay in preparing this contribution which allowed me to include a summary of events since the Symposium serves also to illustrate another aspect of the story. The constant close follow-up of all actions which is needed for progress to occur and opportunities such as UNISPACE III not to be missed, is very time-consuming. When added to the other tasks of a volunteer General Secretary, writing about this work as well as actually doing it comes to rely on marginal resources. If a high profile of the Union in the battle for the environment is to be sustainable in the long term, the IAU Executive Committee will need to review the priorities of the IAU for the use of its human resources and eventually implement the necessary organisational adjustments.

Acknowledgments. On behalf of the IAU, I thank all those colleagues who, over the years, have fought the battle for astronomy to where we stand today. These include, in particular, the past Presidents of IAU Commission 50 and the organisers and Press Officers of this Symposium, but also those in other organisations like ICSU, UNESCO, UN-OOSA, URSI, COSPAR, IUCAF, CIE, and more recently, the International Dark-Sky Association (IDA), who have joined forces with us. Special thanks go to former IAU General Secretaries Derek McNally (1988- 91), whose repeated "Technical Presentations" to COPUOS S&T sensitised it to our subsequent specific proposals, and Lubos Perek (1967-70!), whose tireless efforts, inside knowledge of the UN system, and present position as a National Delegate to COPUOS have been invaluable to our recent progress. I am also grateful to the IAU Executive Committee for steadfastly supporting my ventures into the unfamiliar terrain of the United Nations system. My personal thanks are due to Dr. Hans Haubold of UN-OOSA for patiently coaching me - through several iterations - in the noble art of achieving tangible progress in the UN system from an Observer's humble position.

Finally, my thankful apologies to the Editors of this volume for waiting for this chapter with more patience than I would likely have shown in their place.

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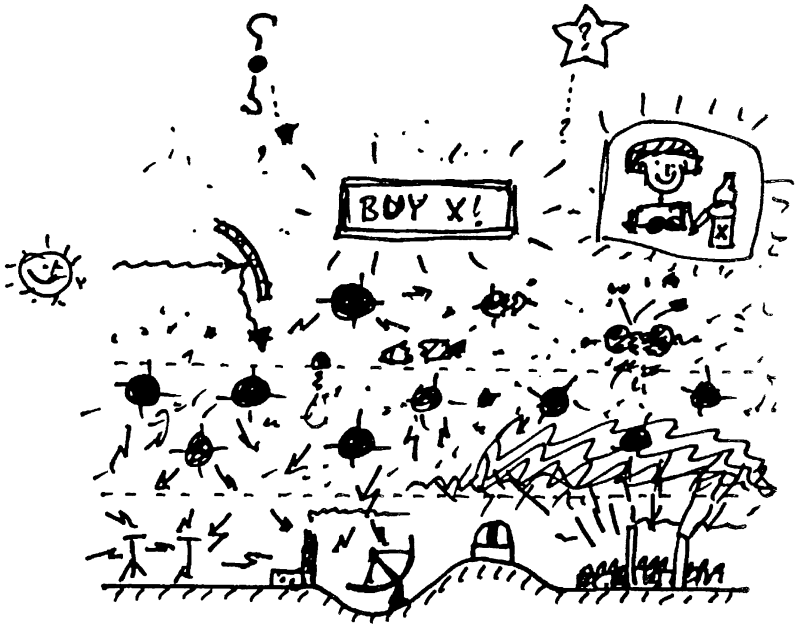

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